G.I-30 · SEPT. 1976

GEOCRES No. ____________________

DIST. 54 ________ REGION ____________________

W.P. No. 772-93-00

CONT. No. ____________________

W. O. No. ____________________

STR. SITE No. ____________________

HWY. No. 11

LOCATION Goreville Rd. Underpass

No of PAGES - —

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. ________

REMARKS: ____________________

DRAFT

DRAFT FOUNDATION INVESTIGATION REPORT
FOR
PROPOSED GOREVILLE ROAD UNDERPASS
W.P. 772-93-00
HIGHWAY 11, DISTRICT 54
SUDBURY

Submitted To:

DELCAN Corporation
133 Wynford Drive
North York, Ontario, M3C 1K1
Canada

Submitted By:

AGRA
104 Crockford Blvd.
Scarborough, Ontario, M1R 3C6
Canada

January 1999
TT98801

AGRA
ENGINEERING GLOBAL SOLUTIONS

AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

AGRA Earth &
Environmental Limited
104 Crockford Blvd.
Scarborough, Ontario
Canada M1R 3C6
Tel (416) 751-6565
Fax (416) 751-7592

January 28, 1999.
Ref. No.: TT98801

Delcan Corporation
133 Wynford Drive
North York, Ontario, M3C 1K1
Canada

Attention: **Mr. Khaled El-Dalati, P. Eng.**

Dear Sir:

Re: **DRAFT FOUNDATION INVESTIGATION REPORT**
FOR
PROPOSED GOREVILLE ROAD UNDERPASS
W.P. 772-93-00
HIGHWAY 11, DISTRICT 54
SUDBURY

We take pleasure in enclosing six (6) Draft copies of our Geotechnical Investigation Report carried out for the above mentioned project and we will be glad to discuss any questions arising from this work.

Soil samples will be retained for a period of one year, and will thereafter be disposed of unless we are otherwise instructed.

We thank you for giving us this opportunity to be of service to you.

Sincerely,

Z.S. Ozden, P. Eng.,
Principal Engineer.

ZSO/dee

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1.0 INTRODUCTION

AGRA, Consulting Geotechnical Engineers, was retained by DELCAN Corporation to conduct a foundation investigation at the site of a proposed bridge that will carry Goreville Road over the realigned northbound and southbound lanes of proposed Highway 11 and associated interchange ramps. The site is located between South River and Trout Creek, to the east of the existing Highway 11 and Goreville Road in the Township of Laurier, Lot 4, Concession 8 in the District of Parry Sound. The proposed bridge will be an approximately 77 m long, 2-lane, two span structure.

The purpose of the investigation has been to obtain information about the subsurface conditions at the site of the proposed bridge and approach embankments by means of exploratory boreholes, and based on the findings, to provide recommendations for the geotechnical design of the foundations of the proposed structure and approach fills.

The field work for the investigation was carried out during the period of November 11 to 22, December 9 to 10, and December 16 to 18, 1998, and consisted of drilling and sampling eighteen boreholes (Borehole Nos. GRD-1, 1B, 1G, 2, 2B, 3, 3B, 3G, 4, 4B, 5, 5B, 5C, 6, 6A, 6B, 7, 8) to depths of 1.5 to 15.4 m, eleven dynamic cone penetration tests and four testpits. A detailed description of field procedures is given in Appendix 'A'.

The plan locations of the boreholes and cone tests, along with stratigraphic sections are shown on Drawing No. 1. Details of subsurface conditions encountered at each borehole location, including the results of in-situ testing, are presented on the Borehole Log Sheets, Enclosure Nos. 1 to 18, inclusive.

2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The site is located approximately 0.3 km east of the intersection of Highway 11 and Goreville Road, between the Villages of Trout Creek and South River. The ground elevation in the general area rises from south to north and from east to west, ranging from about Elevation 375 to 380 m. The area is heavily wooded with deciduous and coniferous trees.

Approximately 100 m north of the proposed bridge site, braided eskers wind across the proposed alignment of Highway 11. The topography in this area is hummocky with numerous boulders blanketing the surface.

Based on available geologic information the site is in an area intersected by small braided eskers partially buried by glaciofluvial sediments. Generally after the last glacial withdrawal, ice-contact sediments (eskers and kames consisting of gravelly sands to sandy gravels with a high boulder content) and glaciofluvial outwash sediments were deposited on top of the existing sandy glacial till or Precambrian bedrock (ranging from granite to gneiss to amphibolite). The area was then inundated by glacial Lake Algonquin depositing sands, silts and clays in low lying areas.

.../...

3.0 SUBSURFACE CONDITIONS

The subsurface conditions were explored at eighteen borehole locations (Borehole Nos. GRD-1, 1B, 1G, 2, 2B, 3, 3B, 3G, 4, 4B, 5, 5B, 5C, 6, 6A, 6B, 7, 8), nineteen auger probe holes, four testpits and were inferred at the locations of eleven dynamic cone penetration tests. The locations of the boreholes and cone penetration tests are shown on the Plan and Profile Drawing No. 1 and are also indicated on the individual Borehole Log Sheets. Cross sections of inferred subsurface stratigraphy are given on Drawing No. 1.

The ground surface at the proposed site generally drops from north to south. The ground elevation at the proposed bridge location generally ranges from about 377.5 to 377.0 m at the north side to about Elevation 376 m at the south (i.e. an elevation drop of 1 to 1.5 m within a distance of 12 m).

In general, the boreholes encountered, below a 0.2 to 0.3 m thick topsoil layer, granular deposits ranging from fine sand to gravelly sand with frequent cobbles and boulders to the full depth of the majority of the boreholes. Bedrock was encountered and cored in three boreholes (Boreholes GRD-2, 3 and 5) at depths ranging from 7.6 m (Elevation 368.0 m) to 12.2 m (Elevation 365.3 m) below existing grade. At the time of the investigation the groundwater table was recorded at depths of 9 to about 10 m below the existing grade or at Elevations generally ranging between 368.5 and 367 m.

Details of the subsurface conditions encountered in these boreholes are presented on the Borehole Log Sheets, Enclosure Nos. 1 to 18. The following paragraphs are only meant to complement and summarize these data.

3.1 TOPSOIL

The boreholes encountered 0.2 to 0.3 m of surficial topsoil. In some areas the presence of cobbles and boulders was noted within the topsoil zone. Measured natural moisture contents of samples from the topsoil ranged from 21 to 31%.

The thickness of topsoil and other organic soils frequently varies in between and beyond the borehole locations.

3.2 FINE SAND

Below the surficial topsoil, the boreholes drilled at the east abutment and central pier locations (i.e. except for Boreholes GRD-5, 5B, 5C, 6, 6A, 6B and 7), encountered fine sand with traces of silt. The deposit extended to depths ranging between 2.3 m or Elevation 375.4 m (Borehole GRD-1) and 4.3 m or Elevation 372.0 m (Borehole GRD-4). This is a granular (i.e. cohesionless) deposit. Grain size distribution analyses were conducted on three samples from the material and the range of particle sizes are presented as a curve envelope in Figure No. 1. The analyses indicate 1 - 3%

gravel, 84 - 89% sand and 10 - 13% silt and clay size particles. The deposit also contains some silty sand seams/lenses. Measured 'N'-values in this unit range from 3 to 22 blows/0.3 m indicating a very loose to compact condition. Measured natural moisture contents ranged from 1 to 15%, but are generally 1 to 2%.

3.3 SAND TO GRAVELLY SAND

Below the topsoil and/or surficial sand, an ice-contact stratified sand to gravelly sand deposit was encountered to the full extent of the borings or until bedrock was encountered. This is a cohesionless (granular) deposit and contains lenses of silty sand and gravel layers, and frequent cobbles and boulders. Seven grain size distribution analyses were conducted and the range of particle sizes are presented as a curve envelope in Figure No. 2. The analyses indicate 2 - 45% gravel, 51 - 96% sand and 2 - 35% silt and clay size particles. Measured 'N'-values generally range from 12 to greater than 50 blows/0.3 m, indicating compact to very dense condition, but generally compact to dense. Dynamic cone penetration results range from 11 to greater than 100 blows/0.3 m. Many of the 'N'-values were found to be unreliable due to refusal on a cobble or boulder, or the sampler pushing coarse gravel. In order to advance several of the boreholes, boulders were cored. Because of the presence of very frequent oversize particles, it was not possible to make a full or reliable assessment of the compactness condition of the deposit. Measured natural moisture contents ranged from 1 to 16%.

Due to difficult drilling conditions four testpits were excavated to Elevation 371 m, one at the proposed east abutment (Borehole GRD-3G) and pier locations (Borehole GRD-1G) and two at the proposed west abutment location (Borehole GRD-5, 5B, 5C, 6, 6A, 6B) to allow sampling below the proposed footing level. The testpits were backfilled with native sand with boulders selectively removed. The backfill is probably in a loose state.

3.4 BEDROCK

Below the overburden soils, bedrock was encountered and NQ size cores were obtained at Boreholes GRD-2, GRD-3 and GRD-5 at depths 7.6 m, 12.2 m and 8.8 m below existing ground surface (Elevations 368.0, 365.3 and 366.9 m). At boreholes GRD-2 and GRD-5 the bedrock consists of sound, pink, Precambrian granite. The rock was cored for a vertical distance of 3.0 m and a rock quality designation ranging from 69 to 100% was measured indicating the rock to be fair to excellent quality, but generally excellent. The core recovery was 100%.

At Borehole GRD-3, the bedrock consists of a black, weathered, Precambrian Amphibolite (Hornblende Schist). Coring was conducted 3.0 m into the rock (100% recovery) and a rock quality designation ranging from 0 to 34% was measured indicating the rock to be very poor to poor quality, but generally very poor.

Based on the recorded elevation of bedrock in the three boreholes and overburden depths in the remaining ones, the surface of the bedrock at the bridge site appears to slope down rather sharply from south to north (as evidenced at Boreholes GRD-1 and GRD-2) and gradually rises from west to east. It should also be pointed out that adjacent to Borehole GRD-2 (where the rock was cored) another probe was drilled within 2 m. This borehole extended to 2.1 m below the recorded (surmized) bedrock surface in Borehole GRD-2. This indicates that either the bedrock surface dips very sharply (or the rock encountered in Borehole GRD-2 was a very large boulder). From these observations and experience in the general area, the surface of the bedrock can be expected to be uneven and unpredictable.

3.5 GROUNDWATER CONDITIONS

Groundwater levels in the open boreholes were observed during the drilling and at the completion of each borehole. The water levels in the open boreholes were checked prior to removing the augers or casing.

The recorded values, shown on the individual Borehole Log Sheets, indicate that the water levels at the time of the investigation ranged from 9 to about 10 m below the ground surface (Elevation 368.5 to 367 m). These groundwater elevations were confirmed from the natural moisture content measured from collected samples. It should, however, be pointed out that the groundwater at the site would fluctuate seasonally and can be expected to be somewhat higher during the spring months and in response to heavy rains.

4.0 CLOSURE

The Limitations of Report, as quoted in Appendix B, is an integral part of this report.

Sincerely,

Andrew Drevininkas, P. Eng.
AD/dee

Z.S. Ozden, P. Eng.

.../...

APPENDIX A

PROCEDURES

The field work for this project was performed during the period of November 11 to 22, December 9 to 10, and December 16 to 18, 1998, and consisted of drilling and sampling eighteen boreholes, eleven dynamic cone penetration tests and four testpits. The plan locations of the boreholes, along with stratigraphic sections are shown on Drawing No. 1.

The boreholes were advanced using a track-mounted power auger drilling rig (CME 75) owned and operated by Canadian Soil Drilling Inc. and a track-mounted power auger drilling rig (BOA 10M) owned and operated by Groundworks Drilling Inc., under the full-time supervision of a soils engineer from AGRA.

Sampling in the boreholes was effected at frequent intervals of depth by the Standard Penetration Test Method (SPT), as specified in ASTM Method D 1586. This consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm diameter o.d. split barrel (split-spoon) sampler into the ground. The number of blows of the hammer to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance or the 'N'-value of the soil and this gives an indication of the consistency or the compactness condition of the soil deposit.

In addition, dynamic cone penetration tests were performed in eleven of the boreholes. This test consists of driving a 60° point, 50 mm diameter cone attached to the drill rod continuously, into the undisturbed ground with a driving energy of 475 J (63 kg hammer falling freely a distance of 76 cm) per blow. The number of blows for each 30 cm of penetration is recorded and this provides an indication of the relative changes in the soil density with depth.

Due to difficult drilling conditions, four testpits were excavated to approximate Elevations of 370 to 371 m (at Boreholes GRD- 1G, 3G, and encompassing Boreholes GRD- 5, 5B, 5C, 6, 6A, 6B). The testpits were backfilled with native sand with large boulders and cobbles selectively removed. Drilling was then carried out from the ground surface and advanced below the bottom of the sand backfill.

The borehole locations were established in the field by our engineering staff, in relation to the already staked out centre-line of Goreville Road (by Dearden and Stanton Limited). The borehole geodetic elevations and co-ordinates were later taken by surveyors from Dearden and Stanton Limited.

The soil samples were shipped in sealed containers to our geotechnical laboratory in Toronto (Scarborough) for further examination and classification. A laboratory testing programme, consisting of natural moisture content and grain-size analyses, was performed on selected representative soil samples. The results of the laboratory tests are presented on the appropriate Borehole Log Sheets and also on Figure Nos. 1 and 2.

The boreholes were left open until the end of each work day to enable us to take additional water level readings. All boreholes were backfilled and grouted on November 22 and December 18, 1998.

APPENDIX B

AGRA

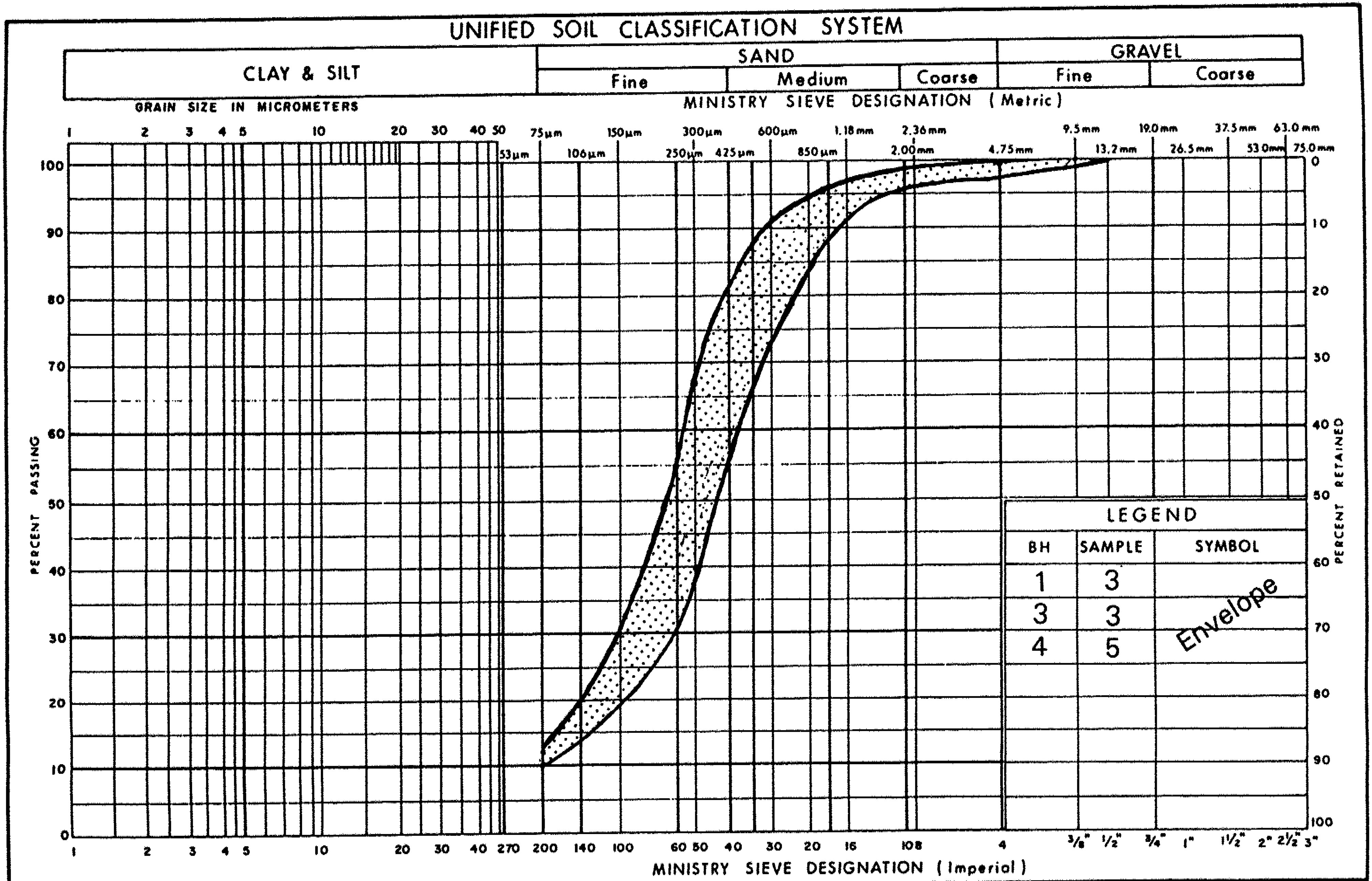
LIMITATIONS OF REPORT

The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AGRA accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

FIGURES

78 12 M



Ministry of Transportation

Ontario

GRAIN SIZE DISTRIBUTION

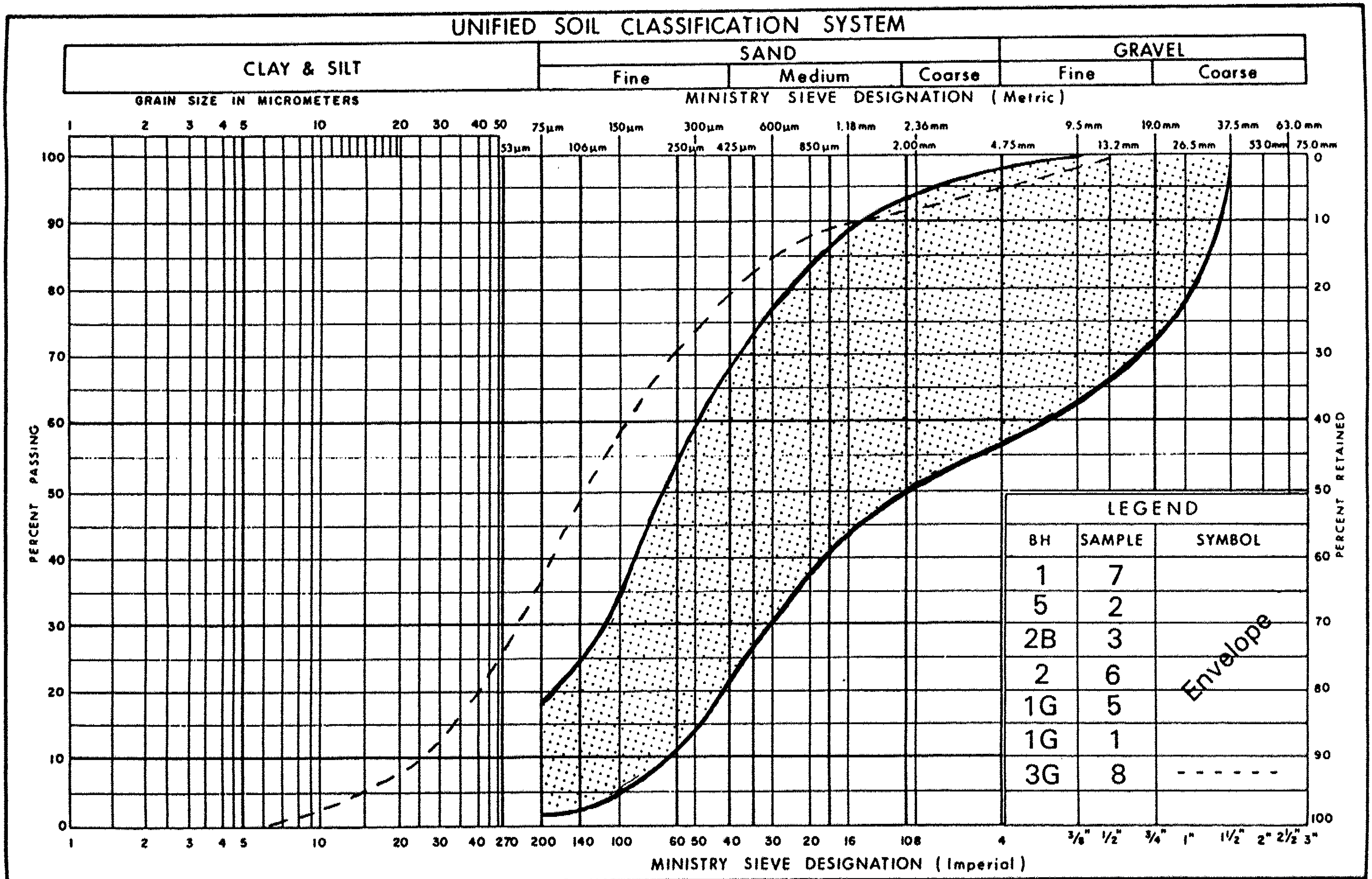
FINE SAND, TRACE SILT

FIG No 1

W P 772-93-00

Ref No. TT98801

78 12 M



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
SAND TO GRAVELLY SAND

FIG No 2
W P 772-93-00
Ref No. TT98801

ENCLOSURES

CONT. No. -
W.P. No. **772-93-00**

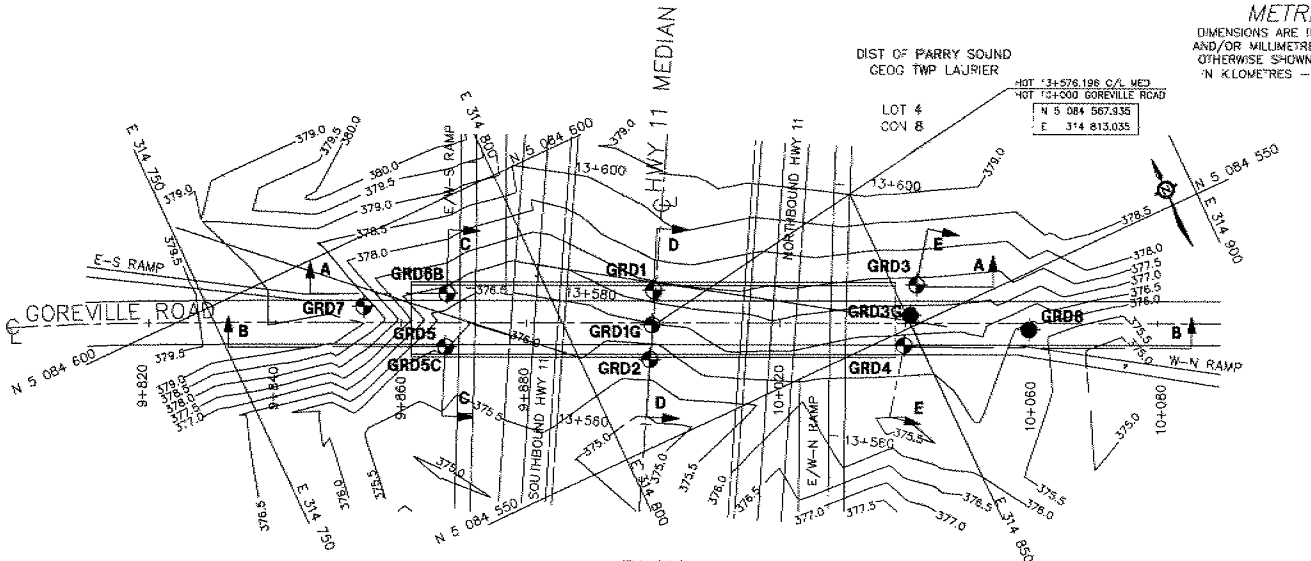
SHEET

GORVILLE ROAD UNDERPASS

BORE HOLE LOCATIONS&SOIL STRATA

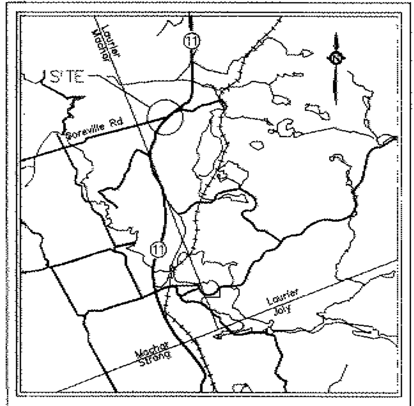
AGRA Earth & Environmental Ltd.

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES – METRES.



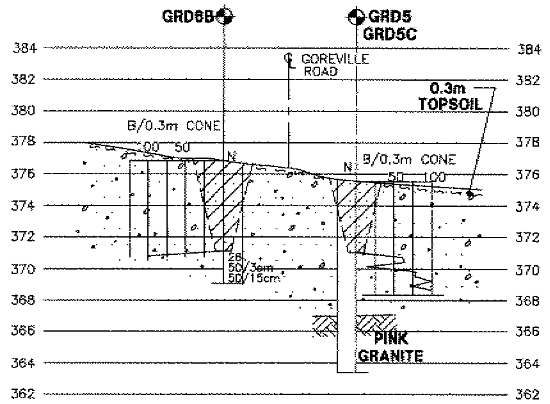
PLAN

5m 0 5m

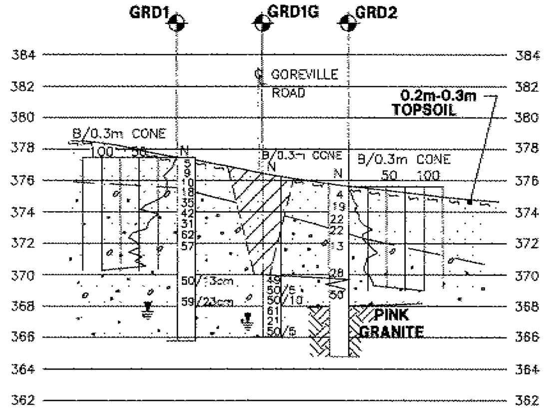


KEY PLAN

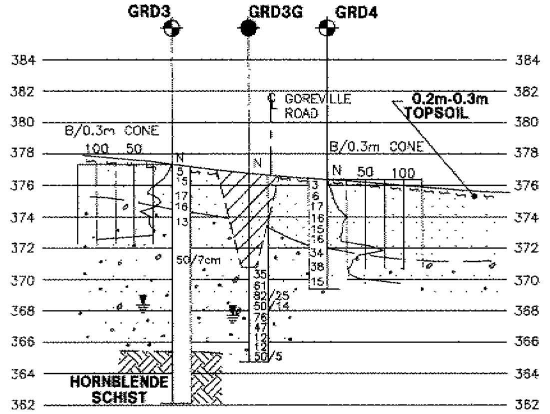
1 km 0 1 km



SECTION C–C



SECTION D–D

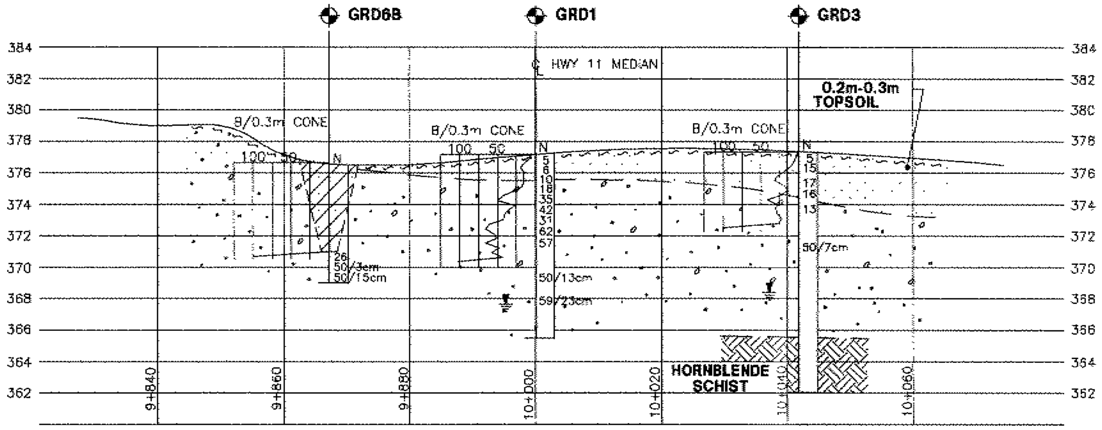


SECTION E–E

2m 0 2m

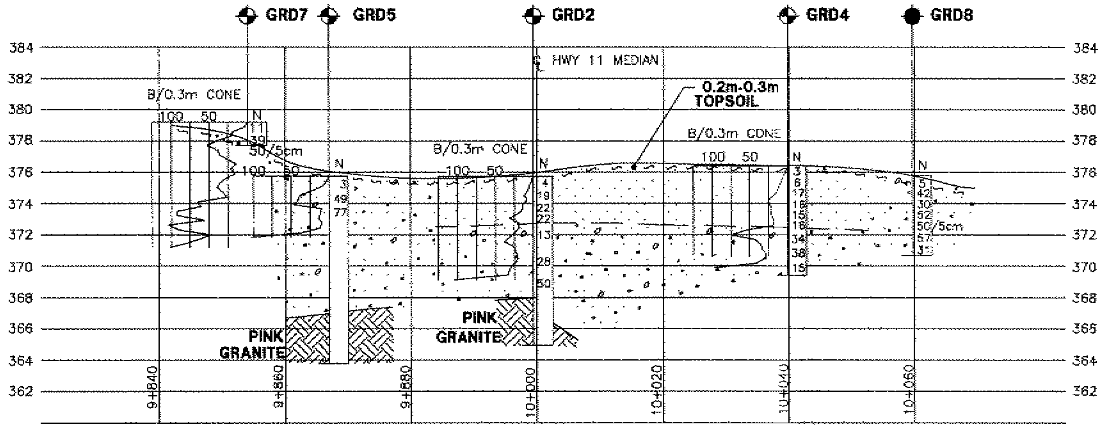
SOIL STRATIGRAPHY LEGEND

░	**SAND TO GRAVELLY SAND** WITH FREQUENT COBBLES&BOULDERS **Compact to Very Dense**
░	**FINE SAND** TRACE SILT **Very Loose to Compact**
▨	**SAND BACKFILL** **Very Loose to Loose**
▩	**BEDROCK**



B/0.3m CONE

SECTION A–A



SECTION B–B

5m 0 5m HOR
2m 0 2m VERT

REF. Hwy 11 Bridge Site Plan
Dwg. by MTO; Oct.1998

LEGEND

●	Bore Hole
⊕	Dynamic Cone Penetration Test (Cone)
◉	Bore Hole & Cone
'N'	Blows/0.3m (Std Pen Test, 475 J/blow)
CONE	Blows/0.3m (60° Cone, 475 J/blow)
⊥	WL at time of investigation Dec 98

No	ELEVATION	CO-ORDINATES NORTH	EAST
GRD1	377.7	5 084 573	314 815
GRD1G	376.1	5 084 568	314 813
GRD2	375.6	5 084 563	314 810
GRD3	377.5	5 084 556	314 854
GRD3G	376.8	5 084 552	314 851
GRD4	376.3	5 084 548	314 848
GRD5 GRD5C	375.7	5 084 579	314 782
GRD6B	377.0	5 084 586	314 785
GRD7	379.3	5 084 590	314 773
GRD8	375.8	5 084 542	314 867

–NOTE–

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen.Cond.

REV.	DATE	BY	DESCRIPTION

HWY No 11			DIST 54
SUBM'D ZO	CHECKED ZO	DATE Jan 27,1999	SITE 44-376
DRAWN MA	CHECKED	APPROVED	DWG 1

FILE:

LOG OF BOREHOLE GRD1

ENCL. No.: 1

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 11th, 1998

SURFACE EL. 377.7 m

LABORATORY DATA						*SAMPLES*		
PL %	W %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value
	21				4 6	1	SS	5
	2				12 17	2	SS	9
	3				13 16 26	3	SS	10
	1				40 47	4	SS	18
					24 33 37	5	SS	35
	1				38 56 61	6	SS	42
	2				50 48	7	SS	31
	1				62 45 54	8	SS	62
	1				40 100/20	9	SS	57
						10	SS	50/13*
						11	SS	50/23**

MATERIAL DESCRIPTION

0.3m TOPSOIL

loose — compact

brown
FINE SAND
trace Silt

dry

compact — dense — v.dense — boulder

brown
SAND
to
GRAVELLY SAND
with frequent
cobbles & boulders

dry

End of Borehole
Groundwater in casing @10.0m
and hole caved @6.0m on
completion.
Move hole 2.0m east,auger refusal
@2.7m.
Move hole 2.0m west, auger refusal
@2.3m.

ELEV. m	DEPTH m
377	1
376	2
375	3
374	4
373	5
372	6
371	7
370	8
369	9
368	10
367	11
366	12

WATER DATA: ▼ 10

REMARKS

Gr	Sa %	Si&Cl
3	84	(13)
24	73	(3)

Auger refusal on boulder @6.9m. Advance by washboring method.

*spoon bouncing on cobble
**No recovery spoon bouncing on cobble

Casing shoe worn out at 12m, withdrew casing, hole caved.

N=50/13
50 blows for
13cm penetration

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD1

LOG OF BOREHOLE GRD1B

ENCL. No.: 2

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 10th, 1998

LABORATORY DATA						*SAMPLES*								
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 377.7 m				
										INFERRED FINE SAND dry	377 376	1 2		Borehole drilled 1.5m east of GRD1.
										AUGER to 6.1m INFERRED GRAVELLY SAND dry	375 374 373 372	3 4 5 6		*spoon bouncing on cobble
	5					1	SS	50/10*		dense to v.dense brown SAND to GRAVELLY SAND with frequent cobbles & boulders dry	371 370 369	7 8 9		N=50/10 50 blows for 10cm penetration
	5					2	SS	40						
	1					3	SS	75*						
	1					4	SS	50/13*						
	2					5	SS	63						
	5					6	SS	40		grey,brown moist	368			
										End of Borehole Auger refusal @9.8m on boulder. No growndwater in hole on completion.				

