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Geotechnical Engineering
Environmental Engineering
Hydrogeology
Geological Engineering
Materials Testing
Building Science

www.patersongroup.ca

October 8, 2008
File: PH0146-REP.06

Sunset Lakes Development Corporation
6598 Pebble Trail Way
Greely, ON
K4P 0B6

Attention: **Mr. Dan Anderson**

Subject: **Report of Geotechnical Study**
Part of Lot 73 & Lot 74, Concession 5
City of Ottawa (Osgoode), Ontario

Dear Mr. Anderson,

Please find enclosed eight (8) copies of our Report No. PH0145-REP.06 pertaining to the geotechnical study conducted by this firm for the Greely Village site.

We trust that this is to your satisfaction.

Sincerely,

Paterson Group Inc.

Stephen J. Walker, P.Eng.

Geotechnical Engineering

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Geotechnical Investigation Report
Greely Village Centre Subdivision
Part of Lot 73 and Part of Lot 74,
Registrar's Compiled Plan 902
Ottawa (Osgoode), Ontario

Prepared For

Sunset Lakes
Development Corporation

October 6, 2008

Report No. PH0145-06

Paterson Group Inc.
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TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Terms of Reference

The firm of Paterson Group Inc. was retained by Mr. Dan Anderson, of Sunset Lakes Development Corporation, to prepare a Geotechnical Report for a parcel of land forming part of the proposed Greely Village Centre, located within Part of Lots 73 & 74, Registrar's Compiled Plan 902, contained within Part of Lot 6, Concession 5, in the former Township of Osgoode, City of Ottawa, Ontario.

1.2 Background

The subject property is located at the corner of Regional Highway No. 31 and Parkway road in the southeast part of the Village of Greely, Ontario (refer to the Key Plan illustrated in Figure 1 of Appendix 5). The property encompasses a total area of 36.1 hectares and will consist of the following land uses on private services:

- Professional Office Park (2.02 hectares);
- Residential subdivision (29.63 hectares).

The purpose of this study has been to ascertain and assess the specific subsurface conditions that currently exist beneath the subject property as they relate to the site servicing and construction of foundations for the anticipated development.

2.0 STUDY METHODOLOGY

2.1 Subsurface Investigation

As part of the prior terrain analysis study, a series of test pits were put down on the subject property to delineate the subsurface soil conditions beneath the site. The field investigation for the residential subdivision and office park was initiated on June 3, 2005. The test pit locations were selected by Paterson Group Inc. personnel to ensure that adequate representation of the subsurface profile was delineated. All test pit locations were selected to accommodate excavation using a standard backhoe. The soil profile and test data sheets for each test pit are provided in Appendix 1. The deeper soil profile was evaluated through the construction of nine test wells on the site.

The test pit locations were recorded and the subsurface conditions, including the soil morphology and depth to the groundwater table, were carefully observed and recorded by Paterson Group Inc. personnel as the test pits were advanced. Representative samples of each major soil type were recovered from the test pits. The samples were carefully sealed and returned to our laboratory for further analysis.

2.2 Laboratory Testing

Hydrometer analysis was performed in accordance with ASTM testing methods, on a total of four (4) soil samples recovered as part of the test pit investigation. The grain size curves and corresponding data are provided in Appendix 2 and are discussed in Section 4.1.

3.0 SITE DESCRIPTION

The primary use of the site has historically been for agricultural use. Specifically, the subject parcel of land has been farmed for various cash crops from a series of fields. Aside from a few trees delineating the field boundaries, the site is generally clear of treed areas.

3.1 Topography and Drainage

The topographical relief of the site is generally flat with near level conditions throughout. Overall relief is towards the north-northeast.

The surficial drainage of the site is achieved through a series of drainage ditches located parallel to Parkway Road. The drainage ditches direct surface runoff towards the roadside ditch along Sale barn Road; the eastern boundary of the site.

3.2 Surrounding Land Uses

The lands directly surrounding the site to the north of Highway No. 31 are predominantly active agricultural lands. Existing privately serviced residential dwellings contained in existing plans of subdivision occupy the south side of Highway No. 31 across from the site.

4.0 GEOLOGY

The following sections describe the regional and site specific geology of the study area.

4.1 Surficial Geology

A review of available surficial soils mapping surrounding the subject property contained in Soil Survey Report No. 58 indicates the site in generally located on deposits of low permeable soils of the Manotick association, specifically the Allendale series. The Allendale series is categorized as a poorly drained marine soil having a grayish brown to olive gray colour with reddish brown to dark yellowish brown mottling throughout.

A narrow band of the well draining Grenville association encroaches from the south east of the property, however this soil occupies a relatively small area of the subject site.

Based on the results of the test-pit excavation program, overburden thickness across the site and beneath the proposed subdivision, is more than 3 m in all areas encountered in the subject property. Using well recognized techniques for field identification of soils, four (4) specific stratigraphic units were identified in the areas investigated. The soils were classified using the Unified Soil Classification System (USCS) and hydraulic conductivities were estimated based on published data correlating soil types to permeability. The stratigraphic units are summarized below in Table 1:

TABLE 1
SUMMARY OF UNIQUE STRATIGRAPHIC UNITS ENCOUNTERED ON SUBJECT PROPERTY

Stratigraphic Unit	General Description (USCS Classification)	Composition[1] (%sand, silt, clay)	Thicknes s (m)	Estimated Hydraulic Conductivity[2] (cm/s)
1	SM - Silty sand - inorganic silt with fine sand composite	Not Available	0.3 to more than 1.2	10^{-3} to 10^{-5}
2	GM- gravel,.sand silt mixture (glacial till)	Not Available	1.2 to more than 1.5	10^{-2} to 10^{-4}
3	ML-MH– inorganic silts and silty or clayey silts with slight plasticity	0.3-3.7% sand 41.7-51.3 silt 45-58% clay	2.1 to more than 6	10^{-5} to less than 10^{-7}
4	CH–CL- inorganic clay of high plasticity to silty clay	5.5-10% sand 20.5 – 29.7% silt 60 – 74% clay	2.7 to more than 6	10^{-7} to less than 10^{-9}

1. Composition for CH, CL, ML and MHdetermined from grain size and hydrometer analysis.
2. Hydraulic conductivity estimated based on MOE Manual of Guidelines and Policies (1987)

These stratigraphic units are generally consistent with the surficial soil map in the close proximity to the site.

Laboratory hydrometer testing was performed on representative samples of the CH, CL, MH and ML soil units to validate in situ field identification and hydraulic conductivity estimates. The percent composition was easily determined (refer to Table 1) and hydraulic conductivity was validated. The grain size analysis curves are provided in Appendix 2.

Test pit locations and corresponding stratigraphy of the main soil types are summarized on the Test Hole Locations Plan (DWG. PH0145-1 in Appendix 3). The test pit logs are found in Appendix 1.

4.2 Bedrock Geology

Published mapping indicates that the study area is underlain by Paleozoic bedrock of the Oxford Formation. The MOE Water Well Records confirm the presence of limestone bedrock under the site at depths varying from 6.7 m to 7.9 m. Site specific observations indicated that bedrock was not encountered in any of the test pits put down in the subject area.

4.3 Groundwater

Groundwater levels (GWLs) were measured in the open test pits at the time of the fieldwork, and where applicable, are indicated on the Soil Profile and Test Data sheets in Appendix 1. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could be higher at the time of construction.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Geotechnical Assessment

The proposed development is to consist of residential dwellings and full private services (well and septic) and local paved roadways. In addition, there will be low-rise office development at the southwest corner of the site as indicated on the site plan. The subject site is, from a geotechnical viewpoint, suitable for the proposed development. It is anticipated that the residential dwellings will have a basement level and will be founded on footings placed on the silty clay, silty sand, and /or glacial till strata, below any fill or topsoil.

Stormwater Management Ponds (SWMP) are proposed to retain runoff on site. The actual details of the stormwater pond construction were not finalized at the time of this submission, however geotechnical guidelines for design and construction are provided in this report.

The above and other considerations are discussed in the following sections.

5.2 Site Grading and Preparation

Stripping Depth

All fill, topsoil and construction remnants should be removed from within the building perimeter sand under roadways. Topsoil and deleterious fill such as those containing organic material should be stripped from under any paved areas and other settlement sensitive structures.

Fill Placement

Fill used for grading (if required) beneath the buildings (but outside the zones of influence of the footings) and under paved areas (below the base and subbase materials) should consist of clean imported granular fill, such as Ontario Provincial Standard Specification (OPSS) Granular A (crushed stone), Granular B Type I or Type II. These materials should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm in thickness and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the buildings (outside the zones of influence of the footings) and paved areas should be compacted to a minimum of 95% of the material's standard Proctor maximum dry density (SPMDD).

