Environment

The Manitoba Water Services Board

Spruce Woods Provincial Park Lagoon Replacement - Environment Act Proposal

Prepared by:

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Project Number:

60221902 (405)

Date:

June 2013

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June 10, 2013

Travis Parsons, P.Eng
Chief Engineer
The Manitoba Water Services Board
2022 Currie Blvd.
Brandon, MB R7A 6Y9

Dear Mr. Parsons:

Project No: **60221902 (405)**

Regarding: **Spruce Woods Lagoon Replacement Environment Act Proposal**

We are pleased to submit our final *Environment Act* Proposal for the Spruce Woods Lagoon. If you require any clarification or any additional information please feel free to contact myself or Alison Weiss, P.Eng.

Sincerely,
AECOM Canada Ltd.

J.Eric Hutchison, P.Eng.
Senior Project Manager

AW:td
Encl.

Cc: Parks and Natural Area – Rebecca Lauhn-Jensen

Distribution List

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1	1	The Manitoba Water Services Board
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Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	A. Weiss	May 11, 2011	Draft
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3	A. Weiss	May 27, 2013	Final

AECOM Signatures

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No. 4671 Date: 2013/06/10

Executive Summary

Manitoba Conservation – Parks and Natural Areas (Parks) has authorized The Manitoba Water Services Board (MWSB) to retain AECOM to assess the existing lagoon facility and prepare a preliminary design for lagoon upgrades at the Spruce Woods Provincial Park. As part of this process, AECOM has prepared this *Environment Act* Proposal for the provincial licensing of the proposed facility upgrade.

Kiche Manitou Campground operates seasonally in Spruce Woods Provincial Park from mid-May until mid-October. The Park offers a variety of activities including camping, hiking, swimming, equestrian trails, and snowmobiling trails. Wastewater treatment is provided by an onsite lagoon system that is designed to discharge to the Assiniboine River.

The existing lagoon is located 29.9 km south of Carberry, Manitoba along Provincial Trunk Highway (PTH) 5 and was constructed in 1982 as a two cell lagoon. The ongoing rate of erosion of the nearby Assiniboine River bank is beginning to present cause for concern with respect to the lagoon's integrity. Parks has accordingly determined that the lagoon must be replaced by a lagoon at a new site.

The proposed lagoon replacement project will include the construction of a new two-celled facultative lagoon, new forcemain to the lagoon, new or upgraded lift station and a new outfall to the Assiniboine River within the Spruce Woods Provincial Park. The project will also include the decommissioning of the existing lagoon.

Construction is anticipated to begin in summer of 2014. Clearing and grubbing may be conducted in the spring of 2014, pending the issue of *an Environment Act* Licence. Construction will be conducted in three phases;

- Phase 1 – lagoon construction in the summer of 2014;
- Phase 2 – construction of the lift station and forcemain in the summer of 2015, and
- Phase 3 – decommissioning of the existing lagoon in 2016.

The proposed lagoon construction is anticipated to be complete in the early fall of 2014. Following the successful completion of the new lagoon, the existing lagoon will be decommissioned in the summer of 2015.

An assessment of the potential environmental effects of the project during construction and operation was carried out. Potential environmental effects were identified by superimposing project components onto existing conditions and applying standard mitigation measures. Based on the assessment of available information and documented assumptions, potential residual environmental effects were found to be negligible to minor in magnitude post-mitigation. The proposed project will provide an overall improvement in effluent quality; however, when compared to flow rates in the Assiniboine River the magnitude of the relative effect is considered a negligible improvement in surface water quality.

A terrestrial survey was conducted to determine the potential for impact to sensitive species and to develop mitigation measures to minimize any impact. Depending on the final design of the outfall, a Request for Project Review will be submitted to Fisheries and Oceans Canada for approval in advance of construction of the outfall, if required. A heritage resources impact assessment (HRIA) was completed in the fall 2013, which concluded that there are no concerns with the proposed lagoon location, the lift station or the main line of the outfall. However, the terminus of the outfall was unknown at the time of investigations. Therefore, a heritage assessment of the outfall location is recommended once the exact location is determined during the detailed design phase. During operation, monitoring of effluent quality will be conducted in accordance with *Environment Act* Licence requirements. With the implementation of the mitigation and monitoring programs identified in this environmental assessment, residual effects are assessed to be negligible to minor and reversible.

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1. Introduction

Parks and Natural Areas Branch (Parks), Conservation and Stewardship (Manitoba) has authorized The Manitoba Water Services Board (MWSB) to retain AECOM to assess the existing lagoon and prepare a preliminary design for lagoon upgrades at the Spruce Woods Provincial Park. As part of this process, AECOM has prepared this *Environment Act* Proposal for the provincial licencing of the subject proposed facility. The Kiche Manitou Campground in Spruce Woods Provincial Park operates seasonally from mid-May until mid-October. The Park offers a variety of activities including camping, miniature golf, hiking, swimming, equestrian trails, and snowmobiling trails. Wastewater treatment is provided by an on-site lagoon system that is designed to discharge to the Assiniboine River.

1.1 Background

The Kiche Manitou Campground offers over 200 campsites, including 163 standard campsites, 21 family campsites, 9 group use campsites, and 13 yurts. The campground has a combination of electrical and basic camping opportunities and no full service sites are currently available. Several modern washrooms are located throughout the campground as well as laundry and shower facilities. All waste from these locations is pumped to the wastewater lagoon through a series of lift stations. The Spruce Woods lagoon also accepts waste hauled from holding tanks located throughout the Park; including the equestrian campground, various small cabins and boat launches. The lagoon accepts waste from approximately twenty-seven locations throughout the Park that contain holding tanks. All holding tanks are emptied in the fall and no waste is hauled through the winter months. As well, septage is hauled from several other locations throughout the Park to the lagoon. No external waste haulers are permitted to dump in the Spruce Woods lagoon. In April 2011, a significant flood occurred in the Spruce Woods Provincial Park, flooding the majority of the campground and damaging the existing facilities. Therefore, it was determined that a new lagoon was to be developed, taking into consideration the water elevations of the 2011 flood event.

1.1.1 Existing and Historical Licences

The existing lagoon facility operates under Clean Environment Commission Order No. 942 issued on February 26, 1982. The following limitations/restrictions are included in the Order:

- The lagoon shall be operated in a manner to minimize odours
- The organic loading of the primary cell shall not exceed 56 kg BOD_5/ha/day.
- Effluent limits include:
  - BOD_5 must be less than 30 mg/L
  - fecal coliform content must be less than 200 per 100 mL of sample as indicated by the MPN index
  - total coliform content must be less than 1500 per 100 mL of sample as indicated by the MPN index
- No discharge is permitted between June 15th and May 15th of the following year
- A clay or otherwise suitable liner shall be installed in all interior surfaces of the lagoon. The clay liner must include a minimum of 1 m of soil having a hydraulic conductivity of 10^{-7} cm/s or less.
- Prior to the completion of the construction of the lagoon, the applicant shall notify the Environmental Management Division and shall either; subject 2 soil samples from the lagoon surfaces to hydraulic conductivity tests or test the soil hydraulic conductivity in situ with results being submitted to the Division.

1.2 Project Purpose

The existing lagoon is located 29.9 km south of Carberry, Manitoba along Provincial Trunk Highway (PTH) 5 and was constructed in 1982 as a two cell facultative lagoon. The ongoing rate of erosion of the nearby Assiniboine River bank is beginning to present a cause for concern with respect to lagoon integrity. Park staff report that the discharge pipe had to be cut back approximately 6 m in recent years to compensate for the eroding river bank. According to

Parks, the secondary cell is compromised and leaks. In 2003, an attempt was made to reline the secondary cell but the banks did not hold and use of the secondary cell was completely abandoned. The primary cell holds liquid but has never required discharge in its 28 years in operation, which is evidence that this cell is also leaking. Parks has determined that the lagoon must be relocated to a new site to prevent the potential erosion of the existing lagoon facility by the Assiniboine River. The replacement lagoon will employ a synthetic liner to prevent leakage and therefore provide improved wastewater treatment. The replacement lagoon location will also address flooding concerns highlighted by the 2011 flood.

1.3 Regulatory Process

The Environmental Assessment and Licensing of projects in Manitoba is legislated under *The Environment Act* (the Act) and its subsequent regulations and guidelines. The Act is administered by the Environmental Approvals Branch, Conservation and Water Stewardship, Manitoba. Under the Act, if proposed alterations to a licensed development do not conform to the Licence requirements or are likely to change the environmental effect, approval is required before the alteration can be implemented.

Alterations to a licensed development can be either minor or major. An alteration is considered minor if the potential negative environmental effects resulting from the alteration are insignificant and there is not an alteration to a Licence condition amended by an appeal. If an alteration is not minor, the alteration is considered to be a major alteration and a new proposal is required for approval.

Based on a meeting with Siobhan Burland Ross and Robert Boswick of Conservation and Water Stewardship, Manitoba, on November 18, 2010, it is likely that the proposed alteration will be considered “major” under *The Environment Act*. As such, a new proposal describing the potential environmental impacts of the proposed project is required. Further, the proposal review will result in a new *Environment Act* Licence issued for the facility and the Clean Environment Commission Order will be rescinded.

As per the *Regulations Designating Physical Activities* (SOR/2012-147) under the *Canadian Environmental Assessment Act*, 2012, the proposed project does not trigger a federal environmental assessment.

1.3.1 Environmental Permits and Approvals

The proposed new outfall ditch will require the alteration of the bank of the Assiniboine River. As such, a Request for Project Review will be submitted to Fisheries and Oceans Canada for approval in advance of construction. Depending on the design of the outfall; an application to Transport Canada under the *Navigable Waters Protection Act* may also be required for the proposed project.

1.4 Document Structure

Section 2 of this document provides a description of the proposed project including construction details. Section 3 of this document provides a description of the environment. Section 4 includes a description of the scope of the assessment, while Section 5 describes the resulting potential environmental effects and mitigation measures. Monitoring and follow up programs are discussed in Section 6. Public consultation is summarized in Section 7 with conclusions and recommendations provided in Section 8.

2. Project Description

2.1 Project Location

The Kiche Manitou campground in Spruce Woods Provincial Park is located between Carberry and Glenboro on PTH 5. The existing lagoon is located 29.9 km south of Carberry, Manitoba on the west side of PTH 5 and was constructed in 1982 as a two cell lagoon. The proposed site for the replacement lagoon facility is approximately 2.3 km northeast of the existing lagoon, and lies at the corner of 24-08-14, bounded to the east by the Steele's Ferry Road (78W) and to the south by the Road 45N. The existing and proposed lagoon locations are shown in **Figure 1**. The predesign report completed for the proposed project is included in **Appendix A**. Photographs of the existing lagoon and outfall and the proposed lagoon site are included in **Appendix B.** Due to the rapidly eroding river bank and flooding concerns, the existing lagoon will be decommissioned and a new lagoon is proposed in a site with less risk of damage from the River. The proposed site for the new lagoon is shown in **Figure 2**.

2.1.1 Existing Land Use/Land Use Designation

The proposed site for the new lagoon is situated on agricultural land currently owned by the Province of Manitoba. The site was formerly leased for hay production; however the hay lease was withdrawn in 2012. There are some trees at the northwestern portion of the site. The proposed site is located within the limits of Spruce Woods Provincial Park as shown in **Figure 1.**

2.2 Existing Facilities

The Spruce Woods lagoon was constructed in 1982 as a two cell lagoon. Wastewater is received from the campground, and several hauled locations from within the Park.

The lagoon is located west of PTH 5 near the Parks maintenance compound. The lagoon was constructed as a replacement to a former Smith & Loveless – extended aeration mechanical treatment plant. The treatment plant was located along the banks of the Assiniboine River and was subjected to regular flooding. This, coupled with the progressive deterioration of effluent quality, resulted in the need to create a new wastewater treatment system and the current lagoon was constructed.

When the lagoon was originally constructed, geotechnical investigations found that the silty and poorly graded sand would require installation of an impervious liner. According to Conservation and Water Stewardship records, the lagoon was constructed with a clay liner in both cells.

Since it was constructed, the lagoon has reportedly not been discharged in the 28 years it has been in operation, displaying clear evidence that the primary cell is likely leaking to some degree. The cell does hold water, but was not full during the visual lagoon assessment completed in August of 2010.

The secondary cell is currently not in operation due to severe leaking from this cell. In speaking with the Park operators, it has been determined that when the lagoon was originally constructed, low wastewater flows resulted in the second cell not being used. With inadequate liquid levels in the secondary cell, the clay liner dried out and cracked, destroying the liner integrity. As a result, the secondary cell has never been able to hold liquid. In 2003, an attempt was made to repair this liner by relining it with clay. However, again the liner was not able to remain wet enough to stay sealed and the secondary cell was completely abandoned.

The existing lagoon was designed to discharge through a PVC pipe in the secondary cell into the Assiniboine River to the west of the lagoon. Discharge was scheduled to occur in the spring as per the requirements of the facility's Clean Environment Commission Order. The continually flowing river at this location has resulted in significant

erosion of the bank near the lagoon site, which has reportedly required that the discharge pipe be cut back approximately 6 m on an annual basis in recent years.

2.2.1 Existing and Projected Loadings

2.2.1.1 Existing Flows

The campground has a combination of electrical and basic camping facilities; no full service sites (served by water, sewer and electric lines) are currently available. Several modern washrooms are located throughout the campground as well as laundry and shower facilities. All wastewater from these locations is pumped to the wastewater lagoon through a series of lift stations.

The Spruce Woods lagoon also accepts waste hauled from approximately 27 locations throughout the Park that use holding tanks; including the equestrian campground, various small cabins and boat launches. All holding tanks are emptied in the fall and no waste is hauled through the winter months. As well, septage is hauled from several other locations throughout the Park. No external waste haulers are permitted to dump in the Spruce Woods lagoon.

Campground

The Kiche Manitou Campground is open 7 days a week from May 14th to September 18th for Bays 1 through 7. Bays 8 to 11, the group sites, and the Yurts remain open for approximately 4 additional weeks until October 11th. During the winter, the campground system is shut down and no waste is pumped to the lagoon.

Estimated wastewater flows are divided into type of site, washroom, laundry and shower facilities, and a campground office. From information published on Manitoba Conservation's website, (http://www.gov.mb.ca/conservation/envprograms/wastewater/pdf/mb_min_sewage_vol_july_2010%20xls.pdf) each camper is expected to contribute 110 L of wastewater per day. Additional flow has been anticipated for shower usage. Infiltration was also taken into consideration. **Table 1** summarizes the existing estimated flows.

Table 1: Current Estimated Flow – Kiche Manitou Campground

Flow Components	Number of sites	Number of Units	Daily Volume per unit (L)	Total Daily Flow (L/day)
Sites Open 18 weeks per year				
Bay 1 to Bay 7	121	423.5 people[2]	110[1]	46,585
Laundry Facility[6]		4 machines	1330	5,320
Main & Beach Shower Facility[7]		10 stalls	Showerhead @ 7.5 L/min	25,410
Campground Office[1]		5 People	49	245
Average Day Flow				**77,560**
Annual Flow (18 weeks operation)				**9,772,560 L**
Sites Open 22 weeks per year				
Bay 8 to Bay 9	42	147 people[2]	110	16,170
Yurts	13	45.5 people[3]	110	5,005
Family Use Sites	21	441 people[4]	110	48,510
Group Use Camp Sites	9	315 people[5]	110	34,650
Bay 10 Shower Facility[7]		7 stalls	Showerhead @ 7.5 L/min	56,910
Average Day Flow				**161,245**
Annual Flow (22 weeks operation)				**24,831,730 L**
Total Campground Annual Flow				**34,604,290 L**

Notes:

1. *Campsite Flows – The numbers used in Table 1for daily wastewater flows per full service RV site, and per person for a developed campground are derived from the Manitoba Minimum Expected Volume of Sewage Per Day Typical Wastewater Flow Rates, July 2010, published by Manitoba Conservation (http://www.gov.mb.ca/conservation/envprograms/wastewater/pdf/mb_min_sewage_vol_july_2010%20xls.pdf).*
2. *Calculations are based on a full campground with 3.5 people per Camping unit.*
3. *Calculations are based on a full campground with 3.5 people per Yurt, three new yurts have been added to the 2011 camping Season.*
4. *Family use campsites allow for up to 6 camping units per site. Calculations are based on a full campground with 3.5 people per camping unit.*
5. *Group use campsites allow for up to 10 camping units per site. Calculations are based on a full campground with 3.5 people per camping unit.*
6. *Laundry Facility – There are currently four washing machines operating at a central facility. It is assumed that when the campground is full, each machine is capable of running 7 loads/day at 190 litres per load.*
7. *Shower Facility – Three shower facilities are present in the main campground, 8 stalls in the main shower facility, 2 stalls at the beach, and 7 stalls in Bay 10. A low flow shower head on the market today ranges from 6.0L/min – 9.4 L/min. The shower facilities are assumed to have installed shower heads of 7.5 L/min. Calculations assumed that each campsite occupant showered once a day for 8 minutes.*
8. *SOURCE: AECOM Predesign Report.*

Hauling Locations

The Spruce Woods lagoon accepts waste hauled from approximately twenty-seven locations throughout the Park. Though several of these locations are open year round, the holding tanks are emptied only during the summer and fall. No waste is hauled during the winter months.

The standard holding tank installed can hold a maximum of 5000 L of waste. All tanks that are only pumped out once per year are emptied in the fall after the campground is closed for the season. **Table 2** summarizes the existing estimated flows from the holding tanks.

Table 2: Current Estimated Flow – Spruce Woods Holding Tanks

Holding Tank Locations	Tank Size (L)	Number of pump outs (per yr)	Total Waste (L)
Day Use - Parking Lot Washroom	5000	5	25,000
Bay 9 Washroom	5000	5	25,000
Bay 10 Washroom	5000	20	100,000
Bay 10 "Y" Washroom	5000	26	130,000
Winter Recreation Area	5000	1	5,000
Canoe/Boat Launch	5000	1	5,000
Marsh's Lake	5000	1	5,000
Spirit Sand - Parking Lot	5000	1	5,000
Spirit Sand - 1st Dune	5000	1	5,000
Spirit Sand - Devils' Punch Bowl	5000	1	5,000
Spirit Sand - Trail	5000	1	5,000
Parsons Hill	5000	1	5,000
Yellow Quill Ski Trail - Parking Lot	5000	1	5,000
Yellow Quill Ski Trail - Cabin 2	5000	1	5,000
Seton Ski Trail - Parking Lot	5000	1	5,000
Seton Ski Trail - Cabin 2	5000	1	5,000
Epinette Trail - Parking Lot	5000	1	5,000
Epinette Trail - Cabin 2	5000	1	5,000
Epinette Trail - Cabin 3	5000	1	5,000
Epinette Trail - Cabin 4 (Jackfish)	5000	1	5,000
Equestrian Canoe Landing (2 tanks)	10000	1	10,000
Snowmobile Warming Cabin 1	5000	1	5,000
Snowmobile Warming Cabin 2	5000	1	5,000
Snowmobile Warming Cabin 3	5000	1	5,000
Holland Bridge Wayside	5000	1	5,000
Seton Wayside	5000	1	5,000
Criddle/Vane Heritage Park	5000	1	5,000
Total Annual Flow			**400,000**

Septage Locations

In addition to the campground and holding tanks, there are several sites throughout the Park that truck septage to the lagoon. The following sites deliver septage to the lagoon; flows are detailed in **Table 3**:

1. The Equestrian Campground, which is run by Friends of Spruce Woods, contains 15 campsites and a three-stall shower and washroom facility. All solid waste from this facility is stored in a septic tank, with grey water being discharged through an ejector system. The septage is emptied out only once a year in the fall.
2. The Maintenance Compound also contains three septic tanks with all grey water being disposed of through an ejector system to the existing lagoon. Septage is collected once a year in the fall.
3. The Wagon ride residence also contains a septic tank and ejector system. Septage is collected once a year in the fall.
4. The Bay 10 shower/washroom, Yurt washroom, trailer dump station, main shower/washroom, beach shower facility, and the Day Use – Park Interpretive Centre all contain holding tanks which are connected to the existing sewer system. However, due to the high solids concentrations in these locations, septage is also pumped out of these tanks periodically. Bay 10 shower/washroom facility is pumped out an average of

4 times per year to maintain the flow in the system. The other five locations are pumped out only once a year in the fall.

Table 3: Current Estimated Flow – Spruce Woods Septage

Septage Locations	Amount of Septage Hauled per year (L)
Equestrian Campground	5,000
Maintenance Compound	15,000
Wagon Ride Residence	5,000
Bay 10 Shower/Washroom	20,000
Trailer Dump Station	5,000
Yurt Washroom	5,000
Main Shower/Washroom	5,000
Beach Shower	1,000
Day Use – Park Interpretive Center	5,000
Total Annual Septage	**66,000 L**

Total annual flow to the lagoon is the sum of the flow from the campground, waste hauled from all the individual holding tanks, hauled septage and infiltration. Infiltration has been estimated by the Park to be approximately 100 L/day year round. Annual flows are summarized in **Table 4**.

Table 4: Current Estimated Flow – Total Annual Flows

Unit	Total Annual Flow (L)
Campground	34,604,290
Holding Tanks	400,000
Septage	66,000
Infiltration	36,500
Total Annual Flow	**35,106,790**

2.2.1.2 Future Flows

Campground

Future projected flows will form the basis for the design of the new lagoon. The Spruce Woods operating staff have specified that in the future, a second campground may be created that would truck all waste to the Spruce Woods lagoon. It is expected that this new campground would include approximately 100 standard sites (no full service sites). Further, at most 50 existing campsites may be converted to full-service sites. In addition, one currently decommissioned site will be converted into a Yurt in the future, bringing the total to 14 Yurts in the Park. No other water or wastewater expansions or upgrades are currently planned for the next twenty years. Projected future wastewater flows are outlined in **Table 5**. Full service sites are expected to generate 180 L/site/day additional wastewater above the current estimated flows.

Table 5: Future Projected Flow – Kiche Manitou Campground

Flow Components	Number of sites	Number of Units	Daily Volume per unit (L)	Total Daily Flow (L/day)
Sites Open 18 weeks per year				
Additional Full Service Sites	50	50	180	9,000
Additional New Future Campground	100	350	110	38,500
Bay 1 to Bay 7	121	423.5 people[2]	110[1]	46,585
Laundry Facility[6]		4 machines	1330	5,320
Main & Beach Shower Facility[7]		10 stalls	Showerhead @ 7.5 L/min	46,410
Campground Office[1]		5 People	49	245
Average Day Flow				**146,060**
Annual Flow (18 weeks operation)				**18,403,560 L**
Sites Open 22 weeks per year				
Bay 8 to Bay 9	42	147 people[2]	110	16,170
Yurts (1 additional)	14	49 people[3]	110	5,390
Family Use Sites	21	441 people[4]	110	48,510
Group Use Camp Sites	9	315 people[5]	110	34,650
Bay 10 Shower Facility7		7 stalls	Showerhead @ 7.5 L/min	57,120
Average Day Flow				**161,840**
Annual Flow (22 weeks operation)				**24,923,360 L**
Total Campground Annual Flow				**43,326,920 L**

Notes:

1. *Campsite Flows – The numbers used in Table 1 for daily wastewater flows per full service RV site, and per person for a developed campground are derived from the Manitoba Minimum Expected Volume of Sewage per Day Typical Wastewater Flow Rates, July 2010, published by Manitoba Conservation (http://www.gov.mb.ca/conservation/envprograms/wastewater/pdf/mb_min_sewage_vol_july_2010%20xls.pdf).*
2. *Calculations are based on a full campground with 3.5 people per Camping unit.*
3. *Calculations are based on a full campground with 3.5 people per Yurt, three new yurts have been added to the 2011 camping Season.*
4. *Family use campsites allow for up to 6 camping units per site. Calculations are based on a full campground with 3.5 people per camping unit.*
5. *Group use campsites allow for up to 10 camping units per site. Calculations are based on a full campground with 3.5 people per camping unit.*
6. *Laundry Facility – There are currently four washing machines operating at a central facility. It is assumed that when the campground is full, each machine is capable of running 7loads/day at 190 litres per load.*
7. *Shower Facility – Three shower facilities are present in the main campground, 8 stalls in the main shower facility, 2 stalls at the beach, and 7 stalls in Bay 10. A low flow shower head on the market today ranges from 6.0L/min – 9.4 L/min. The shower facilities are assumed to have installed shower heads of 7.5 L/min. Calculations assumed that each campsite occupant showered once a day for 8 minutes.*
8. *SOURCE: AECOM Predesign Report.*

Holding Tanks

There is no expected expansion of any of the areas currently containing holding tanks; therefore, the annual flow is expected remain consistent at 400,000 L for all holding tanks in the Park.

Septage

There is no expected expansion of the equestrian campground, or other areas currently hauling septage to the lagoon; therefore, the annual flow is expected remain consistent at 66,000 L for all holding tanks in the Park.

Total annual flow to the lagoon is the sum of the flow from the campground, waste hauled from all the individual holding tanks, and infiltration. Infiltration has been estimated by the Park to be approximately 100 L/day year round. Annual flows are summarized in **Table 6**.

Table 6: Future Projected Flow – Total Annual Flows

Unit	Total Flow (L)
Campground	43,326,920
Hold Tanks	400,000
Septage	66,000
Infiltration	36,500
Total Annual Flow	**43,829,420 L**

2.2.2 Design Criteria

Detailed information on the design criteria is provided in the pre-design report in **Appendix A**.

The proposed wastewater lagoon was sized to treat the projected organic and hydraulic wastewater loads. Organic loading is estimated based on a design population of 3.5 people per camping unit over the next 20 yrs (1,731 people discharging to the lagoon).

To account for the seasonal fluctuations in population throughout the year, the design was based on the average population for the busiest 6 months of the year. Conservation and Water Stewardship guidelines limit the amount of organic loading to 56 kg BOD/ha/day, using an influent BOD loading rate of 0.076 kg BOD/person/day.

Table 7 illustrates the population distribution and BOD load throughout the year.

Table 7: Monthly BOD Load

Month	Campground[1]		Holding Tanks[2]		Septage[3]		Total
	Population	BOD (kg/d)	Population	BOD (kg/d)	(L)	BOD (kg/d)	BOD (kg/d)
Jan	0	0	0	0	0	0	0.00
Feb	0	0	0	0	0	0	0.00
March	0	0	0	0	0	0	0.00
April	0	0	0	0	0	0	0.00
May	1,731	129.78	56000	1.213333	4000	0.933333	131.93
June	1,731	129.78	56000	1.213333	4000	0.933333	131.93
July	1,731	129.78	56000	1.213333	4000	0.933333	131.93
August	1,731	129.78	56000	1.213333	4000	0.933333	131.93
Sept	1,731	129.78	176,000	3.813333	50,000	11.66667	145.27
Oct	957	71.78	0	0	0	0	71.78
Nov	0	0	0	0	0	0	0.00
Dec	0	0	0	0	0	0	0.00
Average Daily BOD load from May to October (kg/d)							**124.13**

Notes:

1. *Campsite Population – Based on a completely full campground with 3.5 people per site from mid-May to October. Closing dates differ throughout the campground; Bay 1 through Bay 7 close on September 19th and Bay 8-11 and the Yurts close on October 11th.*
2. *Holding Tanks – Day use parking lot, Bay 9 washroom, Bay 10 washroom and Bay 10 "Y" washroom are emptied several times throughout the summer, the total flow from each of these locations was averaged over the 5 total months of operation. The remaining holding tanks are only emptied in September.*
3. *Septage –.Bay 10 shower/washroom facility is emptied several times throughout the summer; the total flow from this locations is averaged over the 5 total months of operation. The remaining septage locations are only emptied in September.*

The surface area required for treatment in the primary cell is provided in **Table 8.**

Table 8: Organic Loading

Surface Area Calculations		
Average Daily BOD load from April to September	124.13	kg/day
Loading (Provincial Requirement)	56	kg BOD/ha/day
Required surface area (Average Daily BOD / Loading)	2.2	ha

From these calculations, it is evident that the primary cell will require a surface area of 2.2 ha.

Using a liquid depth of 1.5 m, freeboard of 1 m, and a dike slope of 4:1, the primary cell size is:

Volume (entire cell)	30,690 m^3
Storage Volume (bottom 0.75 m of cell)	14,700 m^3
Surface area (not including 1 m freeboard)	22,200 m^2

The secondary cell is used for hydraulic storage and some ammonia reduction. With only one discharge per year, 365 days of storage capacity will be required. The volume required for the secondary cell is (using a 1.5 m depth and dike slopes of 4:1):

Sludge Blanket Volume (volume below the pipes)	6,732 m^3
Storage Volume	29,129 m^3
Total Volume of the Secondary Cell	35,861 m^3
Surface Area (not including 1 m freeboard)	25,797 m^2

2.2.2.1 Lagoon Construction Components

The proposed lagoon will use a geosynthetic liner to protect groundwater resources. A 60 mil HDPE liner will be installed on a 150 mm thick layer of compacted bedding sand. The bedding sand layer will be placed over a 300 mm thick granular dewatering and degassing system. Clean crushed limestone of 50 mm maximum size will be used for the drainage layer. Geotextile will be used at the bottom and top of the drainage layer to provide separation and filtration. A protective sand layer at least 150 mm thick (or as recommended by the manufacturer) will be placed over the liner. The exterior and interior dikes will each have a 4:1 slope and rip-rap will be required on the interior dike slopes to protect against erosion.

A dewatering and degassing system will be installed under the lagoon liner to allow for release of groundwater seepage and gas that might accumulate under the liner. The dewatering and degassing system will be similar to a weeping tile system. Perforated pipes will be installed below the liner system and will drain to a single header. The header will drain to a manhole that will empty to a perimeter drainage ditch. The dewatering/degassing pipelines will also be connected to risers to release gas. The risers will be installed in the internal dikes of the lagoon cells. Based on piezometer readings taken at the site in August of 2010, it is anticipated that the groundwater level will be within 1 m of the bottom of the dewatering/degassing system.

Perimeter ditching will be incorporated on the north and west sides of the lagoon to collect and direct surface water away from the lagoon dikes in order to prevent the stability of the dikes from being weakened by excess moisture in the fill. The site is relatively flat with the highest point being located in the northwest corner of the lagoon. This allows for drainage along the north side of the lagoon to flow through a drainage ditch into the existing ditch along Steel's Ferry Road. The west side of the lagoon will also drain through a drainage ditch into the existing ditch along Road 45N to the south of the lagoon.

A chain link fence will be located 1.0 m from the toe of the dike, surrounding the entire lagoon.

2.2.2.2 Nutrient Loading

Alum dosing will be implemented for phosphorus removal in the lagoon. While phosphorus removal is not a current licence requirement of the lagoon, it was deemed a requirement by the Parks department.

The addition of alum for phosphorus treatment will result in an increased sludge volume in the lagoon, which will necessitate more frequent sludge removal events (approximately every 5 years) to maintain operational efficiency. It is anticipated that the sludge will either be dewatered and land-filled at the City of Brandon Landfill or be applied to agricultural land. In the event that sludge will be applied to agricultural land, a separate *Environment Act* Proposal will be submitted for the land application event, if required.

2.2.2.3 Lift Station and Forcemain

The existing lift station will require a detailed assessment to assess its overall condition, including ability of the pump to transfer waste to the new lagoon site. The existing lift station uses duplex 3.5 Hp submersible pumps to transfer wastewater approximately 800 m through a 75 mm (3") forcemain to a manhole on the east side of PTH 5, where it flows by gravity to the lagoon on the west side of the highway. The new lagoon, located approximately 1,800 m north east with an approximate elevation change of 41 m from the existing main lift station, will require a new forcemain and larger pumps.

Preliminary calculations show that a new 150 mm (6") forcemain (approximately 16 km in length) and duplex 17.2 kW (23 Hp) pumps will be required to transfer waste from the existing lift station to the new lagoon.

For the purposes of the assessment, it is assumed that a new forcemain will be installed from the lift station to the proposed lagoon as shown in **Figure 2** by open trench method. An upgrade to this lift station is also anticipated.

2.2.2.4 Discharge Route

Treated effluent from the lagoon will be discharged once a year to the Assiniboine River through a new outfall. An underground discharge pipe will extend north along Steele's Ferry Road, east of the lagoon and run approximately 1.8 km in a riprap erosion controlled discharge ditch to the Assiniboine River, allowing for any river bank changes, without damaging the discharge pipe. The discharge pipe will be installed using directional drilling. The design of the outfall ditch will be completed in the detailed design phase.

2.2.2.5 Truck Dump

A truck dump for hauled waste will be located west of the primary cell. It will consist of a 30 m x 16 m gravel pad. A 3.0 m wide curb and concrete swale will direct the sewage into the lagoon. The lagoon fence will transition from the toe of slope to the top of slope in this area. A gate with steel bars will be constructed to allow sewage to pass through without requiring the gate to be opened. The truck dump will accept holding tank waste and septage from holding tanks and ejector systems throughout the Park.

2.2.3 Discharge Timing and Anticipated Quality

The current CEC order (No. 942) states that the lagoon may only discharge between May 15th and June 15th. However, due to the occurrence of a variety of recreational activities downstream of the discharge location, it is proposed that discharge will occur in fall (likely mid-October) every year. On an annual basis, a maximum of 43,829 m^3 will be discharged to the Assiniboine River. The effluent pipeline will have a valve to adjust the flow rate discharged. It is anticipated that the flow will be discharged over 5 to 6 days at an approximate flow rate of 0.08 m^3/s, or at 0.04 m^3/s over approximately 2 weeks, depending on the exact date of the park closure.

The discharge limits anticipated in the *Environment Act* Licence for the proposed facility are:

- 5 day Carbonaceous Biochemical Oxygen Demand (CBOD5) = 25 mg/L
- Total Suspended Solids (TSS) = 25 mg/L
- Total Phosphorus = 1 mg/L
- Total Coliforms = 1500/100 mL sample
- Fecal Coliforms = 200/100 mL sample

The proposed lagoon has been designed to provide effluent quality meeting these limits. It is estimated that the effluent pH will range from 7 to 9. It is not anticipated that the new *Environment Act* Licence will contain limits on nitrogen. Based on engineering estimates, it is anticipated that at the time of discharge (in mid-October every year) the effluent will contain approximately:

- 10 mg/L ammonia
- 5 mg/L organic nitrogen
- 1 mg/L nitrates
- 15 mg/L total Kjeldahl nitrogen

2.2.4 Maintenance Activities

Maintenance at the lagoon site will include the following:

- Maintaining fence
- Maintaining valves
- Maintain even grass cover on dikes, and mow so that growth is less than 0.3 m in height.
- Remove all reeds, rushes and trees within the lagoon and on the dikes to below the low water line.
- Maintain discharge route and pipe to allow proper drainage.
- Maintain a program to prevent and remove burrowing animals.
- Maintain access road to lagoons.

- Conduct sampling and confirm that effluent quality meets license limits prior to discharge of the secondary lagoon to the Assiniboine River.
- Dosing alum into the secondary cell annually prior to discharge.

2.2.5 Decommissioning

Existing Lagoon: Decommissioning of the existing lagoon will be required upon completion of construction of the new lagoon. Decommissioning will involve dewatering the lagoon and disposing of the sludge remaining in the cell. Sewage sludge may be a solid, semi-solid or liquid residue that settles to the bottom of the wastewater lagoon during treatment. It consists of approximately 90-99% water and an accumulation of settleable solids. Sludge also contains significant amounts of nitrogen and phosphorus and to a lesser degree some quantities of heavy metals such as zinc and copper.

Dewatering will be done using Geo Bags. Additional information on the Geo Bags is provided in **Appendix A**. Once the sludge has sufficiently dewatered, a slump test will be conducted to ensure the sludge meets the criteria for disposal at Brandon Landfill. Following confirmation, sludge will be trucked to Brandon for disposal.

The water that seeps through the Geo Bags will be tested for compliance with CEC Order discharge limits and will be discharged to the Assiniboine River. If the water does not meet effluent limits, it will be pumped out and trucked to the primary cell for treatment at the new (proposed) lagoon.

The interconnecting pipes in the existing lagoon will be decommissioned and removed with the lagoon decommissioning.

The existing forcemain from the main lift station to Hwy 5 will be capped and sealed off. The existing gravity pipe from PTH 5 to the existing lagoon will also be capped and sealed but left in place. The manhole located next to PTH 5 will also be decommissioned.

Once the sludge is removed from the lagoon, the dikes will be leveled and the site will be regraded for drainage. The existing clay liner will be left in place. The site will likely be reseeded with grass however re-vegetation plans will be at the discretion of Parks and could include the addition of trees or other native species.

Decommissioning of the existing outfall will be determined in the detailed design stage.

Proposed Lagoon: The proposed lagoon is anticipated to operate well into the future and as such, no specific decommissioning plan is in place for the proposed lagoon. It is anticipated that the proposed lagoon would be decommissioned in a similar manner as the existing lagoon. At the time of decommissioning, a decommissioning plan will be developed for the work in consultation with regulators.

2.3 Project Alternatives

A total of five potential sites were considered for the construction of the new facility, as shown in **Figure 3**.

2.3.1 Site 1

Site 1 (see **Figures 3** and **3A**) is located approximately 1,200 m southeast of the existing lagoon facility on the east side of PTH 5. Geotechnical investigations at Site #1 indicated that the area was very wet and surrounded by dense vegetation. The soil conditions were found to be mainly sand with variable silt and gravel content.

Groundwater levels at Site 1 range from 0.98 to 2.99 m below ground surface. Excavation of the lagoon basin at this site may result in excess seepage, and hydrostatic uplift pressures may damage the liner once constructed.

Therefore, groundwater conditions at Site 1 were considered unsuitable for construction of a wastewater treatment lagoon.

2.3.2 Site 2

Initial geotechnical investigations at Site 2 (see **Figures 3** and **3A**) in August 2010 found soil that had a primary sand stratum with variable silt content, which in turn was underlain by clay till or gravel till. Groundwater levels at the site ranged from 2.19 to 3.44 m below the ground surface. The primary sand stratum at the site is considered suitable for construction of exterior dikes. However, the hydraulic conductivity is sufficiently high that a lagoon excavated into these soils will require a compacted clay or synthetic liner. As there was no significant quantity of clay encountered, a synthetic liner may be a more viable option. Based on the preliminary investigations, Site 2 was determined as a feasible option for the construction of a new wastewater treatment lagoon. However, in the summer of 2011, significant flooding occurred in the area. Based on the water elevation during the flood and the proposed dike elevations of the new lagoon it was concluded that Site 2 could potentially flood during future flood events, and was hence considered unsuitable for the proposed lagoon.

2.3.3 Site 3

Site 3 is located in the northeast corner of the campground along the banks of the Assiniboine River, on top of an elevated flood plain between an outside bend in the Assiniboine River (to the west) and the main valley slope (to the east) as shown in **Figures 3** and **3A**. Slope stability is a major concern at this location (both up slope and down slope).

Further geotechnical investigations of the river bank slope stability, surveys of the river bottom and the slope stability of the hill to the east of the site would be required prior to any potential construction at this site. Further, due to the location, on the outside bend of the River, this location could be at risk due to erosion from the River at some point in the future. Therefore, given the significant amount of geotechnical work required and potential slope stability risks, Site 3 was considered unsuitable for the proposed lagoon.

2.3.4 Site 4

Site 4 is located near the eastern entrance to the Kiche Maitou campground as shown in **Figures 3** and **3A**. This site is located on flat ground that is currently leased to a local farmer and used as agricultural land. Slope stability is not anticipated to be a concern at this location. The elevation at this site is well above the 2011 flood levels, approximately 40 m above the elevation of the existing lagoon site.

The sand stratum primarily encountered during the geotechnical investigated is considered suitable material for the construction of exterior dikes. However, the hydraulic conductivity is sufficiently high that a lagoon excavated into these soils will require a compacted clay or synthetic liner. As there was no significant quantity of clay encountered in the area, a synthetic liner would be used. Based on the preliminary investigations, Site 4 was determined as a feasible option for the construction of a new wastewater treatment lagoon.

2.3.5 Site 5

In an attempt to look at potential sites further away from local residences Site 5 as shown in **Figures 3** and **3A** was considered briefly as it was felt to be at a slightly higher elevation than Site 2. However, a more detailed look at this site revealed that the ground elevation was less than 2 m higher than the elevation at Site 2 and was still lower than the 2011 high water elevation. As a result, the site did not provide significant advantage and was not considered suitable.

2.3.6 Selected Site

Following above-noted investigations at five potential sites, Site 4 was selected as the proposed location for the new lagoon. **Figures 3B** and **3C** provide plan section and 3D views of the proposed lagoon site.

2.4 Project Schedule

Construction is anticipated to begin in May 2014, with clearing and grubbing pending the issuance of an *Environment Act Licence*. The proposed lagoon construction is anticipated to be completed in three phases;

Phase 1: Construction of the lagoon and outfall to be completed by the fall of 2014

Phase 2: Construction of the lift station and forcemain, summer 2015

Phase 3: Decommissioning of the existing lagoon, summer 2016

Following the successful completion of phases 1 and 2, it is anticipated that the existing lagoon will be decommissioned as phase 3 of the project in the summer of 2016.

2.5 Project Funding

Project funding will be provided through the Parks and Natural Areas Branch, Conservation and Water Stewardship (Manitoba).

3. Description of the Environment

3.1 Scope of Description

The environment described in the following sections includes a general description of the Spruce Woods area. Where a detailed description of the physical environment is included, the description is limited to the proposed lagoon site.

3.2 Project Setting

The location of the proposed lagoon site, forcemain and outfall is shown in **Figure 2**. The site lies within the Prairies Ecozone within the Aspen Parkland Ecoregion.

The existing lagoon site is located on the southern portion of 14-08-14 WPM located approximately 29.9 km south of Carberry, Manitoba. The proposed site for the replacement lagoon facility is approximately 2.3 km northeast of the existing lagoon. Steele's Ferry Road (or 78W) lies to the east of the proposed site and Road 45N lies to the south. **Appendix B** includes site photos of the existing lagoon and the proposed site for the new lagoon.

3.3 Physical Environment

3.3.1 Land

3.3.1.1 Topography

The topography of the Project Area varies from approximately 320 m above sea level (masl) along the Assiniboine River at the existing lagoon site to 360 masl near the proposed lagoon site. (Natural Resources Canada 2011 (accessed)

3.3.1.2 Soils

Manitoba Conservation and Water Stewardship determined that according to the South Cypress soils map, soils within the footprint of the proposed lagoon include the Wellwood and Shilox soils. Wellwood soils have an Agriculture Capability rating of Class 1. Under the Nutrient Management Regulation, Class 1 soils are considered rank N1 soils with no restrictions for lagoon development. The Shilox soils however have an Agriculture Capability rating of Class 6M. Under the Nutrient Management Regulation, Class 6M soils are ranked N4 and lagoon development is prohibited.

As such, a soil survey was conducted in fall of 2012 to confirm the soil classes at the proposed lagoon location. Six soil samples were collected throughout the proposed lagoon area for soil characterization. **Table 9** summarizes the findings, and the complete report is included in **Appendix C**.

Table 9: Nutrient Management Soil Classification

Sample Number	Ag Capability Ranking	Nutrient Management Regulation Ranking
Sample 1	3M	N2
Sample 2	5M	N2
Sample 3	5M	N2
Sample 4	5M	N2
Sample 5	2T	N1
Sample 6	2T	N1

As shown in **Table 9**, soil samples were ranked as either 3M, or 5M or 2T. Soils ranked as 2T are classified as highly productive lands and relatively low risk of nitrogen loss to ground water and a high risk of phosphorus and nitrogen loss to surface water. 3M and 5M soils are considered moderately productive solis and limited risk of nitrogen loss to ground and surface water. All of these soil types fall into the Nutrient Management Regulation as N1 and N2, which do not prohibit lagoon development under the Nutrient Management Regulation.

3.3.1.3 Geology

The Project Area is located in the Prairies Ecozone. The Prairies Ecozone is underlain primarily by Cretaceous shales and flat-lying Paleozoic limestone in eastern Manitoba. (Smith et al, 1998)

3.3.2 Water

3.3.2.1 Surface Water

The existing lagoon is designed to discharge to the Assiniboine River. The proposed lagoon will also discharge to the Assiniboine River. The proposed Project Site is northeast of an oxbow cutoff of the Assiniboine River called Kiche Manitou Lake that is used as a beach for the campground. The Park's canoe and boat launches are both located on the Assiniboine River upstream of the proposed discharge location.

Flood risk maps are not available for the general area around the Project Site. Additionally, 100-year flood levels have not been determined for the Assiniboine River in the reach from Brandon to Portage la Prairie. (personal communication, B. Allum, Manitoba Water Stewardship, March 14, 2011). The existing lagoon top of dike elevation is 322.3 masl. According to Parks, in the history of operation of the existing lagoon, it has never been overtopped by flood waters. **Figure 3A** prepared by Parks shows a floodplain in the area of the existing lagoon.

Water samples are routinely collected (approximately on a monthly basis) by Manitoba Water Stewardship along numerous waterways throughout the Province. In the following table, water quality data collected at PR 340 (station MB05MHS006) upstream of Project Area between 2000 and 2010 is summarized to provide an overview of water quality in the Project Area. The Souris River, which joins the Assiniboine River between PR 340 and the Project Site, has some influence on water quality not accounted for in **Table 10**.

Table 10: Average Surface Water Physicochemical Properties in the Assiniboine River upstream of Treesbank (2000-2010)

	Treesbank
Conductivity at 25°C (µS/cm)	935
pH	8.1
Total Kjeldahl Nitrogen (mg/L)	1.4
Total Phosphorous (mg/L)	0.2
Dissolved Oxygen (mg/L)	8.4
Total Suspended Solids (mg/L)	56.8
Dissolved Ammonia (mg/L)	0.2
Dissolved Nitrate/Nitrate (mg/L)	0.5
Dissolved Phosphorus (mg/L)	0.1

Source: *Provincial water quality data Manitoba Water Stewardship (2011)*

Note: *where concentrations were reported as less than the detection limit, half of the detection limit was used to determine the average.*

Historic flow data for the Assiniboine River was examined to characterize flow near the proposed discharge point. Flow data for the Assiniboine River at Brandon and near Holland is presented in **Table 11**. Flows at Holland best characterize those at the Project Site, downstream of the Souris River.

Table 11: Historic Flow Data for Assiniboine River at Brandon and near Holland, Manitoba

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Daily Average Flow Assiniboine River at Brandon 1974-2009 (m^3/s) Note 1												
	16.6	16.6	24.0	99.8	91.1	57.8	41.8	24.9	17.5	17.7	19.6	17.2
Daily Average Flow Assiniboine River near Holland 1961-2009 (m^3/s) Note 2												
	19.9	19.2	29.2	162.0	154.4	94.2	61.8	34.8	23.8	23.9	25.2	21.0

Notes:

1. *Flow from 1974-2009 continuous recording. Station 05 MH013 (Environment Canada HYDAT, 2010a).*
2. *Flow from 1961-1966 recorded seasonally, 1967 to 2009 continuous recording. Station 05MH005. (Environment Canada HYDAT, 2010a).*

Significant withdrawals of water from the Assiniboine River from Brandon to Portage la Prairie consist primarily of municipal supplies and irrigation. Municipal withdrawals take place at Brandon, Portage la Prairie, and the R.M. of Cartier year round for their primary water supply. Over the summer months, during the growing season, numerous licensed irrigation users withdraw water from the Assiniboine River.

3.3.2.2 Groundwater

The Project Area is located within the limits of the Assiniboine Delta Aquifer; an extensive sand and gravel aquifer in southwestern Manitoba. The aquifer has an average saturated thickness of 13.7 m (45 ft). The depth to the aquifer from the ground surface ranges from 0 to 21.3 m (70 ft) below the ground surface. The aquifer is unconfined and is recharged by precipitation. Domestic, farm, irrigation and industrial water uses are licensed for withdrawal from the Assiniboine Delta Aquifer. The estimated aquifer storage capacity is 15,000,000 dam^3. The coarse soils overlying the aquifer make it highly susceptible to contamination. Water quality monitoring in the aquifer to date; however, has indicated that aquifer water quality is considered to be good to excellent. Some concerns exist where nitrate levels are becoming higher than baseline levels. (Assiniboine Delta Aquifer Round Table, 2005)

According to a groundwater pollution hazard areas map prepared for the area within the Cypress Planning District, almost the entire planning district is considered a high groundwater pollution hazard area, including the Spruce Woods Provincial Park. Based on topographic and subsurface features, groundwater in the general Project Area flows in a westerly or northwesterly direction towards the Assiniboine River. (Rutulis, 1978)

A search using the 2009 Manitoba Conservation groundwater well database (GWDRILL) was completed to determine the registered wells within a 1.6 km radius of the proposed lagoon site. The search found a total of 47 registered wells. Of the 47 wells, 34 wells were registered as test wells, one (1) was registered as an observation well and 12 were registered as production wells. One (1) of the production wells was registered for other water use, two (2) production wells were registered for domestic water use, two (2) production wells were registered for domestic and livestock water use, three (3) production wells were registered for livestock water use and four (4) production wells were registered for municipal water use.

According to the well logs, the production wells extract groundwater from 5.0 m (16.5 ft) to 35.9 m (117.9 ft) below the ground surface. The closest two (2) wells to the proposed lagoon site are located to the north of the lagoon site in SE 24-08-14W. Both of these test wells were reported to be located near the Group Use and Slide Rink Area. According to these well logs, the soil stratigraphy consists of layers of sands and clays with some layers of silt. In one of the well logs, the soil stratigraphy consisted of layers of very fine to medium sand from surface to 19.8 m (65.0 ft) below the ground surface. The second well's soil stratigraphy was more stratified, consisting of a surficial layer of silt and clay to a depth of 1.5 m (5 ft) below ground surface, followed by a layer of sand to a depth of 1.8 m

(6 ft) and layers of light grey and yellow clay to a depth of 2.7 m (9 ft) below ground surface. Sand layers, ranging from very fine to coarse and silt were found beneath the yellow clay to a depth of 23.2 m (76.0 ft) below ground surface with a 0.15 m (0.5 ft) layer of clay found at a depth of 11.1 m (36.5 ft) below ground surface. These test wells extract groundwater from approximately 23.2 m (76.0 ft) below the ground surface.

3.3.3 Climate

The climate in the Aspen Parkland Ecoregion is characterized by short, warm summers and long, cold winters. The mean annual temperature ranges from 1.2 to 2.8°C with an average growing season of 173 to 183 growing days. The mean annual precipitation for the ecoregion is approximately 440 to 530 mm and is highest in the growing season. The average yearly soil moisture deficit ranges from 140 to 300 mm. (Smith et al., 1998)

The Glenboro meteorological station measures temperature and precipitation and is the closest weather station (approximately 10 km southwest of the proposed lagoon site), with available historic data, to the proposed lagoon site. **Table 12** shows the monthly temperature and precipitation over the normal year. **Table 13** shows other relevant weather parameters for Glenboro.

Table 12: Mean Monthly Temperatures and Precipitation – Glenboro (1971-2000)
Latitude 49°34'N, Longitude 99°20'W, Elevation 371.9 m

Month	Temperature (°C)	Precipitation (mm)
January	-16.6	19.1
February	-13	15.5
March	-5.7	21.7
April	4.4	36
May	12.3	55.9
June	16.9	75.9
July	19.2	76.8
August	18	70.2
September	12	51.3
October	5.4	33.3
November	-4.9	17.6
December	-14.2	17.8
Annual	2.8	491

Source: *Environment Canada, 2011b*

Table 13: Other Weather Parameters for Glenboro, Manitoba

Parameter	Value
Extreme Maximum Temperature (°C)	39.5 (Aug 4, 1983)
Extreme Minimum Temperature (°C)	-42.8 (Feb. 16, 1979)
Extreme Daily Rainfall (mm)	160.8 (Aug 23, 1981)
Extreme Daily Snowfall (cm)	26.7 (Nov 28, 1975)

Note:

Data obtained from Environment Canada Glenboro meteorological station (2011b).

The Brandon airport meteorological station (approximately 57 km northwest of the proposed lagoon site) is the closest weather station with historic wind data. **Table 14** shows the most frequent wind direction and average wind speed over the normal year.

Table 14: Mean Wind Speed and Direction – Brandon Airport (1971-2000)
Latitude 49°54'N, Longitude 99°57'W, Elevation 409.4 m

Month	Wind Speed (km/h)	Direction
January	15.6	W
February	15.2	W
March	15.5	W
April	16.5	NE
May	16.8	NE
June	15.3	W
July	12.8	W
August	13.1	W
September	15.1	W
October	15.6	W
November	14.9	W
December	15.5	W
Annual	15.2	W

Source: *Environment Canada, 2011a*

3.4 Biological Environment

3.4.1 Flora

The native vegetation of the Aspen Parkland Ecoregion includes trembling aspen and shrubs on moist sites whereas bur oak and grassland communities are encountered on drier sites. Dominant grasses encountered in the Ecoregion include fescues, wheat grasses, June grass and Kentucky bluegrass. (Smith et al. 1998) Vegetation at the existing lagoon site is a mix of trees, shrubs and mowed grass.