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD1B

L O G O F B O R E H O L E GRD1G

ENCL. No.: 3

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 16th, 1998

SURFACE EL. 376.1 m

LABORATORY DATA						*SAMPLES*			**MATERIAL DESCRIPTION**					**REMARKS**		
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value				ELEV. m	DEPTH m	WATER DATA		
										Excavated to 6.0m and backfilled with sand. AUGER to 6.1m	dry	376 375 374 373 372 371	1 2 3 4 5		Gr	Sa %	Si&Cl
	2				111 81	1	SS	49		brown	dry	370	6		45	51	(4)
					106 100/15	2	SS	50/5*	dense to v.dense			369	7				
	3					3	SS	50/10*		brown/grey SAND to GRAVELLY SAND with frequent cobbles & boulders	moist	368	8				
	9					4	SS	61									
	15					5	SS	21	compact		wet	367	9	▼	16	68	(16)
						6	SS	50/5*		End of Borehole Auger refusal @10.1m on boulder. Growndwater in HolSt Augers @9.0m and hole caved @6.1m on completion. Move hole 2.0m east, auger refusal @7.8m. Move hole 2.0m west, Auger refusal @6.2m. DCPT conducted 1.0m south of GRD1G.		366	10		N=50/5 50 blows for 5 cm penetration *spoon bouncing on cobble		

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD1G

LOG OF BOREHOLE GRD2

ENCL. No.: 4

REF. No.:	TT98801	DRILLING DATA	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 18th, 1998

SURFACE EL. 375.6 m

LABORATORY DATA PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	Lab Compr kPa	SAMPLES No.	TYPE	N-Value	SYMBOL	MATERIAL DESCRIPTION			WATER DATA	REMARKS
					2 5	1	SS	4		v.loose	0.2m TOPSOIL brown FINE SAND trace silt			Gr Sa Si&Cl %
	2				7 12	2	SS	19		compact		dry to damp		
	7				8 14	3	SS	22		gravelly				
	2				14 19 30	4	SS	22						
	1				18 18 24	5	SS	13		boulder	brown SAND to GRAVELLY SAND with frequent cobbles & boulders	dry		Auger refusal on boulder @3.0m. Advance by washboring method.
					30 37 24 23					boulder				6 84 (10)
					20 21 27 30 32	6	SS	28		compact				
					100/25	7	SS	50*		dense boulder				*'N'-value unrelaible driving a stone
						8	RC				Pink GRANITE BEDROCK massive, moderately closely jointed			RC8: REC=100% RQD=100%
						9	RC							RC9: REC=100% RQD=88%
						10	RC							RC10: REC=100% RQD=100%

ELEV. m: 375, 374, 373, 372, 371, 370, 369, 368, 367, 366, 365

DEPTH m: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

End of Borehole
No growndwater in hole and hole caved @3.0m on completion.
Move hole 2.0m east, auger refusal @9.7m.
Move hole 2.0m west, auger refusal @4.1m.
DCPT conducted 2.0m south of GRD2.

N=100/25
100 blows for 25 cm penetration

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD2

LOG OF BOREHOLE GRD2B

ENCL. No.: 5

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 23rd, 1998

LABORATORY DATA						*SAMPLES*								
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 375.6 m				
										AUGER to 2.1m	375 374	1 2		Gr Sa Si&Cl % Borehole drilled 1.5m west of GRD2.
	3					1	SS	14		compact brown SAND, trace Silt dry	373	3		
	2					2	SS	35*		compact brown SAND to GRAVELLY SAND with frequent cobbles & boulders dry ---- damp	372	4		2 96 (2)
	2					3	SS	27*						
	7					4	SS	19			371	5		
										End of Borehole Refusal @5.2m on boulder. No groundwater in hole on completion.				*spoon bouncing 'N'-value unreliable

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD2B

LOG OF BOREHOLE GRD3

ENCL. No.: 6

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 19th, 1998

LABORATORY DATA						*SAMPLES*				**MATERIAL DESCRIPTION**		ELEV.	DEPTH	WATER DATA	**REMARKS**
PL %	W %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL			m	m		
										SURFACE EL. 377.5 m					Gr Sa Si&Cl %
	31				3 6	1	SS	5		v.loose	0.2m TOPSOIL	377			
	2				10 19	2	SS	15				376	1		
	1				27 31 19	3	SS	17			brown SAND frequent layers of Silty Sand		2		1 89 (10)
	2				14 22 40	4	SS	16		compact	dry	375	3		
	2				28 29	5	SS	13			brown SAND to GRAVELLY SAND with frequent cobbles & boulders compact dry	374			Auger refusal @3.6m. Advance by washboring method.
					28 22 25 100 100/20					boulder boulder boulder		373 372	4 5 6		*spoon bouncing on boulder
						6	SS	50/7*		boulder boulder boulder boulder boulder boulder	INFERRED SAND to GRAVELLY SAND with frequent cobbles & boulders	371 370 369 368 367 366	7 8 9 10 11 12		N=50/7 50 blows for 7cm penetration
						7	RC				black HORNBLENDE SCHIST BEDROCK (AMPHIBOLITE) closely jointed	365	13		RC8: REC=100% RQD=34%
						8	RC					364			RC9: REC=100% RQD=0%
						9	RC					363	14		RC10: REC=100% RQD=12%
						10	RC						15		RC11: REC=100% RQD=0%

End of Borehole
DCPT conducted 2.0m south of GRD3.
Groundwater in casing @9.0m and hole caved @5.0m on completion.
Move hole 2.0m east, auger refusal @4.5m.
Move hole 2.0m west, auger refusal @3.6m.

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD3

LOG OF BOREHOLE GRD3B

ENCL. No.: 7

REF. No.:	TT98801	DRILLING DATA	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 23rd, 1998

SURFACE EL. 377.5 m

LABORATORY DATA PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	SAMPLES No.	TYPE	N-Value	MATERIAL DESCRIPTION	ELEV. m	DEPTH m	WATER DATA	REMARKS
									AUGER to 4.6m	377 376 375 374	1 2 3 4		Borehole drilled 3.0m south of GRD3. *spoon bouncing 'N'-value unreliable
	3					1	SS	53	dense sandy ------ silty compact to dense brown SAND to GRAVELLY SAND with frequent cobbles & boulders dry	373	5		
	3					2	SS	31		372			
	11					3	SS	25		371	6		
	1					4	SS	50/13*			7		
	1					5	SS	50/7*		370			
					137 80 34 21 26 35 24 17 17 21 15 16 100/23				End of Borehole Auger refusal @7.8m on boulder. No groundwater in hole on completion. DCPT conducted Dec.17/98.	369 368 367 366	8 9 10 11		
									End of DCPT @11.6m. On possible Bedrock				N=50/13 50 blows for 13 cm penetration

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD3B

LOG OF BOREHOLE GRD3G

ENCL. No.: 8

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	SolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 17th, 1998

SURFACE EL. 376.8 m

LABORATORY DATA				UNDR STRNG		*SAMPLES*			REMARKS
PL %	w %	LL %	UNIT WT kN/m3	Field Vane kPa	Lab Compr kPa	No.	TYPE	N-Value	Gr Sa Si Cl %
	6					1	GS		
	6					2	SS	35	
	5					3	SS	61	
	6					4	SS	82/25*	* spoon bouncing on cobble/bedrock
	9					5	SS	50/14*	
	15					6	SS	76	
	8					7	SS	47	
	16					8	SS	12	5 60 35 0
	8					9	SS	12	
	16					10	SS	50/5*	N=82/25 82 blows for 25 cm penetration

MATERIAL DESCRIPTION

Excavated to 6.0m and backfilled with sand.

AUGER
to 6.1m

dense to v.dense — silty compact

brown — brown/grey

SAND
to
GRAVELLY SAND
with frequent cobbles & boulders

damp — moist — wet

End of Borehole
Auger refusal @12.0m on probable Bedrock.
Growndwater in HolSt Augers @9.0m and hole caved @7.5m on completion.
Move hole 2.0m east, auger refusal @3.3m.
Move hole @2.0m west, Auger refusal @5.1m.

ELEV. m	DEPTH m	WATER DATA
376	1	
375	2	
374	3	
373	4	
372	5	
371	6	
370	7	
369	8	
368	9	▼
367	10	
366	11	
365	12	

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD3G

LOG OF BOREHOLE GRD4

ENCL. No.: 9

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 21st, 1998

SURFACE EL. 376.3 m

LABORATORY DATA PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	*SAMPLES* No.	TYPE	N-Value	MATERIAL DESCRIPTION	ELEV. m	DEPTH m	WATER DATA	REMARKS
	21				8 11	1	SS	3	v.loose ----- loose 0.3m TOPSOIL red to brown SAND, trace Silt,Gravel,Cobbles damp	376			Gr Sa Si&Cl %
	11 1				14 21 25	2	SS	6		375	1		
	1 15				21 21	3	SS	17	gravelly compact brown FINE SAND trace silt occ. Gravel layers damp ----- dry		2		
					14 23 25	4	SS	16		374			
	1 4				25 24	5	SS	15		373	3		1 89 (10)
	2				21 22 59	6	SS	16		372	4		
	1				78 46	7	SS	34	dense brown SAND to GRAVELLY SAND with frequent cobbles & boulders		5		BH drilled 2.0m south of GRD4B.
					38 36 31	8	SS	38		371			
	14 1				33 46	9	SS	15	----- compact ----- some Silt	370	6		
					100/17						7		N=100/17 100 blows for 17 cm penetration

Refusal @7.0m on boulder
End of Borehole and DCPT
No groundwater in hole.
DCPT conducted 1.5m north of GRD4.
Move hole 2.0m east, auger refusal @5.5m.
Move hole 2.0m west, auger refusal @5.2m.

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD4

LOG OF BOREHOLE GRD4B

ENCL. No.: 10

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 9th, 1998

LABORATORY DATA						*SAMPLES*								
				UNDR STRNG										
PL %	w %	LL %	UNIT WT kN/m3	Field Vane kPa	Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 376.3 m				
										AUGER to 4.6m	376 375 374 373 372	1 2 3 4		Borehole drilled 2.0m north of GRD4.
	2					1	SS	50*		dense				
	2					2	SS	40			371	5		
	8					3	SS	22		sand compact brown SAND to GRAVELLY SAND with frequent cobbles & boulders	370	6		
	2					4	SS	50/13*			369	7		*spoon bouncing on cobble
	10					5	SS	48		dense damp moist	368	8		
	9					6	SS	30				9		N=50/13 50 blows for 13 cm penetration
										End of Borehole No groundwater in hole.				

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD4B

LOG OF BOREHOLE GRD5

ENCL. No.: 11

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 22nd, 1998

LABORATORY DATA						*SAMPLES*								
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 375.7 m				
	22				3	1	SS	3		v.loose 0.3m TOPSOIL				Gr Sa Si&Cl %
					8									
					23					-----				
	2				39	2	SS	49		damp	375	1		
					42					dense				
	3				47	3	SS	77*		-----	374			39 56 (5)
					12							2		
					13					brown GRAVELLY SAND frequent cobbles & boulders				
					16									
					11						373	3		*'N'-value unrelaible
					14					INFERRED GRAVELLY SAND				
					38									
					100/28					compact	372	4		
											371	5		Auger refusal at @1.6m. Advance by washboring method.
											370	6		
											369	7		
											368	8		
						4	RC				367	9		RC4: REC=100% RQD=91%
										Pink GRANITE BEDROCK massive, moderately closely jointed	366	10		
						5	RC				365	11		RC5: REC=100% RQD=69%
						6	RC				364	12		RC6: REC=100% RQD=100%

End of Borehole
DCPT conducted 1.5m north.
Move hole 2.0m west, auger refusal @0.9m.
Move hole 2.0m east, auger refusal @1.5m.

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD5

LOG OF BOREHOLE GRD5B

ENCL. No.: 12

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 10th, 1998

LABORATORY DATA						*SAMPLES*								
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 375.7 m				
										AUGER to 1.5m	375	1		Borehole drilled 2.0m north of GRD5.
	2					1	SS	37		brown GRAVELLY SAND some cobbles some boulders	374	2		
	2					2	SS	30		dense	373	3		
	4					3	SS	50/7*			372	4		*'N'-value unreliable
						4	SS	110		v.dense				
										End of Borehole Auger refusal @4.7m on boulder. No groundwater in hole.	371			N=50/7 50 blows for 7 cm penetration

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD5B

LOG OF BOREHOLE GRD5C

ENCL. No.: 13

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 10th, 1998

LABORATORY DATA						*SAMPLES*			SYMBOL	MATERIAL DESCRIPTION	ELEV. m	DEPTH m	WATER DATA	REMARKS
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value		SURFACE EL. 375.7 m				
										Excavated to 4.6m and backfilled with sand. AUGER to 4.6m	375 374 373 372	1 2 3 4		
					63 65 17 80 78 100 75 100/10 100/5					Start of DCPT @4.6m. Auger refusal @4.6m on boulder. compact to dense	371 370	5 6		100/10 : 100 blows for 10 cm penetration
										End of DCPT No growndwater in testpit. Move hole 2.0m east, auger refusal @4.6m. Move hole 2.0m west, auger refusal @4.6m. Move hole 2.0m north, auger refusal @4.6m. Move hole 2.0m south, auger refusal @4.6m.	369			

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD5C

LOG OF BOREHOLE GRD6

ENCL. No.: 14

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 24th, 1998

LABORATORY DATA						*SAMPLES*								
PL %	W %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 377.0 m				
	2				2	1	SS	5		loose 0.3m TOPSOIL	377			
					6					------				
					25					brown				
	4				48	2	SS	44		compact to dense GRAVELLY SAND with frequent cobbles & boulders occ.moist Silty Sand layers damp	376	1		
	16													
					36									
	3				39	3	SS	50/13*						
					28					End of Borehole Auger refusal @1.8m on boulder.	375	2		*sampler refusal on boulder
					54									
					100/15					End of DCPT @2.6m No growndwater in hole. BH drilled 1.0m south of GRD6A. Move hole 2.0m east, auger refusal @2.1m. Move hole 2.0m west, auger refusal @3.0m. Move hole 2.0m east & 2.0m south, auger refusal @2.7m. Move hole 2.0m west & 2.0m south, auger refusal @2.4m. DCPT conducted 1.0m south of GRD6.				N=50/13 50 blows for 13 cm penetration

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD6

LOG OF BOREHOLE GRD6A

ENCL. No.: 15

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 16th, 1998

LABORATORY DATA						*SAMPLES*								
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 377.0 m				
										0.2m TOPSOIL Excavated to 6.0m and backfilled with sand dry AUGER to 7.5m	377 376 375 374 373 372	 1 2 3 4 5		Borehole drilled 1.0m north of GRD6.
										brown GRAVELLY SAND with frequent cobbles & boulders v.dense dry	371 370	6 7		
	5					1	SS	54			369	8		
						2	SS	50/0*			368	9		*sampler refusal on boulder
						3	SS	50/0*		End of Borehole Auger refusal @9.2m on boulder. No groundwater and hole caved @4.0m.				

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD6A

LOG OF BOREHOLE GRD6B

ENCL. No.: 16

REF. No.:	**TT98801**	*DRILLING DATA*	
CLIENT:	**DELCAN**		
PROJECT NAME:	**HWY 11, FOUR LANING**	Method:	**HolSt Augering**
LOCATION	**TROUT CREEK,ONTARIO**	Diameter:	**150 mm**
DATUM:	**Geodetic**	Date:	**December 16th, 1998**

LABORATORY DATA						*SAMPLES*							
PL %	W %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	MATERIAL DESCRIPTION	ELEV. m	DEPTH m	WATER DATA	REMARKS
										SURFACE EL. 377.0 m	377			Borehole drilled 1.0m east of GRD6.
										0.2m TOPSOIL				
											376	1		
	3					1	AS			Excavated to 6.0m and backfilled with sand				
											375	2		
											374	3		
										AUGER to 6.1m				
	3					2	AS				373	4		
											372	5		
											371	6		
	1				95	3	SS	26		brown GRAVELLY SAND with frequent cobbles & boulders				
					100/13									
					100/5	4	SS	50/3*		compact	370	7		*sampler refusal on boulder N=50/3 50 blows for 3 cm penetration
						5	SS	50/15*		End of Borehole Auger refusal @7.8m on boulder. No groundwater and hole caved @5.0m. DCPT conducted 2.0m south of GRD6B.Auger refusal @7.2m.				

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD6B

LOG OF BOREHOLE GRD7

ENCL. No.: 17

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Auger
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 24th, 1998

LABORATORY DATA						*SAMPLES*										
PL %	W %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL		**MATERIAL DESCRIPTION**		ELEV. m	DEPTH m	WATER DATA	**REMARKS**
											SURFACE EL. 379.3 m					
	37				3	1	SS	11			0.2 m TOPSOIL		379			
					18						brown					
					21						GRAVELLY SAND					
	2				39	2	SS	39		dense	with frequent cobbles & boulders	dry		1		
					50								378			
					38	3	SS	50/5*			Refusal @ 1.5 m on Boulder					N=50/5
					35						End of Borehole			2		50 blows for
					24						No groundwater and hole caved		377			5 cm penetration
					14						@0.9m on completion.					
					21									3		
					15								376			
					28											*sampler refusal
					35					compact						on boulder
					38					to dense	INFERRED			4		
					33						GRAVELLY SAND		375			
					28						with frequent cobbles & boulders					
					65									5		
					61					------			374			
					90											
					91									6		
					57								373			
					102					dense to						
					88					v.dense						
					48									7		
					63								372			
					82											
					100/20									8		
											End of DCPT @8.0m.					

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD7

LOG OF BOREHOLE GRD8

ENCL. No.: 18

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	SolSt Auger
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 18th, 1998

LABORATORY DATA						*SAMPLES*								
				UNDR STRNG										
PL %	w %	LL %	UNIT WT kN/m3	Field Vane kPa	Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 375.8 m				
	33					1	SS	5		loose 0.2 m TOPSOIL				
	4					2	SS	42			375	1		
	3					3	SS	30		dense	374	2		
	4					4	SS	52		brown GRAVELLY SAND with frequent cobbles & boulders dry	373			
	3					5	SS	50/5*				3		*sampler refusal on cobble N=50/5 50 blows for 5 cm penetration
	2					6	SS	57			372	4		
	9					7	SS	31			371	5		
										End of Borehole No groundwater and hole caved @ on completion.				

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD8

DRAFT

DRAFT FOUNDATION DESIGN REPORT
FOR
PROPOSED GOREVILLE ROAD UNDERPASS
W.P. 772-93-00
HIGHWAY 11, DISTRICT 54
SUDBURY

Submitted To:

DELCAN Corporation
133 Wynford Drive
North York, Ontario, M3C 1K1
Canada

Submitted By:

AGRA
104 Crockford Blvd.
Scarborough, Ontario, M1R 3C6
Canada

January 1999
TT98801

AGRA
ENGINEERING GLOBAL SOLUTIONS

AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

AGRA Earth &
Environmental Limited
104 Crockford Blvd.
Scarborough, Ontario
Canada M1R 3C6
Tel (416) 751-6565
Fax (416) 751-7592

January 27, 1999.
Ref. No.: TT98801

Delcan Corporation
133 Wynford Drive
North York, Ontario, M3C 1K1
Canada

Attention: **Mr. Khaled El-Dalati, P. Eng.**

Dear Sir:

Re: **DRAFT FOUNDATION DESIGN REPORT**
FOR
PROPOSED GOREVILLE ROAD UNDERPASS
W.P. 772-93-00
HIGHWAY 11, DISTRICT 54
SUDBURY

We take pleasure in enclosing six (6) Draft copies of our Geotechnical Investigation Report carried out for the above mentioned project and we will be glad to discuss any questions arising from this work.

Soil samples will be retained for a period of one year, and will thereafter be disposed of unless we are otherwise instructed.

We thank you for giving us this opportunity to be of service to you.

Sincerely,

Z.S. Ozden, P. Eng.,
Principal Engineer.

ZSO/dee

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APPENDICES

FIGURES

ENCLOSURES

1.0 INTRODUCTION

AGRA, Consulting Geotechnical Engineers, was retained by DELCAN Corporation to conduct a foundation investigation at the site of a proposed bridge that will carry Goreville Road over the realigned northbound and southbound lanes of proposed Highway 11 and associated interchange ramps. The site is located between South River and Trout Creek, to the east of the existing Highway 11 and Goreville Road in the Township of Laurier, Lot 4, Concession 8 in the District of Parry Sound. The proposed bridge will be an approximately 77 m long, 2-lane, two span structure.

The purpose of the investigation has been to obtain information about the subsurface conditions at the site of the proposed bridge and approach embankments by means of exploratory boreholes, and based on the findings, to provide recommendations for the geotechnical design of the foundations of the proposed structure and approach fills.

The field work for the investigation was carried out during the period of November 11 to 22, December 9 to 10, and December 16 to 18, 1998, and consisted of drilling and sampling eighteen boreholes (Borehole Nos. GRD-1, 1B, 1G, 2, 2B, 3, 3B, 3G, 4, 4B, 5, 5B, 5C, 6, 6A, 6B, 7, 8) to depths of 1.5 to 15.4 m, eleven dynamic cone penetration tests and four testpits. A detailed description of field procedures is given in Appendix 'A'.

The plan locations of the boreholes and cone tests, along with stratigraphic sections are shown on Drawing No. 1. Details of subsurface conditions encountered at each borehole location, including the results of in-situ testing, are presented on the Borehole Log Sheets, Enclosure Nos. 1 to 18, inclusive.

2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The site is located approximately 0.3 km east of the intersection of Highway 11 and Goreville Road, between the Villages of Trout Creek and South River. The ground elevation in the general area rises from south to north and from east to west, ranging from about Elevation 375 to 380 m. The area is heavily wooded with deciduous and coniferous trees.

Approximately 100 m north of the proposed bridge site, braided eskers wind across the proposed alignment of Highway 11. The topography in this area is hummocky with numerous boulders blanketing the surface.

Based on available geologic information the site is in an area intersected by small braided eskers partially buried by glaciofluvial sediments. Generally after the last glacial withdrawal, ice-contact sediments (eskers and kames consisting of gravelly sands to sandy gravels with a high boulder content) and glaciofluvial outwash sediments were deposited on top of the existing sandy glacial till or Precambrian bedrock (ranging from granite to gneiss to amphibolite). The area was then inundated by glacial Lake Algonquin depositing sands, silts and clays in low lying areas.

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3.0 SUBSURFACE CONDITIONS

The subsurface conditions were explored at eighteen borehole locations (Borehole Nos. GRD-1, 1B, 1G, 2, 2B, 3, 3B, 3G, 4, 4B, 5, 5B, 5C, 6, 6A, 6B, 7, 8), nineteen auger probe holes, four testpits and were inferred at the locations of eleven dynamic cone penetration tests. The locations of the boreholes and cone penetration tests are shown on the Plan and Profile Drawing No. 1 and are also indicated on the individual Borehole Log Sheets. Cross sections of inferred subsurface stratigraphy are given on Drawing No. 1.

The ground surface at the proposed site generally drops from north to south. The ground elevation at the proposed bridge location generally ranges from about 377.5 to 377.0 m at the north side to about Elevation 376 m at the south (i.e. an elevation drop of 1 to 1.5 m within a distance of 12 m).

In general, the boreholes encountered, below a 0.2 to 0.3 m thick topsoil layer, granular deposits ranging from fine sand to gravelly sand with frequent cobbles and boulders to the full depth of the majority of the boreholes. Bedrock was encountered and cored in three boreholes (Boreholes GRD-2, 3 and 5) at depths ranging from 7.6 m (Elevation 368.0 m) to 12.2 m (Elevation 365.3 m) below existing grade. At the time of the investigation the groundwater table was recorded at depths of 9 to about 10 m below the existing grade or at Elevations generally ranging between 368.5 and 367 m.

Details of the subsurface conditions encountered in these boreholes are presented on the Borehole Log Sheets, Enclosure Nos. 1 to 18. The following paragraphs are only meant to complement and summarize these data.

3.1 TOPSOIL

The boreholes encountered 0.2 to 0.3 m of surficial topsoil. In some areas the presence of cobbles and boulders was noted within the topsoil zone. Measured natural moisture contents of samples from the topsoil ranged from 21 to 31%.

The thickness of topsoil and other organic soils frequently varies in between and beyond the borehole locations.

3.2 FINE SAND

Below the surficial topsoil, the boreholes drilled at the east abutment and central pier locations (i.e. except for Boreholes GRD-5, 5B, 5C, 6, 6A, 6B and 7), encountered fine sand with traces of silt. The deposit extended to depths ranging between 2.3 m or Elevation 375.4 m (Borehole GRD-1) and 4.3 m or Elevation 372.0 m (Borehole GRD-4). This is a granular (i.e. cohesionless) deposit. Grain size distribution analyses were conducted on three samples from the material and the range of particle sizes are presented as a curve envelope in Figure No. 1. The analyses indicate 1 - 3%

.../...

gravel, 84 - 89% sand and 10 - 13% silt and clay size particles. The deposit also contains some silty sand seams/lenses. Measured 'N'-values in this unit range from 3 to 22 blows/0.3 m indicating a very loose to compact condition. Measured natural moisture contents ranged from 1 to 15%, but are generally 1 to 2%.

3.3 SAND TO GRAVELLY SAND

Below the topsoil and/or surficial sand, an ice-contact stratified sand to gravelly sand deposit was encountered to the full extent of the borings or until bedrock was encountered. This is a cohesionless (granular) deposit and contains lenses of silty sand and gravel layers, and frequent cobbles and boulders. Seven grain size distribution analyses were conducted and the range of particle sizes are presented as a curve envelope in Figure No. 2. The analyses indicate 2 - 45% gravel, 51 - 96% sand and 2 - 35% silt and clay size particles. Measured 'N'-values generally range from 12 to greater than 50 blows/0.3 m, indicating compact to very dense condition, but generally compact to dense. Dynamic cone penetration results range from 11 to greater than 100 blows/0.3 m. Many of the 'N'-values were found to be unreliable due to refusal on a cobble or boulder, or the sampler pushing coarse gravel. In order to advance several of the boreholes, boulders were cored. Because of the presence of very frequent oversize particles, it was not possible to make a full or reliable assessment of the compactness condition of the deposit. Measured natural moisture contents ranged from 1 to 16%.

Due to difficult drilling conditions four testpits were excavated to Elevation 371 m, one at the proposed east abutment (Borehole GRD-3G) and pier locations (Borehole GRD-1G) and two at the proposed west abutment location (Borehole GRD-5, 5B, 5C, 6, 6A, 6B) to allow sampling below the proposed footing level. The testpits were backfilled with native sand with boulders selectively removed. The backfill is probably in a loose state.

3.4 BEDROCK

Below the overburden soils, bedrock was encountered and NQ size cores were obtained at Boreholes GRD-2, GRD-3 and GRD-5 at depths 7.6 m, 12.2 m and 8.8 m below existing ground surface (Elevations 368.0, 365.3 and 366.9 m). At boreholes GRD-2 and GRD-5 the bedrock consists of sound, pink, Precambrian granite. The rock was cored for a vertical distance of 3.0 m and a rock quality designation ranging from 69 to 100% was measured indicating the rock to be fair to excellent quality, but generally excellent. The core recovery was 100%.

At Borehole GRD-3, the bedrock consists of a black, weathered, Precambrian Amphibolite (Hornblende Schist). Coring was conducted 3.0 m into the rock (100% recovery) and a rock quality designation ranging from 0 to 34% was measured indicating the rock to be very poor to poor quality, but generally very poor.

.../...

Based on the recorded elevation of bedrock in the three boreholes and overburden depths in the remaining ones, the surface of the bedrock at the bridge site appears to slope down rather sharply from south to north (as evidenced at Boreholes GRD-1 and GRD-2) and gradually rises from west to east. It should also be pointed out that adjacent to Borehole GRD-2 (where the rock was cored) another probe was drilled within 2 m. This borehole extended to 2.1 m below the recorded (surmized) bedrock surface in Borehole GRD-2. This indicates that either the bedrock surface dips very sharply (or the rock encountered in Borehole GRD-2 was a very large boulder). From these observations and experience in the general area, the surface of the bedrock can be expected to be uneven and unpredictable.

3.5 GROUNDWATER CONDITIONS

Groundwater levels in the open boreholes were observed during the drilling and at the completion of each borehole. The water levels in the open boreholes were checked prior to removing the augers or casing.

The recorded values, shown on the individual Borehole Log Sheets, indicate that the water levels at the time of the investigation ranged from 9 to about 10 m below the ground surface (Elevation 368.5 to 367 m). These groundwater elevations were confirmed from the natural moisture content measured from collected samples. It should, however, be pointed out that the groundwater at the site would fluctuate seasonally and can be expected to be somewhat higher during the spring months and in response to heavy rains.

4.0 DISCUSSION AND RECOMMENDATIONS

The proposed Highway 11 realignment will consist of a four lane divided highway with an approximately 28 m wide median. The proposed bridge will carry Goreville Road over the proposed realigned northbound and southbound lanes of Highway 11 and the associated interchange ramps. It will be an approximately 77 m long, 2-lane, (12 m wide), two span structure. The grade at the bridge site drops from north to south. In general the existing ground elevation is generally 377.5 to 377 m on the north side of the bridge location and about 376 m on the south, while the grade at the borehole locations ranges from 379.3 to 375.6 m. The proposed grade of Highway 11 at the bridge site is approximately Elevation 372 m. The existing grades under the proposed bridge will therefore be lowered to build the highway, while the existing grades at the west and east abutments will be raised by about 2 to 5 m, respectively. The grade at the pier location will be cut by about 2.6 to 4.7 m below existing grade. The proposed bridge elevation over the highway is approximately 380.7 m.

.../...

The boreholes have shown beneath a veneer of surficial topsoil the presence of fine sand extending to depths ranging between 2.3 and 4.3 m below the ground surface at the east abutment and central pier locations. Beneath the fine sand at these locations and topsoil at the west abutment, the site is underlain by a major deposit of sand to gravelly sand with frequent cobbles and boulders. In three of the boreholes, Precambrian bedrock was contacted at 7.6 to 12.2 m below the ground surface or at Elevations ranging from 368.0 to 365.3 m while in the remaining boreholes the boreholes were terminated in the overburden. The recorded 'N'-values in the surficial sand generally show a loose to compact condition. The compactness condition of the sand to gravelly sand was difficult to assess due to the presence of frequent oversize particles (i.e. many of the test results were considered to be unreliable due to the influence of cobbles and boulders). Based on the available Standard Penetration and Dynamic Cone Penetration test results, however, the material is surmized to be generally compact to dense. The boreholes show that the groundwater table at the time of our investigation was about 9 to 10 m below existing grade.

4.1 FOUNDATIONS

Based on the proposed preliminary bridge configuration, if spread footing foundations are to be utilized, the bottom of footing elevations will likely be about 371.5 m at the west abutment location and 370 m at the east abutment and the central pier location. As discussed before, owing to the presence of very frequent oversized particles (i.e. coarse gravel, cobbles and boulders) the compactness condition of the granular overburden soils could not be fully assessed with the available conventional drilling and field testing equipment. Available 'N'-values, which were judged to be more reliable, and dynamic cone penetration resistances show variable compactness conditions. Based on the overall data, however, it is our opinion that the undisturbed overburden at or below the proposed footing elevations has sufficient bearing resistance for the use of normal footing foundations but settlements may be unpredictable.

The use of deep foundations is considered to be impractical, due to the presence of cobbles and boulders.

4.1.1 Spread Footing Foundations

In view of the above mentioned considerations it is recommended that normal spread footing foundations be used after the improvement of the compactness condition of the overburden to a sufficient depth below the founding level. In-situ soil improvement methods such as vibro-compaction to densify the soil will likely be impractical due to the presence of cobbles and boulders as well as being expensive. Methods such as dynamic compaction and grouting can be considered but are unlikely to be economically viable. It is therefore recommended that normal spread footings be used after the improvement of the overburden immediately beneath the footings by removing the soil to a sufficient depth and recompacting it .

.../...

For this purpose the following approach is recommended. The soil beneath the proposed footing should be removed to a depth of not less than 2.0 m below the bottom elevation of the footing within an area at least 2.0 m beyond the perimeter of the proposed footing (for example for a footing measuring 12.0 x 5.0 m in plan, the size of the excavation at the bottom would be 5 + 2 + 2 = 9 m by 12 + 2 + 2 = 16 m in plan). The sides of the excavation would be sloped not steeper than 1H:1V (flatter if necessary) and therefore at the proposed founding level, the size of the excavation would be 13 m by 20 m or greater. The on-site excavated sand to gravelly sand (see Figure No. 2) can be re-used provided that oversize materials (i.e. cobbles and boulders) with a nominal diameter of greater than 100 mm are selectively removed and that moisture contents are adjusted (i.e. measured native contents show that above the water table the material is considerably dry of the optimum). As mentioned before, the sides of excavations above the water table should not be sloped steeper than 1H:1V but may require flatter side slopes, especially since vibrations induced during compaction may create instability. If excavations extend below the water table or come close to it dewatering will be required, as is discussed later.

When the excavation reaches the required depth, the subgrade should be evaluated and approved by the Geotechnical Engineer. After its approval, the exposed subgrade at the base of the excavation may need to be compacted, if requested by the Geotechnical Engineer, to achieve a density of not less than about 98% of the material's Standard Proctor Maximum Dry Density (SPMDD). The fill used to raise the grade inside the excavation can be on-site excavated soils (after removing the oversize materials, as discussed before) or other approved compactable granular fill such as Granular 'A' materials or similar. It should be placed in layers not exceeding 200 mm in thickness and should be uniformly compacted to not less than 100% of its SPMDD.

A factored bearing resistance at U.L.S. of 750 kPa and a bearing resistance at S.L.S. equal to 300 kPa can be assigned to soil prepared in this manner. The serviceability condition is based on the premise that total and differential settlements will not exceed 25 mm and 20 mm, respectively.

For frost protection, the footings should have a permanent earth cover of not less than 1.9 m.

