APPENDIX A

PROJECT DESCRIPTION

Appendix A1

Concept Design for Wastewater Disposal

AECOM

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Technical Memorandum

Date: July 28th, 2009
To: Brian Beyak, P.Eng, Manitoba Hydro
From: Jamie Ellis, P. Eng, AECOM
Project Number: 0217-200-07 (3) [Hydro Ref: 243 981 0100]
Subject: **Keeyask Infrastructure Project – North Access Road Start Up Camp Concept Design for Wastewater Disposal**

Distribution: Neil Klassen, C.E.T., AECOM
Bob Romanetz, P.Eng, AECOM

1) Introduction

This technical memorandum is provided as Appendix A1 to the Environment Act Proposal submission for the Keeyask Infrastructure Project.

The North Access Road Start Up Camp is located at approximately km 177 north on PR280 (refer to Figure 1). The life of the start up camp is anticipated to be 2 to 3 years, with an occupancy ranging between approximately 125 (max) and 50 (min) persons, depending upon construction activities at the time.

2) Site Layout

Facilities at the start up camp will include the following (refer to Figure 2):

- Accommodation units, with washrooms and laundry facilities
- Offices and stores
- Kitchen and Dining Hall
- Fire Truck/Ambulance Garage
- Generator
- Electrified parking stalls
- Water Treatment Plant (WTP) with water storage tanks
- Groundwater well

Furthermore, a gatehouse will also be built to control access to the North Access Road. As the gatehouse will be in service beyond the life of the camp, it is proposed that this building is served by a small pump out tank.

3) Alternatives Considered

At the outset of the design stage, the relative merits of various options for the disposal of wastewater from the start up camp were considered, as shown in the table below. The concept of greywater and blackwater separation was also considered.

Alternative	Description
A0	Black water trucked to Split Lake lagoon (currently overloaded – included for comparison only)
A1	Black water trucked to Split Lake lagoon with upgrades
A2	Truck All Sewage to Split Lake lagoon with upgrades
B1	Black water trucked to Gillam WWTP
B2	All sewage trucked to Gillam WWTP
C1	Black water trucked to Thompson WWTP
C2	All sewage trucked to Thompson WWTP
D	All sewage to on-site mechanical WWTP with drain field
E	All sewage to septic tank with drain field
F	Lagoon with discharge route

The analysis included a comparison of technical issues, potential for disruption (weather/freezing), training requirements, schedule risks and Class D cost estimates.

The preferred option was Alternative E, as it presented the lowest lifecycle cost, low potential for disruption and limited training requirements. As such, a concept design for an engineered drain field was prepared, as shown in the attached calculations.

4) Design Criteria

The principal reference for field design criteria is The Environment Act Regulation 83/2003 "Onsite Wastewater Management Systems".

5) Geotechnical Investigation

The field investigation at the proposed location for the Start Up Camp drain field was completed on July 21 and 22, 2009 by Jared Baldwin, EIT and Geoff Nolette, CET of AECOM. A total of six test holes were drilled at the locations shown on the Test Hole location plan (Figure 2). Test Holes 09-01, 09-02, 09-03 and 09-04 were drilled in the general vicinity of the proposed drain field. Test Holes 09-05 and 09-06 were drilled between the proposed water well and the drain field locations. The test holes were drilled using a 50mm diameter hand auger to depths ranging from 1.4 to 3 m. The test hole depths were limited by drilling conditions such as wet sand or very stiff clay. Representative soil samples were collected and returned to AECOM's Soils Testing Laboratory for further testing.

Standpipe piezometers were installed in Test holes 09-01, 09-02 and 09-04. Water levels were measured in the piezometers and falling head tests were subsequently performed to provide data that can be used to estimate the hydraulic conductivity of the soils. A draft copy of the test hole logs is attached, including the details of the piezometer installations. The logs will be finalized once the soils testing work is completed.

In general, a thin layer of organics (0.15 to 0.35m thick) was encountered at surface and was typically wet. The organics was underlain by clay in all test holes. A layer of sand ranging in thickness from 1.3 to 1.6m was encountered below the clay in Test Holes 09-01, 09-02, 09-04, a thin layer of sand

(0.2m thick) was encountered in Test Hole 09-05. The water levels measured in the piezometers approximately 12 hours after installation were 2.9m, 1.7m and 1.96m for Test Holes 09-01, 09-02 and 09-04, respectively. As such, static water levels closest to the proposed field site, indicated groundwater flow would be towards the north. The design will be progressed further once the falling head test data is reduced and the soils testing results are available.

In summary, it appears that the site may be suitable for the use of a disposal field, possibly with areas of local excavation of the clay layer, and site grading to ensure minimum separation between the base of the system and groundwater table.

Further geotechnical investigation is proposed to take place over summer 2009, to assist in the detailed design of both the wastewater disposal field and the start up camp facilities. This investigation will comprise the use of a drill rig and will include additional percolation tests.

6) Hydraulic Loading

A consumption figure of 320 LPCD has been assumed, based on information collected from Wuskwatim camp between 2008 and 2009. Therefore, the total flow anticipated is 55,000 litres per day (a conservative estimate), which includes both domestic use and backwash from the water treatment plant (estimated at 15%), plus contingency allowance.

7) Organic Loading

Whilst organic loading is not considered in the design criteria, the maximum organic loading is anticipated to be approximately 9.5 kg BOD per day (based on 75g BOD per person per day). It should be noted that wastewater discharge from the kitchen would first pass through a grease trap.

8) Concept Design

The concept for wastewater disposal comprises the use of two prefabricated septic tanks (with sedimentation and control chambers, and an access manhole). Each would be fitted with small submersible pumps (on a duty/standby arrangement) and a forcemain discharging into a disposal field. Sludge would be removed from the septic tank at periodic intervals via vacuum truck, and transported to a licensed facility for disposal. This concept has also been used previously at other Manitoba Hydro facilities, including Radisson and Henday converter stations.

The Regulations refer to 3 types of system, namely;

1. Trench type disposal field (using wastewater effluent chambers)
2. Trench type disposal field (using perforated distribution pipe)
3. Total area field (using either pipe/aggregate or chamber system, either on grade or aboveground)

The choice of system will be refined as further site information becomes available. However, for the purposes of the concept design, a "Type 1" system, comprising "Infiltrator" units with Quick-4 High Capacity Chambers, has been assumed. It is understood from the manufacturer that there are a number of other installations in Manitoba, and similar work camps in Alberta. The use of a chamber style trench disposal field allows for higher flows than with a perforated distribution pipe and aggregate filled trench due to larger surface area and storage capacity.

The multiple trench field would comprise two header pipes, each connected to a series of perforated plastic chambers located in parallel shallow trenches, with a minimum of 2m separation (as shown in Figure 3).

Wastewater shall be discharged into the chambers via small diameter pressure pipe. The pipe may be either suspended via straps or supported on stools within the chamber. An application rate of approximately 11.7 litres/m^2/day has been assumed, which is anticipated to be conservative, based on the geotechnical information gathered to date.

As currently proposed, a distance of approximately 300m separation would be maintained between the discharge field and the groundwater well. This separation shall be further reviewed prior to the commencement of well drilling.

Pipe materials, diameters, orifice sizes and spacing will be confirmed during detailed design. The use of pump controls will also be reviewed during detailed design, to allow alternate dosing of the fields.

Fencing shall be installed around the field to prevent vehicular traffic loading. A method for the control of surface drainage will be considered during detailed design, and may include perimeter ditching to avoid additional hydraulic load being added to the drainage field.

9) Protection from Freezing

Depth of cover, vegetation planting requirements and methods for snow capture will be further reviewed during detailed design. However, it is anticipated that there will always be warm effluent being pumped into the field, which should provide sufficient heat to avoid freezing.

10) Proposed Operation, Maintenance and Monitoring

Features such as inspection ports (to confirm the field is not saturated) and cleanout ports shall be included during the detailed design stage, along with an outline program for O&M and monitoring.

In the event of a system failure, it is anticipated that a trucked system would be initiated, whilst repairs are carried out. The septic tanks will be sized appropriately to accommodate hauling of waste water off site in the case of an emergency.

11) Decommissioning

Upon decommissioning of the wastewater system, it is anticipated that the pipes would be plugged and surface features removed from the site.

Respectfully submitted,

J. D. Ellis, P.Eng
Community Infrastructure
AECOM Canada Ltd.

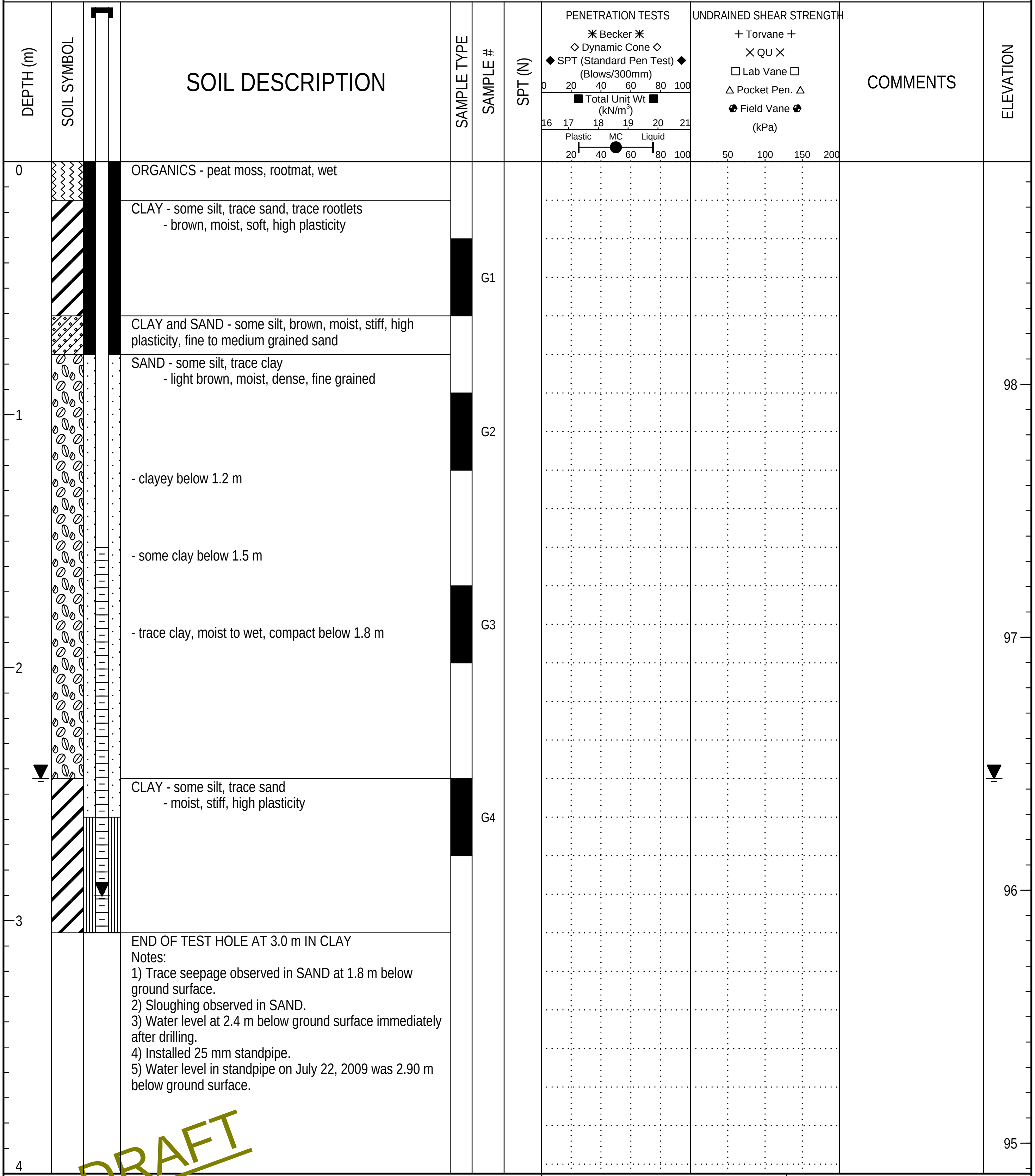
PROVINCE OF MANITOBA
J.D. Ellis
J. D.
28 July ELLIS 2009
Member
31571
REGISTERED PROFESSIONAL ENGINEER

Encs:

1. Test hole logs
2. Calculations
3. Figure 1 – Location Plan
4. Figure 2 – Borehole Location Plan
5. Figure 3 – Proposed Drain Field Layout

PROJECT: Keeyask Generating Station Infrastructure
CLIENT: Manitoba Hydro
TESTHOLE NO: TH-09-01
LOCATION: Start-Up Camp, UTM 15 V, E - 343543, N - 6255132
PROJECT NO.: 0217-200-07
CONTRACTOR:
METHOD: 50 mm Hand Auger
ELEVATION (m): 98.88

SAMPLE TYPE	■ GRAB	◫ SHELBY TUBE	☒ SPLIT SPOON	☰ BULK	▧ NO RECOVERY	▮ CORE
BACKFILL TYPE	■ BENTONITE	⁘ GRAVEL	▥ SLOUGH	⁙ GROUT	▨ CUTTINGS	⁘ SAND



ORGANICS - peat moss, rootmat, wet

CLAY - some silt, trace sand, trace rootlets
- brown, moist, soft, high plasticity

CLAY and SAND - some silt, brown, moist, stiff, high plasticity, fine to medium grained sand

SAND - some silt, trace clay
- light brown, moist, dense, fine grained

- clayey below 1.2 m

- some clay below 1.5 m

- trace clay, moist to wet, compact below 1.8 m

CLAY - some silt, trace sand
- moist, stiff, high plasticity

END OF TEST HOLE AT 3.0 m IN CLAY
Notes:
1) Trace seepage observed in SAND at 1.8 m below ground surface.
2) Sloughing observed in SAND.
3) Water level at 2.4 m below ground surface immediately after drilling.
4) Installed 25 mm standpipe.
5) Water level in standpipe on July 22, 2009 was 2.90 m below ground surface.

