October 25, 2018

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Mr. Sam Mirza-Agha
Town of The Pas
Box 870
81 Edwards Avenue
The Pas, Manitoba
R9A 1K8

T-607.05

P&R 14.73 JRCC

Via email

Dear Mr. Mirza-Agha,

RE: Town of The Pas - Letter Report for The Pas Lagoon Upgrade Geotechnical Investigation

JR Cousin Consultants Ltd. (JRCC) conducted a geotechnical investigation for the Town of The Pas, as part of The Pas wastewater treatment lagoon expansion project. The geotechnical investigation occurred on NW 2-56-26 WPM, on forested land located to the east of the existing lagoon site. The test hole location plan is attached. The soils were investigated for the construction of a liner for lagoon SAGR cells to service the Town of The Pas.

This report outlines the findings of the geotechnical investigation conducted at the proposed lagoon upgrade site, and evaluates the soils to determine their suitability for use as cell liner material, as well as any potential difficulties associated with the construction works, related to soil or groundwater conditions.

1.0 BACKGROUND

1.1 Canada-Manitoba Soil Survey

Based on existing soil reconnaissance survey mapping, the soils in the area of the lagoon expansion consist of:

- Lamb Lake Complex – Organic soils developed on mesic forest peat, overlying extremely calcareous, loamy, moderately stony till. The topography is level to depressional, and the drainage is poor to very poor.
- Orok Complex - Organic soils developed on mesic forest peat, overlying moderately to strongly calcareous, clayey to loamy lacustrine sediments. The topography is level to depressional flat, and the drainage is poor to very poor.
- Cayer Series – Terric Mesisol soils developed on mesic fen peat, overlying moderately to strongly calcareous, loamy lacustrine sediments. The topography is depressional to level and the drainage is very poor to poor.

1.2 Land Use Classification

Based on the soil survey report, these soils have an agricultural land use capability classification of Class 4W to 6W, which is land that has severe limitations for producing forage crops due to excessive water, and soils capable of producing perennial forage crops. Class 4 lands are considered to be in Water Quality Management Zone N2, while Class 6 lands are considered to be in Zone N4 under the

Nutrient Management Regulation (*Reg. 62/2008*). Zone N2 lands do not have any restrictions on developing wastewater treatment lagoons, which will result in the application of nutrients to the soil through effluent discharge. However, Zone N4 lands are considered sensitive lands that should not receive applications of nutrients.

2.0 GEOTECHNICAL FIELD INVESTIGATION

An onsite investigation of geotechnical conditions was conducted by JR Cousin Consultants Ltd. on April 26, 2018. A drill rig was used for drilling the test holes under the direct supervision of JRCC personnel. During the site investigation, six test holes were drilled to a maximum depth of 4.4 m, based on refusal. The test holes were drilled in the lagoon expansion area, to the east of the existing lagoon cell, which was recently cleared forested land. The test hole locations are shown on Plan 1.

The subsurface soil profile within each test hole was logged, water conditions were noted, and representative soil samples were collected as the soils varied along the profile. The samples were visually field-classified and confirmed through laboratory analysis. Shelby tubes of undisturbed in situ soil and bulk soil samples were collected for analysis of soil permeability. Following completion of the test holes, an assessment of the short term groundwater conditions was completed by measuring the static water level in the test holes. All test holes were then backfilled with bentonite. Details of each test hole soil profile, including depth and description of each soil layer and comments on groundwater levels can be found in the test hole logs attached.

2.1 Soil Profile

Based on the soils observed in the test holes, the subsurface soil profile was fairly consistent across the site. The general soil profile consisted of surficial peat, followed by a layer of high plastic clay, overlying a silty clay till material. Test hole one (TH1) located on the southwest corner of the property did not have a layer of peat or high plastic clay, and TH6, also in the southwest section did not have a layer of high plastic clay. The layer of high plastic clay material had an average thickness of 0.7 m. The following table summarizes the general soil profile observed across the potential lagoon area.

Primary Soil Type	Average Depth Range of Soil Layer	Secondary Soil Characteristics
Peat	0 m – 0.5 m	Organic
Clay (High plastic)	0.5 m – 1.2 m	Silty
Silt Till (medium plastic)	1.2 m – 4.4 m	Clayey

2.2 Groundwater and Bedrock

Short-term water accumulation was recorded in the test holes prior to backfilling by measuring the height of standing water in the test holes. The groundwater levels recorded in the test holes can vary based on seasonal conditions, i.e. snowmelt and high precipitation during rainy seasons. Groundwater levels were measured at depths ranging from 0.5 m to 2.7 m below the surface. Refusal was encountered in all of the test holes at depths ranging from 2.4 m to 4.4 m below the surface.

If site construction works occur, contractors should be made aware of the geotechnical conditions encountered onsite, as dewatering and slope stabilization may be required during construction, depending on the depth of excavation required.

3.0 LABORATORY TESTING, ANALYSIS AND DISCUSSION

Representative soil samples from the potential lagoon upgrade area were submitted to Wood Environment and Infrastructure for testing and analysis. The following is a summary of the testing results, while the detailed laboratory results are attached.

Three bagged samples were analyzed for the following:

- Atterberg Limits (plastic limit, liquid limit, and plasticity index, ASTM D4318)
- Soil Classification (ASTM D2487)
- Moisture Content (ASTM D2216)
- Particle Size Analysis (Hydrometer test, ASTM D422).

Two Shelby tube samples and one bulk sample from representative soil layers, were tested for:

- Hydraulic Conductivity (ASTM D5084) (in situ and reworked).

A summary of the laboratory results are as follows:

Sample ID	Soil Classification	Hydraulic Conductivity
TH2 0.4 m – 1.5 m	CH – high plastic clay and silt	-
TH2 1.5 m – 4.2 m	MH – medium plastic silt and clay	1.99×10^{-8} cm/sec (reworked)
TH5 1.5 m – 2.1 m	CH– high plastic clay and silt	1.71×10^{-8} cm/sec (in situ)
TH6 0.5 m – 1.1 m	MH – medium plastic silt and clay	2.28×10^{-8} cm/sec (in situ)

The laboratory indicated that soils with the following characteristics would provide a liner with a hydraulic conductivity of 1×10^{-7} cm/sec or less:

- Liquid limit of 30% or greater
- Plastic index of 10% or greater
- 30% or more passing a number 200 mesh sieve
- 20% or more of clay particles.

