TITLE: GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL SUBDIVISION
NW 24-19-23-W2M
R. M. OF DUFFERIN, SASKATCHEWAN

CLIENT: MR. LYLE BATEMAN

FILE NO: GE-1198 DATE: FEBRUARY 12, 2013

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

DRAWINGS

APPENDICES

GROUND ENGINEERING CONSULTANTS LTD.

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FILE: GE-1198

February 12, 2013

Mr. Lyle Bateman
3138 College Avenue
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Dear Sir:

SUBJECT: GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL SUBDIVISION
NW 24-19-23-W2
R.M. OF DUFFERIN, SASKATCHEWAN

1.0 INTRODUCTION

This report presents the results of a site specific subsurface soils investigation and geotechnical analysis carried out at the above captioned site located approximately 2 km south of the Village of Disley, Saskatchewan. It is understood that the proposed residential subdivision development includes 17 residential lots with associated infrastructure. The objectives of this investigation were to provide the following information:

.1 To define the subsurface soil stratigraphy and engineering properties of the foundation soils;

.2 To provide design and installation recommendations for the most suitable and economical foundation system to support the proposed residential buildings;

.3 To comment on possible excavation and construction problems related to foundation construction with particular reference to groundwater conditions;

.4 To provide recommendations for floor slab design and construction;

.5 To perform a slope stability analysis of the valley wall, comment on possible slope stability problems and provide recommendations for site development, including development restrictions, suitable building sites and set-back distances for residential development;

.6 To provide recommendations on pertinent geotechnical issues identified during the subsurface investigation.

Authorization to proceed with this work was received in your e-mail dated October 11, 2012.

2.0 DESCRIPTION OF SITE

The study area shown in Figure 1 is located in the northwest quarter of 24-19-23-W2M overlooking the north valley wall of the Qu'Appelle Valley. The property includes a strip of land at the top of the valley wall (north end of property) and the majority of the north valley wall. The property has not been previously developed and is currently being used as pasture land. There is an elevation difference of up to 65 metres between the top of the valley wall and the Qu'Appelle River flood plain.

3.0 FIELD AND LABORATORY INVESTIGATION

The subsurface conditions were investigated by drilling 10 test holes at the locations shown on Drawing No. GE-1198-1. The test holes were drilled on October 23, 25, 26 and 29, 2012 using a truck-mounted, Brat 22 digger equipped with a 150 mm diameter continuous flight auger and a 200 mm diameter hollow stem auger. The test holes were drilled to depths ranging from 7.6 to 30.5 metres below existing ground surface.

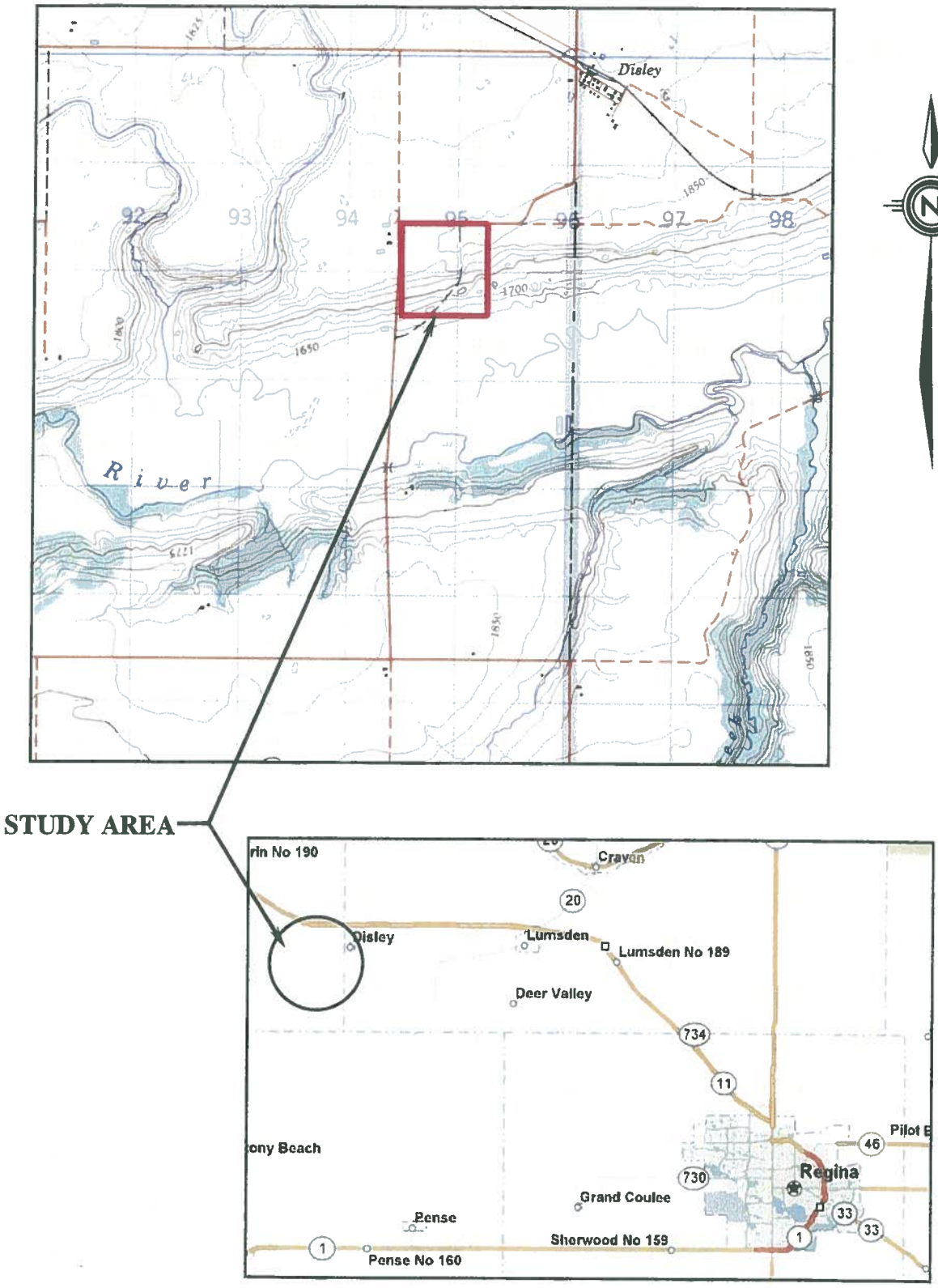

FIGURE 1

LOCATION OF STUDY AREA

Representative disturbed auger samples, spilt-spoon and undisturbed Shelby tube soil samples were recovered from the test borings at selected intervals and were taken to our laboratory for analysis. Each soil sample was visually examined to determine its textural classification and natural moisture content tests were performed on each soil sample. In addition, grain size analyses, Atterberg Limits, sulphate content, unconfined compressive strength and dry density tests were performed on selected soil samples. Estimates of the undrained shear strength of the soil were made using both a pocket penetrometer and a laboratory vane shear apparatus. Standard Penetration tests were conducted in Test Holes 101, 105, 106, 107 and 110. Standpipe piezometers were installed in Test Holes 101, 104, 105, 106, 107, 109 and 110. Details of the soil profile, samples taken, laboratory test results, piezometer installations and stratigraphic interpretations of the subsoils are presented on Drawing Nos. GE-1198-5 to -22, inclusive.

The test hole locations, ground surface elevations and piezometer elevations were surveyed by Midwest Surveys Ltd., with the exception of Test Hole 108 which could not be located at the time of the survey (snow covered). The location of Test Hole 108 was determined using hand held GPS equipment and the ground surface elevation was estimated from the contour plan provided by Midwest Surveys.

4.0 GEOTECHNICAL ANALYSIS

4.1 Geology

The study area is located in the physiographic division known as the Assiniboine River Plain. The prominent landform adjacent to the valley wall is an outwash plain. The glacial sediments which form the surficial geology in the study area consist of surficial outwash sands, clay and till strata. The existing valley was carved out of the till plain by glacial meltwater during the last deglaciation period. The underlying bedrock consists of Upper Cretaceous shale of the Bearpaw Formation. The valley has since been partially filled with alluvium.

4.2 Stratigraphy

The drilling information indicates that the surficial topsoil is underlain by glacial drift sediments which generally consist of an upper sand stratigraphic unit underlain by a till stratigraphic unit which extends to the bedrock surface. Where present, the sand stratigraphic unit extends to depths ranging from 1.2 to 13.1 metres below existing grade. The sand unit was not encountered in Test Holes 102, 103 and 104. The sand is predominantly fine grained to medium grained and loose to medium dense with Standard Penetration "N" values in the order of 5 to 16 blows per foot. Typical gradations of the sand unit are shown on Drawing Nos. GE-1198-18 to –22, inclusive. In Test Holes 101 and 108, the sand is saturated below depths of 7.3 and 6.7 metres, respectively.

The sand unit is underlain by a clayey till stratigraphic unit which extends to depths ranging from 4.9 to 26.5 metres below existing grade. The till unit was not encountered in Test Hole 104. The term till on the borehole logs indicates that the material originates from geological processes associated with glaciation. These processes produce a material that is heterogeneous in composition and as such, may contain pockets and/or seams of material such as sand, gravel, silt or clay. Fine grained sand lenses were encountered in Test Holes 105 through 110, inclusive. In Test Holes 106 and 110, the sand lenses are saturated. The till is clayey, moist and stiff to hard in consistency with undrained shear strengths in the order of 75 to 535 kPa based on unconfined compressive strength tests. Atterberg Limits test results indicate that the till has a Liquid Limit in the order of 32 percent and a Plasticity Index in the order of 20 percent which classifies it as a medium plastic material. The average dry density of the till is 1.94 tonnes per cubic metre.

The glacial sediments are underlain by shale bedrock (Bearpaw Formation) which extends to the maximum depth penetrated in the test holes (30.5 metres). The bedrock surface was not penetrated in Test Holes 102, 103 and 108. The shale consists of non-calcareous, highly plastic clay of marine origin which contains interbedded silt and bentonitic layers. The shale at this site is very stiff to hard in consistency. The variable composition of the shale results in a wide variation in engineering properties. The dry density of the shale ranges from 1.48 to 1.66 tonnes per cubic metre. Atterberg Limits test results indicate that the shale has a Liquid Limit ranging from 69 to 103 percent and a Plasticity Index ranging from 43 to 82

percent. The undrained shear strength of the shale ranges from 135 to 220 kPa based on unconfined compression tests.

4.3 Groundwater

The drilling information indicates that there is a perched water table in the surficial sand unit at the top of the valley wall. Along the edge of the valley wall, the surficial sand is drained, however, the underlying till also contains saturated sand and gravel lenses. Springs occur where these saturated sand and gravel lenses outcrop on the valley wall. Water levels in the piezometers were measured by our technologist after installation and again on November 8 and December 6, 2012. The piezometric surface measurements are summarized in Table 1, below:

TABLE 1

PIEZOMETRIC SURFACE MEASUREMENTS

STANDPIPE PIEZOMETER NO.	DATE MEASURED	DEPTH TO BOTTOM OF SCREEN FROM GROUND SURFACE (m)	GROUNDWATER LEVEL BELOW GRADE (m)	PIEZOMETRIC SURFACE (mASL)
TH 101	October 23, 2012	8.2	7.86	556.09
	November 8, 2012		7.40	556.55
	December 6, 2012		7.31	556.64
TH 104	October 23, 2012	14.3	Dry	--
	November 8, 2012		Dry	--
	December 6, 2012		Dry	--
TH 105	October 23, 2012	14.3	Dry	--
	November 8, 2012		Dry	--
	December 6, 2012		12.79	508.13
TH 106	October 23, 2012	15.8	Dry	--
	November 8, 2012		9.34	507.99
	December 6, 2012		6.88	510.45
TH 107	October 23, 2012	17.3	Dry	--
	November 8, 2012		13.09	520.86
	December 6, 2012		12.97	520.98
TH 109	October 23, 2012	28.0	Dry	--
	November 8, 2012		Dry	--
	December 6, 2012		Dry	--
TH 110	October 23, 2012	27.1	Dry	--
	November 8, 2012		7.40	555.35
	December 6, 2012		7.18	555.57

Water levels in the upper sand unit and sand lenses in the till unit will fluctuate with seasonal variations in precipitation and infiltration. Piezometers founded in the Bearpaw Formation (THs 104, 105, 106 and 109) may not yet be fully stabilized due to the extremely low permeability of the clay shale.

5.0 SLOPE STABILITY

5.1 History of Slope Movement

The Qu'Appelle Valley is the remnant of an early post glacial drainage system. During the last deglaciation, rushing meltwater cut a large, steep-walled valley through the surficial glacial deposits and into the underlying shale bedrock. Undercutting of the bedrock foundation materials undermined the slopes and produced the slumping activity which is still evident in some areas along the valley wall. The slumped areas form the ridges and localized discontinuities in surface drainage now present on the valley wall. The slumping activity has now largely subsided due to the deposition of post-glacial alluvium in the valley which has produced a buttressing effect, helping to stabilize the valley walls. However, gradual creep type movements of the old landslide slump blocks may still be occurring in some areas.

5.2 Stratigraphy

The surficial outwash sand and underlying glacial till are relatively competent soils. The underlying shale bedrock may contain weak layers or bentonite beds which are highly susceptible to landslide movement. The bedrock surface was penetrated at elevations ranging from 538.4 to 506.9 metres (Geodetic). The drilling information indicates that the bedrock surface slopes down towards the bottom of the valley and down from west to east.

One of the main factors controlling slope stability is the position of the till/shale contact with respect to the bottom of the valley wall. Where the till/shale contact is at or above the base of the valley, slopes are flatter and the slump blocks are more frequent. These slopes may actually be less stable than the steeper sloped areas where the till/shale contact is well below the present elevation of the valley bottom. According to the drilling information, the till/shale contact in the study area is slightly above the bottom of the valley wall. The slump blocks have been severely eroded and deposition of alluvial sediments has helped to stabilize the toe of the slope by providing a buttressing effect.

5.3 Topography

The valley wall exhibits the distinctive topographic features of a slope which has been subjected to landsliding. The identifying features are a steep headscarp and a hummocky broken slope. On air photographs, a series of arcuate, interconnected rear headscarps and a pattern of subparallel ridges down the slope are evident. Luxuriant vegetation growth is evident in the numerous undrained closed depressions which have formed behind many of the slump blocks.

5.4 Groundwater

One of the major factors controlling slope stability is the position of the water table. It is generally accepted that a slope that is fully drained will stand at an angle approximately twice that of a slope that has the groundwater table at surface. A high water table induces a higher water pressure at the slide surface which tends to hold the soil particles apart, thereby reducing the effective stress. The total weight of overlying soil is taken by the sum of the pore pressure and the effective stress between soil particles. Therefore, a rise in the water table causes a reduction in the factor of safety against sliding, conversely, lowering the water table would tend to stabilize the slide.

5.5 Discussion

Once landsliding has occurred on a valley slope, the factor of safety with respect to slope stability would be close to unity under natural conditions before any new developments constructed by man. The factor of safety is defined as the resisting forces divided by the driving forces. A safety factor close to 1.0 means that small changes in the stress environment may initiate additional down slope movement in the landslide slump blocks. Usually these movements are gradual creep type movements that range from a few millimetres to possibly several centimetres per year. Large, sudden drops in the order of 300 to 600 mm may also occur, however, these types of movements are less common than gradual creep type movements.

Development on the slopes will usually result in a reduction in the safety factor against sliding due to:

.1 An increase in the groundwater table due to lawn watering and reduction in surface evaporation;

.2 Installation of a water supply system which leads to higher groundwater levels via pipe leaks and increased water consumption;

.3 Landscaping which cuts the toe of individual slump blocks and/or places fill at the top of old slides. This results in decreased resisting forces and increased driving forces. Importing fill material generally increases the driving forces on a slide;

.4 Increased surcharge loads due to road construction and the construction of new buildings.

6.0 SLOPE STABILITY ANALYSIS

The purpose of a slope stability analysis is to determine the factor of safety of a potential failure surface. The analysis involves passing an assumed slip surface through the slope and dividing the inscribed portion into slices. The factor of safety is defined as a ratio between the resisting force and the driving force both applied along the potential failure surface. When the driving force due to the weight of the soil is equal to the resisting force due to shear strength, the factor of safety is equal to 1 and failure is imminent. The slope stability analysis was performed using the *Slide Version 6.0* computer software developed by Rocscience Inc. An effective stress slope stability analysis using the Morgenstern-Price method and half sine interslice force function was used.

6.1 Soil Strength Parameters

The soil strength parameters were interpreted using index properties of the materials determined during the geotechnical testing at the site in addition to our previous experience and information available in our Company files. The parameters used in our slope stability analysis are summarized in Table 2, below:

TABLE 2

SOIL STRENGTH PARAMETERS

SOIL TYPE	PEAK STRENGTH		UNIT WEIGHT
	Friction Angle	Cohesion	
Sand	30°	0 kPa	18.0 kN/m^3
Sand (Saturated)	15°	0 kPa	18.0 kN/m^3
Till (reduced)	19°	6 kPa	20.5 kN/m^3
Pierre Shale (reduced)	14°	5 kPa	16.5 kN/m^3
Pierre Shale (failure plane)	7°	0 kPa	16.5 kN/m^3
Alluvium	15°	0 kPa	18.0 kN/m^3

6.2 Stability Analysis

The slope stability analysis was completed at three cross sections along the valley wall in the proposed subdivision. Slope failures along the Qu'Appelle Valley system are typically seated in weak zones located within the shale bedrock. The factor of safety was generated by modelling a weak plane slightly below the surface of the bedrock shale sloping toward the bottom of the valley. The factor of safety was calculated at each cross section location for the existing conditions, as shown in Table 3, below

TABLE 3

FACTOR OF SAFETY – EXISTING CONDITIONS

Cross Section Location	Factor of Safety
1-1	1.06
2-2	1.14
3-3	1.18

Our test results and slope stability analysis indicates that minimum safety factors along the valley wall are in the order of 1.06 to 1.18. The stability analysis of the existing conditions is shown on the figures included in Appendix A. In each of the figures, all of the potential failure surfaces with a factor of safety less than 1.3 are shown. The location of the surfaces indicates areas of the slopes which are more susceptible to future landslide movement. The results indicate that the lower portion of the valley wall in the west portion of the development is the least stable portion of the site (Cross Section 1-1). Prior to deposition of the alluvial sediments within the valley bottom, when the valley was formed and the

initial slope failures occurred, the factor of safety would be at, or slightly below 1.0. In areas where the shale bedrock outcrops above the alluvium, the factor of safety remains relatively low, as is noted at Cross Section 1-1.

