APPENDIX C

Geotechnical Report

GEOTECHNICAL REPORT
PROPOSED LGD OF PINAWA WWSP EXPANSION
PINAWA, MANITOBA

Prepared for:

LGD of Pinawa
Box 100
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Project No: 101 15463 00
September, 2013

GENIVAR

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ENGINEERS, SCIENTISTS & PROJECT MANAGERS

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 BACKGROUND 1
3.0 TOPOGRAPHY 1
4.0 FIELD METHODOLOGY AND TESTING 2
5.0 SUBSURFACE INVESTIGATION 3
5.1 SOIL PROFILE/GROUNDWATER 3
5.2 LABORATORY TESTING 3
6.0 DESIGN CONSIDERATIONS 4
7.0 ADDITIONAL CONSIDERATIONS 6
8.0 STANDARD LIMITATIONS 8

Appendix A – Site Plan

Appendix B – Testhole Logs and Well Logs

Appendix C – Laboratory Test Results

Appendix D – Granular Specification

1.0 INTRODUCTION

L.G.D. of Pinawa is located in southeastern Manitoba, 110 kilometres northeast of Winnipeg. As part of future development for L.G.D. of Pinawa, a geotechnical investigation of the proposed wastewater lagoon expansion site located at NE 5-14-12 EPM was conducted.

This report deals with the site selection of the wastewater lagoon expansion based on the soil conditions with respect to the recent Environmental Act passed in 1988. Manitoba Conservation's Environmental guidelines now require that the dykes and the bottom of any lagoon be provided with a layer consisting of at least one metre of soil having a permeability of $1x10^{-7}$ cm/s or less or equivalence, i.e. the used of plastic liner.

A site plan of the existing wastewater stabilization ponds, as well as the proposed expansion cell are shown in the attached figures, Figure 1 (Appendix A), which also includes the testhole locations.

2.0 BACKGROUND

At present, L.G.D. of Pinawa has an existing wastewater treatment lagoon system comprised of one primary cell and two secondary cell located partly in SE 5-14-12 EPM and NW 4-14-12 EPM, respectively.

3.0 TOPOGRAPHY

The proposed expansion site is located on a fairly rugged area known as the Precambrian Drift Plain. This area occurs along the eastern side of the Lac du Bonnet area. Surficial deposits are composed of glacio-lacustrine deposits of silty and clayey material deposited on lake floors. The topography of Precambrian is very rugged, hummocky and characterised by numerous rock outcrops and peat bogs interspersed with small lacustrine clay areas. The proposed expansion site is developed on lacustrine clay over glacial till

and followed by granitic bedrock, that range from about 2.7m to 19.8m in thickness overlying igneous and metamorphic rock of the Precambrian period (see the attached nearest well logs of NW 5-14-12E).

4.0 FIELD METHODOLOGY AND TESTING

The subsoils encountered were visually classified to the full extent in the testhole and representative soil samples were recovered at regular depth intervals and some samples were submitted for moisture content, particle size analysis and Atterberg limit tests. Pocket penetrometer tests were conducted on the cohesive soil to determine the approximate unconfined compressive strength and relative density respectively. In addition, two Shelby tube soil samples were obtained and tested for hydraulic conductivity test. Any groundwater seepage and sloughing encountered in the testholes were noted.

The field investigation was undertaken on March 13, 2013. A tracked rig was used to drill a total of ten testholes between 2.3 and 6.1m depths below grade. The testhole locations are shown on the site plan in Appendix A. Detailed descriptions of the soil profiles in each testhole are shown on the attached logs, TH1 to TH10 in Appendix B. Laboratory test results for moisture contents, Atterberg limit, particle size analysis and hydraulic conductivity are attached in Appendix C.

5.0 SUBSURFACE CONDITIONS

5.1 SOIL PROFILE/GROUNDWATER

The general soil profile encountered in testholes, TH1 to TH10 revealed a consistent soil profile. The general soil profile revealed a topsoil/peat moss layer of 250 to 750mm in thickness underlain by high plasticity olive-grey clay that turns to a till-like structure with traces of fine gravel and which extended to the depth explored at 6.1m below grade. The exception to this soil profile is at testhole, TH1 where a suspected boulder/bedrock was encountered at 2.3m depth. Sloughing conditions should be expected at a depth where the clay layer became sandy with traces of fine gravel, about 3.3m to 5.5m below grade. In

addition, surface seepage beneath the topsoil/peat moss should be expected as some water ponding on the low areas was noted during our investigation. A detailed description of the soil profile is presented in the attached logs, Appendix B.

At present, there is a groundwater report prepared by the Planning Branch of the Water Resources Division on this area. Based on the well logs and groundwater availability maps, groundwater bearing formations or aquifers is formed by surficial deposit (extensive sand and gravel or lenses of sand and gravel) and the Precambrian bedrock aquifer. In the vicinity of our proposed site (closest well logs which are attached in Appendix B are from 3-14-12E and 31-14-12E; our site is near NE 5-14-12E), the aquifers in this area are the sand and gravel lenses and the granitic bedrock with fractures. The depth of the aquifer based on the well logs (depth of perforations) in this area range from 3.2m to 155m below grade; note that there is no nearby well log at our site. In addition, any sand and gravel deposits, which are laid down directly on the carbonate rock, are hydraulically connected to the fractures and included in the bedrock aquifer. The yield usually is minor to adequate (about 0.013 to 0.9 litres per second). Water quality in the bedrock aquifer ranges from poor to excellent potable water.

A review of the Groundwater Pollution Hazard Map and Flowing and High Water Level Well Map shows that the proposed site is located outside these map areas.

Based on the drainage map of the area, groundwater flow at the site is immediately towards the south that eventually heads to Winnipeg River.

5.2 LABORATORY TESTING

In the laboratory, selected samples as shown in Appendix C were submitted for moisture contents, Atterberg limit and hydrometer test for classification and hydraulic conductivity. The test results are shown in Appendix C.

