TITLE: GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL SUBDIVISION
SE 3-10-5-W3M
THOMSON LAKE, SASKATCHEWAN

CLIENT: QUEST HOMES

FILE NO: GE-0897 DATE: APRIL 16, 2009

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FILE: GE-0897 April 16, 2009

Quest Homes
Suite 10, 145 – 19th Street
COURTENAY, British Columbia
V9N 9G2

ATTENTION: MR. PETER GERRITSEN

Dear Sir:

SUBJECT: GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL SUBDIVISION
PART OF SE 3-10-5-W3M
THOMSON LAKE, 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 at Thomson Lake, Saskatchewan. It is understood that Phase I of the proposed residential subdivision includes 24 lots which overlook the northwest shoreline of the lake and associated infrastructure. This report also includes areas planned for future development.

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 determine the slope stability, comment on possible slope stability problems and provide recommendations for site development, including 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 2, 2008.

2.0 DESCRIPTION OF SITE

The study area shown in Figure 1 is located in the southeast quarter of 3-10-5-W3M, approximately 9 kilometers southwest of the Town of Gravelbourg, Saskatchewan. The property consists of a relatively flat glacial till plain and a relatively steep shore bluff which overlooks Thompson Lake. There is an elevation difference of up to 6 metres between the top edge of the shore bluff and Thompson Lake. The shore bluff has been eroded at some locations resulting in near vertical slopes in some areas. Photos of the property are included in Appendix A.

3.0 FIELD AND LABORATORY INVESTIGATION

The subsurface conditions were investigated by drilling eight (8) test holes at the locations shown on Drawing No. GE-0897-1. The test holes were drilled on December 10, 2008, using a truck-mounted, P61 digger equipped with a 150 mm diameter continuous flight auger. The test holes were drilled to a depth of 12.2 metres below existing ground surface.

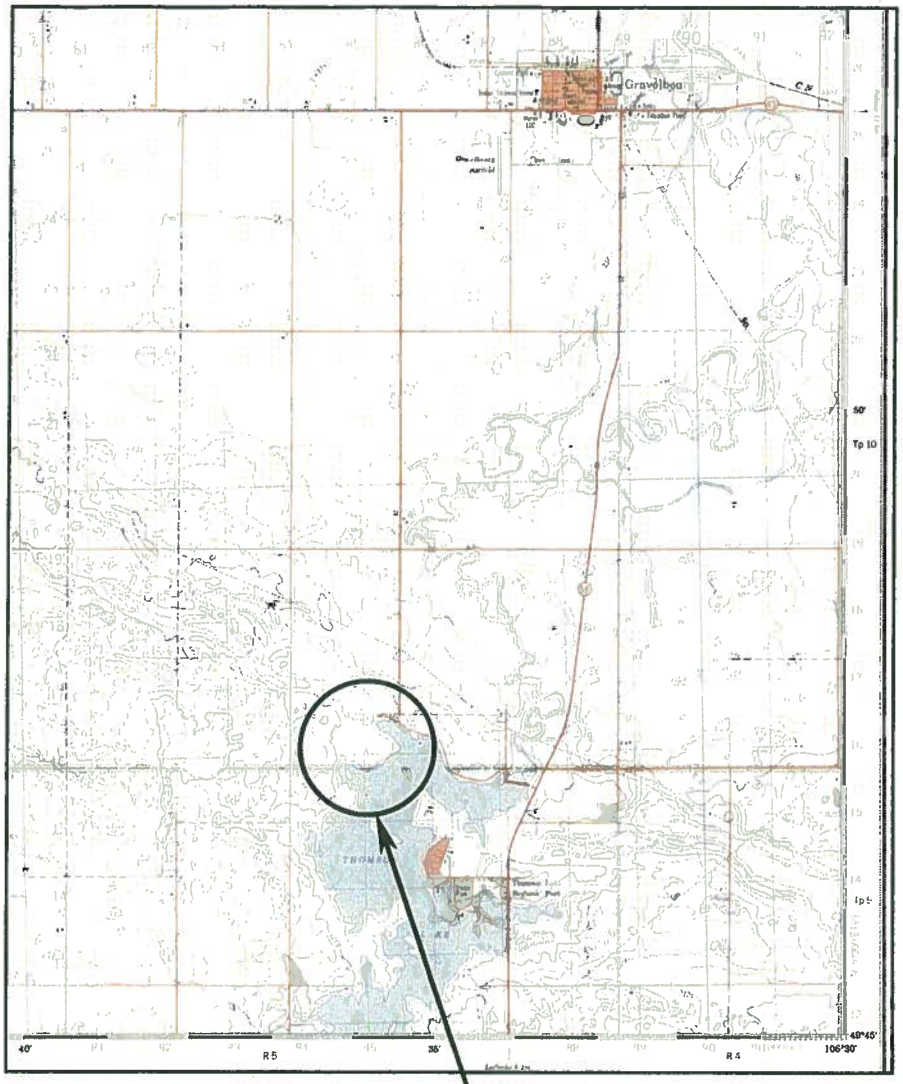

FIGURE 1

LOCATION OF STUDY AREA

Representative disturbed auger samples 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, Atterberg Limits, gradation analysis, sulphate content, unconfined compressive strength and dry density tests were performed on selected soil samples. Estimates of the undrained shear strength of the undisturbed soil were made using both a pocket penetrometer and a laboratory vane shear apparatus. Details of the soil profile, samples taken, laboratory test results and stratigraphic interpretations of the subsoils are presented on Drawing Nos. GE-0897-5 to -16, inclusive.

Standpipe piezometers were installed in Test Holes 101, 103, 105 and 107 to monitor groundwater levels. Details of the piezometer installations are shown on the corresponding test hole logs. The water levels were measured by our technologist on December 10, 2008 after the test drilling was completed and again on April 1, 2009.

The ground surface elevations at the test hole locations were established by representatives of GE Ground Engineering Ltd. and are referenced to the water level in Thomson Lake (Elevation 714.1, Geodetic). The test hole locations were determined in the field using hand-held GPS equipment.

4.0 GEOTECHNICAL ANALYSIS

4.1 Geology

Information obtained from published SRC geological and groundwater maps indicates that the study area is located within an in-filled glacial valley and is overlain by approximately 60 to 80 metres of glacial drift. The drift consists predominantly of glacial till which in some areas contains localized discontinuous clay, silt, sand and gravel lenses. The glacial drift is underlain by the Bearpaw Shale Formation (bedrock) which is approximately 200 to 300 metres thick in the study area.

4.2 Stratigraphy

The drilling information indicates that the surficial topsoil is underlain by an oxidized clayey till stratigraphic unit which extends to the maximum depth penetrated in the test borings (12.2 metres). The till material is a heterogeneous mixture of clay, silt, sand and gravel with occasional clay lenses, sand and gravel lenses, cobblestones and boulders.

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. Typical gradations of the till material are shown on Drawing Nos. GE-0897-14 and –15, attached. Clay lenses were encountered in Test Holes 103, 104 and 105 at varying depths. A wet sand lens was encountered in Test Hole 105 at depths of 7.9 to 11.3 metres. The gradation of the sand is shown on Drawing No. GE-0897-16.

The till is generally oxidized, clayey, moist and very stiff to hard in consistency with undrained shear strengths in the order of 140 to 200 kPa based on unconfined compression tests. Atterberg Limits test results indicate that the till is medium to highly plastic with a Liquid Limit in the order of 56 percent and a Plasticity Index in the order of 38 percent. The average dry density of the till is 1.70 tonnes per cubic metre. The clay lenses are generally firm to stiff in consistency with undrained shear strengths in the order of 50 to 90 kPa based on unconfined compression and vane shear strength tests and medium to highly plastic with a Liquid Limit in the ranging from 36 to 94 percent and a Plasticity Index ranging from 21 to 66 percent.

4.3 Groundwater

The till unit encountered at this site is generally moist and cohesive, however, it contains discontinuous sand lenses, some of which are wet and subject to sloughing. Groundwater accumulation and sloughing was noted in Test Holes 102, 103, 104 and 105 immediately after completion of the drilling. Standpipe piezomters were installed in Test Holes 101, 103, 105 and 107. Water levels in the piezometers were measured by our technologist on

December 10, 2008 and April 1, 2009. 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	December 10, 2008	11.7	dry	-
	April 1, 2009		5.4	714.0
TH 103	December 10, 2008	6.7	dry	-
	April 1, 2009		3.3	714.9
TH 105	December 10, 2008	8.6	7.9	711.6
	April 1, 2009		4.8	714.7
TH 107	December 10, 2008	7.2	dry	-
	April 1, 2009		3.7	714.6

The elevation of the lake is approximately 714.1 metres, geodetic. The data shows that the stabilized water table generally corresponds to the lake level elevation.

5.0 SLOPE STABILITY

5.1 History of Slope Movement

This property has never experienced landsliding in the past. However, where active wave erosion is now occurring, the shore bluff is steep and sensitive to disturbance. Slumping is now occurring along the shore bluff where the toe of the slope has been over-steepened (see photos in Appendix A) by wave erosion.

5.2 Stratigraphy

The glacial till stratigraphic unit encountered at this site is relatively competent. In order to maintain long term stability, the property must be maintained in such a way that the water table is not raised, that positive drainage is maintained and that the shoreline is protected from erosion.

5.3 Topography

The subject property is relatively flat, with the exception of the shore bluff adjacent to Thompson Lake. There is an elevation difference of up to 6 metres from the top of the shore bluff down to Thompson Lake. The slope angle of the shore bluff is generally steep and near vertical in some areas.

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. It must be appreciated that groundwater levels generally rise following development, therefore, the degree of safety with respect to stability can be expected to decrease once the area is developed.

5.5 Shoreline Erosion

Shoreline erosion is dependent primarily on the stratigraphy of the banks. Small particles such as silt and clay are easily eroded and low sand content leaves little material behind for along shore transport. Conversely, the till at this site is relatively competent and when eroded it leaves behind cobbles and boulders which protect the shoreline from further erosion. Assuming that the lake level stays at its current elevation, some erosion of the toe of slope will continue to occur, however, elevated lake levels may result in rapid erosion as well as increasing the amount of submergence of the slope, both of which can cause instability along the shoreline.

5.6 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 landsliding.

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 leaking swimming pools;

.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 (generally circular) 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 5.0* 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.

The soil strength parameters were interpreted using a combination of lab test results and historical 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	
Till	25°	5.0 kPa	21.0 kN/m^3
Silty Clay	14°	5.0 kPa	20.0 kN/m^3

The factor of safety was calculated at typical locations (Cross Sections 1-1, 2-2 and 3-3), as shown on Drawing No. GE-0897-1, for the existing conditions. Using the soil strength parameters obtained during this investigation, the factor of safety against sliding at each cross section location is shown in Table 3, below.

TABLE 3

CALCULATED SAFETY FACTORS

CROSS SECTION LOCATION	FACTOR OF SAFETY
1-1	2.89
2-2	1.34
3-3	3.86

Our test results and slope stability analysis indicates that the existing valley wall has a factor of safety ranging from a high of 3.86 to a low of 1.34. However, where the slope is vertical slumping will occur along the edge of the shore bluff as shown in the photos included in Appendix A. The stability analysis of the existing conditions is shown on the drawings included in Appendix B.

