Keeyask Infrastructure Project
Environmental Assessment Report

ADDENDUM #2

Keeyask Hydropower Limited Partnership

OCTOBER 2009

5900345 MANITOBA LTD.

3rd Floor 820 Taylor Avenue
Winnipeg, Manitoba R3M 3T1
Fax: (204) 474-4947

0221-A-91-110

October 6, 2009

Ms. Elise Dagdick
Environmental Licensing and Approval Branch
Manitoba Conservation
160-123 Main Street
Winnipeg, MB R3C 1A5

Dear Ms. Dagdick:

RE: Addendum #2 Information to the EA Report for the Keeyask Infrastructure Project

On July 31 the Keeyask Hydropower Limited Partnership, through its General Partner 5900345 Manitoba Ltd., submitted an Environment Act Proposal Form, an Environmental Assessment Report, a preliminary Environmental Protection Plan, and payment for the Class 2 Development Review Fee. An Addendum Filing was sent on August 31. Today we are providing the Second Addendum Filing with the following materials:

- Appendix A1-a: Information Regarding Wastewater Disposal.
- Appendix D15: Environmental Non-Government Organization Meeting Notes. The previous addendum filing had included draft notes of this meeting. Those notes have been edited and the final notes are now enclosed.

Should you require any additional information, please feel free to contact Mr. Ryan Kustra at 360-4334 or Mr. Nick Barnes at 360-3999.

Yours truly,

5900345 Manitoba Ltd.
As general partner of the
Keeyask Hydropower Limited Partnership

Per:

K.R.F. Adams
President

Attachments

c. Ms. Tracey Braun

AECOM
99 Commerce Drive, Winnipeg, MB Canada R3P 0Y7
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Technical Memorandum (Rev. 1)

Date:	October 2nd, 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

A technical memorandum relating to wastewater disposal from the North Access Road Start Up Camp (SUC) was previously included as Appendix A1 to the Environment Act Proposal submission for the Keeyask Infrastructure Project (dated July 28th, 2009). This revision includes further information on the concept design, following the completion of additional fieldwork programs.

2) Executive Summary

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 of up to 125 people. For design, a population of 150 persons has been used. Maximum populations are anticipated to occur in summer months. The maximum daily wastewater flow is estimated to be 60,000 litres (including backwash from the water treatment plant plus contingency allowance).

The first stage of work included a review of a number of different options for the disposal of wastewater, such as trucking, a lagoon or a drain field. The review considered lifecycle cost and other factors, such training requirements. The preferred option was an on-site septic tank with drain field. The basis for design and site tests was the Environment Act Regulation 83/2003 "Onsite Wastewater Management Systems".

As such, a preliminary geotechnical program commenced, which comprised the investigation of a site to the west of the camp. After a review of the geotechnical information, a secondary program commenced, to investigate potential sites to the north and east of the camp. The secondary program was completed in September 2009. After review, the site to the east of the proposed camp was preferred, as silty loam material was encountered at elevation 176.5m, with suitable depth to groundwater. Percolation tests were therefore conducted, which showed percolation rates of

between 4 and 13 min/cm. Due to the size of the field, a conservative application rate of 12.7 litres/m^2/day has been used in the design, which results in total trench length of 2150m for a chamber system. The field will be divided into four cells, each containing 19 trenches.

2) Site Layout

The camp layout is preliminary. Facilities at the start up camp will include the following:

- Accommodation units, with washrooms and laundry facilities
- Offices and stores
- Kitchen and Dining Hall
- Fire Truck/Ambulance Garage
- Generator & fuelling area
- Electrified parking stalls
- Water Treatment Plant (WTP) with water storage tanks
- Groundwater well
- Gatehouse (on the North Access Road)
- Septic tanks and drain field

The gatehouse will 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 alternatives 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.

Wastewater disposal alternatives considered (in order of preference)
All sewage to septic tank with drain field
Lagoon with discharge route
Black water trucked to Split Lake lagoon with upgrades
Black water trucked to Gillam Wastewater Treatment Plant (WWTP)
Black water trucked to Thompson WWTP
All sewage trucked to Split Lake lagoon with upgrades
All sewage trucked to Gillam WWTP
All sewage trucked to Thompson WWTP
All sewage to on-site mechanical WWTP with drain field
Black water trucked to Split Lake lagoon (currently overloaded – included for comparison only)

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 all sewage being routed to a septic tank arrangement with a drain field, as it presented the lowest lifecycle cost, low potential for disruption and limited training requirements. This concept has also been used previously at other Manitoba Hydro facilities, including Radisson and

Henday converter stations. As such, a concept design for an engineered drain field was prepared, as shown in the attached calculations (Enclosure 5).

4) Design Criteria

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

5) Geotechnical Investigation

5a) Investigation Programs

Two geotechnical investigations have been completed to evaluate three potential sites for the SUC drain field. The first investigation was completed on July 21 and 22, 2009 by AECOM to evaluate the original proposed site located west of the SUC. 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. Based on the results of this investigation (refer to Enclosure 4) it was recommended that two other areas on the east side of the SUC may be better suited for a drain field. The general extents of these two sites are illustrated on Figure 2 by Test Holes 09-13 to 09-15 which are located east of the SUC and Test Holes 09-16 to 09-19 which are located on the east side of the SUC but on the north side of the NAR. A second geotechnical investigation was completed at these two locations on September 11 and 12, 2009 by Manitoba Hydro (MH) based on a test hole drilling program recommended by AECOM. Percolation testing wells were installed in Test Holes 09-13, 09-14, 09-17 and 09-19 to facilitate percolation testing in accordance with Schedule D - Standards for Conducting Percolation Tests (Regulation for Onsite Wastewater Management ENV-R.M.83-2003). The wells consist of 100 mm diameter PVC pipe with a 300 mm long screened section at the bottom of each well. Construction details of the wells are provided with the attached test hole logs (Enclosure 1). Selected soil samples from the test holes were submitted to AECOM's Materials Testing Laboratory to determine the moisture content and gradation of the soils encountered, the results are also attached (Enclosure 2).

Based on the results of the second geotechnical investigation it was determined that the proposed drain field location on the north side of the NAR (Test Holes 09-16 to 09-19) is not suitable for a drain field due to high groundwater table and/or the presence of clay soils. Some of the soils encountered also appear to be affected by permafrost. The other proposed drain field located east of the SUC (Test Holes 09-13 to 09-15) is suitable for a drain field.

The general ground elevation at Test Holes 09-13, 09-14 and 09-15 is around elevation 179 m, or about 7 to 8 m higher than the groundwater elevations (Elevation 171 to 171.5m) measured in the test holes drilled at the SUC (Test Holes 09-07 to 09-12 on Figure 2). No groundwater seepage or wet soil conditions were encountered in Test Holes 09-13 to 09-15, which were drilled down to elevations ranging from 174.4 to 175.1 m. The upper 1.5 to 3 m of soil at these test hole locations generally consists of a silt with variable clay content (trace clay to clayey). Below the silt layer is a fine grained

sand layer with variable silt content. The gradation testing indicates this layer ranges from a sand with trace to some silt to a sand and silt.

Percolation testing was undertaken by MH approximately 1 week after the drilling was completed. The testing was performed in accordance with Schedule D of the Regulations (Standard Conducting Percolation Tests). The test results are provided in tabular form in Enclosure 3. The percolation rates from Test Holes 09-13 and 09-14 are approximately 13 and 4 minutes per cm, respectively. Based on the Table of soil texture, percolation rates and application rates from Schedule A of the Regulations these rates correspond to the upper bound of the silty loam soil (13 min/cm) and the mid to upper bound of the gravel / sand soil (4 min/cm) which is consistent with the gradation of the soils encountered in the test holes.

No information is available on the direction of groundwater flow on a regional scale. Locally, the groundwater table is expected to be relatively flat, from information gathered during the field programs. In the area of the drain field, it is anticipated that movement of water from the base of the drain field would flow radially outward and downward.

5b) Drain Field Design Recommendations:

- Locate the base of the field in the silty sand layer, no higher than elevation 176.5 m, to provide a separation distance of 5 to 5.5 m from the base of the field to the groundwater table which is assumed to be similar to that measured in the test holes located at the SUC (at elevation 171 to 171.5m),
- Assume a percolation rate slower than 13 min/cm but within the range for the silty loam soil provided in the Regulations to provide a factor of safety on this design parameter
- Install snow fence around the field to trap snow in winter for additional frost protection.

6) Hydraulic Loading

A consumption figure of 340 LPCD has been assumed, based on information collected from Wuskwatim camp between 2008 and 2009. Therefore, the maximum daily flow anticipated is 60,000 litres per day (a conservative estimate), which includes both domestic use, backwash from the water treatment plant, plus a contingency allowance.

7) Organic Loading

Whilst organic loading is not considered in the design criteria, the maximum organic loading is anticipated to be approximately 11.25 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 two components; the septic tanks and drain field, as discussed below.

8a) Septic Tanks

It is proposed that sewage will be collected from camp buildings via pipes within an insulated above-ground utilidor. As the site will generally slope to the west to minimize earthworks and fill volumes, sewage will be collected on the west side of the camp, where it will discharge through a splitter box, into a septic tank arrangement. Tanks shall conform to the requirements of Canadian Standards Association Standard B66–00 (Prefabricated Septic Tanks and Sewage Holding Tanks). Each tank shall be supplied with a manhole extension complete with cover and inlet and outlet fittings (to control odours and movement of floating material). Tanks will be covered with granular fill and box insulation.

The septic tank arrangement shall comprise two large sedimentation tanks and a single control tank. The sedimentation tanks may be formed from a single prefabricated unit, or smaller units joined on site. Valves shall be installed on the incoming and outgoing piping, such that tanks may be isolated for maintenance.

In accordance with the Environment Act Regulation, the tanks shall be sized such that:

- the sedimentation chambers have a combined capacity of 140% of the total daily sewage flow, and,
- the control chambers have a combined capacity of 20% of the total daily sewage flow.

The control chamber shall be fitted with two submersible sewage pumps (on a duty/standby arrangement) and a preinsulated forcemain discharging into a disposal field. Each pump shall have a nominal capacity of approximately 400 litres/minute.

The pumps shall have lifting chains to allow removal and maintenance, and a flexible discharge line connected to the tank outlet. Pumps shall be controlled by float switches within the control tank, and shall be automated to allow alternate operation, with check valve. An audible alarm and strobe light shall be installed to warn of pump failure.

Sludge would be removed from the sedimentation tanks at periodic intervals via vacuum truck, and transported to a licensed facility for disposal.

8b) Drain Field

The Regulations refer to 3 types of system, namely;

- Type 1: Trench type disposal field (using wastewater effluent chambers)
- Type 2: Trench type disposal field (using perforated distribution pipe)
- Type 3: Total area field (using either pipe/aggregate or chamber system, either on grade or above ground)

The use of a chamber style ("Type 1") 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. Therefore, a "Type 1" system has been included in the concept design, comprising "Infiltrator" units with "Quick-4 High Capacity" Chambers, or similar. It is understood from the

manufacturer that there are a number of other installations in Manitoba, and similar work camps in northern Alberta.

Whilst the Regulation states that "the percolation rate for the proposed disposal area shall be determined by averaging the percolation rate determined for each of the test holes", a conservative approach has been taken, due to the size of the field. As such, an application rate of approximately 12.7 litres/m2/day (consistent with silty loam material) has been used in the sizing of the field, based on the geotechnical information gathered to date. A review of the design assumptions, and potential for reduction in field size shall be made during the excavation work. It is proposed that the field is divided into four cells.

The pumps shall be connected to a single preinsulated forcemain which will be routed back through the utilidor, and then buried, up to a distribution box, located in the centre of the four cells. Valves shall be placed on each of the four outgoing pipes, such that the flow to each cell may be varied manually.

The multiple trench field would comprise header pipes, each connected to a series of pipes, with perforated plastic chambers located in parallel shallow trenches, with a minimum of 2m separation. Wastewater shall be discharged into the chambers via small diameter (typically 38mm) pressure pipes. Each pipe shall be drilled with orifice diameters sized and spaced to allow even distribution. The pipes may be either suspended via straps or supported on stools within the chamber.

An access track would be constructed to the field area from the camp. Fencing shall be installed around the field to prevent vehicular traffic loading. It is anticipated that there will always be warm effluent being pumped into the field, which should provide sufficient heat to avoid freezing. Once installation is complete, it is proposed that the field area is covered with a vegetative layer, comprising peat moss and/or mulch, which would be seeded.