As classified during our field investigation, the clay layer beneath the topsoil/peat moss layer down is highly plastic to at least 3m below grade; the average depth of the clay with high plasticity is about 3m below grade. Due to these reasons, hydraulic conductivity of

the in-situ clay beneath the topsoil(TH2@1.5m) and at 3m (TH6@3m) as well as Atterberg limits were tested.

The clay material of the upper 1.5m to 3m depths is a CH material based on hydraulic conductivity, Atterberg limit and particle size analysis tests. *The actual hydraulic conductivity of this material, TH2@1.5m, is 2.9 x 10 $^{-9}$ cm/sec. For design purposes, the hydraulic conductivity of the clay at 3m depth, TH6@3m, is 7.4 x 10 $^{-8}$ cm/sec. The higher result of TH6@3m is due to trace of till inclusions in the sample. Both of these samples met the Manitoba Conservation's Environmental guidelines for lagoon's soil liners, 1.0 x 10 $^{-7}$ cm/sec.*

6.0 DESIGN CONSIDERATIONS

The surface drainage at the proposed site is very poor. In view of this and the presence of extensive surface water, it is expected that significant site access problems (construction traffic) and groundwater problems may occur during the construction for the proposed structure.

To minimize construction problems relative to the surface water, it is strongly recommended that prior to construction, a system of perimeter ditches leading to a lower spot (retention pond) be installed to drain surface water. These ditches should be provided with an adequate gradient to drain the water away from the site through a positive drainage outlet.

Assuming that the surface water is drained, the proposed WWSP will be designed in accordance with the Province of Manitoba Design Objectives for Standard Sewage Lagoons (1985).

The proposed cell will contain a liquid depth of 1.5m and 1m freeboard to minimize the effects of wave action and to provide stability. The inside and outside side slopes of the dykes will be 4:1. The top of the dykes will be designed to be 3m wide to permit vehicles to be driven on the dyke crest. *Depths of more than 2.5m (vertical height from top of dyke*

to bottom of lagoon) should not be attempted without further analysis (slope or settlement).

For lagoon construction, Manitoba Conservation's Environmental guidelines require that the proposed dykes and bottom of the proposed cells be provided with a layer consisting of at least one metre of soil having a permeability of less than $1x10^{-7}$ cm/s. The proposed lagoon site consists mainly of an area where such clay is present.

The selected area, fortunately, consists mainly of upper CH clay, which should meet the specified hydraulic conductivity of $1x10^{-7}$ cm/s. Beneath the proposed excavation (1.5m), the olive-grey clay at this depth achieved a hydraulic conductivity test result of less than $1.0x10^{-7}$ cm/s, thus meeting the guidelines.

Based on our field investigation, well logs from Manitoba Water Well reports and laboratory analysis, the proposed pond liner (base and interior) for this site should be constructed with a 1m liner within the proposed dykes.

Since the existing lagoon's liner is 1m surface liner, the 1m surface liner is appropriate in connecting the existing cell with the proposed expansion. The outside faces of the existing north secondary cell and west existing secondary cell would have to be rebuilt with 1m surface liner of CH material since it consist of sandy till inclusions with some clay.

During construction of the proposed expansion, the following steps should be followed.

1. *Assuming that the surface water is drained,* the entire area for the proposed pond should be stripped of vegetation, topsoil and organic material; the depth of stripping is approximately 250mm to 750mm. The stripped materials should be stockpiled and reused later for the outer slopes and top of the dykes.

2. Layout the proposed pond to the dimensions indicated in the design drawings.

3. For the proposed interior dykes, the 1m liner should be compacted to 95% standard Proctor density at ±2 to 3% of optimum moisture content with a sheepsfoot roller. For the proposed bottom, the exposed brown clay should just be proof-rolled with vibratory roller. *Any unsuitable material such as sand or high percentage silt materials should be removed and replaced with the recommended liner and compacted to 95% standard Proctor density*. Ensure that the liner of the interior dyke consists of at least one metre width of impervious clay compacted to at least a minimum of 95% standard Proctor maximum density in 150mm to 200mm lifts. A shrinkage factor of about 25% should be used in calculating volumes of material to be used. For the base, ensure that clay layer is at least 1m depth; note that suspected boulder/bedrock is encountered at a shallow depth in TH1 location.

4. Any unsuitable material can be used as backfill on the outside face of the dykes. The embankment material should be placed in 150mm lifts compacted with at least eight passes with a sheepsfoot roller having a foot pressure of no less than 700 kPa.

Further erosion control against wind and rain action using riprap placement on the dykes should be provided, if needed, after construction. A well-developed and maintained grass cover above the riprap should add integrity to the dykes.

The entire completed pond system should be fenced to keep people, children in particular away from the pond. All gates should be locked to prevent access.

Appropriate warning signs should be provided on the fence around the pond, to designate the nature of the facility, and advice against trespassing.

We recommend that a minimum distance of 5 meters be maintained between the outside toe of the embankment and the fence.

7.0 ADDITIONAL CONSIDERATIONS

On the basis of the soil conditions encountered during drilling (i.e. mainly an olive-grey clay subgrade), the recommended road pavement construction at this site should be as follows:

Pavement Thicknesses

	Truck Route	% Compaction
Base Coarse	150 mm	100% Std Proctor
Subbase	225 mm	100% Std Proctor

The above pavement sections should be constructed on a prepared stiff clay subgrade, which should be free of any fibrous organics, softened and disturbed soils. The prepared subgrade should be proof rolled with a heavy sheepsfoot roller which translates to at least 95% Std Proctor and inspected by a qualified geotechnical engineer prior to the placement of the overlying granular fill.

The granular base course and subbase materials should include organic-free, non-frozen, aggregate conforming to the Manitoba Highway gradation limits.

Where soft spots are encountered at the subgrade level, construction traffic should be restricted. Soft spots should be excavated with a large backhoe fitted with a smooth bucket, to at least 300mm below the underside of the subbase and replaced with a 300mm thick layer of 100mm down crushed aggregate/limestone. In this regard, the total granular fill thickness would be 675mm for truck access.

Sieve analysis and compaction testing of the granular base and subbase materials should be conducted by qualified geotechnical personnel to ensure that the materials supplied and percent compactions are in accordance with design specifications.