7.0 SITE DEVELOPMENT GUIDELINES

Development in an area of potential landslide activity involves some risk. The risk is associated with the possible reactivation of old landslides or the creation of entirely new landslides. At the present time, the probability of major slope movements taking place in the future is considered to be low. Residential lots are considered to be feasible from a

geotechnical engineering standpoint provided development controls are implemented to minimize the risk of future landslides. To minimize the potential problems associated with slope instability, the following guidelines are provided for lot development at this time.

.1 Residential buildings may be constructed anywhere on the proposed lots. A minimum set back distance of 20 metres from the edge of the shore bluff is recommended for residential buildings. The proposed lot lay-out appears to meet this requirement.

.2 Buildings in this development may be supported on either bored concrete piles or shallow footing type foundation systems. A bored concrete pile type foundation system is recommended for buildings designed with a walk-out type basement.

.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 should be maintained as best as possible.

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

.5 Cuts and fills on the lake front lots are restricted to a maximum depth of 2.0 metres unless approval is obtained from a geotechnical engineer.

.6 Embankments for roadway construction and cut slopes on the lots should be backsloped to a maximum slope of three (3) horizontal to one (1) vertical for long term stability. Alternatively, for steeper cuts on the lots, retaining walls may be constructed to support the cut slopes. Retaining walls should be designed by a professional engineer to withstand the required lateral earth pressures.

.7 Swimming pools usually leak and contribute substantial quantities of water into the soil. For this reason, swimming pools should not be permitted without a design review by a geotechnical engineer.

8.0 FOUNDATION CONSIDERATIONS

It is anticipated that the foundation loads from the proposed residential buildings will be relatively light. The soil conditions at this site are suitable for either bored concrete piles or shallow footing type foundation systems. Our specific design recommendations for both types of foundation systems are presented below:

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

.1 Properly constructed shallow spread footings bearing on the undisturbed native till soil may be designed for a safe net bearing pressure of 145 kPa (3,000 psf). In the area of Test Hole 105, footings may be bearing in the undisturbed surficial clay lens. For, footings founded on the undisturbed silty clay soil, the safe net bearing pressure should be reduced to 95 kPa (2,000 psf). Footings should not be placed on top of fill material. 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 Dewatering should not be required at this site, however, 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.

8.2 Bored Concrete Piles

.1 The relatively light column loads for the building structures 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 38.3 kPa (800 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 4.5 metres is also recommended.

.3 The till unit at this site contains saturated sand lenses. 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.

9.0 EXCAVATION CONSIDERATIONS

Excavations will be in the surficial till unit. Conventional excavation procedures should therefore be applicable to the soils at this site. Undisturbed soils should remain stable at near vertical side slopes for short periods of time. Piling contractors should be aware that difficulties may be encountered due to cobblestones and boulders in the till.

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.

10.0 UNDERGROUND WALLS AND DRAINAGE PROVISIONS

The underground basement walls should be damp-proofed and designed to withstand the lateral earth pressure (p) at any depth (H) in metres as estimated by the following expression:

$$p = k(\gamma H + q) \text{ kPa}$$

WHERE:

- k = 0.4 (the coefficient of earth pressure considered appropriate for the design condition).
- γ = the unit weight of the drained granular backfill, approximately 19.0 kN/m^3.
- q = the equivalent uniform vertical pressure, in kPa of any surcharge acting at the ground surface near the wall.

The expression assumes that the backfill is free-draining and drains to an efficient perimeter drainage system (as described below), thus preventing the build-up of hydrostatic pressure on walls. If effective drainage facilities are not provided, the full hydrostatic pressure which could act on the walls must be considered in design.

Perimeter drainage facilities should be provided around the perimeter of the basement. Drain tile with a minimum diameter of 100 mm, or pipe equivalent should be installed below the level of the lowest floor slab. The tile should be wrapped in filter cloth and encased in a graded, granular filter consisting of at least 100 mm of pea gravel encased by

300 mm of drainage sand. The tile must drain to a positive frost-free sump or outlet from which the water is removed.

Free-draining backfill material should be placed adjacent to the exterior underground walls. The upper 600 mm of the backfill should consist of the native till compacted to a minimum of 95% Standard Proctor density. The ground surface should be sloped away from the building at a grade of at least 5% to further discourage the infiltration of surface water into the backfill.

11.0 FLOOR SLAB CONSIDERATIONS

The soil conditions are suitable for either grade supported floor slabs or structurally supported floors constructed over a crawl space. The following recommendations are provided for both types of floor systems.

11.1 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 either lean mix concrete or a Permalon type vapour barrier to reduce the humidity in the crawl space and prevent drying of the subgrade soils.

.2 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.

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

11.2 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 150 mm below underside of the floor slab should be well graded granular base course (Type 33) compacted to a minimum of 98% Standard Proctor density. Granular material specifications are included in Appendix C.

.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.

12.0 OTHER

.1 Adequate drainage away from the buildings should be provided and maintained to minimize infiltration of water into the subgrade.

.2 Test results on selected samples indicate that the soluble sulphate contents in the soil range from 0.01 to 1.34 percent by dry soil weight. Therefore, Class 3 Concrete, with HS (Type 50) cement as shown in the Guide for Use of Sulphate Resistant Cement on Drawing No. GE-0897-17, 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 It is recommended that GE Ground Engineering Ltd. be retained to provide inspection services during construction of this project. This is to observe compliance with the design concepts, specifications and recommendations and to allow design changes in the event that the subsurface conditions differ from what was anticipated.

.5 This report has been prepared for Quest Homes and is intended for the specific application to the design and construction of the proposed residential subdivision located at Thomson Lake in SE 3-10-5-W3M near the Town of Gravelbourg, 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.

.6 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.

.7 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.

13.0 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
GE GROUND ENGINEERING LTD.

ASSOCIATION OF PROFESSIONAL ENGINEERS
OF SASKATCHEWAN
CERTIFICATE OF AUTHORIZATION
GE GROUND ENGINEERING LTD.
NUMBER 8
PERMISSION TO CONSULT HELD BY:
DISCIPLINE SASK. REG. No. SIGNATURE
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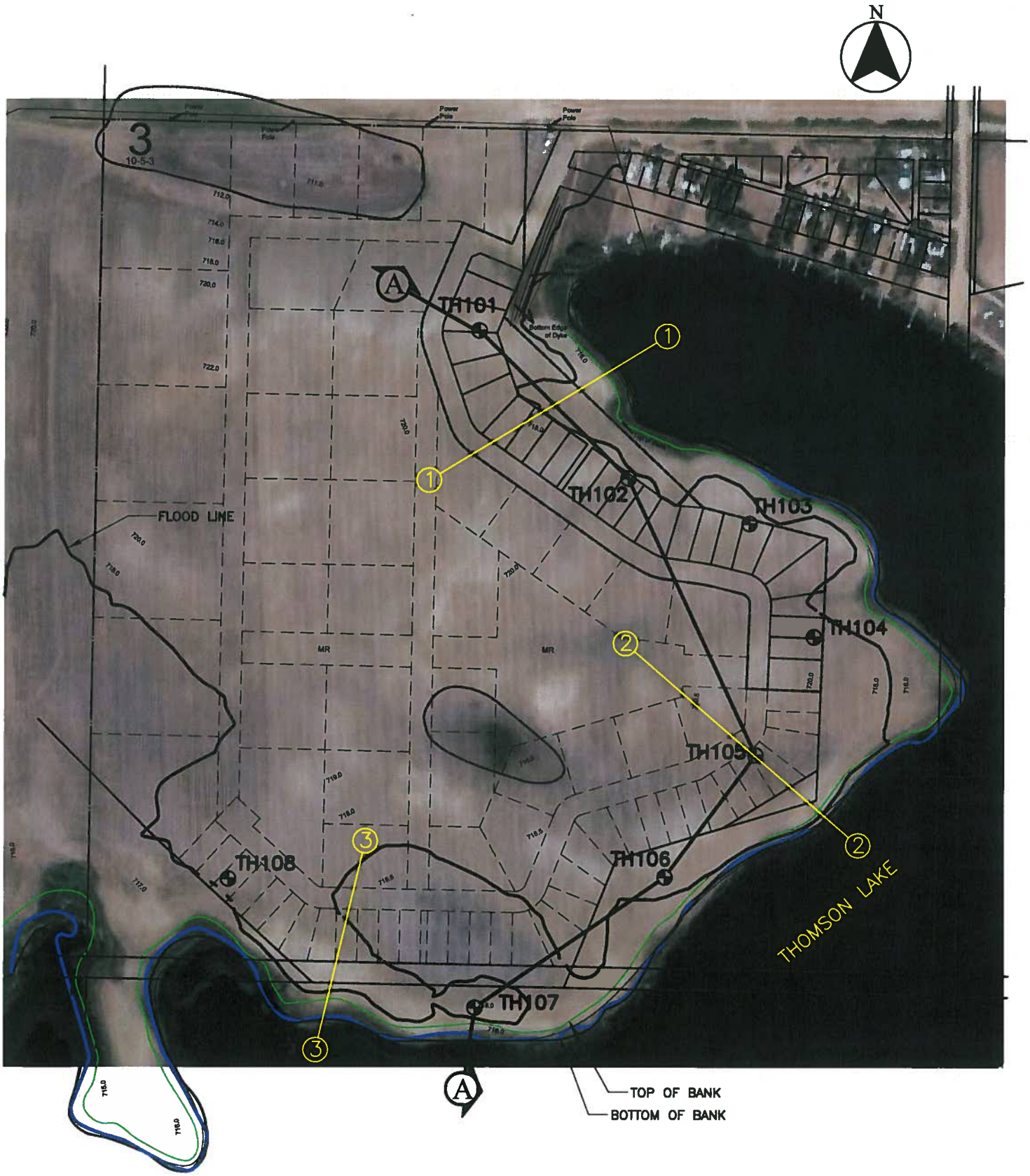
DRAWINGS



NOTES:

1. ② — ② INDICATES SLOPE STABILITY CROSS SECTION

SCALE: 1:5000

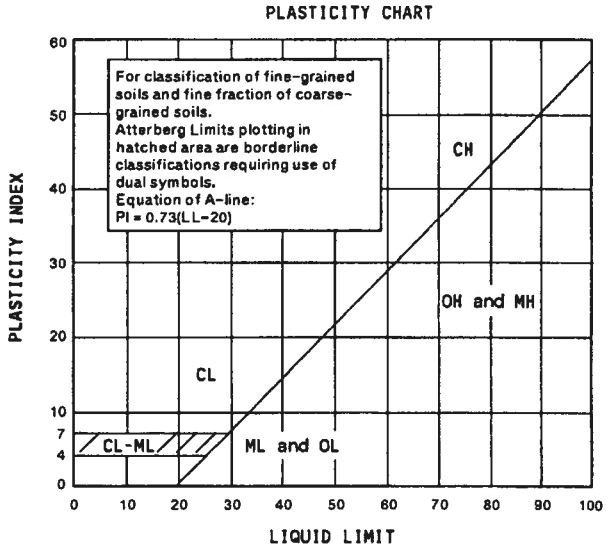
GROUND ENGINEERING LTD.
CONSULTING GEOENVIRONMENTAL ENGINEERS
REGINA, SASKATCHEWAN

SITE PLAN SHOWING LOCATION OF TEST HOLES
PROPOSED RESIDENTIAL SUBDIVISION
PART of SE 3-10-5-W3M
THOMSON LAKE, SASKATCHEWAN

CLIENT:	APPROVED:	DATE:	DWG. No.:
QUEST HOMES		APRIL 16, 2009	GE-0897-1

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	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 $C_u = \frac{D_{60}}{D_{10}}$ 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 / Atterberg limits above "A" line with P.I. greater than 7: Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures	
	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 / Atterberg limits above "A" line with P.I. greater than 7: Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures	
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	PLASTICITY CHART 
			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	

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

SYMBOLS AND TERMS USED IN THE REPORT

CLAY SILT SAND GRAVEL ORGANIC PEAT TILL SHALE FILL

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.