As can be seen from the contours in Figures 2, existing surface drainage generally; flows to the north in the camp area, and flows radially from the proposed drain field area. Surface water from the start up camp pad will be routed to perimeter ditches, which will discharge into the south ditch of the North Access Road. As shown on Figure 4, the drain field area will be graded with a 0.5% fall to the east, to achieve sheet drainage. Perimeter ditching around the field is required to avoid additional hydraulic load being added to the drainage field. Erosion and sedimentation control features may include wood slash bundles and silt fencing. Depth of cover, vegetation planting requirements, erosion control and snow capture will be further reviewed during detailed design.

As currently proposed, a distance of over 600m separation would be maintained between the discharge field and the water supply well. Two potential locations for the well have been identified; just off the borrow pit, or adjacent to the intersection of the two roads (as shown on Figure 1). The location shall be further reviewed prior to the commencement of well drilling. No other groundwater wells have been identified. Also, no watercourses have been identified within the site limits. The nearest surface water features are small lakes some 500m to the east of the existing limits of the borrow pit.

10) Anticipated construction sequence:

- Excavate from existing ground to top of trench elevation and install perimeter ditching (some material may be used beneath the camp, peat moss and other material to be stockpiled separately)
- Excavate trenches for chamber units
- Install chambers and distribution piping within trenches
- Perform tests on distribution piping with water to ensure even flow
- Backfill trenches and cover using equipment (within manufacturer's recommendations for allowable axle loads)
- Cover with vegetative layer and seed site. Install perimeter fencing and snow fences.

11) Proposed Operation, Maintenance and Monitoring

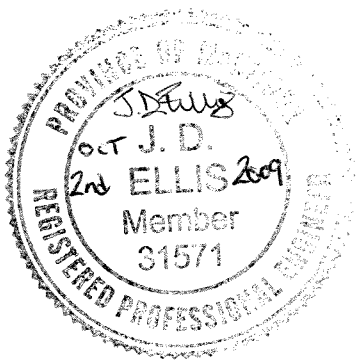
Features such as inspection ports (to confirm the field is not saturated) and cleanout ports on the chambers shall be included during the detailed design stage, along with an outline program for operation and maintenance, along with a groundwater monitoring plan.

In the event of a system failure, it is anticipated that a trucked system would be initiated, whilst repairs are carried out.

12) Decommissioning

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

Respectfully submitted,



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

Encs:
1. Test hole logs
2. Laboratory testing data
3. Percolation test results
4. Memorandum regarding west site
5. Field Sizing Calculations

Figures:
Figure 1 – Location Plan & Aerial Photo
Figure 2 – Borehole Location Plan
Figure 3 – Proposed Camp and Field Layout
Figure 4 – Proposed Field Layout
Figure 5 – Proposed Cross Sections
Figure 6 – Sketch of tank and valve arrangement

Enclosure 1
Test Hole Logs

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

DEPTH (m)	SOIL DESCRIPTION	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0	ORGANICS - peat moss, rootmat, wet				
	CLAY - some silt, trace sand, trace rootlets - brown, moist, soft, high plasticity	G1			
	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				98
1		G2			
	- clayey below 1.2 m				
	- some clay below 1.5 m				
	- trace clay, moist to wet, compact below 1.8 m	G3			97
2					
	CLAY - some silt, trace sand - moist, stiff, high plasticity	G4			
					96
3					
	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.				95
4					

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

DRAFT

AECOM

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-09-02
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/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

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					
	SAND - some clay, some silt - light brown, moist to wet, compact to dense, fine and medium grained		G8			
2						97
			G9			
	- 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						

DRAFT

AECOM

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-09-03
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

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

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	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			
		- moist, firm, intermediate to high plasticity below 0.9 m					
1							1
		- brown, high plasticity below 1.2 m					
			■	G12			
2							2
		- trace silt inclusions (<5 mm dia.), stiff below 2.1 m	■	G13			
			■	G14			
3							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.					
4							

DRAFT

AECOM

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 #	COMMENTS	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 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.			96
4				

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

DRAFT

AECOM

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/m³) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH (kPa): Torvane; QU; Lab Vane; Pocket Pen.; Field Vane 50 100 150 200

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	DEPTH
0		ORGANICS - peat moss, rootmat, wet					
		CLAY - silty, trace sand, trace rootlets - brown, moist, firm to stiff, high plasticity					
			GRAB	G19			
		- sandy, soft, intermediate plasticity below 0.9 m					
1							1
			GRAB	G20			
		- trace sand, very stiff, high plasticity					
		SAND - some silt, trace clay, dry to moist, dense to very dense, fine grained	GRAB	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							2
3							3
4							

DRAFT

AECOM

LOGGED BY: Jared Baldwin	COMPLETION DEPTH: 1.68 m
REVIEWED BY: Gil Robinson	COMPLETION DATE: 22/7/09
PROJECT ENGINEER: Gil Robinson	Page 1 of 1

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: 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	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									

DRAFT

AECOM

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

MANITOBA HYDRO

CIVIL ENGINEERING
MATERIALS & FIELD SERVICES

Field Overburden Log

PROJECT 09 Keeyask Geotechnical Investigation

HOLE NO.	HOLE DEPTH	PAGE
TH-09-07	3.1 m	1 OF 1

NORTHING	6255077	EASTING	0343683
ELEV		DATUM	
AZIMUTH		PLUNGE	
LINE REF		OFFSET	
PROPOSED HOLE NUMBER			
SURVEY SPEC.			

CONTRACTOR	Paddock Drilling Ltd
DRILLER	Wade
DRILLING METHOD	SSA
DRILL NAME	Ranger
DATE STARTED	Sept/11/09
DATE COMPLETED	Sept/11/09
ROCK DEPTH	
WATER DEPTH	NA
HOLE DEPTH	3.1

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLES TOP DEPTH	SAMPLES BASE DEPTH	SAMPLES NO.	SAMPLES TYPE	SAMPLES DIA ()	SAMPLES REC ()	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0	0.06	Peat	Peat – Fibrous									
				0.7	0.8	1	ES					
0.06	3.1	ML	Silt - sandy, NP, moist, ~~soft~~,									
			Brown	1.4	1.5	2	ES					
				2.2	2.3	3	ES					
			~ Moist to wet @ 2.1m	3.0	3.1	4	ES					
			Sloughed to 8'									
			Installed Piezo with 2.5' screen									
			EOH @ 3.1m									

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	0 - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR	BP
DATE	Sept/11/09
SHIFT	DAY

MANITOBA HYDRO

INSTRUMENT COMPLETION DIAGRAM

PROJECT	~~XXXXXXX~~ Keeyask	
HOLE NO.	DEPTH	No. of INSTRUMENTS
TH-09-07	3.1	

LOCATION	
NORTH 6255077	EAST 0343683
ELEV G/S	DATUM
AZIMUTH	PLUNGE
INSTRUMENT IDENTIFICATION NUMBERS	

CONTRACTOR	~~XXXXXXX~~ Paddock
DRILLER	Wade
DRILLING METHOD	~~XXX~~ SSA
DRILL NAME	Ranger
DATE STARTED	Sept 11/09
DATE COMPLETED	Sept 11/09
ROCK SURFACE	NA
GROUNDWATER	NA
END OF HOLE	3.1m

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: 1¼"
Type: PVC

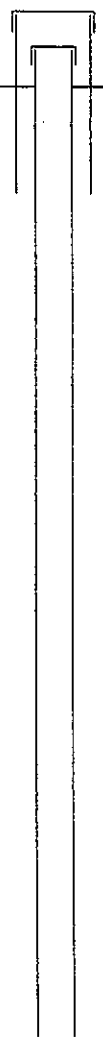
GROUT
Type:
Mix Ratio:
Quantity:

SEAL
Type: EPM
Quantity: 1 bag

SANDPACK
Type: Silica
Quantity: 1 bag

SCREEN
Diameter: 1¼"
Type: PVC
Interval: 5'

TPC	TOP PROTECT CASING
TRC	TOP OF RISER CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
EOH	END OF HOLE

WELL DETAILS	DEPTH (ft.)		WELL CONSTRUCTION DETAILS
		TPC	
	4.0	TRC	
	0.0	GS	
	10'	BSC	
	10'	EOH	

MANITOBA HYDRO

CIVIL ENGINEERING
MATERIALS & FIELD SERVICES

Field Overburden Log

PROJECT 09 Keeyask Geotechnical Investigation

HOLE NO.	HOLE DEPTH	PAGE
TH-09-08	6.1	1 OF 1

NORTHING 6255002	EASTING 0343645
ELEV	DATUM
AZIMUTH	PLUNGE
LINE REF	OFFSET
PROPOSED HOLE NUMBER	
SURVEY SPEC.	

CONTRACTOR	Paddock Drilling Ltd
DRILLER	Wade
DRILLING METHOD	SSA, ~~BD~~
DRILL NAME	~~[illegible]~~ Ranger
DATE STARTED	Sep/12/09
DATE COMPLETED	Sep/12/09
ROCK DEPTH	
WATER DEPTH	NA
HOLE DEPTH	6.1

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION (COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.)	SAMPLES TOP DEPTH	SAMPLES BASE DEPTH	SAMPLES NO.	SAMPLES TYPE	SAMPLES DIA ()	SAMPLES REC ()	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0	0.2	Peat	Peat Fibrous									
0.2	1.5	ML	Silt-Sandy, LP, Moist,									
			soft, brown, Trace clay	0.7	0.8	1	ES					
				1.4	1.5	2	ES					
1.5	6.1	SM	Sand-Silty, MG, FG,									
			moist, Brown									
				2.2	2.3	3	ES					
			- wet @ 3.1m									
				3.0	3.1	4	ES					
			Standpipe to 3.1m									
				3.7	3.8	5	ES					
			Installed well Pipe									
			to 3.8m with 2.5'of									
			Screen	4.5	4.6	6	ES					
			EOH @ 6.1	5.2	5.3	7	ES					
				6.0	6.1	8	ES					

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	0 - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR	BD / CF
DATE	Sep/12/09
SHIFT	Day

MANITOBA HYDRO

INSTRUMENT COMPLETION DIAGRAM

PROJECT		
~~XXXXXXXX~~ Keeyask		
HOLE NO.	DEPTH	No. of INSTRUMENTS
TH-09-08	6.1	

LOCATION	
NORTH 6255002	EAST 0343645
ELEV G/S	DATUM
AZIMUTH	PLUNGE
INSTRUMENT IDENTIFICATION NUMBERS	

CONTRACTOR	~~XXXXXXXX~~ Paddock
DRILLER	Wade
DRILLING METHOD	~~XXX~~ ESA
DRILL NAME	Ranger
DATE STARTED	Sept/12/09
DATE COMPLETED	Sept/12/09
ROCK SURFACE	NA
GROUNDWATER	NA
END OF HOLE	6.1

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: 1¼"
Type: PVC

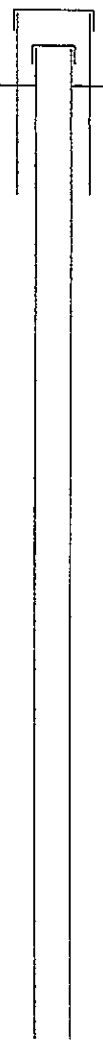
GROUT
Type:
Mix Ratio:
Quantity:

SEAL
Type: EPM
Quantity: 2

SANDPACK
Type: SOCK
Quantity: 2.5'

SCREEN
Diameter: 1¼"
Type: PVC
Interval: 2.5'

TPC TOP PROTECT CASING
TRC TOP OF RISER CASING
GS GROUND SURFACE
BS BENTONITE SEAL
FP FILTER PACK
TSC TOP OF SCREEN
BSC BOTTOM OF SCREEN
EOH END OF HOLE

WELL DETAILS	DEPTH (ft.)		WELL CONSTRUCTION DETAILS
		TPC	
		TRC	
	0.0	GS	
	12.5	BSC	
	20	EOH	

MANITOBA HYDRO

CIVIL ENGINEERING
MATERIALS & FIELD SERVICES

Field Overburden Log

PROJECT 09 Keeyask Geotechnical Investigation

HOLE NO.	HOLE DEPTH	PAGE
TH-09-09	3.1m	1 OF 1

NORTHING	6254942	EASTING	0343760
ELEV		DATUM	
AZIMUTH		PLUNGE	
LINE REF		OFFSET	
PROPOSED HOLE NUMBER			
SURVEY SPEC.			