The soil samples submitted had liquid limits ranging from 21% to 68%; plastic indices ranging from 9 to 46; and clay contents ranging from 23.9% to 77.8%. Based on the above results, the bagged samples from TH6 0.5 m – 3.0 m and TH2 1.5 m – 4.2 m (medium plastic silt and clay) did not meet the criteria stated above, however did meet the permeability requirement (1×10^{-7} cm/sec or less) for a lagoon liner in an undisturbed state and after reworking, in both samples submitted. The bag sample results indicate that the medium

plastic silt and clay soils were marginal and may not consistently meet the permeability requirements. Additional permeability samples in the medium plastic silt and clay layer were attempted, but could not be obtained or utilized, due to the dense nature of the material.

4.0 LAGOON CELL LINER REQUIREMENTS

4.1 Current Guidelines

In accordance with the Manitoba Conservation and Water Stewardship Information Bulletin *Design Objectives for Wastewater Treatment Lagoons* (2014), a soil liner is to be a minimum of 1.0 m thick and have a hydraulic conductivity (i.e. the potential rate of fluid movement through the soil) of 1×10^{-7} m/sec or less. This low permeability rate is to protect the underlying groundwater from lagoon effluent seepage. The liner of a lagoon can be constructed using in situ (undisturbed native) soils, if the soils can consistently achieve a hydraulic conductivity of 1×10^{-7} cm/sec or less in their in situ state. If in situ soils cannot achieve the required hydraulic conductivity, the lagoon liner can be constructed by excavating and reworking suitable clay type soils to form the liner.

If the clay content of the soils is so low that even when excavated and reworked, the soils cannot consistently achieve a hydraulic conductivity of 1×10^{-7} cm/sec or less, a liner constructed of high plastic clay from a borrow pit, or a synthetic geomembrane liner would be required.

4.2 Lagoon SAGR Cell Liner Design

Based on the results of the onsite investigation and laboratory analysis, the excavated soils in the lagoon SAGR expansion area would likely achieve a permeability of 1×10^{-7} cm/sec or less, after reworking and compacting and potentially in an in situ state. Based on the laboratory results, the construction contractor would need to ensure that the soils forming the horizontal and vertical cell liners would be constructed near the optimal soil moisture content, without being too wet or too dry.

4.3 Utilization of Onsite Soils

The surficial peat material should be stripped from the expansion cell construction area and stockpiled for use as top dressing on the top and outer slopes of the SAGR cells. The high plastic clay soils would be suitable for construction of the cell liner wall, while the medium to plastic silt and clay soils below this would be suitable for use in construction of the reworked vertical wall liner and horizontal floor liner.

There is always a risk associated with utilizing excavated soils for the construction of a lagoon liner after reworking and compacting, due to the possibility of unsuitable soils discovered during construction, such as sand and stone. Any unsuitable material (sand or stone seams) discovered during construction would need to be removed from the lagoon liners to prevent the possibility of preferential flow paths through the liners. Based on the site observations and laboratory results, the risk associated with construction of the lagoon in the suitable areas tested is low, however stones were observed in the medium plastic silt and clay layer, which may cause preferential flow paths.

Further discussion would be needed with Manitoba Sustainable Development during the design phase of the project to confirm the suitability of utilizing a clay liner for these cells.

6.0 CLOSURE

The conclusions and recommendations in this report are based on the results of the site investigation and laboratory analysis. In addition, soil and groundwater conditions between test hole locations were generalized to provide an overall assessment of the geotechnical site conditions. If conditions appear different from those encountered at the test hole locations as described in this report, or if the assumptions stated herein are not in agreement with the design, JRCC should be informed so that the recommendations can be reviewed and adjusted as required.

The geotechnical site investigation was conducted to identify soil conditions suitable for use as a SAGR cell liner for the Town of The Pas lagoon. Although no environmental issues were identified during the geotechnical investigation, it does not necessarily follow that such issues do not exist. If the client or any other parties have any environmental concerns regarding the proposed site and works, an appropriate environmental assessment must be conducted.

It is not uncommon for soil conditions to be highly variable across a site. Previous construction activities and placement of fill at a site can augment the variability of soil conditions, especially surficial soil conditions. A contingency must be included in any construction budget to allow for potential variations in soil conditions, which may result in modification of the design and construction procedures.

If you have any questions, please contact the undersigned.

Yours truly,

JR Cousin Consultants Ltd.

Oswald Wohlgemut, M.Sc.
Environmental Scientist

Reviewed by:

Jason Cousin, P.Eng.
Municipal Engineer

cc Asit Dey, Manitoba Sustainable Development – via email

Attachments

Test Hole Location Plan

Test Hole Logs

Wood Environmental Laboratory Test Results

Attachments

Test Hole Location Plan

Test Hole Logs

Wood Environmental Laboratory Test Results

Test Hole Location Plan

Test Hole Logs

SCALE BAR
(IN METRES)

25 0 12.5 25 50 75 100 125

1:1250

No.	REVISIONS	DATE	INITIALS

B.M. EL.

LOCATIONS OF UNDERGROUND STRUCTURES/UTILITIES AS SHOWN ARE BASED ON AVAILABLE INFORMATION BUT NO GUARANTEE IS GIVEN OR IMPLIED THAT ALL EXISTING UNDERGROUND STRUCTURES/UTILITIES ARE SHOWN OR THAT THE GIVEN LOCATIONS ARE EXACT. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL UNDERGROUND STRUCTURES/UTILITIES MUST BE OBTAINED FROM THE APPROPRIATE AUTHORITY/OWNER, BY THE CONTRACTOR, BEFORE PROCEEDING WITH CONSTRUCTION.