6.3 Site Development Guidelines

Development in an area of previous landslide activity involves some risk. The risk is associated with the possible reactivation of old landslides or the creation of entirely new landslides which the Owner must accept. At the present time, the proposed residential lots are considered to be feasible from a geotechnical engineering standpoint provided development controls are implemented to minimize the risk of future landslides and to avoid areas with the higher risk. No additional development on the valley wall is recommended without prior review by a geotechnical engineer. To minimize the potential problems associated with slope stability, the following guidelines are provided for lot development at this time.

.1 Buildings constructed in landslide terrain should be located entirely on one (1) slump block. Therefore, if movement occurs, the building would move with the block to minimize damage to the structure. If a building is constructed across two (2) slump blocks, the blocks may move at different rates and cause severe damage to the building. The approximate location of suitable building sites for the proposed development are shown on Drawing No. GE-1198-1. In order to accurately identify suitable building sites, additional inspections are recommended once the individual property boundaries (lots) have been surveyed (pinned) in the field.

.2 Landscaping should ensure a minimum of 2% slope away from the perimeter of the building.

.3 Water should be encouraged to drain off the property. No landscaping should be done which results in water ponding on the slope. The natural drainage courses down the valley wall should be maintained as best as possible. Lawn watering should be kept to a minimum on the valley wall. Excessive lawn watering will reduce the factor of safety against landsliding.

.4 The valley walls are highly susceptible to erosion. Removal of existing vegetation should be kept to a minimum. Areas where the vegetation is removed should be re-vegetated as soon as possible. Any erosion which does occur should be repaired immediately.

.5 No fill greater than 0.6 metres in depth should be placed at the edge of or on the valley wall without approval from a geotechnical engineer. No cuts greater than 2.5 metres should be allowed without approval from a geotechnical engineer. Excess cut material may be placed as fill at the toe of the slope.

.6 Embankments for roadway construction should be backsloped to a maximum slope of three (3) horizontal to one (1) vertical.

.7 Swimming pools can leak and contribute substantial quantities of water into the soil. For this reason, swimming pools are not recommended for this subdivision.

.8 Residential buildings on Lot 17 should be restricted to a perimeter area of 1200 square feet. All proposed developments on Lots 10 to 17, inclusive should be reviewed by a geotechnical engineer to ensure development complies with the recommended development controls and does not adversely affect slope stability.

7.0 FOUNDATION CONSIDERATIONS

It is anticipated that the foundation loads from the proposed residential buildings will be relatively light. The soil conditions at this site vary including coarse grained sand, silty till and Bearpaw Shale (highly plastic clay). The recommended foundation system is dependent on the soil conditions encountered at each building site. Where sand is encountered, a shallow concrete footing type foundation system is recommended. Shallow concrete footings or a bored concrete pile type foundations may be used in areas where till is encountered, however, difficulties may be encountered with boulders and sandy zones when excavating bored piles. A bored concrete pile type foundation system is recommended for Lot 17 where shale is encountered at the foundation elevation.

Additional test holes or test pits may be required prior to construction in order to determine the most suitable type of foundation system at each proposed building location. Our specific design recommendations for each type of foundation system are presented below:

7.1 Spread Footing and/or Post and Pad Type Foundation System

.1 Properly constructed shallow spread footings bearing on the undisturbed native till and/or sand soil may be designed for a safe net bearing pressure of 140 kPa (3,000 psf). Maximum toe pressure under wind loading may exceed the average pressure by no more than one-third (1/3). Regardless of footing pressure considerations, the minimum width of footings should be 450 mm.

.2 The footings should be placed at a minimum depth of 1.8 metres below finished grade elevation for frost protection. If the footings are placed above this depth, insulation should be placed to prevent frost penetration into the soils beneath the footings. All footings should be adequately reinforced to resist localized stresses.

.3 Every effort should be made to pour the footings as soon as possible after excavation is completed. The steel reinforcing mats should be made up in advance to minimize the possibility of soil disturbance during placement.

.4 All loose or disturbed material at the base of the footing excavations should be compacted prior to placement of forms, reinforcing steel and concrete.

7.2 Bored Concrete Piles

.1 The relatively light column loads for the building structures on the valley wall may be supported by straight shaft piles designed to develop load carrying capacity on the basis of side friction only. An average allowable skin friction value of 33.5 kPa (700 psf) based on the contact area between the pile surface and the surrounding undisturbed soil may be used at this site.

.2 The upper two (2) metres of pile length below the final ground surface should be discounted insofar as side friction carrying capacity is concerned. It is recommended

that the minimum pile shaft diameter be 300 mm to ensure that an adequate pile cross-section is maintained for the full drilled depth. A minimum pile length of 6.0 metres is also recommended.

.3 Temporary sleeves may be required at some locations in order to maintain an open hole during excavation of bored concrete piles at this site. It is recommended that the steel reinforcement and concrete be placed immediately following the completion of the pile excavations in order to minimize the potential for sloughing and/or ingress of groundwater into the piles holes.

.4 Pile shafts carrying little or no bending moment should be reinforced with nominal vertical reinforcement in the form of intermediate grade deformed bars, composing about one-half (1/2) of one (1) percent of the cross-sectional area. The steel reinforcing cage should be projected or dowels set into the top of the caisson to tie into the foundation walls and/or columns.

.5 Concrete used for constructing piles may be placed using the free fall method and the slump should be specified as being not less than 100 mm. This will insure that voids do not exist in the finished pile foundation units. The concrete should remain fluid in the hole until the shaft is completely full in order to take advantage of the fluid pressure in the column of concrete which will develop high pressure against the soil and maximize the shaft's capacity.

.6 For buildings with no basement, a minimum of 75 mm of rigid insulation should be placed on the inside of all perimeter grade beams to reduce the heat losses and to prevent drying of the soils.

8.0 EXCAVATION CONSIDERATIONS

Excavations will be in the surficial till and/or sand. Conventional excavation procedures should therefore be applicable to the soils at this site. Piling contractors should be aware that difficulties may be encountered due to cobblestones and boulders in the till unit. Occupational Health and Safety Regulations require that any trench or excavation in which

persons must work must be cut back at least one (1) horizontal to one (1) vertical or a temporary shoring system must be used to support the sides of the excavation.

9.0 FLOOR SLAB CONSIDERATIONS

The soil conditions are suitable for either grade supported floor slabs or structurally supported floors constructed over a crawl space. Structurally supported floor systems, constructed over crawlspaces, are recommended on Lot 17 to prevent problems associated with differential movement of the highly plastic clay shale. The following recommendations are provided for both types of floor systems.

9.1 Structurally Supported Floor Systems

A structural floor system would be the most positive way to ensure satisfactory long term performance of the floor. We recommend the following items of work for preparation of the subgrade in the crawl space area beneath the floor slab.

.1 The crawl space should be covered with a Permalon Ply X-150 type vapour barrier (or equivalent) to reduce the humidity in the crawl space and prevent drying of the subgrade soils.

.2 Service lines and heating ducts could be installed beneath the floor and this would provide a more comfortable floor for the people occupying the building. Heating ducts should be insulated to prevent heat loss and potential drying of the subgrade soil.

.3 The ground surface in the crawl space should be graded to slope towards a positive outlet in order to drain any water that may enter the crawl space area.

.4 Provisions should be made to ventilate the crawl space area.

9.2 Grade Supported Floor Slabs

.1 The subgrade under a grade supported slab should be as uniform as possible. The surficial topsoil should be stripped from the site and the exposed subgrade should be

proof-rolled with a heavy sheepsfoot or vibratory padfoot roller. Any soft or spongy areas should be excavated and filled with compacted granular material. The final 200 mm below underside of the floor slab should be radon rock.

.2 The concrete slab in areas where only light floor loads are to be supported, may have a minimum thickness of 100 mm. The minimum 28 day concrete compressive strength should be specified as 25 MPa.

.3 A generous amount of reinforcing steel running both ways in the slab is desirable.

.4 A layer of robust polyethylene sheeting should be placed between the granular base and the concrete slab to deter the migration of moisture through the floor.

10.0 SANITARY SEWAGE TREATMENT DISPOSAL RECOMMENDATIONS

10.1 Saskatchewan Onsite Wastewater Disposal Guide

It is understood that on-site wastewater treatment systems will be considered for the subdivision. A preliminary evaluation has been conducted for the subdivision according to the Saskatchewan On-site Wastewater Disposal Guide-Second Edition (January 2009). Developments are classified based on physical characteristics such as geology, hydrogeology, groundwater availability and use as well as the density of the proposed and adjacent developments.

Information gathered during our investigation indicates that the geology and hydrogeology of the subdivision is highly variable, ranging from surficial coarse grained sand layers (unconfined aquifer) to glacial till and highly plastic clay bedrock. The adjacent quarter section to the east is developed with a residential subdivision in which groundwater may be used for domestic supply. The average parcel size for the proposed subdivision is approximately 8.9 acres. Based on these characteristics, the subject property would be classified as a *Medium Density Development in a Sensitive Location.* According to the Disposal Guide, acceptable systems in this type of development include holding tanks, pressure absorption/pressure chamber systems, Type II mounds, lagoons or package treatment plants with disposal.

10.2 Shoreland Pollution Control Regulations

In addition to the Saskatchewan On-site Wastewater Disposal Guide, private sewage disposal located within 457.2 metres (1,500 feet) of the high watermark of a lake, river, stream or other body of water must conform to the Shoreland Pollution Control Regulations (SR 54/76) under the Public Heath Act (1994). The regulation states that no sewage or effluent be discharged within 152.4 metres (500 feet) of the high watermark of a lake, river, stream of other body of water. Between 152.4 and 457.2 metres (500 and 1,5000 feet) above ground filters (sewage mounds) may be considered to dispose of sewage from private dwellings. The high water mark of the Qu'Appelle River will be slightly above the base of the valley wall in the area of the proposed development.

10.3 Sewage Disposal Recommendations

Based on the above guidelines, for lots located within 500 feet of the base of the valley wall, individual holding tanks are required and the effluent picked up and disposed of offsite. For lots located between 500 and 1,500 feet from the base of the valley wall, a Type II sewage mound may be considered for onsite waste disposal. For lots greater than 1,500 feet from the base of the valley wall, a number of onsite disposal options are available. A *Detailed Investigation,* as discussed in the Saskatchewan Onsite Wastewater Disposal Guide, is required at each site where onsite wastewater disposal is considered. For proposed Lot 17, a holding tank type system is recommended because the shale bedrock is present at surface. Table 4, below, summarizes the potential sewage disposal systems for each lot based on the results of this investigation.

TABLE 4

PRIVATE SEWAGE DISPOSAL SYSTEMS

LOT NUMBER(S)	AREA OF LOT (Acres)	POTENTIAL DISPOSAL OPTIONS
1 through 9	5.00 – 8.41	Holding tanks, Pressure absorption/pressure chamber systems, Type II mounds, Lagoons (_4 Ha only), Package treatment plants with Disposal
10 through 13	4.05 - 19.93	Holding tanks, Pressure absorption/pressure chamber systems, Type II mounds, Lagoons (_4 Ha only), Package treatment plants with Disposal**
14 through 16	6.13 - 14.51	Holding Tank, Type II Sewage Mound
17	16.19	Holding Tank

** Only Type II mounds or Holding Tanks are potential options within 1,500 feet of the high watermark of the Qu'Appelle River.

Design recommendations and appropriate set back distances for each type of sewage disposal system are included in the Saskatchewan Onsite Wastewater Disposal Guide.

11.0 OTHER

.1 Adequate drainage away from the buildings should be provided and maintained to minimize infiltration of water into the subgrade. The building sites should be set at as high an elevation as possible in relation to the surrounding area.

.2 Test results on selected samples indicate that the soluble sulphate contents in the soil range from 0.11 to 0.78 percent by dry soil weight. Therefore, Class 3 Concrete, with Type 50 cement as shown in the Guide for Use of Sulphate Resistant Cement on Drawing No. GE-1198-16, is recommended for all concrete placed in contact with the native soils.

.3 In the event that changes are made in the design, location or nature of the project, the conclusions and recommendations included in this report would not be deemed valid unless the changes in the project were reviewed by our firm. Modification to this report would then be made if necessary. Furthermore, it is recommended that this firm be allowed an opportunity for a general review of the final design plans and specifications in order to ensure that the recommendations made in this report are properly interpreted and implemented. If this firm is not allowed the opportunity for this review, we assume no responsibility for the misinterpretation of any of the recommendations.

.4 This report has been prepared for Mr. Lyle Bateman and is intended for the specific application to the design and construction of the proposed residential subdivision located in NW 24-19-23-W2 in the R.M. of Dufferin, Saskatchewan. The analysis and recommendations are based in part on the data obtained from the test hole logs. The boundaries between soil strata have been established at bore hole locations. Between the bore holes, the boundaries are assumed from geological evidence and may be subject to considerable error. Contractors bidding on the project works are particularly advised against reviewing the report without realizing

the limitations of the subsurface information. It is recommended that Contractors should make such tests, inspections and other on-site investigations as is considered necessary to satisfy themselves as to the nature of the conditions to be encountered.

.5 It is recommended that the geotechnical workscope include the following services:

i) geotechnical review of other design professionals' plans relative to their interpretation of geotechnical findings and recommendations, and;

ii) construction monitoring to observe construction activities in light of plans and specifications, and to help assure that unforeseen conditions are detected quickly to permit prompt corrective action and thus prevent minor problems from growing to major proportion.

.6 The soil samples from this site will be retained in our laboratory for 90 days following the date of this report. Should no instructions be received to the contrary, these samples will then be discarded.

12.0 CLOSURE

We trust that this report is satisfactory for your purposes. If you have any questions or require additional information, please contact this office.

Yours very truly
Ground Engineering Consultants Ltd.

Association of Professional Engineers & Geoscientists of Saskatchewan
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PW:ss
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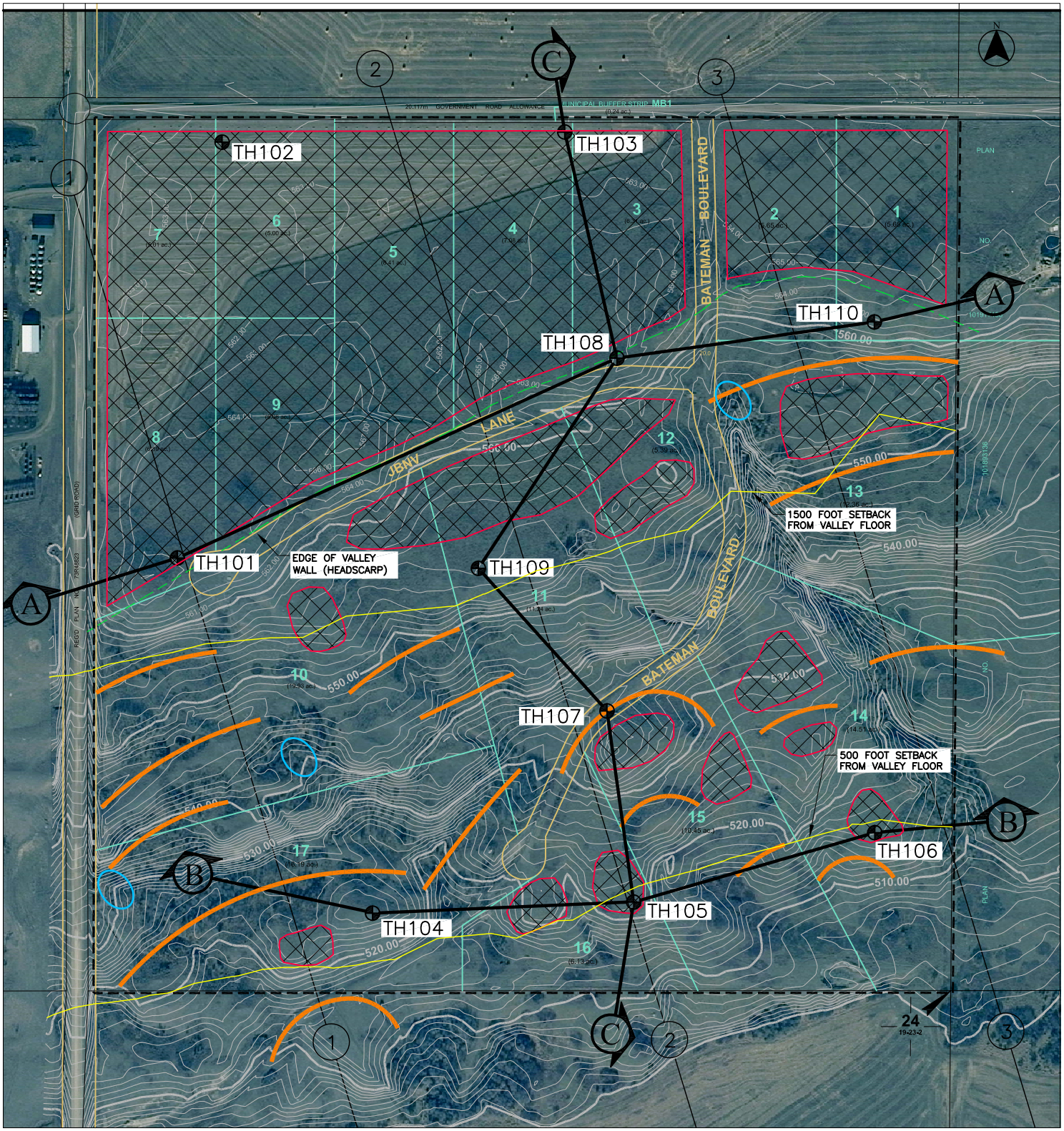
Pw773 Office (1 copy)

DRAWINGS



INDICATES POSSIBLE SPRINGS

INDICATES POTENTIAL BUILDING SITE

INDICATES CONTACT BETWEEN SLUMP BLOCKS

2 INDICATES SLOPE STABILITY CROSS SECTIONS

SURVEY PLAN PROVIDED BY MIDWEST SURVEYS INC.