CONTRACTOR	Paddock Drilling Ltd
DRILLER	Wade
DRILLING METHOD	SSA, ~~DT~~
DRILL NAME	~~Acker Soil Sonic~~ Ranger
DATE STARTED	Sep 1/12/09
DATE COMPLETED	Sep 1/12/09
ROCK DEPTH	
WATER DEPTH	NA
HOLE DEPTH	3.1m

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION (COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.)	SAMPLES TOP DEPTH	SAMPLES BASE DEPTH	SAMPLES NO.	SAMPLES TYPE	SAMPLES DIA ()	SAMPLES REC ()	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0	0.2	Peat	Peat - Fibrous									
0.2	1.5	SM	Sand - Silty, PG, FG, damp Compact (Inferred) Brown Trace Clay UP to 1.1m	0.7	0.8	1	ES					
				1.4	1.5	2	ES					
1.5	3.1	SP	Sand - PG, FG, dry Compact (Inferred), Brown Trace Silt	2.2	2.3	3	ES					
			Installed Piezo to 3.1m with 2.5' Screen	3.0	3.1	4	ES					
			EOH @ 3.1m									

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	0 - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR BP

DATE Sep/12/09

SHIFT Day

MANITOBA HYDRO

INSTRUMENT COMPLETION DIAGRAM

PROJECT	~~[illegible]~~ Keeyask	
HOLE NO.	DEPTH	No. of INSTRUMENTS
TH-09-09	3.1	

LOCATION	
NORTH 6254942	EAST 0343760
ELEV G/S	DATUM
AZIMUTH	PLUNGE
INSTRUMENT IDENTIFICATION NUMBERS	

CONTRACTOR	~~[illegible]~~ Paddock
DRILLER	Wade
DRILLING METHOD	~~[illegible]~~ SSA
DRILL NAME	Ranger
DATE STARTED	Sep/12/09
DATE COMPLETED	Sep/12/09
ROCK SURFACE	NA
GROUNDWATER	NA
END OF HOLE	3.1

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: 1¼"
Type: PVC

GROUT
Type:
Mix Ratio:
Quantity:

SEAL
Type: EPM
Quantity: 1bag

SANDPACK
Type: Sock
Quantity: 2.5'

SCREEN
Diameter: 1¼"
Type: PVC
Interval: 2.5'

TPC	TOP PROTECT CASING
TRC	TOP OF RISER CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
EOH	END OF HOLE

WELL DETAILS	DEPTH (ft.)		WELL CONSTRUCTION DETAILS
		TPC	
	2.5	TRC	
	0.0	GS	
	10	BSC	
	10	EOH	

MANITOBA HYDRO

CIVIL ENGINEERING
MATERIALS & FIELD SERVICES

Field Overburden Log

PROJECT 09 Keeyask Geotechnical Investigation

HOLE NO.	HOLE DEPTH	PAGE
TH-09-10	6.1	1 OF 1

NORTHING 6254474 EASTING 0343838	
ELEV	DATUM
AZIMUTH	PLUNGE
LINE REF	OFFSET
PROPOSED HOLE NUMBER	
SURVEY SPEC.	

CONTRACTOR	Paddock Drilling Ltd
DRILLER	Wade
DRILLING METHOD	SSA, ~~DB~~
DRILL NAME	~~Acker Soil Sentry~~ Ranger
DATE STARTED	Sep/12/09
DATE COMPLETED	Sep/12/09
ROCK DEPTH	
WATER DEPTH	NA
HOLE DEPTH	6.1

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION (COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.)	SAMPLES TOP DEPTH	SAMPLES BASE DEPTH	SAMPLES NO.	SAMPLES TYPE	SAMPLES DIA ()	SAMPLES REC ()	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0	0.2	Pt	Peat - Fibrous									
0.2	6.1	SM	Sand-Silty, FG, PG, Compact (Inferred), Brown, damp	0.7	0.8	1	FS					
			- moist @ 3.0m	1.4	1.5	2	ES					
				2.2	2.3	3	ES					
			- wet @ 4.5m, MC									
				3.0	3.1	4	ES					
			Installed Piezo to 15' with @ 2.5' Screen	3.7	3.8	5	ES					
			Hole Sloughed to 3.6m	4.5	4.6	6	ES					
				5.2	5.3	7	ES					
			EOH @ 6.1	6.0	6.1	8	ES					
			2 bag EPM									

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	0 - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR BP

DATE Sept/12/09

SHIFT Day

MANITOBA HYDRO

INSTRUMENT COMPLETION DIAGRAM

PROJECT		
~~[illegible]~~ Keeyask		
HOLE NO.	DEPTH	No. of INSTRUMENTS
TH-09-10	6.1	

LOCATION	
NORTH 6254974	EAST 0343838
ELEV G/S	DATUM
AZIMUTH	PLUNGE
INSTRUMENT IDENTIFICATION NUMBERS	

CONTRACTOR	~~[illegible]~~ Paddock
DRILLER	Wade
DRILLING METHOD	~~[illegible]~~ SSA
DRILL NAME	Ranger
DATE STARTED	Sep/12/09
DATE COMPLETED	Sep/12/09
ROCK SURFACE	NA
GROUNDWATER	NA
END OF HOLE	6.1

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: 1 1/4
Type: PVC

GROUT
Type:
Mix Ratio:
Quantity:

SEAL
Type: EPM
Quantity: 2 bags

SANDPACK
Type: Sock
Quantity: 2.5'

SCREEN
Diameter: 1 1/4"
Type:
Interval:

TPC	TOP PROTECT CASING
TRC	TOP OF RISER CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
EOH	END OF HOLE

WELL DETAILS	DEPTH (ft.)		WELL CONSTRUCTION DETAILS
		TPC	
	4.0	TRC	
	0.0	GS	
	15	BSC	
	20	EOH	

MANITOBA HYDRO

CIVIL ENGINEERING
MATERIALS & FIELD SERVICES

Field Overburden Log

PROJECT 09 Keeyask Geotechnical Investigation

HOLE NO.	HOLE DEPTH	PAGE
TH-09-11	6.1	1 OF 1

NORTHING 6255011	EASTING 0343747	CONTRACTOR	Paddock Drilling Ltd
ELEV	DATUM	DRILLER	Wade
AZIMUTH	PLUNGE	DRILLING METHOD	SSA, ~~DD~~
LINE REF	OFFSET	DRILL NAME	~~Acker Soil Sentry~~ Ranger
PROPOSED HOLE NUMBER		DATE STARTED	SEP/12/09
SURVEY SPEC.		DATE COMPLETED	SEP/12/09
		ROCK DEPTH	
		WATER DEPTH	NA
		HOLE DEPTH	6.1m

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION (COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.)	SAMPLES TOP DEPTH	SAMPLES BASE DEPTH	SAMPLES NO.	SAMPLES TYPE	SAMPLES DIA ()	SAMPLES REC ()	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0	0.2	Peat	Peat - Fibrous									
0.2		SM	Sand - Silty, FG, FG, Damp									
			Compact Layered, Brown	0.7	0.8	1	ES					
				1.4	1.5	2	ES					
			- Moist @ 1.5m									
				2.2	2.3	3	ES					
			- wet @ 3.1m									
				3.0	3.1	4	ES					
			- Medium Grained @ 4.6									
				3.7	3.8	5	ES					
			Sloughed to 9'									
			Installed well to 12.5'	4.5	4.6	6	ES					
			2.5' of screen									
				5.2	5.3	7	ES					
			EOH @ 6.1m	6.0	6.1	8	ES					

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	0 - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR BT

DATE SEP/12/09

SHIFT Day

MANITOBA HYDRO

INSTRUMENT COMPLETION DIAGRAM

PROJECT	~~Conawapa~~ Keeyask	
HOLE NO.	DEPTH	No. of INSTRUMENTS
TH-09-11	6.1	

LOCATION		CONTRACTOR	~~[illegible]~~ Paddock
		DRILLER	Wade
		DRILLING METHOD	~~[illegible]~~ SSA
NORTH 6255011	EAST 0343747	DRILL NAME	Ranger
ELEV G/S	DATUM	DATE STARTED	SEP/12/09
AZIMUTH	PLUNGE	DATE COMPLETED	SEP/12/09
INSTRUMENT IDENTIFICATION NUMBERS		ROCK SURFACE	NA
		GROUNDWATER	NA
		END OF HOLE	6.1

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: 1¼"
Type: PVC

GROUT
Type:
Mix Ratio:
Quantity:

SEAL
Type: EPM
Quantity: 2

SANDPACK
Type: Sock
Quantity: 2.5'

SCREEN
Diameter: 1¼"
Type: PVC
Interval: 2.5

TPC	TOP PROTECT CASING
TRC	TOP OF RISER CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
EOH	END OF HOLE

WELL DETAILS	DEPTH (ft)		WELL CONSTRUCTION DETAILS
		TPC	
	4.0	TRC	
	0.0	GS	
	12.5	BSC	
	12.5	EOH	

MANITOBA HYDRO

CIVIL ENGINEERING
MATERIALS & FIELD SERVICES

Field Overburden Log

PROJECT 09 Keeyask Geotechnical Investigation

HOLE NO.	HOLE DEPTH	PAGE
TH-09-12	3.1	1 OF 1

NORTHING	6255048	EASTING	0343775
ELEV		DATUM	
AZIMUTH		PLUNGE	
LINE REF		OFFSET	
PROPOSED HOLE NUMBER			
SURVEY SPEC.			

CONTRACTOR	Paddock Drilling Ltd
DRILLER	Wade
DRILLING METHOD	SSA, [redacted]
DRILL NAME	~~Acker Soil Sentry~~ Ranger
DATE STARTED	Sep/11/09
DATE COMPLETED	Sep/11/09
ROCK DEPTH	
WATER DEPTH	NA
HOLE DEPTH	3.1

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION (COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.)	SAMPLES TOP DEPTH	SAMPLES BASE DEPTH	SAMPLES NO.	SAMPLES TYPE	SAMPLES DIA ()	SAMPLES REC ()	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0	0.1	Peat	Peat - Fibrous									
0.1	1.5	CI	Clay - silty, MP, F.M, moist, Brown	0.7	0.8	1	ES			0.75		
				1.4	1.5	2	ES			0.5		
1.5	3.1	ML	Silt - LP, Mois, F.M., Brown, Trace Clay	2.2	2.3	3	ES					
				3.0	3.1	4	ES					
			Installed Pizo 10' 2.5' of Screen									

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	0 - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR	BP / CT
DATE	Sep / 12 / 09
SHIFT	Day

MANITOBA HYDRO

INSTRUMENT COMPLETION DIAGRAM

PROJECT	~~XXXXXXXX~~ Keeyask	
HOLE NO.	DEPTH	No. of INSTRUMENTS
TH-09-12	31	

LOCATION	
NORTH 6255048	EAST 0343775
ELEV G/S	DATUM
AZIMUTH	PLUNGE
INSTRUMENT IDENTIFICATION NUMBERS	

CONTRACTOR	~~XXXXXXXX~~ Paddock
DRILLER	Wade
DRILLING METHOD	~~XXXX~~ SSA
DRILL NAME	Ranger
DATE STARTED	SEP/12/09
DATE COMPLETED	SEP/12/09
ROCK SURFACE	NA
GROUNDWATER	NA
END OF HOLE	10

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: 1¼"
Type: PVC

GROUT
Type:
Mix Ratio:
Quantity:

SEAL
Type: EPM
Quantity: 1 bag

SANDPACK
Type: Silica
Quantity: 0.5

SCREEN
Diameter: 1¼"
Type: PVC
Interval: 2.5'

TPC	TOP PROTECT CASING
TRC	TOP OF RISER CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
EOH	END OF HOLE

WELL DETAILS	DEPTH (ft.)		WELL CONSTRUCTION DETAILS
		TPC	
	2.5	TRC	
	0.0	GS	
	10	BSC	
	10	EOH	

MANITOBA HYDRO

CIVIL ENGINEERING
MATERIALS & FIELD SERVICES

Field Overburden Log

PROJECT 09 Keeyask Geotechnical Investigation

HOLE NO.	HOLE DEPTH	PAGE
TH-09-13	4.6	1 OF 1

NORTHING 6254890	EASTING 0343912	CONTRACTOR	Paddock Drilling Ltd
ELEV	DATUM	DRILLER	Wade
AZIMUTH	PLUNGE	DRILLING METHOD	SSA
LINE REF	OFFSET	DRILL NAME	Dandet
PROPOSED HOLE NUMBER		DATE STARTED	Sept/12/09
SURVEY SPEC.		DATE COMPLETED	Sept/12/09
		ROCK DEPTH	
		WATER DEPTH	NA
		HOLE DEPTH	4.6