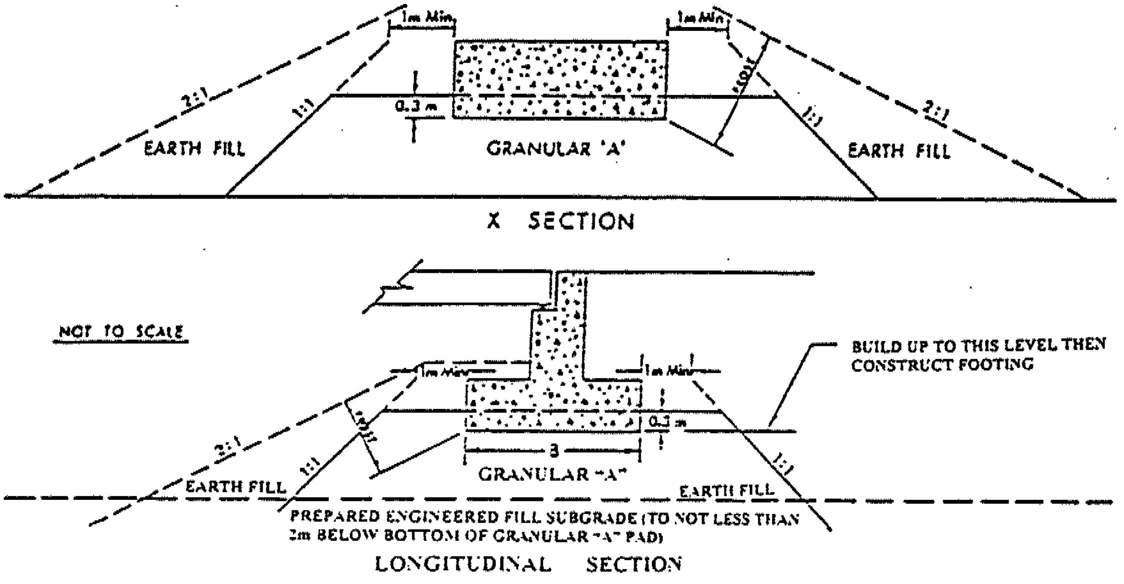
Rock was encountered in Borehole GRD-2 at Elevation 368.0 m. If bedrock or boulders are encountered within the excavations (extended to 2.0 m below the footing base elevation), they should be removed to at least 0.1 m below the proposed excavation depth and replaced with compacted granular material. Allowance may need to be made for this purpose.

A potential problem with this approach would be the position of the water table. If water is encountered at or near the bottom of the excavation then dewatering will be required. Dewatering will need to be capable of drawing the water level to no less than 0.8 m below the bottom of the excavation. When preparing the dewatering scheme, the presence of cobbles and boulders and of the bedrock should be considered. If the water table is not properly lowered, the granular soil at bottom of the excavation can lose its load carrying capability (in addition to the instability of the side slopes) especially since there may be a requirement to compact the exposed subgrade from the surface. If this happens and the engineered fill is placed on disturbed and loosened subgrade

.../...

(and sides), excessive settlements can occur after the application of the structural loads. For this reason, we recommend that the contractor investigate the position of the water table before starting the excavation to assess required dewatering. The proposed dewatering scheme should be reviewed by the Geotechnical Engineer. As discussed before, water levels at the time of our investigation was generally recorded between elevations 368.5 and 367 m and was generally somewhat higher at the proposed pier location. To reduce the probability of encountering problems due to the groundwater table, we recommend that the proposed footing elevations be raised by at least 1 m, if at all possible, especially at the east abutment and (central) pier locations.

The recommended resistance values at U.L.S. and S.L.S. can be increased to 850 kPa and 350 kPa, respectively, if abutments (perched) are founded on engineered fill consisting of Granular 'A' type material (as per MTO standards) placed on top of the subgrade prepared as discussed above. In this case the thickness of the Granular 'A' pad (compacted in thin layers to at least 100% of the material's SPMDD) supporting the spread footing foundations should be at least 1.2 m. The construction of the Granular 'A' pad and of the earth fill should meet the minimum requirements as per Ontario Ministry of Transportation, as shown in Figure A below.



NOTES:
1 - PREPARE SUBGRADE AS DISCUSSED IN REPORT
2 - PLACE GRANULAR "A" & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.O. STANDARDS.
3 - CONSTRUCT CONCRETE FOOTING.
4 - PLACE REMAINDER OF GRANULAR "A" & EARTH FILL AS REQUIRED.

Ministry of Transportation Ontario	ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE	FIG No A WP

In any event as mentioned before, for frost protection, the footings should have a permanent earth cover if at least 1.9 m.

Under inclined loading conditions the Bearing Resistance at U.L.S. should be reduced in accordance with Clause 6-8.4.2 of O.H.B.D.C., 3rd Edition.

The unfactored horizontal resistance against sliding between concrete and approved compacted granular fill surface can be calculated using a friction angle of 29 degrees. This value can be increased to 35 degrees for Granular 'A' type material.

4.2 LATERAL EARTH PRESSURES

Backfill behind abutments and retaining walls should consist of non-frost susceptible, free draining granular materials in accordance with the Ontario Ministry of Transportation Standards.

Free-draining backfill materials and the provision of drain pipes and weep holes, etc., should prevent hydrostatic pressure build-up. Computation of earth pressures should be in accordance with O.H.B.D.C. For design purposes, the following physical properties can be used.

Compacted Granular 'A'

Angle of Internal Friction (ϕ) = 35^0 (unfactored)
Unit Weight = 22 kN/m ^{3}
Coefficient of Lateral Earth Pressures:
$K_a = 0.27$
$K_b = 0.35$
$K_o = 0.43$
$K^* = 0.45$

Compacted Granular 'B'

Angle of Internal Friction (ϕ) = 30^0 (unfactored)
Unit Weight = 21 kN/m ^{3}
Coefficient of Lateral Earth Pressures:
$K_a = 0.33$
$K_b = 0.41$
$K_o = 0.50$
$K^* = 0.57$

NOTE: K_b is the backfill earth pressure coefficient for an unrestrained structure including compaction effects.

.../...

K^* is the earth pressure coefficient for a soil loading a fully restrained structure and includes compaction effects.

The earth pressure coefficient adopted will depend on whether the retaining structure is restrained or movements can be allowed such that the active state of earth pressure can develop. The effect of compaction should also be taken into account in the selection of the appropriate earth pressure coefficients.

Vibratory equipment for use behind abutments and retaining walls should be restricted in size as per current MTO practice.

As an alternative to conventional retaining walls, MTO's Retained Soil System may be used. The following should be included in the Contract Documents:

- identify longitudinal extent in plan of the Retained Soil System.
- identify in plan transverse space constraints (top of wall and bottom of wall)
- identify elevation of top of wall and bottom of wall
- include NSSP for Retained Soil Systems in Contract Documents

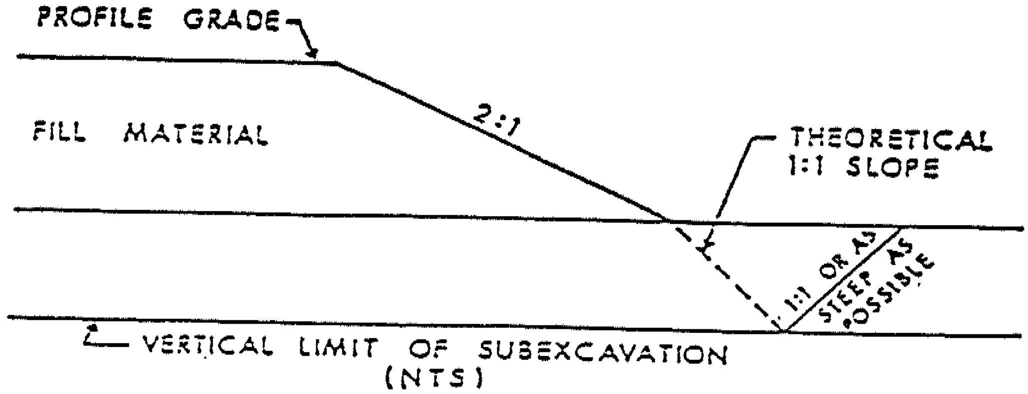
The Retained Soil System should be of high performance and moderate to high appearance.

4.3 CONSTRUCTION COMMENTS

As the proposed bridge deck level is about Elevation 380.7 m, and the existing grade elevations at the immediate approaches are approximately 379.3 to 376.0 m, up to about 1 to 5 m high embankments will have to be built. Based on the borehole results, the strength of the foundation materials is such that deep-seated failures are not anticipated, provided all organic soils, weak or otherwise unsuitable materials are removed as per MTO Standards before placing the fill.

Based on the borings, the average thickness of the unsuitable soils (i.e. organic topsoil and the weak zones of the underlying soil) can be expected to be about 0.3 to 0.4 m. All organic and other unsuitable soils should be removed within an envelope given by an imaginary slope not steeper than 1:1 from the toe of the proposed embankment as depicted by the sketch below. After stripping, the exposed subgrade should be inspected, approved and properly compacted from the surface under the supervision of qualified personnel.

.../...



REMOVAL OF UNSUITABLE SOILS FROM BENEATH APPROACH FILLS

Provided that all organic and otherwise unsuitable materials are removed and the subgrade is properly compacted from the surface as detailed above, the settlement of the foundation materials (i.e. not including the settlement of the embankment material under its own weight) should not exceed 25 mm and should be substantially completed within three weeks of placing the embankment fill to its full height. Such settlements are considered acceptable and will not necessitate preloading or surcharging.

Water level measurements in the boreholes indicate water levels between Elevations 367 and 368.5 m. Potential problems, depending on the groundwater table level at the time of construction and depth of excavations to prepare the engineered fill to support footings, due to groundwater, were discussed in Section 4.1.1 of this report and will not be repeated here. No problems due to groundwater are anticipated for excavations extending to or above Elevation 371± m. Any surface water seepage, if necessary, can easily be handled by gravity drainage and pumping from open sumps.

Allowance should be made to place an approximately 150 mm thick layer of lean concrete on the bearing surface to receive the foundations within four hours of preparation and acceptance of the bearing soil. It should be pointed out that if the foundation soil is disturbed, excessive settlements can occur after structural loads are applied.

All foundation excavations and bearing surfaces should be inspected and approved by the Geotechnical Engineer. We recommend that following construction of the footing, backfill be placed to a height of at least 1.2 m above the footing to prevent disturbance and frost penetration.

5.0 CLOSURE

We recommend that once the details of the structure are finalized, our recommendations should be reviewed for their specific applicability.

The Limitations of Report, as quoted in Appendix B, is an intergral part of this report.

Sincerely,

Andrew Drevininkas, P. Eng.

Z.S. Ozden, P. Eng.

AD/dee

.../...

APPENDIX A

PROCEDURES

The field work for this project was performed during the period of November 11 to 22, December 9 to 10, and December 16 to 18, 1998, and consisted of drilling and sampling eighteen boreholes, eleven dynamic cone penetration tests and four testpits. The plan locations of the boreholes, along with stratigraphic sections are shown on Drawing No. 1.

The boreholes were advanced using a track-mounted power auger drilling rig (CME 75) owned and operated by Canadian Soil Drilling Inc. and a track-mounted power auger drilling rig (BOA 10M) owned and operated by Groundworks Drilling Inc., under the full-time supervision of a soils engineer from AGRA.

Sampling in the boreholes was effected at frequent intervals of depth by the Standard Penetration Test Method (SPT), as specified in ASTM Method D 1586. This consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm diameter o.d. split barrel (split-spoon) sampler into the ground. The number of blows of the hammer to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance or the 'N'-value of the soil and this gives an indication of the consistency or the compactness condition of the soil deposit.

In addition, dynamic cone penetration tests were performed in eleven of the boreholes. This test consists of driving a 60° point, 50 mm diameter cone attached to the drill rod continuously, into the undisturbed ground with a driving energy of 475 J (63 kg hammer falling freely a distance of 76 cm) per blow. The number of blows for each 30 cm of penetration is recorded and this provides an indication of the relative changes in the soil density with depth.

Due to difficult drilling conditions, four testpits were excavated to approximate Elevations of 370 to 371 m (at Boreholes GRD- 1G, 3G, and encompassing Boreholes GRD- 5, 5B, 5C, 6, 6A, 6B). The testpits were backfilled with native sand with large boulders and cobbles selectively removed. Drilling was then carried out from the ground surface and advanced below the bottom of the sand backfill.

The borehole locations were established in the field by our engineering staff, in relation to the already staked out centre-line of Goreville Road (by Dearden and Stanton Limited). The borehole geodetic elevations and co-ordinates were later taken by surveyors from Dearden and Stanton Limited.

The soil samples were shipped in sealed containers to our geotechnical laboratory in Toronto (Scarborough) for further examination and classification. A laboratory testing programme, consisting of natural moisture content and grain-size analyses, was performed on selected representative soil samples. The results of the laboratory tests are presented on the appropriate Borehole Log Sheets and also on Figure Nos. 1 and 2.

The boreholes were left open until the end of each work day to enable us to take additional water level readings. All boreholes were backfilled and grouted on November 22 and December 18, 1998.

APPENDIX B

AGRA

LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in testholes. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

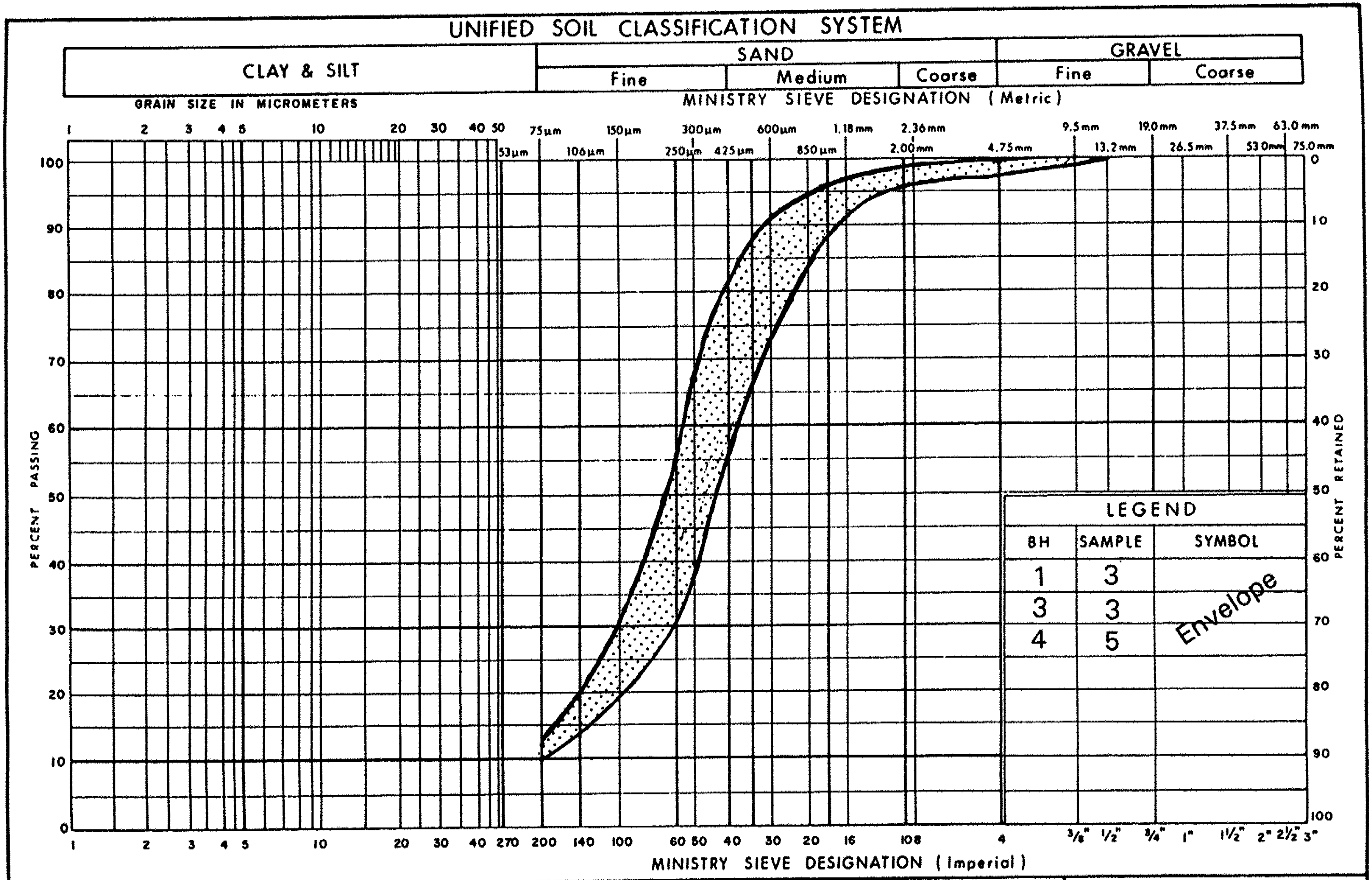
The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AGRA accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

FIGURES

78 12 M



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

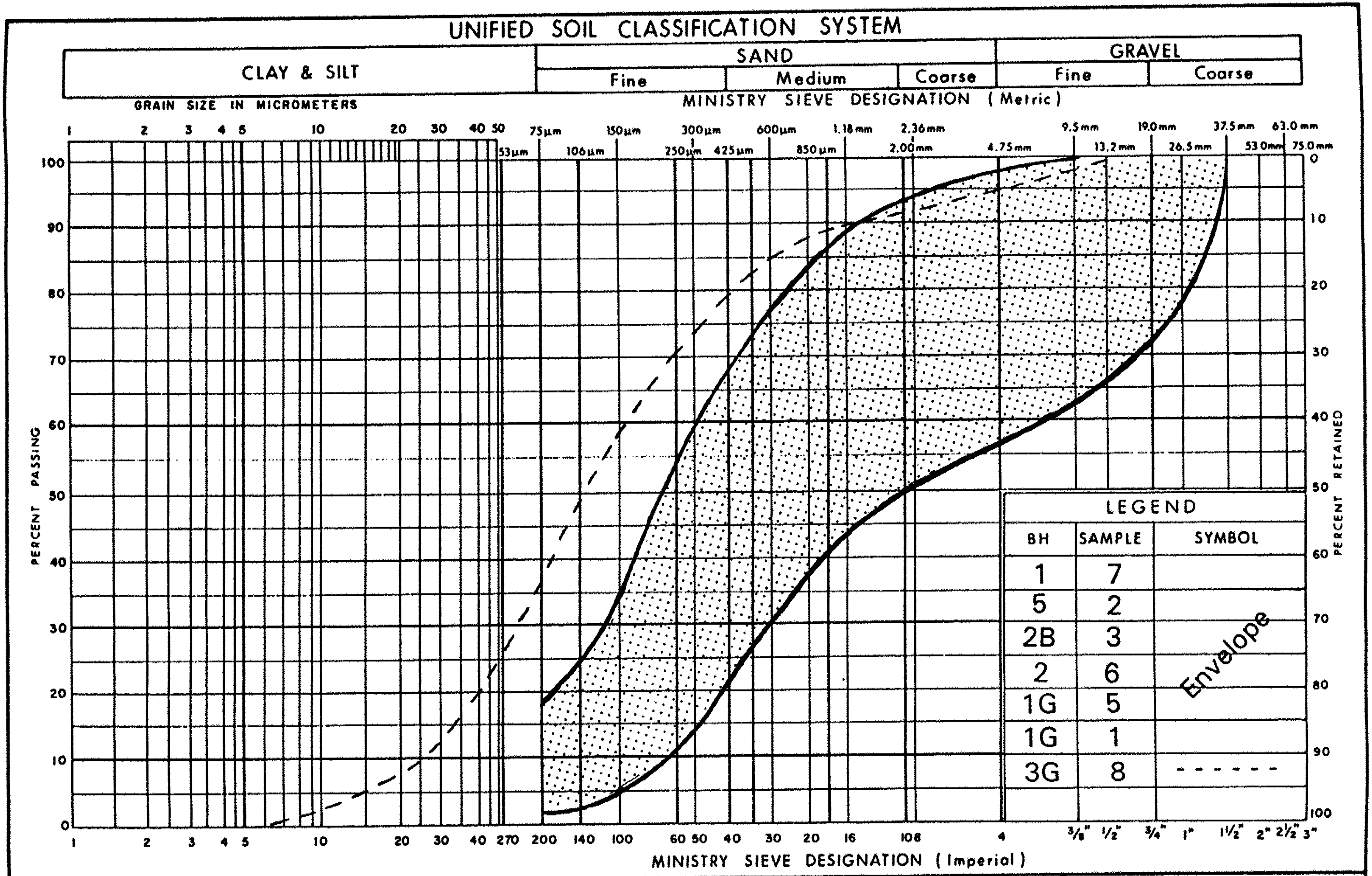
FINE SAND, TRACE SILT

FIG No 1

W P 772-93-00

Ref No. TT98801

78 12 M



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
SAND TO GRAVELLY SAND

FIG No 2

W P 772-93-00

Ref No. TT98801

ENCLOSURES

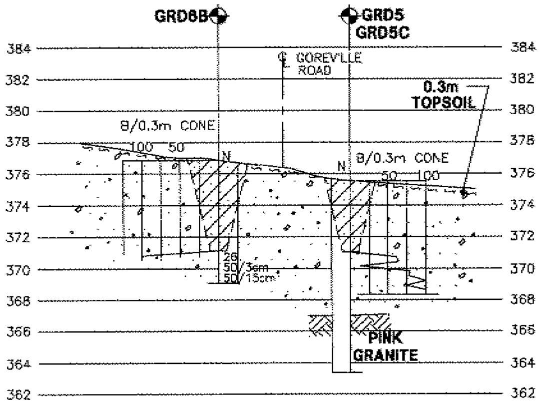
CONT. No. -
W.P. No. 772-93-00

SHEET

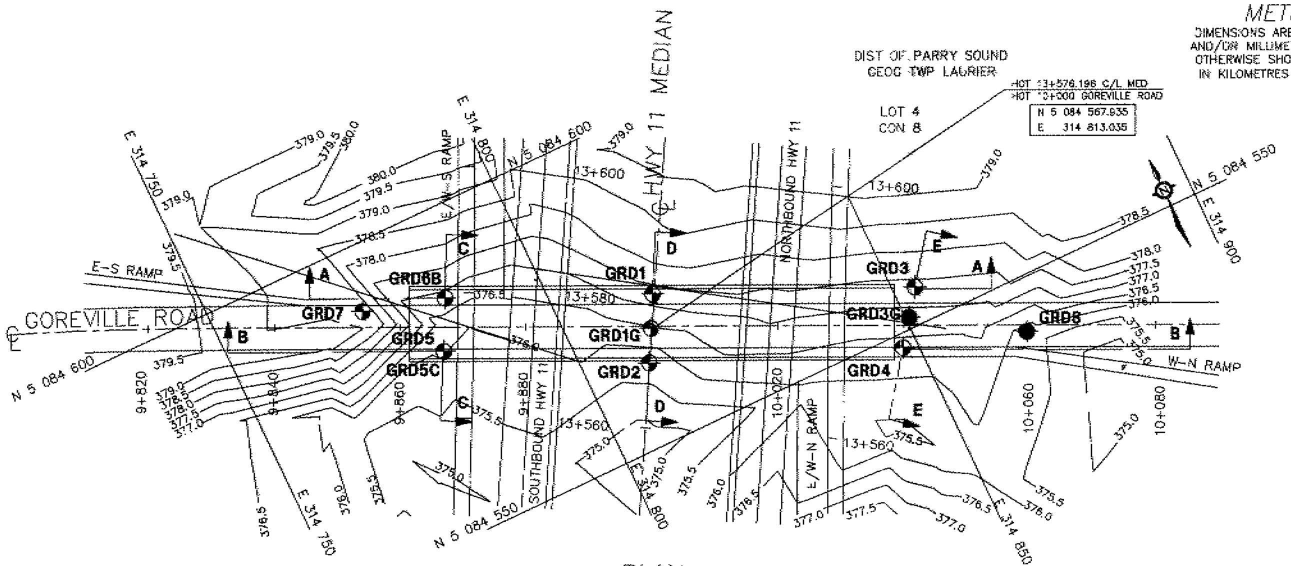
GORVILLE ROAD UNDERPASS
BORE HOLE LOCATIONS&SOIL STRATA

AGRA Earth & Environmental Ltd.

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.STATIONS IN KILOMETRES – METRES.

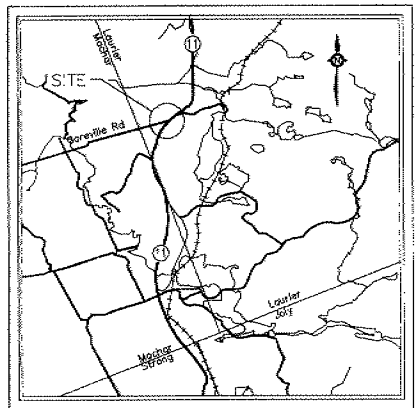


SECTION C–C



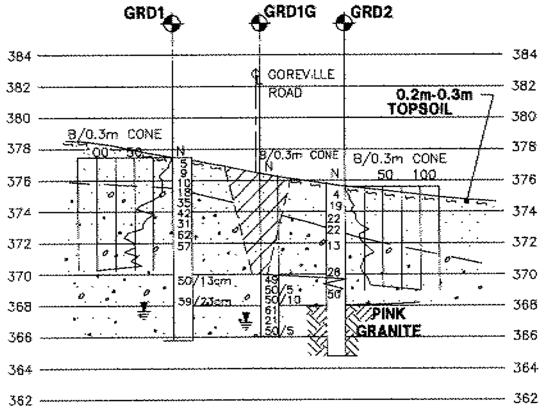
PLAN

5m 0 5m

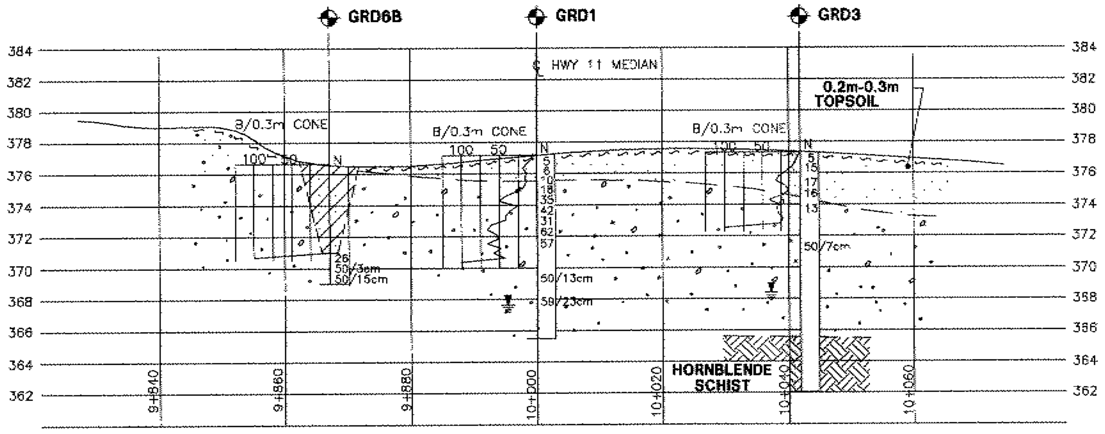


KEY PLAN

1 km 0 1 km

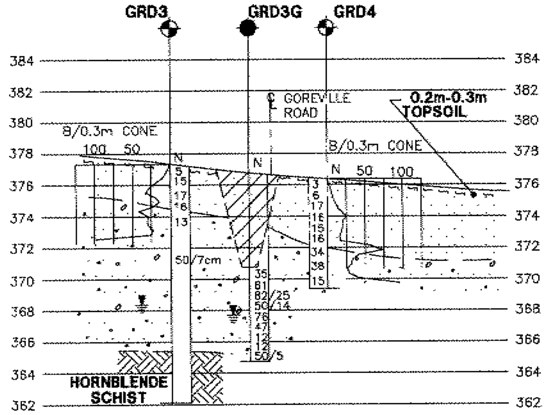


SECTION D–D



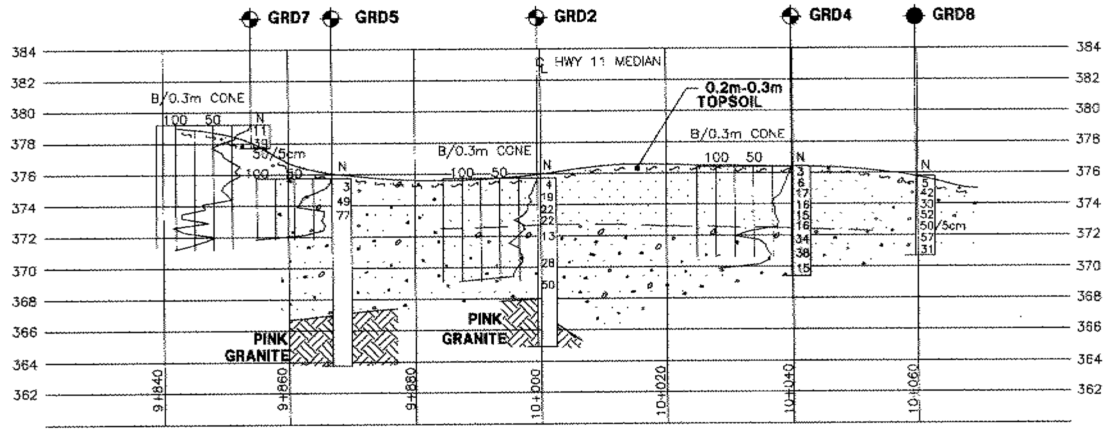
B/0.3m CONE

SECTION A–A



SECTION E–E

2m 0 2m



SECTION B–B

5m 0 5m HOR
2m 0 2m VERT

SOIL STRATIGRAPHY LEGEND

- ░ **SAND TO GRAVELLY SAND** WITH FREQUENT COBBLES&BOULDERS **Compact to Very Dense**
- ░ **FINE SAND** TRACE SILT **Very Loose to Compact**
- ▨ **SAND BACKFILL** **Very Loose to Loose**
- ▩ **BEDROCK**

REF.Hwy 11 Bridge Site Plan
Dwg. by MTO; Oct.1998

LEGEND

●	Bore Hole
⊖	Dynamic Cone Penetration Test (Cone)
◈	Bore Hole & Cone
'N'	Blows/0.3m (Std Pen Test, 475 J/blow)
CONE	Blows/0.3m (60° Cone, 475 J/blow)
⊻	WL at time of investigation Dec 98

No	ELEVATION	CO-ORDINATES NORTH	EAST
GRD1	377.7	5 084 573	314 815
GRD1G	376.1	5 084 568	314 813
GRD2	375.6	5 084 563	314 810
GRD3	377.5	5 084 556	314 854
GRD3G	376.8	5 084 552	314 851
GRD4	376.3	5 084 548	314 848
GRD5 GRD5C	375.7	5 084 579	314 762
GRD6B	377.0	5 084 586	314 785
GRD7	379.3	5 084 590	314 773
GRD8	375.8	5 084 542	314 867

–NOTE–

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen.Cond.

REV.	DATE	BY	DESCRIPTION

HWY No 11			DIST 54
SUBM'D ZO	CHECKED ZO	DATE Jan 27,1999	SITE 44-376
DRAWN MA	CHECKED	APPROVED	DWG 1

FILE:

LOG OF BOREHOLE GRD1

ENCL. No.: 1

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 11th, 1998

LABORATORY DATA						*SAMPLES*								
PL %	W %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	MATERIAL DESCRIPTION	ELEV. m	DEPTH m	WATER DATA	REMARKS
										SURFACE EL. 377.7 m				
	21				4 6	1	SS	5		0.3m TOPSOIL				Gr Sa Si&Cl %
	2				12 17	2	SS	9		loose brown FINE SAND trace Silt dry	377	1		
	3				13 16 26	3	SS	10		compact	376	2		3 84 (13)
	1				40 47	4	SS	18		compact dry	375	3		
					24 33 37	5	SS	35			374	4		
	1				38 56 61	6	SS	42		dense brown SAND to GRAVELLY SAND with frequent cobbles & boulders	373	5		24 73 (3)
	2				50 48	7	SS	31						
	1				62 45 54	8	SS	62			372	6		
	1				40 100/20	9	SS	57		v.dense	371	7		Auger refusal on boulder @6.9m. Advance by washboring method.
										boulder	370	8		
						10	SS	50/13*			369	9		*spoon bouncing on cobble
						11	SS	59/23**			368	10	▼	**No recovery spoon bouncing on cobble
											367	11		
											366	12		Casing shoe worn out at 12m, withdrew casing, hole caved.
										End of Borehole Groundwater in casing @10.0m and hole caved @6.0m on completion. Move hole 2.0m east,auger refusal @2.7m. Move hole 2.0m west, auger refusal @2.3m.				N=50/13 50 blows for 13cm penetration

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD1

LOG OF BOREHOLE GRD1B

ENCL. No.: 2

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 10th, 1998

LABORATORY DATA						*SAMPLES*				**MATERIAL DESCRIPTION**				
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL		ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 377.7 m				
										INFERRED FINE SAND dry	377 376	1 2		Borehole drilled 1.5m east of GRD1.
										AUGER to 6.1m INFERRED GRAVELLY SAND dry	375 374 373 372	3 4 5 6		*spoon bouncing on cobble
	5					1	SS	50/10*		dense to v.dense brown SAND to GRAVELLY SAND with frequent cobbles & boulders dry	371	7		
	5					2	SS	40						
	1					3	SS	75*			370	8		
	1					4	SS	50/13*						N=50/10 50 blows for 10cm penetration
	2					5	SS	63			369	9		
	5					6	SS	40		grey,brown moist	368			

End of Borehole
Auger refusal @9.8m on boulder.
No growndwater in hole on completion.

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD1B

LOG OF BOREHOLE GRD1G

ENCL. No.: 3

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 16th, 1998

LABORATORY DATA						*SAMPLES*								
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 376.1 m				
											376			Gr Sa Si&Cl %
										Excavated to 6.0m and backfilled with sand.	375	1		
											374	2		
										AUGER to 6.1m — dry	373	3		
											372	4		
											371	5		
											370	6		
	2				111 81	1	SS	49						45 51 (4)
					106 100/15	2	SS	50/5*		dense to v.dense — brown — dry	369	7		
	3					3	SS	50/10*			368	8		
										brown/grey — moist				
	9					4	SS	61		SAND to GRAVELLY SAND				
											367	9	▼	
	15					5	SS	21		compact — with frequent cobbles & boulders — wet				16 68 (16)
						6	SS	50/5*		End of Borehole	366	10		N=50/5 50 blows for 5 cm penetration *spoon bouncing on cobble

End of Borehole
Auger refusal @10.1m on boulder.
Growndwater in HolSt Augers @9.0m and hole caved @6.1m on completion.
Move hole 2.0m east, auger refusal @7.8m.
Move hole 2.0m west, Auger refusal @6.2m.
DCPT conducted 1.0m south of GRD1G.