LOGGED BY: Jared Baldwin
COMPLETION DEPTH: 3.05 m
REVIEWED BY: Gil Robinson
COMPLETION DATE: 21/7/09
PROJECT ENGINEER: Gil Robinson

PROJECT: Keeyask Generating Station Infrastructure
CLIENT: Manitoba Hydro
TESTHOLE NO: TH-09-02
LOCATION: Start-Up Camp, UTM 15 V, E - 343493, N - 6255034
PROJECT NO.: 0217-200-07
CONTRACTOR:
METHOD: 50 mm Hand Auger
ELEVATION (m): 99.03

SAMPLE TYPE	■ GRAB	▥ SHELBY TUBE	☒ SPLIT SPOON	☰ BULK	◺ NO RECOVERY	▐ CORE
BACKFILL TYPE	■ BENTONITE	⁘ GRAVEL	▥ SLOUGH	⁘ GROUT	◺ CUTTINGS	⁘ SAND

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

DEPTH (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0	ORGANICS - peat moss, rootmat, wet					99
	CLAY - silty, trace sand, trace organics - grey, moist, firm, high plasticity - brown below 0.5 m	■	G6			
	CLAY and SAND - silty - light brown, moist, stiff, high plasticity, fine grained sand					
1	CLAY and SILT - sandy - light brown, moist, firm to stiff, intermediate to high plasticity	■	G7			98
	SILT and SAND - clayey - brown, moist, stiff, intermediate plasticity, fine grained sand	■	G8			
2	SAND - some clay, some silt - light brown, moist to wet, compact to dense, fine and medium grained	■	G9			97
	- trace clay below 2.4 m	■	G10			
3	END OF TEST HOLE AT 3.0 m IN SAND Notes: 1) Trace seepage observed in SILT and SAND at 1.5 m below ground surface. 2) Sloughing observed in SAND. 3) Water level at 2.1 m below ground surface immediately after drilling. 4) Installed 25 mm standpipe. 5) Water level in standpipe on July 22, 2009 was 1.69 m below ground surface.					96
4						

LOGGED BY: Jared Baldwin
COMPLETION DEPTH: 3.05 m
REVIEWED BY: Gil Robinson
COMPLETION DATE: 21/7/09
PROJECT ENGINEER: Gil Robinson

PROJECT: Keeyask Generating Station Infrastructure	CLIENT: Manitoba Hydro	TESTHOLE NO: TH-09-03
LOCATION: Start-Up Camp, UTM 15 V, E - 343491, N - 6254972		PROJECT NO.: 0217-200-07
CONTRACTOR:	METHOD: 50 mm Hand Auger	ELEVATION (m):

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	DEPTH
0		ORGANICS - peat moss, rootmat, wet							
		CLAY - silty, some sand - light brown, frozen to 0.9 m							
		- some ice inclusions (<2 mm dia.) between 0.6 and 0.9 m.	■	G11					
1		- moist, firm, intermediate to high plasticity below 0.9 m							1
		- brown, high plasticity below 1.2 m							
			■	G12					
2			■	G13					2
		- trace silt inclusions (<5 mm dia.), stiff below 2.1 m							
			■	G14					
3		END OF TEST HOLE AT 3.0 m IN CLAY Notes: 1) Seepage observed from ORGANICS. 2) No sloughing observed. 3) Water level at 2.1 m below ground surface immediately after drilling from seepage in ORGANICS. 4) Backfilled test hole with auger cuttings.							3
4									

LOGGED BY: Jared Baldwin	COMPLETION DEPTH: 3.05 m
REVIEWED BY: Gil Robinson	COMPLETION DATE: 21/7/09
PROJECT ENGINEER: Gil Robinson	Page 1 of 1

PROJECT: Keeyask Generating Station Infrastructure	CLIENT: Manitoba Hydro	TESTHOLE NO: TH-09-04
LOCATION: Start-Up Camp, UTM 15 V, E - 343558, N - 6255055		PROJECT NO.: 0217-200-07
CONTRACTOR:	METHOD: 50 mm Hand Auger	ELEVATION (m): 99.33

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ☒ SPLIT SPOON ☰ BULK ◫ NO RECOVERY ▌CORE

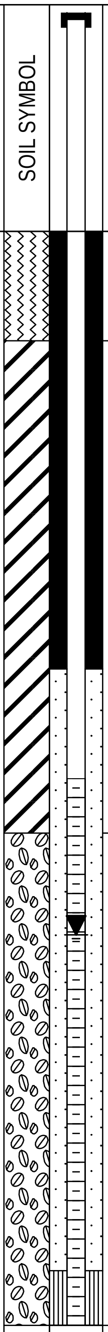
BACKFILL TYPE ■ BENTONITE ⁙ GRAVEL ▥ SLOUGH ⁙ GROUT ◫ CUTTINGS ⁙ SAND

DEPTH (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	ELEVATION
0	ORGANICS - peat moss, rootmat, wet				
	CLAY - silty, trace to some sand - brown, frozen to 1.1 m				99
	- trace ice inclusions (<1 mm dia.) between 0.6 and 1.1 m	■	G15		
1	- moist, firm, high plasticity below 1.1 m				
	- stiff below 1.4 m	■	G16		98
	SAND - silty, some clay - light brown, moist to wet, compact to dense, fine grained				
2		■	G17		
	- clayey below 2.4 m				97
	- some clay below 2.7 m	■	G18		
3	END OF TEST HOLE AT 3.0 m IN SAND				
					96
4					

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



END OF TEST HOLE AT 3.0 m IN SAND
Notes:
1) Seepage observed from ORGANICS.
2) Sloughing observed in SAND.
3) Water level at 0.2 m below ground surface immediately after drilling from seepage in ORGANICS.
4) Installed 25 mm standpipe.
5) Water level in standpipe on July 22, 2009 was 1.96 m below ground surface.

LOGGED BY: Jared Baldwin	COMPLETION DEPTH: 3.05 m
REVIEWED BY: Gil Robinson	COMPLETION DATE: 21/7/09
PROJECT ENGINEER: Gil Robinson	Page 1 of 1

PROJECT: Keeyask Generating Station Infrastructure
CLIENT: Manitoba Hydro
TESTHOLE NO: TH-09-05
LOCATION: Start-Up Camp, UTM 15 V, E - 343701, N - 6254939
PROJECT NO.: 0217-200-07
CONTRACTOR:
METHOD: 50 mm Hand Auger
ELEVATION (m):

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ☒ SPLIT SPOON ☰ BULK ◿ NO RECOVERY ◧ CORE

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

DEPTH (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS
0	ORGANICS - peat moss, rootmat, wet				
	CLAY - silty, trace sand, trace rootlets - brown, moist, firm to stiff, high plasticity	■	G19		
1	- sandy, soft, intermediate plasticity below 0.9 m	■	G20		
	- trace sand, very stiff, high plasticity				
	SAND - some silt, trace clay, dry to moist, dense to very dense, fine grained	■	G21		
	CLAY - silty, trace sand, brown, dry to moist, very stiff, high plasticity				
	END OF TEST HOLE AT 1.7 m IN CLAY Notes: 1. Hand auger refusal at 1.7 m below ground surface. 2. No seepage or sloughing observed. 3. Backfilled test hole with auger cuttings.				
2					
3					
4					

AECOM

LOGGED BY: Jared Baldwin
COMPLETION DEPTH: 1.68 m
REVIEWED BY: Gil Robinson
COMPLETION DATE: 22/7/09
PROJECT ENGINEER: Gil Robinson

PROJECT: Keeyask Generating Station Infrastructure	CLIENT: Manitoba Hydro	TESTHOLE NO: TH-09-06
LOCATION: Start-Up Camp, UTM 15 V, E - 343616, N - 6254945		PROJECT NO.: 0217-200-07
CONTRACTOR:	METHOD: 50 mm Hand Auger	ELEVATION (m):

SAMPLE TYPE ■ GRAD ▥ 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	DEPTH
0		ORGANICS - peat moss, rootmat, wet							
	▨	CLAY - silty, trace sand, trace rootlets - brown, moist, firm to stiff, high plasticity							
1	▨	- some sand, soft below 0.9 m							1
	▨	- trace sand, very stiff, high plasticity							
		END OF TEST HOLE AT 1.4 m IN CLAY Notes: 1. Hand auger refusal at 1.4 m below ground surface. 2. No seepage or sloughing observed. 3. Backfilled test hole with auger cuttings.							
2									2
3									3
4									

LOGGED BY: Jared Baldwin	COMPLETION DEPTH: 1.52 m
REVIEWED BY: Gil Robinson	COMPLETION DATE: 22/7/09
PROJECT ENGINEER: Gil Robinson	Page 1 of 1

Ref **Notes:** **Output**

TABLE OF CONTENTS **PAGES**

Introduction

These calculations are required to determine the required size of a drain field for the Keeyask Generating Station start-up camp.

The drain field will dispose of both grey and septic water from the start-up camp using a two cell septage tank, pump and drain field.

Design Constraints

Ref			
	Camp popluation	125	
	Per capita water consumption	320	LCPD
	Total daily effluent flow (Accounts for WTP Backwash)	55000	L/Day
1	Application rate (Selcted as a "worst case" for sizing)	11.74	L/m^2/Day

References:

1 Enviroment Act (E125 - R.M. 83/2003), Table (Wastewater Effluent Application Rates for Trench-type and Total Area Disposal Fields)

Ref	Notes:			Output
	Trench System using a Traditional Pipe and Aggregate			
	Camp population	125		
	Water consumption	320	LPCD	
	Percent of water discharged through system	100%		
	Daily Volume (Q)	55000	L	
1	Application Rate	11.74	L/m^2/Day	
	(Based on assumption of clay soil in area)			
	Trench Geometry			
2	Trench width (W)	1.00	m	
	(Maximum allowed width)			
3	Trench Depth	1.00	m	
	(Maximum allowed depth)			
4	Height of distribution pipe above trench bottom (H)	0.6	m	
	(1m deep trench - (0.3 m earth cover + 0.1 m stone cover))			
5	Area of trench per linear meter (A)	1.300	m^2/Linear m	

$$LengthofTrench = \frac{DailyEffluentFlow}{(ApplicationRate) \times (ApplicationArea)}$$

Ref	Notes:			Output
	Length of trench required	3603.72	m	
	Field Geometry			
6	Length of laterals	18	m	
	(Maximum length of laterals)			
	# of laterals required	201		
7	Spacing	2	m	
	(Minimum distance between trenches)			
	Total width of field (assume one large area)	601.00	m	
	Total field area	10818.00	m^2	

References:
1 Environment Act (E125 - R.M. 83/2003), Table (Wastewater Effluent Application Rates for Trench-type and Total Area Disposal Fields)
2 Environment Act (E125 - R.M. 83/2003), Schedule A, Section 2(3)
3 Environment Act (E125 - R.M. 83/2003), Schedule A, Section 2(3)
4 Environment Act (E125 - R.M. 83/2003), Schedule A, Section 2(4)
5 Environment Act (E125 - R.M. 83/2003), Schedule A, Section 2(4)
6 Environment Act (E125 - R.M. 83/2003), Schedule A, Section 2(4)
7 Environment Act (E125 - R.M. 83/2003), Schedule A, Section 2(3)

Ref	Notes:			Output
	Trench System using a Chamber Design			
	Camp population	125		
	Water consumption	320	LPCD	
	Percent of water discharged through system	100%		
	Daily Volume (Q)	55000	L	
1	Application Rate	11.74	L/m^2/Day	
	(Based on assumption of clay soil in area)			
2	Open Area Multiplier	1.5		
	Trench Geometry			
3	Trench width (W)	0.86	m	
	(Width of Infiltrator Systems Quick4 High Capacity Chambers)			
4	Area of trench per linear meter (A)	1.463	m^2/Linear m	
	(Area of Infiltrator Systems Quick4 High Capacity Chambers)			

$$LengthofTrench = \frac{DailyEffluentFlow}{(ApplicationRate)\times(ApplicationArea)\times(OpenAreaMultiplier)}$$

Ref	Notes:			Output
	Length of trench required	2134.81	m	
	Field Geometry			
5	Length of laterals	30	m	
	(Maximum length of laterals)			
	# of laterals required	72		
6	Spacing	2	m	
	(Minimum distance between trenches)			
	Total width of field (assume one large area)	204.21	m	
	Total field area	6126.24	m^2	

References:

1 Environment Act (E125 - R.M. 83/2003), Table (Wastewater Effluent Application Rates for Trench-type and Total Area Disposal Fields)
2 Environment Act (E125 - R.M. 83/2003), Schedule A, Section 2(5)
3 Design and Installation Manual for Quick4 Chambers in Manitoba, Page 5
4 Design and Installation Manual for Quick4 Chambers in Manitoba, Page 9
5 Environment Act (E125 - R.M. 83/2003), Schedule A, Section 2(5)
6 Environment Act (E125 - R.M. 83/2003), Schedule A, Section 2(3)

Ref	Notes:			Output
	Total Area Field Using Pipe and Aggregate			
	Camp population	125		
	Water consumption	320	LPCD	
	Percent of water discharged through system	100%		
	Daily Volume (Q)	55000	L	
1	Application Rate	11.74	L/m^2/Day	
	(Based on assumption of clay soil in area)			
2	Safety Factor	2		
	(Safety factor for pipe and aggregate systems)			

$$\boxed{AreaofField = \frac{(DailyEffluentFlow)\times(SafetyFactor)}{ApplicationRate}}$$

	Area of field required	9369.68	m^2	
	Field Geometry			
	Assumed width of field	30	m	
	Length of field	312.32	m	

References:

1 Environment Act (E125 - R.M. 83/2003), Table (Wastewater Effluent Application Rates for Trench-type and Total Area Disposal Fields)

2 Environment Act (E125 - R.M. 83/2003), Schedule A, Section 2(6)

Ref	Notes:			Output
	Total Area Field Using a Chamber Design			
	Camp population	125		
	Water consumption	320	LPCD	
	Percent of water discharged through system	100%		
	Daily Volume (Q)	55000	L	
1	Application Rate	11.74	L/m^2/Day	
	(Based on assumption of clay soil in area)			
2	Safety Factor	1.5		
	(Safety factor for chamber systems)			

$$\boxed{AreaofField = \frac{(DailyEffluentFlow)\times(SafetyFactor)}{ApplicationRate}}$$

	Area of field required	7027.26	m^2	
	Field Geometry			
	Assumed width of field	30	m	
	Length of field	234.24	m	

References:

1 Environment Act (E125 - R.M. 83/2003), Table (Wastewater Effluent Application Rates for Trench-type and Total Area Disposal Fields)

2 Environment Act (E125 - R.M. 83/2003), Schedule A, Section 2(6)

Ref **Notes:** **Output**

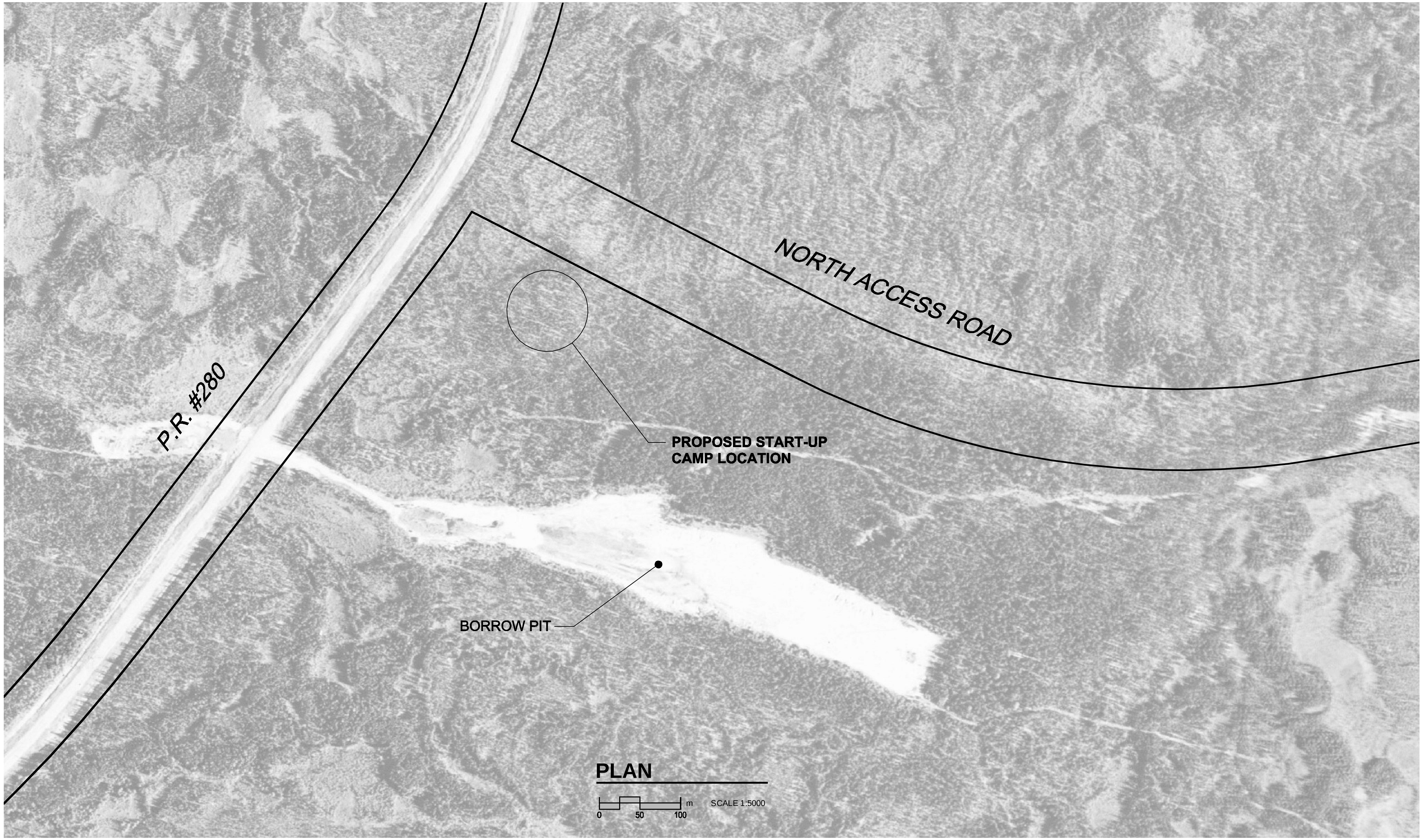
Summary:

Total field areas:

Pipe and aggregate trench system	**10,818**	m^2
Chamber trench system	**6,126**	m^2
Pipe and aggregate total area field	**9,370**	m^2
Chamber total area field	**7,027**	m^2

Therefore:

Chamber trench system will cover the least amount of total area

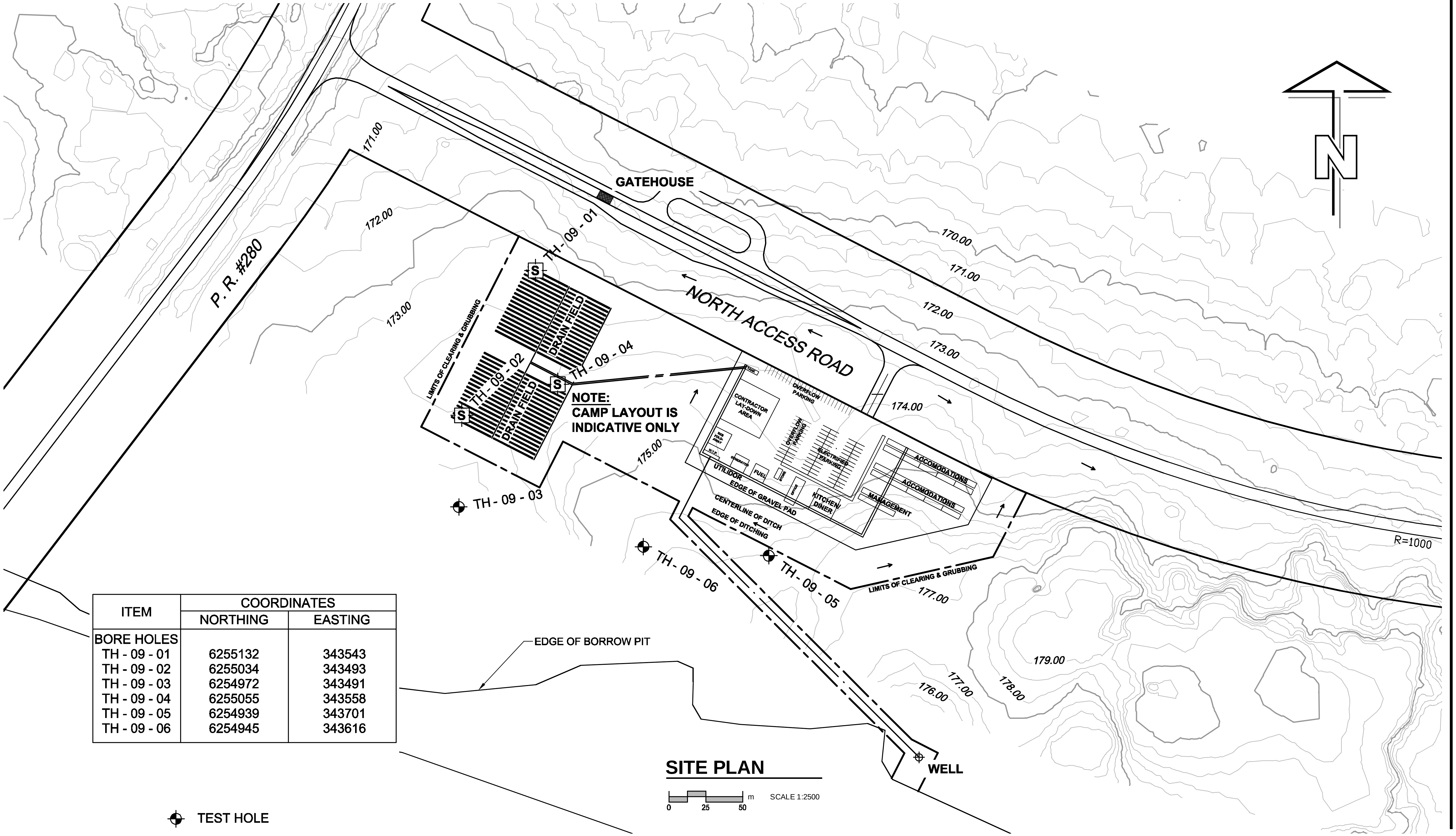


ISS/REV: A
AECOM FILE NAME: 0217-200-07_01-C-F001_RX.dwg Saved By: berardk PLOT: 7/27/2009 12:20:27 PM B SIZE 11" x 17" (279.4mm x 431.8mm)

Keeyask Generating Station - Infrastructure Eng
North Access Road Startup Camp - 243981-0100

AECOM

LOCATION PLAN
Figure 1



ITEM	COORDINATES	
	NORTHING	EASTING
BORE HOLES		
TH - 09 - 01	6255132	343543
TH - 09 - 02	6255034	343493
TH - 09 - 03	6254972	343491
TH - 09 - 04	6255055	343558
TH - 09 - 05	6254939	343701
TH - 09 - 06	6254945	343616