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION (COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.)	SAMPLES TOP DEPTH	SAMPLES BASE DEPTH	SAMPLES NO.	SAMPLES TYPE	SAMPLES DIA ()	SAMPLES REC ()	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0	1.5	ML	Silt - LP, Firm-Stiff, moist, Brown, some clay	0.7	0.8	1	FS			1.0		
				1.4	1.5	2	FS			1.0		
1.5	4.6	SM	Sand - PG, FG, Compact (Interbed), damp, Brown, some silt	2.2	2.3	3	FS					
			No Sloughing	3.0	3.1	4	FS					
			Percolating well installed to 5'	3.7	3.8	5	FS					
			Piezo installed 10' 2.5' of screen	4.5	4.6	6	FS					

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	0 - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR RP / CF

DATE Sept. / 12 / 09

SHIFT

MANITOBA HYDRO

INSTRUMENT COMPLETION DIAGRAM

PROJECT	Keeyask	
HOLE NO.	DEPTH	No. of INSTRUMENTS
TH-09-13	4.6	

LOCATION	
NORTH 6254890	EAST 0343912
ELEV G/S	DATUM
AZIMUTH	PLUNGE
INSTRUMENT IDENTIFICATION NUMBERS	

CONTRACTOR	Paddock Drilling LTD
DRILLER	Wade
DRILLING METHOD	SSA
DRILL NAME	Ronas
DATE STARTED	SEP 9/12/09
DATE COMPLETED	SEP 1/12/09
ROCK SURFACE	
GROUNDWATER	NA
END OF HOLE	4.6

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: 1¼"
Type: PVC

GROUT
Type:
Mix Ratio:
Quantity:

SEAL
Type: EPM
Quantity: 1 bag

SANDPACK
Type: silica sand
Quantity: 0.5 bags

SCREEN
Diameter: 1¼"
Type: PVC
Interval: 2.5'

TPC TOP PROTECT CASING
TRC TOP OF RISER CASING
GS GROUND SURFACE
BS BENTONITE SEAL
FP FILTER PACK
TSC TOP OF SCREEN
BSC BOTTOM OF SCREEN
EOH END OF HOLE

WELL DETAILS	DEPTH (ft)		WELL CONSTRUCTION DETAILS
		TPC	
	2.5	TRC	
	0.0	GS	
	10	BSC	
	15	EOH	

MANITOBA HYDRO

INSTRUMENT COMPLETION DIAGRAM

PROJECT	Keeyask	
HOLE NO.	DEPTH	No. of INSTRUMENTS
TH-09-13A	5'	

LOCATION	1m South of TH-09-13
NORTH	EAST
ELEV G/S	DATUM
AZIMUTH	PLUNGE
INSTRUMENT IDENTIFICATION NUMBERS	

CONTRACTOR	Paddock Drilling LTD
DRILLER	Wade
DRILLING METHOD	SSA
DRILL NAME	Ranger
DATE STARTED	Sep 12/09
DATE COMPLETED	Sep 12/09
ROCK SURFACE	NA
GROUNDWATER	NA
END OF HOLE	NA

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: 4"
Type: PVC

GROUT
Type:
Mix Ratio:
Quantity:

SEAL
Type: EPM
Quantity: 2.5

SANDPACK
Type: Silica Sand
Quantity: 0.5 bags

SCREEN
Diameter:
Type:
Interval:

TPC	TOP PROTECT CASING
TRC	TOP OF RISER CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
EOH	END OF HOLE

WELL DETAILS	DEPTH (ft)		WELL CONSTRUCTION DETAILS
		TPC	
		TRC	
	0.0	GS	
	3'-10"		
Pea Gravel	4'-10"	BSC	
	5'	EOH	

MANITOBA HYDRO

CIVIL ENGINEERING
MATERIALS & FIELD SERVICES

Field Overburden Log

PROJECT 09 Keeyask Geotechnical Investigation

HOLE NO.	HOLE DEPTH	PAGE
TH-09-14	4.6	1 OF 1

NORTHING 6254860 EASTING 0344001	
ELEV	DATUM
AZIMUTH	PLUNGE
LINE REF	OFFSET
PROPOSED HOLE NUMBER	
SURVEY SPEC.	

CONTRACTOR	Paddock Drilling Ltd
DRILLER	wade
DRILLING METHOD	SSA
DRILL NAME	Ranger
DATE STARTED	Sep 12 /09
DATE COMPLETED	Sep/12 /09
ROCK DEPTH	
WATER DEPTH	NA
HOLE DEPTH	4.6

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION (COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.)	SAMPLES TOP DEPTH	SAMPLES BASE DEPTH	SAMPLES NO.	SAMPLES TYPE	SAMPLES DIA ()	SAMPLES REC ()	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0	3.1	ML	Silt - LP, damp, Firm, Brown, Trace Sand									
				0.7	0.8	1	ES					
				1.4	1.5	2	ES					
			Trace Clay @ 1.5m									
				2.2	2.3	3	ES					
3.1	4.6	SM	Sand - silty, FG, PG, damp, Compact (Loosened), Brown									
				3.0	3.1	4	ES					
			Installed Percolating well to 5'	3.7	3.8	5	ES					
			Installed Piezo to 4' 5' of Screen on the bottom	4.5	4.6	6	ES					

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	0 - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR BD

DATE Sep/12/09

SHIFT Day

MANITOBA HYDRO

INSTRUMENT COMPLETION DIAGRAM

PROJECT	Keeyask	
HOLE NO.	DEPTH	No. of INSTRUMENTS
TH-09-14	4.6	

LOCATION	
NORTH 6254860	EAST 0344001
ELEV G/S	DATUM
AZIMUTH	PLUNGE
INSTRUMENT IDENTIFICATION NUMBERS	

CONTRACTOR	Paddock Drilling LTD
DRILLER	Wade
DRILLING METHOD	SSA
DRILL NAME	Ranger
DATE STARTED	SEP/12/09
DATE COMPLETED	SEP/12/09
ROCK SURFACE	NA
GROUNDWATER	NA
END OF HOLE	4.6

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: 1 1/4"
Type: PVC

GROUT
Type:
Mix Ratio:
Quantity:

SEAL
Type: EPM
Quantity: 1 bag

SANDPACK
Type: Silica Sand
Quantity: 1 bag

SCREEN
Diameter: 1 1/4"
Type: PVC
Interval: 5'

TPC TOP PROTECT CASING
TRC TOP OF RISER CASING
GS GROUND SURFACE
BS BENTONITE SEAL
FP FILTER PACK
TSC TOP OF SCREEN
BSC BOTTOM OF SCREEN
EOH END OF HOLE

WELL DETAILS	DEPTH (ft)		WELL CONSTRUCTION DETAILS
		TPC	
	4.0	TRC	
	0.0	GS	
	15	BSC	
	15	EOH	

MANITOBA HYDRO

INSTRUMENT COMPLETION DIAGRAM

PROJECT	Keeyask	
HOLE NO.	DEPTH	No. of INSTRUMENTS
TH-09-14A	5'	

LOCATION	1m South OF TH-09-14
NORTH	EAST
ELEV G/S	DATUM
AZIMUTH	PLUNGE
INSTRUMENT IDENTIFICATION NUMBERS	

CONTRACTOR	Paddock Drilling LTD
DRILLER	Wade
DRILLING METHOD	SSA
DRILL NAME	Ranger
DATE STARTED	SEP/12/09
DATE COMPLETED	SEP/12/09
ROCK SURFACE	NA
GROUNDWATER	NA
END OF HOLE	5'

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: 4"
Type: PVC

GROUT
Type:
Mix Ratio:
Quantity:

SEAL
Type: EPM
Quantity: 2.5

SANDPACK
Type: silica sand
Quantity: 0.5 bags

SCREEN
Diameter:
Type:
Interval:

TPC TOP PROTECT CASING
TRC TOP OF RISER CASING
GS GROUND SURFACE
BS BENTONITE SEAL
FP FILTER PACK
TSC TOP OF SCREEN
BSC BOTTOM OF SCREEN
EOH END OF HOLE

WELL DETAILS	DEPTH (ft)		WELL CONSTRUCTION DETAILS
		TPC	
	3.0	TRC	
	0.0	GS	
	3'-10"	TSC	
	4'-10"	BSC	
Pea gravel			
	5	EOH	

MANITOBA HYDRO

CIVIL ENGINEERING
MATERIALS & FIELD SERVICES

Field Overburden Log

PROJECT 09 Keeyask Geotechnical Investigation

HOLE NO.	HOLE DEPTH	PAGE
TH-09-15	4.6	1 OF 1

NORTHING 6254864 EASTING 0344106	
ELEV	DATUM
AZIMUTH	PLUNGE
LINE REF	OFFSET
PROPOSED HOLE NUMBER	
SURVEY SPEC.	

CONTRACTOR	Paddock Drilling Ltd
DRILLER	wade
DRILLING METHOD	SSA
DRILL NAME	Ranger
DATE STARTED	SEP 7/11/09
DATE COMPLETED	SEP/11/09
ROCK DEPTH	
WATER DEPTH	N/A
HOLE DEPTH	4.6

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION (COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.)	SAMPLES TOP DEPTH	SAMPLES BASE DEPTH	SAMPLES NO.	SAMPLES TYPE	SAMPLES DIA ()	SAMPLES REC ()	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0	0.06	OL	Organic Clay (TOPSOIL)									
				0.7	0.8	1	ES					
0.06	1.6	ML	Silt - Clayey, very soft, LP, Moist, TAN - Brown, Trace Sand	1.4	1.5	2	ES					
1.6	3.1	SM	Sand - Silty, FG, PG, Dry, Brown, Compact (Tufted)	2.2	2.3	3	ES					
				3.0	3.1	4	ES					
			Sloughed to 2.3 m									
				3.7	3.8	5	ES					
				4.5	4.6	6	ES					

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	0 - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR BP

DATE SEP/11/09

SHIFT Day

MANITOBA HYDRO

CIVIL ENGINEERING
MATERIALS & FIELD SERVICES

Field Overburden Log

PROJECT 09 Keeyask Geotechnical Investigation

HOLE NO.	HOLE DEPTH	PAGE
TH-09-16	3.1	1 OF 1

NORTHING 6255073 EASTING 0344001	
ELEV	DATUM
AZIMUTH	PLUNGE
LINE REF	OFFSET
PROPOSED HOLE NUMBER	
SURVEY SPEC.	

CONTRACTOR	Paddock Drilling Ltd
DRILLER	Wade
DRILLING METHOD	SSA
DRILL NAME	Ranger
DATE STARTED	SEP/12/09
DATE COMPLETED	SEP/12/09
ROCK DEPTH	
WATER DEPTH	NA
HOLE DEPTH	3.1

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLES TOP DEPTH	SAMPLES BASE DEPTH	SAMPLES NO.	SAMPLES TYPE	SAMPLES DIA ()	SAMPLES REC ()	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0	0.2	Peat	Peat - Fibrous									
0.2	3.1	CL	Clay - Silty, MP, Frozen									
			brown	0.7	0.8	1	ES					
			- Firm, moist @ 1.4m	1.4	1.5	2	ES			0.25		
			Grey @ 2.1m.	2.2	2.3	3	ES			0.5		
			Installed 10' Piezo 2.5' of Screen	3.0	3.1	4	ES			0.5		

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	0 - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR	BT
DATE	SEPT/12/09
SHIFT	Day

MANITOBA HYDRO

INSTRUMENT COMPLETION DIAGRAM

PROJECT		
~~[illegible]~~ Keeyask		
HOLE NO.	DEPTH	No. of INSTRUMENTS
TH-09-16	3.1	

LOCATION	
NORTH 6255073	EAST 0344001
ELEV G/S	DATUM
AZIMUTH	PLUNGE
INSTRUMENT IDENTIFICATION NUMBERS	

CONTRACTOR	~~[illegible]~~ Paddock
DRILLER	Wade
DRILLING METHOD	~~[illegible]~~ SSA
DRILL NAME	Ranger
DATE STARTED	Sep/12/09
DATE COMPLETED	Sep/12/09
ROCK SURFACE	NA
GROUNDWATER	NA
END OF HOLE	3.1

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: 1 1/4"
Type: PVC

GROUT
Type:
Mix Ratio:
Quantity:

SEAL
Type: EPM
Quantity: 1 bag

SANDPACK
Type: silica sand
Quantity: 0.5

SCREEN
Diameter: 1 1/4"
Type: PVC
Interval: 2.5

TPC	TOP PROTECT CASING
TRC	TOP OF RISER CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
EOH	END OF HOLE

WELL DETAILS	DEPTH (ft.)		WELL CONSTRUCTION DETAILS
		TPC	
	3.0	TRC	
	0.0	GS	
	10	BSC	
	10	EOH	

MANITOBA HYDRO

CIVIL ENGINEERING
MATERIALS & FIELD SERVICES

Field Overburden Log

PROJECT 09 Keeyask Geotechnical Investigation

HOLE NO.	HOLE DEPTH	PAGE
TH-09-17	3.1 m	1 OF 1

NORTHING 6255103	EASTING 0344064	CONTRACTOR	Paddock Drilling Ltd
ELEV	DATUM	DRILLER	Wade
AZIMUTH	PLUNGE	DRILLING METHOD	SSA
LINE REF	OFFSET	DRILL NAME	Ranger
PROPOSED HOLE NUMBER		DATE STARTED	Sept/11/09
SURVEY SPEC.		DATE COMPLETED	Sept/11/09
		ROCK DEPTH	
		WATER DEPTH	NA
		HOLE DEPTH	3.1m

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION (COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.)	SAMPLES TOP DEPTH	SAMPLES BASE DEPTH	SAMPLES NO.	SAMPLES TYPE	SAMPLES DIA ()	SAMPLES REC ()	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0	0.2	Peat	Peat - Fibrous									
0.2	3.1	CI	Clay-Silty, MP, Frozen, Brown	0.7	0.8	1	FS					
				1.4	1.5	2	FS					
			Installed 4" PVC 5' - 3' of Stick up 1' of Stick up									
				2.2	2.3	3	FS					
			EOH @ 3.1m	3.0	3.1	4	FS					

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	O - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR	BP
DATE	Sep/11/09
SHIFT	Day

MANITOBA HYDRO

INSTRUMENT COMPLETION DIAGRAM

PROJECT		
~~XXXXXXX~~ Keeyask		
HOLE NO.	DEPTH	No. of INSTRUMENTS
TH-09-17	3.1m	

LOCATION	
NORTH 6255103	EAST 0344064
ELEV G/S	DATUM
AZIMUTH	PLUNGE
INSTRUMENT IDENTIFICATION NUMBERS	

CONTRACTOR	~~XXXXXXX~~ Rockrock
DRILLER	wade
DRILLING METHOD	~~XXX~~ SSA
DRILL NAME	Ranger
DATE STARTED	Sept/11/09
DATE COMPLETED	Sept/11/09
ROCK SURFACE	NA
GROUNDWATER	NA
END OF HOLE	3.1m

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: 4"
Type: PVC

GROUT
Type:
Mix Ratio:
Quantity:

SEAL
Type: EPM
Quantity: 1 bag

SANDPACK
Type: Silica
Quantity: 1.5 bags

SCREEN
Diameter:
Type:
Interval:

TPC	TOP PROTECT CASING
TRC	TOP OF RISER CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
EOH	END OF HOLE

WELL DETAILS	DEPTH (ft.)		WELL CONSTRUCTION DETAILS
		TPC	
		TRC	
	0.0	GS	
	3'-10"		
Peagravel	4'-10"	BSC	
	5'	EOH	

MANITOBA HYDRO

CIVIL ENGINEERING
MATERIALS & FIELD SERVICES

Field Overburden Log

PROJECT 09 Keeyask Geotechnical Investigation

HOLE NO.	HOLE DEPTH	PAGE
TH-09-18	3.1	1 OF 1

NORTHING 6255031	EASTING 0344097	CONTRACTOR	Paddock Drilling Ltd
ELEV	DATUM	DRILLER	Wade
AZIMUTH	PLUNGE	DRILLING METHOD	ASA
LINE REF	OFFSET	DRILL NAME	Rander
PROPOSED HOLE NUMBER		DATE STARTED	Sep/11/09
SURVEY SPEC.		DATE COMPLETED	Sep/11/09
		ROCK DEPTH	
		WATER DEPTH	Surface
		HOLE DEPTH	3.1

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION (COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.)	SAMPLES TOP DEPTH	SAMPLES BASE DEPTH	SAMPLES NO.	SAMPLES TYPE	SAMPLES DIA ()	SAMPLES REC ()	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0	0.2	Peat	Peat - Fibrous									
0.2	3.1	ML	Silt - N-LP, very soft, wet, TAN, Trace to some Sand									
				0.7	0.8	1	ES					
				1.4	1.5	2	ES					
			Clay seam @ 2.2m approx 5cm thick									
				2.2	2.3	3	ES					
			Sloughed into surface									
				3.0	3.1	4	ES					
			EOH @ 3.1m									

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	0 - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR	BP
DATE	Sep/11/09
SHIFT	Day

MANITOBA HYDRO

CIVIL ENGINEERING
MATERIALS & FIELD SERVICES

Field Overburden Log

PROJECT 09 Keeyask Geotechnical Investigation

HOLE NO.	HOLE DEPTH	PAGE
TH-09-19	3.1	1 OF 1

NORTHING 6255015	EASTING 0343961
ELEV	DATUM
AZIMUTH	PLUNGE
LINE REF	OFFSET
PROPOSED HOLE NUMBER	
SURVEY SPEC.	

CONTRACTOR	Paddock Drilling Ltd
DRILLER	Wade
DRILLING METHOD	SSA
DRILL NAME	Ranger
DATE STARTED	SEP/11/09
DATE COMPLETED	SEP/11/09
ROCK DEPTH	
WATER DEPTH	NA
HOLE DEPTH	3.1

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION (COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.)	SAMPLES TOP DEPTH	SAMPLES BASE DEPTH	SAMPLES NO.	SAMPLES TYPE	SAMPLES DIA ()	SAMPLES REC ()	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0	1.5	ML	Silt-CL, moist, very soft, Tan, some sand									
			- wet @ 1.5 m	0.7	0.8	1	ES					
				1.4	1.5	2	ES					
1.5	3.1	SM	Sand-silty, Pr., F-MC., wet, Brown, compact (Inferred)	2.2	2.3	3	ES					
			4" well Installed to 5' with 3' of Sticking, bottom 1' slotted.	3.0	3.1	4	ES					
			hole sloughed @ 1.5 m									
			EOH @ 3.1 m									

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	0 - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR	RP
DATE	SEP/11/09
SHIFT	Day

MANITOBA HYDRO

INSTRUMENT COMPLETION DIAGRAM

PROJECT	~~XXXXXXX~~ Keeyask	
HOLE NO.	DEPTH	No. of INSTRUMENTS
TH-09-19	3.1	

LOCATION	
NORTH 6255015	EAST 0343961
ELEV G/S	DATUM
AZIMUTH	PLUNGE
INSTRUMENT IDENTIFICATION NUMBERS	

CONTRACTOR	~~XXXXXXX~~ Paddock
DRILLER	Wade
DRILLING METHOD	~~XXX~~ SSA
DRILL NAME	Ranger
DATE STARTED	Sep/11/09
DATE COMPLETED	Sep/11/09
ROCK SURFACE	NA
GROUNDWATER	
END OF HOLE	3.1

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: 4"
Type: PVC

GROUT
Type:
Mix Ratio:
Quantity:

SEAL
Type: EPM
Quantity: 1 bag

SANDPACK
Type: silica
Quantity: 1 bag

SCREEN
Diameter:
Type:
Interval:

TPC	TOP PROTECT CASING
TRC	TOP OF RISER CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
EOH	END OF HOLE

WELL DETAILS	DEPTH (ft.)		WELL CONSTRUCTION DETAILS
		TPC	
		TRC	
	0.0	GS	
	3'-10"		
Sw cut	4'-10"	BSC	
Pea gravel	5'	EOH	

MANITOBA HYDRO

Civil Engineering

Materials And Field Services

KEEYASK

DEPTH (m)	LAYER DEPTH (ELEV) (m)	SAMPLE NUM.	Moisture (PL, M.C., LL) 20 40 60 80 / Standard Penetration Uncorrected Blow Count (N) 20 40 60 80	Unconfined Compression ● / Vane Shear Insitu ⊕ Lab ◆ (kPa) 20 40 60 80 / Penetrometer (Lab) ▽ / Penetrometer (Field) ▽ (kPa) 20 40 60 80	GRAPHIC LOG	USCS	DESCRIPTION
						PT	LOCATION G-2 ESKER TERRAIN TYPE VEGETATION
		1	○			SM	(0.10 - 0.40) SAND, fine, with silt, orange, oxidized, overlain by 0.10 peat
		2	○			CI	(0.40 - 1.20) CLAY, trace sand, light brown, varved, occasional sand pockets
1	1.20 (178.90)					SM	(1.20 - 3.80) SAND, with silt, light brown 1.20 to 3.30 - with subrounded fine gravel 1.40 to 3.80 - moist
		3	○				
2							
3		4					3.30 to 3.80 - sand is fine grained, and silt
4							

PRELIMINARY

COORDINATES 6254587.30 N, 343962.20 E UTM27-15 CRD1929	AZIMUTH Vertical	PLUNGE -90.00°	START DATE 1991 04 25	HOLE TYPE (CAT 229)	HOLE G-5360
	DATUM ELEV 180.10	ROCK ELEV	END DATE 1991 04 25	CONTRACTOR ZELEN-RG	
COMPOSITE LOG	ACRES MANITOBA LTD			DATE PRINTED 2009 06 12	SHEET 1 OF 1

NAD 27

MANITOBA HYDRO

COMPOSITE LOG
[new]

FIELD OVERBURDEN LOG

PROJECT

HOLE NO.	HOLE DEPTH	PAGE
G-5017	26.69	1 OF 1

LOCATION G-2 ESKER - WEST 91-213 G-2 ESKER - WEST 91-213	CONTRACTOR MIDWEST-RH
	DRILLER MIDWEST-RH
	DRILLING METHOD
NORTHING 6254671.70 N EASTING 343882.60 E	DRILL NAME Sound Dynamics
ELEV 180.20 DATUM GROUND	DATE STARTED 4/28/1991
AZIMUTH VERTICAL PLUNGE VERTICAL	DATE COMPLETED 4/28/1991
LINE REF OFFSET	ROCK DEPTH Bedrock not identified
PROPOSED HOLE NUMBER	WATER DEPTH - Water Table not identified
SURVEY SPEC. UTM27-15 CRD1929 Proposed	HOLE DEPTH 26.69

PRELIMINARY

TOP DEPTH	BASE DEPTH	SOIL TYPE	DESCRIPTION COLOR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLES TOP DEPTH	BASE DEPTH	NO.	TYPE	DIA (cm)	REC (cm)	PEN (kPa)	SPT BLOW COUNTS	VANE SHEAR (kPa)
0.00			(0.00 - 0.10) Peat, brown, rootlets, wet.									
0.10			(0.10 - 0.30) Clay, brown, and silt, tr.fine									
0.10	0.30	Nbn	sand, frozen, med.dense.									
0.30			(0.30 - 3.20) Sand, lt.brown, and silt, fine	0.30	0.30	1B	DS					
			grained, uniform, moist, med.dense.									
3.20			(3.20 - 5.40) Sand, lt.brown, tr.silt, uniform,									
			fine grained, moist, dense.									
5.40			(5.40 - 8.20) Sand, brown, medium to fine									
			grained, damp, med.dense.									
8.20			(8.20 - 10.50) Sand, grey-brown, and silt,									
			tr.clay, medium to fine grained, moist,									
			dense.									
10.50			(10.50 - 18.70) Sand, grey, medium									
			grained, damp, medium dense.									
18.70			(18.70 - 23.60) Sand, brown, and silt,									
			tr.gravel, dmap, med.dense.									
23.60			(23.60 - 26.69) Sand, grey, and silt, tr.clay,									
			tr.gravel, damp, med.dense.									
26.69			(26.69) End of Hole.									
			NAD 27									

SAMPLING METHOD		SHIPPING CONTAINER	
A - SPLIT TUBE	E - AUGER CUTTINGS	N - LINER	R - PAIL
B - THIN WALL TUBE	F - WASH	0 - TUBE	S - PLIOFILM
C - AUGER BARREL	G - BULK SAMPLE	P - MOISTURE TIN	W - WAXED
D - CORE BARREL	H - BLOCK SAMPLE	G - GLASS JAR	Z - DISCARDED

INSPECTOR P.HILLIUS

FIELD LOG FOR VERIFICATION

The soil descriptions and observations are those observed by the drill inspector and have not been compared to lab testing results and are intended for review purposes only.

Enclosure 2
Laboratory testing data

AECOM

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Memorandum

Date:	September 18, 2009
To:	Gil Robinson
From:	Stephen Petsche
Subject:	Keeyask Generating Station – Infrastructure
Project number:	0217-200-07-0300

Distribution:

Attached are testing results for the above noted project. The testing included moisture contents and gradation determination on ten (10) samples collected from TH 09-13, TH 09-14 and TH 09-15. After the moisture contents were determined, the samples were washed over the 0.075 mm sieve, dried and hand sieved until refusal.