ENGINEER'S SEAL

PRELIMINARY

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f. (204) 489-0487
www.jrcc.ca
ENGINEERING CONSULTANTS
ENGINEERING EXCELLENCE SINCE 1981

CODE: T-607.05
DESIGNED BY: DK
DRAWN BY: RH
REVIEWED BY: JRC

PROJECT: TOWN OF THE PAS
LAGOON UPGRADE EAP

TITLE: TESTHOLE LOCATION PLAN

SCALE:	DATE:	PLAN:	SHEET:
1:1250	18/10/12	X	X OF Y

Oct 12, 2018 - 2:52pm P:\607\001 The Pas_Town\001.05 Wastewater Treatment Facility Study and EAP\04 Drawings\Acad\Cards\Testhole Location Plan.dwg

J. R. Cousin Consultants Ltd.

TEST HOLE LOGS

SYMBOL INDEX


GW. : Well graded gravels and gravel sand mixtures, little or no fines


GP. : Poorly graded gravels, gravel - sand mixtures, little or no fines


GM. : Silty gravels, gravel-sand-silt mixtures


GC. : Clayey gravels, gravel-sand-clay mixtures


SW. : Well graded sands, gravelly sands, little or no fines


SP. : Poorly graded sands, or gravelly sands, little or no fines


SM. : Silty sands, sand-silt mixtures


SC. : Clayey sands, sand-clay mixtures


ML. : Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity


CL. : Inorganic clays of low plasticity, gravelly clays, sandy or silty clays, lean clays


OL. : Organic silts and organic silty clays of low plasticity


CI. : Inorganic clays of medium or intermediate plasticity


MH. : Inorganic silts, fine sandy or silty soils


CH. : Inorganic clays of high plasticity, fat clays


OH. : Organic clays of medium to high plasticity, organic silts


Pt. : Peat, humus, swamp soils with high organic contents


TOPSOIL

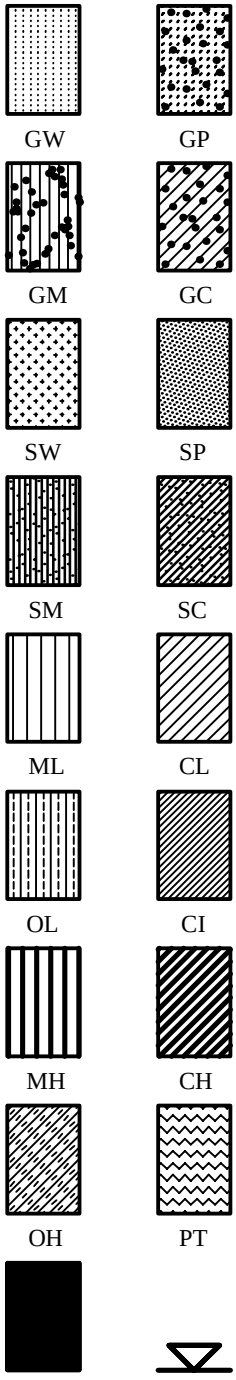
The soil logs are based upon objective data available to us at the time of forming our opinions. The soil logs indicate site specific soil characteristics and must not be generalized over larger areas due to the limited number of test holes as compared to that of an unlimited number of test holes. Every effort is made to evaluate the information by methods generally recognized. The soil logs represent our opinions. J.R. Cousin Consultants Ltd. cannot be responsible for actual site conditions proved to be materially at variance from our analysis or from the data generalization over untested areas.

J. R. Cousin Consultants Ltd.

TEST HOLE LOG SHEET

LOCATION : The Pas Lagoon Expansion Area
CODE : T-607.05
DATE : April 26, 2018
COORDINATES: 5965094 N, 354205 E
ELEVATION : 263.18m
PROJECT : The Pas - Wastewater Treatment Feasibility Study and EAP
METHOD OF SAMPLING : Drill Rig
TEST HOLE # 1

DEPTH OF SAMPLE	FIELD CLASSIFICATION
0m / 0	TOPSOIL - Silty, leaf litter
	SILT - Brown, medium plastic, clayey, stones, moist, stiff
2'	
1m	
4'	
	SILT - Brown, low plastic, sandy, stones, damp, stiff
6'	
2m	
8'	
	- Refusal at 2.7m
3m / 10'	
12'	
4m	
14'	
16'	
5m	
18'	
6m / 20'	



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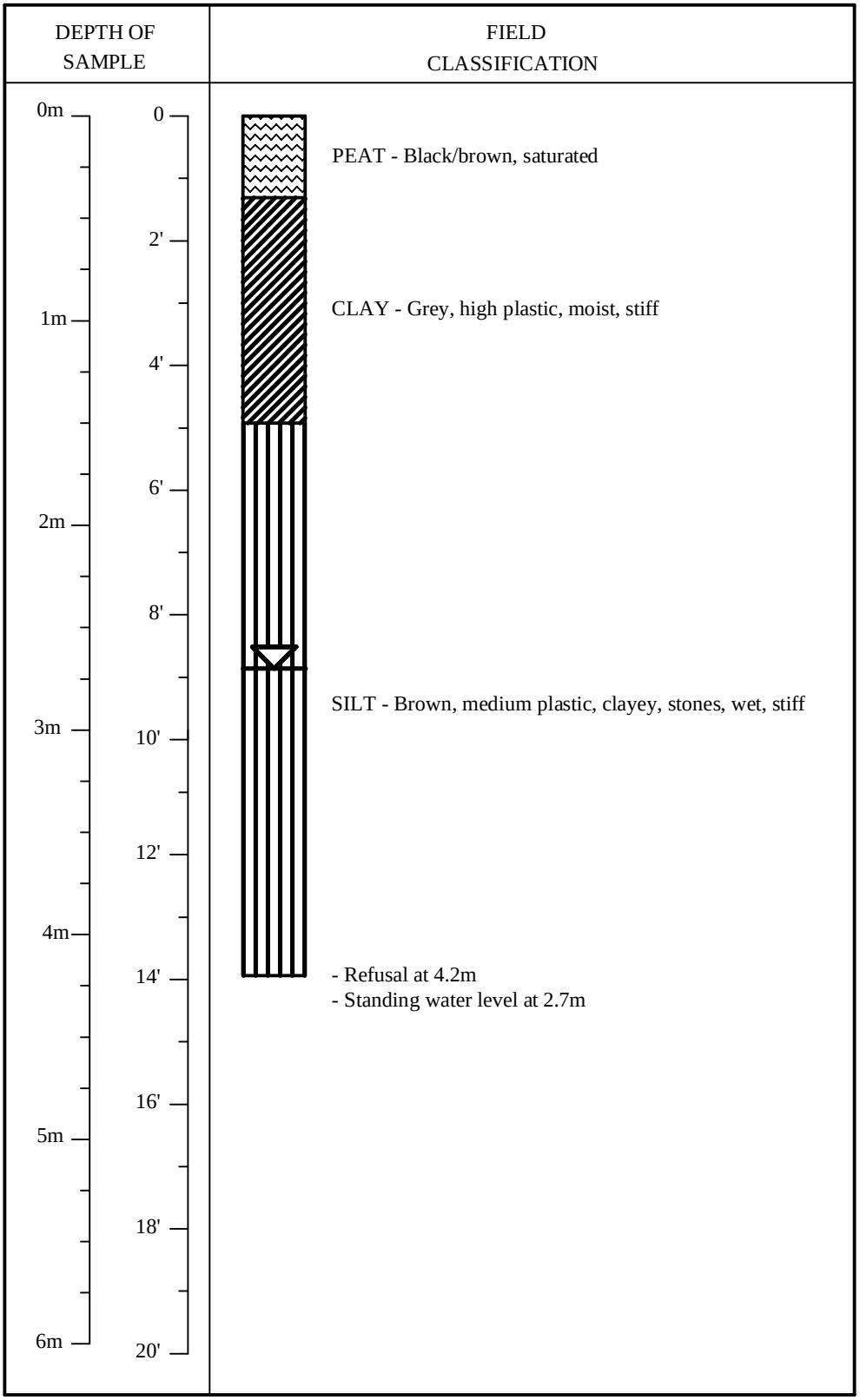
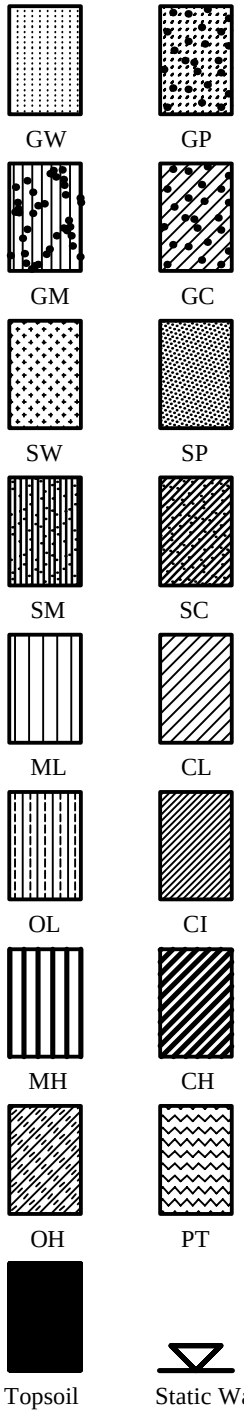
J. R. Cousin Consultants Ltd.