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD1G

LOG OF BOREHOLE GRD2

ENCL. No.: 4

REF. No.:	TT98801	DRILLING DATA	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 18th, 1998

SURFACE EL. 375.6 m

PL %	W %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	
					2	1	SS	4	v.loose
					5				
					7				
	2				12	2	SS	19	compact
					8				
	7				14	3	SS	22	gravelly
					14				
	2				19				
					30	4	SS	22	
					18				
	1				18	5	SS	13	boulder
					24				
					30				
					37				boulder
					24				
					23				
					20	6	SS	28	
					21				compact
					27				
					30				
					32				
					100/25	7	SS	50*	dense
									boulder
						8	RC		
						9	RC		
						10	RC		

MATERIAL DESCRIPTION

0.2m TOPSOIL
brown
FINE SAND
trace silt
dry to damp

brown
SAND
to
GRAVELLY SAND
with frequent
cobbles & boulders
dry

Pink
GRANITE BEDROCK
massive, moderately
closely jointed

End of Borehole
No growndwater in hole and hole caved @3.0m on completion.
Move hole 2.0m east, auger refusal @9.7m.
Move hole 2.0m west, auger refusal @4.1m.
DCPT conducted 2.0m south of GRD2.

REMARKS

Gr	Sa	Si&Cl
%		
6	84	(10)

Auger refusal on boulder @3.0m. Advance by washboring method.

*'N'-value unrelaible driving a stone

RC8:
REC=100%
RQD=100%

RC9:
REC=100%
RQD=88%

RC10:
REC=100%
RQD=100%

N=100/25
100 blows for 25 cm penetration

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD2

LOG OF BOREHOLE GRD2B

ENCL. No.: 5

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 23rd, 1998

LABORATORY DATA						*SAMPLES*			SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value						
										SURFACE EL. 375.6 m				Gr Sa Si&Cl %
										AUGER to 2.1m	375 374	1 2		Borehole drilled 1.5m west of GRD2.
	3					1	SS	14		compact brown SAND, trace Silt dry	373	3		
	2					2	SS	35*		compact brown SAND to GRAVELLY SAND with frequent cobbles & boulders dry —— damp	372	4		2 96 (2)
	2					3	SS	27*			371	5		
	7					4	SS	19						
										End of Borehole Refusal @5.2m on boulder. No groundwater in hole on completion.				*spoon bouncing 'N'-value unreliable

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD2B

LOG OF BOREHOLE GRD3

ENCL. No.: 6

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 19th, 1998

LABORATORY DATA						*SAMPLES*								
PL %	W %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 377.5 m				
	31				3 6	1	SS	5		v.loose 0.2m TOPSOIL	377			Gr Sa Si&Cl %
	2				10 19	2	SS	15			376	1		
	1				27 31 19	3	SS	17		brown SAND frequent layers of Silty Sand		2		1 89 (10)
	2				14 22 40	4	SS	16		compact dry	375	3		
	2				28 29	5	SS	13		brown SAND to GRAVELLY SAND with frequent cobbles & boulders compact dry	374			Auger refusal @3.6m. Advance by washboring method.
					28 22 25 100 100/20					boulder boulder boulder	373 372	4 5 6		*spoon bouncing on boulder
						6	SS	50/7*		INFERRED SAND to GRAVELLY SAND with frequent cobbles & boulders boulder boulder boulder boulder boulder boulder	371 370 369 368 367 366	7 8 9 10 11 12	▼	N=50/7 50 blows for 7cm penetration
						7	RC			black HORNBLENDE SCHIST BEDROCK (AMPHIBOLITE) closely jointed	365	13		RC8: REC=100% RQD=34%
						8	RC				364	14		RC9: REC=100% RQD=0%
						9	RC				363			RC10: REC=100% RQD=12%
						10	RC					15		RC11: REC=100% RQD=0%

End of Borehole
DCPT conducted 2.0m south of GRD3.
Groundwater in casing @9.0m and hole caved @5.0m on completion.
Move hole 2.0m east, auger refusal @4.5m.
Move hole 2.0m west, auger refusal @3.6m.

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD3

LOG OF BOREHOLE GRD3B

ENCL. No.: 7

REF. No.:	TT98801	DRILLING DATA	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 23rd, 1998

LABORATORY DATA						SAMPLES								
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	MATERIAL DESCRIPTION	ELEV. m	DEPTH m	WATER DATA	REMARKS
										SURFACE EL. 377.5 m				
											377	1		Borehole drilled 3.0m south of GRD3.
										AUGER to 4.6m	376	2		
											375	3		
											374	4		*spoon bouncing 'N'-value unreliable
	3					1	SS	53		dense sandy ——— silty compact to dense brown SAND to GRAVELLY SAND with frequent cobbles & boulders dry	373	5		
	3					2	SS	31			372	6		
	11					3	SS	25			371			
	1					4	SS	50/13*			370	7		
	1					~~5~~	~~SS~~	~~50/7*~~		End of Borehole Auger refusal @7.8m on boulder. No groundwater in hole on completion. DCPT conducted Dec.17/98.	369	8		
					137 80 34 21 26 35 24 17 17 21 15 16 100/23						368 367 366	9 10 11		
										End of DCPT @11.6m. On possible Bedrock				N=50/13 50 blows for 13 cm penetration

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD3B

LOG OF BOREHOLE GRD3G

ENCL. No.: 8

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	SolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 17th, 1998

LABORATORY DATA						*SAMPLES*								
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 376.8 m				Gr Sa Si Cl %
										Excavated to 6.0m and backfilled with sand.	376	1		
	6					1	GS				375	2		
										AUGER to 6.1m	374	3		
											373	4		
											372	5		
											371	6		
	6					2	SS	35						
	5					3	SS	61		brown	370	7		
	6					4	SS	82/25*		damp ----- brown/grey -----	369	8		* spoon bouncing on cobble/bedrock
	9					5	SS	50/14*		dense to v.dense moist -----	368	9	▼	
	15					6	SS	76		SAND to GRAVELLY SAND with frequent cobbles & boulders wet				
	8					7	SS	47			367	10		
	16					8	SS	12		----- silty	366	11		5 60 35 0
	8					9	SS	12		compact	365	12		
	16					10	SS	50/5*		End of Borehole Auger refusal @12.0m on probable Bedrock. Growndwater in HolSt Augers @9.0m and hole caved @7.5m on completion. Move hole 2.0m east, auger refusal @3.3m. Move hole @2.0m west, Auger refusal @5.1m.				N=82/25 82 blows for 25 cm penetration

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD3G

LOG OF BOREHOLE GRD4

ENCL. No.: 9

REF. No.:	**TT98801**	*DRILLING DATA*	
CLIENT:	**DELCAN**		
PROJECT NAME:	**HWY 11, FOUR LANING**	Method:	**HolSt Augering**
LOCATION	**TROUT CREEK,ONTARIO**	Diameter:	**150 mm**
DATUM:	**Geodetic**	Date:	**November 21st, 1998**

LABORATORY DATA						*SAMPLES*				ELEV. m	DEPTH m	WATER DATA	REMARKS
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL				Gr Sa Si&Cl %
	21				8	1	SS	3		376			
					11								
	11				14								
	1				21	2	SS	6			1		
					25					375			
	1				21	3	SS	17					
	15				21						2		
					14					374			
					23	4	SS	16					
					25						3		
	1				25	5	SS	15		373			1 89 (10)
	4				24								
					21						4		
	2				22	6	SS	16					
					59					372			
	1				78	7	SS	34					
					46						5		
					38					371			BH drilled 2.0m south of GRD4B.
					36	8	SS	38					
					31						6		
	14				33	9	SS	15		370			
	1				46								
					100/17						7		N=100/17 100 blows for 17 cm penetration

MATERIAL DESCRIPTION

SURFACE EL. 376.3 m

v.loose
------
loose

0.3m TOPSOIL
red to brown SAND,
trace Silt,Gravel,Cobbles

damp

---

gravelly
compact

brown
FINE SAND
trace silt
occ. Gravel layers

damp
----
dry

---

dense
-----
compact

brown
SAND
to
GRAVELLY SAND
with frequent cobbles & boulders
----
some Silt

Refusal @7.0m on boulder
End of Borehole and DCPT
No groundwater in hole.
DCPT conducted 1.5m north of GRD4.
Move hole 2.0m east, auger refusal @5.5m.
Move hole 2.0m west, auger refusal @5.2m.

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD4

LOG OF BOREHOLE GRD4B

ENCL. No.: 10

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 9th, 1998

LABORATORY DATA						*SAMPLES*			SYMBOL	MATERIAL DESCRIPTION	ELEV. m	DEPTH m	WATER DATA	REMARKS
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value						
										SURFACE EL. 376.3 m				
										AUGER to 4.6m	376 375 374 373 372	1 2 3 4		Borehole drilled 2.0m north of GRD4.
	2					1	SS	50*						
	2					2	SS	40		dense -----	371	5		
	8					3	SS	22		sand compact brown SAND to GRAVELLY SAND with frequent cobbles & boulders	370	6		
	2					4	SS	50/13*		-----	369	7		*spoon bouncing on cobble
	10					5	SS	48		dense damp ----- moist		8		
	9					6	SS	30			368	9		
										End of Borehole No groundwater in hole.				N=50/13 50 blows for 13 cm penetration

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD4B

LOG OF BOREHOLE GRD5

ENCL. No.: 11

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 22nd, 1998

SURFACE EL. 375.7 m

LABORATORY DATA PL %	W %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	*SAMPLES* No.	TYPE	N-Value	SYMBOL	MATERIAL DESCRIPTION	ELEV. m	DEPTH m	WATER DATA	REMARKS
	22				3 8	1	SS	3		v.loose 0.3m TOPSOIL				Gr Sa Si&Cl %
	2				23 39	2	SS	49		damp	375	1		
	3				42 47	3	SS	77*		dense	374			39 56 (5)
					12 13 16 11 14 38 100/28					brown GRAVELLY SAND frequent cobbles & boulders INFERRED GRAVELLY SAND compact	373 372 371 370 369 368	2 3 4 5 6 7 8		*'N'-value unrelaible Auger refusal at @1.6m. Advance by washboring method.
						4	RC			Pink GRANITE BEDROCK massive, moderately closely jointed	367 366	9 10		RC4: REC=100% RQD=91%
						5	RC				365	11		RC5: REC=100% RQD=69%
						6	RC				364	12		RC6: REC=100% RQD=100%

End of Borehole
DCPT conducted 1.5m north.
Move hole 2.0m west, auger refusal @0.9m.
Move hole 2.0m east, auger refusal @1.5m.

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD5

LOG OF BOREHOLE GRD5B

ENCL. No.: 12

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 10th, 1998

LABORATORY DATA						*SAMPLES*								
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 375.7 m				
										AUGER to 1.5m	375	1		Borehole drilled 2.0m north of GRD5.
	2					1	SS	37		brown GRAVELLY SAND some cobbles some boulders	374	2		
	2					2	SS	30			373	3		
	4					3	SS	50/7*		dense	372	4		*'N'-value unreliable
						4	SS	110		v.dense				
										End of Borehole Auger refusal @4.7m on boulder. No groundwater in hole.	371			N=50/7 50 blows for 7 cm penetration

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD5B

LOG OF BOREHOLE GRD5C

ENCL. No.: 13

REF. No.:	**TT98801**	*DRILLING DATA*	
CLIENT:	**DELCAN**		
PROJECT NAME:	**HWY 11, FOUR LANING**	Method:	**HolSt Augering**
LOCATION	**TROUT CREEK,ONTARIO**	Diameter:	**150 mm**
DATUM:	**Geodetic**	Date:	**December 10th, 1998**

LABORATORY DATA						*SAMPLES*								
				UNDR STRNG										
PL %	w %	LL %	UNIT WT kN/m3	Field Vane kPa	Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 375.7 m				
										Excavated to 4.6m and backfilled with sand. AUGER to 4.6m	375 374 373 372	1 2 3 4		
					63 65 17 80 78 100 75 100/10 100/5					Start of DCPT @4.6m. Auger refusal @4.6m on boulder. compact to dense	371 370 369	5 6		100/10 : 100 blows for 10 cm penetration
										End of DCPT No growndwater in testpit. Move hole 2.0m east, auger refusal @4.6m. Move hole 2.0m west, auger refusal @4.6m. Move hole 2.0m north, auger refusal @4.6m. Move hole 2.0m south, auger refusal @4.6m.				

Vertical Scale: **1:100**

AGRA

Checked: **RM**

SHEET **1** OF **1** BH No**GRD5C**

LOG OF BOREHOLE GRD6

ENCL. No.: 14

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 24th, 1998

LABORATORY DATA						*SAMPLES*			SYMBOL	MATERIAL DESCRIPTION	ELEV. m	DEPTH m	WATER DATA	REMARKS
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value						
										SURFACE EL. 377.0 m				
	2				2	1	SS	5		loose 0.3m TOPSOIL	377			
					6					------ brown				
					25					GRAVELLY SAND damp				
	4				48	2	SS	44		compact to dense with frequent cobbles & boulders	376	1		
	16				36					occ.moist Silty Sand layers				
	3				39	3	SS	50/13*						
					28					End of Borehole Auger refusal @1.8m on boulder.	375	2		*sampler refusal on boulder
					54									
					100/15					End of DCPT @2.6m No growndwater in hole. BH drilled 1.0m south of GRD6A. Move hole 2.0m east, auger refusal @2.1m. Move hole 2.0m west, auger refusal @3.0m. Move hole 2.0m east & 2.0m south, auger refusal @2.7m. Move hole 2.0m west & 2.0m south, auger refusal @2.4m. DCPT conducted 1.0m south of GRD6.				N=50/13 50 blows for 13 cm penetration

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD6

LOG OF BOREHOLE GRD6A

ENCL. No.: 15

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 16th, 1998

LABORATORY DATA						*SAMPLES*			SYMBOL	MATERIAL DESCRIPTION	ELEV. m	DEPTH m	WATER DATA	REMARKS
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	Lab Compr kPa	No.	TYPE	N-Value						
										SURFACE EL. 377.0 m	377			
										0.2m TOPSOIL				Borehole drilled 1.0m north of GRD6.
										Excavated to 6.0m and backfilled with sand	376	1		
											375	2		
										dry	374	3		
										AUGER to 7.5m	373	4		
											372	5		
										brown GRAVELLY SAND with frequent cobbles & boulders	371	6		
										v.dense dry	370	7		
	5					1	SS	54			369	8		
						2	SS	50/0*			368	9		*sampler refusal on boulder
						3	SS	50/0*		End of Borehole Auger refusal @9.2m on boulder. No groundwater and hole caved @4.0m.				

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD6A

LOG OF BOREHOLE GRD6B

ENCL. No.: 16

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 16th, 1998

LABORATORY DATA						*SAMPLES*							
PL %	W %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
									SURFACE EL. 377.0 m	377			
									0.2m TOPSOIL				Borehole drilled 1.0m east of GRD6.
										376	1		
	3					1	AS		Excavated to 6.0m and backfilled with sand				
										375	2		
										374	3		
									AUGER to 6.1m				
	3					2	AS			373	4		
										372	5		
										371	6		
	1				95	3	SS	26	brown GRAVELLY SAND with frequent cobbles & boulders				
					100/13								
					100/5	4	SS	50/3*	compact	370	7		*sampler refusal on boulder
						5	SS	50/15*	End of Borehole Auger refusal @7.8m on boulder. No groundwater and hole caved @5.0m. DCPT conducted 2.0m south of GRD6B.Auger refusal @7.2m.				N=50/3 50 blows for 3 cm penetration

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No GRD6B

LOG OF BOREHOLE GRD7

ENCL. No.: 17

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Auger
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 24th, 1998

LABORATORY DATA						*SAMPLES*				**MATERIAL DESCRIPTION**						**REMARKS**
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL				ELEV. m	DEPTH m	WATER DATA	
											SURFACE EL. 379.3 m					
	37				3	1	SS	11			0.2 m TOPSOIL		379			
					18						brown					
					21						GRAVELLY SAND					
	2				39	2	SS	39		dense	with frequent cobbles & boulders	dry		1		
					50								378			
					38	3	SS	50/5*			Refusal @ 1.5 m on Boulder					N=50/5
					35						End of Borehole			2		50 blows for
					24						No groundwater and hole caved		377			5 cm penetration
					14						@0.9m on completion.					
					21									3		
					15								376			
					28					compact						*sampler refusal
					35					to dense						on boulder
					38						INFERRED			4		
					33						GRAVELLY SAND		375			
					28						with frequent cobbles & boulders					
					65									5		
					61					------			374			
					90											
					91									6		
					57								373			
					102					dense to						
					88					v.dense						
					48									7		
					63								372			
					82											
					100/20									8		
											End of DCPT @8.0m.					

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD7

LOG OF BOREHOLE GRD8

ENCL. No.: 18

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	SolSt Auger
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	December 18th, 1998

LABORATORY DATA						*SAMPLES*								
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 375.8 m				
	33					1	SS	5		0.2 m TOPSOIL loose				
	4					2	SS	42			375	1		
	3					3	SS	30		dense brown GRAVELLY SAND with frequent cobbles & boulders	374	2		
	4					4	SS	52		dry	373	3		
	3					5	SS	50/5*						*sampler refusal on cobble N=50/5 50 blows for 5 cm penetration
	2					6	SS	57			372	4		
	9					7	SS	31			371	5		
										End of Borehole No groundwater and hole caved @ on completion.				

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1 BH No. GRD8

G.I.-30 · SEPT. 1976

GEOCRES No.

DIST. 54 REGION

W.P. No. 772-93-01

CONT. No.

W. O. No.

STR. SITE No.

HWY. No. 11

LOCATION Lindsay Hill Bridge

No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

AGRA
ENGINEERING GLOBAL SOLUTIONS

AGRA Earth &
Environmental Limited
104 Crockford Blvd.
Scarborough, Ontario
Canada M1R 3C6
Tel (416) 751-6565
Fax (416) 751-7592

RECEIVED
OCT 26 1999
FOUNDATION DESIGN SECTION

September 28, 1999
Ref. No. TT98801

Delcan Corporation
133 Wynford Drive
North York, Ontario
M3C 1K1

Attention: **Mr. Khaled El-Dalati, P. Eng.**
Senior Project Manager

Dear Sir,

Re: **Additional Boreholes at Lindsay's Hill Interchange**
Trout Creek, Ontario
W.P. 772-93-00

Further to your request, we are pleased to present the findings of the additional boreholes drilled at the above captioned site.

AGRA Consulting Geotechnical Engineers, was requested by Delcan Corporation on behalf of MTO to conduct a preliminary geotechnical investigation in the area of the proposed Lindsay Hill's Road Interchange Alternative 2(J) and in the area of the Non-Interchange Alternative, in the Black Creek swamp area, north of Glen Roberts Drive.

The purpose of the investigation has been to obtain information about the subsurface conditions in the area of the proposed interchange alternatives by means of exploratory boreholes.

We understand that for Alternative 2(J), proposed Lindsay's Hill Road will intersect with the proposed service road east of Highway 11, beyond the toe of the existing slope within the swamp. Borehole 201 was advanced in this general area.

For the Non-Interchange Alternative, Borehole 202 was drilled north of Glen Roberts Drive, between Black Creek and CNR.

INVESTIGATION PROCEDURES

The field work for this additional investigation was performed on July 8 and August 24, 1999, and consisted of drilling and sampling one borehole (Borehole No. 201) to a depth of 18.3m, and one borehole (Borehole 202) to a depth of 12.7 m. The approximate plan location of the boreholes are shown on Drawing No. 1 and 2.

Borehole 201 was advanced using hollow stem continuous flight augers with a track-mounted power auger drilling rig (BOA 6M) owned and operated by Groundworks Drilling Inc., under the full-time supervision of a professional engineer from AGRA.

Borehole 202 was advanced using wash boring methods using portable hand drilling equipment, owned and operated by Eastern Soils Investigation Limited, under the full-time supervision of geotechnical personnel from AGRA.

Sampling in the borehole was effected at frequent intervals of depth by the Standard Penetration Test Method (SPT), as specified in ASTM Method D 1586. This consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm diameter o.d. split barrel (split-spoon) sampler into the ground. The number of blows of the hammer to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance or the 'N'-value of the soil and this gives an indication of the consistency or the compactness condition of the soil deposit. In addition to the SPT, in-situ shear vane testing of the cohesive overburden were conducted at frequent intervals of depth.

The borehole locations were established in the field by our engineering staff, relative to existing features and the existing gravel access roads. We understand that the precise borehole locations and elevations will be surveyed by Dearden and Stanton Limited. The locations indicated on Drawing Nos. 1 and 2 are approximate only.

The soil samples were shipped in sealed containers to our geotechnical laboratory in Toronto (Scarborough) for further examination and classification. A laboratory testing programme, consisting of natural moisture content and Atterberg Limits tests, was performed on selected representative soil samples. The results of the laboratory tests are presented on the Borehole Log Sheets.

The boreholes were left open until completion to measure the water level and then backfilled with auger cuttings.

SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered in the boreholes are presented on the Borehole Log Sheets. The following paragraphs are only meant to summarize the subsurface conditions in the general investigation area.

Borehole 201

Below a peat deposit of approximately 2.6 m in thickness, a sand and silty sand deposit was encountered to a depth of about 5.6 m. From the measured 'N'-value of 13 blows/0.3m, the cohesionless sand deposits are compact. Underlying the sand is a weak silty clay deposit which was encountered to the full depth of the borehole (18.3 m below existing grade). Within this cohesive stratum in-situ shear vane tests were conducted, resulting in shear strengths ranging from 26 to 48 kPa indicating clayey soils of firm consistency, while below a depth of about 17m the shear strength increased to values of 57 to 97 kPa, indicating stiff consistency.

The laboratory testing programme indicated the following results within the silty clay deposit:

Plastic Limit:	21%
Liquid Limit:	31%
Plasticity Index:	10%
Moisture Content:	35 to 59%

The above results indicate the clay to be of low plasticity, weak and compressible.

The water level measurements are generally close to the surface (approximately at 0.15 m below ground surface). The ground water table may fluctuate seasonally or in response to severe weather events.

Borehole 202

Below a 0.15 m topsoil layer, and a loose sand layer extending to a depth of 0.6 m , a silty clay to clayey silt deposit was encountered to a depth of about 8.1 m. Below this cohesive deposit is a silt stratum extending to a depth of 9.7 m, which is underlain by a silty sand deposit extending to the remaining depth of the borehole.

The grey, clayey silt to silty clay deposit is generally varved. Measured 'N'-values range from 3 to 12 blows/0.3m, indicating a soft to stiff consistency. Within this cohesive stratum in-situ shear vane tests were conducted, resulting in a shear strength in excess of 110 kPa in the upper 2 m ± of the deposit, while below this depth the shear strength decreased to values ranging from 22 to 57 kPa. These values indicate clayey soils of very stiff consistency with the surficial 2 m ±, and soft to firm below.

The laboratory testing programme indicates a plastic limit of 19%, liquid limit of 25%, a plasticity index of 6%, and moisture contents ranging from 30 to 43%. These results indicate the clay to be of low plasticity, weak and compressible.

The silt deposit underlying the cohesive soil contains frequent thin clay and sand seams. A measured 'N'-value of 12 blows/0.3 m indicates a compact condition. Laboratory testing indicates a plastic limit of 16%, a liquid limit of 19%, a plasticity index of 3% and moisture contents ranging from 26 to 30%.

Underlying the silt is a silty sand deposit. The cohesionless sand deposit contains occasional thin clay seams. Measured 'N'-values range from 5 to 12 blows/0.3 m, indicating a loose to compact condition. Sampler and casing refusal on a boulder or on the bedrock surface was obtained at a depth of 12.7 m below ground surface.

The water level measurement on completion of the borehole was at 1.8 m below existing ground surface, but due to the impermeable nature of the clayey soils, the water table may not have stabilized. The ground water table may fluctuate seasonally or in response to severe weather events.

Should you have any questions regarding this information please do not hesitate to call.

Sincerely

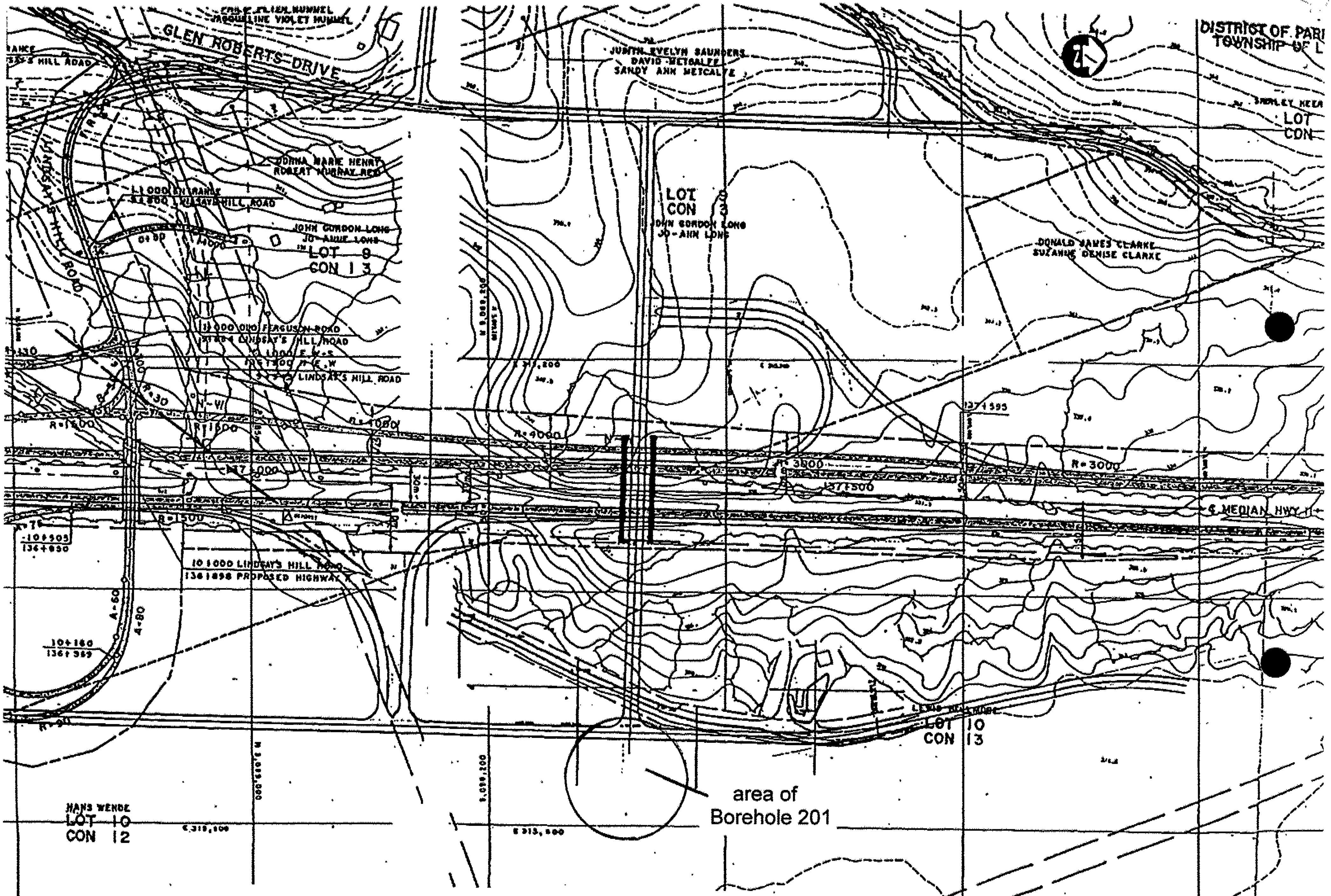
Andrew Drevininkas, P. Eng.

Ramon Miranda, P. Eng.

George S.W. Chow, P. Eng.

AGRA
ENGINEERING GLOBAL SOLUTIONS

ENCLOSURES



area of Borehole 201

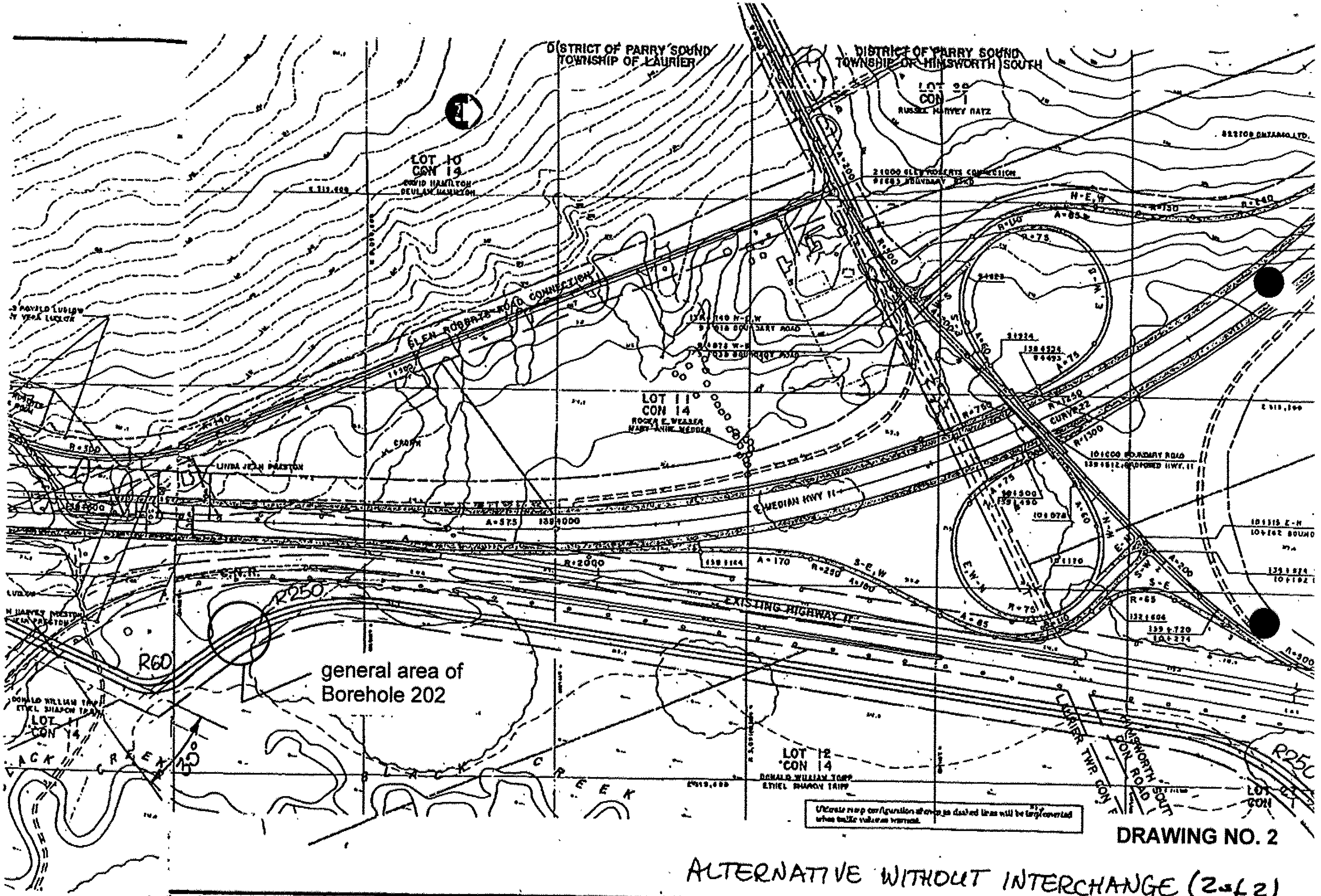
LINDSAY'S HILL ROAD INTERCHANGE

ALTERNATIVE 2(j) Modified

Underpass With Access Ramps

(Flyover With "Buck-Saw Access" Further South)

DRAWING NO. 1



DRAWING NO. 2

ALTERNATIVE WITHOUT INTERCHANGE (2 of 2)

HWAY 11
FALLS TO POWASSAN
LANNING STUDY AND

SCALE
HORIZ. 0 50 100 150 200m

KEY PLAN

LEGEND
PROPOSED ROAD
EXISTING ROAD

Plan

RECORD OF BOREHOLE No 201

1 OF 1

METRIC

W.P. 772-93-00

DIST 54 HWY 11

DATUM Assumed

LOCATION

BOREHOLE TYPE Hollow Stem

DATE 8 July 1999

ORIGINATED BY AD

COMPILED BY AD

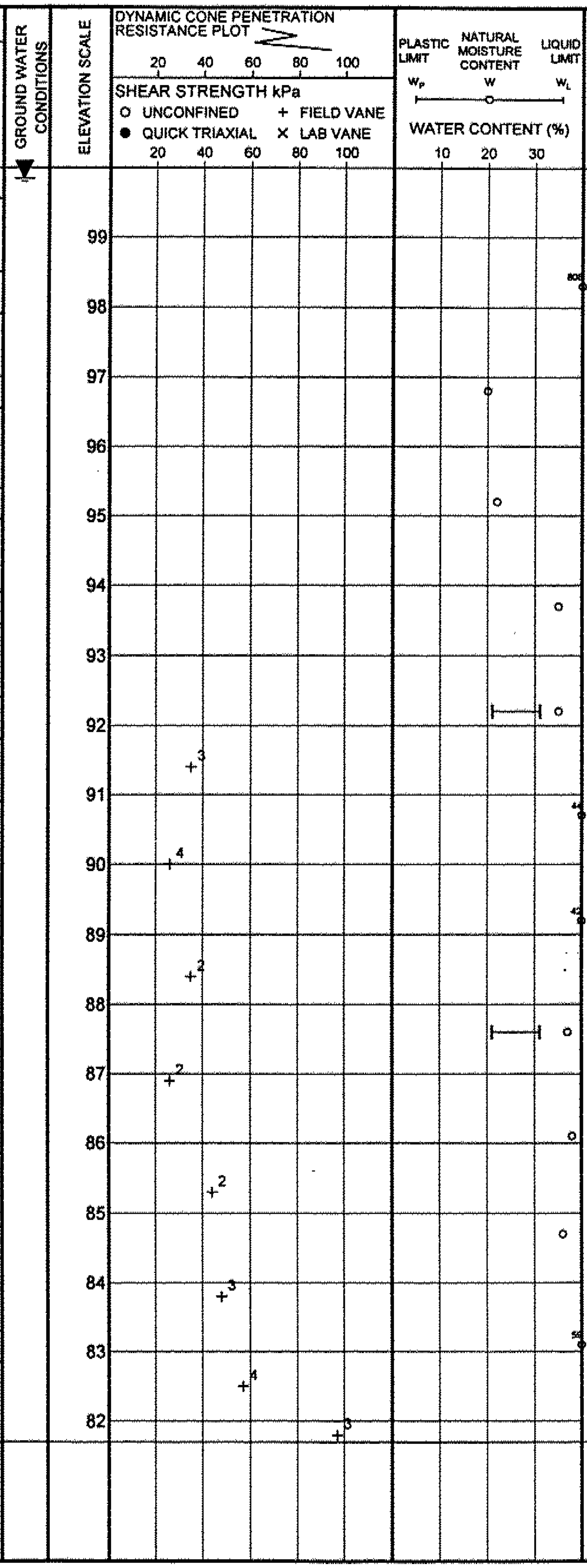
CHECKED BY ZSO

SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
100.0 0.0	black PEAT wet
97.4 2.6	brown SAND fine to medium compact, wet
96.0 4.0	brown SILTY SAND compact, wet
94.4 5.6	SAND layer grey SILTY CLAY firm stiff
81.7 18.3	END OF BOREHOLE Water Level in Open Bore: on completion: 0.15m