SCALE: 1:5000

GROUND ENGINEERING CONSULTANTS LTD.

CIVIL & GEOENVIRONMENTAL ENGINEERS
415–7th AVENUE
REGINA, SASKATCHEWAN, CANADA

SITE PLAN SHOWING LOCATION OF TEST HOLES
PROPOSED RESIDENTIAL SUBDIVISION
NW 24–19–23–W2
R.M. of DUFFERIN, SASKATCHEWAN

CLIENT:	APPROVED:	DATE:	DWG. No.:
MR. LYLE BATEMAN		FEBRUARY 12, 2013	GE–1198–1

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation: D 2487 - 69 AND D 2488 - 69

(Unified Soil Classification System)

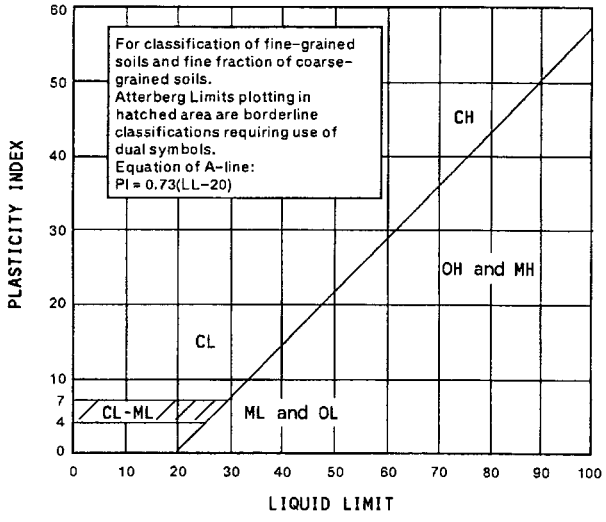
Major Divisions			Group Symbols	Typical Names	Classification Criteria
Coarse-grained soils More than 50% retained on No. 200 sieve *	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines	Not meeting both criteria for GW
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above "A" line with P.I. greater than 7
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean sands	SW	Well-graded sands and gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6: $C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			SP	Poorly graded sands and gravelly sands, little or no fines	Not meeting both criteria for SW
		Sands with fines	SM	Silty sands, sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4
			SC	Clayey sands, sand-clay mixtures	Atterberg limits above "A" line with P.I. greater than 7
Fine-grained soils 50% or more passes No. 200 sieve *	Silts and clays Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL	Organic silts and organic silty clays of low plasticity	
	Silts and clays Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts	
			CH	Inorganic clays of high plasticity, fat clays	
			OH	Organic clays of medium to high plasticity	
	Highly organic soils		Pt	Peat, muck and other highly organic soils	

Classification on basis of percentage of fines
Less than 5% pass No. 200 sieve ..... GW, GP, SW, SP
More than 12% pass No. 200 sieve ..... GM, GC, SM, SC
5 to 12% pass No. 200 sieve ..... Borderline classifications requiring use of dual symbols

Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols

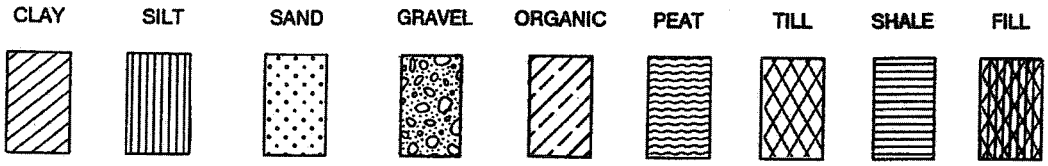
Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols

PLASTICITY CHART



*Based on the material passing the 75mm (3in) sieve.

SYMBOLS AND TERMS USED IN THE REPORT



The symbols may be combined to denote various soil combinations, the predominate soil being heavier.

RELATIVE PROPORTIONS

TERM	RANGE
Trace	0 - 5%
A Little	5 - 15%
Some	15 - 30%
With	30 - 50%

ASTM CLASSIFICATION BY PARTICLE SIZE

Boulder		> 300 mm
Cobble		300 mm - 75 mm
Gravel		75 mm - 4.75 mm
Sand		
	coarse	4.75 mm - 2 mm
	medium	2 mm - 425 um
	fine	425 um - 75 um
Silt		75 um - 5 um
Clay		< 5 um

DENSITY OF SANDS AND GRAVELS

DESCRIPTIVE TERM	RELATIVE DENSITY [1]	N VALUE STANDARD [2] PENETRATION TEST
Very loose	0 - 15%	0 - 4 Blows per 300mm
Loose	15 - 35%	4 - 10 Blows per 300mm
Medium Dense	35 - 65%	10 - 30 Blows per 300mm
Dense	65 - 85%	30 - 50 Blows per 300mm
Very Dense	85 - 100%	> 50 Blows per 300mm

CONSISTENCY OF CLAYS AND SILTS

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa) (CFEM, 2nd Edt., 1985)	N VALUE STANDARD [2] PENETRATION TEST	FIELD IDENTIFICATION (ASTM D 2488-84)
Very Soft	<12	< 2 Blows per 300mm	Thumb will penetrate soil more than 25 mm
Soft	12 - 25	2 - 4 Blows per 300mm	Thumb will penetrate soil about 25 mm
Firm	25 - 50	4 - 8 Blows per 300mm	Thumb will indent soil about 6 mm
Stiff	50 - 100	8 - 15 Blows per 300mm	Thumb will indent, but only with great effort (CFEM)
Very Stiff	100 - 200	15 - 30 Blows per 300mm	Readily indented by thumbnail (CFEM)
Hard	>200	> 30 Blows per 300mm	Thumb will not indent soil but readily indented with thumbnail

NOTES: 1. Relative Density determined by standard laboratory tests.
2. N Value - Blows/300mm of a 620N hammer falling 762mm on a 50mm O.D. Split Spoon.

SYMBOLS AND TERMS USED IN THE REPORT (continued)

GROUNDWATER

▼ Water level measured in the borings at the time and under the conditions indicated. In sand, the indicated levels can be considered reliable groundwater levels. In clay soil, it is not possible to determine the groundwater level within the normal scope of a test boring investigation, except where lenses or layers of more pervious waterbearing soil are present and then a long period of time may be necessary to reach equilibrium. Therefore, the position of the water level symbol for cohesive or mixed texture soils may not indicate the true level of the groundwater table. The available water level information is given at the bottom of the log sheet.

▽ Water level determined by piezometer installation – In all soils the levels can be considered reliable groundwater levels.

DESCRIPTIVE SOIL TERMS

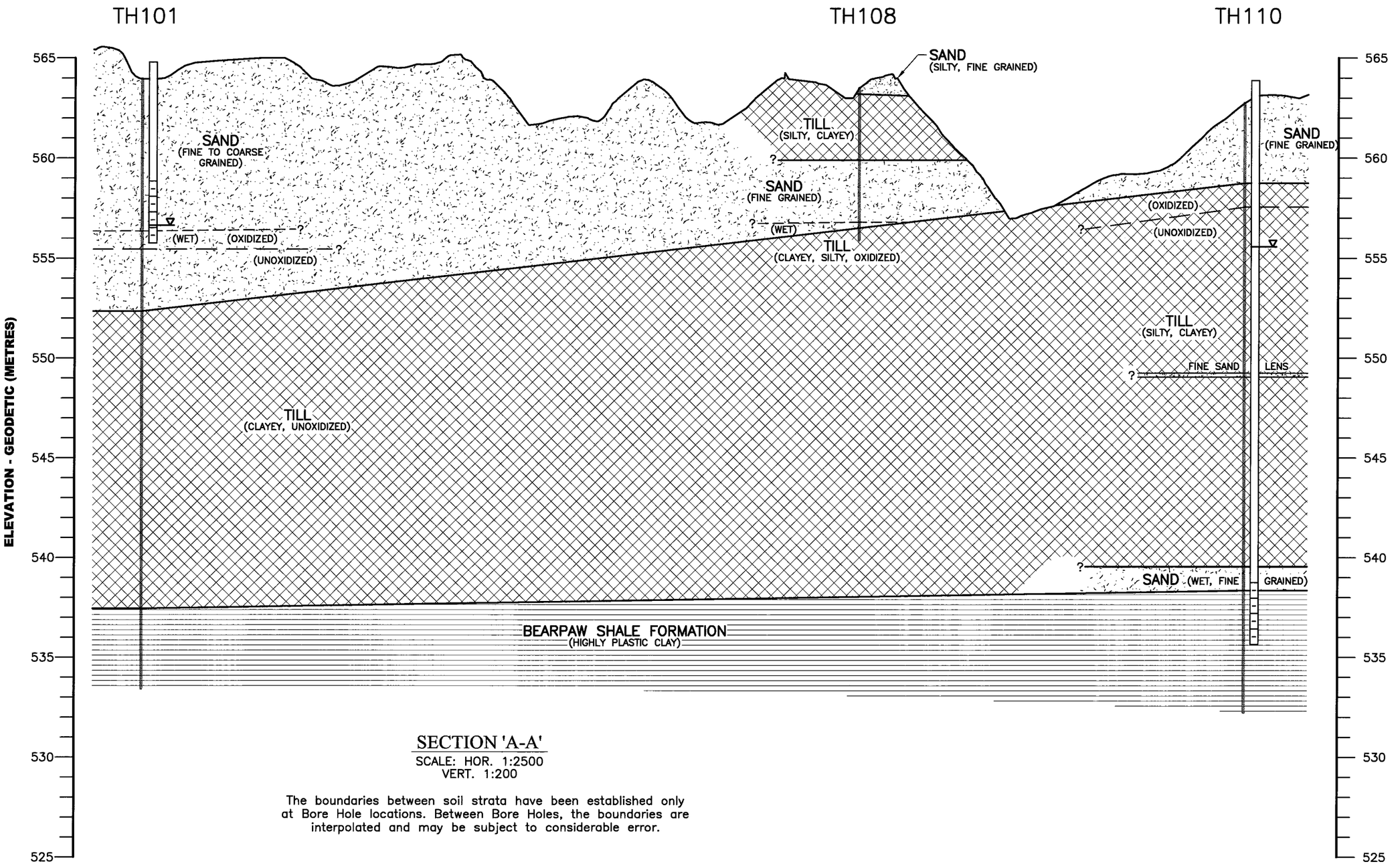
WELL GRADED	Having wide range of grain sizes and substantial amounts of all intermediate sizes.
POORLY GRADED	Predominantly of one grain size.
SLICKENSIDES	Refers to a clay that has planes that are slick and glossy in appearance; slickensides are caused by shear movements.
SENSITIVE	Exhibiting loss of strength on remolding.
FISSURED	Containing cracks, usually attributable to shrinkage. Fissured clays are sometimes described as having a nuggetty structure.
STRATIFIED	Containing layers of different soil types.
ORGANIC	Containing organic matter; may be decomposed or fibrous.
PEAT	A fibrous mass of organic matter in various stages of decomposition. Generally dark brown to black in color and of spongy consistency.
BEDROCK	Preglacial material.
DRIFT	Material deposited directly by glaciers or glacial melt-water.
ALLUVIAL	Soils that have been deposited from suspension from moving water.
LACUSTRINE	Soils that have been deposited from suspension in fresh water lakes.

DRILLING AND SAMPLING TERMS

SYMBOL	DEFINITION
C.S.	Continuous Sampling
Sy	75mm Thin Wall Tube Sample
Sy (2)	50mm Thin Wall Tube Sample
SPT (SS)	50mm O.D. Split Spoon Sample
BLOWS / 300mm	"N" Value – Standard Penetration Test
Bag	Disturbed Bag Sample
No.	Sample Identification Number
⟶	Piezometer Tip
S.I.	Slope Indicator
SPG ⟶	Observed Seepage

LABORATORY TEST SYMBOLS

SYMBOL	DEFINITION
●	Moisture Content – Percent of Dry Weight
⊢⟶	Plastic and Liquid Limit determined in accordance with ASTM D-423 and D-424
◆	Dry Density – t/m^3
■	Shear Strength – As determined by Unconfined Compression Test
▲	Shear Strength – As determined by Field Vane
▲	Shear Strength – As determined by Pocket Penetrometer Test
$\%SO_4$	Water Soluable Sulphates – Percent of Dry Weight
M.A.	Grain Size Analysis

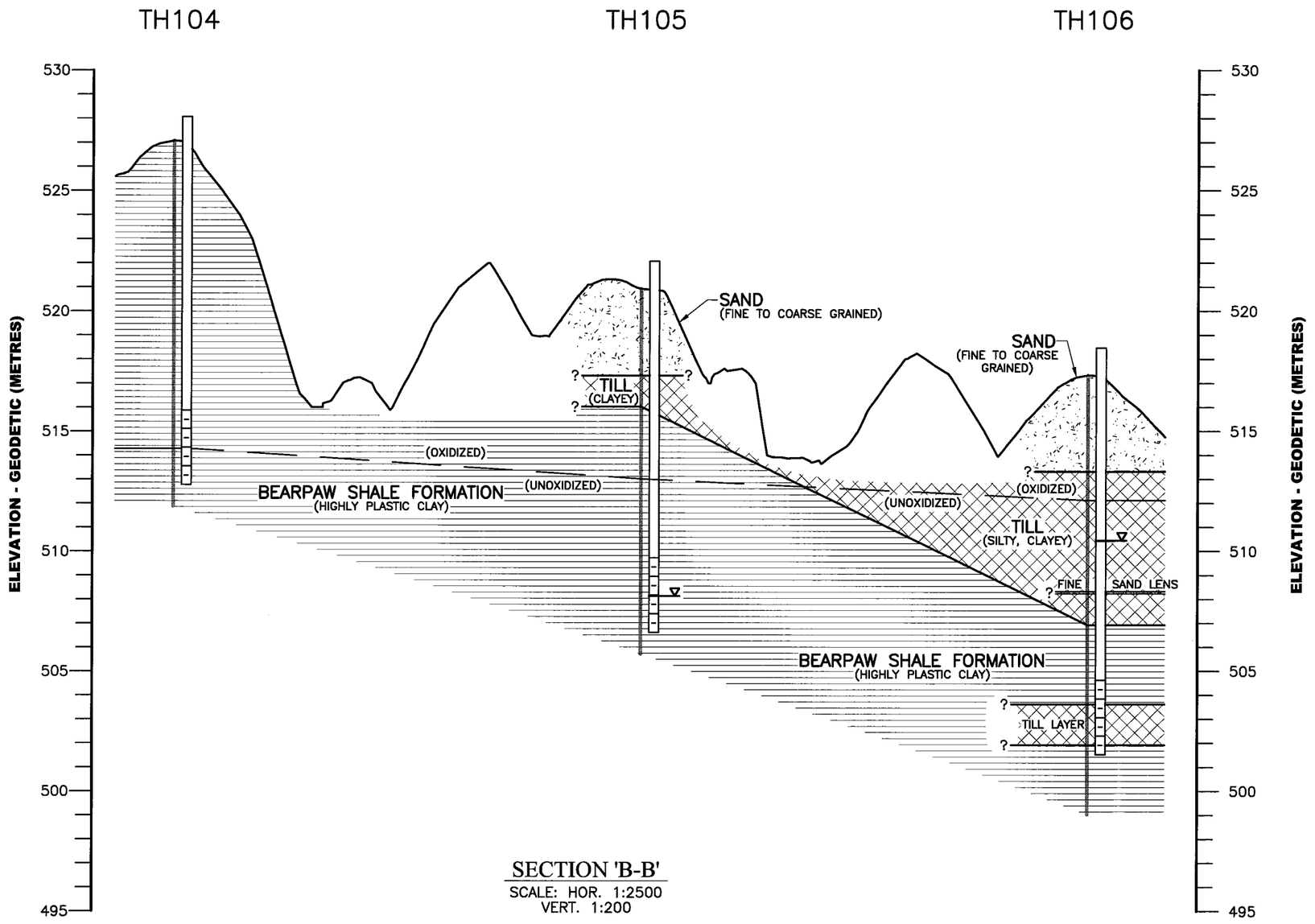


SECTION 'A-A'

SCALE: HOR. 1:2500
VERT. 1:200

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes, the boundaries are interpolated and may be subject to considerable error.