TEST HOLE LOG SHEET

LOCATION : The Pas Lagoon Expansion Area
CODE : T-607.05
DATE : April 26, 2018
COORDINATES: 5965139 N, 354291 E
ELEVATION : 262.21m
PROJECT : The Pas - Wastewater Treatment Feasibility Study and EAP
METHOD OF SAMPLING : Drill Rig
TEST HOLE # 2





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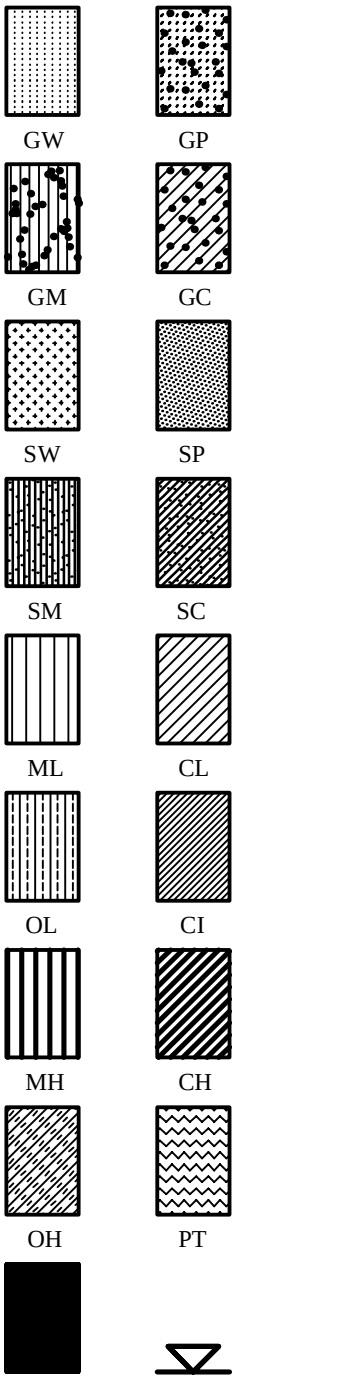
TEST HOLE LOG SHEET

LOCATION : The Pas Lagoon Expansion Area
CODE : T-607.05
DATE : April 26, 2018
COORDINATES: 5965083 N, 354352 E
ELEVATION : 261.84m
PROJECT : The Pas - Wastewater Treatment Feasibility Study and EAP
METHOD OF SAMPLING : Drill Rig
TEST HOLE # 3

DEPTH OF SAMPLE	FIELD CLASSIFICATION
0m / 0	PEAT - Black/brown, saturated
2'	
1m	CLAY - Grey, high plastic, moist, stiff
4'	
6'	SILT - Brown, medium plastic, clayey, stones, wet, stiff
2m	
8'	- Refusal at 2.4m - Standing water at 0.5m
3m / 10'	
12'	
4m	
14'	
16'	
5m	
18'	
6m / 20'	



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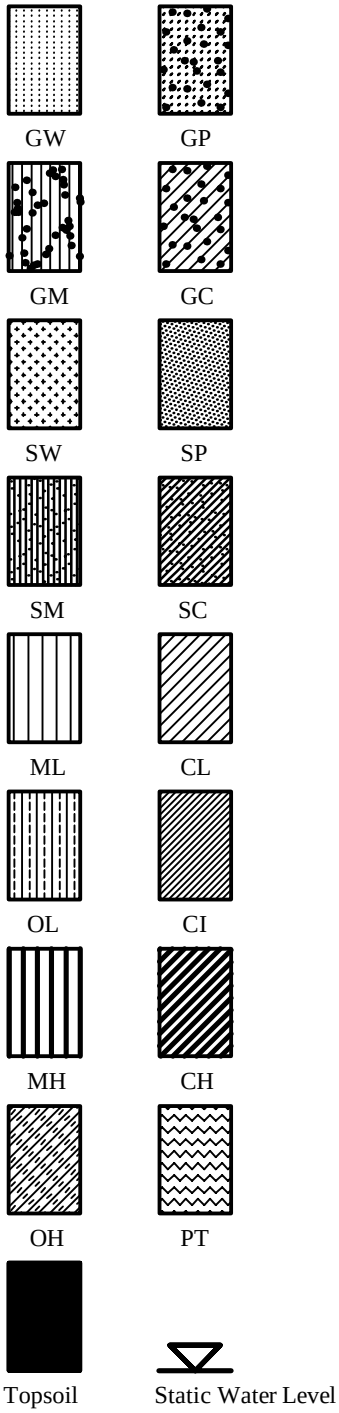
J. R. Cousin Consultants Ltd.