SAMPLES

NUMBER	TYPE	"N" VALUES
1	SS	1
2	SS	1
3	SS	13
4	SS	13
5	SS	3
6	SS	1
7	SS	0*
8	SS	0*
9	SS	0*
10	SS	0*
11	SS	0*
12	SS	0*



UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

SS7 to 12: drill rods sank under own weight

+³, X³: Numbers refer to Sensitivity

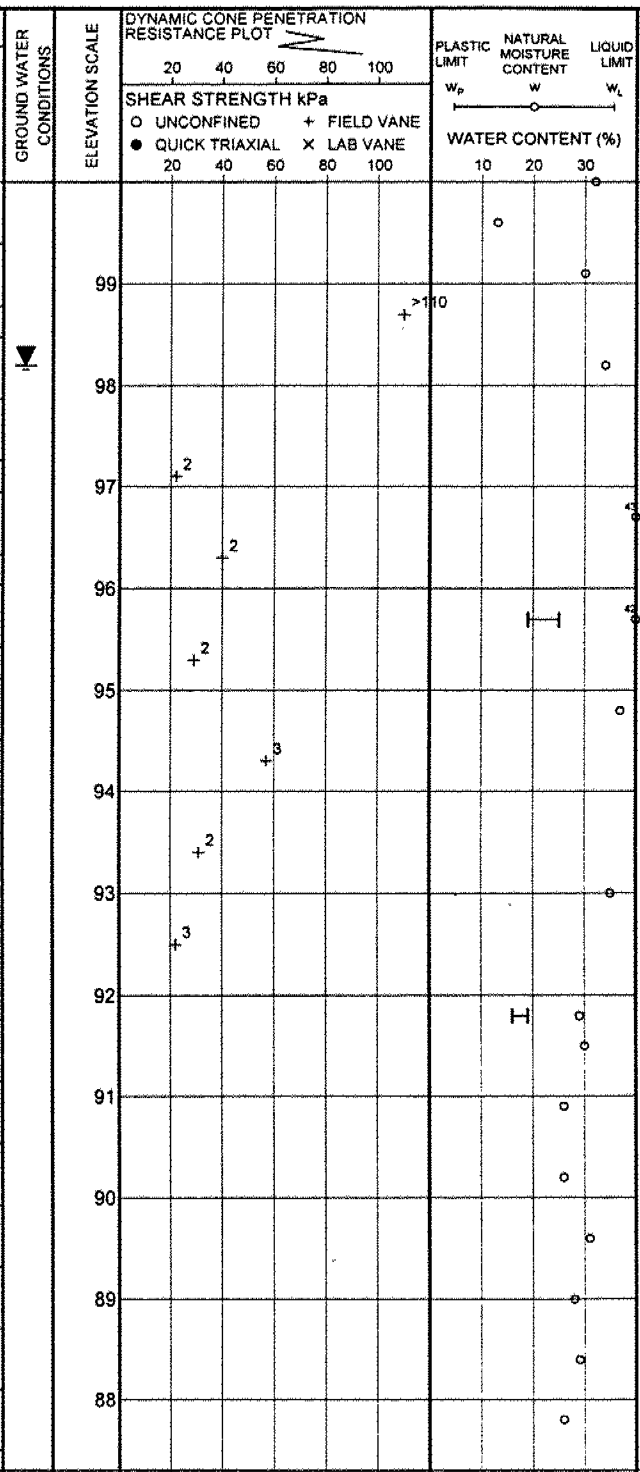
O³% STRAIN AT FAILURE

RECORD OF BOREHOLE No 202

1 OF 1 **METRIC**

W.P. 772-93-00 LOCATION Between CNR & Black Creek ORIGINATED BY MA
DIST 54 HWY 11 BOREHOLE TYPE Wash boring COMPILED BY AD
DATUM Assumed DATE 24 August 1999 CHECKED BY AD

ELEV DEPTH	SOIL PROFILE: DESCRIPTION		SAMPLES: NUMBER	TYPE	"N" VALUES
100.0 0.0	0.15m TOPSOIL brown **SAND** trace Silt,damp,loose		1	SS	7
99.4 0.6	grey,varved **SILTY CLAY** to **CLAYEY SILT**		2	SS	11
		stiff to very stiff	3	SS	12
			4	TW	-
		soft	5	SS	3
		firm	6	SS	4
		stiff	7	SS	3
			8	TW	-
		firm	9	SS	3
		soft	10	SS	6
91.9 8.1	grey **SILT** with frequent clay & sand seams compact, wet		11	SS	12
			12	SS	12
90.3 9.7	grey **SILTY SAND** with occasional clay seams wet		13	SS	13
			14	SS	5
			15	SS	10
		loose	16	SS	8
		compact	17	SS	12
			18	SS	50/3
87.3 12.7	END of BOREHOLE CASING REFUSAL ON PROBABLE BOULDER Water Level on completion: 1.8m				



UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

$+^3, \times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

AGRA Earth &
Environmental Limited
104 Crockford Blvd.
Scarborough, Ontario
Canada M1R 3C6
Tel (416) 751-6565
Fax (416) 751-7592

February 23, 1999
Ref. No.: TT98801

Ministry of Transportation
Foundation Design Section
Central Building
1201 Wilson Avenue
Dowsview, Ontario, M3M 1J8
Canada

Attention: **Mr. D. Dundas, P. Eng.**
Mr. T. Sangiuliano, P. Eng.

Dear Sirs:

Re: **PROPOSED LINDSAY HILL/HIGHWAY 11 BRIDGE**
FOUR LANING OF HIGHWAY 11, BETWEEN TROUT CREEK
AND SOUTH RIVER
DISTRICT 54, SUDBURY REGION, ONTARIO

Under the cover of this letter we are forwarding to you a preliminary draft report for the above captioned project, to enable you to become familiar with the subsurface conditions at the site and our method of approach, prior to our meeting.

Please let me know if you require any other information.

Sincerely,

Z.S. Ozden, P. Eng.

ZSO/dee
Encl.

PRELIMINARY

1.0 INTRODUCTION

AGRA, Consulting Geotechnical Engineers, was retained by DELCAN Corporation to conduct a foundation investigation at the site of a proposed bridge that will carry Lindsay Hill Road over the proposed realigned northbound and southbound lanes of Highway 11. The site is located between South River and Trout Creek, along the existing Highway 11, in Laurier Township Lot 9, Concession 12, in the Parry Sound District. The proposed bridge will be a two-lane, two span structure. The west and east spans will be approximately 33.5 m and 36 m long, while the bridge width will be about 12 m.

The purpose of the investigation has been to obtain information about the subsurface conditions at the site of the proposed bridge and approach embankments by means of exploratory boreholes, and based on the findings, to provide recommendations for the geotechnical design of the foundations of the proposed structure and approach fills.

The field work for the investigation was carried out during the period of November 3 to 14, December 19 to 21, 1998, and January 6 to 17, 1999, and consisted of drilling and sampling seven boreholes (Borehole Nos. LH1 to LH7, inclusive) to depths ranging from 14.6 to 27.6 m, and performing two dynamic cone penetration tests (within about 1.5 m of the locations of Borehole Nos. LH1 and LH2). Bedrock was cored at two locations and it was proven by diamond drilling methods in NQ size. A detailed description of field procedures is given in Appendix A.

The plan locations of the boreholes, along with stratigraphic section are shown on Drawing No. 1. Details of subsurface conditions encountered at each borehole location, including the results of in-situ testings, are presented on the Borehole Log Sheets, Enclosure Nos. 1 to 7, inclusive.

2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The site is located at the intersection of Highway 11 and Lindsay Hill Road, between the Villages of Trout Creek and South River. The ground elevation in the general area rises from east to west, ranging from about Elevation 314.4 m to 316.9 m. The site is generally heavily wooded and the area to the east of the proposed bridge is swampy.

.../...

Based on available geologic information* the site is underlain by glaciolacustrine sediments. These deposits are commonly confined by bedrock uplands and the sediments are subdivided into: 1) nearshore and deltaic sand and minor gravel and, 2) offshore silt and clay. Sections within deltaic deposits exhibit planar, ripple- and cross laminated sand and fine gravel usually flat-lying to gently dipping to the south and southwest.

The glaciolacustrine fine grained deposits, primarily grey silt and red clay rhythmites, occur sporadically in depressions in the glaciolacustrine basin area. The rhythmic sequences commonly grade upwards to a greyish-red, massive, blocky silt-clay. These fine grained sediments are occasionally folded and faulted. A thin unit of planar to ripple-laminated sand and fine gravel generally caps the fine grained sequences. The silts and clays represent distal and quiescent lake conditions during the main Algonquin and early post-Algonquin phases.

The glaciolacustrine sediments were deposited on top of the existing Precambrian bedrock, ranging from granite to gneiss to amphibolite.

3.0 SUBSURFACE CONDITIONS

The subsurface conditions were explored at the location of seven boreholes (Borehole Nos. LH1 to LH7, inclusive). Dynamic cone penetration tests were also performed within 1.5 m of Borehole Nos. LH1 and LH2. The locations of the boreholes are shown on Drawing No. 1 and are also indicated on the individual Borehole Log Sheets. A cross section of inferred subsurface stratigraphy is given in Drawing No. 1.

Details of the subsurface conditions encountered in these boreholes are presented on the Borehole Log Sheets, Enclosure Nos. 1 to 7. The following paragraphs are only meant to complement and summarize these data.

3.1 TOPSOIL/PEAT

Topsoil was encountered at Borehole Nos. LH1, LH3, LH5 and LH6 extending to depths ranging from 0.2 to 0.3 m below ground surface. The top 0.6 m of Borehole Nos. LH2 and LH4, and the soil to a depth of about 1.0 m in Borehole No. LH1 were organically stained. Measured natural moisture contents of the samples from the topsoil layer ranged from 27 to 115%.

Peat was encountered in Borehole No. LH7, extending to 1.7 m below the existing grade. The measured moisture content of a sample from the peat layer was 175%.

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*Kor, P.S.G. and Delorme, R.J. 1980. Quaternary Geology of the South River Area; Ontario Geological Survey, Preliminary Map P.3160, Scale 1:50 000

.../...

In our experience the thickness of topsoil and other organic soils frequently varies in between and beyond the borehole locations.

3.2 UPPER FINE SAND

Underlying the surficial organic soils (i.e. topsoil or peat), all seven boreholes encountered a fine sand deposit, extending to an average depth of about 4.9 m (average Elevation 310.5 m) below the existing ground surface (i.e. to 4.0 to 4.5 m in Borehole Nos. LH1-LH4 to 5.2 to 6.6 m in Borehole Nos. LH5 to LH7).

The grain-size distribution of samples from the deposit is given in Figure No. 1. These indicate 0-1% gravel, 86-97% sand (mostly fine) and 0-8% soil fines (i.e. silt & clay size particles).

Standard penetration tests carried out in this upper sand deposit yielded 'N'-values generally ranging from 4 to 26 blows/0.3 m, with occasional lower values (0, 2, 3 blows/0.3m) near the surface, indicating a generally loose to compact condition. The results of dynamic cone penetration tests carried out near Borehole Nos. LH1 and LH2 ranged from 9 to 33 blows/0.3 m.

The measured natural moisture contents range from 10 to 26%, but are generally 14 to 24%, indicating a wet state.

3.3 SILTY CLAY/CLAYEY SILT

Underlying the fine sand, Borehole Nos. LH3 (west approach location), LH1 (central pier location) and Borehole Nos. LH5, LH6 and LH7 (east abutment and approach) contacted a stratified deposit consisting of thin clay, silty clay, clayey silt, silt and sandy silt with occasional silty sand & sand seams. The deposit was contacted at depths ranging from about 4.4 m below the ground surface or Elevation 310.1 m (BH LH3) on the west side to 6.6 m or Elevation 307.8 m (BH LH7) on the east. Its thickness ranges from about 2.2 m at Borehole No. LH3 (west approach) to more than about 13.5 m at Borehole No. LH7 (east approach) and as such the deposit in general appears to be thickening from west to east.

The grain-size distribution of samples from the deposit is presented in Figure No. 2. The analyses results indicate 0-2% sand, 54-76% silt and 22-44% clay size particles.

Atterberg limits tests performed in the laboratory on samples from these materials (after discarding any obvious silt seams) gave the following index values.

Liquid Limit = 30-43%
Plastic Limit = 18-24%
Plasticity Index = 9-19%

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These values are characteristic of clayey soils of low to intermediate (but generally low) plasticity (Figure No. 6). A somewhat unusual feature of these findings is that with most soils, the measured clay size percentages would normally be associated with higher plasticity index values than indicated above. Another unusual observation is that the samples of the material obtained from the boreholes showed a much higher degree of dilatancy than would be expected from soils containing a relatively high percentage of clay size particles as measured. This rather unusual property could perhaps be caused by clay size particles being rather inactive.

The grain-size distribution of samples from the more silty zones (two samples) is given in Figure No. 3. These show 7% sand, 87-88% silt and 5-6% clay size particles. The following index values were obtained in the laboratory (three samples) as shown in Figure No. 7.

Liquid Limit = 20-25%
Plastic Limit = 15-20%
Plasticity Index = 4-5%

The measured natural moisture contents of samples from the silty clay/clayey silt deposit range from 22 to 39% and as such they are generally close to or higher than the measured liquid limit values. Such results are generally indicative of weak and compressible soils.

The bulk unit weights of several suitable soil samples were measured in the laboratory and the results ranged from 17.8 to 20.5 kN/m^3.

Standard Penetration tests carried out in the silty clay/clayey silt deposit yielded 'N'-values generally in the range of 0 to 8 blows/0.3 m with higher values (13, 16, 17 and 23 blows/0.3 m) near the bottom of the deposit in Borehole Nos. LH6 and LH7. Dynamic cone penetration tests carried out adjacent to Borehole No. LH1 gave blow counts ranging from 32 to 138 blows/0.3 m. These high results are inconsistent with the low 'N'-values in the same boreholes (which ranged from 4 to 5 blows/0.3 m) and the undrained in-situ shear strength values of 15 to 20 kPa (as measured by field vane tests).

Field vane tests conducted in the boreholes gave undrained in-situ shear strengths of 15 to 49 kPa. A quick triaxial compression test on a sample from a thin walled (Shelby) tube sample obtained from a depth of about 8.0 m in Borehole No. LH6 gave a value of 25 kPa. These results indicate a soft to stiff consistency. The results of all the field vane and of the quick triaxial compression tests are summarized in Figure No. 13.

The results of consolidation tests performed on four samples from the deposit are given in Figure Nos. 9, 10, 11 and 12.

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3.4 SILT

Borehole Nos. LH2, LH4 and LH5 contacted, immediately underlying the upper fine sand deposit (at depths ranging between 4.0 and 5.2 m below the ground surface), a deposit of silt to sandy silt. This deposit is transition from the overlying upper fine sand to the underlying silty clay/clayey silt (Borehole No. LH5) or the lower sand (Borehole Nos. LH2 and LH4). A similar transition zone was also encountered in Borehole Nos. LH1 and LH5 immediately underlying silty clay/clayey silt at depths of 7.0 and 10.2 m, respectively.

The silt deposit contains some thin silty clay and occasional silty sand and silt seams. The grain-size distribution of three samples from the deposit is presented in Figure No. 4 and these indicate 7-15% sand, 79-85% silt and 6-8% clay size particles.

Atterberg limits tests were performed in the laboratory, on six samples which gave the following values (Figure No. 8):

Liquid Limit = 18-21%
Plastic Limit = 15-19%
Plasticity Index = 2-3%

The measured natural moisture contents generally range from 18 to 28%, indicating a wet condition.

Standard Penetration tests performed in this unit gave 'N'-values of 6 to 26 blows/0.3 m. From these values the compactness condition of the deposit is considered loose to compact, but generally compact.

3.5 LOWER SAND

Underlying the silt or silty clay/clayey silt deposits all the boreholes, except for Borehole No. LH7, showed the presence of a lower sand deposit.

In Borehole Nos. LH4 and LH3 (most westerly boreholes) the surface of this deposit was contacted at about Elevation 310 m (i.e. about 7 m below the ground surface) and generally dips to about Elevation 300.5 m in Borehole No. LH6 (at about 14 m below grade). Borehole No. LH7 (located further east) was terminated at Elevation 294± m within the silty clay/clayey silt deposit without encountering this sand deposit.

Borehole Nos. LH3 and LH5 were terminated in this deposit. Borehole Nos. LH1 and LH4 were also terminated in this deposit upon encountering refusal while in Borehole Nos. LH2 and LH5 the surface of the bedrock underlying the deposit was proven by rock coring (Elevations 295.8 m and 290.0 m, respectively).

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The grain-size distribution of ten samples from the deposit is given in Figure No. 5 and the results show 42% gravel, 52-85% sand, 2-14% soil fines (i.e. silt & clay). The presence of cobbles and boulders was also inferred while drilling, especially towards the bottom of the stratum.

Measured 'N'-values in the deposit generally range from 10 to 35 blows/0.3 m with occasional lower (5, 6, 7 and 9 blows/0.3 m) and higher (43 to in excess of 50 blows/0.3 m) values, mainly near the surface and close to the bottom of the deposit, respectively, indicating a generally compact to dense condition, changing to dense to very dense at increased depths. The results of the dynamic core penetration tests carried out in the deposit adjacent to Borehole Nos. LH 1 and LH2, range from 23 to in excess of 100 blows/0.3 m.

The measured moisture contents ranged from 8 to 21%, indicating a wet state.

3.6 BEDROCK & POSSIBLE BEDROCK

Bedrock was encountered and cored in Borehole Nos. LH2 and LH5 at depths of 20.0 m (Elevation 295.8 m) and 24.5 m (Elevation 290.0 m) below the existing ground surface, respectively. At both boreholes, the bedrock consists of pink Precambrian granite. The granite was cored to a depth of 3.0 m and the percentage of core recovery was 95 to 97%. A rock quality designation (R.Q.D.) value of between 70 and 96% was measured. Based on these and a visual examination of the rock cores, the rock is considered to be fair to excellent quality, but generally good to excellent.

'Possible bedrock' was contacted (refusal on the augers) at the bottom of Borehole No. LH4, at a depth of about 14.7 m (Elevation 302.2 m) below the ground surface.

Refusal to normal washboring was encountered in Borehole No. LH1 at 19.2 m to washboring and the borehole was further advanced to 20.7 m (Elevation 294.2 m) by rock coring methods. The core indicated the presence of frequent cobbles in the overburden within this zone. Further attempts to advance the boring by coring (three attempts) were unsuccessful and therefore the presence of the bedrock at the location could not be proven by rock coring.

3.7 GROUNDWATER CONDITIONS

Groundwater levels in the open boreholes were observed during the drilling and at the completion of each borehole. In addition, piezometers were installed in all seven boreholes, to enable us to monitor the groundwater levels over a prolonged period of time without interference from surface water.

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The recorded values, shown on the individual Borehole Log Sheets, indicate that the water levels at the time of the investigation ranged from 2.6 m below ground surface on the west approach (Borehole No. LH4) to ground surface east of the west abutment (Borehole Nos. LH1 and LH5 to LH7). These depths correspond to an average elevation of 314.4 m.

Based on these values together with the moisture contents of the samples, it can be assumed that the groundwater level at the time of our investigation was generally about 1 m below the ground surface along the west approach and at or very close to the ground surface east of the west abutment location. The groundwater at the site would fluctuate seasonally and can be expected to be higher during the spring months and in response to heavy rains.

4.0 DISCUSSION AND RECOMMENDATIONS

The existing Highway 11 will be realigned and widened from the existing two lanes. The widened road will consist of a four lane divided highway with a 30 m wide median. The proposed bridge will carry Lindsay Hill Road over the proposed realigned northbound and southbound lanes of Highway 11. The proposed bridge will be an approximately 70 m long, 2-lane, two span structure. The proposed elevation for the bridge is approximately 332 m while the grade at the borehole locations range from 314.5 to 315.8 m. The proposed grade of Highway 11 at the bridge site is approximately at Elevation 324 m and therefore the grade for the highway will be raised by about 8 to 9 m from the existing grades. The grades at the west and east abutments at the bridge will be raised by about 16 m. Based on the preliminary information given to us by DELCAN, an integral abutment structure is being considered for the proposed bridge.

The boreholes have shown beneath a surficial organic layer the presence of a generally loose to compact fine sand to an average depth of about 4.9 m below ground surface. This is in turn underlain by loose to compact silt and/or a soft to firm silty clay/clayey silt deposit with an increasing thickness from about 2 m near the west embankment (Borehole No. LH3) to a dominant layer covering the remaining depth of the borehole (i.e. to more than 20 m below the ground surface) on the proposed east approach (Borehole No. LH7). This cohesive deposit or the silt are, in turn, underlain by a second (lower) sand deposit (at all the borehole locations, except for Borehole No. LH7) with occasional cobbles and boulders, the frequency of which appears to increase with increasing depth. The 'N'-values indicate that the sand is generally compact changing to dense to very dense towards the bottom. Beneath the lower sand deposit 'possible bedrock' was contacted in Borehole No. LH4 at the west approach embankment location. Precambrian granite bedrock was encountered and cored at the location of the east and west abutments at Borehole Nos. LH2 and LH5 at 20.0 and 24.5 m, respectively. Borehole No. LH1, drilled at the central pier location, encountered refusal on a boulder at 19.2 m below the ground surface. The borehole was cored through cobbles and boulders to 20.7 m without encountering the bedrock. The boreholes show that the

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groundwater table lies at or close to the ground surface.

4.1 FOUNDATIONS

Owing to the presence of loose to compact sand and silt and weak (i.e. generally soft to stiff) and compressible silty clay/clayey silt, the use of normal shallow foundations is considered impractical and therefore we recommend that the structure be supported on deep foundations, extending to the bedrock or the very dense sand overburden immediately above the bedrock.

A low displacement type of pile, such as a steel H-pile, would be better suited for the prevailing subsurface conditions. We recommend that a steel H-pile with a heavy section, such as HP310X110, with reinforced tips as per MTO specifications, be used.

Induced stresses due to the weight of the fill placed for the approach embankments and to raise the grade for Highway 11 construction at the (central) pier will cause settlement of the underlying soils, which will then transfer the loads by negative skin friction to the piles, thus causing down-drag. In order to reduce potential problems due to down-drag and settlements, the fill to raise the grade should be placed as early as possible prior to driving the piles.

Assuming that the fills to raise the grade will be placed at least three months prior to constructing the piles at the west abutment and the central pier areas and at least six months prior to constructing the piles at the east abutment, the following axial resistances are recommended.

TABLE I

LOCATION	PILE SIZE	RECOMMENDED FACTORED AXIAL RESISTANCE AT U.L.S.	RECOMMENDED RESISTANCE AT S.L.S.
Borehole No. LH2 (West Abutment)	HP310X110	1500kN	1000kN
Borehole No. LH1 (Central Pier)	HP310X110	1400kN	900kN
Borehole No. LH5 (East Abutment)	HP310X110	1400kN	900kN

The serviceability condition is based on the premise that the maximum total and differential settlements will not exceed 25 mm and 20 mm, respectively.

.../...

The piles would preferably be driven to bedrock, the surface elevation of which was established at Elevation 295.9 m at Borehole No. LH2 at the west abutment location and at Elevation 290.0 m at Borehole No. LH5 at the east abutment location, while at the central pier location Borehole No. LH1 could not be extended to the bedrock due to the presence of cobbles and boulders. This borehole was terminated within the overburden at about Elevation 294 m. Boreholes indicate that it may not be practical to extend all the piles to the surface of the bedrock and that some may terminate in the overburden immediately above the bedrock in the very dense sand or even at higher elevations due to cobble and boulders. Estimated probable tip elevations are given in Table II. Also summarized in the same table are the highest acceptable pile tip elevations in the event of practical refusal in the overburden.

TABLE II

LOCATION/ BOREHOLE NO.	ESTIMATED PROBABLE PILE TIP ELEVATION	MINIMUM ACCEPTABLE PILE TIP ELEVATION
West Abutment Borehole No. LH2	296.0 m (bedrock)	296.5 m (overburden)
Central Pier Borehole No. LH1	294.0 m	296.0 m (overburden)
East Abutment Borehole No. LH5	291.5 m - 290.0 m (overburden-bedrock)	292.5 m (overburden)

As mentioned before, the presence of cobbles and boulders may cause practical refusal at elevations above those shown (due to cobbles and boulders) in which case additional piles may need to be driven, requiring modifications to the original design. It is also possible that due to the undulations in the surface of the bedrock, which are not uncommon in the northern sites, the piles may drive several meters below the tip elevations given above. We recommend that these aspects be taken into consideration when ordering the piles.

The piles should be driven with a suitably heavy hammer capable of delivering an energy of at least 50 kJ/blow. The energy should however be restricted to not more than 60 kJ/blow.

The driving of the piles should be controlled by a recognized pile driving formula, such as the Hiley Formula. The estimated ultimate resistance of the piles (driven to practical refusal in the overburden) by the Hiley Formula is approximately 3800kN. Because of the presence of cobbles and boulders, the piles should be equipped with reinforced tips as per MTO Standards. Based on the available data, the surface of the bedrock slopes down from west to east, but not very steeply (i.e. a difference in elevation of about 6 m was recorded over a horizontal distance of about 80 m between Borehole Nos. LH2 and LH5) and based on this rock points are not deemed to be necessary. Field observations to the contrary may however necessitate

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the use of rock points. Oversize materials (e.g. greater than 75 mm nominal diameter) should not be used in the fills through which piles would be driven.

We recommend that at each support location at least one-quarter of the piles be retapped one to two days after driving to check that relaxation has not occurred. If it has then all the piles should be retapped. Heave of the adjacent piles should also be observed.

For frost protection the pile caps should have a permanent earth cover of at least 2.0 m.

The recommended horizontal resistances for the HP310X110 steel H-piles are as follows:

Factored Horizontal Resistance at U.L.S. = 120kN
Horizontal Resistance at S.L.S. = 60kN

At the pier location (and also at the abutment location if an integral abutment type is not to be constructed), the unbalanced horizontal loads could be resisted by battered piles.

In accordance with MTO requirements (MTO Structural Office Standard), piles for integral abutments require a 3 m long flex zone. In essence the current MTO standard for the flex zone consists of an annular space in between two consecutive CSP's. One of the CSP's surrounds the H-pile (i.e. has a diameter slightly greater than the pile width, while the second CSP has a somewhat larger diameter (typically 0.6 m for a 310mm H-pile). The annular space in between the CSP's is the 3 m long flex zone. After the pile is driven the space between the H-pile and the inner CSP is filled with cement bentonite or coarse sand.

4.2 SETTLEMENTS OF EMBANKMENT APPROACH FILLS

The height of the fill for both east and west approaches are generally 16 m above the existing grades.

Assuming that all organic soils, fill, weak or otherwise unsuitable materials are removed as per MTO Standards before placing the fill, the anticipated settlements of the founding soils due to stresses induced by the embankments (i.e. not including the settlement of the embankment itself under its own weight) are approximately 0.3 m at Borehole No. LH4 location (i.e. west approach), increasing to about 0.4 m at Borehole No. LH3 location (about 20 m west of the proposed west abutment location), further increasing to about 0.5 m at Borehole No. LH2 at the proposed west abutment location. If a lightweight fill with a compacted unit weight of 11.5kN/m^3 is used, the settlements would be about 60% of the quoted values. These settlements would be practically completed after about 3 months of the placement of the fill to its full height.

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At the (central) pier location where the height of the fill will be about 7 to 8 m above the existing grade, the anticipated settlement of the foundation soils is 0.25 m for normal earth fill and about 60% of this value for lightweight fill. These settlements would be substantially completed after about three months of the placement of the fill to its full height.

At the east abutment location (Borehole No. LH5) the anticipated settlement is approximately 0.7 m increasing to about 0.8 m at Borehole No. LH6 (about 20 m east) and to about 0.9 m at Borehole No. LH7 about 20 m further east. For lightweight fill the predicted settlements would be about 60% of the figures quoted. The findings of these boreholes indicate that the thickness of the clay layer increases easterly and while at Borehole No. LH5 the calculated settlements can be expected to be substantially completed within about 6 months after the placement of the fill to its full height, the anticipated time (due to the consolidation of the silty clay/clayey silt stratum) can be expected to increase to eight months at Borehole No. LH6 location. At Borehole No. LH7 location, the settlement can be expected to take about 1 year with a further settlement of about 50 to 100 mm after this period. These time rates of settlements can be expected to increase further east due to the anticipated increase in the thickness of the clayey stratum.

4.3 EMBANKMENT STABILITY

The presence of loose to compact upper sand and silt and particularly weak silty clay/clayey silt deposits requires consideration for both the long and especially the short-term stability of the approach embankments and of the abutments.

The stability of the embankments was analyzed by the limit equilibrium method, utilizing Bishop's simplified method of analysis. For this purpose the computer programme Slope/W and the following assumed soil parameters were utilized.

Drained Stability Analyses

Embankment Fill (Select Subgrade Material - SSM):
ϕ = 32 degrees
$c' = 0$
$\gamma = 22 kN/m^3$

Embankment Fill (Lightweight Fill - Blast Furnace Slag, ⅜" Structural Coarse):
ϕ = 35 degrees
$c' = 0$
$\gamma = 11.5 kN/m^3$

Fine Sand:
$\phi' = 30$ degrees
$c' = 0$
$\gamma = 19 kN/m^3$

Silt/Sandy Silt:
$\phi' = 28\text{-}29$ degrees
$c' = 0$
$\gamma = 18.5 kN/m^3$

Silty Clay/Clayey Silt:
$\phi' = 24$ degrees
$c' = 3$ kPa
$\gamma' = 18\text{-}19 kN/m^3$

Lower Sand:
$\phi' = 30\text{-}35$ degrees
$c' = 0$
$\gamma = 19\text{-}20 kN/m^3$

For undrained (short-term) analysis the same parameters were used except for the silty clay/clayey silt layer. In this case an undrained cohesion value (c-value) was calculated by averaging out the measured field vane test results at each individual borehole location and assuming a ϕ value of zero. The assumed individual c-values for individual layers used for the analyses ranged from 18 to 50 kPa. The groundwater table was assumed to be at the present ground surface level. The embankment slope stability results can be summarized as follows.

4.3.1 West Approach

Borehole No. LH4: The silty clay/clayey silt was not encountered in this Borehole and therefore short and long term analyses are identical. Figure No. 14 shows that the obtained factor of safety for a normal 2H:1V slope with two 2 m wide berms is satisfactory (i.e. F.S. = 1.60).

Borehole No. LH3: This boreholes showed the presence of an approximately 2 m thick silty clay/clayey silt layer. Based on a vane test result an undrained shear strength of 37 kPa was assigned to this layer. Normal 2H:1V side slopes (with two 2 m wide berms) gave an unacceptably low short-term safety factor, while as shown in Figure No. 15, the calculated safety factor for a 2H:1V slope with three 4 m wide berms is acceptable (i.e. 1.41). The calculated factor of safety for the long term condition is also acceptable (Figure No. 16).

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For lightweight fill with a 2H:1V slope with two 2 m wide berms, acceptable factors of safety were calculated for both short and long term conditions (Figure Nos. 17 and 18).

Borehole No. LH2 (proposed west abutment location): This borehole did not encounter the silty clay/clayey silt deposit and an acceptable safety factor of 1.40 was obtained for both short and long term conditions (Figure No. 19).

These findings indicate that it is feasible to build the west approach embankment using an SSM fill with three 4 m wide berms or a lightweight fill with normal 2H:1V side slopes with two 2 m wide berms. The construction sequence however will require the latter. The construction sequence dictates that the southbound lanes be constructed first, during which time the traffic on Highway 11 will be maintained along the existing (future northbound) Highway. After the southbound lanes are constructed these will carry the traffic when the northbound lanes are being constructed. The construction of the west approach will require a temporary 2.5H:1V forward slope as shown on Figure No. 20. This slope will have to be maintained for at least 3 months in order to effect settlements prior to the construction of the highway. Stability analyses at Borehole Nos. LH2 and LH1 locations (Figure Nos. 21 and 22) show that the use of lightweight fill is necessary to achieve desirable factor of safety figures. The lightweight fill should extend westerly to about Station 9+930 and west of this station normal SSM can be used with normal 2H:1V side slopes (with two 2 m wide berms).

After the three month period that portion of the fill above the proposed highway elevation can be removed, as shown on Figure No. 23 and the southbound lanes can be built. After the construction of these, the traffic can be diverted to the newly constructed highway and the construction of the fill for the northbound lanes can start.

4.3.2 East Approach

Borehole No. LH5 (east abutment): Here the embankment will be about 16.5 m high. Figure No. 24 shows that an inadequate short-term safety factor (i.e. F.S.=1.1) is obtained for normal SSM fill, even with two, 6 m wide berms. Figure No. 25 shows that the construction of only a 10 m high embankment (with a 14 m wide mid height berm) is feasible. For this reason a staged construction or the use of lightweight fill will be necessary. Figure Nos. 26 and 27 show that with a lightweight fill, the embankment constructed of 2H:1V side slopes (with two 2 m wide embankments) possesses an adequate safety factor both in the short and long term.

Borehole No. LH6: This borehole is located about 20 m east of Borehole No. LH5 and the weak silty clay/clayey silt layer thickens in an easterly direction. Figure No. 28 shows that short-term factor of safety of a 16 m high SSM embankment (with 2H:1V vertical slopes and two 2 m wide berms) is less than unity, while the long term factor of safety is acceptable (Figure No. 29).

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An acceptable short-term factor of safety is obtained with a 8 m high embankment incorporating a 20 m wide mid-height berm (Figure No. 30).