GROUND ENGINEERING CONSULTANTS LTD. CIVIL & GEOENVIRONMENTAL ENGINEERS 415–7th AVENUE REGINA, SASKATCHEWAN, CANADA	STRATIGRAPHIC CROSS SECTION 'A–A' PROPOSED RESIDENTIAL SUBDIVISION NW 24–19–23–W2 R.M. of DUFFERIN, SASKATCHEWAN		
CLIENT: MR. LYLE BATEMAN	APPRDVED:	DATE: FEBRUARY 12, 2013	DWG. No.: GE–1198–5



SECTION 'B-B'

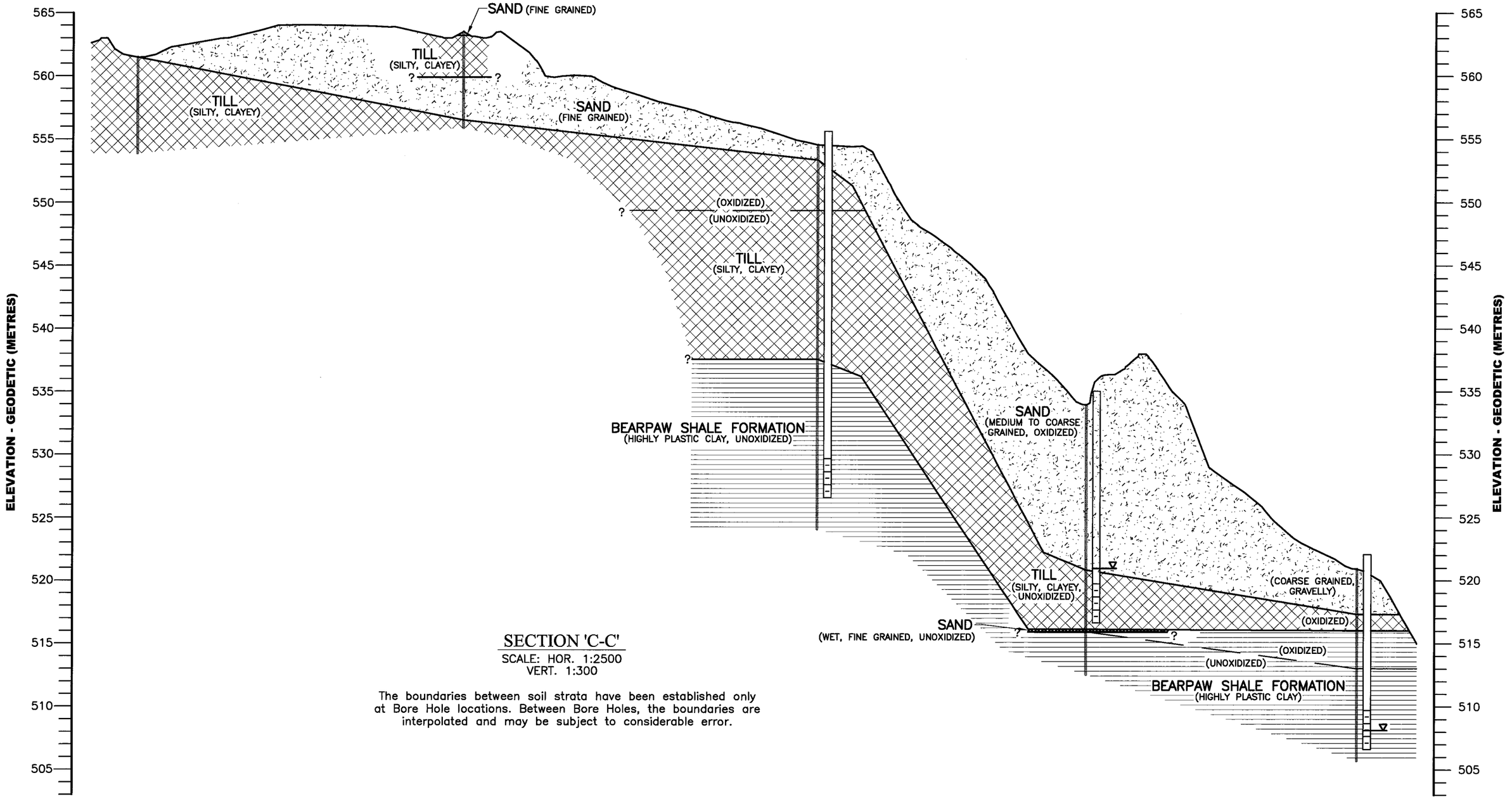
SCALE: HOR. 1:2500
VERT. 1:200

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes, the boundaries are interpolated and may be subject to considerable error.

GROUND ENGINEERING CONSULTANTS LTD.
CIVIL & GEOENVIRONMENTAL ENGINEERS
415–7th AVENUE
REGINA, SASKATCHEWAN, CANADA

STRATIGRAPHIC CROSS SECTION 'B–B'
PROPOSED RESIDENTIAL SUBDIVISION
NW 24–19–23–W2
R.M. of DUFFERIN, SASKATCHEWAN

CLIENT:	APPROVED:	DATE:	OWG. No.:
MR. LYLE BATEMAN		FEBRUARY 12, 2013	GE–1198–6



SECTION 'C-C'

SCALE: HOR. 1:2500
VERT. 1:300

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes, the boundaries are interpolated and may be subject to considerable error.

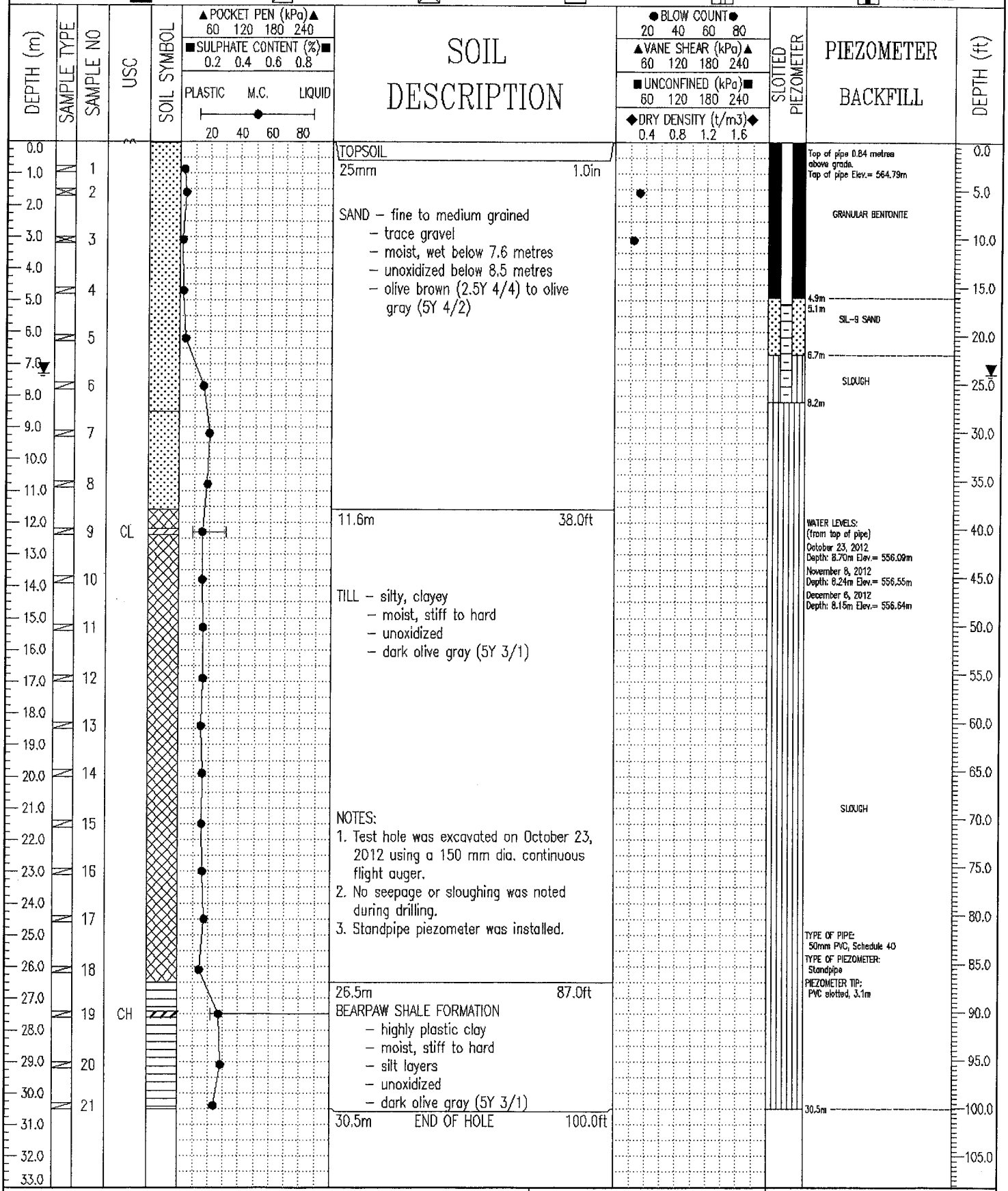
GROUND ENGINEERING CONSULTANTS LTD.
CIVIL & GEOENVIRONMENTAL ENGINEERS
415–7th AVENUE
REGINA, SASKATCHEWAN, CANADA

STRATIGRAPHIC CROSS SECTION 'C–C'
PROPOSED RESIDENTIAL SUBDIVISION
NW 24–19–23–W2
R.M. of DUFFERIN, SASKATCHEWAN

CLIENT:	APPROVED:	DATE:	DWG. No.:
MR. LYLE BATEMAN		FEBRUARY 12, 2013	GE–1198–7

PROJECT: PROPOSED SUBDIVISION	LOCATION: NW 24-19-23-W2	TEST HOLE NO: 1198-TH101
CLIENT: MR. LYLE BATEMAN	LOCATION: NEAR DISLEY, SASKATCHEWAN	PROJECT NO: GE-1198
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 563.95 metres (GEODETIC)	ELEVATION: 563.95 (m)

SAMPLE TYPE: SHELBY TUBE | DISTURBED | SPT SAMPLE | PAIL SAMPLE | NO RECOVERY | JAR SAMPLE

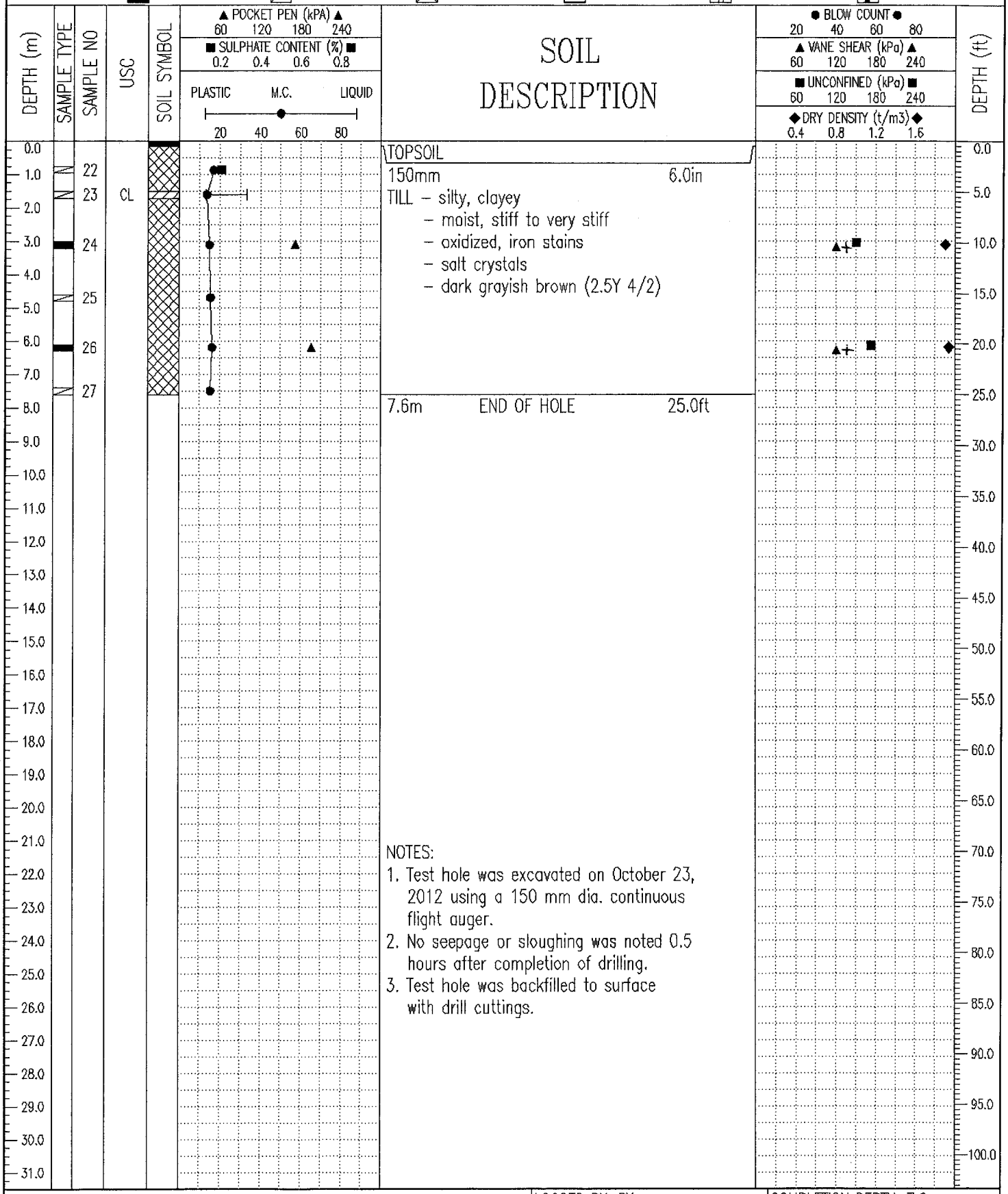


GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: RY	COMPLETION DEPTH: 30.5 m
	REVIEWED BY: PW	COMPLETE: 12/10/23
	Fig. No: 1198-8	Page 1 of 1

13/01/18 09:48AM

PROJECT: PROPOSED SUBDIVISION	LOCATION: NW 24-19-23-W2	TEST HOLE NO: 1198-TH102
CLIENT: MR. LYLE BATEMAN	LOCATION: NEAR DISLEY, SASKATCHEWAN	PROJECT NO: GE-1198
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 559.80 metres (GEODETIC)	ELEVATION: 559.80 (m)

SAMPLE TYPE: SHELBY TUBE | DISTURBED | SPT SAMPLE | PAIL SAMPLE | NO RECOVERY | JAR SAMPLE



TOPSOIL
150mm 6.0in

TILL – silty, clayey
– moist, stiff to very stiff
– oxidized, iron stains
– salt crystals
– dark grayish brown (2.5Y 4/2)

7.6m END OF HOLE 25.0ft

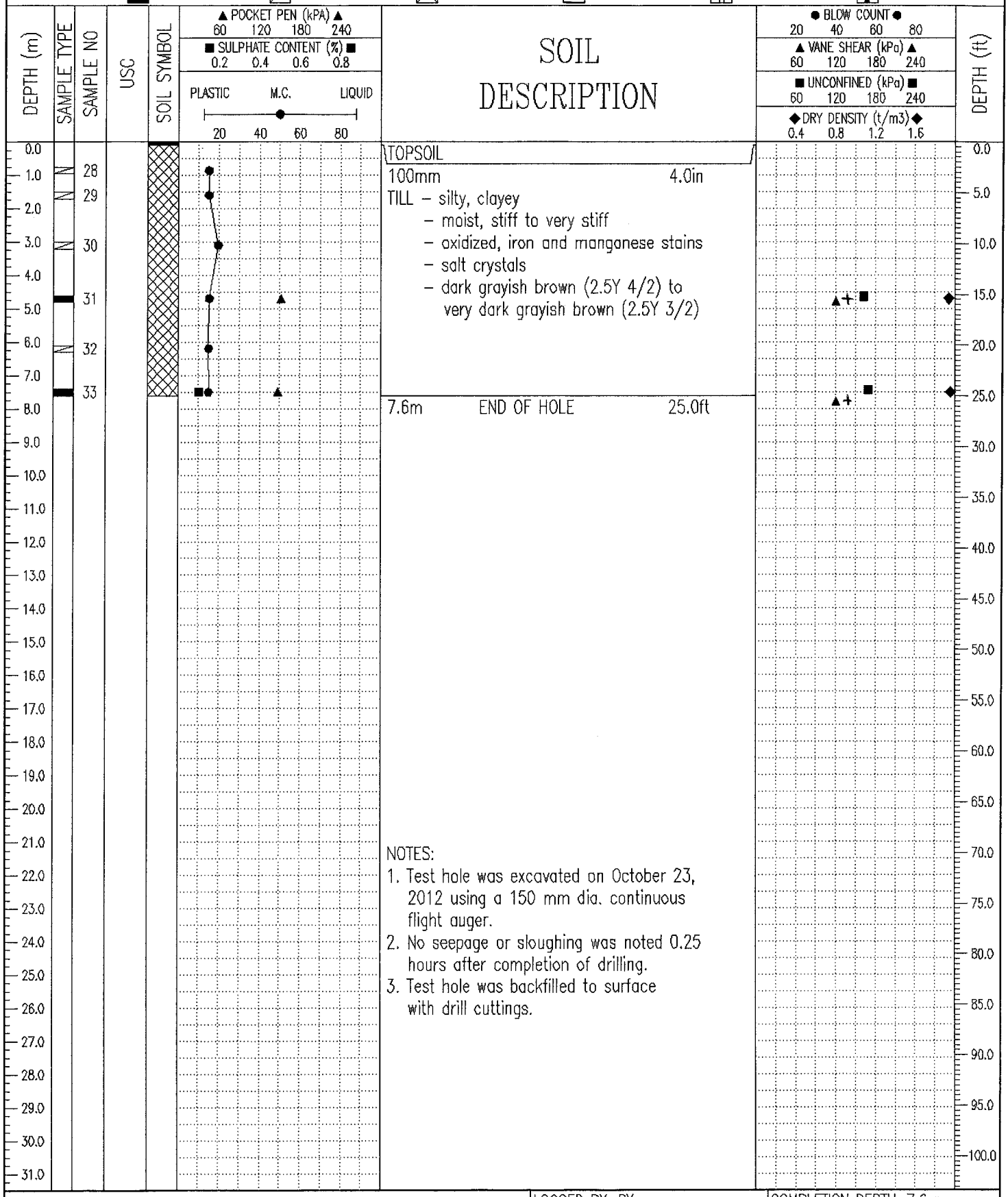
NOTES:
1. Test hole was excavated on October 23, 2012 using a 150 mm dia. continuous flight auger.
2. No seepage or sloughing was noted 0.5 hours after completion of drilling.
3. Test hole was backfilled to surface with drill cuttings.

GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: RY	COMPLETION DEPTH: 7.6 m
	REVIEWED BY: PW	COMPLETE: 12/10/23
	Fig. No: 1198-9	Page 1 of 1

13/01/18 09:48AM

PROJECT: PROPOSED SUBDIVISION	LOCATION: NW 24-19-23-W2	TEST HOLE NO: 1198-TH103
CLIENT: MR. LYLE BATEMAN	LOCATION: NEAR DISLEY, SASKATCHEWAN	PROJECT NO: GE-1198
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 561.48 metres (GEODETIC)	ELEVATION: 561.48 (m)

SAMPLE TYPE: SHELBY TUBE | DISTURBED | SPT SAMPLE | PAIL SAMPLE | NO RECOVERY | JAR SAMPLE



TOPSOIL

100mm 4.0in

TILL – silty, clayey
- moist, stiff to very stiff
- oxidized, iron and manganese stains
- salt crystals
- dark grayish brown (2.5Y 4/2) to very dark grayish brown (2.5Y 3/2)

7.6m END OF HOLE 25.0ft

NOTES:
1. Test hole was excavated on October 23, 2012 using a 150 mm dia. continuous flight auger.
2. No seepage or sloughing was noted 0.25 hours after completion of drilling.
3. Test hole was backfilled to surface with drill cuttings.

GROUND ENGINEERING LTD.	LOGGED BY: RY	COMPLETION DEPTH: 7.6 m
Regina, Saskatchewan	REVIEWED BY: PW	COMPLETE: 12/10/23
	Fig. No: 1198-10	Page 1 of 1

13/01/18 09:49AM

PROJECT: PROPOSED SUBDIVISION	LOCATION: NW 24-19-23-W2	TEST HOLE NO: 1198-TH104
CLIENT: MR. LYLE BATEMAN	LOCATION: NEAR DISLEY, SASKATCHEWAN	PROJECT NO: GE-1198
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 527.07 metres (GEODETIC)	ELEVATION: 527.07 (m)

SAMPLE TYPE: SHELBY TUBE | DISTURBED | SPT SAMPLE | PAIL SAMPLE | NO RECOVERY | JAR SAMPLE

DEPTH (m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	▲POCKET PEN (kPa)▲ 60 120 180 240 ■SULPHATE CONTENT (%)■ 0.2 0.4 0.6 0.8 PLASTIC M.C. LIQUID 20 40 60 80	SOIL DESCRIPTION	●BLOW COUNT● 20 40 60 80 ▲VANE SHEAR (kPa)▲ 60 120 180 240 ■UNCONFINED (kPa)■ 60 120 180 240 ◆DRY DENSITY (t/m3)◆ 0.4 0.8 1.2 1.6	SLOTTED PIEZOMETER	PIEZOMETER BACKFILL	DEPTH (ft)
0.0						TOPSOIL			Top of pipe 1.00 metres above grade. Top of pipe Elev.= 528.07m	0.0
1.0	N	34				75mm 3.0in				
2.0	N	35	CH						GRANULAR BENTONITE	5.0
3.0		36				BEARPAW SHALE FORMATION – highly plastic clay – moist, stiff to hard – silt layers – iron stains – unoxidized below 12.8 metres – dark grayish brown (2.5Y 4/2) to dark olive gray (5Y 3/1)				10.0
4.0										
5.0	N	37								15.0
6.0	N	38								20.0
7.0										
8.0	N	39								25.0
9.0		40								30.0
10.0										
11.0	N	41							10.8m 11.2m SIL-9 SAND	35.0
12.0	N	42								40.0
13.0										
14.0		43							14.3m TAILINGS	45.0
15.0	N	44				15.2m END OF HOLE 50.0ft			14.8m SLOUGH 15.2m	50.0
16.0										
17.0										55.0
18.0										
19.0									WATER LEVELS: (from top of pipe) October 25, 2012 Depth: Dry November 8, 2012 Depth: Dry December 6, 2012 Depth: Dry	60.0
20.0										65.0
21.0										
22.0										70.0
23.0										75.0
24.0										
25.0										80.0
26.0									TYPE OF PIPE: 50mm PVC, Schedule 40 TYPE OF PIEZOMETER: Standpipe PIEZOMETER TIP: PVC slotted, 3.1m	85.0
27.0										
28.0										90.0
29.0										95.0
30.0										
31.0										100.0
32.0										105.0
33.0										

NOTES:
1. Test hole was excavated on October 25, 2012 using a 150 mm dia. continuous flight auger.
2. No seepage or sloughing was noted during drilling.
3. Standpipe piezometer was installed.

GROUND ENGINEERING LTD.
Regina, Saskatchewan

LOGGED BY: RY	COMPLETION DEPTH: 15.2 m
REVIEWED BY: PW	COMPLETE: 12/10/25
Fig. No: 1198-11	Page 1 of 1

13/01/18 09:49AM

PROJECT: PROPOSED SUBDIVISION	LOCATION: NW 24-19-23-W2	TEST HOLE NO: 1198-TH105
CLIENT: MR. LYLE BATEMAN	LOCATION: NEAR DISLEY, SASKATCHEWAN	PROJECT NO: GE-1198
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 520.92 metres (GEODETIC)	ELEVATION: 520.92 (m)

SAMPLE TYPE: SHELBY TUBE | DISTURBED | SPT SAMPLE | PAIL SAMPLE | NO RECOVERY | JAR SAMPLE

DEPTH (m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	▲POCKET PEN (kPa)▲ 60 120 180 240 ■SULPHATE CONTENT (%)■ 0.2 0.4 0.6 0.8 PLASTIC M.C. LIQUID 20 40 60 80	SOIL DESCRIPTION	●BLOW COUNT● 20 40 60 80 ▲VANE SHEAR (kPa)▲ 60 120 180 240 ■UNCONFINED (kPa)■ 60 120 180 240 ◆DRY DENSITY (t/m3)◆ 0.4 0.8 1.2 1.6	SLOTTED PIEZOMETER	PIEZOMETER BACKFILL	DEPTH (ft)
0.0						TOPSOIL			Top of pipe 1.15 metres above grade. Top of pipe Elev.= 522.07m	0.0
1.0	N	45				75mm 3.0in				
2.0	N	46				SAND – fine to medium grained – trace gravel – moist – oxidized – dark grayish brown (2.5Y 4/2)				5.0
3.0	M	47							GRANULAR BENTONITE AND TAILINGS	10.0
4.0						3.6m 12.0ft				
5.0		48				TILL – silty, clayey – moist, stiff to very stiff – oxidized, iron stains – dark grayish brown (2.5Y 4/2)				15.0
6.0	N	49								20.0
7.0						4.9m 16.0ft				
8.0	N	50				BEARPAW SHALE FORMATION – highly plastic clay – moist, stiff to hard – oxidized, iron stains – salt crystals – unoxidized below 7.9 metres – dark grayish brown (2.5Y 4/2) to dark olive gray (5Y 3/1)				25.0
9.0		51								30.0
10.0										
11.0	N	52							10.7m 11.2m SIL-9 SAND	35.0
12.0	N	53								40.0
13.0										
14.0	N	54							14.3m TAILINGS	45.0
15.0		55				15.2m END OF HOLE 50.0ft			15.2m	50.0
16.0										
17.0										55.0
18.0									WATER LEVELS: (from top of pipe) October 25, 2012 Depth: Dry November 8, 2012 Depth: Dry December 6, 2012 Depth: 13.94m Elev.= 508.13m	60.0
19.0										
20.0										65.0
21.0										
22.0										70.0
23.0										75.0
24.0										
25.0										80.0
26.0									TYPE OF PIPE: 50mm PVC, Schedule 40 TYPE OF PIEZOMETER: Standpipe PIEZOMETER TIP: PVC slotted, 3.1m	85.0
27.0										
28.0										90.0
29.0										95.0
30.0										
31.0										100.0
32.0										105.0
33.0										

NOTES:
1. Test hole was excavated on October 25, 2012 using a 150 mm dia. continuous flight auger.
2. No seepage or sloughing was noted during drilling.
3. Standpipe piezometer was installed.

GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: RY	COMPLETION DEPTH: 15.2 m
	REVIEWED BY: PW	COMPLETE: 12/10/25
	Fig. No: 1198-12	Page 1 of 1

13/01/18 09:49AM

PROJECT: PROPOSED SUBDIVISION	LOCATION: NW 24-19-23-W2	TEST HOLE NO: 1198-TH106
CLIENT: MR. LYLE BATEMAN	LOCATION: NEAR DISLEY, SASKATCHEWAN	PROJECT NO: GE-1198
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 517.33 metres (GEODETIC)	ELEVATION: 517.33 (m)

SAMPLE TYPE: SHELBY TUBE | DISTURBED | SPT SAMPLE | PAIL SAMPLE | NO RECOVERY | JAR SAMPLE

DEPTH (m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	▲POCKET PEN (kPa)▲ 60 120 180 240 / ■SULPHATE CONTENT (%)■ 0.2 0.4 0.6 0.8 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL DESCRIPTION	●BLOW COUNT● 20 40 60 80 / ▲VANE SHEAR (kPa)▲ 60 120 180 240 / ■UNCONFINED (kPa)■ 60 120 180 240 / ◆DRY DENSITY (t/m3)◆ 0.4 0.8 1.2 1.6	SLOTTED PIEZOMETER	PIEZOMETER BACKFILL	DEPTH (ft)
0.0						TOPSOIL			Top of pipe 1.15 metres above grade. Top of pipe Elev.= 518.48m	0.0
1.0	N	56				50mm 2.0in SAND – fine to medium grained – trace gravel – moist – oxidized – dark grayish brown (2.5Y 4/2)				
2.0	N	57							GRANULAR BENTONITE AND TAILINGS	5.0
3.0	N	58								10.0
4.0						4.0m 13.0ft				
5.0	N	59	CL			TILL – silty, clayey – moist, stiff to hard – oxidized, iron stains – salt crystals – unoxidized below 5.2 metres – fine sand lens from 9.0 to 9.1 metres – dark grayish brown (2.5Y 4/2) to dark olive gray (5Y 3/1)				15.0
6.0	N	60								20.0
7.0 ▼										
8.0		61								25.0
9.0	N	62								30.0
10.0										
11.0	N	63	CH			10.4m 34.0ft BEARPAW SHALE FORMATION – highly plastic clay – moist, hard – unoxidized – silty till layer from 13.7 to 15.4 metres – dark olive gray (5Y 3/1)			11.0m	35.0
12.0	N	64							12.7m SIL-S SAND	40.0
13.0										
14.0		65								45.0
15.0	N	66							15.8m SLOUGH	50.0
16.0										
17.0	N	67								55.0
18.0	N	68				18.3m END OF HOLE 60.0ft			18.3m	60.0
19.0										
20.0									WATER LEVELS: (from top of pipe) October 25, 2012 Depth: Dry November 8, 2012 Depth: 10.49m Elev.= 507.99m December 6, 2012 Depth: 8.03m Elev.= 510.45m	65.0
21.0										
22.0										70.0
23.0										
24.0										80.0
25.0										
26.0									TYPE OF PIPE: 50mm PVC, Schedule 40	85.0
27.0									TYPE OF PIEZOMETER: Standpipe	
28.0									PIEZOMETER TIP: PVC slotted, 3.1m	90.0
29.0										95.0
30.0										
31.0										100.0
32.0										
33.0										105.0

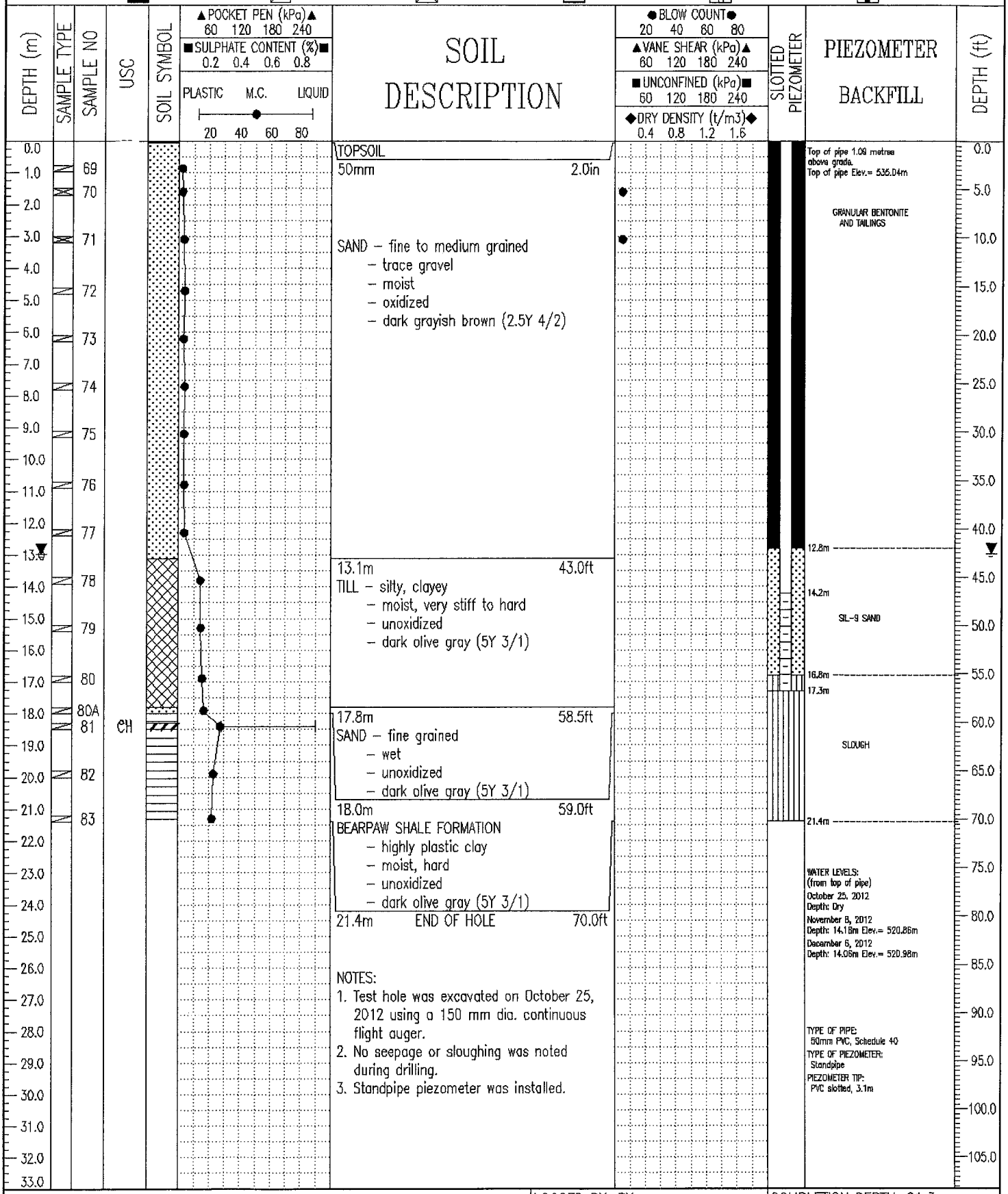
NOTES:
1. Test hole was excavated on October 25, 2012 using a 150 mm dia. continuous flight and 250 mm dia. hollow stem augers.
2. No seepage or sloughing was noted during drilling.
3. Standpipe piezometer was installed.

GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: RY	COMPLETION DEPTH: 18.3 m
	REVIEWED BY: PW	COMPLETE: 12/10/25
	Fig. No: 1198-13	Page 1 of 1

13/01/18 01:37PM

PROJECT: PROPOSED SUBDIVISION	LOCATION: NW 24-19-23-W2M	TEST HOLE NO: 1198-TH107
CLIENT: MR. LYLE BATEMAN	LOCATION: NEAR DISLEY, SASKATCHEWAN	PROJECT NO: GE-1198
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 533.95 metres (GEODETIC)	ELEVATION: 533.95 (m)

SAMPLE TYPE: SHELBY TUBE | DISTURBED | SPT SAMPLE | PAIL SAMPLE | NO RECOVERY | JAR SAMPLE



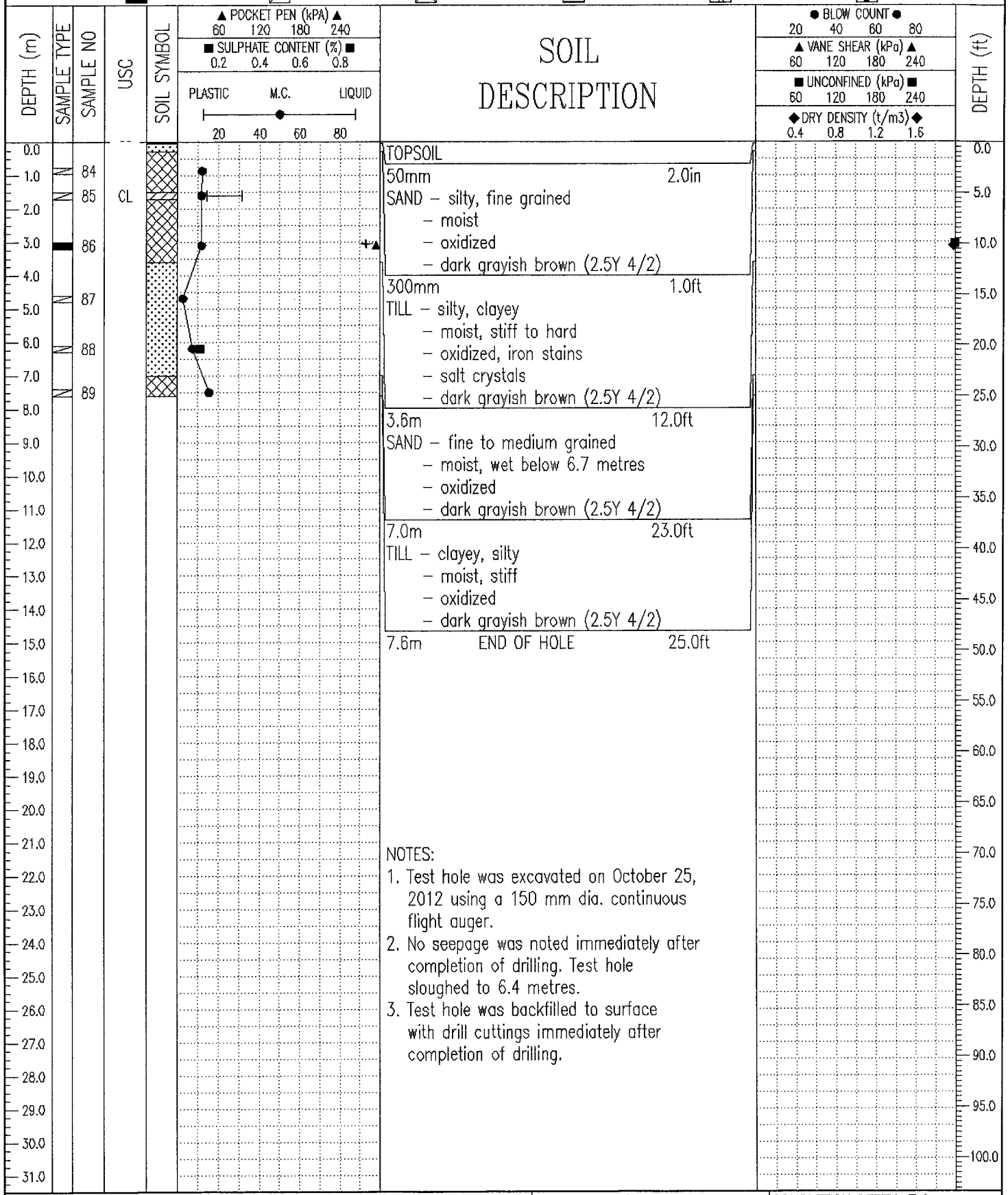
NOTES:
1. Test hole was excavated on October 25, 2012 using a 150 mm dia. continuous flight auger.
2. No seepage or sloughing was noted during drilling.
3. Standpipe piezometer was installed.

GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: RY	COMPLETION DEPTH: 21.3 m
	REVIEWED BY: PW	COMPLETE: 12/10/25
	Fig. No: 1198-14	Page 1 of 1

13/01/18 09:49AM

PROJECT: PROPOSED SUBDIVISION	LOCATION: NW 24-19-23-W2	TEST HOLE NO: 1198-TH108
CLIENT: MR. LYLE BATEMAN	LOCATION: NEAR DISLEY, SASKATCHEWAN	PROJECT NO: GE-1198
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 563.50 metres (GEODETIC)	ELEVATION: 563.50 (m)

SAMPLE TYPE: SHELBY TUBE | DISTURBED | SPT SAMPLE | PAIL SAMPLE | NO RECOVERY | JAR SAMPLE



TOPSOIL
50mm 2.0in
SAND – silty, fine grained
- moist
- oxidized
- dark grayish brown (2.5Y 4/2)

300mm 1.0ft
TILL – silty, clayey
- moist, stiff to hard
- oxidized, iron stains
- salt crystals
- dark grayish brown (2.5Y 4/2)

3.6m 12.0ft
SAND – fine to medium grained
- moist, wet below 6.7 metres
- oxidized
- dark grayish brown (2.5Y 4/2)

7.0m 23.0ft
TILL – clayey, silty
- moist, stiff
- oxidized
- dark grayish brown (2.5Y 4/2)

7.6m END OF HOLE 25.0ft

NOTES:
1. Test hole was excavated on October 25, 2012 using a 150 mm dia. continuous flight auger.
2. No seepage was noted immediately after completion of drilling. Test hole sloughed to 6.4 metres.
3. Test hole was backfilled to surface with drill cuttings immediately after completion of drilling.

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LOGGED BY: RY	COMPLETION DEPTH: 7.6 m
REVIEWED BY: PW	COMPLETE: 12/10/25
Fig. No: 1198-15	Page 1 of 1

13/01/18 09:49AM

PROJECT: PROPOSED SUBDIVISION	LOCATION: NW 24-19-23-W2	TEST HOLE NO: 1198-TH109
CLIENT: MR. LYLE BATEMAN	LOCATION: NEAR DISLEY, SASKATCHEWAN	PROJECT NO: GE-1198
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 554.56 metres (GEODETIC)	ELEVATION: 554.56 (m)

SAMPLE TYPE: SHELBY TUBE | DISTURBED | SPT SAMPLE | PAIL SAMPLE | NO RECOVERY | JAR SAMPLE

DEPTH (m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	▲POCKET PEN (kPa)▲ 60 120 180 240 ■SULPHATE CONTENT (%)■ 0.2 0.4 0.6 0.8 PLASTIC M.C. LIQUID 20 40 60 80	SOIL DESCRIPTION	●BLOW COUNT● 20 40 60 80 ▲VANE SHEAR (kPa)▲ 60 120 180 240 ■UNCONFINED (kPa)■ 60 120 180 240 ◆DRY DENSITY (t/m3)◆ 0.4 0.8 1.2 1.6	SLOTTED PIEZOMETER	PIEZOMETER BACKFILL	DEPTH (ft)
0.0						TOPSOIL			Top of pipe 1.06 metres above grade. Top of pipe Elev.= 555.62m	0.0
1.0	N	90				50mm 2.0in				
2.0	N	91				SAND – fine to medium grained – moist – oxidized – dark grayish brown (2.5Y 4/2)			GRANULAR BENTONITE AND TAILINGS	5.0
3.0		92			▲	1.2m 4.0ft	▲			10.0
4.0										
5.0	N	93				TILL – silty, clayey – moist, stiff to hard – oxidized, iron and manganese stains – sand layers – unoxidized below 5.2 metres – fine sand lens from 13.5 to 13.7 metres – dark grayish brown (2.5Y 4/2) to dark olive gray (5Y 3/1)				15.0
6.0		94					▲			20.0
7.0										
8.0	N	95								25.0
9.0	N	96								30.0
10.0										
11.0	N	97								35.0
12.0	N	98								40.0
13.0										
14.0	N	99								45.0
15.0		100			▲		▲+		WATER LEVELS: (from top of pipe) October 26, 2012 Depth: Dry November 8, 2012 Depth: Dry December 6, 2012 Depth: Dry	50.0
16.0										
17.0	N	101				17.0m 56.0ft BEARPAW SHALE FORMATION – highly plastic clay – moist, hard – unoxidized – dark olive gray (5Y 3/1)				55.0
18.0	N	102	CH							60.0
19.0										
20.0	N	103								65.0
21.0										
22.0		104					+▲		TYPE OF PIPE: 50mm PVC, Schedule 40 TYPE OF PIEZOMETER: Standpipe PIEZOMETER TIP: PVC slotted, 3.1m	70.0
23.0	N	105								75.0
24.0										
25.0	N	106				NOTES: 1. Test hole was excavated on October 26, 2012 using a 150 mm dia. continuous flight auger. 2. No seepage was noted immediately after completion of drilling. Test hole sloughed to 28.0 metres. 3. Standpipe piezometer was installed.			24.7m 24.9m SIL-9 SAND	80.0
26.0	N	107								85.0
27.0										
28.0	N	108							28.0m SLOUGH	90.0
29.0	N	109								95.0
30.0										
31.0	N	110				30.5m END OF HOLE 100.0ft			30.5m	100.0
32.0										105.0
33.0										

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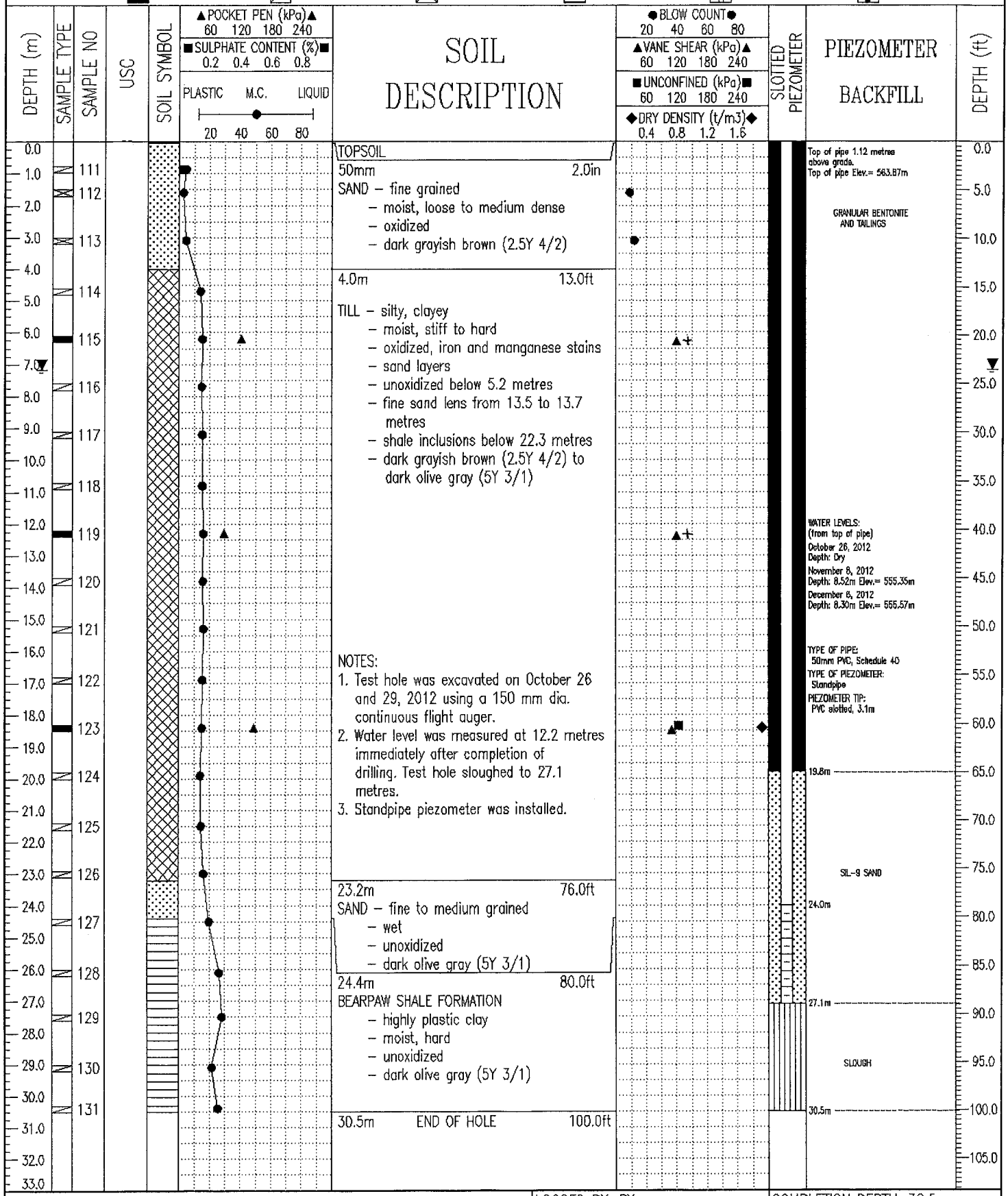
Regina, Saskatchewan

LOGGED BY: RY	COMPLETION DEPTH: 30.5 m
REVIEWED BY: PW	COMPLETE: 12/10/26
Fig. No: 1198-16	Page 1 of 1

13/01/18 09:49AM

PROJECT: PROPOSED SUBDIVISION	LOCATION: NW 24-19-23-W2	TEST HOLE NO: 1198-TH110
CLIENT: MR. LYLE BATEMAN	LOCATION: NEAR DISLEY, SASKATCHEWAN	PROJECT NO: GE-1198
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 562.75 metres (GEODETIC)	ELEVATION: 562.75 (m)

SAMPLE TYPE: SHELBY TUBE | DISTURBED | SPT SAMPLE | PAIL SAMPLE | NO RECOVERY | JAR SAMPLE



GROUND ENGINEERING LTD.
Regina, Saskatchewan

LOGGED BY: RY	COMPLETION DEPTH: 30.5 m
REVIEWED BY: PW	COMPLETE: 12/10/26
Fig. No: 1198-17	Page 1 of 1

13/01/18 09:52AM

GROUND ENGINEERING CONSULTANTS LTD.
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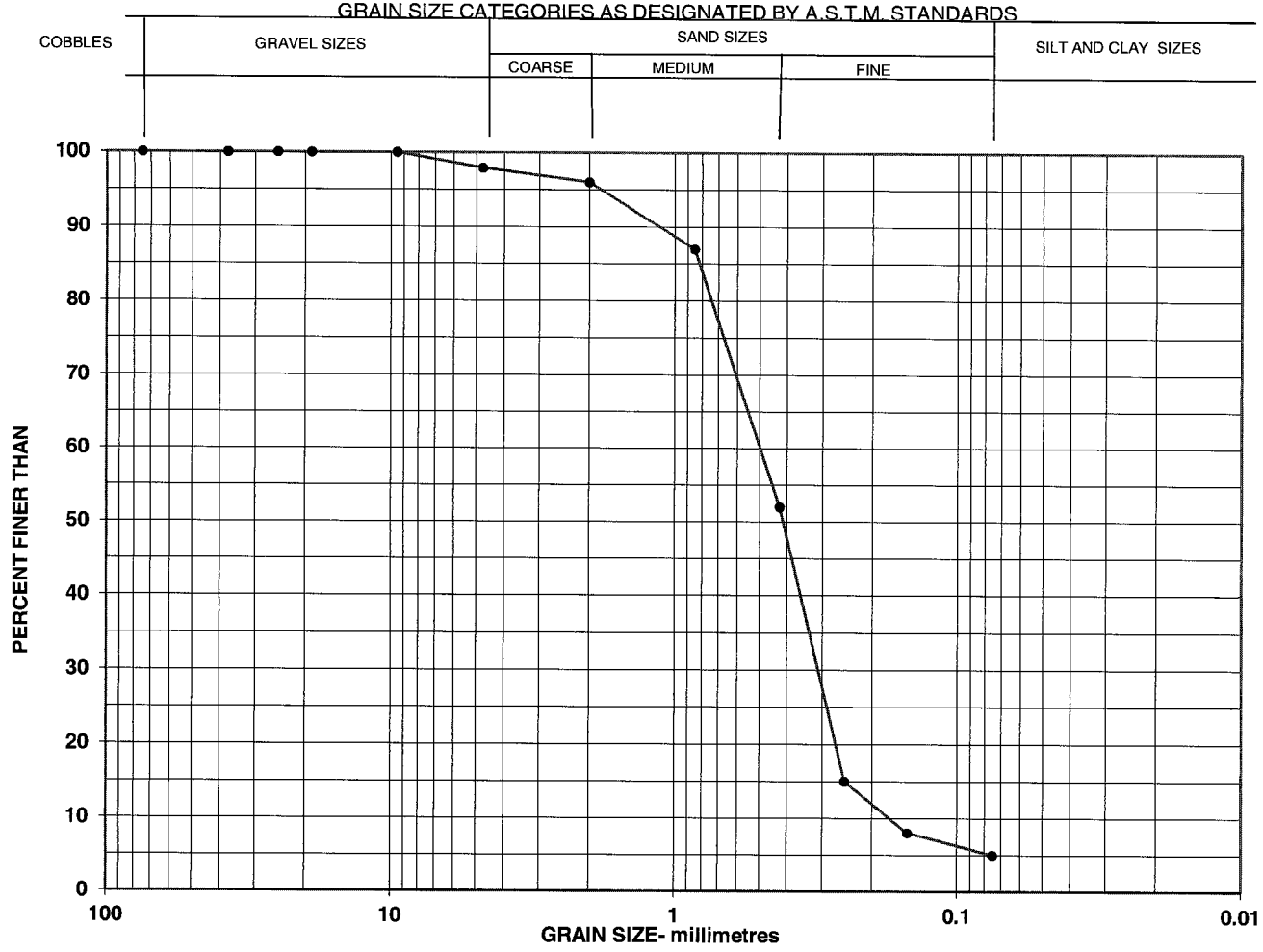
E-MAIL: groundeng@accesscomm.ca

GRAIN SIZE CURVE

(A.S.T.M. C-136, C.S.A. A23.2-2A & 5A)

JOB No: GE-1198 **DATE:** October 29, 2012 **TECH:** F. LABORTE
CLIENT: MR. LYLE BATEMAN
PROJECT: GI - PROPOSED SUBDIVISION
LOCATION: NW 24-19-23-W2, RM OF DUFFERIN, SASKATCHEWAN



SIZE OF OPENING (mm)	SPECIFIED % FINER THAN	PERCENT FINER THAN
75.0		100
37.5		100
25.0		100
19.0		100
9.51		100
4.75		98
2.00		96
0.850		87
0.425		52
0.250		15
0.150		8
0.075		5

GRAIN SIZE CATEGORY	PARTICLE SIZE RANGE (mm)	PERCENT RETAINED
GRAVEL	75 to 4.75	2
COARSE SAND	4.75 to 2.0	2
MEDIUM SAND	2.0 to 0.425	44
FINE SAND	0.425 to 0.075	47
SILT & CLAY	< 0.075	5

SAMPLE DESCRIPTION : SAND, A LITTLE SILT AND CLAY, A TRACE OF GRAVEL.

MATERIAL SUPPLIED BY: **SAMPLED BY :** R. YAREMKO OF GROUND ENGINEERING CONSULTANTS LTD.

SAMPLE LOCATION: TH101
SAMPLE NUMBER: 3 AT 10' BELOW GRADE **DATE SAMPLED :** October 23, 2012

DISTRIBUTION:

WE CERTIFY TESTING PROCEDURES IN ACCORDANCE WITH C.S.A. & A.S.T.M. STANDARDS FOR THAT PORTION OF THE TESTING PERFORMED BY THIS COMPANY GROUND ENGINEERING CONSULTANTS LTD.

Per: _____
KELLY MAUNDER, A.Sc.T.