The zone of influence of a footing is considered to extend out and down from the bottom edges of the footing, at a slope of 1H:1V to the undisturbed in situ soil (below any fill or organic matter).

Throughout the zones of influence of the footings, the engineered fill should consist of OPSS Granular A (crushed stone) or Granular B Type II placed in maximum 300 mm thick layers and compacted to a minimum of 98% of the material's SPMDD.

Non-specified existing fill, along with site-excavated soil, can be used as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to reduce voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of their respective SPMDD values. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless a composite drainage system (such as System Platon or Miradrain G100N) connected to a perimeter drainage system is provided.

5.3 Foundation Design

Shallow Foundations - Allowable Bearing Pressures

Based on the soil profile encountered at the test hole locations, it is anticipated that silty clay, silty sand, and / or glacial till will be encountered at the anticipated founding levels. These materials, below any topsoil and fill, are suitable bearing strata upon which to found footings for the support of the dwellings.

Footings, up to 2.0 m wide, placed on undisturbed silty clay, silty sand, and / or glacial till can be designed using an allowable bearing pressure of 100 kPa This value is provided on the assumption that the grade raise will be less than 1.5 m above original ground level.

An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil have been removed in the dry prior to the placement of concrete. A clean bedrock surface consists of one from which all soil fill, deleterious materials and loose rock have been removed prior to the concrete placement.

The allowable bearing pressures provided herein are for preliminary design purposes. The bearing values should be determined on a lot per lot basis, based on assessments conducted by the geotechnical consultant at the time of construction.

For the proposed office development, it is understood that the project design is to conform with OBC 2006, which requires these bearing capacities to be calculated using Limit States Design.

A bearing resistance value at serviceability limit states (SLS) for footings placed on an undisturbed, silty clay, silty sand and / or glacial till bearing surfaces can be taken as 100 kPa. A factored bearing resistance value at ultimate limit states (ULS) for footings can be taken as 150 kPa. A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value at ULS. For design purposes, a "D" Site Class should be used.

The bearing resistance values provided above are based on the premise that footings will be constructed at a typical depth of 1.5 to 2.1 metres below existing grade, however, there is no sensitivity with respect to foundation elevation, given the subsurface profile that exists. Furthermore, it is assumed that a maximum footing width of 2.0 metres for strip footings, and 3.0 metres for square footings will be respected in the design of the foundations. Predicted settlements, given the above, will be within tolerable limits, and are expected to be of the order of 25 mm total and 20mm differential.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Above the groundwater level, adequate lateral support is provided when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V (or flatter), passes only through in situ soil or engineered fill of the same or higher capacity as the soil. Flatter slopes will be required below groundwater level. Near vertical (1H:6V) slopes can be used for sound bedrock bearing media.

Settlement/Grade Raise

Footings placed on in situ soil and designed using the allowable bearing pressures provided herein will be subjected to potential post construction total and differential settlements of 25 and 20 mm, respectively, provided the grade raise is kept below the permissible level (maximum 1.5 m above the original ground surface over silty clay areas).

5.4 Basement Slab

With the removal of all topsoil and existing fill within the footprint of the proposed dwellings, the native soil surface or bedrock will be considered to be acceptable subgrade surfaces on which to commence backfilling for floor slab construction. Any soft areas should be removed and backfilled with appropriate backfill material prior to placing any fill. OPSS Granular B Type I or Type II are recommended for backfilling below the floor slab (outside the zones of influence of the footings) where required. It is recommended that the upper 200 mm of sub-slab fill consists of 19 mm clear crushed stone. All backfill materials within the footprints of the proposed buildings (outside the zones of influence of the footings) should be placed in maximum 300 mm thick loose layers and compacted to at least 95% of the material's SPMDD.

5.5 Pavement

No site specific anticipated traffic data was provided for the design of the proposed roadways. For preliminary design purposes, the pavement structure presented in Table 2 could be used for local roadways. The subgrade material is anticipated to consist of silty sand silty clay, and / or glacial till.

Table 2
Recommended Pavement Structure
Local Residential Roads

Thickness mm	Material Description
40	**WEAR COURSE** – SP 12.5 Asphaltic Concrete
40	**BINDER COURSE** – SP 19 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
375	**SUBBASE** - OPSS Granular B Type II
	SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type I or Type II material.

The pavement granulars (base and subbase) should be placed in maximum 300 mm thick layers and compacted to a minimum of 100% of the material's SPMDDs using suitable compaction equipment.

Satisfactory performance of the pavement structure is largely dependent on keeping the contact zone between the subgrade material and the base stone in a dry condition. Failure to provide adequate drainage under conditions of heavy wheel loading can result in the fine subgrade soil being pumped into the voids in the stone subbase, thereby reducing its load carrying capacity. The subgrade soil will consist mostly of silty sand or silty clay. Drainage of the pavement structure will be handled by roadside ditches.

5.6 Stormwater Management Pond

The SPECIFIC details of the proposed SWMP are not known at this time. It is the intention to retain stormwater on site, and the ponds are expected to be constructed into the silty clay stratum, typical of the stormwater ponds constructed throughout the Greely area. The side slopes of the pond should be no steeper than 2.5H:1V.

5.7 Swimming Pools

The site conditions are conducive to the construction of both in-ground and above ground swimming pools. In that there are no ravines or hazard lands present on this property, there are no geotechnical restrictions with respect to the installation of swimming pools.

6.0 DESIGN AND CONSTRUCTION PRECAUTIONS

6.1 Foundation Drainage and Backfill

It is recommended that a perimeter foundation drainage system be provided for the proposed dwellings. The system should consist of a 100 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 10 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structures. The pipe should have a positive outlet, such as a gravity connection to a sump pit in the basement of the house.

Backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. Imported granular materials, such as clean sand or OPSS Granular B Type I material, should be used for this purpose. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls unless a drainage blanket (such as System Platon or Miradrain G100N) connected to a perimeter drainage system is provided.

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures, including attached garages, are required to be insulated against the deleterious effects of frost action. A minimum 1.5 m thick soil cover (or equivalent foundation insulation) should be provided in this regard.

Exterior unheated footings, such as those for isolated exterior piers and wing walls may require more soil cover or a combination of soil cover and insulation.

6.3 Groundwater Control

The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

The flow of groundwater into the excavations through the overburden materials should be relatively low and is expected to be controllable using properly sized pumps and sumps.

6.4 Winter Construction

Precautions must be taken if winter construction is considered for this project. The subsoil conditions at this site mostly consist of frost susceptible materials. In the presence of water and freezing conditions, ice could form within the soil mass. Heaving upon freezing and settlement upon thawing could occur.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters and tarpaulins or other suitable means. In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the buildings and/or the footings are protected with sufficient soil cover to prevent freezing at the founding level.

7.0 OBSERVATION AND MATERIAL TESTING SERVICES

It is a requirement for the foundation design data provided herein to be applicable that the following material testing and observation program be performed by the geotechnical consultant.

- Observation of all bearing surfaces prior to the placement of concrete.
- Observation of all subgrades prior to backfilling and follow-up field density tests to ensure that the specified level of compaction has been achieved.
- Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued upon the completion of a satisfactory observation and material testing program by the geotechnical consultant.

8.0 STATEMENT OF LIMITATIONS

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review the grading plan once available and our recommendations when the drawings and specifications are complete.

The client should be aware that any information pertaining to soils and all test hole logs are furnished as a matter of general information only and test hole descriptions or logs are not to be interpreted as descriptive of conditions at locations other than those of the test holes.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, we request that we be notified immediately in order to permit reassessment of our recommendations.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Sunset Lakes Corporation or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Stephen J. Walker, P.Eng.