Based on a site visit conducted in July 2012 by a regional wildlife biologist from Conservation and Water Stewardship, vegetation along the proposed forcemain includes trees and shrubs. At the new lagoon location, vegetation consists of tame hayland and was likely smooth brome and alfalfa. The proposed outfall route included some native prairie.

3.4.2 Fauna

Wildlife in the Aspen Parkland Ecoregion has been significantly affected by agricultural development including grassland and wetland habitat loss. Wapiti (elk) are found in the Spruce Woods area. Pronghorn antelope are sighted very rarely in the region. Common species to the region include; white-tailed deer, coyote, red fox, ground squirrel, cottontail rabbit, hare, striped skunk, redback vole and deer mice. Bird species include various raptors such as ferruginous hawk, sparrow hawk and red-tailed hawk. Other birds in the region include; mourning dove, black-billed magpie, red-winged blackbird, killdeer, meadowlark and various ducks. Common amphibians in the Ecoregion include red-sided and western plains garter snakes and various frogs. (Smith et al. 1998)

3.4.3 Aquatic Resources

The Assiniboine River provides diverse habitat for aquatic biota. Habitat ranges from swiftly flowing water in glides and riffles to quiet pools, shallows and back eddies along shores and in the lee of islands. Bottom substrate ranges from mud/silt to cobble and boulder. Downstream of Brandon, the river is dominated by cobble substrate and a riffle-pool morphology as far downstream as the Spruce Woods area, which is a transition zone between the steeper gradient of the upstream reach and the Red River Valley. The riverbed in the Spruce Woods area is dominated by

clean sand, while habitats farther downstream are more homogenous, with lower current velocities and finer substrata. Whereas a number of tributaries exist within and upstream of Spruce Woods Park, tributary habitats farther downstream are minimal.

The diversity of habitat provided by the Assiniboine River is reflected by the diversity of fish species found in the river. Due to the diversity of habitats within the river mainstream and the limited tributary habitat available, most species present in the Assiniboine River are able to undergo their entire life cycles within the river mainstream. Some species, such as golden shiner, blackchin shiner, weed shiner, and brook stickleback are predominantly found in oxbow lakes. The common carp is abundant in the area, but other non-native species do not yet exist upstream of the Portage Dam. Lake sturgeon were historically found in the Assiniboine River, but were extirpated in the early 1900's. The Manitoba Department of Natural Resources, Fisheries Branch and the University of Manitoba have been successfully re-introducing lake sturgeon into the Assiniboine River at Brandon since 1996.

The majority of fish found in the Assiniboine River are considered “cool water” species, which are tolerant of water temperatures typically found in southern Manitoba during the summer months (20°C to 28°C). Lake Whitefish and Lake Cisco are considered to be “cold water” species, but are primarily found in lakes in the Qu’Appelle River watershed and are rarely captured in the Assiniboine River mainstream.

Toews and Schneider-Vieira (1999) conducted a fisheries assessment of the Assiniboine River near Brandon in the fall of 1998. A total of 17 fish species were observed during the electrofishing survey: the most commonly captured species were shorthead redhorse (56.1%) and white sucker (7%); other species captured, in order of abundance were, silver redhorse, sauger, walleye, quillback, and common carp.

The Assiniboine River supports a locally popular recreational fishery in locations that permit access. Subsistence and commercial fisheries do not exist on the river.

3.4.4 Protected Species

To determine the potential species at risk that may be in the Project Area, the Manitoba Conservation Data Centre, Occurrence of Species by Ecoregion for the Aspen Parkland Ecoregion was examined (Manitoba Conservation Data Centre, 2011). The species listed for the Ecoregion were then cross referenced with the Manitoba *Endangered Species Act* (Manitoba Conservation, Wildlife and Ecosystem Protection, 2011) and Schedule 1 of the Federal *Species at Risk Act* (Government of Canada, 2010) to determine the listed rare or sensitive species that may occur in the Project Area. Species distribution maps available from the Manitoba Conservation Wildlife and Ecosystem Branch (2011) and the Species at Risk Public Registry (Government of Canada, 2010) were also used, where possible, to determine listed species that may occur in the Project Area. The search results indicate potential for 16 listed species to occur in the general Project Area as shown in **Table 15**.

Table 15: Federally and Provincially Listed Species that May Occur in the Project Area

Species	Federal SARA Species Schedule 1 Status[1]	Manitoba Conservation Endangered Species Act Status[2]	Environmental Considerations
Invertebrate Animal			
Pale Yellow Dune Moth *Copablepharon grande*	Special Concern	Not listed	• Typically found in sparsely vegetated sandy habitats; semi-stable dunes with sparse grass and forb cover.[1] • Flight season is typically from early July to late August in Canada.[1]
Dusky Dune Moth *Copablepharon longipenne*	Endangered	Not listed	• Typically found in sparsely vegetated active sand dunes.[1] • Flight season is typically from mid-June to mid-August in Canada.[1]
Golden-edged Gem *Schinia avemensis*	Endangered	Not listed	• Range extends from Spruce Woods Provincial Park to Alberta in Canada.[1] • Typically found in active dunes and dune blow-outs.[1] • Generally found near the prairie sunflower (only known host plant).[1] • Flight season is typically from July 10 to August 20.[1]
White Flower Moth *Schinia bimatris*	Endangered	Not listed	• Found in the Spirit Dunes in Spruce Woods Provincial Park and the Canadian Forces Base Shilo in Manitoba.[1] • Typically found in active sand dunes.[1] • Spruce Woods population is associated with White Primrose.[1]
Vascular Plant			
Rough Purple False-foxglove *Agalinis aspera*	Endangered	Not listed	• Known to occur in southern Manitoba, including Brandon.[1] • Typically found in wet meadows often at risk due to drainage or heavy grazing; primarily found in remnant prairie habitats along roadsides[1] • Blooms from late July/early August to late August/early September.[1]
Hackberry *Celtis occidentalis*	Not listed	Threatened	• Commonly found on rich, moist sites along stream banks or flood plains.[3] • In Canada, found as far west as Manitoba.[3]
Smooth Goosefoot *Chenopodium subglabrum*	Threatened	Not listed	• Typically found in unstable sand areas. Also found on river sand bars and sandy floodplain terraces.[1] • Generally found in association with sand-berry, sagebrush and juniper.[1] • Flowers from June to August; with seed production in August and September.[1]
Small White Lady's-slipper *Cypripedium candidum*	Endangered	Endangered	• Found in the Brandon area in south central Manitoba, southeastern Manitoba and southern Interlake district.[1] • In the Brandon area, populations found in fields and along road allowances.[1] • Typically found in wooded grasslands, open tall grass prairies, dry-mesic hillsides, low calcareous prairie and calcareous fens.[1]

Species	Federal SARA Species Schedule 1 Status[1]	Manitoba Conservation Endangered Species Act Status[2]	Environmental Considerations
Vertebrate Animal			
Sprague's Pipit *Anthus spragueii*	Threatened	Threatened	• Typically found in native grasslands.[1] • Canadian distribution includes southwest Manitoba, southern Saskatchewan, southeast Alberta and a small area in southcentral British Columbia.[1] • Generally arrive on breeding grounds in late April/early May; and lay eggs between late May and early July.[1]
Ferruginous Hawk *Buteo regalis*	Threatened	Threatened	• Recently re-established in southern Manitoba, with concentrations also found around Brandon and Glenboro.[2] • Typically found prairie and open, arid habitats with grasses or sagebrush.[1] • Generally return to Canada in late March/early April.[1]
Piping Plover *Charadrius melodus*	Endangered	Endangered	• Nests on gravel shores of shallow, saline lakes and on sandy shores of larger prairie lakes above the high water mark.[1] • Nesting season in Canada is between late April and September.[1]
Snapping Turtle *Chelydra serpentine serpentine*	Special Concern	Not listed	• Slow moving water ways with soft mud bottoms and dense vegetation is the preferred habitat; but have been observed in almost every type of freshwater habitats.[1] • Established populations found in ponds, sloughs, shallow bays, river edges and slow streams.[1] • Nesting occurs from late May to late June, with the eggs hatching from mid to late September.[1]
Northern Prairie Skink *Eumeces septentrionalis*	Endangered	Not listed	• Mainly found in sandy soils in the Carberry Sandhills within the Assiniboine delta.[1] • Typically found in mixed-grass prairies with sandy soils.[1] • Nesting occurs from late April to late July/early August.[1] • Hibernation starts mid-September for seven months.[1]
Loggerhead Shrike *Lanius ludovicianus excubitorides*	Threatened	Endangered	• Typically found in grasslands, sagebrush stands, pastures, agricultural areas and thinly wooded areas.[1] • Returns to breeding areas from late April to early June; with eggs laid from late May to early July. [1]
Silver Chub *Macrhybopsis storeiana*	Special Concern	Not listed	• In Manitoba, found in large, moderate flowing rivers with a substrate of silt or sand.[1] • Spawning occurs in spring or early summer.[1]
Mule or Black-tailed Deer *Odocoileus hemionus*	Not listed	Threatened	• Found in a variety of habitats, including temperate forests, deserts, semi-deserts, open ranges, grasslands, fields, scrub habitats and mountain areas.[4]

Notes:

1. *Species at Risk Public Registry (Government of Canada, 2010).*
2. *Species Listed Under the Manitoba Endangered Species Act (Manitoba Conservation, Wildlife and Ecosystem Protection, 2011).*
3. *Plants Profile (Natural Resources Conservation Service, 2011).*
4. *Red List of Threatened Species (Sanchez Rojas and Gallina Tessaro, 2008).*

As there are several at risk vegetation and wildlife species potentially present in the Project Area, a terrestrial survey was conducted in July 2012 by a regional wildlife biologist from Conservation and Water Stewardship to determine the potential to impact sensitive or protected species at the proposed Project Site. The survey reported the following results:

- The proposed forcemain runs along an existing ROW and the area is wetter so there are no concerns about endangered flora or fauna since these species are found mainly in the uplands sand prairie/dune habitat.
- There is potential to encounter turtle nests when working near wetlands.
- The area encompassed by the proposed lagoon site is currently tame hayland. However, judging by the plants growing along the edge of the field, comprising vegetation is likely to be smooth brome and alfalfa. Therefore, there are no concerns with respect to endangered flora or fauna at the Project Site.
- The ditches along the road where the proposed outfall will be routed contain some native prairie. Therefore, there is potential to encounter Prairie skinks along the outfall.

3.5 Transportation

Vehicular access to Spruce Woods is primarily provided by PTH 5, which runs north/south between PTH 1 and PTH 2. As the Park is located on the Assiniboine River, boat (summer) and snowmobile (winter) access is also available. Access within the Park is provided by local roads and trails.

According to the 2011 Traffic Flow Map available from the Manitoba Infrastructure and Transportation Traffic Engineering Branch (2012), 2011 annual average daily traffic (AADT) along PTH 5 is 670 vehicles per day south of the Assiniboine River and 410 vehicles per day north of the Assiniboine River. Where PTH 5 intersects with PTH 2, AADT ranges from 1490 to the east to 1590 to the west of the intersection.

3.6 Heritage Resources

A Heritage Resource Impact Assessment (HRIA) was conducted for the proposed project in the fall of 2012, as per the direction of the Heritage Resources Branch, Culture Heritage and Tourism, Manitoba. The HRIA concluded that there are no concerns with the existing or proposed lagoon location, the lift station or the main line of the outfall. However, the terminus of the outfall was unknown at the time of the investigations. Therefore, a heritage assessment of this area is recommended once the terminus location is determined during the detailed design stage. The correspondence with HRB and the HRIA is provided in **Appendix D**.

3.7 Socio-Economic Environment

Within the Aspen Parkland Ecoregion, agriculture is the dominant land use. Spring wheat and other cereal grain production via continuous cropping and dry land methods are prevalent; however, oilseeds and hay are also grown. In areas of sandy soil and feasible irrigation, potato production has increased in the Ecoregion. (Smith et al. 1998)

The Kiche Manitou campground offers over 200 campsites, including 163 standard campsites, 21 family campsites, 9 group use campsites and 13 yurts. From mid-May to mid-September, the entire campground is open. Fall camping is also available from mid-September to mid-October within four of the camping bays, the group use sites and the yurts. Additional dwellings at the Park include a residence at the Wagon ride and 15 campsites at the Equestrian Campground. In the future, it is anticipated that a 14th yurt will be constructed at the current campground and a second campground will be created, which will provide approximately 100 additional standard campsites. Population for the campground is anticipated to fluctuate seasonally, ranging from zero persons in the winter to a high of 1,731 people in the summer.

The nearest communities to the Park include the Town of Carberry (approximately 24 km northwest of the Project Site), the Village of Glenboro (approximately 12 km southwest of the Project Site) and the City of Brandon

(approximately 55 km northwest of the Project Site). The Town of Carberry reported a population of 1,669 in 2011, an 11% increase from 2006. The village of Glenboro reported a population of 645, which is a 1.9% increase from the population of the town in 2006. The City of Brandon reported a population of 46,061 in 2011, representing an increase of 11% from its population in 2006. (Statistics Canada, 2012)

3.8 Land Use

Under the *Provincial Parks Act*, the Spruce Woods Provincial Park is classified as a Natural Park. The purpose of the Park is to preserve areas representative of the Assiniboine Delta Natural Region and to provide for a variety of recreational and resource uses. Within the Park, approximately 75% is categorized as "backcountry", 22% is categorized as "recreational development", 3% is categorized as "heritage" and <1% is categorized as "access". The majority of the lands surrounding the Assiniboine River, including the area of the existing and proposed lagoons are classified as "recreational development". Land categorized as "recreational development" at Spruce Woods Provincial Park:

- *"Provides developed recreational facilities including campgrounds, day use areas, equestrian and canoe-in campgrounds, visitor reception centre.*
- *Preserves special sites including river bottom forest, and contains the S.S. Alpha wreckage and former homesteads.*
- *Contains agricultural haying and grazing leases."*

Lands categorized as "access" are located along PTH 5, while "heritage" lands are located west of PTH 5 south and east of an oxbow in the Assiniboine River. The remainder of the Park is classified as "backcountry". (Manitoba Conservation, Parks and Natural Areas Branch, 1998)

4. Scope of the Assessment

To assess the potential environmental impact of the proposed Spruce Woods Park Lagoon Replacement Project, geographic and temporal boundaries were defined as follows.

4.1 Temporal Boundaries

The temporal boundaries of the assessment are divided into the following phases:

- **Construction Phase –** Construction will be completed in three phases, Phase 1: Construction of the lagoon and outfall to be completed by the fall of 2014, Phase 2: Construction of the lift station and forcemain, summer 2015, Phase 3: Decommissioning of the existing lagoon, summer 2016.
- **Operation Phase** – anticipated occurring from Summer 2015 into the future.
- **Decommissioning Phase** – anticipated occurring at least 15 to 20 years into the future.

4.2 Geographic Boundaries

Spatial boundaries for the assessment are described below. However, where specifically noted, these boundaries may be adjusted to suit the environmental component (EC) affected.

- The **Project Site** includes any land that will be disturbed by project activities.
- The **Project Area** includes any area, up to 1 km beyond the Project Site, which could be disturbed by project effects. This includes effects during construction, such as noise, vehicle emissions, traffic, etc.
- The **Project Region** includes an area up to 10 km beyond the Project Site that may be affected by project activities. Effects that may be seen outside of the Project Area may include items such as climate change due to greenhouse gas emissions.

The Project Site, Project Area and Project Region are shown in **Figure 4**.

4.3 Environmental and Social Components

This environmental assessment considers changes to the environment caused by the project, as well as any resultant effects on the socio-economic environment. Environmental components (ECs) and social components (SC) were selected following the guidance provided in Manitoba Conservation's Information Bulletin, "Environment Act Proposal Report Guidelines".

The potential interactions between project components and ECs and SCs are identified in **Table 16**. Potential interactions were identified based on the professional judgement of the assessor combined with assumed implementation of standard environmentally responsible construction techniques and operating procedures in the course of the project construction, operation and decommissioning. The potential interactions identified in **Table 16** are assessed in Section 5. Mitigation measures and residual effects are also described in Section 5.

Table 16. Identification of Potential EC/SC Interactions with Project

	Environmental Component																				Social Components[2]					
	Air Quality (dust, emissions, noise)		Climate (wind, precipitation, inversion, fog)		Soil (erosion, compaction, settling, stability, quality)		Geology		Surface Water (quality, quantity, flow, flood, current, tides, wave action, shoreline/bottom alteration, drought, littoral process)		Groundwater (quantity, quality, flow, water table)		Flora (abundance)		Fauna (population change, productive capacity, habitat modification)		Fish/Fish Habitat (population change, productive capacity, habitat modification)		Species at Risk		Aesthetics	Land Use (protected areas, zoning, official plan)	Transportation	Recreation Tourism	Heritage Resources	Human Health and Safety
	Project on EC	EC on Project	Project on EC	EC on Project	Project on EC	EC on Project	Project on EC	EC on Project	Project on EC	EC on Project	Project on EC	EC on Project	Project on EC	EC on Project	Project on EC	EC on Project	Project on EC	EC on Project	Project on EC	EC on Project	Project on SC	Project on SC	Project on SC	Project on SC	Project on SC	Project on SC
Construction Phase																										
Clearing and grubbing	X			X	X								X		X		X		X		X	X			X	X
New lagoon construction	X			X	X						X								X		X	X		X	X	X
New forcemain construction	X			X	X								X		X				X				X	X		X
New outfall construction	X			X	X				X				X		X		X		X				X		X	X
Decommission existing lagoon	X			X	X				X				X								X	X	X			X
Re-vegetation	X			X	X								X		X						X					X
Operation Phase																										
New lagoon	X										X										X					X
Annual discharge to Assiniboine River									X								X									X
Periodic lagoon desludging	X			X											X								X	X		X
Maintenance activities	X			X											X											X

Notes:

1. x = identified interaction
2. only indirect interactions with SCs as a result of an direct project/EC interactions were considered

5. Environmental Effects Assessment and Mitigation Measures

5.1 Effects Assessment Methodology

This section contains the results of the environmental assessment.

Applying professional judgement and a thorough understanding of the different components of the proposed project (outlined in Section 2 of this application), AECOM determined the potential for each component of the proposed project to interact with each environmental component (presented in **Table 16**). The assessment includes any effects on social components resulting from residual adverse environmental effects.

As indicated in Section 4, the assessment takes into account mitigation measures that have been incorporated into the proponent's proposed plan, as well as environmental protection practices and procedures included in the proponent's standard of operation.

Environmental effects that may be caused as a result of accidents or malfunctions are discussed separately in Section 5.16.

Table 17 below explains the technical terms used in the effects assessment.

Table 17: Explanation of Terms Used in Effects Assessment

Project Phase:	Refers to the phase of the project as construction or operation of the proposed facility.
Potential Effect:	Potential change that the project may cause in the environment.
Magnitude of Effect:	Refers to the estimated percentage of population or resource that may be affected by activities associated with the construction and operation of the proposed lagoon. Where possible and practical, the population or resource base has been defined in quantitative or ordinal terms (e.g., hectares of soil types, units of habitat). Magnitude of effect has been classified as either less than (<) 1%, 1 to 10%, or greater than (>) 10% of the population, or resource base. Where the magnitude of an effect has been defined as virtually immeasurable and represents a non-significant change from background in the population or resource, the effect is considered negligible. An exception to this is in terms of potential human health effects where, for example deaths due to waterborne disease amounting to 1% of the population would still be considered major.
Direction of Effect:	Refers to whether an effect on a population or a resource is considered to have a positive, adverse or neutral effect.
Duration of Effect:	Refers to the time it takes a population or resource to recover from the effect. If quantitative information was lacking, duration was identified as short-term (<1 year), moderate term (1 to 10 years) and long term (>10 years).
Frequency	Refers to the number of times an activity occurs over the project phase, and is identified as once, rare, intermittent, or continuous.
Scope of Effect:	Refers to the geographical area potentially affected by the effect and was rated as Project Site, Project Area or project regional boundary as defined in Section 4.0. Where possible, quantitative estimates of the resource affected by the effect were provided.
Reversibility:	Refers to the extent an adverse effect is reversible or irreversible over a 10-year period.
Residual Effect:	A qualitative assessment of the residual effect remaining after employing mitigation measures

Magnitude of Effect	Direction of Effect	Duration of Effect	Frequency	Scope of Effect	Reversibility of Effect
Negligible (immeasurable)	Positive	Short term (< 1 year)	Once	Project Site	Reversible
Minor (<1%)	Negative	Moderate (1 to 10 years)	Rare	Project Area	Irreversible
Moderate (1 to 10%)	Neutral	Long term (>10 years)	Intermittent	Project Region	
Major (>10%)			Continuous		

The following sections address the various components of the environment and social environment, which are anticipated to be affected by the proposed construction and operating activities. The potential effects on specific environmental parameters are described in quantitative terms, where possible. Effects are defined as negligible, minor, moderate or major according to terms in **Table 17**. Effects that are negligible in magnitude are considered sufficiently mitigated and no further mitigation measures are proposed. Where residual effects were found to be negligible in magnitude, the effects were not considered significant. A summary table of the potential effects and proposed mitigation measures is provided in **Appendix E**.

It is anticipated that decommissioning of the proposed lagoon will not occur for at least 20 years. Although a detailed decommissioning plan is not in place for the proposed lagoon, it is anticipated that the decommissioning of the proposed lagoon will be conducted in a manner similar to the decommissioning of the existing lagoon. The impacts associated with the decommissioning of the existing lagoon are discussed for each environmental component in the construction phase sections included in the following pages. It is assumed that the eventual decommissioning of the proposed lagoon will be planned and completed in accordance with applicable regulations and in consultation with regulatory agencies.

5.2 Air

5.2.1 Construction

5.2.1.1 Dust

During construction activities, air quality may be affected during the clearing and grubbing, excavation work, road upgrades, re-vegetation as well as decommissioning activities at the existing lagoon site. Dust and particulate matter have the potential to negatively affect air quality with subsequent effects to human health (including respiratory issues) and flora (dust deposition). To mitigate potential air quality effects and subsequent effects on human health the following mitigation measures will be undertaken:

- Material stockpile height will be limited.
- The disturbed/exposed areas will be kept to a minimum.
- If required, additional dust suppression activities, such as spraying roads and material stockpiles with water, will be completed.

With these mitigation methods employed as necessary, the residual effects of dust generation on air quality and subsequent effects on human health and flora are expected to be negligible.

5.2.1.2 Noise

Noise will be generated to varying degrees during construction. Construction noises may be expected to arise from use of heavy equipment at the site, clearing trees, grubbing and disposal activities. The construction noise is expected to be typical of heavy equipment, such as trucks, graders, loaders and excavators. As land use in the Project Area is primarily recreational/agricultural, noise effects on human receptors is possible. The nearest residence is approximately 0.3 km east of the proposed lagoon site. Another residence is approximately 0.36 km south of the proposed lagoon site. Both dwellings have trees around them, which will create a buffer and mitigate noise. There is significant riparian vegetation between the construction site and the campground area which is anticipated to mitigate potential noise impacts. A preconstruction survey (described in Section 5.8) will be undertaken in advance of construction to identify any sensitive wildlife species that may be affected by the project with mitigation measures developed as required.

Noise effects will be further mitigated with the implementation of the following measures:

- Construction hours will be limited as required to normal working hours.

- Equipment will be properly maintained.
- Provide hearing protection to human receptors on the site as required.

Minor noise effects may occur during working hours on the site; however, noise would generally be limited to normal working hours occurring over the short construction period. Effects due to noise are considered reversible. Although minor noise effects may occur during construction on the site, the off-site noise at the nearest human receptors (permanent residences and Kiche Manitou campground) is anticipated to be negligible.

5.2.1.3 Exhaust Emissions

There exists potential for air quality effects due to vehicle and construction equipment emissions during the construction period. Emissions are expected to be generated during clearing and grubbing, excavations and equipment movement at the site. These emissions could decrease the quality of the air by increasing the amount of carbon monoxide, carbon dioxide, particulate matter and nitrogen oxides within the air. The air quality effects could have subsequent effects on human health. Effects on air quality due to exhaust emissions during construction will be mitigated with the implementation of the following mitigation measures:

- Vehicles and equipment/machinery will be properly maintained.
- Vehicle idling will be kept to a minimum.

The residual off-site effects of construction vehicle and equipment exhaust on air quality would be negligible.

5.2.1.4 Odour

The decommissioning of the existing lagoon has the potential to generate odour impacts. The removal of sludge from the lagoon in particular has the potential to generate odours. Sludge will be dried in or adjacent to the lagoon using Geo Bags. These bags will be filled with sludge and allowed to dewater before removing the sludge from the bags and transporting the dewatered sludge to the City of Brandon Landfill. It is anticipated that the lagoon sludge removal will occur as soon as practical in the early summer of 2014. The existing lagoon location is approximately 390 m from the Kiche Manitou Campground. As the odour emissions will mainly be generated during the filling of the Geo Bags during the early summer, and based on the separation distance between the existing lagoon and the campground, significant odour effects are not anticipated.

5.2.2 Operation

5.2.2.1 Noise

Noise will be generated during the operation phase of the project during septage delivery, maintenance activities and during the periodic removal of sludge from the lagoon. Noise during septage delivery will be typical of a heavy duty vehicle. Noise during the sludge removal is anticipated to be typical of heavy duty vehicles and vehicle traffic. Noise during maintenance activities is anticipated to be typical of lawn equipment, trucks and small hand held tools. The traffic will not increase noise or traffic levels beyond what would be expected in a rural area. The intermittent nature of the noise and separation distance to the nearest permanent residence (approximately 300 m to the east of the lagoon site) is anticipated to mitigate potential noise effects. The significant riparian vegetation between the lagoon site and Spruce Woods Campground and separation distance of approximately 1.6 km is also anticipated to sufficiently mitigate potential noise impacts to Park users.

Noise during operation also has the potential to affect local fauna. The rural traffic adjacent to the proposed lagoon site (see Section 3.5) has likely already deterred noise sensitive wildlife species from the Project Area. Further, the project noise during operation will be limited to maintenance noise such as mowing and some vehicle noise from septage delivery and the periodic removal of sludge from the lagoon. Sludge removal activities will occur in the fall

when species are less sensitive to noise disruptions than during more sensitive periods such as nesting in the spring/summer. The site will also be fenced to limit wildlife access to the site. Further, vehicle access to the site will be limited to the western side of the site adjacent to the highway, away from potential higher value wildlife habitat located to the north of the lagoon site adjacent to the Assiniboine River. Therefore impact on wildlife due to noise is not likely during operation.

Residual effects are anticipated to be negligible.

5.2.2.2 Odour

During the operation phase, odour may be generated during the spring thaw. It is anticipated that the odours generated during the spring thaw will not coincide with high use period of the Park as the Park does not open until mid-May. Odours may also be generated during periodic lagoon sludge removal. It is anticipated that lagoon sludge removal will be conducted following the annual discharge in the fall approximately every 5 years. Therefore the sludge removal period will not coincide with the high use period for the Provincial Park resulting in a reduction in the magnitude of the effect. For the remainder of the year, odours are anticipated to be minimal as the lagoon will be aerobic and substantial methane generation is not anticipated.

The closest permanent residence is located approximately 300 m east of the proposed lagoon site, and there is a second residence approximately 360 m south of the proposed site. The Kiche Manitou campground is approximately 2 km southwest of the proposed lagoon site. The separation distance to the resident and provision of a shelterbelt around the lagoon is anticipated to improve odour dispersion resulting in minor to negligible odour impacts.

The residual effects due to odours in the operation phase of the project are anticipated to be negligible. If complaints are received during operation of the lagoon, Parks will work with the concerned residences to address the issue.

5.2.2.3 Greenhouse Gas Emissions

Wastewater treatment can generate methane; a potent greenhouse gas. The proposed primary and secondary lagoon cells will be 1.5 and 1.8 m deep respectively. According to the Intergovernmental Panel on Climate Change (IPCC), lagoons less than 1 m in depth generally provide aerobic conditions and negligible quantities of methane are generated. Lagoons deeper than 2-3 m, however, can produce significant amounts of methane. (IPCC 2006) As the lagoons will be less than 2 m in depth, significant methane emissions are not anticipated.

The vehicle emissions associated with sludge removal, maintenance and septage delivery are anticipated to negligibly contribute to local greenhouse gas concentrations.

An examination of Environment Canada's 2009 reported facility emissions found that no lagoons in Manitoba report greenhouse gas emissions. Therefore, it is not anticipated that lagoons are a significant emitter of greenhouse gas emissions as no facilities currently meet the annual 50,000 tonnes of carbon dioxide equivalent reporting threshold. (Environment Canada 2010b).

5.3 Climate

5.3.1 Construction

Construction activities are not anticipated to affect climate or weather. Climate, especially weather patterns, however has the potential to affect the project during all aspects of construction from transporting construction material to the site, decommissioning, de-sludging existing lagoon, construction of the new lagoon and pipelines and clean-up and re-vegetation.

Temperature and precipitation have the potential to affect the construction/installation of the lagoon, underground piping and re-vegetation. Wind, precipitation and temperature have the potential to affect the success of re-vegetation efforts. To mitigate potential climate effects on the project during the construction phase, the following measures will be implemented:

- Construction activities will occur at the appropriate time of year and/or when the climate is favourable to do so.
- During construction activities, all equipment will be stored in appropriate areas when not in use to prevent equipment damage, and potential subsequent leaks, from occurring during a severe weather event.
- Work will be stopped if harm to workers may occur.

The residual environmental effects due to climate on the construction of the project are anticipated to be negligible with the implementation of the outlined mitigation measures.

5.3.2 Operation

During the operation phase of the project, climate may affect lagoon sludge removal and maintenance activities. Precipitation, wind and temperature all have the potential to affect the ability to remove and dewater sludge from the lagoon and to transport the sludge to landfill or application sites. To mitigate potential effects, lagoon sludge removal or maintenance activities will occur when climate conditions are favourable to do so. In the event that climate conditions may lead to harm to workers, work will be stopped.

During the operation phase, climate may also affect the lagoon's ability to treat wastewater and may affect flow conditions in the Assiniboine River. The lagoon has been designed to provide 365 days of storage for the wastewater. The storage period is anticipated to provide treatment of the wastewater to meet anticipated *Environment Act* Licence requirements and therefore mitigation for climate conditions that may affect the lagoon's ability to provide wastewater treatment. The new lagoon will be above the flood plain, which offers additional mitigation or potential effects due to flooding.

The residual environmental effects due to climate on the operation of the project are anticipated to be negligible with the implementation of the outlined mitigation measures.

5.4 Soil

5.4.1 Construction

5.4.1.1 Erosion

During construction, there exists potential for impacts to soils due to erosion. Erosion effects have the potential to occur primarily during clearing/grubbing, excavation work, site restoration and decommissioning of existing lagoon site, and during movement of heavy equipment on the site. Soil may be lost as a result of wind and precipitation erosive action. Erosion of soil and material stockpiles due to wind and precipitation has the potential to cause subsequent effects on air quality. Further, work for the new outfall including clearing and grubbing and excavation has the potential to create conditions favourable to erosion with potential subsequent impacts on surface water quality and fish and fish habitat.

The proposed outfall design and proposed decommissioning of the existing outfall will be submitted to Fisheries and Oceans Canada for review under terms of the habitat protection requirements of the federal *Fisheries Act*, as required.

Effects on air quality will be mitigated as described in Section 5.2.1.1. To minimize erosion, the following measures will be implemented:

- Material stockpiles at the site will be covered if required.
- The disturbed surface will be kept to a minimum with re-vegetation occurring as soon as practical where required.
- Erosion control measures such as silt fences will be employed as described in an Erosion Control Protection Plan (to be developed).

With the implementation of the above mitigation measures, the residual effect is negligible.

5.4.1.2 Compaction

Equipment movement at the Project Site has the potential to cause soil compaction. Soil compaction has the potential to affect flora and can change surface drainage patterns. To minimize compaction, the following measures will be implemented:

- Construction vehicles and equipment will use designated pathways as indicated by Parks or their designate to access work areas.
- The Contractor is responsible for the appropriate repair of any areas where equipment has compacted soils with the repairs including appropriate grading and re-vegetation.

The residual effect on soil compaction is anticipated to be negligible.

5.4.1.3 Waste Disposal

Construction waste such as; used oils, rags, containers, drums and plastic, if disposed of inappropriately, can have effects on soils and subsequent effects on groundwater and flora. To prevent potential effects due to inappropriate waste disposal, the following mitigation measures will be implemented:

- All construction waste will be properly stored on-site and then taken off site (including biosolids) and disposed of at an appropriate waste disposal facility.

The post mitigation effects due to waste disposal are considered negligible.

5.4.1.4 Fuel and Materials Storage

Soil quality may be affected by fuel spills from storage areas or accidental spills of construction materials. Accidental spills are discussed in Section 5.16.2. To minimize the potential for soil contamination from storage of fuels, the following measures will be implemented:

- All potentially hazardous products (if required on site) will be stored in a pre-designated, safe and secure product storage area(s) in accordance with applicable legislation.
- Storage sites will be inspected periodically for compliance with the requirements.
- Service and minor repairs of equipment performed on site will be performed by trained personnel.
- Any used oils or other hazardous liquids will be collected and disposed of according to provincial requirements.
- Vehicles and equipment will be maintained to minimize leaks. Regular inspections of hydraulic and fuel systems on machinery will be completed on a routine basis, when detected, leaks will be repaired immediately.

With implementation of mitigation measures mentioned above, the residual effect on soil quality from fuel and materials storage is assessed to be negligible.

5.4.2 Operation

During the operation phase of the project, the lagoon will require periodic (approximately every 5 years) sludge removal. Sludge removed from the lagoon will either be applied to agricultural land or will be landfilled at a Class 1 waste disposal facility. The land application of sludge may require an *Environment Act* Licence which will be applied for at a later date should it be determined that this is the preferred sludge management option. If the land application of sludge is conducted in accordance with *Environment Act* licence requirements, the sludge can increase the nutrient content of soils and provide a sustainable alternative to inorganic fertilizers without degrading soil quality. The landfilling of sludge will not provide any soil quality benefits.

The residual effect on soil quality is anticipated to be positive if land application of sludge occurs or neutral if the sludge is landfilled. Overall, residual effects are anticipated to be negligible considering the small size of the lagoon and that sludge removal will only occur approximately once every five years.

5.5 Geology

The construction and operation activities of the proposed lagoon will not affect the Project Site, area or regional geology as construction activities will be generally limited to the surficial soil environment.

5.6 Surface Water

5.6.1 Construction

5.6.1.1 Sediment and Turbidity

During the construction phase, there is increased potential for erosion of disturbed soils and material stockpiles. Pipeline bedding material, salvaged topsoil, and other materials may be temporarily stockpiled at/along the site for use in the construction and re-vegetation process. Excavated soil stockpiles will also be present at the proposed lagoon site. Erosive action due to heavy precipitation and winds can result in the loss of soil resources and potential subsequent negative effects to surface water and aquatic resources. Mitigation measures that will be employed include minimizing the height of stockpiles and minimizing the amount of material disturbed during forcemain and outfall installation and lagoon excavation work. Silt fences will also be employed to minimize sediment transport where appropriate. Additional protection is provided by the separation distance from much of the project to the Assiniboine River. Material stockpiles will be kept away from drainage areas and surface water. The magnitude of the negative residual effect to surface waters is anticipated to be negligible with the implementation of the outlined mitigation measures.

In addition to the soil erosion potential created due to earthworks for project construction, the construction of the proposed new outfall has the potential to deposit sediment and create turbidity in the Assiniboine River during installation. The design of the proposed outfall will be conducted in the detailed design phase but it is anticipated that the majority of the outfall structure will be constructed in isolation from, and/or above the water level of the Assiniboine River. The proposed design will be submitted to Fisheries and Oceans Canada for review under terms of the habitat protection requirements of the federal *Fisheries Act*. It is anticipated that approval from Fisheries and Oceans Canada for the proposed outfall will stipulate required mitigation measures to minimize potential effects on surface water quality and subsequent effects on aquatic resources. Work for the proposed outfall will be conducted in accordance with Fisheries and Oceans Canada requirements to mitigate the potential aquatic effects.

5.6.1.2 Treated Effluent Discharges

To decommission the existing lagoon, effluent will need to be discharged from the lagoon to the Assiniboine River. Effluent will be sampled and tested for compliance with the existing Clean Environment Commission Order conditions prior to discharge. If the effluent quality does not meet limits, it will be stored for a longer period to meet

limits or will be trucked to the new primary lagoon cell for treatment. With the proposed mitigation measures in place, surface water quality effects due to effluent discharges are anticipated to be negligible.

5.6.2 Operation

5.6.2.1 Treated Effluent Discharges

Effluent discharges to surface waters have the potential to negatively affect surface water quality with subsequent effects on fish and fish habitat and other downstream users.

The proposed lagoon is designed to meet anticipated provincial *Environment Act* Licence effluent limits and improve the quality of effluent discharged to the Assiniboine River. Although the existing lagoon has reportedly never been discharged to the Assiniboine River through the existing effluent outfall, seepage of raw, partially treated or treated effluent through the cell is inferred over the years the lagoon has been in operation. Based on proximity of the existing lagoon site to the Assiniboine River, it is likely that groundwater at the site discharges to the Assiniboine River and, as such, any seepage would also discharge to the Assiniboine River near the existing lagoon site with the groundwater. The new lagoon will be lined to prevent seepage of wastewater to the groundwater and subsequently the Assiniboine River. The new lagoon will treat wastewater prior to discharge.

The proposed lagoon is designed to meet anticipated *Environment Act* Licence limits for five day- carbonaceous biochemical oxygen demand, total suspended solids, total phosphorus, total coliforms and fecal coliforms. The existing lagoon operates under a Clean Environment Commission Order that does not contain limits on total suspended solids, or phosphorus; however, it is anticipated that the new *Environment Act* Licence will contain limits for these parameters. The new lagoon will be required to provide a higher quality effluent than the existing lagoon; therefore, providing an improvement in surface water quality.

The proposed lagoon upgrade will require the annual discharge of treated effluent to the Assiniboine River. On an annual basis, a maximum of 43,829 m^3 will be discharged to the Assiniboine River. The effluent pipeline will have a valve to adjust the flow rate discharged. It is anticipated that the flow will be discharged over 5 to 6 days at an approximate flow rate of 0.08 m^3/s. Average Assiniboine River flow rates at Brandon are approximately 17.5 and 17.7 m^3/s in September and October respectively as presented in Section 3.3.2.1. Average Assiniboine River flow rates downstream of the Project Area near Holland are 23.8 and 23.9 m^3/s in September and October respectively as presented in Section 3.3.2.1. If the average Assiniboine River flow rate at Brandon for September is conservatively used to estimate flow conditions at the Project Site during a discharge event, the effluent discharge represents 0.5 % of the flow in the Assiniboine River and is considered a negligible contribution. Further, it is anticipated that flows will be greater at the discharge point than those recorded at Brandon, as the Souris River enters the Assiniboine River upstream of the Project Site.

Effluent guidelines contained in *Environment Act* Licences are established by provincial and federal regulatory agencies to protect environmental and human health. Therefore, if the lagoon is operated in compliance with its *Environment Act* Licence, negligible impacts on downstream surface water users (potable water supplies and irrigators) are likely. Further, the fall timing of the discharge is not anticipated to coincide with irrigation withdrawals from the Assiniboine River.

The improvement in effluent quality is considered a positive relative effect; however, based on the small effluent volume, the effect is considered to be a negligible improvement in Assiniboine River water quality.

5.7 Groundwater

5.7.1 Construction

5.7.1.1 Waste Disposal

As described in Section 5.4.1.3, construction waste will be taken off site for disposal. With the implementation of the mitigation measures presented in Section 5.4.1.3, the post mitigation effects on groundwater due to waste disposal are considered negligible.

5.7.1.2 Groundwater Drawdown

Dewatering excavations during construction has the potential to affect the elevation of the local groundwater table and potentially the ability of nearby groundwater users to use water. However, based on the groundwater observations conducted as part of the geotechnical program for the project, all of the test holes were dry during drilling and no static water level was observed in any of the test holes prior to backfilling, therefore, it is not likely that dewatering will be required. As significant dewatering will not likely be required and as the registered domestic supply wells withdraw groundwater from a minimum depth of 6.9 m below the ground surface, negligible effects on the elevation of the local groundwater table are anticipated.

5.7.2 Operation

5.7.2.1 Chemical Use and Storage

During the operation phase of the project, there is potential for groundwater contamination from alum use and storage. Alum dosing will be conducted by adding liquid alum directly to the secondary cell, using a small chemical pump on the back of a boat or by spraying the liquid alum onto the secondary cell water surface and mixing the cell contents with a boat motor. If liquid alum is released to the environment, it will not likely be in large quantities and will not likely contaminate groundwater. Alum will be delivered on an annual basis and it is not anticipated that significant chemical storage will be required. If required, chemicals will be temporarily stored in a suitable chemical storage area at the Park to reduce the potential for any contamination to occur. All chemical storage will be in accordance with regulatory requirements resulting in negligible potential effects on groundwater. Residual effects on groundwater resources during operation are anticipated to be negligible.

5.7.2.2 Biosolids Management

The lagoon will require periodic sludge removal approximately every 5 years. The land application of biosolids has the potential to cause groundwater impacts. If biosolids are applied to land, an *Environment Act* Licence will be required for this work in advance of application. Spills of biosolids during transport or application also have the potential to cause groundwater impacts. Biosolids will be applied to agricultural land by qualified applicators in accordance with *Environment Act* Licence requirements to minimize the potential for spills and subsequent effects on groundwater.

If biosolids are not land applied they will likely be landfilled at the Class 1 Waste Disposal Facility in the City of Brandon. The transport of biosolids will be by qualified personnel. The biosolids will be transported in water-tight containers to reduce the potential for spills during transport. The landfill has measures in place to mitigate potential groundwater impacts.

With the implementation of the described mitigation measures, the residual effects are anticipated to be negligible in magnitude.

5.7.2.3 Leakage of Pipelines or Lagoon Cells

During the operation of the proposed lagoon, there is potential for groundwater quality effects due to leaks in pipelines and the lagoon cells. To prevent potential groundwater effects, the proposed new forcemain will be pressure tested prior to operation. As the outfall pipeline will be a gravity pipeline and will not be operated under high pressure, the likelihood of a leak is reduced. Further as the outfall will contain only treated effluent, potential groundwater effects are minimized. If, during operation, a pipeline leak is identified, the area where the leak is occurring will be determined and subsequent repairs will be implemented along with any necessary investigation and remediation if required. The proposed lagoon cells will be lined with a geosynthetic liner to protect groundwater resources. The lagoon cells will be equipped with a dewatering/degassing system which will drain to a common manhole. The liquid collected in the manhole can be tested if there is suspicion the lagoon cells are leaking.

It is anticipated that the *Environment Act* Licence may include an annual groundwater monitoring requirement at the proposed lagoon site. Parks will comply with any monitoring requirements of the new *Environment Act* Licence.

If leakages are identified during facility operation or if contamination is identified during the groundwater monitoring program, Parks will investigate the source of the leakage/contamination. The investigation will be conducted with the intent to repair any problems as well as to provide monitoring and investigations to confirm that the surrounding land/groundwater has not been contaminated and no risk to human health exists as a result.

With the proposed mitigation measures in place, the residual effects of the proposed project on groundwater resources are anticipated to be negligible.

5.8 Flora, Fauna and Species at Risk

5.8.1 Construction

5.8.1.1 Vegetation and Wildlife Habitat Loss

During the construction phase of the proposed project, vegetation will be lost due to ground disturbance, soil compaction from heavy equipment use and clearing and grubbing activities. Further, species population may be reduced due to accidental spills of fuel or chemicals. Vegetation loss can also result in habitat loss for wildlife. To mitigate vegetation loss, re-vegetation will occur as required in disturbed areas following construction.

It is anticipated that up to 12.8 ha of land (including 5 ha of trees) will be disturbed due to equipment movement, excavations and general disturbance associated with the proposed project. The majority of this land however, is currently under agricultural production and is not anticipated to contain sensitive vegetation or critical habitat for wildlife species. Some land however will be cleared of vegetation for the proposed new outfall and lagoon cells and some clearing may also be required for the new forcemain.

As noted in Section 3.4.4, there is potential to encounter turtle nests when working near wetlands. Further, the ditches along the road where the proposed outfall will be routed contain some native prairie. Therefore, there is potential to encounter Prairie skinks along the outfall. A terrestrial survey will be conducted by Parks staff in advance of construction to identify any sensitive species with mitigation measures developed as required. Further, if any turtle nests or prairie skinks are observed during construction, the Parks' regional biologist will relocate the species. Assuming successful relocation of any species encountered, existing level of disturbance on the Project Site and abundance of similar habitat available in the Project Area, the residual effect is evaluated to be minor to moderate in magnitude.

5.8.1.2 Habitat Fragmentation/Alienation

The permanent loss of habitat due to the construction of the proposed project is limited to the footprint of the new lagoon and part of the new outfall as the majority of the proposed outfall and forcemain alignment will be re-vegetated as soon as practical following installation. Depending on the final outfall design, there may be some permanent loss of fauna habitat if the outfall will discharge to the river bank over rip rap. It is estimated that the proposed new structures will result in the permanent loss of approximately 12.85 ha of potential fauna habitat. However, based on the terrestrial survey conducted in July 2012, the majority of the project area is considered to be disturbed and does not contain native species and this habitat is not likely considered high value wildlife habitat. As part of the proposed project, a terrestrial survey will be conducted in advance of construction. The terrestrial survey will identify locations of critical habitat and will recommend mitigation measures to minimize the magnitude of potential impacts. Therefore the permanent loss of important habitat associated with the project is anticipated to be negligible in magnitude.

The existing lagoon site will be decommissioned which will include levelling of the dikes and re-vegetation. It is not anticipated that existing lagoon site will be returned to natural vegetation however will likely be re-vegetated but will not likely be maintained. Therefore as the existing lagoon site is already a disturbed site with no significant native vegetation and as re-vegetation will not return the site to a natural vegetation condition, no additional habitat fragmentation or alienation impacts beyond those that already exist are likely to occur in the area.

Residual effects are considered of long term duration occurring continuously at the Project Site and are considered reversible.

5.8.1.3 Dust deposition

During construction dust deposition on vegetation can potentially affect growth rates. Construction activities have the potential to generate fugitive dust emissions. Assuming the implementation of typical good construction practices, residual effects to vegetation due to airborne dust and particulates will be negative and negligible in magnitude, occurring intermittently over the short term in the Project Area.

5.8.1.4 Waste Disposal

As described in Section 5.4.1.3, construction waste will be taken off site for disposal. With the implementation of the mitigation measures presented in Section 5.4.1.3, the residual effects on flora, fauna and species at risk are considered negligible.

5.8.1.5 Spills

Similar to Section 5.4.1.4, during construction, there is a risk of fuel or chemical leaks from storage areas, or accidental spills which could affect flora. Accidental spills are addressed in Section 5.16. The residual effect is anticipated to be negligible and if mitigation measures as described in 5.4.1.4 are implemented.

5.8.2 Operation

5.8.2.1 Dust Deposition

There is potential for airborne dust and particulate generation during the operational phase of the project due to traffic on site gravel access roads. Airborne dust and particulate emissions can negatively affect vegetation due to dust deposition. Minimal traffic is expected to access the site for regular maintenance activities, septage deposit and sludge removal. Increased traffic may be experienced during periodic sludge removal but is anticipated to only occur

once every five years. To mitigate operational dust impacts, on-site speed limits will be kept low and chemical or water application to the gravel access road will be conducted if required. Dust effects would occur intermittently with effects occurring over the short term and confined to the Project Site and immediate area. Effects are considered negligible.

5.8.2.2 Disturbance due to Noise

As negligible noise effects are anticipated during operation and as local species are already accustomed to noise and traffic due to the proximity of the 75W and 45N Roads, operational noise effects on wildlife are anticipated to be negligible.

5.8.2.1 Management of Burrowing Animals

During the operation phase of the project, a management program to deter burrowing animals from burrowing in the new lagoon will be developed. As no protected burrowing species are found in the Spruce Woods area and the habitat available within the Project Site is not unique to the area, effects are assessed to be negligible.

5.9 Fish and Fish Habitat

5.9.1 Construction

5.9.1.1 Fuel and Chemical Storage

During the construction phase, potential spills could include vehicle fluids, such as diesel and oils, as well as any chemicals or solvents used in the construction process. Accidental spills are addressed in Section 5.16. In addition to the measures outlined in Section 5.4.1.4, if on-site refuelling is required during the construction process, it will be conducted in dedicated areas located more than 100 m from the nearest high water mark with measures in place to provide containment. With these measures in place, residual effects on Fish and Fish Habitat from fuel and chemical storage on site is anticipated to be negligible.

5.9.1.2 Sediment and Turbidity

During the construction phase, there is potential for erosion of disturbed soils and stockpiled fill material. Erosion can cause a decline in surface water quality with subsequent effects on fish and fish habitat due to turbidity and sediment accumulation. Mitigation measures proposed in Section 5.6.1.1 will be implemented in the construction phase to minimize potential aquatic impacts. Residual effects are anticipated to be negligible.

5.9.1.3 Construction of Outfall

Depending on the final design of the outfall, there is potential for effects on fish and fish habitat during the outfall construction. Bank and stream bed alterations all have the potential to affect fish and fish habitat. Based on Fisheries and Oceans Canada's future review of the detailed design of the proposed outfall, where impacts to fish and fish habitat cannot be avoided, Parks and Fisheries and Oceans Canada will develop habitat compensation plans as required to mitigate potential losses of fish habitat. Residual effects are anticipated to be negligible and mitigable.

5.9.2 Operation

5.9.2.1 Treated Effluent Discharges to the Assiniboine River

As indicated in Section 5.6.2.1, the proposed project is anticipated to provide an immediate improvement in wastewater treatment at the Spruce Woods Provincial Park. However, based on the small volume of the treated effluent discharge compared to the Assiniboine River flow rate, the project will result in a negligible relative

improvement in surface water quality in the river. However, as the treated effluent is still a discharge to the Assiniboine River, the improvement in treatment is considered a negligibly negative effect on fish and fish habitat.

The lagoon will discharge treated water in the fall to the Assiniboine River at ambient temperatures, and as such impacts related to heated effluents such as effects related to the waterbody's oxygen carrying capacity and behaviour modification in fish are not anticipated.

Ammonia and in particular the un-ionized form of ammonia is considered a toxic substance to fish. Effects on fish vary according to exposure rates and can include lesions in the gills, tissue degradation in the kidneys and reduction in growth or reproduction with potential for exposure to be lethal. (Canadian Council of Ministers on the Environment 2000).

The *Wastewater Systems Effluent Regulations* have been developed under the *Fisheries Act* as part of the implementation of the Canadian Council of Ministers of the Environment, *Canada-wide Strategy for the Management of Municipal Wastewater Effluent.* Under the *Wastewater Systems Effluent Regulation*, the maximum concentration of un-ionized ammonia in wastewater approved for discharge to surface water is 1.25 mg/L expressed as nitrogen (N), at 15°C ± 1°C.

As indicated in Section 2.3.3, it is estimated that total ammonia concentrations in the effluent will be approximately 10 mg/L with effluent pH ranging from 7 to 9. To determine the concentration of un-ionized ammonia in the effluent the following formula provided in the *Wastewater Systems Effluent Regulations* was used:

$$\textbf{Un-ionized ammonia = total ammonia x } 1/(1+ 10^{\wedge\ 9.56-pH})$$

Where: total ammonia is the concentration of total ammonia — namely, un-ionized ammonia (NH_3) plus ionized ammonia (NH_4+) and, pH is the initial pH of the effluent at 15°C ± 1°C

The concentration of un-ionized ammonia in the effluent was calculated for a range of effluent pH values at 15°C. A summary of the un-ionized ammonia concentrations in the effluent is provided in **Table 18** assuming a concentration of 10 mg/L total ammonia in the effluent.

Table 18: Concentration of Un-ionized Ammonia in mg/L based on an Effluent Concentration of 10 mg/L Total Ammonia at 15°C

pH	Un-Ionized Ammonia (mg/L)
6	0.003
6.5	0.009
7	0.027
7.5	0.086
8	0.268
8.5	0.801
9	**2.159**

Note: *Concentrations shown in Bold exceed the Wastewater Systems Effluent Regulations for un-ionized ammonia (1.25 mg/L at 15°C).*

As shown in the table, under the majority of discharge scenarios, the effluent will meet the un-ionized ammonia limit. The limit however will likely be exceeded when effluent pH is at 9. A pH of 9 would be a rare occurrence and would be less likely in the fall during a discharge event than in early summer. Further, when the effluent is discharged to

the Assiniboine River, dilution will reduce the un-ionized ammonia to below proposed limits immediately below the outfall. As such toxicity impacts to fish are not anticipated.

