GEOTECHNICAL REPORT

PRELIMINARY GEOTECHNICAL ASSESSMENT, 7054 HART HIGHWAY, PRINCE GEORGE, B.C.

Prepared for

NORTHERN HEALTH AUTHORITY
PRINCE GEORGE, B.C.

Prepared by

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PROJECT No. K-2037

May 17, 2006

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APPENDICES

1.0 INTRODUCTION

The Northern Health Authority (NHA) is assessing the feasibility of constructing a new long term care facility at 7054 Hart Highway in Prince George, B.C. The facility will likely consist of a two-storey, wood-framed structure. NHA commissioned GeoNorth Engineering Ltd. (GeoNorth) to carry out a geotechnical overview assessment of the site and provide preliminary recommendations for site preparation and foundation design of the proposed building. At the time of this report details of the proposed development, including the building size and location, were not yet determined. NHA also asked us to commission an environmental engineering consultant to conduct a Phase I Environmental Site Assessment (ESA) for the property.

The subject property is located in the Austin East area of Prince George. The property is bounded on the west by the Highway 97 N Frontage Road (Hart Highway), on the east by Dagg Road, on the north by existing residential properties, and on the south by the Hart Pioneer Centre and the Hart Pentecostal Church. The site has an area of approximately 2 hectares. A plan showing the site location is on Drawing 2037-A1, in Appendix A. A plan showing an orthophoto taken in 2003, available on the City of Prince George website, is on Drawing 2037-A2, and a plan showing the site layout is on Drawing 2037-A3, both in Appendix A.

2.0 SITE HISTORY

2.1 Background Geological Information

To obtain background geological information, we reviewed Geological Survey of Canada Bulletin 196, "Glacial Geomorphology and Pleistocene History of Central British Columbia", by H.W. Tipper, published in 1971, and the accompanying maps 1287A and 1288A, "Surficial Geology, McLeod Lake", and "Surficial Geology, Prince George", respectively. The maps show that the City of Prince George is situated mostly within the area that was covered by a large, regional glacial lake that existed during deglaciation, approximately 10,000 years before present.

A large glacial meltwater stream entered the lake from the northwest, entering in the north and northwestern portions of the city. The stream carried large quantities of sediment from the northwest part of the interior plateau and deposited a large delta at the edge of the lake. The deposit is kettled, indicating that large blocks of ice were buried or surrounded by the delta sediments. The melting of the ice in the kettles and the subsequent erosion of the area resulted in the rugged topography that is typical of the northern part of Prince George.

Based on our review of the geological report, and on our previous experience in the area, we expect that the site is underlain by silt and fine-grained sand to considerable depth. The soil is typically highly erodible, frost susceptible, and contains sufficient silt and clay to prevent free drainage of surface water.

2.2 Local Site History

To obtain information on the previous development on the site, we reviewed orthophotos taken in 1993 and 2003, available on the City of Prince George website. The 1993 and 2003 photos show the remains of a residence in the northwest corner of the property that had been demolished prior to 1993. The photos also show a residence northeast of the Hart Pioneer Centre, fronting onto Dagg Road, and another nearby structure of similar size, likely a shop or garage. The 1993 photo shows another small house present near the south end of the west edge of the property, near the frontage road, which is not visible on the 2003 photo. This house was removed prior to 2003 and its location levelled. The orthophotos also show several derelict automobiles on the property.

During our 2006 investigation, we noted that the residence and associated building near Dagg Road were removed and the site levelled. At present, there are no buildings on the site, with the exception of the remains of the house on the northwest corner of the site. It is possible that there has been previous development or disturbance to the site not evident on the orthophotos or at the site.

We commissioned Morrow Environmental Consultants Inc. (Morrow) to carry out a Phase I Environmental Site Assessment (ESA). The Phase I ESA consists of a review of historical and background information and regulatory records, and a site reconnaissance. A copy of Morrow's report is in Appendix D.

3.0 SITE INVESTIGATION

On April 28 and May 1 and 3, 2006, personnel from our office carried out the overview assessment. We walked around the site, noted surface conditions, took photographs, and reviewed subsurface conditions in six test pits (TP06-1 to 6).

The test pits were excavated to between 3.4 and 4.3 m depth using a rubber-tired backhoe supplied by R.F. Klein and Sons Excavating Ltd. of Prince George, B.C. We logged the test pits as they were advanced and obtained representative samples for laboratory testing. We located the test pits using a hand-held GPS receiver, calibrated by measuring the coordinates of known points from the City of Prince George website. We measured the elevations of the test pits using a survey level and rod and referenced them to City of Prince George Integrated Survey Monument 86H1654 (elevation 735.999 m), located at the intersection of Eden Drive and Taft Drive, 150 m east of the property.

Test pit logs describing subsurface conditions are presented on Plates 2037-B1 to B3, in Appendix B. An explanation of the terms and symbols used on the logs is in Appendix C. We carried out laboratory testing on all samples to determine the natural moisture content of the soil. Selected samples were tested to determine their grain size distribution and fines content, that is, the percentage of soil by weight that is smaller than 0.075 mm diameter. The testing results are shown on the test pit logs and on Plate 2037-B4, also in Appendix B.

4.0 SURFACE AND SUBSURFACE CONDITIONS

4.1 Surface Conditions

The site is primarily flat-lying, with a gentle, east-facing slope in the northwest corner, north of the Hart Pioneer Centre. Areas of the property are treed, as shown on Drawing 2037-A2. Along the Highway 97 frontage road, there are indications of variable depths of fill associated with one or more previously existing houses. There is an existing gravel road between the Hart Pioneer Centre parking lot and Dagg Road.