GE GROUND ENGINEERING LTD.

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.

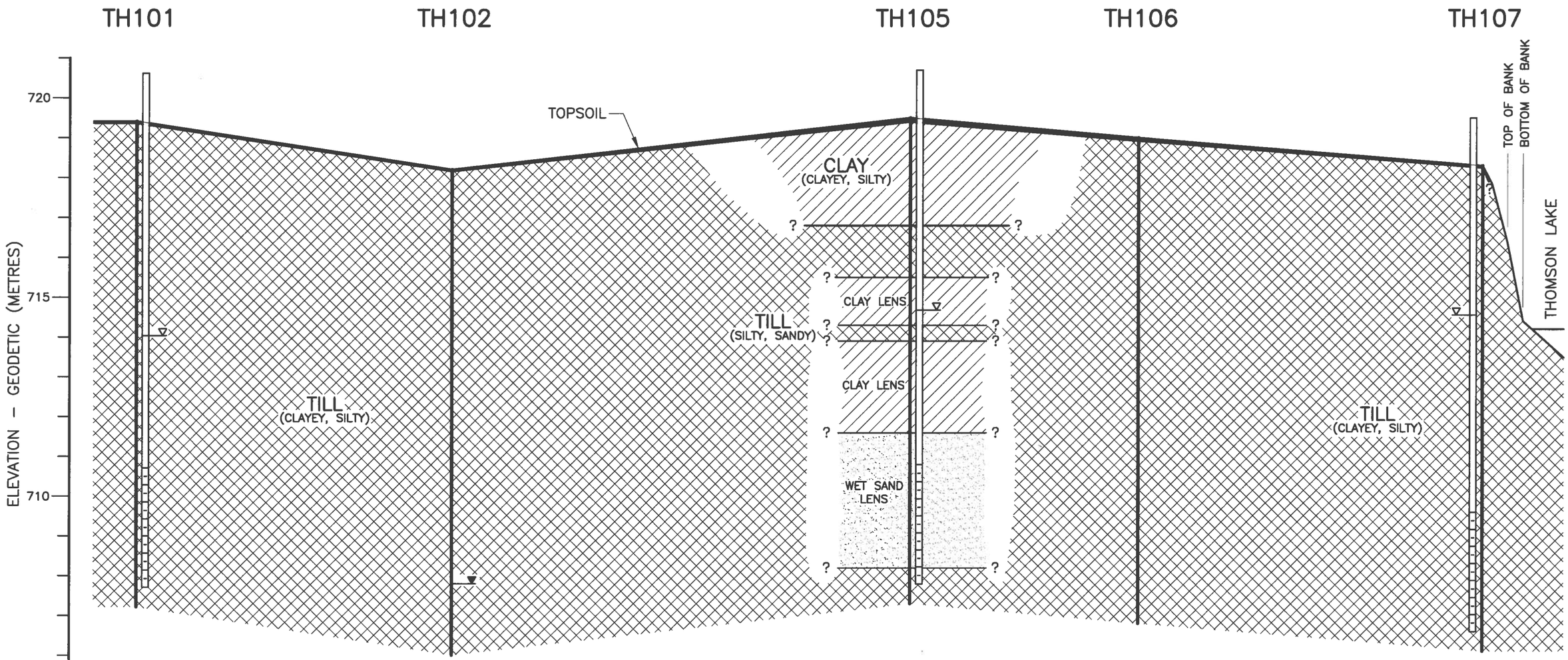
DRILLING AND SAMPLING TERMS

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

GE GROUND ENGINEERING LTD.



SECTION 'A-A'

SCALE: HOR. 1:2500
VERT. 1:100

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.

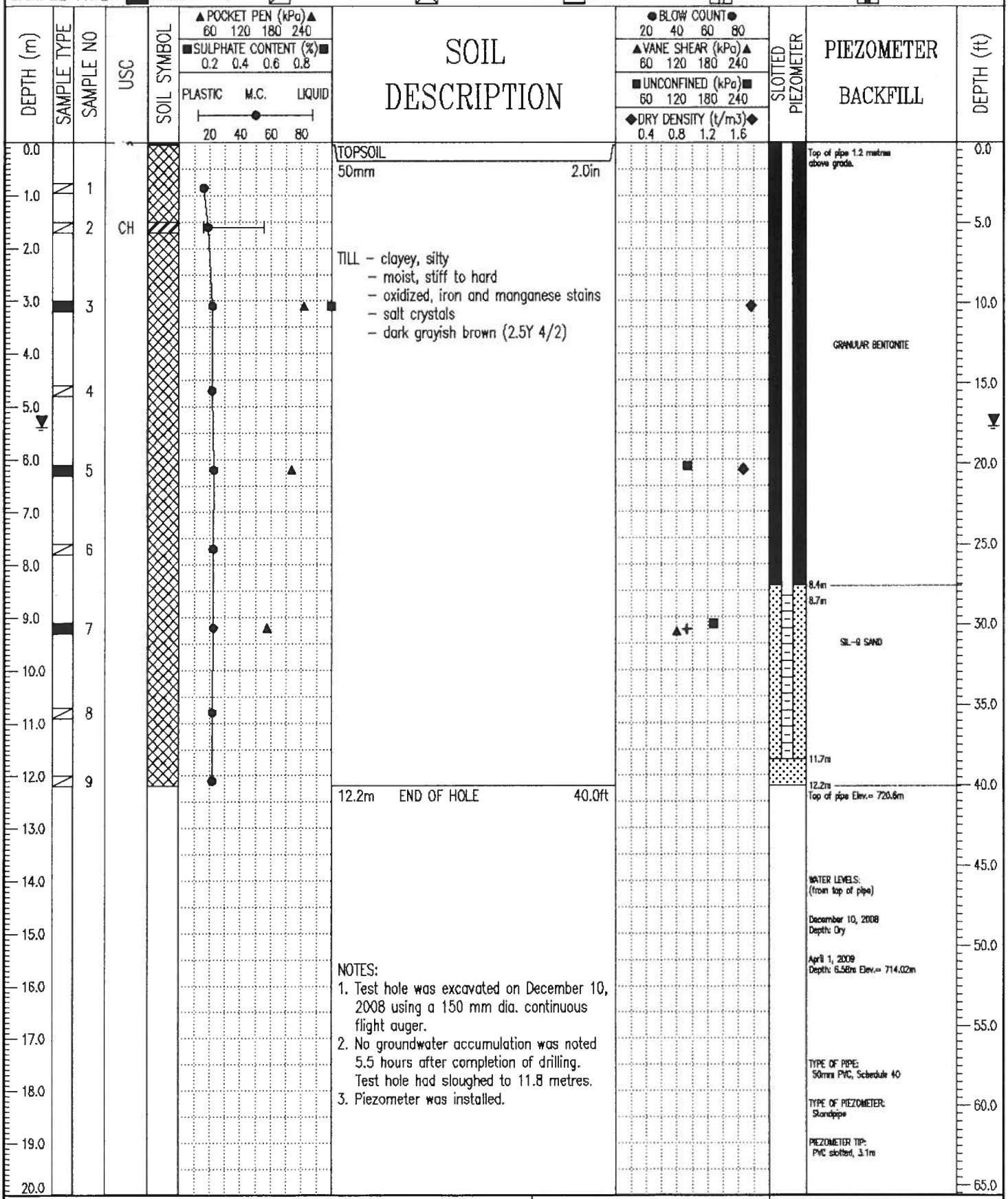
GROUND ENGINEERING LTD.
CONSULTING GEOENVIRONMENTAL ENGINEERS
REGINA, SASKATCHEWAN

STRATIGRAPHIC CROSS SECTION 'A-A'
PROPOSED RESIDENTIAL SUBDIVISION
PART of SE 3-10-5-W3M
THOMSON LAKE, SASKATCHEWAN

CLIENT:	APPROVED:	DATE:	DWG. No.:
QUEST HOMES		APRIL 16, 2009	GE-0897-5

PROJECT: PROP. RESIDENTIAL SUBDIVISION	LOCATION: 5516641 N; 13385019 E	TEST HOLE NO: 0897-TH101
CLIENT: QUEST HOMES	LOCATION: THOMSON LAKE, SASKATCHEWAN	PROJECT NO: GE-0897
DRILL RIG: P-61 DIGGER	ELEVATION: 719.4 metres (GEODETIC)	ELEVATION: 719.40 (m)

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

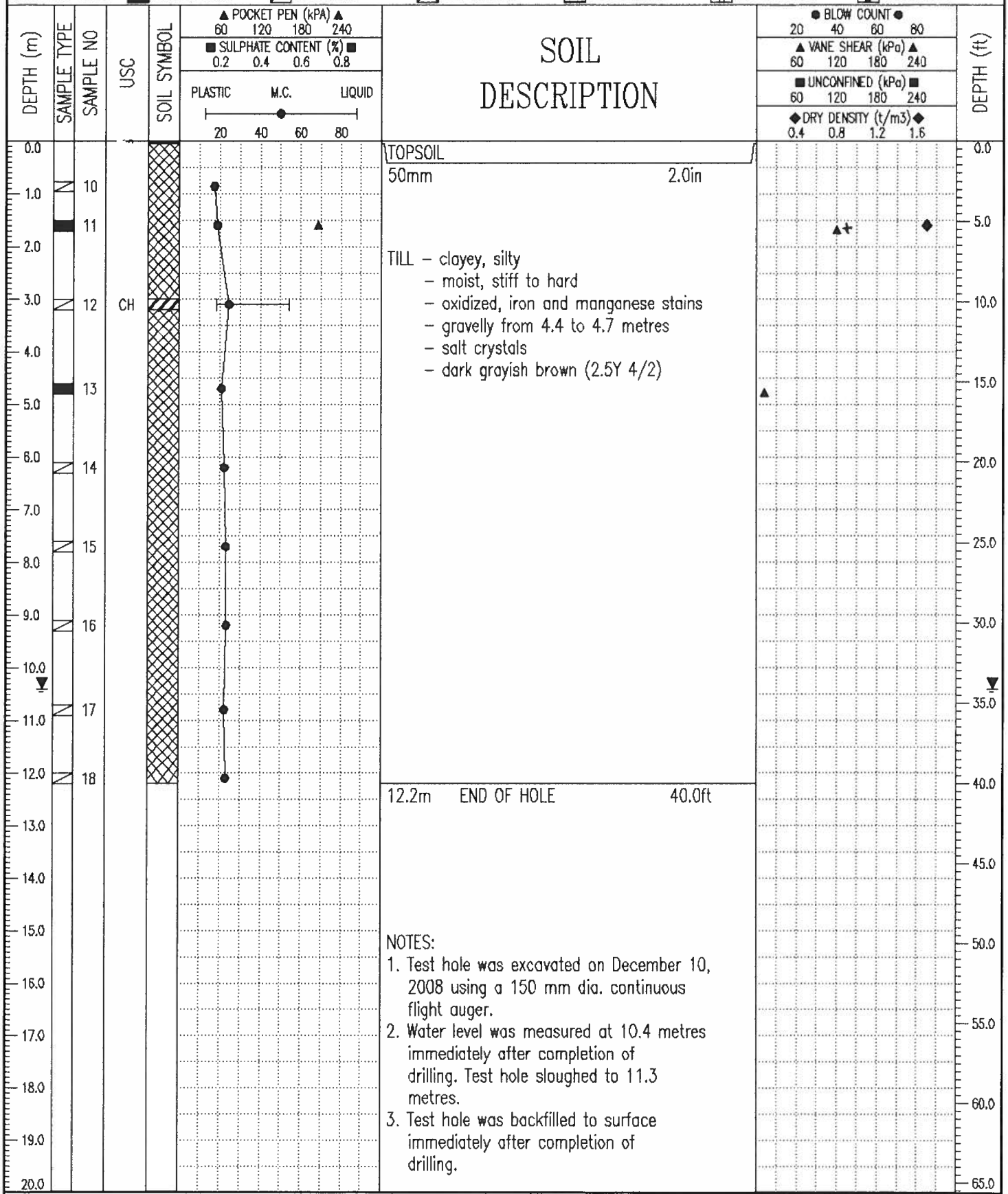


GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: RY	COMPLETION DEPTH: 12.2 m
	REVIEWED BY: PW	COMPLETE: 08/12/10
	Fig. No: 0897-6	Page 1 of 1