SITE PLAN

m 0 25 50 SCALE 1:2500

⊕ TEST HOLE

S STANDPIPE

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AECOM

TEST HOLE LOCATION PLAN

Figure 2

ISS/REV: A
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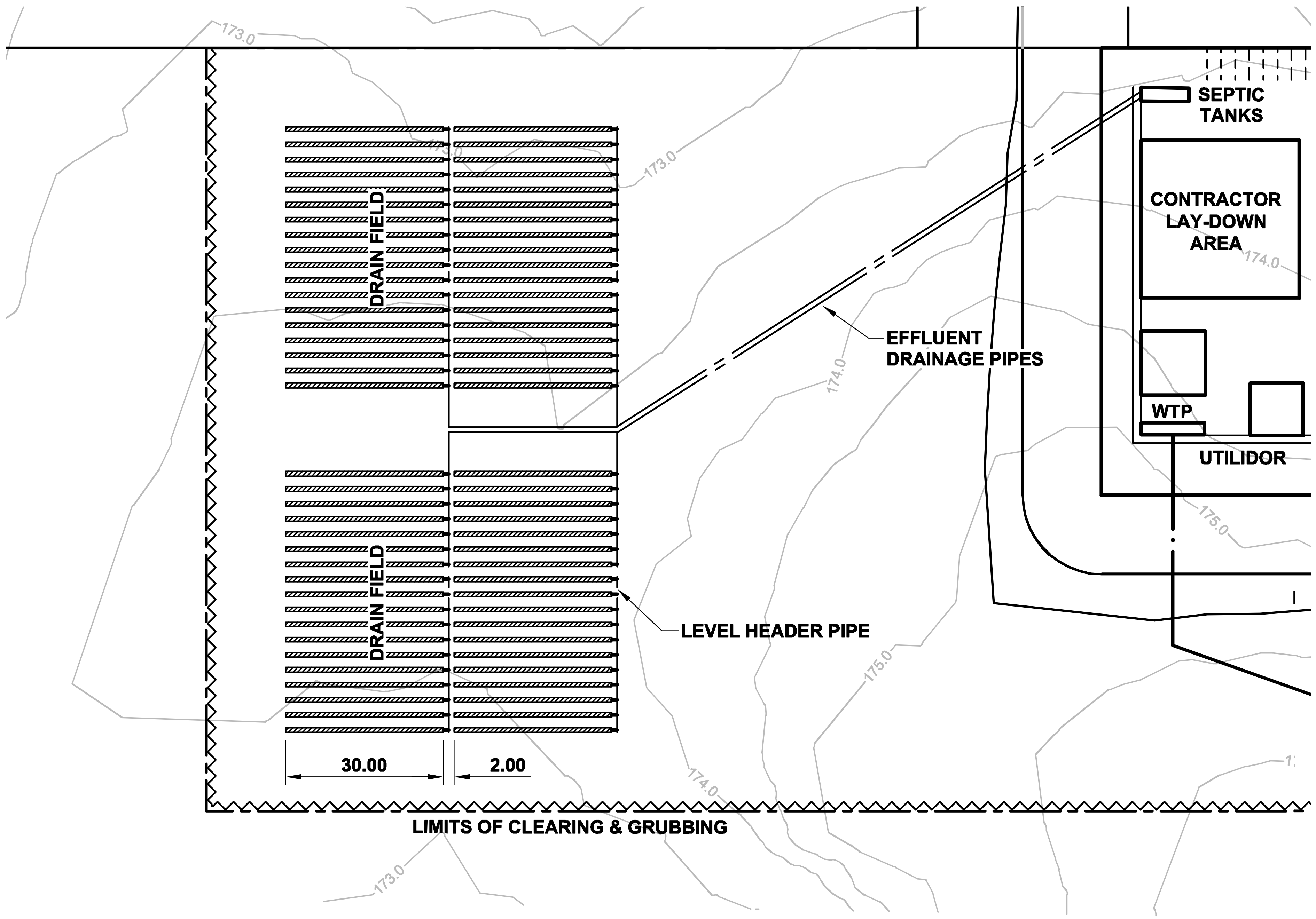
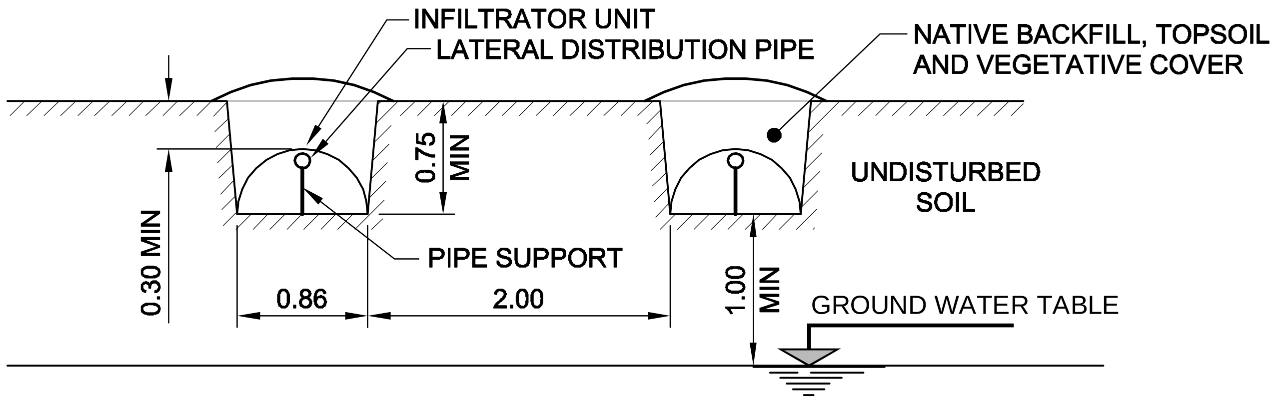


PLAN

0 10 20 m SCALE 1:1000



TYPICAL SECTION THROUGH FIELD

0 0.5 1 m SCALE 1:50

B SIZE 11" x 17" (279.4mm x 431.8mm)
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AECOM FILE NAME: 0217-200-07_01-C-F003_RX.dwg
ISS/REV: A

AECOM

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PROPOSED DRAIN FIELD LAYOUT
Figure 3

Appendix A2

Analysis of Alternatives

ROAD

Alignment of the proposed road involved a scoping process from selection of a preferred corridor based on a regional analysis to selection of a preferred alignment within the preferred corridor.

The regional analysis involved gathering information on the physiography, topography, geology, soils, and broad environmental constraints. Technical feasibility, life-cycle costs, distance to borrow sources and environmental factors were used in the analysis. The Gull Esker provided technical and cost benefits for a corridor and appeared to avoid sensitive areas.

Once a preferred corridor was selected, work began on selecting a preferred alignment within the corridor. There will be a 100-m right-of-way (ROW) for the road and the centreline will vary within the 100-m ROW zone. The selection process generally followed five steps.

The first step in this process involved the establishment of the North Access Road Route Selection Committee in July 2005 (described further in Section 4.1.1. of the main report), comprised of members of Manitoba Hydro and their consultants, along with representatives from the local potentially affected First Nation communities of Fox Lake Cree Nation, Tataskweyak Cree Nation, York Factory First Nation, War Lake Cree Nation and Manitoba Infrastructure and Transportation.

The second step involved the assessment of alternative routes based on a benefit/cost analysis and aerial photograph interpretation. In this analysis, two alternatives were developed along a common roadway alignment while a third alternative was developed along a different roadway alignment. Efforts were made to follow an existing winter trail route which already had received some disturbance.

The third step in the process involved field studies to evaluate the alternative alignments. Manitoba Hydro conducted a field program in the winter of 2007-08 for the purpose of collecting data for use in the detailed design stage of the proposed road. The field program involved analyses of the preferred road options using input from technical specialists (including over-flights and ground-based environmental investigations for potential routes) and consultation with the North Access Road Route Selection Committee. In addition, the Committee members were given the opportunity to fly over the proposed route and if necessary, suggest alternative alignments.

The fourth step in the process involved the development of constraint mapping on aspects such as fisheries, heritage resources potential, bird nesting and/or concentration areas, rare or uncommon habitat, wetlands and organic soils with excessive ice, potential bear dens, caribou calving, enduring physical features, etc., as well as maps of local First Nations' sensitivities such as resource harvesting trails and traplines. The output was used to identify environmental sensitivities within the proposed route alignments and to establish mitigation measures and/or alignment adjustments for protection of identified environmental considerations.

An analysis of the constraint mapping allowed for alignment adjustments to avoid sensitive areas. Integrated with the previous analyses, the process enabled the selection of a preferred alignment based on the following factors:

- Minimizing potential adverse effects to the environment;
- Remaining cost-effective and provide good technical potential for a safe route design; and
- Minimizing construction schedule risks.

A final step in the process was a series of public meetings in local First Nation communities (Bird, Gillam and Ilford) to present the road and gather feedback on the preferred route alignment. This is described in Section 4.1.1 of the main text.

The preferred alignment allows for borrow material for the road to be obtained from within the ROW instead of distant borrow pits. There is an existing borrow pit near the junction of PR 280 and the road, which may be used along with material from the G-3 deposit, but overall, material for the road will be taken from within the 100-m ROW.

START-UP CAMP WASTEWATER TREATMENT

As described in the Concept Design (Appendix A1), a range of alternatives was considered for sanitary wastewater disposal at the start-up camp, including hauling black water or sewage to Split Lake, Gillam or Thompson, a mechanical treatment plant, a holding tank with a drain or septic field, and a sewage lagoon. The alternatives were evaluated from monetary and non-monetary aspects, such as potential for disruption (bad weather, freezing conditions) and training requirements.

The wastewater lagoon at Split Lake is already overloaded. Hauling wastewater to Gillam or Thompson presents risk due to inclement weather, would be costly, and consume a large amount of fuel. A mechanical plant would require trained operators and an adsorption field, as there is no adequate receiving stream nearly the site.

A wastewater lagoon would be feasible but is high in cost. The septic tank/field option was identified as the preferred alternative for reasons of cost, relatively low risk, and reliability. Preliminary information on site conditions indicates that the soil is likely suitable for a disposal field and, accordingly, the septic tank/field option is planned. Further geotechnical investigations are underway to confirm the suitability of the soil conditions. In the event that this information does not confirm the appropriateness of this option, the alternatives of a mechanical plant with an adsorption field or hauling of the wastewater to Gillam will be proposed.

START-UP CAMP

The presence of an existing disturbed area near the beginning of the proposed road corridor provided the basis for selecting the start-up camp location. Conditions that favoured this location included distance from PR 280, raised elevation, presence of treed buffer area, proximity to a potential potable water source, and site drainage away from water source. A location away from PR 280, but close enough to allow ready access to this existing road was a major factor in site selection.

MAIN CAMP (PHASE ONE)

The location of the main camp for the proposed Keeyask GS project was determined relative to the location of the GS facilities, and considered access to the site and suitability of site conditions. Distance from the GS site was considered to be a critical factor in location. Favourable conditions also included relatively level land surface, foundation type, site drainage, avoidance of wetlands, proximity of granular sources, potable water supply and waste disposal opportunities.

STREAM CROSSING

Three main alternatives were considered for the crossing at Looking Back Creek. The alternatives included a multi-plate culvert, a bridge with abutments and a clear-span bridge. The preferred alternative was the clear-span bridge due to the minimal risk of adverse effects on fish and fish habitat, despite the comparatively higher cost. The selected crossing location was determined to be more favourable than upstream and downstream locations where the creek was either wider or not confined to a channel. No alternatives were considered for the crossing at the unnamed tributary, due to the low sensitivity of the site.

BORROW AREAS

Borrow areas, including granular sources, in the Local Study Area were identified from previous investigations by Manitoba Hydro along the Nelson River. From among the sources available, borrow areas for road construction, camp development and other infrastructure were selected based on their distance from the construction activity and characteristics of the borrow materials. From among a group that appeared to be economically feasible to use, environmental input was provided to determine sensitivities. In general it was decided to remain within the defined ROW as much as possible.

POTABLE WATER SUPPLY

Potable water supply alternatives for the start-up camp were to haul in water from Gillam or Thompson and to use local well water. Use of a proposed well in the vicinity of the start-up camp was preferred on the basis of cost, supply sustainability and environmental considerations.

Appendix A3

Contracts and Workforce Requirements

Table A.3-1 presents estimated peak Project workforce requirements by quarter and by occupation for the Project. These estimates could change when the Project is implemented depending on how the contractors choose to perform their work.

Table A.3-1 Estimated Keeyask Early Infrastructure Workforce Requirements by Occupations

Item	Labour	2009	2010				2011				2012		Quarterly Peak	Person Year
		Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2		
	NON-DESIGNATED TRADES (CONSTRUCTION, TRANSPORTATION AND INDUSTRIAL)													
1	Trade Helpers and Construction Labours	**7**	**7**	**7**	**7**	**10**	**8**	**15**	**21**	**18**	**14**	**12**	**21**	**25**
2	Driller / Blaster	**1**	**2**	**2**										**1**
3	Heavy Equipment Operator (excluding Crane Operators)	**8**	**10**	**21**	**21**	**30**	**20**	**22**	**23**	**10**	**5**	**3**	**23**	**35**
4	Teamster	**0**	**3**	**10**	**10**	**15**	**12**	**15**	**16**	**5**	**3**	**1**	**16**	**19**
	DESIGNATED TRADES (CONSTRUCTION, TRANSPORTATION AND INDUSTRIAL)													
5	Crane Operator	**0**	**0**					**1**	**1**	**1**	**1**	**1**	**1**	**1**
6	Mechanic	**1**	**1**	**1**	**1**	**1**		**1**	**1**	**1**	**1**	**1**	**1**	**2**
7	Carpenter	**0**	**0**	**1**	**1**	**1**	**1**	**5**	**6**	**6**	**5**	**4**	**6**	**6**
8	Painter									**2**	**2**	**2**		**1**
9	Cement Mason									**2**		**2**		**1**
10	Roofer								**2**	**2**	**2**		**2**	**1**
11	Insulator								**2**	**2**	**2**		**2**	**1**
12	Iron Worker (excluding Reinforcing Workers)	**0**	**0**											**0**
13	Electrician			**1**	**1**	**1**	**1**	**2**	**4**	**4**	**4**	**3**	**4**	**5**
14	Plumber			**1**	**1**	**1**	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**4**
15	Pipefitter							**2**	**2**	**2**	**2**		**2**	**2**
	CONSTRUCTION SUPPORT AND SERVICE TRADES													
16	Technical (Surveyors and Drafting)							**4**	**4**	**4**	**4**	**2**	**4**	**4**
17	Catering and Janitorial	**0**	**2**	**2**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**19**
18	Security				**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**9**
19	First Aid				**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**9**
20	Employee Retention Support				**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**4**
	CONTRACTOR SUPERVISORY													
21	Project Superintendent	**1**	**3**	**2**	**1**	**2**	**2**	**3**	**4**	**2**	**2**	**1**	**4**	**6**
	MANITOBA HYDRO SITE STAFF													
22	**Manitoba Hydro Site Staff**	**2**	**4**	**8**	**15**	**15**	**15**	**15**	**15**	**15**	**13**	**3**	**15**	**30**
	Infrastructure Project Estimated Workforce	**22**	**33**	**56**	**80**	**98**	**82**	**109**	**126**	**101**	**85**	**60**	**126**	**184**

APPENDIX B

ENVIRONMENTAL SETTING INFORMATION

Appendix B1

Aquatic Environment Information

Table B1-1: *In situ* Water Quality Parameters Measured at the Stream Crossing Sites