The Manitoba Water Quality Standards, Objectives and Guidelines contain limits on ammonia for the protection of aquatic ecosystems (Manitoba Conservation 2002). Ammonia Objectives are defined for waters with cold and cool water species and are pH and temperature dependant. The Assiniboine River is considered a cool water fishery and as such cool water equations were used to determine the applicable ammonia Objectives. As presented in Section 3.3.2.1, average pH in the Assiniboine River at PR 340 upstream of Treesbank was approximately 8.1. As discharge will occur in the fall and Assiniboine River temperatures may be above or below 5 °C, equations 1 to 6 in the Manitoba Water Quality Standards, Objectives and Guidelines were used to calculate ammonia Objectives under various temperatures. The equation with the most conservative Objective was used to determine a conservative ammonia objective. For all temperatures examined, equation 1 for chronic exposure gave the most conservative ammonia Objective. The calculated ammonia Objectives are shown in **Table 19**.

Table 19: Total Ammonia Limits calculated using the Manitoba Water Quality Standards, Objectives and Guidelines

pH	Temperature (°C)	Equation 1 (chronic) (mg/L)
8.1	5	2.1
8.1	10	2.1
8.1	15	2.03
8.1	20	1.47

The above total ammonia limits apply to the Assiniboine River in the fully-mixed zone downstream of the effluent outfall. To determine the total ammonia concentration in the Assiniboine River after discharge, the combined quality was determined using flow rates and concentrations. To conservatively estimate the low flow scenario in the Assiniboine River, the minimum managed flow at Brandon of 2.8 m^3/s (100 cfs) was used. As indicated in Section 3.3.2.1, the average dissolved ammonia concentration at Treesbank was 0.2 mg/L. Effluent ammonia concentrations were 10 mg/L total ammonia at a flow rate of 0.08 m^3/s. The combined quality of the Assiniboine River following the effluent discharge will be a total ammonia concentration of 0.472 mg/L, well below the chronic ammonia Objectives of the Manitoba Water Quality Standards, Objectives and Guidelines. As the calculated quality is well below the objectives, negligible impacts are anticipated.

Effects are anticipated to be negligible in magnitude immediately following the upgrade. Effects are anticipated to occur over the long term on an intermittent basis in the project region. The improvement in effluent quality is considered positive; however, based on the size of the project is not considered to be significant.

5.9.2.2 Gradient of Outfall

Depending on the design of the new outfall, effects on fish are possible during operation. If the outfall structure does not include adequate gradient, fish may move into the outfall and use it as habitat. There is potential for this to negatively affect fish during discharge periods. Fish may swim into the outfall and may become stranded when the discharge period is complete. To mitigate potential effects on fish, the outfall will be designed during the detailed design phase with as much gradient as possible to prevent fish movement into the outfall ditch. Residual effects are considered negligible. Further, there may be potential for erosion along the channel during discharge which may subsequently affect water quality. Appropriate mitigation, such as riprap will be implemented along the outfall channel to minimize changes to water quality due to erosion. Residual effects are considered negligible.

5.10 Aesthetics

5.10.1 Construction

The aesthetics of the Project Site during construction could undergo minor changes due to the presence of construction equipment and related general disturbance. However, as the construction period is fairly short, the disturbance would be minimal. To mitigate potential aesthetic effects the following mitigation measures will be implemented:

- Construction waste and debris will be stored in bins and removed on a regular basis from the Project Site.
- Prior to the end of each construction day, the site will be inspected for loose construction waste and debris in order to maintain a clean Project Site.
- Disturbed soils will be restored as required upon completion.

The existing lagoon site will be decommissioned and will include levelling of dikes and re-vegetation. It is anticipated that re-vegetation will increase the aesthetic value of the existing lagoon site, however as the existing lagoon site is sheltered by trees from public view, this aesthetic change is likely minimal.

The residual aesthetic effects are considered negligible.

5.10.2 Operation

During the operation phase of the project, the aesthetics of the Project Area will be altered. The proposed lagoon site will change from agricultural lands to a diked and fenced lagoon site. To minimize potential aesthetic impacts, a shelterbelt will be installed around the proposed lagoon site. The forcemain and outfall alignments will be re-vegetated and maintained following construction to mitigate any aesthetic effects. Therefore the residual effects are considered to be neutral.

5.11 Land Use

5.11.1 Construction

The proposed lagoon will alter the land use of the site from agricultural land use to wastewater treatment land use. Under the *Nutrient Management Regulation*, the development of a sewage treatment lagoon is permitted at this site as it is not designated as N4 under the regulation. A shelterbelt will be installed around the proposed lagoon site to reduce the potential aesthetic effect of the change in land use on other nearby land uses as shown in **Figures 3B** and **3C**. The proposed forcemain will be installed below ground and as such will only temporarily alter the land use during the installation process. An underground discharge pipe will be placed in the ROW along Steele's Ferry Road on the east side of the lagoon site and will run north approximately 1.8 km to the River. From there the pipe will discharge into a riprap erosion controlled discharge ditch which will flow the remaining distance to the River. Therefore similar to the forcemain, the majority of the outfall will only temporarily disrupt the land use at the site. The open ditch for the outfall will permanently alter the land use from a treed area to a ditch. Although the design of the ditch will be conducted at a later design stage, the width will be minimized as much as possible which is anticipated to result in a negligible residual impact on land use.

The existing lagoon will be decommissioned. Decommissioning will include levelling the dikes and re-vegetation, following which the site will be left to return to natural conditions. The site will no longer be used for wastewater treatment, however as it will not likely be used as a recreational area, impact to land use is anticipated to be negligible.

5.11.1.1 Operation

The change in land use at the proposed site will occur during the construction phase of the project. No additional land use changes are anticipated to occur during the operation phase of the project.

5.12 Transportation

5.12.1 Construction

During construction activities, transportation may be affected during the transportation of materials to/from the site. Traffic accessing the site for deliveries and material disposal will likely be intermittent during the working hours. The geosynthetic liner, sand bedding material, piping and rip rap will all need to be transported to the lagoon site. It is anticipated that construction deliveries will be brought to site via PTH 5. According to the 2011 Traffic Flow Map available from the Manitoba Infrastructure and Transportation Traffic Engineering Branch (2012), 2011 annual average daily traffic (AADT) along PTH 5 is 670 vehicles per day south of the Assiniboine River and 410 vehicles per day north of the Assiniboine River. The number of trucks accessing the site per day will be determined by the contractor conducting the work.

During the decommissioning of the lagoon, dewatered biosolids will be transported to the City of Brandon landfill for disposal. A short term increase in local traffic may be experienced during the transport of the dewatered biosolids but the traffic volume is expected to be well within the capacity of PTH 5 and therefore is anticipated to be a negligible effect. As the effect will also be very short in duration and will only occur once, effects are anticipated to be negligible.

The residual transportation effects are anticipated to be negligible.

5.12.2 Operation

During the operation phase of the proposed project, periodic lagoon sludge removal will be required. The land application or landfilling of the sludge will require trucks for transport of the material. As the traffic associated with the land application or landfilling is anticipated to only occur approximately every 5 years and is anticipated to be a small portion of the existing traffic on PTH 5 (already being experienced by campers and locals), residual effects are expected to be negligible.

5.13 Recreation Tourism

5.13.1 Construction

The construction of the new lagoon will require disturbance of lands within Spruce Woods Provincial Park. The proposed lagoon site is located on land that is currently leased out for agricultural production. As the proposed lagoon site is currently partially under agricultural production, its recreation tourism value is considered to be low. The new forcemain will run along an existing maintained road which is adjacent to the Trans Canada Trail. Some disruption to recreational activity along this road during construction may occur. The new outfall will follow an existing road (45N), and will intersect the Trans Canada Trail, and possibly the Springridge Trail (depending on the final discharge route). Some disruption to the trail may occur during this time. Although some disturbance will occur, in the footprint, it will only occur during the construction phase and periodic maintenance (when required), and is therefore assessed to be minor in magnitude. Detours will be posted as necessary to further mitigate tourism effects along the trail and disturbance will be near existing roads further minimizing the potential effects.

The existing lagoon will be decommissioned by levelling the dikes and re-vegetating the site and left to return to natural conditions over time, it is not anticipated that the lagoon site will be converted into a new recreational area,

therefore the impact of decommissioning the existing lagoon is anticipated to be a neutral impact to recreation tourism.

The overall impact on recreation tourism is anticipated to be negligible.

5.13.2 Operation

Odour impacts during lagoon operation have the potential to affect recreation tourism during facility operation. However as discussed in Section 5.2.2.2, odour impacts are not anticipated to coincide with high use seasons of the Spruce Woods Provincial Park. The proposed lagoon site will be sheltered from public view with a shelterbelt which will also provide a positive aesthetic impact.

5.14 Heritage Resources

5.14.1 Construction

Construction activities have the potential to result in damage or loss of heritage resources. In accordance with the recommendation from HRB, an HRIA was undertaken for the project. The HRIA concluded that there are no concerns with the existing or proposed lagoon location, the lift station or the main line of the outfall. However, the terminus of the outfall was unknown at the time of the investigations. Therefore, a heritage assessment of this area is recommended once the terminus location is determined during the detailed design stage. The HRIA is included in **Appendix D**. To mitigate potential effects on heritage resources the following mitigation measures will be implemented:

- If artefacts, historical features or skeletal remains are encountered during construction, work activities will stop immediately around the affected area with the find reported to the site supervisor. A qualified archaeologist may investigate and assess the find prior to the continuation of work.
- If skeletal remains are encountered during construction activities, the find will be immediately reported to the site supervisor and the Royal Canadian Mounted Police.

With the implementation of the outlined mitigation measures, the residual effects on heritage resources are considered negligible.

5.14.2 Operation

During the operational phase of the proposed project, no additional ground disturbance will occur. As a result, potential effects on heritage resources during the operational phase of the project are not anticipated.

5.15 Human Health and Safety

5.15.1 Construction

During construction, there is potential for negative effects to worker safety. Exposure to fuels, moving vehicles, construction equipment and pinch points could all negatively impact worker safety. In Manitoba, worker protection is provided through legislated standards, procedures and training under the *Workplace Safety and Health Act*. To mitigate potential human health and safety impacts, the following mitigation measures will be implemented:

- All construction will be carried out in accordance with the Workplace Safety and Health Act to minimize health and safety effects.
- Contractors will adhere to the requirements of applicable health and safety legislation and the site specific safety plan developed by the prime contractor or contractor as appropriate.
- All workers will wear appropriate PPE at all times, including hearing and respiratory protection as required.

The residual effects to worker safety, if these mitigation measures are employed, are anticipated to be negligible.

5.15.2 Operation

During the operation phase of the project, Park Staff will be trained in the safe use of chemicals such as alum. Training will include the provision of appropriate PPE, spill protocols and safe handling procedures. Park staff will also be provided with appropriate training for all work associated with the lagoon (maintenance mowing, effluent sampling etc.).

The lagoon site will be fenced to limit public access. The limited access is anticipated to minimize the potential for drowning.

Licensed contractors will be retained to conduct periodic lagoon sludge removal activities to ensure work is conducted in a safe manner.

In advance of annual lagoon discharge, the lagoon effluent will be tested in accordance with *Environment Act* Licence requirements. Effluent will only be discharged if Licence limits are met to minimize the potential for surface water quality related human health effects. It is anticipated that the *Environment Act* Licence will include limits on discharge timing as well as quality parameters such as total coliforms to protect the human health of downstream Assiniboine River users.

With the above mitigation measures in place, the residual effects on human health and safety in operation are anticipated to be negligible.

5.16 Accidents and Malfunctions

5.16.1 Fire

During construction activities, there exists the potential for fires at the work site involving mechanical equipment and fuels. Effects related to fires include, but are not limited to, forest fire risk (and vegetation and wildlife habitat loss), harm to on-site personnel, equipment, and the potential release of contaminants and hazardous materials. During the operation phase of the project, small quantities of fuel will be used on site for powering mowers. Alum does not typically present a fire or explosion hazard and as such does not present a potential fire risk during the operation phase.

All precautions necessary will be taken to prevent fire hazards at the site, these include, but are not limited to:

- All flammable waste will be removed on a regular basis and disposed of at an appropriate disposal site.
- Appropriate fire extinguisher(s) will be available on the work site during construction activities. Such equipment will comply with and be maintained to, the manufacturers' standards.
- All on-site fire prevention/response equipment will be checked on a routine basis, in accordance with local fire safety regulations, to confirm the equipment is in proper working order at all times.
- Greasy or oily rags or materials subject to spontaneous combustion will be deposited and stored in appropriate receptacles away from surface water. This material will be removed from the site on a regular basis and be disposed of at an appropriate waste disposal facility.
- In periods of high forest fire risk, idling of vehicles will be reduced. Further, vehicles will be restricted to designated roads/trails to reduce potential fire ignition risk.

Implementing the above mitigation measures would likely result in negligible residual effects.

5.16.2 Spills

During construction and operation there is potential for environmental effects due to fuel and chemical spills. Accidents (including transportation accidents) could also result in the accidental release of alum, hazardous materials and/or equipment fluids or biosolids if they are being transported. A number of potential environmental concerns are also associated with the accidental release of chemicals and fuels resulting from improper storage and handling procedures. These include effects on soils, vegetation and groundwater quality, degradation of air quality and a direct threat to human health and safety.

To prevent spills from occurring during project activities, the following procedures will be employed.

- All potentially hazardous products will be stored in a pre-designated, safe and secure product storage area(s) at the work site in accordance with applicable legislation and in approved location by Parks.
- Storage sites will be inspected periodically for compliance with requirements as applicable.
- On site construction staff will be trained in how to deal with spills, including knowledge of how to properly deploy site spill kit materials.
- Any used oils or other hazardous liquids will be collected and disposed of according to provincial requirements.
- Service and minor repairs of equipment performed on site are only to be performed by trained personnel; however service will preferably be completed off site.
- Vehicles and equipment will be maintained to minimize leaks. Regular inspections of hydraulic and fuel systems on machinery will be completed on a routine basis; when detected, leaks will be repaired immediately.
- If on-site refuelling is required during the construction process, it will be conducted in dedicated areas located more than 100 m from the nearest high water mark with measures in place to provide containment, as required.
- Chemicals required for the construction process will be similarly stored in small quantities or with secondary containment.
- If required, site construction equipment will be utilized to quickly construct earthen check dams in drainage courses to minimize the potential for spills or contaminated water to flow towards aquatic habitats.

Implementing the above mitigation measures would likely result in negligible, reversible residual effects.

5.16.3 Dike Failure

During the operation phase of the proposed project, inadequate dike design could result in dike failure and subsequent release of raw, partially treated or treated effluent to the environment. Environmental effects could include erosion, surface and groundwater quality effects, flora loss, fauna habitat loss, fish and fish habitat effects and human health and safety effects. To prevent lagoon dike failure, the dikes will be geotechnically designed to contain the liquid load. The internal dikes of the lagoons will be lined with rip rap to protect the dikes from erosive wave action. A perimeter drainage ditch will prevent the dikes from being weakened from standing water in the fill. Regular inspection of dike integrity will be conducted by Parks personnel. In the event that deficiencies are identified, appropriate repair will be undertaken as soon as possible. With the described mitigation measures in place, the residual likelihood of dike failure is anticipated to be negligible.

5.16.4 Pipeline Malfunction

To prevent pipeline failure, new pipes will be tested prior to operation to identify any potential leaks. The proposed outfall pipeline has a low potential for leaks as it will be a gravity pipeline. Further, in the event of a leak of this pipeline any leaks would be of treated effluent therefore minimizing potential environmental impacts. In the event of

an identified pipeline failure, the location of the failure will be identified, the pipeline will be repaired and appropriate remediation measures will be undertaken.

5.16.5 Liner Failure

The proposed lagoon design includes a synthetic liner to protect groundwater resources. Potential leaks in the liner have the potential to cause groundwater impacts. During the construction process, liner joints will be welded in accordance with manufacturer specifications. The new lagoon will also include a dewatering/degassing system installed below the liner that will work similar to a house weeping tile system. The dewatering/degassing system will collect any seepage from the lagoon liner or any groundwater that rises to the level of the system to avoid pressure on the liner. The dewatering/degassing system will drain to a manhole that will discharge to the perimeter ditch. Parks will have the ability to test the water quality in the manhole to identify leaks. It is anticipated that the new *Environment Act* Licence may include a requirement to complete an annual groundwater monitoring program to identify potential leaks. If leakages are identified during facility operation or if contamination is identified during the groundwater monitoring program, Parks will investigate the source of the leakage/contamination. The investigation will be conducted with the intent to repair any problems as well as to provide monitoring and investigations to confirm the surrounding land/groundwater has not been contaminated and no risk to human health exists as a result.

5.16.6 Transportation Accidents

Transportation accidents can result in the release to the environment of vehicle fluids (such as diesel, oils etc.) and the material the vehicles were transporting (such as biosolids). Effects related to spills can include air, soil, surface water and groundwater quality impacts with potential for subsequent effects on flora, fauna, aquatic resources and human health. In the event of a transportation accident resulting in a spill, appropriate remediation measures will be coordinated with Manitoba Conservation and undertaken in accordance with the nature of the spilled material. Residual effects are anticipated to be negligible.

5.17 Effects of the Environment on the Project

5.17.1 Climate Change

Climate change has the potential to affect environmental conditions in Manitoba in several ways. Some examples of climate change effects that may plausibly affect this project include an increase in the ambient temperature of the area potentially resulting in a decrease in the flow of the Assiniboine River and changes in precipitation patterns.

Increases in ambient temperatures of the area may result in a longer agricultural growing season and increased water demands from the Assiniboine River for irrigation or other uses. Increased water demands may lead to a reduction in flow in the Assiniboine River. A reduction in the flow of the Assiniboine River has the potential to result in a corresponding reduction in the river's ability to assimilate wastewater discharges. As the proposed project is anticipated to improve treated effluent quality over the existing treatment provided and the discharge volume is negligible compared to the Assiniboine River flow, the magnitude of this potential effect is reduced by the proposed project.

In years of heavy rainfall or flooding, soils may become saturated or the groundwater elevation may rise, making land application of biosolids impractical. If land application is selected as the preferred biosolids management option, Parks will keep abreast of long term changes in environmental conditions and as necessary, look at alternative locations to use the biosolids.

5.17.2 Severe Weather

Severe weather conditions including high winds, heavy precipitation, and storms could affect the proposed project during construction and operation. High winds could result in erosion of disturbed areas and material stockpiles. To minimize the potential for this, disturbed areas will be kept to a minimum. In addition, the height of material stockpiles will be limited as required in high winds to mitigate wind erosion of stockpiles and, where applicable, re-vegetation will occur as soon as practical.

Heavy precipitation could result in erosion and runoff flooding of the site and surrounding area. Runoff flooding effects during construction and decommissioning activities will be mitigated by constructing temporary drainage and water diversion measures as appropriate, including the installation of silt fences to minimize erosion and sediment transport to the Assiniboine River or Kiche Manitou Lake. After construction is complete, the site will be re-vegetated to facilitate erosion control once the silt fences are removed.

During construction, site supervisors will be cognizant of weather conditions. To mitigate against extreme weather conditions, the following procedures will be employed as necessary:

- Flooding and erosion effects during construction activities will be mitigated by constructing temporary drainage and water diversion measures as appropriate.
- Erosion control measures will be employed throughout the construction phase of the project.
- Stockpiles will be protected from extreme weather elements as required.
- A stop-work policy will be in place to prevent workers from being exposed to extreme weather as necessary.

With the implementation of the above mitigation measures, the residual effects are anticipated to be negligible.

5.17.3 Flood

The proposed lagoon dikes will be designed to be higher than flood levels experienced in the spring of 2011 at the site. The lagoon design will prevent potential impacts to surface water quality due to lagoon breech during flood periods.

The annual discharge of treated effluent to the Assiniboine River is not anticipated to coincide with typical flood periods.

The residual effects are anticipated to be negligible.

5.17.4 Drought

In cases of drought, the Assiniboine River flow may be reduced causing a reduction of the assimilative capacity of the river and a decrease in the water quality. In general, the improved treatment provided by the new lagoon will reduce the impact that would be experienced by the river in the case of reduced flows.

Drought events can also result in significant evaporation from the lagoon cells. As the lagoon will include a synthetic liner, no impacts related to cracking of clay liners and subsequent potential lagoon integrity issues are not anticipated.

5.17.5 Seismic Activity

The proposed project is located in a region of Manitoba that has been assessed as an area of relatively low seismic hazard (Natural Resources Canada 2008). Seismic activity is not expected to affect the proposed project.

6. Monitoring and Follow Up

Mitigation requirements identified for the proposed project are summarized in **Appendix E**.

A Request for Project Review will also be submitted to Fisheries and Oceans Canada for approval in advance of construction of the outfall, as required. Fisheries and Oceans Canada will indicate the required mitigation measures to prevent the harmful alteration, disruption or destruction (HADD) of fish habitat during the construction process and may include implementation of a Habitat Compensation Plan and will be determined by Fisheries and Oceans Canada.

Parks staff will conduct a terrestrial survey of the project site in advance of construction. If sensitive species are identified (nesting birds, turtle nests etc.) mitigation measures will be developed as appropriate.

An HRIA of the terminus of the outfall is recommended once the terminus location is determined during the detailed design stage.

During the operation phase of the project, monitoring of effluent quality will be conducted in accordance with *Environment Act* Licence requirements to minimize the potential for surface water quality impacts.

Follow-up programs verify the accuracy of the environmental assessment of a project and determine the effectiveness of measures taken to mitigate the adverse environmental effects of the project. For the proposed project, standard mitigation will be applied as described herein and a formal follow-up program is not anticipated to be required.

7. Public Engagement

Public Engagement is an integral part of the environmental assessment process. It provides the opportunity for interested stakeholders to receive information from project proponents and, in return, it allows the proponents to gain an understanding of potential concerns. Public involvement can also provide an opportunity to actively involve stakeholders in the early stages of a project which, in turn, delivers a sense of transparency in the assessment and planning process.

Manitoba Parks, together with AECOM, determined that the local residents would be interested in participating in the public involvement process as the new lagoon will be constructed on the outer edge of Spruce Woods Provincial Park.

Public engagement included a public Open House event located at the Spruce Woods Provincial Park Provincial Park Interpretive Centre. A summary of the public involvement that has been undertaken for the Spruce Woods lagoon project is included in the following section.

7.1 Open House

On September 29, 2012, a public Open House was held in the Spruce Woods Provincial Park at the Park Interpretive Centre by Manitoba Parks and AECOM. This open house provided an opportunity to convey information concerning the proposed lagoon project, including the findings of environmental baseline studies and the environmental assessment, background investigations into available sites for the new lagoon and rationale for selecting the preferred site. This forum provided an opportunity for the public to provide the project team with feedback regarding the project.

To inform the public of this event, advertisements were placed in the Brandon Sun on September 22, 2012, The Baldur-Glenboro Gazette on September 18, 2012, the Carberry News Express on September 17, 2012 and the Central Plain Herald Leader on September 20, 2012.

The Open House event was held at the Spruce Woods Interpretive Centre from 10 am until 2 pm and approximately 20 attendees participated in the Open House throughout the day. The Open House event consisted of an informal discussion of the display boards and responding to questions and comments from attendees by representatives from AECOM and Parks.

Large print outs of the project details were displayed on easels around the room for attendees to examine in detail. Hardcopies of the Comment Sheet were made available to all attendees, which included a link to the web site containing the display board material and an online comment sheet. Two comment sheets were submitted. Comments were as follows:

- One comment indicated that the location of the new lagoon and its proximity to the public municipal road and nearby residents could affect the surrounding inhabited country environment. It was recommended that the lagoon be located north of the winter recreation area in section 24-8-14W or in the northern end of the SE ¼ of section 24-8-14W1.
    - During the open house, AECOM's representative discussed the alternative location north of the winter recreation area. This location was evaluated as Proposed Site #3 discussed in Section 2.3.3. Proposed Site #3 is located on top of an elevated flood plain between an outside bend in the Assiniboine River (to the west) and the main valley slope (to the east). Slope stability at this location was a major concern.
    - During the open house, Parks' representative identified that the second location proposed, north end of SE ¼ of section 24-8-14W1, was an existing Prairie Grass Heritage Site. Construction in this area is prohibited.

- Another comment received also suggested relocating the lagoon to the SW ¼ of Section 24, north of the skating rink (Winter Recreation Area). A second option suggested was the NE ¼ or the SE ¼ north of the trees.
  - As discussed in the Open House, both of these locations were evaluated and rejected due to slope stability concerns in the first location and the Prairie Grass Heritage Site regulations in the second option.
- In addition to the two comments received after the Open House, one letter was sent to Manitoba Parks prior to the open house event. This letter identified concerns over the lagoon location in regard to lagoon odour effects on the nearby residents.
  - During the open house, AECOM's representative identified that the new lagoon would consist of several layers of shelter belt material to both minimize any odours and the visual effect of the new lagoon on residents.
- No other comments were received.

Through discussions with Open House attendees, it was obvious that the lagoons proximity to local residents was the main concern. All Open House attendees acknowledged the need to relocate the lagoon from the existing location to a location safe from river erosion and future floods. During the design stage for the new lagoon, an evaluation of several alternative locations was conducted, however, the current location was deemed to be the only viable option.

8. Conclusions and Recommendations

It is recommended that the mitigation measures, monitoring and follow up programs described in this report are implemented to minimize potential environmental effects and/or identify effects early so that appropriate action can be undertaken.

Overall the negative residual effects of the proposed development were considered to be negligible to minor in magnitude. The proposed project will provide an overall improvement in effluent quality, however when compared to flow rates in the Assiniboine River the magnitude of the effect is considered a negligible relative improvement in surface water quality.

A Request for Project Review will be submitted to Fisheries and Oceans Canada for approval in advance of construction of the outfall, as required. Fisheries and Oceans Canada will indicate the required mitigation measures to prevent the harmful alteration, disruption or destruction (HADD) of fish habitat during the construction process and may include implementation of a Habitat Compensation Plan.

Parks staff will conduct a terrestrial survey of the project site in advance of construction. If sensitive species are identified (nesting birds, turtle nests etc.) mitigation measures will be developed as appropriate.

An HRIA of the terminus of the outfall is recommended once the terminus location is determined during the detailed design stage. As per the recommendations in the HRIA, while no heritage concerns were found for the Project Site, there is always potential for heritage resources to be discovered during excavation activities. Should this happen, an archaeologist will be contacted and the finding reported to HRB. In addition, should human remains be discovered, all activity at the location

During operation, monitoring of effluent quality will be conducted in accordance with anticipated *Environment Act* Licence requirements. With the implementation of the mitigation and monitoring programs identified in this environmental assessment, residual effects from the proposed project are assessed to be negligible to minor.

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Figures

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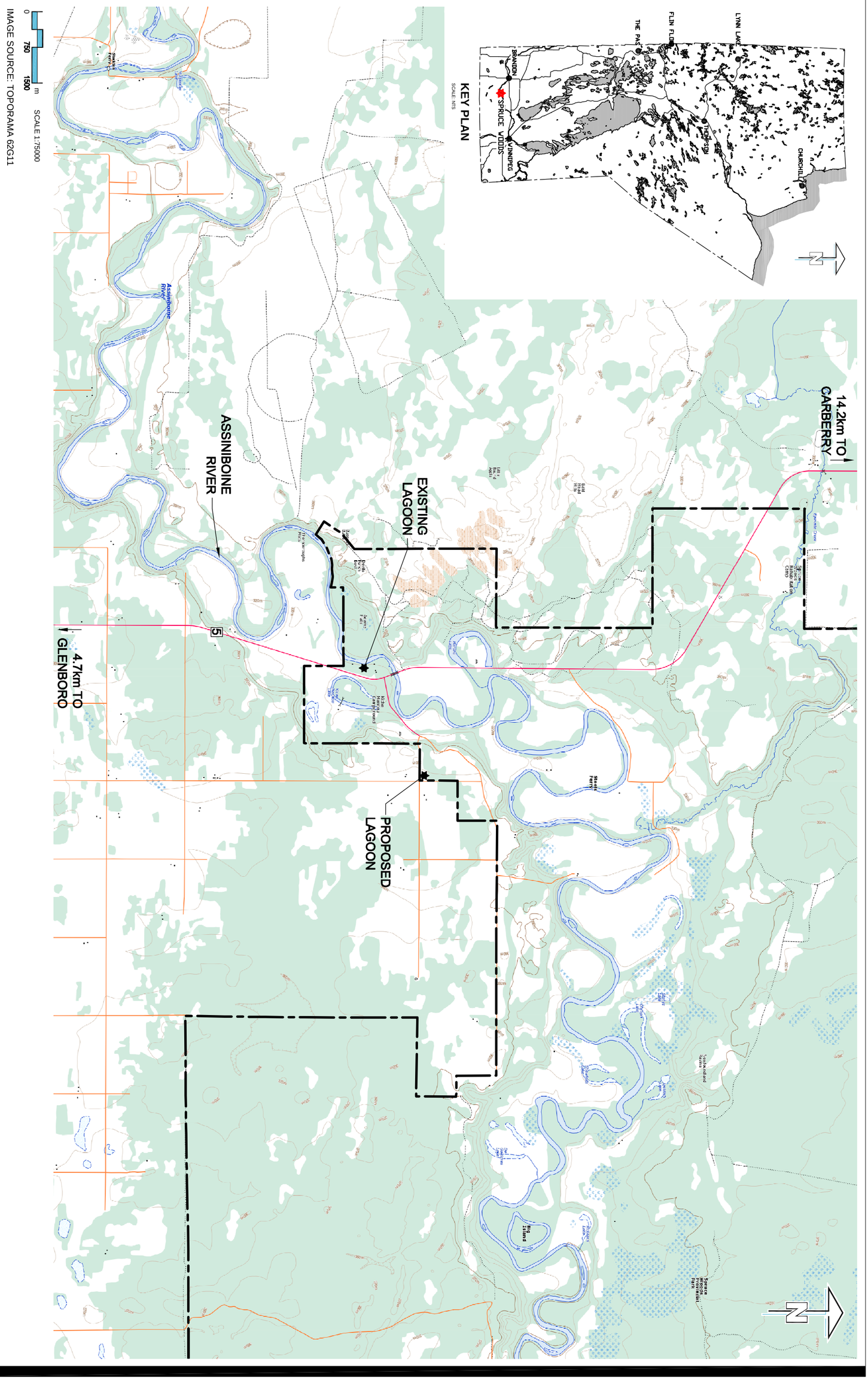

Lagoon Replacement Environment Act Proposal
Spruce Woods Provincial Park
The Manitoba Water Services Board

Location Plan

AECOM

Figure: 1

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Lagoon Replacement Environment Act Proposal
Spruce Woods Provincial Park
The Manitoba Water Services Board

Existing and Proposed Lagoon

AECOM

Figure: 2

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Lagoon Replacement Environment Act Proposal
Spruce Woods Provincial Park
The Manitoba Water Services Board

Alternative Sites Examined

AECOM

Figure: 3

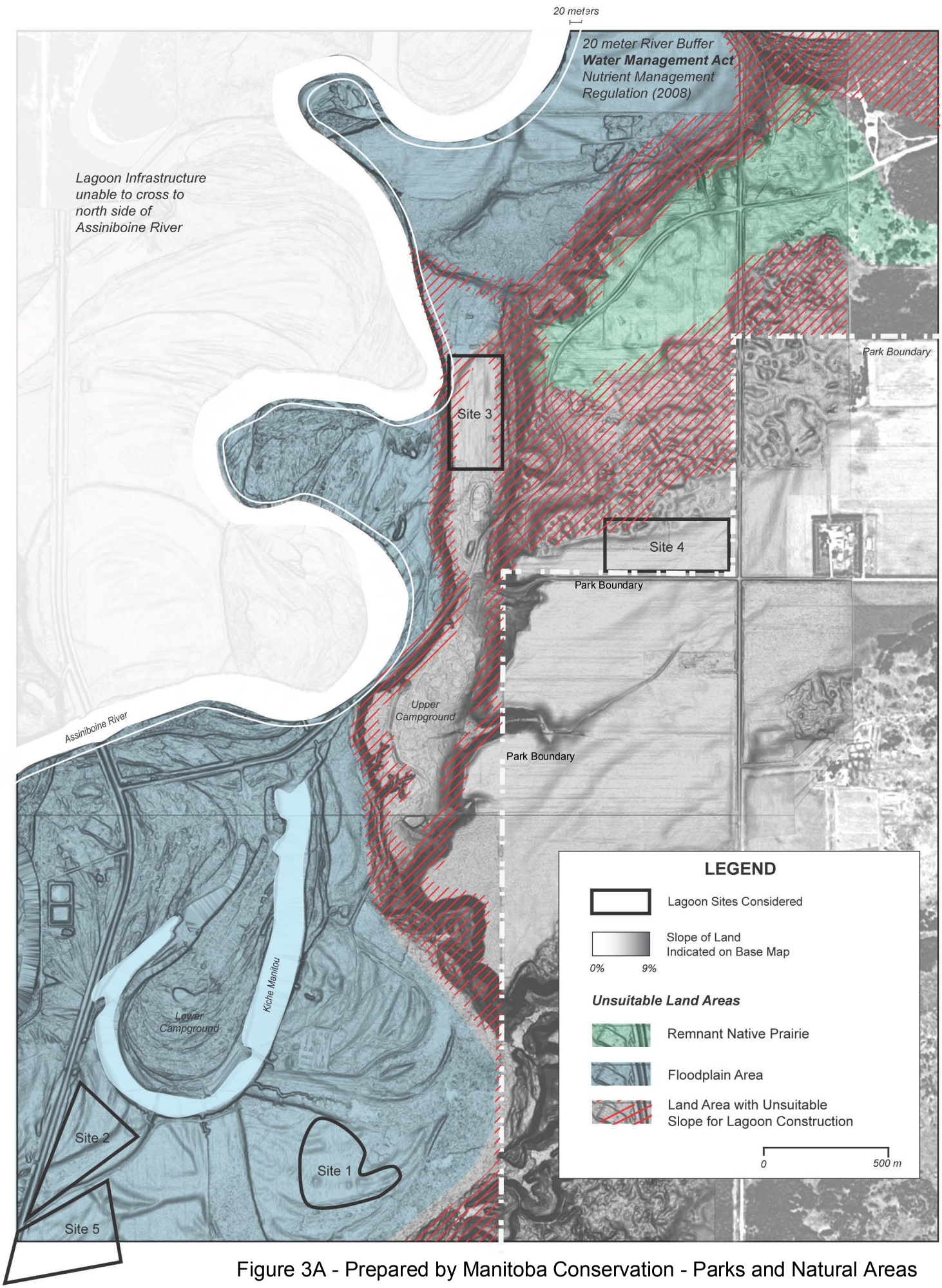

Figure 3A - Prepared by Manitoba Conservation - Parks and Natural Areas

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Lagoon Replacement Environment Act Proposal
Spruce Woods Provincial Park
The Manitoba Water Services Board

Geographic Boundaries of the Assessment

AECOM

Figure: 4

Appendix A
Pre-design Report

The Manitoba Water Services Board
Manitoba Conservation

Spruce Woods Provincial Park Lagoon Preliminary Design Report

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Project Number:

60221902.403

Date:

May, 2013

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("Consultant") for the benefit of the client ("Client") in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations");
- represents Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to Consultant which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

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May 28, 2013

Travis Parsons, P.Eng
Chief Engineer
The Manitoba Water Services Board
2022 Currie Blvd.
Brandon MB, R7A 6Y9

Dear Mr. Parson:

Project No: **60221902.403**

Regarding: **Spruce Woods Provincial Park Lagoon Preliminary Design Report – Final**

We are pleased to submit the Spruce Woods Provincial Park Lagoon Preliminary Design Report. The report includes information on the site selection, wastewater flows, lagoon layout and construction considerations, and forms the basis for the detailed design and implementation phases of the project.

We appreciate the assistance proved by the Manitoba Water Services Board and Parks and Natural Areas during the preparation of the Predesign Report. Please contact us if you have any further requirements at this time.

Sincerely,
AECOM Canada Ltd.

Eric Hutchison, P.Eng.
Project Manager
Eric.Hutchison@aecom.com

HB:td
Encl.

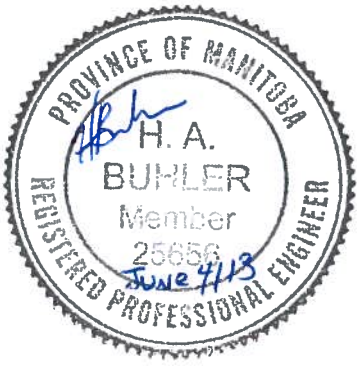
Distribution List

# of Hard Copies	PDF Required	Association / Company Name
1	1	MB Conservation
1	1	The Manitoba Water Services Board

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	H.Buhler	Jan 30, 2013	Draft
2	H.Buhler	May 27, 2013	Final

AECOM Signatures



Report Prepared By:

Heather Buhler, P.Eng

Report Reviewed By:

Eric Hutchison, P.Eng

Executive Summary

The Manitoba Water Services Board (MWSB) has retained AECOM to prepare an assessment, preliminary design, and environment act proposal for the Spruce Woods Provincial Park Lagoon. This facility is owned and operated by Manitoba Conservation Parks and Natural Areas (Parks). The existing lagoon is located 29.9 km south of Carberry, Manitoba along PTH 5 and was constructed in 1982 as a two cell lagoon. The existing lagoon is in jeopardy from the constantly eroding Assiniboine River bank, which moves approximately 6 m closer to the lagoon each year. The existing secondary cell has been completely abandoned due to leaking, after attempts to repair the liner were unsuccessful. The primary cell holds liquid, but has never required discharge, which is evidence that this cell is also leaking.

Wastewater is received by forcemain from the campground, which has 163 standard campsites, 21 family campsites, 9 group use campsites, 13 yurts, several modern washroom and shower facilities. Hauled waste is trucked from 27 holding tanks throughout the Park and septage is hauled from several locations within the Park. Including infiltration, future projected flows for the new lagoon have a total annual flow of almost 44 ML.

A total of five potential locations throughout the Park were proposed by Parks staff and evaluated to determine their suitability as a new lagoon location. The original investigations of two potential locations, completed in 2010, resulted in the selection of one site along PTH 5 south of the campground. However, significant flooding in the spring of 2011 resulted in the need to review alternative sites at higher elevations. All the sites are within the Park boundary, several on land currently being leased out as agricultural land. Geotechnical investigations recommended the site located near the eastern gate of the campground. The primary sand stratum encountered is considered suitable material for the construction of exterior dikes. Groundwater levels in the area were low and the site elevation is well above the 2011 high water level.

Hydraulic conductivity of the soil necessitates a compacted clay or synthetic liner. As there is no significant quantity of clay available nearby, a synthetic liner was selected as a more viable option. The geosynthetic liner will be installed in both the primary and secondary cells with appropriate layers of bedding sand above and below. A dewatering and degassing system will be installed below the liner to allow for the release of groundwater seepage and gas that may accumulate under the liner.

The total volume of the primary cell will be 30,690 m^3, while the secondary cell will have a total volume of 35,861 m^3.

Construction of a service road will be required to provide for truck access associated with the new lagoon. The existing lift station and forcemain will also require upgrades in order to handle the hydraulics of a 1.7 km uphill pumping distance and higher flows in the future.

The new lagoon will discharge into the Assiniboine River which flows into Lake Winnipeg and the lagoon is owned and operated by the Province, so it is expected that the lagoon's operating licence will have a phosphorus limit of 1 mg/L. Two options were studied for phosphorus removal, alum dosing and the Phosphex™ system. While both systems will remove phosphorus to discharge levels, the alum dosing option is recommended due to its simplicity and low life cycle costs.

Once the new lagoon is constructed and operational, the existing lagoon will be decommissioned. This will involve dewatering the lagoon and disposing of the remaining sludge, as well as landscaping and revegetating.

The Estimated capital costs for the new facultative lagoon and all associated piping, infrastructure and decommissioning of the existing lagoon are expected to be $5,313,500.00.

Based on the preliminary schedule, the environment act proposal, being prepared as a separate document, will be completed in February, 2013. Public consultations were completed in September, 2012. The project is expected to be tendered and awarded by the end of April 2013 with construction starting in May 2013. Lagoon construction is scheduled to be completed by October 2013 with the decommissioning in the existing lagoon completed the following summer, 2014.

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Appendix C. Summary of the Capital, O&M, and Life Cycle Costs
Appendix D. Drawings
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Appendix F. Soil Survey Report

1. Introduction

Manitoba Conservation – Parks and Natural Areas (Parks) has authorized The Manitoba Water Services Board (MWSB) to hire a consultant to assess the existing lagoon and prepare a preliminary design for any required lagoon upgrades. MWSB has retained AECOM to prepare the assessment and preliminary design for the Spruce Woods Provincial Park Lagoon.

Spruce Woods Provincial Park Campground operates seasonally from mid May until mid October. The Park offers a variety of activities including seasonal camping, miniature golf, hiking, swimming, equestrian trails, and snowmobiling trails.

The existing lagoon is located 29.9 km south of Carberry, Manitoba along Provincial Truck Highway #5 (PTH 5) and was constructed in 1982 as a two cell lagoon. The existing lagoon is in jeopardy from the constantly eroding Assiniboine River bank which moves closer to the lagoon each year. Park staff estimate that the discharge pipe has to be cut back approximately 6 m a year to account for the eroding river bank. The secondary cell is also seriously compromised and leaks continually. In 2003 an attempt was made to reline the secondary cell but the banks did not hold and the secondary cell was completely abandoned. Parks has determined that the lagoon must be relocated to a new site. Five new sites selected by Parks staff were evaluated by AECOM, and one site was selected. This report provides an assessment of the selected lagoon location, preliminary design, and construction considerations.

2. Sources of Wastewater

The Spruce Woods Campground offers 163 standard campsites, 21 family camp sites, 9 group use campsites, and 13 yurts. The campground has a combination of electrical and basic camping opportunities; no full service sites are currently available. Several modern washrooms are located throughout the campground as well as laundry and shower facilities. All waste from these locations is pumped to the wastewater lagoon through a series of lift stations.

The Spruce Woods lagoon also accepts waste hauled from holding tanks located throughout the Park; including the equestrian campground, various small cabins and boat launches. The lagoon accepts waste from approximately twenty-seven locations throughout the Park that contain holding tanks. All holding tanks are emptied in the fall and no waste is hauled through the winter months. As well, septage is hauled from several other locations throughout the Park. No external waste haulers are permitted to dump in the Spruce Woods lagoon.

Spruce Woods is rather unique in its operating dates. A large section of the campground offers fall camping from the September long weekend until Thanksgiving, in mid October. After the September long weekend Bays 8 to 11, the group sites, and the yurts remain open for approximately 4 additional weeks.

3. Condition Assessment of Existing Lagoon

The Spruce Woods lagoon is located west of PTH 5 behind the Parks maintenance compound. The lagoon was constructed as a replacement to an existing mechanical treatment plant, Smith & Loveless – extended aeration, in 1982. The treatment plant was located along the banks of the Assiniboine River and was subject to regular flooding from the river. This, coupled with the progressive deterioration of effluent quality resulted in the need to create a new wastewater treatment system and a conventional sewage lagoon was constructed.

When the lagoon was originally constructed, geotechnical investigations found that the silty and poorly graded sand would require an impervious liner to be constructed. The contractor was given the option of constructing a 1m thick compacted clay liner or a 20 mil PVC liner, whichever was the most economical. The lagoon was constructed with a clay liner in both cells.

Primary Cell

The lagoon has not been discharged in the 30 years it's been in operation, displaying clear evidence that the primary cell is leaking to some degree. The cell does hold liquid and was not overly full during the visual lagoon assessment completed in August of 2010.

The secondary cell is currently not in operation due to severe leaking. In speaking with the Park operators, it has been determined that when the lagoon was originally constructed low wastewater flows resulted in the second cell not being used. With inadequate liquid levels in the secondary cell the clay liner dried out and cracked destroying the supposed impervious liner. As a result, the secondary cell has never been able to hold liquid. In 2003, an attempt was made to repair this liner by relining it with clay a second time. However, again the liner was not able to remain wet enough to stay sealed and the secondary cell was completely abandoned.

The existing lagoon discharge, which has never been used, is not in an ideal location due to a shifting River course. The existing lagoon was designed to discharge through a PVC pipe into the Assiniboine River west of the lagoon. Discharge was scheduled to occur in the spring prior to the park opening. It was felt that discharging directly into the River in the spring would further prevent downstream pollution by the high dilution rate during peak run-off period. However, the continually erosion of the river bank at this location has resulted in the discharge pipe be cut back approximately 6 m each year.

Discharge Pipe

Due to the rapidly eroding river bank the exiting lagoon site will be abandoned and a new lagoon constructed in a site with less risk of damage from the River.

4. Proposed Site Investigations

A total of five sites were taken into consideration for the construction of the new facility. Alternate Site #1 and Site #2 were both originally investigated in the summer of 2010. Site #1 is located approximately 1,200 m southeast of the existing lagoon facility on the east side of PTH 5. Site #2 is approximately 170 m south of the existing lagoon facility also on the east side of PTH 5. Both sites are situated on agricultural land currently being leased out by Parks. See **Figure 1** for site locations.

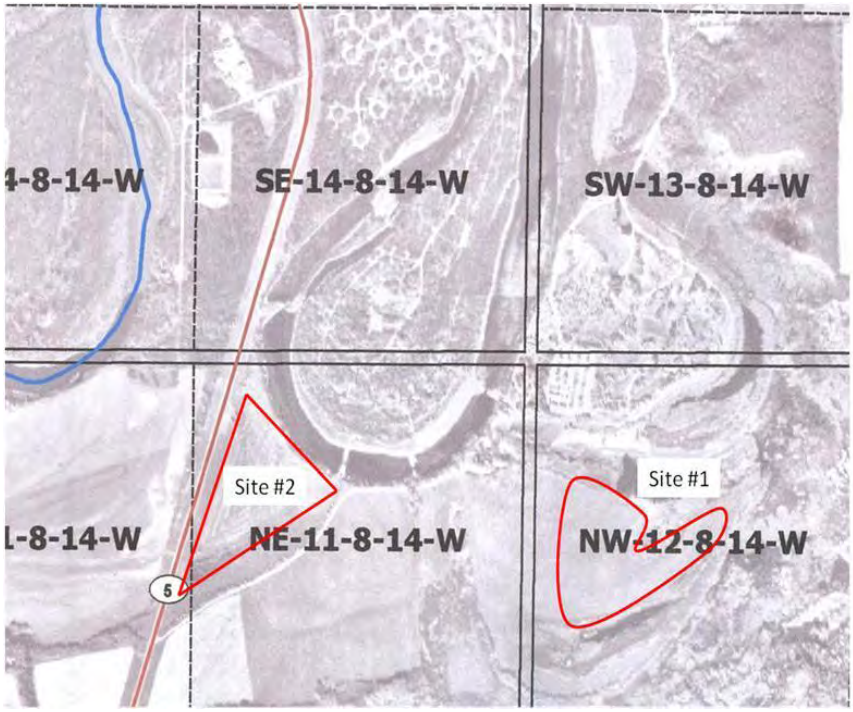


Figure 1: Proposed Lagoon Sites #1 and #2

4.1 Site #1

Geotechnical investigations at Site #1 found the area very wet and surrounded by dense vegetation. The soil conditions were found to be mainly sand with variable silt and gravel content. The complete geotechnical report for all sites is included in **Appendix A**.

Figure 2: Site #1

Four piezometers were left in the ground at Site #1 to monitor groundwater levels. Water levels were recorded on August 5th and August 29th, 2010. Groundwater levels in August were fairly stable ranging from 0.98 to 2.99 m below the ground surface. As such, excavation of the proposed lagoon basin may result in excess seepage, and hydrostatic uplift pressures may damage the liner once constructed.

Groundwater conditions encountered at Site #1 are considered unsuitable and construction of a wastewater treatment lagoon and this site is not recommended. No further investigations were conducted on Site #1.

4.2 Site #2

Geotechnical investigations have been conducted on an area approximately 200 x 100 m at Site #2. Test holes found soil that has a primary sand stratum with variable silt content, which in turn is underlain by clay till or gravel till.

Figure 3: Site #2

Three piezometers were installed at Site #2 to monitor groundwater levels. Water levels were recorded on August 4th and August 29th, 2010. Groundwater levels in August were fairly stable ranging from 2.19 to 3.44 m below the ground surface.

The primary sand stratum encountered during the geotechnical investigated is considered suitable material for the construction of exterior dikes. However, the hydraulic conductivity is sufficiently high that a lagoon excavated into these soils will require a compacted clay or synthetic liner. As there was no significant quantity of clay encountered, a synthetic liner may be a more viable option. Based on the preliminary investigations, Site #2 was determined as a feasible option for the construction of a new wastewater treatment lagoon. Design of a new wastewater lagoon proceeded on Site #2 with a preliminary design report and draft Environment Act Proposal being completed in early 2011.

In April 2011 a significant flood occurred in the Spruce Woods Provincial Park, flooding the majority of the park and Site #2. Based on the high water elevation during the flood and the proposed dike elevations of the new lagoon it was determined that Site #2 was a risky location for a new lagoon and could potentially be flooded during future flood events.

Figure 4: Flooded Spruce Woods Campground

4.3 Site #3

After the 2011 flood, the Parks staff was forced to investigate alternative sites for the new wastewater lagoon. In the fall of 2011, three additional sites were reviewed as potential new lagoon locations. Site #3 is located in the northeast corner of the campground along the banks of the Assiniboine River. **Figure 5** shows the approximate location of Site #3.

Figure 5: Site #3

Site #3 is located on top of an elevated flood plain between an outside bend in the Assiniboine River (to the west) and the main valley slope (to the east). Slope stability is a major concern at this location as both up slope and down slope of the existing topography which will affect the lifespan of the lagoon.

Further geotechnical investigations of the river bank slope stability, surveys of the river bottom and the slope stability of the hill to the east of the site would be required prior to any potential construction on this site. In addition, regardless of the geotechnical investigations, it is understood that due to the location, on the outside bend of the River, this location will be in danger of eroding into the River at some point in the future.

Due to the significant concerns with respect to slope stability and future risks inherent with this site, Site #3 is considered unsuitable for construction of a wastewater treatment lagoon and this site is not recommended. No further investigations were conducted on Site #3.

4.4 Site #4

Site #4 is located near the eastern entrance to the Spruce Woods campground at the high point in the park, as shown in **Figure 6**. This site is located on flat ground that is currently leased to a local farmer and used as agricultural land. Slope stability is not anticipated to be a concern at this location. The elevation at this site is well above the 2011 flood levels, approximately 40 m above the elevation of the existing lagoon site.

Figure 6: Site #4

The primary sand stratum encountered during the geotechnical investigated is considered suitable material for the construction of exterior dikes. However, the hydraulic conductivity is sufficiently high that a lagoon excavated into these soils will require a compacted clay or synthetic liner. As there was no significant quantity of clay encountered in the area, a synthetic liner will be used. Based on the preliminary investigations, Site #4 was determined to be a feasible option for the construction of a new wastewater treatment lagoon.

4.5 Site #5

In an attempt to look at potential sites further away from local residents, Site #5 was considered as it was expected to be at a slightly higher elevation than the original Site #2. However, survey data at this site revealed that the ground elevation was less than 2 m higher than the elevation in Site #2 and was still lower than the 2011 high water elevation. **Figure 7** shows an approximate location of Site #5.

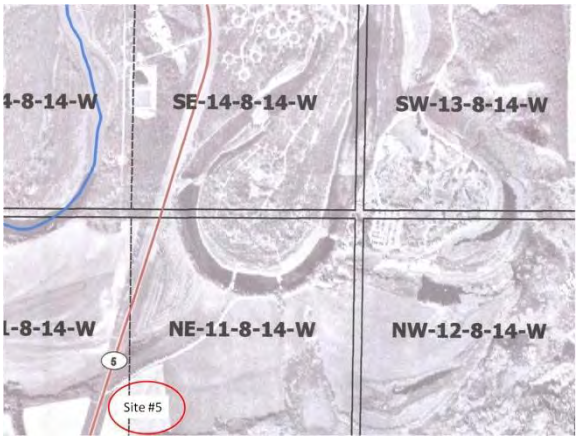


Figure 7: Site #5

Due to the ground elevation at this site, Site #5 is considered unsuitable for construction of a wastewater treatment lagoon and this site is not recommended. No further investigations were conducted on Site #5.

5. Current Wastewater Flows

The Spruce Woods Campground is open 7 days a week from May 14th to September 18th for Bays 1 through 7. Bays 8 to 11, the group sites, and the yurts remain open for approximately 4 additional weeks until October 11th. During the winter, the campground system is shut down and no waste is pumped to the lagoon.

Estimated wastewater flows are divided into type of site, washroom, laundry and shower facilities, and a campground office. From information published on Manitoba Conservation's website, (http://www.gov.mb.ca/conservation/envprograms/wastewater/pdf/mb_min_sewage_vol_july_2010%20xls.pdf) each camper is expected to contribute 110 L of wastewater per day. Additional flow has been anticipated for shower usage. Infiltration was also taken into consideration. **Table 1** summarizes the estimated flows.

