DYREGROV CONSULTANTS
CONSULTING GEOTECHNICAL ENGINEERS

GEOTECHNICAL REPORT

CENTRATE NUTRIENT TREATMENT

NITROGEN REMOVAL FACILITY

NORTH END WATER POLLUTION CONTROL CENTRE

Prepared for

EARTH TECH (CANADA) INC.

on behalf of

THE CITY OF WINNIPEG

February 2006 **Project No. 252788**

1.0 INTRODUCTION

This report summarizes the results of a geotechnical investigation undertaken by Dyregrov Consultants at the site of the proposed Centrate Nutrient Treatment Nitrogen Removal Facility at the City of Winnipeg's North End Water Pollution Control Centre. The work was done at the request of Earth Tech (Canada) Inc., on behalf of the City of Winnipeg, by Fax dated November 24, 2005 under the signature of Mr. Eric Hutchison, P.Eng.

2.0 PROPOSED DEVELOPMENT

It is our understanding that the proposed facility will be located west of the existing primary digesters, as illustrated on Figure 1. It will include a Centrate Treatment Facility with approximate dimensions of 40 by 80 metres, a methanol storage tank area and a soda ash facility. The Centrate Treatment Facility will contain below grade tanks which will require excavations to 5 to 6 metres below existing grade. A 2 metre diameter and 45 metre high stack will be located near the northeast corner of the facility. The methanol storage tank area will support three horizontal tanks and pumping equipment. The soda ash facility will be a vertical tank on a concrete pad.

3.0 DESCRIPTION OF THE FIELDWORK

A total of four 500 mm diameter boreholes were put down on January 31, 2006 at the locations shown on the site plan, Figure 1. A truck-mounted power auger supplied by Subterranean (Winnipeg) Ltd. was used. Borings 1, 2 and 3 were extended to auger refusal and Test Hole 4 was terminated at the 3.96 metre depth. The soil profile was examined and logged on a continuous basis as drilling progressed. Disturbed and relatively undisturbed soil samples were recovered at regular intervals for on-site classification and for laboratory testing purposes.

The site investigations were delayed while attempts to have underground facilities located prior to the site investigations.

4.0 THE SOIL PROFILE

The soil profile is similar to that encountered at other locations in the NEWPCC site and consists essentially of a thick deposit of lacustrine clays that are underlain by glacial till. Overlying the lacustrine clay is a silt and clay fill which contains some sand and gravel sizes. Near the mid point of the fill, it is black with a significant odour. The odour is apparently from former sludge drying beds. The fill thickness varies from 1.93 to 2.44 metres.

Beneath the fill is a thin (0.46 - 0.92 m) layer of lacustrine clay which covers a wet tan silt deposit in each of the test holes. The surface of the silt was at depths ranging from 2.44 to 3.20 m and thicknesses ranging from 0.76 to 1.07 m. The bottom of the silt varied from 3.51 to 4.12 m from the ground surface. Sloughing of the silt into the borings was noted in all of the test holes.

The lacustrine clays are stiff to very stiff in terms of their relative consistency, with undrained shear strengths generally in the range of about 40 to 80 kPa. The strength data from unconfined compression, Torvane and pocket penetrometer tests are shown on Test Hole 1, Figure 2. The clays are highly plastic.

Glacial silt till was encountered at depths between 18.29 and 19.05 metres in the test holes. The till is a mixture of sand, gravel and boulder sized materials within a predominately silt matrix that has a low but variable clay content. The till was classified as soft to medium dense and dense or very dense on the basis of a visual examination of auger cuttings. Moisture contents of the till samples are also indicative of its relative density with the dense to very dense materials having moisture contents in the 6.7 to 8.3 range. Auger refusal occurred at depths between 20.27 and 21.05 metres.

The soil profile and the results of field and laboratory tests are described in detail on the borehole logs, Figures 2 to 5.

5.0 RECOMMENDATIONS

5.1 General

It is our understanding that the proposed development will include the Centrate Treatment Facility and separate Methanol Storage Tanks and a Soda Ash Facility.

The Centrate Treatment Facility will have a footprint in the order of 40 by 80 metres with below grade reinforced concrete tanks and other areas which will require excavation in the order of 5.0 to 6.0 metres from existing grade. An independent 2 metre diameter by 45 metre high stack will be located near the northeast corner of the facility.