Location	Sample	Time	UTM (15V)		Total Depth	Ice Depth	Effective Depth[1]	Temperature	DO		
ID	Date		Northing	Easting	(m)	(m)	(m)	(°C)	(mg/L)	(% Saturation)	pH
Open-Water Season											
SC-1	17-Jun-03	10:40	361400	6250123				17.5	9.37	98	7.85
SC-1	14-Jul-03	13:10						18.6	7.87	84	7.94
SC-1	25-Aug-03	13:52						18.4	8.91	95	8
SC-1	30-Sep-03	14:19						4.8	12.38	100	8.01
SC-1	23-Jun-04	14:55	361830	6250384				11.8	12.3	114	7.89
SC-1	20-Jul-04	8:15	361699	6250276				17.2	3.64	38	7.66
SC-1	31-Aug-04	13:28	359942	6250140				10.4	9.54	86	7.73
SC-1	5-Oct-04	15:16						5.7	12.41	102	7.71
SC-1	16-May-05	9:30	360595	6250077	1.13			5.8	12.62	104	-
SC-2	17-Jun-03	11:00	345436	6254874				16.2	8.05	82	7.27
SC-2	14-Jul-03	13:32						18.7	6.28	67	7.14
SC-2	25-Aug-03	14:11						15.1	3.55	35	6.96
SC-2	30-Sep-03	14:38						4.4	9.32	75	6.82
SC-2	23-Jun-04	15:15	345771	6255326	0.23			7.8	11.82	102	7.61
SC-2	20-Jul-04	8:40						9.6	6.96	62	7.73
SC-2	31-Aug-04	13:44	345771	6255825	0.25			6.5	13.06	109	7.72
SC-2	5-Oct-04	15:30			0.33			2.2	14.22	109	7.1
SC-2	16-May-05	-	345689	6254940	0.38			4.6	9.25	75	7.71
Winter 2005											
SC-1	19-Mar-05	11:04	360550	6250031	1	1	0	-	-	-	-
SC-2[2]	19-Mar-05	10:34	345190	6254273	0.49	0.28	0.21	1.1	1.72	13	-

[1] Calculated. Effective depth = Total depth - Ice depth

[2] Sample site 1 km upstream of actual stream crossing site

Figure B1-1: Stream Crossing Aquatic Habitat Assessment Sheets

ROW Watercourse Crossing Description

Figure 1: Aerial view of Looking Back Creek with the crossing location indicated by the red line and the direction of flow by the white arrow.

Figures 2 and 3: Upstream view (left photo) and downstream view of Looking Back Creek, with the crossing location indicated by the red line and the direction of flow by the white arrow.

Keeyask Access Road
Stream Crossing Assessment

Location

UTM:	0360595 / 6250077 - NAD 83	**Watercourse Name:**	Looking Back Creek
Date:	7 October, 2004	**Site:**	SC – 1

Site Description

Stream Order:	3
Watershed Size:	124.7 km^2
Upstream of Crossing:	119.8 km^2
Regulated:	No
Channelized:	No
Channel Width:	7.4 m
Wetted Width:	7.4 m
Floodplain Width:	Right: 17 m, Left: 14 m
Maximum Depth:	0.8 m
Stage:	Moderate
Sign of flood above surveyed stage:	0.3 m
Valley Slope Gradient:	Left – 5% Right – 6%
Stream Gradient:	1%
Velocity:	0.31 m/sec
Discharge:	1.32 m^3/sec
Cover Type and Composition:	Total – 30% Over Veg. – 10% LOD – 30% Cutbank – 10% Boulder – 10% In. Veg. – 40%
Habitat Type:	Run – 100%
Bottom Contour:	Uniform
Substrate Type:	Fines – 90% Boulder – 10%
Substrate Compaction:	Moderate
Bank Unstable:	0%
Water Temperature:	3 °C
Turbidity:	7.1 NTU

Riparian Vegetation:	The creek lies within a relatively narrow, well-drained floodplain containing grasses and willows. The valley forest is composed of black spruce and jackpine with an understory of moss, shrubs, and forbs.
Aquatic Vegetation:	Yes
Unique Features:	n/a
Summary:	This crossing is located in the lower portion of the creek, approximately 4 km from Stephens Lake. Habitat in the creek consists primarily of run habitat less than 1 m deep, with some side channel pools. Small areas of gravel/cobble riffle occur further upstream from the crossing. The creek substrates are primarily fines with some boulder and cobble/gravel. The presence of beaver dams began 2 km upstream of the crossing, continuing upstream to the headwaters.

Fisheries Assessment

Capture Method:	Fall 2004 - Backpack Electrofishing, 1.5“ and 3.5” gillnet. Spring 2005 – Hoopnet, kicknet.
Species Present:	Fall 2004 - None. Spring 2005 – walleye, northern pike.
Life History Stage:	Fall 2004 - n/a Spring 2005 – pre-spawn and post-spawn adults. One northern pike egg.

Fisheries Assessment

Large-bodied Species[1]

Spawning:	Yes.
Migration:	Yes.
Rearing:	Yes.
Over-wintering:	Possibly.

Small-bodied Species[2]

Open-water Presence:	Yes.
Over-wintering:	Possibly.

Fish Use and Fish Habitat Summary

This creek provides good habitat for spring and summer spawning, foraging, and rearing for small and large-bodied species. Spawning habitat for walleye or suckers was not present at the crossing site. Vegetated areas of run habitat along the shorelines may be used by pike for spawning. Overwintering habitat may be present at the crossing site in some years but not in others. Habitats in the crossing area were common elsewhere in Looking Back Creek and no rare habitats were present (i.e. gravel riffles, deep off-current pools). Access to the creek from Stephens Lake was unimpeded by Beaver dams.

[1] For example: walleye, pike, suckers

[2] For example: sticklebacks, minnows

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Figure B1-1: Stream Crossing Aquatic Habitat Assessment Sheets

ROW Watercourse Crossing Description

Figure 1: Aerial view of Unnamed Creek with the crossing location indicated by the red line and the direction of flow by the white arrow.

Figures 2 and 3: Upstream view (left photo) and downstream view of Unnamed Creek at the crossing location.

Location

UTM:	0345689 / 6254940 - NAD 83
Date:	6 October, 2004
Watercourse Name:	Unnamed Tributary of the South Moswakot River
Site:	SC– 2

Site Description

Stream Order:	1
Watershed Size:	35.5 km^2
Upstream of Crossing:	4.0 km^2
Regulated:	No
Channelized:	No
Channel Width:	2.5 m
Wetted Width:	2.2 m
Floodplain Width:	Right: 8 m, Left: 8 m
Maximum Depth:	0.6 m
Stage:	Moderate
Sign of flood above surveyed stage:	n/a
Valley Slope Gradient:	Left – 12% Right – 10%
Stream Gradient:	1%
Velocity:	0.02 m/sec
Discharge:	0.02 m^3/sec
Cover Type and Composition:	Total – 60% Over Veg. – 50% LOD – 30% Cutbank – 10% In. Veg. – 10% Canopy Clos. – 80%
Habitat Type:	Pool – 100%
Bottom Contour:	Uniform
Substrate Type:	Fines – 100%
Substrate Compaction:	Low
Bank Unstable:	0%
Water Temperature:	1 °C
Turbidity:	1.5 NTU

Riparian Vegetation:	The creek lies within a relatively narrow, floodplain containing dense willow growth, sedges, grasses, and forbs. The valley forest is composed of black spruce with a moss understory. Further upstream and downstream of the crossing, the creek flows through a broad poorly drained floodplain.
Aquatic Vegetation:	Yes
Unique Features:	Approximately 50 m downstream of the crossing, a log ramp has been constructed to permit crossing the creek along a cut line.
Summary:	This small creek drains two small lakes prior to entering the South Moswakot River (approximately 10 km downstream of the crossing). The crossing is located approximately 1 km from the headwater of the creek. A small beaver dam immediately downstream of the crossing creates a small pool at the crossing site. Several side channels occur within the floodplain.

Fisheries Assessment

Capture Method:	Fall 2004 and Spring 2005- Backpack Electrofishing
Survey Length:	50 m
Species Present:	None.
Life History Stage:	n/a

Fisheries Assessment

Large-bodied Species[1]

Spawning:	No.
Migration:	No.
Rearing:	No.
Over-wintering:	No.

Small-bodied Species[2]

Open-water Presence:	Possibly.
Over-wintering:	No.

Fish Use and Fish Habitat Summary

If fish make use of this site it is likely restricted to spawning, foraging, and rearing during summer by small-bodied species such as brook stickleback and fathead minnow. Low DO levels or absence of water indicate that this habitat does not support fish in winter. The distance from over-wintering habitat and large number of beaver dams reduces the quality of habitat and the likelihood of fish use. Habitat in this creek at the crossing site is typical for this creek and others in the area.

Keeyask Access Road
Stream Crossing Assessment

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[1] For example: walleye, pike, suckers

[2] For example: sticklebacks, minnows

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AQUATIC ENVIRONMENT SPECIALISTS

Table B1-2: Presence of Aquatic Invertebrates From Kick Net Samples in Streams Along the Proposed Road

Crossing	SC-1			SC-2		
Site	**Crossing**	**Upstream**	**Downstream**	**Crossing**	**Upstream**	**Downstream**
Date	**07-Oct-04**	**07-Oct-04**	**07-Oct-04**	**06-Oct-04**	**06-Oct-04**	**06-Oct-04**
Annelida						
Oligochaeta	X	X	X	X	X	X
Hirudinea	X	X	X	X	X	-
Crustacea						
Ostracoda	X	X	-	X	X	X
Amphipoda	X	X	X	-	-	-
Arachnida						
Acarina	-	-	-	-	X	X
Mollusca						
Bivalvia						
Pisidiidae	X	X	X	X	-	X
Gastropoda						
Hydrobiidae	-	-	X	-	-	-
Lymnaeidae	-	-	X	-	-	-
Physidae	-	-	-	-	-	-
Planorbidae	X	X	X	-	-	-
Valvatidae	-	X	X	-	-	-
Entognatha						
Collembola (semi-aquatic)	-	-	-	X	X	X
Insecta						
Odonata						
Anisoptera						
Corduliidae	X	-	-	-	-	-
Zygoptera						
Aeshnidae	-	-	-	-	-	-
Coenagrionidae	-	-	X	-	-	-
Coleoptera						
Chrysomelidae (aquatic)	-	-	X	-	-	-
Chrysomelidae (semi-aquatic)	-	-	-	-	X	-
Dytiscidae	-	-	X	-	-	-
Elmidae	X	X	-	-	-	-
Haliplidae	-	X	X	-	-	-
Staphylinidae (semi-aquatic)	-	-	-	-	-	-
Hemiptera						
Corixidae	-	-	X	-	-	-
Ephemeroptera						
Baetidae	X	X	X	-	X	-
Caenidae	X	X	X	-	-	-
Ephemerellidae	-	X	X	-	-	-
Ephemeridae	X	X	X	-	-	-
Heptageniidae	X	-	-	-	-	-
Leptophlebiidae	X	X	X	X	X	X
Plecoptera						
Nemouridae	X	X	-	-	-	X
Perlodidae	X	-	-	-	-	-
Trichoptera						
Brachycentridae	-	-	-	-	-	X
Hydropsychidae	X	-	X	-	-	-
Hydroptilidae	X	X	X	-	-	-
Lepidostomatidae	X	X	X	-	X	-
Limnephilidae	X	X	X	-	X	-
Phryganeidae	X	-	-	-	X	-
Polycentropodidae	X	X	X	-	-	-
Diptera						
Ceratopogonidae	X	-	-	X	-	X
Chaoboridae	-	-	-	-	-	-
Chironomidae	X	X	X	X	X	X
Dixidae	-	-	-	-	-	-
Empididae	-	-	-	-	-	X
Simuliidae	X	X	X	-	-	-
Number of Invertebrate Taxa	**24**	**21**	**25**	**8**	**12**	**11**
Total for Stream Crossing		**33**			**17**	

Appendix B2

Terrestrial Ecosystems and Habitat Information

TERRESTRIAL HABITAT APPROACH AND METHODS

Terrestrial ecosystems and habitat can be classified into two major types, upland and wetland, based on dramatic differences in surface water, groundwater and the dominant disturbance regimes. Wetlands are land areas where groundwater, surface water and ice conditions and processes are the dominant influences on vegetation and soils. Wetland classes include bog, fen, swamp, marsh and shallow water (National Wetlands Working Group 1997). Bogs, fens and some swamps are peatlands. Uplands are all areas that are not wetlands. Large fires are the dominant disturbance type on uplands and the treed peatland types in the Regional Study Area (RSA). In the remaining wetland types, water and ice regimes are the dominant disturbance regimes.

HABITAT MAPPING

Mapping for the proposed Infrastructure Project environmental assessment focuses on the attributes that are generally important to the species of interest for the assessment as well as the other key topics such as wetland function. A mapped type is a combination of soils, vegetation, depth to groundwater, permafrost, topography and disturbance regime that is distinctly different from surrounding areas. The resulting maps are referred to as habitat maps due to the focus on habitat for plants and animals.