GE-1198-18

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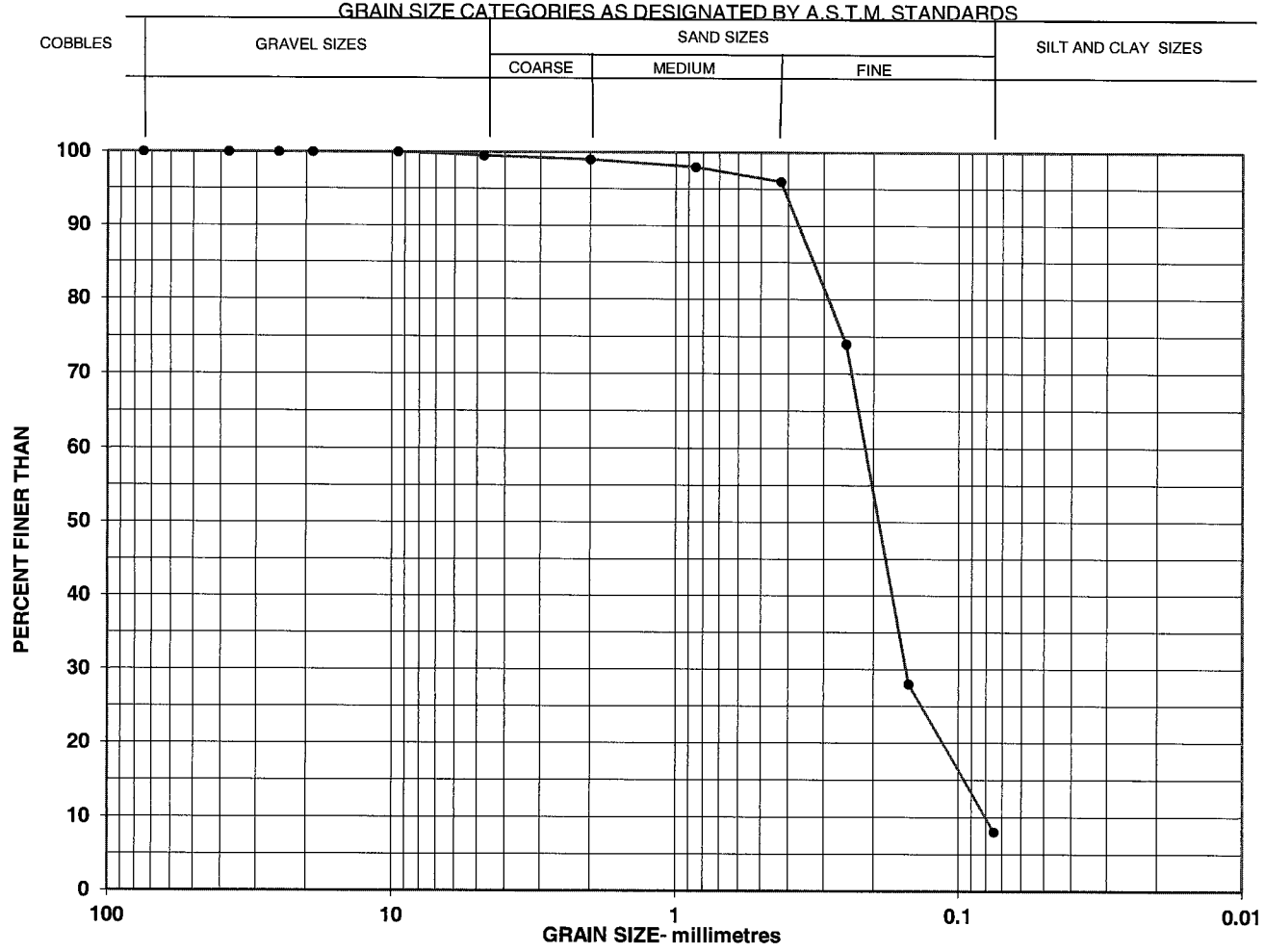
E-MAIL: groundeng@accesscomm.ca

GRAIN SIZE CURVE

(A.S.T.M. C-136, C.S.A. A23.2-2A & 5A)

JOB No: GE-1198 **DATE:** October 29, 2012 **TECH:** F. LABORTE
CLIENT: MR. LYLE BATEMAN
PROJECT: GI - PROPOSED SUBDIVISION
LOCATION: NW 24-19-23-W2, RM OF DUFFERIN, SASKATCHEWAN



SIZE OF OPENING (mm)	SPECIFIED % FINER THAN	PERCENT FINER THAN
75.0		100
37.5		100
25.0		100
19.0		100
9.51		100
4.75		100
2.00		99
0.850		98
0.425		96
0.250		74
0.150		28
0.075		8

GRAIN SIZE CATEGORY	PARTICLE SIZE RANGE (mm)	PERCENT RETAINED
GRAVEL	75 to 4.75	1
COARSE SAND	4.75 to 2.0	1
MEDIUM SAND	2.0 to 0.425	3
FINE SAND	0.425 to 0.075	88
SILT & CLAY	< 0.075	8

SAMPLE DESCRIPTION : SAND, A LITTLE SILT AND CLAY, A TRACE OF GRAVEL.

MATERIAL SUPPLIED BY: _____ **SAMPLED BY :** R. YAREMKO OF GROUND ENGINEERING CONSULTANTS LTD.

SAMPLE LOCATION: TH101

SAMPLE NUMBER: 7 AT 30' BELOW GRADE **DATE SAMPLED :** October 23, 2012

DISTRIBUTION:

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GE-1198-19

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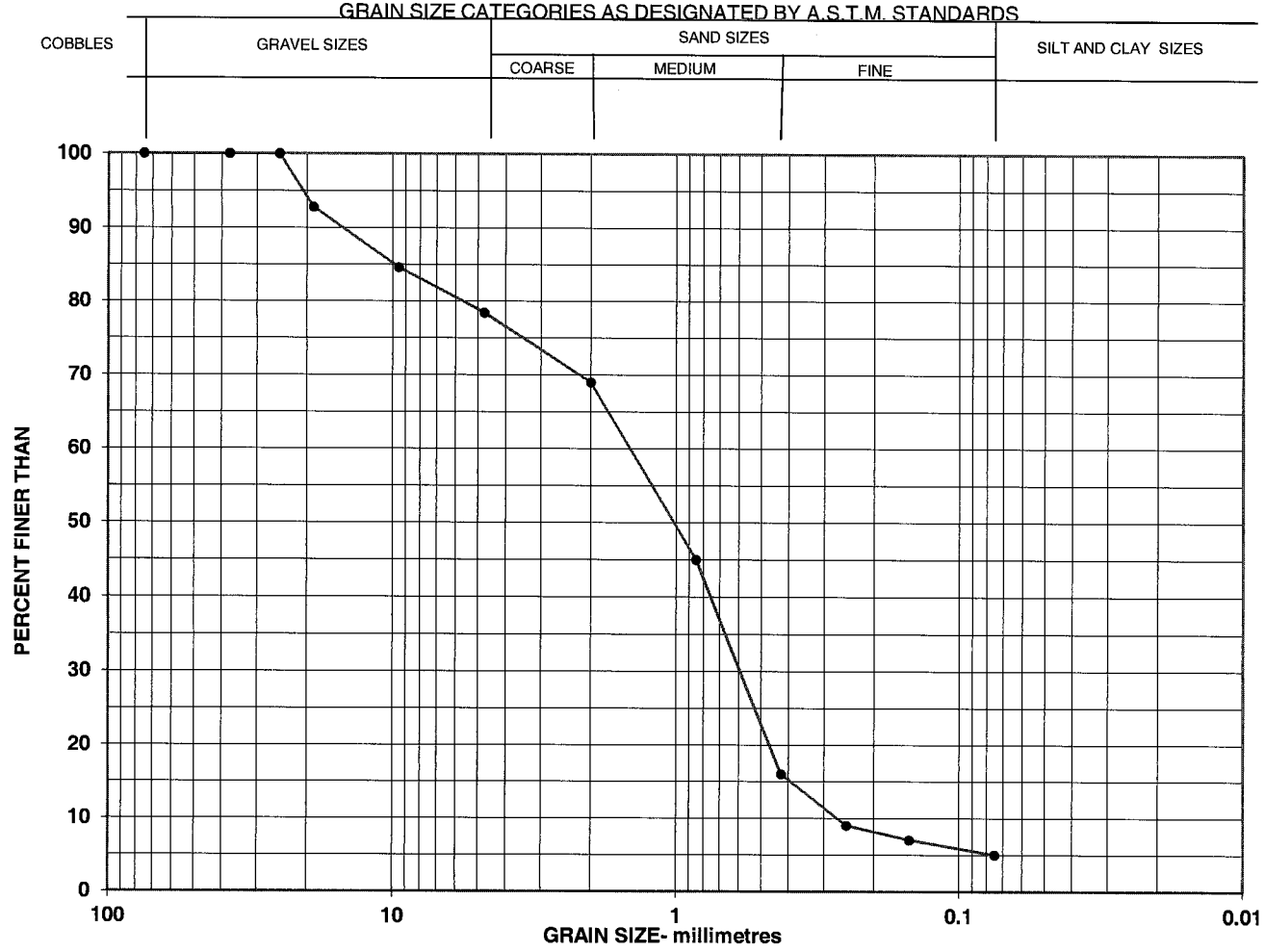
GRAIN SIZE CURVE

(A.S.T.M. C-136, C.S.A. A23.2-2A & 5A)

JOB No: GE-1198 **DATE:** October 30, 2012 **TECH:** F. LABORTE
CLIENT: MR. LYLE BATEMAN
PROJECT: GI - PROPOSED SUBDIVISION
LOCATION: NW 24-19-23-W2, RM OF DUFFERIN, SASKATCHEWAN



SIZE OF OPENING (mm)	SPECIFIED % FINER THAN	PERCENT FINER THAN
75.0		100
37.5		100
25.0		100
19.0		93
9.51		85
4.75		78
2.00		69
0.850		45
0.425		16
0.250		9
0.150		7
0.075		5

GRAIN SIZE CATEGORY	PARTICLE SIZE RANGE (mm)	PERCENT RETAINED
GRAVEL	75 to 4.75	22
COARSE SAND	4.75 to 2.0	9
MEDIUM SAND	2.0 to 0.425	53
FINE SAND	0.425 to 0.075	11
SILT & CLAY	< 0.075	5

SAMPLE DESCRIPTION : SAND, SOME GRAVEL, A LITTLE SILT AND CLAY.

MATERIAL SUPPLIED BY: **SAMPLED BY :** R. YAREMKO OF GROUND ENGINEERING CONSULTANTS LTD.

SAMPLE LOCATION: TH105
SAMPLE NUMBER: 46 AT 5' BELOW GRADE **DATE SAMPLED :** October 23, 2012

DISTRIBUTION:

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KELLY MAUNDER, A.Sc.T.

GE-1198-20

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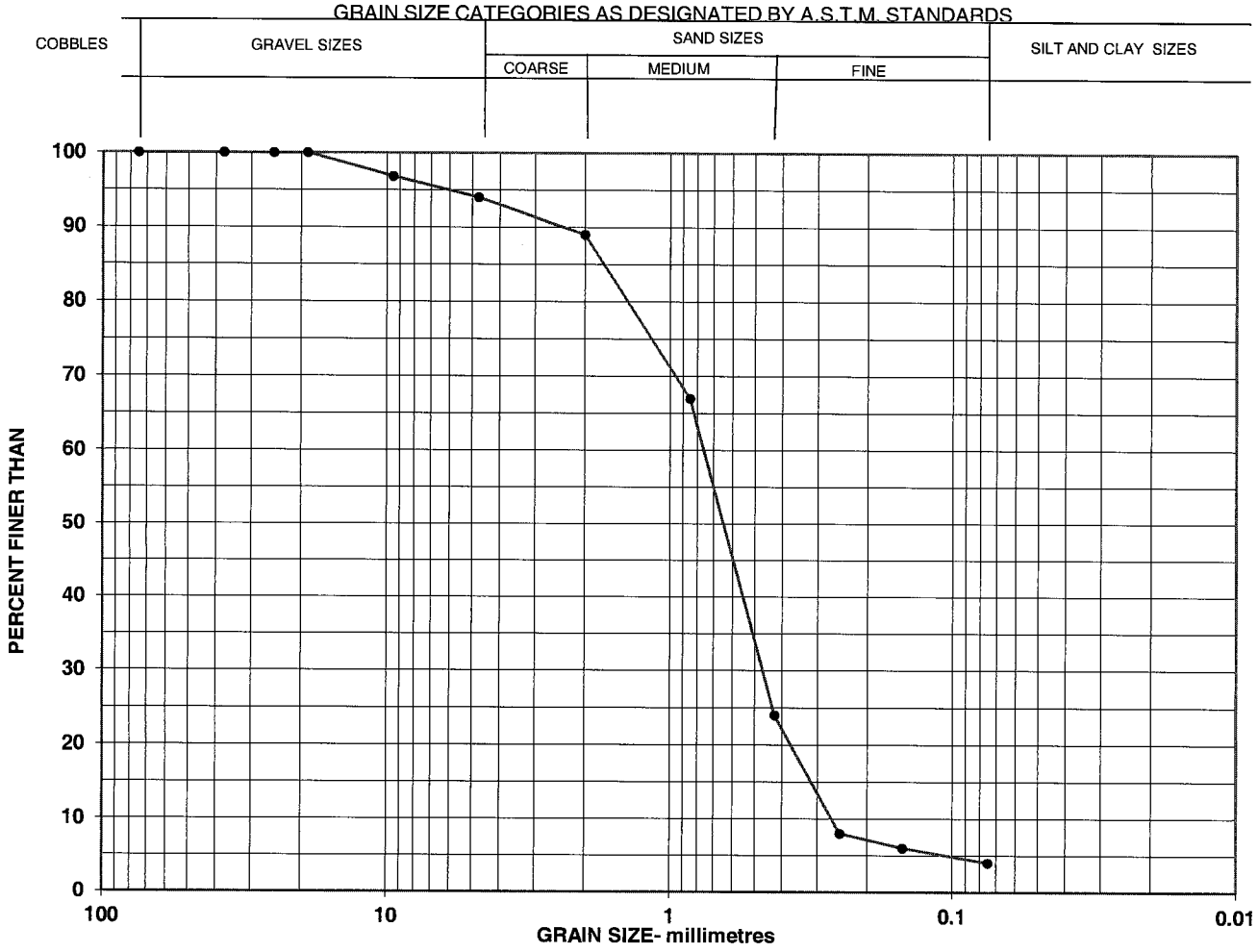
E-MAIL: groundeng@accesscomm.ca

GRAIN SIZE CURVE
(A.S.T.M. C-136, C.S.A. A23.2-2A & 5A)

JOB No: GE-1198 **DATE:** October 30, 2012 **TECH:** F. LABORTE
CLIENT: MR. LYLE BATEMAN
PROJECT: GI - PROPOSED SUBDIVISION
LOCATION: NW 24-19-23-W2, RM OF DUFFERIN, SASKATCHEWAN



SIZE OF OPENING (mm)	SPECIFIED % FINER THAN	PERCENT FINER THAN
75.0		100
37.5		100
25.0		100
19.0		100
9.51		97
4.75		94
2.00		89
0.850		67
0.425		24
0.250		8
0.150		6
0.075		4

GRAIN SIZE CATEGORY	PARTICLE SIZE RANGE (mm)	PERCENT RETAINED
GRAVEL	75 to 4.75	6
COARSE SAND	4.75 to 2.0	5
MEDIUM SAND	2.0 to 0.425	65
FINE SAND	0.425 to 0.075	20
SILT & CLAY	< 0.075	4

SAMPLE DESCRIPTION : SAND, A LITTLE GRAVEL, A TRACE OF SILT AND CLAY.

MATERIAL SUPPLIED BY: **SAMPLED BY :** R. YAREMKO OF GROUND ENGINEERING CONSULTANTS LTD.

SAMPLE LOCATION: TH107
SAMPLE NUMBER: 75 AT 30' BELOW GRADE **DATE SAMPLED :** October 23, 2012

DISTRIBUTION:

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Per: _____
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GE-1198-21

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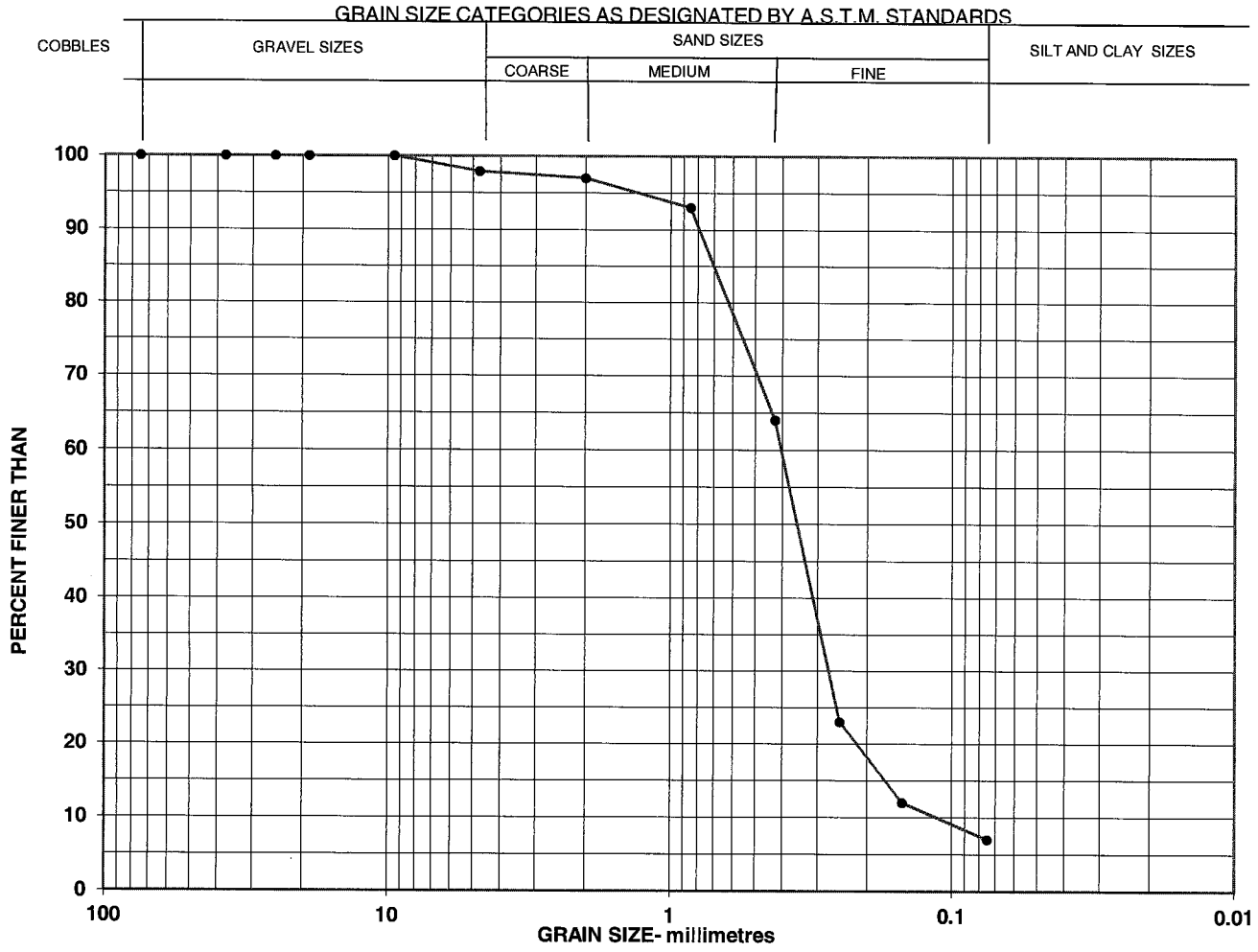
E-MAIL: groundeng@accesscomm.ca

GRAIN SIZE CURVE

(A.S.T.M. C-136, C.S.A. A23.2-2A & 5A)

JOB No: GE-1198 **DATE:** October 30, 2012 **TECH:** F. LABORTE
CLIENT: MR. LYLE BATEMAN
PROJECT: GI - PROPOSED SUBDIVISION
LOCATION: NW 24-19-23-W2, RM OF DUFFERIN, SASKATCHEWAN



SIZE OF OPENING (mm)	SPECIFIED % FINER THAN	PERCENT FINER THAN
75.0		100
37.5		100
25.0		100
19.0		100
9.51		100
4.75		98
2.00		97
0.850		93
0.425		64
0.250		23
0.150		12
0.075		7

GRAIN SIZE CATEGORY	PARTICLE SIZE RANGE (mm)	PERCENT RETAINED
GRAVEL	75 to 4.75	2
COARSE SAND	4.75 to 2.0	1
MEDIUM SAND	2.0 to 0.425	33
FINE SAND	0.425 to 0.075	57
SILT & CLAY	< 0.075	7

SAMPLE DESCRIPTION : SAND, A LITTLE SILT AND CLAY, A TRACE OF GRAVEL.

