TITLE: GEOTECHNICAL INVESTIGATION
PROPOSED GOLF COURSE AND
RESIDENTIAL SUBDIVISION (PHASE I)
SECTIONS 7 & 8-19-21-W2
SOUTH OF LUMSDEN, SASKATCHEWAN

CLIENT: [redacted]

FILE NO: GE-0005 DATE: APRIL 25, 2000

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DRAWINGS

APPENDICES

GROUND ENGINEERING LTD.

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FILE: GE-0005

April 25, 2000

[redacted]

ATTENTION: [redacted]

Dear Sir:

SUBJECT: GEOTECHNICAL INVESTIGATION
PROPOSED GOLF COURSE AND
RESIDENTIAL SUBDIVISION (PHASE I)
SECTIONS 7 & 8-19-21-W2
SOUTH OF LUMSDEN, SASKATCHEWAN

1.0 INTRODUCTION

This report presents the results of a site specific subsurface soils investigation and geotechnical analysis carried out at the site of the above captioned development located approximately 7 kilometres south of Lumsden, Saskatchewan. It is understood that the proposed development consists of an 18 hole golf course, a new club house and approximately 250 residential lots with associated infrastructure, including roadways, sewer and water and a new sewage lagoon. The residential areas will be developed in at least two (2) phases. The objectives of this investigation were to provide the following information:

.1 To define the subsurface soil stratigraphy and engineering properties of the soils at the location of the proposed sewage lagoon, club house and Phase I residential lots;

.2 To provide design recommendations for construction of the proposed sewage lagoon;

.3 To provide design recommendations for a lagoon lining system, if required;

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

.5 To provide design and installation recommendations for the most suitable and economical type of foundation system to support the proposed club house and residential buildings;

.6 To provide recommendations with regard to the type of cement to use for concrete in contact with native soils;

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

.8 To provide recommendations for pavement structure design for the roadways and parking lots;

.9 To comment on possible slope stability problems and provide recommendations for site development;

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

Authorization to proceed with this work was received verbally on January 20, 2000.

2.0 DESCRIPTION OF SITE

The study area shown in Figure 1 is located approximately 7 kilometres south of Lumsden along the Wascana Creek Valley. The south side of the property includes a flat area in the bottom of the valley which is the flood plain of Wascana Creek, a tributary of the Qu'Appelle River. There are numerous oxbows and meander scars located throughout the flood plain area. Wascana Creek is an underfit stream located within the limits of the flood

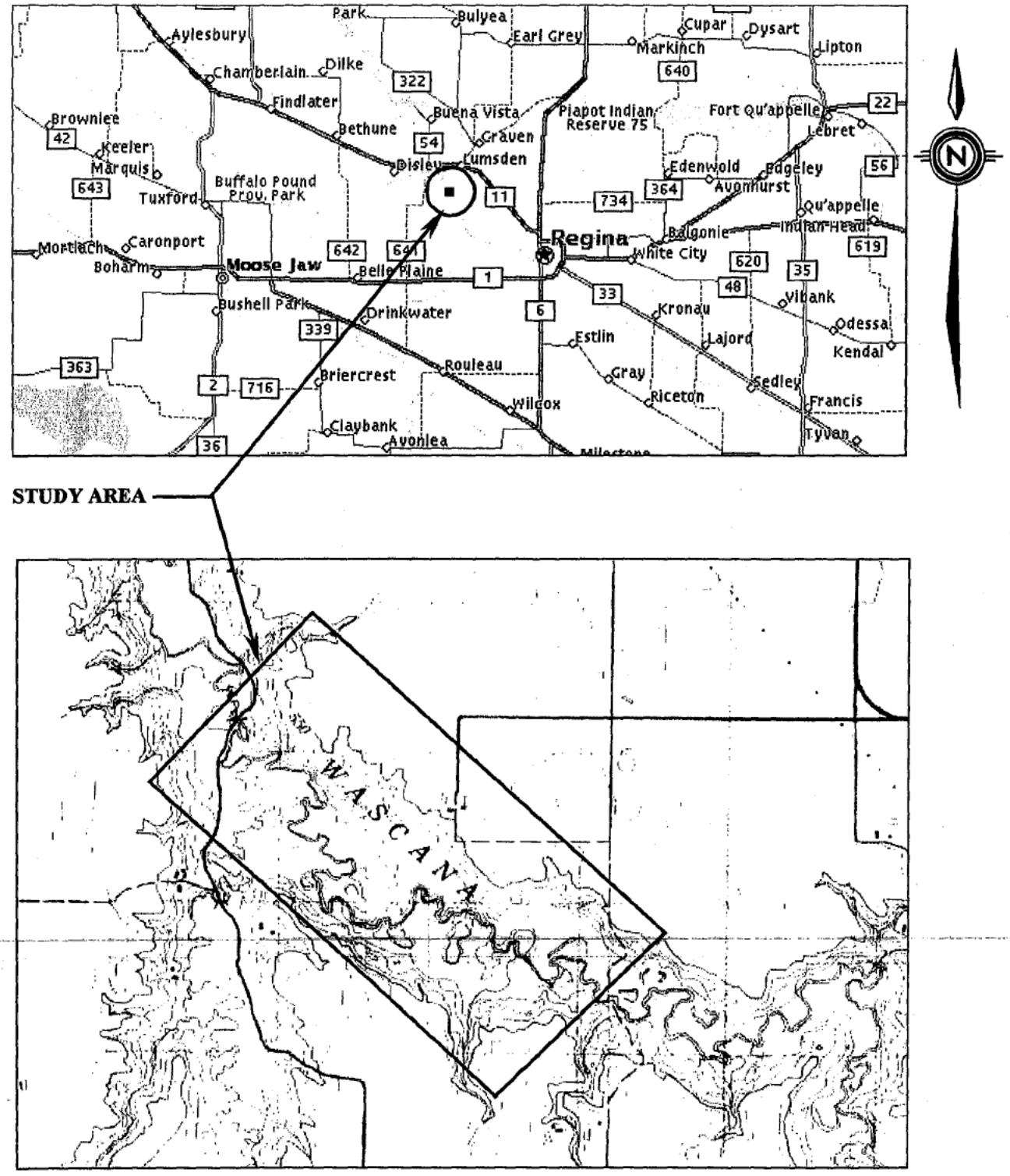


FIGURE 1

LOCATION OF STUDY AREA

plain. The north side of the property consists of a flat lacustrine plain at the top of the valley wall and the north valley wall overlooking Wascana Creek. This area of the Wascana Creek Valley shows some signs of landslide activity in the distant past. The valley wall is generally quite steep with densely vegetated steep sided ravines formed by erosion of the valley wall. There is an elevation difference of approximately 50 metres between the top of the valley wall and the flood plain.

The locations of the proposed sewage lagoon, club house and Phase I residential lots are shown on Drawing No. GE-0005-1A. The proposed sewage lagoon site is located in the flood plain at the south side of the property. The club house and a small residential area (four (4) lots) are located on the valley wall. The remainder of the residential lots are located above the valley wall within the glaciolacustrine plain. Some of these lots partially extend onto the top portion of the valley wall.

3.0 FIELD AND LABORATORY INVESTIGATION

The subsurface conditions were investigated by a total of 16 test holes which were drilled at the locations shown on Drawing No. GE-0005-1A. The test holes were drilled on February 17 and 18, 2000, using a truck-mounted, Brat 22 digger equipped with a 150 mm diameter continuous flight auger. The test holes were drilled to depths ranging from 6.1 to 21.3 metres below existing ground surface.

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, Standard Proctor density, sulphate content and unconfined compressive strength tests were performed on selected soil samples. Estimates of the undrained shear strength were made using both a pocket penetrometer and a laboratory vane shear apparatus. Hydraulic conductivity tests were conducted on remolded composite samples. Details of the soil profile, samples taken, laboratory test results and stratigraphic interpretations of the subsoils are presented on Drawing Nos. GE-0005-5 to -35, inclusive.

The ground surface elevations at the test hole locations are referenced to geodetic datum obtained from a topographic survey plan prepared by [redacted]

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 in this area is a glaciolacustrine plain. The glacial sediments which form the surficial geology in the study area consist of lacustrine clay, till, and outwash sands and gravel. The existing valley was carved out of the glaciolacustrine plain by glacial meltwater during the last deglaciation period. The valley has since been partially filled with alluvium which forms the flood plain of Wascana Creek. The underlying bedrock consists of Upper Cretaceous shale of the Bearpaw Formation.

4.2 Stratigraphy

The drilling information from Test Holes 101 to 105 (proposed lagoon site) indicates that the surficial topsoil is underlain by alluvial soils which extend to the maximum depth penetrated in the test holes (6.1 metres). The alluvium consists predominantly of a surficial layer of clayey silt which is underlain by layers of silty sand and sandy silt. A surficial layer of silty sand was encountered in Test Hole 101. These soils are normally consolidated and become saturated below depths ranging from 2.1 to 2.7 metres below existing ground surface elevations. Typical gradations of the alluvium are shown on Drawing Nos. GE-0005-24 to -27.

The drilling information from Test Holes 109 to 114 (proposed subdivision) indicates that the surficial topsoil is underlain by a silty clay stratigraphic unit which extends to the maximum depth penetrated in the test holes (6.1 metres). The clay is a highly plastic potentially active (swelling and shrinking) type of clay that is unsaturated. It is highly over consolidated due to desiccation and stiff to very stiff in consistency. The number of silt layers and silt content increases with depth. Atterberg Limits test results indicate that the clay has a Liquid Limit in the order of 65 percent and a Plasticity Index in the order of 45 percent.

Two (2) relatively deep test holes (Test Holes 115 and 116) were drilled on the valley wall where four (4) residential lots are proposed. The surficial topsoil is underlain by a till stratigraphic unit which extends to depths ranging from 6.4 to 7.8 metres below existing ground surface. 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. Lenses of highly plastic clay, sand and gravel were encountered in the till unit at this site. The till at this site is clayey, moist and very stiff to hard in consistency. It has undrained shear strengths in excess of 120 kPa based on vane shear and pocket penetrometer tests. Atterberg Limits test results indicate that the till has a Liquid Limit in the order of 35 percent and a Plasticity Index in the order of 20 percent which classifies it as a medium plastic material. The dry density of the till is in the order of 2.05 tonnes per cubic metre. The till is underlain by shale bedrock which extends to the maximum depth penetrated in the test holes (21.3 metres).

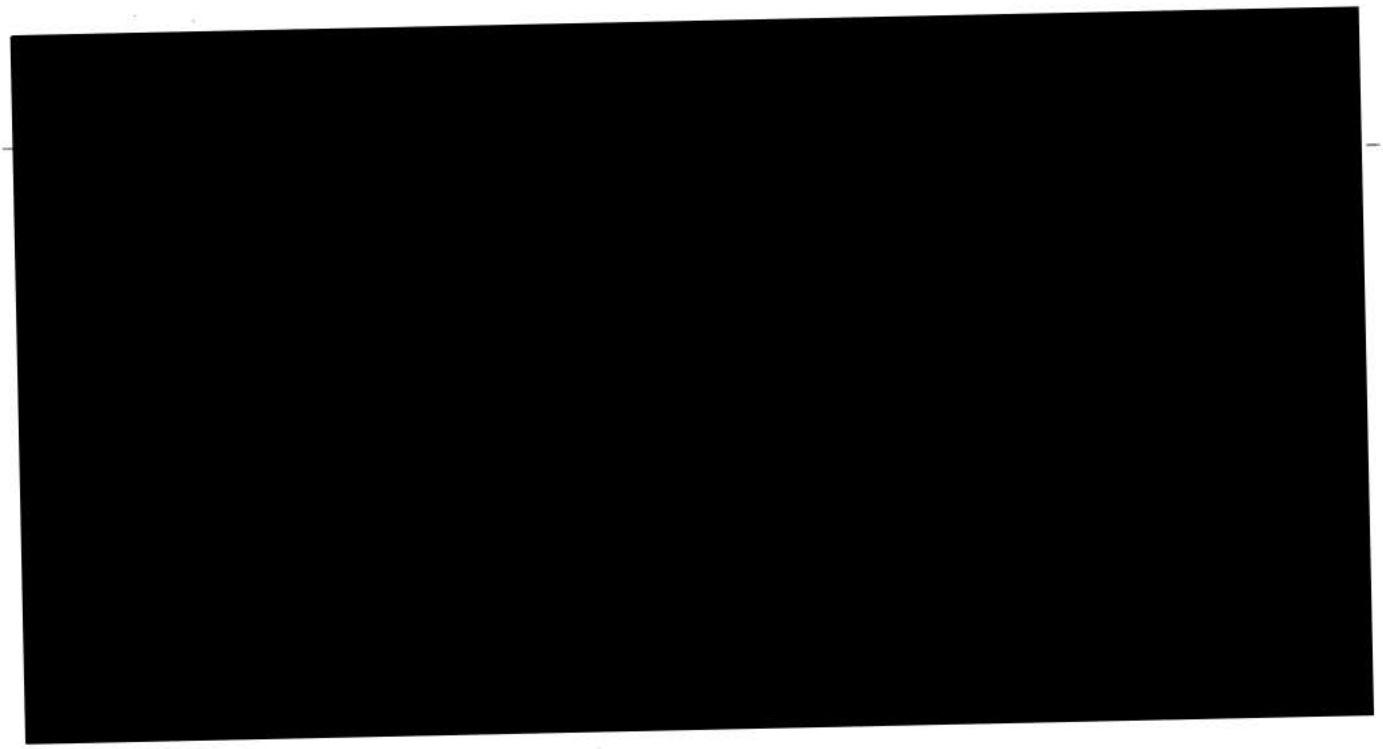
The drilling information from Test Holes 106 to 108 (proposed clubhouse site) indicates that the surficial topsoil is underlain by a till stratigraphic unit and shale bedrock of the Bearpaw Formation. The proposed building site is located on top of an old landslide slump block. Test Hole 107 is located at the top of the slump block where the surficial till unit extends to a depth of 3.7 metres. The till is underlain by the shale which extends to the maximum depth penetrated in the test holes (13.7 metres). 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 1.45 to 1.60 tonnes per cubic metre. Atterberg Limits test results indicate that the shale has a Liquid Limit ranging from 50 to 90 percent and a Plasticity Index ranging from 45 to 75 percent. The undrained shear strength varies from 145 to 530 kPa based on unconfined compression tests. The upper portion of the shale is weathered (oxidized) with prominent jointing and iron staining evident. The shale becomes unoxidized below depths ranging from 6.4 to 12.5 metres below existing ground surface. The weathered shale is weaker (more fractured) than the underlying unoxidized shale.

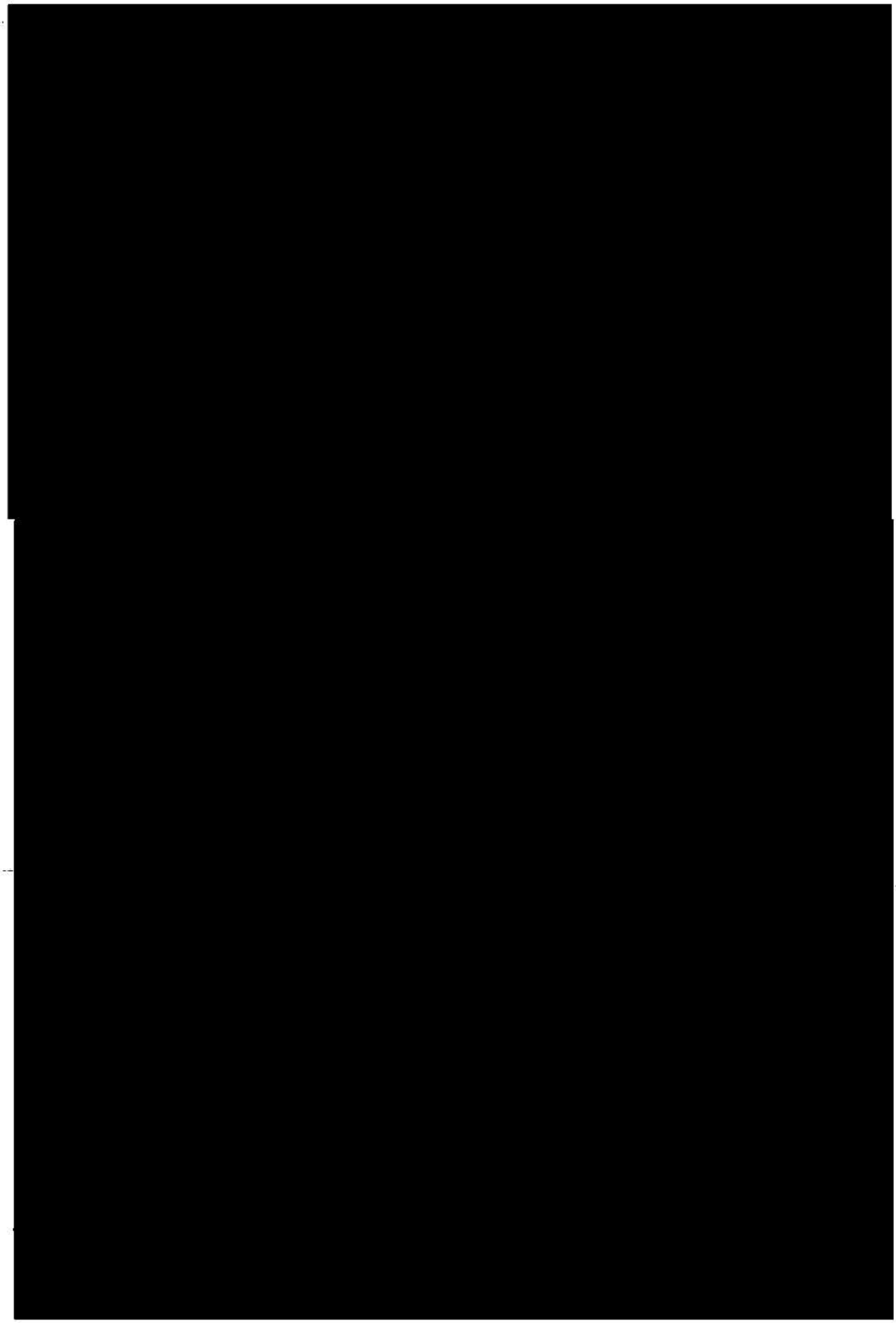
4.3 Groundwater

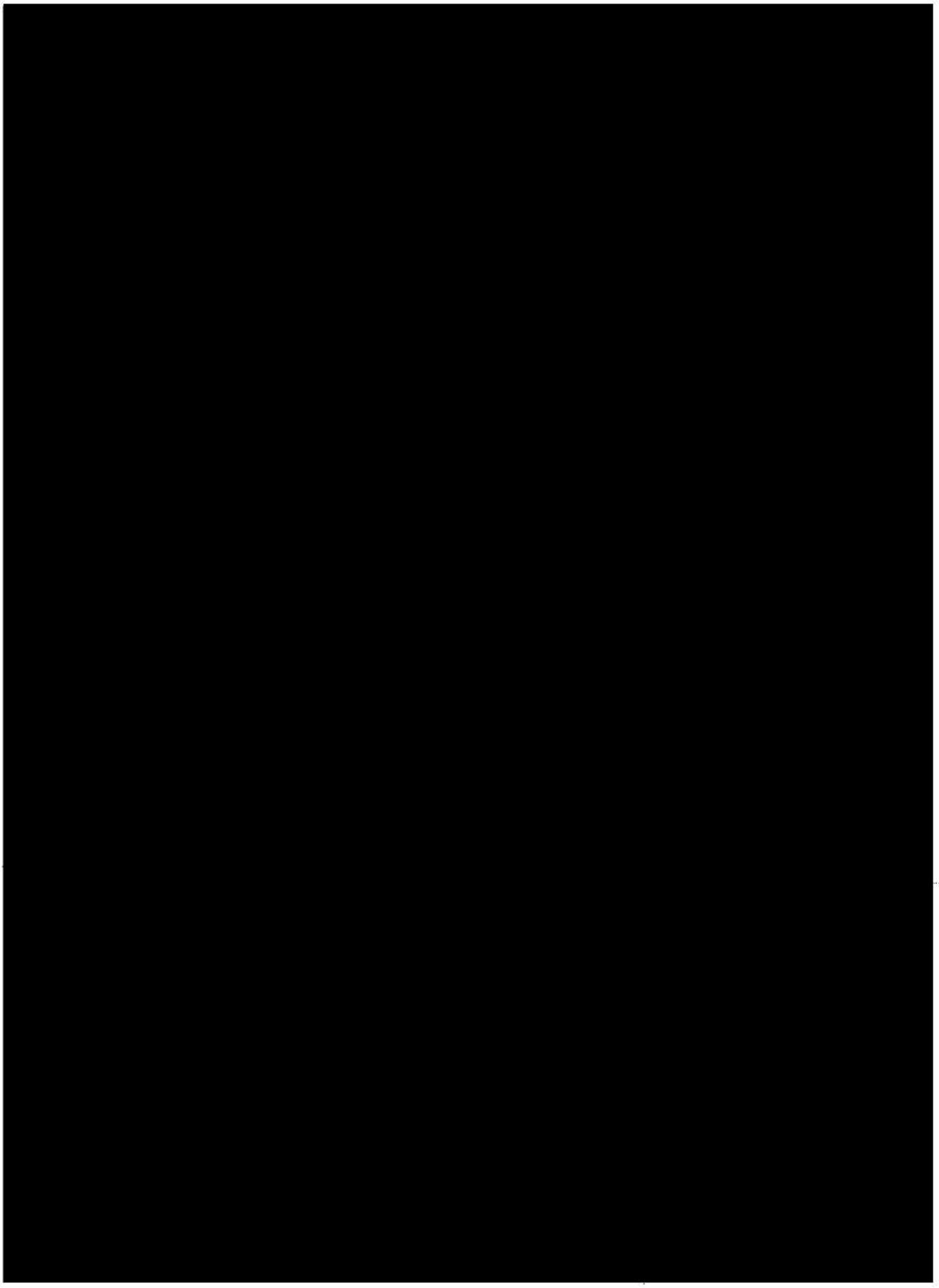
The drilling information indicates that there is a shallow groundwater table at the site of the proposed sewage lagoon (Test Holes 101 to 105). The alluvial deposits encountered in this area generally become saturated below depths ranging from 2.1 to 2.7 metres below existing grade. Test Holes 101 to 104 were left open for up to 20 minutes, after which, water levels were measured at depths ranging from 2.4 to 3.0 metres. Piezometers were not installed to monitor the long term groundwater levels, however, on the basis of the drilling information, the water levels measured at the time of the investigation are probably close to stabilized water levels. During periods of heavy rainfall or spring run-off, the water table within the flood plain could be considerably higher.

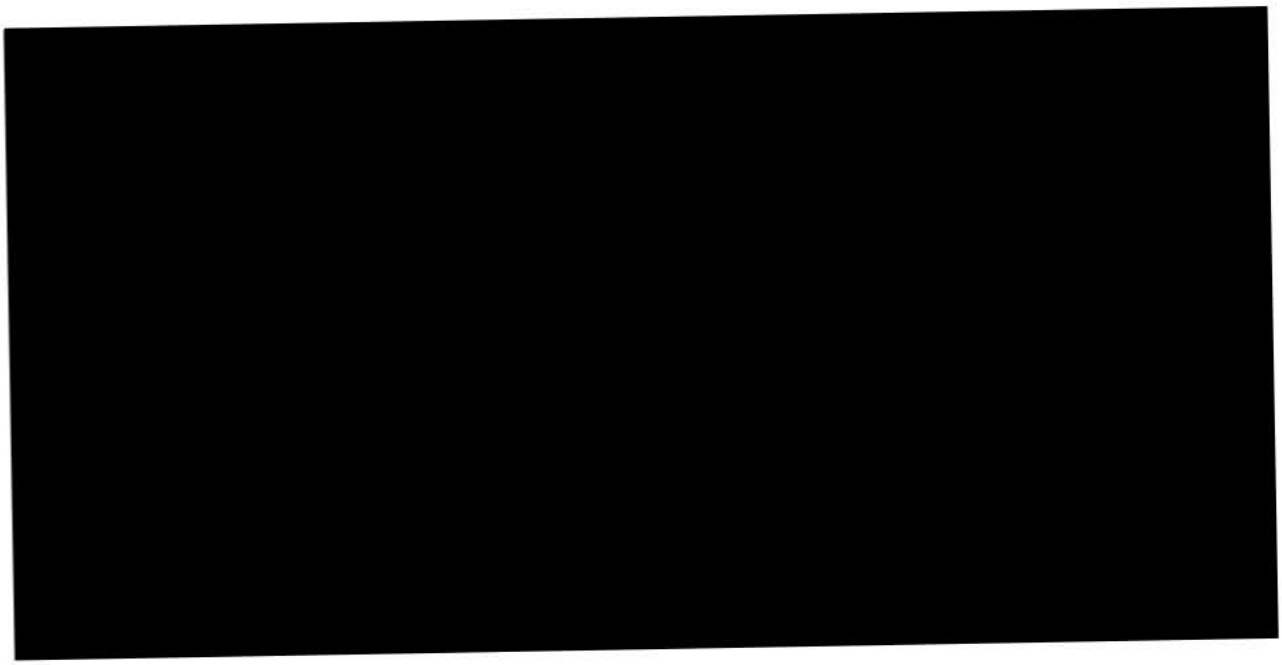
The till, clay and shale strata encountered in Test Holes 106 to 116 are generally moist. No seepage or sloughing was noted during drilling. There is the possibility that discontinuous sand and gravel lenses present in the till may be saturated in some areas. Piezometers were not installed to monitor the long term groundwater levels in these areas.

The ravines on the valley wall are densely vegetated which indicates that there may be a localized shallow water table in these areas due to springs or surface infiltration into the valley wall.









6.0 SLOPE STABILITY

In February, 2000, our Company conducted a geotechnical inspection of the subject property. The objective of the inspection was to provide a preliminary engineering opinion on the feasibility of the proposed development insofar as geotechnical considerations are concerned. The preliminary inspection concluded that the proposed development was considered feasible. A copy of our letter dated February 7, 2000, is included in Appendix A.

The following information supplements our preliminary assessment and is based on the information obtained from Test Holes 115 and 116 where residential lots are proposed on the valley wall.

6.1 Stratigraphy

The surficial glacial till is relatively competent, however, it is highly susceptible to erosion if the surficial vegetation is disturbed. The underlying shale bedrock may contain weak layers or bentonite beds which are highly susceptible to landslide movement. The elevation of the bedrock surface is shown on the stratigraphic cross section, Drawing No. GE-0005-7. The drawing shows that the bedrock surface slopes down towards the bottom of the valley.

6.2 History of Slope Movement

The valley in which Wascana Creek is situated 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 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 walls. The slumping activity has now subsided due to the deposition post glacial alluvium in the valley which has produced a buttressing effect, helping to stabilize the valley walls. At the present time, some areas of the valley wall are subject to instability due to erosion from Wascana Creek. The proposed lot locations on the valley wall are located in an area where no previous landsliding has occurred.

6.3 Topography

The topography of the valley wall varies considerably from a gradual slope (five (5) horizontal to one (1) vertical) to quite steep areas (one (1) horizontal to one (1) vertical). There is an elevation difference of approximately 50 metres from the top of the valley wall to the flood plain at the bottom of the valley. There are also numerous densely vegetated steep sided ravines which intersect the valley wall.