Terrestrial habitat was mapped at a scale of 1:15,000 for a 1,502 km^2 area surrounding the proposed Project (i.e., the Habitat Mapping Area; see Figure 3.4-1). Habitat attributes were photo-interpreted from black and white stereo photos taken on July 8, 2003 at a scale of 1:15,000, for most of the Habitat Mapping Area. Photos taken in 1999 at 1:20,000 scale, 1991 at 1:12,000 scale and 1986 at 1:20,000 scale were used where 2003 photo coverage was not available. Although map validation demonstrated that tamarack is underrepresented in the habitat mapping, the bias is lower than in the Forest Resource Inventory that existed for the southern portion of the Habitat Mapping Area.

Historical fire mapping was derived from a combination of sources including photo-interpretation, provincial fire history records, the federal large fire database, low altitude helicopter photos and Landsat 7 imagery *(ca.* 2000).

Habitat characterization data was collected in 201 plots located in the RSA during the summers of 2003, 2004, 2007 and 2008 (see Figure 1 for sample locations in the Local Study Area (LSA). These plots were located in a range of habitat types. Vegetation, soils, woody material, groundwater, permafrost, disturbance and other relevant environmental data were collected at each plot. Soil profiles in 136 additional locations were sampled during the summer of 2002.

ECOSYSTEM DIVERSITY AND HABITAT TYPES

Ecosystem diversity was measured as the number and relative amounts of habitat types. These measures were derived from the Habitat Mapping Area. Some habitat area percentages were scaled to the RSA for the assessment of some habitat effects that are evaluated on a percentage of area basis. A comparison of fire history, waterbody and small-scale surface materials mapping in the Habitat Mapping Area and the broader Regional Study Area suggested that habitat composition was similar. The assumption that the Habitat Mapping Area is representative of the Regional Study Area may not hold for very uncommon habitat types. This issue was addressed by showing that effects can generally be reduced below acceptable levels using the Habitat Mapping Area as the assessment region. Consequently, it was not necessary to assume that a similar percentage of these habitat types were found elsewhere in the larger region.

The common and several other habitat types were characterized based on the habitat characterization field data. A plant species was considered to be "characteristic" of a habitat type if it occurred in at least 75% of the plots sampled in that type and at least 15 plots were sampled.

Priority habitat types considered in the terrestrial habitat and ecosystem effects assessment were habitat types that are regionally rare and/or highly diverse. Priority habitat types were identified in three steps. First, similar broad habitat types were combined into generalized habitat types. Second, rare habitat types were identified by classifying a generalized habitat type as very uncommon if it covered less than 1.01% of Habitat Mapping Area land area, uncommon if it covered between 1.01 and 10% of the land area, and, common for the remaining types. Young regenerating burns were not considered for priority habitat types because they are an age class of other habitat types and because they are continually created by frequent large fires. In the third step, a generalized habitat type was classified as diverse if it typically includes a relatively high number of plant species and/or a relatively high degree of structural diversity. Typical species richness and structural diversity were determined from habitat characterization plots sampled in the RSA.

WETLAND FUNCTION

Given the limited scope of the proposed Project, potential changes to peatland composition, high-quality wetland composition and local hydrology are used as a proxy for potential effects on wetland function. In other words, if the proposed Project is expected to have little effect on these attributes then changes to wetland function are not expected.

High quality wetlands in the LSA were identified through two steps. First, wetlands in the Habitat Mapping Area were extracted from the terrestrial habitat map. Second, for the LSA, low level helicopter photos were used to select the high quality wetlands and wetlands that were too small to appear in the habitat map. The second step was not completed for the Habitat Mapping Area outside of the LSA given the level of effort required relative to anticipated potential Project effects.

Most carbon is stored in the soil in northern terrestrial ecosystems (Robinson and Moore 1999; Vardy *et al.* 2000). Given the limited scope of the proposed Project, potential effects on carbon cycling are assessed by estimating changes to total peatland area by peatland type. These measures are a proxy for total peatland soil organic matter.

PLANTS

Plant species nomenclature follows Flora of North America (Flora of North America Editorial Committee 1993+) where volumes currently exist for the genus and the Manitoba Conservation Data Centre elsewhere. Priority plant species in this assessment are those that are rare, near a range limit, invasive or non-native. Rare, invasive and non-native plant surveys were conducted in 2004 and 2008 (Figure B2-1 in Appendix B2). Habitat characterization plots provided supplemental rare, invasive and non-native plant location data. Some species of conservation concern may be present but undetected in the LSA. A list of rare plant species that may occur in the LSA was generated based on species found in all of the RSA sample locations.

FRAGMENTATION

Human linear features have a number of potential effects on ecosystem functions and landscape flows. Linear features convert habitat into other types, fragment habitat, act as a conduit, filter, source and/or sink for species and create edge which reduces habitat for interior species. Linear features serve as a conduit when they increase predation or facilitate the expansion of invasive plant species, among other things. Linear features that act as filters reduce connectivity, which affects genetic interchange. A road functions as a sink when crossing animals are killed by vehicles. These are only a few examples that illustrate the ecological functions of linear features.

Fragmentation essentially refers to the extent to which an area is broken up into smaller areas by human features and how easy is it for animals, plant propagules and other ecological flows such as surface water to move from one area to another area. Road density (i.e., km of roads per km^2 of study area) can be a good synthetic indicator of the extent of fragmentation effects on plant and animal populations (Forman 1995). Among other things, increasing road density improves access which can lead to increased resource harvesting, habitat disturbance and fire frequency. Non-linear human features that contribute to fragmentation (e.g., communities) are usually located along roads in the north.

Road density in the Habitat Mapping Area was used a synthetic indicator of fragmentation. All weather roads were mapped from the same stereo photos that were used for the habitat mapping.

Past studies that have used benchmarks for road density effects have used values estimated for grizzly bears from field data. Grizzly bears are considered to be one of the North American species that is most sensitive to roads (AXYS 2001). If the grizzly bear is the most sensitive species, then the grizzly bear benchmark should be a cautious benchmark for other species. Road densities below 0.16 km/km^2 are not expected to affect grizzly bears (AXYS 2001).

Table B2.2-1: Soil Order for Soil Sample Locations in the Habitat Mapping Area

Soil Order	N	Percentage of Locations
Non-soil (outcrop)	6	0.6
Brunisolic	91	9.8
Cryosolic	241	26.0
Gleysolic	56	6.0
Luvisolic	13	1.4
Organic	442	47.7
Regosolic	77	8.3
All	926	100.0

Table B2-2: Ecosite Composition of the Project Study Areas as a Percentage of Total Land Area (%(ha))[1]

Ecosite	Project Footprint				LSA (includes Project Footprint)	Region[2]
	Borrow Area Zones	Infra-structure	Road	All		
Bedrock outcrop						0 (*36*)
Thin mineral					0 (*26*)	0 (*454*)
Moderately deep mineral						0 (*280*)
Deep mineral	18 (*211*)	26 (*90*)	14 (*33*)	19 (*334*)	15 (*1,146*)	10 (*10,374*)
Thin, wet peat	1 (*14*)	0 (*1*)	0 (*0*)	1 (*16*)	1 (*47*)	1 (*1,451*)
Veneer bog	39 (*454*)	48 (*166*)	47 (*109*)	41 (*729*)	32 (*2,432*)	39 (*41,701*)
Blanket peatland	17 (*203*)	5 (*18*)	27 (*63*)	16 (*284*)	24 (*1,812*)	26 (*28,433*)
Peat plateau bog	0 (*3*)	0 (*0*)		0 (*4*)	0 (*25*)	0 (*419*)
Peat plateau bog/ collapse scar mosaic	13 (*152*)	15 (*53*)	11 (*25*)	13 (*230*)	16 (*1,231*)	11 (*11,567*)
Peat plateau bog forming or disintegrating	5 (*54*)	1 (*4*)	1 (*3*)	3 (*61*)	6 (*429*)	5 (*5,238*)
Collapse scar					0 (*4*)	0 (*160*)
Wet, deep peat	0 (*1*)	0 (*0*)	0 (*0*)	0 (*1*)	0 (*32*)	1 (*883*)
Horizontal peatland	2 (*26*)	1 (*3*)		2 (*29*)	2 (*152*)	3 (*3,457*)
Aquatic peatland	4 (*47*)	2 (*8*)	0 (*0*)	3 (*55*)	4 (*293*)	3 (*3,533*)
Human	1 (*10*)	1 (*5*)	0 (*1*)	1 (*16*)	0 (*34*)	0 (*172*)
Total Land Area (ha)	***100 (1,176)***	***100 (347)***	***100 (234)***	***100 (1,758)***	***100 (7,664)***	***100 (108,162)***

[1] A value of 0 indicates a percentage that rounds to 0; a blank indicates that the type is absent.

[2] Reported values are calculated from the Habitat Mapping Area. Regional Study Area expected to have similar percentages.

Table B2-3: Project Study Areas for Terrestrial Ecosystems and Habitat

Study Area	Footprint	Feature	Size (ha)		
			Project Footprint	Indirect Habitat Effects Zone (i.e., 150 m buffer of Project Footprint) and Direct Project Effects in this Zone	Total
Land and Water Area					
Project Areas					
	Road	100 m Right-Of-Way	234	380	614
	Borrow Zone	G-1	871	203	1,014
	Borrow Zone	G-5	313	109	422
	Infrastructure	Start-up Camp	30	23	53
	Infrastructure	Main Camp (Phase One)	317	115	432
	All of the above		*1,765*	*830*	*2,595*
	Indirect Ecosystem and Other Direct Project Effects		n/a	5,273	5,273
	All of the above[1]		*1,765*	*6,103*	*7,868*
Local Study Area[2]					7,868
Habitat Mapping Area					150,198
Regional Study Area					14,000,000
Land Area					
Project Areas					
	Road	100 m Right-Of-Way	234	376	610
	Borrow Zone	G-1	863	201	1,064
	Borrow Zone	G-5	312	109	421
	Infrastructure	Start-up Camp	30	23	53
	Infrastructure	Main Camp (Phase One)	317	115	432
	All of the above		*1,756*	*824*	*2,581*
	Indirect Ecosystem and Other Direct Project Effects		n/a	5,083	5,083
	All of the above[1]		*1,756*	*5,907*	*7,664*
Local Study Area[2]					7,664
Habitat Mapping Area					108,162
Regional Study Area					10,080,000

[1] Total area for all project footprints is the Local Study Area.

[2] Total area of project footprints and Indirect Habitat Effects Zone and Other Direct Project Effects

Table B2-4: Land Cover Composition of the Project Study Areas as a Percentage of Total Land Area (%(ha))[1]

Land Cover	Project Footprint				LSA (includes Project Footprint)	Region[2]
	Borrow Area Zones	Infra-structure	Road	All		
Broadleaf Treed on Mineral Soil	1 (*8*)	2 (*8*)		1 (*17*)	0 (*33*)	0 (*395*)
Broadleaf Treed on Peatland	0 (*2*)			0 (*2*)	0 (*5*)	0 (*95*)
Needleleaf Treed on Mineral Soil	6 (*73*)	16 (*55*)	7 (*17*)	8 (*145*)	8 (*580*)	8 (*8,859*)
Needleleaf Treed on Peatland	24 (*288*)	12 (*43*)	37 (*87*)	24 (*418*)	35 (*2,667*)	67 (*72,327*)
Tall Shrub or Low Vegetation on Mineral Soil	1 (*11*)	2 (*7*)	0 (*1*)	1 (*19*)	1 (*44*)	1 (*1,138*)
Tall Shrub or Low Vegetation on Peatland	13 (*153*)	4 (*13*)	3 (*8*)	10 (*174*)	14 (*1,102*)	16 (*16,948*)
Outcrop						0 (*36*)
Regenerating Recent Burn on Mineral Soil	10 (*118*)	6 (*20*)	7 (*16*)	9 (*154*)	7 (*515*)	1 (*716*)
Regenerating Recent Burn on Peatland	44 (*512*)	57 (*197*)	45 (*105*)	46 (*814*)	35 (*2,684*)	7 (*7,477*)
Human Features	1 (*10*)	1 (*5*)	0 (*1*)	1 (*16*)	0 (*34*)	0 (*170*)
Total Land Area (ha)	***100 (1,176)***	***100 (347)***	***100 (234)***	***100 (1,758)***	***100 (7,664)***	***100 (108,162)***

[1] A value of 0 indicates a percentage that rounds to 0; a blank indicates that the type is absent.

[2] Reported values are calculated from the Habitat Mapping Area. Regional Study Area expected to have similar percentages.