A 16.0 m high lightweight fill with 3H:1V side slopes, incorporating two 4 m wide berms has an acceptable safety factor (Figure No. 31). The long term condition with this configuration is shown in Figure No. 32 and is acceptable.

Borehole No. LH7: Stability conditions become less favourable in an easterly direction at Borehole No. LH7.

Figure No. 33 shows that at this borehole location only a 7 m high embankment can be constructed of SSM with 2H:1V slopes and a 20 m long mid-height berm, while Figure No. 34 indicates that if lightweight fill is used, a 16 m high embankment can be built with a 4H:1V slope and two berms (5 m and 7 m wide). Figure No. 35 shows the long term stability condition for the same configuration.

In order to effect the consolidation settlements, sufficiently ahead of the bridge construction, the fill must be in place at the east abutment location for about 6 to 8 months, unless this is accelerated by means of the installation of prefabricated vertical drains (i.e. wick drains). The magnitude and the time length for the anticipated settlements can be expected to increase further east, along with possibly less favourable conditions for slope stability.

In conclusion, the unfavourable conditions encountered at the site require the use of lightweight fill (with very flat side slopes on the east side) to build the approach embankments, or a staged construction (with SSM or lightweight fill). In addition, in order to effect a significant portion of the foundation settlements of the embankments and to substantially eliminate down-drag forces on the piles, the fills will need to be constructed three months (west approach and abutment) to six to eight months (at the east abutment) with a further increase towards the east (i.e. more than one year at Borehole No. LH7 and possibly more further east), unless wick drains are used to accelerate the time rate of consolidation.

It should be pointed out that staged construction assumes that the shear strength of the silty clay/clayey silt stratum will increase in time under the weight of the staged embankment fill in such a manner that the next stage (higher) fills can be placed in a timely manner. While this is usually the case, exceptions to this have been reported. Such construction will therefore require advance planning and field instrumentation. Again the time required for the staged construction can be reduced by means of prefabricated vertical drains.

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For these reasons we recommend that consideration be given to reducing the height of embankments, especially on the east side. It is believed that this can be achieved by providing an overpass structure rather than an underpass. It is also believed that even more favourable conditions can probably be created for the construction of the bridge by moving the structure site slightly north of its present location.

5.0 CLOSURE

Our report will be revised and finalized after receiving your initial comments. We will then issue a draft report for your comments/review.

Sincerely,

Houshang Shad, Ph.D.

Z.S. Ozden, P. Eng.

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APPENDIX A

PROCEDURES

The field work for this project was performed during the period of November 3 to 14, December 19 to 21, 1998 and January 6 to 17, 1999, and consisted of drilling and sampling seven boreholes, performing dynamic cone penetration tests at the adjacent locations of two boreholes and coring the bedrock at two locations. The plan locations of the boreholes, along with stratigraphic sections are shown on Drawing No. 1.

Three boreholes were drilled to depths ranging between 20.0 and 24.5 m, at the proposed abutment locations and pier position; two boreholes were drilled to 14.8 m and 17.2 m along the centre-line of the bridge, for the west approach fill; two boreholes to 15.8 and 20.2 m along the centre-line of the bridge, for the east approach fill. Dynamic cone penetration tests were adjacent to the boreholes drilled for the pier and the west bridge abutment, and the bedrock below the east and west bridge abutments was cored for about 3.0 m. The boreholes for this geotechnical investigation were advanced using a track mounted auger drills capable of completing augered holes or wash borings. Diamond drilling capability was used to advance the boreholes into the bedrock. The field work was carried out under the full-time supervision of soils engineers for AGRA.

Sampling in the boreholes was effected at frequent intervals of depth by the Standard Penetration Test Method (SPT), as specified in ASTM Method D 1586. This consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm diameter o.d. split barrel (split-spoon) sampler into the ground. The number of blows of the hammer to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.3 m is recorded as the Standard Penetration Resistance or the 'N'-value of the soil and this gives an indication of the consistency or the compactness condition of the soil deposit. Thin wall (Shelby tube) samples were also obtained within the cohesive deposits, and the undrained in-situ shear strength together with the sensitivity of these deposits were determined using field vane.

The borehole locations were established in the field by our engineering staff and the elevations together with the northings and eastings of the borehole locations were provided to us by Deaden & Stanton Limited.

APPENDIX B

AGRA

LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in testholes. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

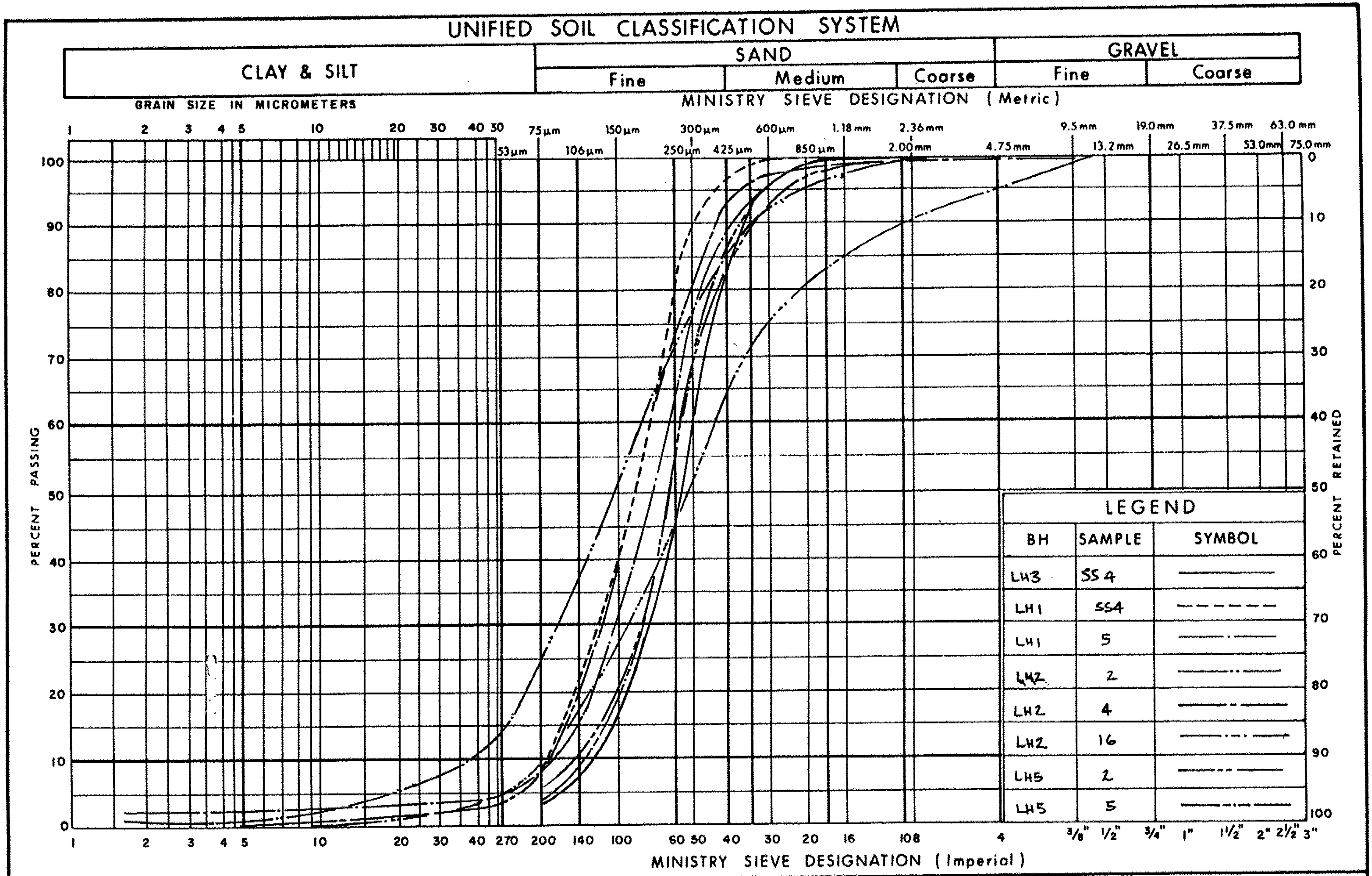
The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AGRA accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

FIGURES

78 12 M



LEGEND

BH	SAMPLE	SYMBOL
LH3	SS 4	———————
LH1	SS4	– – – – – –
LH1	5	——— · ———
LH2	2	——— ·· ———
LH2	4	——— – ———
LH2	16	——— · – · ———
LH5	2	——— – – ———
LH5	5	——— – · ———

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GRAIN SIZE DISTRIBUTION

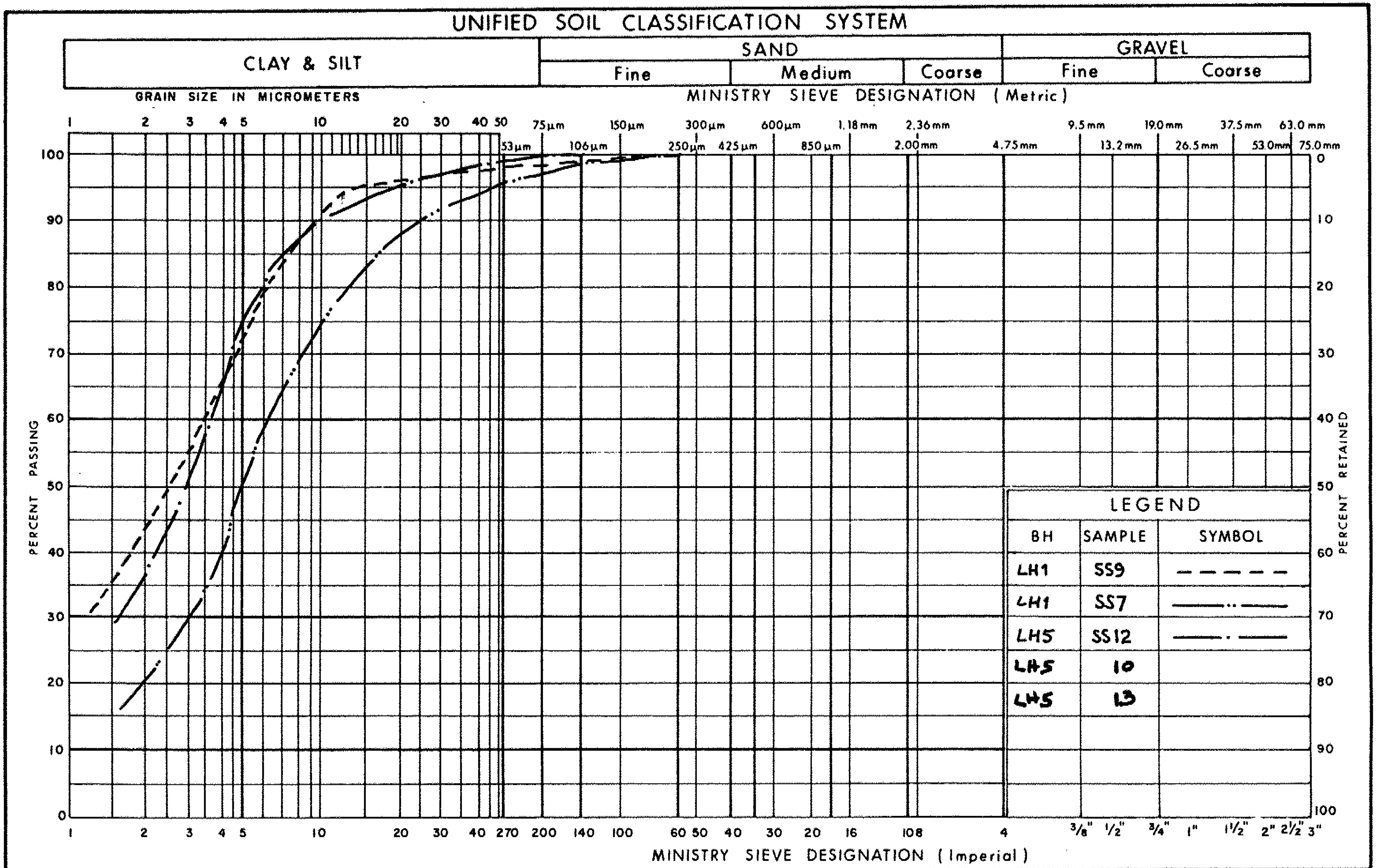
FINE SAND

FIG No 1

W P 772-93-01

SITE: 44-375

78 12 M



LEGEND

BH	SAMPLE	SYMBOL
LH1	SS9	— — — — —
LH1	SS7	——··——
LH5	SS12	——·——
LH5	10	
LH5	13	

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GRAIN SIZE DISTRIBUTION

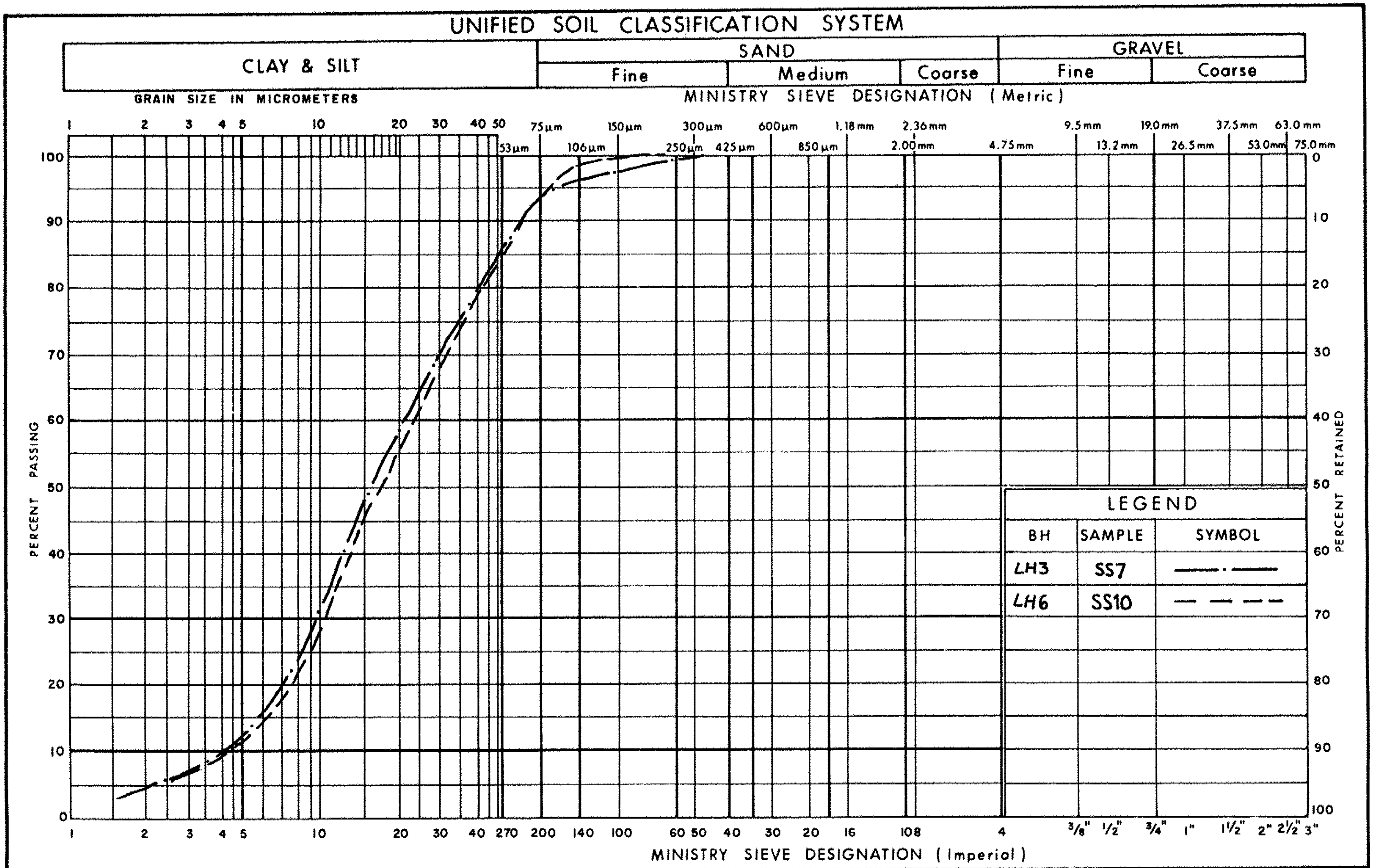
SILTY CLAY/CLAYEY SILT

FIG No 2

W P 772-93-01

SITE: 44-375

78 12 M



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GRAIN SIZE DISTRIBUTION

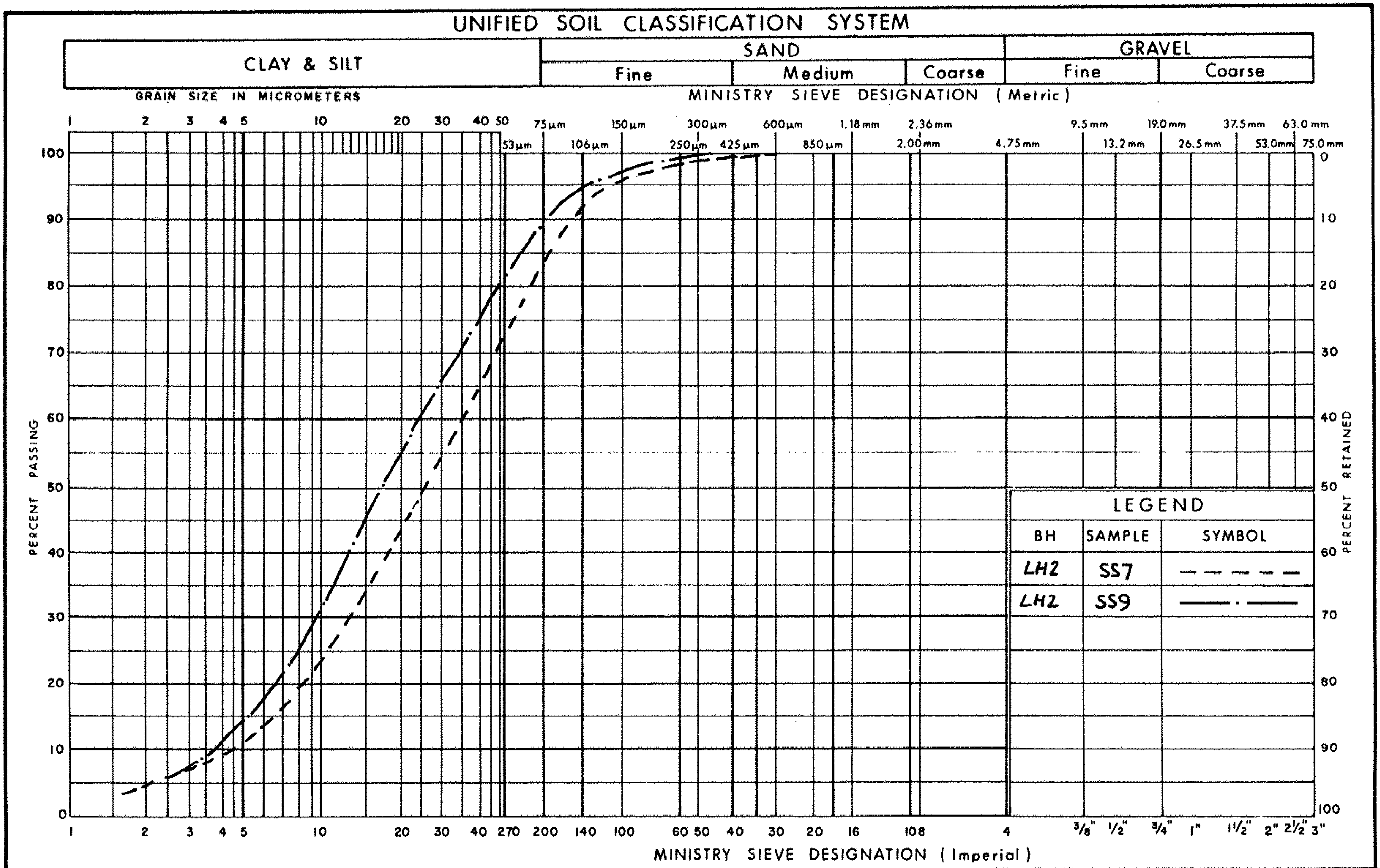
SILT ZONES IN SILTY CLAY/CLAYEY SILT

FIG No 3

W P 772-93-01

SITE: 44-375

78 12 M



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GRAIN SIZE DISTRIBUTION

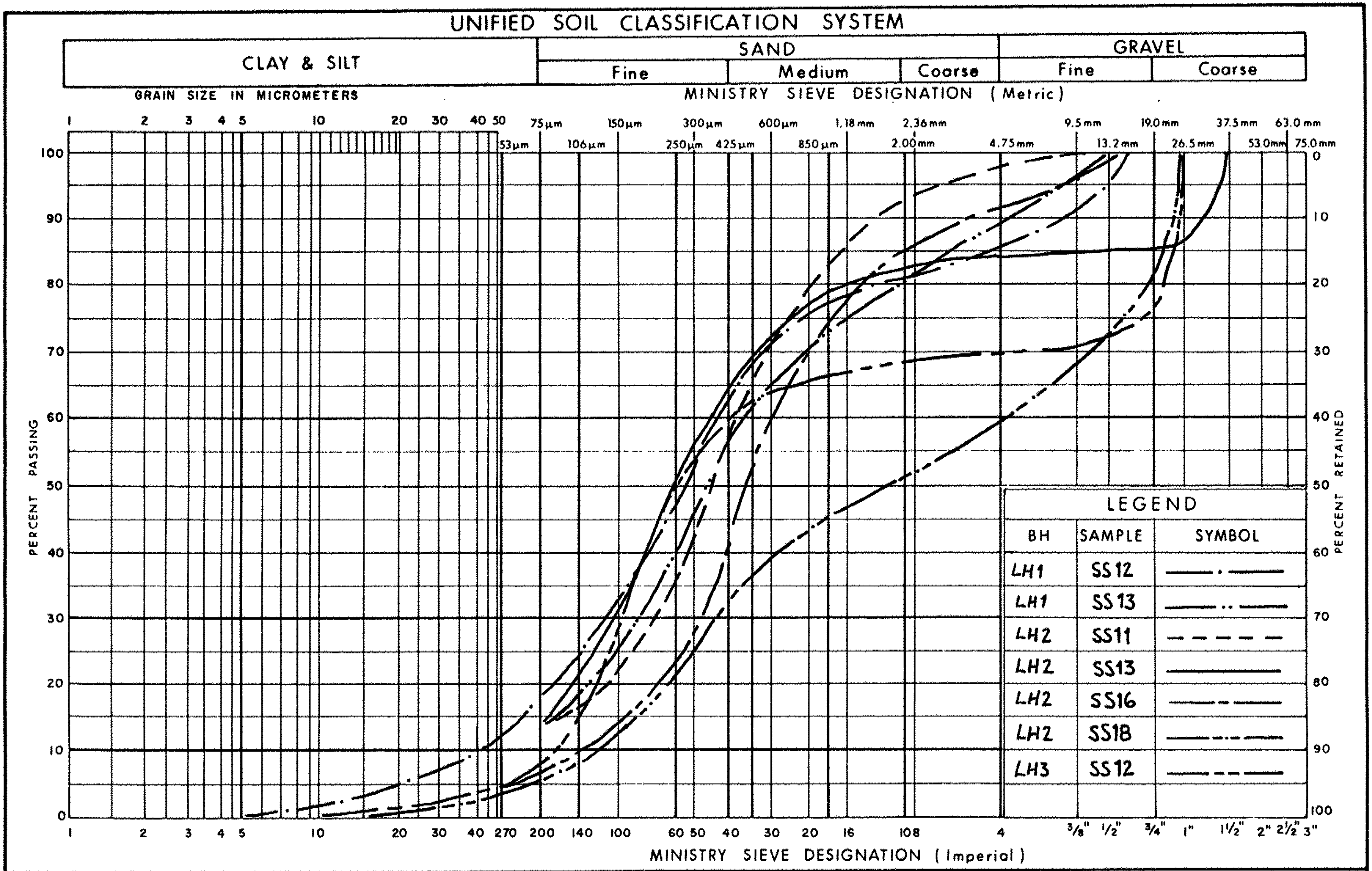
SILT

FIG No 4

W P 772-93-01

SITE: 44-375

78 12 M



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GRAIN SIZE DISTRIBUTION

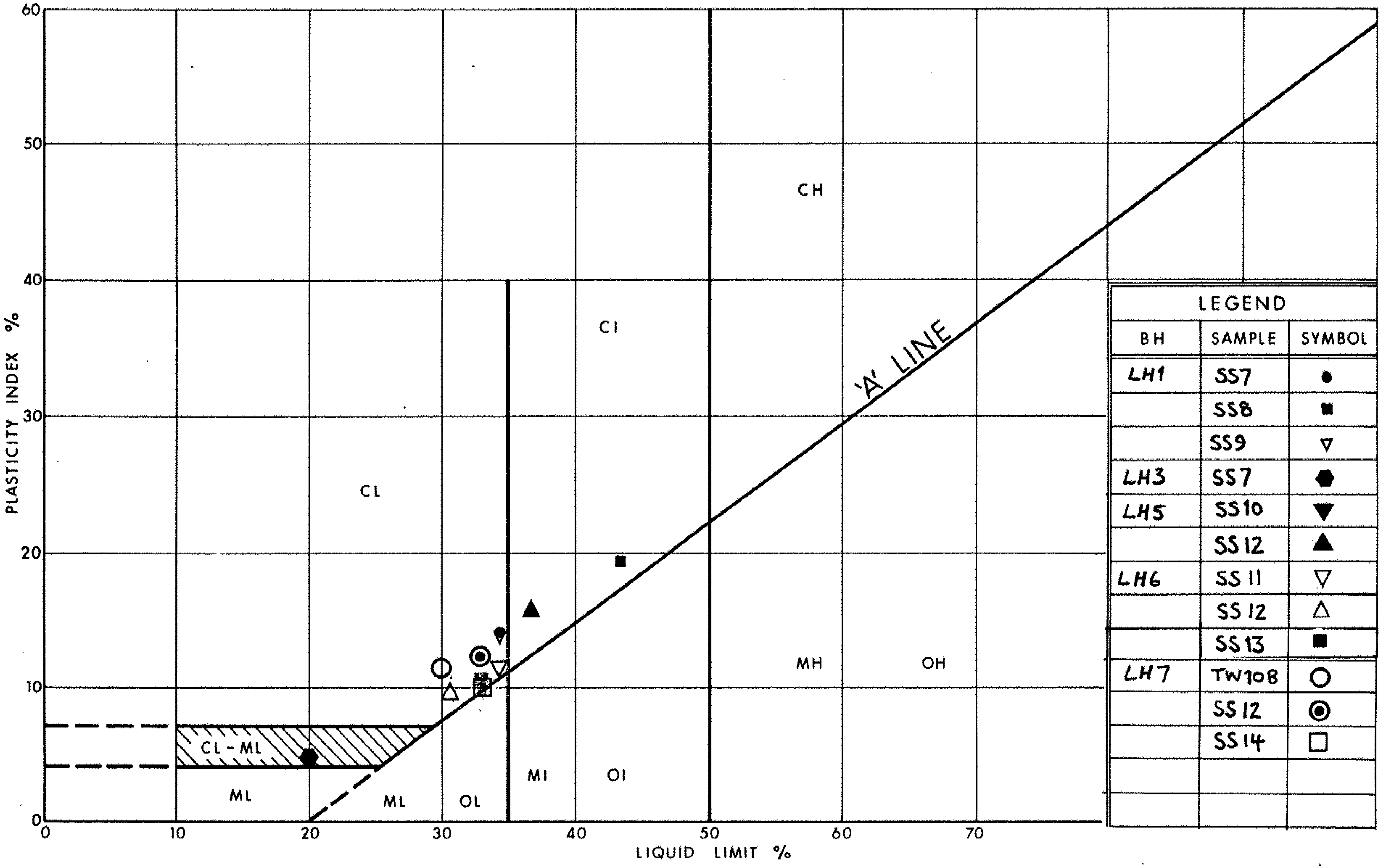
SAND

FIG No 5

W P 772-93-01

SITE: 44-375

Oct 75, FF-S-21



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PLASTICITY CHART

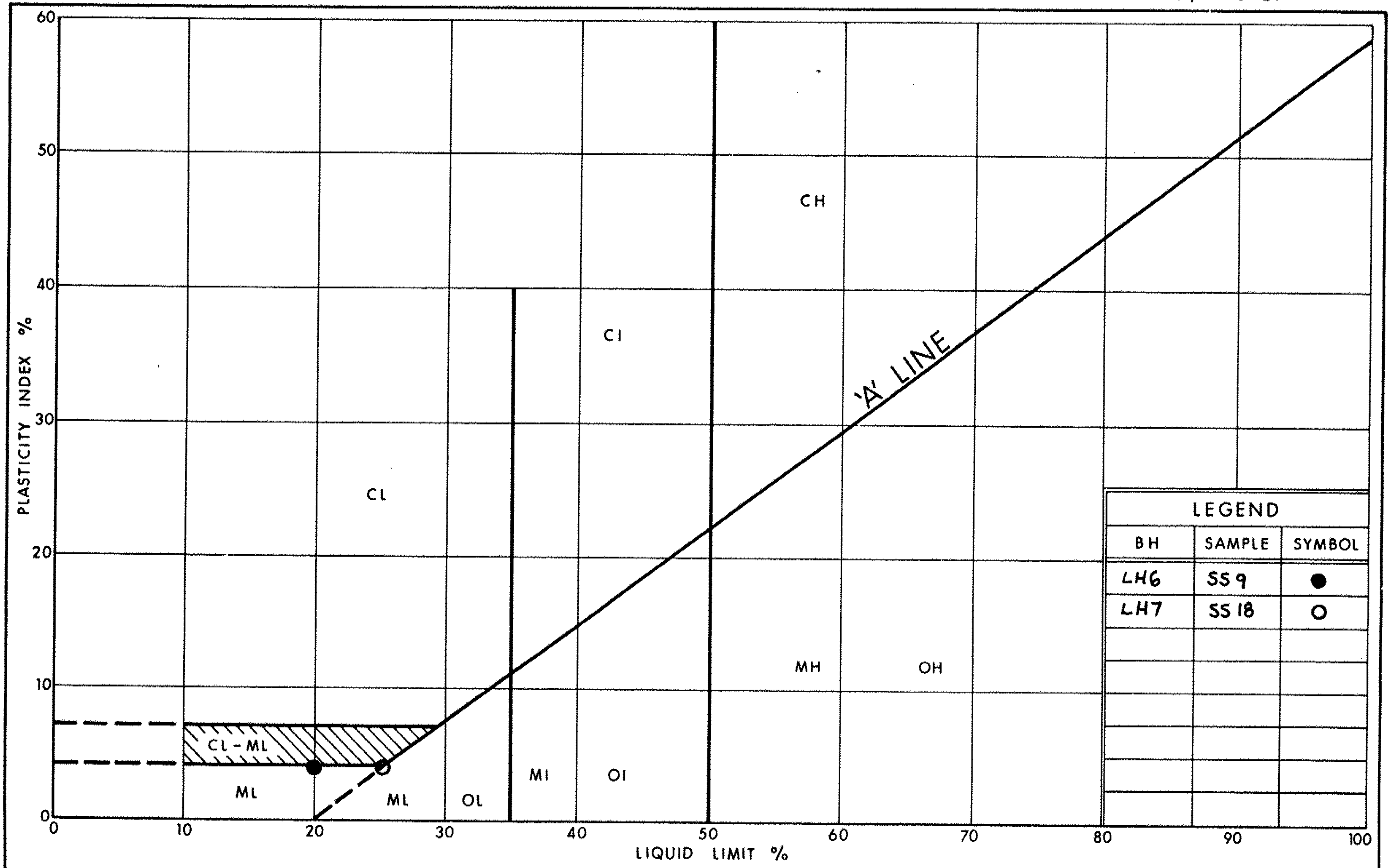
CLAYEY SILT/SILTY CLAY

FIG No 6

W P 772-93-01

SITE: 44-375

Oct 75, FF-S-21



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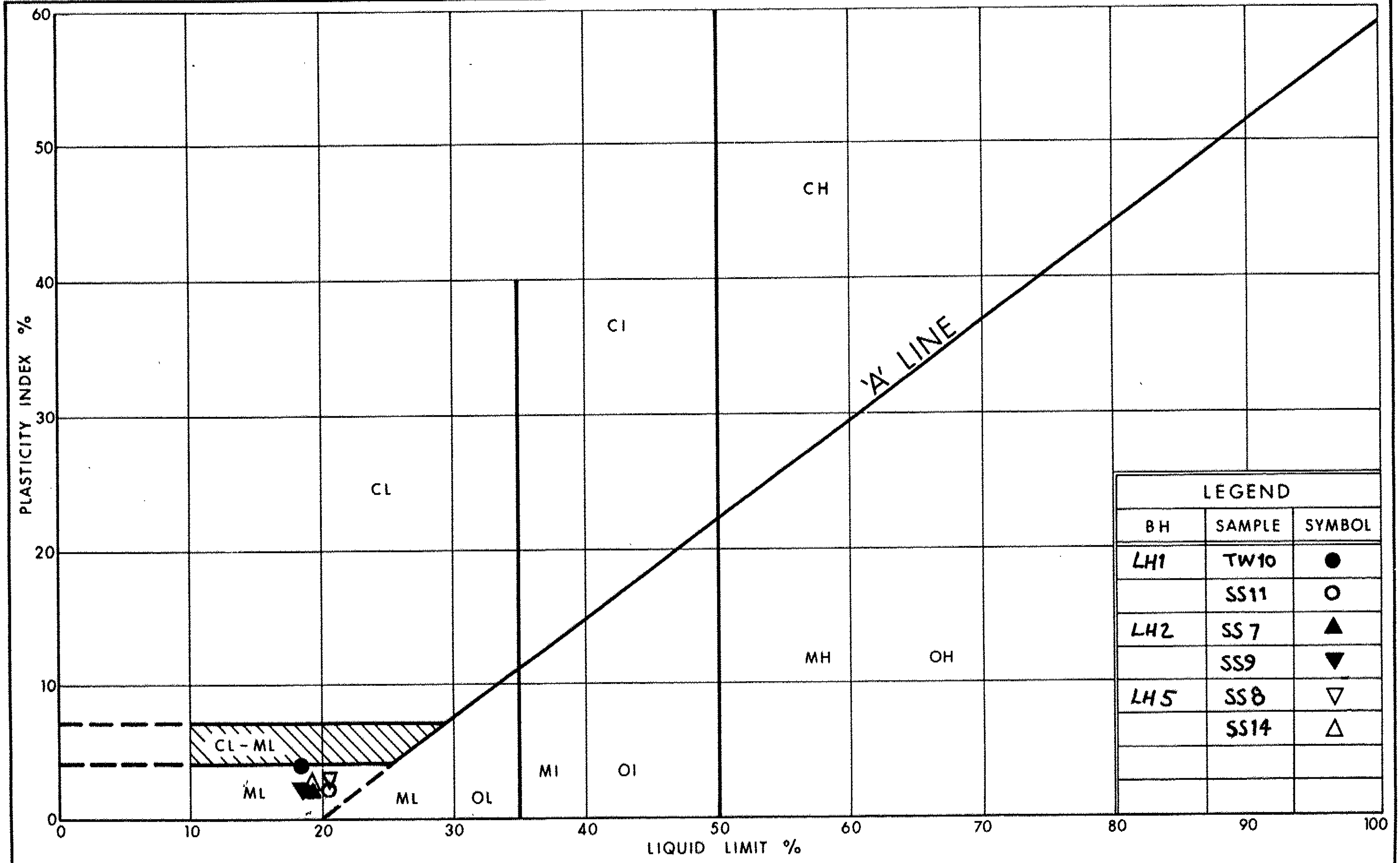
PLASTICITY CHART