10/06/08
S. I. G WALKER

APPENDIX ONE

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

Ottawa (Greely), Ontario

DATUM Approximate geodetic

REMARKS

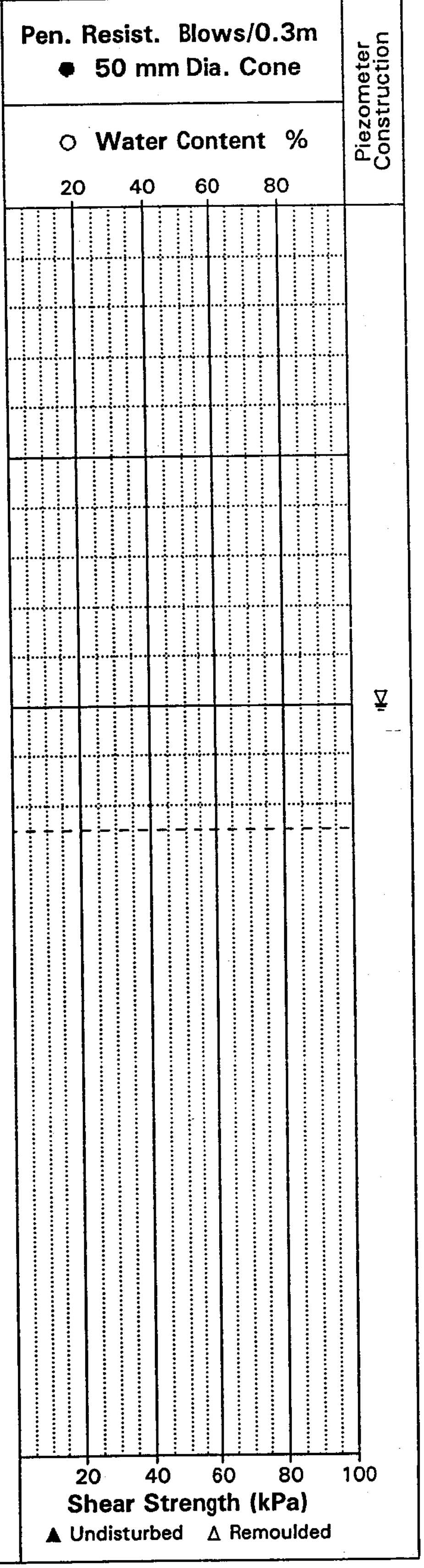
BORINGS BY Backhoe

DATE 3 JUN 05

FILE NO. PH0145

HOLE NO. TP18/MW5

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	87.71
TOPSOIL 0.40	■						
Yellow-brown medium **SAND** 0.80	⛆	G	1				
	▨					1	86.71
Stiff, brown-grey SILTY **CLAY**	▨	G	2				
	▨					2	85.71
2.50	▨						
End of Test Pit (Water infiltration @ 2.0m depth)							



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Hydrogeological Study and Terrain Analysis
Greely Village Centre, Parkway Road
Ottawa (Greely), Ontario

DATUM Approximate geodetic

FILE NO. PH0145

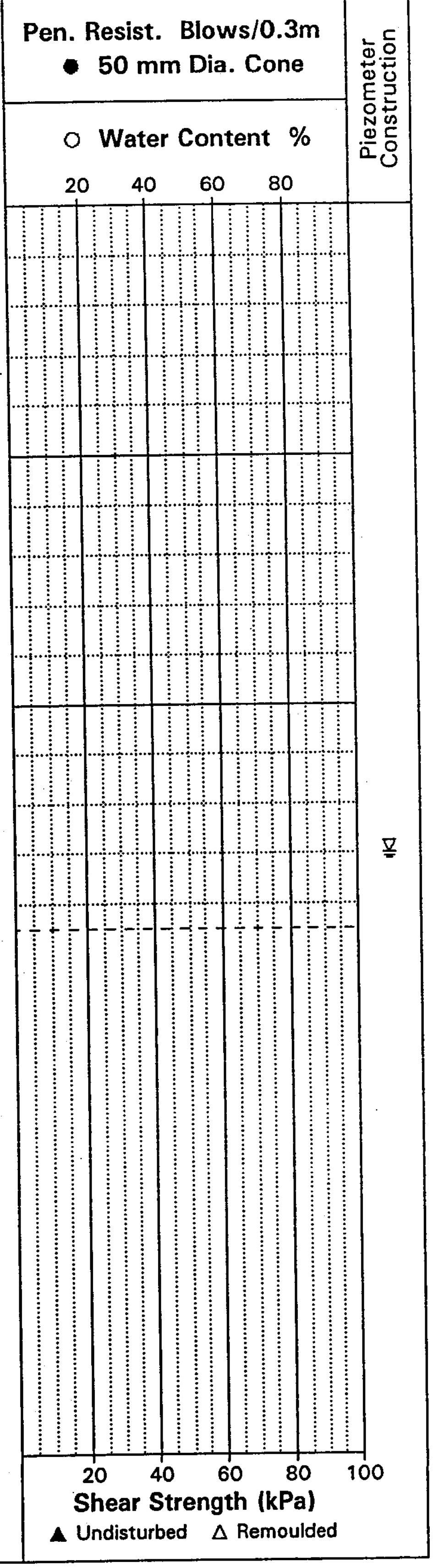
REMARKS

HOLE NO. TP19

BORINGS BY Backhoe

DATE 3 JUN 05

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	88.00
TOPSOIL 0.40	■						
Red-brown fine SAND 1.18	⁘	G	3			1	87.00
Stiff, grey SILTY CLAY 2.90	▨					2	86.00
End of Test Pit (Water infiltration @ 2.6m depth)							



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Hydrogeological Study and Terrain Analysis
Greely Village Centre, Parkway Road
Ottawa (Greely), Ontario

DATUM Approximate geodetic

REMARKS

BORINGS BY Backhoe

DATE 3 JUN 05

FILE NO. PH0145

HOLE NO. TP20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
GROUND SURFACE						0	88.51		
TOPSOIL 0.30									
Red-brown fine SAND		G	4						
						1	87.51		
1.20									
GLACIAL TILL: Compact to dense, grey silty sand with gravel, cobbles and boulders		G	5						∇
		G	6						
2.00						2	86.51		
End of Test Pit (Water infiltration @ 1.5m depth)									

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Hydrogeological Study and Terrain Analysis
Greely Village Centre, Parkway Road
Ottawa (Greely), Ontario

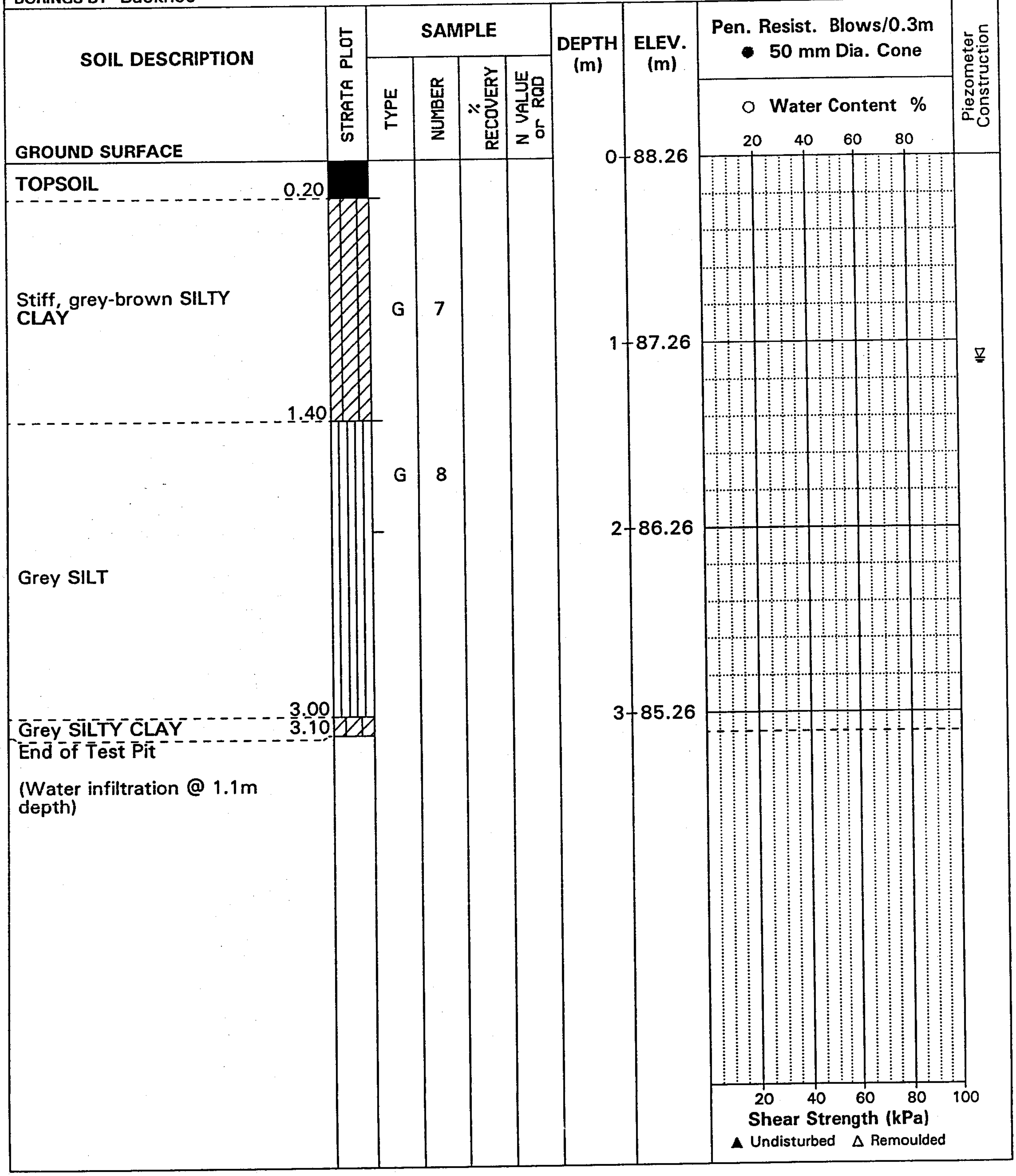
DATUM Approximate geodetic

FILE NO. PH0145

REMARKS

HOLE NO. TP21/MW6

BORINGS BY Backhoe **DATE** 3 JUN 05



SOIL DESCRIPTION	Depth of base (m)	TYPE	NUMBER
TOPSOIL	0.20		
Stiff, grey-brown SILTY CLAY	1.40	G	7
Grey SILT	3.00	G	8
Grey SILTY CLAY	3.10		