Table B2-5: Vegetation Structure Composition of the Project Study Areas as a Percentage of Total Vegetated Area (%(ha))[1]

Vegetation Structure	Project Footprint				LSA (includes Project Footprint)	Region[2]
	Borrow Area Zones	Infra-structure	Road	All		
Forest	12 (*140*)	17 (*59*)	12 (*29*)	13 (*227*)	12 (*945*)	16 (*17,106*)
Forest/ Tall Shrub	0 (*0*)			0 (*0*)	0 (*1*)	0 (*28*)
Woodland	12 (*134*)	9 (*31*)	18 (*41*)	12 (*206*)	15 (*1,140*)	27 (*29,396*)
Woodland/ Tall Shrub	0 (*0*)		0 (*0*)	0 (*0*)	0 (*3*)	0 (*109*)
Woodland & Sparsely Treed Mixture	2 (*22*)	0 (*0*)	5 (*11*)	2 (*33*)	7 (*513*)	21 (*22,468*)
Woodland & Sparsely Treed Mixture/ Tall Shrub						0 (*63*)
Sparsely Treed	6 (*68*)	4 (*12*)	10 (*23*)	6 (*103*)	8 (*640*)	11 (*11,963*)
Sparsely Treed/ Tall Shrub	0 (*4*)	1 (*4*)	0 (*0*)	0 (*8*)	0 (*21*)	0 (*252*)
Tall Shrub	1 (*17*)	0 (*1*)	0 (*1*)	1 (*19*)	1 (*85*)	1 (*931*)
Low Vegetation	13 (*147*)	5 (*19*)	3 (*8*)	10 (*173*)	14 (*1,062*)	16 (*17,171*)
Regenerating Recent Burn	54 (*630*)	63 (*216*)	52 (*121*)	56 (*967*)	42 (*3,199*)	8 (*8,194*)
Total Area (ha)	***100 (1,166)***	***100 (343)***	***100 (234)***	***100 (1,742)***	***100 (7,630)***	***100 (107,990)***

[1] A value of 0 indicates a percentage that rounds to 0; a blank indicates that the type is absent.

[2] Reported values are calculated from the Habitat Mapping Area. Regional Study Area expected to have similar percentages.

Table B2-6: Broad Habitat Composition of the Project Study Areas as a Percentage of Total Land Area (%(ha))[1]

Broad Habitat Type[3]	Project Footprint				LSA (includes Project Footprint)	Region[2]
	Borrow Area Zones	Infra-structure	Road	All		
TA Mixture on Mineral Soil	0 (*3*)	1 (*5*)		0 (*8*)	0 (*9*)	0 (*119*)
TA Mixedwood on Mineral Soil	0 (*2*)	1 (*3*)		0 (*5*)	0 (*18*)	0 (*210*)
JP Pure on Mineral Soil	1 (*17*)			1 (*17*)	0 (*35*)	0 (*342*)
JP Pure on Peatland	1 (*8*)			0 (*8*)	0 (*10*)	0 (*51*)
JP Mixture on Mineral Soil	1 (*17*)		3 (*7*)	1 (*24*)	2 (*138*)	0 (*418*)
JP Mixture on Peatland	0 (*5*)		2 (*4*)	0 (*8*)	0 (*32*)	0 (*202*)
JP Mixedwood on Mineral Soil	0 (*6*)			0 (*6*)	1 (*70*)	0 (*92*)
BS Pure on Mineral Soil	3 (*29*)	13 (*44*)	3 (*8*)	5 (*82*)	3 (*267*)	6 (*6,716*)
BS Mixture on Mineral Soil		3 (*11*)	1 (*2*)	1 (*12*)	1 (*44*)	1 (*845*)
BS Mixedwood on Mineral Soil	0 (*4*)			0 (*4*)	0 (*24*)	0 (*307*)
BS Pure on Peatland	21 (*252*)	11 (*39*)	32 (*75*)	21 (*367*)	33 (*2,506*)	64 (*68,899*)
BS Pure/ Tall Shrub on Peatland	0 (*4*)	1 (*4*)	0 (*0*)	0 (*8*)	0 (*24*)	0 (*381*)
BS Mixture on Peatland	1 (*16*)	0 (*0*)	4 (*9*)	1 (*25*)	1 (*67*)	1 (*1,427*)
TL Pure on Peatland					0 (*0*)	0 (*150*)
TL Mixture on Peatland	0 (*1*)			0 (*1*)	0 (*13*)	1 (*1,093*)
Tall Shrub on Peatland	1 (*17*)	0 (*1*)	0 (*1*)	1 (*19*)	1 (*85*)	1 (*898*)
Low Vegetation on Mineral Soil	1 (*11*)	2 (*7*)	0 (*1*)	1 (*19*)	1 (*44*)	1 (*1,105*)
Low Vegetation on Peatland	12 (*136*)	3 (*12*)	3 (*7*)	9 (*154*)	13 (*1,017*)	15 (*16,050*)
Regenerating Recent Burn on Mineral Soil	10 (*118*)	6 (*20*)	7 (*16*)	9 (*154*)	7 (*515*)	1 (*716*)
Regenerating Recent Burn on Peatland	44 (*512*)	57 (*197*)	45 (*105*)	46 (*814*)	35 (*2,684*)	7 (*7,477*)
Human Features	1 (*10*)	1 (*5*)	0 (*1*)	1 (*16*)	0 (*34*)	0 (*170*)
Total Area (ha)	***100 (1,176)***	***100 (347)***	***100 (234)***	***100 (1,758)***	***100 (7,664)***	***100 (108,162)***

[1] A value of 0 indicates a percentage that rounds to 0; a blank indicates that the type is absent.

[2] Reported values are calculated from the Habitat Mapping Area. Regional Study Area expected to have similar percentages.

[3] Not all broad habitat types are included. See Table B2-2 for priority habitat types with less than 50 ha total area in the Habitat Mapping Area. TA=trembling aspen; JP=jack pine; BS=black spruce; TL=tamarack.

Table B2-7: Forest Composition of the Project Study Areas as a Percentage of Total Forested Area[1]

Broad Habitat Type[3]	Project Footprint				LSA (includes Project Footprint)	Region[2]
	Borrow Area Zones	Infra-structure	Road	All		
TA Mixedwood on Mineral Soil	1 (*1*)	5 (*3*)		2 (*4*)	2 (*15*)	1 (*177*)
TA Mixture on Mineral Soil	2 (*3*)	8 (*5*)		3 (*8*)	1 (*8*)	1 (*110*)
JP Mixedwood on Mineral Soil	3 (*5*)			2 (*5*)	5 (*45*)	0 (*56*)
JP Mixture on Mineral Soil	9 (*12*)		21 (*6*)	8 (*18*)	11 (*100*)	1 (*248*)
JP Pure on Mineral Soil	1 (*1*)			1 (*1*)	1 (*9*)	0 (*59*)
JP Mixture on Peatland	1 (*2*)		9 (*2*)	2 (*4*)	2 (*18*)	1 (*90*)
BS Mixedwood on Mineral Soil	1 (*1*)			0 (*1*)	2 (*16*)	1 (*235*)
BS Mixture on Mineral Soil					0 (*1*)	0 (*1*)
BS Pure on Mineral Soil	15 (*21*)	62 (*36*)	22 (*6*)	28 (*63*)	19 (*182*)	26 (*4,404*)
BS Mixture on Peatland	9 (*12*)		13 (*4*)	7 (*16*)	4 (*39*)	5 (*924*)
BS Pure on Peatland	54 (*76*)	16 (*9*)	33 (*9*)	41 (*94*)	49 (*465*)	55 (*9,429*)
TL Mixture on Mineral Soil						0 (*61*)
TL Mixture on Peatland	0 (*1*)			0 (*1*)	0 (*2*)	3 (*461*)
Total Area (ha)	***100 (140)***	***100 (59)***	***100 (29)***	***100 (227)***	***100 (945)***	***100 (17,134)***

[1] A value of 0 indicates a percentage that rounds to 0; a blank indicates that the type is absent.

[2] Reported values are calculated from the Habitat Mapping Area. Regional Study Area expected to have similar percentages.

[3] TA=trembling aspen; JP=jack pine; BS=black spruce; TL=tamarack.

Table B2-8: Priority Habitat Types

Area and Percentage of Total Land Area[1] in the Study Areas

Priority Habitat Type	Abundance[3]	Region[2] Area (ha)	Area in Project Areas as Percentages of Region Area (ha in parentheses)	
			Project Footprint	LSA (includes Project Footprint)
Balsam poplar on all soils	V	*2*		50 (*1*)
Trembling aspen on all soils	V	*427*	4 (*16*)	8 (*32*)
White birch on all soils	V	*63*	4 (*3*)	7 (*4*)
Jack pine on outcrop	V	*11*		
Jack pine on mineral soils	V	*851*	5 (*47*)	29 (*244*)
Jack pine on peatlands	V	*265*	6 (*17*)	20 (*52*)
Black spruce mixedwood on mineral soils	V	*307*	1 (*4*)	8 (*24*)
Black spruce mixedwood on peatlands	V	*49*		10 (*5*)
Black spruce mixture on mineral soils	V	*854*	1 (*12*)	5 (*44*)
Black spruce mixture/ tall shrub on peatlands	V	*16*		
Black spruce on outcrop	V	*8*		
Black spruce, non-tamarack mixture on peatlands	V	*148*	8 (*13*)	15 (*22*)
Tamarack mixedwood on peatlands	V	*1*		
Tamarack mixture on mineral soils^	V	*93*		
Tamarack pure on mineral soils	V	*38*		
Tamarack pure on peatlands	V	*150*		0 (*0*)
Tamarack/ tall shrub on peatlands	V	*21*		
Tall shrub on mineral soils	V	*34*		
Tall shrub on peatlands	V	*898*	2 (*19*)	9 (*85*)
Low vegetation on aquatic peatlands in runnels	V	*810*	2 (*14*)	3 (*28*)
Low vegetation on collapse scar	V	*148*		3 (*4*)
Low vegetation on deep wet peat	V	*94*	0 (*0*)	1 (*1*)
Low vegetation on depressional aquatic peatlands	V	*429*	0 (*2*)	12 (*53*)
Low vegetation on depressional horizontal peatlands	V	*945*	1 (*10*)	10 (*91*)
Low vegetation on horizontal peatlands except depressions	V	*275*	1 (*4*)	2 (*7*)
Low vegetation on level aquatic peatlands	V	*852*	1 (*5*)	10 (*88*)
Low vegetation on outcrop	V	*16*		
Low vegetation on thin wet peat	V	*167*	1 (*1*)	3 (*5*)
Black spruce pure on mineral soils	U	*6,716*	1 (*82*)	4 (*267*)
Black spruce, tamarack mixture on peatlands^	U	*1,663*	1 (*21*)	4 (*69*)
Tamarack mixture on peatlands^	U	*1,115*	0 (*1*)	1 (*13*)
Low vegetation on depressional transition PPB	U	*1,770*	1 (*19*)	11 (*190*)
Low vegetation on remaining peatlands	U	*10,272*	1 (*91*)	5 (*533*)

[1] A value of 0 indicates a percentage that rounds to 0; a blank indicates that the type is absent.

[2] Reported values are calculated from the Habitat Mapping Area.

[3] Abundance: V= very uncommon- covers <= 1% of Sub-region land area; U= uncommon- covers >1% and <= 10% of Habitat Mapping Area.

Table B2-9: Wetland Composition of the Study Areas as a Percentage of Total Land Area (%(ha))[1]						
Wetland Type	**Project Footprint**				**LSA (includes Project Footprint)**	**Region**[2]
	Borrow Areas	**Infra-structure**	**Road**	**All**		
Trembling aspen Mixedwood on Peatland					0 (*5*)	0 (*5*)
Trembling aspen Mixture on Peatland					0 (*5*)	0 (*5*)
Trembling aspen Pure on Peatland	0 (*0*)				0 (*0*)	0 (*0*)
Trembling aspen Mixedwood/ Tall shrub on Peatland					0 (*1*)	0 (*1*)
Trembling aspen Mixture/ Tall shrub on Peatland					0 (*2*)	0 (*2*)
Jack pine Mixedwood on Peatland	1 (*1*)			0 (*1*)		0 (*2*)
Jack pine Mixture on Peatland	0 (*0*)				0 (*0*)	0 (*0*)
Jack pine Pure on Peatland					0 (*0*)	0 (*0*)
Black spruce Mixedwood on Peatland				0 (*1*)	0 (*4*)	0 (*5*)
Black spruce Mixture on Peatland	0 (*0*)		7 (*0*)	2 (*7*)	3 (*149*)	3 (*156*)
Black spruce Mixture/ Tall shrub on Peatland					0 (*12*)	0 (*12*)
Tamarack Mixture on Peatland	0 (*0*)			2 (*5*)	8 (*361*)	7 (*367*)
Tamarack Mixture/ Tall shrub on Peatland				0 (*0*)	0 (*19*)	0 (*19*)
Tamarack Pure on Peatland				0 (*0*)	2 (*83*)	2 (*83*)
Tamarack Pure/ Tall shrub on Peatland					0 (*15*)	0 (*15*)
Tall shrubs on Peatland	16 (*12*)	9 (1)	14 (*0*)	15 (*44*)	14 (*622*)	14 (*679*)
Low vegetation on Peatland	42 (*31*)	49 (5)	10 (*0*)	79 (*238*)	72 (*3,313*)	72 (*3,587*)
Marsh and Other	40 (*30*)	42 (4)	70 (*0*)	2 (*5*)		1 (*40*)
Total Area (ha)	***100 (74)***	***100 (10)***	***100 (1)***	***100 (302)***	***100 (4,592)***	***100 (4,979)***

[1] A value of 0 indicates a percentage that rounds to 0; a blank indicates that the type is absent.

[2] Reported values are calculated from the Habitat Mapping Area. Regional Study Area expected to have similar percentages.