Several derelict automobiles were on the site at the time of our investigation. We also noted other assorted refuse including pieces of automobiles, appliances, tires, and numerous abandoned bicycles. In the northwest corner of the property, some of the refuse is in pits or trenches excavated at least 2 m into the ground surface, including the excavation to remove the basement of the house on the northwest corner of the property. Some of the pits are lined with lumber and plywood and most are in various stages of collapse. Near the demolished house in the northwest corner of the property, there is a 760 mm corrugated steel pipe (CSP) at least 2 m long, buried vertically, likely the remains of an outdoor toilet. The CSP contains refuse, including old bicycles. Most of the refuse, the pits, and the trenches appear to be associated with the previously existing residence or residences in the northwest corner of the property.

On the northeast corner of the property, we did not observe signs of significant disturbance except for an abandoned vehicle that is visible on the 2003 photos, and is still at the site. There are indications that portions of this area were selectively logged in the past, but the cleared areas are overgrown with young poplar and willow trees. Aside from the logging, we did not see evidence of previous development.

We did not observe any refuse east of the Hart Pioneer Centre, except for surface litter.

The site of the recently demolished house and outbuildings near Dagg Road is typically flat and cleared of vegetation. Some areas disturbed during recontouring of the site are

undergoing significant settlement. We expect that excavations to remove footings, basements, or crawl-spaces in this area are likely filled with loose, random fill.

4.2 Subsurface Conditions

TP06-1 encountered 0.1 m of organic silt over fine to medium grained sand to 0.9 m, over stiff to hard, low to non plastic silt to the bottom of the test pit at 3.3 m depth. Below 1.2 m, the silt contains a trace of sand and a few cobbles and boulders, and pockets of gravelly, sandy silt.

TP06-2 encountered 0.3 m of sand and gravel fill, over a thin organic layer, over gravelly, coarse grained sand to 0.9 m, over stiff, sandy, non-plastic silt to 3.0 m, over fine to medium grained sand to the bottom of the test pit at 3.8 m depth.

TP06-3 encountered 0.1 m of organic silt over fine grained sand with varying silt content to 0.6 m, over very stiff to hard, low to non-plastic silt with a trace of sand to the bottom of the test pit at 3.6 m depth.

TP06-4 encountered fine to medium grained sand with a trace of fines to the bottom of the test pit at 4.3 m, with the exception of a layer of non-plastic silt with some fine grained sand between 1.2 and 1.7 m depth.

TP06-5 and 6 encountered very stiff, non-plastic silt with a trace of sand to the full depth of the pits at 3.8 m. TP06-5 encountered an old trench drain along one side of the test pit. The drain consists of a 0.9 m deep trench filled with drain rock. Within the drain rock there were two perforated pipes: a 150 mm diameter cast iron pipe at about 0.8 m depth and a 90 mm diameter ABS pipe at about 0.5 m depth.

No groundwater or bedrock was encountered in any of the test pits.

5.0 DISCUSSION AND RECOMMENDATIONS

From a geotechnical aspect, the site is suitable for the proposed development, however, the site conditions are not straightforward. The amount of site preparation required will depend on where the proposed building is situated on the site and how deep the foundations will be placed.

The site has been previously disturbed and contains areas that have been excavated and filled. The existing fill and disturbed soil are not suitable for support of building foundations and grade-supported slabs and we recommend that the fill, refuse, and any deleterious soil be removed from below the proposed building areas. This investigation was not intended to delineate the depth or extent of fill on site. The depth of fill is likely to vary across the site.

The following preliminary recommendations are based on our understanding of the proposed building and the necessary assumption that the subsurface conditions encountered in the test pits are representative of conditions across the site.

5.1 Site Preparation

The natural, undisturbed sand and silt are appropriate for the support of strip and pad spread footings. Prepare building areas by removing all existing fill, organic and deleterious materials to expose undisturbed natural soil. The natural silt and sand are highly susceptible to disturbance from machinery and inclement weather. Finish all excavations using an excavator equipped with a smooth-edged bucket or excavate the final few centimetres by hand. Where fill is required to raise the grade, use compacted structural fill that meets our specification for Select Granular Subbase (SGSB), described in Table 1, in Section 5.3. Place the fill on the excavated surface in thin, uniform layers, and compact each layer to at least 100% Standard Proctor Density (ASTM D698) (SPD). The appropriate layer thickness will depend on the size and compactive energy of the equipment, and on the moisture content of the soil, but do not exceed 300 mm.

The silt and fine-grained sand are highly susceptible to erosion and to shallow slope movement by frost action. Design the final site grading with slopes no steeper than 2.5 horizontal to 1 vertical. Control surface runoff to reduce erosion from concentrated flow and protect sloping areas from rill erosion. Seed all exposed soil surfaces with an appropriate seed mixture.

5.2 Foundation Design

Based on the results of our investigation, we recommend designing spread footings using a preliminary bearing pressure of 120 kPa, with a minimum width of 0.45 m for strip footings and 0.6 m for pad footings. Place the footings on natural silt and sand, or on compacted structural fill placed on the silt and sand.

Where footings are placed on the natural soil, we recommend placing a layer of lean-mix concrete, at least 50 mm thick, over the excavated surface to protect it from disturbance due to inclement weather and foot traffic.

Where footings will be placed on compacted structural fill, place and compact the fill as described in section 5.1, above. Extend the compacted fill beyond the edges of the footings out at a 45˚ angle down from the bottom, outside edges of the footings.