The methanol storage tank area will support three horizontal tanks and pumping equipment. The support is expected to be provided by a pile supported structural slab. Foundation loads will be relatively light.

The soda ash facility will be a vertical tank on a concrete pad which will be supported on a pile foundation. Relatively heavy loads are anticipated.

5.2 Foundations

The two principal foundation options for the support of the structural aspects of the project are driven precast prestressed end bearing concrete piles and cast-in-place concrete friction piles for lighter loads. The preferred foundation alternative for the heavy loads is the driven precast concrete piles which would be end bearing in the underlying glacial till. Precautions will have to be exercised to minimize the impacts of vibrations induced by the pile driving operations on adjacent facilities.

Driven precast concrete piles have been uses extensively at the NEWPCC and are considered appropriate for this project if the loads can be distributed to take full advantage of the relatively high capacities of these piles. These piles, if driven to practical refusal, may be assigned conventional supporting capacities of 445, 625 and 800 kN for nominal 300, 350 and 400 mm sizes respectively. The piles should be driven with a diesel hammer with a rated energy of not less than 40 kilojoules. Practical refusal may be defined as final penetration resistance sets of 5, 8 and 12 blows per less than 25 mm for the 300, 350 and 400 mm sizes respectively. At least three sets should be obtained. If followers are used, the final penetration resistance criteria should be increased by 50 percent. No reduction in individual pile capacity is necessary for reasons related to group action provided that pile heave is monitored, measures undertaken to minimize it (by preboring) and redriving is done as necessary in pile groups. Pile spacing should not be less than 2.5 pile diameters centre to centre. Pile concrete should be at least 7 days old.

Inspections of the driven pile installation should be undertaken by technologists experienced with their installation. The presence of cobbles and boulders which are known to be present in the glacial till may result in pile installation problems which should be monitored.

Preboring should be done at the driven pile locations with diameters that are 50 mm larger than the pile size. The preboring is effective in reducing ground vibrations and pile heave and contributes positively to pile verticality. When driving within 3 metres of existing underground facilities, deeper prebore to within 1.5 metres of the glacial till should be considered. If followers are required for driving the piles, the size of the prebore should be 50 mm larger than the follower and for a depth equal to the length of the follower.

It is understood that pile loads may be suitable for the use of the cast-in-place concrete friction piles to support the methanol storage tank structural slab. These piles should have a minimum diameter of 400 mm and may be sized on the basis of an allowable shaft adhesion of 18.0 kPa. The shaft support should be discounted to a depth below the bottom of the silt which is some 3.5 to 4.0 metres from existing grade or 3 metres, whichever is larger. Also, the piles should not penetrate the glacial silt till to avoid problems with the groundwater conditions which could be encountered in the glacial till. In this regard, it is recommended that the pile tips should not extend closer than 1.5 metres to the glacial till surface. Pile spacing should not be closer than 3 pile diameters centre to centre. If pile groups are required, group action should be considered. Temporary steel sleeves should be on hand and used on an as-required basis to prevent seepage and caving into the borings, particularly from the water bearing silt.

The friction piles potentially subject to frost heave and uplift should contain full length reinforcement and should be a minimum length of 7.6 metres. Alternatively, the piles could be protected by the use of flat lying, rigid, high density insulation around the pile at least 300 mm below the finished grade.

Slabs on grade to support light loads such as for the methanol storage tank are not recommended due to the presence of the large thickness of fill which is present. In addition, the major excavations and backfill for the centrate treatment facility are expected to encompass the proposed methanol tank area. The presence of the fill and/or backfill could lead to significant differential movements of the slabs.

5.3 Slabs

It is understood that the structurally supported floor slabs will be used throughout the Centrate treatment facility and at the methanol storage tanks and soda ash facility. The floors (and grade beams) should be separated from the underlying soil subgrade by a 300 mm void. It is presumed that these slabs will have no underdrainage and that water could collect below them. This is conducive to swelling and generous allowance for this is recommended. It is understood that a perimeter drain will be provided.

5.4 Excavations

Excavations are required for the Centrate treatment facility to depths of 5.0 to 6.0 metres. The excavations will have to be shored or will require relatively flat excavation slopes too ensure safety of workers and adjacent facilities. Excavated materials should not be stockpiled immediately adjacent to the work as their presence may negatively impact the stability of the excavation slopes, shoring or any underground facilities.