Table 1: Current Estimated Flow – Spruce Woods Campground

Flow Components	Number of Sites	Number of Units	Daily Volume per Unit (L)	Total Daily Flow (L/day)
Sites Open 18 Weeks per Year				
Bay 1 to Bay 7	121	423.5 people[2]	110[1]	46,585
Laundry Facility[6]		4 machines	1330	5,320
Main & Beach Shower Facility[7]		10 stalls	Showerhead @ 7.5 L/min	25,410
Campground Office[1]		5 People	49	245
Average Day Flow				**77,560**
Annual Flow (18 weeks operation)				**9,772,560 L**
Sites Open 22 Weeks per Year				
Bay 8 to Bay 9	42	147 people[2]	110	16,170
Yurts	13	45.5 people[3]	110	5,005
Family Use Sites	21	441 people[4]	110	48,510
Group Use Camp Sites	9	315 people[5]	110	34,650
Bay 10 Shower Facility[7]		7 stalls	Showerhead @ 7.5 L/min	56,910
Average Day Flow				**161,245**
Annual Flow (22 weeks operation)				**24,831,730 L**
Total Campground Annual Flow				**34,604,290 L**

Notes:

1 *Campsite Flows – The numbers used in **Table 1** for daily wastewater flows per full service RV site, and per person for a developed campground are derived from the Manitoba Minimum Expected Volume of Sewage Per Day Typical Wastewater Flow Rates, July 2010, published by Manitoba Conservation (http://www.gov.mb.ca/conservation/envprograms/wastewater/pdf/mb_min_sewage_vol_july_2010%20xls.pdf)*

2 *Calculations are based on a full campground with 3.5 people per Camping unit.*

3 *Calculations are based on a full campground with 3.5 people per yurt, three new yurts have been added to the 2011 camping Season.*

4 *Family use campsites allow for up to 6 camping units per site. Calculations are based on a full campground with 3.5 people per camping unit.*

5 *Group use campsites allow for up to 10 camping units per site. Calculations are based on a full campground with 3.5 people per camping unit.*

6 *Laundry Facility – There are currently four washing machines operating at a central facility. It is assumed that when the campground is full, each machine is capable of running 7 loads/day at 190 litres per load.*

7 *Shower Facility – Three shower facilities are present in the main campground, 8 stalls in the main shower facility, 2 stalls at the beach, and 7 stalls in Bay 10. A low flow shower head on the market today ranges from 6.0 L/min – 9.4 L/min. The shower facilities are assumed to have installed shower heads of 7.5 L/min. Calculations assumed that each campsite occupant showered once a day for 8 minutes.*

5.1 Hauling Locations

Spruce Woods lagoon accepts waste hauled from approximately twenty-seven locations throughout the Park. Though several of these locations are open year round, the holding tanks are emptied only during the summer and fall. No waste is hauled during the winter months.

The standard holding tank can hold a maximum of 5,000 L of waste. All tanks that are pumped out once per year are emptied in the fall after the campground is closed for the season. **Table 2** lists all of the holding tanks throughout the Park.

Table 2: Current Estimated Flow – Spruce Woods Holding Tanks

Holding Tank Locations	Tank Size (L)	Number of Pump Outs (per yr)	Total Waste (L)
Day Use - Parking Lot Washroom	5,000	5	25,000
Bay 9 Washroom	5,000	5	25,000
Bay 10 Washroom	5,000	20	100,000
Bay 10 "Y" Washroom	5,000	26	130,000
Winter Recreation Area	5,000	1	5,000
Canoe/Boat Launch	5,000	1	5,000
Marsh's Lake	5,000	1	5,000
Spirit Sand - Parking Lot	5,000	1	5,000
Spirit Sand - 1st Dune	5,000	1	5,000
Spirit Sand - Devils' Punch Bowl	5,000	1	5,000
Spirit Sand - Trail	5,000	1	5,000
Parsons Hill	5,000	1	5,000
Yellow Quill Ski Trail - Parking Lot	5,000	1	5,000
Yellow Quill Ski Trail - Cabin 2	5,000	1	5,000
Seton Ski Trail - Parking Lot	5,000	1	5,000
Seton Ski Trail - Cabin 2	5,000	1	5,000
Epinette Trail - Parking Lot	5,000	1	5,000
Epinette Trail - Cabin 2	5,000	1	5,000
Epinette Trail - Cabin 3	5,000	1	5,000
Epinette Trail - Cabin 4 (Jackfish)	5,000	1	5,000
Equestrian Canoe Landing (2 tanks)	10,000	1	10,000
Snowmobile Warming Cabin 1	5,000	1	5,000
Snowmobile Warming Cabin 2	5,000	1	5,000
Snowmobile Warming Cabin 3	5,000	1	5,000
Holland Bridge Wayside	5,000	1	5,000
Seton Wayside	5,000	1	5,000
Criddle/Vane Heritage Park	5,000	1	5,000
Total Annual Flow			**400,000 L**

5.2 Septage Locations

In addition to the campground and holding tanks, there are several sites throughout the Park that truck septage to the lagoon. The following sites deliver septage to the lagoon; flows are detailed in **Table 3**:

1. The Equestrian Campground, which is run by Friends of Spruce Woods, contains 15 campsites and a three stall shower and washroom facility. All solid waste from this facility is stored in a septic tank, with grey water being discharged through an ejector system. The septage is emptied out only once a year in the fall.
2. The Maintenance Compound contains three septic tanks with all grey water being disposed of through an ejector system to the existing lagoon. Septage is collected once a year in the fall.
3. The Wagon ride residence contains a septic tank and ejector system. Septage is collected once a year in the fall.
4. The Bay 10 shower/washroom, yurt washroom, trailer dump station, main shower/washroom, beach shower facility, and the Day Use – Park Interpretive Centre all contain holding tanks which are connected to the existing sewer system. However, due to the high solids concentrations in these locations, septage is also pumped out of these tanks periodically. Bay 10 shower/washroom facility is pumped out an average of 4 times per year to maintain the flow in the system. The other five locations are pumped out only once a year in the fall.

Table 3: Current Estimated Flow - Spruce Woods Septage

Septage Locations	Amount of Septage Hauled per year (L)
Equestrian Campground	5,000
Maintenance Compound	15,000
Wagon Ride Residence	5,000
Bay 10 Shower/Washroom	20,000
Trailer Dump Station	5,000
Yurt Washroom	5,000
Main Shower/Washroom	5,000
Beach Shower	1,000
Day Use – Park Interpretive Center	5,000
Total Annual Septage	**66,000 L**

Total annual flow to the lagoon is the sum of the flow from the campground, waste hauled from all the individual holding tanks, hauled septage and infiltration. Infiltration has been estimated by the Park staff to be approximately 100 L/day year round. Annual flows are summarized in **Table 4**.

Table 4: Current Estimated Flow – Total Annual Flows

Unit	Total Annual Flow (L)
Campground	34,604,290
Holding Tanks	400,000
Septage	66,000
Infiltration	36,500
Total Annual Flow	**35,106,790 L**

6. Future Wastewater Flows

6.1 Campground

Future projected flows will form the basis for the design of the new lagoon. The Spruce Woods operating staff have specified that in the future, a second campground may be created which would truck all waste to the Spruce Woods lagoon. It is expected that this new campground would facilitate approximately 100 standard sites (no full service sites).

There is also the potential to add some full service sites, at most 50 existing campsites may be converted to full-service sites. In addition, one currently decommissioned site will be converted into a yurt in the future, bring the total to 14 yurts in the Park. No other water or wastewater expansions or upgrades are currently planned for the next twenty years. Projected future wastewater flows are outlined in **Table 5**. Full service sites are expected to generate 180 L/site/day additional wastewater above the current estimated flows.

Table 5: Future Projected Flow - Spruce Woods Campground

Flow Components	Number of Sites	Number of Units	Daily Volume per unit (L)	Total Daily Flow (L/day)
Sites Open 18 weeks per year				
Full Service Sites	50	50 unit	180	9,000
New Future Campground	100	350 people	110	38,500
Bay 1 to Bay 7	121	423.5 people[2]	110[1]	46,585
Laundry Facility[6]		4 machines	1330	5,320
Main & Beach Shower Facility[7]		10 stalls	Showerhead @ 7.5 L/min	46,410
Campground Office[1]		5 people	49	245
Average Day Flow				**146,060**
Annual Flow (18 weeks operation)				**18,403,560 L**
Sites Open 22 weeks per year				
Bay 8 to Bay 9	42	147 people[2]	110	16,170
Yurts	14	49 people[3]	110	5,390
Family Use Sites	21	441 people[4]	110	48,510
Group Use Camp Sites	9	315 people[5]	110	34,650
Bay 10 Shower Facility7		7 stalls	Showerhead @ 7.5 L/min	57,120
Average Day Flow				**161,840**
Annual Flow (22 weeks operation)				**24,923,360 L**
Total Campground Annual Flow				**43,326,920 L**

Notes:

1 Campsite Flows – The numbers used in Table 5 for daily wastewater flows per full service RV site, and per person for a developed campground are derived from the Manitoba Minimum Expected Volume of Sewage Per Day Typical Wastewater Flow Rates, July 2010, published by Manitoba Conservation (http://www.gov.mb.ca/conservation/envprograms/wastewater/pdf/mb_min_sewage_vol_july_2010%20xls.pdf)

2 Calculations are based on a full campground with 3.5 people per Camping unit.

3 *Calculations are based on a full campground with 3.5 people per yurt, three new yurts have been added to the 2011 camping Season.*

4 *Family use campsites allow for up to 6 camping units per site. Calculations are based on a full campground with 3.5 people per camping unit.*

5 *Group use campsites allow for up to 10 camping units per site. Calculations are based on a full campground with 3.5 people per camping unit.*

6 *Laundry Facility – There are currently four washing machines operating at a central facility. It is assumed that when the campground is full, each machine is capable of running 7loads/day at 190 litres per load.*

7 *Shower Facility – Three shower facilities are present in the main campground, 8 stalls in the main shower facility, 2 stalls at the beach, and 7 stalls in Bay 10. A low flow shower head on the market today ranges from 6.0L/min – 9.4 L/min. The shower facilities are assumed to have installed shower heads of 7.5 L/min. Calculations assumed that each campsite occupant showered once a day for 8 minutes.*

6.2 Holding Tanks

There is no expected expansion of any of the areas currently containing holding tanks; therefore, the annual flow is expected remain consistent at 400,000 L for all holding tanks in the Park.

6.3 Septage

There is no expected expansion of the equestrian campground, or other areas currently hauling septage to the lagoon; therefore, the annual flow is expected remain consistent at 66,000 L for all holding tanks in the Park.

6.4 Total Future Flows

Total annual flow to the lagoon is the sum of the flow from the campground, waste hauled from all the individual holding tanks, and infiltration. Infiltration has been estimated by the Park to be approximately 100 L/day year round. Annual flows are summarized in **Table 6**.

Table 6: Future Projected Flow - Total Annual Flows

Unit	Total Flow (L)
Campground	43,326,920
Hold Tanks	400,000
Septage	66,000
Infiltration	36,500
Total Annual Flow	**43,829,420 L**

7. Design Criteria

The wastewater lagoon must be sized to treat the projected organic and hydraulic wastewater loads. Organic loading is estimated based on population. A design population was calculated from the total number of campsites and cabins, based on approximately 3.5 people per camping unit. This calculation projects a total population over the next 20 yrs of 1,731 people discharging to the lagoon. However, as this is a seasonal location the maximum population is only present during the two busiest months of the year, July and August. For a proportion of the year there is no load going to the lagoon.

Since organic loading is based on the population base, special consideration should be given in determining the appropriate population to use for the organic loading design for a seasonal facility. The maximum population in the middle of the summer is not representative of the rest of the year and if used as the design basis may result in a lagoon that is oversized. However, at the same time the lagoon needs to be large enough to treat the flows and loads expected during the summer.

To account for the seasonal fluctuations in population throughout the year we recommend basing the design on the average population for the six months the park is in operation. Manitoba Conservation guidelines limit the amount of organic loading to 56 kg BOD/ha/day with an influent BOD loading rate of 0.075 kg BOD/person/day. The key to a facultative lagoon's operation is oxygen production by photosynthetic algae and surface reaeration. The surface area of the primary cell is where the wastewater treatment occurs. Oxygen at the surface is utilized by the aerobic bacteria in stabilizing the organic material in the upper layer of waste. The bottom layer of the primary cell is considered storage where anaerobic fermentation occurs.

The secondary cell is sized based on the hydraulic storage required to store the remaining waste throughout 365 days. Treated waste is therefore stored in the bottom half of the primary cell and the entire secondary cell until the annual discharge period.

Table 7 illustrates the population distribution and BOD load throughout the year.

Table 7: Monthly BOD load

Month	Campground[1]		Holding Tanks[2]		Septage[3]		Total
	Population	BOD (kg/d)	L/mth	BOD (kg/d)	L/yr	BOD (kg/d)	BOD (kg/d)
Jan	0	0	0	0	0	0	0.00
Feb	0	0	0	0	0	0	0.00
March	0	0	0	0	0	0	0.00
April	0	0	0	0	0	0	0.00
May	1,731	129.78	56000	1.213333	4000	0.933333	131.93
June	1,731	129.78	56000	1.213333	4000	0.933333	131.93
July	1,731	129.78	56000	1.213333	4000	0.933333	131.93
August	1,731	129.78	56000	1.213333	4000	0.933333	131.93
Sept	1,731	129.78	176,000	3.813333	50,000	11.66667	145.27
Oct	957	71.78	0	0	0	0	71.78
Nov	0	0	0	0	0	0	0.00
Dec	0	0	0	0	0	0	0.00
Average Daily BOD load from May to October (kg/d)							**124.13**

Notes:

1 *Campsite Population – Based on a completely full campground with 3.5 people per site from mid May to October. Closing dates differ throughout the campground; Bay 1 through Bay 7 close on September 19th and Bay 8-11 and the yurts close on October 11th.*

2 *Holding Tanks – Day use parking lot, Bay 9 washroom, Bay 10 washroom and Bay 10 "Y" washroom are emptied several times throughout the summer, the total flow from each of these locations was averaged over the 5 total months of operation. The remaining holding tanks are only emptied in September.*

3 *Septage –.Bay 10 shower/washroom facility is emptied several times throughout the summer, the total flow from this location is averaged over the 5 total months of operation. The remaining septage locations are only emptied in September.*

4 *Holding Tank BOD calculations based on a standard 650 mg/L of BOD*

5 *Septage BOD calculations are based on a standard 7000 mg/L of BOD*

The surface area required for treatment in the primary cell is calculated in **Table 8.**

Table 8: Organic Loading

Surface Area Calculations	Unit	
Average Daily BOD load from April to September	124.13	kg/day
Loading (Provincial Requirement)	56	kg BOD/ha/day
Required surface area (Average Daily BOD / Loading)	2.2	ha

From these calculations it is evident that the primary cell will require a surface area of 2.2 ha.

Using a liquid depth of 1.5 m, freeboard of 1 m, and a dike slope of 4:1 the lagoon cells are sized using the following equation:

$$V = (d/6) \times (A_t + A_b + 4\ A_m)$$

Where:

V = Volume
d = depth of the lagoon
A_t = Area of the top of the lagoon, $A_t = L \times W$
A_b = Area of the bottom of the lagoon, $A_b = (L - 2 \times ES \times d)\ (W - 2 \times SS \times d)$
A_m = Area of the midsection of the lagoon, $A_m = (L - ES \times d)(W - SS \times d)$
SS = slope of the sides of the lagoon
ES = slope of the ends of the lagoon
L = Length of the top of the lagoon
W = Width of the top of the lagoon

Using this equation the primary cell size is:

Table 9: Primary Cell Size

Primary Cell Size	Units
Volume (entire cell)	30,690 m^3
Storage Volume (bottom 0.75 m of cell)	14,700 m^3
Surface area (not including 1 m freeboard)	22,200 m^2

The secondary cell is used for hydraulic storage and some ammonia reduction. The current CEC licence states that the lagoon may only discharge between May 15th and June 15th. This discharge time will likely not be acceptable to Manitoba Conservation, as currently in Manitoba no lagoon is permitted to discharge prior to June 15th due to the potentially high ammonia levels in the effluent at this time of the year. Also,

there is evidence that there is a variety of recreational activities on the river after June 15th, the Park's canoe and boat launches are both located downstream of the discharge route. Therefore, it is expected that a fall discharge will be required; only one discharge per year will be allowed.

With only one discharge per year, 365 days of storage are required. The total storage requirement is equal to the total amount of waste produced per year from the campground and cabins, 43,829 m^3 (**Table 6**). The bottom 0.75 m of depth in the primary cell is considered storage, as it is too deep to provide the surface aeration required for treatment. The volume required for the secondary cell is calculated by the total storage required minus the storage volume in the bottom half of the primary cell. In addition to this volume the secondary cell must maintain a minimum of 300 mm of waste on the bottom of the lagoon to prevent freezing of the pipes after discharge. Therefore, additional storage is required to maintain a minimum water level in the cell at all times.

The total liquid depth of the secondary cell is 1.5 m with an additional 1 m freeboard. The bottom 0.3 m of the cell will contain the sludge blanket; this volume is in addition to the storage volume required. Assuming one discharge per year the volume required for the secondary cell is:

Table 10: Secondary Cell Size

Secondary Cell Size	Units
Sludge Blanket Volume (volume below the pipes)	6,732 m^3
Storage Volume	29,129 m^3
Total Volume of the Secondary Cell	35,861 m^3
Surface Area (not including 1 m freeboard)	25,797 m^2

8. Phosphorus Removal

Municipal wastewater generally contains from 4 to 12 mg/L of total phosphorous, of which 1-5 mg/L is organic and the remainder is inorganic phosphorus. In Manitoba, a common value for total phosphorus is approximately 8 mg/L. Current regulations for wastewater lagoons recommend total phosphorus levels to be below 1 mg/L in the effluent prior to discharge.

The Spruce Woods lagoon will discharge into the Assiniboine River which flows into Lake Winnipeg, therefore it is expected that the lagoon's operating licence will have a phosphorus limit of 1 mg/L. While the newest regulations state that new or expanding facilities serving a populations of less than 2,000 people can demonstrate a nutrient reduction strategy instead of meeting the 1 mg/L total phosphorus limit, Manitoba Conservation has opted to be proactive and design this lagoon to meet the phosphorus limit of 1 mg/L. As such two methods of phosphorus removal were studied; the Phosphex™ system from Agassiz Enviro-Systems Inc. was compared to chemical dosing with alum the most commonly used method.

8.1 Phosphex™ System

Phosphex™ is a new system that uses a waste by-product from steel production, Basic Oxygen Furnace (BOF) slag or other slag material, to remove phosphorus and arsenic from water. Treatment is through the flow of wastewater through a permeable bed or chamber containing the slag material. The slag material promotes the removal of water-born contaminants and pathogens to very low levels. The Phosphex™ system requires little to no electricity and recycles the waste material created by the steel industry. The supplier states that the Phosphex™ system is capable of removing 98% or more of dissolved phosphorus, the destruction of water borne pathogens, bacteria, and viruses, and is capable of removing many dissolved contaminants including arsenic, mercury, and uranium. The Phosphex™ system boasts the ability to decrease phosphorus levels to less than 0.15 mg/L.

Phosphex ™ Filter Media

The pH of wastewater discharged from the Phosphex™ system can range from 8-11, which can be a problem for the receiving stream. Reducing the pH of the effluent can be completed by a carbon-dioxide injection system or a peat filter. Peat filters are the most cost effective system if there is a source of peat near the lagoon site. However, pH control from peat filters is notoriously uncontrollable. There is the potential for this filter to need regular replacement. As a result, a CO_2 injection system is recommended. The system is relatively simple and provides reliable control of pH from the effluent.

The media for the Phosphex™ system requires a constant flow of water, for systems that are continual discharge, this is not an issue. For intermittent flow, such as a seasonal campground, a float and pump configuration is required to ensure the media remains saturated. This system is ideal for a continuous discharge lagoon; however, these are extremely uncommon in Manitoba. A continuous discharge lagoon would be extremely difficult to install at Spruce Woods Provincial Park due to seasonal usage, regulatory and public concerns. A continuous discharge lagoon must also meet the same regulations set for a mechanical wastewater treatment plant, including an ammonia limit. To accommodate for the lack of continuous discharge at the proposed Spruce Woods Lagoon, Agassiz has suggested a batch discharge from the lagoon during the operating months and shut-down of the Phosphex™ system during the winter while there is no flow into the lagoon. Essentially, water will continuously flow from the secondary cell into the Phosphex™ system, and from there, clean water flows into an additional small storage cell where it

will stored for 30 days, to allow for detailed testing of the water prior to monthly discharges. Agassiz feels that this batch system will alleviate any concerns about the water quality that is being discharged.

The Phosphex™ system is a very new system, with only one small-scale trail installation in Miami, Manitoba. The pilot test was constructed in late May 2009; the system was operated throughout the spring and fall of the 2010 season. No full scale testing has yet been completed.

For the Spruce Woods lagoon system Agassiz has proposed to install one sacrificial filter and one main filter. The sacrificial filter uses the same media as the main filter and is also used to protect the larger main filter from high levels of BOD. This filter will remove approximately 60% of the phosphorus and the majority of the coliforms in the effluent prior to entering the main filter. As a result this filter will require new media every two years. The supplier estimates that approximately 50% of this media can be reconditioned through drying and crushing of old media to expose reactive surfaces. Reconditioning the media will reduce to cost of regular media replacement, but requires time by the operators to complete. The use of a sacrificial filter will significantly extend the life of the larger and more expensive main filter.

A small building is used to house the electrical panel, pump controls, CO_2 injection controls, small mechanical filter and any alarms. With the use of the sacrificial filter the mechanical filter may not be required. Excluding this system in the project would reduce the overall maintenance required at the lagoon by reducing the mechanical systems on site. The requirement for the mechanical filter is based on effluent quality, and so is uncertain until the lagoons are constructed. It is possible it will be originally installed and then removed if not required.

A bypass discharge would be provided to allow for lagoon discharge directly from the secondary cell in the situation where the Phosphex™ system is not operating as designed.

The Phosphex™ filter life expectancy is a minimum 10 years with relatively low O&M costs. Maintenance for small systems includes annual opening of the cover to inspect for crusts on the media, analysing the water for phosphorus levels and pH. Once phosphorus is no longer being removed effectively, the media can be replaced by disposal through a licensed non-hazardous waste handler and replaced with new media. The supplier estimates that approximately 75% of the media can be reconditioned through drying and crushing of old media to expose reactive surfaces.

With a monthly batch system, the water will need to be sampled monthly prior to discharge. There is also some level of maintenance associated with the two small pumps, the CO_2 injection system and the mechanical filter that are required for the system. When compared to a mechanical treatment plant this system has relatively low O&M cost but compared to a standard facultative lagoon the amount of operator attention required is significant.

One of the main concerns with the Phosphex™ system at the Spruce Woods lagoon is the limited space at the lagoon site. The site selected for the new lagoon will have limited space for the additional clean batch cells, the sacrificial filter and main Phosphex™ filter. Ideally, the supplier recommends completely realigning the service road to provide a significant amount of additional space, adding to the overall capital cost of the project.

8.2 Chemical Dosing

Chemical precipitation is a commonly used method of removing phosphorus from wastewater by the addition of a coagulant or the salts of multivalent metal ions such as calcium, aluminum and iron. Alum or hydrated aluminum is most commonly used to precipitate phosphates from wastewater lagoons. The dosage rate required is a function of the required phosphorus removal, as the concentration of

phosphorus decreases the efficiency of the metal salt decreases. Dosage is generally determined on the basis of bench-scale testing.

The dosing process involves the chemical, commonly alum for lagoons, being added into the secondary cell by fairly basic means. The Birds Hill and Stephenfield Provincial Park lagoons both used alum dosing in the fall of 2010 to lower phosphorus levels prior to discharge. In both instances the alum was sprayed from a fire tanker with fire pump, hose and nozzle, onto the secondary cell water surface. One person drove the tractor pulling the fire tanker, one person controlled the pump, one person assisted with the fire hose, and one person directed the alum spray; a total of four operators were required. Once all of the alum was discharged onto the water surface, a small boat and motor with two people was driven around the secondary cell to mix the alum throughout the cell.

Alternatively, chemical could have been added directly through use of a small chemical pump to inject the chemicals into the propwash located at the stern of the boat, providing an even distribution throughout the cell.

Personal protective equipment is required for all operators during alum dosing; this includes Tyvek suits, facemasks, goggles and gloves. A first aid kit, complete with fresh water should always be nearby. Once all spraying is complete, all pumps, tanks, boat and motor and PPE need to be flushed with clean water, based on Parks procedures. Discharge of the lagoon can occur once the phosphorus result of <1mg/L are shown on the laboratory samples. This usually occurs 24-48 hours after alum dosing.

Chemical addition for the precipitation of phosphorous can result in increased sludge volume, specifically sludge with poor settling and dewatering characteristics. Precipitation with metals or salts can also depress the pH. If nitrification is required, additional alkalinity will be consumed and the pH will drop further. Sludge volumes have been known to increase by up to 40% through chemical precipitation of phosphorus. Along with larger sludge volumes comes the additional cost of sludge removal and disposal.

8.3 Cost Comparison

8.3.1 Option 1 – Phosphex™ System

The Phosphex™ system is expected to have a capital cost approximately $640,000, based on a supplier quotation. This budget is an installed price including material, labour and the following:

- Insulated 12'x12' accessories building
- Manitoba Hydro connection to a 200 Amp service
- Phosphex™ sacrificial filter, main filter, all pumps and associated plumbing
- CO2 pH neutralizing system
- Two years operation and supervision not including sampling costs
- Training
- Two year warranty on mechanical components
- Five year warranty on main Phosphex™ filter

The only regular maintenance will be from the small pumps, mechanical filter, and regular water sampling. It is estimated that the cost for electricity for the pumps and the CO_2 system, will be approximately $870/annually. There is also the cost of media replacement every two years for the sacrificial filter and every 10 years for the main filter. For a cost comparison the cost of replacing the sacrificial filter every two years has been estimated as an annual cost. **Table 11** details the estimated annual O&M costs for the Phosphex™ system. These costs include general maintenance of the lagoon including grass mowing, access road maintenance and sampling, in addition to the costs associated with the Phosphex™ system.

Table 11: Annual Estimated O&M Costs for the Phosphex™ System

#	Item	Unit	Quantity	Unit Price	Total Amount
1	Grass Mowing and General Maintenance	ls	1	$ 1,100	$ 1,100
2	Monthly Sample Collection and Analysis	ls	4	$ 550	$ 2,200
3	Lagoon Access Road Maintenance	ls	1	$ 1,100	$ 1,100
4	Valves and Maintenance	ls	1	$ 550	$ 550
5	Power	ls	1	$ 870	$ 870
6	Pumps & Mechanical Filter Maintenance	ls	1	$ 1,100	$ 1,100
7	Sacrificial Media Replacement (replaced every 2 yr)	ls	1	$ 1,400	$ 1,400
8	CO_2 for pH control	ls	1	$ 3,300	$ 3,300
9	Misc. Electrical/ Mechanical	ls	1	$ 1,100	$ 1,100
	Annual Operations & Maintenance Cost				**$ 12,720**

Notes:

1 Cost of replacing the sacrificial filter is $2800 every two years.

2 Costs are estimated in 2013 dollars

8.3.2 Option 2 - Alum Dosing

Alum dosing is likely the simplest method of reducing phosphorous levels to below 1 mg/L. The capital cost estimate includes the cost of a boat and motor, as a boat provides the most even distribution of alum with little additional cost or labour.

There are two common methods for determining the appropriate alum dosage. One method involves taking samples and determining the existing phosphorus concentration in the secondary cell and matching the reading with those on a precalculated chart. This chart lists the associated alum dosage which would be applied to the lagoon wastewater at the level of phosphorus concentration obtained in the sample. The other, more common method is for the operator to use past experiences of applying alum. Should conditions change, phosphorus levels increase or decrease, the operator will either add more or less alum to ensure continued compliance with phosphorus effluent guidelines. Alum dose rates can vary from 50 mg/L to 175 mg/L. Dosing greater than 175 mg/L has a less significant effect on phosphorus removal. After comparing dose rates used at Birds Hill and Stephenfield it was determined that a dose rate of 100 mg/L will be a good basis for cost comparisons.

The volume of the secondary cell is 35,861 m^3 or 35,861,000 L. At a dose rate of 100 mg/L of 3,586,100,000 mg or 3,586 kg of alum is required. Both Stephenfield and Bird's Hill Park have their alum delivered by Border Chemicals. The cost from Border Chemicals is $300.00 per tonne of alum (2013 rates) at 48.7% concentration, plus a delivery fee of $800.00 to Spruce Woods lagoon site. Calculations for cost determination of alum to the Spruce Woods lagoon follows:

Specific Gravity of Alum: 1.335

3,586 kg alum required

Alum is delivered at 48.7% concentration

3,586 / 0.487 = 7,363 kg total

7,363 kg = 7.4 tonnes rounded up to 8 tonnes total

8 tonnes * $300.00 = $2,400 per year of phosphorus removal

Table 12 details the annual O&M costs expected for lagoon operation, with alum dosing. These costs include general maintenance of the lagoon including grass mowing, access road maintenance and sampling, in addition to the costs associated with the alum dosing.

Table 12: Annual Estimated O&M Costs for Alum Dosing

#	Item	Unit	Quantity	Unit Price	Total Amount
1	Grass Mowing and General Maintenance	ls	1	$ 1,100	$ 1,100
2	Sample Collection and Analysis	ls	1	$ 550	$ 550
3	Lagoon Access Road Maintenance	ls	1	$ 1,100	$ 1,100
4	Valves and Maintenance	ls	1	$ 550	$ 550
5	Alum	tonnes	8	$ 300	$ 2,400
6	Alum Delivery	ls	1	$ 800	$ 800
Annual Operations & Maintenance Cost					**$ 6,500**

Notes:

1 Costs are estimated in 2013 dollars

In order to dose the alum in the secondary cell a capital cost would be required to purchase a 16 ft aluminum or fibreglass boat. $11,000 has been allotted for the boat and motor purchase in the capital cost of the project.

Also, as alum dosing has been known to increase sludge volumes by 40%, we have allotted an amount for desludging the lagoon ever 10 yrs instead of every 20 yrs used for a traditional lagoon. A complete breakdown of the O&M costs for both systems are included in **Appendix C**.

8.3.3 Cost Summary

The following cost estimates are preliminary estimates for concept comparison purposes only. **Table 13** summarizes the capital cost for each of the two options. Capital costs do not include the initial construction cost of the lagoon. It is assumed that both options are based on the same size lagoon. The Phosphex™ supplier feels that if his system of batch discharges were utilized that the lagoon size could be significantly decreased and offset the capital cost of the filter installation. However, as the Phosphex™ system would be installed as an experimental system, the lagoon must be sized to operate effectively, in the event the Phosphex™ system is unable to perform as designed. A detailed cost breakdown for both systems is included in **Appendix C**.

Table 13: Summary of Costs for Phosphorus Removal Options

#	Item	Option 1 - Phosphex™	Option 2 - Alum Dosing
1	Capital Cost[1]	$ 640,000.00	$ 11,000.00
2	Annual Operation & Maintenance	$ 173,800.00	$ 89,400.00
3	Lagoon Desludging	$ 22,800.00 [3]	$ 56,600.00[2]
4	Media Replacement	$ 77,300.00[4]	-
	Total 20 Year Life Cycle Cost	**$ 914,000.00**	**$ 157,000.00**

Notes:

1 Capital costs do not include the overall cost of the lagoon construction, only the additional cost of each option.

2 With Alum Dosing desludging will be completed in year 10 & year 20

a. Year 10 - $50,000 @ 0.676 = $33,800

b. Year 20 - $50,000 @ 0.456 = $22,800

3 Phosphex System - No Alum Dosing desludging will be completed in year 20
a. Year 20 - $50,000 @ 0.456 = $22,800 in present day dollars
4 Phosphex™ Media Replacement in year 10 & year 20
a. Year 10 - $68,300 @ 0.676 = $46,200 in present day dollars
b. Year 20 - $68,300 @ 0.456 = $31,100 in present day dollars
5 Discount rate of 4%
6 Class "D" Cost estimate intended for comparison purposes only
7 Cost Estimates are in 2013 dollars

8.4 Recommendations

The Phosphex™ system has potential as an efficient system for phosphorus removal. Testing has shown the system is capable of lowering phosphorus levels to as low as 0.1 mg/l. However, the additional capital cost to construct the system, cost of the carbon dioxide system for pH control, and regular maintenance on the pumps and mechanical filter make this system significantly more expensive than simply dosing the effluent with alum to achieve a similar result. However, were phosphorus limits to be lowered to less than 1 mg/L, as seen in other jurisdictions, a system like the Phosphex™ system may be required, as chemical dosing is not likely to lower the phosphorus levels consistently below 1 mg/L.

At this point the Phosphex™ system is not recommended for the Spruce Woods lagoon due to the requirement for discharging during the summer months into a recreational area, limited space for the filter installation around the lagoon site, and the additional maintenance and cost associated with the system. The recommendation is for the Park to use chemical dosing of alum to reduce phosphorus in the secondary cell prior to discharge.

9. Construction Considerations

The existing wastewater lagoon located in Spruce Woods Provincial Park will be decommissioned upon the completion of the new wastewater lagoon. The proposed new lagoon will be constructed on Site #4 (Refer to Section 4.4) located near the east entrance to the campground.

Site #4 is bordered on two sides by roadways. To the east is the Steele's Ferry Road (or 78W) and to the south is Road 45N which also functions as the eastern entrance into the campground.

Section 4 summarized the calculation for the lagoon size required to treat the waste produced from the campground and the holding tanks. The lagoon site plan and layout are illustrated in Figures 1 through Figure 3 in **Appendix D**.

The new lagoon will be located approximately 2,300 m north east of the existing lagoon.

A dense tree buffer will be provided along the south and east sides of the lagoon. This will limit noise or odours to the surrounding residents and campground, as well as improve the aesthetics of the lagoon. Tree species will be determined by the Park to optimise the species of plants that will thrive in this location.

9.1 Nutrient Management Regulation

The Nutrient Management Regulation of the Water Protection Act regulates the development of wastewater lagoons where groundwater or water bodies are sensitive to impacts. These areas are determined by the agricultural capability of the land. The Water Quality Management Zones are divided into six different zones which are based on the Agricultural Capability Classes. Any lagoon located in Water Quality Management Zone N4 will require additional approvals.

The proposed Spruce Woods Lagoon site is located on a WWD soil (Agricultural Capability Class 1, Zone N1) and SHX (Shilox) soil (Agricultural Capability Class 6M, Zone N4). As a portion of the proposed lagoon location is within Zone N4, additional approvals will be required.

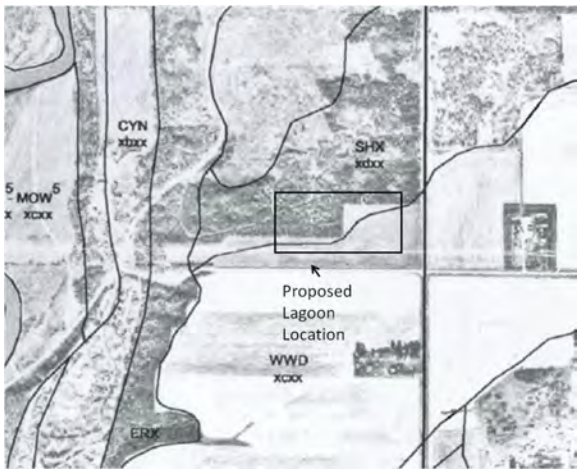


Figure 8: Soil Classification of Proposed Lagoon Site

A site specific survey was conducted by a pedologist, to confirm the soil class at the proposed lagoon location. Six samples were collected throughout the proposed lagoon area, Table 14 summarizes the finding, and the complete report is included in **Appendix F**.

Table 14: Nutrient Management Soil Classification

Sample Number	Ag Capability Ranking	Nutrient Management Regulation Ranking
Sample 1	3M	N2
Sample 2	5M	N2
Sample 3	5M	N2
Sample 4	5M	N2
Sample 5	2T	N1
Sample 6	2T	N1

Soil samples found the soil to be ranked as either 3M, 5M or 2T. 2T soils are classified as highly productive lands and relatively low risk of nitrogen loss to groundwater and a high risk of phosphorus and nitrogen loss to surface water. 3M and 5M soils are considered moderately productive solids and limited risk of nitrogen loss to ground and surface water. All of these soil types fall into the nutrient management regulations ranks as N1 and N2, which allows for the construction of a wastewater lagoon on these soils.

9.2 Zoning Bylaws

In discussion with Community Planning Service it was determined that the proposed lagoon location is located completely on Provincial Park land and therefore subject to crown land planning. The adjacent Rural Municipality (RM) of South Cypress Zoning By-laws requires that all new sewage lagoons be located a minimum of 305 m (1000 ft) from any existing dwellings. Mapping information currently available from the RM does not show any existing dwellings within 305 m from the planned lagoon location. There are, however, two farm dwellings located to the south and east of the proposed location, both are outside the 305 m limit. Refer to **Figure 9**.

Figure 9: Proposed Lagoon Site Buffer Zone

It has been recommended that since there is private property located only 0.3 km from the proposed site, that notice of the proposed location of the new facility should be provided to the RM of South Cypress Council and the Cypress Planning District Board. In planning for future development the Council and the Board will need to make sure that any new dwellings in the area are setback at least 305 m (1000 ft) from the new sewage lagoon.

9.3 Lagoon Construction Components

The lagoon will use a geosynthetic liner to protect groundwater resources. The 60 mil HDPE liner will be installed on a 150 mm thick layer of compacted bedding sand. The bedding sand layer will be placed over 300 mm thick granular dewatering and degassing system. Clean crushed limestone of 50 mm maximum size will be used for the drainage layer. Geotextile will be used at the bottom and top of the drainage layer to provide separation and filtration. A protective sand layer at least 150 mm thick (or as recommended by the manufacturer) will be placed over the liner. The exterior and interior dikes each have a 4:1 slope and rip-rap will be required on the dike slopes to protect against erosion.

A dewatering and degassing system will be installed under the lagoon liner to allow for the release of groundwater seepage and gas that might accumulate under the liner.

Perimeter ditching will be incorporated on the north and west sides of the lagoon to collect and direct surface water away from the lagoon dikes in order to prevent the stability of the dikes from being weakened by excess moisture in the fill. The site is relatively flat with the highest point being located in the northwest corner of the lagoon. This allows for drainage along the north side of the lagoon to flow through a drainage ditch into the existing ditch along Steel's Ferry Road. The west side of the lagoon will also drain through a drainage ditch into the existing ditch along Road 45N to the south of the lagoon.

Drainage on the south and east side of the lagoon will flow naturally into the ditches along the two roads. **Figure 10** illustrates the proposed drainage route around the lagoon cells.

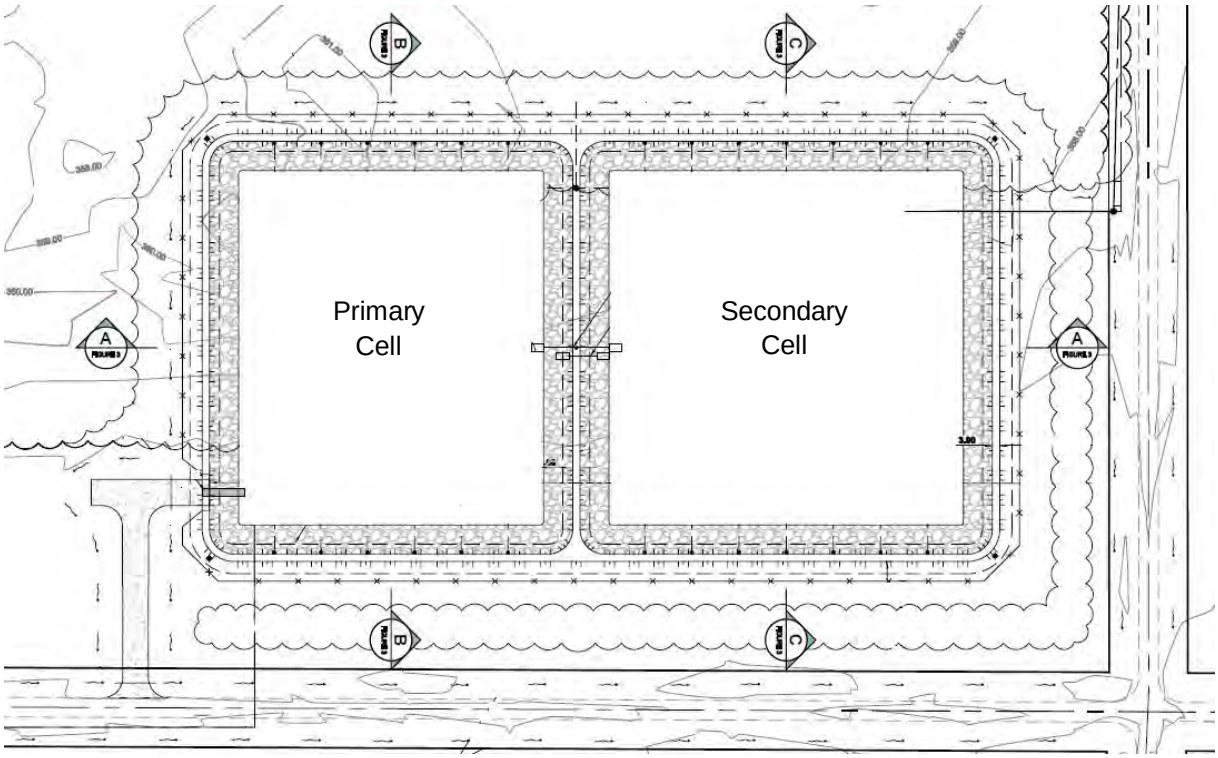


Figure 10: Proposed Lagoon Layout

With the construction of the new lagoon, the amount of surface runoff in the proposed lagoon area will be reduced, as a large portion of rain water will now be stored in the new lagoon cells. Therefore, there are no anticipated environmental concerns associated with drainage water flowing to the existing ditches as this water is clean run-off water and there will be no expected increase in the water volume flowing to the ditches.

A chain link fence will be located 1.0 m from the toe of the dike, surrounding the entire lagoon.

9.4 Lift Station & Forcemain

The existing main lift station was damaged during the 2011 flood and requires a complete overhaul. A detailed assessment of the hydraulics to pump the waste to the new lagoon site will be required during detailed design. The existing lift station at Spruce Woods uses duplex 3.5 HP submersible pumps to transfer wastewater approximately 800 m through a 75 mm (3") forcemain to a manhole on the east side of highway PTH 5, where it flows by gravity to the lagoon on the west side of the highway. The new lagoon, located approximately 1,800 m north east with an approximate elevation change of 41 m from the existing main lift station, will require a new forcemain and larger pumps.

Preliminary calculations show that a new 150 mm (6") forcemain and duplex 17.2 kW (23 Hp) pumps will to be required to transfer waste from the existing lift station to the new lagoon.

A further detailed assessment of the lift station and forcemain will be completed once the Park has determined their long term plans for the lower campground infrastructure and camp layout. If the current

location of the lift station is maintained a review of flood proofing alternatives must be evaluated for this lift station.

9.5 Discharge Route

Treated effluent from the lagoon will be discharged once per year through a new outfall. Based on conversations with Manitoba Conservation, it is believed that discharging into the Assiniboine River will still be permitted, although only once the licence is granted will this be confirmed. An underground discharge pipe will be placed in the right of way along Steele's Ferry Road on the east side of the lagoon site and will run north approximately 1,800 m to the River. From there the pipe will discharge into a riprap erosion controlled discharge ditch, which will flow the remaining distance to the River. The use of the discharge ditch will accommodate changes in the river banks location over the years without damaging the discharge pipe.

A legal land survey of the Park boundary may be required during the detailed design to finalize the exact location of the outfall pipe. It has been identified that there is private land located on the west side the Steele's Ferry Road right before the River. Further survey will be completed during detailed design along the outfall path to confirm elevations and an appropriate path that best avoids private property.

9.6 Truck Dump

A truck dump for hauled waste from within the Park will be located on the west side of the primary cell. It will consist of a 30 m x 16 m gravel pad. A 3.0 m wide concrete swale will direct the sewage into the lagoon. The lagoon fence will transition from the toe of slope to the top of slope in this area. A gate will be constructed with steel bars on the lower half which will allow sewage to pass through permitting dumping without requiring the gate to be opened. The truck dump will accept holding tank waste and septage from holding tanks and ejector systems throughout the Park.

10. Decommissioning Plan

Decommissioning of the existing lagoon will be required upon completion of construction of the new lagoon. Decommissioning will involve dewatering the lagoon and disposing of the remaining sludge remaining in the cell. Sewage sludge may be a solid, semi-solid or liquid residue that settles to the bottom of the wastewater lagoon during treatment. It consists of approximately 90-99% water and an accumulation of settleable solids. Sludge also contains significant amounts of nitrogen and phosphorus and to a lesser degree some quantities of heavy metals such as zinc and copper.

There are essentially two options for disposing of the remaining sludge in the lagoon; landfill or land application. Land application involves land applying the dewatered sludge to agricultural land for the purposed of providing nutrients to the soil.

10.1 Land Application of Sludge

The nitrogen and phosphorus in the sludge can be very useful in land application by improving the physical and chemical properties of the soils. But the same constituents in sludge that may benefit soil and crops can also produce detrimental effects when applied in excessive rates or under improper conditions.

Land application involves the dredging or pumping of all the sludge from the lagoon. The sludge must then be hauled to local agricultural land for application. This process required an additional permit at the cost of $5000.

In addition to the permit there are restrictions placed on the land in regards to crops planted in the following year.

10.2 Landfilling Sludge

To dispose of wastewater sludge in a municipal landfill, it is required the landfill be rated at Class 1. The nearest Class 1 landfill to Spruce Woods Provincial Park is located in Brandon, Manitoba.

The Brandon Landfill has stated that they are willing to accept the Spruce Woods sludge as long as it is dewatered and passes a slump test. A slump test is commonly used for measuring the water content in a substance. A cone shaped mold is placed on a sample of the sludge and tamped down. The mold is then carefully lifted upwards, so as not to disturb the material. This subsidence of the material, after the removal of the cone, is termed as slump, and is measured to the nearest 5 mm. If the mixture collapses then the material is found to be too wet.

Dewatering the sludge will be through the use of Geobags. Geobags are made of geo-textile fabric which is woven from heavy plastic threads. A common Geo-Bag size is 13 m in diameter and 60 m long. This sized bag will hold 535 m^3 of material when it is full. The fabric has small openings of 50 to 100 microns between the threads. The lagoon sludge can be directly pumped into the bag, which retains the solids and allows water to pass through the small openings. Over approximately a 6 month period, the retained material dewaters and can then be hauled in dump trucks to a landfill.

Geobags appear to be the easiest method of dealing with the sludge from the existing lagoon.

10.3 Decommissioning of Operating Lagoon Cells

Wastewater generated by the Park is presently directed into a two cell lagoon located west of the campground. The operating lagoon facility occupies an area of approximately 7,000 m^2. Once the new lagoon is operational the existing lagoon cells will be decommissioned.

In summary, the lagoon decommissioning will consist of the following steps:

1. Decommission the existing ejector system from the maintenance shop and install two new holding tanks to collect this wastewater flow.
2. Treated effluent from thw lagoon will be discharged to the Assiniboine River, with approved test results. Liquid may be discharged via the existing discharge pipe.
3. Pump the remaining lagoon sludge into Geobags placed along the top of the dikes. Over the winter the remaining liquid will be allowed to leak out of the bags and drain back into the lagoon cells.
4. In late spring or early summer, once the Geobags are completely drained, confirm the sludge is inert through testing. Truck this sludge to the Brandon landfill.
5. Any liquid that drained from the Geobags can be tested and discharged.
6. Remove and/ or recover all infrastructure works such as valves, pipes, culverts, etc. Waste materials such as scrap steel, wood, etc.. should be disposed of at the nearest landfill.
7. Push the dikes into the cells and evenly spread dike material.
8. The lagoon site will be graded and sloped to promote surface water runoff and proper drainage.
9. The site will be seeded to promote revegetation.

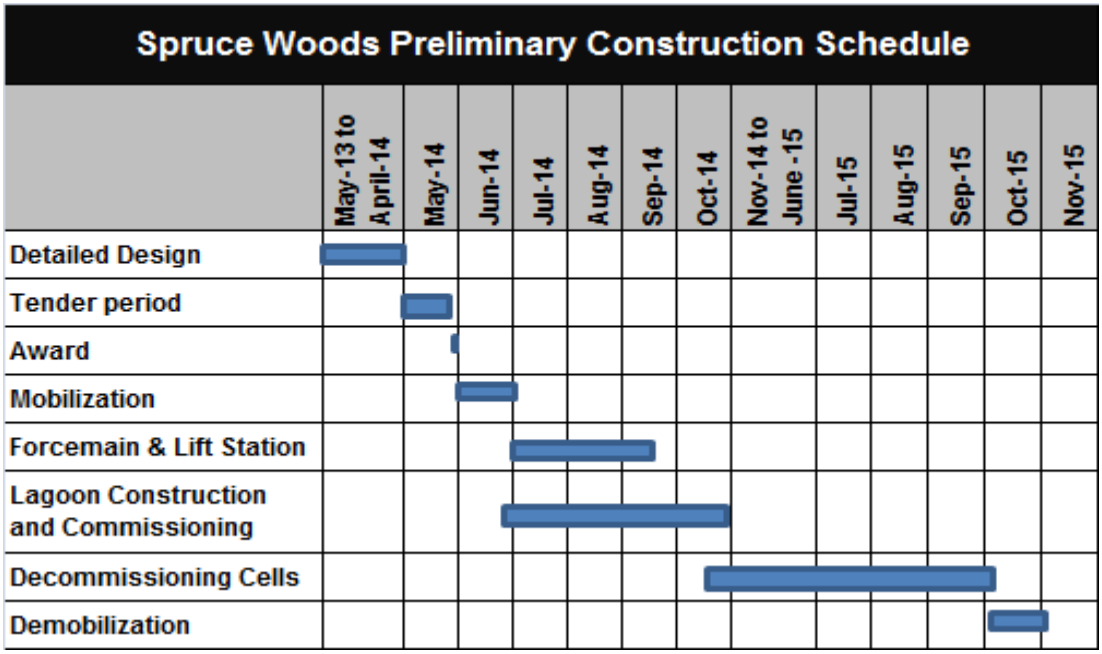
11. Schedule

The project schedule for the Spruce Woods Lagoon is based on the following milestones:

- Environment act proposal will be submitted as a separate document. Public consultations were completed on September 29, 2012.
- Tender and award is scheduled for the end of April 2014.
- Construction is expected to commence in May 2014.
- Completion date October 2014
- Decommissioning of the existing lagoon completed the following summer, 2015.

Table 15, below, shows a brief outline of the expected sequence of events throughout the design and construction of the new Spruce Woods lagoon. A detailed schedule is included in **Appendix E**.

Table 15: Preliminary Schedule



12. Recommendations and Capital Cost Estimate

12.1 General

The purpose of this section is to provide a summary of recommendations and life cycle costs for the project.

AECOM recommends construction of a facultative lagoon complete with a piped conveyance system connecting the campground to the new lagoon system. The future campground development would be trucked to the new lagoon. The piped conveyance system consists of a lift station, forcemain, and truck dump. Once the new infrastructure is in place, decommissioning of the existing lagoon can occur and the old lagoon site rehabilitated.

12.2 Scope of Work

The scope of the work is as follows:

- Two cell facultative lagoon
- Upgrades to existing lift station in lower campground
- 1,800 m of new forcemain from existing main lift station in lower campground
- Truck dump facility
- Effluent discharge pipe
- Effluent discharge ditch
- Decommissioning of the existing lagoon

12.3 Estimated Costs

Capital Costs for the facultative lagoon at Spruce Woods Provincial Park are summarized in **Table 15**. A detailed Cost estimate is included in **Appendix B**.

Table 16: Preliminary Cost Estimate

Spruce Woods Preliminary Costs Estimate			
A	Forcemain & Lift Station		$1,213,000
B	Roads		$59,000
C	Lagoon and Related Works		$2,300,000
D	Miscellaneous (includes mobilization, demobilization, insurance, material testing etc.)		$264,000
E	Decommissioning		$99,500
	Sub Total		**$3,935,500**
	Engineering	15%	$590,000
	Contingency Allowance	10%	$394,000
	MWSB Finance and Administration Allowance	10%	$394,000
	Total		**$5,313,500**

Appendix A

Geotechnical Investigation

AECOM
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Winnipeg, MB, Canada R3P 0Y7
www.aecom.com

204 477 5381 tel
204 284 2040 fax

Memorandum

To	Eric Hutchison	Page	1
CC	Heather Buhler		
Subject	Spruce Woods Lagoon		
From	Jared Baldwin		
Date	July 6, 2012	Project Number	60221902 (402.19)

1. Introduction

The existing wastewater treatment facility at Spruce Woods Provincial Park Campground has reached its functional capacity and a new facility is required to service the campground. The existing lagoon is located 29.9 km south of Carberry, along Highway 5. Two sites were investigated in 2010; however, due to flooding of the Assiniboine River during the spring and summer of 2011, these two sites were abandoned because of their location within the lower flood plain. The site currently under consideration is located east of Spruce Woods Campground near the south-east corner of the campground's property on agricultural land currently being leased.