TEST HOLE LOG SHEET

LOCATION : The Pas Lagoon Expansion Area
CODE : T-607.05
DATE : April 26, 2018
COORDINATES: 5965162 N, 354383 E
ELEVATION : 262.20m
PROJECT : The Pas - Wastewater Treatment Feasibility Study and EAP
METHOD OF SAMPLING : Drill Rig
TEST HOLE # 4

DEPTH OF SAMPLE	FIELD CLASSIFICATION
0m / 0	PEAT - Black/brown, saturated
2'	CLAY - Grey, high plastic, moist, stiff
1m / 4'	
6'	
2m	SILT - Brown, medium plastic, clayey, stones, wet, stiff
8'	
3m / 10'	- Refusal at 3.0m - Standing water at 1.0m
12'	
4m / 14'	
16'	
5m	
18'	
6m / 20'	



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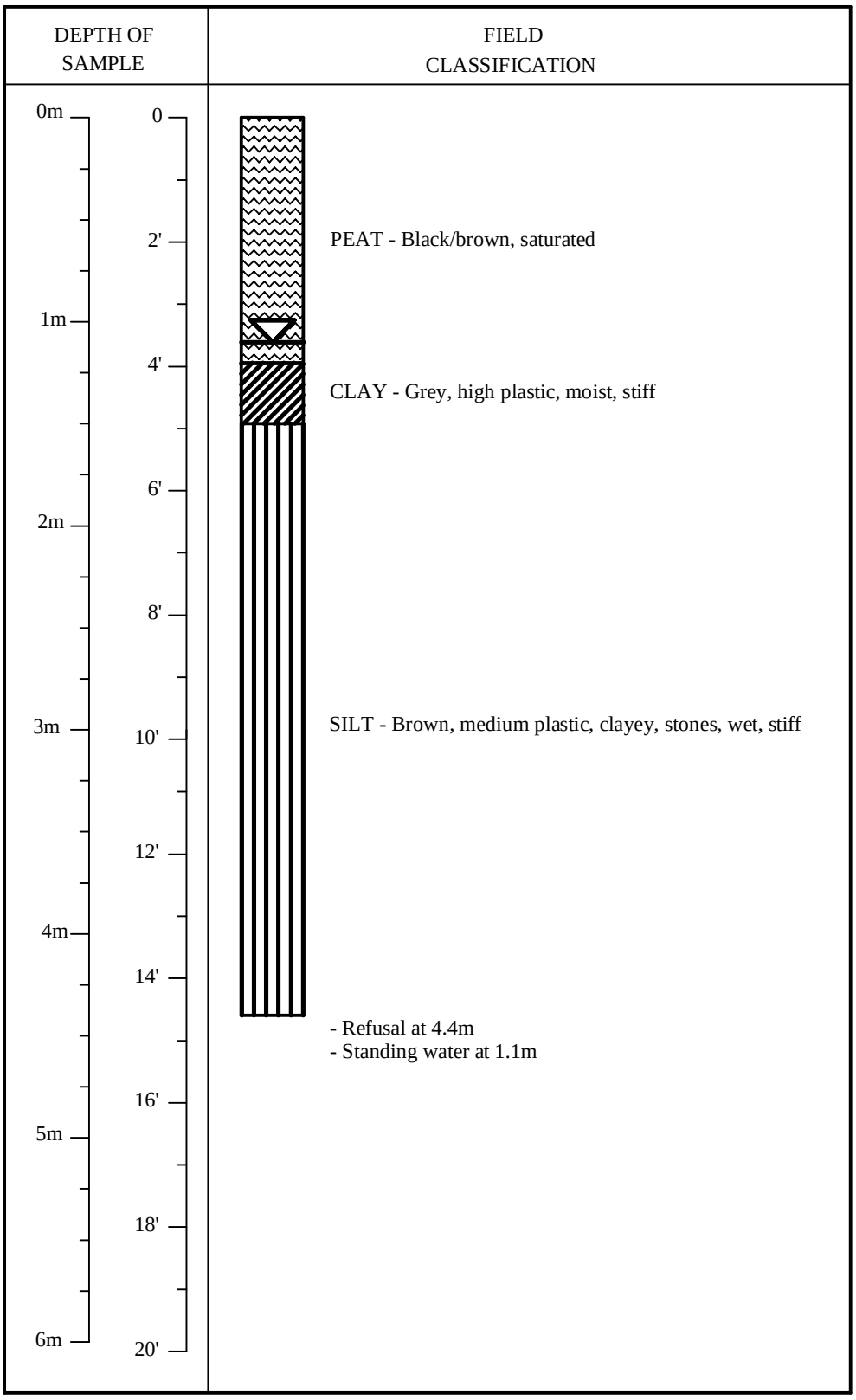
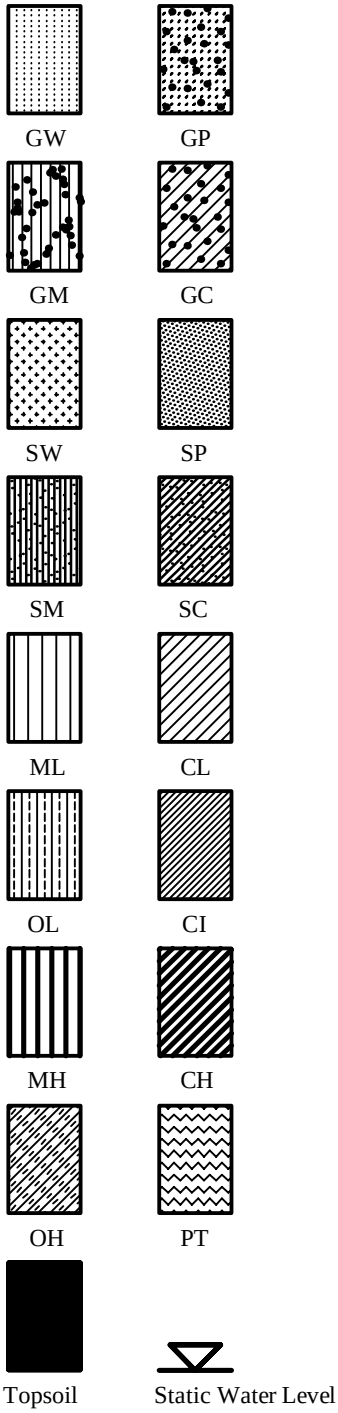
J. R. Cousin Consultants Ltd.