The design of the excavations slopes should recognize the presence of the fill and water bearing silt which was noted in the test holes. It may be necessary to control seepage from the silt during construction. It is recommended that the contractor provide an excavation plan endorsed by an independent geotechnical engineer.

The excavated slopes should be protected from weathering by suitable temporary coverings.

Temporary shoring may be designed on the basis of the earth pressure distribution illustrated in Figure 6. Ground movements behind the shoring will occur and it is largely unavoidable. The amount that will occur cannot be predicted with much accuracy, mainly because the movement is as much a function of excavation procedures and workmanship as it is a function of theoretical considerations. The impact of these movements should be assessed.

It is recommended that toe support for soldier piles be provided by concrete plugs within the clay deposit immediately below the excavation surface. It is recommended that the toe support not be provided from driving the soldier piles and/or sheet piles into the underlying glacial till/bedrock. This will minimize the potential for a long term groundwater connection between the bedrock aquifer and the proposed facility.

Where shoring is provided at the base of any excavated slopes, the effects of sloping ground above the shoring, on the shoring, must be considered.

5.5 Below-Grade Walls

The below-grade walls should be designed to resist lateral earth pressures that are derived on the basis of the following conventional relationship:

$$P = K \gamma D$$

where P = lateral earth pressure at depth below final grade D (kN/m^2)
K = earth pressure coefficient (0.5)
γ = soil backfill unit weight (17.5 kN/m^3)
D = depth from final grade to point of pressure calculation (m)

The base of the wall should be provided with a filter-protected positive drainage system to prevent the buildup of hydrostatic pressure against the wall. Where drainage is not provided, the lateral pressure should be increased to 17.5 kN/m^3. An allowance for surface live loads should be included if significant load is applied with a distance from the wall equal to the height of the wall. The lateral pressure due to the live load should be presumed equal to 50 percent of the vertical pressure due to the live load.

The selection of backfill materials should be reviewed during the design and their impact on the foregoing pressures assessed. It is preferred that free draining granular material be placed adjacent to the walls. The balance of the backfill may be with acceptable excavated clay soil. The backfill against the wall should receive nominal compaction. The maximum difference in the surface of the elevation of the backfill should be less than 0.5 metres.

5.6 Pavements

On the basis of the test hole stratigraphy, there is at least 2 metres of clay fill which contains some scattered sand and gravel. Near the mid point of the fill thickness, it is black and has a significant odour which is expected to be related to former sludge drying beds. Removal of this material would require significant depths of excavation.

The subgrade preparation should consist of "proof rolling" the pavement areas. Any areas of significant deformation should be removed and replaced with acceptable materials. All fill placement and excavated surfaces should be compacted to a uniform density of 95 percent of Standard Proctor density.

At the locations of the test holes, the subgrade preparation is not expected to impact the soft tan silt which was encountered in all of the test holes.

It is recommended that the pavement section for the truck area consist of a minimum 100 mm of asphaltic concrete placed on 380 mm of crushed granular base course or an equivalent section. For parking areas, the pavement section could consist of 50 mm of asphaltic concrete placed on 200 mm of crushed granular base course or equivalent. These sections should be placed on the prepared subgrade.

5.7 <u>Other</u>

All concrete in contact with the soil should be manufactured with sulphate-resistant cement and should be of high quality.

Site drainage should be away from the facility site at a gradient of at least 2 percent.