DEPTH (m)	ELEV. (m)
0	88.26
1	87.26
2	86.26
3	85.26

End of Test Pit

(Water infiltration @ 1.1m depth)

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Hydrogeological Study and Terrain Analysis
Greely Village Centre, Parkway Road
Ottawa (Greely), Ontario

DATUM Approximate geodetic

FILE NO. PH0145

REMARKS

HOLE NO. TP22

BORINGS BY Backhoe

DATE 3 JUN 05

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	87.34
TOPSOIL — 0.30	■						
Dense, yellow-brown **SILTY SAND** with cobbles		G	9			1	86.34
— 1.30							
GLACIAL TILL: Dense, grey silty sand with gravel, cobbles		G	10			2	85.34
— 3.00						3	84.34
End of Test Pit (TP dry upon completion)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

Piezometer Construction

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Hydrogeological Study and Terrain Analysis
Greely Village Centre, Parkway Road
Ottawa (Greely), Ontario

DATUM Approximate geodetic

REMARKS

BORINGS BY Backhoe

DATE 3 JUN 05

FILE NO. PH0145

HOLE NO. TP23

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	86.89		
TOPSOIL 0.28									
Yellow-brown medium to coarse SAND		G	11						
						1	85.89		∇
1.40									
Dense, grey SILT						2	84.89		
						3	83.89		
3.20 End of Test Pit									
(Water infiltration @ 1.3m depth)									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Hydrogeological Study and Terrain Analysis
Greely Village Centre, Parkway Road
Ottawa (Greely), Ontario

DATUM Approximate geodetic

REMARKS

BORINGS BY Backhoe

DATE 3 JUN 05

FILE NO. PH0145

HOLE NO. TP24

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
GROUND SURFACE						0	86.15		
TOPSOIL 0.28	■								
Red-brown medium SAND 0.60	⁖	G	13						
	▨					1	85.15		▽
Brown-grey SILTY CLAY	▨	G	14						
	▨					2	84.15		
2.30									
End of Test Pit (Water infiltration @ 1.30m depth)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Hydrogeological Study and Terrain Analysis
Greely Village Centre, Parkway Road
Ottawa (Greely), Ontario

DATUM Approximate geodetic

REMARKS

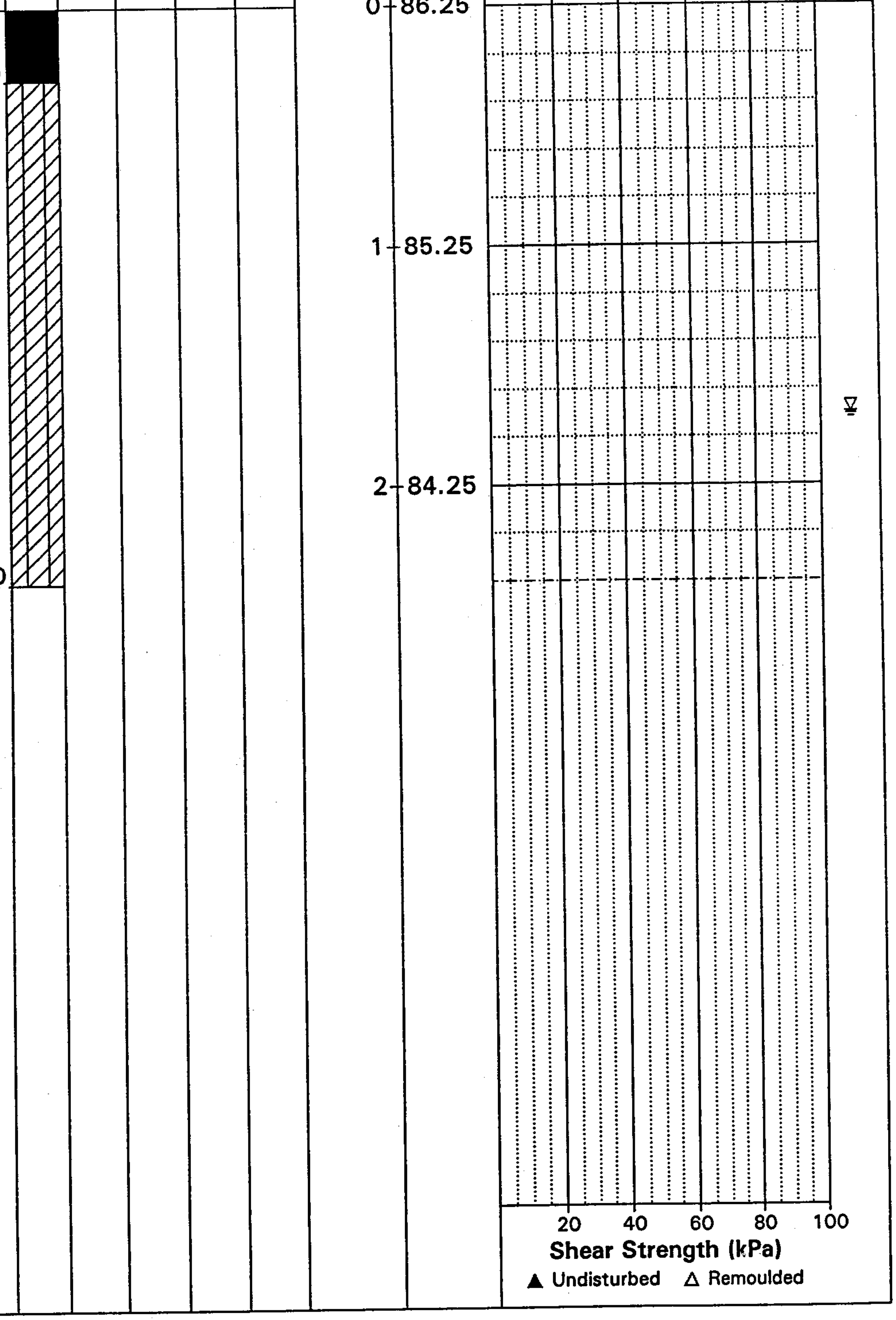
BORINGS BY Backhoe

DATE 3 JUN 05

FILE NO. PH0145

HOLE NO. TP25

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	86.25
TOPSOIL 0.30							
Brown SILTY CLAY						1	85.25
- grey by 1.8m depth						2	84.25
2.40 End of Test Pit (Water infiltration @ 1.7m depth)							



patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Hydrogeological Study and Terrain Analysis
Greely Village Centre, Parkway Road
Ottawa (Greely), Ontario

FILE NO. PH0145

HOLE NO. TP26

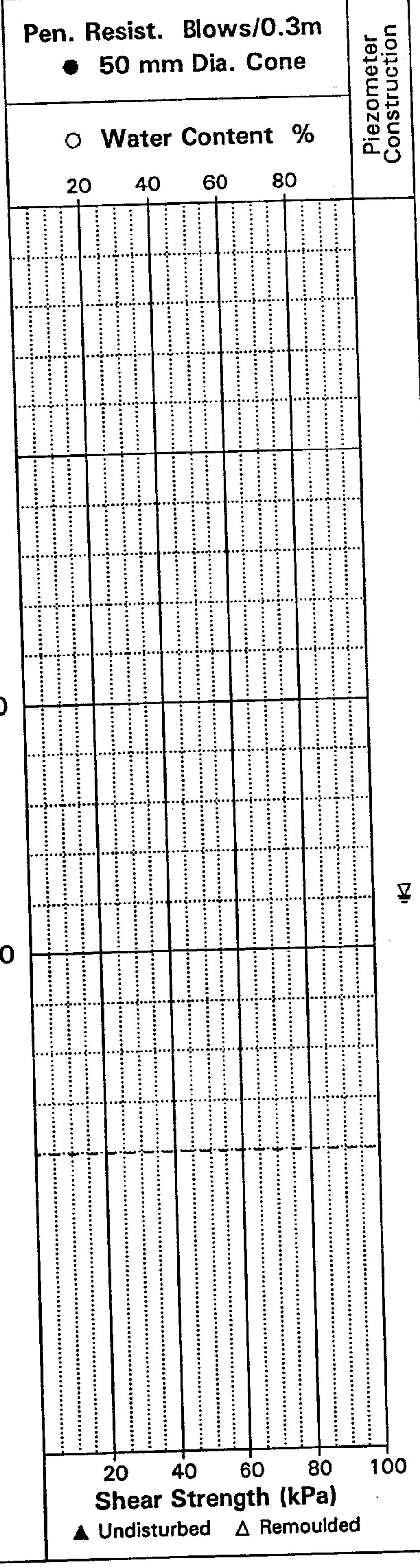
DATUM Approximate geodetic

REMARKS

BORINGS BY Backhoe

DATE 3 JUN 05

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	85.90
TOPSOIL							
0.50							
Brown SILT						1	84.90
						2	83.90
- grey by 2.9m depth						3	82.90
		G	15				
3.20							
GLACIAL TILL: Grey clayey sandy silt with gravel, cobbles and boulders		G	16				
3.80							
End of Test Pit							
(Water infiltration @ 2.8m depth)							