SILT ZONES IN SILTY CLAY/CLAYEY SILT

FIG No 7
W P 772-93-01
SITE: 44-375

Oct 75, FF-S-21



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PLASTICITY CHART

SILT/SANDY SILT

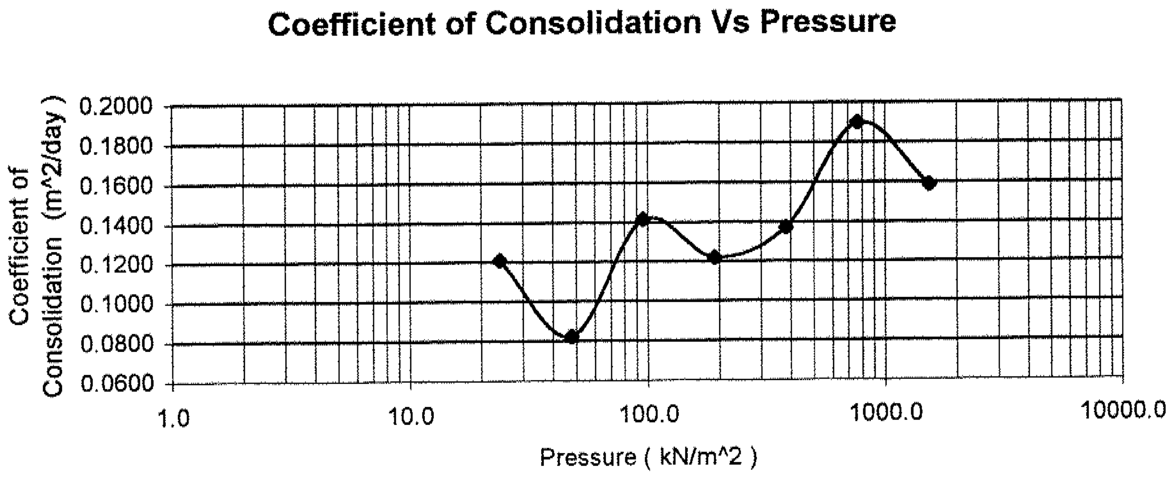
FIG No 8

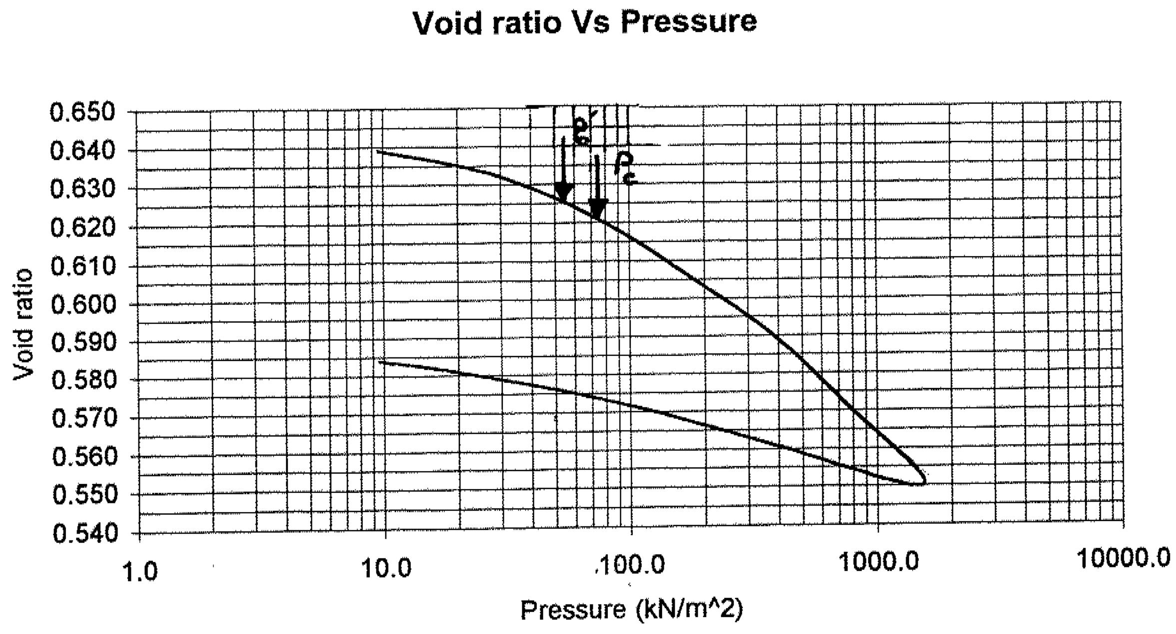
W P 772-93-01

SITE: 44-375

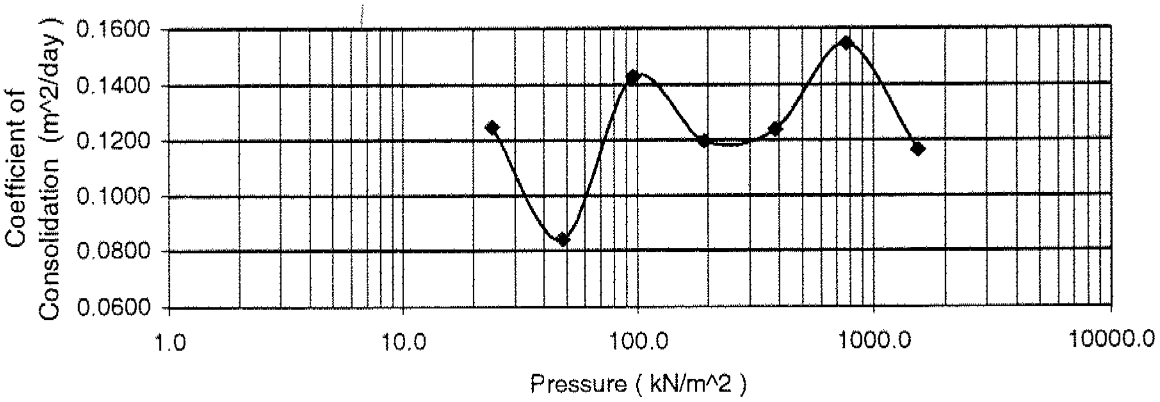
Figure No. 9

	Presssure (tsf)	Cv (ft^2/day)	Presssure (kN/m^2)	Cv (m^2/day)	Void ratio	
Job# : TT98801	0.10		9.6		0.639	**BH# : LH 3**
Sample# : TW 8B	0.25	1.303	24.0	0.1211	0.634	**Depth : 5.5m**
	0.50	0.886	47.9	0.0823	0.627	**Date : Dec.02, 1998**
	1.00	1.522	95.8	0.1414	0.617	
	2.00	1.315	191.7	0.1222	0.604	
	4.00	1.477	383.3	0.1372	0.590	
	8.00	2.045	766.7	0.1900	0.571	
Cc = 0.062	16.00	1.706	1533.4	0.1585	0.550	
	4.00		383.3		0.561	
	1.00		95.8		0.572	
	0.25		24.0		0.580	
	0.10		9.6		0.584	

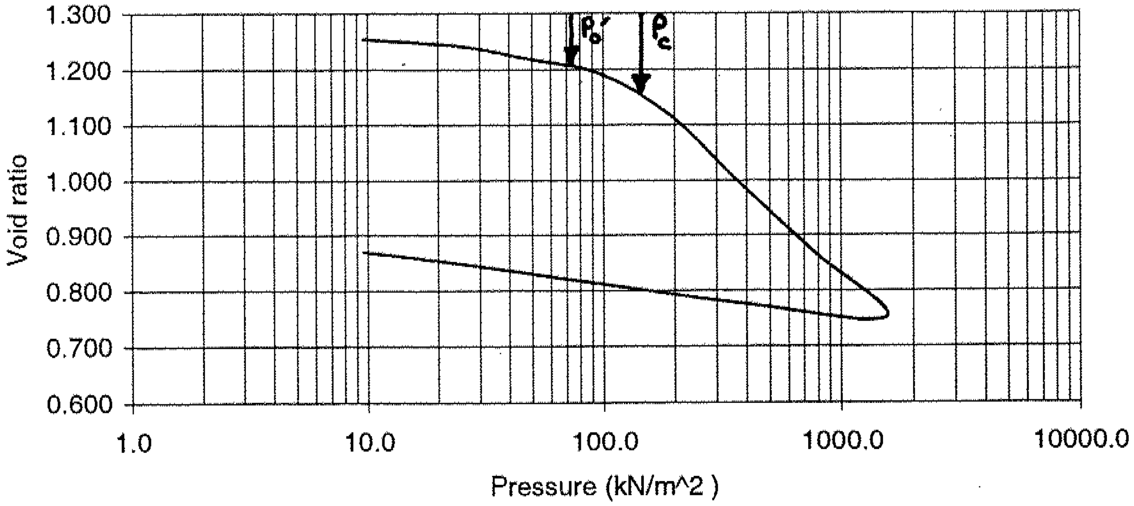

Coefficient of Consolidation Vs Pressure


Void ratio Vs Pressure

	Presssure (tsf)	Cv (ft^2/day)	Presssure (kN/m^2)	Cv (m^2/day)	Void ratio	
Job# : TT98801	0.10		9.6		1.255	**BH# : LH5**
Sample# : TW12	0.25	1.342	24.0	0.1247	1.242	**Depth : 8.4m**
	0.50	0.905	47.9	0.0841	1.219	**Date : Nov.27, 1998**
	1.00	1.537	95.8	0.1428	1.192	
	2.00	1.286	191.7	0.1195	1.118	
	4.00	1.333	383.3	0.1238	0.991	
	8.00	1.663	766.7	0.1545	0.869	
Cc = 0.38	16.00	1.252	1533.4	0.1163	0.751	
	4.00		383.3		0.777	
	1.00		95.8		0.813	
	0.25		24.0		0.850	
	0.10		9.6		0.870	



Coefficient of Consolidation Vs Pressure

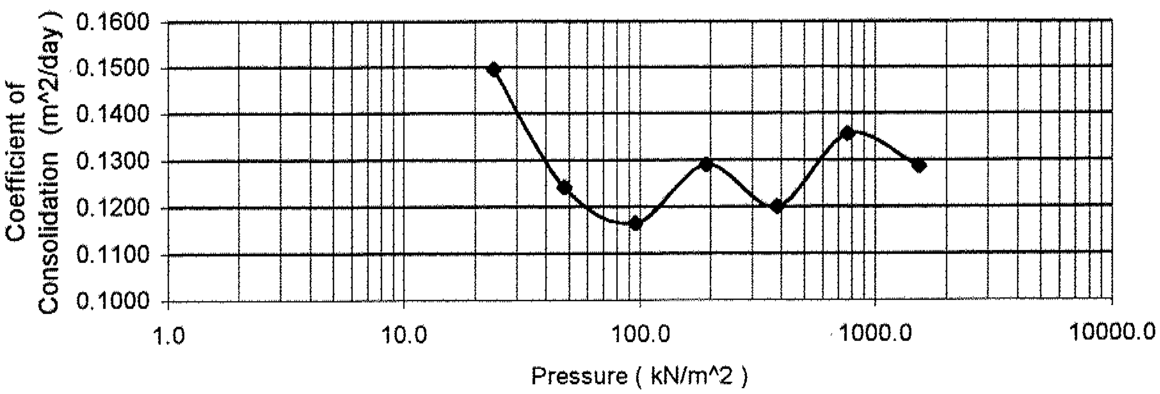


Void ratio Vs Pressure

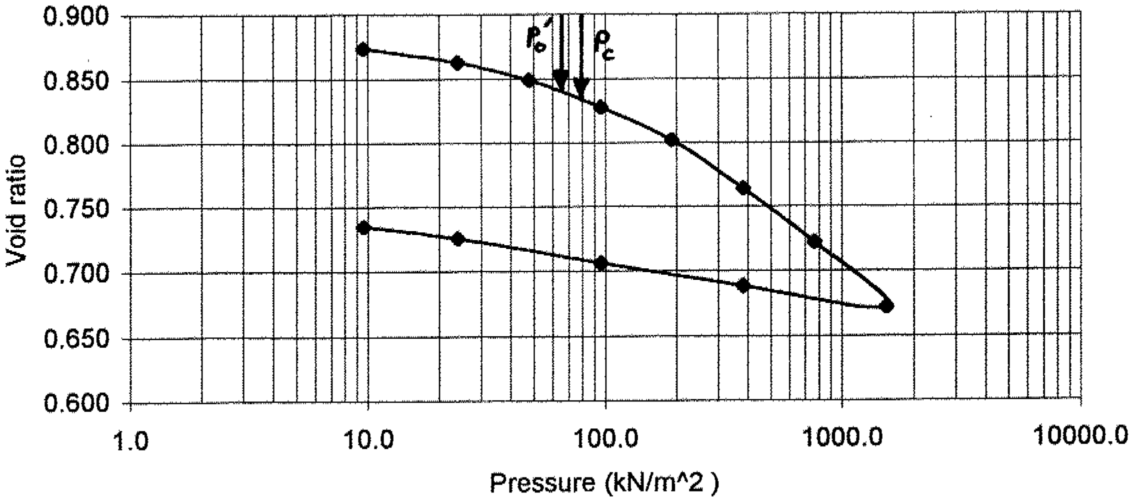
Figure No. 11

	Presssure	Cv	Presssure	Cv	Void ratio	
	(tsf)	(ft^2/day)	(kN/m^2)	(m^2/day)		
Job# : TT98801	0.10		9.6		0.874	**BH# :** LH6
Sample # : LH6/ 9A	0.25	1.610	24.0	0.1496	0.863	**Depth : 7.5m**
	0.50	1.336	47.9	0.1241	0.849	**Date : Dec.22, 1998**
	1.00	1.254	95.8	0.1165	0.828	
	2.00	1.388	191.7	0.1289	0.802	
	4.00	1.292	383.3	0.1200	0.764	
	8.00	1.460	766.7	0.1357	0.722	
Cc = 0.14	16.00	1.385	1533.4	0.1286	0.672	
	4.00		383.3		0.688	
	1.00		95.8		0.706	
	0.25		24.0		0.725	
	0.10		9.6		0.735	

Coefficient of Consolidation Vs Pressure

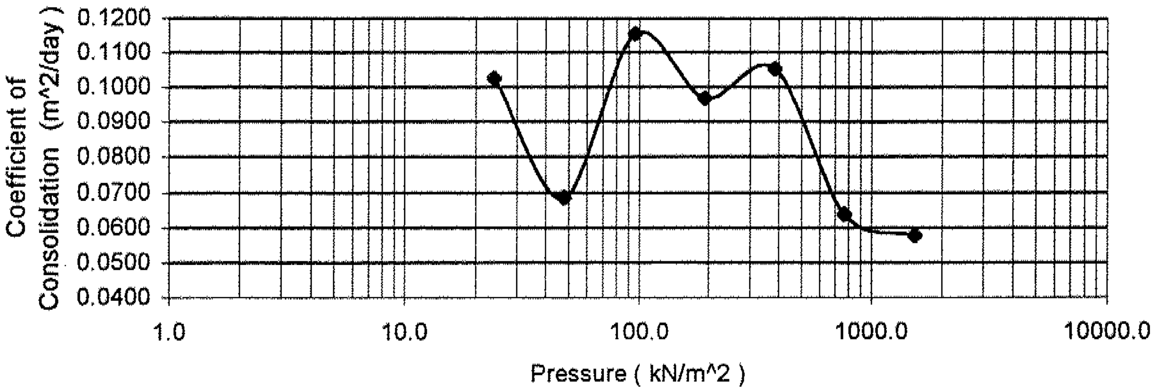


Void ratio Vs Pressure



	Presssure (tsf)	Cv (ft^2/day)	Presssure (kN/m^2)	Cv (m^2/day)	Void ratio	
Job# : TT98801	0.10		9.6		0.902	**BH# : LH7**
Sample# : TW10B	0.25	1.105	24.0	0.1027	0.887	**Depth : 7.6m**
	0.50	0.739	47.9	0.0687	0.858	**Date : Nov.30, 1998**
	1.00	1.243	95.8	0.1155	0.826	
	2.00	1.044	191.7	0.0970	0.781	
	4.00	1.135	383.3	0.1054	0.739	
	8.00	0.687	766.7	0.0638	0.687	
Cc = 0.165	16.00	0.622	1533.4	0.0578	0.622	
	4.00		383.3		0.642	
	1.00		95.8		0.672	
	0.25		24.0		0.690	
	0.10		9.6		0.704	

Coefficient of Consolidation Vs Pressure



Void ratio Vs Pressure

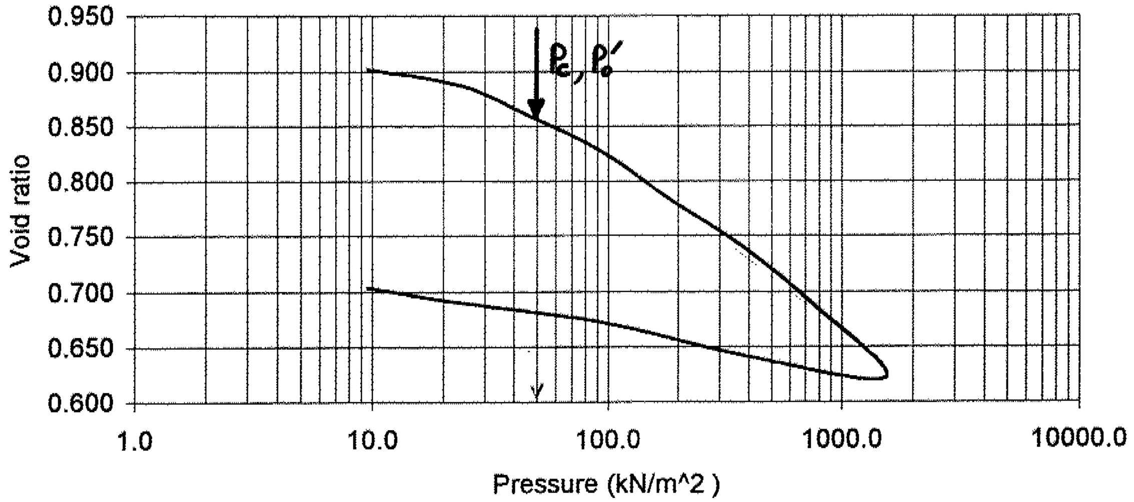


Fig: 13 Field Vane and Quick Triaxial Test Results

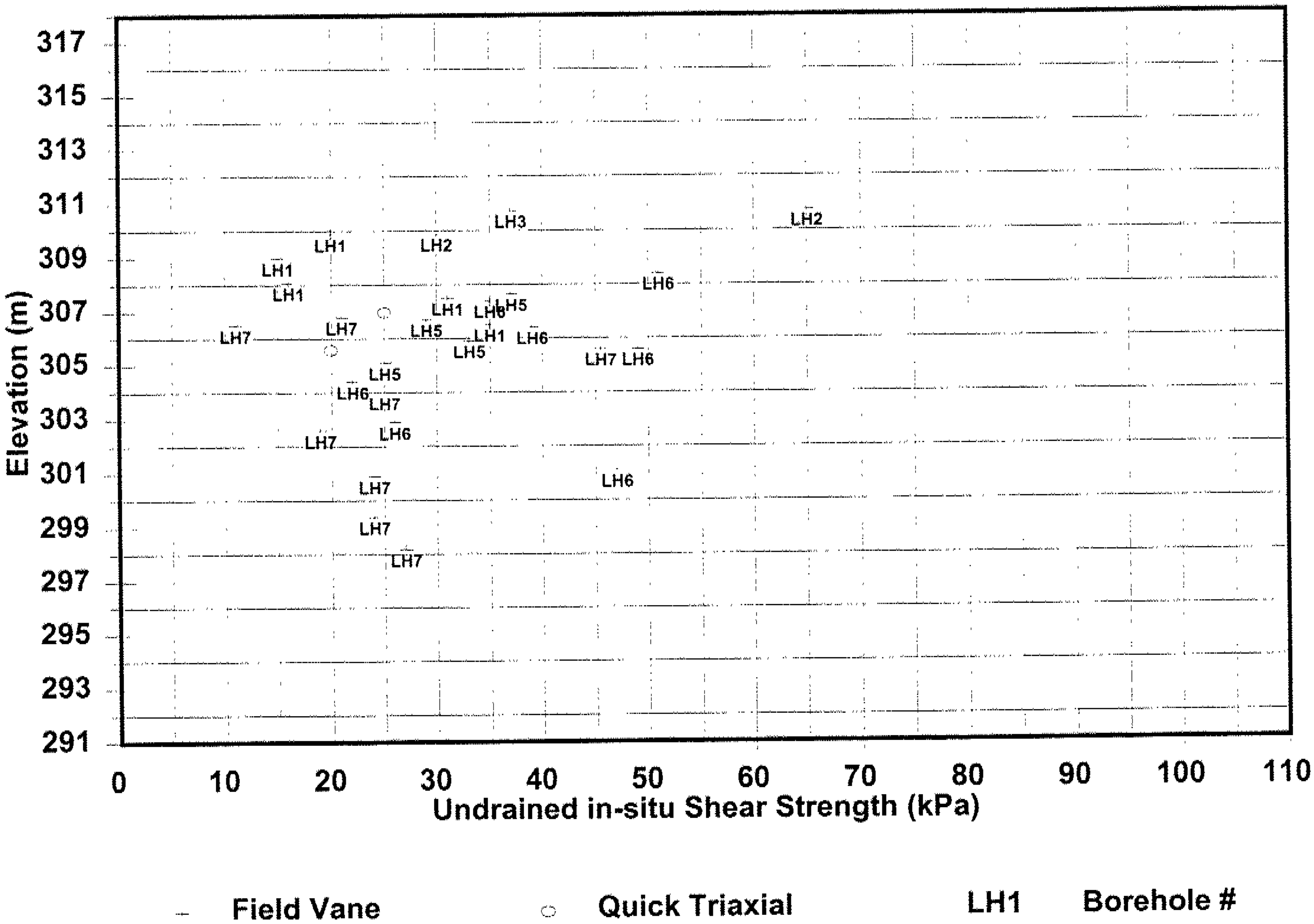
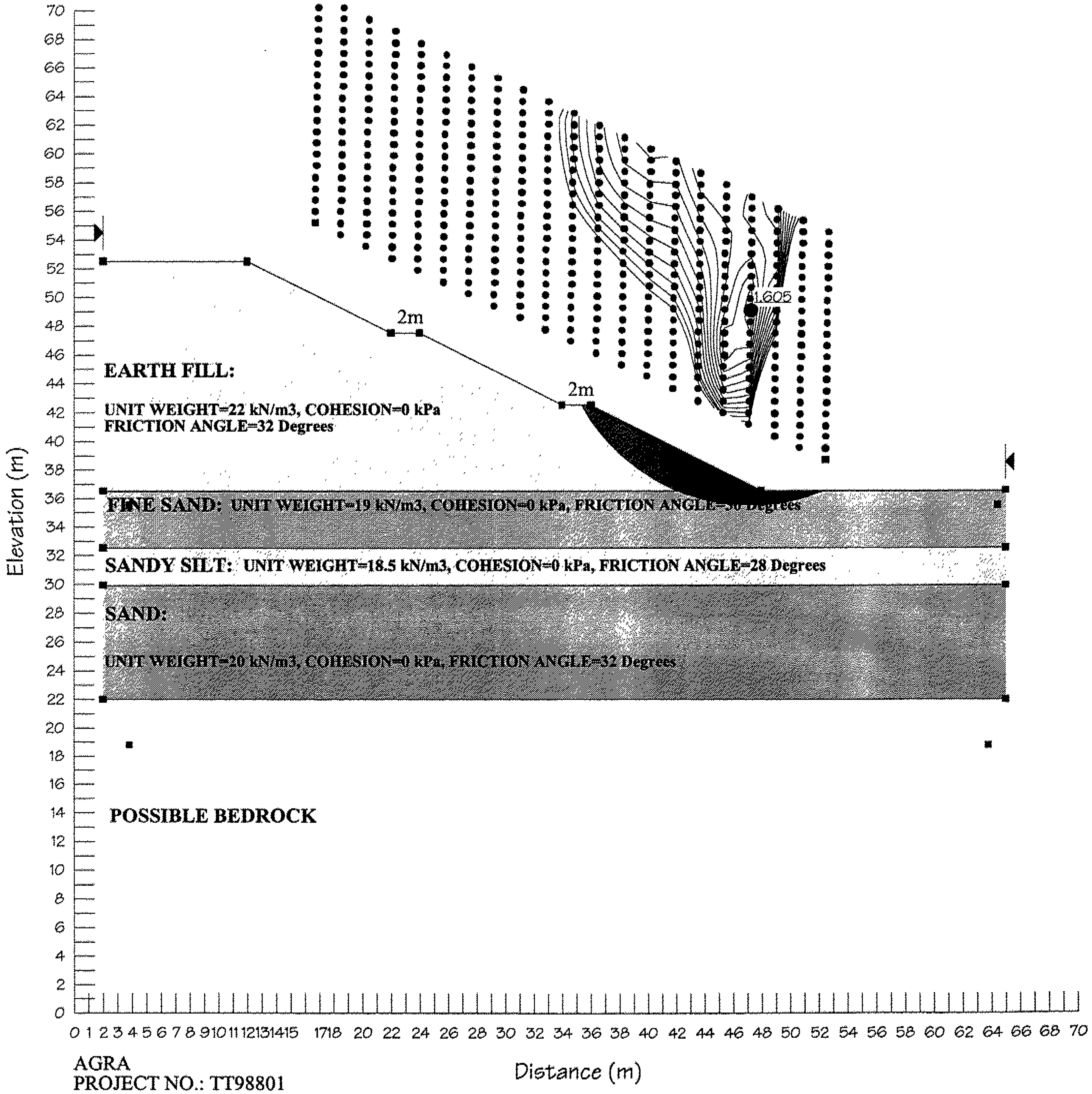


FIGURE - 14

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR WEST APPROACH
SHORT & LONG TERM CONDITION
BISHOP METHOD
16m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH 2m BERM
BH #: LH4



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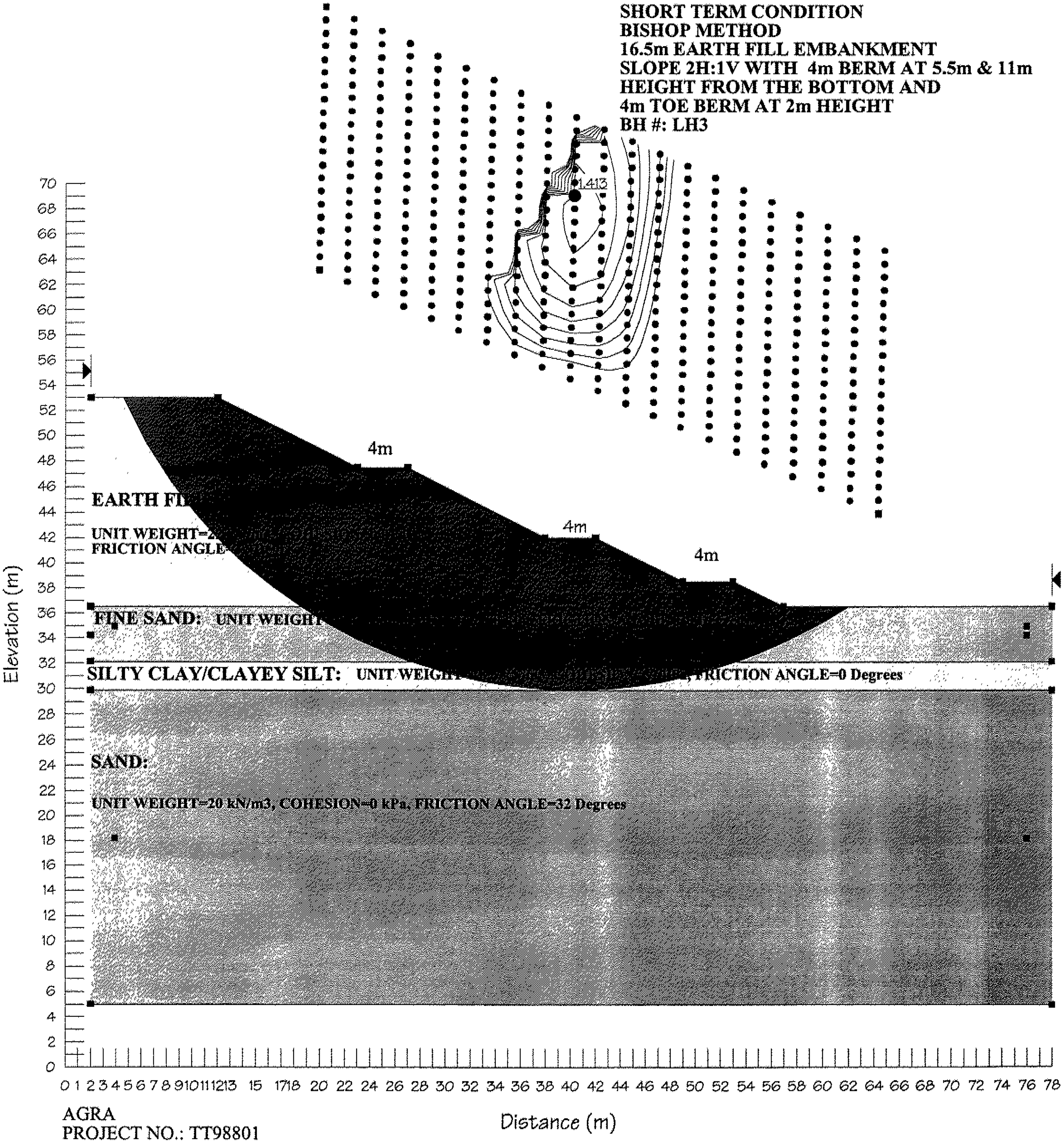
(FILE NAME: TT98HWY11W-westapproach-12)/ Date: February 22, 1999

FIGURE - 15

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
WEST APPROACH
SHORT TERM CONDITION
BISHOP METHOD
16.5m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH 4m BERM AT 5.5m & 11m
HEIGHT FROM THE BOTTOM AND
4m TOE BERM AT 2m HEIGHT
BH #: LH3



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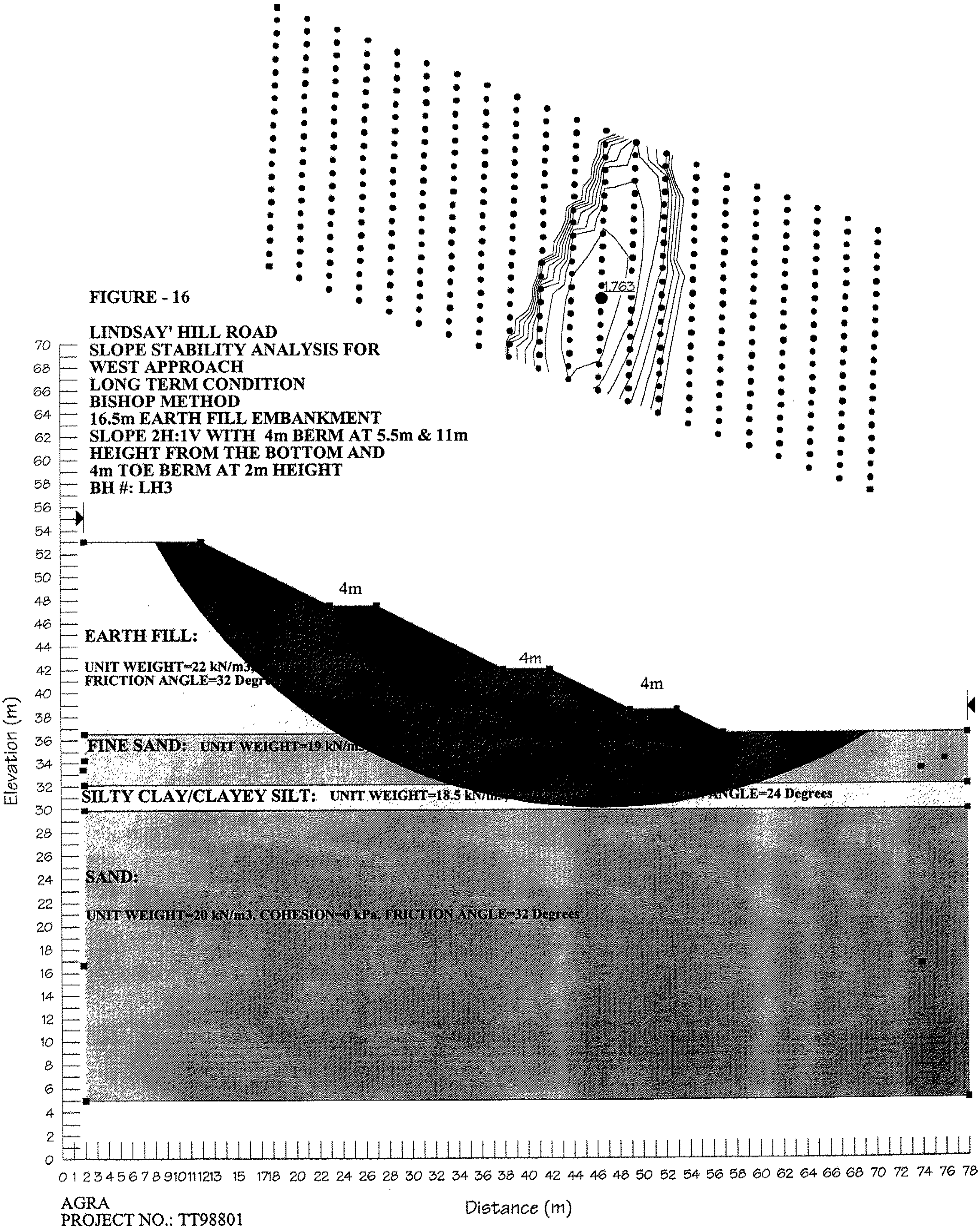
(FILE NAME: TT98HWY11W-westapproach-12LH3-2)/Date: February 22, 1999