8.0 STANDARD LIMITATIONS

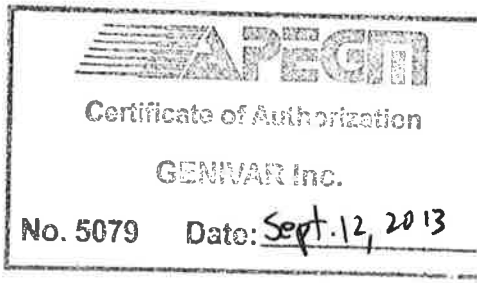
The factual data, interpretations and recommendations contained in this report pertain to the specific project as described in this report and are not applicable to any other project, site location or party. The comments given in this report are intended only for the guidance of the design engineer. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual test data, as to how subsurface conditions may affect their work.

Soil descriptions in this report are based on commonly accepted methods of classification and identification employed in professional geotechnical practice. Classification and identification of soil involves judgement and GENIVAR does not guarantee descriptions as exact, but infers accuracy only to the extent that is common in current geotechnical practice.

Soil formations are variable to a greater or lesser extent. The testpit logs indicate the approximate subsurface conditions only at the locations of the testpit. Boundaries between zones on the logs are often not distinct, but rather transitional, and have been interpreted. Subsurface conditions between test holes are inferred and may vary significantly from conditions encountered at the testpit.

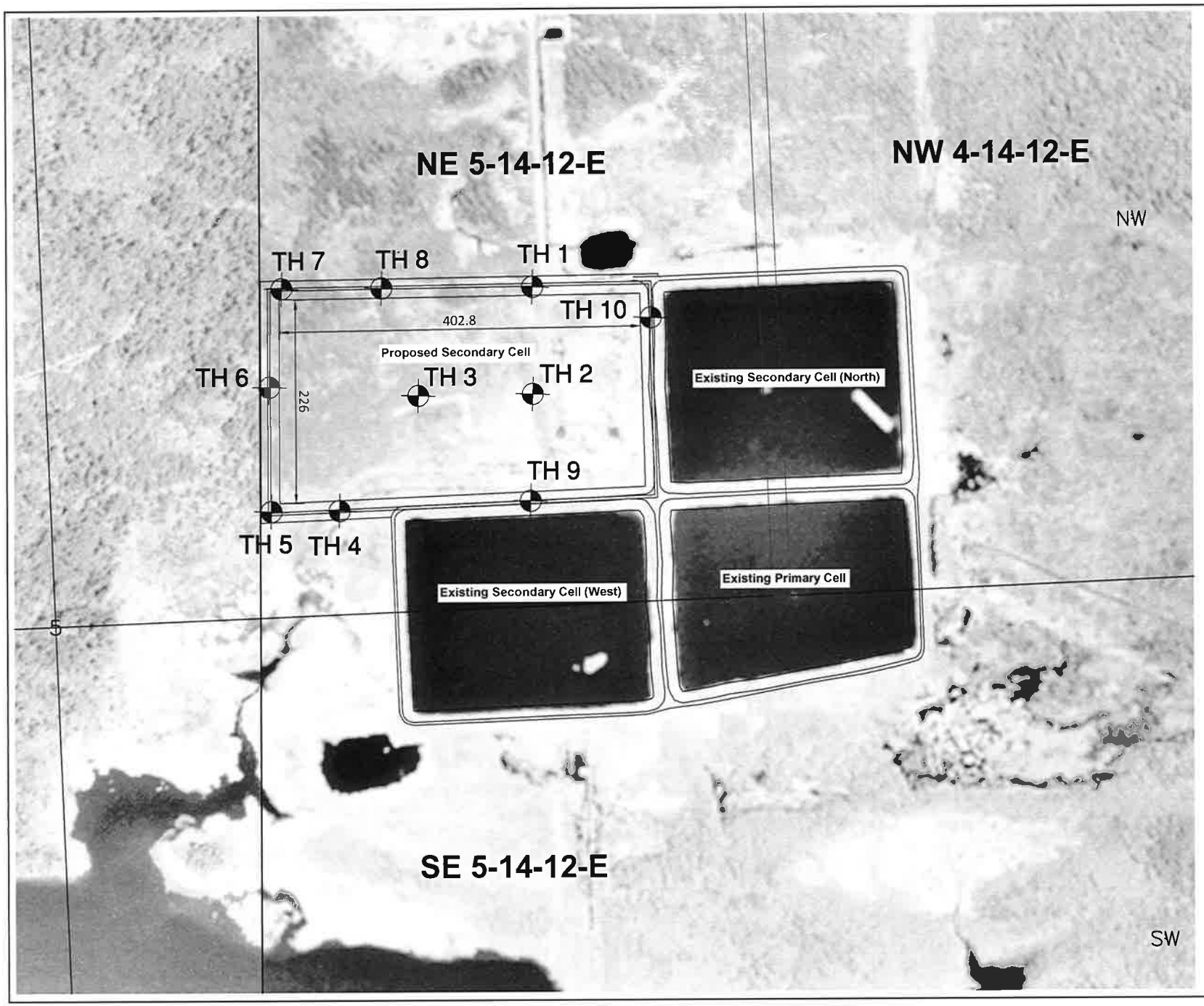
Where conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of the use, or reliance by the client, of this report that GENIVAR is notified of the changes and provided with an opportunity to review the recommendations of this report.

Prepared by: S.S. Urbano Jr., P. Eng.
Reviewed by: Ross Webster, P.Eng.