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Hydrogeological Study and Terrain Analysis
Greely Village Centre, Parkway Road
Ottawa (Greely), Ontario

DATUM	Approximate geodetic
REMARKS	
BORINGS BY	Backhoe
DATE	3 JUN 05
FILE NO.	PH0145
HOLE NO.	TP27

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
TOPSOIL 0.30					
Red-brown fine SAND 0.60					
Brown SILT - grey by 2.6m depth 4.60					
End of Test Pit (Water infiltration @ 2.4m depth)					

DEPTH (m)	ELEV. (m)
0	85.57
1	84.57
2	83.57
3	82.57
4	81.57

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

▽

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Hydrogeological Study and Terrain Analysis
Greely Village Centre, Parkway Road
Ottawa (Greely), Ontario

DATUM Approximate geodetic

FILE NO. PH0145

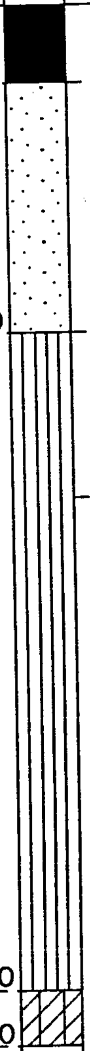
REMARKS

HOLE NO. TP28/MW7

BORINGS BY Backhoe

DATE 3 JUN 05

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.28				
Red-brown medium SAND	1.20	G	17		
Grey-brown SILT - grey by 1.8m depth	3.60	G	18		
Grey SILTY CLAY	3.80				
End of Test Pit (Water infiltration @ 1.2m depth)					



DEPTH (m)	ELEV. (m)
0	85.72
1	84.72
2	83.72
3	82.72

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

∇

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Hydrogeological Study and Terrain Analysis
Greely Village Centre, Parkway Road
Ottawa (Greely), Ontario

FILE NO. PH0145

HOLE NO. TP29/MW8

DATUM Approximate geodetic

REMARKS

BORINGS BY Backhoe

DATE 3 JUN 05

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	84.55		
TOPSOIL 0.32									
		G	19			1	83.55		
Grey-brown SILT									▽
- grey by 1.7m depth									
						2	82.55		
		G	20						
						3	81.55		
3.50 End of Test Pit (Water infiltration @ 1.5m depth)									

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE & TEST DATA

Hydrogeological Study and Terrain Analysis
Greely Village Centre, Parkway Road
Ottawa (Greely), Ontario

DATUM Approximate geodetic

REMARKS

BORINGS BY Backhoe

DATE 3 JUN 05

FILE NO. PH0145

HOLE NO. TP30/MW9

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20, 40, 60, 80)	Piezometer Construction
GROUND SURFACE						0	85.62		
TOPSOIL 0.20									
Red-brown SILTY SAND 0.60									
Grey-brown SILT						1	84.62		
- grey by 1.4m depth									
						2	83.62		
									▽
						3	82.62		
3.60									
End of Test Pit (Water infiltration @ 2.4m depth)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Hydrogeological Study and Terrain Analysis
Greely Village Centre, Parkway Road
Ottawa (Greely), Ontario

DATUM Approximate geodetic

REMARKS

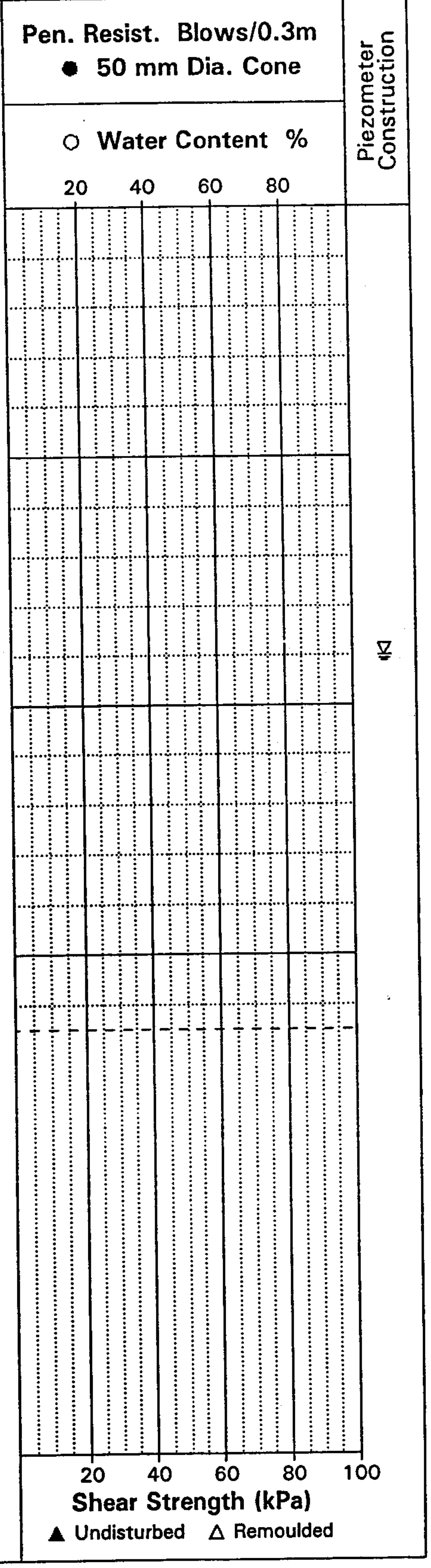
BORINGS BY Backhoe

DATE 3 JUN 05

FILE NO. PH0145

HOLE NO. TP31

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	85.65
TOPSOIL 0.30							
Red-brown fine SAND 0.60		G	21				
						1	84.65
Brown-grey SILTY CLAY		G	22			2	83.65
						3	82.65
3.30 End of Test Pit (Water infiltration @ 1.8m depth)							



SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

Relative Density	'N' Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

Consistency	Undrained Shear Strength (kPa)	'N' Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SOIL DESCRIPTION (continued)

Cohesive soils can also classified according to their "sensitivity". The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NXL size core. However, it can be used on smaller core sizes, such as BX, if the bulk of the fractures caused by drilling stresses (called "mechanical breaks") are easily distinguishable from the normal in-situ fractures.

RQD %	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.) Rock core samples are obtained with the use of standard diamond drilling bits

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC% - Natural moisture content or water content of sample, %
LL - Liquid limit, % (water content above which soil behaves as a liquid)
PL - Plastic limit, % (water content above which soil behaves plastically)
PI - Plasticity index, % (difference between LL and PL)

Dxx - Grain size at which xx% of the soil, by weight, is of finer grain sizes
These grain size descriptions are not used below 0.075 mm grain size
D10 - Grain size at which 10% of the soil is finer (effective grain size)
D60 - Grain size at which 60% of the soil is finer

Cc - Concavity coefficient = $(D30)^2$ / (D10 x D60)
Cu - Uniformity coefficient = D60 / D10

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sand and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

p'_o - Present effective overburden pressure at sample depth
p'_c - Preconsolidation pressure of (maximum past pressure on) sample
Ccr - Recompression index (in effect at pressures below p'_c)
Cc - Compression index (in effect at pressures above p'_c)

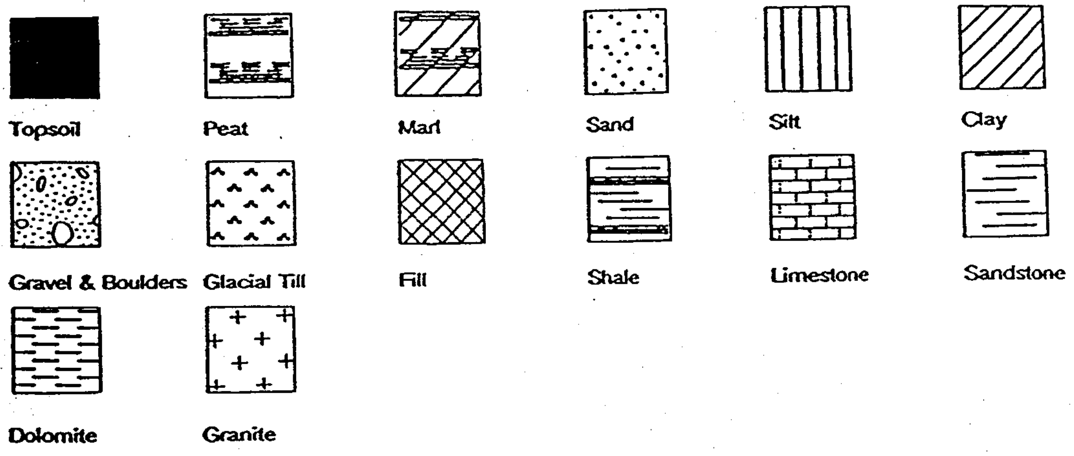
OC Ratio Overconsolidation ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