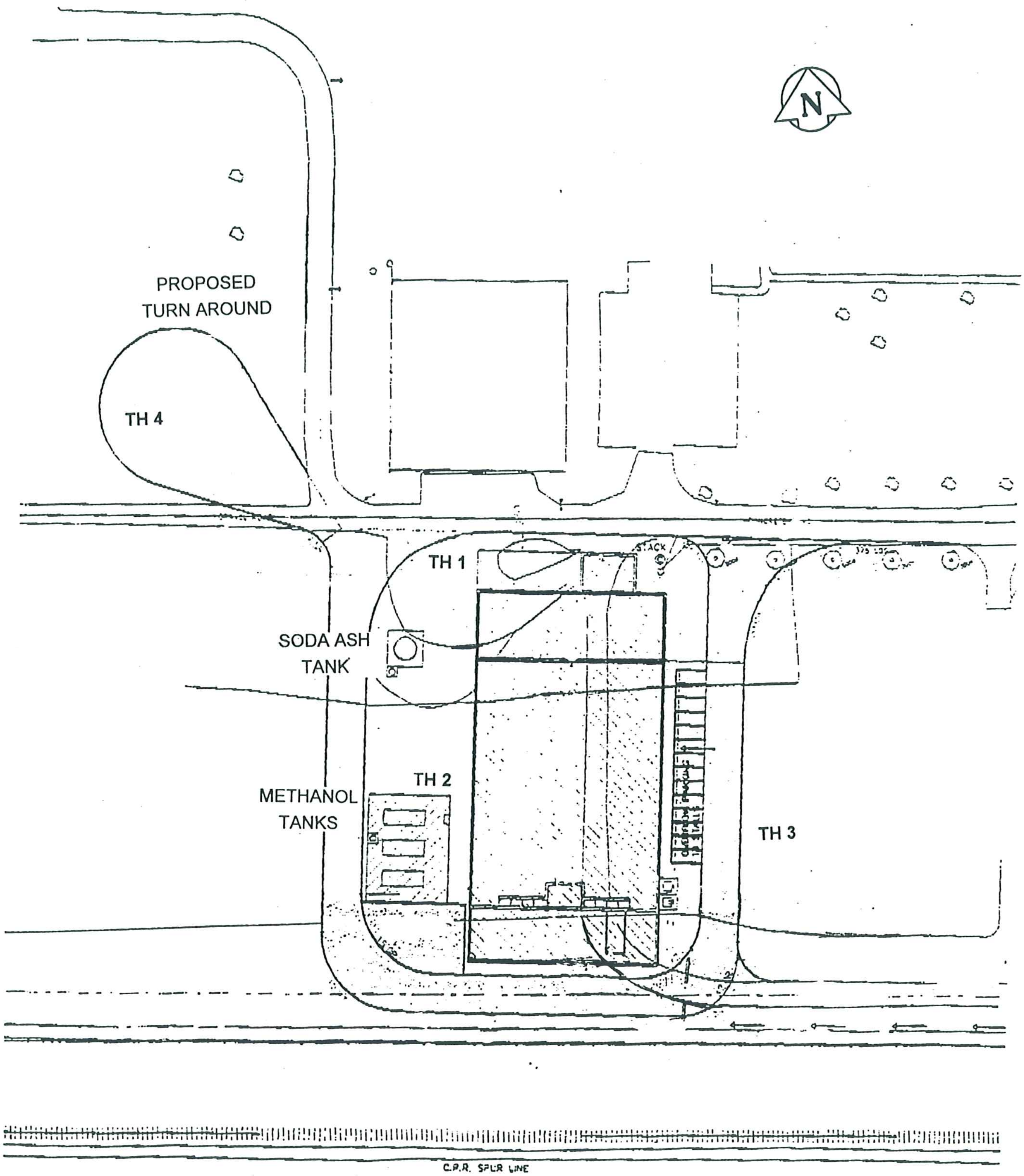
Respectfully submitted,

DYREGROV CONSULTANTS

PROVINCE OF MANITOBA
A. O.
DYREGROV
20/02/02
REGISTERED PROFESSIONAL ENGINEER

Per:

A.O. Dyregrov, P.Eng.



DYREGROV CONSULTANTS CONSULTING GEOTECHNICAL ENGINEERS	**NEWPCC CENTRATE NUTRIENT TREATMENT** **NITROGEN REMOVAL FACILITY**