This memorandum summarizes the results of the 2011 and 2012 geotechnical investigations completed at Spruce Woods Provincial Park Campground. This memorandum contains a summary of the subsurface conditions and provides geotechnical recommendations related to the design and construction of the proposed sewage lagoon.

2. Field Investigation

On November 7, 2011, twelve test holes (11-01 to 12) were drilled within the proposed lagoon area. One standpipe piezometer was installed in test hole 11-04. On June 18, 2912, six additional test holes (12-13 to 18) were drilled within the revised footprint of the proposed lagoon area. The test hole locations are shown on Figure 01.

Test hole drilling was completed by Paddock Drilling Ltd. using a RM-30 track mounted drill rig equipped with 125 mm diameter solid stem augers during both trips. Both field programs were carried out by Omer Eissa, EIT, of AECOM. Subsurface, groundwater, and drilling conditions were observed and recorded during drilling. Disturbed soil samples retrieved during the field investigation were transported to AECOM's materials testing laboratory in Winnipeg. The laboratory testing program consisted of moisture content determination and grain size analysis.

Test holes were tied into the UTM coordinate system by AECOM survey staff after drilling. The UTM coordinates of each test hole are provided in the test hole logs. Test hole logs are attached at the end of this document.

3. Subsurface Conditions

Sub-surface conditions can vary highly across a site and the information provided in this section is a summary of the findings from the field investigation and laboratory testing program.

In descending order, the general soil profile is as follows:

- Topsoil
- Upper Sand
- Silt and Clay
- Lower Sand

A brief description of the soil units encountered during drilling is provided below:

3.1 *Topsoil*

Topsoil was encountered at ground surface across the investigated area. The thickness of the topsoil was approximately 0.5 m in all test holes. The topsoil is generally sandy with rootlets throughout, dark brown to black, and dry to moist.

3.2 *Upper Sand*

Sand was encountered in all test holes beneath the topsoil. The sand contains varying amounts of silts, varying amounts of clays, and varying amounts of gravels. The sand is brown, dry to moist, compact, fine grained, and poorly graded. In general, the moisture content and coarseness of the sand increases with depth. The thickness of the sand ranged between 1.0 and 10.2 m. Test holes 11-01, 03, 04, 08 to 12 and test holes 12-13 to 18 terminated in sand before encountering other soil layers.

Standard penetration test (SPT) blow count (N value) ranges between 7 and 20 during the field investigation. The moisture content ranges from 1.7 to 19.8 percent.

3.3 *Silt and Clay*

Silt and clay was encountered below the sand in test holes 11-02, and 05 to 07. The silt and clay contains trace to some sand and is dark brown, dry to moist, soft to firm, and low to intermediate plasticity. The thickness of the silt and clay ranged between 0.5 to 1.9 m. Test hole 11-06 terminated in the silt and clay before encountering auger refusal.

One SPT with an N value of 9 was completed in the silt and clay. The moisture content rages from 11.6 to 32.5 percent.

3.4 *Lower Sand*

Sand was encountered in test holes 11-02, 05, and 07. The sand contains trace to some silt and trace to some clay. The sand is brown, moist, compact, fine to medium grained, and poorly graded. The thickness of the sand ranged from 0.6 to 1.9 m. Test holes 11-02, 05 and 07 terminated in the sand.

The moisture content ranges from 3.0 to 15.9 percent.

3.5 *Sloughing and Groundwater Conditions*

All of the test holes were dry during drilling and no static water level was observed in any of the test holes before backfilling. One standpipe piezometer was installed in test hole 11-04 and was dry at the end of drilling. The standpipe was dry on June 18, 2012.

Sloughing was encountered in five test holes at depths between 2.7 and 4.2 m below surface.

Groundwater levels could change seasonally, annually, or as a result of construction activities.

4. Recommendations

The subsurface conditions encountered are expected to provide a suitable foundation for the perimeter dykes of the proposed facility. Assuming a balanced cut-fill design approach, the native sandy soils can be used to construct these dykes provided that additional measures are used to control seepage, slope stability, and constructability. These measures include the incorporation of a geosynthetic liner on the floor and interior face of the dykes and across the top of the dykes for at least 1 m. Alternatively, clay can be imported and compacted to form a natural liner in the floor and dykes of the facility; however, in our experience, unless the lagoon is to be constructed within natural clay deposits, the availability of suitable clay and the haul distance generally makes this option uneconomical.

If a geosynthetic liner is used it should be placed over a 150 mm thick layer, or as recommended by the manufacturer, of compacted bedding sand. The native sand is a suitable material for use as bedding for the geosynthetic liner providing gravel pieces, as recommended by the manufacturer, are removed. A geotextile above and below the geosynthetic liner may be required, as recommended by the manufacturer, to protect the liner against damage during construction. A protective sand layer at least 300 mm thick, or as recommended by the manufacturer, should be placed over the liner.

If a clay liner is used, the properties and thickness of the liner should be in compliance with provincial requirements (i.e., 1 m thick layer of compacted clay having a hydraulic conductivity of 1×10^{-9} m/s). The clay should be placed in layers not to exceed 300 mm of non-compacted thickness at moisture content at or up to 3 percent higher than the optimum moisture content and compacted to at least 95 percent of the Standard Proctor maximum dry density (SPMDD). A clay borrow investigation was not included as part of our scope of work. Uplift, as a result of groundwater pressures, is not anticipated to be an issue during construction.

Dykes constructed using the native sand not exceeding 3 m high should be designed with side slopes not steeper than 3.5H:1V. Stability analysis is required should embankment heights be greater than 3 m. Depending on the final floor elevation, there may be a need to perform an additional investigation to identify a borrow source in close proximity to the proposed site in order to have adequate and sufficient construction materials available. Selective excavations may be required to avoid soil with high silt content which is typically difficult to compact and moisture control.

All topsoil and deleterious matter or a minimum of 150 mm of the surface soils, whichever is greatest, should be removed within the entire facility's footprint. Native foundation soils beneath the dykes and floor of the facility should be compacted to at least 95 percent SPMDD. The soils to be used during construction of the dykes should be placed in layers not to exceed 300 mm of non-compacted thickness and compacted to at least 98 percent SPMDD.

A perimeter drainage ditch or a collection system from the drainage layer, if used, may be required based on environmental requirements. Side slopes of a ditch excavated in the native soils should not exceed 1 m in depth or 3H:1V in slope.

Erosion protection measures will be required on the slope surfaces of the proposed dykes. The exterior slopes can be protected using a 150 mm layer of topsoil and vegetation cover. The interior slopes will require a rip-rap protection layer. Further recommendation can be provided as part of the detailed design phase of the proposed facility.

Should you require any further assistance, please do not hesitate to contact the undersigned.

Respectfully submitted,

Jared Baldwin, M.Sc., P.Eng.
Geotechnical Engineer

JB:dh

Reviewed by:

Faris Khalil, P.Eng.
Manager, Geotechnical Engineering

AECOM

Figure 01

0 25 50 m SCALE 1:2500

IMAGE SOURCE: GOOGLE EARTH PRO
IMAGE DATE: APRIL 28, 2011

LEGEND

- TEST HOLE
- STANDPIPE PIEZOMETER

AECOM

The Manitoba Water Services Board
Spruce Woods Wastewater Lagoon

Test Hole Location Plan

Figure - 01

AECOM

Test Hole Logs

AECOM Canada Ltd.

GENERAL STATEMENT

NORMAL VARIABILITY OF SUBSURFACE CONDITIONS

The scope of the investigation presented herein is limited to an investigation of the subsurface conditions as to suitability for the proposed project. This report has been prepared to aid in the evaluation of the site and to assist the engineer in the design of the facilities. Our description of the project represents our understanding of the significant aspects of the project relevant to the design and construction of earth work, foundations and similar. In the event of any changes in the basic design or location of the structures as outlined in this report or plan, we should be given the opportunity to review the changes and to modify or reaffirm in writing the conclusions and recommendations of this report.

The analysis and recommendations presented in this report are based on the data obtained from the borings and test pit excavations made at the locations indicated on the site plans and from other information discussed herein. This report is based on the assumption that the subsurface conditions everywhere are not significantly different from those disclosed by the borings and excavations. However, variations in soil conditions may exist between the excavations and, also, general groundwater levels and conditions may fluctuate from time to time. The nature and extent of the variations may not become evident until construction. If subsurface conditions differ from those encountered in the exploratory borings and excavations, are observed or encountered during construction, or appear to be present beneath or beyond excavations, we should be advised at once so that we can observe and review these conditions and reconsider our recommendations where necessary.

Since it is possible for conditions to vary from those assumed in the analysis and upon which our conclusions and recommendations are based, a contingency fund should be included in the construction budget to allow for the possibility of variations which may result in modification of the design and construction procedures.

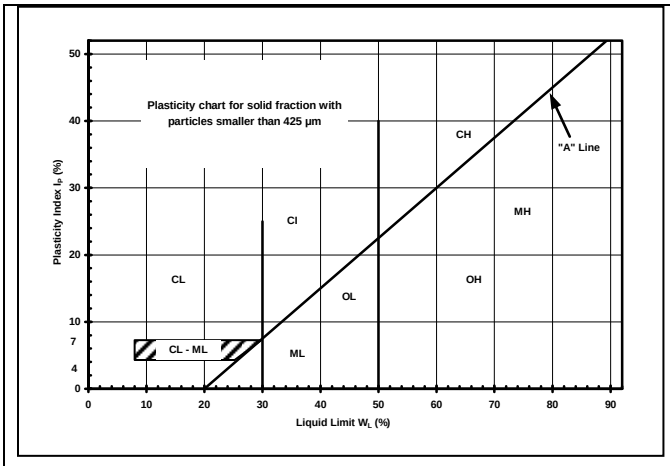
In order to observe compliance with the design concepts, specifications or recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated, we recommend that all construction operations dealing with earth work and the foundations be observed by an experienced soils engineer. We can be retained to provide these services for you during construction. In addition, we can be retained to review the plans and specifications that have been prepared to check for substantial conformance with the conclusions and recommendations contained in our report.

EXPLANATION OF FIELD & LABORATORY TEST DATA

Description				UMA Log Symbols	USCS Classification	Laboratory Classification Criteria			
						Fines (%)	Grading	Plasticity	Notes
COARSE GRAINED SOILS	GRAVELS (More than 50% of coarse fraction of gravel size)	CLEAN GRAVELS (Little or no fines)	Well graded gravels, sandy gravels, with little or no fines		GW	0-5	$C_U > 4$ $1 < C_C < 3$		Dual symbols if 5-12% fines. Dual symbols if above "A" line and $4<W_P<7$ $C_U = \frac{D_{60}}{D_{10}}$ $C_C = \frac{(D_{30})^2}{D_{10} x D_{60}}$
			Poorly graded gravels, sandy gravels, with little or no fines		GP	0-5	Not satisfying GW requirements		
		DIRTY GRAVELS (With some fines)	Silty gravels, silty sandy gravels		GM	> 12		Atterberg limits below "A" line or $W_P<4$	
			Clayey gravels, clayey sandy gravels		GC	> 12		Atterberg limits above "A" line or $W_P<7$	
	SANDS (More than 50% of coarse fraction of sand size)	CLEAN SANDS (Little or no fines)	Well graded sands, gravelly sands, with little or no fines		SW	0-5	$C_U > 6$ $1 < C_C < 3$		
			Poorly graded sands, gravelly sands, with little or no fines		SP	0-5	Not satisfying SW requirements		
		DIRTY SANDS (With some fines)	Silty sands, sand-silt mixtures		SM	> 12		Atterberg limits below "A" line or $W_P<4$	
			Clayey sands, sand-clay mixtures		SC	> 12		Atterberg limits above "A" line or $W_P<7$	
FINE GRAINED SOILS	SILTS (Below 'A' line negligible organic content)	$W_L<50$	Inorganic silts, silty or clayey fine sands, with slight plasticity		ML			Classification is Based upon Plasticity Chart	
		$W_L>50$	Inorganic silts of high plasticity		MH				
	CLAYS (Above 'A' line negligible organic content)	$W_L<30$	Inorganic clays, silty clays, sandy clays of low plasticity, lean clays		CL				
		$30<W_L<50$	Inorganic clays and silty clays of medium plasticity		CI				
		$W_L>50$	Inorganic clays of high plasticity, fat clays		CH				
	ORGANIC SILTS & CLAYS (Below 'A' line)	$W_L<50$	Organic silts and organic silty clays of low plasticity		OL				
		$W_L>50$	Organic clays of high plasticity		OH				
HIGHLY ORGAINIC SOILS			Peat and other highly organic soils		Pt	Von Post Classification Limit		Strong colour or odour, and often fibrous texture	

	Asphalt		Till		
	Concrete		Bedrock (Undifferentiated)		AECOM
	Fill		Bedrock (Limestone)		

When the above classification terms are used in this report or test hole logs, the designated fractions may be visually estimated and not measured.



FRACTION		SEIVE SIZE (mm)		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
		Passing	Retained	Percent	Identifier
Gravel	Coarse	76	19	35-50	and
	Fine	19	4.75		
Sand	Coarse	4.75	2.00	20-35	"y" or "ey" *
	Medium	2.00	0.425		
	Fine	0.425	0.075	10-20	some
Silt (non-plastic) or Clay (plastic)		< 0.075 mm		1-10	trace

* for example: gravelly, sandy clayey, silty

Definition of Oversize Material

COBBLES: 76mm to 300mm diameter
BOULDERS: >300mm diameter

LEGEND OF SYMBOLS

Laboratory and field tests are identified as follows:

- q_u - undrained shear strength (kPa) derived from unconfined compression testing.
- T_v - undrained shear strength (kPa) measured using a torvane
- pp - undrained shear strength (kPa) measured using a pocket penetrometer.
- L_v - undrained shear strength (kPa) measured using a lab vane.
- F_v - undrained shear strength (kPa) measured using a field vane.
- γ - bulk unit weight (kN/m^3).
- SPT - Standard Penetration Test. Recorded as number of blows (N) from a 63.5 kg hammer dropped 0.76 m (free fall) which is required to drive a 51 mm O.D. Raymond type sampler 0.30 m into the soil.
- DPPT - Drive Point Pentrometer Test. Recorded as number of blows from a 63.5 kg hammer dropped 0.76 m (free fall) which is required to drive a 50 mm drive point 0.30 m into the soil.
- w - moisture content (W_L, W_P)

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Su (kPa)	**CONSISTENCY**
<12	very soft
12 – 25	soft
25 – 50	medium or firm
50 – 100	stiff
100 – 200	very stiff
200	hard

The resistance (N) of a non-cohesive soil can be related to compactness condition as follows

N – BLOWS/0.30 m	**COMPACTNESS**
0 - 4	very loose
4 - 10	loose
10 - 30	compact
30 - 50	dense
50	very dense

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 11-01**
LOCATION: UTM: 14 U, 5 501 623.88 m N, 483 033.59 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 357.92

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ☒ SPLIT SPOON ▤ BULK ▨ NO RECOVERY ◧ CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
0		TOPSOIL - sandy, rootlets - dark brown to black, dry to moist						
1		SAND - some silt to silty, some clay to clayey, trace oxidation - brown, dry, compact - fine grained, poorly graded	■	G1				357
			■	G2			Gravel: 0.0%, Sand: 45.3%, Silt: 33.0%, Clay: 21.8% SPT Blows: 8, 8, 9	
2		- moist, medium grained below 1.5 m	☒	S3	17			356
			■	G4				
3			■	G5				355
4			■	G6				354
5		END OF TEST HOLE AT 4.6 m IN SAND Notes: 1. No seepage observed. 2. Sloughing observed at 3.8 m below ground surface. 3. Test hole backfilled with auger cuttings.						353
6								352
7								351
8								350
9								349
10								348

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100; ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU × ☐ Lab Vane ☐ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 4.57 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

AECOM

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 11-02**
LOCATION: UTM: 14 U, 5 501 494.30 m N, 483 031.63 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 357.17

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ▨ SPLIT SPOON ▤ BULK ▨ NO RECOVERY ◧ CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100 ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21 Plastic MC Liquid 20 40 60 80 100	UNDRAINED SHEAR STRENGTH + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200	COMMENTS	ELEVATION
0		TOPSOIL - sandy, rootlets - dark brown to black, dry to moist							357
1		SAND - some silt to silty, some clay to clayey, trace oxidation - light brown to brown, dry - fine grained	■	G7					356
2			■	G8		●			355
3		SILT and CLAY - trace sand - dark brown, moist, soft to firm - low to intermediate plasticity	■	G9		●			354
4			▥	T10				Gravel: 0.0%, Sand: 8.3%, Silt: 46.5%, Clay: 45.1%	353
5		SAND - some silt to silty, some clay to clayey, trace gravel - brown, moist, compact - fine to medium grained, poorly graded	■	G11		●		Gravel: 1.4%, Sand: 73.4%, Silt: 13.2%, Clay: 12.0%	352
6		END OF TEST HOLE AT 4.6 m IN SAND Notes: 1. No seepage observed. 2. Sloughing observed at 4.2 m below ground surface. 3. Test hole backfilled with auger cuttings.							351
7									350
8									349
9									348
10									

AECOM

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 4.57 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 11-03**
LOCATION: UTM: 14 U, 5 501 563.18 m N, 482 979.78 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 357.81

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ▨ SPLIT SPOON ▤ BULK ▧ NO RECOVERY ◧ CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100; ■ Total Unit Wt ■ (kN/m³) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100	UNDRAINED SHEAR STRENGTH: + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200	COMMENTS	ELEVATION
0		TOPSOIL - sandy, rootlets - dark brown to black, dry to moist							
1		SAND - some silt to silty, some clay to clayey, trace oxidation - light brown to brown, dry to moist, compact - fine grained, poorly graded	■	G12		●			357
		- medium grained below 2.3 m	■	G13		●		Gravel: 0.0%, Sand: 52.9%, Silt: 31.8%, Clay: 15.3%	
2			■	G14		●			356
3			▨	S15	15	●		SPT Blows: 5, 7, 8	355
		END OF TEST HOLE AT 3.5 m IN SAND Notes: 1. No sloughing or seepage observed. 2. Test hole backfilled with auger cuttings upon completion.							354
4									
5									353
6									352
7									351
8									350
9									349
10									348

AECOM

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 3.51 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **SP 11-04**
LOCATION: UTM: 14 U, 5 501 563.70 m N, 482 907.14 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 357.48

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100; ■ Total Unit Wt ■ (kN/m³) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100	UNDRAINED SHEAR STRENGTH: + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ✤ Field Vane ✤ (kPa) 50 100 150 200	COMMENTS	ELEVATION
0		TOPSOIL - sandy, rootlets - dark brown to black, dry to moist							357
1		SAND - some silt to silty, some clay to clayey, trace oxidation - light brown to brown, dry to moist - fine grained, poorly graded		G16					
		- some silt, some clay below 1.2 m		G17					356
2									
				G18					355
3				G19					
									354
4									
		- trace fines below 4.6 m		G20				Gravel: 0.0%, Sand: 92.2%, Fines: 7.8%	353
5									
									352
6				G21					
									351
7									
				G22					350
8									
									349
9				G23					
									348
10									

AECOM

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 10.67 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 1 of 2

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **SP 11-04**
LOCATION: UTM: 14 U, 5 501 563.70 m N, 482 907.14 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 357.48

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	SOIL SYMBOL	SLOTTED PIEZOMETER	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100; ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100	UNDRAINED SHEAR STRENGTH: + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200	COMMENTS	ELEVATION
10				■	G24					347
			END OF TEST HOLE AT 10.7 m IN SAND							
11			Notes: 1. No sloughing or seepage observed. 2. Installed 25 mm diameter standpipe piezometer (SP-11-04) to 10.7 m below ground with Casagrande tip and approximately 1.0 m stick-up. 3. Backfilled test hole with sand to 9.7 m, bentonite chips to 8.2 m, auger cuttings to 1.5 m, and bentonite chips to surface. Above ground protective casing installed. 4. No water level was observed in SP 11-04 on June 18, 2012.							346
12										345
13										344
14										343
15										342
16										341
17										340
18										339
19										338
20										

AECOM

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 10.67 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 2 of 2

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 11-05**
LOCATION: UTM: 14 U, 5 501 621.14 m N, 482 847.26 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 359.14

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
0		TOPSOIL - sandy, rootlets - dark brown to black, dry to moist						359
1		SAND - some silt, some clay, trace oxidation - light brown to brown, dry to moist - fine grained		G25				358
2		SILT and CLAY - some sand to sandy, some organics, trace roots - dark brown, dry, soft to firm - low plasticity		S26	9		SPT Blows: 5, 4, 5	357
3		SAND - trace silt - brown, moist - medium grained		G27				356
4				G28				355
5		END OF TEST HOLE AT 4.6 m IN SAND Notes: 1. No seepage observed. 2. Sloughing observed at 4.0 m below ground surface. 3. Test hole backfilled with auger cuttings.						354
6								353
7								352
8								351
9								350
10								

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100
■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21
Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 4.57 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

AECOM

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 11-06**
LOCATION: UTM: 14 U, 5 501 545.73 m N, 482 844.11 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 357.77

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
0		TOPSOIL - sandy, rootlets - dark brown to black, dry to moist						
		SAND - some silt, trace oxidation - light brown to brown, dry to moist - fine grained		G29				357
1								
		SILT and CLAY - some sand - brown, dry, firm - low to intermediate plasticity		G30				356
2				G31			Gravel: 0.0%, Sand: 18.2%, Silt: 39.5%, Clay: 42.3%	
				G32				355
3		END OF TEST HOLE AT 3.1 m IN SILT AND CLAY Notes: 1. No slouging or seepage observed. 2. Test hole backfilled with auger cuttings.						
								354
4								
								353
5								
								352
6								
								351
7								
								350
8								
								349
9								
								348
10								

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100; ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 3.05 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

AECOM

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 11-07**
LOCATION: UTM: 14 U, 5 501 493.46 m N, 482 844.78 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 357.19

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
0		TOPSOIL - sandy, rootlets - dark brown to black, dry to moist						357
1		SAND - some silt, some clay, trace oxidation - mottled brown and grey, moist - fine grained		G33				
				G34				356
2		SILT and CLAY - some sand, trace orgaincs, dark brown, dry to moist, firm, low to intermediate plasticity		G35				
		SAND - some silt to silty, some clay to clayey, trace oxidation - brown, moist, loose to compact - medium grained		G36				355
3								
				S37	10		SPT Blows: 5, 4, 6	354
4		END OF TEST HOLE AT 3.5 m IN SAND Notes: 1. No sloughing and seepage observed. 2. Test hole backfilled with auger cuttings.						353
5								352
6								351
7								350
8								349
9								348
10								

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100
■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21
Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200

AECOM

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 3.51 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 11-08**
LOCATION: UTM: 14 U, 5 501 543.25 m N, 482 726.58 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 357.81

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
0		TOPSOIL - sandy, rootlets - dark brown to black, dry to moist						
		SAND - some silt to silty, some clay to clayey, trace oxidation - light brown and brown, dry to moist - fine grained		G38				357
1				G39				356
2		- trace fines, medium grained below 2.1 m						355
3		END OF TEST HOLE AT 3.1 m IN SAND Notes: 1. No sloughing and seepage observed. 2. Test hole backfilled with auger cuttings.		G40				354
4								353
5								352
6								351
7								350
8								349
9								348
10								

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100; ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU × ☐ Lab Vane ☐ △ Pocket Pen. △ ⚘ Field Vane ⚘ (kPa) 50 100 150 200

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 3.05 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

AECOM

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 11-09**
LOCATION: UTM: 14 U, 5 501 490.70 m N, 482 722.50 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 357.59

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
0		TOPSOIL - sandy, rootlets - dark brown to black, dry to moist						
1		SAND - some silt to silty, some clay to clayey, trace oxidation - light brown to brown, moist - fine grained, poorly graded		G41			Gravel: 0.0%, Sand: 60.0%, Silt: 24.7%, Clay: 15.3%	357
2				G42				356
3		- medium grained below 2.3 m		G43				355
				G44				
		END OF TEST HOLE AT 3.1 m IN SAND Notes: 1. No seepage observed. 2. Sloughing observed at 2.7 m below ground surface. 3. Test hole backfilled with auger cuttings.						354
4								353
5								352
6								351
7								350
8								349
9								348
10								

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100
■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21
Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200

AECOM

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 3.05 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 11-10**
LOCATION: UTM: 14 U, 5 501 546.42 m N, 482 582.28 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 357.99

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
0		TOPSOIL - sandy, rootlets - dark brown to black, dry to moist						
1		SAND - some silt to silty, some clay to clayey, trace oxidation - reddish brown and grey, moist - fine grained, poorly graded		G45				357
				G46				
2								356
		- some fines below 2.3 m		G47			Gravel: 0.0%, Sand: 84.0%, Fines: 16.0%	
3				G48				355
		END OF TEST HOLE AT 3.1 m IN SAND Notes: 1. No seepage observed. 2. Sloughing observed at 2.7 m below ground surface. 3. Test hole backfilled with auger cuttings.						
4								354
5								353
6								352
7								351
8								350
9								349
10								

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100
■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21
Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 3.05 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

AECOM

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 11-11**
LOCATION: UTM: 14 U, 5 501 490.62 m N, 482 602.52 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 357.68

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ▨ SPLIT SPOON ▤ BULK ▨ NO RECOVERY ◧ CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100 ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21 Plastic MC Liquid 20 40 60 80 100	UNDRAINED SHEAR STRENGTH + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200	COMMENTS	ELEVATION
0		TOPSOIL - sandy, rootlets - dark brown to black, dry to moist							357
1		SAND - some silt to silty, some clay to clayey, trace oxidation - brown and grey, dry to moist, compact - fine grained, poorly graded		G49		●			
		- some silt, trace clay below 1.2 m		G50		●			
2				S51	20	● ◆		SPT Blows: 6, 8, 12	356
3				G52		●			355
4				G53		●			354
5									353
6				G54		●			352
7		- trace fines below 7.3 m		G55		●		Gravel: 0.0%, Sand: 95.9%, Fines: 4.1%	351
8									350
9				G56		●			349
10									348

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

AECOM

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 12.19 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 1 of 2

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 11-11**
LOCATION: UTM: 14 U, 5 501 490.62 m N, 482 602.52 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 357.68

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100; ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100	UNDRAINED SHEAR STRENGTH: + Torvane + × QU × ☐ Lab Vane ☐ △ Pocket Pen. △ ⚈ Field Vane ⚈ (kPa) 50 100 150 200	COMMENTS	ELEVATION
10									347
11				G57					346
12				G58					345
13		END OF TEST HOLE AT 12.2 m IN SAND Notes: 1. No seepage or sloughing observed. 2. Test hole backfilled with auger cuttings.							344
14									343
15									342
16									341
17									340
18									339
19									338
20									

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

AECOM

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 12.19 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 2 of 2

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 11-12**
LOCATION: UTM: 14 U, 5 501 519.26 m N, 482 481.09 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 358.03

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
0		TOPSOIL - sandy, rootlets - dark brown to black, dry to moist						
		SAND - some silt to silty, some clay to clayey, trace oxidation - brown and grey, moist, loose - fine grained		G59				
1				G60				357
2								356
		- trace silt, medium grained below 2.3 m		G61				
				G62				
3				S63	7		SPT Blows: 5, 4, 3	355
4				G64				354
				G65				
		END OF TEST HOLE AT 4.6 m IN SAND Notes: 1. No seepage observed. 2. Sloughing observed at 4.1 m below ground surface. 3. Test hole backfilled with auger cuttings.						
5								353
6								352
7								351
8								350
9								349
10								

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100
■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21
Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU × ☐ Lab Vane ☐ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 4.57 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 11/7/11
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

AECOM

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 12-13**
LOCATION: UTM: 14 U, 5 501 682.63 m N, 482 983.88 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 358.99

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0		TOPSOIL - sandy, rootlets, dark brown, moist					
		SAND - some silt to silty - brown, dry to moist, compact - fine grained		G1			
1							358
		- trace silt pockets at 1.5 m		S2	15	SPT Blows: 6, 6, 9	
2							357
				G3			
3		- reddish brown, trace oxidation below 3.1 m		S4	8	SPT Blows: 4, 3, 5	356
				G5			
4							355
				S6	15	SPT Blows: 6, 7, 8	
5				G7			354
6							353
				S8	12	SPT Blows: 4, 5, 7	
		END OF TEST HOLE AT 6.7 m IN SAND Notes: 1. No seepage observed. 2. Sloughing observed at 5.5 m below ground surface. 3. Test hole backfilled with auger cuttings.					
7							352
8							351
9							350
10							

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100 ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21 Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU × ☐ Lab Vane ☐ △ Pocket Pen. △ ⊕ Field Vane ⊕ (kPa) 50 100 150 200

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 6.55 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 6/18/12
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

AECOM

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 12-14**
LOCATION: UTM: 14 U, 5 501 579.27 m N, 482 665.49 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 358.55

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
0		TOPSOIL - sandy, some clay, trace silt, black to dark brown, moist						
		SAND - some silt to silty - brown, moist - fine grained						358
1				G9				
				G10				357
2				G11				
								356
3								
								355
4				G12				
								354
5								
								353
6				G13				
		END OF TEST HOLE AT 6.1 m IN SAND Notes: 1. No seepage observed. 2. Sloughing observed at 5.7 m below ground surface. 3. Test hole backfilled with auger cuttings.						352
7								
								351
8								
								350
9								
								349
10								

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100
■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21
Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 6.10 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 6/18/12
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

AECOM

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 12-15**
LOCATION: UTM: 14 U, 5 501 627.58 m N, 482 664.30 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 360.16

SAMPLE TYPE ■ GRAB ▯ SHELBY TUBE ☒ SPLIT SPOON ▬ BULK ⊘ NO RECOVERY ◧ CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100 ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21 Plastic MC Liquid 20 40 60 80 100	UNDRAINED SHEAR STRENGTH + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200	COMMENTS	ELEVATION
0		TOPSOIL - sandy, trace to some clay, trace silt, dark brown to black, moist							360
		SAND - some silt - brown, moist - fine grained, poorly graded							
1			■	G14		●		Gravel: 0%, Sand: 82.2%, Fines: 17.8%	359
2									358
		- trace silt pockets, light grey, dense between 2.7 and 3.1 m	■	G15		●			
3									357
4			■	G16		●			356
5									355
6			■	G17		●			354
		END OF TEST HOLE AT 6.1 m IN SAND Notes: 1. No seepage observed. 2. Sloughing observed at 5.6 m below ground surface. 3. Test hole backfilled with auger cuttings.							
7									353
8									352
9									351
10									

AECOM

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 6.10 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 6/18/12
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 12-16**
LOCATION: UTM: 14 U, 5 501 653.13 m N, 482 780.30 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 360.80

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ▨ SPLIT SPOON ▤ BULK ▨ NO RECOVERY ◧ CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100 ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21 Plastic MC Liquid 20 40 60 80 100	UNDRAINED SHEAR STRENGTH + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200	COMMENTS	ELEVATION
0		TOPSOIL - sandy, trace silt, trace clay, dark brown to black, moist							
		SAND - some silt silt - brown, moist - fine grained							
1				G18					360
2									359
3				G19					358
4									357
5				G20					356
6				G21					355
		END OF TEST HOLE AT 6.1 m IN SAND Notes: 1. No seepage observed. 2. Sloughing observd at 5.6 m below ground surface. 3. Test hole backfilled with auger cuttings.							
7									354
8									353
9									352
10									351

AECOM

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 6.10 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 6/18/12
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 12-17**
LOCATION: UTM: 14 U, 5 501 594.61 m N, 482 784.78 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 358.67

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
0		TOPSOIL - sandy, some silt, trace clay - dark brown, moist		G22				358
1		SAND - silty, clayey, light grey to brown, dry to moist - fine grained, poorly graded - intermediate plasticity clay		G23			Gravel: 0%, Sand: 51.0%, Silt: 27.4%, Clay: 21.6%	357
2		SAND - some silt - brown, moist - fine grained - trace clay pockets between 2.1 and 2.7 m						356
3				G24				355
4								
5				G25				354
6				G26				353
7		END OF TEST HOLE AT 6.1 m IN SAND Notes: 1. No seepage observed. 2. Sloughing observed at 5.6 m below ground surface. 3. Test hole backfilled with auger cuttings.						352
8								351
9								350
10								349

PENETRATION TESTS: ✳ Becker ✳ | ◇ Dynamic Cone ◇ | ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100 | ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21 | Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + | × QU × | □ Lab Vane □ | △ Pocket Pen. △ | ✤ Field Vane ✤ (kPa) 50 100 150 200

AECOM

LOGGED BY: Omer Eissa	COMPLETION DEPTH: 6.10 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 6/18/12
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

PROJECT: Spruce Woods Lagoon	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH 12-18**
LOCATION: UTM: 14 U, 5 501 670.87 m N, 482 903.03 m E		PROJECT NO.: 60221902
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM-30, 125 mm SSA	ELEVATION (m): 359.24

SAMPLE TYPE ■ GRAB ▯ SHELBY TUBE ☒ SPLIT SPOON ☰ BULK ⧄ NO RECOVERY ◧ CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100; ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100	UNDRAINED SHEAR STRENGTH: + Torvane + × QU × ☐ Lab Vane ☐ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200	COMMENTS	ELEVATION
0		TOPSOIL - sandy, dark brown, moist						359
		SAND - silty - brown, moist - fine grained, poorly graded						
1				G27			Gravel: 0%, Sand: 69.4%, Fines: 30.6%	358
2								357
		- trace clay pockets at 2.7 m		G28				
3								356
4								355
				G29				
5								354
6				G30				
		END OF TEST HOLE AT 6.1 m IN SAND Notes: 1. No seepage observed. 2. Sloughing observed at 5.6 m below ground surface. 3. Test hole backfilled with auger cuttings.						353
7								352
8								351
9								350
10								

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 7/6/12

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LOGGED BY: Omer Eissa	COMPLETION DEPTH: 6.10 m
REVIEWED BY: Jared Baldwin	COMPLETION DATE: 6/18/12
PROJECT ENGINEER: Eric Hutchison	Page 1 of 1

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Laboratory Results

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Memorandum

To	Omer Eissa	Page	1
CC			
Subject	Spruce Woods Lagoon		
From	Stephen Petsche		
Date	November 30, 2011	60221902	

Attached are testing results for the above noted project. The testing included sixty-three (63) Moisture Content tests and eight (8) Grain Size Distribution (hydrometer and mechanical methods) tests on samples submitted to the lab.

If you have any questions, please call.

Sincerely,

Stephen Petsche, C.E.T.
Coordinator, Lab and Technical Services

Attach.

MOISTURE CONTENT

JOB No.: 60221902
CLIENT: Manitoba Water Services Board
PROJECT: Spruce Woods Lagoon

DATE: November 18, 2011

HOLE NO.	TH11-01	-	-	-	-	-
SAMPLE NO.	G1	G2	S3	G4	G5	G6
DEPTH (FT)	1.5 - 2.5	4.5 - 5.0	5.0 - 6.5	7.5 - 8.0	10.0 - 11.0	12.5 - 14.0
MOISTURE CONTENT %	13.0	9.1	19.8	7.7	3.4	2.2
HOLE NO.	TH11-02	-	-	-	-	TH11-03
SAMPLE NO.	G7	G8	G9	T10	G11	G12
DEPTH (FT)	2.5 - 3.5	5.0 - 6.0	7.5 - 8.5	13.0 - 14.0	13.0 - 14.0	2.5 - 4.0
MOISTURE CONTENT %	Missing	6.2	32.5	15.9	Missing	5.7
HOLE NO.	TH11-03	-	-	TH11-04	-	-
SAMPLE NO.	G13	G14	S15	G16	G17	G18
DEPTH (FT)	4.0 - 5.0	7.5 - 9.0	10.0 - 11.5	2.5 - 3.5	4.0 - 5.0	7.5 - 9.0
MOISTURE CONTENT %	7.5	18.7	17.5	7.5	3.1	18.0
HOLE NO.	TH11-04	-	-	-	-	-
SAMPLE NO.	G19	G20	G21	G22	G23	G24
DEPTH (FT)	10.0 - 11.0	15.0 - 16.0	19.0 - 20.0	24.0 - 25.0	29.0 - 23.0	32.5 - 33.5
MOISTURE CONTENT %	1.9	4.0	2.5	2.6	2.9	Missing

NOTES:

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MOISTURE CONTENT

JOB No.: 60221902
CLIENT: Manitoba Water Services Board
PROJECT: Spruce Woods Lagoon

DATE: November 18, 2011

HOLE NO.	TH11-05	-	-	-	TH11-06	-
SAMPLE NO.	G25	G26	G27	G28	G29	G30
DEPTH (FT)	2.5 - 3.5	5.0 - 6.5	10.0 - 11.0	12.5 - 14.0	2.5 - 4.0	5.0 - 6.0
MOISTURE CONTENT %	2.0	11.6	7.8	3.0	4.5	18.9

HOLE NO.	TH11-06	-	TH11-07	-	-	-
SAMPLE NO.	G31	G32	G33	G34	G35	G36
DEPTH (FT)	7.5 - 9.0	10.0 - 11.0	2.5 - 4.0	5.0 - 6.0	6.0 - 7.0	7.5 - 9.0
MOISTURE CONTENT %	18.7	17.1	10.4	14.0	23.8	6.9

HOLE NO.	TH11-07	TH11-08	-	-	TH11-09	-
SAMPLE NO.	S37	G38	G39	G40	G41	G42
DEPTH (FT)	10.0 - 11.5	2.5 - 4.0	5.0 - 6.0	9.0 - 10.0	2.5 - 4.0	5.0 - 6.0
MOISTURE CONTENT %	4.7	7.0	14.2	4.1	6.2	9.1

HOLE NO.	TH11-09	-	TH11-10	-	-	-
SAMPLE NO.	G43	G44	G45	G46	G47	G48
DEPTH (FT)	7.5 - 8.5	9.0 - 10.0	2.0 - 3.0	4.0 - 5.0	7.5 - 8.5	9.0 - 10.0
MOISTURE CONTENT %	18.2	19.2	9.7	1.9	3.8	5.2

NOTES:

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MOISTURE CONTENT

JOB No.: 60221902
CLIENT: Manitoba Water Services Board
PROJECT: Spruce Woods Lagoon

DATE: November 18, 2011

HOLE NO.	TH11-11	-	-	-	-	-
SAMPLE NO.	G49	G50	G51	G52	G53	G54
DEPTH (FT)	2.5 - 4.0	4.0 - 5.0	5. - 6.5	9.0 - 10.0	14.0 - 15.0	19.0 - 20.0
MOISTURE CONTENT %	7.6	5.2	7.1	5.2	1.7	1.9

HOLE NO.	TH11-11	-	-	-	TH11-12	-
SAMPLE NO.	G55	G56	G57	G58	G59	G60
DEPTH (FT)	24.0 -25.0	29.0 - 30.0	34.0 - 35.0	39.0 - 40.0	2.5 - 4.0	4.0 - 5.0
MOISTURE CONTENT %	2.3	2.9	3.1	2.7	7.7	3.20

HOLE NO.	TH11-12	-	-	-	-	
SAMPLE NO.	G61	G62	S63	G64	G65	
DEPTH (FT)	7.5 - 9.0	9.0 - 10.0	10.0 - 11.5	12.5 - 14.0	14.0 - 15.0	
MOISTURE CONTENT %	2.2	2.7	2.8	3.9	2.4	

HOLE NO.						
SAMPLE NO.						
DEPTH (FT)						
MOISTURE CONTENT %						

NOTES:

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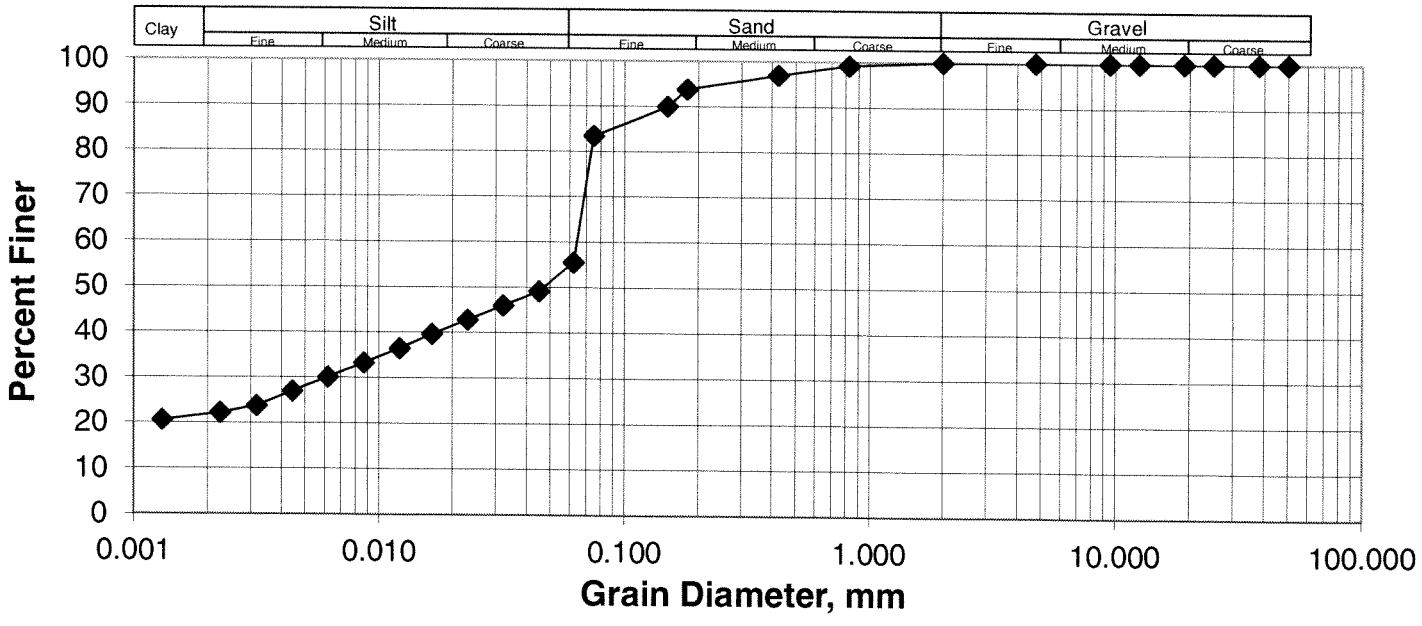
Job No.:	60221902	Hole No.:	TH11-01
Client:	Manitoba Water Services Board	Sample No.:	G2
Project :	Spruce Woods Lagoon	Depth:	4.5 - 5.0'
Date Tested:	26-Nov-11	Date Sampled:	
Tested By:		Sampled By:	

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	100.0	0.0750	83.4
38.0	100.0	0.83	99.2	0.0621	55.5
25.0	100.0	0.43	97.0	0.0450	49.2
19.0	100.0	0.18	93.8	0.0322	46.0
12.5	100.0	0.15	90.0	0.0230	42.8
9.5	100.0	0.075	83.4	0.0165	39.6
4.75	100.0			0.0122	36.5
2.00	100.0			0.0087	33.3
				0.0062	30.1
				0.0044	26.9
				0.0032	23.8
				0.0023	22.2
				0.0013	20.6

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**33.0%**
Sand	**45.3%**	**Clay**	**21.8%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

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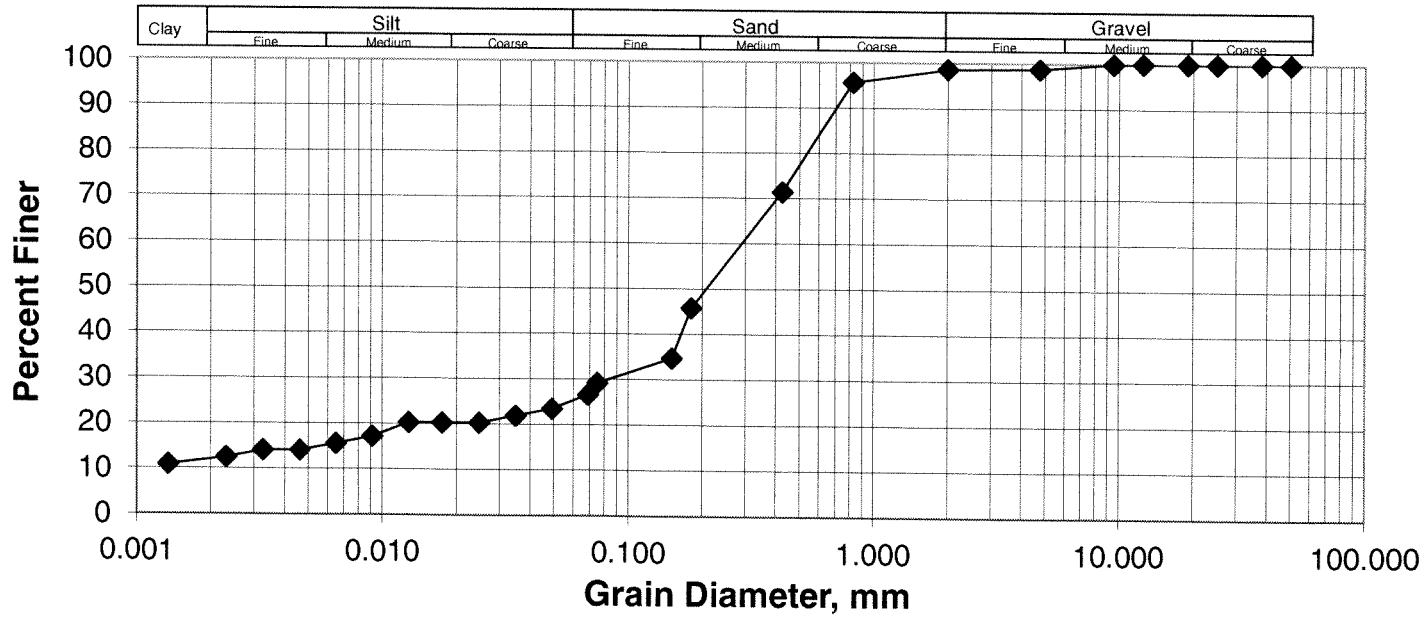
Job No.:	60221902	Hole No.:	TH11-02
Client:	Manitoba Water Services Board	Sample No.:	T10
Project :	Spruce Woods Lagoon	Depth:	13.0 - 14.0'
Date Tested:	26-Nov-11	Date Sampled:	
Tested By:		Sampled By:	

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	98.6	0.0750	29.2
38.0	100.0	0.83	95.7	0.0687	26.6
25.0	100.0	0.43	71.4	0.0491	23.4
19.0	100.0	0.18	45.8	0.0349	21.9
12.5	100.0	0.15	34.7	0.0248	20.3
9.5	99.9	0.075	29.2	0.0175	20.3
4.75	98.8			0.0128	20.3
2.00	98.6			0.0091	17.2
				0.0065	15.6
				0.0046	14.0
				0.0033	14.0
				0.0023	12.5
				0.0013	10.9

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**1.4%**	**Silt**	**13.2%**
Sand	**73.4%**	**Clay**	**12.0%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

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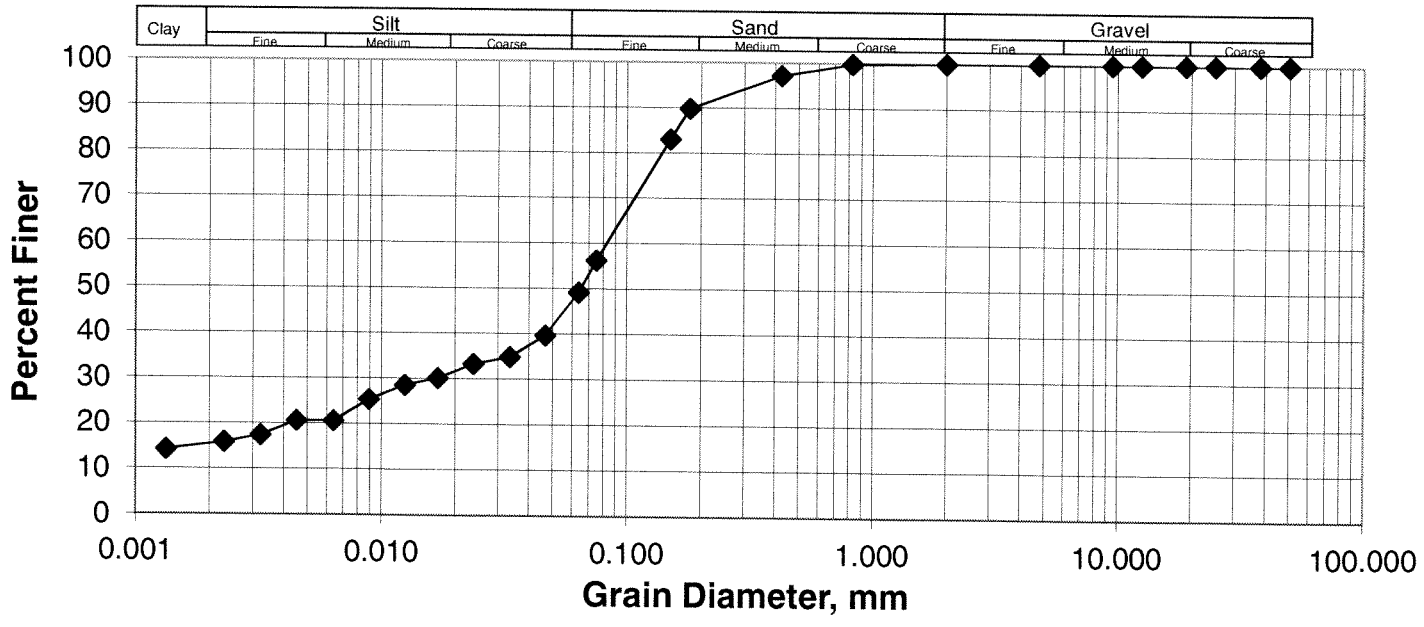
Job No.:	60221902	Hole No.:	TH11-03
Client:	Manitoba Water Services Board	Sample No.:	G13
Project :	Spruce Woods Lagoon	Depth:	4.0 - 5.0'
Date Tested:	26-Nov-11	Date Sampled:	
Tested By:		Sampled By:	

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	100.0	0.0750	56.2
38.0	100.0	0.83	99.8	0.0636	49.2
25.0	100.0	0.43	97.2	0.0466	39.6
19.0	100.0	0.18	89.8	0.0335	34.9
12.5	100.0	0.15	83.0	0.0238	33.3
9.5	100.0	0.075	56.2	0.0170	30.1
4.75	100.0			0.0125	28.5
2.00	100.0			0.0089	25.3
				0.0064	20.6
				0.0045	20.6
				0.0032	17.4
				0.0023	15.8
				0.0013	14.2

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**31.8%**
Sand	**52.9%**	**Clay**	**15.3%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

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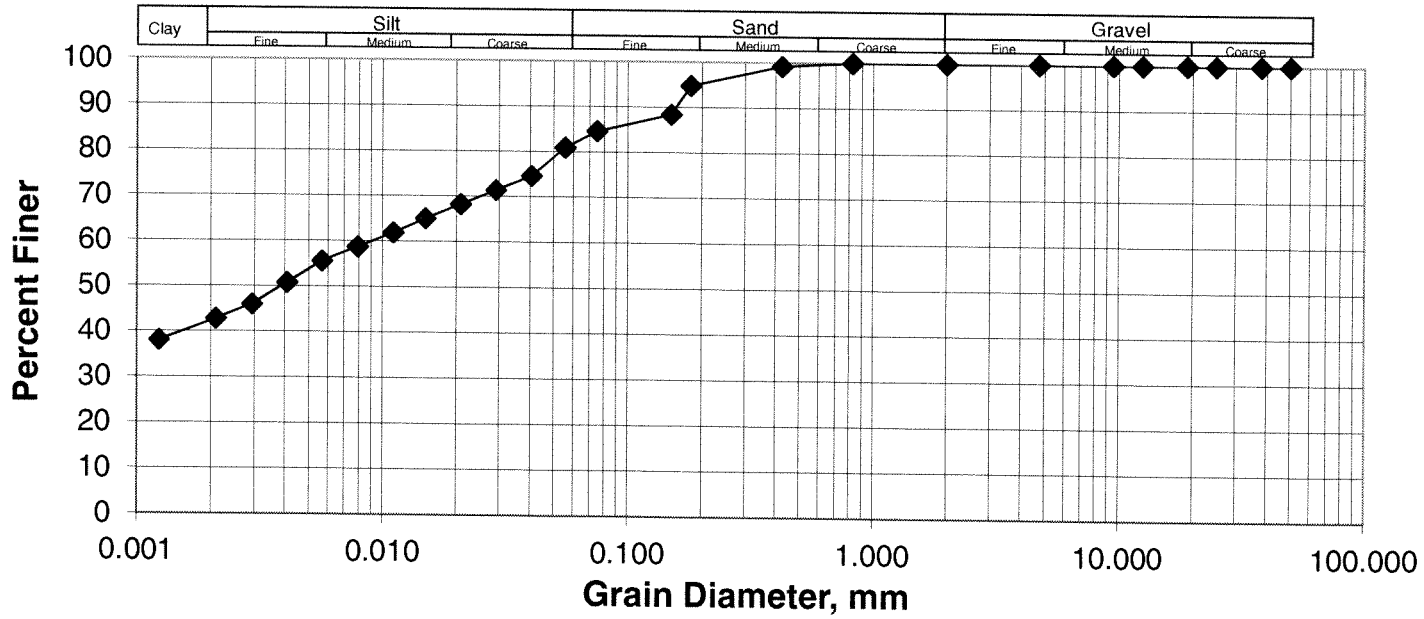
Job No.:	60221902	Hole No.:	TH11-06
Client:	Manitoba Water Services Board	Sample No.:	G31
Project :	Spruce Woods Lagoon	Depth:	7.5 - 9.0'
Date Tested:	26-Nov-11	Date Sampled:	
Tested By:		Sampled By:	