6.4 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 with time as more people move out to the valley.

At the time of our investigation, there was no groundwater encountered in the test holes drilled on the valley wall. The ravines on the valley wall are densely vegetated which indicates there may be a localized shallow water table in these areas due to springs or surface infiltration into the valley wall.

6.5 Time Effects

The bentonitic marine shale of the Bearpaw Formation which outcrops along the bottom of the valley wall is known to loose strength with time. This type of behaviour is unique to this type of soil. As a result, a slope which appears to be stable and has stood for long periods of time may suddenly be involved in large scale movements with no apparent explanation.

6.6 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 additional downslope 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 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.

7.0 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. At the present time, the valley wall is relatively stable and the probability of significant slope movements taking place in the future is considered to be low in most areas except where Wascana Creek is undercutting the toe of the slope. No visible signs of recent landslide activity are evident on the valley wall. Our analysis indicates that the factor of safety against sliding is approximately 1.25. The proposed lots in the area of Test Holes 115 and 116 are considered to be feasible from a geotechnical engineering standpoint provided development controls are implemented to minimize the risk of future landslides. 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 development at this time.

.1 The locations of the proposed residential lots and club house were obtained from [redacted] and are shown on Drawing No. GE-0005-1. Due to the steepness of the valley wall in some areas, a minimum setback distance of 5.0 metres is recommended from the edge of the valley wall to any new building structure. The areas where a set back is recommended are shown on Drawing No. GE-0005-1.

.2 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 so that only minor damage would occur 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 contact areas between slump blocks which were identified in our preliminary inspection are shown on Drawing No. GE-0005-1. The proposed building site for the club house will be located very close to a contact area between two (2) slump blocks. It is recommended that the final location of the club house be reviewed by a geotechnical engineer to ensure the building is constructed entirely on one (1) slump block.

.3 A bored concrete pile type foundation system is recommended for all buildings in this development.

.4 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.

.5 The valley walls are 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.

.6 Cuts and fills on the valley wall should be kept to a minimum and no cut or fill greater than 2.0 metres is recommended. The proposed clubhouse is located on top of a slump block which is situated near the bottom of the valley wall. It is understood that the top of the slump block will be cut to permit construction of the club house. A cut of up to 3.5 metres is permitted at this location. The excavated material may be used for the lagoon liner or as fill in other areas of the development.

.7 Embankments for roadway construction should be backsloped to a maximum slope of one (1) horizontal to two (2) vertical.

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

.9 All underground utilities (especially sewer and water) should be placed before any homes are constructed. The placement of the underground lines should be done as quickly as possible. Water and sewer lines should be designed and constructed for early leak detection and to minimize potential seepage into the valley wall.

8.0 FOUNDATION CONSIDERATIONS

Spread footings are not considered to be a suitable type of foundation system because of the presence of potentially active type clay subsoils encountered at this site. We recommend that the walls and columns of the proposed building structures be supported on a bored concrete pile type of foundation system which will transfer building loads below the active zone of seasonal moisture content changes. Our specific design recommendations for this type of foundation system are presented below:

.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 of 33.5 kPa (700 psf) based on the contact area between the pile surface and 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 400 mm to ensure that an adequate pile cross-section is maintained for the full drilled depth. A minimum pile length of six (6) metres is also recommended. For residential buildings, the minimum pile diameter may be reduced to 300 mm.

.3 On the basis of the drilling information, temporary sleeves should not be required to construct bored concrete piles at this site. However, it is recommended that the steel

reinforcement and concrete be placed as soon as possible after the pile hole is excavated in order to minimize the potential for sloughing into the bottom of the pile excavations.

.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. If the pile shafts carry significant bending moments, the shaft should be reinforced with vertical reinforcement composing about 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 Spandrel grade beams should be reinforced continuously at both top and bottom to resist possible negative bending stresses at mid span. To eliminate the possibility of upheaval, the grade beams should be constructed with a minimum 100 mm void space underneath to prevent contact with the underlying soil.

.7 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 on the valley wall and on the top of the valley will be in the surficial glacial deposits and shale bedrock. Conventional excavation procedures should therefore be applicable to the soils in these areas. These undisturbed soils should remain stable at near

vertical side slopes for short periods of time. Piling Contractors should be aware that minor difficulties may be encountered due to cobblestones and boulders in the till.

Excavations within the flood plain will be in the surficial alluvial deposits. Excavations should have side slopes cut back at an inclination of one (1) vertical to one (1) horizontal to minimize soil sloughing problems. Contractors should be aware that dewatering may be required for any excavation extending below a depth of about 1.5 metres below existing grade.

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 FLOOR SLAB CONSIDERATIONS

The surficial highly plastic clay soil at this site will swell over the long term as soil moisture is gradually drawn upwards by capillary action. In the case of grade supported concrete slabs, differential movements could be as high as 50 to 100 mm at this site. In this regard, a structural floor system would be the more desirable alternative insofar as overcoming the problems associated with differential movement of the floor slab. Alternatively, if some differential movement can be tolerated, the floor may be constructed as a grade supported slab on a prepared subgrade and granular base. The following recommendations are provided for both types of floor systems.

10.1 Structurally Supported Floor Systems

With the presence of a highly plastic clay subgrade, 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 Dual Polycrepe vapour barrier which is pressed down with 50 mm of sand to reduce the humidity in the crawl space and prevent drying of the subgrade soils. If the subgrade is not protected and the clay is

allowed to dry out and shrink, there is a potential for a reduction in the carrying capacity of friction type piles in the long term.

.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 in the summer months.

10.2 Grade Supported Floor Slabs

In opting for a grade supported slab, the Owner must accept some risk. At this site, the risk is present because of the potentially active clay subgrade. The following recommendations are given in an attempt to minimize differential movement of the floor slab.

.1 The subgrade under a grade supported slab should be as uniform as possible. The surficial topsoil should be stripped from the site. The exposed subgrade should be compacted with a vibratory sheepsfoot or padfoot roller to 95% Standard Proctor density. Any soft or spongy areas should be excavated and filled with compacted granular material. A well graded pit run sand (Type 10) compacted to 95% Standard Proctor density is suitable for this purpose. Excessive compaction of the clay subgrade is not recommended because this will increase the swell potential of the clay. The clay subgrade should be at or preferably 1% to 2% above its optimum moisture content.

In order to achieve this moisture content, moisture conditioning will likely be required. The final 200 mm below underside of the floor slab should be a well graded granular base course (Type 33) compacted to a minimum of 98% Standard

Proctor Density. Specifications for granular fill materials are included in Appendix B.

.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. If relatively heavy floor loads are anticipated, the floor should be designed according to the design chart shown on Drawing No. GE-0005-36.

.3 It is recommended that the grade supported concrete slabs be designed as floating slabs, completely independent of the foundation walls and/or columns. Isolation joints should be provided at columns and walls to separate the grade supported floor slabs from any connection with the building or appurtenances. It is assumed that the floor slab will possess sufficient rigidity to distribute the loading across the floor slab. The floor slab must be stiff enough to distribute the contact stresses and yet strong enough to resist resulting moments. A generous amount of reinforcing running both ways on the top and bottom of the slab is desirable. Control joints (sawn or premolded) are recommended at a maximum spacing of about 6 to 10 metres.

.4 A vapour barrier should be placed between the granular base and the concrete slab to deter the migration of moisture through the floor.

11.0 PAVEMENT STRUCTURE

The following recommendations are provided for the design and construction of pavement structures at this site.

.1 The pavement should be designed to slope in order to provide adequate drainage of water away from the perimeter of the buildings and from the surface of paved areas. The need for adequate drainage cannot be overstressed. To ensure fast runoff, the surface of the pavement should have a slope of at least two (2) percent, either to the outer perimeter of the paved areas, or to suitably located catch basins leading to

underground drains. The contour of the finished pavement at all points should prevent water from standing on the surface, and surface water should not be permitted to seep back under the outer edges of the pavement. Subsurface drains should be installed in locations where subsurface water may accumulate within the pavement structure or where it is necessary to intercept water that would tend to make its way into the pavement structure.

.2 The subgrade in the roadways and parking areas should be treated in much the same manner as the subgrade under a grade supported floor slab. The subgrade should be compacted at optimum moisture content plus or minus 2% with a vibratory sheepsfoot or padfoot type compactor. Any soft or spongy areas should be replaced with granular material before placing the base or subbase.

.3 Pavement structures have been analyzed for heavy truck loading, i.e. 34,000 pound tandem axles, and for light service areas such as parking lots for automobiles. These are given in Table 3, below.

TABLE 3

RECOMMENDED PAVEMENT STRUCTURES

	ASPHALT CONCRETE SURFACE COURSE (mm)	BASE COURSE THICKNESS (mm)	SUBBASE THICKNESS (mm)
Heavy Structure	100	150	300
Light Structure	50	150	150

.4 The thicknesses given are for the total required structure.

.5 Suggested specifications for asphaltic concrete and base course materials are included in Appendix B.

12.0 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 0.32 to 0.63 percent by dry soil weight. Class 2 concrete, with Type 50 cement as specified in the Guide for Use of Sulphate Resistant Cement on Drawing No. GE-0005-37, is recommended for use for all concrete in contact with the native soil.

.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 [redacted] and is intended for the specific application to the design and construction of the sewage lagoon, club house and Phase I residential subdivision for the proposed [redacted] 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.

Prepared by: [redacted]

Reviewed by: [redacted]

[redacted]

Distribution: [redacted]
UMA Engineering Ltd. (1 copy)
sh091 Office (1 copy)

DRAWINGS

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

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

(Unified Soil Classification System)

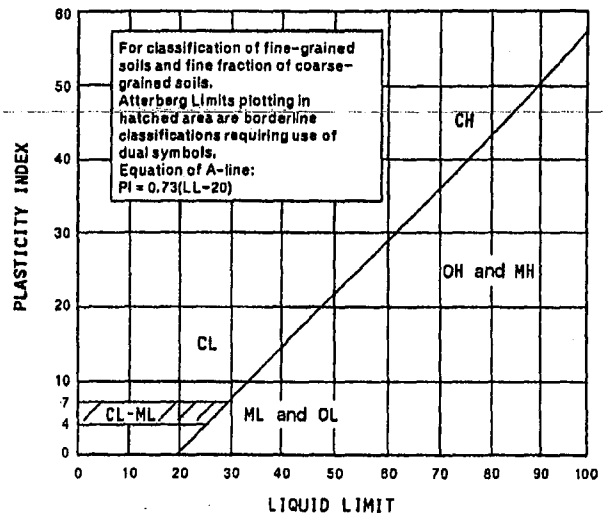
Major Divisions			Group Symbols	Typical Names	Classification Criteria
Coarse-grained soils: More than 50% retained on No. 200 sieve *	Gravels: 50% or more of coarse fraction retained on No. 4 sieve	Clean gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ 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

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

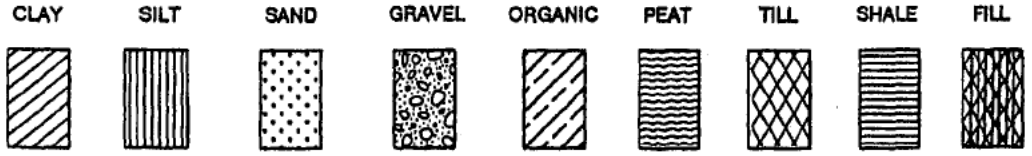
Major Divisions			Group Symbols	Typical Names
Fine-grained soils: 50% or more passes No. 200 sieve *	Silts and clays: Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty 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

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.

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.

CLIENT: [redacted]

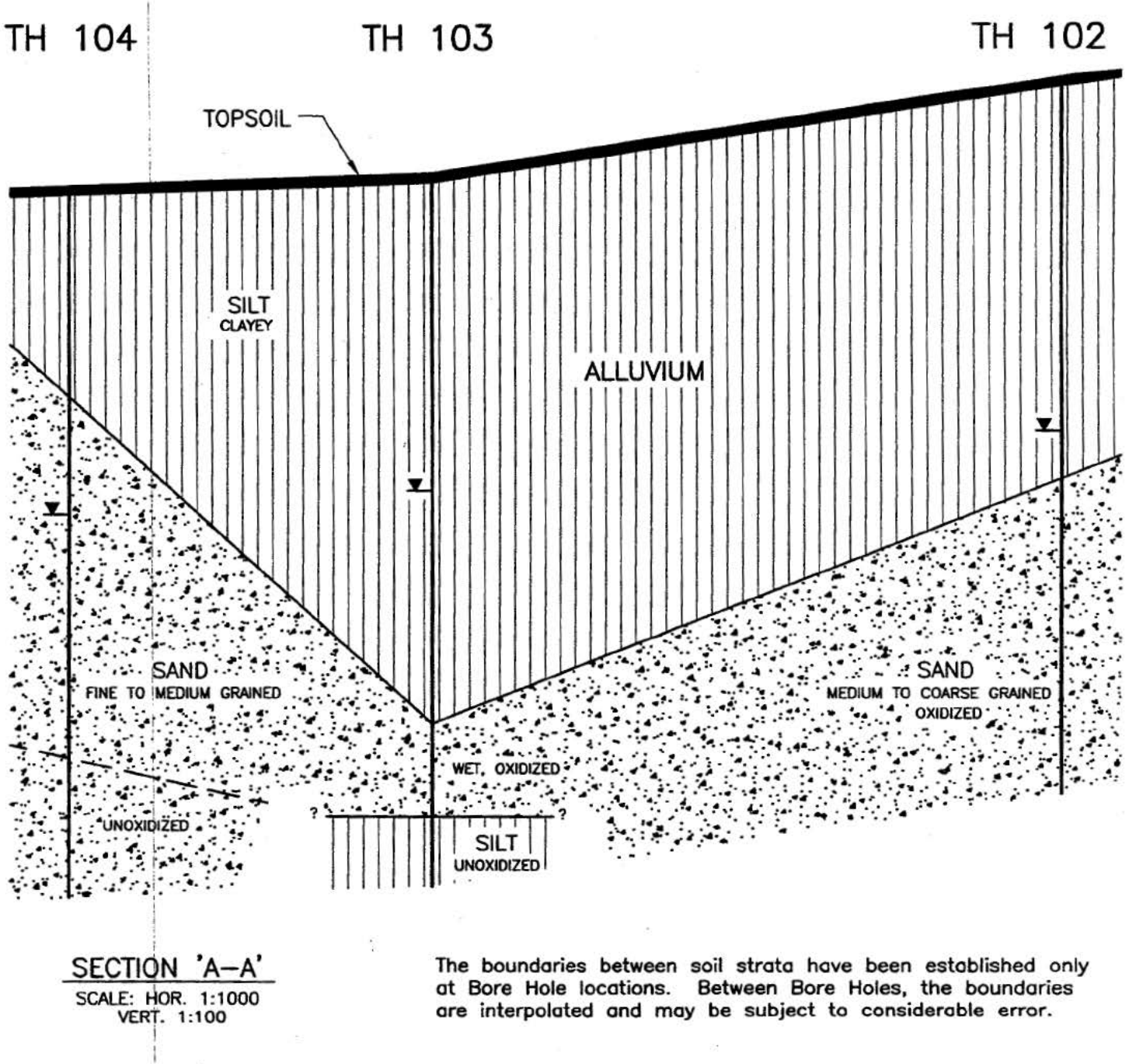
GROUND ENGINEERING LTD.
CONSULTING GEOENVIRONMENTAL ENGINEERS
REGINA, SASKATCHEWAN

APPROVED:

DATE: APRIL 25, 2000

DWG. No.: GE-0005-5

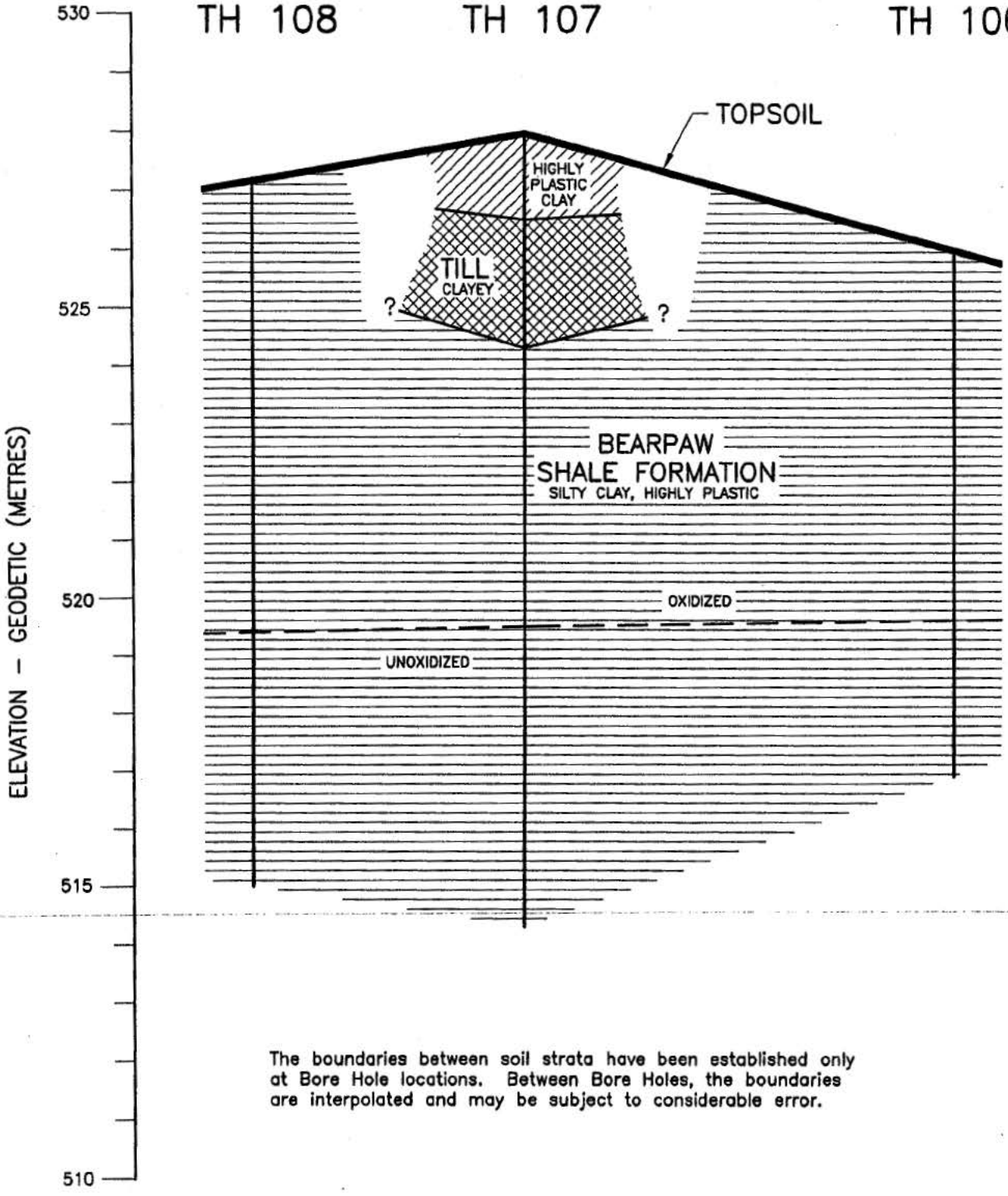
STRATIGRAPHIC CROSS SECTION 'A-A'
PROPOSED SUBDIVISION AND GOLF COURSE
SECTIONS 7 & 8 19-21-W2M
WASCANA CREEK VALLEY, SASKATCHEWAN



SECTION 'A-A'

SCALE: HOR. 1:1000
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.



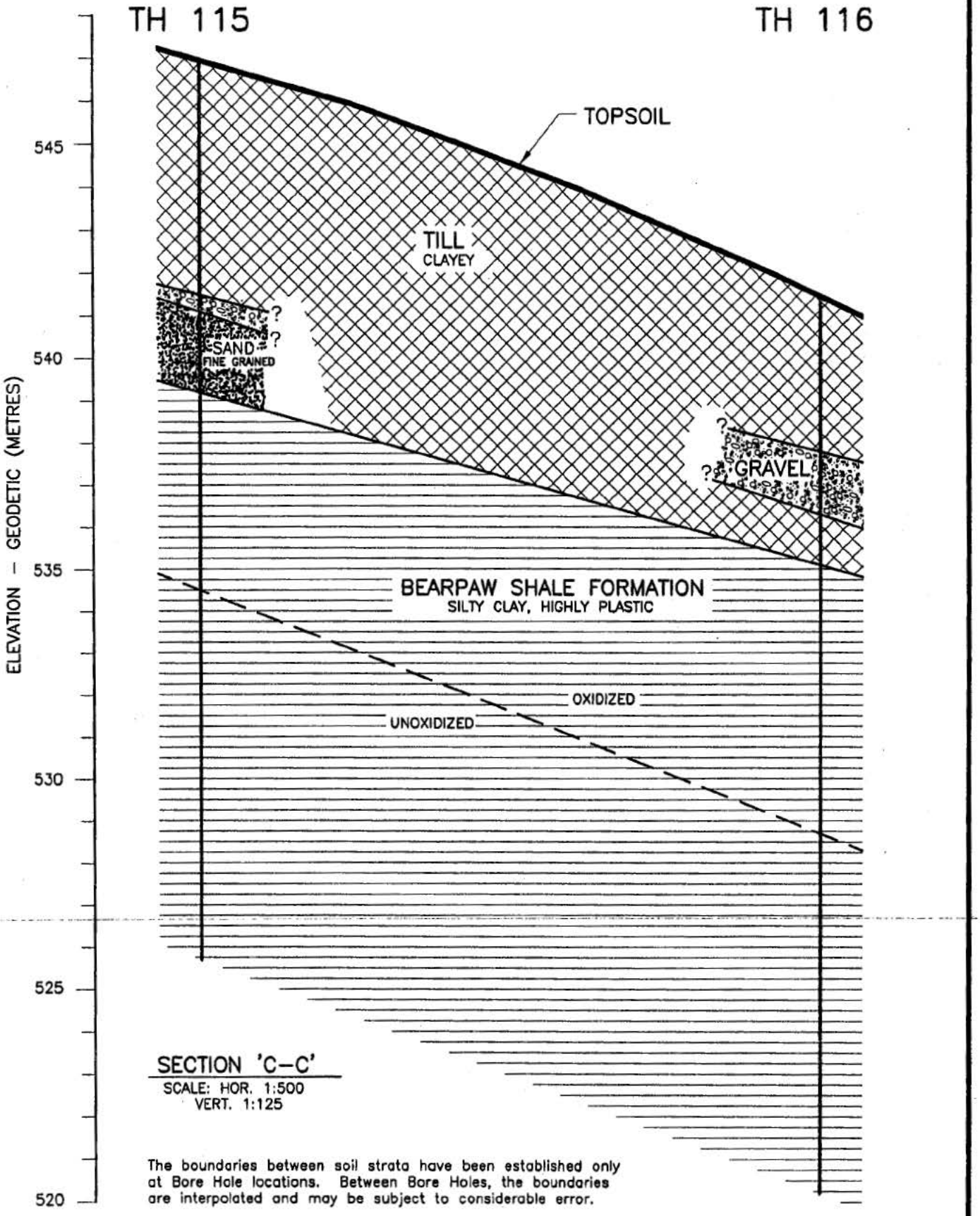
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes, the boundaries are interpolated and may be subject to considerable error.