SCALE	DATE	MADE	CHKD	JOB	FIGURE
NTS	8/2/06	TJH	AOD	252788	1

DYREGROV CONSULTANTS	Logged/Dwn.: TH Checked: AOD	Test Hole No. 1	Project No. 252788
PROJECT: NEWPCC NITROGEN BUILDING		DATE OF INVEST. JANUARY 31, 2006	
CLIENT: EARTH TECH		DRILL : SUBTERRANEAN 500mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION	
	0.00	232.26		0.00-2.44 FILL	
	0.75	231.51		SILT AND CLAY MATRIX WITH SOME SAND AND GRAVEL,	
	1.50	230.76		AT 0.76 BLACK / GREYISH CLAY, (ODOR FROM OLD DRYING BEDS), SOFT	
	2.25	230.01			
	3.00	229.26		2.44-3.20 CLAY BROWN, SILTY, STIFF, HIGH PLASTIC	
	3.75	228.51		3.20-4.12 SILT TAN, WET, SLOUGHING	
	4.50	227.76		4.12-18.29 CLAY	
	5.25	227.01		BROWN TO DARK BROWN, STIFF, HIGH PLASTIC LAMINATED,	Qu-85.8 KPA Pp-143.6 KPA Tv-75.6 KPA
	6.00	226.26			W -16.87 KN/M
	6.75	225.51			
	7.50	224.76		GREY, STIFF, HIGH PLASTIC, TRACE SILT AND FINE SAND INCLUSIONS	Qu-124.2 KPA Pp-153.2 KPA
	8.25	224.01			Tv-63.2 KPA W -16.92 KN/M
	9.00	223.26			
	9.75	222.51			
	10.50	221.76		GREY, STIFF, HIGH PLASTIC, TRACE SILT AND FINE SAND INCLUSIONS, ODD FINE GRAVEL STONES	Pp-129.3 KPA Tv-63.2 KPA
	11.25	221.01			
	12.00	220.26		'SAME'	Qu-124.8 KPA W -17.36 KN/M
	12.75	219.51			Qu-53.3 KPA Pp-119.7 KPA
	13.50	218.76			Tv-45.0 KPA W -17.13
	14.25	218.01			Qu-65.3 KPA Pp-124.5 KPA
	15.00	217.26			Tv-51.7 KPA W -17.03 KN/M
	15.75	216.51			
	16.50	215.76			
	17.25	215.01			
	18.00	214.26			
	18.75	213.51		18.29-20.27 GLACIAL SILT TILL SILTY, SANDY, SOME COBBLES AND BOULDERS	
	19.50	212.76		SOFT AND SLOUGHING AT 19.0 +/- MORE DENSE TO VERY DENSE	
	20.25	212.01		VERY DENSE	
	21.00	211.26		END OF TEST HOLE AT 20.27 IN VERY DENSE GLACIAL SILT TILL	

MOISTURE CONTENT (%)