The silt and fine-grained sand is highly frost susceptible and can form ice lenses during extended periods of cold weather. Ice lenses below concrete footings and grade supported slabs can cause the concrete to heave and crack. For footings that will be warmed by building heat, we recommend providing at least 1.2 m of soil cover to protect the bearing soil from freezing. For footings not warmed by building heat, such as canopies or carports, or unheated buildings, provide at least 2.4 m of soil cover, or protect the footings using rigid board insulation. We can provide a detail for using insulation as frost protection at your request.

5.3 Grade-Supported Slabs

The natural silt and sand will provide adequate support for grade-supported floor slabs. To reduce the potential for future slab movement and cracking, where the floor loading is less than about 20 kPa, prepare slab areas using the following procedures:

- Remove all existing fill, organic soil and soft, deleterious materials to expose the natural silt and sand, and excavate to a depth of at least 450 mm below the bottom of slab elevation.

- Compact the top surface of the natural silt and sand to at least 100% SPD. Add water or dry the natural ground as required to achieve the specified density.

- Excavate rutted areas that are identified during the compaction process and replace with SGSB, defined in Table 1, below. Place the fill in thin, uniform layers and compact each layer to at least 100% SPD.

- Bring slab areas to grade using SGSB, placed in uniform layers no thicker than 300 mm, and compact each layer to at least 100% SPD. Provide at least 300 mm of SGSB below the slab area.

- Directly below the slab, place a minimum 150 mm thick layer of Well Graded Base (WGB), as defined in Table 1, and compact it to at least 100% SPD.

Table 1 - Gradation Specifications

Sieve Size (mm)	Percentage Passing	
	Well Graded Base (WGB)	Select Granular Subbase (SGSB)
100	-	100
75	-	95-100
25	100	-
19	80-100	50-100
9.5	50-85	-
4.75	35-70	15-60
2.36	25-50	-
1.18	15-35	-
0.300	5-20	3-15
0.075	0-5	0-5

Use crushed and screened material for WGB. The SGSB can be a pit run material that meets the above gradation. Use durable aggregate that will not degrade from exposure to water, freeze-thaw cycles or handling, spreading and compacting. It must not contain organic materials or an excess of flat or elongated stones. Do not place fill that is frozen and do not place fill on frozen ground.

6.0 CLOSURE

Due to the amount of previous disturbance across the site, we recommend further subsurface investigation once the proposed building location and dimensions are known. We recommend that a geotechnical engineer or their representative review all excavations prior to the placement of fill or concrete to confirm that the base of the excavation is on natural ground and that the soil has sufficient strength for support of footings. We recommend that structural

fill be placed and compacted under the direction of a geotechnical engineer or their representative. Test each lift of fill for compaction starting with the first lift.

This report was prepared by GeoNorth Engineering Ltd. for the use of the Northern Health Authority and their consultants. The material in it reflects GeoNorth Engineering's judgement in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, is the responsibility of such Third Parties. GeoNorth Engineering Ltd. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

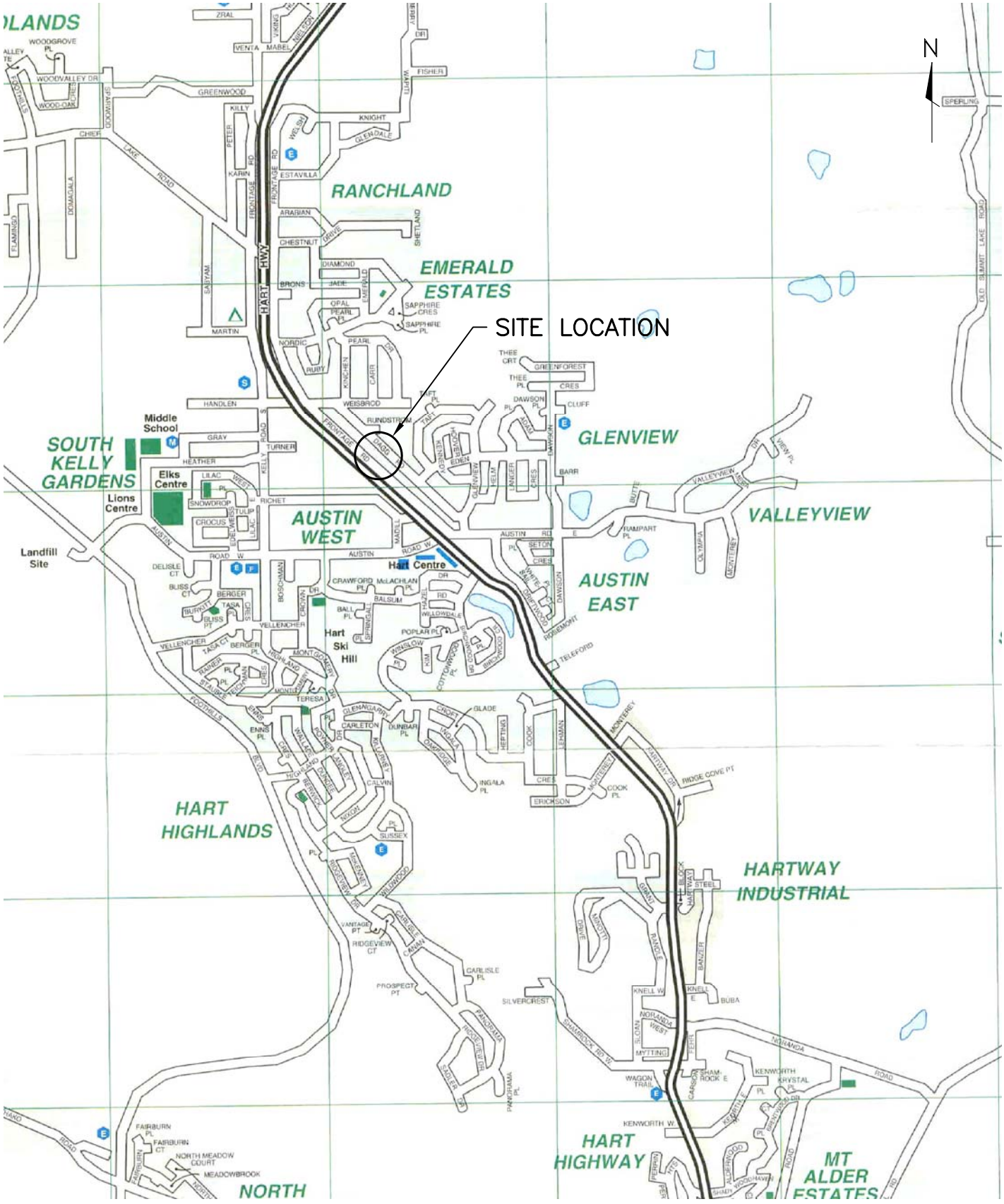
Respectfully submitted,
GeoNorth Engineering Ltd.