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	100.0	0.0750	84.6
38.0	100.0	0.83	100.0	0.0557	80.9
25.0	100.0	0.43	99.2	0.0405	74.6
19.0	100.0	0.18	94.8	0.0291	71.4
12.5	100.0	0.15	88.4	0.0209	68.2
9.5	100.0	0.075	84.6	0.0149	65.1
4.75	100.0			0.0111	61.9
2.00	100.0			0.0079	58.7
				0.0057	55.5
				0.0041	50.8
				0.0029	46.0
				0.0021	42.8
				0.0012	38.1

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**39.5%**
Sand	**18.2%**	**Clay**	**42.3%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

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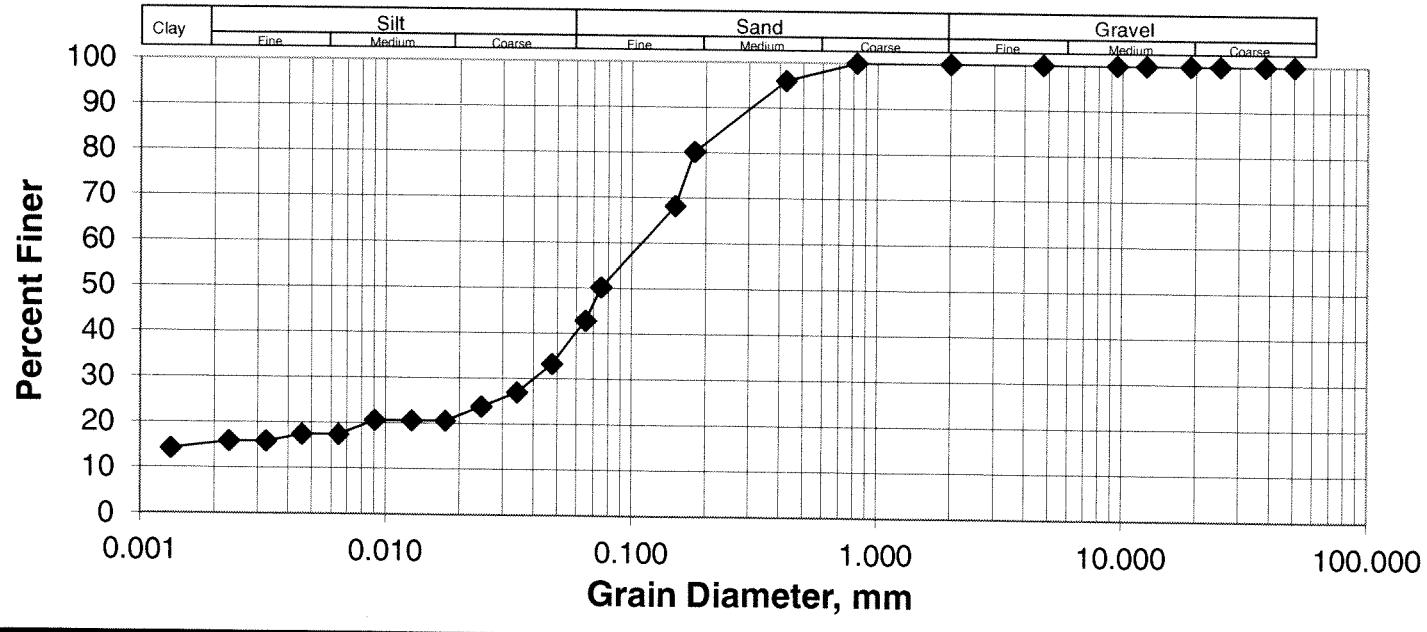
Job No.:	60221902	Hole No.:	TH11-09
Client:	Manitoba Water Services Board	Sample No.:	G41
Project :	Spruce Woods Lagoon	Depth:	2.5 - 4.0'
Date Tested:	26-Nov-11	Date Sampled:	
Tested By:		Sampled By:	

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	100.0	0.0750	50.2
38.0	100.0	0.83	100.0	0.0651	42.8
25.0	100.0	0.43	96.0	0.0476	33.3
19.0	100.0	0.18	80.2	0.0343	26.9
12.5	100.0	0.15	68.2	0.0245	23.8
9.5	100.0	0.075	50.2	0.0175	20.6
4.75	100.0			0.0128	20.6
2.00	100.0			0.0090	20.6
				0.0065	17.4
				0.0046	17.4
				0.0032	15.8
				0.0023	15.8
				0.0013	14.2

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**24.7%**
Sand	**60.0%**	**Clay**	**15.3%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

GRAIN SIZE DISTRIBUTION

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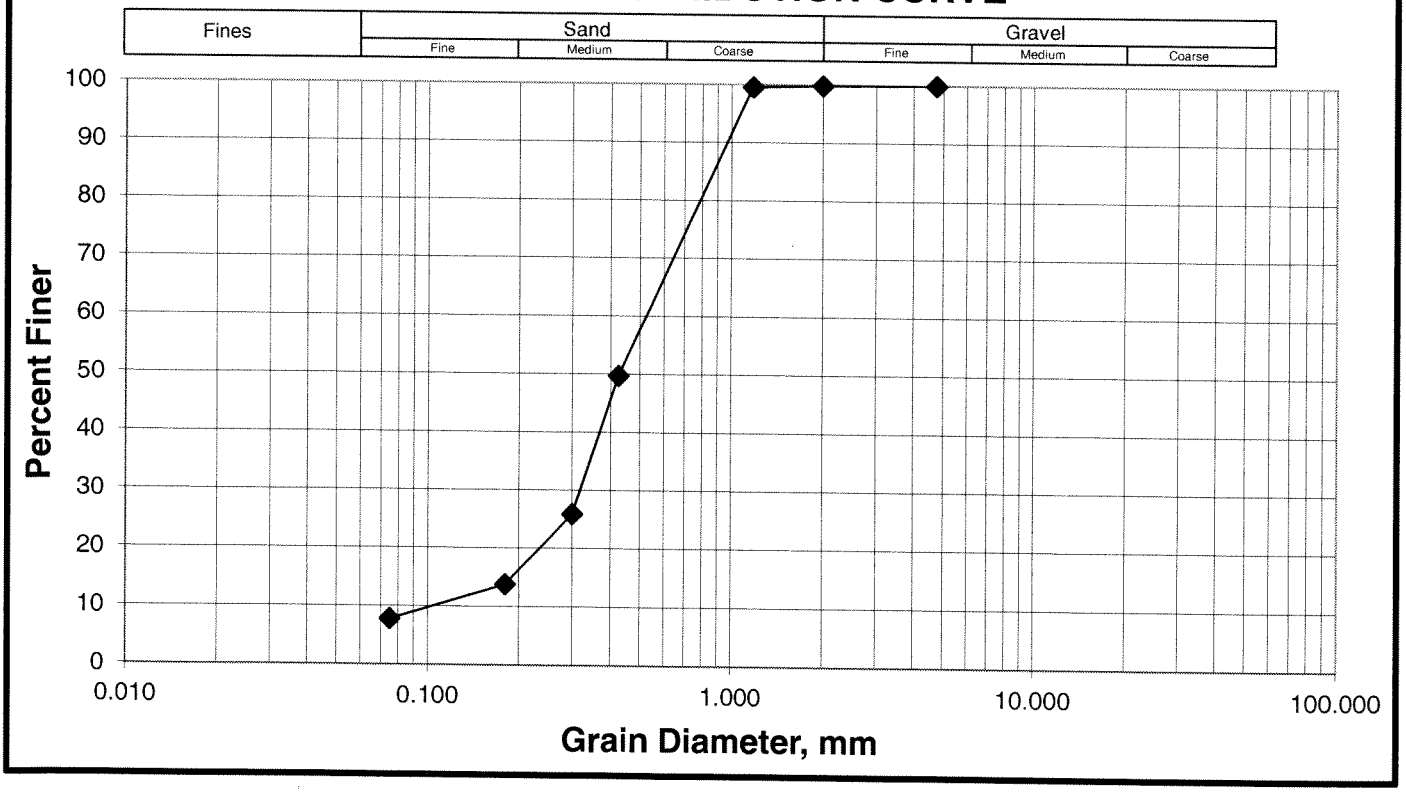
Client: Manitoba Water Services Board
Project: Spruce Woods Lagoon
Job No: 60221902
Date : 25-Nov-11

Sample Location: TH11-04 G20
Depth: 15.0 - 16.0'
Sample Description: Sand

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
150.0	6"		
100.0	4"		
75.0	3"		
50.0	2"		
37.5	1.5"		
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.5	1/2"		
9.5	3/8"		
4.75	No. 4	100.0	
2.00	No. 10	99.9	
1.18	No. 16	99.6	
0.425	No. 40	49.7	
0.300	No. 50	25.9	
0.180	No. 80	13.8	
0.075	No. 200	7.8	

GRAIN SIZE DISTRIBUTION CURVE



GRAIN SIZE DISTRIBUTION

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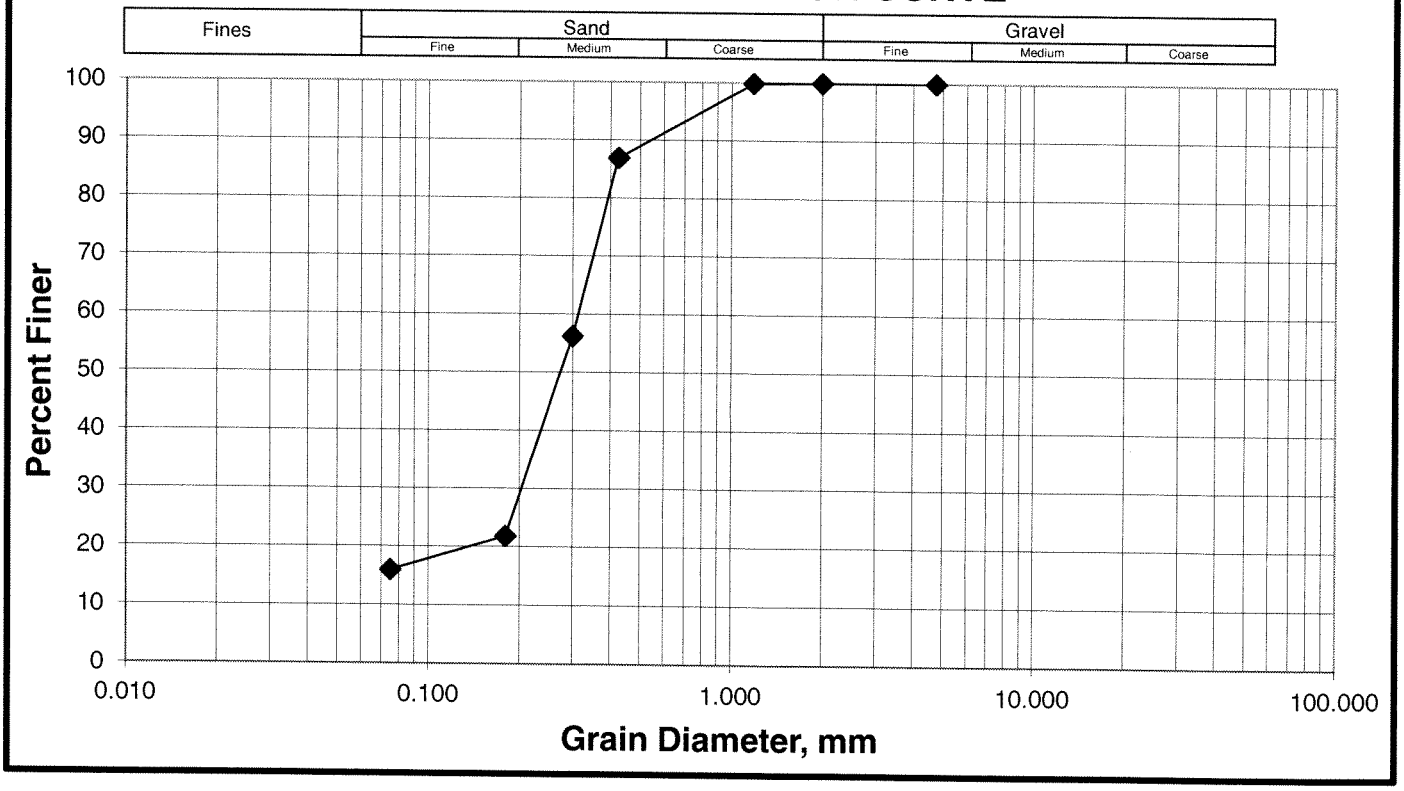
Client: Manitoba Water Services Board
Project: Spruce Woods Lagoon
Job No: 60221902
Date : 25-Nov-11

Sample Location: TH11-10 G47
Depth: 7.5 - 8.5'
Sample Description: Sand

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
150.0	6"		
100.0	4"		
75.0	3"		
50.0	2"		
37.5	1.5"		
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.5	1/2"		
9.5	3/8"		
4.75	No. 4	100.0	
2.00	No. 10	100.0	
1.18	No. 16	99.9	
0.425	No. 40	86.9	
0.300	No. 50	56.2	
0.180	No. 80	21.8	
0.075	No. 200	16.0	

GRAIN SIZE DISTRIBUTION CURVE



GRAIN SIZE DISTRIBUTION

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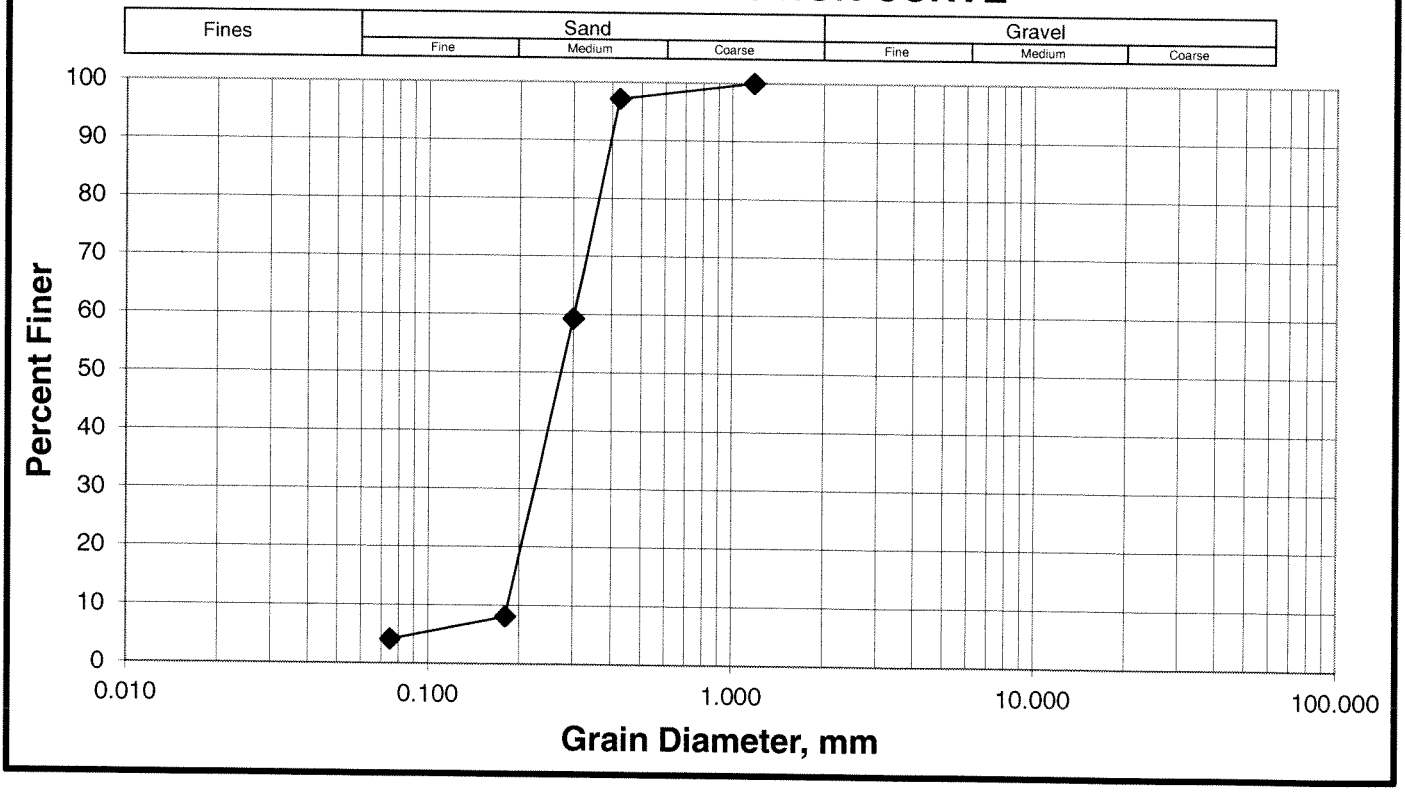
Client: Manitoba Water Services Board
Project: Spruce Woods Lagoon
Job No: 60221902
Date : 25-Nov-11

Sample Location: TH11-11 G55
Depth: 24.0 - 25.0'
Sample Description: Sand

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
150.0	6"		
100.0	4"		
75.0	3"		
50.0	2"		
37.5	1.5"		
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.5	1/2"		
9.5	3/8"		
4.75	No. 4		
2.00	No. 10		
1.18	No. 16	100.0	
0.425	No. 40	97.2	
0.300	No. 50	59.3	
0.180	No. 80	8.1	
0.075	No. 200	4.1	

GRAIN SIZE DISTRIBUTION CURVE



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Memorandum

To	Omer Eissa	Page	1
CC			
Subject	Spruce Woods Lagoon		
From	Stephen Petsche		
Date	~~November 30~~, 2011 December 5	60221902	

Attached are testing results for the above noted project. The testing included one (1) Grain Size Distribution (hydrometer method) test. Also included is an updated copy of the Moisture Content tests previously reported and a corrected Grain Size Distribution (hydrometer method) test on the sample originally labelled TH11-02 T10. The sample was incorrectly labelled during sampling and tested as per the lab requisition form.

If you have any questions, please call.

Sincerely,

Stephen Petsche, C.E.T.
Coordinator, Lab and Technical Services

Attach.

MOISTURE CONTENT

JOB No.: 60221902
CLIENT: Manitoba Water Services Board
PROJECT: Spruce Woods Lagoon

DATE: November 18, 2011

HOLE NO.	TH11-01	-	-	-	-	-
SAMPLE NO.	G1	G2	S3	G4	G5	G6
DEPTH (FT)	1.5 - 2.5	4.5 - 5.0	5.0 - 6.5	7.5 - 8.0	10.0 - 11.0	12.5 - 14.0
MOISTURE CONTENT %	13.0	9.1	19.8	7.7	3.4	2.2
HOLE NO.	TH11-02	-	-	-	-	TH11-03
SAMPLE NO.	G7	G8	G9	T10	G11	G12
DEPTH (FT)	2.5 - 3.5	5.0 - 6.0	7.5 - 8.5	10.0 - 12.0	13.0 - 14.0	2.5 - 4.0
MOISTURE CONTENT %	Missing	6.2	32.5	n/a	15.9	5.7
HOLE NO.	TH11-03	-	-	TH11-04	-	-
SAMPLE NO.	G13	G14	S15	G16	G17	G18
DEPTH (FT)	4.0 - 5.0	7.5 - 9.0	10.0 - 11.5	2.5 - 3.5	4.0 - 5.0	7.5 - 9.0
MOISTURE CONTENT %	7.5	18.7	17.5	7.5	3.1	18.0
HOLE NO.	TH11-04	-	-	-	-	-
SAMPLE NO.	G19	G20	G21	G22	G23	G24
DEPTH (FT)	10.0 - 11.0	15.0 - 16.0	19.0 - 20.0	24.0 - 25.0	29.0 - 23.0	32.5 - 33.5
MOISTURE CONTENT %	1.9	4.0	2.5	2.6	2.9	Missing

NOTES:

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MOISTURE CONTENT

JOB No.: 60221902
CLIENT: Manitoba Water Services Board
PROJECT: Spruce Woods Lagoon

DATE: November 18, 2011

HOLE NO.	TH11-05	-	-	-	TH11-06	-
SAMPLE NO.	G25	G26	G27	G28	G29	G30
DEPTH (FT)	2.5 - 3.5	5.0 - 6.5	10.0 - 11.0	12.5 - 14.0	2.5 - 4.0	5.0 - 6.0
MOISTURE CONTENT %	2.0	11.6	7.8	3.0	4.5	18.9

HOLE NO.	TH11-06	-	TH11-07	-	-	-
SAMPLE NO.	G31	G32	G33	G34	G35	G36
DEPTH (FT)	7.5 - 9.0	10.0 - 11.0	2.5 - 4.0	5.0 - 6.0	6.0 - 7.0	7.5 - 9.0
MOISTURE CONTENT %	18.7	17.1	10.4	14.0	23.8	6.9

HOLE NO.	TH11-07	TH11-08	-	-	TH11-09	-
SAMPLE NO.	S37	G38	G39	G40	G41	G42
DEPTH (FT)	10.0 - 11.5	2.5 - 4.0	5.0 - 6.0	9.0 - 10.0	2.5 - 4.0	5.0 - 6.0
MOISTURE CONTENT %	4.7	7.0	14.2	4.1	6.2	9.1

HOLE NO.	TH11-09	-	TH11-10	-	-	-
SAMPLE NO.	G43	G44	G45	G46	G47	G48
DEPTH (FT)	7.5 - 8.5	9.0 - 10.0	2.0 - 3.0	4.0 - 5.0	7.5 - 8.5	9.0 - 10.0
MOISTURE CONTENT %	18.2	19.2	9.7	1.9	3.8	5.2

NOTES:

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MOISTURE CONTENT

JOB No.: 60221902
CLIENT: Manitoba Water Services Board
PROJECT: Spruce Woods Lagoon

DATE: November 18, 2011

HOLE NO.	TH11-11	-	-	-	-	-
SAMPLE NO.	G49	G50	G51	G52	G53	G54
DEPTH (FT)	2.5 - 4.0	4.0 - 5.0	5. - 6.5	9.0 - 10.0	14.0 - 15.0	19.0 - 20.0
MOISTURE CONTENT %	7.6	5.2	7.1	5.2	1.7	1.9

HOLE NO.	TH11-11	-	-	-	TH11-12	-
SAMPLE NO.	G55	G56	G57	G58	G59	G60
DEPTH (FT)	24.0 -25.0	29.0 - 30.0	34.0 - 35.0	39.0 - 40.0	2.5 - 4.0	4.0 - 5.0
MOISTURE CONTENT %	2.3	2.9	3.1	2.7	7.7	3.20

HOLE NO.	TH11-12	-	-	-	-	
SAMPLE NO.	G61	G62	S63	G64	G65	
DEPTH (FT)	7.5 - 9.0	9.0 - 10.0	10.0 - 11.5	12.5 - 14.0	14.0 - 15.0	
MOISTURE CONTENT %	2.2	2.7	2.8	3.9	2.4	

HOLE NO.						
SAMPLE NO.						
DEPTH (FT)						
MOISTURE CONTENT %						

NOTES:

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GRAIN SIZE DISTRIBUTION

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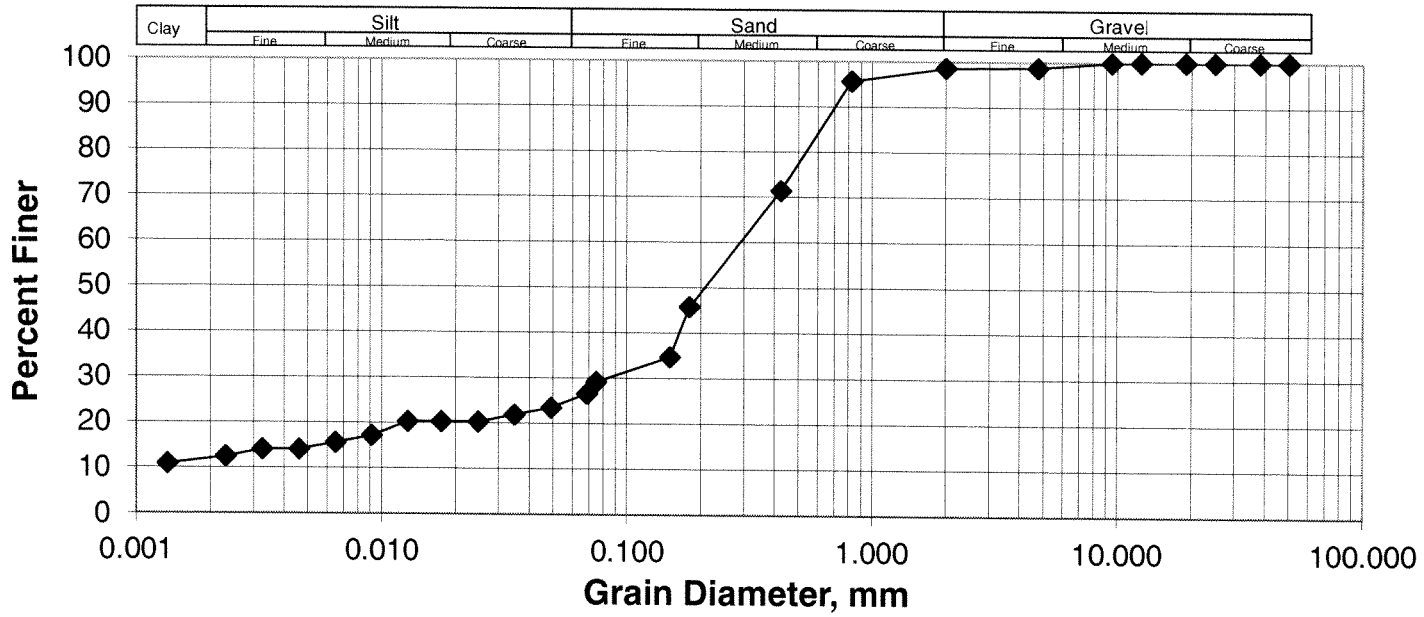
Job No.:	60221902	Hole No.:	TH11-02
Client:	Manitoba Water Services Board	Sample No.:	G11
Project :	Spruce Woods Lagoon	Depth:	13.0 - 14.0'
Date Tested:	26-Nov-11	Date Sampled:	
Tested By:		Sampled By:	

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	98.6	0.0750	29.2
38.0	100.0	0.83	95.7	0.0687	26.6
25.0	100.0	0.43	71.4	0.0491	23.4
19.0	100.0	0.18	45.8	0.0349	21.9
12.5	100.0	0.15	34.7	0.0248	20.3
9.5	99.9	0.075	29.2	0.0175	20.3
4.75	98.8			0.0128	20.3
2.00	98.6			0.0091	17.2
				0.0065	15.6
				0.0046	14.0
				0.0033	14.0
				0.0023	12.5
				0.0013	10.9

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**1.4%**	**Silt**	**13.2%**
Sand	**73.4%**	**Clay**	**12.0%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

GRAIN SIZE DISTRIBUTION

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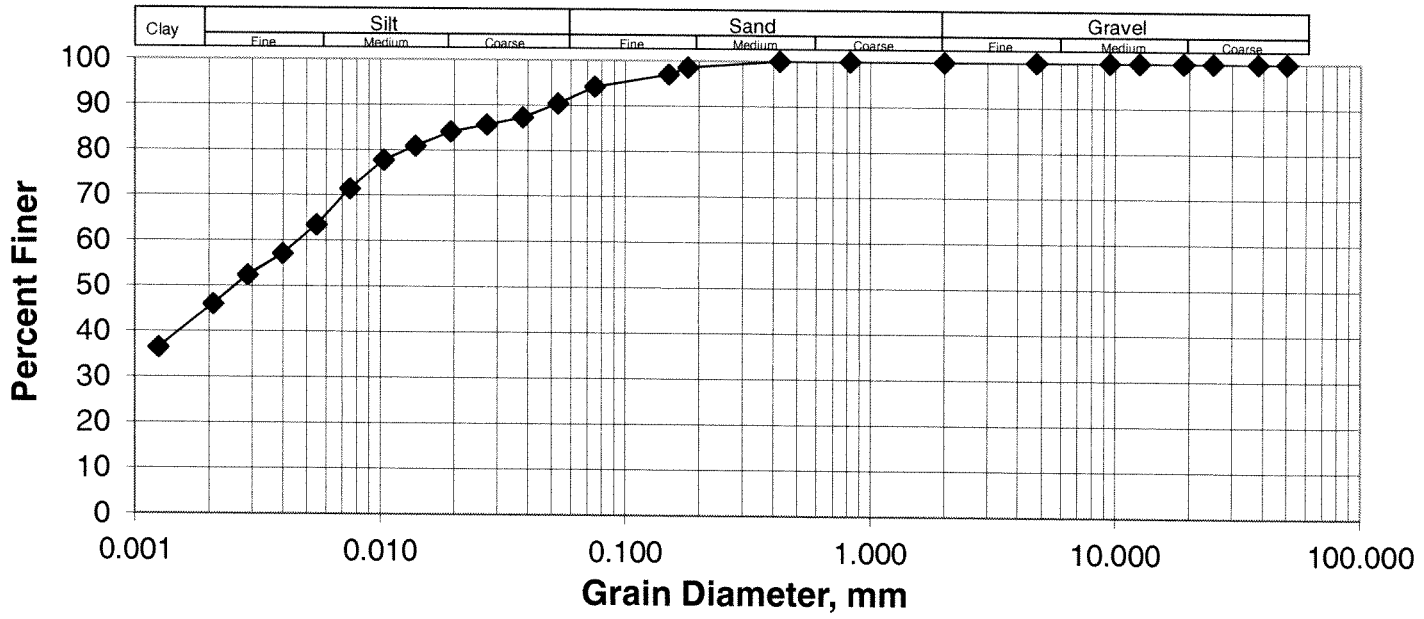
Job No.:	60221902	Hole No.:	TH11-02
Client:	Manitoba Water Services Board	Sample No.:	T10
Project :	Spruce Woods Lagoon	Depth:	10.0 - 12.0'
Date Tested:	2-Dec-11	Date Sampled:	
Tested By:		Sampled By:	

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	100.0	0.0750	94.2
38.0	100.0	0.83	100.0	0.0530	90.5
25.0	100.0	0.43	100.0	0.0381	87.3
19.0	100.0	0.18	98.6	0.0272	85.7
12.5	100.0	0.15	97.0	0.0194	84.1
9.5	100.0	0.075	94.2	0.0139	80.9
4.75	100.0			0.0103	77.8
2.00	100.0			0.0075	71.4
				0.0055	63.5
				0.0040	57.1
				0.0029	52.3
				0.0021	46.0
				0.0012	36.5

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**46.5%**
Sand	**8.3%**	**Clay**	**45.1%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

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Memorandum

To	Jared Baldwin	Page	1
CC	Omer Eissa		
Subject	Spruce Woods Lagoon		
From	Stephen Petsche		
Date	June 28, 2012	60221902	

Attached are testing results for the above noted project. The testing included thirty (30) Moisture Content tests, one (1) Atterberg Limits test and three (3) Grain Size Distribution (hydrometer and mechanical methods) tests on samples submitted to the lab.

If you have any questions, please call.

Sincerely,

Stephen Petsche, C.E.T.
Coordinator, Lab and Technical Services

Attach.

MOISTURE CONTENT

JOB No.: 60221902
CLIENT: Manitoba Water Services Board
PROJECT: Spruce Woods Lagoon

DATE: June 18, 2012

HOLE NO.	TH12-13	-	-	-	-	-
SAMPLE NO.	G1	S2	G3	S4	G5	S6
DEPTH (FT)	2.5 - 3.0	5.0 - 6.5	8.0 - 9.0	10.0 - 11.5	12.0 - 13.0	15.0 - 16.5
MOISTURE CONTENT %	2.9	9.7	3.1	2.9	2.9	3.3

HOLE NO.	TH12-13	-	TH12-14	-	-	-
SAMPLE NO.	G7	S8	G9	G10	G11	G12
DEPTH (FT)	17.0 - 18.0	20.0 - 21.5	2.0 - 3.0	4.0 - 5.0	7.0 - 8.0	13.0 - 14.0
MOISTURE CONTENT %	2.3	2.4	9.9	6.4	9.2	2.5

HOLE NO.	TH12-14	TH12-15	-	-	-	TH12-16
SAMPLE NO.	G13	G14	G15	G16	G17	G18
DEPTH (FT)	19.0 - 20.0	4.0 - 5.0	9.0 - 10.0	14.0 - 15.0	19.0 - 20.0	4.0 - 5.0
MOISTURE CONTENT %	6.6	5.6	14.1	3.6	2.9	4.9

HOLE NO.	TH12-16	-	-	TH12-17	-	-
SAMPLE NO.	G19	G20	G21	G22	G23	G24
DEPTH (FT)	9.0 - 10.0	14.0 - 15.0	19.0 - 20.0	1.0 - 2.0	4.0 - 5.0	9.0 - 10.0
MOISTURE CONTENT %	3.8	3.2	3.5	12.2	14.1	24.3

NOTES:

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MOISTURE CONTENT

JOB No.: 60221902
CLIENT: Manitoba Water Services Board
PROJECT: Spruce Woods Lagoon

DATE: June 18, 2012

HOLE NO.	TH12-17	-	TH12-18	-	-	-
SAMPLE NO.	G25	G26	G27	G28	G29	G30
DEPTH (FT)	14.0 - 15.0	19.0 - 20.0	4.0 - 5.0	9.0 - 10.0	14.0 - 15.0	19.0 - 20.0
MOISTURE CONTENT %	3.8	4.1	5.1	11.9	2.5	2.0

HOLE NO.						
SAMPLE NO.						
DEPTH (FT)						
MOISTURE CONTENT %						

HOLE NO.						
SAMPLE NO.						
DEPTH (FT)						
MOISTURE CONTENT %						

HOLE NO.						
SAMPLE NO.						
DEPTH (FT)						
MOISTURE CONTENT %						

NOTES:

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JOB No.:	60221902	DATE:	28-Jun-12
CLIENT:	Manitoba Water Services Board	TEST HOLE:	TH12-03
PROJECT:	Spruce Woods Lagoon	SAMPLE:	G23
LOCATION:		DEPTH:	4.0 - 5.0'
		TECH.:	SP

Liquid Limit

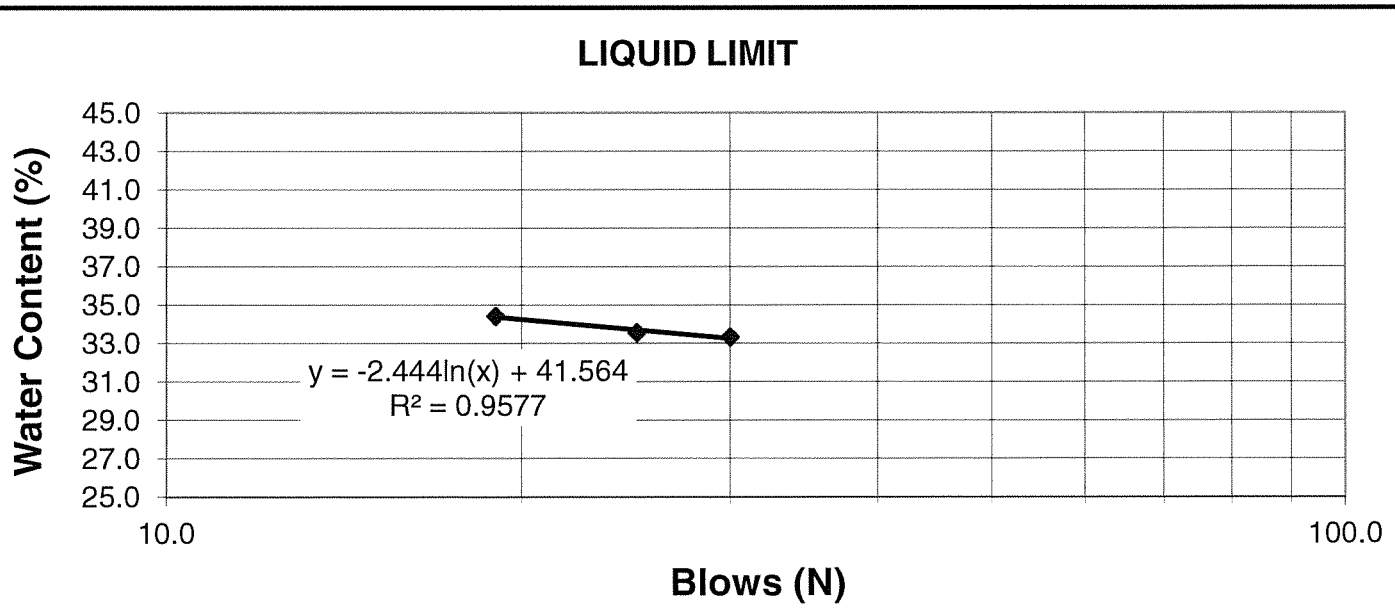
WATER CONTENT

Blows	30	25	19		
WT. SAMPLE WET + TARE (gr)	129.186	133.262	131.640		
WT. SAMPLE DRY + TARE (gr)	125.304	129.056	127.541		
WT. TARE (gr)	113.658	116.524	115.633		
WT. WATER (gr)	3.882	4.206	4.099		
WT. DRY SOIL (gr)	11.646	12.532	11.908		
MOISTURE CONTENT (%)	33.333	33.562	34.422		

Plastic Limit

WATER CONTENT

WT. SAMPLE WET + TARE (gr)	120.725	122.023			
WT. SAMPLE DRY + TARE (gr)	119.853	121.008			
WT. TARE (gr)	113.629	113.702			
WT. WATER (gr)	0.872	1.015			
WT. DRY SOIL (gr)	6.224	7.306			
MOISTURE CONTENT (%)	14.010	13.893			



Liquid Limit =	33.7	Plastic Limit =	14.0	Plasticity Index =	19.7

GRAIN SIZE DISTRIBUTION

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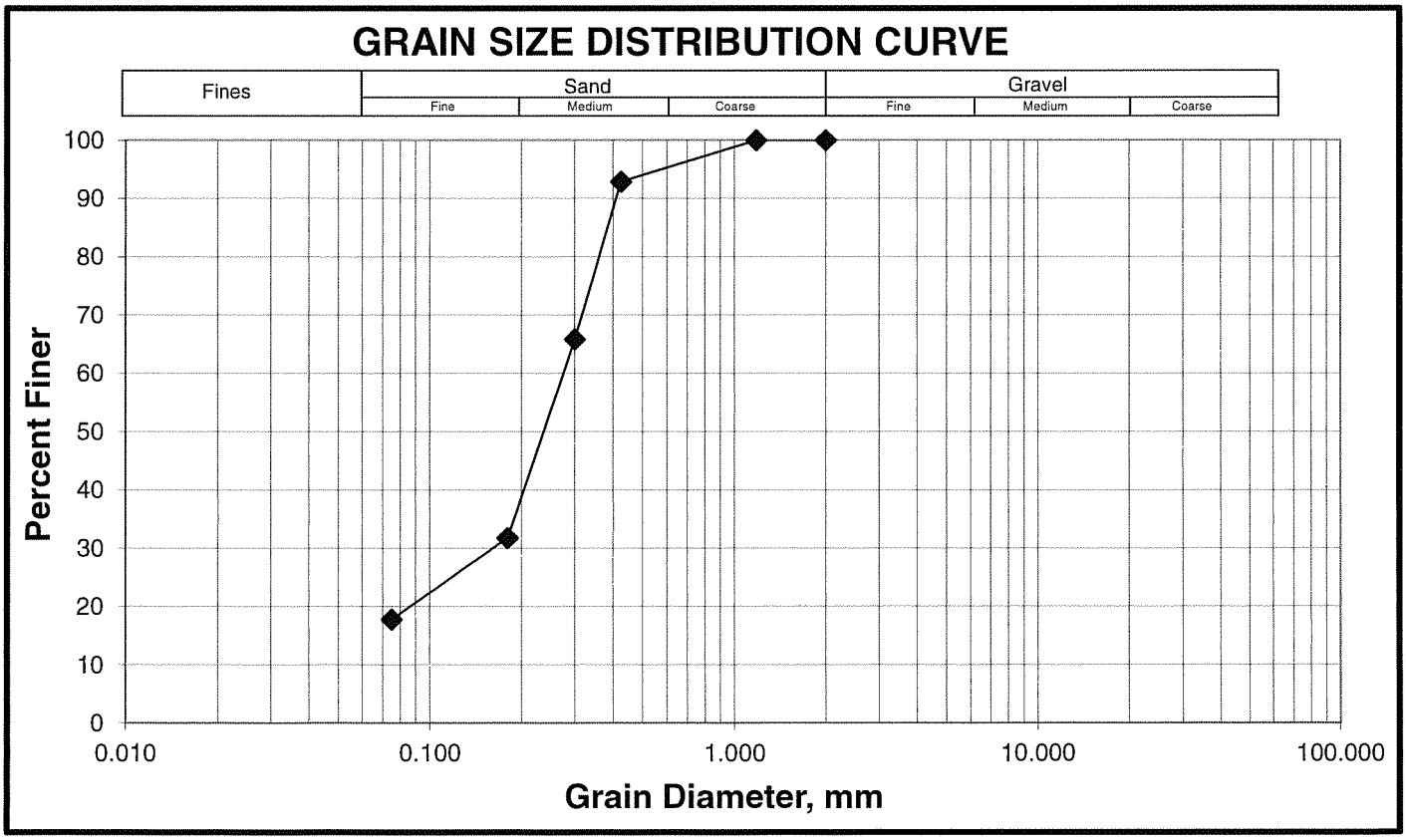
Client:	Manitoba Water Services Board	Test Hole No.:	TH12-15
Project:	Spruce Woods Lagoon	Sample No.:	G14
Job No:	60221902	Depth:	4.0 - 5.0'
Date :	20-Jun-12	Sample Description:	Sand

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
150.0	6"		
100.0	4"		
75.0	3"		
50.0	2"		
37.5	1.5"		
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.5	1/2"		
9.5	3/8"		
4.75	No. 4		
2.00	No. 10	100.0	
1.18	No. 16	100.0	
0.425	No. 40	92.9	
0.300	No. 50	65.8	
0.180	No. 80	31.8	
0.075	No. 200	17.8	



GRAIN SIZE DISTRIBUTION

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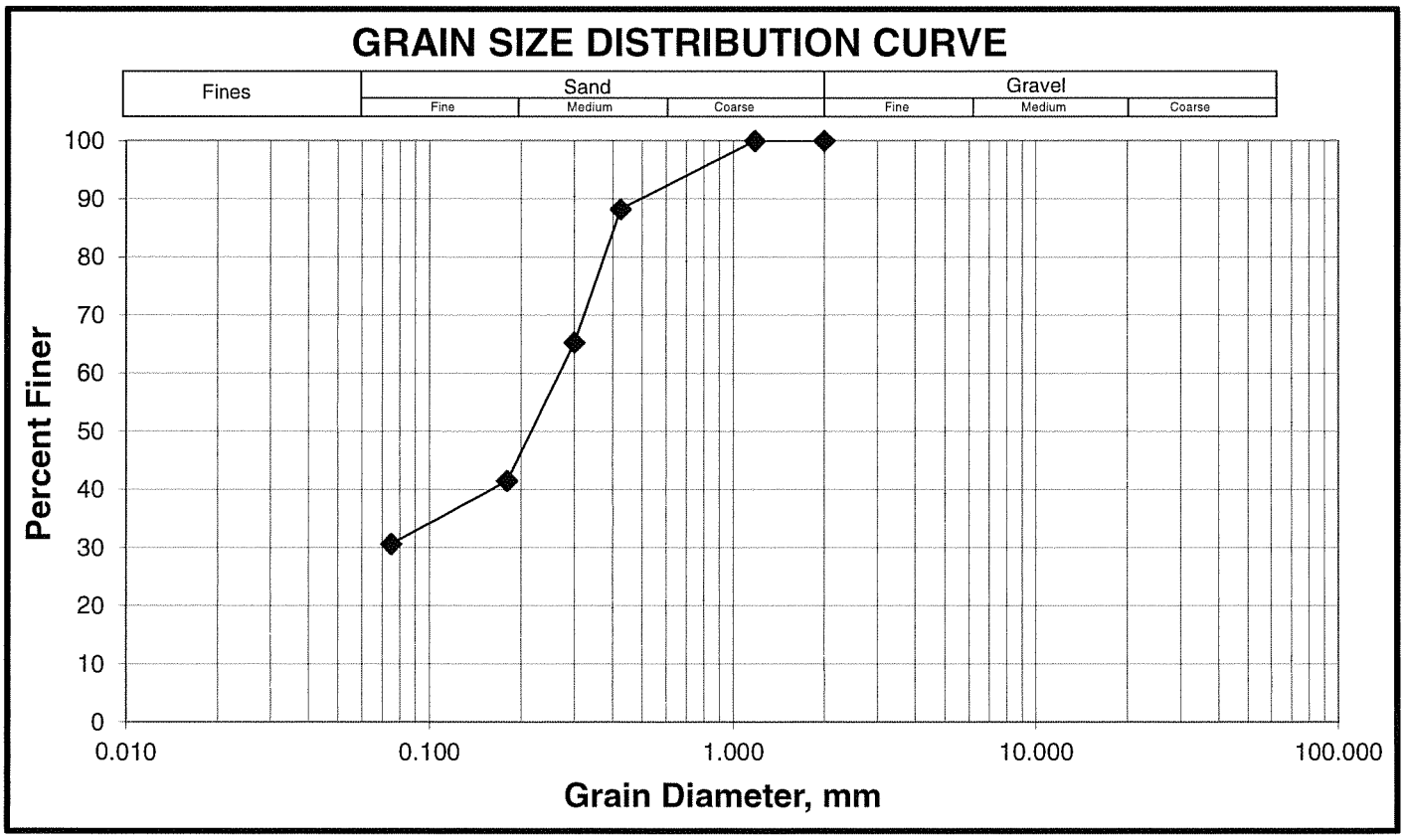
Client:	Manitoba Water Services Board	Test Hole No.:	TH12-18
Project:	Spruce Woods Lagoon	Sample No.:	G27
Job No:	60221902	Depth:	4.0 - 5.0'
Date :	20-Jun-12	Sample Description:	Sand

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
150.0	6"		
100.0	4"		
75.0	3"		
50.0	2"		
37.5	1.5"		
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.5	1/2"		
9.5	3/8"		
4.75	No. 4		
2.00	No. 10	100.0	
1.18	No. 16	100.0	
0.425	No. 40	88.2	
0.300	No. 50	65.3	
0.180	No. 80	41.5	
0.075	No. 200	30.6	



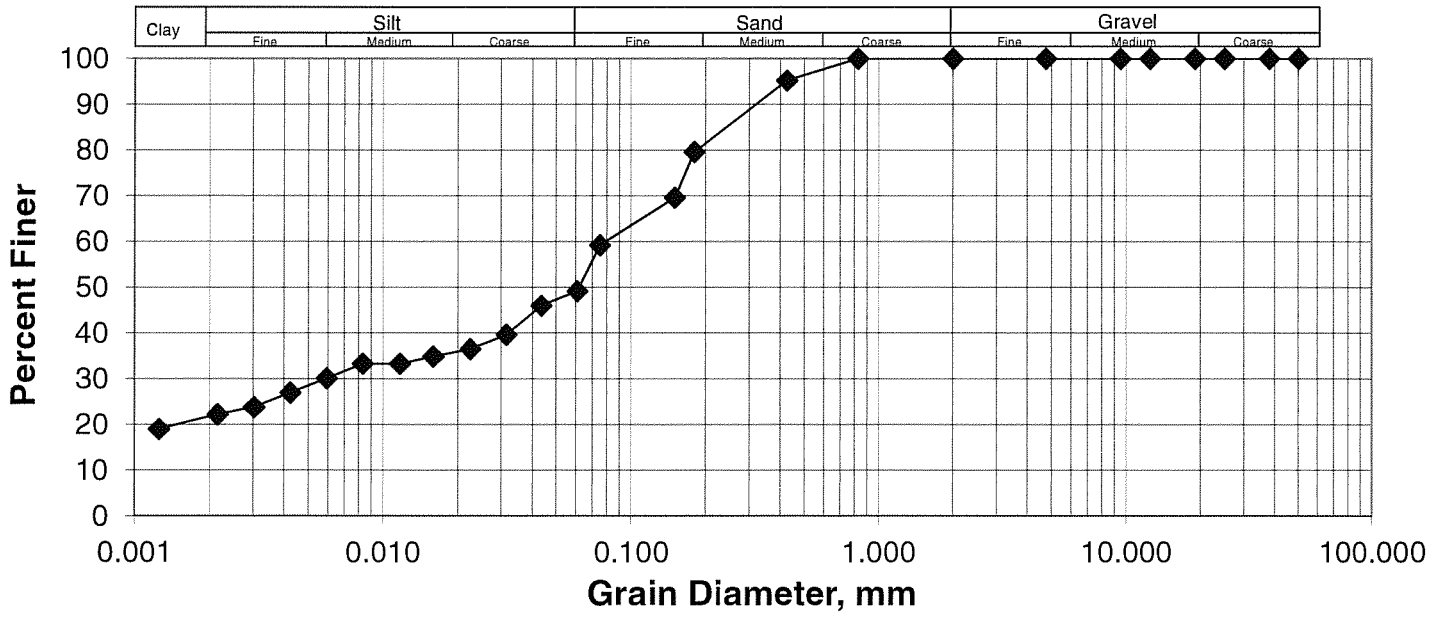
GRAIN SIZE DISTRIBUTION

MATERIALS LABORATORY
AECOM
99 Commerce Dr., Winnipeg, MB R3P 0Y7 Canada
tel (204) 477-5381 **fax** (204) 284-2040

Job No.:	60221902	Hole No.:	TH12-03
Client:	Manitoba Water Services Board	Sample No.:	G23
Project :	Spruce Woods Lagoon	Depth:	4.0 - 5.0'
Date Tested:	26-Jun-12	Date Sampled:	
Tested By:		Sampled By:	

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	100.0	0.0750	59.2
38.0	100.0	0.83	100.0	0.0608	49.2
25.0	100.0	0.43	95.2	0.0435	46.0
19.0	100.0	0.18	79.6	0.0315	39.6
12.5	100.0	0.15	69.6	0.0225	36.5
9.5	100.0	0.075	59.2	0.0160	34.9
4.75	100.0			0.0117	33.3
2.00	100.0			0.0083	33.3
				0.0059	30.1
				0.0042	26.9
				0.0030	23.8
				0.0021	22.2
				0.0013	19.0

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**27.4%**
Sand	**51.0%**	**Clay**	**21.6%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

Appendix B

Preliminary Cost Estimate

Spruce Woods Lagoon

Preliminary Cost Estimate

20-Mar-13

Item	Description	Unit of Measurement	Estimated Total Quantity	Estimated Unit Price	Estimated Total Cost
A	**Forcemain & Lift Station**				
A.1	150 mm forcemain with Common Backfill	lin.m.	2,145	$150	$321,750
A.2	Replace Lift Station	lump sum	1	$300,000	$300,000
A.3	Supply and Install 350 mm Outfall pipe	lin.m.	2,035	$175	$356,125
A.4	Supply and Install 1200 mm Manhole c/w Frame and Cover	vt.m.	60	$3,200	$192,000
A.5	CCTV and Mandrel Television Inspection	lin.m.	1,850	$18	$33,300
A.6	Demolition (capping existing forcemain pipe, drilling holes in bottom of manhole, filling manhole with sand and cutting off at ground surface)	lump sum	1	$10,000	$10,000
Sub-Total Section A.					**$1,213,175**
B	**Roads**				
B.1	Subgrade Compaction	sq. m.	2,035	$2	$4,070
B.2	Granular Base Coarse (150 mm Thickness)	cu. m.	240	$55	$13,200
B.3	Granular Subbase (300 mm Thickness)	cu. m.	535	$45	$24,075
B.4	Supply & Install Stop Sign (MUTCD type R1-1 750mm X 750mm)	ea	1	$600	$600
B.5	Supply & Install Geotextile, Roads (Woven)	sq. m.	2,035	$3	$6,105
B.6	Supply & Install 450 mm Diameter CSP 1.6 mm Wall Thickness	lin. m.	44	$250	$11,000
Sub-Total Section B.					**$59,050**