GROUND ENGINEERING LTD.
CONSULTING GEOENVIRONMENTAL ENGINEERS
REGINA, SASKATCHEWAN

STRATIGRAPHIC CROSS SECTION 'B-B'
PROPOSED SUBDIVISION AND GOLF COURSE
SECTIONS 7 & 8 19-21-W2M
WASCANA CREEK VALLEY, SASKATCHEWAN

CLIENT:	APPROVED:	DATE:	DWG. No.:
[redacted]		APRIL 25, 2000	GE-0005-6

ARCHIVE: GE-2000-FILES\GE-0005\0005-6-CROSS-SECTIONS.DWG



SECTION 'C–C'

SCALE: HOR. 1:500
VERT. 1:125

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

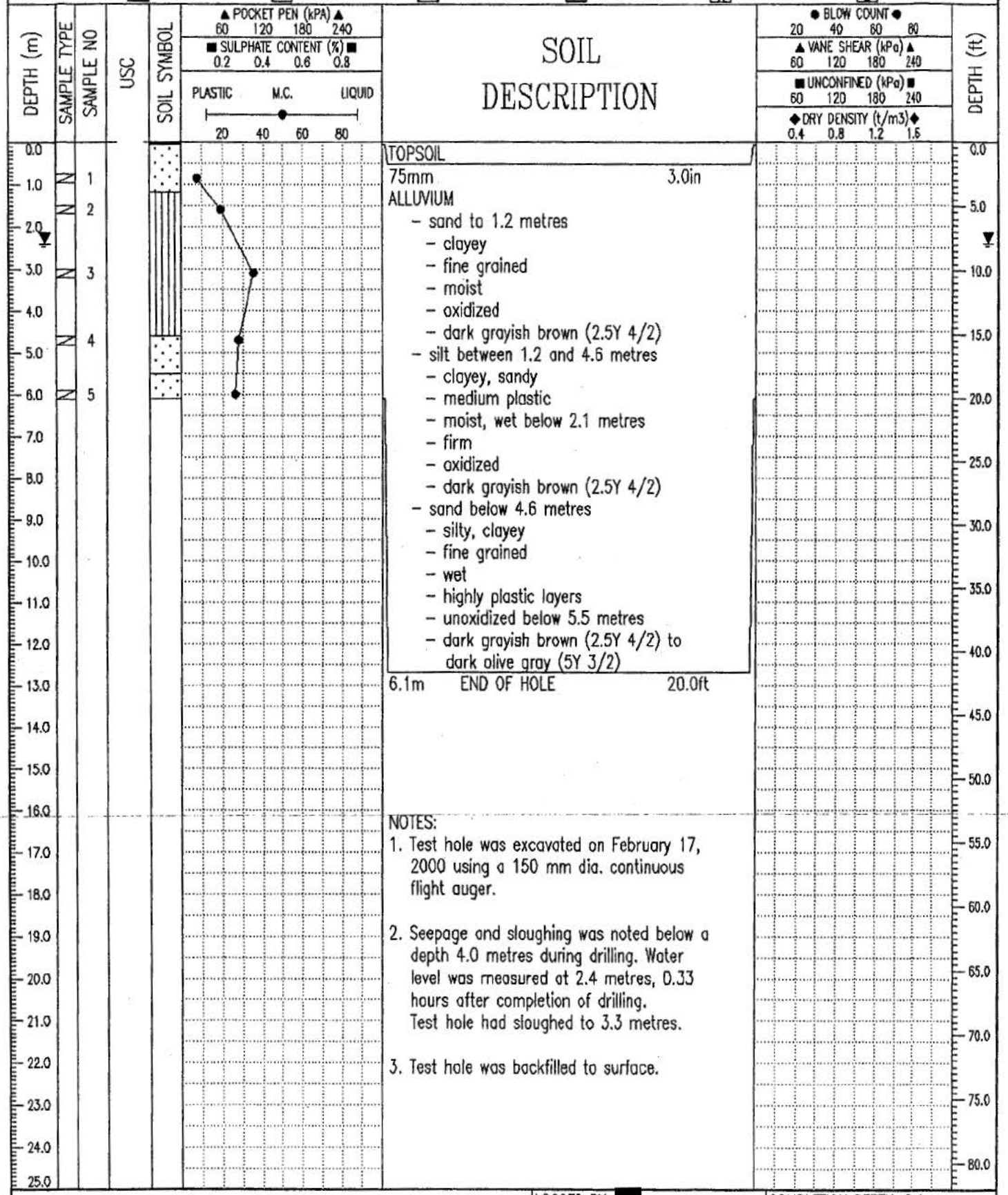
STRATIGRAPHIC CROSS SECTION 'C–C'
PROPOSED SUBDIVISION AND GOLF COURSE
SECTION 7 & 8–19–21–W2M
WASCANA CREEK VALLEY, SASKATCHEWAN

CLIENT:	APPROVED:	DATE:	DWG. No.:
[redacted]		APRIL 25, 2000	GE–0005–7

ARCHIVE GE-2000\FILES\GE-0005\0005-7-CROSS-SECTIONS.DWG

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8, 19-21-W2M	TEST HOLE NO: 0005-TH101
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 512.40 metres (GEODETIC)	ELEVATION: 512.40 (m)

SAMPLE TYPE: ■ SHELBY TUBE ⊘ DISTURBED ⊠ SPT SAMPLE ☰ PAIL SAMPLE ▯ NO RECOVERY ▮ JAR SAMPLE



TOPSOIL
75mm 3.0in
ALLUVIUM
- sand to 1.2 metres
  - clayey
  - fine grained
  - moist
  - oxidized
  - dark grayish brown (2.5Y 4/2)
- silt between 1.2 and 4.6 metres
  - clayey, sandy
  - medium plastic
  - moist, wet below 2.1 metres
  - firm
  - oxidized
  - dark grayish brown (2.5Y 4/2)
- sand below 4.6 metres
  - silty, clayey
  - fine grained
  - wet
  - highly plastic layers
  - unoxidized below 5.5 metres
  - dark grayish brown (2.5Y 4/2) to dark olive gray (5Y 3/2)

6.1m END OF HOLE 20.0ft

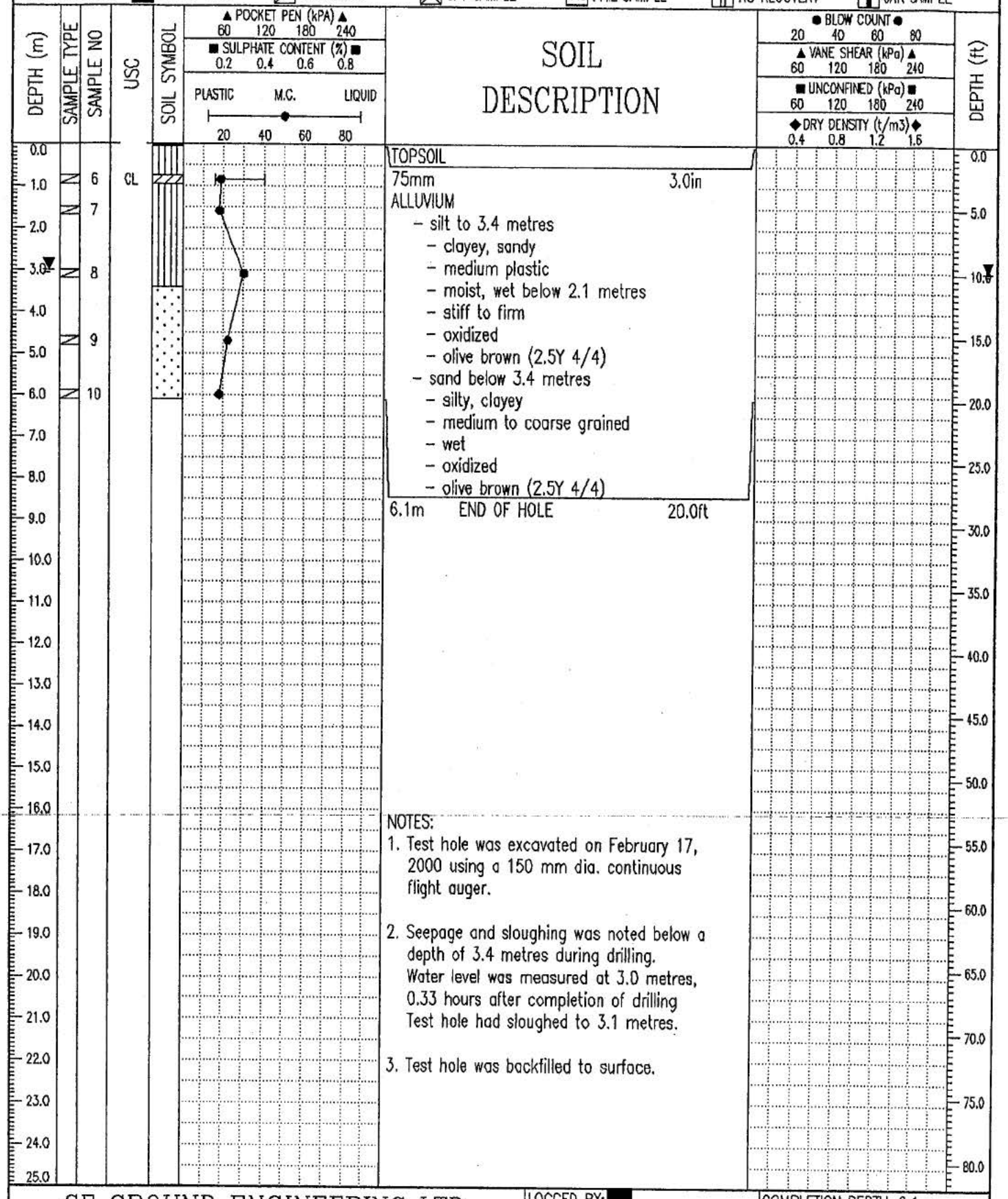
NOTES:
1. Test hole was excavated on February 17, 2000 using a 150 mm dia. continuous flight auger.
2. Seepage and sloughing was noted below a depth 4.0 metres during drilling. Water level was measured at 2.4 metres, 0.33 hours after completion of drilling. Test hole had sloughed to 3.3 metres.
3. Test hole was backfilled to surface.

GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: [redacted]	COMPLETION DEPTH: 6.1 m
	REVIEWED BY: [redacted]	COMPLETE: 00/02/17
	Fig. No: GE-0005-8	Page 1 of 1

08/08/11 04:37PM

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH102
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 512.40 metres (GEODETIC)	ELEVATION: 512.40 (m)

SAMPLE TYPE: ■ SHELBY TUBE ⧄ DISTURBED ⊠ SPT SAMPLE ▤ PAIL SAMPLE ▥ NO RECOVERY ▮ JAR SAMPLE



NOTES:

1. Test hole was excavated on February 17, 2000 using a 150 mm dia. continuous flight auger.
2. Seepage and sloughing was noted below a depth of 3.4 metres during drilling. Water level was measured at 3.0 metres, 0.33 hours after completion of drilling Test hole had sloughed to 3.1 metres.
3. Test hole was backfilled to surface.

GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: ■	COMPLETION DEPTH: 6.1 m
	REVIEWED BY: ■	COMPLETE: 00/02/17
	Fig. No: GE-0005-9	Page 1 of 1

08/09/11 04:38PM

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH103
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 511.60 metres (GEODETIC)	ELEVATION: 511.60 (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	DEPTH (ft)
0.0						TOPSOIL		0.0
1.0	N	11	CL			75mm 3.0in		5.0
2.0	N	12				ALLUVIUM		
3.0	N	13				– silt to 4.7 metres		10.0
4.0						– clayey, sandy		
5.0	N	14				– moist, wet below 2.4 metres		15.0
6.0	N	15				– firm		20.0
7.0						– medium plastic		
8.0						– oxidized, iron stains		25.0
9.0						– olive brown (2.5Y 4/4)		30.0
10.0						– sand between 4.7 and 5.5 metres		
11.0						– silty		35.0
12.0						– fine to medium grained		40.0
13.0						– wet		
14.0						– oxidized		45.0
15.0						– olive brown (2.5Y 4/4)		50.0
16.0						– silt below 5.5 metres		
17.0						– sandy		55.0
18.0						– wet, firm		60.0
19.0						– organics		
20.0						– unoxidized		65.0
21.0						– very dark gray (5Y 3/1)		70.0
22.0						6.1m END OF HOLE 20.0ft		
23.0								75.0
24.0								
25.0								80.0

NOTES:

1. Test hole was excavated on February 17, 2000 using a 150 mm dia. continuous flight auger.
2. Seepage and sloughing was noted below a depth of 3.0 metres during drilling. Water level was measured at 2.7 metres, 0.16 hours after completion of drilling Test hole had sloughed to 3.0 metres.
3. Test hole was backfilled to surface.

GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: [redacted]	COMPLETION DEPTH: 6.1 m
	REVIEWED BY: [redacted]	COMPLETE: 00/02/17
	Fig. No: GE-0005-10	Page 1 of 1

08/09/11 04:38PM

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH104
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 511.50 metres (GEODETIC)	ELEVATION: 511.50 (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	DEPTH (ft)
0.0						TOPSOIL		0.0
						75mm 3.0in		
1.0	N	16				ALLUVIUM		5.0
2.0	N	17				– silt to 1.8 metres		
						– clayey		
3.0	N	18				– trace amounts of sand		10.0
4.0						– moist, firm to stiff		
						– medium plastic		15.0
5.0	N	19				– oxidized		
						– salt crystals		
6.0	N	20				– dark grayish brown (2.5Y 4/2)		20.0
7.0						– sand below 1.8 metres		
						– silty, clayey		25.0
8.0						– fine to medium grained		
						– moist, wet below 2.7 metres		
9.0						– unoxidized below 4.9 metres		30.0
						– gravel lenses below 3.7 metres		
10.0						– olive brown (2.5Y 4/4)		
						6.1m END OF HOLE 20.0ft		35.0
11.0								
12.0								40.0
13.0								
14.0								45.0
15.0								
16.0								50.0
17.0								55.0
18.0								
19.0								60.0
20.0								65.0
21.0								
22.0								70.0
23.0								75.0
24.0								
25.0								80.0

NOTES:

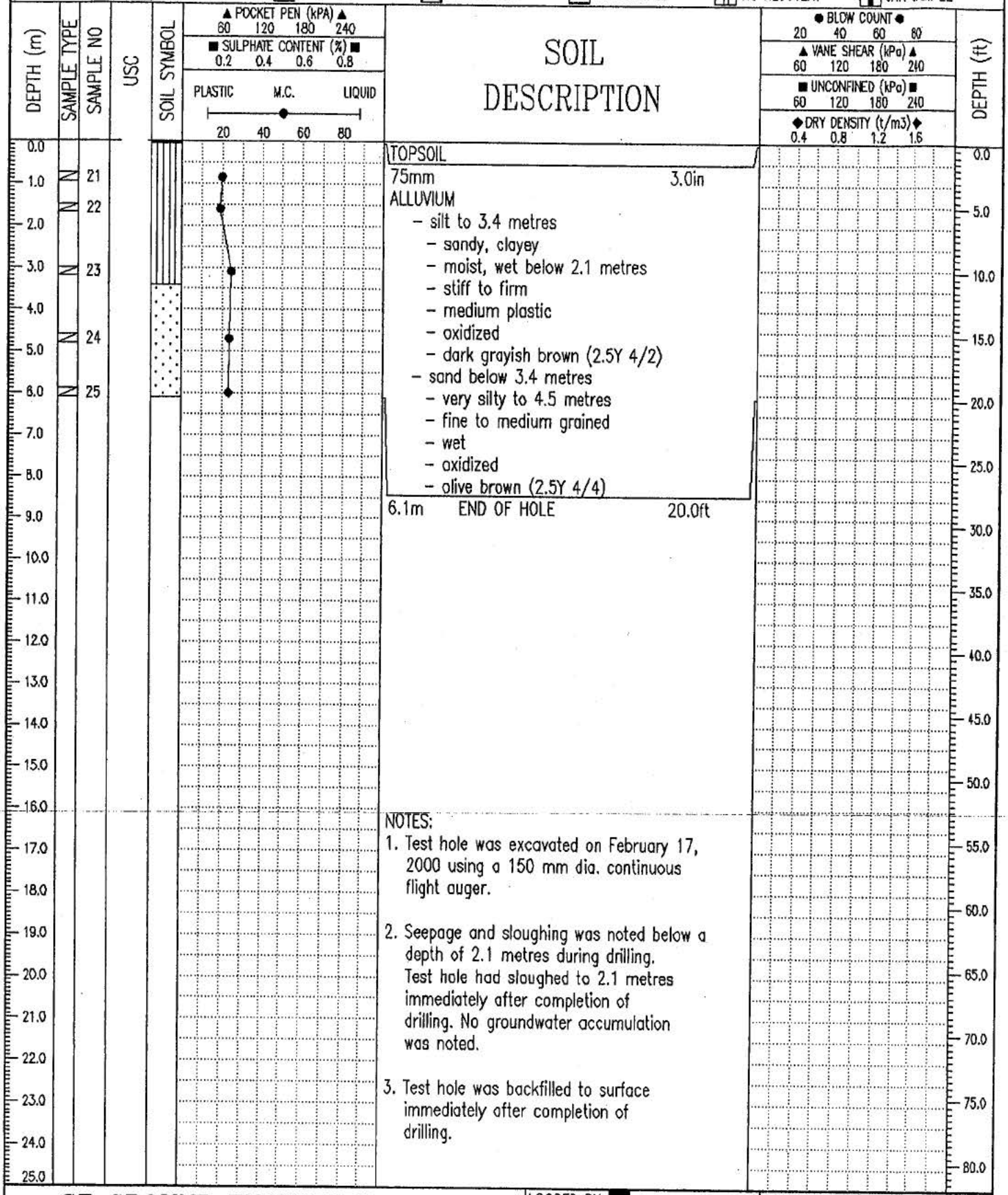
1. Test hole was excavated on February 17, 2000 using a 150 mm dia. continuous flight auger.
2. Seepaeg and sloughing was noted below a depth of 2.9 metres during drilling. Water level was measured at 2.8 metres, 0.25 hours after completion of drilling Test hole had sloughed to 2.9 metres.
3. Test hole was backfilled to surface.

GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: [redacted]	COMPLETION DEPTH: 6.1 m
	REVIEWED BY: [redacted]	COMPLETE: 00/02/17
	Fig. No: GE-0005-11	Page 1 of 1

08/08/11 04:39PM

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH105
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 512.00 metres (GEODETIC)	ELEVATION: 512.00 (m)

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



TOPSOIL
75mm 3.0in
ALLUVIUM
- silt to 3.4 metres
  - sandy, clayey
  - moist, wet below 2.1 metres
  - stiff to firm
  - medium plastic
  - oxidized
  - dark grayish brown (2.5Y 4/2)
- sand below 3.4 metres
  - very silty to 4.5 metres
  - fine to medium grained
  - wet
  - oxidized
  - olive brown (2.5Y 4/4)

6.1m END OF HOLE 20.0ft

NOTES:
1. Test hole was excavated on February 17, 2000 using a 150 mm dia. continuous flight auger.
2. Seepage and sloughing was noted below a depth of 2.1 metres during drilling. Test hole had sloughed to 2.1 metres immediately after completion of drilling. No groundwater accumulation was noted.
3. Test hole was backfilled to surface immediately after completion of drilling.

GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: [redacted]	COMPLETION DEPTH: 6.1 m
	REVIEWED BY: [redacted]	COMPLETE: 00/02/17
	Fig. No: GE-0005-12	Page 1 of 1

08/09/11 04:39PM

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH106
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 526.00 metres (GEODETIC)	ELEVATION: 526.00 (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	DEPTH (ft)
0.0						TOPSOIL		0.0
1.0	N	26	---			75mm 3.0in		
2.0	N	27	CH			BEARPAW SHALE – silty clay – highly plastic – non-calcareous – moist, stiff to very stiff – hard below 3.0 metres – silt lenses – iron stains – unoxidized below 6.4 metres – gypsum crystals – dark grayish brown (2.5Y 4/2) to very dark gray (5Y 3/1)		5.0
3.0		28						10.0
4.0								15.0
5.0	N	29						20.0
6.0	N	30						
7.0								25.0
8.0		31						
9.0	N	32	CH			9.1m END OF HOLE 30.0ft		30.0
10.0								35.0
11.0								
12.0								40.0
13.0								
14.0								45.0
15.0								50.0
16.0								
17.0						NOTES: 1. Test hole was excavated on February 17, 2000 using a 150 mm dia. continuous flight auger. 2. No seepage or sloughing was noted during drilling. 3. Test hole was backfilled to surface immediately after completion of drilling.		55.0
18.0								
19.0								60.0
20.0								65.0
21.0								70.0
22.0								
23.0								75.0
24.0								
25.0								80.0

GE GROUND ENGINEERING LTD.
Regina, Saskatchewan

LOGGED BY: [redacted]
REVIEWED BY: [redacted]
Fig. No: GE-0005-13

COMPLETION DEPTH: 9.1 m
COMPLETE: 00/02/17

08/09/11 04:39PM

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH107
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 528.00 metres (GEODETIC)	ELEVATION: 528.00 (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	DEPTH (ft)
0.0						TOPSOIL		0.0
1.0	N	33	CH			75mm 3.0in CLAY – silty, silt lenses – highly plastic – moist, stiff to very stiff – salt crystals – oxidized – dark grayish brown (2.5Y 4/2)		5.0
2.0	N	34						
3.0	N	35						10.0
4.0								
5.0		36				1.5m 5.0ft TILL – clayey, silty – moist, very stiff – oxidized, iron and manganese stains – salt crystals – olive brown (2.5Y 4/4)	◆	15.0
6.0	N	37	CH					20.0
7.0								
8.0	N	38				3.7m 12.0ft BEARPAW SHALE – silty clay – highly plastic – non-calcareous – moist, hard – unoxidized below 8.5 metres – gypsum crystals – dark grayish brown (2.5Y 4/2) to very dark gray (5Y 3/1)		25.0
9.0		39					■	30.0
10.0								
11.0	N	40						35.0
12.0	N	41						40.0
13.0								
14.0		42				13.7m END OF HOLE 45.0ft		45.0
15.0								50.0
16.0						NOTES: 1. Test hole was excavated on February 17, 2000 using a 150 mm dia. continuous flight auger. 2. No seepage or sloughing was noted during drilling. 3. Test hole was backfilled to surface immediately after completion of drilling.		
17.0								55.0
18.0								
19.0								60.0
20.0								65.0
21.0								70.0
22.0								
23.0								75.0
24.0								
25.0								80.0

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Regina, Saskatchewan

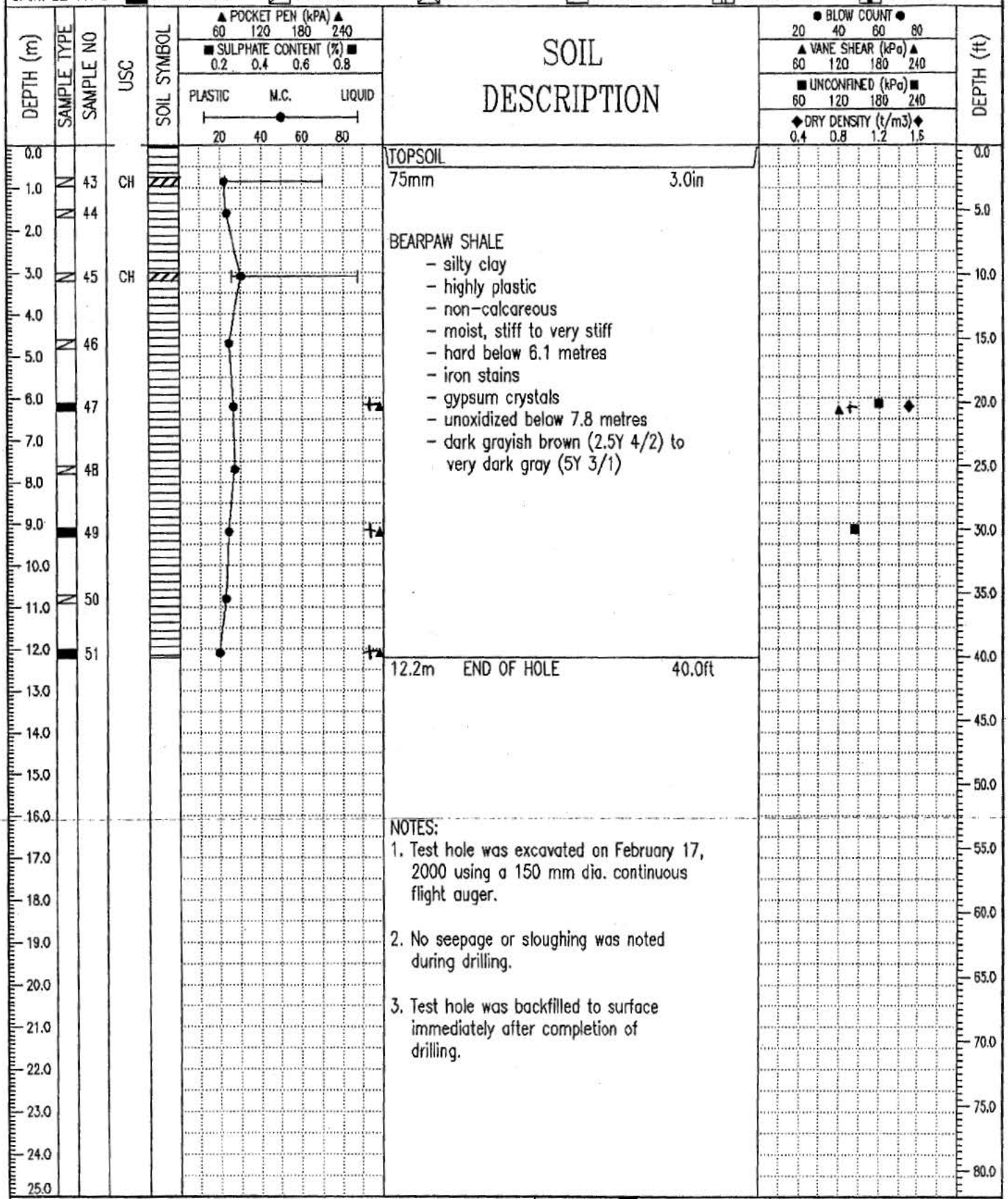
LOGGED BY: [redacted]
REVIEWED BY: [redacted]
Fig. No: GE-0005-14

COMPLETION DEPTH: 13.7 m
COMPLETE: 00/02/17

08/09/11 04:39PM

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH108
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 527.20 metres (GEODETIC)	ELEVATION: 527.20 (m)

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



TOPSOIL
75mm 3.0in

BEARPAW SHALE
- silty clay
- highly plastic
- non-calcareous
- moist, stiff to very stiff
- hard below 6.1 metres
- iron stains
- gypsum crystals
- unoxidized below 7.8 metres
- dark grayish brown (2.5Y 4/2) to very dark gray (5Y 3/1)

12.2m END OF HOLE 40.0ft

NOTES:
1. Test hole was excavated on February 17, 2000 using a 150 mm dia. continuous flight auger.
2. No seepage or sloughing was noted during drilling.
3. Test hole was backfilled to surface immediately after completion of drilling.

GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: [redacted]	COMPLETION DEPTH: 12.2 m
	REVIEWED BY: [redacted]	COMPLETE: 00/02/17
	Fig. No: GE-0005-15	Page 1 of 1

08/09/11 04:40PM

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH109
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 559.20 metres (GEODETIC)	ELEVATION: 559.20 (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	DEPTH (ft)
0.0						TOPSOIL		0.0
1.0	N	52	CH			75mm 3.0in		5.0
2.0	N	53				CLAY – silty, highly plastic – siltier with depth – moist, stiff to very stiff – silt layers – oxidized, iron stains – salt crystals – dark grayish brown (2.5Y 4/2)		10.0
3.0	N	54						15.0
4.0								
5.0	N	55						20.0
6.0	N	55A				6.1m END OF HOLE 20.0ft		25.0
7.0								30.0
8.0								35.0
9.0								40.0
10.0								45.0
11.0								50.0
12.0								55.0
13.0								60.0
14.0								65.0
15.0								70.0
16.0						NOTES: 1. Test hole was excavated on February 17 and 18, 2000 using a 150 mm dia. continuous flight auger. 2. No seepage or sloughing was noted during drilling. 3. Test hole was backfilled to surface immediately after completion of drilling.		75.0
17.0								80.0
18.0								
19.0								
20.0								
21.0								
22.0								
23.0								
24.0								
25.0								

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LOGGED BY: [redacted]	COMPLETION DEPTH: 6.1 m
REVIEWED BY: [redacted]	COMPLETE: 00/02/17
Fig. No: GE-0005-16	Page 1 of 1

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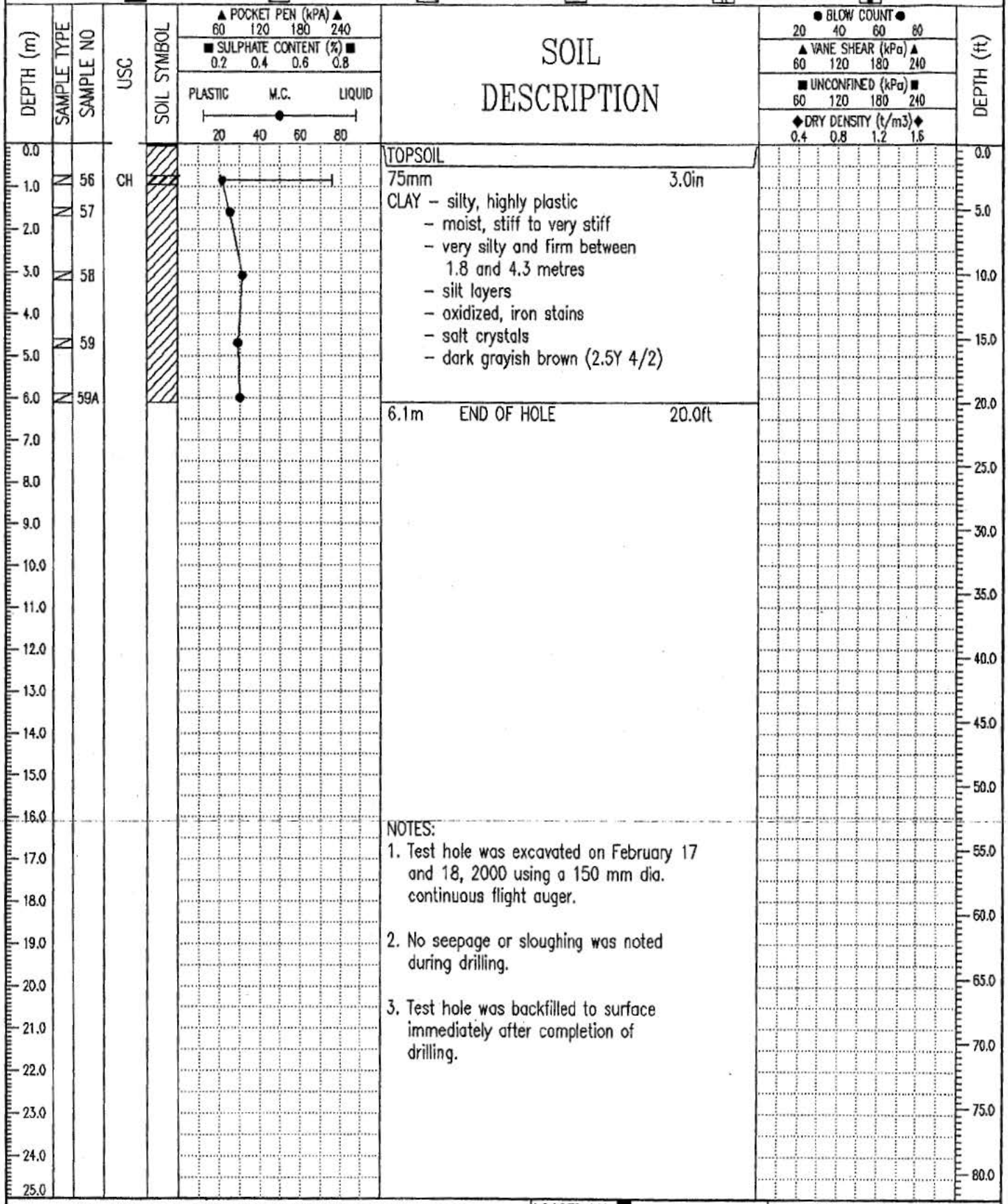
PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH110
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 558.50 metres (GEODETIC)	ELEVATION: 558.50 (m)

SAMPLE TYPE: ■ SHELBY TUBE ⧄ DISTURBED ☒ SPT SAMPLE ☰ PAIL SAMPLE ▯ NO RECOVERY ▮ JAR SAMPLE



TOPSOIL
75mm 3.0in

CLAY – silty, highly plastic
- moist, stiff to very stiff
- very silty and firm between 1.8 and 4.3 metres
- silt layers
- oxidized, iron stains
- salt crystals
- dark grayish brown (2.5Y 4/2)

6.1m END OF HOLE 20.0ft

NOTES:
1. Test hole was excavated on February 17 and 18, 2000 using a 150 mm dia. continuous flight auger.
2. No seepage or sloughing was noted during drilling.
3. Test hole was backfilled to surface immediately after completion of drilling.

GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: [redacted]	COMPLETION DEPTH: 6.1 m
	REVIEWED BY: [redacted]	COMPLETE: 00/02/17
	Fig. No: GE-0005-6	Page 1 of 1

08/09/11 04:40PM

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH111
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 560.70 metres (GEODETIC)	ELEVATION: 560.70 (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	DEPTH (ft)
0.0						TOPSOIL		0.0
1.0	N	60	CH			75mm 3.0in		5.0
2.0	N	61				CLAY – silty, highly plastic – moist, stiff to very stiff – oxidized, iron stains – salt crystals – silt layers – dark grayish brown (2.5Y 4/2)		10.0
3.0	N	62						15.0
4.0								
5.0	N	63						20.0
6.0	N	63A				6.1m END OF HOLE 20.0ft		25.0
7.0								30.0
8.0								35.0
9.0								40.0
10.0								45.0
11.0								50.0
12.0								55.0
13.0								60.0
14.0								65.0
15.0								70.0
16.0						NOTES: 1. Test hole was excavated on February 17 and 18, 2000 using a 150 mm dia. continuous flight auger. 2. No seepage or sloughing was noted during drilling. 3. Test hole was backfilled to surface immediately after completion of drilling.		75.0
17.0								80.0
18.0								
19.0								
20.0								
21.0								
22.0								
23.0								
24.0								
25.0								

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LOGGED BY: [redacted]
REVIEWED BY: [redacted]
Fig. No: GE-0005-7

COMPLETION DEPTH: 6.1 m
COMPLETE: 00/02/17

08/09/11 04:40PM

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH112
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 559.30 metres (GEODETIC)	ELEVATION: 55.30 (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	DEPTH (ft)
0.0						TOPSOIL		0.0
1.0	N	64				75mm 3.0in		5.0
2.0	N	65				CLAY – silty, highly plastic – moist, stiff to very stiff – oxidized, iron stains – salt crystals – silt layers – dark grayish brown (2.5Y 4/2)		10.0
3.0	N	66						15.0
4.0								
5.0	N	67						20.0
6.0	N	67A				6.1m END OF HOLE 20.0ft		25.0
7.0								30.0
8.0								35.0
9.0								40.0
10.0								45.0
11.0								50.0
12.0								55.0
13.0								60.0
14.0								65.0
15.0								70.0
16.0						NOTES: 1. Test hole was excavated on February 17 and 18, 2000 using a 150 mm dia. continuous flight auger. 2. No seepage or sloughing was noted during drilling. 3. Test hole was backfilled to surface immediately after completion of drilling.		75.0
17.0								80.0
18.0								
19.0								
20.0								
21.0								
22.0								
23.0								
24.0								
25.0								

GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: [redacted] REVIEWED BY: [redacted]	COMPLETION DEPTH: 6.1 m COMPLETE: 00/02/17
	Fig. No: GE-0005-19	Page 1 of 1

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PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH113
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 560.20 metres (GEODETIC)	ELEVATION: 560.20 (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	DEPTH (ft)
0.0						TOPSOIL		0.0
1.0	N	68	CH			75mm 3.0in CLAY – silty, highly plastic – moist; stiff – very silty and firm between 3.7 and 5.0 metres – oxidized, iron stains – silt layers – dark grayish brown (2.5Y 4/2)		5.0
2.0	N	69						
3.0	N	70						10.0
4.0								
5.0	N	71						15.0
6.0	N	71A				6.1m END OF HOLE 20.0ft		20.0
7.0								
8.0								25.0
9.0								30.0
10.0								
11.0								35.0
12.0								40.0
13.0								
14.0								45.0
15.0								50.0
16.0						NOTES: 1. Test hole was excavated on February 17 and 18, 2000 using a 150 mm dia. continuous flight auger. 2. No seepage or sloughing was noted during drilling. 3. Test hole was backfilled to surface immediately after completion of drilling.		55.0
17.0								
18.0								60.0
19.0								
20.0								65.0
21.0								
22.0								70.0
23.0								75.0
24.0								
25.0								80.0

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LOGGED BY: [redacted]
REVIEWED BY: [redacted]
Fig. No: GE-0005-20

COMPLETION DEPTH: 6.1 m
COMPLETE: 00/02/17

08/09/11 04:41PM

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH114
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 559.00 metres (GEODETIC)	ELEVATION: 559.00 (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	DEPTH (ft)
0.0						TOPSOIL		0.0
1.0	N	72	CH			75mm 3.0in CLAY – silty, highly plastic – moist, stiff – very silty and firm below 5.5 metres – sand layers below 5.5 metres – oxidized, iron stains – silt layers – dark grayish brown (2.5Y 4/2) to olive brown (2.5Y 4/4)		5.0
2.0	N	73						
3.0	N	74						10.0
4.0								
5.0	N	75						15.0
6.0	N	75A						20.0
7.0						6.1m END OF HOLE 20.0ft		
8.0								25.0
9.0								30.0
10.0								
11.0								35.0
12.0								40.0
13.0								
14.0								45.0
15.0								50.0
16.0								
17.0						NOTES: 1. Test hole was excavated on February 17 and 18, 2000 using a 150 mm dia. continuous flight auger.		55.0
18.0								60.0
19.0						2. No seepage or sloughing was noted during drilling.		
20.0								65.0
21.0						3. Test hole was backfilled to surface immediately after completion of drilling.		70.0
22.0								
23.0								75.0
24.0								
25.0								80.0

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Regina, Saskatchewan

LOGGED BY: ■	COMPLETION DEPTH: 6.1 m
REVIEWED BY: ■	COMPLETE: 00/02/17
Fig. No: GE-0005-21	Page 1 of 1

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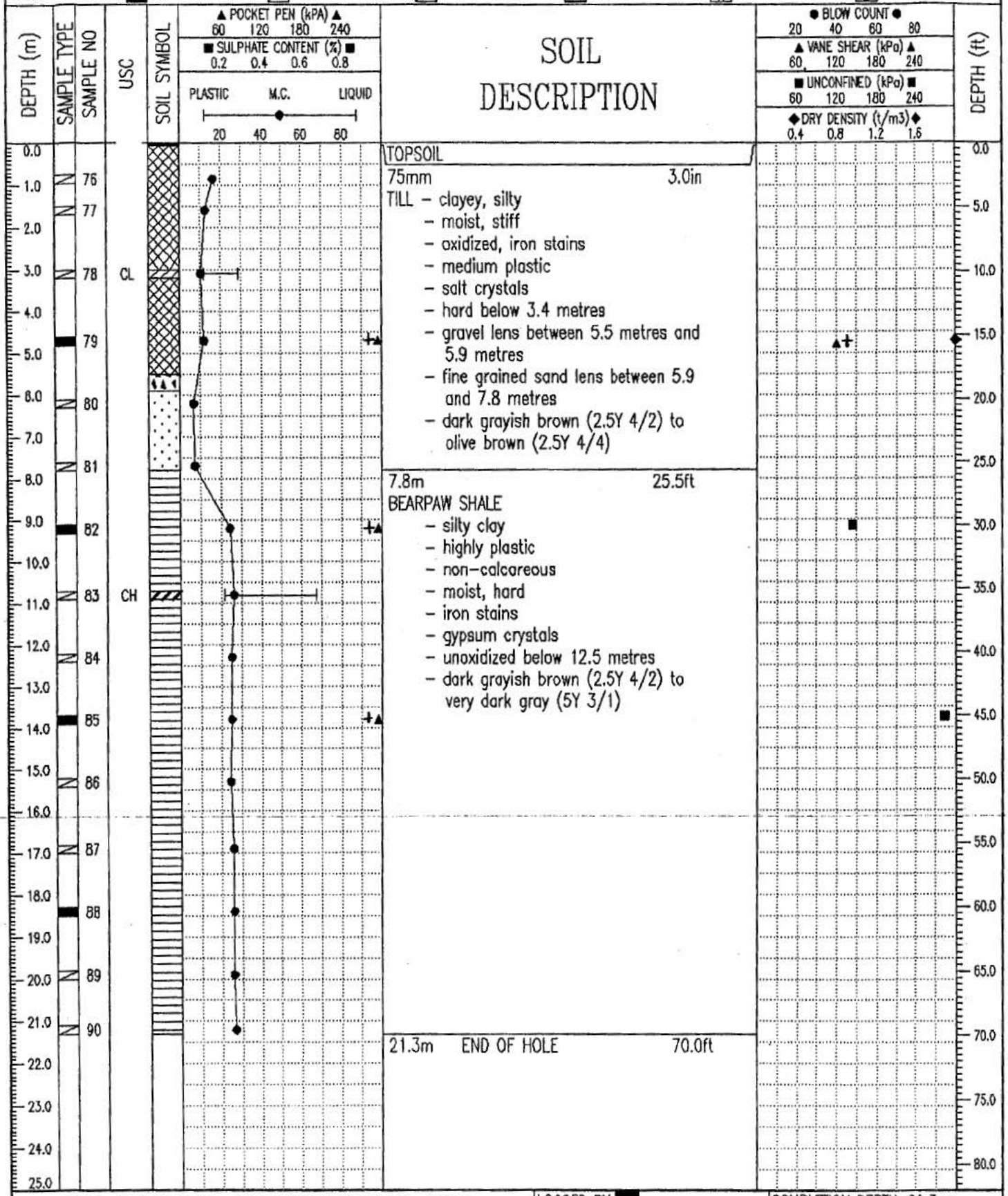
PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION:SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH115
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 547.00 metres (GEODETIC)	ELEVATION: 547.00 (m)

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



TOPSOIL
75mm 3.0in

TILL – clayey, silty
- moist, stiff
- oxidized, iron stains
- medium plastic
- salt crystals
- hard below 3.4 metres
- gravel lens between 5.5 metres and 5.9 metres
- fine grained sand lens between 5.9 and 7.8 metres
- dark grayish brown (2.5Y 4/2) to olive brown (2.5Y 4/4)

7.8m 25.5ft

BEARPAW SHALE
- silty clay
- highly plastic
- non-calcareous
- moist, hard
- iron stains
- gypsum crystals
- unoxidized below 12.5 metres
- dark grayish brown (2.5Y 4/2) to very dark gray (5Y 3/1)

21.3m END OF HOLE 70.0ft

GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: [redacted]	COMPLETION DEPTH: 21.3 m
	REVIEWED BY: [redacted]	COMPLETE: 00/02/18
	Fig. No: GE-0005-22	Page 1 of 2

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PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION:SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH115
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 547.00 metres (GEODETIC)	ELEVATION: 547.00 (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	DEPTH (ft)
25.0								85.0
26.0								90.0
27.0								95.0
28.0								100.0
29.0								105.0
30.0								110.0
31.0								115.0
32.0								120.0
33.0								125.0
34.0								130.0
35.0								135.0
36.0								140.0
37.0								145.0
38.0								150.0
39.0								155.0
40.0								160.0
41.0								
42.0								
43.0								
44.0								
45.0								
46.0								
47.0								
48.0								
49.0								
50.0								

NOTES:

1. Test hole was excavated on February 18, 2000 using a 150 mm dia. continuous flight auger.
2. No seepage or sloughing was noted during drilling.
3. Test hole was backfilled to surface immediately after completion of drilling.

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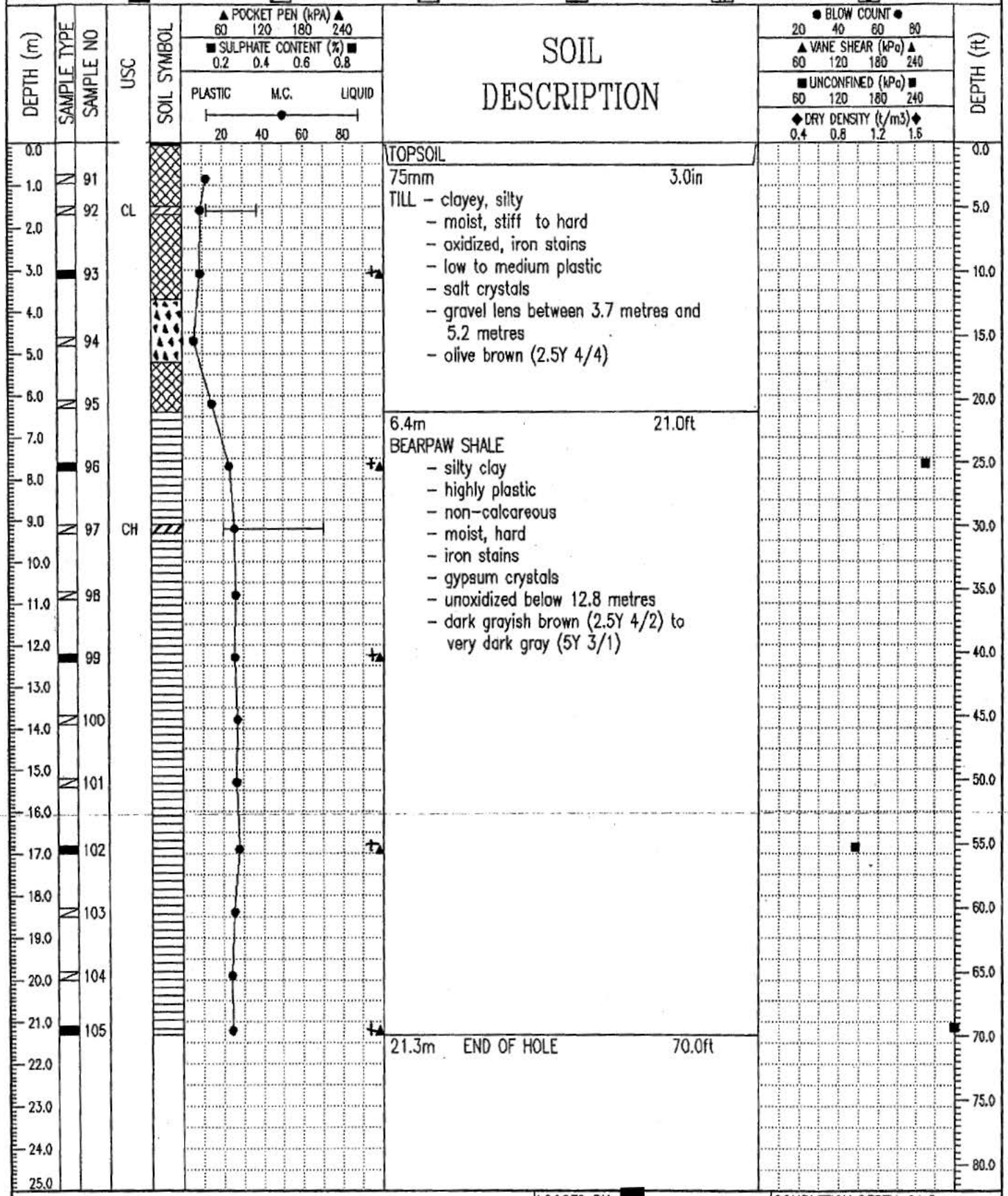
Regina, Saskatchewan

LOGGED BY: [redacted]	COMPLETION DEPTH: 21.3 m
REVIEWED BY: [redacted]	COMPLETE: 00/02/18
Fig. No: GE-0005-22	Page 2 of 2

08/09/11 04:42PM

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH116
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 541.50 metres (GEODETIC)	ELEVATION: 541.50 (m)

SAMPLE TYPE: ■ SHELBY TUBE ⧄ DISTURBED ☒ SPT SAMPLE ▤ PAIL SAMPLE ▥ NO RECOVERY ▮ JAR SAMPLE



GE GROUND ENGINEERING LTD. Regina, Saskatchewan	LOGGED BY: [redacted]	COMPLETION DEPTH: 21.3 m
	REVIEWED BY: [redacted]	COMPLETE: 00/02/18
	Fig. No: GE-0005-23	Page 1 of 2

08/09/11 04:42PM

PROJECT: PROP. SUBDIVISION & GOLF COURSE	LOCATION: SECTIONS 7 & 8 19-21-W2M	TEST HOLE NO: 0005-TH116
CLIENT: [redacted]	LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN	PROJECT NO: GE-0005
DRILL RIG: BRAT 22 DIGGER	ELEVATION: 541.50 metres (GEODETIC)	ELEVATION: 541.50 (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	DEPTH (ft)
25.0								85.0
26.0								90.0
27.0						NOTES: 1. Test hole was excavated on February 18, 2000 using a 150 mm dia. continuous flight auger. 2. No seepage or sloughing was noted during drilling. 3. Test hole was backfilled to surface immediately after completion of drilling.		95.0
28.0								100.0
29.0								105.0
30.0								110.0
31.0								115.0
32.0								120.0
33.0								125.0
34.0								130.0
35.0								135.0
36.0								140.0
37.0								145.0
38.0								150.0
39.0								155.0
40.0								160.0
41.0								
42.0								
43.0								
44.0								
45.0								
46.0								
47.0								
48.0								
49.0								
50.0								

GE GROUND ENGINEERING LTD.
Regina, Saskatchewan

LOGGED BY: [redacted]
REVIEWED BY: [redacted]
Fig. No: GE-0005-23

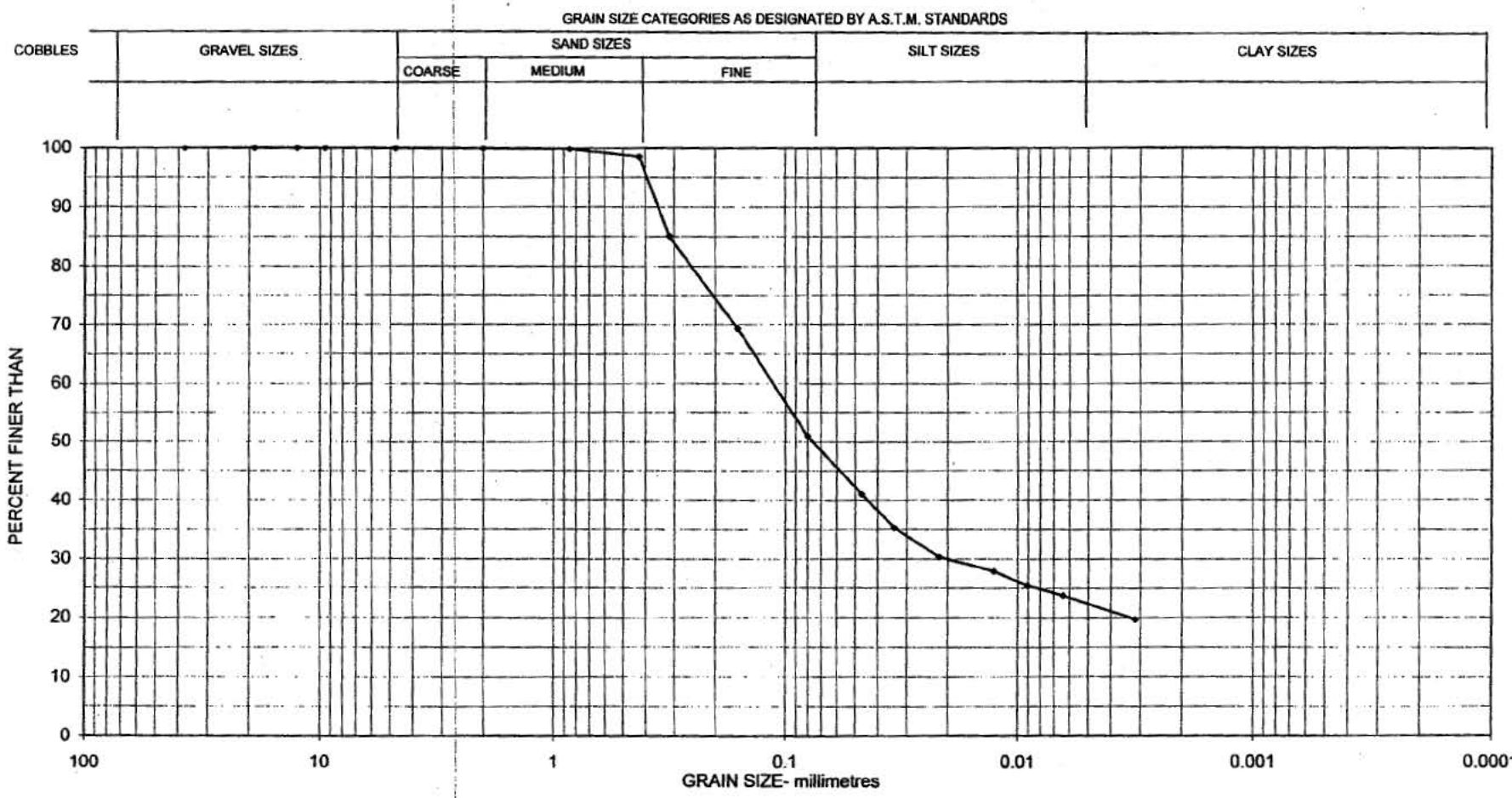
COMPLETION DEPTH: 21.3 m
COMPLETE: 00/02/18

08/09/11 04:42PM

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-0005 DATE: February 23, 2000 TECH: [redacted]
CLIENT: [redacted]
PROJECT: PROPOSED SUBDIVISION DEVELOPMENT AND GOLF COURSE
LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN



GRAIN SIZE CLASSIFICATION	PERCENTAGE OF SAMPLE
GRAVEL	0
COARSE SAND	0
MEDIUM SAND	1
FINE SAND	48
SILT	29
CLAY	22

SAMPLE DESCRIPTION : SAND, SOME SILT, SOME CLAY

SAMPLED BY : [redacted] GE GROUND ENGINEERING LTD.

DATE SAMPLED : February 17, 2000
TEST HOLE NUMBER : 101
SAMPLE NUMBER : COMPOSITE
DEPTH OF SAMPLE (ft) : 0 TO 5' 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.

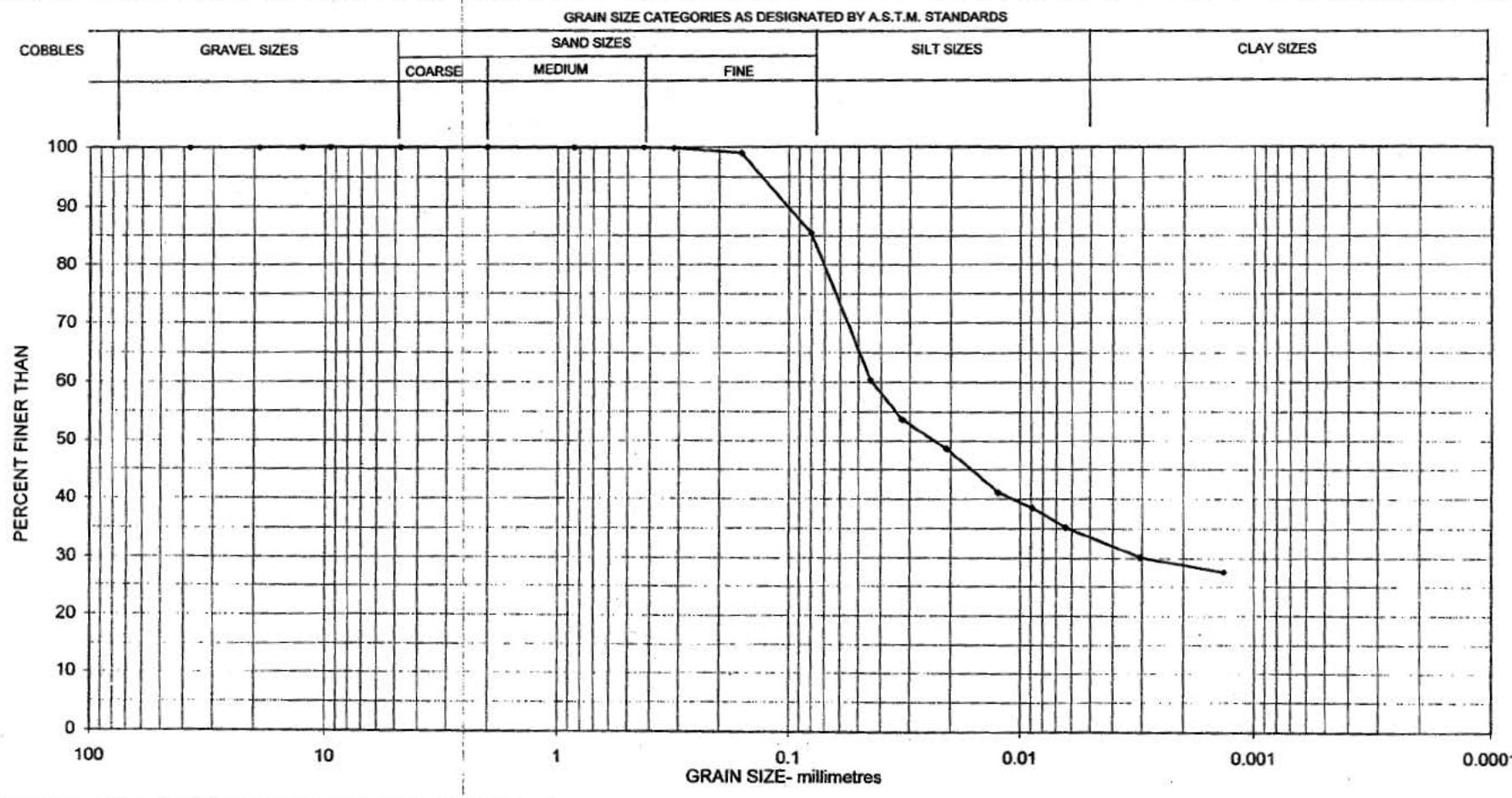
Per: [redacted]

GE-0005-24

GE GROUND ENGINEERING LTD.
CIVIL & GEOENVIRONMENTAL ENGINEERS
415 - 7th AVENUE, REGINA, SASKATCHEWAN, CANADA
S4N 4P1 TELEPHONE: (306) 569-9079, FAX: (306) 566-3677

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

JOB No: GE-0005 DATE: March 8, 2000 TECH: [redacted]
CLIENT: [redacted]
PROJECT: PROPOSED SUBDIVISION DEVELOPMENT AND GOLF COURSE
LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN



GRAIN SIZE CLASSIFICATION	PERCENTAGE OF SAMPLE
GRAVEL	0
COARSE SAND	0
MEDIUM SAND	0
FINE SAND	15
SILT	52
CLAY	33

SAMPLE DESCRIPTION : SILT, WITH CLAY, SOME FINE SAND

SAMPLED BY : [redacted] GE GROUND ENGINEERING LTD.