09/04/13 08:29AM

PROJECT: PROP. RESIDENTIAL SUBDIVISION	LOCATION: 5516497 N; 13385155 E	TEST HOLE NO: 0897-TH102
CLIENT: QUEST HOMES	LOCATION: THOMSON LAKE, SASKATCHEWAN	PROJECT NO: GE-0897
DRILL RIG: P-61 DIGGER	ELEVATION: 718.2 metres (GEODETIC)	ELEVATION: 718.20 (m)

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



NOTES:

1. Test hole was excavated on December 10, 2008 using a 150 mm dia. continuous flight auger.
2. Water level was measured at 10.4 metres immediately after completion of drilling. Test hole sloughed to 11.3 metres.
3. Test hole was backfilled to surface immediately after completion of drilling.

GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: RY	COMPLETION DEPTH: 12.2 m
	REVIEWED BY: PW	COMPLETE: 08/12/10
	Fig. No: 0897-7	Page 1 of 1

08/04/13 08:29AM

PROJECT: PROP. RESIDENTIAL SUBDIVISION	LOCATION: 5516452 N; 13385267 E	TEST HOLE NO: 0897-TH103
CLIENT: QUEST HOMES	LOCATION: THOMSON LAKE, SASKATCHEWAN	PROJECT NO: GE-0897
DRILL RIG: P-61 DIGGER	ELEVATION: 718.2 metres (GEODETIC)	ELEVATION: 718.20 (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 50mm 2.0in			Top of pipe 1.2 metres above grade.	0.0
1.0	N	19								5.0
2.0		20				TILL – clayey, silty – moist, stiff to hard – oxidized, iron and manganese stains – sandy from 1.8 to 5.0 metres – clay lens from 5.0 to 5.9 metres – salt crystals – dark grayish brown (2.5Y 4/2)				
3.0	N	21							GRANULAR BENTONITE	10.0
4.0									3.3m 3.6m SIL-9 SAND	15.0
5.0	N	22								
	N	22A								
	N	22B								
6.0	N	23								20.0
7.0									8.7m	
8.0	N	24							SLOUGH	25.0
9.0	N	25								30.0
10.0										
11.0	N	26								35.0
12.0	N	27				12.2m END OF HOLE 40.0ft			12.2m Top of pipe Elev.= 718.4m	40.0
13.0										
14.0									WATER LEVELS: (from top of pipe)	45.0
15.0									December 10, 2008 Depth: Dry	50.0
16.0									April 1, 2009 Depth: 4.54m Elev.= 714.86m	
17.0										55.0
18.0									TYPE OF PIPE: 50mm PVC, Schedule 40	
19.0									TYPE OF PIEZOMETER: Standpipe	60.0
20.0									PIEZOMETER TIP: PVC slotted, 3.1m	65.0

NOTES:
1. Test hole was excavated on December 10, 2008 using a 150 mm dia. continuous flight auger.
2. Water level was measured at 7.6 metres immediately after completion of drilling. Test hole sloughed to 8.2 metres.
3. Piezometer was installed.

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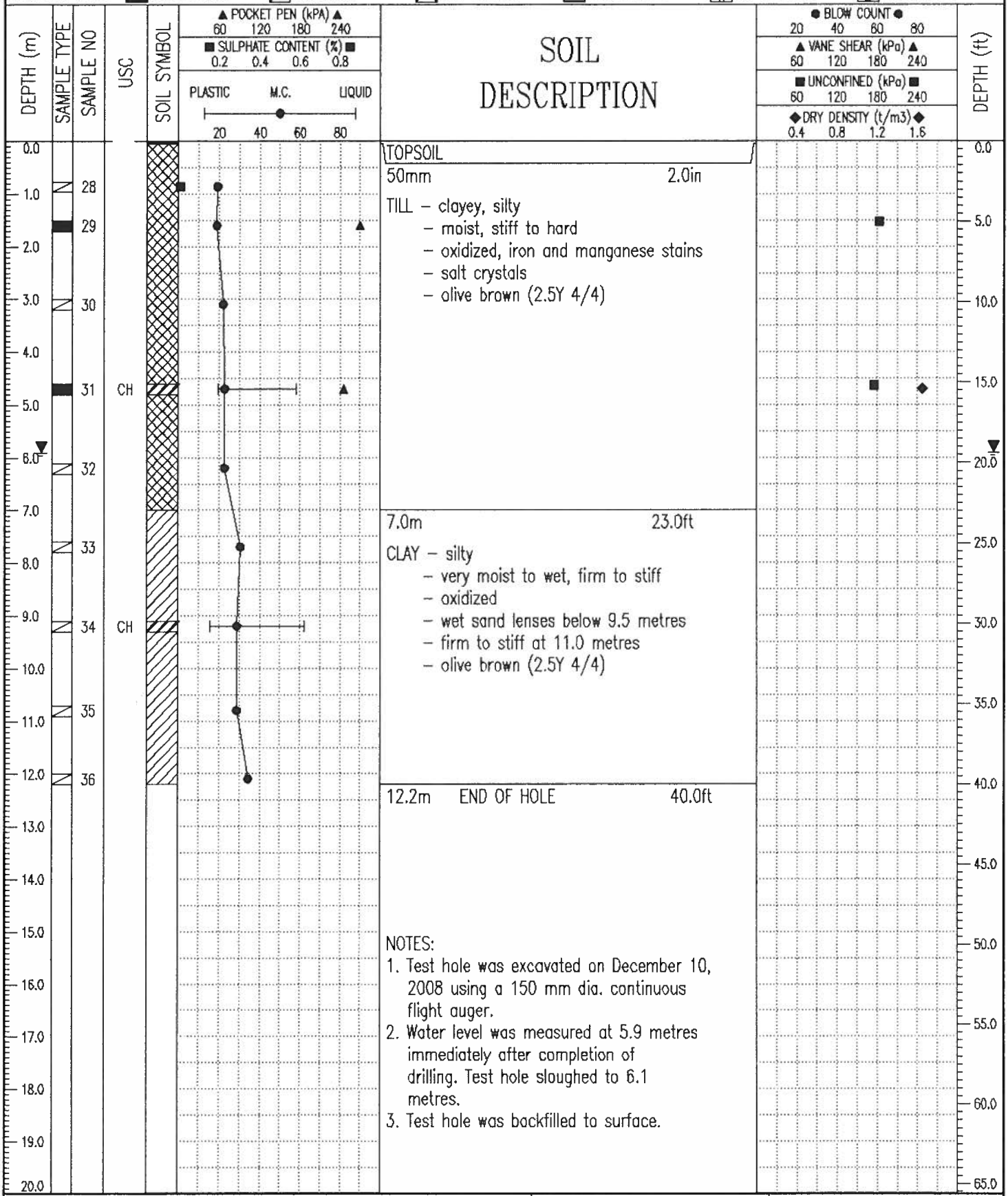
Regina, Saskatchewan

LOGGED BY: RY	COMPLETION DEPTH: 12.2 m
REVIEWED BY: PW	COMPLETE: 08/12/10
Fig. No: 0897-8	Page 1 of 1

09/04/14 01:18PM

PROJECT: PROP. RESIDENTIAL SUBDIVISION	LOCATION: 5516346 N; 13385327 E	TEST HOLE NO: 0897-TH104
CLIENT: QUEST HOMES	LOCATION: THOMSON LAKE, SASKATCHEWAN	PROJECT NO: GE-0897
DRILL RIG: P-61 DIGGER	ELEVATION: 719.8 metres (GEODETIC)	ELEVATION: 719.80 (m)

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



TOPSOIL
50mm 2.0in

TILL – clayey, silty
- moist, stiff to hard
- oxidized, iron and manganese stains
- salt crystals
- olive brown (2.5Y 4/4)

7.0m 23.0ft

CLAY – silty
- very moist to wet, firm to stiff
- oxidized
- wet sand lenses below 9.5 metres
- firm to stiff at 11.0 metres
- olive brown (2.5Y 4/4)

12.2m END OF HOLE 40.0ft

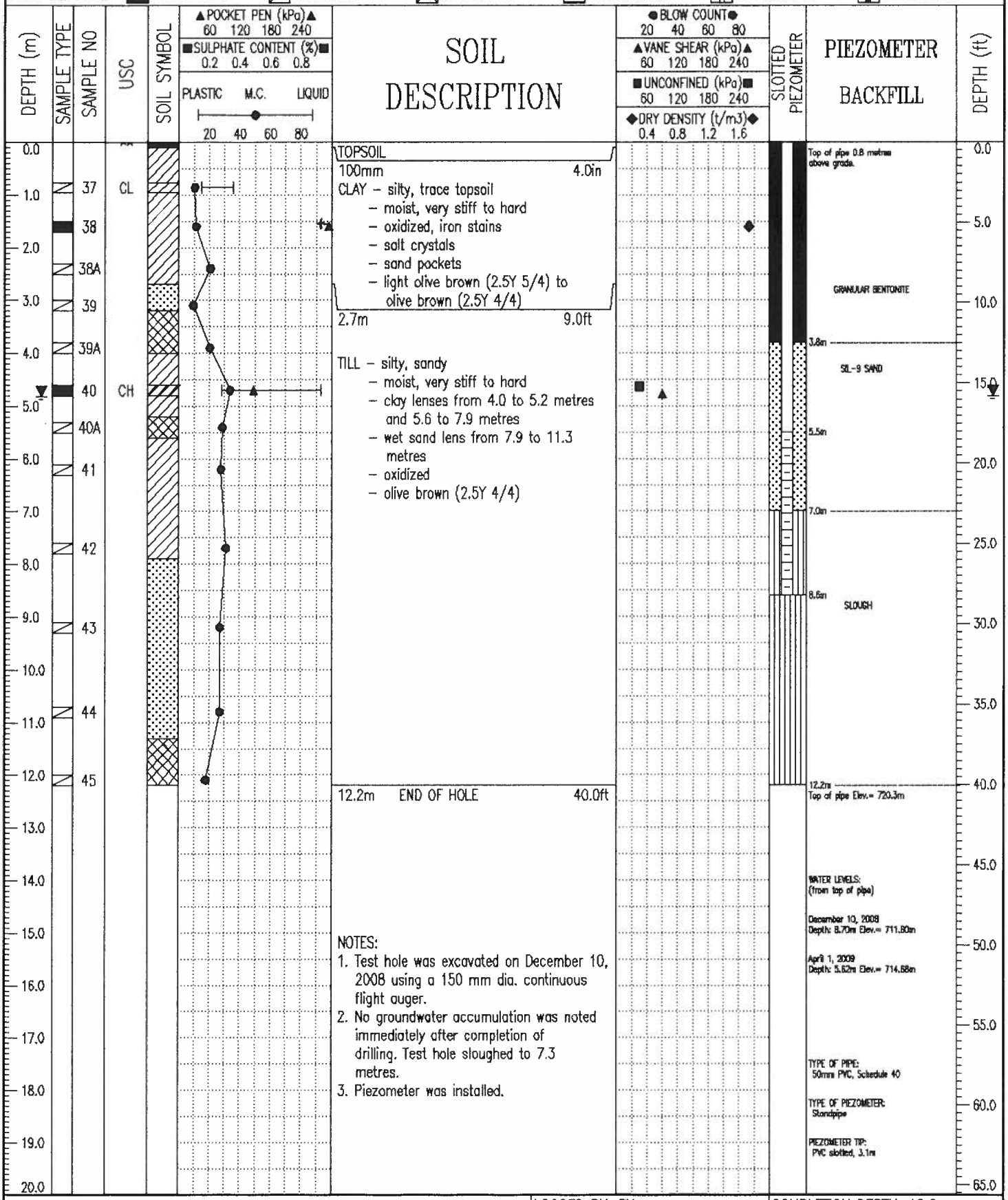
NOTES:
1. Test hole was excavated on December 10, 2008 using a 150 mm dia. continuous flight auger.
2. Water level was measured at 5.9 metres immediately after completion of drilling. Test hole sloughed to 6.1 metres.
3. Test hole was backfilled to surface.

GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: RY	COMPLETION DEPTH: 12.2 m
	REVIEWED BY: PW	COMPLETE: 08/12/10
	Fig. No: 0897-9	Page 1 of 1

09/04/13 08:29AM

PROJECT: PROP. RESIDENTIAL SUBDIVISION	LOCATION: 5516237 N; 13385268 E	TEST HOLE NO: 0897-TH105
CLIENT: QUEST HOMES	LOCATION: THOMSON LAKE, SASKATCHEWAN	PROJECT NO: GE-0897
DRILL RIG: P-61 DIGGER	ELEVATION: 719.5 metres (GEODETIC)	ELEVATION: 719.50 (m)

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



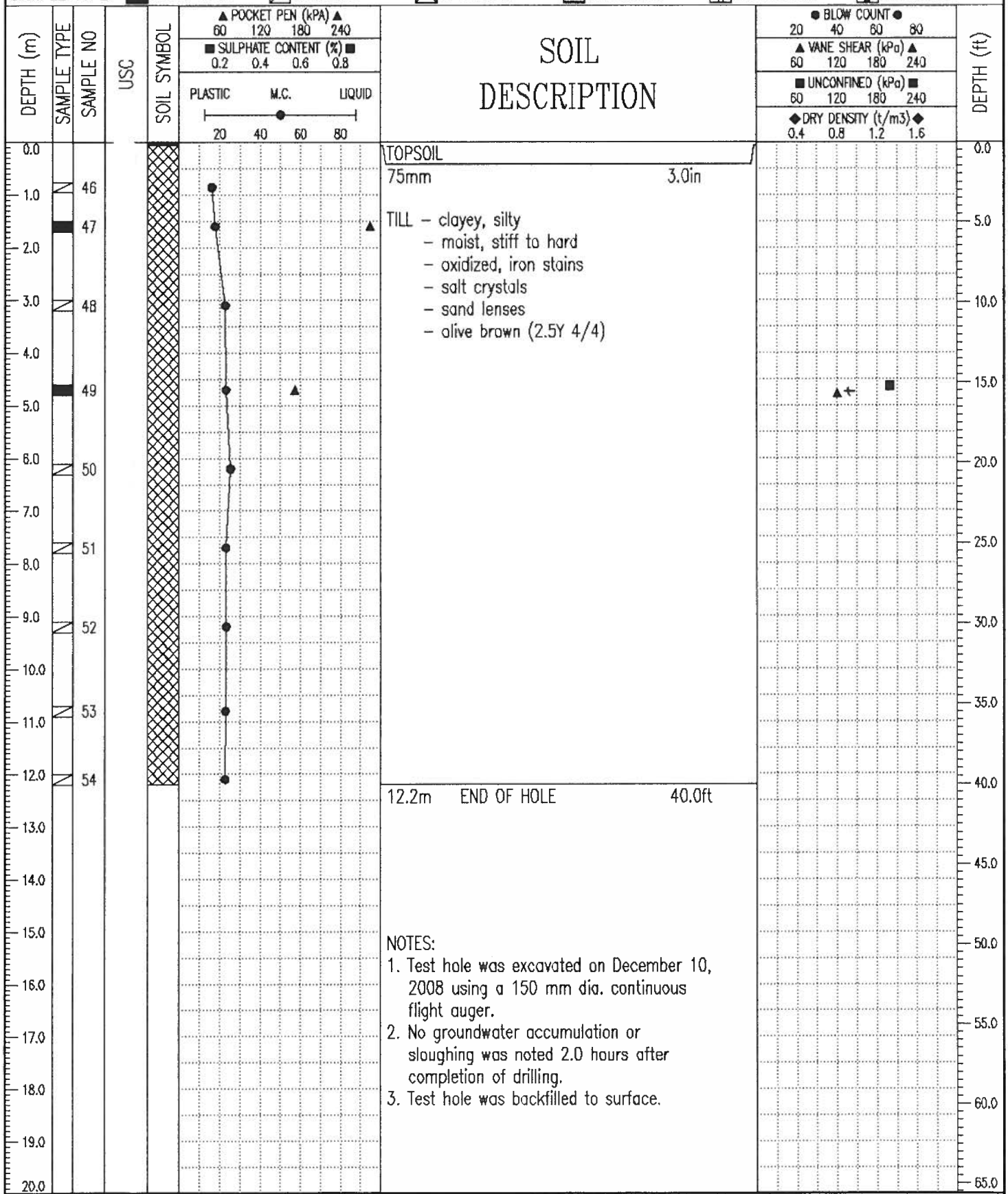
NOTES:
1. Test hole was excavated on December 10, 2008 using a 150 mm dia. continuous flight auger.
2. No groundwater accumulation was noted immediately after completion of drilling. Test hole sloughed to 7.3 metres.
3. Piezometer was installed.

GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: RY	COMPLETION DEPTH: 12.2 m
	REVIEWED BY: PW	COMPLETE: 08/12/10
	Fig. No: 0897-10	Page 1 of 1

09/04/13 08:30AM

PROJECT: PROP. RESIDENTIAL SUBDIVISION	LOCATION: 5516125 N; 13385180 E	TEST HOLE NO: 0897-TH106
CLIENT: QUEST HOMES	LOCATION: THOMSON LAKE, SASKATCHEWAN	PROJECT NO: GE-0897
DRILL RIG: P-61 DIGGER	ELEVATION: 719.0 metres (GEODETIC)	ELEVATION: 719.00 (m)

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



TOPSOIL
75mm 3.0in

TILL – clayey, silty
- moist, stiff to hard
- oxidized, iron stains
- salt crystals
- sand lenses
- olive brown (2.5Y 4/4)

12.2m END OF HOLE 40.0ft

NOTES:
1. Test hole was excavated on December 10, 2008 using a 150 mm dia. continuous flight auger.
2. No groundwater accumulation or sloughing was noted 2.0 hours after completion of drilling.
3. Test hole was backfilled to surface.

GE GROUND ENGINEERING LTD.	LOGGED BY: RY	COMPLETION DEPTH: 12.2 m
Regina, Saskatchewan	REVIEWED BY: PW	COMPLETE: 08/12/10
	Fig. No: 0897-11	Page 1 of 1

08/04/16 10:15AM

PROJECT: PROP. RESIDENTIAL SUBDIVISION	LOCATION: 5516007 N; 13385001 E	TEST HOLE NO: 0897-TH107
CLIENT: QUEST HOMES	LOCATION: THOMSON LAKE, SASKATCHEWAN	PROJECT NO: GE-0897
DRILL RIG: P-61 DIGGER	ELEVATION: 718.3 metres (GEODETIC)	ELEVATION: 718.30 (m)

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

DEPTH (m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL
0.0				
1.0	N	55		
2.0		56	CH	
3.0		57		
4.0	N	58		
5.0				
6.0	N	59		
7.0				
8.0	N	60		
9.0				
10.0	N	61		
11.0				
12.0	N	62		
13.0		63		
14.0				
15.0				
16.0				
17.0				
18.0				
19.0				
20.0				

▲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

TOPSOIL
50mm 2.0in

TILL – clayey, silty
- moist, very stiff to hard
- oxidized, iron stains
- unoxidized below 10.1 metres
- salt crystals
- olive brown (2.5Y 4/4) to dark gray (5Y 4/1)

12.2m END OF HOLE 40.0ft

NOTES:
1. Test hole was excavated on December 10, 2008 using a 150 mm dia. continuous flight auger.
2. No groundwater accumulation or sloughing was noted immediately after completion of drilling.
3. Piezometer was installed.

●BLOW COUNT● 20 40 60 80
▲VANE SHEAR (kPa)▲ 60 120 180 240
■UNCONFINED (kPa)■ 50 120 180 240
◆DRY DENSITY (t/m3)◆ 0.4 0.8 1.2 1.6

SLOTTED PIEZOMETER

PIEZOMETER BACKFILL

Top of pipe 1.2 metres above grade.
GRANULAR BENTONITE
3.4m
4.1m
SIL-9 SAND
7.2m
SLOUGH
12.2m
Top of pipe Elev.= 719.5m

WATER LEVELS:
(from top of pipe)
December 10, 2008
Depth: Dry
April 1, 2009
Depth: 4.94m Elev.= 714.56m

TYPE OF PIPE:
50mm PVC, Schedule 40
TYPE OF PIEZOMETER:
Standpipe
PIEZOMETER TIP:
PVC slotted, 3.1m