PERMEABILITY TEST

k - Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

SYMBOLS AND TERMS (continued)

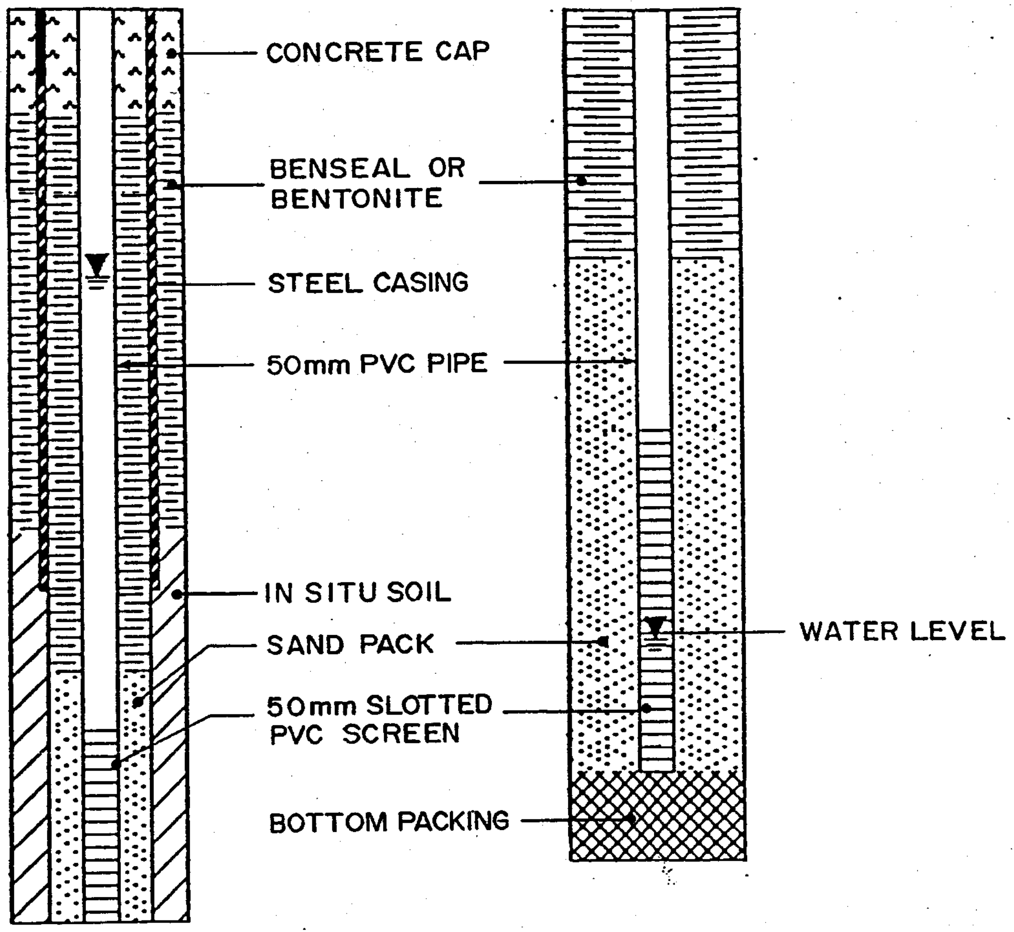
STRATA PLOT



MONITORING WELL AND PIEZOMETER CONSTRUCTION

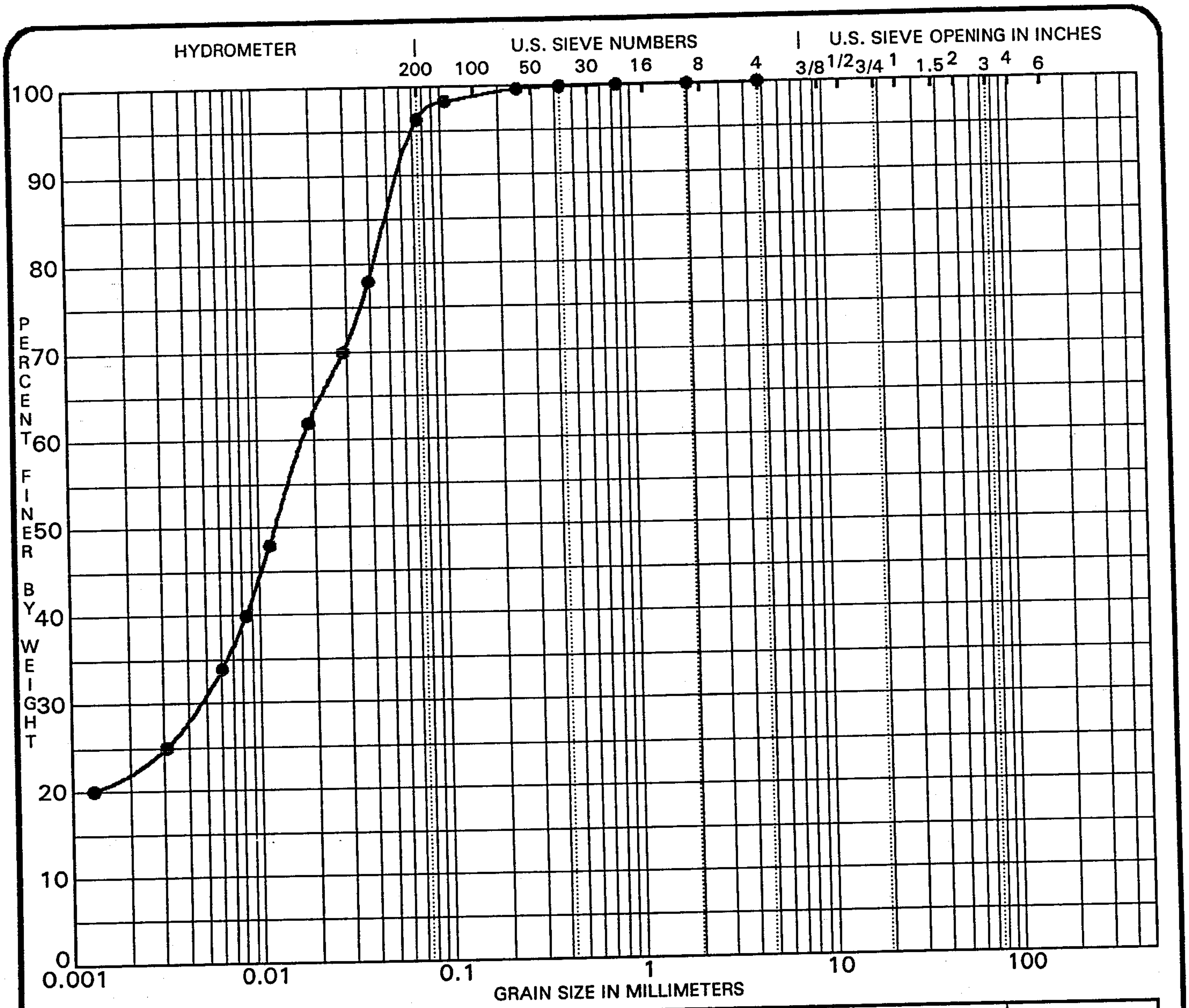
Monitoring Well Construction

Piezometer Construction



APPENDIX TWO

LABORATORY TEST DATA



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	TP21/MW6 G7	INORGANIC SILT to CLAYEY SILT (ML)						

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP21/MW6 G7	4.75	0.02	0.005		0.0	3.7		

CLIENT Sunset Lakes Development Corp.