DATE SAMPLED : February 17, 2000
TEST HOLE NUMBER : 102
SAMPLE NUMBER : 6 & 7
DEPTH OF SAMPLE (ft) : 2.5' & 5' 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.

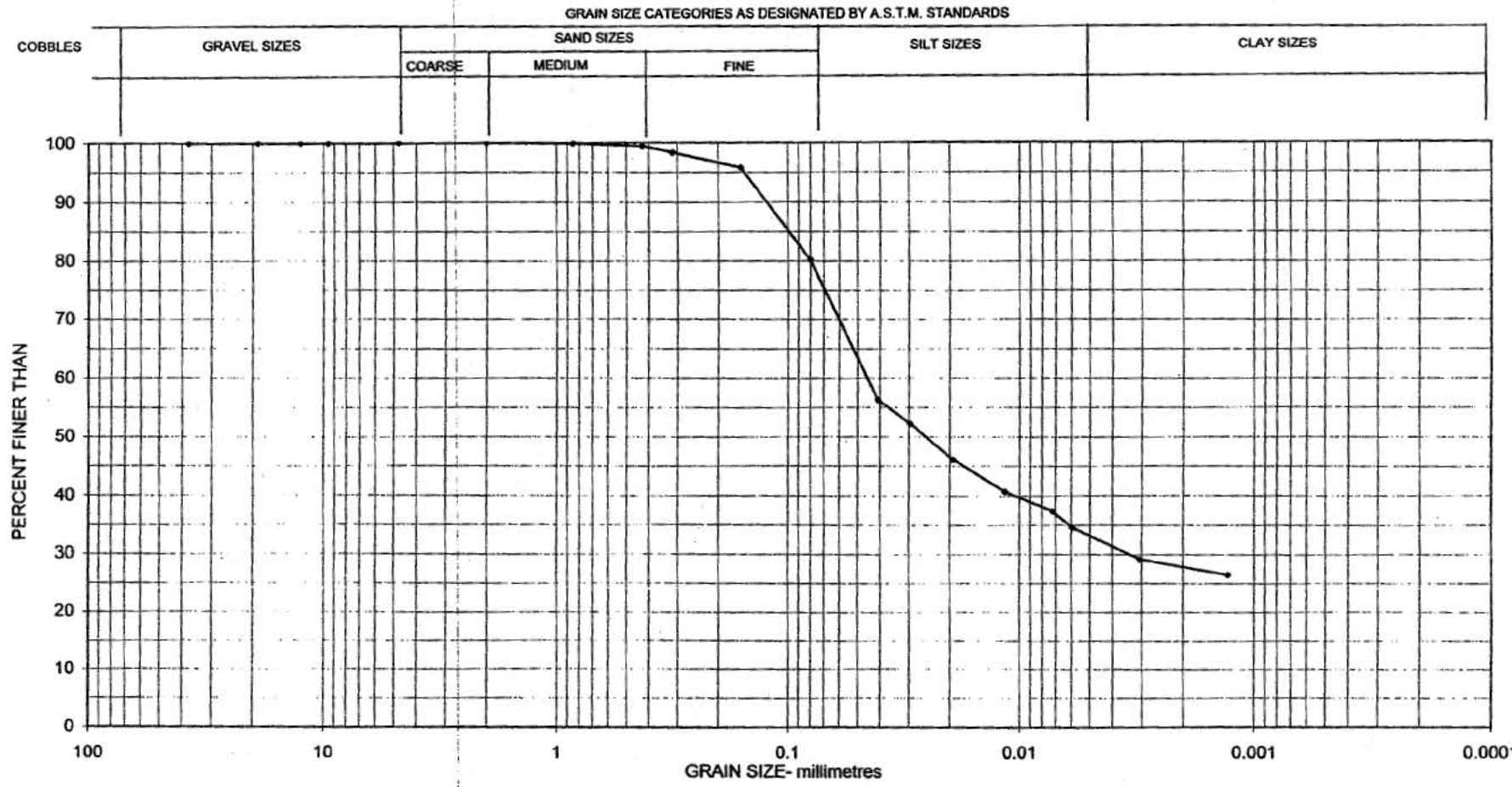
Per: [redacted]

GE-0005-25

GE GROUND ENGINEERING LTD.
CIVIL & GEOENVIRONMENTAL ENGINEERS
415 - 7th AVENUE, REGINA, SASKATCHEWAN, CANADA
S4N 4P1 TELEPHONE: (306) 569-9075, FAX: (306) 585-3677

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

JOB No: GE-0005 DATE: March 7, 2000 TECH: [redacted]
CLIENT: [redacted]
PROJECT: PROPOSED SUBDIVISION DEVELOPMENT AND GOLF COURSE
LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN



GRAIN SIZE CLASSIFICATION	PERCENTAGE OF SAMPLE
GRAVEL	0
COARSE SAND	0
MEDIUM SAND	1
FINE SAND	19
SILT	47
CLAY	33

SAMPLE DESCRIPTION : SILT, WITH CLAY, SOME SAND

SAMPLED BY : [redacted], A.Sc.T. OF GE GROUND ENGINEERING LTD.

DATE SAMPLED : February 17, 2000
TEST HOLE NUMBER : 103
SAMPLE NUMBER : COMPOSITE
DEPTH OF SAMPLE (ft) : 0 TO 5' 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.

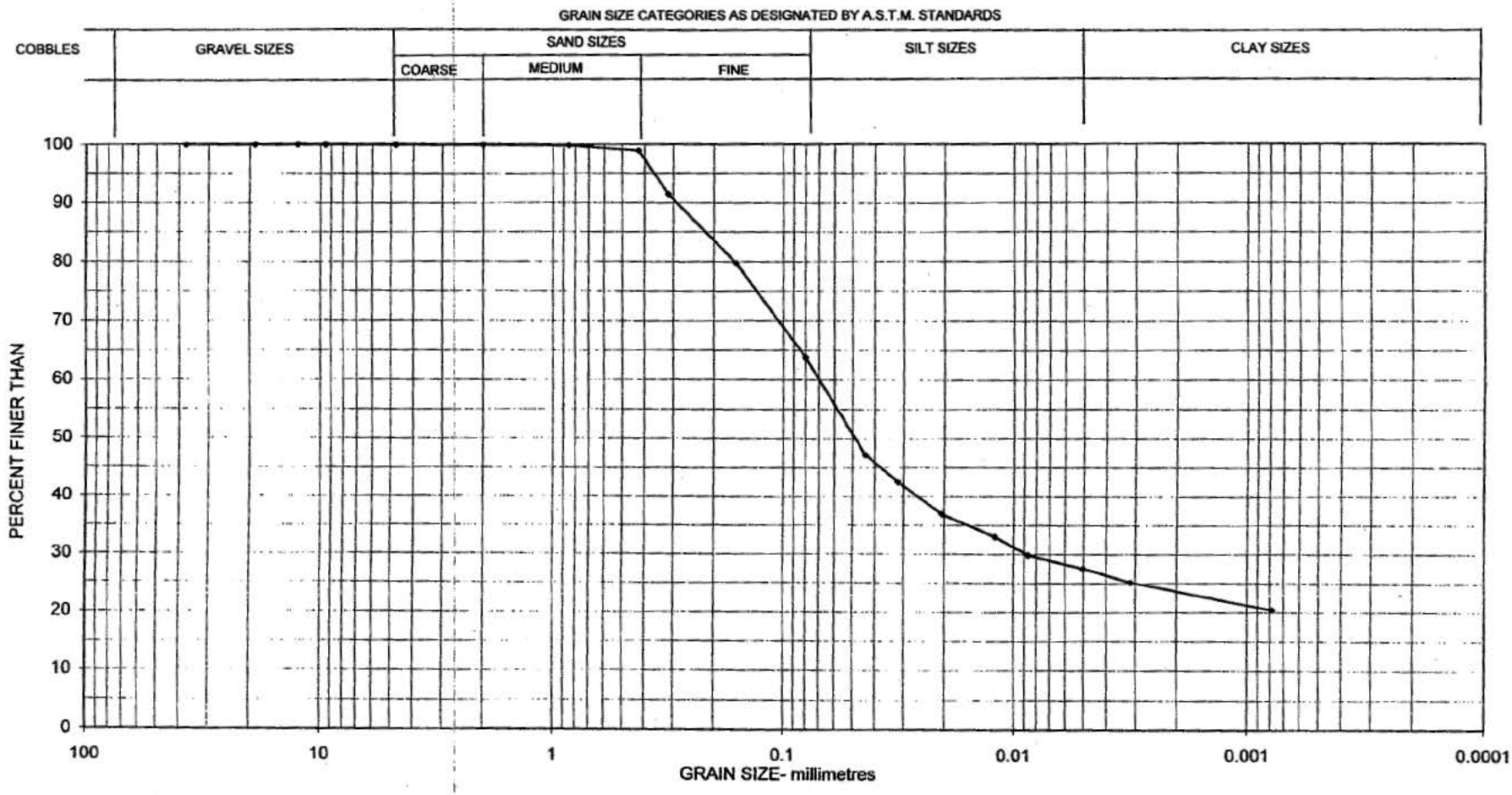
Per: [redacted]

GE-0005-26

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-0005 DATE: February 24, 2000 TECH: [redacted]
CLIENT: [redacted]
PROJECT: PROPOSED SUBDIVISION DEVELOPMENT AND GOLF COURSE
LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN



GRAIN SIZE CLASSIFICATION	PERCENTAGE OF SAMPLE
GRAVEL	0
COARSE SAND	0
MEDIUM SAND	1
FINE SAND	35
SILT	36
CLAY	28

SAMPLE DESCRIPTION : SAND, WITH SILT, SOME CLAY

SAMPLED BY : [redacted], TECH. OF GE GROUND ENGINEERING LTD.

DATE SAMPLED : February 17, 2000
TEST HOLE NUMBER : 105
SAMPLE NUMBER : COMPOSITE
DEPTH OF SAMPLE (ft) : 5 TO 10' 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.

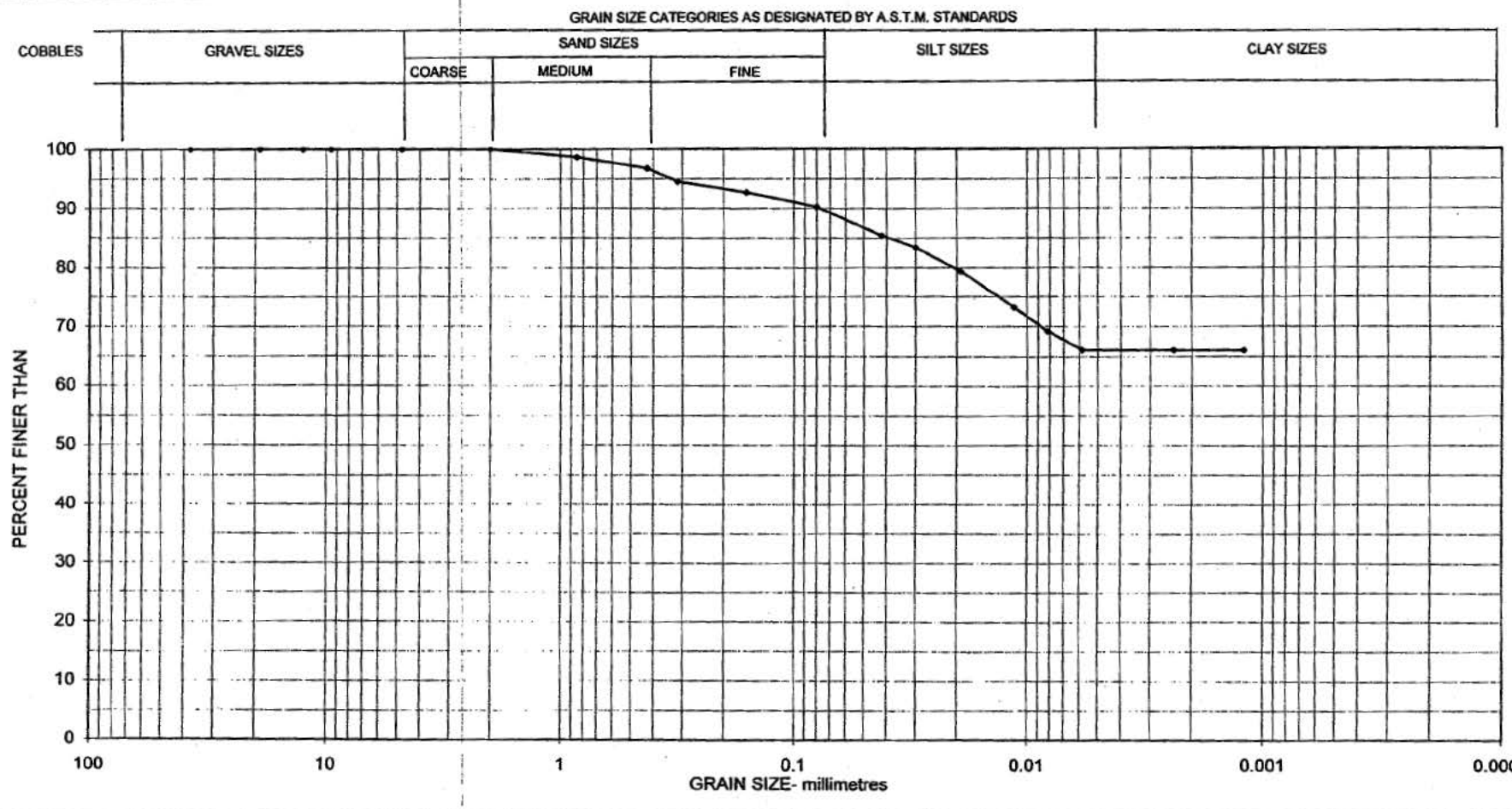
Per: [redacted]

GE-0005-27

GE GROUND ENGINEERING LTD.
CIVIL & GEOENVIRONMENTAL ENGINEERS
415 - 7th AVENUE, REGINA, SASKATCHEWAN, CANADA
S4N 4P1 TELEPHONE: (306) 569-9075, FAX: (306) 565-3477

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

JOB No: GE-0005 DATE: March 8, 2000 TECH: [redacted]
CLIENT: [redacted]
PROJECT: PROPOSED SUBDIVISION DEVELOPMENT AND GOLF COURSE
LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN



GRAIN SIZE CLASSIFICATION	PERCENTAGE OF SAMPLE
GRAVEL	0
COARSE SAND	0
MEDIUM SAND	3
FINE SAND	7
SILT	24
CLAY	66

SAMPLE DESCRIPTION : CLAY, SOME SILT, A LITTLE SAND

SAMPLED BY : [redacted] GE GROUND ENGINEERING LTD.

DATE SAMPLED : February 17, 2000
TEST HOLE NUMBER : 107
SAMPLE NUMBER : COMPOSITE
DEPTH OF SAMPLE (ft) : 0 TO 5' 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.

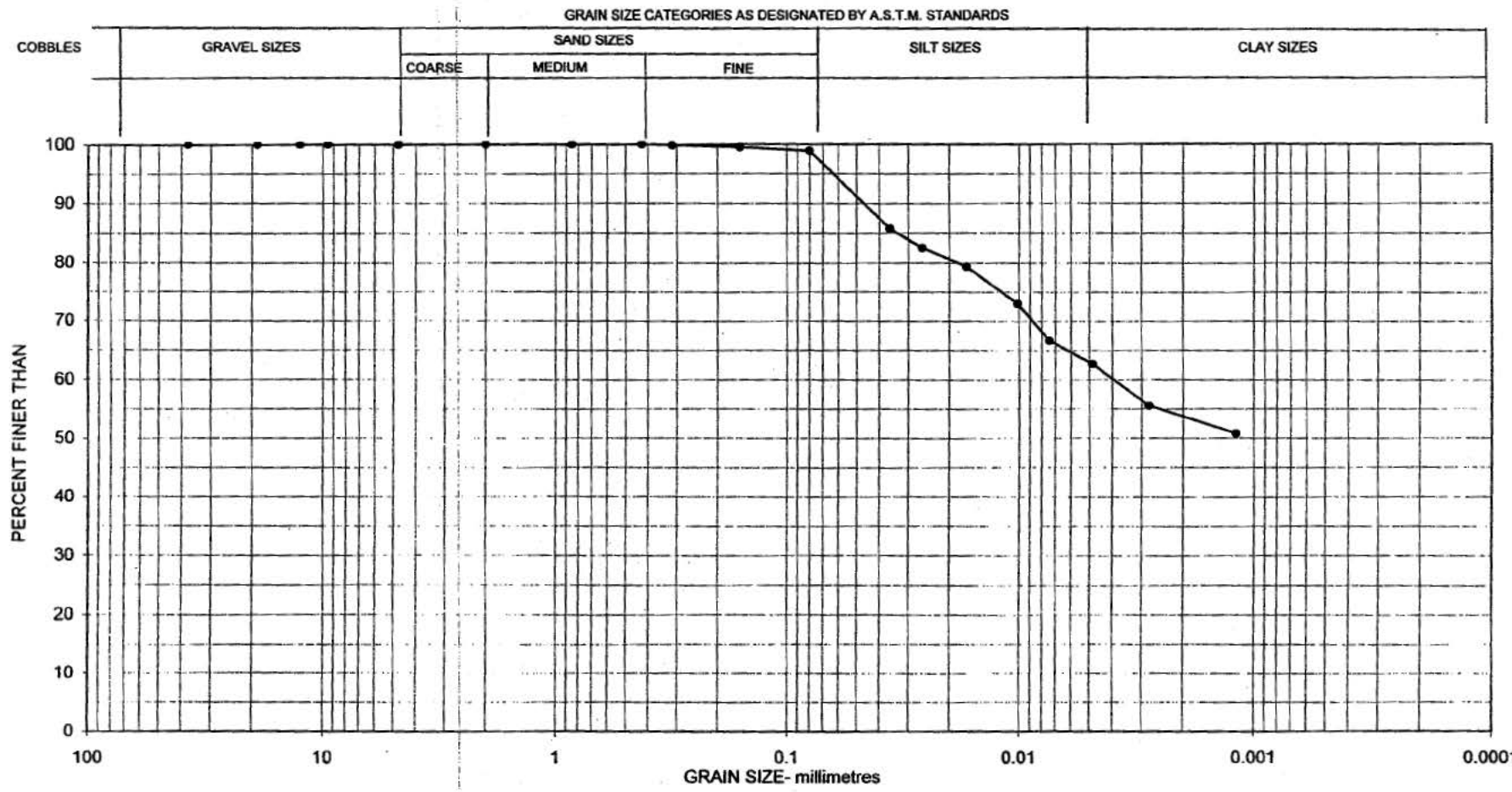
Per: [redacted]

GE-0005-28

GE GROUND ENGINEERING LTD.
CIVIL & GEOENVIRONMENTAL ENGINEERS
415 - 7th AVENUE, REGINA, SASKATCHEWAN, CANADA
S4N 4P1 TELEPHONE: (306) 569-9075, FAX: (306) 585-3677

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

JOB No: GE-0005 DATE: March 8, 2000 TECH: [redacted]
CLIENT: [redacted]
PROJECT: PROPOSED SUBDIVISION DEVELOPMENT AND GOLF COURSE
LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN



GRAIN SIZE CLASSIFICATION	PERCENTAGE OF SAMPLE
GRAVEL	0
COARSE SAND	0
MEDIUM SAND	0
FINE SAND	1
SILT	36
CLAY	63

SAMPLE DESCRIPTION : CLAY, WITH SILT, A TRACE OF FINE SAND

SAMPLED BY : [redacted] GE GROUND ENGINEERING LTD.

DATE SAMPLED : February 17, 2000
TEST HOLE NUMBER : 109
SAMPLE NUMBER : COMPOSITE
DEPTH OF SAMPLE (ft) : 0 TO 5' 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: [redacted]

GE-0005-29

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

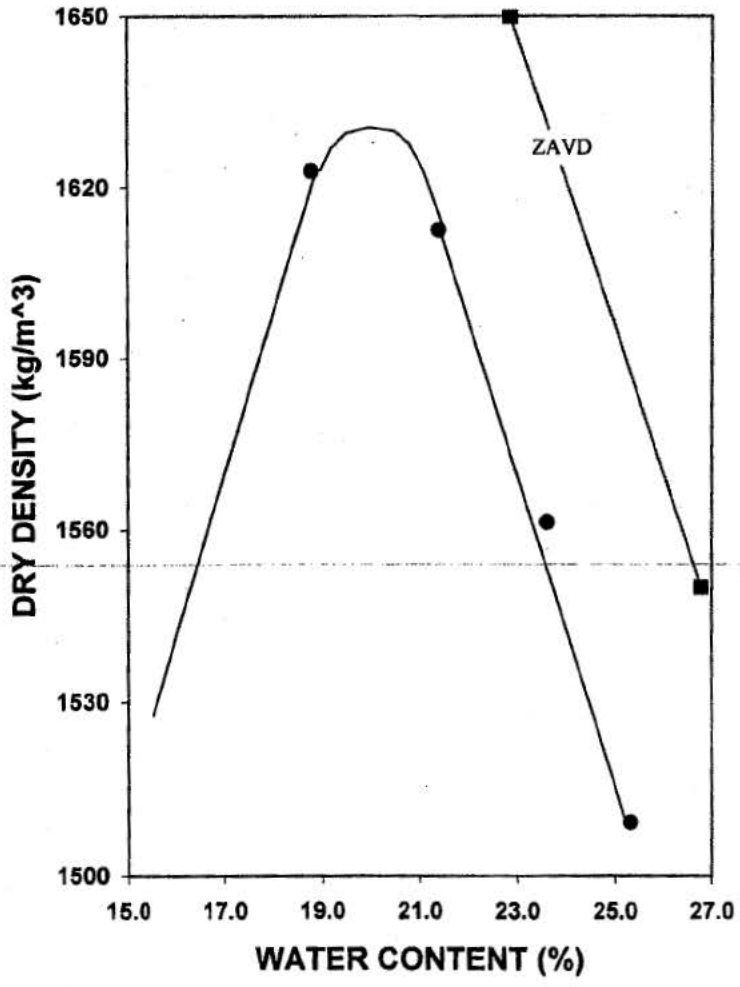
PROCTOR TEST

(ASTM D-698 AND D-1557)

FILE NUMBER :	GE-0005	SAMPLE NUMBER :	TH-103, 0 TO 5' COMPOSITE
PROJECT :	PROPOSED SUBDIVISION & GOLF COURSE	CLIENT :	[redacted]
LOCATION :	SOUTH OF LUMSDEN, SASKATCHEWAN	DIST. :	
TECH. :	[redacted]		
DATE :	March 6, 2000		

COMPACTED DENSITY AND MOISTURE CONTENTS :

DRY DENSITY (kg/m^3)	1623	1613	1561	1509				
MOISTURE CONTENT (%)	18.8	21.4	23.6	25.3				



OPTIMUM MOISTURE CONTENT = 20.0 (%)

MAXIMUM DRY DENSITY = 1632 (kg/m^3)

METHOD OF COMPACTION :	STANDARD PROCTOR ASTM D-698, METHOD A
METHOD OF PREPARATION :	DRY
DIAMETER OF MOLD (mm) :	100
NUMBER OF LAYERS :	3
NUMBER OF BLOWS PER LAYER :	25
HEIGHT OF FREE FALL (mm) :	305
WEIGHT OF TAMPER (kg) :	2.49
DESCRIPTION OF COMPACTOR :	ROUND, FLAT, 50mm DIAMETER
TYPE OF MATERIAL :	NATIVE CLAY
USED FOR :	PROPOSED LAGOON SITE
SAMPLED BY:	[redacted]
SAMPLED FROM :	TH-103, 0 TO 5' COMPOSITE.
DATE SAMPLED :	February 18, 2000
SUPPLIED BY :	---
ROCK CORRECTION APPLIED :	NO
SPECIFIC GRAVITY =	2650 (ASSUMED)

FORMULA : ZERO AIR VOIDS (ZAVD) = (1/DRY DENSITY) - (1/SPECIFIC GRAVITY)

REVIEWED BY :

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

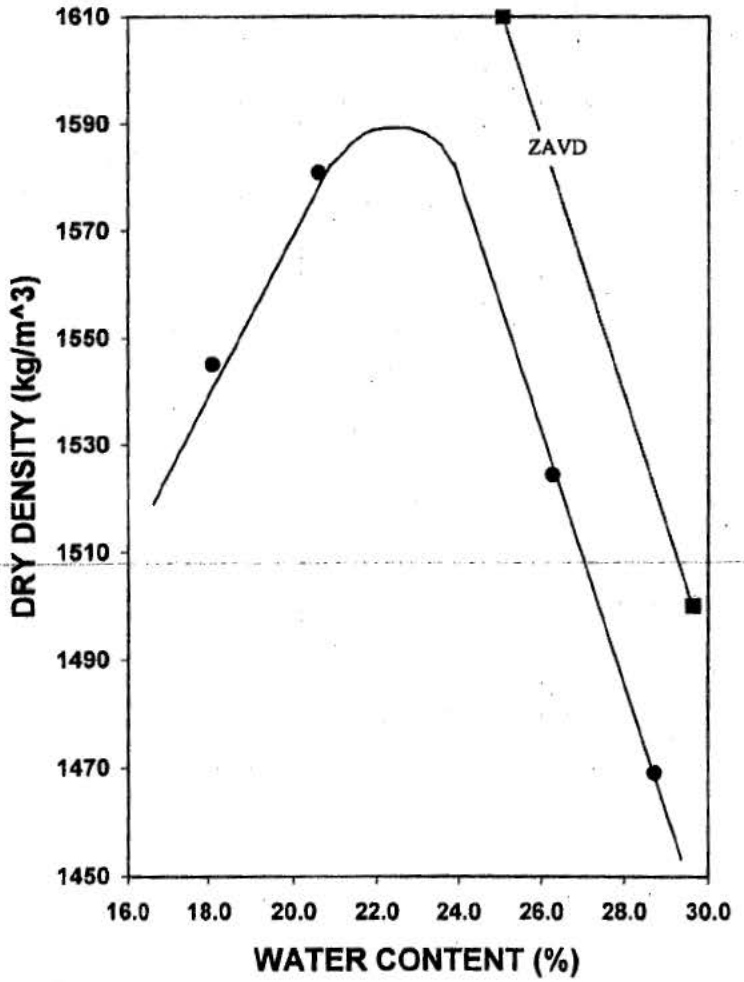
PROCTOR TEST

(ASTM D-698 AND D-1557)