Per: D.A. Hughes-Games, E.I.T.

Reviewed by,
GeoNorth Engineering Ltd.

Per: S.M. Judge, P.Eng.

A P P E N D I X A



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NORTHERN HEALTH AUTHORITY
PRELIMINARY GEOTECHNICAL OVERVIEW ASSESSMENT
7054 HART HIGHWAY, PRINCE GEORGE, B.C.
SITE LOCATION PLAN

SCALE: 1:25,000	DATE: 2006/05/17	DRAWN: LU	CHKD: –	PROJ: K-2037	DWG: 2037-A1

NOTES:

1. SITE PLAN BASED ON DIGITAL INFORMATION FROM CITY OF PRINCE GEORGE WEB SITE AND ITS ACCURACY IS NOT GUARANTEED (2003 ORTHOPHOTO).
2. TEST PIT LOCATIONS ARE APPROXIMATE.

SCALE: 1:1000	APPROVED:	NORTHERN HEALTH AUTHORITY PRELIMINARY GEOTECHNICAL OVERVIEW ASSESSMENT 7054 HART HIGHWAY, PRINCE GEORGE, B.C. SITE PLAN SHOWING TEST PIT LOCATIONS	GEONORTH ENGINEERING LTD. 1301 Kelliher Road Prince George, B.C. V2L 5S8 Tel. (250) 564-4304 Fax (250) 564-9323
DATE: 2006/05/17			
DWN BY: LU			
MAP REF: –			
DWG NO. 2037-A2	REV. –	PROJECT NO: K-2037	

NOTES:

1. SITE PLAN BASED ON DIGITAL INFORMATION FROM CITY OF PRINCE GEORGE WEB SITE AND ITS ACCURACY IS NOT GUARANTEED.
2. TEST PIT LOCATIONS ARE APPROXIMATE.

HART PENTECOSTAL CHURCH

HART PIONEER CENTRE

TP06-4

TP06-3

TP06-5

TP06-2

TP06-1

TP06-6

GRAVEL ROAD

FRONTAGE ROAD

HIGHWAY 97 (HART HIGHWAY)

DAGG ROAD

HOUSE (DEMOLISHED BETWEEN 1993 & 2003)

EDGE OF FILL 0.3-1.0 m HIGH

PILE OF FILL

BUILDINGS (DEMOLISHED AFTER 2003)

DERELICT AUTOMOBILE

DERELICT AUTOMOBILE

REMAINS OF HOUSE (DEMOLISHED PRIOR TO 1993)

APPROXIMATE AREAS CONTAINING BURIED REFUSE

N

NORTHERN HEALTH AUTHORITY
PRELIMINARY GEOTECHNICAL OVERVIEW ASSESSMENT
7054 HART HIGHWAY, PRINCE GEORGE, B.C.
SITE PLAN

SCALE:	1:1000
DATE:	2006/05/17
DWN BY:	LU
MAP REF:	–
DWG NO.	2037-A3
REV.	–
PROJECT NO:	K-2037
APPROVED:	

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A P P E N D I X B

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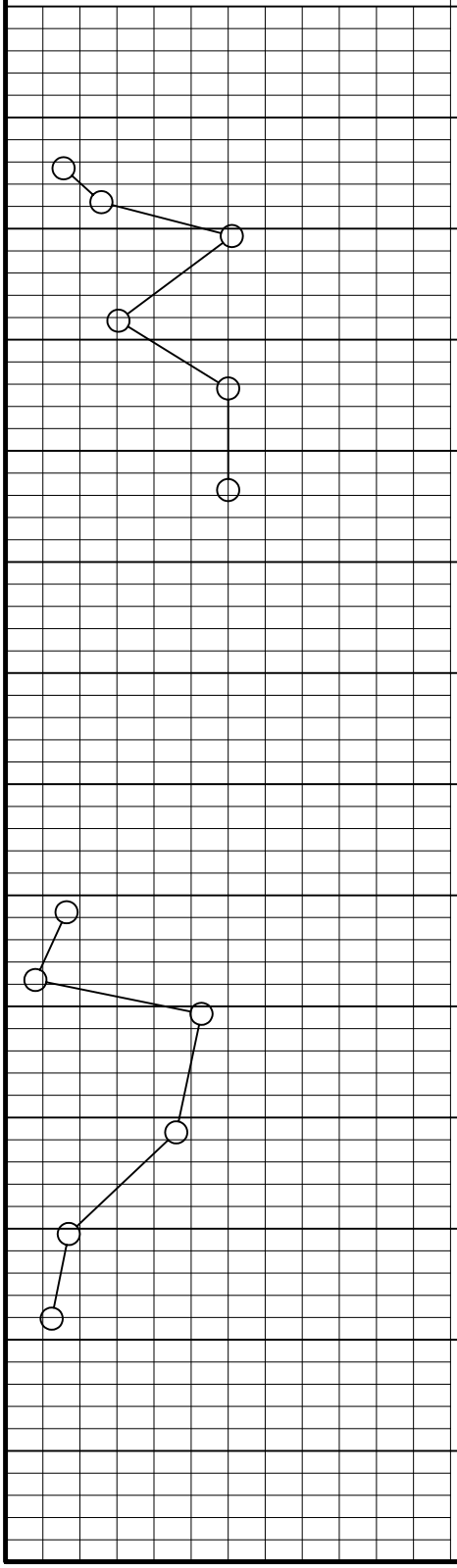
TEST PIT LOG