APPENDIX A

SITE PLAN



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APEGM

S.S. URBANO

L.G.D. OF PINAWA

L.G.D. OF PINAWA LAGOON EXPANSION

101-15483-00

2013/04/05

1:2000

LVC

LVC

SSU

CIVIL

TESTHOLES LOCATION

C01

1 OF 1

0

APPENDIX B

TESTHOLE LOGS and WELL LOGS

GENIVAR

Project No: 101-15463-00

TH1

Project: Town of Pinawa WWSP Expansion

Client: Town of Pinawa

Enclosure:

Location: Pinawa, MB. (NE 5-14-12-EPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
		Ground Surface	100			
0 / 0		**FILL** 900mm thick; 150mm of GRANULAR FILL over 750mm of CLAY FILL, mixed brown and black; FROST to 1.2m	99.2			
3 / 1		**CLAY** olive-grey, fissured; stiff below 1.2m, high plasticity, trace of fine gravel; beige at 1.7m, sandy. A.R. AT 2.3M ON SUSPECTED BOULDER/BEDROCK.	97.8	175		
7 / 2		End of Testhole				

PP(kPa): 50, 150, 250, 350

Water Content %: Wp, 0, Wl; 10, 30, 50, 70, 90

Drill Method: S/S Auger

Drill Date: 03/13/13

Hole Size: 125 mm

GENIVAR
10 Prairie Way
Winnipeg, MB.
R2J 3J8

Elevation:

Checked by: SSU

Sheet: 1 of 1

GENIVAR

Project No: 101-15463-00

TH2

Project: Town of Pinawa WWSP Expansion

Client: Town of Pinawa

Enclosure:

Location: Pinawa, MB. (NE 5-14-12-EPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth	Symbol	Description	Depth/Elev.,m	PP(kPa) 50 150 250 350	SPT, N	Water Content % Wp |-----0-----| Wl 10 30 50 70 90
ft m		Ground Surface	100			
0 0		***PEAT MOSS*** 750mm thick; brown and black, spongy; FROST to 0.3m	99.3			
1 2 3 1				150		
4 5 6 2						
7 8 9 10 3		***CLAY*** stiff, olive-grey, fissured, high plasticity; till-like structure below 4.6m, trace of fine gravel, tan-brown, sandy. TESTHOLE CAVED IN AT 5.5M DEPTH AFTER COMPLETION OF DRILLING.				
11 12 13 4						
14 15 16 5						
17 18 19 20 6			94			
21 22 23 7		End of Testhole				
24 25						

Drill Method: S/S Auger

Drill Date: 03/13/13

Hole Size: 125 mm

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10 Prairie Way
Winnipeg, MB.
R2J 3J8

Elevation:

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Sheet: 1 of 1

GENIVAR

Project No: 101-15463-00

TH3

Project: Town of Pinawa WWSP Expansion

Client: Town of Pinawa

Enclosure:

Location: Pinawa, MB. (NE 5-14-12-EPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
				50 150 250 350		Wp 10 30 — 0 — 50 70 Wl 90
0 / 0		Ground Surface	100			
1		***PEAT MOSS*** 600mm thick; brown and black, spongy; FROST to 0.3m	99.5			
2 / 1						
3				125		
4						
5						
6 / 2		***CLAY*** stiff, olive-grey, fissured, high plasticity; brown at 1.2m; till-like structure below 3.3m, trace of fine gravel, tan-brown, sandy. TESTHOLE IS DRY AFTER COMPLETION OF DRILLING.				
7						
8						
9						
10 / 3				100		
11						
12						
13 / 4						
14						
15			95.5	125		
16 / 5		End of Testhole				
17						
18						
19						
20 / 6						
21						
22						
23 / 7						
24						
25						

Drill Method: S/S Auger

Drill Date: 03/13/13

Hole Size: 125 mm

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Winnipeg, MB.
R2J 3J8

Elevation:

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Sheet: 1 of 1

GENIVAR

Project No: 101-15463-00

TH4

Project: Town of Pinawa WWSP Expansion

Client: Town of Pinawa

Enclosure:

Location: Pinawa, MB. (NE 5-14-12-EPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
		Ground Surface	100			
0 / 0		***PEAT MOSS+TOPSOIL*** 300mm thick; 150mm brown and black, spongy over 150mm SANDY LOAM; FROST to 0.3m	99.8			
1 / 1				200		
2 / 1						
3 / 1				150		
4 / 2		***CLAY*** stiff, olive-grey, fissured, high plasticity; brown at 1.2m; till-like structure below 3m, trace of fine gravel, tan-brown; sandy at 4.1m. TESTHOLE IS DRY AFTER COMPLETION OF DRILLING.				
5 / 2						
6 / 2						
7 / 2						
8 / 3						
9 / 3				125		
10 / 3						
11 / 3						
12 / 4						
13 / 4						
14 / 4						
15 / 5			95.5	75		
16 / 5		End of Testhole				
17 / 5						
18 / 5						
19 / 6						
20 / 6						
21 / 6						
22 / 7						
23 / 7						
24 / 7						
25 / 7						

PP(kPa): 50 150 250 350

Water Content %: Wp 10 30 50 70 90 Wl

Drill Method: S/S Auger

Drill Date: 03/13/13

Hole Size: 125 mm

GENIVAR
10 Prairie Way
Winnipeg, MB.
R2J 3J8

Elevation:

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Sheet: 1 of 1

GENIVAR

Project No: 101-15463-00

TH5

Project: Town of Pinawa WWSP Expansion

Client: Town of Pinawa

Enclosure:

Location: Pinawa, MB. (NE 5-14-12-EPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
				50 150 250 350		Wp |—0—| Wl 10 30 50 70 90
0 / 0		Ground Surface	100			
0 / 0		***PEAT MOSS+TOPSOIL*** 450mm thick; 300mm brown and black, spongy over 150mm SANDY LOAM; FROST to 0.3m	99.6			
2 / 1				150		
4 / 1				150		
6 / 2		***CLAY*** stiff, grey-black, fissured, high plasticity; brown at 1m; till-like structure below 3.3m, trace of fine gravel, tan-brown, sandy. TESTHOLE IS DRY AFTER COMPLETION OF DRILLING.				
10 / 3				125		
13 / 4						
15 / 4			95.5	50		
15 / 4		End of Testhole				
16 / 5						
20 / 6						
23 / 7						
25						

Drill Method: S/S Auger

Drill Date: 03/13/13

Hole Size: 125 mm

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10 Prairie Way
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R2J 3J8

Elevation:

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Sheet: 1 of 1

GENIVAR

Project No: 101-15463-00

TH6

Project: Town of Pinawa WWSP Expansion

Client: Town of Pinawa

Enclosure:

Location: Pinawa, MB. (NE 5-14-12-EPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
		Ground Surface	100			
0 / 0		***PEAT MOSS+TOPSOIL*** 450mm thick; 300mm brown and black, spongy over 150mm SANDY LOAM, trace of rootlets; FROST to 0.3m	99.6	100		
3 / 1				100		
6 / 2						
9 / 3		***CLAY*** stiff, grey-black, fissured, high plasticity; brown at 1m; till-like structure below 3m, trace of fine gravel, tan-brown, sandy; grey at 5.8m, clayey. TESTHOLE IS DRY AFTER COMPLETION OF DRILLING.		75		
12 / 4						
15 / 5				50		
18 / 6			94	125		
		End of Testhole				
21 / 7						
24						

PP(kPa) scale: 50, 150, 250, 350

Water Content % scale: Wp |----0----| Wl; 10, 30, 50, 70, 90

Drill Method: S/S Auger

Drill Date: 03/13/13

Hole Size: 125 mm

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R2J 3J8

Elevation:

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Sheet: 1 of 1

GENIVAR

Project No: 101-15463-00

TH7

Project: Town of Pinawa WWSP Expansion

Client: Town of Pinawa

Enclosure:

Location: Pinawa, MB. (NE 5-14-12-EPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
		Ground Surface	100			
0 / 0		**TOPSOIL** 250mm thick; 250mm CLAYEY LOAM, trace of rootlets; FROST to 0.3m	99.8			
1 / 0						
2 / 1		**CLAY** stiff, brown, fissured, high plasticity; till-like structure below 1.4m, trace of fine gravel and sand, tan-brown; clayey below 3m, grey. A.R. AT 3.5M DEPTH ON SUSPECTED BOULDER/BEDROCK.		150		
3 / 1				75		
4 / 2						
5 / 2						
6 / 2						
7 / 2						
8 / 3						
9 / 3						
10 / 3						
11 / 3			96.6	150		
12 / 4		End of Testhole				
13 / 4						
14 / 4						
15 / 4						
16 / 5						
17 / 5						
18 / 5						
19 / 5						
20 / 6						
21 / 6						
22 / 6						
23 / 7						
24 / 7						
25 / 7						

PP(kPa): 50, 150, 250, 350

Water Content %: Wp 10 30 | 0 | 50 70 Wl 90

Drill Method: S/S Auger

Drill Date: 03/13/13

Hole Size: 125 mm

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R2J 3J8

Elevation:

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Sheet: 1 of 1

GENIVAR

Project No: 101-15463-00

TH8

Project: Town of Pinawa WWSP Expansion

Client: Town of Pinawa

Enclosure:

Location: Pinawa, MB. (NE 5-14-12-EPM)

Engineer: SSU

SUBSURFACE PROFILE

Depth (ft / m)	Symbol	Description	Depth/Elev.,m
0 / 0		Ground Surface	100
0 / 0		***TOPSOIL***	99.8
		150mm thick; 150mm CLAYEY LOAM, trace of rootlets; FROST to 0.3m	
2 / 1		***CLAY*** soft, olive-grey, fissured, high plasticity; stiff at 1.2m, brown; trace of fine gravel at 1.5m; sandy at 3.3m, tan-brown, soft; clayey, stiff at 4.3m. TESTHOLE IS WET AT THE SURFACE.	
15 / 4			95.5
		End of Testhole	

SAMPLE

PP(kPa): 50, 150, 250, 350

SPT, N

Water Content %: Wp, 0, Wl; 10, 30, 50, 70, 90

PP(kPa) values: 25, 125, 75, 25, 125

Drill Method: S/S Auger

Drill Date: 03/13/13

Hole Size: 125 mm

GENIVAR
10 Prairie Way
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R2J 3J8

Elevation:

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Sheet: 1 of 1

GENIVAR

Project No: 101-15463-00

TH9

Project: Town of Pinawa WWSP Expansion

Client: Town of Pinawa

Enclosure:

Location: Pinawa, MB. (NE 5-14-12-EPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa) 50 150 250 350	SPT, N	Water Content % Wp 10 30 50 70 90 Wl
0 / 0		Ground Surface	102			
1 / 2 / 3 / 1		***FILL*** 2100mm thick; 150mm of GRANULAR FILL over 1950mm thick of CLAY FILL, mixed, grey and traces of till inclusions down to 0.8m; high plasticity clay below 0.8m; FROST to 1.5m				
4 / 5 / 6 / 2			99.4	100		
7 / 8 / 9 / 10 / 3		***CLAY*** grey-black, stiff, fissured; brown below 2.4m, high plasticity	98.5	100		
11 / 12 / 13 / 4		End of Testhole				
14 / 15 / 16 / 5						
17 / 18 / 19 / 6						
20 / 21 / 22 / 7						
23 / 24 / 25						

Drill Method: S/S Auger

Drill Date: 03/13/13

Hole Size: 125 mm

GENIVAR
10 Prairie Way
Winnipeg, MB.
R2J 3J8

Elevation: Top of Existing Dyke

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Sheet: 1 of 1

GENIVAR

Project No: 101-15463-00

TH10

Project: Town of Pinawa WWSP Expansion

Client: Town of Pinawa

Enclosure:

Location: Pinawa, MB. (NE 5-14-12-EPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
		Ground Surface	102			
0–3 ft / 0–1 m		***FILL*** 1500mm thick; 150mm of GRANULAR FILL over 1350mm thick of CLAY FILL, mixed, brown and black, high plasticity clay ; FROST to 1m	100	150		
3–10 ft / 1–3 m		***CLAY*** brown, stiff, fissured, high plasticity; till-like structure below 2.4m, sandy, tan-brown	98.5	100		
		End of Testhole				

PP(kPa) scale: 50, 150, 250, 350

Water Content % scale: Wp |----0----| Wl; 10, 30, 50, 70, 90

Drill Method: S/S Auger

Drill Date: 03/13/13

Hole Size: 125 mm

GENIVAR
10 Prairie Way
Winnipeg, MB.
R2J 3J8

Elevation: Edge of Existing Dyke

Checked by: SSU

Sheet: 1 of 1

LOCATION: 3-14-12E

Owner: R SCHNELLERT
Driller: Friesen Drillers Ltd.
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
Date Completed: 1982 Mar 17

WELL LOG

From (ft.)	To (ft.)	Log
0	15.0	BROWN SANDY TILL
15.0	38.0	GREY TILL
38.0	45.0	COARSE SAND AND GRAVEL
45.0	50.0	GRAVELLY TILL

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	45.0	casing		4.50		INSERT	BLACK IRON
40.0	45.0	perforations			0.015	WIRE WOUND S. S.	