C	**Lagoon and Related Works**				
C.1	Clearing and Grubbing (Lagoon, Perimeter Ditch, and Road)	ha	4	$6,500	$27,300
C.2	Topsoil Stripping - Stockpile and Place as required (Lagoon, Ditching, and Roads)	cu. m.	42,510	$10	$425,100
C.3	Common Excavation (Lagoon, Perimeter Effluent Ditching, and Roads)	cu. m.	41,010	$8	$328,080
C.4	Borrow Excavation and Placement (Lagoon and Roads)	cu. m.	620	$15	$9,300
C.5	Bedrock (Boulders) Excavation	cu. m.	100	$150	$15,000
C.6	Supply and Install Sand Liner Bedding (150 mm depth)				
	a) Bedding Below Liner (150mm)	cu. m.	8,665	$10	$86,650
	b) Ballast Above Liner (300mm)	cu. m.	17,325	$10	$173,250
C.7	Supply and Install Geotextile (Non Woven), Beneath Liner	sq. m.	57,750	$3	$173,250
C.8	Geomembrane Liner (60 mil HDPE)	sq. m.	57,750	$8	$462,000
C.9	Coarse on Lagoon Berms (300 mm Thick)	cu. m.	1,190	$50	$59,500
C.10	Supply and Install 1.82 m Chain Link Fence, complete	lin. m.	1,540	$80	$123,200
C.11	Seeding (Lagoon, Perimeter and Effluent Ditching)	ha	1	$5,000	$5,000
C.12	Lagoon Riprap (50 to 100 mm c/w Geotextile, 5 m wide by 150 mm Thickness)	sq. m.	6,615	$15	$99,225
C.13	Inlet/Outlet Reinforced Concrete Pad	each	8	$4,000	$32,000
C.14	Supply and Install Flange x Flange Gate Valve	each	5	$4,000	$20,000

C.15	HDPE DR 17 (Interconnection Pipe)	lin. m.	236	$200	$47,200
C.16	Supply & Install Signage	each	2	$1,000	$2,000
C.17	6.0m 304 Sch40 Stainless Steel End on Higher End	lin. m.	47	$400	$18,800
C.18	Supply and Install Lagoon Monitoring Wells	each	8	$1,500	$12,000
C.19	Filling of New Lagoon to 0.6 m Depth	lump sum	1	$20,000	$20,000
C.20	Supply and Install Lagoon Degassing/Dewatering	lump sum	1	$75,000	$75,000
C.21	Ditch Lining c/w Geotextile (150mm)	sq. m.	3,168	$25	$79,200
C.22	Random Riprap (100 mm to 300 mm c/w Geotextile, 300 mm Thickness)	cu. m.	44	$35	$1,540
C.23	Concrete Truck Dump Splash Pad	each	1	$5,000	$5,000
Sub-Total Section C.					**$2,299,595**
D	**Miscellaneous**				
D.1	Material Testing (Cash Allowance)	lump sum	1	$10,000	$10,000
D.2	Tree Planting (Allowance)	lump sum	1	$50,000	$50,000
D.3	Rigid Box Insulation (including sides)	lin. m.	40	$100	$4,000
D.4	Mobilization, Camp, Insurance, De-Mobilization	lump sum	1	$200,000	$200,000
Sub-Total Section D.					**$264,000**

E	**Decommissioning**				
E.1	Geo Bags Installed and Filled	each	1	$10,000	$10,000
E.2	Dredging and Pumping	tonne	700	$12	$8,400
E.3	Loading and Hauling	tonne	700	$15	$10,500
E.4	Landfill fee	tonne	700	$58	$40,600
E.5	Push dykes into Lagoon cells. Grade and slope site. Seed	lump sum	1	$30,000	$30,000
Sub-Total Section E.					**$99,500**
SUMMARY:					
A	Forcemain & Liftstation				$1,213,175
B	Roads				$59,050
C	Lagoon and Related Works				$2,299,595
D	Miscellaneous				$264,000
E	Decommissioning				$99,500
TOTAL:					**$3,935,320**
	Engineering Allowance	15%			$590,298
	Contingency Allowance	10%			$393,532
	MWSB Administration Allowance	10%			$393,532
	Total				**$5,312,682**

Appendix C

Summary of the Capital, O&M, and Life Cycle Costs for Phosphorus Removal

Spruce Woods Provincial Park Lagoon Preliminary Design
December, 2012
20 Year Life Cycle Cost

Summary Table

	Option 1 - Phosphex	Option 2 - Alum Dosing
Capital Cost	**$640,000.00**	**$11,000.00**
Annual Operation & Maintenance	**$173,800.00**	**$89,400.00**
Lagoon Desludging	**$22,800.00** (2)	**$56,600.00** (1)
Media Replacement	**$77,300.00** (3)	**$0.00**
Total 20 Year Life Cycle Cost	**$914,000.00**	**$157,000.00**

Note:
Discount Rate = 4%
Capital Cost do not include overall construction of the lagoon
Costs are estimated in 2013 dollars
1) With Alum Dosing desludged will be completed in year 10 & year 20
Year 10 $50,000 @ 0.676 = $33,800 in present day dollars
Year 20 $50,000 @ 0.456 = $22,800 in present day dollars
2) No Alum Dosing desludging will be completed in year 20
Year 20 $50,000 @ 0.456 = $22,800 in present day dollars
3) Phosphex Media Replacement in year 10 & year 20
Year 10 $68,300 @ 0.676 = $46,200 in present day dollars
Year 20 $68,300 @ 0.456 = $31,100 in present day dollars

Capital Cost Comparison

#	Item	Option 2 - Alum Dosing	Option 1 - Phosphex
		Total Amount	**Total Amount**
1	Phosphex Package (Filters, power, media, building)	$0	$634,000
2	Boat and Motor for Alum Distribution	$11,000	$0
Sub-Total Lagoon and Related Works		**$11,000**	**$640,000**
Total Capital Cost		**$11,000**	**$640,000**

Capital Costs do not include the overall cost of the lagoon construction

Yearly O&M

Option 1 **Phosphex**

#	Item	Unit	Quantity	Unit Price	Total Amount
1	Grass Mowing and General Maintenance	ls	1	$1,100.00	$1,100
2	Monthly Sample Collection and Analysis	ls	4	$550.00	$2,200
3	Lagoon Access Road Maintenance	ls	1	$1,100.00	$1,100
4	Valves and Maintenance	ls	1	$550.00	$550
5	Power	ls	1	$870.00	$870
6	Pumps & Mechanical Filter Maintenance	ls	1	$1,100.00	$1,100
7	Sacrifical Media Replacement (replaced every 2 yrs)	ls	1	$1,400.00	$1,400
8	C02 for pH control	ls	1	$3,300.00	$3,300
9	Misc. Electrical/ Mechanical	ls	1	$1,100.00	$1,100
Yearly Operations & Maintenance Cost					**$12,720**

Yearly O&M

Option 2 **Alum Dosing**

#	Item	Unit	Quantity	Unit Price	Total Amount
1	Grass Mowing and General Maintenance	ls	1	$1,100.00	$1,100
2	Sample Collection and Analysis	ls	1	$550.00	$550
3	Lagoon Access Road Maintenance	ls	1	$1,100.00	$1,100
4	Valves and Maintenance	ls	1	$550.00	$550
5	Alum	ls	8	$300.00	$2,400
6	Alum Delivery	ls	1	$800.00	$800
Yearly Operations & Maintenance Cost					**$6,500**

O&M Life Cyle Cost

Year	Present Worth Factor	O&M Option 1 Phosphex	O&M Option 2 Alum Dosing	
2013		$6,500.00	$12,720.00	(not included in O&M)
2014	0.962	$6,300.00	$12,300.00	
2015	0.925	$6,100.00	$11,800.00	
2016	0.889	$5,800.00	$11,400.00	
2017	0.855	$5,600.00	$10,900.00	
2018	0.822	$5,400.00	$10,500.00	
2019	0.790	$5,200.00	$10,100.00	
2020	0.760	$5,000.00	$9,700.00	
2021	0.731	$4,800.00	$9,300.00	
2022	0.703	$4,600.00	$9,000.00	
2023	0.676	$4,400.00	$8,600.00	
2024	0.650	$4,300.00	$8,300.00	
2025	0.625	$4,100.00	$8,000.00	
2026	0.601	$4,000.00	$7,700.00	
2027	0.577	$3,800.00	$7,400.00	
2028	0.555	$3,700.00	$7,100.00	
2029	0.534	$3,500.00	$6,800.00	
2030	0.513	$3,400.00	$6,600.00	
2031	0.494	$3,300.00	$6,300.00	
2032	0.475	$3,100.00	$6,100.00	
2033	0.456	$3,000.00	$5,900.00	
O&M Present Worth	1.456	**$89,400.00**	**$173,800.00**	

Discount Rate = 4%

Phosphex Media Replacement Life Cyle Cost

Year	Present Worth Factor	Media Replacement	Media Replacement
2013		$0	$173,800.00
2014	0.962	$0	$0.00
2015	0.925	$0	$0.00
2016	0.889	$0	$0.00
2017	0.855	$0	$0.00
2018	0.822	$0	$0.00
2019	0.790	$0	$0.00
2020	0.760	$0	$0.00
2021	0.731	$0	$0.00
2022	0.703	$0	$0.00
2023	0.676	$68,300	$46,200.00
2024	0.650	$0	$0.00
2025	0.625	$0	$0.00
2026	0.601	$0	$0.00
2027	0.577	$0	$0.00
2028	0.555	$0	$0.00
2029	0.534	$0	$0.00
2030	0.513	$0	$0.00
2031	0.494	$0	$0.00
2032	0.475	$0	$0.00
2033	0.456	$68,300	$31,100.00
O&M Present Worth	**13.593**	**$136,600**	**$77,300.00**

Discount Rate = 4%

Cost of Media Replacement Supplied by Agassiz Enviro-Systems Inc

Sludge Removal Life Cycle Cost - Alum Doses

Year	Present Worth Factor	Desludging Future Value	Desludging Present Value
2013		$0	$0.00
2014	0.962	$0	$0.00
2015	0.925	$0	$0.00
2016	0.889	$0	$0.00
2017	0.855	$0	$0.00
2018	0.822	$0	$0.00
2019	0.790	$0	$0.00
2020	0.760	$0	$0.00
2021	0.731	$0	$0.00
2022	0.703	$0	$0.00
2023	0.676	$50,000	$33,800.00
2024	0.650	$0	$0.00
2025	0.625	$0	$0.00
2026	0.601	$0	$0.00
2027	0.577	$0	$0.00
2028	0.555	$0	$0.00
2029	0.534	$0	$0.00
2030	0.513	$0	$0.00
2031	0.494	$0	$0.00
2032	0.475	$0	$0.00
2033	0.456	$50,000	$22,800.00
O&M Present Worth	**13.593**	**$100,000**	**$56,600.00**

Discount Rate = 4%

Sludge Removal Life Cycle Cost - No Alum

Year	Present Worth Factor	Desludging Future Value	Desludging Present Value
2013		$0	$0.00
2014	0.962	$0	$0.00
2015	0.925	$0	$0.00
2016	0.889	$0	$0.00
2017	0.855	$0	$0.00
2018	0.822	$0	$0.00
2019	0.790	$0	$0.00
2020	0.760	$0	$0.00
2021	0.731	$0	$0.00
2022	0.703	$0	$0.00
2023	0.676	$0	$0.00
2024	0.650	$0	$0.00
2025	0.625	$0	$0.00
2026	0.601	$0	$0.00
2027	0.577	$0	$0.00
2028	0.555	$0	$0.00
2029	0.534	$0	$0.00
2030	0.513	$0	$0.00
2031	0.494	$0	$0.00
2032	0.475	$0	$0.00
2033	0.456	$50,000	$22,800.00
O&M Present Worth	**13.593**	**$50,000**	**$22,800.00**

Discount Rate = 4%

Appendix D

Drawings

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PLAN

Issue Status: PRE-DESIGN

The Manitoba Water Services Board
Manitoba Conservation and Water Stewardship

Spruce Woods Lagoon

General Plan

AECOM

Project No.: 60221902

Figure: 1

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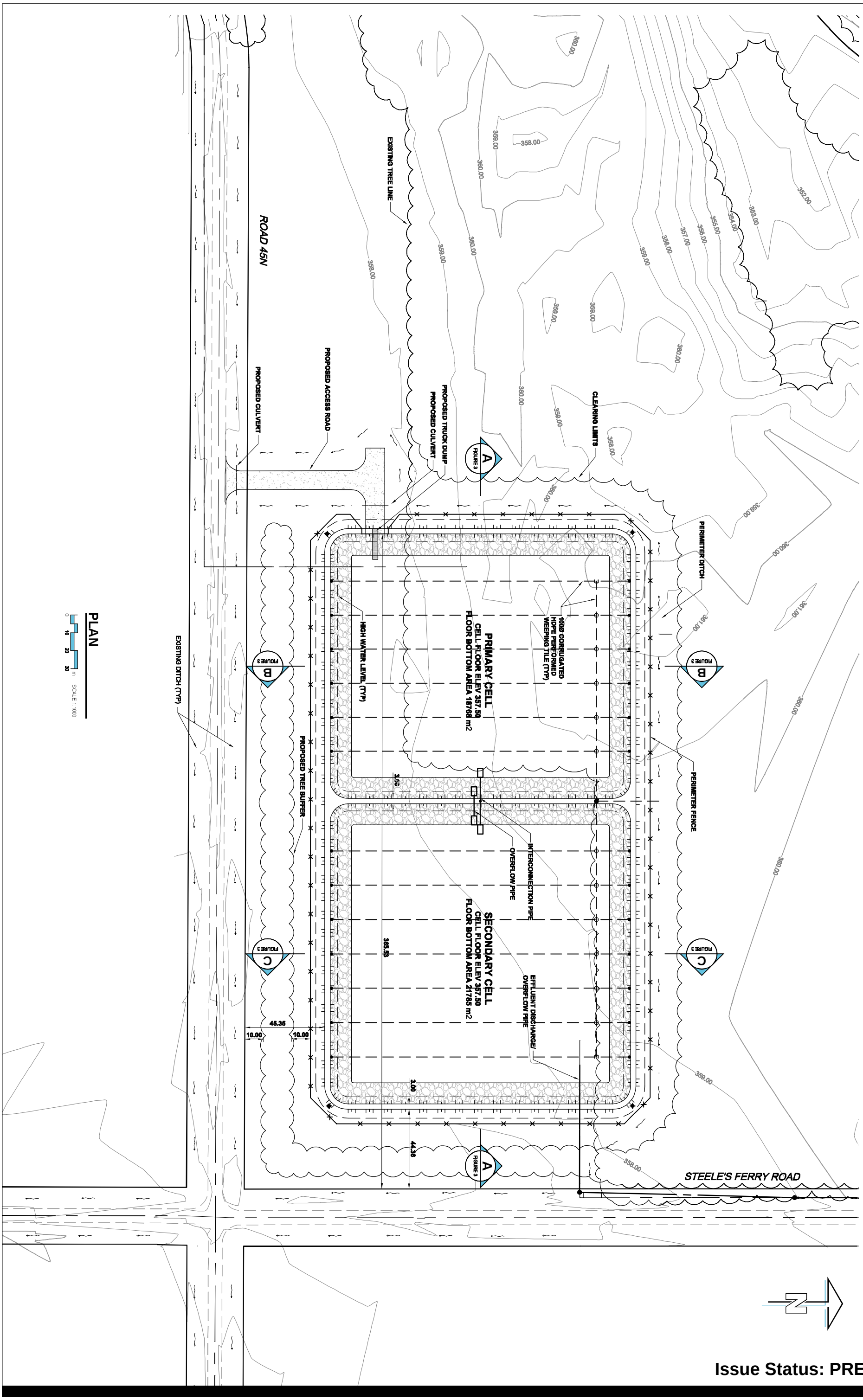

PLAN

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Issue Status: PRE-DESIGN

The Manitoba Water Services Board
Manitoba Conservation and Water Stewardship

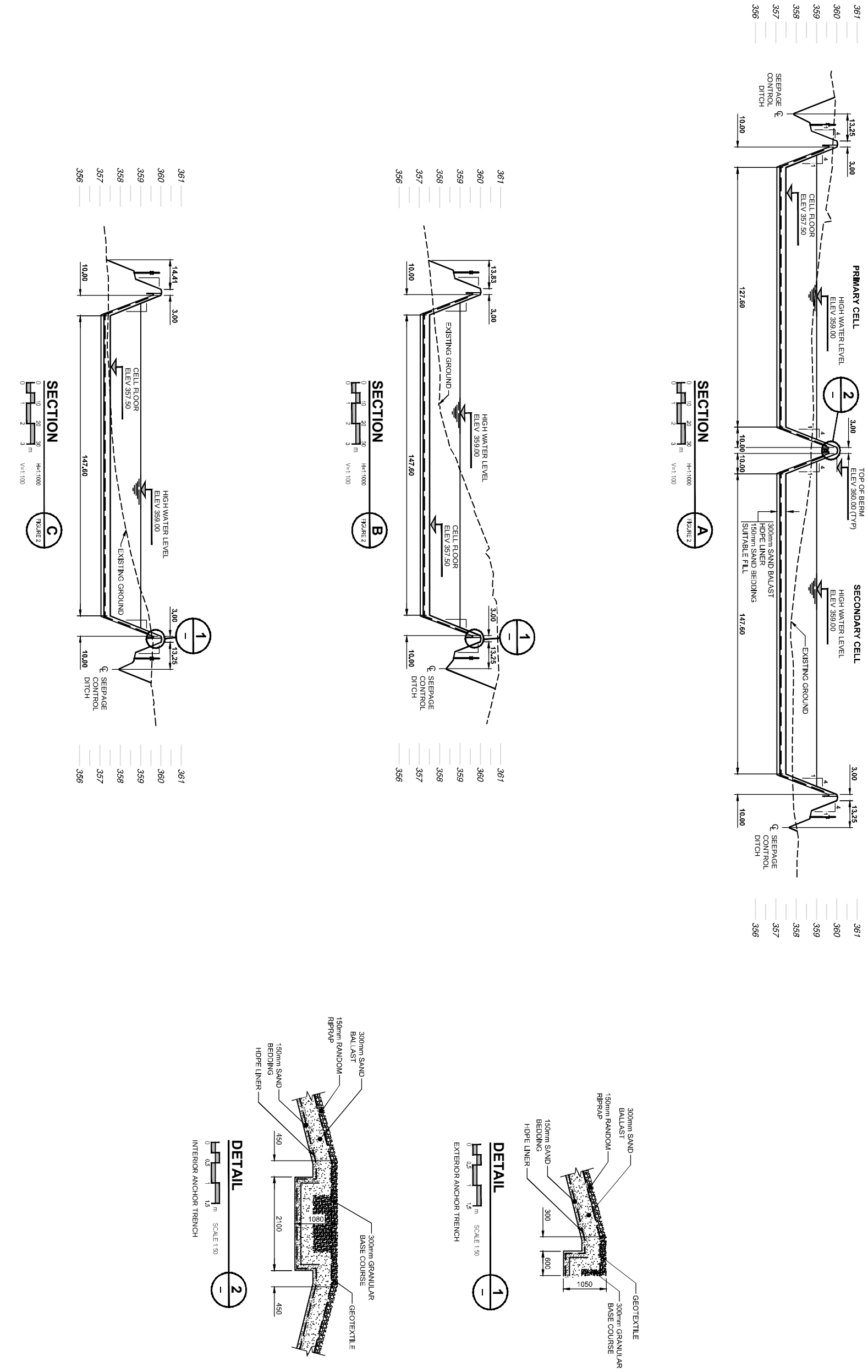
Spruce Woods Lagoon

Lagoon Plan

AECOM

Project No.: 60221902

Figure: 2



Issue Status: PRE-DESIGN

The Manitoba Water Services Board
Manitoba Conservation and Water Stewardship

Project No.: 60221902

Spruce Woods Lagoon

Lagoon Sections

AECOM

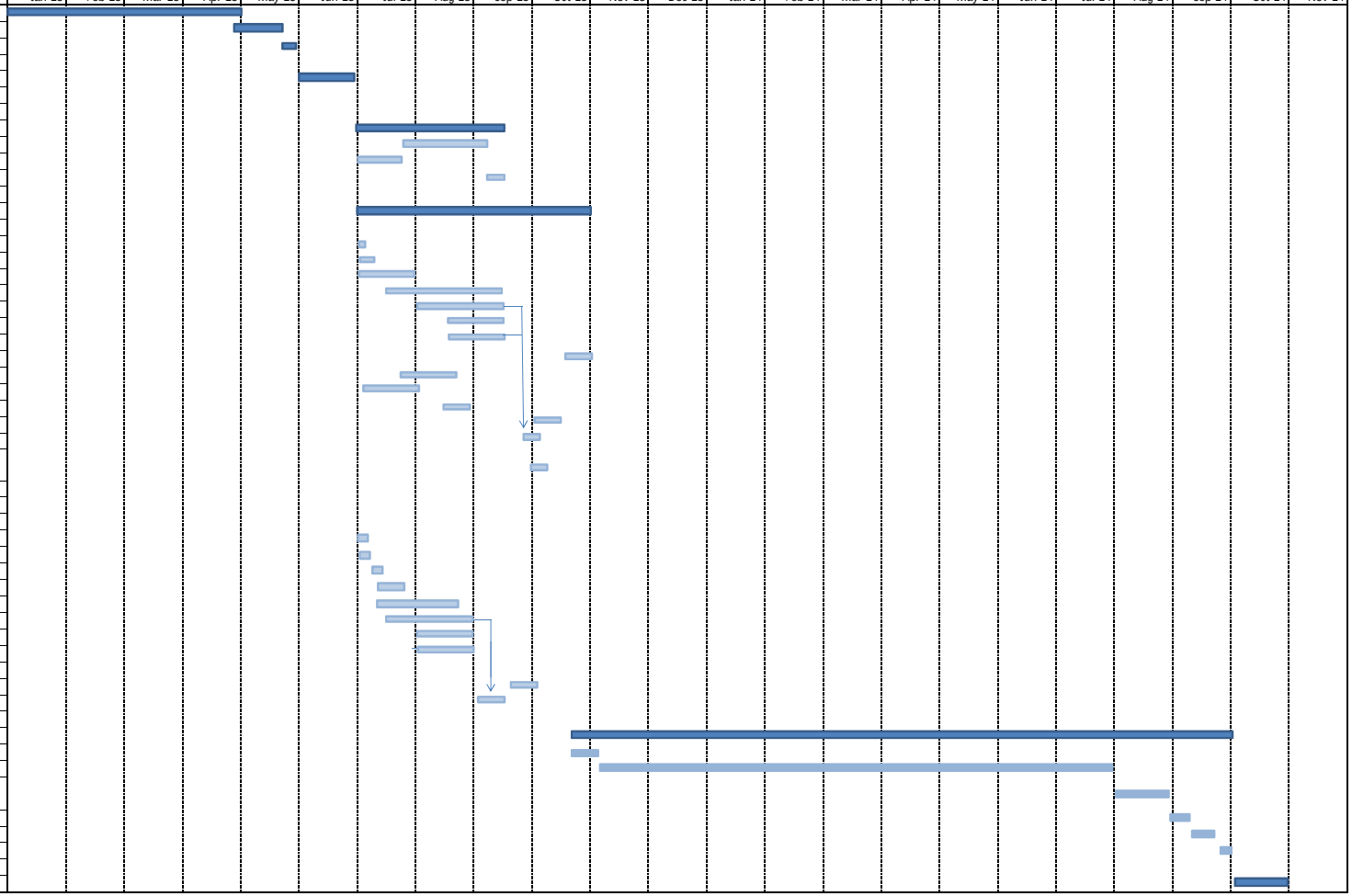
Figure: 3

Appendix E

Schedule

Spruce Woods Preliminary Construction Schedule

	Duration
Detailed Design	142 days
Tender period	75 days
Award	14 days
Mobilization	30 days
Equipment, Trailers, material	
Forcemain & Lift Station	70 days
Forcemain extention to lagoon	45 days
Lift station	20 days
Tie-in	5 days
Lagoon Construction and Commissioining	120 days
Primary Cell	
Perimeter Ditch	5 days
Temporary Roads	10 days
Topsoil and common excavation	30 days
Berm placement	60 days
Supply and install sand liner	45 days
Supply and install geotextile	30 days
Supply and install geomembrane	30 days
Supply and install fence	15 days
Interconnection pipe	36 days
Degassing and Dewatering System	30 days
Truck Dump	15 days
Lagoon monitoring wells	10 days
Commissioning and transfer operation to primary	10 days
Lagoon access road: compaction, geotextile, granualar base	7 day
Secondary Cell	
Clearing and stripping of empty cell	10 days
Perimeter Ditch	10 days
Shaping and repairing existing berms	10 days
Interconnection pipe	12 days
Supply and install sand liner	45 days
Supply and install geotextile	30 days
Supply and install geomembrane	30 days
Degassing and Dewatering System	
Lagoon monitoring wells	**5 days**
Supply and install fence	15 days
Commission cell	10 days
Decommissioing Cells	300 days
Filling Geobags from operating cells	10 days
Drying Geobags	240 days
Discharge remaining liquid and remove Geobags to Landfill	30 days
Push the dikes into the cells	10 days
Final shaping and grading	10 days
Seeding	5 days
Demobilization	14 days



Appendix F

Soil Survey Report

July 19, 2012

Mr. Ron Tone
Tone Ag Consulting Ltd.
Box 333, St.Pierre, MB
R0A 1V0
rontone@toneag.com
204-433-7189

Reference: Soil Information For Proposed Lagoon Site SE 24-08-14W.

Soil inspection sites 1 to 4 are in the wooded area mapped as SHX/xdxx on the soil survey map.

Site 5 and 6 are located in the WWD/xcxx on the soil survey map.

See attached site information.

Should you have any further questions on this assessment, please call me at (204) 261-9393 or email at phaluschak@mts.net

Sincerely
P.Haluschak
Soil Scientist (Pedologist)

Wheatland soil profile and landscape at the site 2

Wellwood soil profile and landscape at the site 6

Site 1. Soil Conditions and Landscape Features:

Quarter section	Section	Township	Range	Heading	GPS co-ordinates (NAD 83)	
					Easting	Northing
SE	24	08	14	W	14 U - 0483026	5501692

Land use	Erosion	Rockiness	Topography					Stoniness	Salinity	Soil Drainage
			Class	Percent	Length (m)	Position	Aspect			
Woodland	-	None	C	2.0	50	mid		None	None	Well

Physical Component / Textural Group	Chemical Component	Mode of Deposition	Material Modifier	Parent Material
Sandy / Coarse	MC = Mod. Calcareous	Fluvial lacustrine	Mixed	I
Loamy/Medium	MC = Mod. Calcareous	Fluvial lacustrine	Mixed	II

Horizon Number	Horizon	Depth (cm)	Textural Modifier	Texture	CaCO3	Salts	Roots	Mottles	Coarse Fragments	Color (moist)	Color (dry)
1	LFH	4 - 0			-	-	p	-	-		
2	Ah	0 - 20		SL	-	-	p	-	-	10YR 2/1	10YR 3/1
3	Bm	20 - 60		LS	-	-	p	-	-	10YR 3/1	10YR 3/2
4	BC	60 - 70		MS	wc	-	p	-	-	10YR 3/3	10YR 4/3
5	2Ahbk	70 - 110		SL	mc	-	-	-	-	10YR 3/2	10YR 4/2
6	2Bmbk	110 - 120		L	sc	-	-	-	-	10YR 4.5/2	10YR 5/1.5

Absence (-) or Presence (p) designations are used for CaCO3, Salts, Roots, Mottles and Coarse Fragments.
WC = Weakly calcareous; MC = Moderately Calcareous; VC = Very Strongly Calcareous; SC = Strongly Calcareous

Special Notes: Vegetation at the site includes oak, poplar and grasses.

Soil Classification: Orthic Black Chernozem - Hallboro Soil Series (HAL / xcxx)

Agricultural Capability Rating: 3 M

Site 2. Soil Conditions and Landscape Features:

Quarter section	Section	Township	Range	Heading	GPS co-ordinates (NAD 83)	
					Easting	Northing
SE	24	08	14	W	14 U - 0482899	5501700

Land use	Erosion	Rockiness	Topography					Stoniness	Salinity	Soil Drainage
			Class	Percent	Length (m)	Position	Aspect			
Woodland	-	None	C	2.0	50	mid		None	None	Well

Physical Component / Textural Group	Chemical Component	Mode of Deposition	Material Modifier	Parent Material
Sandy / Coarse	MC = Mod. Calcareous	Fluvial lacustrine	Mixed	I

Horizon Number	Horizon	Depth (cm)	Textural Modifier	Texture	CaCO3	Salts	Roots	Mottles	Coarse Fragments	Color (moist)	Color (dry)
1	LFH	4 - 0			-	-	p	-	-		
2	Ah	0 - 11		SL	-	-	p	-	-	10YR 2/1	10YR 2/2
3	Bm1	11 - 55		MS	-	-	p	-	-	10YR 3/4	10YR 4/4
4	Bm2	55 - 65		MS	-	-	p	-	-	10YR 4/3	10YR 5/3.5
5	Cca	65 - 78		MS	sc	-	-	-	-	10YR 4/3	10YR 5/3
	Ck	78 - 120		LS	mc	-	-	-	-	10YR 3.5/3	10YR 4/3

Absence (-) or Presence (p) designations are used for CaCO3, Salts, Roots, Mottles and Coarse Fragments.
WC = Weakly calcareous; MC = Moderately Calcareous; VC = Very Strongly Calcareous; SC = Strongly Calcareous

Special Notes: Vegetation at the site includes oak, poplar and grasses. Significant profile development has occurred so that the A horizon will meet the Chernozemic criteria and a brown B horizon is evident.

Soil Classification: Orthic Black Chernozem - Wheatland Soil Series (WHL / xcxx)

Agricultural Capability Rating: 5 M

Site 3. Soil Conditions and Landscape Features:

Quarter section	Section	Township	Range	Heading	GPS co-ordinates (NAD 83)	
					Easting	Northing
SE	24	08	14	W	14 U - 0482795	5501688

Land use	Erosion	Rockiness	Topography					Stoniness	Salinity	Soil Drainage
			Class	Percent	Length (m)	Position	Aspect			
Woodland	-	None	C	2.0	50	mid		None	None	Well

Physical Component / Textural Group	Chemical Component	Mode of Deposition	Material Modifier	Parent Material
Sandy / Coarse	MC = Mod. Calcareous	Fluvial lacustrine	Mixed	I

Horizon Number	Horizon	Depth (cm)	Textural Modifier	Texture	CaCO3	Salts	Roots	Mottles	Coarse Fragments	Color (moist)	Color (dry)
1	LFH	3 - 0			-	-	p	-	-		
2	Ah	0 - 10		SL	-	-	p	-	-	10YR 2/1	10YR 3/1
3	Bm	10 - 55		LS	-	-	p	-	-	10YR 3/3	10YR 4/3
4	BC	55 - 90		MS	-	-	p	-	-	10YR 3.5/4	10YR 4/4
5	Cca	90 - 120		MS	sc	-	p	-	-	10YR 4/3	10YR 5/3

Absence (-) or Presence (p) designations are used for CaCO3, Salts, Roots, Mottles and Coarse Fragments.
WC = Weakly calcareous; MC = Moderately Calcareous; VC = Very Strongly Calcareous; SC = Strongly Calcareous

Special Notes: Vegetation at the site includes oak, poplar and grasses. Significant profile development has occurred so that the A horizon will meet the Chernozemic criteria and a brown B horizon is evident.

Soil Classification: Orthic Black Chernozem - Wheatland Soil Series (WHL / xcxx)

Agricultural Capability Rating: 5 M

Site 4. Soil Conditions and Landscape Features:

Quarter section	Section	Township	Range	Heading	GPS co-ordinates (NAD 83)	
					Easting	Northing
SE	24	08	14	W	14 U - 0482676	5501693

Land use	Erosion	Rockiness	Topography					Stoniness	Salinity	Soil Drainage
			Class	Percent	Length (m)	Position	Aspect			
Woodland	-	None	C	2.0	50	mid		None	None	Well

Physical Component / Textural Group	Chemical Component	Mode of Deposition	Material Modifier	Parent Material
Sandy / Coarse	MC = Mod. Calcareous	Fluvial lacustrine	Mixed	I

Horizon Number	Horizon	Depth (cm)	Textural Modifier	Texture	$CaCO_3$	Salts	Roots	Mottles	Coarse Fragments	Color (moist)	Color (dry)
1	LFH	3 - 0			-	-	p	-	-		
2	Ah	0 - 11		SL	-	-	p	-	-	10YR 2/1	10YR 3/1
3	Bm	11 - 55		MS	-	-	p	-	-	10YR 3/2.5	10YR 4/3
4	BC	55 - 90		MS	mc	-	p	-	-	10YR 4/3	10YR 5/3
5	Ck	90 - 120		MS	mc	-	p	-	-	10YR 4/3.5	10YR 5/3

Absence (-) or Presence (p) designations are used for CaCO3, Salts, Roots, Mottles and Coarse Fragments.
WC = Weakly calcareous; MC = Moderately Calcareous; VC = Very Strongly Calcareous; SC = Strongly Calcareous

Special Notes: Vegetation at the site includes oak, poplar and grasses. Significant profile development has occurred so that the A horizon will meet the Chernozemic criteria and a brown B horizon is evident.

Soil Classification: Orthic Black Chernozem - Wheatland Soil Series (WHL / xcxx)

Agricultural Capability Rating: 5 M

Site 5. Soil Conditions and Landscape Features:

Quarter section	Section	Township	Range	Heading	GPS co-ordinates (NAD 83)	
					Easting	Northing
SE	24	08	14	W	14 U - 0482682	5501503

Land use	Erosion	Rockiness	Topography					Stoniness	Salinity	Soil Drainage
			Class	Percent	Length (m)	Position	Aspect			
Forage	-	None	C	2.0	100	mid		None	None	Well

Physical Component / Textural Group	Chemical Component	Mode of Deposition	Material Modifier	Parent Material
Fine Loamy / Medium	MC = Mod. Calcareous	Lacustrine	Mixed	I
Sandy/Coarse	MC = Mod. Calcareous	Lacustrine	Mixed	II

Horizon Number	Horizon	Depth (cm)	Textural Modifier	Texture	CaCO3	Salts	Roots	Mottles	Coarse Fragments	Color (moist)	Color (dry)
1	Ap	0 - 20		L	-	-	p	-	-	10YR 2/1	10YR 2/2
2	Bm	20 - 42		L	-	-	p	-	-	10YR 3/2	10YR 3.5/3
3	Cca	42 - 72		SiCL	sc	-	p	-	-	10YR 4.5/2	10YR 6/2
4	2Ck1	72 - 95		VFSL	mc	-	p	-	-	10YR 4.5/4	10YR 5.5/3
5	2Ck2	95 - 120		LVFS	mc	-	-	-	-	10YR 4/4	10YR 5/3.5

Absence (-) or Presence (p) designations are used for $CaCO_3$, Salts, Roots, Mottles and Coarse Fragments.
WC = Weakly calcareous; MC = Moderately Calcareous; VC = Very Strongly Calcareous; SC = Strongly Calcareous

Special Notes: Vegetation includes alfalfa and grass

Soil Classification: Orthic Black Chernozem - Wellwood Soil Series (WWD / xcxx)

Agricultural Capability Rating: 2T

Site 6. Soil Conditions and Landscape Features:

Quarter section	Section	Township	Range	Heading	GPS co-ordinates (NAD 83)	
					Easting	Northing
SE	24	08	14	W	14 U - 0483028	5501504

Land use	Erosion	Rockiness	Topography					Stoniness	Salinity	Soil Drainage
			Class	Percent	Length (m)	Position	Aspect			
Forage	-	None	C	2.0	100	mid		None	None	Well

Physical Component / Textural Group	Chemical Component	Mode of Deposition	Material Modifier	Parent Material
Fine Loamy / Medium	MC = Mod. Calcareous	Lacustrine	Mixed	I
Sandy/Coarse	MC = Mod. Calcareous	Lacustrine	Mixed	II

Horizon Number	Horizon	Depth (cm)	Textural Modifier	Texture	CaCO3	Salts	Roots	Mottles	Coarse Fragments	Color (moist)	Color (dry)
1	Ap	0 - 17		L	-	-	p	-	-	10YR 3/1	10YR 3/2
2	Bm1	20 - 45		CL	-	-	p	-	-	10YR 3/2.5	10YR 4/3
3	Bm2	42 - 75		SiCL	-	-	p	-	-	10YR 4/3.5	10YR 4/4
4	Cca	75 - 85		SIL	sc	-	p	-	-	10YR 4.5/3	10YR 6/2
5	2Ck1	85 - 110		VFSL	mc	-	-	-	-	10YR 4.5/4	10YR 5.5/4
6	2Ck2	110 - 120		LVFS	wc	-	-	-	-	10YR 4.5/4	10YR 5.5/4

Absence (-) or Presence (p) designations are used for $CaCO_3$, Salts, Roots, Mottles and Coarse Fragments.
WC = Weakly calcareous; MC = Moderately Calcareous; VC = Very Strongly Calcareous; SC = Strongly Calcareous

Special Notes: Vegetation includes alfalfa and grass

Soil Classification: Orthic Black Chernozem - Wellwood Soil Series (WWD / xcxx)

Agricultural Capability Rating: 2T

Appendix B
Photograph Log

Photograph 1. Facing southeast showing the existing primary lagoon cell ↑

Photograph 2. Facing northeast showing the existing primary lagoon cell ↑

Photograph 3. Facing southeast showing the existing unused secondary lagoon cell ↑

Photograph 4. Facing north showing the existing lagoon discharge pipe on the right hand side of the photograph ↑

Photograph 5. Facing north showing the proposed lagoon site↑

Appendix C
Soils Report

July 19, 2012

Mr. Ron Tone
Tone Ag Consulting Ltd.
Box 333, St.Pierre, MB
R0A 1V0
rontone@toneag.com
204-433-7189

Reference: Soil Information For Proposed Lagoon Site SE 24-08-14W.

Soil inspection sites 1 to 4 are in the wooded area mapped as SHX/xdxx on the soil survey map.

Site 5 and 6 are located in the WWD/xcxx on the soil survey map.

See attached site information.

Should you have any further questions on this assessment, please call me at (204) 261-9393 or email at phaluschak@mts.net

Sincerely
P.Haluschak
Soil Scientist (Pedologist)

Wheatland soil profile and landscape at the site 2

Wellwood soil profile and landscape at the site 6

Site 1. Soil Conditions and Landscape Features:

Quarter section	Section	Township	Range	Heading	GPS co-ordinates (NAD 83)	
					Easting	Northing
SE	24	08	14	W	14 U - 0483026	5501692

Land use	Erosion	Rockiness	Topography					Stoniness	Salinity	Soil Drainage
			Class	Percent	Length (m)	Position	Aspect			
Woodland	-	None	C	2.0	50	mid		None	None	Well

Physical Component / Textural Group	Chemical Component	Mode of Deposition	Material Modifier	Parent Material
Sandy / Coarse	MC = Mod. Calcareous	Fluvial lacustrine	Mixed	I
Loamy/Medium	MC = Mod. Calcareous	Fluvial lacustrine	Mixed	II

Horizon Number	Horizon	Depth (cm)	Textural Modifier	Texture	CaCO3	Salts	Roots	Mottles	Coarse Fragments	Color (moist)	Color (dry)
1	LFH	4 - 0			-	-	p	-	-		
2	Ah	0 - 20		SL	-	-	p	-	-	10YR 2/1	10YR 3/1
3	Bm	20 - 60		LS	-	-	p	-	-	10YR 3/1	10YR 3/2
4	BC	60 - 70		MS	wc	-	p	-	-	10YR 3/3	10YR 4/3
5	2Ahbk	70 - 110		SL	mc	-	-	-	-	10YR 3/2	10YR 4/2
6	2Bmbk	110 - 120		L	sc	-	-	-	-	10YR 4.5/2	10YR 5/1.5

Absence (-) or Presence (p) designations are used for CaCO3, Salts, Roots, Mottles and Coarse Fragments.
WC = Weakly calcareous; MC = Moderately Calcareous; VC = Very Strongly Calcareous; SC = Strongly Calcareous

Special Notes: Vegetation at the site includes oak, poplar and grasses.

Soil Classification: Orthic Black Chernozem - Hallboro Soil Series (HAL / xcxx)

Agricultural Capability Rating: 3 M

Site 2. Soil Conditions and Landscape Features:

Quarter section	Section	Township	Range	Heading	GPS co-ordinates (NAD 83)	
					Easting	Northing
SE	24	08	14	W	14 U - 0482899	5501700

Land use	Erosion	Rockiness	Topography					Stoniness	Salinity	Soil Drainage
			Class	Percent	Length (m)	Position	Aspect			
Woodland	-	None	C	2.0	50	mid		None	None	Well

Physical Component / Textural Group	Chemical Component	Mode of Deposition	Material Modifier	Parent Material
Sandy / Coarse	MC = Mod. Calcareous	Fluvial lacustrine	Mixed	I

Horizon Number	Horizon	Depth (cm)	Textural Modifier	Texture	CaCO3	Salts	Roots	Mottles	Coarse Fragments	Color (moist)	Color (dry)
1	LFH	4 - 0			-	-	p	-	-		
2	Ah	0 - 11		SL	-	-	p	-	-	10YR 2/1	10YR 2/2
3	Bm1	11 - 55		MS	-	-	p	-	-	10YR 3/4	10YR 4/4
4	Bm2	55 - 65		MS	-	-	p	-	-	10YR 4/3	10YR 5/3.5
5	Cca	65 - 78		MS	sc	-	-	-	-	10YR 4/3	10YR 5/3
	Ck	78 - 120		LS	mc	-	-	-	-	10YR 3.5/3	10YR 4/3

Absence (-) or Presence (p) designations are used for CaCO3, Salts, Roots, Mottles and Coarse Fragments.
WC = Weakly calcareous; MC = Moderately Calcareous; VC = Very Strongly Calcareous; SC = Strongly Calcareous

Special Notes: Vegetation at the site includes oak, poplar and grasses. Significant profile development has occurred so that the A horizon will meet the Chernozemic criteria and a brown B horizon is evident.

Soil Classification: Orthic Black Chernozem - Wheatland Soil Series (WHL / xcxx)

Agricultural Capability Rating: 5 M

Site 3. Soil Conditions and Landscape Features:

Quarter section	Section	Township	Range	Heading	GPS co-ordinates (NAD 83)	
					Easting	Northing
SE	24	08	14	W	14 U - 0482795	5501688

Land use	Erosion	Rockiness	Topography					Stoniness	Salinity	Soil Drainage
			Class	Percent	Length (m)	Position	Aspect			
Woodland	-	None	C	2.0	50	mid		None	None	Well

Physical Component / Textural Group	Chemical Component	Mode of Deposition	Material Modifier	Parent Material
Sandy / Coarse	MC = Mod. Calcareous	Fluvial lacustrine	Mixed	I

Horizon Number	Horizon	Depth (cm)	Textural Modifier	Texture	CaCO3	Salts	Roots	Mottles	Coarse Fragments	Color (moist)	Color (dry)
1	LFH	3 - 0			-	-	p	-	-		
2	Ah	0 - 10		SL	-	-	p	-	-	10YR 2/1	10YR 3/1
3	Bm	10 - 55		LS	-	-	p	-	-	10YR 3/3	10YR 4/3
4	BC	55 - 90		MS	-	-	p	-	-	10YR 3.5/4	10YR 4/4
5	Cca	90 - 120		MS	sc	-	p	-	-	10YR 4/3	10YR 5/3

Absence (-) or Presence (p) designations are used for CaCO3, Salts, Roots, Mottles and Coarse Fragments.
WC = Weakly calcareous; MC = Moderately Calcareous; VC = Very Strongly Calcareous; SC = Strongly Calcareous

Special Notes: Vegetation at the site includes oak, poplar and grasses. Significant profile development has occurred so that the A horizon will meet the Chernozemic criteria and a brown B horizon is evident.

Soil Classification: Orthic Black Chernozem - Wheatland Soil Series (WHL / xcxx)

Agricultural Capability Rating: 5 M

Site 4. Soil Conditions and Landscape Features:

Quarter section	Section	Township	Range	Heading	GPS co-ordinates (NAD 83)	
					Easting	Northing
SE	24	08	14	W	14 U - 0482676	5501693

Land use	Erosion	Rockiness	Topography					Stoniness	Salinity	Soil Drainage
			Class	Percent	Length (m)	Position	Aspect			
Woodland	-	None	C	2.0	50	mid		None	None	Well

Physical Component / Textural Group	Chemical Component	Mode of Deposition	Material Modifier	Parent Material
Sandy / Coarse	MC = Mod. Calcareous	Fluvial lacustrine	Mixed	I

Horizon Number	Horizon	Depth (cm)	Textural Modifier	Texture	CaCO3	Salts	Roots	Mottles	Coarse Fragments	Color (moist)	Color (dry)
1	LFH	3 - 0			-	-	p	-	-		
2	Ah	0 - 11		SL	-	-	p	-	-	10YR 2/1	10YR 3/1
3	Bm	11 - 55		MS	-	-	p	-	-	10YR 3/2.5	10YR 4/3
4	BC	55 - 90		MS	mc	-	p	-	-	10YR 4/3	10YR 5/3
5	Ck	90 - 120		MS	mc	-	p	-	-	10YR 4/3.5	10YR 5/3

Absence (-) or Presence (p) designations are used for CaCO3, Salts, Roots, Mottles and Coarse Fragments.
WC = Weakly calcareous; MC = Moderately Calcareous; VC = Very Strongly Calcareous; SC = Strongly Calcareous

Special Notes: Vegetation at the site includes oak, poplar and grasses. Significant profile development has occurred so that the A horizon will meet the Chernozemic criteria and a brown B horizon is evident.

Soil Classification: Orthic Black Chernozem - Wheatland Soil Series (WHL / xcxx)

Agricultural Capability Rating: 5 M

Site 5. Soil Conditions and Landscape Features:

Quarter section	Section	Township	Range	Heading	GPS co-ordinates (NAD 83)	
					Easting	Northing
SE	24	08	14	W	14 U - 0482682	5501503

Land use	Erosion	Rockiness	Topography					Stoniness	Salinity	Soil Drainage
			Class	Percent	Length (m)	Position	Aspect			
Forage	-	None	C	2.0	100	mid		None	None	Well

Physical Component / Textural Group	Chemical Component	Mode of Deposition	Material Modifier	Parent Material
Fine Loamy / Medium	MC = Mod. Calcareous	Lacustrine	Mixed	I
Sandy/Coarse	MC = Mod. Calcareous	Lacustrine	Mixed	II

Horizon Number	Horizon	Depth (cm)	Textural Modifier	Texture	CaCO3	Salts	Roots	Mottles	Coarse Fragments	Color (moist)	Color (dry)
1	Ap	0 - 20		L	-	-	p	-	-	10YR 2/1	10YR 2/2
2	Bm	20 - 42		L	-	-	p	-	-	10YR 3/2	10YR 3.5/3
3	Cca	42 - 72		SiCL	sc	-	p	-	-	10YR 4.5/2	10YR 6/2
4	2Ck1	72 - 95		VFSL	mc	-	p	-	-	10YR 4.5/4	10YR 5.5/3
5	2Ck2	95 - 120		LVFS	mc	-	-	-	-	10YR 4/4	10YR 5/3.5

Absence (-) or Presence (p) designations are used for CaCO3, Salts, Roots, Mottles and Coarse Fragments.
WC = Weakly calcareous; MC = Moderately Calcareous; VC = Very Strongly Calcareous; SC = Strongly Calcareous

Special Notes: Vegetation includes alfalfa and grass

Soil Classification: Orthic Black Chernozem - Wellwood Soil Series (WWD / xcxx)

Agricultural Capability Rating: 2T

Site 6. Soil Conditions and Landscape Features:

Quarter section	Section	Township	Range	Heading	GPS co-ordinates (NAD 83)	
					Easting	Northing
SE	24	08	14	W	14 U - 0483028	5501504

Land use	Erosion	Rockiness	Topography					Stoniness	Salinity	Soil Drainage
			Class	Percent	Length (m)	Position	Aspect			
Forage	-	None	C	2.0	100	mid		None	None	Well

Physical Component / Textural Group	Chemical Component	Mode of Deposition	Material Modifier	Parent Material
Fine Loamy / Medium	MC = Mod. Calcareous	Lacustrine	Mixed	I
Sandy/Coarse	MC = Mod. Calcareous	Lacustrine	Mixed	II

Horizon Number	Horizon	Depth (cm)	Textural Modifier	Texture	CaCO3	Salts	Roots	Mottles	Coarse Fragments	Color (moist)	Color (dry)
1	Ap	0 - 17		L	-	-	p	-	-	10YR 3/1	10YR 3/2
2	Bm1	20 - 45		CL	-	-	p	-	-	10YR 3/2.5	10YR 4/3
3	Bm2	42 - 75		SiCL	-	-	p	-	-	10YR 4/3.5	10YR 4/4
4	Cca	75 - 85		SIL	sc	-	p	-	-	10YR 4.5/3	10YR 6/2
5	2Ck1	85 - 110		VFSL	mc	-	-	-	-	10YR 4.5/4	10YR 5.5/4
6	2Ck2	110 - 120		LVFS	wc	-	-	-	-	10YR 4.5/4	10YR 5.5/4

Absence (-) or Presence (p) designations are used for CaCO3, Salts, Roots, Mottles and Coarse Fragments.
WC = Weakly calcareous; MC = Moderately Calcareous; VC = Very Strongly Calcareous; SC = Strongly Calcareous

Special Notes: Vegetation includes alfalfa and grass

Soil Classification: Orthic Black Chernozem - Wellwood Soil Series (WWD / xcxx)

Agricultural Capability Rating: 2T

Appendix D

Heritage Resources Impact Assessment

2012

Spruce Woods Provincial Park Lagoon Replacement

Heritage Resource Impact Assessment & Monitoring

Heritage Permit A47-12

Prepared For:
AECOM and
The Manitoba Water Services Board

Prepared By:
Northern Lights Heritage Services Inc.
2739 Pembina Hwy
Winnipeg, MB R3T 2H5

October 2012

Spruce Woods Provincial Park Lagoon Replacement

2012

Heritage Resource Impact Assessment & Monitoring

Final Report

Heritage Permit A47-12
October 2012

Prepared by

Northern Lights Heritage Services Inc.
2739 Pembina Highway
Winnipeg, MB R3T 2H5

Executive Summary

The Manitoba Water Services Board is undertaking an Environmental Assessment for the replacement of a lagoon within Spruce Woods Provincial Park. The Project requires a Heritage Resource Impact Assessment (HRIA) as part of the Environmental Licensing.

Northern Lights Heritage Services Inc. (NLHS) conducted the initial HRIA for the project between July 31 and Aug 1, 2012 under heritage permit A47-12. The survey of the proposed project infrastructure included the proposed two-cell lagoon, new forcemain to the lagoon, new or upgraded lift station and a new outfall to the Assiniboine River.

After changes were made to the project plans, and the placement of the proposed two-cell lagoon was shifted westward, NLHS was contacted to conduct a HRIA based on the revised design. This HRIA was conducted on October 24, 2012 under the same heritage permit.

The HRIA of the project area was negative for heritage resources within; therefore there are no further heritage concerns with the implementation of the Project from a heritage perspective.

Project Personnel

Project Director:

Virginia Petch Ph.D., RPA, EP

Field Leaders:

Lisa Bobbie M.A.

Emily Linnemann B.A. (Adv.)

Field Archaeologists:

Hani Khalidi M.A.

Dave Norris M.A.

Emily Linnemann B.A. (Adv.)

Report Preparation:

Lisa Bobbie M.A.

Emily Linnemann B.A. (Adv.)

Report Editor:

Virginia Petch, PhD., RPA, EP

GIS Mapping:

Lisa Bobbie M.A.

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1.0 INTRODUCTION

The Manitoba Water Services Board is proposing the replacement of a lagoon within Spruce Woods Provincial Park. The project will require a licence under the *Environmental Act* (Manitoba). As part of the Environmental Assessment Report, the Project requires a Heritage Resource Impact Assessment (HRIA) to identify if heritage resources may be affected. Northern Lights Heritage Services Inc. (NLHS) conducted the HRIA for the project between July 31 and Aug 1, 2012 under heritage permit A47-12 (Appendix A). After the location for the proposed two-cell lagoon was shifted by project planners, NLHS was contacted to conduct a HRIA based on the revised design. This HRIA was conducted on October 24, 2012 under the same heritage permit.

1.1 Project Description

Currently, Spruce Woods Provincial Park is serviced by a two-cell lagoon located 250 metres (m) west of Provincial Highway #5. The on-going rate of erosion of the nearby Assiniboine River bank is the cause of concern with respect to lagoon location and integrity. The decision to replace the lagoon at a new site will include the construction of a new two-celled facultative lagoon, new forcemain to the lagoon, new or upgraded lift station and a new outfall to the Assiniboine River (Figure 1). The project will also include the decommissioning of the existing lagoon.

The proposed location for the replacement lagoon is approximately 2.5km northeast of the original location near the junction of Steel's Ferry Road and Road 45N. Excavation of the lagoon will consist of removal of approximately 0.45 m of topsoil, followed by an excavation extending a further 1 m into the underlying substrate. The excavated materials will provide the materials needed for the berm surrounding each cell.