CLIENT: NORTHERN HEALTH AUTHORITY
PROJECT: PRELIMINARY GEOTECHNICAL OVERVIEW ASSESSMENT
7054 HART HIGHWAY, PRINCE GEORGE, B.C.

LOGGED	FILE NO.	DATE OF INVEST.	EXCAVATOR TYPE
DHG	K-2037	2006/05/01	Rubber Tire

WATER CONTENT (%)
○ NATURAL WATER CONTENT
△ LIQUID ATTERBERG LIMIT
□ PLASTIC ATTERBERG LIMIT
10 20 30 40 50



DEPTH (m)	SYMBOL	SOIL DESCRIPTION	SAMPLES	COMMENTS
		TP06-1		
0		ORGANIC SILT, some sand.		– Elev. 748.3 m
		0.1 SAND, medium to fine grained, trace fines, layered, compact, brown, damp. – at 0.9 m, moist to wet.		
1		0.9 SILT, some clay, layered, fissured, very stiff to hard, low plasticity, brown, damp.		
2		1.2 SILT, trace fine grained sand, layered, stiff, non-plastic, brown, damp. – at 1.8 m, 0.6 m dia. boulder. at 2.4 m, 0.2 m dia. cobble. – below 2.4 m, contains frequent drop stones and pockets of rafted till.		– Wash Test, 95.6% fines
3				
4		3.3 End of hole at 3.4 m. No seepage observed. Test Pit walls did not slough.		
5				
		TP06-2		
0		SAND, gravelly, some fines, trace organics, compact to dense, brown, damp (FILL). – thin, organic layer at 0.3 m.		– Elev. 742.9 m
1		0.3 SAND, coarse grained, gravelly, fine to medium grained gravel, clean, compact, brown, damp.		– Grain Size Analysis, See Plate 2037-B4
2		0.9 SILT, sandy, layered, stiff, non-plastic, brown, damp.		– Wash Test, 66.5% fines
3		3.0 SAND, fine to medium grained, trace fines, compact, grey-brown, damp.		
4		3.8 End of hole at 3.8 m. No seepage observed. Test Pit walls did not slough.		
5				

PLATE NO. 2037-B1

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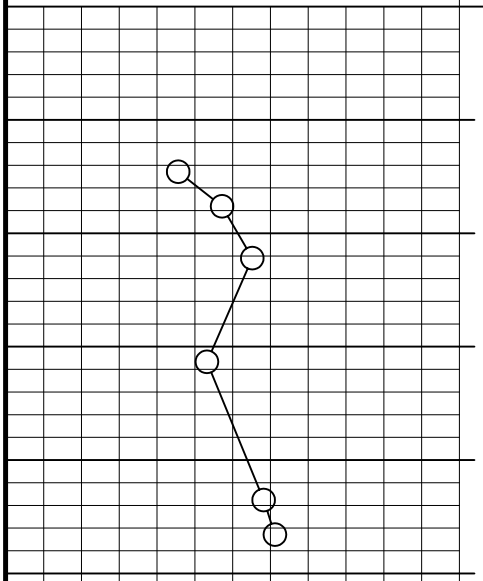
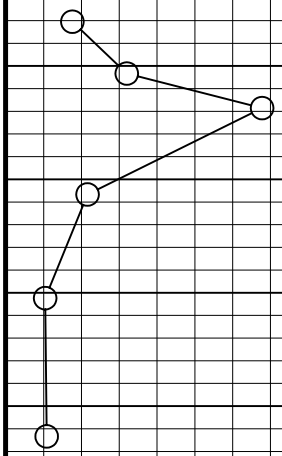
TEST PIT LOG

CLIENT: NORTHERN HEALTH AUTHORITY
PROJECT: PRELIMINARY GEOTECHNICAL OVERVIEW ASSESSMENT
7054 HART HIGHWAY, PRINCE GEORGE, B.C.