Top of Casing: 2.0 ft. below ground

PUMPING TEST

Date: 1982 Mar 17
Pumping Rate: 15.0 Imp. gallons/minute
Water level before pumping: ft. below ground
Pumping level at end of test: 35.0 ft. below ground
Test duration: hours, minutes
Water temperature: ?? degrees F

LOCATION: NW5-14-12E

Owner: H S DOVWES
Driller: MANKEY, EMIL
Well Name:
Well Use: TEST WELL
Water Use:
Date Completed: 1974 Jul 30

WELL LOG

From (ft.)	To (ft.)	Log
0	12.0	YELLOW CLAY
12.0	65.0	GREY CLAY
65.0	74.0	LOOSE GRANITE

No construction data for this well.

Top of Casing: ft. below ground

No pump test data for this well.

LOCATION: SE31-14-12E

Owner: NATURAL RESOURCES
Driller: Friesen Drillers Ltd.
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
Date Completed: 1990 Nov 30

WELL LOG

From (ft.)	To (ft.)	Log
0	9.0	CLAY
9.0	10.0	GRANITE
10.0	10.5	GRANITE FRACTURED, WHITE AND BLACK
10.5	249.8	GRANITE GREY AND BLACK
249.8	509.7	GRANITE WHITE AND BLACK SPECKS

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	13.0	casing	6.50			INSERT	BLACK IRON
13.0	509.7	open hole		5.20			

Top of Casing: 1.0 ft. below ground

PUMPING TEST

Date: 1990 Nov 30
Pumping Rate: 0.2 Imp. gallons/minute
Water level before pumping: 10.0 ft. below ground
Pumping level at end of test: ?? ft. below ground
Test duration: 2 hours, minutes
Water temperature: ?? degrees F

LOCATION: NW32-14-12E

Owner: UNKNOWN
Driller: UNKNOWN
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
Date Completed: 1983 Nov 17

No well log data for this well.

No construction data for this well.

Top of Casing: 0.0

No pump test data for this well.

REMARKS

1984 URANIUM STUDY IN SOUTHEAST MANITOBA, SITE 81, WELL LOG UNAVAILABLE

APPENDIX C

LABORATORY TEST RESULTS

ENG-TECH
CONSULTING LIMITED

#6 - 854 Marion Street, Winnipeg, Manitoba, R2J 0K4
Phone: (204) 233-1694 Fax: (204) 235-1579
E-mail: eng_tech@mts.net
www.eng-tech.ca

April 29, 2013

File No. 13-035-01

Genivar Consultants Limited
10 Prairie Way,
Winnipeg, MB
R2J 3J8

ATTENTION: Mr. Silvestre S. Urbano, P. Eng.

RE: WWSP Expansion, Town of Pinawa, Manitoba

ENG-TECH Consulting Limited (ENG-TECH) completed the testing services for the proposed expansion of the above facility in the Town of Pinawa, MB. ENG-TECH received fifteen sample bags and two Shelby tube samples to complete moisture content analysis on all samples (17), three (3) Atterberg Limit tests, and two (2) hydraulic conductivity tests. Results for the moisture content and Atterberg Limit tests are outlined in Table 1 and the hydraulic conductivity test data are outlined in Table 2, while the graphical representation of the hydraulic conductivity versus elapsed time are shown in Figures 1 and 2.

The Atterberg Limit tests were completed on a sample labeled as TH2 @ 5ft, and the combined samples from TH6 @ 2.5ft & 5ft, and TH9 @ 2.5ft & 5ft. The Plastic Limits obtained ranged between 15 and 28, and the Liquid Limits varied between 38 and 89. As such, the Plasticity Indices were 23 for the TH6 sample, 42 for the TH9 sample and 61 for the TH2 sample; the latter two samples are indicative of a highly plastic clay, whereas the sample for TH6 is classified as a medium plastic clay.

ENG-TECH prepared and tested two (2) samples for hydraulic conductivity in accordance with ASTM D5084-03, *Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter*. The final hydraulic conductivity values (k_{20}) of 2.9×10^{-8} cm/sec and 7.4×10^{-8} cm/sec were obtained for the samples identified as TH2 @ 5-6.5ft and TH6 @ 10-12ft, respectively.

Closure

ENG-TECH trusts the above is all the information you require. If you have any questions, please contact the undersigned.

Sincerely,
ENG-TECH Consulting Limited

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

CDH/erm
Attachments: Table 1 – Soil Sample Analysis
Table 2 – Hydraulic Conductivity Test Results
Figure 1 – Hydraulic Conductivity Versus Elapsed Time (TH2 5-6.5ft)
Figure 2 – Hydraulic Conductivity Versus Elapsed Time (TH6 10-12ft)