If you have any questions, please call.

Sincerely,

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

Attach.

MOISTURE CONTENT

JOB No.: 0217-200-07-0300
CLIENT: Manitoba Hydro
PROJECT: Keeyask Generating Station - Infrastructure

DATE: September 18, 2009
TECHNICIAN: SP

HOLE NO.	09-13	09-13	09-13	09-13	09-14	09-14
DEPTH (m)	1.4 - 1.5	2.2 - 2.3	3.0 - 3.1	4.5 - 4.6	2.2 - 2.3	3.0 - 3.1
SAMPLE NO.	ES-02	ES-03	ES-04	ES-06	ES-03	ES-04
MOISTURE CONTENT %	19.2	12.7	6.5	5.1	18.6	19.6

HOLE NO.	09-14	09-15	09-15	09-15
DEPTH (m)	3.7 - 3.8	2.2 - 2.3	3.0 - 3.1	3.7 - 3.8
SAMPLE NO.	ES-05	ES-03	ES-04	ES-05
MOISTURE CONTENT %	12.4	13.1	7.9	10.5

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

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

NOTES:

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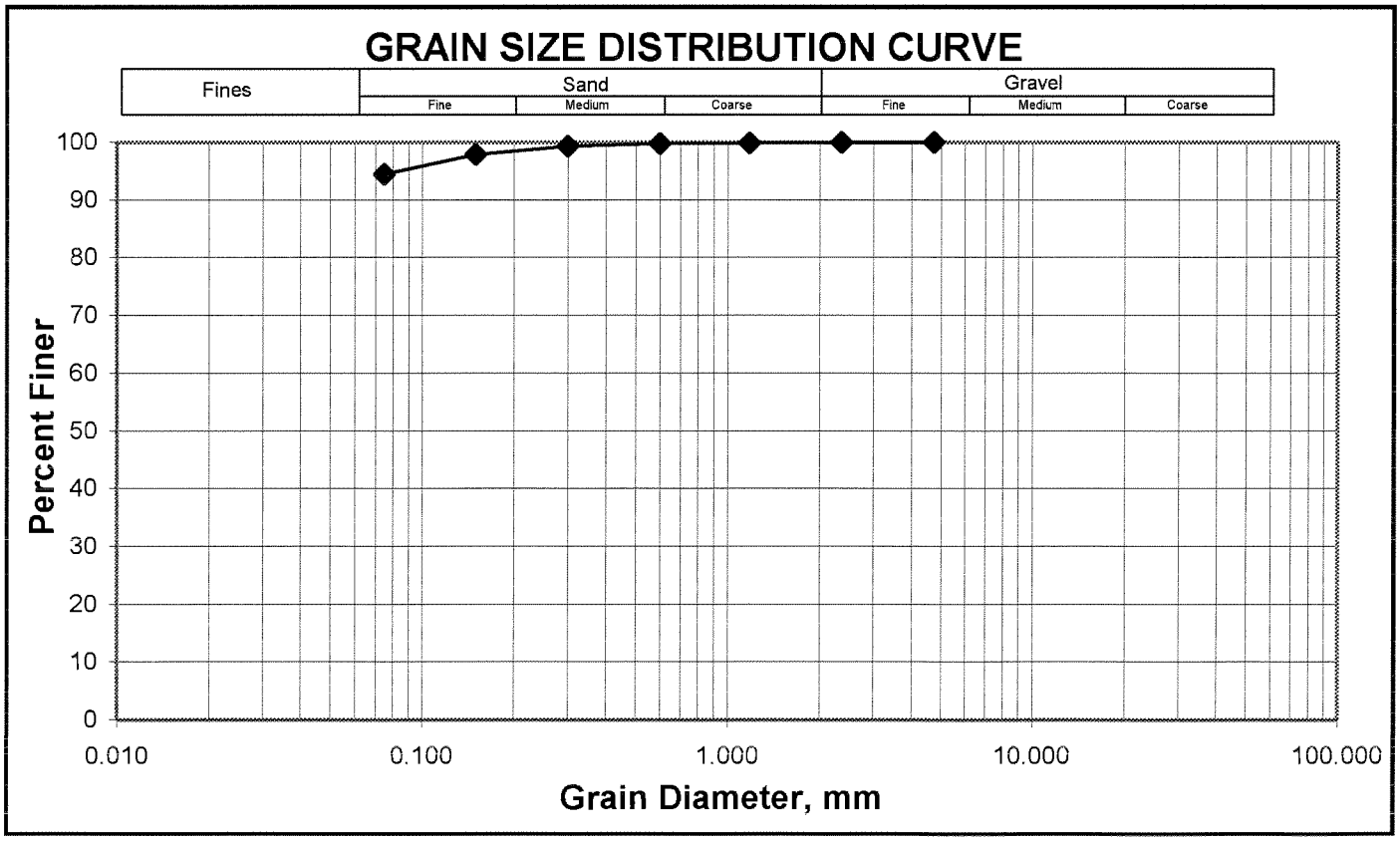
Client:	Manitoba Hydro	Hole No.	09-13
Project:	Keeyask Gen. Stn. - Infrastructure	Sample No.	ES-02
Job No:	0217-200-07-0300	Depth:	1.4 - 1.5 m
Date :	18-Sep-09	Sample Description:	Silt, Trace Fine Sand

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
100.0	4"		
75.0	3"		
50.0	2"		
37.5	1 1/2"		
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.50	1/2"		
9.50	3/8"		
4.75	No.4		
2.36	No.8	100.0	
1.180	No. 16	99.9	
0.600	No.30	99.8	
0.300	No. 50	99.3	
0.150	No. 100	97.9	
0.075	No. 200	94.5	



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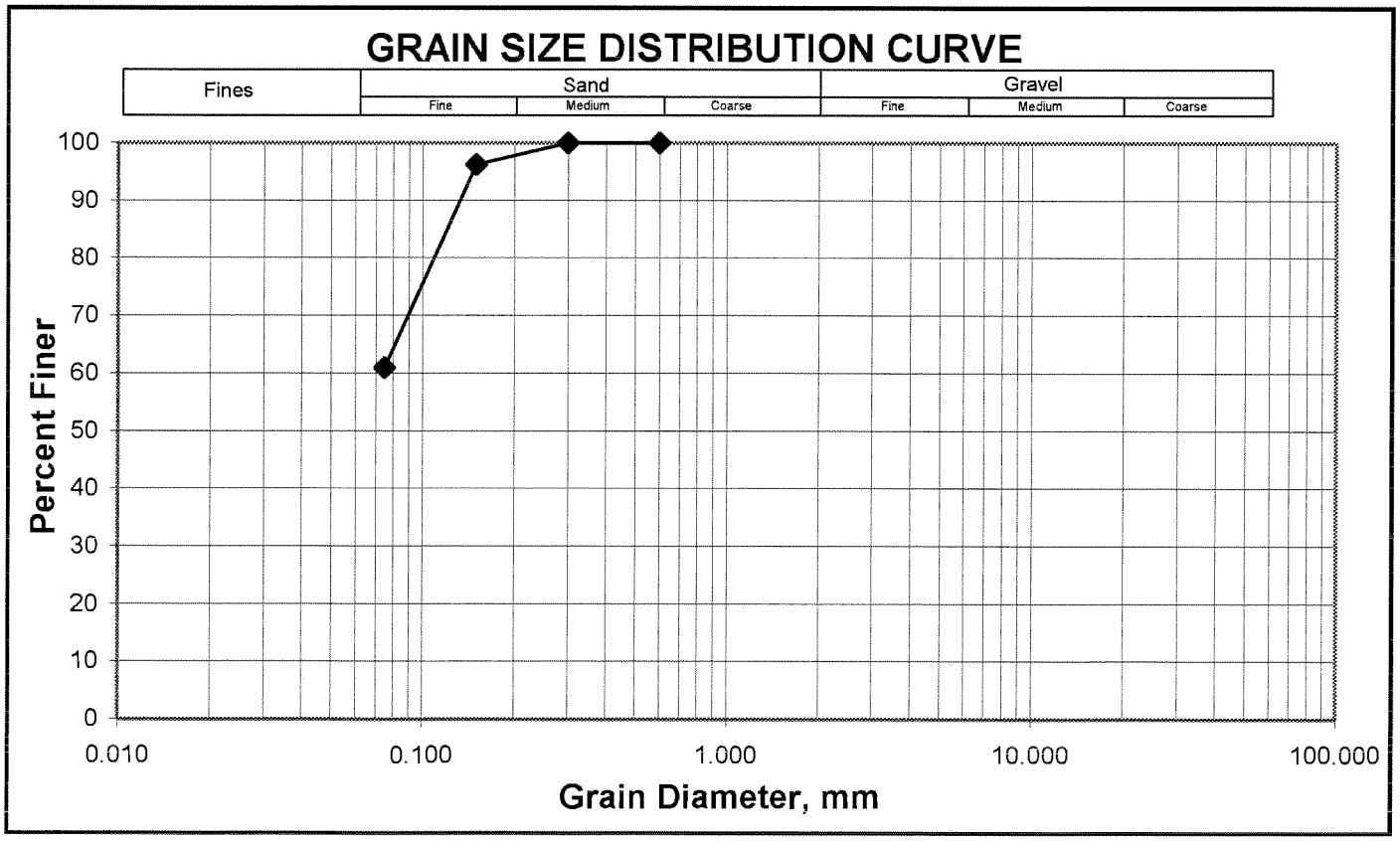
Client:	Manitoba Hydro	Hole No.	09-13
Project:	Keeyask Gen. Stn. - Infrastructure	Sample No.	ES-03
Job No:	0217-200-07-0300	Depth:	2.2 - 2.3 m
Date :	18-Sep-09	Sample Description:	Silt and Sand

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
100.0	4"		
75.0	3"		
50.0	2"		
37.5	1 1/2"		
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.50	1/2"		
9.50	3/8"		
4.75	No.4		
2.36	No.8		
1.180	No. 16		
0.600	No.30		
0.300	No. 50	100.0	
0.150	No. 100	96.3	
0.075	No. 200	61.0	



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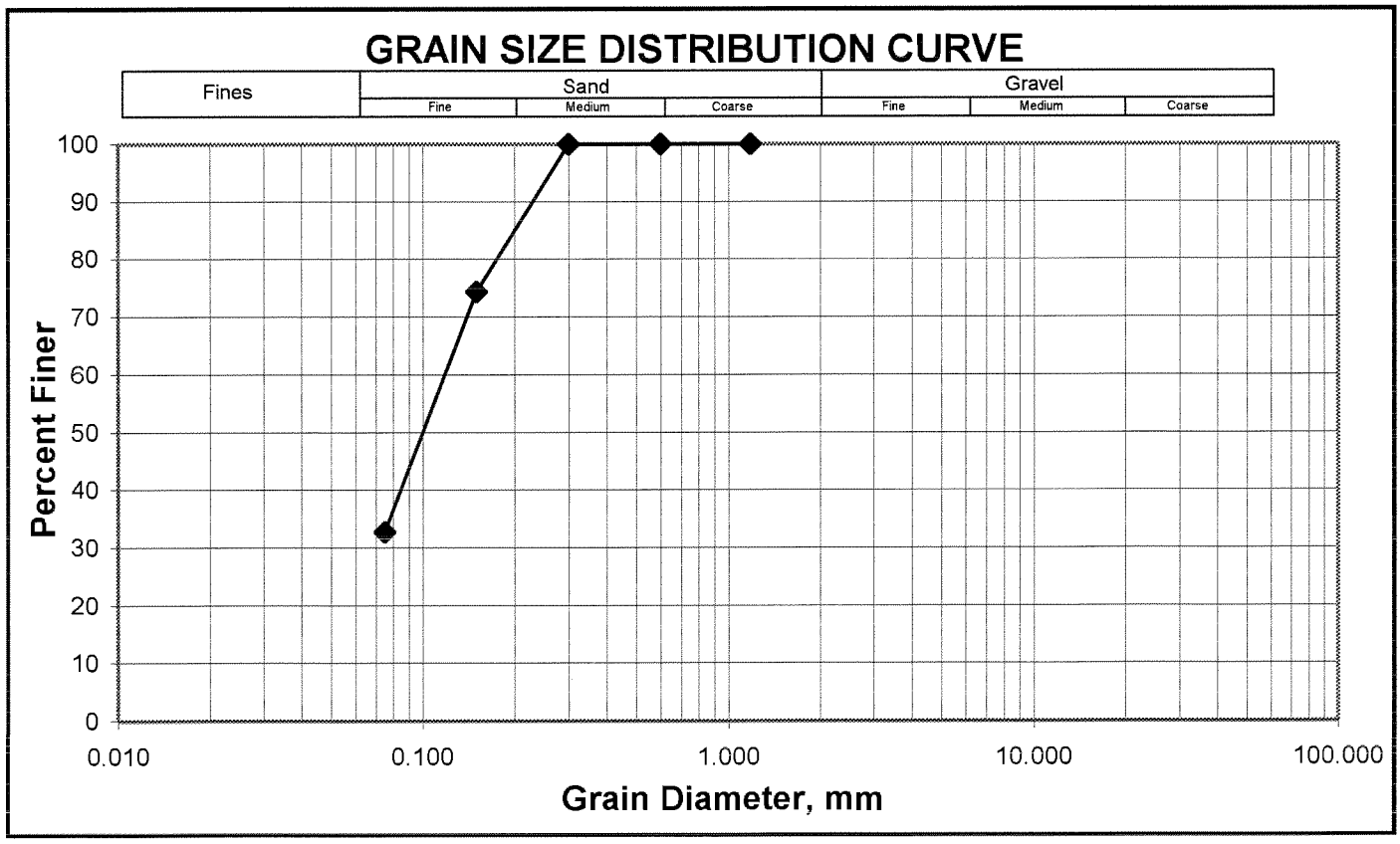
Client:	Manitoba Hydro	Hole No.	09-13
Project:	Keeyask Gen. Stn. - Infrastructure	Sample No.	ES-04
Job No:	0217-200-07-0300	Depth:	3.0 - 3.1 m
Date :	18-Sep-09	Sample Description:	Silty Sand