TEST HOLE LOG SHEET

LOCATION : The Pas Lagoon Expansion Area
CODE : T-607.05
DATE : April 26, 2018
COORDINATES: 5965190 N, 354230 E
ELEVATION : 262.54m
PROJECT : The Pas - Wastewater Treatment Feasibility Study and EAP
METHOD OF SAMPLING : Drill Rig
TEST HOLE # 5





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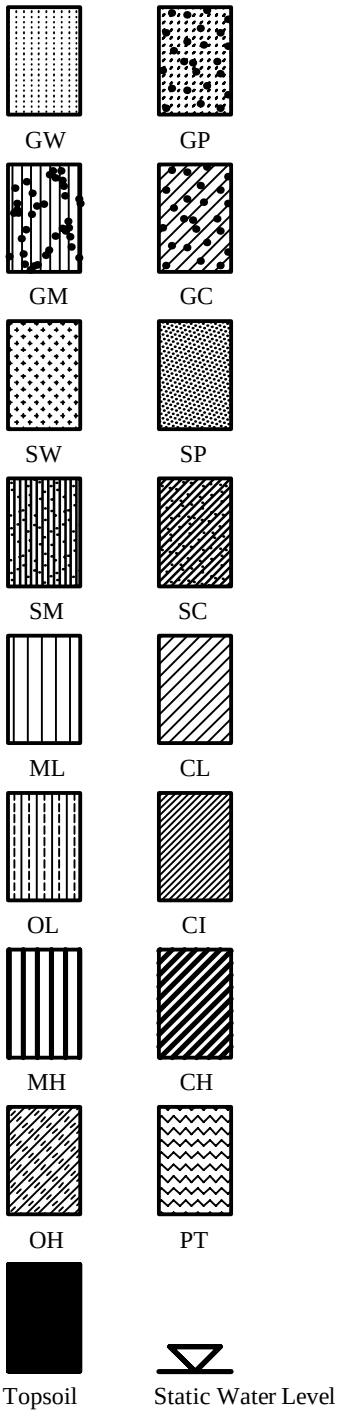
J. R. Cousin Consultants Ltd.

TEST HOLE LOG SHEET

LOCATION : The Pas Lagoon Expansion Area
CODE : T-607.05
DATE : April 26, 2018
COORDINATES: 5965115 N, 354244 E
ELEVATION : 262.50m
PROJECT : The Pas - Wastewater Treatment Feasibility Study and EAP
METHOD OF SAMPLING : Drill Rig
TEST HOLE # 6

DEPTH OF SAMPLE	FIELD CLASSIFICATION
0m / 0	PEAT - Black/brown, saturated
2'	
1m / 4'	
6'	SILT - Brown, medium plastic, clayey, stones, wet, stiff
2m / 8'	
3m / 10'	- Refusal at 3.0m
12'	
4m / 14'	
16'	
5m / 18'	
6m / 20'	