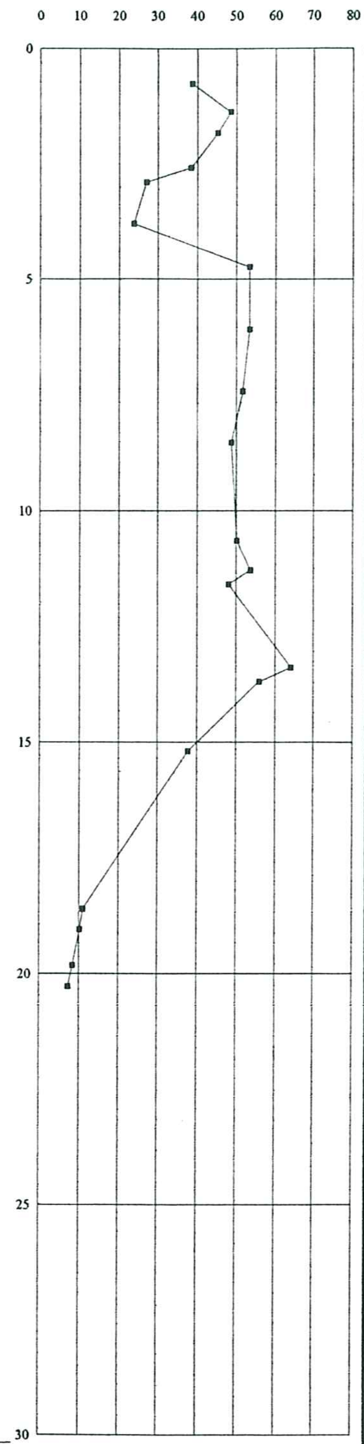


FIGURE 2

DYREGROV CONSULTANTS	Logged/Dwn.: TH Checked: AOD	Test Hole No. 2	Project No. 252738
PROJECT: NEWPCC NITROGEN BUILDING CLIENT: EARTH TECH		DATE OF INVEST. JANUARY 31, 2006 DRILL : SUBTERRANEAN 500mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION	
	0.00	232.13			
	0.75	231.38		0.00-2.13 FILL SILT AND CLAY MATRIX WITH SOME SAND AND GRAVEL,	
	1.50	230.63		TRACE BLACK CLAY, AT 1.22 BLACK / GREYISH, DAMP, CRUMBLY	
	2.25	229.88		(ODOR FROM OLD DRYING BEDS), SOFT 2.13-2.59 CLAY	
	3.00	229.13		BROWN, STIFF 2.59-3.65 SILT	
	3.75	228.38		TAN, WET, SLOUGHING	
	4.50	227.63		3.65-19.05 CLAY BROWN, SILTY, HIGH PLASTIC, STIFF	
	5.25	226.88			
	6.00	226.13		BROWN TO DARK BROWN, SILTY, LAMINATIONS HIGH PLASTIC, STIFF, TRACE SILT AND FINE SAND	Qu-51.2 KPA Pp-76.6 KPA
	6.75	225.38		INCLUSIONS	Tv-54.6 KPA W -16.78 KN/M
	7.50	224.63			
	8.25	223.88			
	9.00	223.13			
	9.75	222.38		GREY, STIFF, 'SAME'	Pp-134.1 KPA Tv-58.4 KPA
	10.50	221.63			
	11.25	220.88			
	12.00	220.13			
	12.75	219.38			
	13.50	218.63			
	14.25	217.88			
	15.00	217.13			
	15.75	216.38			
	16.50	215.63			
	17.25	214.88			
	18.00	214.13		SILT TILL AND CLAY MATRIX, SOFT, SLOUGHING	
	18.75	213.38			
	19.50	212.63		19.05-21.95 GLACIAL SILT TILL SILTY, SANDY, TRACE (+) CLAY, SOME COBBLES AND	
	20.25	211.88		BOULDERS, SOFT, SOME SLOUGHING AT 20.0 +/- BECOMING DENSE TO VERY DENSE	
	21.00	211.13		WITH DEPTH	
	21.75	210.38		VERY DENSE	
	22.50	209.63		END OF TEST HOLE AT 21.05 IN VERY DENSE GLACIAL SILT TILL	

MOISTURE CONTENT (%)