DEPTH (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0

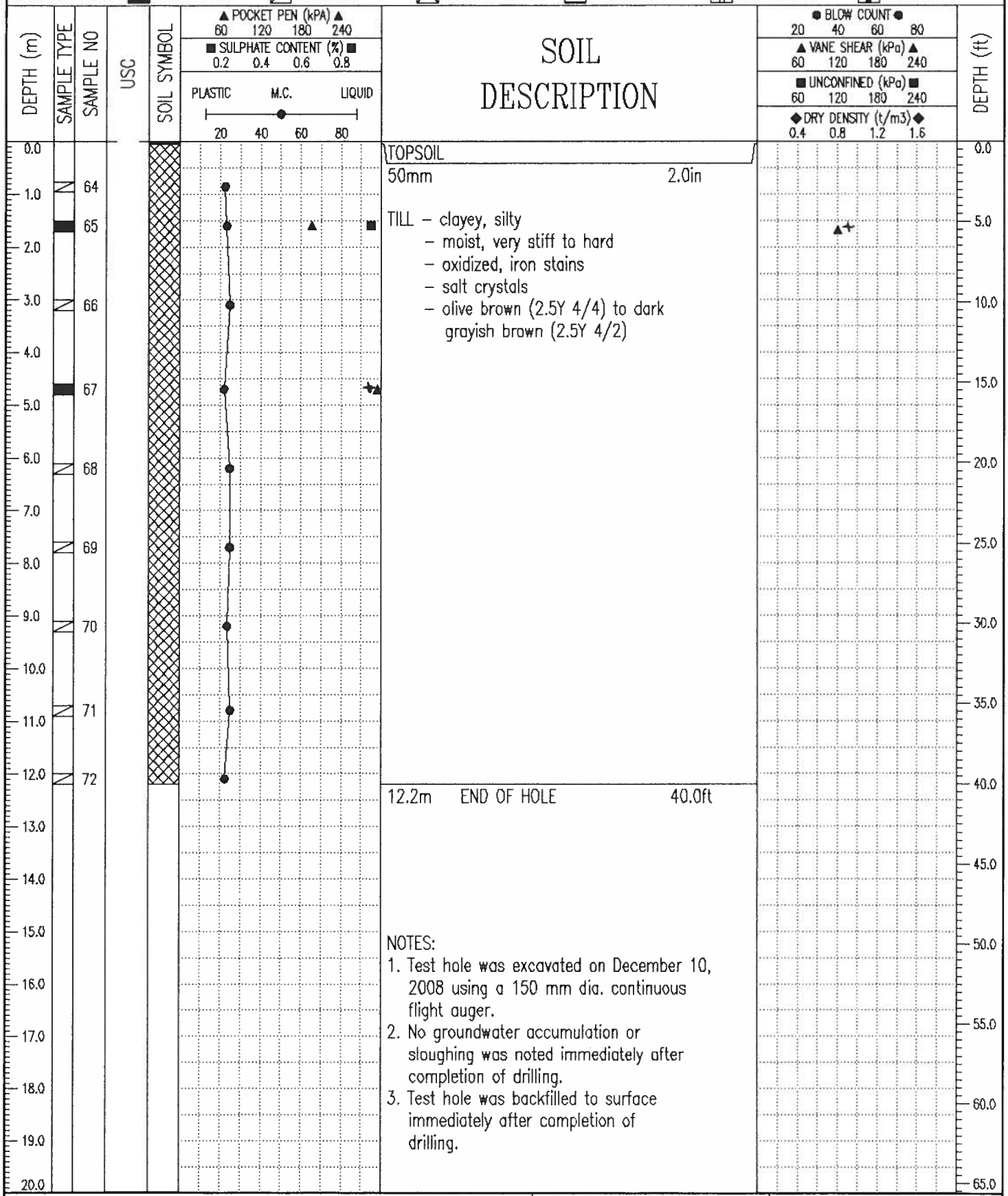
GE GROUND ENGINEERING LTD.
Regina, Saskatchewan

LOGGED BY: RY	COMPLETION DEPTH: 12.2 m
REVIEWED BY: PW	COMPLETE: 08/12/10
Fig. No: 0897-12	Page 1 of 1

09/04/13 08:30AM

PROJECT: PROP. RESIDENTIAL SUBDIVISION	LOCATION: 5516133 N; 13384777 E	TEST HOLE NO: 0897-TH108
CLIENT: QUEST HOMES	LOCATION: THOMSON LAKE, SASKATCHEWAN	PROJECT NO: GE-0897
DRILL RIG: P-61 DIGGER	ELEVATION: 719.6 metres (GEODETIC)	ELEVATION: 719.60 (m)

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



TOPSOIL
50mm 2.0in

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

12.2m END OF HOLE 40.0ft

NOTES:
1. Test hole was excavated on December 10, 2008 using a 150 mm dia. continuous flight auger.
2. No groundwater accumulation or sloughing was noted immediately after completion of drilling.
3. Test hole was backfilled to surface immediately after completion of drilling.

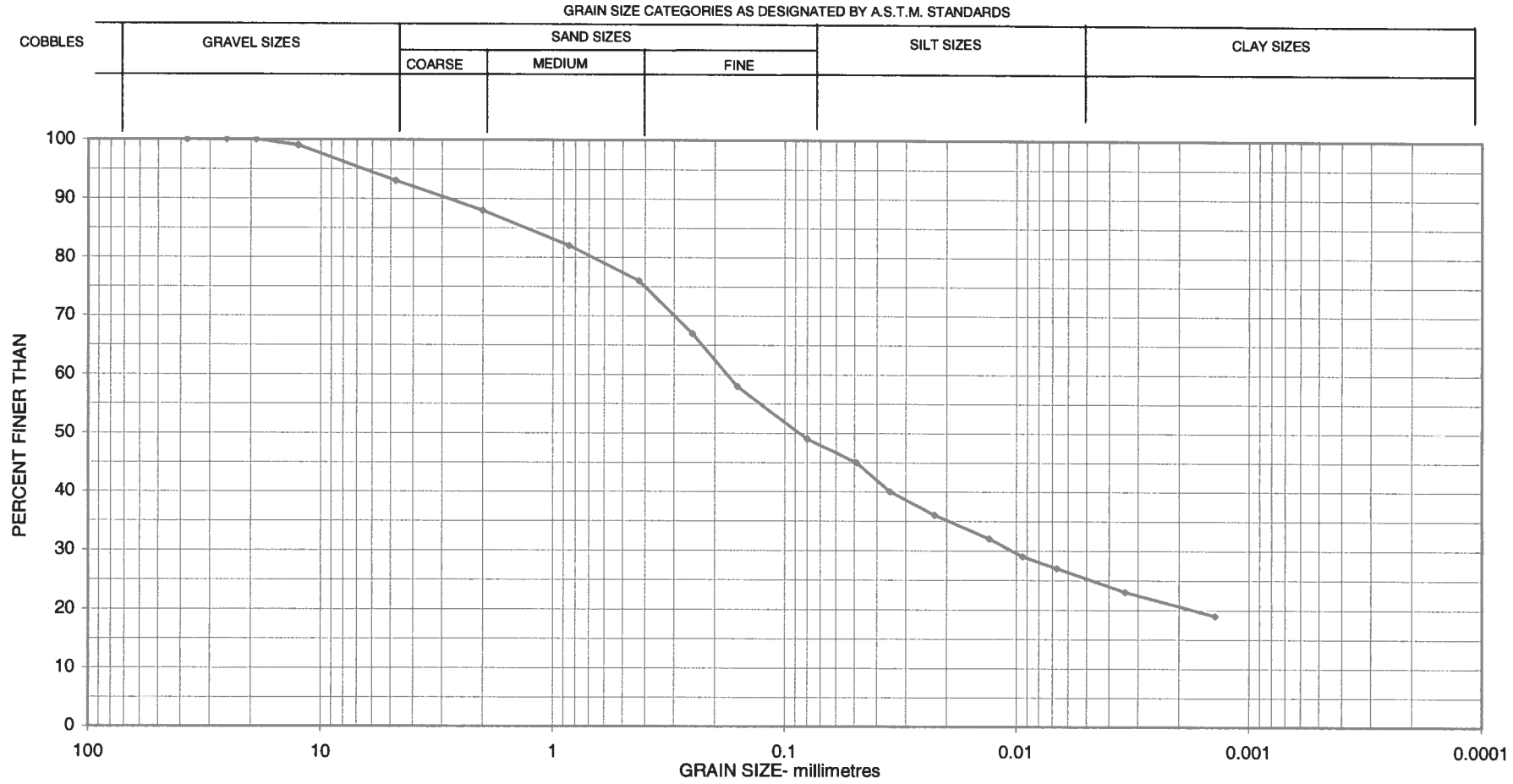
GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: RY	COMPLETION DEPTH: 12.2 m
	REVIEWED BY: PW	COMPLETE: 08/12/10
	Fig. No: 0897-13	Page 1 of 1

09/04/13 08:31AM

GE GROUND ENGINEERING LTD.
CIVIL & GEOENVIRONMENTAL ENGINEERS
415 - 7th AVENUE, REGINA, SASKATCHEWAN, CANADA
S4N 4P1 TELEPHONE: (306) 569-9075, FAX: (306) 565-3877

GRAIN SIZE CURVE - HYDROMETER
(A.S.T.M. D-422)

JOB No: GE-0897 DATE: December 17, 2008 TECH: I. HE, EIT
CLIENT: QUEST HOMES
PROJECT: GEOTECHNICAL INVESTIGATION - PROPOSED NEW RESIDENTIAL SUBDIVISION
LOCATION: THOMSON LAKE, SASKATCHEWAN



GRAIN SIZE CLASSIFICATION	PERCENTAGE OF SAMPLE
GRAVEL	7
COARSE SAND	5
MEDIUM SAND	12
FINE SAND	27
SILT	24
CLAY	25

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

SAMPLED BY : R. YAREMKO OF GE GROUND ENGINEERING LTD.

DATE SAMPLED : December 10, 2008
TEST HOLE NUMBER : TH 103
SAMPLE NUMBER : 22A
DEPTH OF SAMPLE (ft) : 16' BELOW GRADE

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 GE GROUND ENGINEERING LTD.

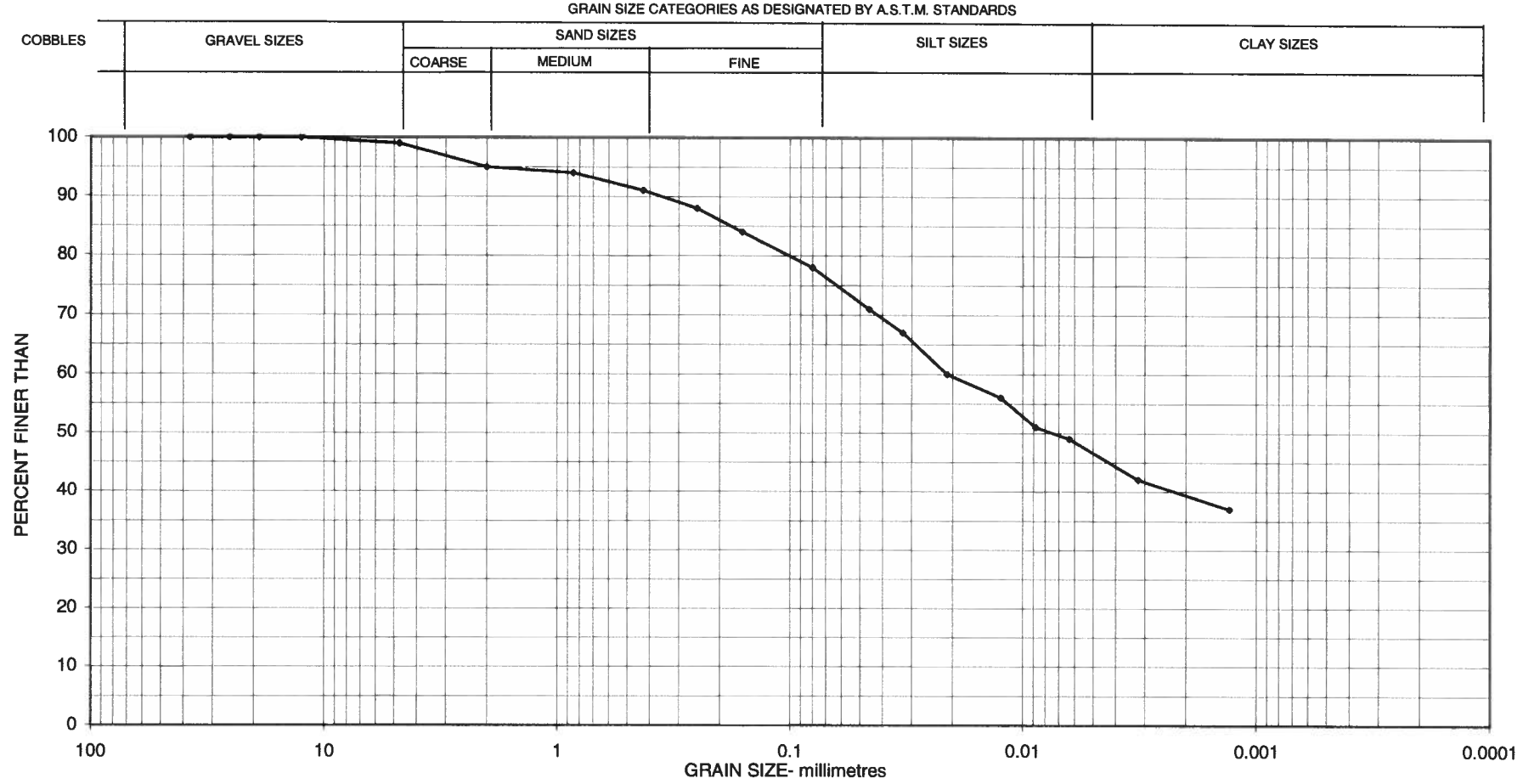
Per: _____
KELLY MAUNDER, A.Sc.T.