PROJECT Hydrogeological Study and Terrain Analysis -
Greely Village Centre, Parkway Road

FILE NO. PH0145

DATE 3 JUN 05

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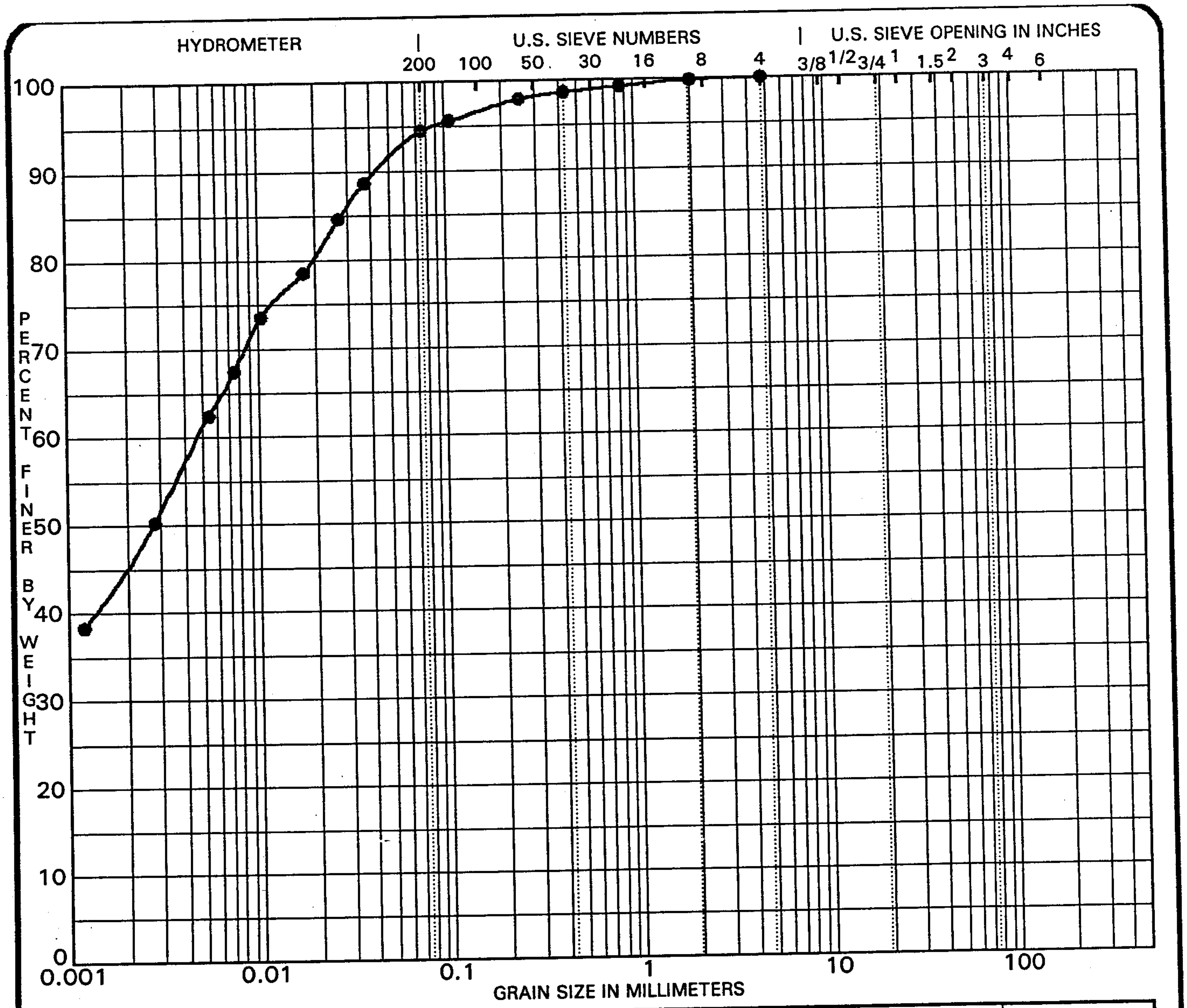
28 Concourse Gate, Unit 1, Ottawa, Ontario K2E 7T7

GRAIN SIZE DISTRIBUTION



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● **TP24** **G14**	**SILTY CLAY (CL)**						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **TP24** **G14**	**4.75**	**0.00**			**0.0**	**5.5**		

CLIENT **Sunset Lakes Development Corp.**

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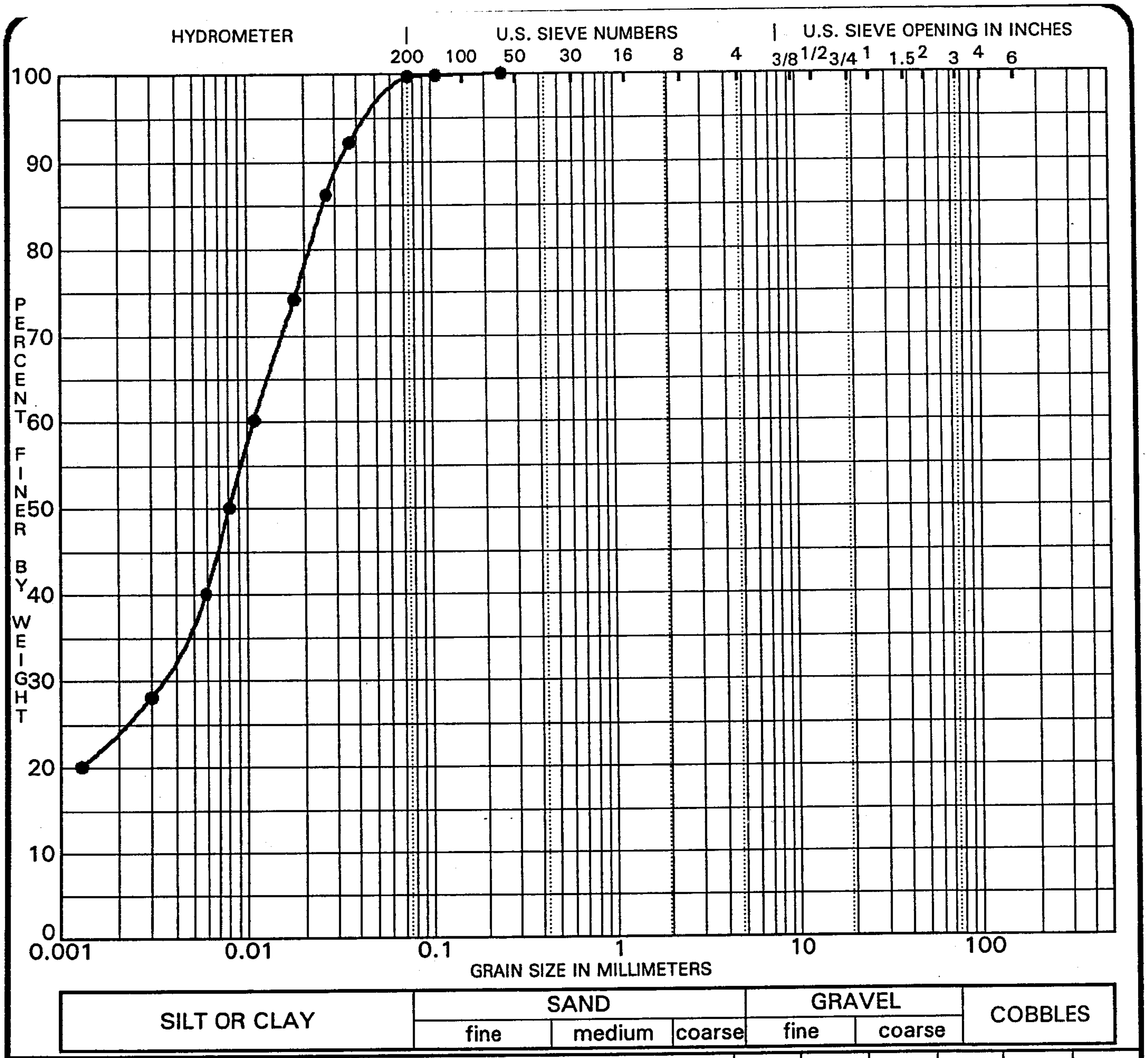
28 Concourse Gate, Unit 1, Ottawa, Ontario K2E 7T7

GRAIN SIZE DISTRIBUTION



Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● **TP28/MW7 G18**	**CLAYEY SILT to SILTY CLAY (MH)**						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **TP28/MW7 G18**	**0.25**	**0.01**	**0.003**		**0.0**	**0.3**		