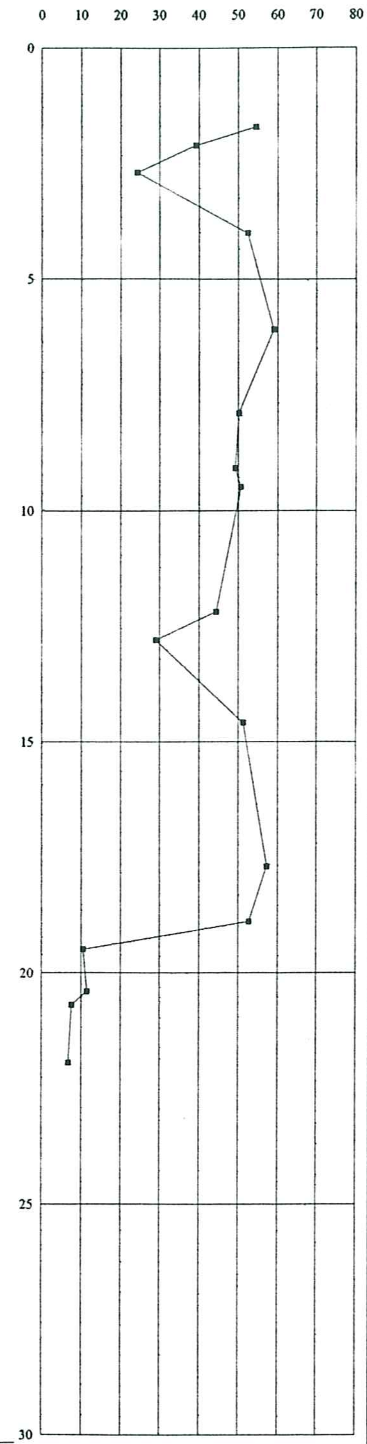


FIGURE 3

DYREGROV CONSULTANTS	Logged/Dwn.: TH Checked: AOD	Test Hole No. 3	Project No. 252788
PROJECT: NEWPCC NITROGEN BUILDING		DATE OF INVEST. JANUARY 31, 2006	
CLIENT: EARTH TECH		DRILL : SUBTERRANEAN 500mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
	0.00	231.82		0.00-1.98 FILL SILT AND CLAY MATRIX WITH SOME SAND AND GRAVEL,
	0.75	231.07		
	1.50	230.32		AT 0.90 BLACK / GREYISH CLAY, (ODOR FROM OLD DRYING BEDS), SOFT
	2.25	229.57		1.98-2.44 CLAY BROWN, SILTY, STIFF, HIGH PLASTIC
	3.00	228.82		2.44-3.51 SILT TAN, WET, SLOUGHING
	3.75	228.07		
	4.50	227.32		3.51-18.75 CLAY BROWN, SILTY, STIFF, HIGH PLASTIC
	5.25	226.57		
	6.00	225.82		
	6.75	225.07		GREY, STIFF, HIGH PLASTIC, TRACE SILT AND FINE SAND INCLUSIONS
	7.50	224.32		
	8.25	223.57		
	9.00	222.82		
	9.75	222.07		
	10.50	221.32		'SAME'
	11.25	220.57		
	12.00	219.82		
	12.75	219.07		
	13.50	218.32		
	14.25	217.57		
	15.00	216.82		
	15.75	216.07		
	16.50	215.32		
	17.25	214.57		
	18.00	213.82		
	18.75	213.07		
	19.50	212.32		18.75-20.73 GLACIAL SILT TILL SILT, SAND, SOME GRAVEL AND COBBLES AND BOULDERS SOFT TO MEDIUM IN UPPER AREA AND MORE DENSE TO VERY DENSE WITH DEPTH
	20.25	211.57		
	21.00	210.82		END OF TEST HOLE AT 20.73 IN VERY DENSE GLACIAL SILT TILL

MOISTURE CONTENT (%)

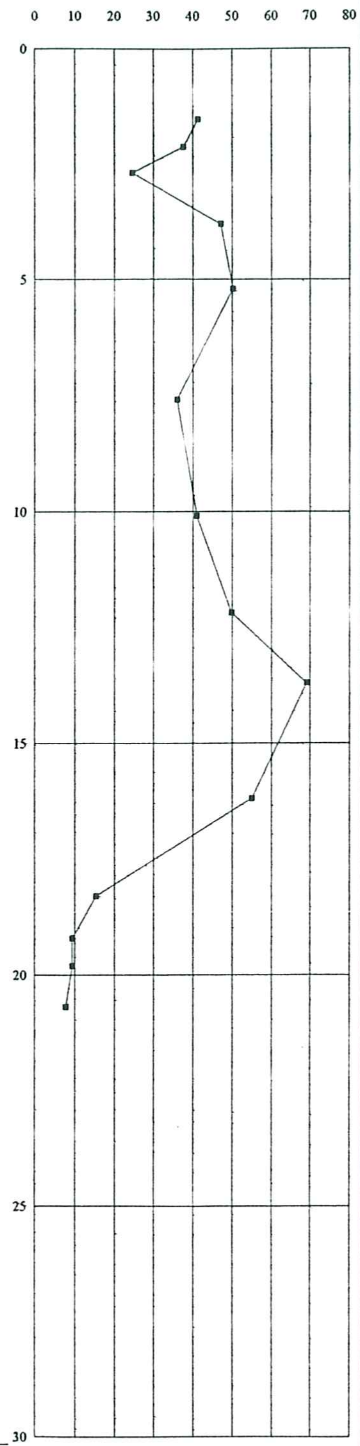


FIGURE 4

DYREGROV CONSULTANTS	Logged/Dwn.: TH Checked: AOD	Test Hole No. 4	Project No. 252788
PROJECT: NEWPCC NITROGEN BUILDING CLIENT: EARTH TECH		DATE OF INVEST. JANUARY 31, 2006 DRILL : SUBTERRANEAN 500 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
	0.00	231.53		
	0.75	230.78		0.00-2.13 FILL SILT AND CLAY, TRACE OF SAND AND GRAVEL
	1.50	230.03		AT 1.67 BLACK / GREYISH CLAY (ODOR FROM OLD DRYING BEDS), SOFT
	2.25	229.28		2.13-3.05 CLAY BROWN, SILTY, STIFF, HIGH PLASTIC
	3.00	228.53		
	3.75	227.78		3.05-3.81 SILT TAN, WET, SLOUGHING
	4.50	227.03		3.81-3.96 BROWN, SILTY, STIFF, HIGH PLASTIC
				END OF TEST HOLE AT 3.96 IN BROWN CLAY

MOISTURE CONTENT (%)