LOGGED	FILE NO.	DATE OF INVEST.	EXCAVATOR TYPE
DHG	K-2037	2006/05/01	Rubber Tire

WATER CONTENT (%)
○ NATURAL WATER CONTENT
△ LIQUID ATTERBERG LIMIT
□ PLASTIC ATTERBERG LIMIT
10 20 30 40 50





DEPTH (m)	SYMBOL	SOIL DESCRIPTION	SAMPLES	COMMENTS
		TP06-3		
0		ORGANIC SILT, some sand.		– Elev. 739.3 m
		0.1		
		SAND, fine grained, trace silt to silty, compact, grey-brown, damp.		
1		0.6		
		SILT, some fine grained sand, very stiff to hard or compact, low to non-plastic, brown, moist.		– Wash Test, 90.4% fines
2				
3				
		3.6		
4		End of hole at 3.6 m.		
		No seepage observed.		
5		Test Pit walls did not slough.		
		TP06-4		
0		SAND, trace silt, trace organics, compact, red-brown, damp.		– Elev. 737.9 m
		0.3		
		SAND, fine to medium grained, uniform, trace fines to clean, compact, brown, damp.		
1		1.2		– Wash Test, 87.2% fines
		SILT, some fine grained sand, layered, very stiff, non-plastic, brown, moist.		
2		1.7		
		SAND, fine grained, trace fines, uniform, layered, compact, grey-brown, damp.		
3				
4		4.3		
		End of hole at 4.3 m.		
5		No seepage observed.		
		Test Pit walls did not slough.		

PLATE NO. 2037-B2

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TEST PIT LOG

CLIENT NORTHERN HEALTH AUTHORITY
PROJECT PRELIMINARY GEOTECHNICAL OVERVIEW ASSESSMENT
7054 HART HIGHWAY, PRINCE GEORGE, B.C.

LOGGED	FILE NO.	DATE OF INVEST.	EXCAVATOR TYPE
DHG	K-2037	2006/05/01	Rubber Tire

WATER CONTENT (%)
○ NATURAL WATER CONTENT
△ LIQUID ATTERBERG LIMIT
□ PLASTIC ATTERBERG LIMIT
10 20 30 40 50

DEPTH (m) | SYMBOL | SOIL DESCRIPTION | SAMPLES | COMMENTS

TP06-5

0

SILT, trace to some fine grained sand, layered, very stiff, non-plastic, brown, mottled, damp.

– Elev. 738.4 m

1

– Wash Test, 94.1% fines

2

3

3.8

End of hole at 3.8 m.
No seepage observed.
Test Pit walls did not slough.

4

5

TP06-6

0

ORGANIC SILT, some sand.
0.1
SILT, trace to some fine grained sand, layered, very stiff, non-plastic, brown, damp to moist.

– Elev. 739.9 m

1

2

– Wash Test, 93.3% fines

3

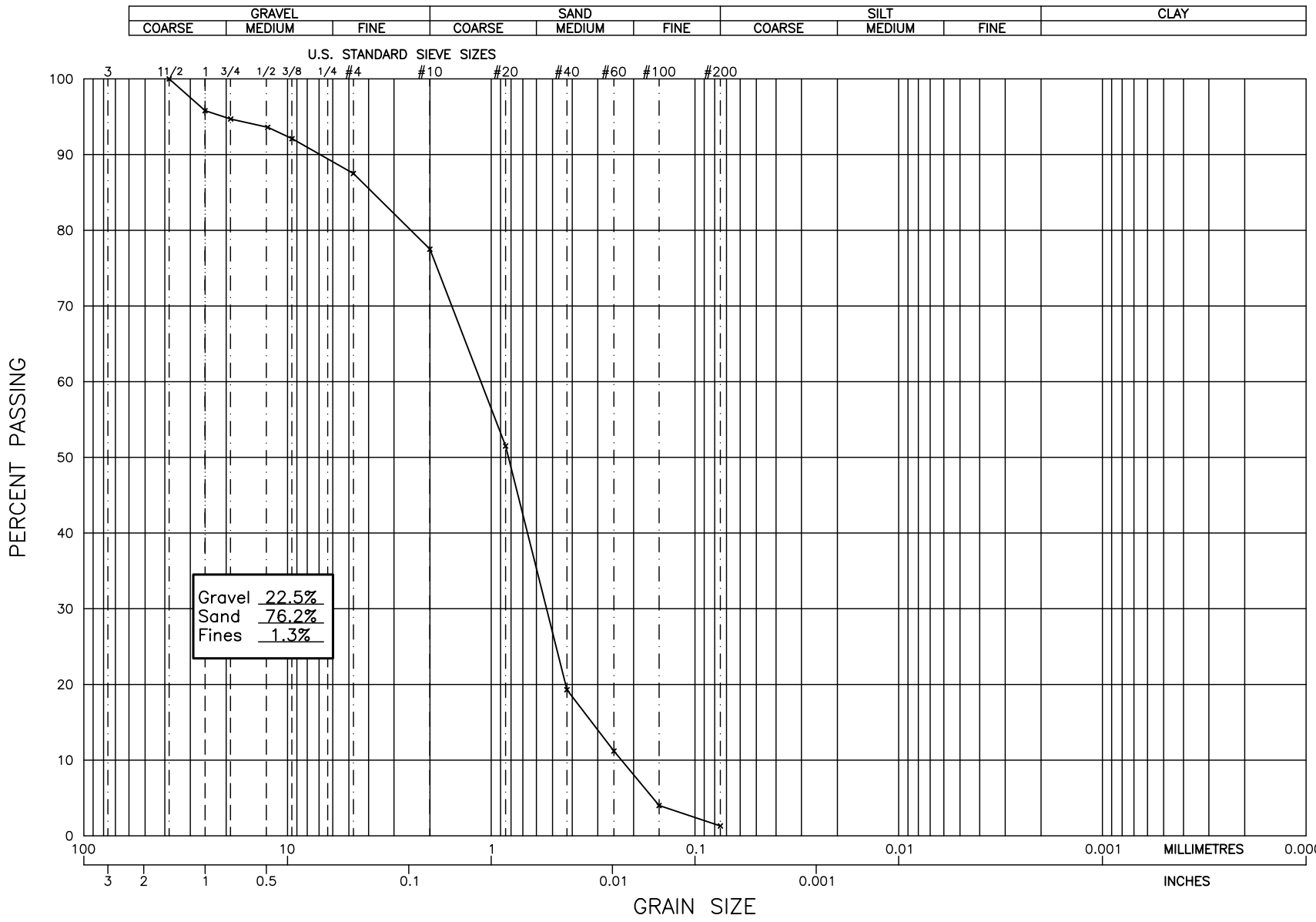
3.8

End of hole at 3.8 m.
No seepage observed.
Test Pit walls did not slough.