CLIENT **Sunset Lakes Development Corp.**

PROJECT **Hydrogeological Study and Terrain Analysis -**
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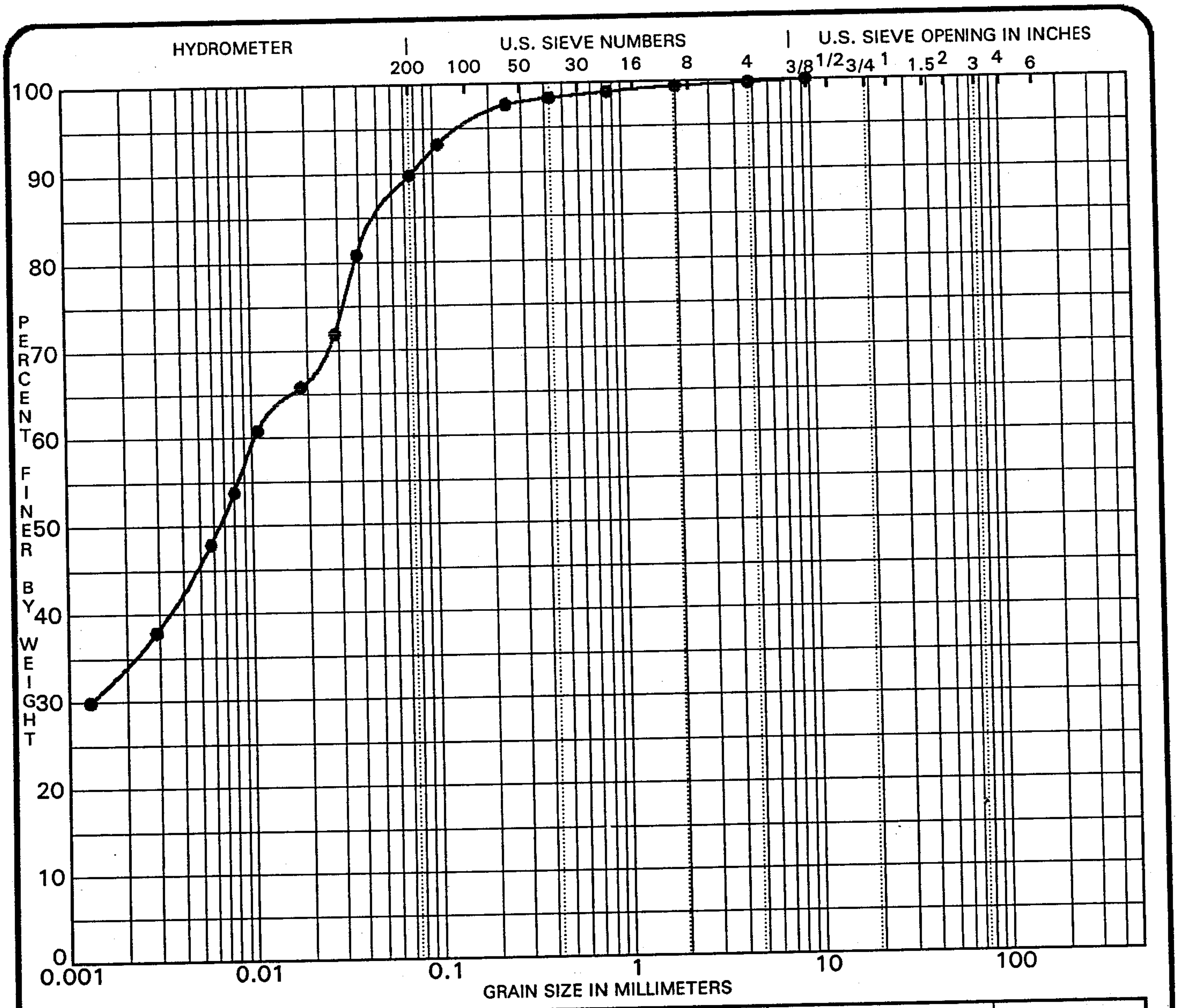
28 Concourse Gate, Unit 1, Ottawa, Ontario K2E 7T7

GRAIN SIZE DISTRIBUTION



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
● TP31	G22	SILTY CLAY (CH)						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● TP31	G22	9.50	0.01	0.001		0.3	10.0		

CLIENT **Sunset Lakes Development Corp.**

PROJECT **Hydrogeological Study and Terrain Analysis -**
Greely Village Centre, Parkway Road

FILE NO. **PH0145**

DATE **3 JUN 05**

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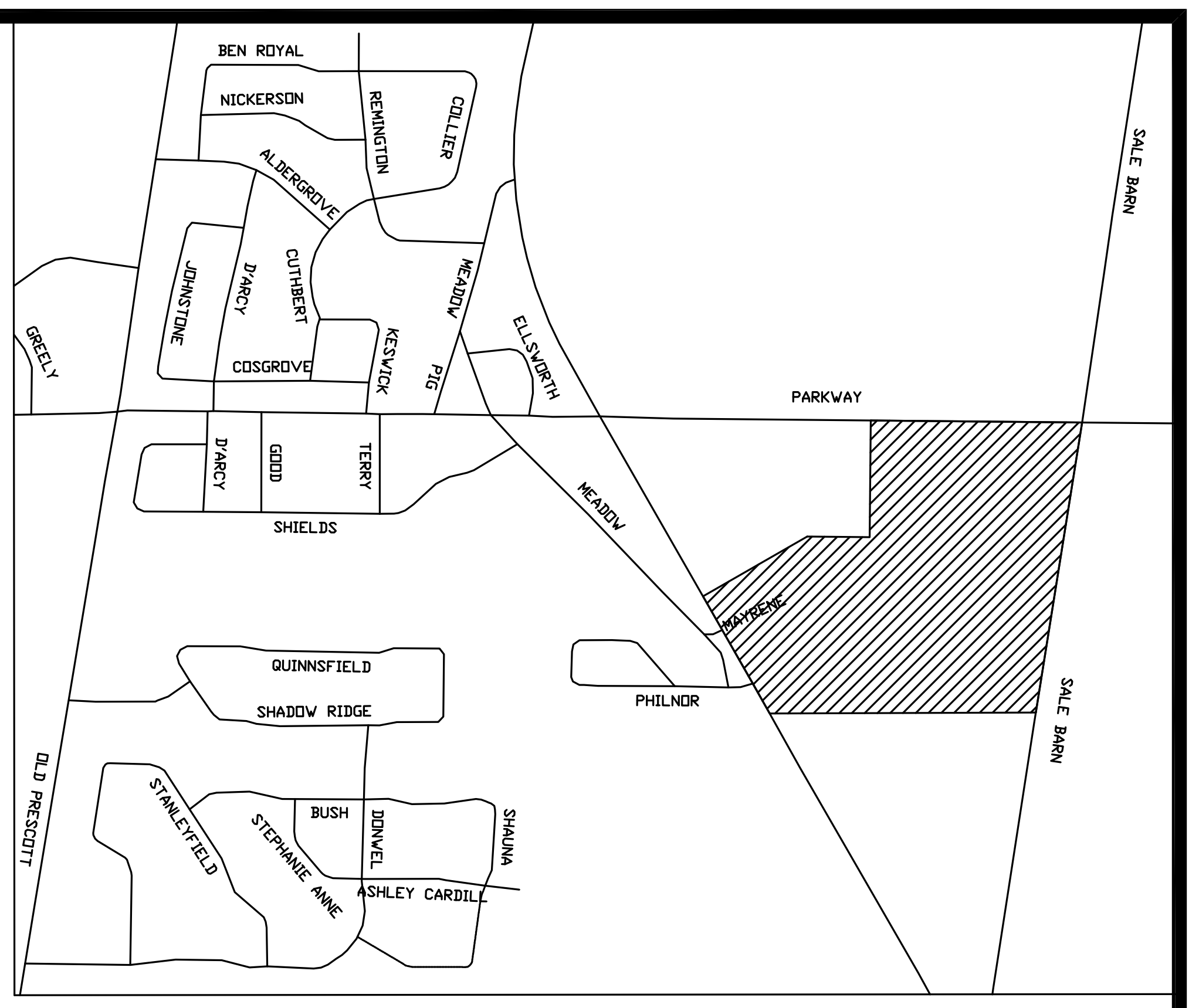
GRAIN SIZE DISTRIBUTION

APPENDIX THREE

DRAWING NO. PH0145-1 - TEST HOLE LOCATION PLAN



LEGEND:

▨	TOPSOIL
▨	SAND
▨	SILTY SAND
▨	SILTY CLAY (CL) /CLAYEY SILT(ML)
▽	GLACIAL TILL
▽ 2.0	WATER INFILTRATION DEPTH (m)
■	TEST PIT LOCATION
⊕	TEST WELL LOCATION
◆	MONITORING WELL LOCATION
90.70	GROUND SURFACE ELEVATION (m)

NO.	REVISIONS	DATE	INITIAL
1	ADDITION OF NEW TEST PITS, TW, AND MW DATA	19/06/06	RAP

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consulting engineers
28 Concourse Gate, Unit 1, Ottawa, Ontario K2E 7T7

SCALE: 1:2000
DESIGN: RAP
DRAWN: MH
CHECKED: RAP
DATE: 09/2005

PROPOSED VILLAGE CENTRE SUBDIVISION
SALE BARN ROAD
OTTAWA, ONTARIO

DWG. NO. PH0145-1

SUNSET LAKES DEVELOPMENT CORP.

TEST HOLE LOCATION PLAN

PH0145-1R.DWG