GE-0897-14

GE GROUND ENGINEERING LTD.
CIVIL & GEOENVIRONMENTAL ENGINEERS
415 - 7th AVENUE, REGINA, SASKATCHEWAN, CANADA
S4N 4P1 TELEPHONE: (306) 569-9075, FAX: (306) 565-3677

GRAIN SIZE CURVE - HYDROMETER
(A.S.T.M. D-422)

JOB No: GE-0897 DATE: December 17, 2008 TECH: I. HE, EIT
CLIENT: QUEST HOMES
PROJECT: GEOTECHNICAL INVESTIGATION - PROPOSED NEW RESIDENTIAL SUBDIVISION
LOCATION: THOMSON LAKE, SASKATCHEWAN



GRAIN SIZE CLASSIFICATION	PERCENTAGE OF SAMPLE
GRAVEL	1
COARSE SAND	4
MEDIUM SAND	4
FINE SAND	13
SILT	32
CLAY	46

SAMPLE DESCRIPTION : TILL - CLAY WITH SILT, SOME SAND A TRACE OF GRAVEL.

SAMPLED BY : R. YAREMKO OF GE GROUND ENGINEERING LTD.

DATE SAMPLED : December 10, 2008
TEST HOLE NUMBER : TH 103
SAMPLE NUMBER : 24
DEPTH OF SAMPLE (ft) : 25' BELOW GRADE

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 GE GROUND ENGINEERING LTD.

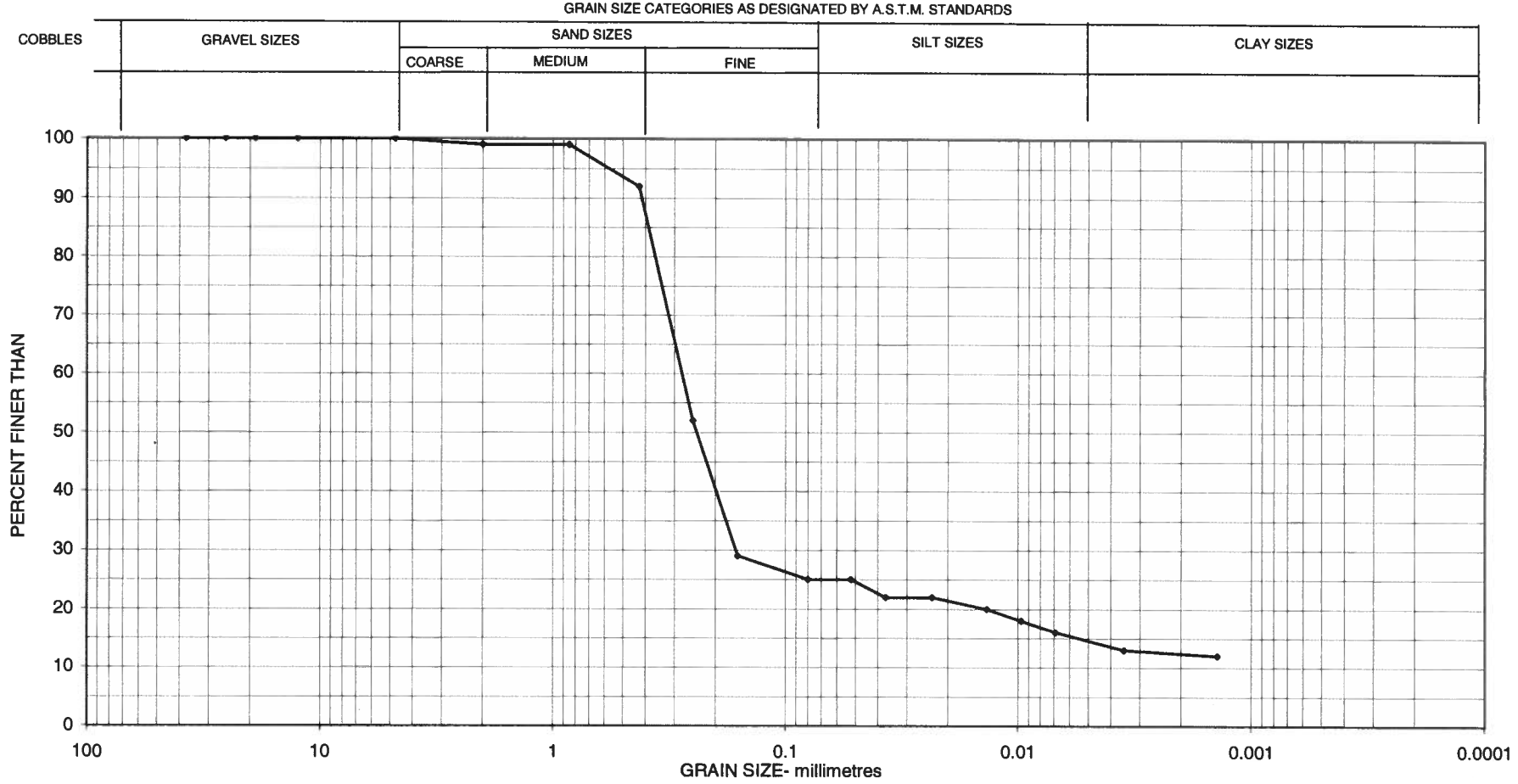
Per: _____
KELLY MAUNDER, A.Sc.T.

GE-0897-15

GE GROUND ENGINEERING LTD.
CIVIL & GEOENVIRONMENTAL ENGINEERS
415 - 7th AVENUE, REGINA, SASKATCHEWAN, CANADA
S4N 4P1 TELEPHONE: (306) 569-9075, FAX: (306) 565-3877

GRAIN SIZE CURVE - HYDROMETER
(A.S.T.M. D-422)

JOB No: GE-0897 DATE: December 17, 2008 TECH: I. HE, EIT
CLIENT: QUEST HOMES
PROJECT: GEOTECHNICAL INVESTIGATION - PROPOSED NEW RESIDENTIAL SUBDIVISION
LOCATION: THOMSON LAKE, SASKATCHEWAN



GRAIN SIZE CLASSIFICATION	PERCENTAGE OF SAMPLE
GRAVEL	0
COARSE SAND	1
MEDIUM SAND	7
FINE SAND	67
SILT	11
CLAY	14

SAMPLE DESCRIPTION : SAND, A LITTLE CLAY, A LITTLE SILT.

SAMPLED BY : R. YAREMKO OF GE GROUND ENGINEERING LTD.

DATE SAMPLED : December 10, 2008
TEST HOLE NUMBER : TH 105
SAMPLE NUMBER : 43
DEPTH OF SAMPLE (ft) : 30' BELOW GRADE

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 GE GROUND ENGINEERING LTD.

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

GE-0897-16

* GUIDE FOR USE OF SULPHATE RESISTANT CEMENT (TYPE V)

Concentration of Sulphates Expressed as SO_3

Class	In Soil		In Ground-Water	Types of cement and limiting mix proportions for dense, fully compacted concrete and special protective measures when necessary (note 2). The cement contents shown apply to 20mm maximum size aggregate which should comply with BS 1047.
	Total SO_3	SO_3 in 1:1 Water Extract		
1	Less Than 0.2%		Less Than 30 Parts / 100 000	Ordinary Portland cement or Portland blastfurnace cement. For structural reinforced concrete work; minimum cement content 280 kg/m^3 (475 lbs./cu. yd.); maximum free water/cement ratio 0.55 by weight. For plain concrete, these recommendations may be relaxed.
2	0.2% to 0.5%		30-120 parts / 100 000	See Note 1. (a) Ordinary Portland cement or Portland blastfurnace cement. Minimum cement content 330 kg/m^3 (560 lbs./cu. yd.); maximum free water/cement ratio 0.50 by weight. (b) Sulphate -resistant Portland cement. Minimum cement content 280 kg/m^3 (475 lbs./cu. yd.); maximum free water/ cement ratio 0.50 by weight. (c) Supersulphated cement. Minimum cement content 310 kg/m^3 (525 lbs./cu. yd.); maximum free water/cement ratio 0.50 by weight.
3	0.5% to 1.0%	2.5-5.0 g/litre	120-250 parts / 100 000	Sulphate-resisting Portland cement, supersulphated cement or high alumina cement. Minimum cement content 330 kg/m^3 (560 lbs./cu. yd.); maximum free water/cement ratio 0.50 by weight.
4	1.0% to 2.0%	5.0-10.0 g/litre	250-500 parts / 100 000	(a) Sulphate-resisting Portland cement or supersulphated cement. Minimum cement content 370 kg/m^3 (625 lbs./cu. yd.) maximum free water/cement ratio 0.45 by weight. (b) High alumina cement. Minimum cement content 340 kg/m^3 (575 lbs./cu. yd.); maximum free water/cement ratio 0.45 by weight.
5	Over 2%	Over 10 g/litre	Over 500 parts / 100 000	Either cements described in 4(a) plus adequate protective coatings of inert material such as asphalt or bituminous emulsions reinforced with fibreglass membranes, or high alumina cement with a minimum cement content of 370kg/m^3 (625 lbs./cu. yd.); maximum free water/cement ratio 0.40 by weight.