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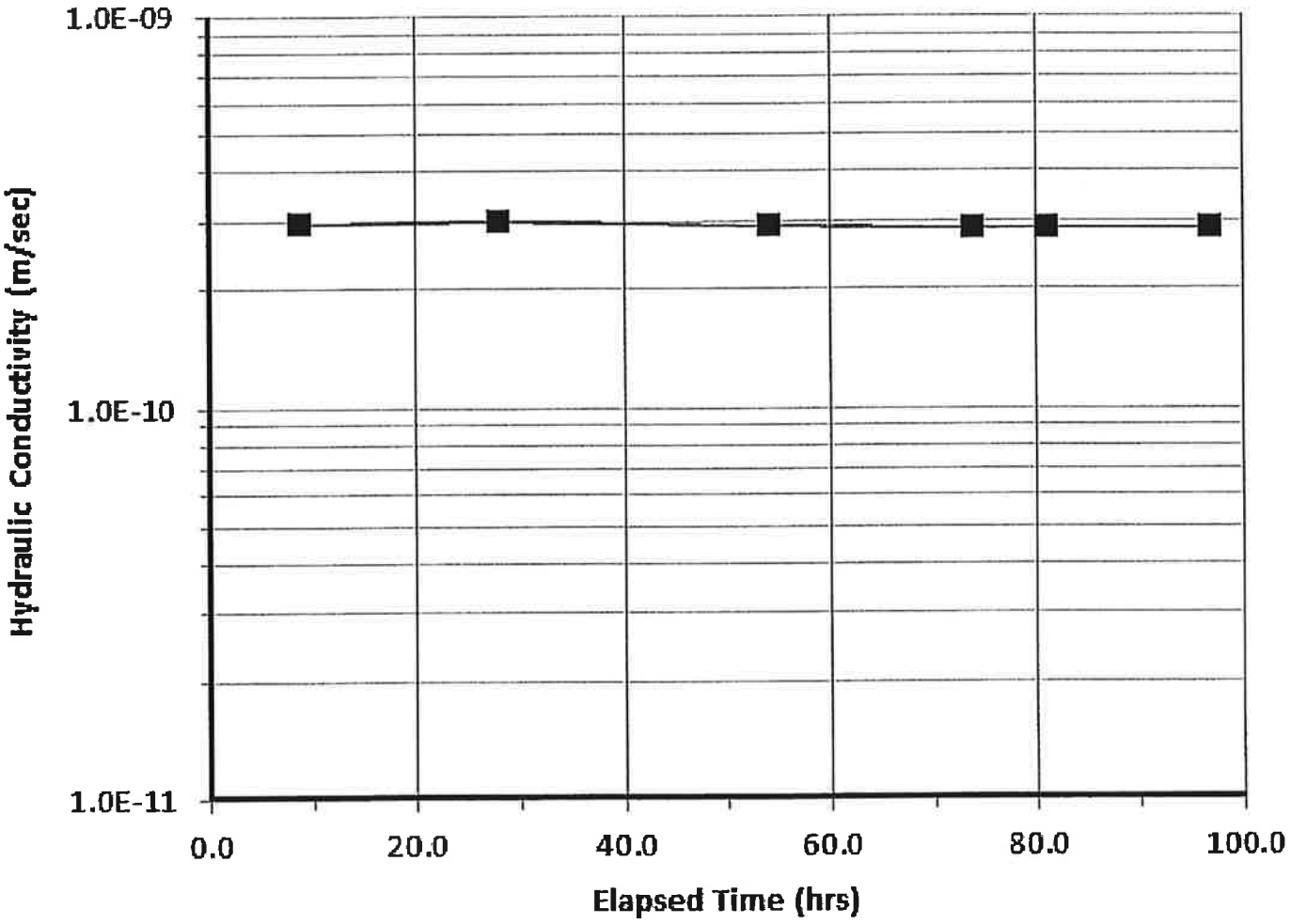
TABLE 1 SOIL SAMPLE ANALYSIS
WWSP EXPANSION – TOWN OF PINAWA, MANITOBA

Test Hole	Ref. No.	Depth (ft.)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index
TH1		5	29.5			
TH1		7.5	13.2			
TH2		2.5	36.7			
TH2	13-35-1-1	5	37.5	89	28	61
TH2	13-35-1-4	5-6.5	40.2			
TH2		7.5	37.4			
TH2		10	37.6			
TH2		15	35.6			
TH2		20	13.3			
TH6	13-35-1-2	2.5	51	38	15	23
TH6		5	18.3			
TH6		10	22.9			
TH6	13-35-1-5	10-12	18.2			
TH6		15				
TH6		20				
TH9	13-35-1-3	2.5	19.4	62	20	42
TH9		5	33.4			

TABLE 2 HYDRAULIC CONDUCTIVITY TEST RESULTS
WWSP EXPANSION, TOWN OF PINAWA, MANITOBA

SAMPLE IDENTIFICATION	TH2 5-6.5ft	TH6 10-12ft
INITIAL VALUES		
ENG-TECH Reference No.	13-35-1-4	13-35-1-5
Length of Sample in Tube (cm)	36.0	63.0
Length (cm)	6.05	5.92
Diameter (cm)	7.06	7.07
Area (cm^2)	39.2	39.2
Volume (cm^3)	236.8	232.0
Water Content (%)	36.8	18.2
Bulk Dry Density (kg/m^3)	1352	1804
Specific Gravity (G_s) (assumed)	2.70	2.70
Void Ratio	0.997	0.497
Degree of Saturation (%)	99.7	98.9
FINAL VALUES		
Length (cm)	6.05	5.93
Diameter (cm)	7.17	7.10
Area (cm^2)	40.3	39.6
Volume (cm^3)	243.8	234.6
Water Content (%)	40.2	18.5
Bulk Dry Density (kg/m^3)	1297	1802
Specific Gravity (G_s) (assumed)	2.70	2.70
Void Ratio	1.082	0.498
Degree of Saturation (%)	~100	~100
CONSOLIDATION PHASE		
Confining Pressure (kPa)	103.4	103.4
Pore Water Pressure (kPa)	82.7	82.7
Effective Stress (kPa)	20.7	20.7
PERMEATION PHASE		
Confining Pressure (kPa)	103.4	103.4
Pore Water Pressure (kPa)	82.7	82.7
Effective Stress (kPa)	20.7	20.7
Hydraulic Gradient	25.6	26.1
Permeant Fluid	Distilled Water	Distilled Water
HYDRAULIC CONDUCTIVITY at TEST TEMPERATURE OF 21 °C (cm/sec)	3.0×10^{-8}	7.6×10^{-8}
HYDRAULIC CONDUCTIVITY at TEMPERATURE OF 20 °C (K_{20}) (cm/sec)	2.9×10^{-8}	7.4×10^{-8}