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
100.0	4"		
75.0	3"		
50.0	2"		
37.5	1 1/2"		
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.50	1/2"		
9.50	3/8"		
4.75	No.4		
2.36	No.8		
1.180	No. 16		
0.600	No.30	100.0	
0.300	No. 50	100.0	
0.150	No. 100	74.4	
0.075	No. 200	32.8	



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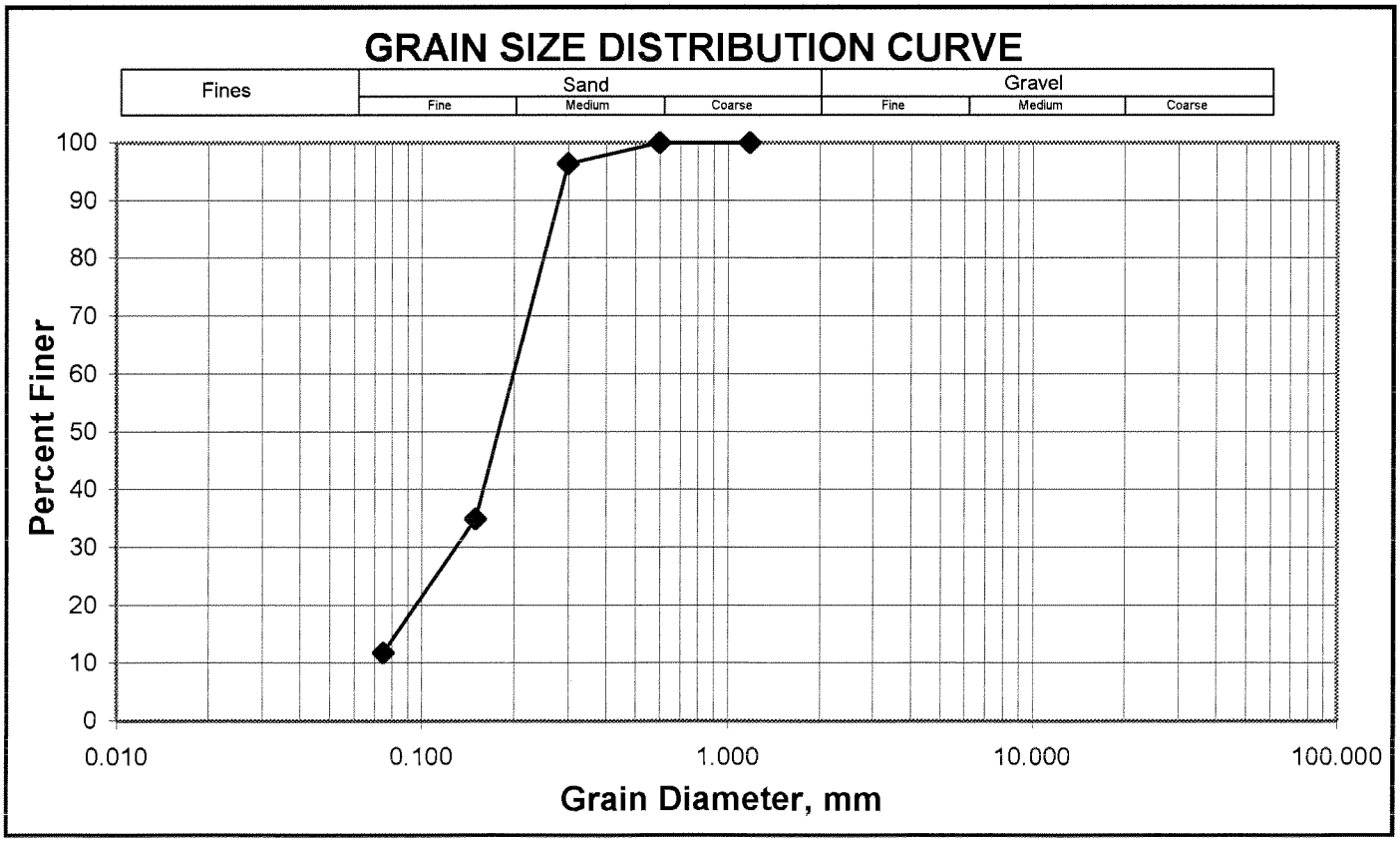
Client:	Manitoba Hydro	Hole No.	09-13
Project:	Keeyask Gen. Stn. - Infrastructure	Sample No.	ES-06
Job No:	0217-200-07-0300	Depth:	4.5 - 4.6 m
Date :	18-Sep-09	Sample Description:	Sand, Some silt

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
100.0	4"		
75.0	3"		
50.0	2"		
37.5	1 1/2"		
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.50	1/2"		
9.50	3/8"		
4.75	No.4		
2.36	No.8		
1.180	No. 16		
0.600	No.30	100.0	
0.300	No. 50	96.4	
0.150	No. 100	35.0	
0.075	No. 200	11.8	



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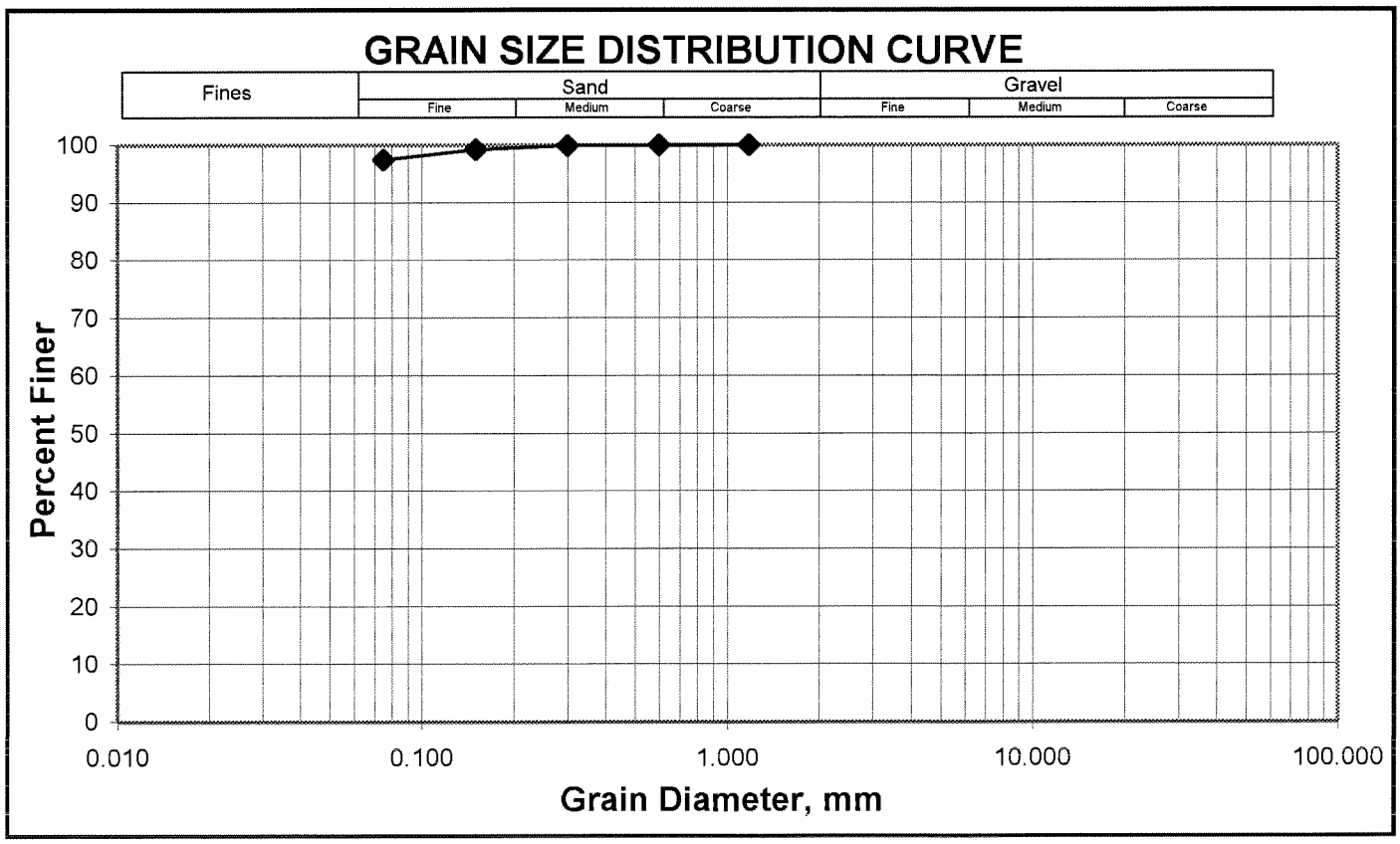
Client:	Manitoba Hydro	Hole No.	09-14
Project:	Keeyask Gen. Stn. - Infrastructure	Sample No.	ES-03
Job No:	0217-200-07-0300	Depth:	2.2 - 2.3 m
Date :	18-Sep-09	Sample Description:	Silt, Trace Fine Sand

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
100.0	4"		
75.0	3"		
50.0	2"		
37.5	1 1/2"		
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.50	1/2"		
9.50	3/8"		
4.75	No.4		
2.36	No.8		
1.180	No. 16		
0.600	No.30	100.0	
0.300	No. 50	99.9	
0.150	No. 100	99.3	
0.075	No. 200	97.5	