MATERIAL SUPPLIED BY: **SAMPLED BY :** R. YAREMKO OF GROUND ENGINEERING CONSULTANTS LTD.

SAMPLE LOCATION: TH110
SAMPLE NUMBER: 113 AT 10' BELOW GRADE **DATE SAMPLED :** October 23, 2012

DISTRIBUTION:

WE CERTIFY TESTING PROCEDURES IN ACCORDANCE WITH C.S.A. & A.S.T.M. STANDARDS FOR THAT PORTION OF THE TESTING PERFORMED BY THIS COMPANY GROUND ENGINEERING CONSULTANTS LTD.

Per: _____
KELLY MAUNDER, A.Sc.T.

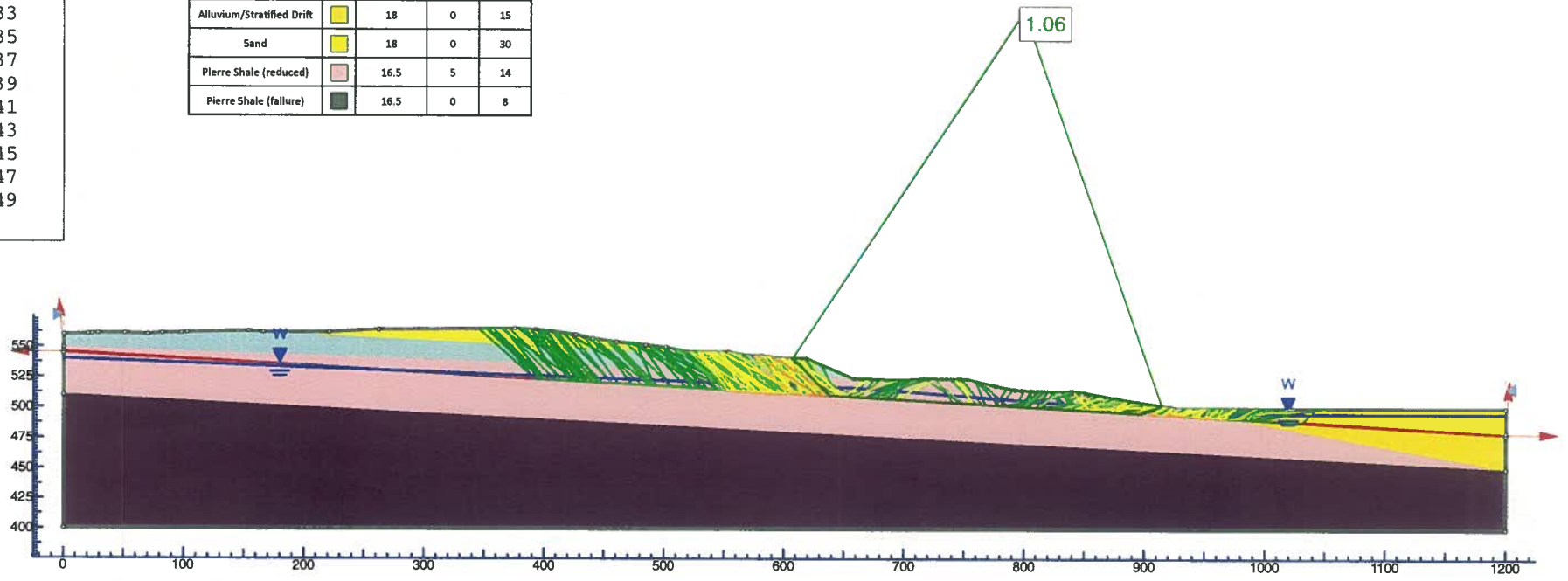
GE-1198-22

APPENDIX A

Safety Factor

1.01
1.03
1.05
1.07
1.09
1.11
1.13
1.15
1.17
1.19
1.21
1.23
1.25
1.27
1.29
1.31
1.33
1.35
1.37
1.39
1.41
1.43
1.45
1.47
1.49

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Sand (saturated)		18	0	15
Till (reduced)		20.5	6	19
Alluvium/Stratified Drift		18	0	15
Sand		18	0	30
Plerre Shale (reduced)		16.5	5	14
Pierre Shale (failure)		16.5	0	8



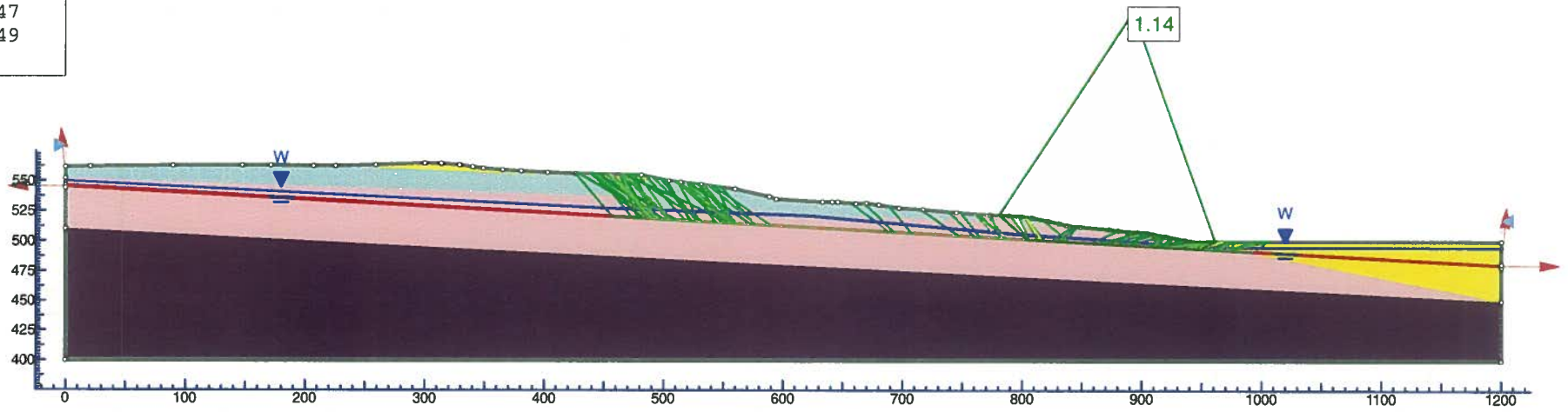
SLIDEINTERPRET 6.020

Project	GE-1198 - Proposed Residential Subdivision - NW 24-19-23-W2		
Analysis Description	Cross Section 1-1		
Drawn By	PCW	Scale 1:5500	Company Ground Engineering Consultants Ltd.
Date			File Name 1-1 Current Conditions.slim

Safety Factor

1.01
1.03
1.05
1.07
1.09
1.11
1.13
1.15
1.17
1.19
1.21
1.23
1.25
1.27
1.29
1.31
1.33
1.35
1.37
1.39
1.41
1.43
1.45
1.47
1.49

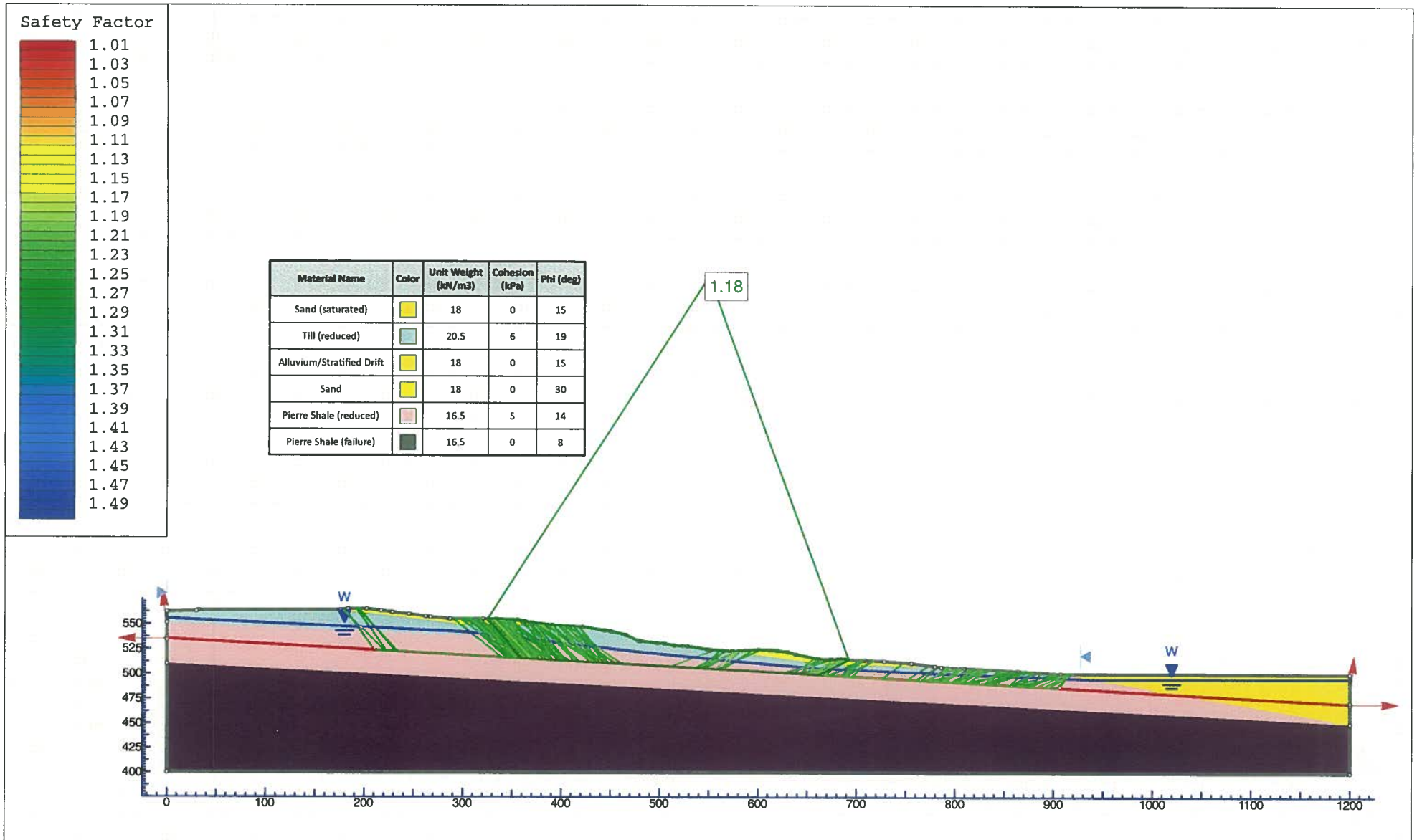
Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Sand (saturated)		18	0	15
Till (reduced)		20.5	6	19
Alluvium/Stratified Drift		18	0	15
Sand		18	0	30
Pierre Shale (reduced)		16.5	5	14
Pierre Shale (failure)		16.5	0	8



rocscience

SLIDEINTERPRET 6.020

Project	GE-1198 - Proposed Residential Subdivision - NW 24-19-23-W2				
Analysis Description	Cross Section 2-2				
Drawn By	PCW	Scale	1:5500	Company	Ground Engineering Consultants Ltd.
Date				File Name	2-2 Current Conditions.slim



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Sand (saturated)		18	0	15
Till (reduced)		20.5	6	19
Alluvium/Stratified Drift		18	0	15
Sand		18	0	30
Pierre Shale (reduced)		16.5	5	14
Pierre Shale (failure)		16.5	0	8

SLIDEINTERPRET 6.020

Project	GE-1198 - Proposed Residential Subdivision - NW 24-19-23-W2		
Analysis Description	Cross Section 3-3		
Drawn By	PCW	Scale 1:5500	Company Ground Engineering Consultants Ltd.
Date			File Name 3-3 Current Conditions.slim

APPENDIX B

3300 - 1 DESCRIPTION

1.01 The work shall consist of spreading and compacting screened or crushed aggregate on a prepared surface.

1.02 The following definitions shall apply for this specification:

(a) Mean:

The arithmetic average of a set of 'n' test results constituting the sample.

(b) Moving average:

The arithmetic mean of 3 consecutive test results.

(c) Sub-base aggregate:

The aggregate before mixing, when binder is to be added or the aggregate before spreading and compacting, when no binder is to be added.

(d) Sub-base mix:

The sub-base aggregate after mixing with binder and water but before spreading and compacting.

(e) Sub-base course:

The sub-base aggregate or sub-base mix in place on the road during and after spreading and compacting.

3300 - 2 MATERIALS

Aggregate

2.01 Sub-base aggregate shall be composed of sound, hard, and durable particles of sand, gravel and rock free from injurious quantities of soft or flaky particles, shale, loam, clay balls and organic or other deleterious material.

3300 - 3 CONSTRUCTION

General

3.01 (a) Sub-base course shall comply with the requirements listed in Table 1:

TABLE 1

Sieve Designation	Percent By Weight Passing Canadian Metric Sieve Series		
	TYPE		
	6	8	10
50.0 mm	100.0	100.0	100.0
2.0 mm	0 - 80.0	0 - 90.0	
400 um	0 - 45.0	0 - 60.0	
160 um	0 - 20.0	0- 25.0	
71 um	0 - 6.0	0 - 15.0	0 - 20.0
Plasticity Index (all types)	0 - 6.0		

3505 - 2 MATERIALS

Aggregate

2.01 Base aggregate shall be composed of sound, hard and durable particles of sand, gravel and rock free from injurious quantities of elongated, soft or flaky particles, shale, loam, clay balls and organic or other deleterious material.

3505 - 3 CONSTRUCTION

General

3.01 (a) Base course shall comply with the requirements listed in Table 1.

TABLE 1

SIEVE DESIGNATION	PERCENT BY WEIGHT PASSING CANADIAN METRIC SIEVE SERIES		
	TYPE		
	31	33	35
31.5 mm	100.0		
18.0 mm	75.0 - 90.0	100.0	100.0
12.5 mm	65.0 - 83.0	75.0 - 100.0	81.0 - 100.0
5.0 mm	40.0 - 69.0	50.0 - 75.0	50.0 - 85.0
2.0 mm	26.0 - 47.0	32.0 - 52.0	32.0 - 65.0
900 um	17.0 - 32.0	20.0 - 35.0	20.0 - 43.0
400 um	12.0 - 22.0	15.0 - 25.0	15.0 - 30.0
160 um	7.0 - 14.0	8.0 - 15.0	8.0 - 18.0
71 um	6.0 - 11.0	6.0 - 11.0	7.0 - 12.0
Plasticity Index	0 - 7.0	0 - 6.0	0 - 5.0
Fractured Face %	50.0 Minimum		
Light Weight Pieces %	5.0 Maximum		

(b) A tolerance of 3% in the percent by weight passing the maximum size sieve shall be permitted providing 100% of the oversize passes the 40.0 mm sieve for Type 31 base course and the 22.4 mm sieve for Types 33 and 35 base course.

3.02 The following shall apply to Department owned or controlled aggregate sources shown on the plans or as described in the Special Provisions:

(a) Overburden shall be removed from material deposits in accordance with Specification 2260 For Removal Of Overburden.

(b) Rock passing a 450 mm square opening screen and larger than the maximum specified size shall be crushed and incorporated simultaneously throughout the crushing operation.

(c) Stockpiles shall be constructed in accordance with Specification 3600 For Stockpiling Aggregates.

3.03 Binder, filler, and blender sand shall be provided in accordance with Specification 3400 For Binder, Filler And Blender Sand.

3.04 Binder, filler and blender sand shall be added using a separate conveyor system.

3.05 Binder, filler and blender sand feeds shall be accurately controlled and coordinated.