FILE NUMBER :	GE-0005
SAMPLE NUMBER :	TH-107, 0 TO 5' COMPOSITE
PROJECT :	PROPOSED SUBDIVISION & GOLF COURSE
LOCATION :	SOUTH OF LUMSDEN, SASKATCHEWAN
TECH. :	[redacted]
DATE :	March 6, 2000
CLIENT :	[redacted]
DIST. :	

COMPACTED DENSITY AND MOISTURE CONTENTS :

DRY DENSITY (kg/m³)	1545	1581	1524	1469				
MOISTURE CONTENT (%)	18.1	20.6	26.3	28.7				



OPTIMUM MOISTURE CONTENT =	22.4	(%)
MAXIMUM DRY DENSITY =	1589	(kg/m³)
METHOD OF COMPACTION :	STANDARD PROCTOR ASTM D-698, METHOD A	
METHOD OF PREPARATION :	DRY	
DIAMETER OF MOLD (mm) :	100	
NUMBER OF LAYERS :	3	
NUMBER OF BLOWS PER LAYER :	25	
HEIGHT OF FREE FALL (mm) :	305	
WEIGHT OF TAMPER (kg) :	2.49	
DESCRIPTION OF COMPACTOR :	ROUND, FLAT, 50mm DIAMETER	
TYPE OF MATERIAL :	NATIVE CLAY	
USED FOR :	A PROPOSED BORROW AREA	
SAMPLED BY:	[redacted]	
SAMPLED FROM :	TH-107, 0 TO 5' COMPOSITE.	
DATE SAMPLED :	February 18, 2000	
SUPPLIED BY :	---	
ROCK CORRECTION APPLIED :	NO	
SPECIFIC GRAVITY =	2700	(ASSUMED)

FORMULA : ZERO AIR VOIDS (ZAVD) = (1/DRY DENSITY) - (1/SPECIFIC GRAVITY)

REVIEWED BY :

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

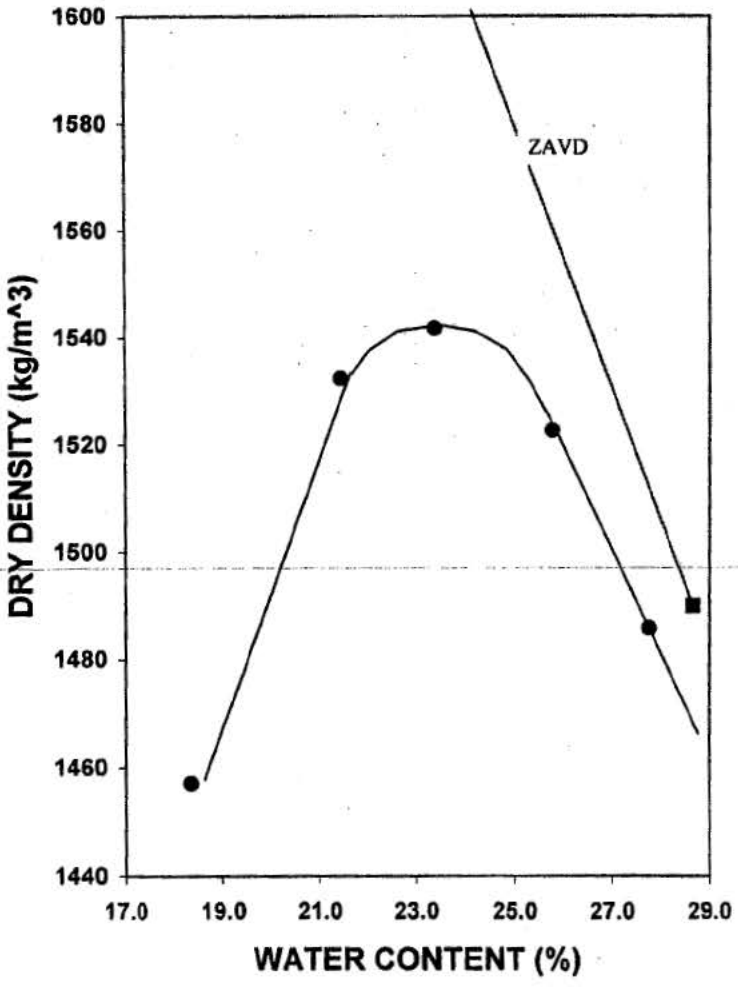
PROCTOR TEST

(ASTM D-698 AND D-1557)

FILE NUMBER :	GE-0005	SAMPLE NUMBER :	TH-109, 0 TO 5' COMPOSITE
PROJECT :	PROPOSED SUBDIVISION & GOLF COURSE	CLIENT :	[redacted]
LOCATION :	SOUTH OF LUMSDEN, SASKATCHEWAN	DIST. :	
TECH. :	[redacted]		
DATE :	March 6, 2000		

COMPACTED DENSITY AND MOISTURE CONTENTS :

DRY DENSITY (kg/m^3)	1457	1532	1542	1523	1486			
MOISTURE CONTENT (%)	18.4	21.5	23.4	25.8	27.8			



OPTIMUM MOISTURE CONTENT = 23.6 (%)
MAXIMUM DRY DENSITY = 1542 (kg/m^3)

METHOD OF COMPACTION :	STANDARD PROCTOR
	ASTM D-698, METHOD A
METHOD OF PREPARATION :	DRY
DIAMETER OF MOLD (mm) :	100
NUMBER OF LAYERS :	3
NUMBER OF BLOWS PER LAYER :	25
HEIGHT OF FREE FALL (mm) :	305
WEIGHT OF TAMPER (kg) :	2.49
DESCRIPTION OF COMPACTOR :	ROUND, FLAT, 50mm DIAMETER
TYPE OF MATERIAL :	NATIVE CLAY
USED FOR :	A PROPOSED BORROW AREA
SAMPLED BY:	[redacted]
SAMPLED FROM :	TH-109, 0 TO 5' COMPOSITE.
DATE SAMPLED :	February 18, 2000
SUPPLIED BY :	---
ROCK CORRECTION APPLIED :	NO
SPECIFIC GRAVITY =	2600 (ASSUMED)

FORMULA : ZERO AIR VOIDS (ZAVD) = (1/DRY DENSITY) - (1/SPECIFIC GRAVITY)

REVIEWED BY :

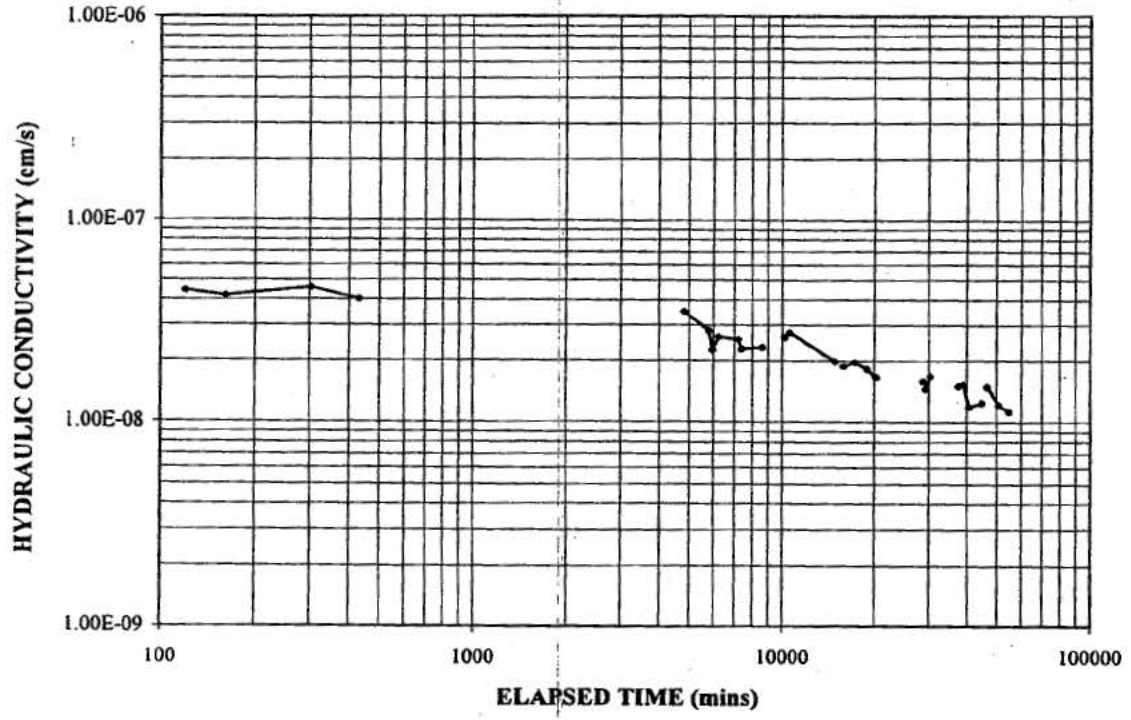
GROUND ENGINEERING LTD.
CIVIL & GEOENVIRONMENTAL ENGINEERS
415 - 7th AVENUE, REGINA, SASKATCHEWAN, CANADA
S4N 4P1 TELEPHONE: (306) 586-9075, FAX: (306) 586-3677

HYDRAULIC CONDUCTIVITY
ASTM - D-2434

JOB No: GE-0005 DATE: March 21, 2000 TECH.: [redacted]
PROJECT: PROPOSED SUBDIVISION DEVELOPMENT AND GOLF COURSE
LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN
CLIENT: [redacted]

SAMPLE PREPARATION AND COMPACTION

TEST NUMBER:	1	MAXIMUM DRY DENSITY :	1632 t/m^3	MOLDING DRY DENSITY :	1585 t/m^3
TEST HOLE NUMBER:	103	OPTIMUM MOISTURE CONTENT :	20.0 %	MOLDING MOISTURE CONTENT :	20.6 %
SAMPLE NUMBER :	COMPOSITE	METHOD OF COMPACTION :	STANDARD PROCTOR	METHOD OF COMPACTION :	PNEUMATIC
DEPTH BELOW GRADE:	0 TO 5'		ASTM D-698, METHOD A	PERCENT COMPACTION :	97.1 %
				SAMPLE DIAMETER :	10.10 cm
SAMPLE DESCRIPTION:	SILT, WITH CLAY, SOME SAND			SAMPLE HEIGHT :	11.60 cm



GE-0005-33

ADDITIONAL TESTING PERFORMED

ATTERBERG LIMIT TEST RESULTS

AVERAGE PLASTIC LIMIT:	17
AVERAGE LIQUID LIMIT:	41
PLASTIC INDEX:	24
TYPE OF MATERIAL:	CH - HIGHLY PLASTIC CLAY

HYDROMETER ANALYSIS

GRAIN SIZE CLASSIFICATION	PERCENTAGE OF SAMPLE
GRAVEL	0
COARSE SAND	0
MEDIUM SAND	1
FINE SAND	19
SILT	47
CLAY	33

HYDRAULIC CONDUCTIVITY

k = 1.12 E-8 cm/s @ 54753 min

GROUND ENGINEERING LTD.
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415 - 7th AVENUE, REGINA, SASKATCHEWAN, CANADA
S4N 4P1 TELEPHONE: (306) 569-9070, FAX: (306) 585-3877

HYDRAULIC CONDUCTIVITY

ASTM - D-2434

JOB No: GE-0005 DATE: March 21, 2000 TECH.: [redacted]

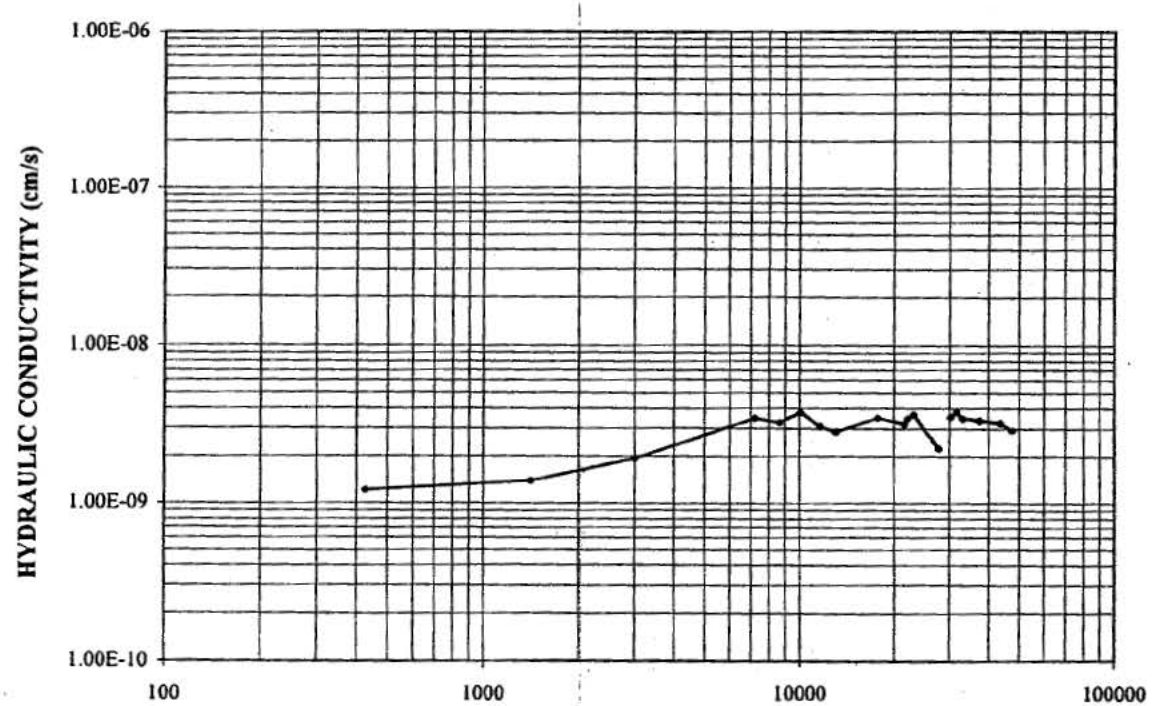
PROJECT: PROPOSED SUBDIVISION DEV. AND GOLF COURSE

LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN

CLIENT: [redacted]

SAMPLE PREPARATION AND COMPACTION

TEST NUMBER:	2	MAXIMUM DRY DENSITY :	1589 t/m^3	MOLDING DRY DENSITY :	1542 t/m^3
TEST HOLE NUMBER:	107	OPTIMUM MOISTURE CONTENT :	22.4 %	MOLDING MOISTURE CONTENT :	22.3 %
SAMPLE NUMBER :	COMPOSITE	METHOD OF COMPACTION :	STANDARD PROCTOR	METHOD OF COMPACTION :	PNEUMATIC
DEPTH BELOW GRADE:	0 TO 5'		ASTM D-698, METHOD A	PERCENT COMPACTION :	97.0 %
				SAMPLE DIAMETER :	10.10 cm
SAMPLE DESCRIPTION:	CLAY, SOME SILT, A LITTLE SAND			SAMPLE HEIGHT :	11.60 cm



GE-0005-34

ADDITIONAL TESTING PERFORMED

ATTERBERG LIMIT TEST RESULTS

AVERAGE PLASTIC LIMIT:	18
AVERAGE LIQUID LIMIT:	63
PLASTIC INDEX:	45
TYPE OF MATERIAL:	CH - HIGHLY PLASTIC CLAY

HYDROMETER ANALYSIS

GRAIN SIZE CLASSIFICATION	PERCENTAGE OF SAMPLE
GRAVEL	0
COARSE SAND	0
MEDIUM SAND	3
FINE SAND	7
SILT	24
CLAY	66

HYDRAULIC CONDUCTIVITY

k = 2.91E-09 cm / s @ 47529 min

GE GROUND ENGINEERING LTD.
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115 - 7th AVENUE, REGINA, SASKATCHEWAN, CANADA
S4N 4P1 TELEPHONE: (306) 665-6078, FAX: (306) 665-3677

HYDRAULIC CONDUCTIVITY

ASTM - D-2434

JOB No: GE-0005 DATE: March 21, 2000 TECH.: [redacted]

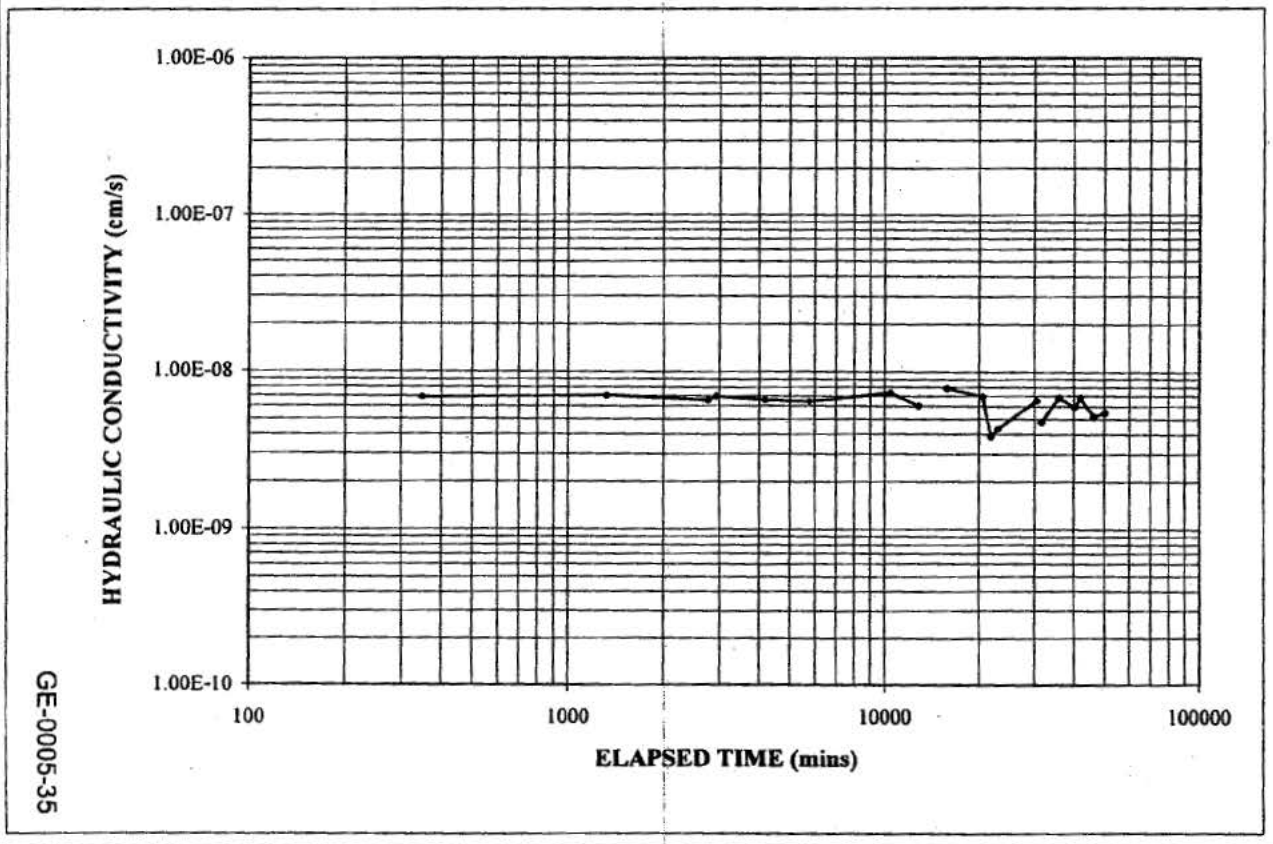
PROJECT: PROPOSED SUBDIVISION DEV. AND GOLF COURSE

LOCATION: SOUTH OF LUMSDEN, SASKATCHEWAN

CLIENT: [redacted]

SAMPLE PREPARATION AND COMPACTION

TEST NUMBER:	3	MAXIMUM DRY DENSITY :	1542 t/m^3	MOLDING DRY DENSITY :	1498 t/m^3
TEST HOLE NUMBER:	109	OPTIMUM MOISTURE CONTENT :	23.6 %	MOLDING MOISTURE CONTENT :	23.5 %
SAMPLE NUMBER :	COMPOSITE	METHOD OF COMPACTION :	STANDARD PROCTOR	METHOD OF COMPACTION :	PNEUMATIC
DEPTH BELOW GRADE:	0 TO 5'		ASTM D-698, METHOD A	PERCENT COMPACTION :	97.1 %
				SAMPLE DIAMETER :	10.10 cm
SAMPLE DESCRIPTION:	CLAY, WITH SILT, A TRACE OF FINE SAND			SAMPLE HEIGHT :	11.60 cm



GE-0005-35

ADDITIONAL TESTING PERFORMED

ATTERBERG LIMIT TEST RESULTS

AVERAGE PLASTIC LIMIT:	19
AVERAGE LIQUID LIMIT:	59
PLASTIC INDEX:	40
TYPE OF MATERIAL:	CH - HIGHLY PLASTIC CLAY

HYDROMETER ANALYSIS

GRAIN SIZE CLASSIFICATION	PERCENTAGE OF SAMPLE
GRAVEL	0
COARSE SAND	0
MEDIUM SAND	0
FINE SAND	1
SILT	36
CLAY	63

HYDRAULIC CONDUCTIVITY

k = 5.48 E-09 cm / s @ 50287 min

SLAB ON GRADE DESIGN CHART

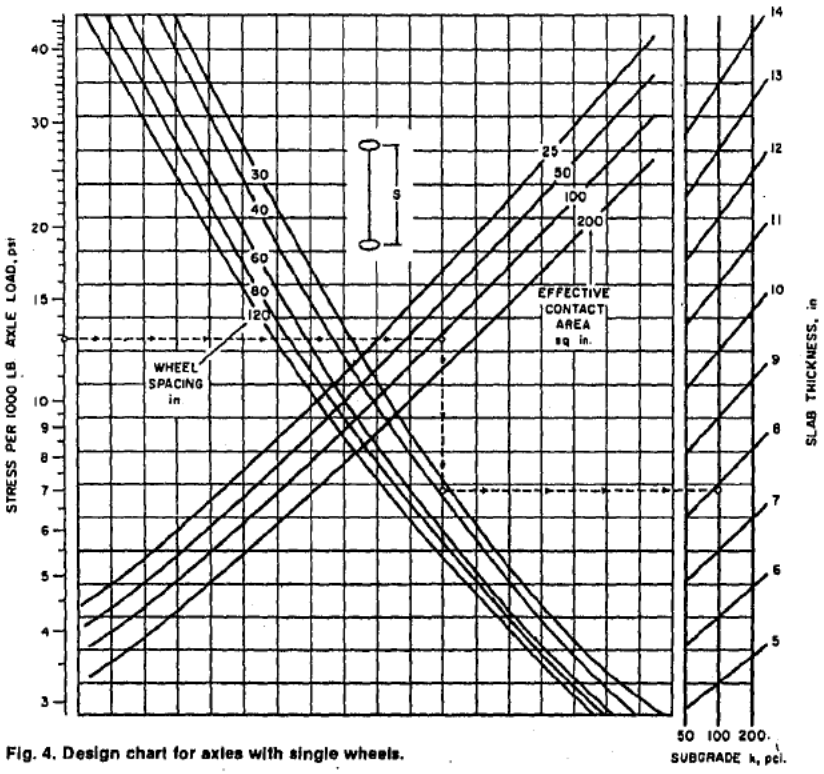


Fig. 4. Design chart for axles with single wheels.

Table 3. Approximate Relationship Between Compressive and Flexural Strength

Compressive strength, psi	Flexural strength, psi
3500	445-590
4000	480-640
4500	500-670
5000	535-710
6000	585-780
7000	630-840

k Value		
Soil type	Psi/in.	Mpa/m
silts and clays	50-100	13-27
sandy soils	200	54
sands-gravels	300	81

Design Procedure

Vehicle Loads

Design for industrial lift-truck loads requires knowledge of several specifics:

- Maximum axle loads
- Number of load repetitions
- Wheel contact area
- Spacing between wheels on heaviest axles
- Subgrade strength
- Flexural strength of concrete

Traffic and load data for past and future operating conditions for lift trucks can be gathered from plant maintenance departments, planning and operations departments, and truck manufactures' data. With this information, the safety factor can be selected and used to determine and allowable working stress with which to enter the design charts.

The safety factor (flexural strength divided by working stress) reflects the expected frequency of loadings of the heaviest vehicles. Safety factors in the range of 1.7 to 2.0 are suggested for industrial and commercial floors. The high number should be used where the heavy load traffic is frequent and channelized. Where traffic is light and not channelized, low safety factors of 1.4 to 1.7 can be used.

STRESS PER 1000lb AXLE LOAD IS CALCULATED BY
DIVIDING THE FLEXURAL STRENGTH BY THE APPROPRIATE
SAFETY FACTOR DIVIDED BY THE TOTAL AXLE LOAD IN KIPS

FROM "FLOORS ON GROUND" by RALPH E. SPEARS, PCA 1978

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

Concentration of Sulphates Expressed as SO_3

Class	In Soil: Total SO_3	In Soil: SO_3 in 1:1 Water Extract	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.
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

GROUND ENGINEERING LTD.

CIVIL & GEOENVIRONMENTAL ENGINEERS

415 - 7th AVENUE • REGINA • SASKATCHEWAN • CANADA • S4N 1P1
TELEPHONE: (306) 569-9075 FAX: (306) 565-3677 EMAIL: geground@accesscomm.ca

FILE: GE-0005

February 7, 2000

[redacted]

ATTENTION: [redacted]

Dear Sir:

SUBJECT: GEOTECHNICAL INSPECTION
PROPOSED GOLF COURSE & RESIDENTIAL SUBDIVISION
SECTIONS 7 & 8-19-21-W2
SOUTH OF LUMSDEN, SASKATCHEWAN

1.0 INTRODUCTION

On January 20, 2000, you verbally requested that we inspect the above captioned property located approximately 7 km south of Lumsden, Saskatchewan. The purpose of the inspection was to provide an engineering opinion on the feasibility of the proposed project insofar as geotechnical considerations are concerned. It is understood that the proposed development consists of an 18 hole golf course, a new club house and approximately 250 residential lots with associated infrastructure including roadways, sewer and water and a new sewage lagoon. The field inspection was conducted on February 5, 2000.

2.0 AIR PHOTO INTERPRETATION AND SITE RECONNAISSANCE

This parcel of property includes the north valley wall of Wascana Creek which is located in an area which has experienced landslide activity in the past. The air photos show a number of old slump blocks along the bottom of the valley wall where slope failures have occurred in the past. The slip surfaces between slump blocks as determined from the air photos and the site inspection are shown on Drawing No. GE-0005-1, attached.