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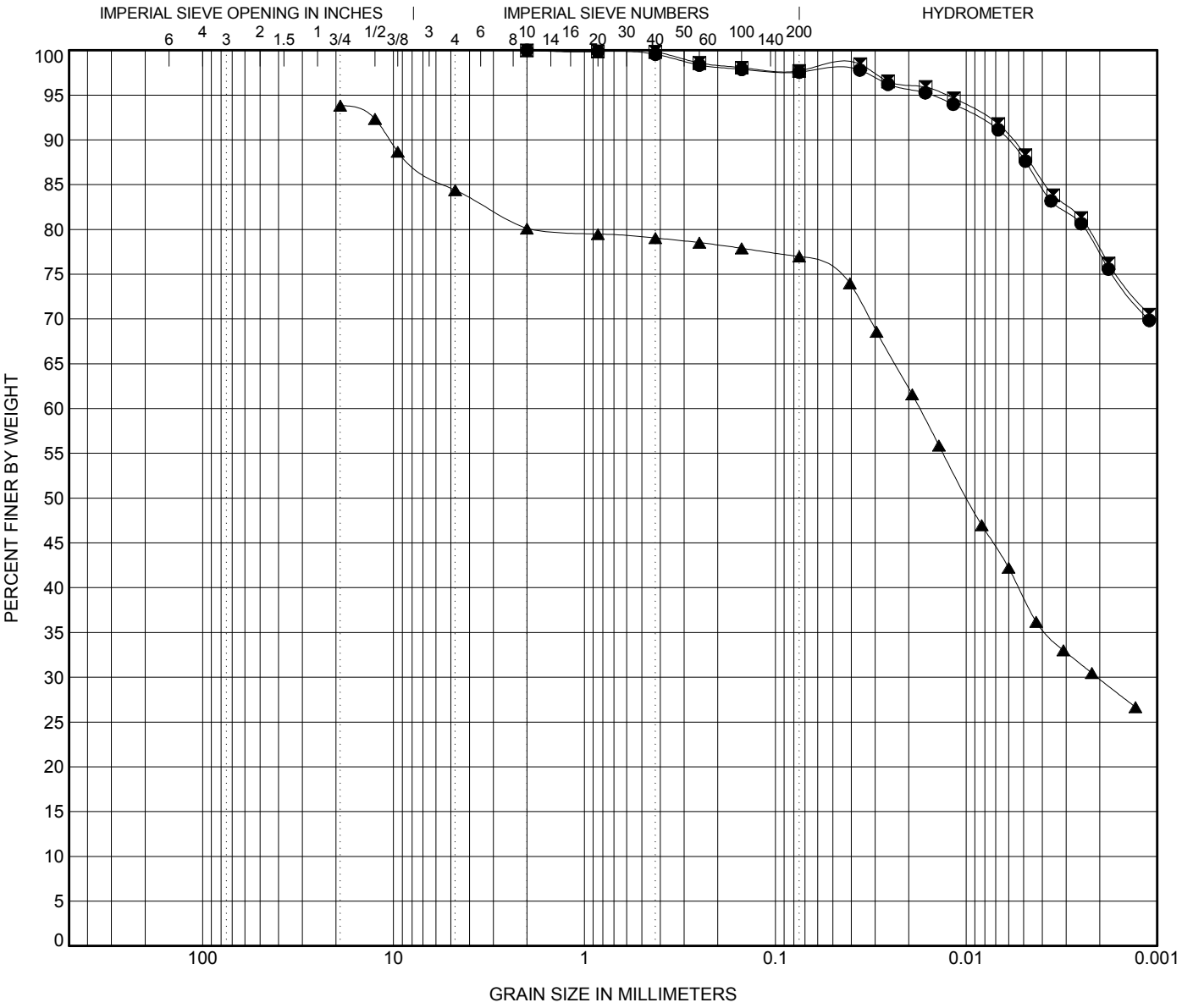
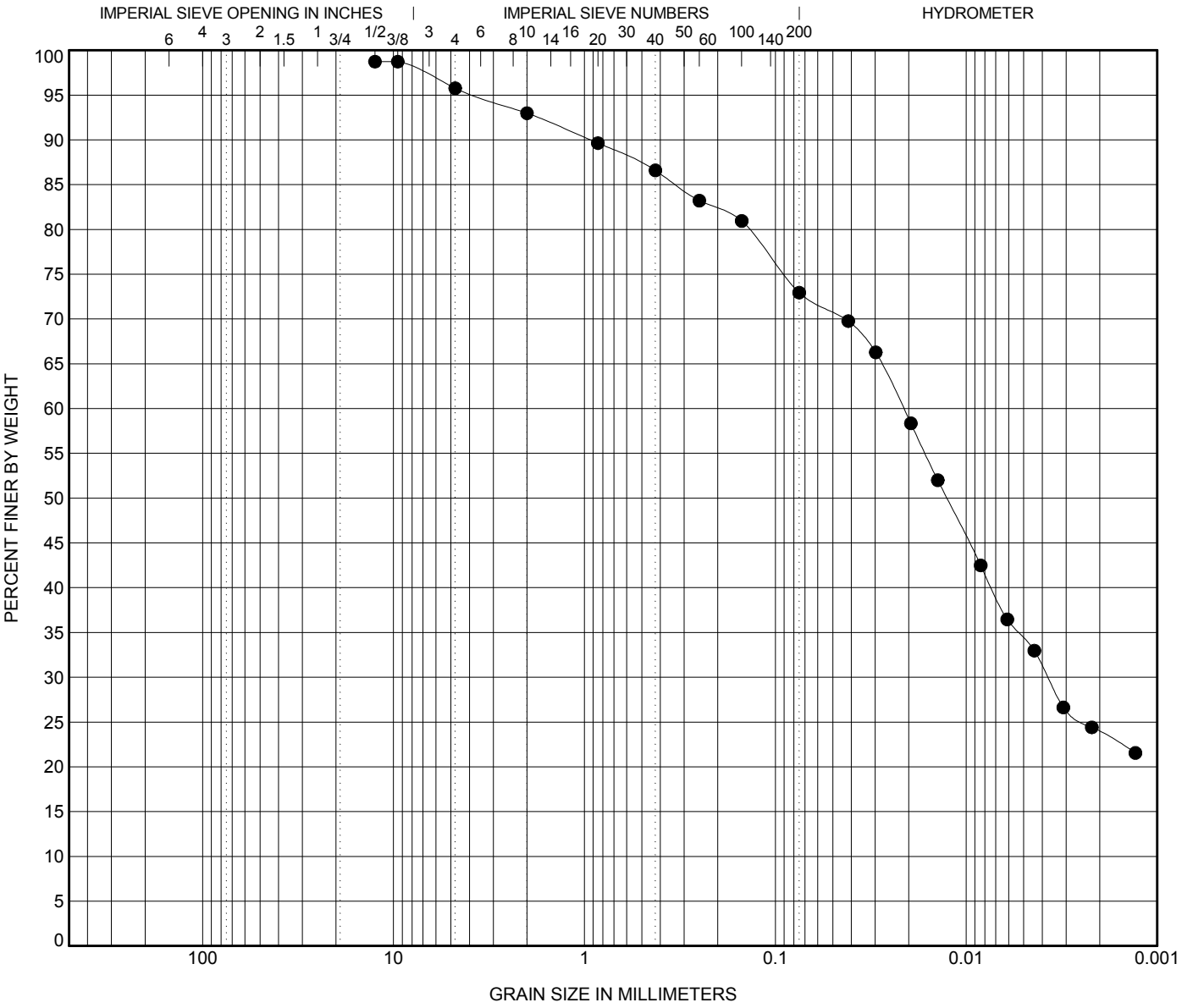
Wood Environmental Laboratory Test Results



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample ID	Depth	MC	LL	PL	PI	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TH02**	**0.4 m**	**13.9**	**68**	**22**	**46**	**2**				**0.0**	**2.4**	**20.4**	**77.2**
⧓	**TH05**	**1.5 m**	**28.6**	**61**	**22**	**39**	**2**				**0.0**	**2.3**	**19.9**	**77.8**
▲	**TH06**	**0.5 m**	**10.7**	**24**	**14**	**10**	**19**	**0.018**	**0.002**		**9.4**	**7.4**	**47.2**	**29.8**

PARTICLE SIZE DISTRIBUTION



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample ID	Depth	MC	LL	PL	PI	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TH02**	**1.5 m**	**11.6**	**21**	**12**	**9**	**12.5**	**0.021**	**0.004**		**3.0**	**22.8**	**49.1**	**23.9**

PARTICLE SIZE DISTRIBUTION

ASTM D5084 - HYDRAULIC CONDUCTIVITY REPORT

wood.

TO: Oswald Wohlgemut, M.Sc
JR Cousin Consultants Ltd
91 Scurfield Boulevard
Winnipeg, MB R3Y 1G4

PROJECT NO: WX11334 - 3100
CLIENT: JR Cousin Consultants Ltd
DATE SUBMITTED: 8-May-18

PROJECT: Soil Analysis for The Pas

TEST HOLE: Bulk Samples
SAMPLE NO.: TH2: Re-worked Sample
SAMPLE DEPTH: 1.5-4.2

PERMEANT: De-Aired Tap Water
HYDRAULIC GRADIENT: 28.60

CONSTANT HEAD METHOD (K = cQL/thA)

	Sample Height, L (cm)	Sample Dia. (cm)	Water Content (%)	Dry Density (kg/m^3)	Degree of Saturation (%)	Cell Pressure (kPa)	Back Pressure (kPa)	Differential Pressure, h (kPa)
Initial	7.38	7.12	12.7%	2098	100.8%	241.4	196.5	20.7
Final	7.35	7.05	12.7%	2140	109.4%			