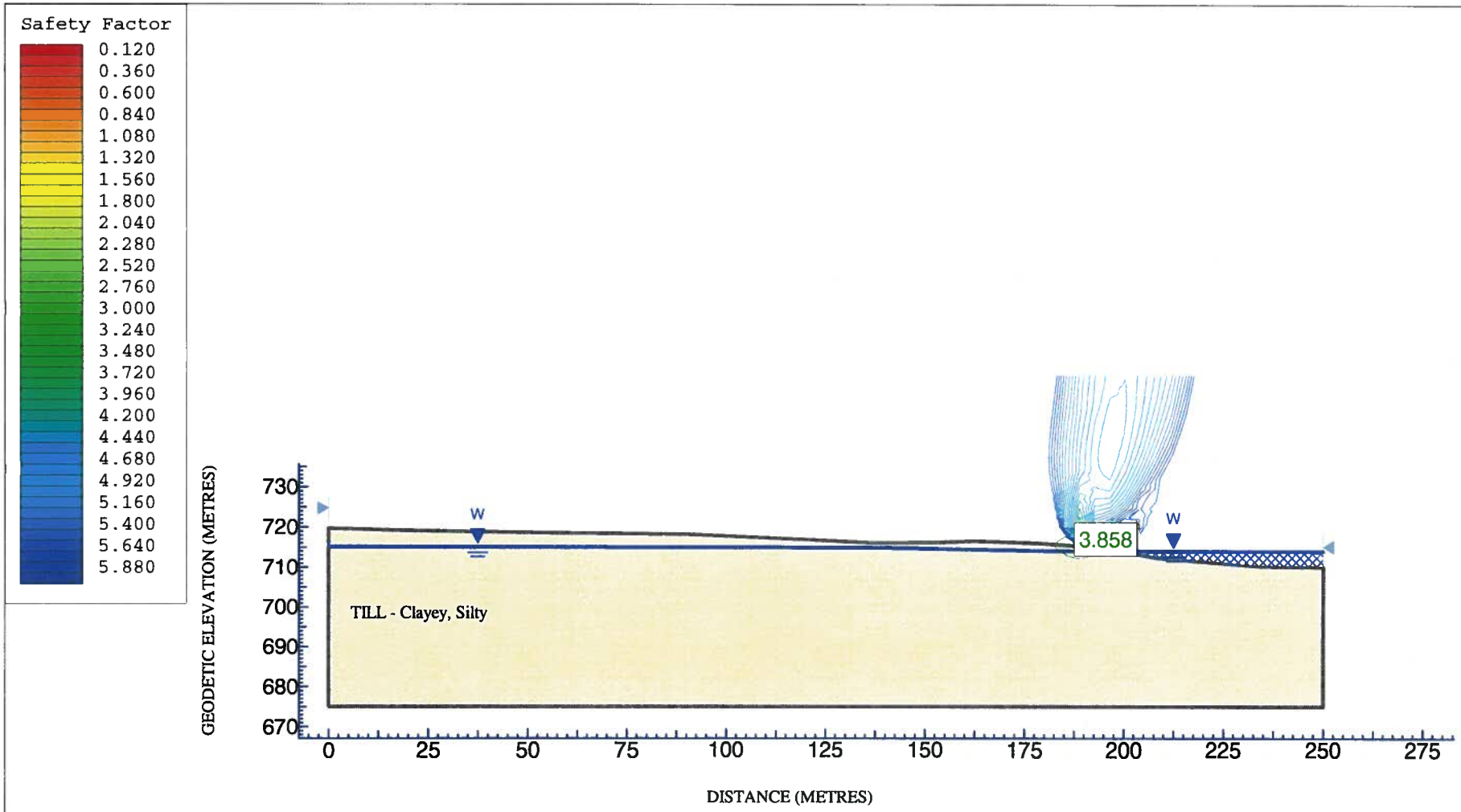
NOTES:

1. The cement contents given in class 2 are the minima recommended by the manufacturers. For SO_3 contents near the upper limit of class 2, cement contents above these minima are advised.
2. For severe conditions, e.g. thin sections, sections under hydrostatic pressure on one side only and sections partly immersed, consideration should be given to a further reduction of water/cement ratio and, if necessary, an increase in cement content to ensure the degree of workability needed for full compaction and thus minimum permeability.

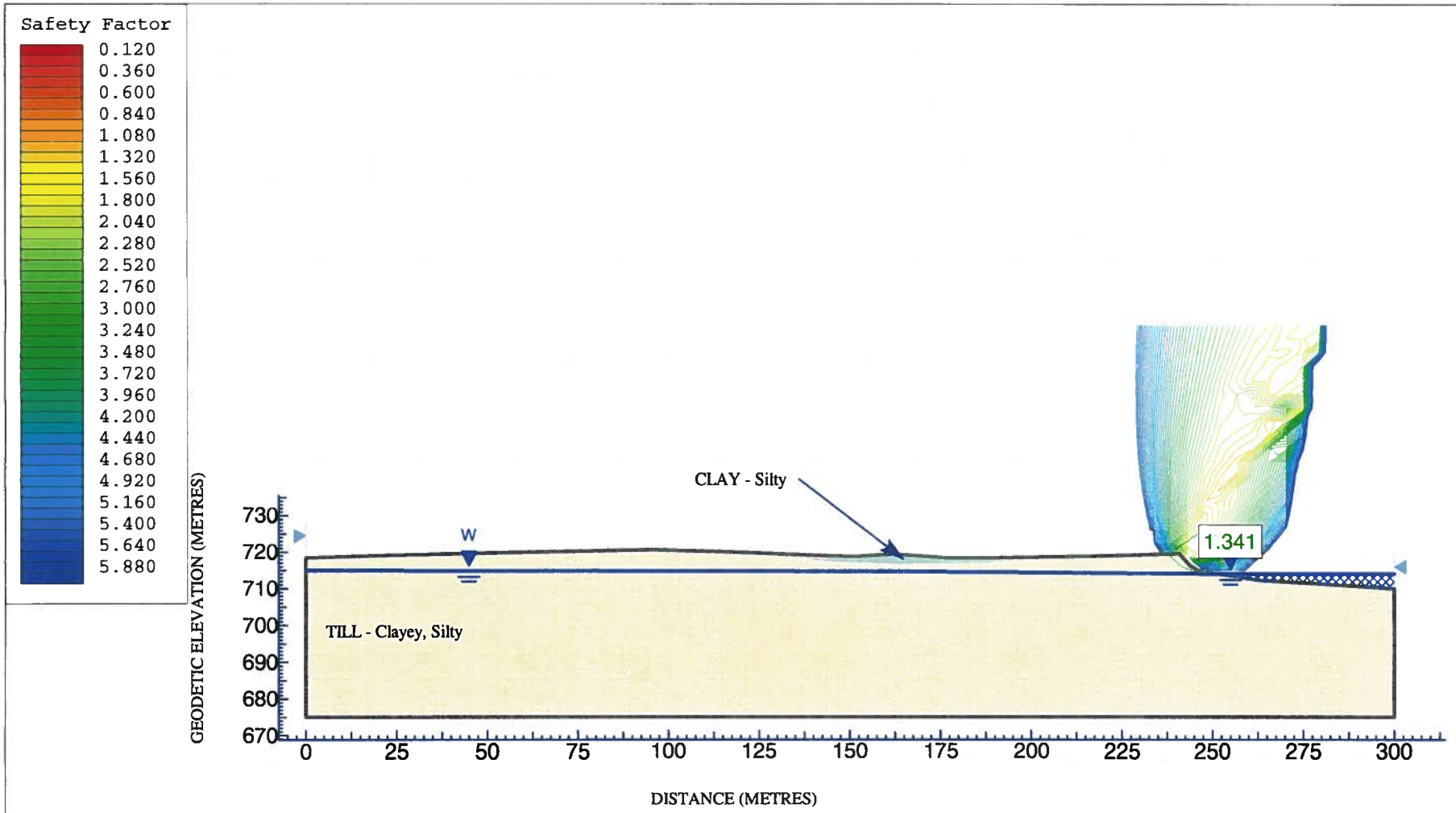
*REFERENCE - Portland Cement Association

APPENDIX A

APPENDIX B



GE-0897 - CROSS SECTION '1-1'
PROPOSED RESIDENTIAL SUBDIVISION
SE 3-10-5-W3M
THOMPSON LAKE, SASKATCHEWAN



GE-0897 - CROSS SECTION '2-2'
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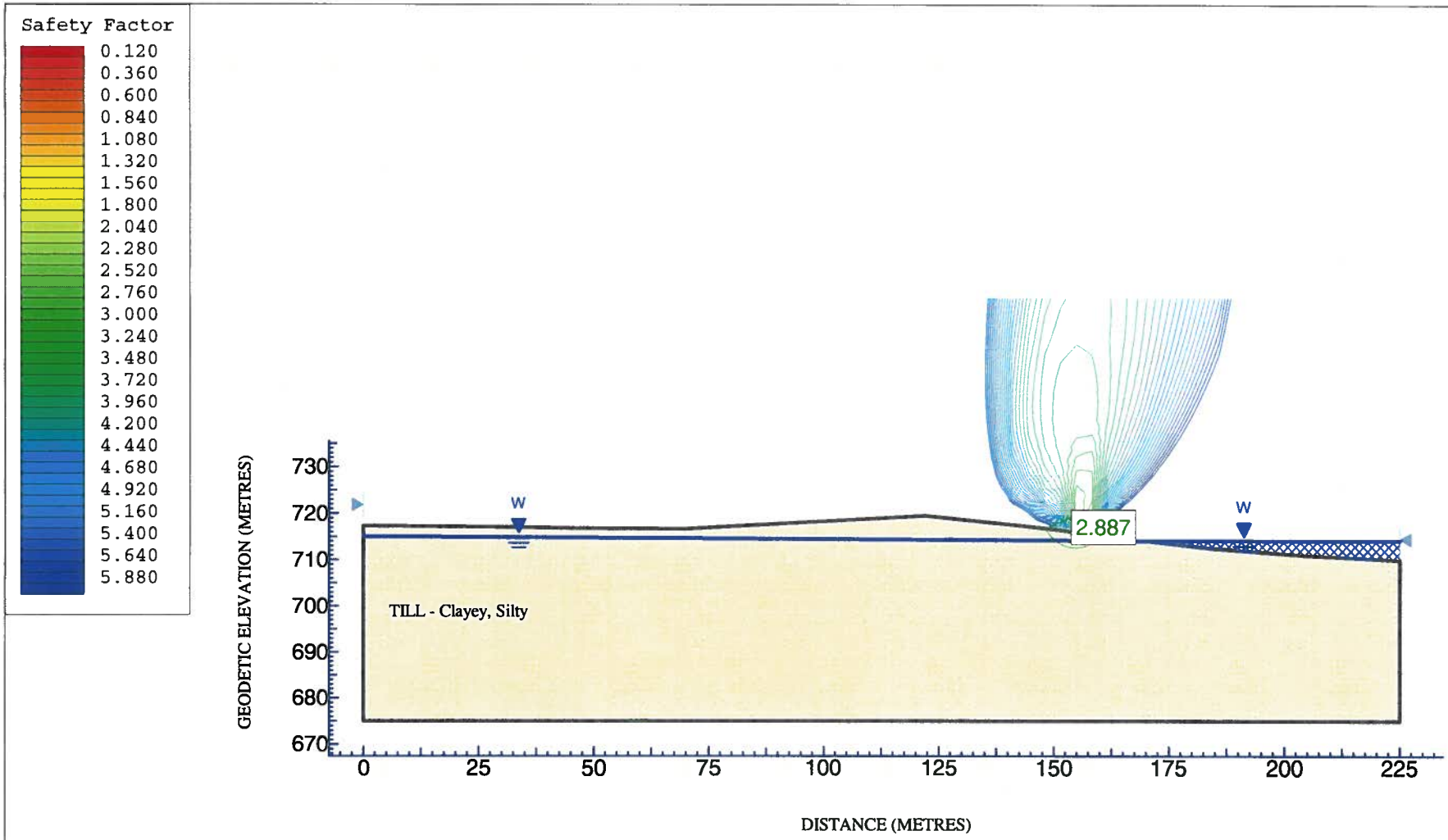
SE 3-10-5-W3M
THOMPSON LAKE, SASKATCHEWAN



GE-0897 - CROSS SECTION '3-3'
PROPOSED RESIDENTIAL SUBDIVISION
SE 3-10-5-W3M
THOMPSON LAKE, SASKATCHEWAN

APPENDIX C

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.