Hydraulic Conductivity



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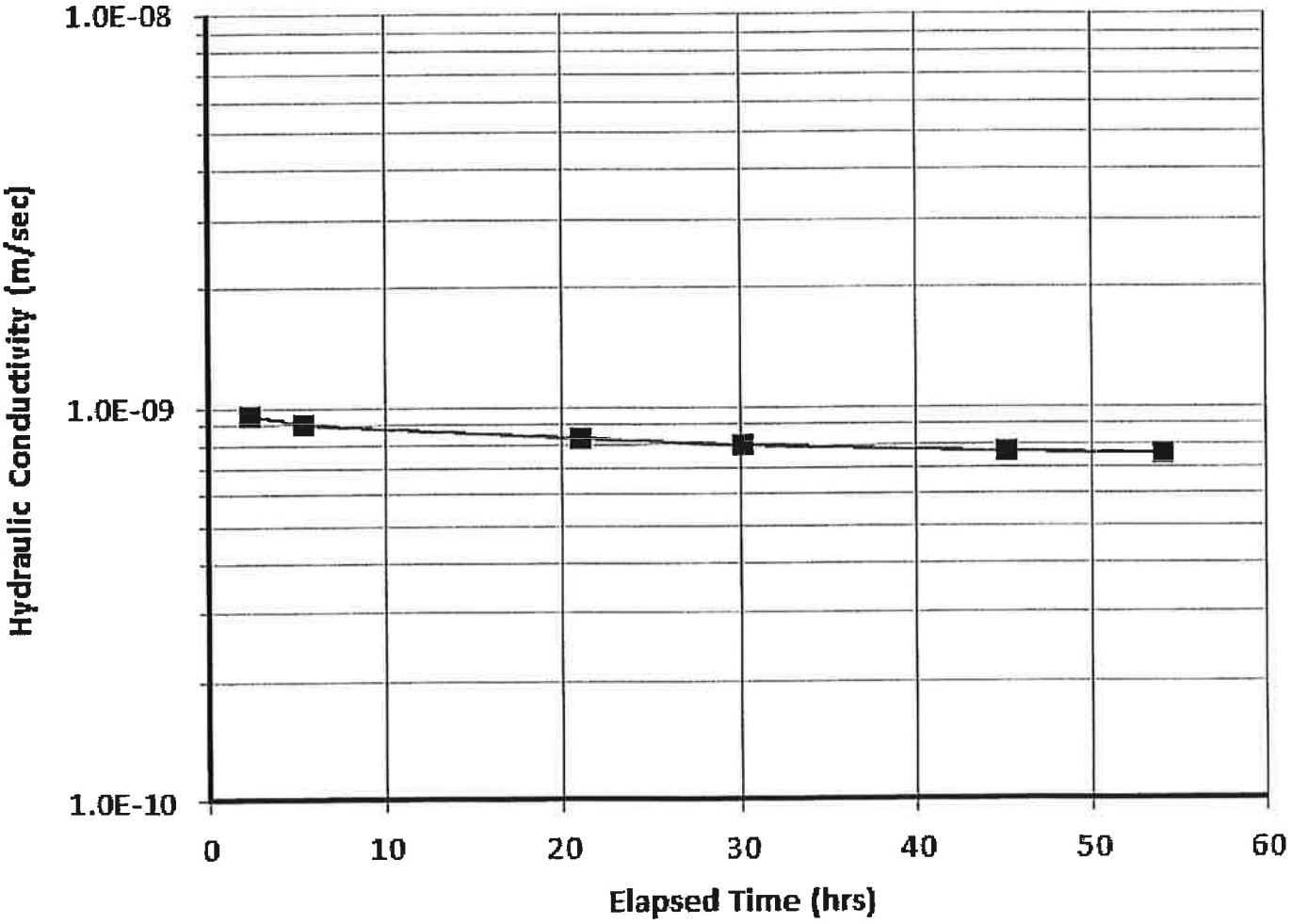
ENG. STAMP:

APEGM
Certificate of Authorization
ENG-TECH Consulting Limited
No. 2475 Expiry: April 30, 2014

CLIENT: GENIVAR CONSULTING LIMITED				PROJECT: WWSP EXPANSION, TOWN OF PINAWA, MANITOBA
DATE: APRIL 2013			FILE No.: 13-035-01	HYDRAULIC CONDUCTIVITY VERSUS ELAPSED TIME (TH2 5-6.5ft)
DRAWN BY: ERM	FIGURE No.: 1	REV.:	SCALE: N/A	

Hydraulic Conductivity



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DATE: APRIL 2013			FILE No.: 13-035-01	HYDRAULIC CONDUCTIVITY VERSUS ELAPSED TIME (TH6 10-12ft)
DRAWN BY: ERM	FIGURE No.: 2	REV.:	SCALE: N/A	

APPENDIX D

GRANULAR SPECIFICATION

900. 3.2 - Aggregate Requirements (Cont'd)

The Los Angeles Abrasion Loss on granular base course aggregate will be based on the total sample submitted.

Shale Content is the percent by weight of the particles retained on a 4.75 sieve that are shale particles.

Clay balls are the percent by weight of particles retained on a 12.5 mm sieve that are clay particles.

The aggregate shall be well graded and shall not vary from maximum to minimum of the specification ranges for consecutive tests.

The requirements for each Class will be as follows:

GRANULAR BASE COURSE					
Passing Standard Sieves	CLASS "A"		CLASS "B"	CLASS "C"	
	Gravel	Limestone	Gravel or Limestone	Gravel	Limestone
37.5 mm sieve				100%	
25 mm sieve				85 - 100%	100%
19 mm sieve	100%	100%	100%		
16 mm sieve	80 - 100%				
4.75 mm sieve	40 - 70%	35 - 70%	30 - 75%	25 - 80%	25 - 80%
2 mm sieve	25 - 55%		25 - 65%		
425 um sieve	15 - 30%	15 - 30%	15 - 35%	15 - 40%	
75 um sieve	8 - 15%	8 - 17%	8 - 18%	8 - 18%	8 - 20%
Minimum Crush Count	35%	100%	25%	15%	100%
Maximum					
a) Los Angeles Abrasion Loss	35%	35%	35%	40%	40%
b) Shale Content	12%		12%	20%	
c) Clay Balls	10%		10%		