The valley wall has been eroded extensively since it was first formed and the valley has been partially filled with alluvial sediments. The deposition of sediments has helped to stabilize the valley wall. A number of ravines have formed on the valley wall as the result of erosion. The ravines are densely vegetated. Wascana Creek is actively eroding its banks and this has resulted in the formation of oxbows, meander scars and localized areas of instability resulting in slumping along the creek channel.

3.0 STRATIGRAPHY

Based on our air photo analysis and site inspection we anticipate that the slope consists of till material. This type of soil is relatively competent. It is probable that the till unit extends from the top of the valley down to the elevation of the valley floor. The till plain north of the valley wall may be overlain by glaciolacustrine sediments consisting of Regina Clay. The soils in the bottom of the valley are alluvial deposits which could consist of interbedded clay, silt and/or sand.

4.0 DISCUSSION

Development in an area of previous landslide activity involves some risk. The risk is that old landslides may be reactivated or that new ones may occur. In this case, the conditions which caused landsliding in the past no longer exist because of sediments deposited in the bottom of the valley. These sediments act as a buttress to the slope. The till soil at this site is relatively competent although it is highly susceptible to erosion if the surficial vegetation is removed. We conclude that this area is now relatively stable and that the risk of future landslide activity is low.

However, the valley wall is relatively steep and for this reason does not appear suitable for residential development.

5.0 RECOMMENDATIONS

Our preliminary findings indicate that this project is feasible from a geotechnical perspective. However, a detailed geotechnical investigation will be required to determine minimum set back distances for residential development, foundation design recommendations for the club house and residential buildings, design recommendations for lagoon construction and design recommendations for roadways and parking lots.

The soil salinity test results provided by SaskWater did not detect any serious salinity problems. However, a wide variation in soil types was encountered in the bottom of the valley. This may have an affect insofar as lagoon construction is concerned. If the soils at the proposed lagoon site are too sandy, it may be necessary to import more clayey soils from the top of the valley to the lagoon site to construct the liner and dykes of the lagoon.

6.0 CLOSURE

We trust this report satisfies your present requirements. If you have any questions or require additional information, please contact our office.

Yours very truly

GE GROUND ENGINEERING LTD.

Prepared By: [redacted]

Reviewed By: [redacted]

TA:ll
Distribution: [redacted]
ta316 Office (1 copy)

APPENDIX B

3300 - SPECIFICATION FOR SUB-BASE COURSE

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		

(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 63.0 mm sieve.

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) 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 Sub-base aggregate shall be pushed to a trap or into a stockpile prior to screening.

Processing

3.05 The production of sub-base course shall comply with the following:

(a) The Contractor shall cease operations if the moving average for any sieve does not comply with the specified requirements listed in Table 1.

(b) Operations shall not recommence until the specified requirements are met.

(c) Upon recommencement of operations, the specified requirements shall be met on each of the initial 2 tests.

(d) Failure to cease operations shall subject all subsequent materials to the requirements of General Provision 1400-7 (Unacceptable and Unauthorized Work).

Spreading and Compacting

3.06 The thickness of a compacted lift of sub-base course shall not exceed 120 mm. The lift thickness may be increased if the Contractor can demonstrate that with the use of vibratory compaction equipment and construction procedures, the compaction requirements can be achieved for lifts greater than 120 mm.

3.07 Sub-base courses shall be compacted until no further settlement is apparent and the particles are well keyed into place. The sub-base course shall be free from any rutting or deformations before the placement of the next course.

3.08 If excess moisture originating from external causes including but not limited to precipitation and/or Contractor's operation is present in the sub-base course and/or underlying material prior to the acceptance of the completed surfacing structure; the Contractor shall dry the sub-base course and/or the underlying material to the optimum moisture content and compact the sub-base and/or the underlying material to not less than the specified density or the optimum density in accordance with the requirements for Moisture-Density Proctor (STP 205-5).

Stabilizing

3.09 If the sub-base course proves to be unstable, the Engineer shall require the Contractor to stabilize the sub-base aggregate by one or a combination of the following methods:

(a) By the addition of binder or filler at the aggregate source or at the screening plant. The binder or filler shall be added and thoroughly distributed throughout the aggregate until a homogeneous mixture is obtained.

(b) By the addition of crushed aggregate on the road.

(c) By the addition of emulsified asphalt to the compaction water in the proportions designated by the Engineer. The Department shall supply the asphalt.

(d) Any other method proposed by the Contractor and approved by the Engineer.

Seasonal Shutdown

3.10 If work must be carried over from one construction season to the next, there shall be no exposed sub-base aggregate, mix or sub-base course remaining on the road unless covered by a lift of base course.

3300-4 SAMPLING AND TESTING

General

4.01 Unless otherwise specified, test procedures shall be in accordance with Saskatchewan Highways and Transportation's Standard Test Procedures Manual.

4.02 The test procedures in effect on the closing date of the tenders shall apply.

3300 - 5 MEASUREMENT

5.01 Sub-base course shall be measured in tonnes.

3300 - 6 PAYMENT

6.01 Payment for Sub-base Course shall be at the contract unit price per tonne. The contract unit price shall be full compensation for completing the work except for those activities for which specific provision for payment is made in this section.

6.02 If the contract includes a bid item for:

(a) Hauling Sub-base Course and Hauling Binder, Filler And Blender Sand; payment shall be made in accordance with Specification 2405 For Hauling On The Basis Of The Kilometre.

(b) Watering; payment shall be made in accordance with Specification 2500 For Watering.

(c) Binder, Filler And Blender Sand; payment shall be made in accordance with Specification 3400 For Binder, Filler And Blender Sand.

(d) Granular Base Course; payment for Granular Base Course used as stabilizing agent shall be at the contract unit price For Granular Base Course.

(e) Prime, Tack or Flush Coat; payment for emulsified asphalt used as stabilizing agent shall be the contract unit price for Prime, Tack and Flush Coat.

3505 - SPECIFICATION FOR GRANULAR BASE COURSE

3505 - 1 DESCRIPTION

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

1.02 The following definitions shall apply:

(a) Acceptance limit:

The maximum or minimum value for a test result above or below which the section of roadway shall be rejected.

(b) Acceptance testing:

The testing performed to determine compliance with the specification regarding certain requirements, limits and tolerances for the quality of materials and workmanship to be supplied.

(c) Base aggregate:

The aggregate before pugmilling.

(d) Base mix:

The mix after pugmilling, but before spreading.

(e) Base course:

The mix in place on the road during and after spreading and compacting.

(f) Mean:

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

(g) Moving average:

The arithmetic mean of 3 consecutive test results.

(h) Surface defects:

Surface defects that are due to the Contractor's operation shall include but shall not be limited to the following:

(i) Potholing.

(ii) Surface failures.

(iii) Ravelling.

(iv) Rutting.

(v) Bumps or dips.

(vi) Irregular cross slopes.

(vii) Segregation.

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.

Reject Aggregate

3.06 If the Contractor is required to reject a fraction of the raw aggregate to meet the aggregate requirements in Table 1, the following shall apply:

(a) The raw aggregate shall be screened over a maximum 9.0 mm square opening screen or a 5.0 mm slotted screen prior to crushing.

(b) The Contractor shall be responsible for the rejected material up to a maximum of 10% of the raw aggregate by weight.

(c) The quantity of raw aggregate shall be calculated as follows:

Raw aggregate = (Granular base course less binder, filler and blender sand) x 1.11

Processing

3.07 Base mix production shall comply with the following requirements during the pugmilling stage:

(a) The Contractor shall cease operations if the moving average for any sieve does not comply with the specified requirements listed in Table 1.

(b) Operations shall not recommence until the specified requirements are met.

(c) Upon recommencement of operations, the specified requirements shall be met on each of the initial 2 tests.

(d) Failure to cease operations shall subject all subsequent materials to the requirements of General Provision 1400-7 (Unacceptable and Unauthorized Work).

3.08 Base aggregate shall be stockpiled after the crushing operation and prior to the pugmilling.

3.09 During pugmilling operations, the Contractor shall have sufficient base aggregate in stockpile for at least 24 h of pugmilling operation until crushing is completed.

3.10 Pugmilling shall be performed in a stationary mixing plant. The mixing unit shall be designed to ensure complete mixing of the materials.

3.11 The pugmill shall be equipped with spray bars for the addition of water.

3.12 The moisture content of the base mix shall not be greater than 5 % by weight when it leaves the pugmill.

Spreading And Compacting

3.13 Base mix shall be spread on dry and unfrozen surfaces.

3.14 Base mix shall not be compacted if the atmospheric temperature is less than 2 °C.

3.15 Base course spilled on new asphalt concrete shall be removed immediately.

3.16 The finished surface of the base course shall be true to grade and cross section and free of any surface defects.

3.17 If specified in the Special Provisions or shown on the plans, a prime coat shall be placed on the finished final lift of base course in accordance with Specification 4000 For Bituminous Prime, Tack, And Flush Coat. Prime coat shall be placed within 24 h, weather permitting, after receiving written authorization from the Engineer.

3.18 If a seal coat is specified for shoulder base course, the surface of the final lift of shoulder base course shall be *constructed 10 mm below the surface of the final lift of the wearing course.*

3.19 If excess moisture originating from external causes including but not limited to precipitation and/or Contractor's operation is present in the subgrade and/or sub-base course and/or base course prior to the acceptance of the completed surfacing structure; the Contractor shall dry the subgrade and/or sub-base course and/or base course to the optimum moisture content and compact the subgrade and/or sub-base course and/or base course to not less than the specified density or the optimum density in accordance with the requirements for Moisture-Density Proctor (STP 205-5).

Seasonal Shutdown

3.20 If work must be carried over from one construction season to the next and the number of working days/completion date have not expired, the following shall apply:

(a) For accepted final lift of base course on which a wearing course has not been placed, the following shall apply:

(i) At the time seasonal operations cease, a prime coat, seal coat, or asphalt concrete shall be placed on the full width of base course as directed by the Engineer.

(ii) The Department shall bear all the costs including materials for placing the prime coat, seal coat, and asphalt concrete on the full width of base course up to a maximum length of 1.5 km.

(iii) The Contractor shall bear all the costs including materials for placing the prime coat, seal coat, and asphalt concrete on the full width of base course on all other sections outside the 1.5 km limit. The Contractor may remove the base course in lieu of placing a prime coat, seal coat or asphalt concrete on it.

(iv) When work resumes, the Department shall bear the cost of removing the prime coat, seal coat, and asphalt concrete if required and remedying unacceptable base course including replacing the prime and prime materials on the 1.5 km limit.

(v) When work resumes, the Contractor shall bear the cost of removing the prime coat, seal coat, and asphalt concrete if required and remedying unacceptable base course including replacing the prime and prime materials on all other sections outside the 1.5 km limit.

(b) For unaccepted base course and accepted lower lifts of base course, the following shall apply:

(i) At the time seasonal operations cease, a prime coat, seal coat, or asphalt concrete shall be placed on the full width of base course as directed by the Engineer.

(ii) The Department shall bear all the costs including materials for placing the prime coat, seal coat, and asphalt concrete on the full width of base course up to a maximum length of 1.5 km.

(iii) The Contractor shall bear all the costs including materials for placing the prime coat, seal coat, and asphalt concrete on the full width of base course on all other sections outside the 1.5 km limit. The Contractor may remove the base course in lieu of placing a prime coat, seal coat or asphalt concrete on it.

(iv) When work resumes, the Department shall bear the cost of removing the prime coat, seal coat, and asphalt concrete if required and remedying unacceptable base course including replacing the prime and prime materials on the 1.5 km limit.

(v) When work resumes, the Contractor shall bear the cost of removing the prime coat, seal coat, and asphalt concrete if required and remedying unacceptable base course including replacing the prime and prime materials on all other sections outside the 1.5 km limit.

3.21 If work must be carried over from one construction season to the next and the number of working days/completion date have expired, the following shall apply:

(a) For accepted final lift of base course on which a wearing course has not been placed, the following shall apply:

(i) At the time seasonal operations cease, a prime coat, seal coat, or asphalt concrete shall be placed on the full width of base course as directed by the Engineer.

(ii) The Department shall bear all the costs including materials for placing the prime coat, seal coat, and asphalt concrete on the full width of base course up to a maximum length of 1.0 km.

(iii) The Contractor shall bear all the costs including materials for placing the prime coat, seal coat, and asphalt concrete on the full width of base course on all other sections outside the 1.0 km limit. The Contractor may remove the base course in lieu of placing a prime coat, seal coat or asphalt concrete on it.

(iv) When work resumes, the Contractor shall bear the costs of removing the prime coat, seal coat, and asphalt concrete if required and remedying unacceptable base course including replacing the prime and prime materials on all sections of base course.

(b) For unaccepted base course and accepted lower lifts of base course, the following shall apply:

(i) At the time seasonal operations cease, a prime coat, seal coat, or asphalt concrete shall be placed on the full width of base course as directed by the Engineer.

(ii) The Contractor shall bear all the costs including materials for placing the prime coat, seal coat, and asphalt concrete on the full width of base course. The Contractor may remove the base course in lieu of placing a prime coat, seal coat or asphalt concrete on it.

(iii) When work resumes, the Contractor shall bear the costs of removing the prime coat, seal coat, and asphalt concrete if required and remedying unacceptable base course including replacing the prime and prime materials on all sections of base course.

3.22 The Contractor shall bear the cost of maintenance, except snow and ice removal, on sections of roadway where the road surface has been disturbed by the construction operations.

3505 - 4 SAMPLING AND TESTING

General

4.01 Unless otherwise specified, test procedures shall be in accordance with Saskatchewan Highways and Transportation's Standard Test Procedures Manual.

4.02 The test procedures in effect on the closing date of the tenders shall apply.

Acceptance Testing

4.03 Upon notification from the Contractor that a section of the roadway has been inspected and is ready for acceptance testing, the Engineer shall carry out the required tests for density and surface defects.

Acceptance Testing for Density

4.04 The maximum density value and the corresponding optimum moisture content shall be determined in accordance with the requirements for Moisture-Density Proctor (STP 205-5).

4.05 Densities shall not be taken at locations within 0.5 m of an unsupported edge and 0.1 m of a supported edge.

4.06 Acceptance testing for density of the base course on the road shall be determined in accordance with the requirements for Density-In-Place By Nuclear Gauge (STP 205-7).

4.07 Frequency and locations of testing on any section shall be at the discretion of the Engineer.

3505 - 5 ACCEPTANCE OR REJECTION

5.01 The section of base course shall be considered acceptable if it contains no surface defects and if:

(a) The average density meets or exceeds 100 % of maximum density.

(b) All individual test results are greater than 98 % of maximum density.

(c) The moisture content is less than or equal to the optimum moisture content.

5.02 If shoulder base course is placed in a separate operation and shoulder base course is the final wearing course; the section of shoulder base course shall be considered acceptable if it contains no surface defects and if:

(a) The average density meets or exceeds 95.0 % of maximum density.

(b) All individual test results are greater than 93.0 % of maximum density.

(c) The moisture content is less than or equal to the optimum moisture content.

Product Rejection

5.03 If the densities for any section of the roadway are outside the acceptance limits outlined in Sections 5.01 and 5.02, the section shall be rejected as unacceptable work and the following shall apply:

(a) The Contractor shall have the opportunity to remedy existing base course by rerolling or by any other method suggested by the Contractor and approved by the Engineer. The Contractor may request that the section of the roadway be retested during or after the completion of the remedial attempts.

(b) The section shall be tested a total of 3 times free of cost to the Contractor. The Contractor shall pay the cost of any additional testing. The rate for the Department testing shall be as designated in the Special Provisions.

(c) If the base course in the section remains outside the acceptance limits after the remedial attempts, the Contractor shall remove and replace all the base course in that section. The Engineer may approve a base course overlay of equal thickness in lieu of removing and replacing the base course.

5.04 Any section with surface defects shall be rejected as unacceptable work.

Repairs

5.05 Surface defects shall be repaired in a manner acceptable to the Engineer.

3505 - 6 MEASUREMENT

6.01 Granular base course shall be measured in tonnes.

6.02 Reject aggregate shall be measured by the cross section method. The volume of reject shall be multiplied by 1.7 to calculate tonnes.

3505 - 7 PAYMENT

7.01 Payment for Granular Base Course and Granular Shoulder Base Course shall be at the contract unit price per tonne. The unit price shall be full compensation for completing the work except for those activities for which specific provision for payment is made in this section.

7.02 The rate that the Department shall pay for rejecting aggregate in excess of 10% shall be as designated in the Special Provisions of the contract.

7.03 If the contract includes a bid item for:

(a) Hauling Granular Base Course, Hauling Granular Shoulder Base Course and/or Hauling Binder, Filler And Blender Sand; payment shall be made in accordance with Specification 2405 For Hauling On The Basis Of The Kilometre.

(b) Watering; payment shall be made in accordance with Specification 2500 For Watering.

(c) Binder, Filler And Blender Sand; payment shall be made in accordance with Specification 3400 For Binder, Filler And Blender Sand.

(d) Prime, Tack or Flush Coat; payment shall be made in accordance with Specification 4000 For Bituminous Prime, Tack And Flush Coat.

7.04 All remedial work shall be performed at the Contractor's expense including the cost of materials.

4100 - 1 DESCRIPTION

1.01 The work shall consist of mixing aggregates, reclaimed asphalt concrete and asphalt, and spreading and compacting the mixture on a prepared surface.

1.02 The following definitions shall apply for this specification:

(a) Acceptance limit:

The maximum or minimum value for a test result above or below which the sublot or lot shall be rejected.

(b) Acceptance testing:

The testing performed by the Engineer to determine compliance with the specifications regarding specified requirements, limits and tolerances for the quality of materials and workmanship supplied.

(c) Asphalt:

The asphalt material being added as bituminous binder.

(d) Asphalt concrete:

The asphalt mix in place on the road including levelling and surface courses, during and after spreading and compacting.

(e) Asphalt mix:

The mix after the asphalt mix aggregate and asphalt have been blended together.

(f) Asphalt mix aggregate:

The aggregate after all virgin aggregates, reclaimed asphalt concrete and additives have been combined.

(g) Asphalt mix design:

The laboratory determination of the precise proportions of asphalt, all virgin aggregates, reclaimed asphalt concrete and additives to be blended together to meet the specified properties for the asphalt mix.

(h) Lot:

A portion of asphalt concrete that is one paver width wide and 1 000 m long. The lot shall be assessed as a unit for the purpose of payment and selected to represent work produced by essentially the same process and materials. The first and last lot on each construction section may vary in length from 600 m to 1 599 m. Any portion that is less than 600 m shall be added to the adjacent lot.

(i) Mean:

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

(j) Moving average:

The arithmetic mean of 3 consecutive test results.

(k) Reclaimed asphalt concrete:

The asphalt concrete reclaimed from the roadway.

(l) Segregated area:

An area 0.1 m^2 or greater where the surface texture is either too stony or lacking in continuous matrix of asphalt and fine aggregate with the coarse aggregate in relation to the surrounding acceptable asphalt concrete.

(m) Segregation severity

(i) None:

Completely uniform surface texture. The matrix of asphalt and fine aggregate is in place between the coarse aggregate.

(ii) Minor:

Significantly more stone is visible than in the surrounding acceptable asphalt concrete usually with a lack of continuous contact with the surrounding matrix.

(iii) Severe:

Areas that usually appear as very stony mix, with stone against stone and may be missing matrix.

(n) Sublot:

For density, a sublot is a 200 m portion of a lot. A sublot may vary in length from 100 m to 299 m. Any portion that is less than 100 m shall be added to the adjacent sublot.

For smoothness, a sublot is a portion of the final lift of asphalt concrete that is one paver width wide and 100 m long. The first and last sublot on each construction section may be less than 100 m long.

(o) Surface defects:

Surface defects that are due to the Contractor's operation shall include but shall not be limited to the following:

(i) Areas of segregation less than 0.1 m^2.

(ii) Areas containing excess or insufficient asphalt.

(iii) Areas of open texture.

(iv) Improper matching of longitudinal and transverse joints on final lift only.

(v) Roller marks on final lift of asphalt concrete.

(vi) Cracking or tearing.

(vii) Contamination by diesel, hydraulic fluids or other harmful products.

(viii) Foreign objects or materials that are detrimental to the asphalt concrete.

4100 - 2 MATERIALS

Asphalt

2.01 The Department shall supply and pay for the asphalt and anti-stripping agents.

Aggregate

2.02 Virgin 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 and organic or other deleterious material.

4100-3 CONSTRUCTION

General

3.01 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 The Removal Of Overburden.

(b) Rock passing a 610 mm square opening screen and larger than the maximum specified size shall be crushed and incorporated simultaneously throughout the crushing operation.

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

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

3.03 The Contractor shall supply the equipment necessary to add a liquid anti-stripping agent or lime when specified by the Engineer. If liquid anti-stripping agent is specified it shall be added in-line with the liquid asphalt when it is being pumped into the storage tank. If lime is specified as an anti-stripping agent the following shall apply:

(a) The hydrated lime shall be blended by a pugmill into the cold aggregate feed. The lime shall be added at a rate of approximately 1% by weight.

(b) Sufficient water shall be added at the pugmill to ensure a minimum 3% moisture content in the aggregate.

Aggregate

3.04 The Contractor shall split the aggregate into 3 separate stockpiles in accordance with the following:

(a) The natural fines stockpile shall be produced by screening the raw aggregate over a maximum 9.0 mm square opening screen or 5.0 mm slotted screen prior to crushing.

(b) The aggregate retained on the screen used in section 3.04 (a) shall be crushed and split into crushed coarse and crushed fine stockpiles.

(c) The crushed coarse stockpile shall contain no more than 10% of the material passing the 5.0 mm square opening sieve.

(d) The crushed fine stockpile shall contain no less than 90% of the material passing the 5.0 mm square opening sieve.

(e) The Contractor shall provide accurate measurements of quantities and percentages of aggregate being placed in each stockpile after producing 50% of the aggregate or 10 000 t, whichever is greater; or when all the aggregate is produced if the total quantity is less than 10 000 t.

3.05 The crushed coarse, crushed fines and natural fines stockpiles shall be mathematically recombined at the percentages provided by the Contractor. If the resulting aggregate does not meet the requirements of Table 1, the Contractor shall be required to reject a fraction of the material in the natural fines stockpile in accordance with section 3.08.

TABLE 1

Property	Aggregate Type		
	70	71	72
Sieve Designation	Percent by Weight Passing Canadian Metric Sieve Series		
18.0 mm	100.0		
16.0 mm	78.0-98.0	100.0	
12.5 mm	68.0-92.0	78.0-98.0	100.0
9.0 mm		66.0-90.0	76.0-92.0
5.0 mm	38.0-65.0	46.0-72.0	56.0-78.0
400 um	9.0-25.0	10.0-27.0	14.0-30.0
71 um	2.0-9.0	2.0-9.0	2.0-10.0
Sand Equivalent	45.0 Minimum		
Fractured Face %	45.0 Minimum	45.0 Minimum	55.0 Minimum

3.06 If recycled asphalt concrete is designated in the contract the following shall apply:

(a) The crushed coarse, crushed fines and natural fines stockpiles shall be recombined mathematically at the percentages provided by the Contractor. If the resulting aggregate does not meet the requirements of Table 2, the Contractor shall be required to reject a fraction of the material in the natural fines stockpile in accordance with section 3.08.

TABLE 2

Property	Aggregate Type For Recycled Asphalt Concrete		
	70 R	71 R	72 R
Sieve Designation	Percent by Weight Passing Canadian Metric Sieve Series		
18.0 mm	100.0		
16.0 mm	78.0-98.0	100.0	
12.5 mm	68.0-92.0	78.0-98.0	100.0
9.0 mm		66.0-90.0	76.0-92.0
5.0 mm	38.0-65.0	46.0-72.0	56.0-78.0
400 um	9.0-25.0	10.0-27.0	14.0-30.0
71 um	0-6.0	0-6.0	0-6.0
Sand Equivalent	45.0 Minimum		
Fractured Face %	45.0 Minimum	45.0 Minimum	55.0 Minimum

3.07 A tolerance of 3% in the percent by weight passing the maximum size sieve shall be permitted providing 100% of the oversize passes the 22.4 mm sieve for Type 70 and Type 70 R aggregate, the 18.0 mm sieve for Type 71 and Type 71 R aggregate and the 16.0 mm sieve for Type 72 and Type 72 R aggregate.

Reject Aggregate

3.08 If the Contractor is required to reject a fraction of the material in the natural fines stockpile to meet the aggregate requirements in Table 1 and Table 2, the following shall apply:

(a) The Contractor shall be responsible for the rejected material up to a maximum of 10% of the raw aggregate by weight.

(b) The quantity of raw aggregate shall be calculated as follows:

Raw aggregate = Asphalt concrete less reclaimed asphalt concrete (as shown in contract) x 1.11

Asphalt Mix Design

3.09 The asphalt mix design shall be established by the Engineer in accordance with the requirements for Marshall Mix Design (STP 204-10) within 10 calendar days after 50% of the aggregate has been produced or 10 000 t, whichever is greater, and provided that the Contractor has complied with section 3.04 (d).

3.10 The compactive effort for preparation of the Marshall specimen shall be 50 blows.

Plant Requirements

3.11 The plant shall comply with the following:

(a) The total flow of aggregate shall be metered by an electronic weigh belt system with an indicator that can be monitored by the plant operator and which is interlocked with a variable speed positive displacement pump so that the proportions of aggregate and asphalt entering the mixer remain constant.

(b) The weighing system for aggregate and asphalt shall have provision to enable easy calibration, without having the material enter the mixer.

(c) The plant shall be equipped with heat sensing devices to indicate the temperature of:

(i) on a conventional plant, the dried aggregate at the discharge end of the drier;

(ii) on a drum mixer, the asphalt mix at the discharge end of the drum and the emissions from the stack.

3.12 The mixer shall be a twin shaft pugmill or a drum mixer.

3.13 The drier of a conventional plant shall be equipped with a dust collector.

3.14 If reclaimed asphalt concrete is added, the following shall apply:

(a) The reclaimed asphalt concrete shall be added using a separate conveyor system capable of accurately proportioning the required percentage of reclaimed asphalt concrete.

(b) The reclaimed asphalt concrete shall not exceed 40 mm when measured in any direction before entering the plant.

(c) The reclaimed asphalt concrete shall be protected from any direct flame contact.

(d) The Contractor shall undertake all the necessary adjustments to ensure proper heat transfer and breakdown of the reclaimed asphalt concrete to form a homogeneous end product.

Plant Operation

3.15 A uniform mixture shall be produced in which all particles are thoroughly coated. Aggregate particles shall not be coated with residue from fuel combustion.

3.16 The Contractor shall immediately shut down the plant when:

(a) the stack emissions temperature exceeds the asphalt mix temperature at the mixer discharge by more than 20°C or;

(b) the temperatures exceed the limits outlined in the following table:

Grade of Asphalt	DEGREES CELSIUS Maximum Temperature of Dry Aggregates	Asphalt Storage Temperature	Asphalt Mix Temperature at Mixer Discharge
150-200A			
200-300A	160	120-175	125-135
300-400A	150	114-175	110-130
400-500A	140	110-175	105-120

3.17 All material produced subsequent to the occurrence of an event specified in section 3.16 shall be deemed to be unacceptable material for the purposes of General Provision 1400-7 (Unacceptable And Unauthorized Work).