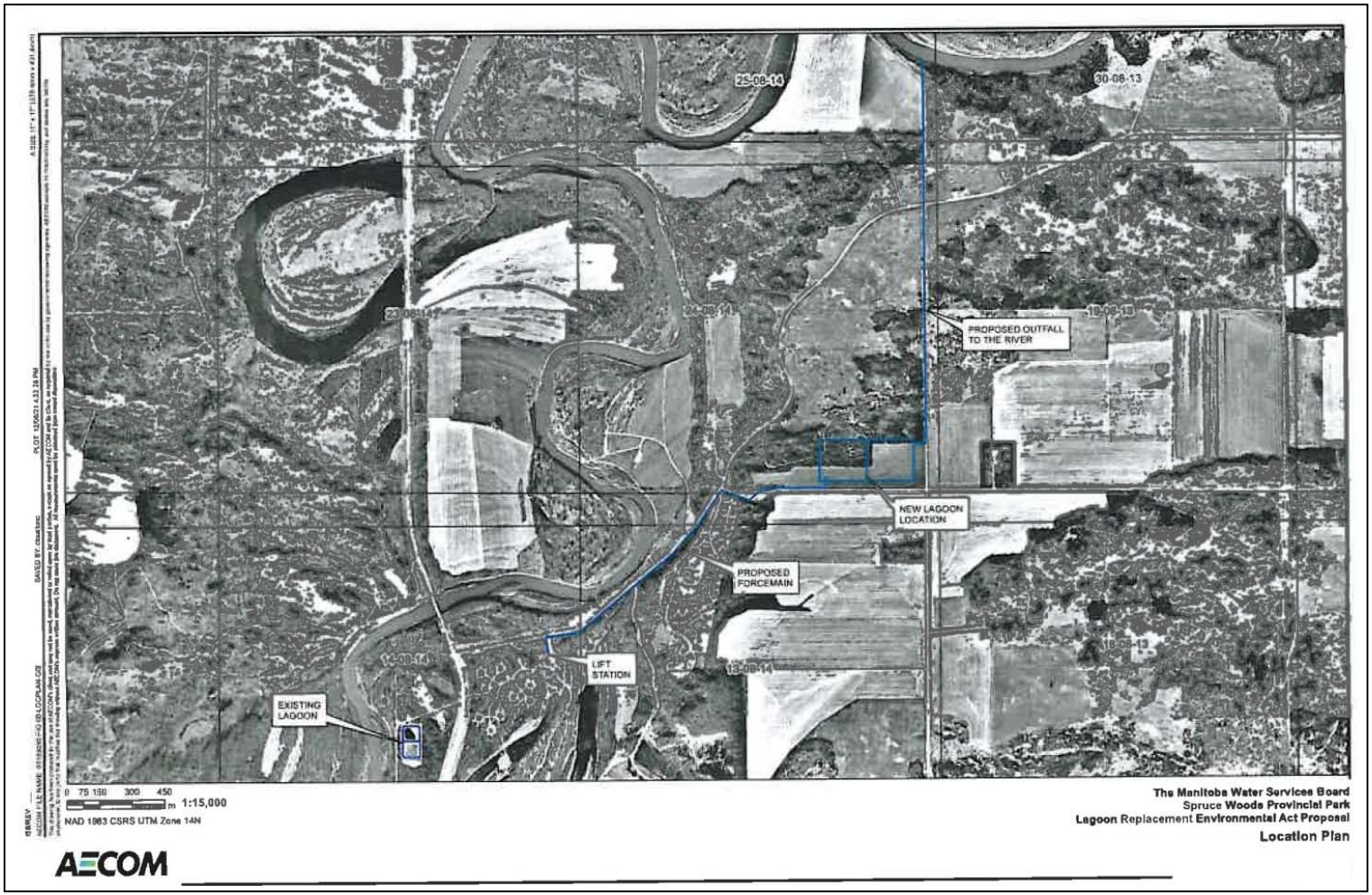

Figure 1. Spruce Woods Provincial Park Lagoon Replacement – map of initial proposed Infrastructure locations. (Map courtesy of AECOM).

2.0 PROJECT BACKGROUND - HERITAGE

The Project Study Area has high potential for the presence of heritage resources. Evidence human occupation dates to 11,000 years ago (Government of Manitoba). Prior to field investigations, the Provincial Heritage Registry was examined to determine existing archaeological or registered heritage sites within the Project Study Area. The results showed that there are four registered archaeological sites and four Provincial Plaques within a 2 km radius of the Project (Figure 2).

Table 1. Registered Archaeological Sites within 2 km of Spruce Woods Lagoon

BORDEN_NO	MAP_SHEET	COMMON_NAM	CULTURAL_A	SITE_TYPE
DkLt-Y3	62G/11	BISON WALLOW	UNDETERMINED	H.UNINTERPRETED
DjLt-21	62G/11	ABERNATHY #1	PREHISTORIC	E.WORKSHOP
DjLt-7	62G/11	MOORE SITE #1	UNDETERMINED	I.ISOLATED FIND
DjLt-20	62G/11	ABERNATHY #2	ARCHAIC	E.WORKSHOP
DjLt-4	62G/11	SETON BRIDGE	UNDETERMINED	D.KILL SITE
DkLt-37	62G/11	STEEL'S FERRY OVERLOOK	PREHISTORIC; HISTORIC	E.WORKSHOP

Table 2. Registered Plaque Locations within 2 km of Spruce Woods Lagoon

ID	Plaque Name	Year	Comments
PLAQ401	Fort des Epinettes - Pine Fort	1981	LOCATED IN KICHE MANITOU CAMPGROUND IN SPRUCE WOODS PROVINCIAL PARK
PLAQ834	Newfoundland Ravine and Trail	1982	LOCATED IN KICHE MANITOU CAMPGROUND IN SPRUCE WOODS PROVINCIAL PARK
PLAQ1534	Assiniboin (Nakota) First Nation	2000	LOCATED IN KICHE MANITOU CAMPGROUND IN SPRUCE WOODS PROVINCIAL PARK
PLAQ368	Fair Valley School	1980	LOCATED ON THE NORTHWEST CORNER OF NW 19-8-13 W

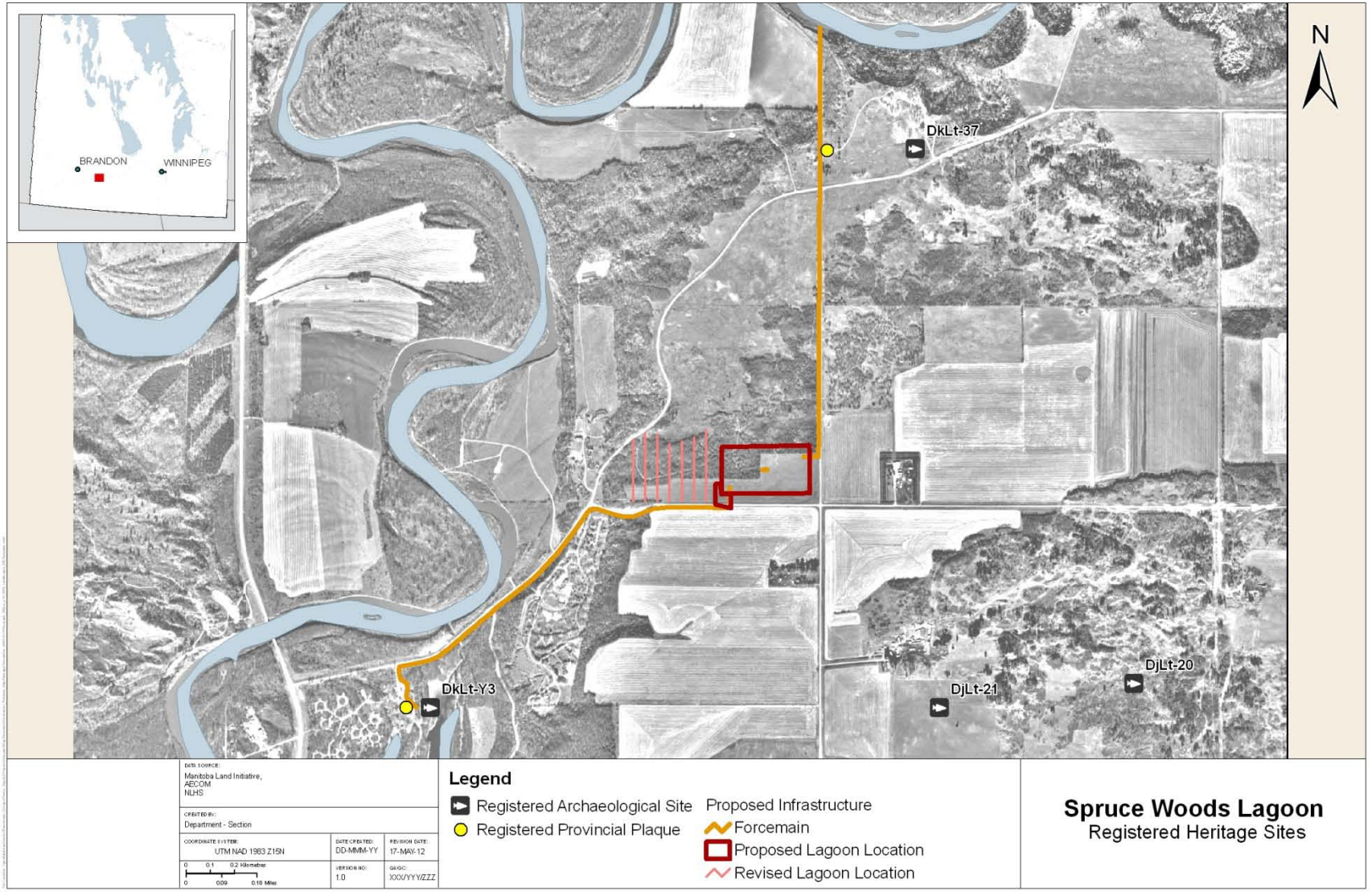

Figure 2. Locations of Registered Heritage Sites within Project Study Area.

3.0 HERITAGE RESOURCE IMPACT ASSESSMENT

The HRIA for the Spruce Woods Lagoon took place between July 31st and August 1st, 2012 and on October 24, 2012. The assessment focused on the four project components. These are discussed separately in the following sections. Assessment methods consisted of pedestrian surveys using Garmin handheld GPS units were tracked throughout the four areas of investigation. Shovel testing was conducted in favourable areas and all observations were recorded. These data were downloaded into GIS for documentary purposes.

3.1 Existing Lagoon

The existing lagoon area is located on the west side of PR 5. The primary purpose of assessing the existing lagoon was for comparative purposes with the new lagoon location and to confirm that remediation or decommissioning activities would not affect undiscovered heritage resources. The general area has undergone significant modification and is in close proximity to the Manitoba Conservation Park Services Buildings and staff bunkhouses. The existing lagoon is approximately 50 metres from the edge of the Assiniboine River and riverbank erosion is a cause for concern to the existing lagoon integrity. Previous Government of Manitoba buildings existed between the lagoon and the river, however these buildings have since been removed as they were beginning to slump into the river. A pedestrian survey did not reveal evidence of surface artifacts. There are no heritage concerns for the decommissioning the existing lagoon.

3.2 Lift Station

The existing lift station was visited during the survey; however it was evident that the replacement or upgrade construction would not affect heritage resources. The lift station is situated along a road leading into the lower bays of the Kiche Manitou Campground and is positioned on a built-up graveled area (Figure 3). The initial installation of the lift station and associated pipes would have disturbed the surrounding ground area and therefore has already undergone impacts. There are no heritage concerns for the upgrade or replacement of lift station.

Figure 3. Existing lift station.

3.3 New Two-cell Lagoon (July 31-August 1 Survey)

The main heritage field survey occurred within the proposed parameters of the proposed two-cell lagoon located 1.5 km northeast of the Kiche Manitou Campground within Spruce Woods Provincial Park. The proposed lagoon structure will included two holding cells each measuring 150m^2 in dimension. The proposed location for the lagoon is currently an agricultural field with a forested area located in the northern portion of the proposed lagoon footprint. The survey of the field consisted of pedestrian survey transect spaced approximately 10m apart (Figure 4). The field had been left as summer-fallow; therefore only minimal vegetation in the form of alfalfa covered the ground surface and could be easily viewed for exposed artifactual materials (Figure 5). The forested area contained cut-lines for test drilling purposes. These cut-lines were surveyed and 10 shovel tests were excavated within selected areas to test for *in situ* heritage resources. The shovel tests were recorded on NLHS standardized shovel test forms and detailed information such as soil type, surrounding vegetation, vista, and slope (Appendix B). All shovel tests were negative for heritage resources or features.

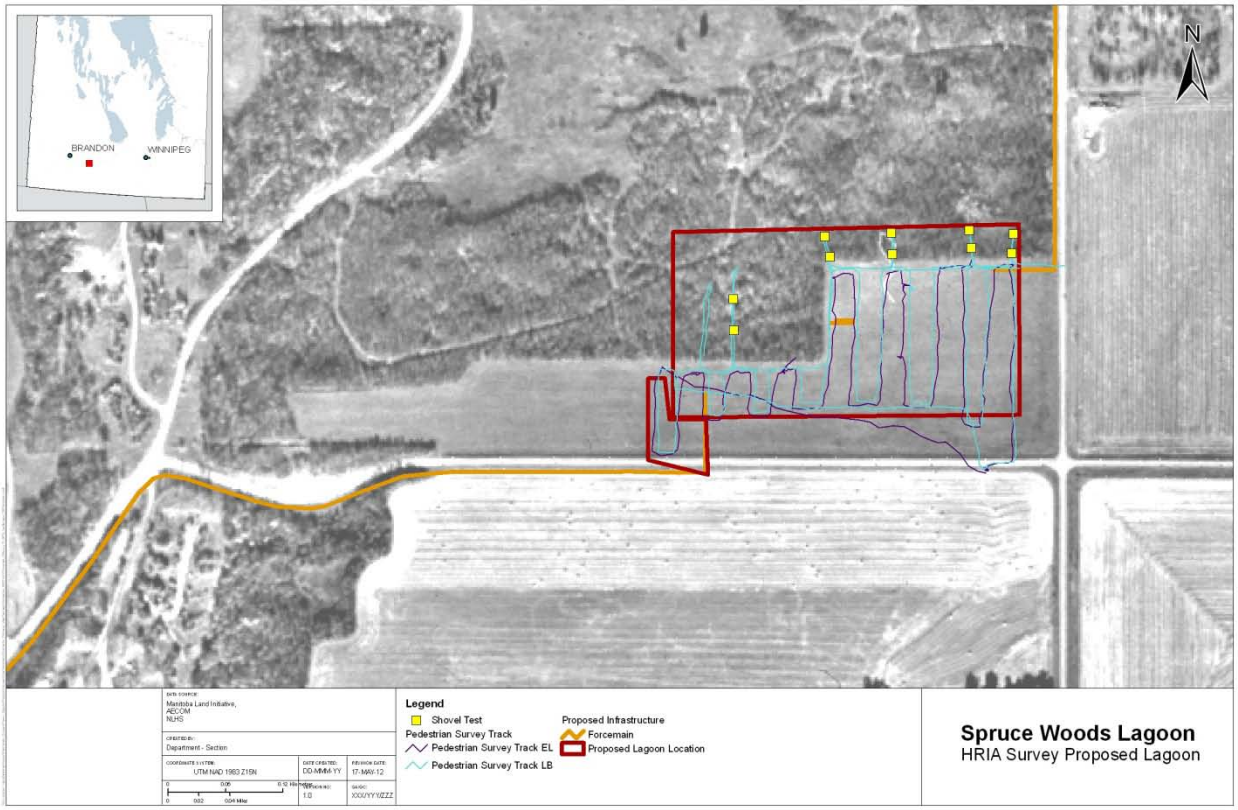

Figure 4. Archaeological assessment of the Spruce Woods proposed lagoon area (July-August 2012).

Figure 5. Survey of proposed new two-cell lagoon in exposed field.

3.4 New Two-cell Lagoon (October 24 Survey)

The proposed location for the new two-cell lagoon was shifted approximately 400m west from the original design. As with the previous location of the lagoon (see Section 3.3, above), the environment of the proposed lagoon footprint consists of a fallow agricultural field in the southern portion with a forested area to the north. For consistency with the previous HRIA survey, survey of the field consisted of pedestrian survey transect spaced approximately 10-15m apart (Figure 6). An existing activity trail (Figure 7) and cut-lines in the forested area were surveyed and 16 shovel tests were excavated within selected areas along the cut-lines and at the edge of the trail to test for *in situ* heritage resources (Figure 8). The shovel tests were recorded on NLHS standardized shovel test forms (Appendix C). All shovel tests were negative for heritage resources or features.

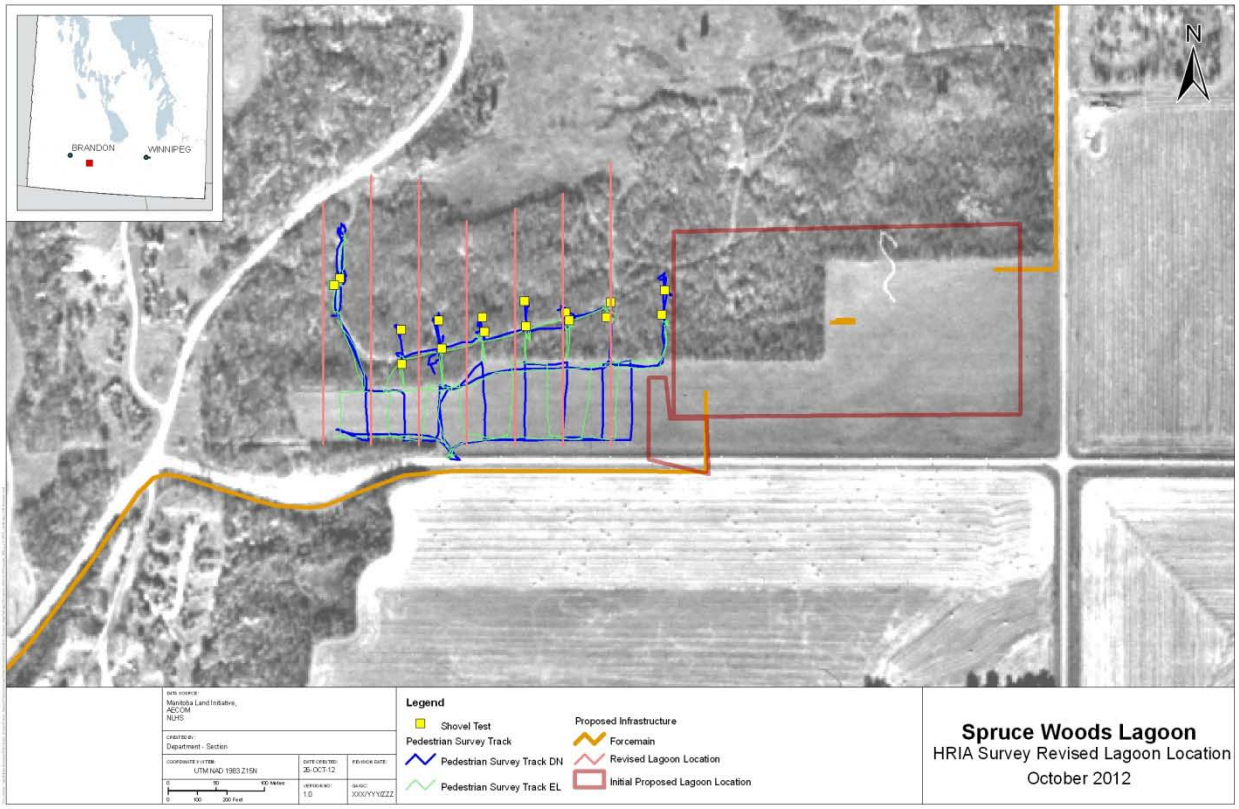

Figure 6. Archaeological assessment of the Spruce Woods proposed lagoon area (October 2012).

Figure 7. Existing activity trail in forested part of proposed new two-cell lagoon footprint area.

Figure 8. Shovel testing along cut-line in forested area.

3.5 Outfall to Assiniboine River

The proposed location of the outfall to the Assiniboine River will follow the existing mile road, also known as Steel's Ferry Road. At the time of the survey, the exact location of the outfall terminus at the Assiniboine River was still to be confirmed. In addition, there were landowner restrictions on the west side of the road. A general assessment could be made for the main line, as the area on either side of the road has previously undergone impact from roadway and drainage ditch construction. As a result of these previous impacts there are no heritage concerns for the main line section. However, there is heritage concern for the outfall terminus due to its proximity to the Assiniboine River. When the exact location becomes known, a survey and testing should be conducted.

A second area of concern is a registered heritage plaque for the Fair Valley School (Figure 9); this is situated on the east side of Steel's Ferry Road. The plaque was noted at site coordinates 14 U 483106E 5502914N, approximately 20 metres east of the road. The UTM coordinates differ slightly from the HRB heritage register which place the site further inland from the road. Currently the site does not fall within the proposed outfall line right-of-way but should be avoided if construction plans are altered.

Figure 9. Fair Valley School Plaque.

4.0 ASSESSMENT

The assessment of the four components for Spruce Woods Provincial Park Lagoon Replacement Project did not provide physical evidence of heritage resources within the study area. However, the proximity of the certain project components to the Assiniboine River, which was used as a major travel artery, has high potential for undiscovered heritage resources. The terminus of the outfall at the Assiniboine River was unable to be assessed due to land access issues and requires further assessment once project planning confirms exact placement details.

5.0 SUMMARY AND CONCLUSIONS

Northern Lights Heritage Services Inc. conducted a heritage resource impact assessment for the Spruce Woods Provincial Park Lagoon Replacement Project between July 31st to August 1st, 2012 and on October 24, 2012. The four components of the project were examined for heritage resources with negative results; therefore, there are no concerns with the existing or proposed lagoon locations, the lift station or the main line of the outfall. The terminus of the outfall was inaccessible at the time of the survey. Heritage assessment of this area is recommended once the terminus location is determined.

All heritage resources are protected by Manitoba's *Heritage Resources Act* (1986). While no heritage concerns are indicated there is always the potential for heritage resources to be discovered during excavation activities and the project archaeologist be contacted. In addition, should human remains be discovered all activity at the location is to cease immediately and the Historic Resources Branch notified.

5.0 REFERENCES CITED

Government of Manitoba

1986 *The Heritage Resources Act* (Manitoba) (C.C.S.M. c. H39.1).

Government of Manitoba, Manitoba Conservation and Water Stewardship

2012 Spruce Woods Provincial Park. Online document accessed Sept 28, 2012
http://www.gov.mb.ca/conservation/parks/popular_parks/western/spruce_info.html

Appendices

Appendix A: Heritage Permit A47-12

The Heritage Resources Act (Subsection 14(2) and Sections 52 and 53)

Heritage Permit No. A47-12

Manitoba
Culture, Heritage and Tourism

Pursuant to Section/Subsection: 53 **of *The Heritage Resources Act:***

Name: Lisa Bobbie
Northern Lights Heritage Services Inc.

Address: 2739 Pembina Hwy
Winnipeg MB R3T 2H5

Attention: Lisa Bobbie

(hereinafter referred to as "the Permittee"),

is hereby granted permission to:

conduct HRIA of proposed lagoon site for Spruce Woods Provincial Park

during the period:

July 30-31, 2012

This permit is issued subject to the following conditions:

(1) That the information provided in the application for this permit dated the **July 25, 2012** is true in substance and in fact;

(2) That the permittee shall comply with all of the provisions of *The Heritage Resources Act* and any regulations or orders thereunder; PLEASE NOTE ATTACHMENT RE: CUSTODY AND OWNERSHIP OF HERITAGE OBJECTS;

(3) That the Permittee shall provide to the Minister a writtern report or reports with respect to the Permittee's activities pursuant to this permit, the form and content of which shall be satisfactory to the Minister and which shall be provided on the following dates:
March 31, 2013

(4) That this permit is not transferable;

(5) This permit may be revoked by the Minister where, in the opinion of the Minister, there has been a breach of any of the terms or conditions herein or of any provision of *The Heritage Resources Act* or any regulations, thereunder;

(6) Special conditions:

a. The permittee must obtain permission from any landowner, lessee or regulatory authority as applicable, concerning access to any property to be examined;

b. Neither the Government of Manitoba nor the party issuing this permit shall be liable for any damages resulting from any activities carried out pursuant to this permit, and the Permittee specifically agrees, in consideration for receiving this permit, to indemnify and hold harmless the Minister and the Government of Manitoba, the Minister and any employees and officials of the Government, against any and all actions, liens, demands, loss, liability, cost, damage and expense including, without limitations, reasonable legal fees, which the Government, Minister or any employee or official of the Government may suffer or incur by reasons of any of the activities pursuant to or related to this permit.

c. The permittee has, along with this permit, received enclosure:
Provisions Regarding Found Human Remains Under THE HERITAGE RESOURCES ACT, And Manitoba's Policy Respecting the Reporting, Exhumation and Reburial of Found Human Remains (1987).

d. None added.

e. None added.

f. None added.

g. None added.

h. None added.

Dated at the City of Winnipeg, in Manitoba, this 9th day of August, 2012

for Donna Dul
Minister of Culture, Heritage, and Tourism

Manitoba Culture, Heritage, and Tourism
Historic Resources Branch

Appendix B: Spruce Woods Provincial Park Lagoon Replacement Shovel Test Forms July 31-August 1, 2012

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/08/01
03. Map Sheet: 62G/11 04. Area: N/A
05. Site Name: N/A
06. Transect ID.: Cut Line "A" 07. Test Pit No.:
08. Site / **Non-Site** (circle) 1
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-483028E/5501690N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 370 meters asl
12. Distance to previous test: N/A
13. Extent of area tested: 50 cm x 40 cm x 41 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / West / **North** / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: N/A (metres)
18. Ground Cover: Poison Ivy
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover:
21. Disturbance: None / Rodent / **Tree** / Other Tree roots
22. Soil Stratigraphy:

[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Organic leaf litter		0-1
A. Dark brown silty sand	Dry	1-23
B. Beige sand	Dry	23-41+
C.		
D.		
E.		

23. Name of Excavator & Comments: H Khalidi/L Bobbie; nothing recovered

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/08/01
03. Map Sheet: 62G/11 04. Area: N/A
05. Site Name: N/A
06. Transect ID.: Cut Line "A" 07. Test Pit No.:
08. Site / **Non-Site** (circle) 2
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-483027E/5501670N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 368 meters asl
12. Distance to previous test: 22m south of TP1
13. Extent of area tested: 50 cm x 40 cm x 35 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / West / **North** / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: N/A (metres)
18. Ground Cover: Poison Ivy
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover:
21. Disturbance: None / Rodent / **Tree** / Other Tree roots
22. Soil Stratigraphy:

[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Organic leaf litter		0-1
A. Black organic silty soil		1-27
B. Light gray silt soil		27-35+
C.		
D.		
E.		

23. Name of Excavator & Comments: H Khalidi/L Bobbie; nothing recovered

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/08/01
03. Map Sheet: 62G/11 04. Area: N/A
05. Site Name: N/A
06. Transect ID.: Cut Line "B" 07. Test Pit No.:
08. Site / **Non-Site** (circle) 3
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482982E/5501694N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 367 meters asl
12. Distance to previous test: N/A
13. Extent of area tested: 61 cm x 59 cm x 21 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / West / **North** / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: N/A (metres)
18. Ground Cover: Poison Ivy, Rose, Grasses
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover:
21. Disturbance: None / Rodent / **Tree** / Other Tree roots
22. Soil Stratigraphy:

[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Grass mat		0-6
A. Dark gray silty soil; hard-packed		6-21
B. Light brown sandy soil; hard-packed		21+
C.		
D.		
E.		

23. Name of Excavator & Comments: H Khalidi/L Bobbie; nothing recovered

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/08/01
03. Map Sheet: 62G/11 04. Area: N/A
05. Site Name: N/A
06. Transect ID.: Cut Line "B" 07. Test Pit No.:
08. Site / **Non-Site** (circle) 4
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482985E/5501674N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 367 meters asl
12. Distance to previous test: 20m S of TP 3
13. Extent of area tested: 86 cm x 56 cm x 20 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / West / **North** / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: N/A (metres)
18. Ground Cover: Poison Ivy
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover:
21. Disturbance: None / Rodent / **Tree** / Other Tree roots
22. Soil Stratigraphy:

[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Leaf litter		0-1
A. Black silty soil; hard-packed		1-6
B. Brown sandy soil		6-20+
C.		
D.		
E.		

23. Name of Excavator & Comments: H Khalidi/L Bobbie; nothing recovered

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/08/01
03. Map Sheet: 62G/11 04. Area: N/A
05. Site Name: N/A
06. Transect ID.: Cut Line "D" 07. Test Pit No.:
08. Site / **Non-Site** (circle) 5
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482901E/5501691N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 355 meters asl
12. Distance to previous test: N/A
13. Extent of area tested: 55 cm x 59 cm x 23 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / West / **North** / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: N/A (metres)
18. Ground Cover: Poison Ivy, rose
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover:
21. Disturbance: None / Rodent / **Tree** / Other Tree roots
22. Soil Stratigraphy:

[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Leaf litter		0-1
A. Black silty soil; slightly hard-packed		1-7
B. Brown silty sand		7-23+
C.		
D.		
E.		

23. Name of Excavator & Comments: H Khalidi/L Bobbie; nothing recovered

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/08/01
03. Map Sheet: 62G/11 04. Area: N/A
05. Site Name: N/A
06. Transect ID.: Cut Line "D" 07. Test Pit No.:
08. Site / **Non-Site** (circle) 6
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482902E/5501669N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 362 meters asl
12. Distance to previous test: 22m S of TP 5
13. Extent of area tested: 57 cm x 57 cm x 22 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / West / **North** / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: N/A (metres)
18. Ground Cover: Poison Ivy, grass, rose
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover:
21. Disturbance: None / Rodent / **Tree** / Other Tree roots
22. Soil Stratigraphy:

[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Leaf litter		0-1
A. Dark brown silty soil	Dry	1-15
B. Brown silty sand	Dry	15-22+
C.		
D.		
E.		

23. Name of Excavator & Comments: H Khalidi/L Bobbie; nothing recovered

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/08/01
03. Map Sheet: 62G/11 04. Area: N/A
05. Site Name: N/A
06. Transect ID.: Cut Line "F" 07. Test Pit No.: 7
08. Site / **Non-Site** (circle)
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482831E/5501687N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 359 meters asl
12. Distance to previous test: N/A
13. Extent of area tested: 56 cm x 47 cm x 26 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / West / **North** / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: N/A (metres)
18. Ground Cover: Poison Ivy, grass, rose
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover:
21. Disturbance: None / Rodent / **Tree** / Other Tree roots
22. Soil Stratigraphy:

[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Leaf litter		0-1
A. Dark brown silty soil	Dry, not hard	1-7
B. Brown silty soil	Dry, not hard	7-26+
C.		
D.		
E.		

23. Name of Excavator & Comments: H Khalidi/L Bobbie; nothing recovered, big roots

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/08/01
03. Map Sheet: 62G/11 04. Area: N/A
05. Site Name: N/A
06. Transect ID.: Cut Line "F" 07. Test Pit No.:
08. Site / **Non-Site** (circle) 8
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482836E/5501666N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 360 meters asl
12. Distance to previous test: 21m S of TP7
13. Extent of area tested: 51 cm x 56 cm x 27 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / West / **North** / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: N/A (metres)
18. Ground Cover: Poison Ivy, grass, rose
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover:
21. Disturbance: None / Rodent / **Tree** / Other Tree roots
22. Soil Stratigraphy:

[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Leaf litter/root mat		0-7
A. Dark brown silty soil	Dry, slightly hard-packed	7-16
B. Brown silt		16-27+
C.		
D.		
E.		

23. Name of Excavator & Comments: H Khalidi/L Bobbie; nothing recovered

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/08/01
03. Map Sheet: 62G/11 04. Area: N/A
05. Site Name: N/A
06. Transect ID.: Cut Line "H" 07. Test Pit No.:
08. Site / **Non-Site** (circle) 9
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482737E/5501621N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 358 meters asl
12. Distance to previous test: N/A
13. Extent of area tested: 59 cm x 60 cm x 20 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / West / **North** / Northeast / Northwest (circle)
15. Slope: 0-2 º / **3-5 º** / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: N/A (metres)
18. Ground Cover: Poison Ivy, rose
19. Dominant Tree Cover: White poplar
20. Secondary Tree Cover: Oak
21. Disturbance: None / Rodent / **Tree** / Other Tree roots
22. Soil Stratigraphy:

[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Thick grass mat		0-6
A. Dark brown silt	Slightly hard	6-16
B. Brown silt	Dry, not hard	16-20+
C.		
D.		
E.		

23. Name of Excavator & Comments: H Khalidi/L Bobbie; nothing recovered

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/08/01
03. Map Sheet: 62G/11 04. Area: N/A
05. Site Name: N/A
06. Transect ID.: Cut Line "H" 07. Test Pit No.:
08. Site / **Non-Site** (circle) 10
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482736E/5501589N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 353 meters asl
12. Distance to previous test: 32m S of TP9
13. Extent of area tested: 57 cm x 56 cm x 23 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / West / **North** / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: N/A (metres)
18. Ground Cover: Poison Ivy
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover:
21. Disturbance: None / Rodent / **Tree** / Other Tree roots
22. Soil Stratigraphy:

[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Root mat		0-4
A. Dark brown soil		4-10
B. Brown silt		10-23+
C.		
D.		
E.		

23. Name of Excavator & Comments: H Khalidi/L Bobbie; nothing recovered

Appendix C: Spruce Woods Provincial Park Lagoon Replacement Shovel Test Forms October 24, 2012

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: W side Lagoon, W side trail
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_EL_20121024 07. Test Pit No.:
08. Site / **Non-Site** (circle) EL1
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482319E/5501636N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 344 meters asl
12. Distance to previous test: N/A
13. Extent of area tested: 50 cm x 54 cm x 30 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~840 (metres)
18. Ground Cover: Poison Ivy, grasses, dead leaves
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: N/A
21. Disturbance: **None** / Rodent / Tree / Other
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Black sandy soil	Damp	0-25
A. Brown sand	Damp	25-30+
B.		
C.		
D.		
E.		

23. Name of Excavator & Comments: E. Linnemann. No finds

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: W side Lagoon, E Side trail
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_DN_20121024 07. Test Pit No.:
08. Site / **Non-Site** (circle) D1
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482325E/5501643N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 343 meters asl
12. Distance to previous test: N/A
13. Extent of area tested: 45 cm x 45 cm x 47 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~840 (metres)
18. Ground Cover: dead leaves, grasses
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: some Poplar
21. Disturbance: **None** / Rodent / Tree / Other
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Organic leaf litter	Damp	0-2
A. Black silty sand	Damp	2-18
B. mottled brown/black silty sand	Damp	18-22
C. Brown sand	Damp	22-47
D.		
E.		

23. Name of Excavator & Comments: D. Norris – test pit placed on highest point of Land, no finds

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: Cutline J – top of hill
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_EL_20121024 07. Test Pit No.:
08. Site / **Non-Site** (circle) EL2
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482661E/5501605N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 362 meters asl
12. Distance to previous test: approx. 30 m south of D2
13. Extent of area tested: 48 cm x 50 cm x 35 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~1200 (metres)
18. Ground Cover: grasses, dead leaves, alder(?)
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: poplar
21. Disturbance: None / Rodent / **Tree** / Other **roots**
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Black organic sand	Damp (slight)	0-10
A. Brown sand	Damp	10-35+
B.		
C.		
D.		
E.		

23. Name of Excavator & Comments: E. Linnemann. No finds

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: Cutline J
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_DN_20121024 07. Test Pit No.:
08. Site / **Non-Site** (circle) D2
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482664E/5501631N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 357 meters asl
12. Distance to previous test: approx. 30 m north of EL2
13. Extent of area tested: 45 cm x 45 cm x 52 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: N/A (metres)
18. Ground Cover: Grasses and shrubs with leaves
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: some Poplar
21. Disturbance: **None** / Rodent / Tree / Other
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Leaf layer/roots (LFH)	Damp/moist	0-4
A. Black silty sand	Damp	4-12
B. Mottled dark brown sand	Damp	12-30
C. Mottled light brown sand	Damp	30-50
D. Beige sand	Dry	50-52
E.		

23. Name of Excavator & Comments: D. Norris – test pit placed at the highest point on cut line J – no finds.

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA
02. Date: 2012/10/24
03. Map Sheet: 62G/11
04. Area: Cutline K – top of hill
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_EL_20121024
07. Test Pit No.: EL3
08. Site / **Non-Site** (circle)
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482603E/5501602N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 360 meters asl
12. Distance to previous test: approx. 15 m south of D3
13. Extent of area tested: 50 cm x 47 cm x 45 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~1100 (metres)
18. Ground Cover: Poison Ivy, grasses, dead leaves, alder (?)
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: N/A
21. Disturbance: **None** / Rodent / Tree / Other
22. Soil Stratigraphy:
    [Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Black Sand	Damp	0-45+
A.		
B.		
C.		
D.		
E.		

23. Name of Excavator & Comments: E. Linnemann. No finds

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: Cutline K
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_DN_20121024 07. Test Pit No.:
08. Site / **Non-Site** (circle) D3
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482607E/5501618N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 360 meters asl
12. Distance to previous test: approx. 15 m north of EL3
13. Extent of area tested: 45 cm x 45 cm x 50 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~1100 (metres)
18. Ground Cover: Grasses and dead leaves
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: some Poplar
21. Disturbance: **None** / Rodent / Tree / Other
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Grassy root layer	Damp/moist	0-3
A. Black silty sand	Damp	3-30
B. Mottled dark brown sand	Damp	30-40
C. Beige sand	Damp	40-50
D.		
E.		

23. Name of Excavator & Comments: D. Norris – test pit placed at highest point on cut line K – no finds.

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: Cut line L –top of hill
05. Site Name: N/A
06. Transect ID.: SWLAgoon_HRIA_EL_20121024 07. Test Pit No.: EL4
08. Site / **Non-Site** (circle)
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482564E/5501599N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 360 meters asl
12. Distance to previous test: approx. 10 m south of D4
13. Extent of area tested: 45 cm x 48 cm x 42 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~1050 (metres)
18. Ground Cover: dead leaves, grasses, moss, choke cherry/red willow (?)
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: Poplar
21. Disturbance: None / Rodent / **Tree** / Other **roots**
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Black sand	Damp	0-15
A. Dark gray sand	Damp	15-42 +
B.		
C.		
D.		
E.		

23. Name of Excavator & Comments: E. Linnemann. No finds

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: Cutline L
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_DN_20121024 07. Test Pit No.:
08. Site / **Non-Site** (circle) D4
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482560E/5501607E [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 357 meters asl
12. Distance to previous test: approx. 10 m north of EL4
13. Extent of area tested: 45 cm x 47 cm x 47 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~1050 (metres)
18. Ground Cover: grasses, wheat, dead leaves
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: some Poplar
21. Disturbance: **None** / Rodent / Tree / Other
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Root/leaf layer	Moist/damp	0-3
A. Black silty sand	Damp	3-22
B. Mottled gray/black sand	Damp	22-47
C.		
D.		
E.		

23. Name of Excavator & Comments: D. Norris – placed at the highest point along cut line L – no finds

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: Cutline M – top of hill
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_EL_20121024 07. Test Pit No.: EL5
08. Site / **Non-Site** (circle)
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482519E/5501593N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 361 meters asl
12. Distance to previous test: approx. 20 m south of D5
13. Extent of area tested: 45 cm x 45 cm x 49 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~1000 (metres)
18. Ground Cover: dead leaves, grasses, moss, alder(?)
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: N/A
21. Disturbance: None / Rodent / **Tree** / Other **roots**
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Black Sand	Damp	0-20
A. Gray sand	Damp	20-49+
B.		
C.		
D.		
E.		

23. Name of Excavator & Comments: E. Linnemann. No finds

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: Cutline M
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_DN_20121024 07. Test Pit No.:
08. Site / **Non-Site** (circle) D5
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482517E/5501619N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 359 meters asl
12. Distance to previous test: approx. 20 m north of EL5
13. Extent of area tested: 45 cm x 45 cm x 53 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~1000 (metres)
18. Ground Cover: grasses, dead leaves
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: some Poplar
21. Disturbance: **None** / Rodent / Tree / Other
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Leaf/root layer	Moist/Damp	0-5
A. Black sand	Damp	5-15
B. Mottled dark brown sand	Damp	15-35
C. Mottled light brown sand	Damp	35-53
D.		
E.		

23. Name of Excavator & Comments: D. Norris - @ 53 cm sand is completely dry
No finds

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: Cutline N – top of hill
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_EL_20121024 07. Test Pit No.:
08. Site / **Non-Site** (circle) EL6
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482476E/5501587N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 361 meters asl
12. Distance to previous test: N/A
13. Extent of area tested: 42 cm x 43 cm x 40 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~950 (metres)
18. Ground Cover: dead leaves, grasses, wood chips
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: N/A
21. Disturbance: None / Rodent / **Tree** / Other **roots**
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Black sand	Damp	0-10
A. Brown sand	Damp	10-40+
B.		
C.		
D.		
E.		

23. Name of Excavator & Comments: E. Linnemann. No finds

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: Cutline N
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_DN_20121024 07. Test Pit No.:
08. Site / **Non-Site** (circle) D6
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482474E/5501602N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 356 meters asl
12. Distance to previous test: N/A
13. Extent of area tested: 47 cm x 45 cm x 53 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~950 (metres)
18. Ground Cover: grass, wheat, dead leaves
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: some Poplar
21. Disturbance: **None** / Rodent / Tree / Other
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Leaf/grass layer	Moist/damp	0-4
A. Black sand	Damp	4-10
B. Mottled beige/brown sand	Damp	10-20
C. Beige sand	damp	20-53
D.		
E.		

23. Name of Excavator & Comments: D. Norris - @53 cm sand is completely dry
No finds

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: Cutline O – top of hill
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_EL_20121024 07. Test Pit No.: EL7
08. Site / **Non-Site** (circle)
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482431E/5501570N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 360 meters asl
12. Distance to previous test: approx. 40 m south of D7
13. Extent of area tested: 47 cm x 43 cm x 40 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~900 (metres)
18. Ground Cover: grasses, dead leaves
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: N/A
21. Disturbance: None / Rodent / **Tree** / Other **roots**
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Black Sand	Damp	0-16
A. Brown sand	Damp	16-40+
B		
C.		
D.		
E.		

23. Name of Excavator & Comments: E, Linnemann. No finds

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: Cutline O
05. Site Name: N/A
06. Transect ID.: SWLAgoon_HRIA_DN_20121024 07. Test Pit No.:
08. Site / **Non-Site** (circle) D7
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482428E/5501599N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 358 meters asl
12. Distance to previous test: approx. 40 m north of EL7
13. Extent of area tested: 45 cm x 47 cm x 48 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~900 (metres)
18. Ground Cover: Grasses, wheat, dead leaves
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: some Poplar
21. Disturbance: **None** / Rodent / Tree / Other
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Leaf/Grass root	Moist/damp	0-4
A. Black silty sand	Damp	4-10
B. Beige brown sand	Damp	10-48
C.		
D.		
E.		

23. Name of Excavator & Comments: D. Norris – placed at the highest point along cut line
No finds

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: Cutline P
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_EL_20121024 07. Test Pit No.:
08. Site / **Non-Site** (circle) EL8
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482389E/5501554N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 360 meters asl
12. Distance to previous test: approx. 30 m south of D8
13. Extent of area tested: 45 cm x 56 cm x 43 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~850 (metres)
18. Ground Cover: grasses, dead leaves
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: N/A
21. Disturbance: **None** / Rodent / Tree / Other
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Black Sand	Damp	0-23
A. Brown sand	Damp	23-43+
B		
C.		
D.		
E.		

23. Name of Excavator & Comments: E. Linnemann. No finds

Northern Lights Heritage Services Inc. Survey Data Form

01. Project: Spruce Woods Lagoon HRIA 02. Date: 2012/10/24
03. Map Sheet: 62G/11 04. Area: Cutline P
05. Site Name: N/A
06. Transect ID.: SWLagoon_HRIA_DN_20121024 07. Test Pit No.:
08. Site / **Non-Site** (circle) D8
09. Subsurface Result: Positive / **Negative** (circle)
10a. UTM: 14-482389E/5501589N [NAD 83]
10b. UTM: [NAD 27]
11. Elevation: 354 meters asl
12. Distance to previous test: approx. 30 m north of EL8
13. Extent of area tested: 45 cm x 47 cm x 52 cm *deep*
14. Aspect: South/ Southeast / Southwest / East / **West** / North / Northeast / Northwest (circle)
15. Slope: **0-2 º** / 3-5 º / 6-10 º / >10º (circle)
16. Vista: 360-271 º / 270-181 º / 180-91 º / 90-46 º / **45-0º** (circle)
17. Distance to water: ~850 (metres)
18. Ground Cover: grasses, wheat, leaves
19. Dominant Tree Cover: Oak
20. Secondary Tree Cover: some Poplar
21. Disturbance: **None** / Rodent / Tree / Other
22. Soil Stratigraphy:
[Colour, Moisture, Recoveries, Depth]

Colour and Soil type (i.e. Black organic, olive green clay)	Moisture (i.e. friable, saturated, etc)	Depth cm (i.e. 10-16 cm)
Oh Leaf/Grassy layer	Moist/damp	0-7
A. Black sand	Damp	7-22
B. Mottled beige/black sand	Damp	22-30
C. Beige sand	damp	30-52
D.		
E.		

23. Name of Excavator & Comments: D. Norris – placed at the highest point along cut line
No finds

Appendix E
Summary Table

Appendix E: Summary of Mitigation Measures: Proposed Lagoon Replacement, Spruce Woods Provincial Park, Manitoba

Effect	Phase	Mitigation
Dust generation during clearing and grubbing, excavation work, road upgrades, re-vegetation and decommissioning Soil loss due to erosion Surface water quality effects due to sediment and turbidity and potential effects on fish and fish habitat	Construction	• Material stockpile height must be limited. • The disturbed/exposed areas must be kept to a minimum. • If required, additional dust suppression activities, such as spraying material stockpiles/roads with water, must be completed. • Impose site speed limits as required. • Erosion control measures such as silt fences must be employed as required. • Proposed outfall design will be submitted to Fisheries and Oceans Canada for review. • Construction of outfall will be conducted in accordance with Fisheries and Oceans Canada requirements.
Noise generated from use and arrival of heavy equipment at the site including subsequent human and fauna effects	Construction	• Construction hours must be limited as required to normal working hours. • Equipment must be properly maintained. • Provide hearing protection to human receptors as required.
Effects on air quality due to exhaust emissions; potential subsequent effects on human health	Construction	• Vehicles and equipment/machinery must be properly maintained. • Vehicle idling is kept to a minimum.
Noise generated by septage delivery, maintenance activities and sludge removal including subsequent human and fauna effects	Operation	• Separation distance to receptors and intermittent nature of noise mitigate impacts.
Odour generation and potential effects on humans including effects on recreation tourism	Operation	• Sludge removal in the fall to avoid high use period for park. • Shelterbelt around lagoon and separation distance to receptors mitigates impacts.
Greenhouse gas emissions	Operation	• Lagoon depth less than 2-3 m limits potential methane generation.
Weather effects on project	Construction/Operation	• Construction and operational activities must occur at the appropriate time of year and/or when the climate is favourable to do so. • During construction activities, all equipment must be stored in appropriate areas when not in use to prevent equipment damage, and potential subsequent leaks, from occurring during a severe weather event. • Work must be stopped if harm to workers may occur. • Lagoon designed to provide 365 days of wastewater storage to allow discharge to the Assiniboine River when effluent quality limits can be met.

Effect	Phase	Mitigation
Soil compaction due to equipment movement	Construction	• Construction vehicles and equipment must use designated pathways as indicated by Parks to access work areas. • The contractor is responsible for the appropriate repair of any areas where equipment has compacted soils with the repairs including appropriate grading and re-vegetation (if required).
Soil/ Groundwater/ Flora, Fauna and Species at Risk effects due to waste disposal	Construction	• Construction/decommissioning waste must be properly stored on-site then taken off-site and disposed of at an appropriate waste disposal facility.
Soil/ Groundwater/ Flora, Fauna and Species at Risk/ Fish and Fish habitat effects due to spills from heavy equipment operation or refuelling, chemical or fuel leaks from storage areas, or accidental spills (including transportation accidents)	Construction/Operation	• All potentially hazardous products (if required onsite) must be stored in a pre-designated, safe and secure product storage area(s) in accordance with applicable legislation. • Storage sites must be inspected periodically for compliance with the requirements. • Refuelling of heavy equipment must adhere to proper procedures such as using a designated area more than 100 m from a waterbody defined by Parks, with secondary containment, with preference to refuel off-site. • Service and minor repairs of equipment performed on-site must be performed by trained personnel. • Any used oils or other hazardous liquids must be collected and disposed of according to provincial requirements. • Vehicles and equipment must be maintained to minimize leaks. Regular inspections of hydraulic and fuel systems on machinery must be completed on a routine basis, when detected, leaks must be repaired immediately. • Staff must be trained in how to deal with spills, including knowledge of how to properly deploy site spill kit materials. • Appropriate type and size of spill kits must be available on-site.
Surface water quality effects and fish and fish habitat effects due to treated effluent discharges	Construction/Operation	• Effluent sampled and tested for compliance with Clean Environment Commission Order (for existing lagoon discharge) and new Environment Act Licence (for proposed lagoon discharge)
Groundwater/Surface water/Fish and Fish Habitat effects due biosolids management or leakage of pipelines or lagoon cells (including liner failure or pipeline malfunction)	Operation	• Pressure testing of forcemain during construction. • Line lagoon cells with geosynthetic liner. Weld joints in accordance with manufacturer specifications. • Equip lagoon cells with dewatering/degassing system. Conduct testing of liquid in manhole for dewatering/degassing system if a leak is suspected. • Conduct annual groundwater monitoring program in accordance *with Environment Act* Licence requirements.

Effect	Phase	Mitigation
		• If a leak is identified, repair and necessary investigation and remediation will occur if required. • Design proposed lagoon berms to be higher than site specific flood levels. • If biosolids are applied to land a separate *Environment Act* Licence will be applied for. • If biosolids are dewatered and land-filled at the City of Brandon Class 1 Waste Disposal Facility, the landfill will employ measures to mitigate potential groundwater impacts.
Flora and Fauna habitat loss and habitat fragmentation/alienation	Construction	• Re-vegetation to occur as required in disturbed areas. • Preconstruction survey by Parks biologist • Contact Regional Wildlife Biologist to re-locate turtle nests, or any other protected species encountered.
Fish stranding due to outfall design	Operation	• Design outfall to minimize fish movement into the outfall ditch.
Aesthetics	Construction/Operation	• Construction waste and debris must be stored in bins and removed on a regular basis from the project site. • Prior to the end of each construction day, the site must be inspected for loose construction waste and debris in order to maintain a clean project site. • Disturbed soils must be restored as required upon completion. • Plant shelterbelt around proposed lagoon to limit visibility. • Re-vegetation of forcemain and outfall alignments and existing lagoon site.
Transportation	Construction	• None Required
Heritage Resources	Construction	• HRIA of outfall terminus to be conducted once alignment is known • If artefacts, historical features or skeletal remains are encountered during construction, work activities must stop immediately around the affected area with the find reported to the site supervisor. A qualified archaeologist may investigate and assess the find prior to the continuation of work. • If skeletal remains are encountered during construction activities, the find must be immediately reported to the site supervisor and the Royal Canadian Mounted Police.
Human Health and Safety	Construction/Operation	• All construction/decommissioning must be carried out in accordance with *The Workplace Safety and Health Act* to minimize health and safety effects. • Contractors must adhere to the requirements of applicable health and safety legislation and the site specific safety plan developed by the prime contractor or contractor as appropriate. • All workers must wear appropriate PPE at all times, including hearing and respiratory

Effect	Phase	Mitigation
		protection as required. • Operations staff will be provided with appropriate training for all work associated with the lagoon (maintenance mowing, effluent sampling, chemical application etc.) • Lagoon site fenced to limit public access. • Licenced contractors retained to de-sludge lagoons. • Lagoon effluent tested in accordance with *Environment Act* Licence requirements.
Accidents and Malfunctions - Fire	Construction/Operation	• All flammable waste must be removed on a regular basis and disposed of at an appropriate disposal site. • Appropriate fire extinguisher(s) must be available on the work site during construction activities. Such equipment must comply with and be maintained to, the manufacturers' standards. • All on-site fire prevention/response equipment must be checked on a routine basis, in accordance with local fire safety regulations, to ensure the equipment is in proper working order at all times. • Greasy or oily rags or materials subject to spontaneous combustion must be deposited and stored in appropriate receptacles away from surface water. This material must be removed from the Site on a regular basis and be disposed of at an appropriate waste disposal facility. • In periods of high forest fire risk, idling vehicles will be reduced. Further, vehicles will be restricted to designated roads/trails to reduce potential fire ignition risk.
Accidents and Malfunctions - Berm Failure	Operation	• Berms designed to contain liquid load. • Internal berms lined with rip rap to prevent erosion. • Perimeter ditch installed to prevent standing water contact with berms. • Regular inspection of berm integrity by Parks staff.