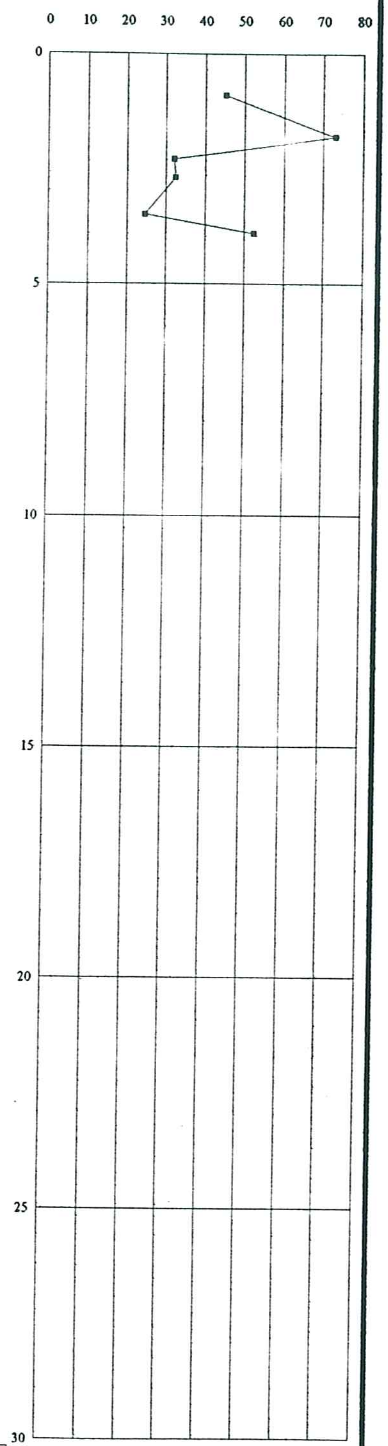
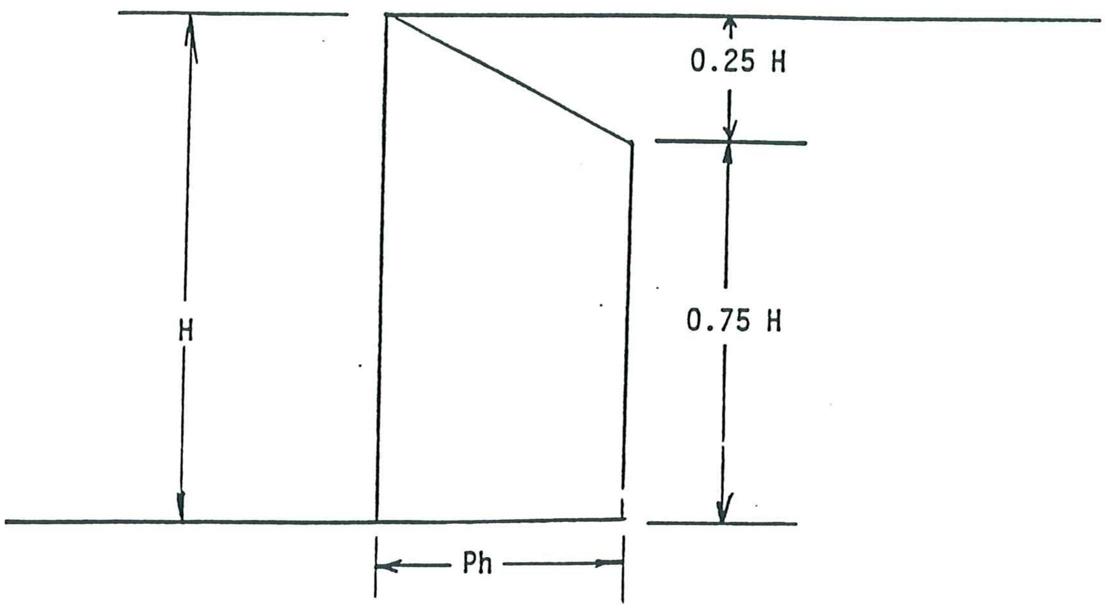


FIGURE 5



$Ph = 0.4\gamma H$

Where: Ph = Lateral earth pressure on shoring (17.28 KM/M³)

γ = Soil unit weight (kPa)

H = Wall height (M)

Note: Add surface load surcharge where applicable

DYREGROV CONSULTANTS CONSULTING GEOTECHNICAL ENGINEERS			EARTH PRESSURE DISTRIBUTION TEMPORARY SHORING CENTRATE NUTRIENT TREATMENT, NEWPCC		
SCALE NTS	DATE 20/2/06	MADE TJH	CHKD AOD	JOB 252788	FIGURE 6