3.18 Plant operations shall not recommence until the temperature limits in section 3.16 are met.

3.19 For the initial 24 h of plant production at each plant set-up, the percentage of asphalt added shall not vary by more than 0.5% from the design asphalt content. Full scale plant production shall not commence until the percentage of asphalt added to trial batches of asphalt mix complies with the foregoing requirement.

3.20 The Contractor shall cease operations if after the initial 24 h of production the moving average for the percent of asphalt added varies by more than 0.3% from the design asphalt content.

3.21 After the asphalt mix gradation has been established, the following shall apply:

(a) The Contractor shall cease operations if the moving average for any sieve does not comply with the specified requirements listed below:

Sieve Designation	Maximum Permissible Variation from the Asphalt Mix Design Percent By Weight Passing Canadian Metric Sieve Series
16.0 mm	±5.0
12.5 mm	±5.0
9.0 mm	±5.0
5.0 mm	±5.0
2.0 mm	±4.0
900 um	±3.0
400 um	±3.0
160 um	±2.0
71 um	±1.5

(b) Road operations shall not recommence until the specified requirements are met.

(c) Upon recommencement of operations the specified requirements shall be met on each of the initial 2 tests.

(d) Failure to cease operations shall subject all subsequent materials to the requirements of General Provision 1400-7 (Unacceptable and Unauthorized Work).

3.22 The asphalt mix shall contain no more than 1.5% moisture by weight.

3.23 The Contractor shall dispose of any rejected asphalt mix in a manner that is acceptable by the Engineer.

Delivering to the Road

3.24 The asphalt mix shall be hauled in vehicles previously cleaned of all accumulations of asphalt mix and foreign materials. Gasoline, kerosene, diesel or other similar products shall not be used for lubricating truck boxes if they adversely contaminate the asphalt mix.

3.25 The asphalt mix shall be protected from precipitation and excessive heat loss.

3.26 Prior to unloading into the paver, the temperature at a depth of 40 mm below the surface of the asphalt mix shall not be less than 105°C.

3.27 Trucks shall be turned around only at approaches.

Pavers

3.28 Pavers shall be self propelled units capable of spreading and finishing the asphalt concrete to the specified typical cross section and thickness shown on the paving plans. For traffic lanes, pavers shall be equipped with:

(a) Automatic screed controls, for the control of longitudinal and transverse slope and joint matching. The automatic control device shall be capable of being operated from either side of the paver.

(b) Screed with hydraulic extensions.

Spreading

3.29 A tack coat shall be applied in accordance with Specification 4000 For Bituminous Prime, Tack And Flush Coat.

3.30 Asphalt mix shall be spread on dry, clean and unfrozen surfaces.

3.31 Asphalt concrete shall not be placed if the atmospheric temperature is less than 2°C.

3.32 The final lift of asphalt concrete shall not be placed if:

(a) the atmospheric temperature is less than 5°C; or

(b) the surface temperature is less than 7°C;

from September 24 to the date on which the Contractor ceases operations during any year.

3.33 The thickness of a compacted lift of asphalt concrete shall be not less than 1.5 times the maximum particle size of the asphalt mix aggregate nor greater than 60 mm.

3.34 Longitudinal joints shall not be permitted in any lane on the final lift of asphalt concrete.

3.35 The asphalt mix temperature in the paver shall not be less than 105 °C.

3.36 Contact faces of curbs, gutters, manholes, and sidewalks shall be coated with asphalt using a hand applicator before placing the asphalt mix.

3.37 When paving is discontinued in any lane, the asphalt concrete shall be feathered to a slope of 10 horizontal to 1 vertical. When paving is resumed, the transverse joint shall be straight and have a vertical face when the taper is removed.

3.38 Asphalt mix shall not be placed or allowed to fall on previously laid top lift asphalt concrete or the existing asphalt concrete when it is not to be overlaid.

3.39 Transverse construction joints from one lift to the next shall be separated by at least 2 m.

3.40 Road intersections and approaches shall be paved in accordance with the plans or as directed by the Engineer.

3.41 If designated by the Engineer, a flush coat shall be applied in accordance with Specification 4000 For Bituminous Prime, Tack And Flush Coat.

Compacting

Control Strip

3.42 At the beginning of work, the Contractor shall construct a control strip to establish a rolling pattern for achieving a density of not less than 97% of the Marshall density. The control strip shall comply with the following:

(a) The control strip shall have a length of at least 250 m and shall be of the same thickness as the lift it represents.

(b) The material used shall conform to the requirements of the asphalt concrete stated in the contract.

(c) The Engineer and/or the Contractor at any time may order the construction of new control strip if there are reasons to indicate that the paving operation, the mix design or lift thickness have been altered.

(d) Compaction shall commence immediately and shall be completed before the temperature of the asphalt concrete falls below 55°C for 150-200 A and 200-300 A asphalt concrete mixes and 40 °C for 300-400 A and 400-500 A asphalt concrete mixes.

(e) Compaction shall continue until a minimum 97% of the Marshall density is achieved or until no appreciable increase in the density can be achieved even with the use of pneumatic tired rollers with a minimum pressure of 620 kPa and having the tire size and wheel load indicated in the chart below:

Tire Size (mm)	Minimum load per tire (kg)
190.5 x 381.0	1 600
228.5 x 508.0	2 060
279.4 x 508.0	2 700

(f) If a minimum 97% of the Marshall density is not achieved then the value of the maximum density achieved after complying with section 3.42 (e) shall be used as the target density.

(g) The speed of steel rollers shall not exceed 5 km/h and the speed of pneumatic rollers shall not exceed 8 km/h.

(h) The control strip, if accepted, shall remain in place and shall become part of the completed work.

3.43 Each lift of asphalt concrete shall be compacted to not less than 97% of the Marshall density established for the sublot in accordance with the following:

~~(a) The Marshall density for the sublot shall be established using a 3 point moving average.~~

(b) When a new moving average is initiated, it shall include the entire sublot where the sample is taken and shall apply to subsequent sublots until the next 3 point moving average is established.

(c) A new moving average shall be initiated for each new asphalt mix design.

3.44 Longitudinal joints shall be rolled directly behind the paver.

3.45 Traffic shall not be allowed to travel on the finished surface until the temperature of the asphalt concrete has reached 65°C or less. Watering shall be permitted to cool the asphalt concrete.

4100 - 4 SAMPLING AND TESTING

General

4.01 Unless otherwise specified, test procedures shall be in accordance with Saskatchewan Highways and Transportation's Standard Test Procedures Manual.

4.02 The test procedures in effect on the closing date of the tenders shall apply.

4.03 The failure of the Engineer to provide test results within the time provided in this specification shall not relieve the Contractor of his obligation to remedy any defect, but the Department shall be obligated to reimburse the Contractor for any additional costs incurred by the Contractor to remedy the defect if the additional costs are attributable to the delay in receiving results.

Acceptance Testing

4.04 Within this specification, certain requirements, limits and tolerances are specified regarding the quality of materials and workmanship to be supplied. Compliance with these requirements where so specified, shall be judged by testing as described in this section. These tests cannot be disputed on the grounds of statistical theory or a specified or implied Contractor's risk.

4.05 Sampling and acceptance testing for density shall be in accordance with the following:

(a) Upon notification from the Contractor that a sublot has been inspected and is ready for acceptance testing, the Engineer shall locate 3 test sites in the sublot in accordance with the requirements for Sampling Location By Random Method (STP 107).

(b) At each test site, the Engineer shall measure the density in accordance with requirements for Density-In-Place By Nuclear Gauge (STP 204-6) and the following:

(i) if the first test result is greater than 98.0%, no further testing shall be conducted for the sublot; or

(ii) if the first test result is less than 98.0%, the additional 2 test sites shall be tested and the 3 tests shall be averaged for the sublot.

(c) The Engineer shall develop a correlation between the results of the nuclear gauge and the results of the asphalt concrete cores obtained from the compacted lift of asphalt concrete. The density results obtained from the cores shall be used to correct the density results obtained from the nuclear gauge.

(d) Testing shall be conducted prior to placement of the next lift of asphalt concrete.

(e) The Engineer shall provide the Contractor with a copy of the results of acceptance tests within 2 calendar days of receiving notification from the Contractor that the sublot is ready for acceptance testing. When all the density acceptance tests for a lot are completed, the Engineer shall advise the Contractor, as to the acceptability of the lot with respect to density.

4.06 If the remedial work by the Contractor on a rejected sublot involves either the overlaying or the removal and replacement of the asphalt concrete in the sublot, all test results from acceptance testing performed on the rejected sublot prior to the remedial work shall be discarded and new sampling and acceptance testing shall be performed in accordance with section 4.05.

4.07 Sampling and acceptance testing for smoothness shall be in accordance with the following:

(a) The surface of the sublots shall be profiled by the Engineer using a Cox Profilograph in accordance with the requirements for Roughness Profile With Profilograph (STP 222).

(b) If a sublot has been rejected the surface of the sublot shall not be profiled.

(c) The Engineer shall provide the Contractor with a copy of the results of acceptance tests for smoothness within 12 calendar days of the placement of the asphalt concrete.

(d) When all the acceptance tests for a lot are completed, the Engineer shall advise the Contractor as to the acceptability of the lot with respect to smoothness.

4.08 Sampling and acceptance testing for segregation shall be in accordance with the following:

(a) Each lane-km including the shoulder shall be inspected for areas of segregation.

(b) The Engineer shall provide the Contractor with the locations of the visually identified segregation after receiving notification from the Contractor that the sublot is ready for acceptance testing in accordance with the following:

(i) within 12 calendar days during the course of the construction; and

(ii) within 4 calendar days after the completion of the asphalt concrete on the project.

(c) A segregated area shall be categorised by the worst condition prevalent for 50% or more of the length of the segregated area.

(d) If the worst condition in a segregated area is not prevalent for 50% of the length of the area, then the area shall be measured in relation to the length of minor and severe segregation.

(e) Segregation on the shoulder shall be excluded from the segregation severity and segregation frequency pay adjustments.

(f) Each lane-km shall be inspected for segregation frequency.

(g) The segregation frequency is determined by counting all segregated areas, minor and severe, 0.1 m^2 or greater in a lane-km.

(h) Continuous or semi-continuous longitudinal segregation shall result in the lane-km being assessed a value of 1 for each 50 m length.

(i) For the purpose of area calculations, the segregation severity is to be measured across the full lane width for severe and half lane width for minor.

(j) If the minor segregation is more than one half the lane width or is across the centre of the lane, the full width shall be used.

4.09 Sampling and acceptance testing for surface defects shall be in accordance with the following:

(a) Each lane-km including the shoulder shall be inspected for surface defects.

(b) The Engineer shall provide the Contractor with the locations of the visually identified surface defects after receiving notification from the Contractor that the sublot is ready for acceptance testing in accordance with the following:

(i) within 12 calendar days during the course of the construction; and

(ii) within 4 calendar days after the completion of the asphalt concrete on the project.

(c) Surface defects on the shoulder shall be excluded from frequency of surface defects pay adjustments.

4.10 The results of acceptance testing for density, smoothness, segregation and surface defects shall be used to accept or reject the sublot and/or lot.

4.11 The results of acceptance testing for density, smoothness, segregation and surface defects shall be used to establish the extent of pay adjustments as defined in Tables 3, 4, 5, 6 A, 6 B, 7 and 8.

4.12 Initial acceptance testing including the marking of bumps, dips, segregated areas and surface defects shall be performed free of cost to the Contractor. The Contractor shall pay the cost of all retesting performed following the remedying of work in any sublot that has been rejected excluding acceptance testing for segregation and surface defects. The rate for Department testing shall be as designated in the Special Provisions of the contract.

Exclusions to Random Sampling

4.13 Random sampling methods shall not apply to the following:

(a) Smoothness.

(b) Small areas such as approaches, tapers, areas of handwork and gores.

(c) Areas of visually identified segregation.

(d) Areas of surface defect repair.

Appeal of Acceptance Test Results And Appeal Testing

4.14 Appeal of the acceptance test results for smoothness shall be in accordance with the following:

(a) Within 2 calendar days of receipt of the acceptance test results for a sublot, the Contractor may appeal the test results by requesting verification tests.

(b) Retesting shall be performed by the Department and the new results shall be binding on the Contractor and the Department.

(c) If the verification testing does not result in a decrease of the pay adjustments for the sublot, all testing costs incurred during the appeal procedure shall be paid by the Contractor. The rate for Department testing shall be as designated in the Special Provisions of the contract.

4.15 Appeal of the acceptance test results for segregation shall be in accordance with the following:

(a) Within 6 calendar days of receipt of the locations of the visually identified segregation, the Contractor may appeal the results by requesting verification tests.

(b) The Engineer shall obtain a core sample at a location that is representative of the area being considered. The core sample shall be obtained in accordance with the requirements for Asphalt Concrete Samples Obtained By Coring (STP 204-5). The Engineer shall determine the density, asphalt content and the asphalt mix gradation of the sample.

(c) The area shall be considered minor segregation if the test results indicate:

(i) a density of 94% or higher but less than 97% of the Marshall density established for the sublot;

(ii) the asphalt content deviates by more than 0.3% but not more than 0.6% from the design asphalt content; or

(iii) the asphalt mix gradation does not comply with the requirements specified in section 3.21.

(d) The area shall be considered severe segregation if the test results indicate:

(i) a density below 94% of the Marshall density established for the sublot;

(ii) the asphalt content deviates by more than 0.6% from the design asphalt content; or

(iii) the asphalt mix gradation does not comply with the requirements specified in section 3.21.

(e) If the verification testing does not result in a decrease of the pay adjustments for the area, all testing costs incurred during the appeal procedure shall be paid by the Contractor. The rate for Department testing shall be as designated in the Special Provisions of the contract.

4.16 The Engineer shall provide the Contractor with a copy of the results of verification tests within 6 calendar days of receipt of the request for verification tests.

4.17 If the Engineer determines that certain test results are faulty due to testing equipment malfunction, improper testing procedures or calculations, retesting shall be performed at the expense of the Department.

4100 - 5 ACCEPTANCE OR REJECTION

5.01 Acceptance of any lot at full payment shall occur if:

(a) The average density of the asphalt concrete in the lot meets or exceeds 97.0% of the established Marshall densities and the density of the asphalt concrete in each sublot meets or exceeds 94.0% of the Marshall density established for the sublot.

(b) The smoothness of the final lift of asphalt concrete in each sublot meets the following Profile Index (PrI) requirements:

(i) on tangents and horizontal curves having a centreline radius of 600 m or more the PrI shall not exceed 15 mm per 100 m;

(ii) on horizontal curves having a centreline radius of less than 600 m and on the transition portions of such curves, on sublots within 50 m of a bridge or railway crossing and on the sublot at each construction limit of the contract the PrI shall not exceed 20 mm per 100 m; and

(iii) individual bumps/dips do not exceed 8 mm as measured in the vertical direction.

(c) There is no segregation in the final lift of asphalt concrete and the number of surface defects in the final lift of asphalt concrete is less than 6 per lane-km in accordance with Table 7.

(d) All segregation and surface defects have been repaired in a manner that is acceptable to the Engineer.

5.02 Acceptance of any lot at reduced payment shall occur if:

(a) The average density of the asphalt concrete in the lot is less than 97.0% of the established Marshall densities and the density of the asphalt concrete in each sublot meets or exceeds 92.5% of the Marshall density established for the sublot.

(b) The smoothness of the final lift of asphalt concrete in each sublot does not meet the PrI requirements outlined in section 5.01 (b) but meets the following PrI requirements:

(i) on tangents and horizontal curves having a centreline radius of 600 m or more the PrI shall not exceed 23 mm per 100 m;

(ii) on horizontal curves having a centreline radius of less than 600 m and on the transition portions of such curves, on sublots within 50 m of a bridge or railway crossing and on the sublot at each construction limit of the contract the PrI shall not exceed 28 mm per 100 m; and

(iii) individual bumps/dips do not exceed 12 mm as measured in the vertical direction.

(c) There is segregation in the final lift of asphalt concrete and the number of surface defects in the final lift of asphalt concrete is greater than 5 per lane-km in accordance with Table 7.

(d) All segregation and surface defects have been repaired in a manner that is acceptable to the Engineer.

5.03 If the acceptance test results on a sublot indicate a pay adjustment for density, the Contractor shall be allowed one opportunity to reroll the sublot if the density is less than 94.0%.

5.04 If the acceptance test results on a sublot indicate a pay adjustment for smoothness, additional work to increase the smoothness shall not be allowed, except for the repair of individual bumps and dips that exceed 12 mm.

5.05 If the acceptance test results on a sublot indicate a pay adjustment for smoothness, additional work to repair individual bumps and dips from 9 mm to 12 mm shall not be permitted.

Product Rejection

5.06 The lot shall be rejected as unacceptable work if:

(a) The density for a sublot or a lot are outside the acceptance limit outlined in section 5.02 (a).

(b) The smoothness of the final lift in a sublot is outside the acceptance limits outlined in section 5.02 (b).

(c) Severe segregation is present in any lift of asphalt concrete below the final lift.

(d) If segregation and surface defects have not been repaired in a manner that is acceptable to the Engineer.

Repairs

5.07 If the density of a sublot is outside the acceptance limit outlined in section 5.02 (a), the Contractor shall be allowed one opportunity to reroll the sublot. If after rerolling, the density of the sublot remains outside the acceptance limit, the sublot shall be repaired by removing and replacing all the asphalt concrete in the sublot.

5.08 If the smoothness of the final lift of asphalt concrete in a sublot is outside the acceptance limits outlined in section 5.02 (b), the sublot shall be repaired by either overlaying or removing and replacing all the asphalt concrete in the sublot. The depth to be removed and the overlay thickness shall be subject to the approval of the Engineer.

5.09 Individual bumps and dips that exceed 12 mm in the vertical direction shall be repaired in accordance with the following:

(a) Overlaying or removing and replacing the full lane width of the asphalt concrete in the vicinity of the bump or dip.

(b) The depth to be removed and the overlay thickness shall be subject to the approval of the Engineer.

(c) Alternate repair methods may be proposed to the Engineer provided that such methods do not cause any damages such as but not limited to excessive crushing, pulverizing or displacing the asphalt concrete.

5.10 Segregated areas on the final lift of asphalt concrete shall be repaired as follows:

(a) Minor segregation shall be repaired as follows:

(i) spot flush and a second full lane width flush; or

(ii) slurry seal patch over the full lane width.

(iii) shoulders shall be repaired in the same manner as the adjacent lane.

(b) Severe segregation for individual areas less than 100 m in length shall be repaired with a slurry seal patch over the full lane width or the shoulder width.

(c) Severe segregation for individual areas 100 m or greater in length shall be repaired as described in section 5.10 (b) or by removing and replacing or overlaying the area.

(d) Alternate repair methods proposed by the Contractor shall be subject to approval of the Engineer. The nature of the deficiencies shall be taken into account in the consideration of the repair.

(e) Repairs shall be subject to the approval of the Engineer.

5.11 Severe segregation on lower lifts of asphalt concrete shall be removed and replaced.

5.12 On all lifts of asphalt concrete, surface defects shall be repaired in a manner that is acceptable to the Engineer.

5.13 If an overlay is used as a remedial measure on a rejected sublot, the following shall apply:

(a) A tack coat shall be applied in accordance with Specification 4000 For Bituminous Prime, Tack And Flush Coat unless otherwise directed by the Engineer.

(b) Adjacent lanes and shoulders shall also be overlaid to the same thickness and length.

(c) On all lifts of asphalt concrete below the final lift the overlay shall be completed prior to the next lift being placed.

5.14 Work on any sublot which has been rejected shall be remedied within 30 calendar days of receipt of the acceptance test results.

4100 - 6 MEASUREMENT

6.01 Asphalt concrete shall be measured in tonnes.

6.02 Reject aggregate shall be measured by the cross section method. The volume of reject shall be multiplied by 1.7 to calculate tonnes.

4100 - 7 PAYMENT

7.01 Payment for Asphalt Concrete shall be at the contract unit price per tonne less the pay adjustments for density, smoothness, bumps/dips, segregation and surface defects.

7.02 The sum of the pay adjustments for density, smoothness, bumps/dips, segregation and surface defects for each lot shall not exceed the maximum pay adjustment. The maximum pay adjustment shall be calculated as follows:

Maximum Pay Adjustment Per Lot	=	Contract Unit Price Bid Per Tonne	x	Tonnes of Asphalt Concrete In Lot

7.03 The contract unit price shall be full compensation for completing the work except for those activities for which specific provision for payment is made in this section.

7.04 The dollar value of the pay adjustment for density shall be as follows:

(a) The pay adjustment for each lot shall be determined from Table 3, by using the mean of the deviation of the test results for each lot from the established Marshall densities.

(b) Sublots with a density below 94.0% of the established Marshall densities shall be subject to an additional pay adjustment as determined from Table 3.

(c) If any sublot has been rejected, payment shall not be made for the asphalt concrete in the lot until the rejected sublot has been remedied.

7.05 The dollar value of the pay adjustments for smoothness and individual bumps/dips for each sublot in the final lift of asphalt concrete shall be as follows:

(a) The pay adjustment for smoothness shall be determined from Table 4.

(b) The pay adjustment for individual bumps/dips shall be determined from Table 5.

(c) The sum of the pay adjustments for smoothness and individual bumps/dips shall not exceed $1,500 per sublot.

7.06 The dollar value of the pay adjustment for severity of segregation shall be determined from Table 6 A.

7.07 The dollar value of the pay adjustment for segregation frequency shall be determined from Table 6 B.

7.08 The dollar value of the pay adjustment for frequency of surface defects shall be determined from Table 7.

7.09 The dollar value for the pay adjustment for final surface condition shall be determined from Table 8.

7.10 If the contract includes a bid item for:

(a) Hauling Asphalt Concrete payment shall be made in accordance with Specification 2405 For Hauling On The Basis Of The Kilometre.

(b) Reclaimed Asphalt Concrete payment shall be made in accordance with Specification 4105 For Reclaiming Asphalt Concrete

(c) Hauling Reclaimed Asphalt Concrete payment shall be made in accordance with Specification 2405 For Hauling On The Basis Of The Kilometre.

(d) Filler And Blender payment shall be made in accordance with Specification 3400 For Binder, Filler And Blender Sand.

(e) Hauling Filler And Blender payment shall be made in accordance with Specification 2405 For Hauling On The Basis Of The Kilometre.

(f) Tack Coat And Flush Coat payment shall be made in accordance with Specification 4000 For Bituminous Prime, Tack And Flush Coat.

7.11 The rate the Department shall pay for rejecting aggregate in excess of 10% or for rejecting aggregate to improve the quality of the asphalt mix design shall be as designated in the Special Provisions of the contract.

7.12 The pay adjustments determined through testing of the remedial work shall be applied to that quantity of material in the lot or sublot which was originally rejected.

7.13 If any sublot has been rejected, payment shall not be made for the asphalt concrete in the lot until the rejected sublot has been remedied.

7.14 All remedial work shall be performed at the Contractor's expense including the cost of materials.

Table 3

PAY ADJUSTMENTS FOR DENSITY

DEVIATION OF THE DENSITY FROM THE SPECIFIED DENSITY	PAY ADJUSTMENT DOLLARS PER TONNE
≥0.0	0.00
-0.1	-0.10
-0.2	-0.15
-0.3	-0.20
-0.4	-0.30
-0.5	-0.40
-0.6	-0.50
-0.7	-0.60
-0.8	-0.70
-0.9	-0.80
-1.0	-0.90
-1.1	-1.00
-1.2	-1.20
-1.3	-1.40
-1.4	-1.60
-1.5	-1.80
-1.6	-2.00
-1.7	-2.20
-1.8	-2.40
-1.9	-2.60
-2.0	-2.80
-2.1	-3.00
-2.2	-3.30
-2.3	-3.60
-2.4	-3.90
-2.5	-4.20
-2.6	-4.50
-2.7	-4.80
-2.8	-5.10
-2.9	-5.40
-3.0	-5.80
-3.1	-6.20
-3.2	-6.60
-3.3	-7.00
-3.4	-7.50
-3.5	-8.00
-3.6	-8.50
-3.7	-9.00
-3.8	-9.70
-3.9	-10.40
-4.0	-11.10
-4.1	-12.00
-4.2	-13.00
-4.3	-14.00
-4.4	-15.00
-4.5	NO PAYMENT
>-4.5	REJECT

TABLE 4
PAY ADJUSTMENTS FOR SMOOTHNESS

PrI FOR TANGENTS AND CURVES WITH RADIUS 600 METRES OR GREATER	PrI FOR CURVES WITH RADIUS LESS THAN 600 METRES, SUBLOTS WITHIN 50 METRES OF A BRIDGE OR RAILWAY CROSSING, AND THE SUBLOT AT EACH CONSTRUCTION LIMIT	PAY ADJUSTMENT FOR SMOOTHNESS OF TOP LIFT DOLLARS PER SUBLOT LUMP SUM
15 or less	20 or less	0.00
16	21	-40.00
17	22	- 90.00
18	23	-150.00
19	24	-220.00
20	25	-300.00
21	26	-390.00
22	27	-490.00
23	28	-600.00
Greater than 23	Greater than 28	REJECT

TABLE 5
PAY ADJUSTMENTS FOR INDIVIDUAL BUMPS/DIPS

BUMPS/DIPS MEASURED IN THE VERTICAL DIRECTION	BUMPS/DIPS LOCATED BEYOND 15 METRES OF A CONSTRUCTION LIMIT DOLLARS PER BUMP/DIP
9 mm	-100
10 mm	-200
11 mm	-300
12 mm	-400
Greater than 12 mm	*REJECT

*SHALL ALSO APPLY TO BUMPS/DIPS LOCATED WITHIN 15 m OF A CONSTRUCTION LIMIT

TABLE 6 A
PAY ADJUSTMENTS FOR SEVERITY OF SEGREGATION

SEVERITY OF SEGREGATION	PAY ADJUSTMENT DOLLARS PER SQUARE METRE
Minor	- 1.50
Severe	- 3.00

TABLE 6 B
PAY ADJUSTMENTS FOR SEGREGATION FREQUENCY

SEGREGATION FREQUENCY PER LANE KILOMETRE	PAY ADJUSTMENT DOLLARS PER LANE KILOMETRE
0 - 5	0
6 - 15	- 125
16 +	- 250

TABLE 7
PAY ADJUSTMENTS FOR FREQUENCY OF SURFACE DEFECTS

FREQUENCY OF SURFACE DEFECTS PER LANE KILOMETRE	PAY ADJUSTMENT DOLLARS PER LANE KILOMETRE
0 - 5	0
6 - 15	- 100
16 +	- 250

TABLE 8
PAY ADJUSTMENTS FOR FINAL SURFACE CONDITION

NUMBER OF SUBLOTS PER LANE KILOMETRE WITH PrI > 10	NUMBER OF INDIVIDUAL BUMPS/DIPS MEASURED IN THE VERTICAL DIRECTION PER LANE KILOMETRE > 8 mm	SEGREGATION FREQUENCY PER LANE KILOMETRE	NUMBER OF SURFACE DEFECTS PER LANE KILOMETRE	PAY ADJUSTMENT DOLLARS PER LANE KILOMETRE
0	0	0-2	0-5	*+200.

*ALL CONDITIONS IN TABLE 8 SHALL BE MET FOR THE PAY ADJUSTMENTS TO APPLY