Table B2-10: Priority Plant Species Found During Field Studies

Species		S-Rank	Number of locations		Total
Common Name	Scientific Name*		Local Study Area	Habitat Mapping Area	
Rare to Uncommon Species					
Oblong-leaved sundew	*Drosera anglica*	S3		3	3
Hairy butterwort	*Pinguicula villosa*	S3S4	10	22	32
Shrubby willow	*Salix arbusculoides*	S3		12	12
Rock willow	*Salix vestita*	S3		4	4
Range Limit Species					
Twining honeysuckle	*Lonicera dioica*	S5	1	0	1
Ground-pine	*Lycopodium dendroideum*	S5	1	0	1
Tufted bulrush	*Scirpus cespitosus*	S4	1	2	3
Hairy goldenrod	*Solidago hispida*	S5	2	7	9
All			15	50	65

*See Table B2-15 for full nomenclature.

Table B2-11: Invasive and Non-native Plant Species Found During Field Studies			
Species		**No. Locations**	**Invasive**
Common Name	**Scientific Name**		
Ox-eye Daisy	*Chrysanthemum leucanthemum*	1	
Narrow-leaved hawks-beard	*Crepis tectorum*	1	
Wild barley	*Hordeum jubatum*	2	
Reed canary grass	*Phalaris arundinacea*	1	yes
Common plantain	*Plantago major*	1	
Common dandelion	*Taraxacum officinale*	3	
All		9	

Table B2-12: Project Footprint and Indirect Habitat Effects as Percentages of Regional Study Area

Project/Study Area	Project Footprint (%)	Indirect and Other Direct Habitat Effects (%)	Total (%)
Road	0.02	0.03	0.06
Start-up Camp	0.00	0.00	0.00
Main Camp (Phase One)	0.03	0.01	0.04
Borrow G-1 Refined	0.01		0.01
Borrow G-5 Refined	0.00		0.00
Definite Project Footprints (sum of above areas)	0.07	0.05	0.12
Borrow Zone G-1 Outside Refined Area	0.07	0.02	0.08
Borrow Zone G-5 Outside Refined Area	0.03	0.01	0.04
Project Footprint (sum of above areas)	0.16	0.08	0.24
Local Study Area not including Project Footprint		0.47	0.47
Total % of Area	0.16	0.55	0.71

Table B2-13: Priority Habitat Types – Percentage and Area (*ha*) in the Project Areas Before and After Mitigation

Priority Habitat Type	Area (ha) in Habitat Mapping Area	Percentage and Area of Habitat Mapping Land Area* Affected Before Mitigation (%(ha))			Percentage and Area (*ha*) of Habitat Mapping Area[1] Affected After Mitigation[2]
		Project Footprint[2]	Potential Indirect Habitat and Other Direct Effects (150 m buffer)	Total	
Balsam poplar on all soils	*2*				
Trembling aspen on all soils*	*427*	4 (*16*)	1 (*3*)	4 (*19*)	2 (*10*)
White birch on all soils	*63*	5 (*3*)		5 (*3*)	3 (*2*)
Jack pine on outcrop	*11*				
Jack pine on mineral soils*	*851*	6 (*47*)	5 (*45*)	11 (*92*)	3 (*26*)
Jack pine on peatlands	*265*	6 (*17*)	6 (*15*)	12 (*32*)	2 (*5*)
Black spruce on outcrop	*8*				
Black spruce mixedwood on mineral soils	*307*	1 (*4*)	3 (*10*)	5 (*14*)	
Black spruce mixture on mineral soils	*854*	1 (*12*)	1 (*7*)	2 (*19*)	1 (*12*)
Black spruce mixedwood on peatlands	*49*		4 (*2*)	4 (*2*)	
Black spruce, non-tamarack mixture on peatlands	*148*	9 (*13*)	1 (*1*)	9 (*14*)	
Black spruce mixture/ tall shrub on peatlands	*16*				
Tamarack mixture on mineral soils	*93*				
Tamarack pure on mineral soils	*38*				
Tamarack mixedwood on peatlands	*1*				
Tamarack pure on peatlands	*150*				
Tamarack/ tall shrub on peatlands	*21*				
Tall shrub on mineral soils	*33*				
Tall shrub on peatlands	*895*	2 (*19*)	1 (*13*)	4 (*32*)	0 (*2*)
Low vegetation on outcrop	*16*				
Low vegetation on thin wet peat	*167*	1 (*1*)	1 (*1*)	1 (*2*)	
Low vegetation on deep wet peat	*94*				
Low vegetation on transition PPB in other topography	*284*	3 (*8*)	1 (*2*)	4 (*10*)	1 (*4*)
Low vegetation on collapse scar	*148*				
Low vegetation on depressional horizontal peatlands	*945*	1 (*10*)	0 (*3*)	1 (*13*)	
Low vegetation on horizontal peatlands except depressions	*275*	1 (*4*)	0 (*1*)	2 (*5*)	
Low vegetation on depressional aquatic peatlands	*429*	0 (*2*)	1 (*5*)	2 (*7*)	
Low vegetation on level aquatic peatlands	*847*	1 (*5*)	0 (*4*)	1 (*9*)	
Low vegetation on aquatic peatlands in other topography	*5*				
Low vegetation on aquatic peatlands in runnels	*810*	2 (*14*)	0 (*2*)	2 (*16*)	1 (*6*)

[1] A value of 0 indicates a percentage that rounds to 0; a blank indicates that the type is absent.

[2] Includes all of the borrow area zones.

* A habitat type that also generally also has high plant species diversity.

Table B2-14: Peatland Area in the Project Footprint as a Percentage of the Regional Study Area		
Project Component/Effect	**Percentage of RSA**	**Area (ha)**
Road	0.02	200
Camps	0.03	253
Borrow Area Zones	0.10	955
Road- Indirect Habitat Effects	0.03	272
Infrastructure- Indirect Habitat Effects	0.01	118
Borrow- Indirect Habitat Effects	0.03	281
Total	0.21	2,079

Table B2-15: Plant Species Found During Field Studies

Scientific Name*	Common Name	CDC S-Rank**	Comments
Vascular Plants			
Achillea millefolium L. var. *borealis* (Bong.) Farw.	Common Yarrow	S5	
Actaea rubra (Ait.) Willd.	Red Baneberry	S5	
Alnus viridis (Vill.) de Candolle subsp. crispa	Green Alder	S5	
Alnus incana (L.) Moench. subsp.rugosa	Speckled Alder	S5	
Andromeda polifolia L.	Bog Rosemary	S5	
Aralia nudicaulis L.	Wild Sarsaparilla	S5	
Arctostaphylos alpina (L.) Spreng. ssp. rubra	Alpine Bearberry	S5	
Arctostaphylos uva-ursi (L.) Spreng.	Bearberry	S5	
Aster ciliolatus Lindl.	Lindley's Aster	S5	
Betula papyrifera Marsh.	Paper Birch	S5	Also includes *B. neoalaskana* Sarg. in field data. Species are differentiated by twigs and leaves.
Betula pumila L. var. *glandulifera* Regel	Swamp Birch	S5	
Calamagrostis canadensis (Michx.) Nutt.	Reed Grass	S5	
Carex aquatilis Wahl.	Water Sedge	S5	
Carex argyrantha Tuckerm.	Sedge	SNA	Now known as *C. foenea* Willd. in FNA Vol 23
Carex concinna R. Br.	Beautiful Sedge	S4S5	
Carex deflexa Hornem.	Bent Sedge	S5	
Carex houghtoniana Torr.	Sand Sedge	S5	
Carex magellanica Lam.	Bog Sedge	S5	
Carex trisperma Dew.	Three-seeded Sedge	S5	
Chamaedaphne calyculata (L.) Moench	Leatherleaf	S5	
Chrysanthemum leucanthemum L.	Ox-eye Daisy	SNA	Introduced species
Corallorhiza trifida Chat.	Early Coralroot	S5	
Cornus canadensis L.	Bunchberry	S5	
Corydalis sempervirens (L.) Pers.	Pink Corydalis	S5	
Crepis tectorum L.	Narrow-leaved Hawk's-beard	SNA	Introduced species
Drosera rotundifolia L.	Round-leaved Sundew	S5	
Epilobium angustifolium L.	Fireweed	S5	
Equisetum arvense L.	Common Horsetail	S5	
Equisetum scirpoides Michx.	Dwarf Scouring-rush	S5	
Equisetum sylvaticum L.	Woodland Horsetail	S5	
Fragaria virginiana Dcne.	Smooth Wild Strawberry	S5	
Galium trifidum L.	Bedstraw	S5	
Geocaulon lividum (Richards.) Fern.	Northern Comandra	S5	
Hordeum jubatum L.	Foxtail Barley	S5	
Kalmia polifolia Wang.	Pale Bog-laurel	S5	
Larix laricina (Du Roi) Koch	Tamarack	S5	
Ledum groenlandicum Oeder.	Labrador Tea	S5	
Linnaea borealis L.	Twinflower	S5	
Lonicera dioica L.	Twining Honeysuckle	S5	
Lycopodium annotinum L.	Stiff Clubmoss	S5	

Table B2-15: Plant Species Found During Field Studies			
Scientific Name*	**Common Name**	**CDC S-Rank****	**Comments**
Lycopodium complanatum L.	Ground-cedar	S5	
Lycopodium dendroideum Michx.	Ground-pine	S5	
Menyanthes trifoliata L.	Bogbean	S5	
Mertensia paniculata (Ait.) Don	Tall Lungwort	S5	
Mitella nuda L.	Bishop's Cap	S5	
Petasites palmatus (Ait.) Gray	Palmate-leaved Coltsfoot	S5	
Picea glauca (Moench.) Voss	White Spruce	S5	
Picea mariana (Mill.) BSP	Black Spruce	S5	
Pinguicula villosa L.	Hairy Butterwort	S3S4	
Pinus banksiana Lamb.	Jack Pine	S5	
Plantago major L.	Common Plantain	SNA	Introduced species
Platanthera hyperborea (L.) Lindl.	Northern Green Bog-orchid	SNA	
Populus balsamifera L.	Balsam Poplar, Black Poplar	S5	
Pyrola asarifolia Michx.	Common Pink Wintergreen	S5	
Pyrola grandiflora Radius	Arctic Wintergreen	S4	
Pyrola secunda L.	One-sided Wintergreen	S5	
Pyrola virens Schweigg.	Green-flowered Wintergreen	S5	
Rhamnus alnifolia L'Her.	Alder-leaved Buckthorn	S5	
Ribes glandulosum Grauer	Skunk Currant	S5	
Ribes hudsonianum Richards.	Northern Wild Black Currant	S5	
Ribes lacustre (Pers.) Poir.	Bristly Black Currant	S4	
Ribes oxyacanthoides L.	Bristly Wild Gooseberry	S5	
Ribes triste Pall.	Wild Red Currant	S5	
Rosa acicularis Lindl.	Prickly Rose	S5	
Rubus acaulis Michx.	Stemless Raspberry	S5	
Rubus chamaemorus L.	Cloudberry	S5	
Rubus idaeus L.	Raspberry	S5	
Rubus pubescens Raf.	Dewberry	S5	
Salix bebbiana Sarg.	Bebb's Willow	S5	
Salix myrtillifolia Anderss.	Low Blueberry Willow	S5	
Salix pellita Anderss.	Satin Willow	S4	
Salix planifolia Pursh.	Plane-leaved Willow	S5	
Scheuchzeria palustris L.	Pod Grass	S4?	
Scirpus cespitosus L.	Tufted Bulrush	S4	
Shepherdia canadensis (L.) Nutt.	Soapberry	S5	
Smilacina trifolia (L.) Desf.	Three-leaved Solomon's Seal	S5	
Solidago hispida Muhl.	Goldenrod	S5	
Taraxacum officinale Weber.	Common Dandelion	S5	
Vaccinium myrtilloides Michx.	Velvet-leaf Blueberry	S5	
Vaccinium oxycoccus L.	Small Bog Cranberry	S5	
Vaccinium uliginosum L.	Bog Bilberry	S5	
Vaccinium vitis-idaea L.	Dry-ground Cranberry	S5	
Viburnum edule (Michx.) Raf.	Low-bush Cranberry	S5	
Viola renifolia Gray	Kidney-shaped Violet	S5	
Mosses and Lichens Identified to Species in the Field			
Hylocomium splendens	Stair step moss		

Table B2-15: Plant Species Found During Field Studies			
Scientific Name*	**Common Name**	**CDC S-Rank****	**Comments**
Pleurozium schreberi	Schreber's moss		
Ptilium crista-castrensis			
Cladina mitis			
Cladina rangiferina			
Cladina stellaris			

* Nomenclature follows Flora of North America (FNA) where volumes currently exist for the genus and the Manitoba Conservation Data Centre elsewhere.

** CDC Ranking Codes: S1= Very rare throughout its range or in the province. May be especially vulnerable to extirpation., S2= Rare throughout its range or in the province. May be vulnerable to extirpation., S3=Uncommon, S3S4 and S3?= Uncommon to apparently secure, S4= Widespread, abundant, and apparently secure throughout its range or in the province, with many occurrences, but the element is of long-term concern, S5= Demonstrably widespread, abundant, and secure throughout its range or in the province, and essentially irradicable under present conditions, SNA= A conservation status rank is not applicable to the element; ?= Inexact; S#S#= A range between two of the numeric ranks. Denotes range of uncertainty about the exact rarity of the specie.