4

5

PLATE NO. 2037-B3



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NORTHERN HEALTH AUTHORITY
PRELIMINARY GEOTECHNICAL OVERVIEW ASSESSMENT
7054 HART HIGHWAY, PRINCE GEORGE, B.C.
GRAIN SIZE ANALYSIS OF TP06-2, 0.8 m DEPTH

SCALE:	DATE:
N.T.S.	2006/05/17
PROJECT NO:	DRAWING NO.
K-2037	2037-B4

A P P E N D I X C

EXPLANATION OF TERMS AND SYMBOLS USED ON TEST HOLE LOGS

SOIL DESCRIPTION

Soil is classified in accordance with the International Society of Soil Mechanics and Foundation Engineering (ISSMFE) system as described in the 1992 Canadian Foundation Engineering Manual (CFEM) 3rd Edition. Descriptions for each soil type encountered are divided by contact lines at interface depths. Each description has a corresponding graphic symbol which relates to soil type.

Major Soil Division

The major soil division is the main fraction of soil and constitutes at least 35% by weight. Soil is classified as GRAVEL, SAND, CLAY, SILT or ORGANIC according to the criteria on page 3.

Interpretation

Where applicable, a bracketed term such as (FILL) or (TILL) is included to describe soil genesis.

Grain Size and Shape

Grain size descriptions for soil follow the criteria on page 3.
The shape of coarse and oversized particles is described as:

angular – sharp corners
subangular – slightly rounded corners
subrounded – no angular corners
rounded – smooth rounded surface
platy – flat, plate shaped

Soil Composition

The following terms are used to describe the percentage of soil components by weight based on laboratory sieve analyses or field estimates.

Descriptive Term		Percentage Passing
"and"	and sand, and gravel, etc.	>35%
"___y"	clayey, sandy, etc.	20 to 35%
"some"	some silt, some gravel, etc.	10 to 20%
"trace"	trace of sand, trace of silt, etc.	0 to 10%

The amount of cobbles and boulders, in increasing proportion, are described as:
isolated < occasional < frequent < numerous.

Compactness and Consistency

The following terms are used to describe the compactness of cohesionless soil based on the Standard Penetration Test (SPT) or field estimates:

Descriptive Term	SPT 'N' Value
very loose	0 to 4
loose	4 to 10
compact	10 to 30
dense	30 to 50
very dense	over 50

The following terms are used to describe the consistency of fine grained soils based on unconfined compressive strength as determined by field or laboratory tests, or estimates:

Description Term	Unconfined Compressive Strength (kPa)
very soft	<25
soft	25 to 50
firm	50 to 100
stiff	100 to 200
very stiff	200 to 400
hard	>400

Structure

Soil macrostructure and microstructure are described.

Plasticity

Plasticity of fine grained soil is estimated or determined from Atterberg Limit tests based on the plasticity chart on page 3.

EXPLANATION OF TERMS AND SYMBOLS USED ON TEST HOLE LOGS

SOIL DESCRIPTION (cont'd)

Colour and Odour
Colour and odour of soil is described, especially where it may indicate organic inclusions or give evidence of soil contamination.

Inclusions
The quantity of inclusions is described using the same relative–amount terms used for cobbles and boulders, noted above.

Water Content
Soil moisture, in increasing amount, is subjectively described as:
dry < damp < moist < wet < saturated < excess water.

SOIL SAMPLES

Graphic symbols indicate the depth and condition of soil samples:

 Disturbed

 Undisturbed

Undisturbed samples may be taken with tubes, from blocks or by coring. All other types of samples are disturbed.

FIELD TESTS

Standard Penetration Test (SPT) (ASTM D1586)
The SPT results are reported as the 'N' value at the appropriate depth. The 'N' value denotes the number of blows of a 63.5 kg hammer, freely dropping 760 mm, required to drive a 50.8 mm diameter split–spoon sampler from 150 mm to 460 mm into the bottom of a drill hole.

Dynamic Cone Penetration Test (DCPT)
Dynamic cone penetration test results are shown graphically. The number of blows required to drive a 50.8 mm diameter cone 305 mm is shown opposite the depth. The method of driving the cone is the same as for the SPT test described above.

Field Vane Test (FVT) (ASTM D2573–72)
Undrained shear strength of cohesive soil is measured using a 100 mm long by 50 mm diameter vane. Test results for peak and residual strengths are graphically reported at the appropriate depths using the following symbols:

⊗ Peak Shear Strength
× Residual Shear Strength

Pocket Penetrometer and Torvane Tests
The pocket penetrometer and torvane provide an indication of a soil's unconfined compressive strength and undrained shear strength, respectively. Pocket penetrometer results are shown graphically using ◊ symbols. Torvane results are reported using the same symbols used for the field vane test.

LABORATORY TESTS

The following symbols are used to denote laboratory test results:

○	Natural water content, w_N (ASTM D2216)
□	Atterberg Plastic Limit, w_P (ASTM D424)
△	Atterberg Liquid Limit, w_L (ASTM D423)
MA	Mechanical grain size (sieve) analysis or hydrometer test, or both (ASTM D422)
qu	Unconfined compressive strength test on an undisturbed sample (ASTM D2166)
SO_4	Test for concentration of water–soluble sulphates
γ	Unit weight of soil or rock
γ_d	Dry unit weight of soil or rock.