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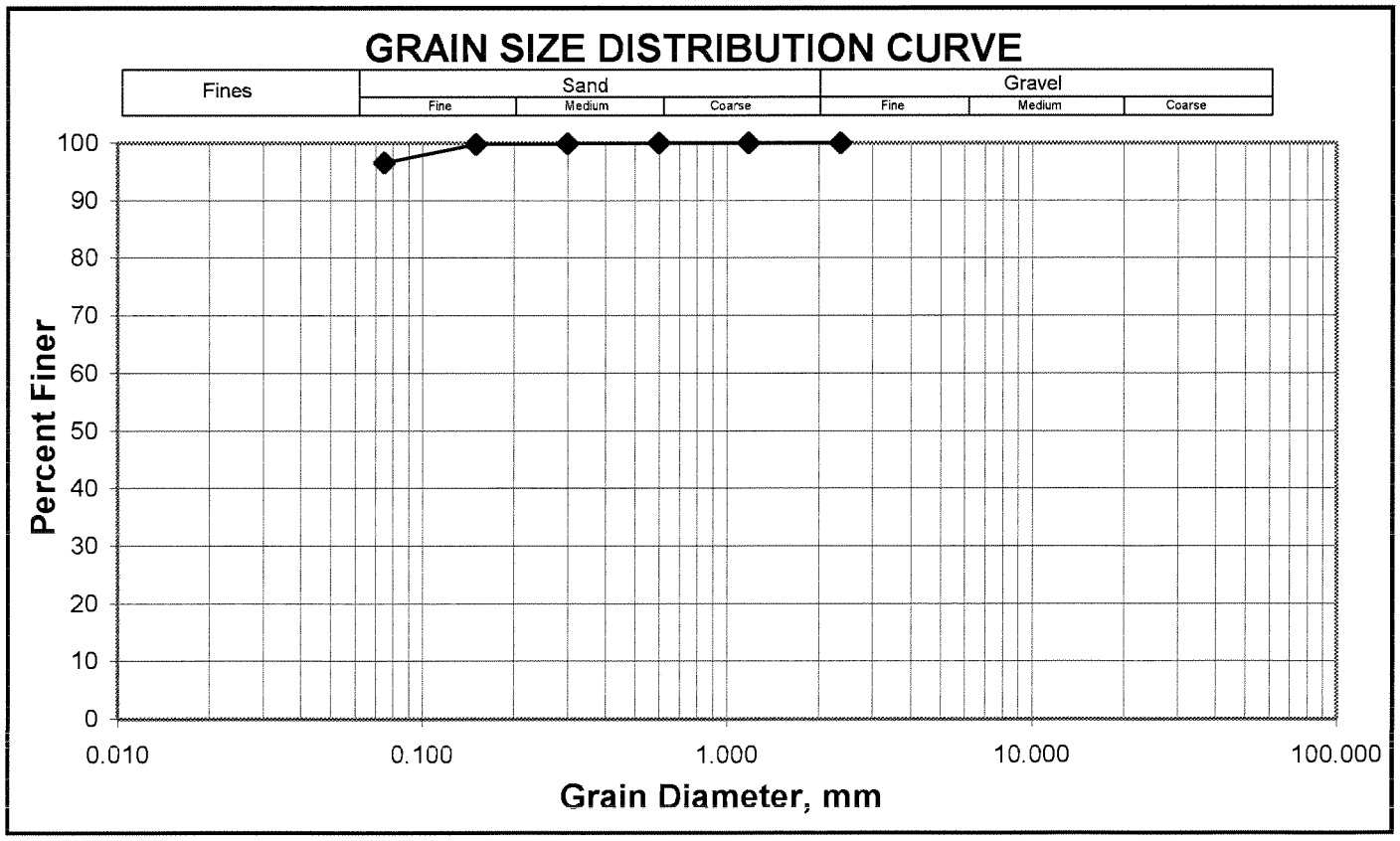
Client:	Manitoba Hydro	Hole No.	09-14
Project:	Keeyask Gen. Stn. - Infrastructure	Sample No.	ES-04
Job No:	0217-200-07-0300	Depth:	3.0 - 3.1 m
Date :	18-Sep-09	Sample Description:	Silt, Trace Fine Sand

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
100.0	4"		
75.0	3"		
50.0	2"		
37.5	1 1/2"		
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.50	1/2"		
9.50	3/8"		
4.75	No.4		
2.36	No.8		
1.180	No. 16	100.0	
0.600	No.30	100.0	
0.300	No. 50	99.9	
0.150	No. 100	99.8	
0.075	No. 200	96.6	



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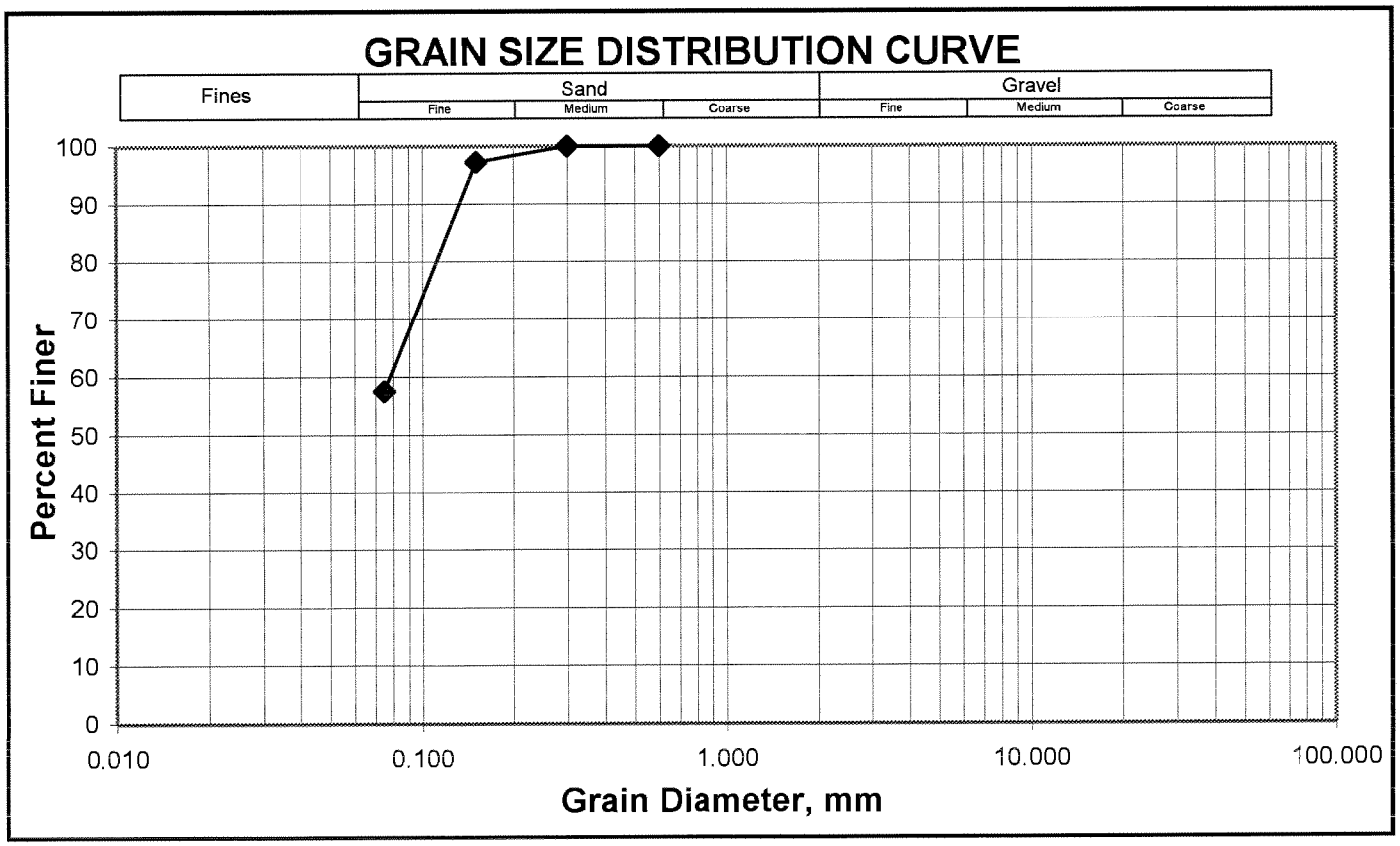
Client:	Manitoba Hydro	Hole No.	09-14
Project:	Keeyask Gen. Stn. - Infrastructure	Sample No.	ES-05
Job No:	0217-200-07-0300	Depth:	3.7 -3.8 m
Date :	18-Sep-09	Sample Description:	Silt and Sand

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
100.0	4"		
75.0	3"		
50.0	2"		
37.5	1 1/2"		
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.50	1/2"		
9.50	3/8"		
4.75	No.4		
2.36	No.8		
1.180	No. 16		
0.600	No.30		
0.300	No. 50	100.0	
0.150	No. 100	97.2	
0.075	No. 200	57.5	



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Project:	Keeyask Gen. Stn. - Infrastructure	Sample No.	ES-03
Job No:	0217-200-07-0300	Depth:	2.2 - 2.3 m
Date :	18-Sep-09	Sample Description:	Silty Sand

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
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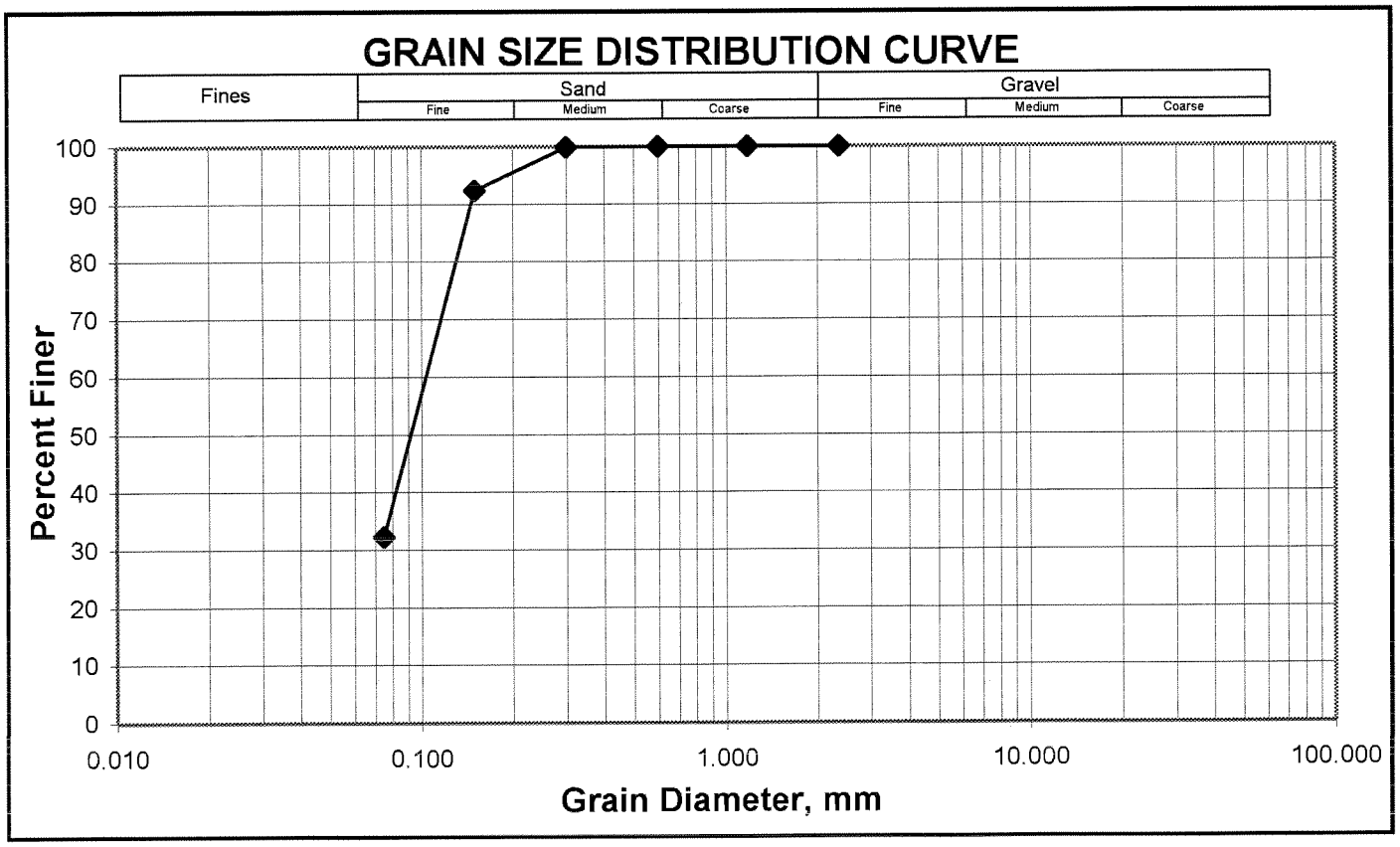
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.50	1/2"		
9.50	3/8"		
4.75	No.4		
2.36	No.8		
1.180	No. 16	100.0	
0.600	No.30	100.0	
0.300	No. 50	99.9	
0.150	No. 100	92.4	
0.075	No. 200	32.3	



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Client:	Manitoba Hydro	Hole No.	09-15
Project:	Keeyask Gen. Stn. - Infrastructure	Sample No.	ES-04
Job No:	0217-200-07-0300	Depth:	3.0 - 3.1 m
Date :	18-Sep-09	Sample Description:	Silty Sand

Sieve (mm.)	Sieve No.	Total Percent Passing	Specification (min - max)
100.0	4"		
75.0	3"		
50.0	2"		
37.5	1 1/2"		
25.0	1"		
19.0	3/4"		
16.0	5/8"		
12.50	1/2"		
9.50	3/8"		
4.75	No.4		
2.36	No.8		
1.180	No. 16	100.0	
0.600	No.30	100.0	
0.300	No. 50	99.9	
0.150	No. 100	66.0	
0.075	No. 200	26.6