Date & Time		Time, t	Flow (Q)		Temp. Corr, c	Hyd. Cond. Corrected, K (cm/s)
Start	End	(seconds)	Influent (ml)	Effluent (ml)		
5/30/18 10:17 AM	5/30/18 11:41 AM	5040	0.20	0.10	1.225	3.21E-08
5/30/18 11:41 AM	5/30/18 2:29 PM	10080	0.25	0.30	0.956	2.29E-08
5/30/18 2:29 PM	5/30/18 4:31 PM	7320	0.20	0.20	0.956	2.30E-08
5/30/18 4:31 PM	5/31/18 8:04 AM	55980	1.35	1.45	0.956	2.10E-08
5/31/18 8:04 AM	5/31/18 1:36 PM	19920	0.50	0.50	0.956	2.11E-08
5/31/18 1:36 PM	5/31/18 6:13 PM	16620	0.35	0.40	0.956	1.90E-08
5/31/18 6:13 PM	6/1/18 10:13 AM	57600	1.35	1.45	0.962	2.06E-08
6/1/18 10:13 AM	6/1/18 6:25 PM	29520	0.65	0.75	0.968	2.02E-08
6/1/18 6:25 PM	6/2/18 8:48 AM	51780	1.20	1.20	0.974	1.99E-08

Sample tested at 96% Standard Proctor Moisture Dry Density. Proctor Reference WX11334.3100-01

Average Temperature Corrected Value (cm/s): 1.99E-08

Wood Environment & Infrastructure Solutions

Per: Brad Wiebe

Brad Wiebe, M.Sc., P.Eng.
Senior Associate Geotechnical Engineer

Reporting of these results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

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ASTM D5084 - HYDRAULIC CONDUCTIVITY REPORT

wood.

TO: Oswald Wohlgemut, M.Sc
JR Cousin Consultants Ltd
91 Scurfield Boulevard
Winnipeg, MB R3Y 1G4

PROJECT NO: WX11334 - 3100
CLIENT: JR Cousin Consultants Ltd
DATE SUBMITTED: 3-Jul-18

PROJECT: Soil Analysis for The Pas

TEST HOLE: TH05
SAMPLE NO.:
SAMPLE DEPTH: 1.5-2.1m

PERMEANT: De-Aired Tap Water
HYDRAULIC GRADIENT: 26.18

CONSTANT HEAD METHOD (K = cQL/thA)

	Sample Height, L (cm)	Sample Dia. (cm)	Water Content (%)	Dry Density (kg/m^3)	Degree of Saturation (%)	Cell Pressure (kPa)	Back Pressure (kPa)	Differential Pressure, h (kPa)
Initial	8.05	7.16	28.6%	1531	98.9%	241.4	196.5	20.7
Final	8.15	7.19	31.0%	1478	98.9%			

Date & Time		Time, t	Flow (Q)		Temp. Corr, c	Hyd. Cond. Corrected, K (cm/s)
Start	End	(seconds)	Influent (ml)	Effluent (ml)		
7/11/18 1:57 PM	7/12/18 8:22 AM	66300	1.35	1.50	0.980	2.00E-08
7/12/18 8:22 AM	7/12/18 5:37 PM	33300	0.65	0.70	0.980	1.88E-08
7/12/18 5:37 PM	7/13/18 7:58 AM	51660	1.00	1.00	0.980	1.80E-08
7/13/18 7:58 AM	7/13/18 2:12 PM	22440	0.40	0.50	0.980	1.86E-08
7/13/18 2:12 PM	7/14/18 7:31 AM	62340	1.20	1.00	0.980	1.64E-08
7/14/18 7:31 AM	7/16/18 1:40 PM	194940	3.60	3.90	0.980	1.79E-08
7/16/18 1:40 PM	7/18/18 7:56 AM	152160	2.50	2.60	0.980	1.56E-08
7/18/18 7:56 AM	7/18/18 11:26 AM	12600	0.25	0.25	0.980	1.84E-08

Average Temperature Corrected Value (cm/s): 1.71E-08

Wood Environment and Infrastructure Solutions

Per:

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Senior Associate Geotechnical Engineer

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ASTM D5084 - HYDRAULIC CONDUCTIVITY REPORT

wood.

TO: Oswald Wohlgemut, M.Sc
JR Cousin Consultants Ltd
91 Scurfield Boulevard
Winnipeg, MB R3Y 1G4

PROJECT NO: WX11334 - 3100
CLIENT: JR Cousin Consultants Ltd
DATE SUBMITTED: 8-May-18

PROJECT: Soil Analysis for The Pas

TEST HOLE: Bulk Samples
SAMPLE NO.: TH06: 0.5 - 1.1m
SAMPLE DEPTH: 0.5-1.1m

PERMEANT: De-Aired Tap Water
HYDRAULIC GRADIENT: 27.78

CONSTANT HEAD METHOD (K = cQL/thA)

	Sample Height, L (cm)	Sample Dia. (cm)	Water Content (%)	Dry Density (kg/m^3)	Degree of Saturation (%)	Cell Pressure (kPa)	Back Pressure (kPa)	Differential Pressure, h (kPa)
Initial	7.59	7.15	10.7%	2185	100.4%	241.4	196.5	20.7
Final	7.54	7.15	11.6%	2181	107.4%			

Date & Time		Time, t	Flow (Q)		Temp. Corr, c	Hyd. Cond. Corrected, K (cm/s)
Start	End	(seconds)	Influent (ml)	Effluent (ml)		
5/30/18 10:15 AM	5/30/18 11:39 AM	5040	0.10	0.15	1.225	2.72E-08
5/30/18 11:39 AM	5/30/18 2:27 PM	10080	0.30	0.35	0.956	2.76E-08
5/30/18 2:27 PM	5/30/18 4:28 PM	7260	0.20	0.20	0.956	2.36E-08
5/30/18 4:28 PM	5/31/18 8:02 AM	56040	1.55	1.55	0.956	2.37E-08
5/31/18 8:02 AM	5/31/18 1:34 PM	19920	0.55	0.55	0.956	2.36E-08
5/31/18 1:34 PM	5/31/18 6:11 PM	16620	0.45	0.45	0.956	2.32E-08
5/31/18 6:11 PM	6/1/18 10:11 AM	57600	1.55	1.55	0.962	2.32E-08
6/1/18 10:11 AM	6/1/18 6:23 PM	29520	0.70	0.80	0.968	2.20E-08
6/1/18 6:23 PM	6/2/18 8:46 AM	51780	1.35	1.35	0.974	2.28E-08

Average Temperature Corrected Value (cm/s): 2.28E-08

Wood Environment and Infrastructure Solutions

Per:

Brad Wiebe, M.Sc., P.Eng.
Senior Associate Geotechnical Engineer

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