COMMENTS

Groundwater conditions are indicated using the following symbols:


groundwater table
seepage.

Comments often included are additional test results, drilling progress, monitoring equipment installation details and other relevant information.

ISSMFE SOIL CLASSIFICATION SYSTEM

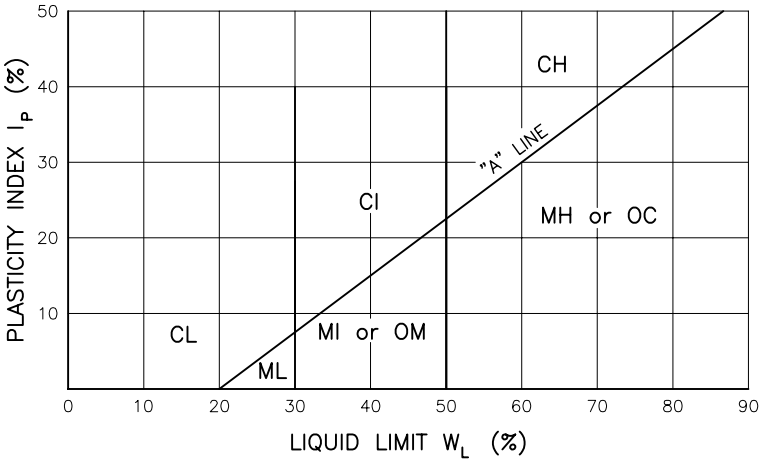
MAJOR DIVISION			GROUP SYMBOL	GRAPHIC SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
COARSE–GRAINED SOIL	GRAVEL 2.0 – 60.0 mm DIAMETER	CLEAN GRAVEL	GW		WELL–GRADED GRAVEL AND SANDY GRAVEL MIXTURES WITH LESS THAN 5% FINES.	$C_u = \frac{D_{60}}{D_{10}} > 6,\ C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$
			GP		POORLY–GRADED GRAVEL AND SANDY GRAVEL MIXTURES WITH LESS THAN 5% FINES.	NOT MEETING ABOVE REQUIREMENTS.
		DIRTY GRAVEL	GM		SILTY GRAVEL AND SILT–SAND–GRAVEL MIXTURES WITH MORE THAN 15% FINES.	ATTERBERG LIMITS BELOW "A" LINE.
			GC		CLAYEY GRAVEL AND CLAY–SAND–GRAVEL MIXTURES WITH MORE THAN 15% FINES.	ATTERBERG LIMITS ABOVE "A" LINE.
	SAND 0.06 – 2.0 mm DIAMETER	CLEAN SAND	SW		WELL–GRADED SAND AND GRAVELLY SAND MIXTURES WITH LESS THAN 5% FINES.	$C_u = \frac{D_{60}}{D_{10}} > 6,\ C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$
			SP		POORLY–GRADED SAND AND GRAVELLY SAND MIXTURES WITH LESS THAN 5% FINES.	NOT MEETING ABOVE REQUIREMENTS.
		DIRTY SAND	SM		SILTY SAND AND SILT–GRAVEL–SAND MIXTURES WITH MORE THAN 15% FINES.	ATTERBERG LIMITS BELOW "A" LINE.
			SC		CLAYEY SAND AND CLAY–GRAVEL–SAND MIXTURES WITH MORE THAN 15% FINES.	ATTERBERG LIMITS ABOVE "A" LINE.
FINE–GRAINED SOIL	SILT BELOW "A" LINE ON PLASTICITY CHART. NEGLIGIBLE ORGANIC CONTENT.		ML		INORGANIC SILT, VERY FINE SAND, ROCK FLOUR, AND SANDY SILT OF LOW PLASTICITY.	SEE PLASTICITY CHART BELOW
			MI		INORGANIC SILT OF INTERMEDIATE PLASTICITY.	
			MH		INORGANIC SILT AND MICACEOUS OR DIATOMACEOUS SOIL OF HIGH PLASTICITY.	
	CLAY ABOVE "A" LINE ON PLASTICITY CHART. NEGLIGIBLE ORGANIC CONTENT.		CL		INORGANIC CLAY OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAY, 'LEAN' CLAY	
			CI		INORGANIC CLAY OF INTERMEDIATE PLASTICITY, SILTY CLAY.	
			CH		INORGANIC CLAY OF HIGH PLASTICITY, 'FAT' CLAY.	
	ORGANIC SILT & CLAY BELOW "A" LINE ON PLASTICITY CHART		OC		ORGANIC CLAY	
			OM		ORGANIC SILT	
HIGHLY ORGANIC SOIL			Pt		PEAT AND OTHER HIGHLY ORGANIC SOIL	HIGH ORGANIC CONTENT AND FIBROUS TEXTURE.

GRAIN SIZE

Coarse–grained soil and silt is identified on the basis of grain size diameter as follows:

SILT:	Fine	0.002 – 0.006 mm
	Medium	0.006 – 0.020 mm
	Coarse	0.020 – 0.060 mm
SAND:	Fine	0.06 – 0.20 mm
	Medium	0.20 – 0.60 mm
	Coarse	0.60 – 2.00 mm
GRAVEL:	Fine	2.0 – 6.0 mm
	Medium	6.0 – 20.0 mm
	Coarse	20.0 – 60.0 mm
COBBLES:		60.0 – 200 mm
BOULDERS:		> 200 mm

PLASTICITY CHART



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