FIGURE - 16

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
WEST APPROACH
LONG TERM CONDITION
BISHOP METHOD
16.5m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH 4m BERM AT 5.5m & 11m
HEIGHT FROM THE BOTTOM AND
4m TOE BERM AT 2m HEIGHT
BH #: LH3



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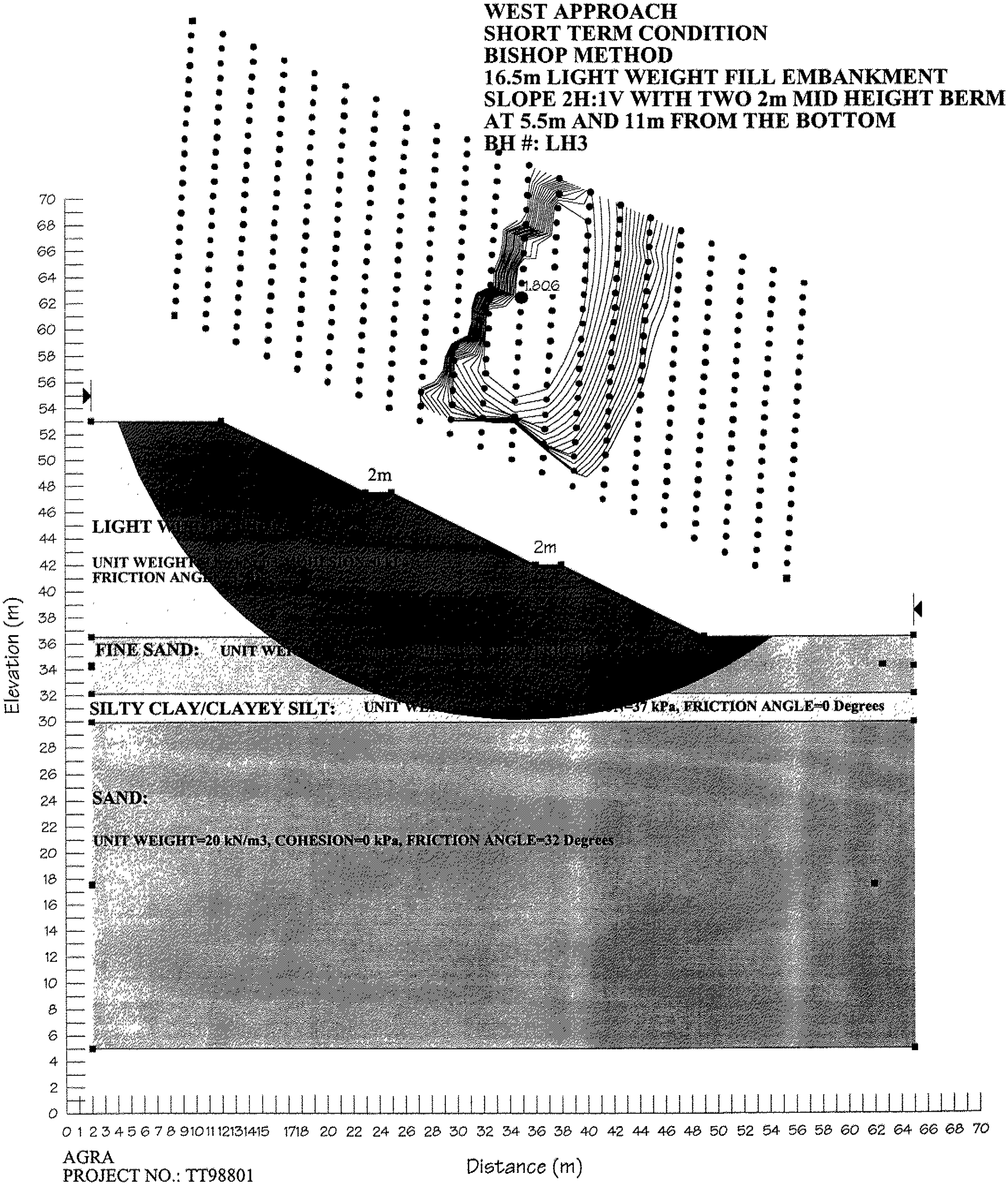
(FILE NAME: TT98HWY11W-westapproach-12LH3-2)/Date: February 22, 1999

FIGURE - 17

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR WEST APPROACH
SHORT TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2H:1V WITH TWO 2m MID HEIGHT BERM AT 5.5m AND 11m FROM THE BOTTOM
BH #: LH3



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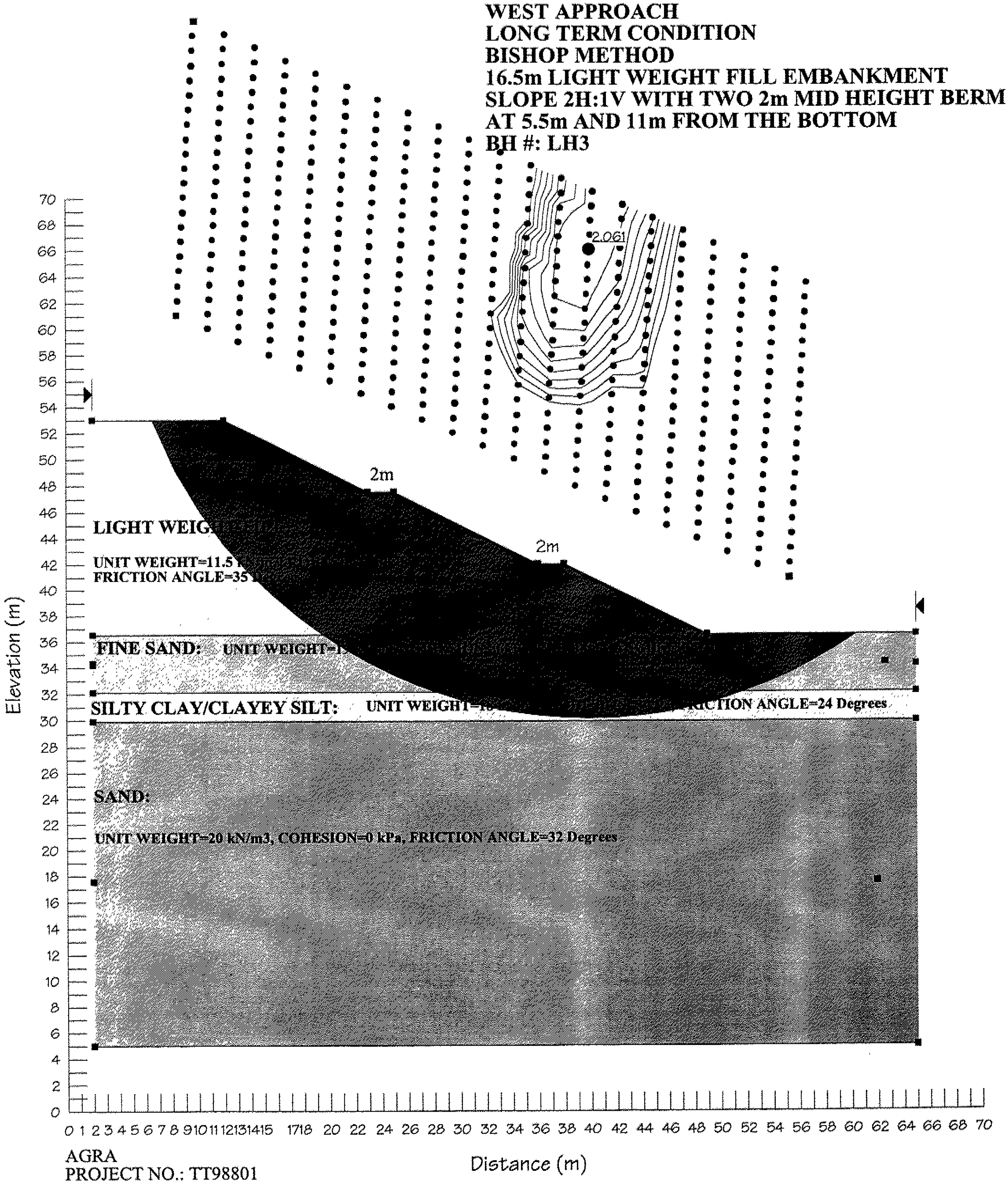
(FILE NAME: TT98HWY11W-westapproach-12LH3)/ Date: February 22, 1999

FIGURE - 18

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
WEST APPROACH
LONG TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2H:1V WITH TWO 2m MID HEIGHT BERM
AT 5.5m AND 11m FROM THE BOTTOM
BH #: LH3



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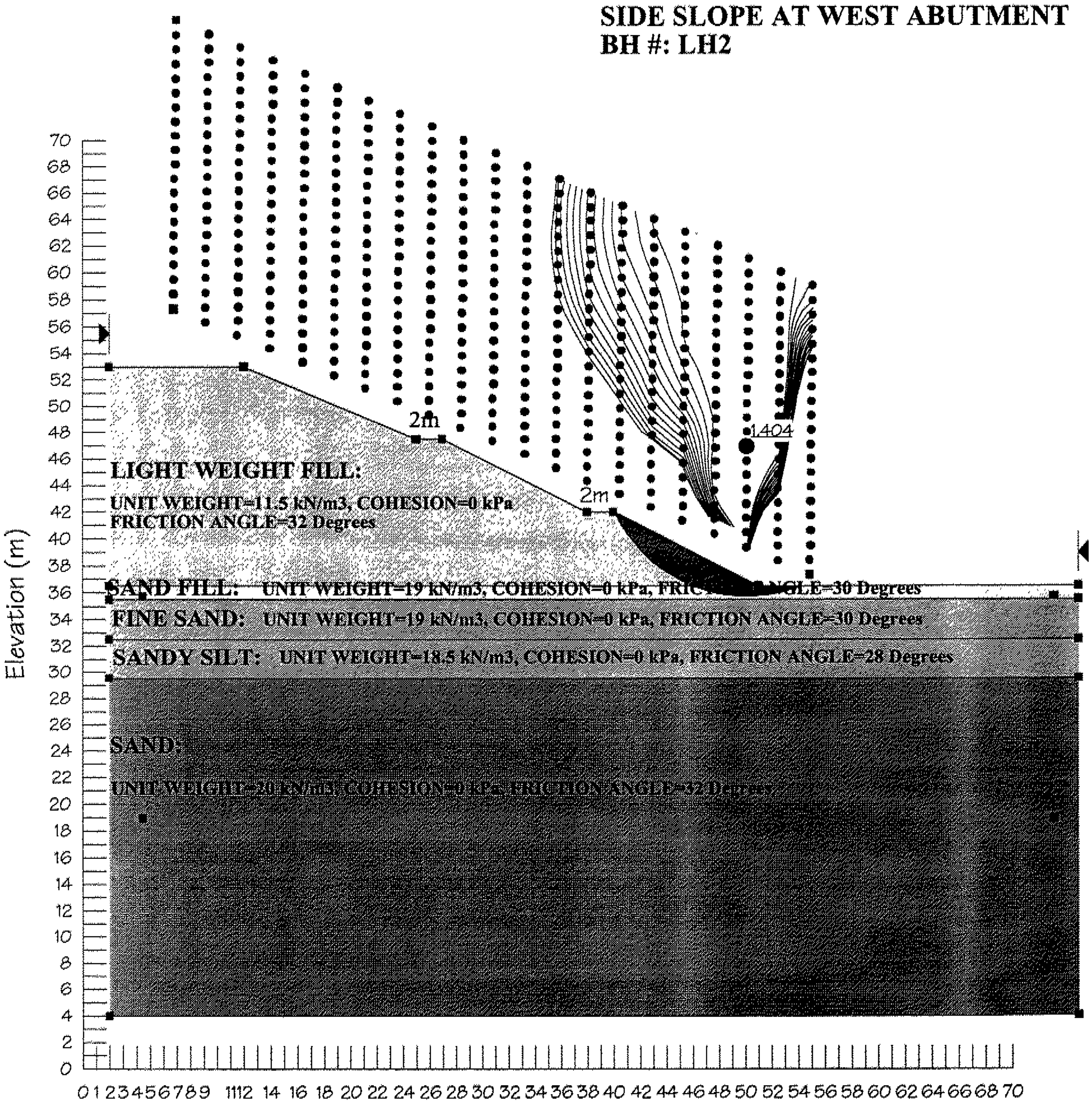
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-westapproach-12LH3)/ Date: February 22, 1999

FIGURE - 19

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
SHORT & LONG TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2H:1V WITH TWO 2m BERM AT
5.5m & 11.0m FROM THE BOTTOM
SIDE SLOPE AT WEST ABUTMENT
BH #: LH2



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PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-WESTABUT1LH2S)/ Date: February 22, 1999

FIGURE NO. 20

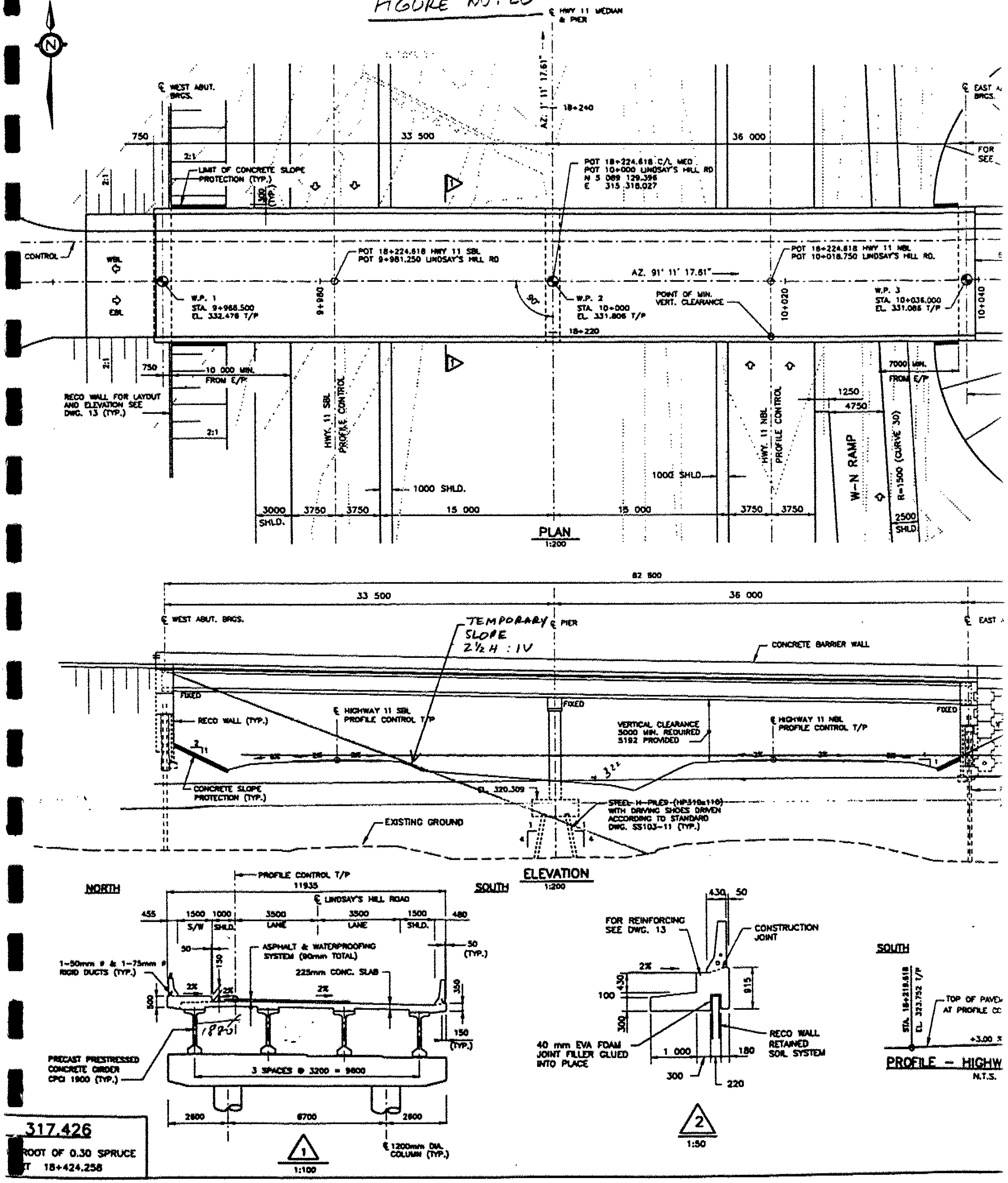
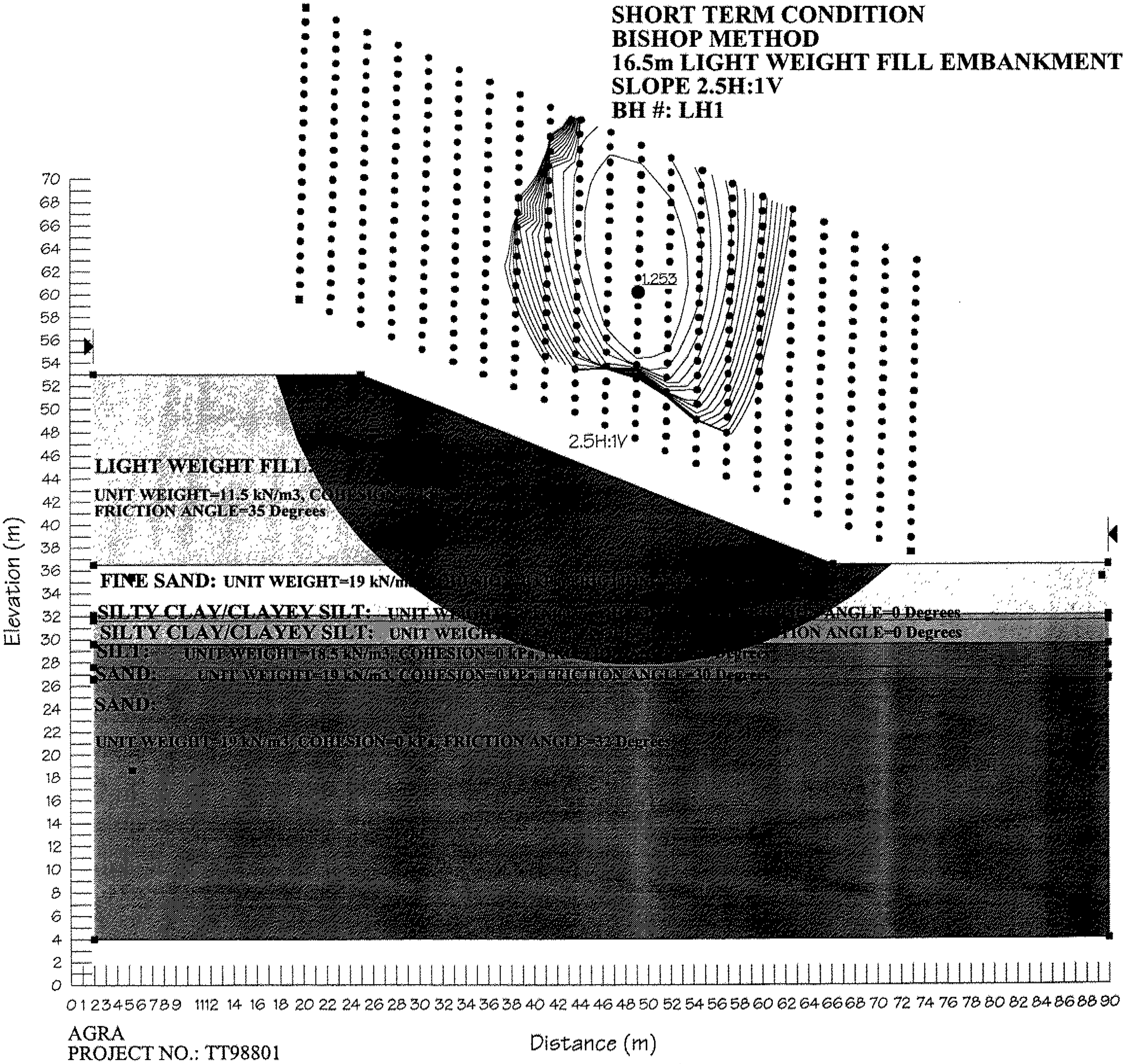


FIGURE NO. 20

FIGURE - 21

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
WEST ABUTMENT TO PIER
SHORT TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2.5H:1V
BH #: LH1



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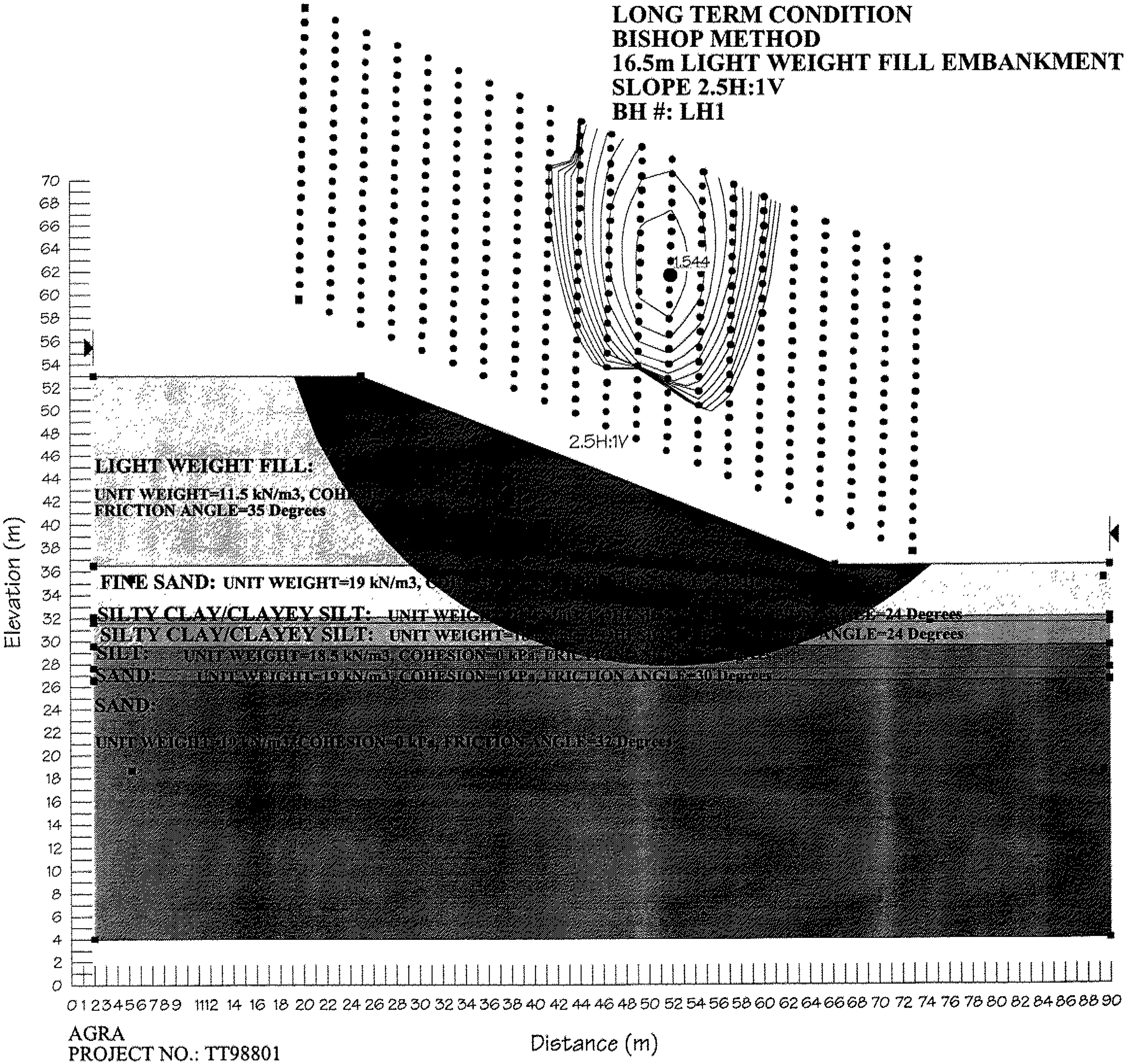
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-WESTABUT1LH1-2)/ Date: February 22, 1999

FIGURE - 22

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
WEST ABUTMENT TO PIER
LONG TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2.5H:1V
BH #: LH1



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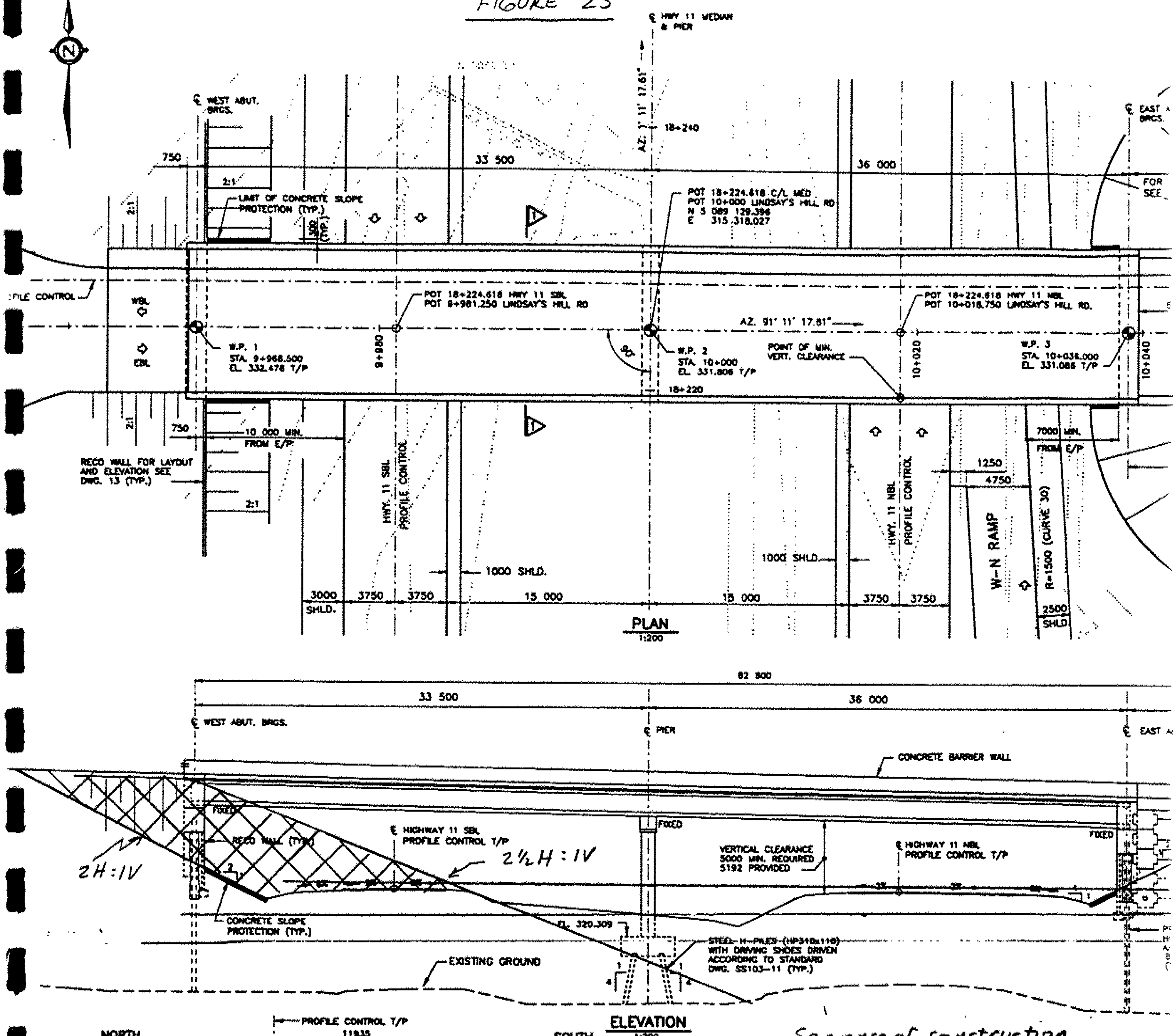
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-WESTABUT1LH1-2)/ Date: February 22, 1999

FIGURE 23



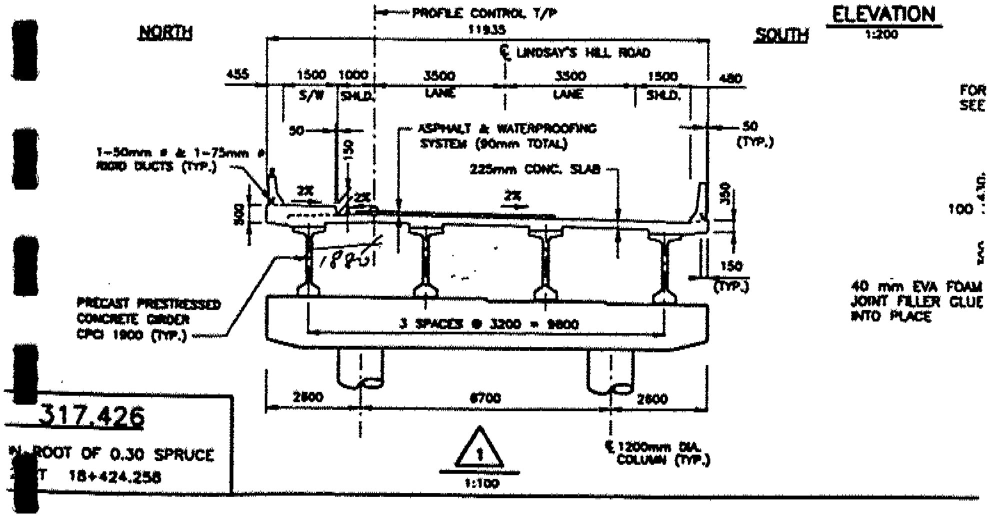


FIGURE 23

Sequence of construction

1- Build temporary slope @ 2½H:1V side slopes (see Fig. 20)

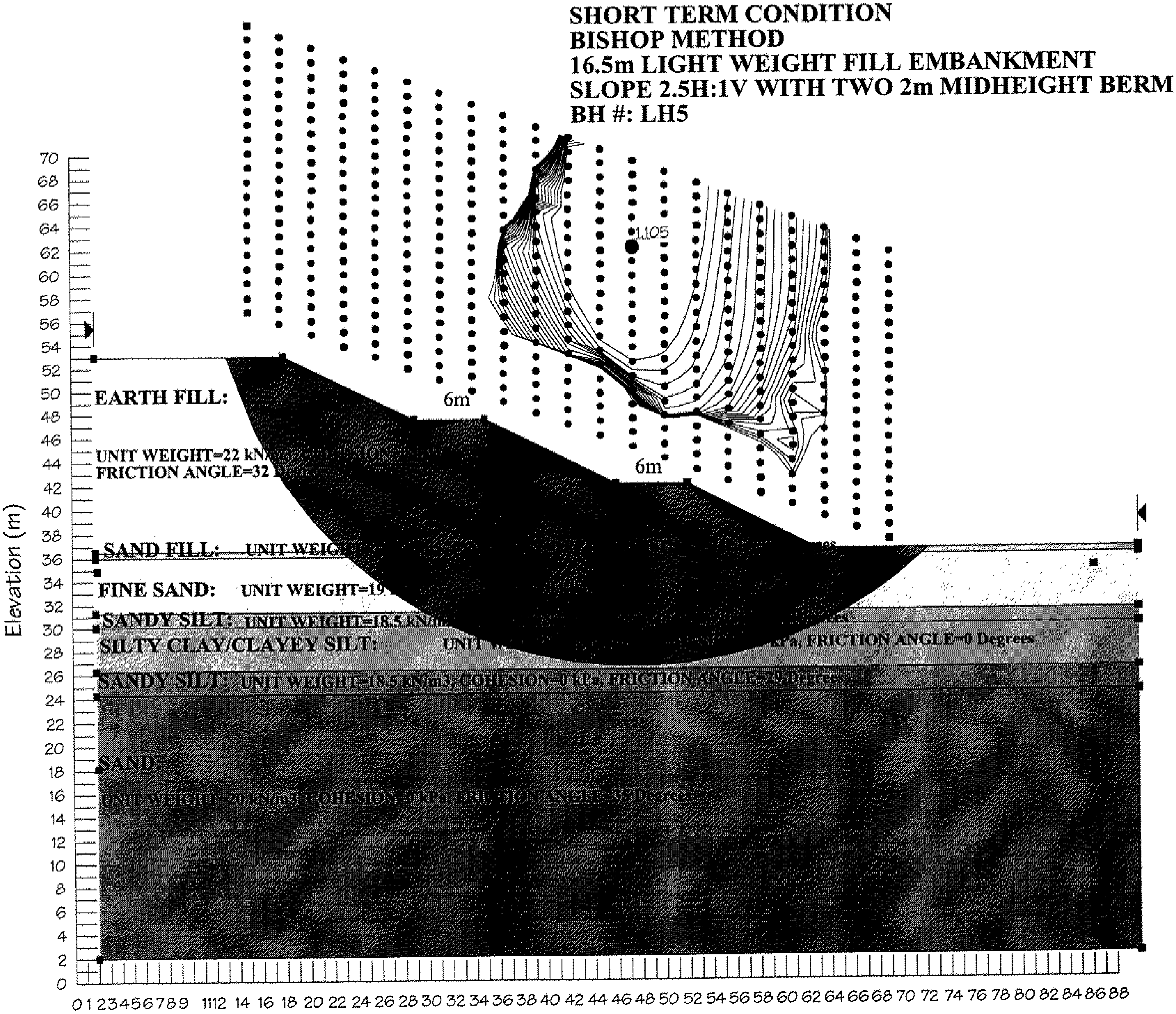
2- Wait for 3 months to effect consolidation settlements

3- Excavate back the shaded area, shown in this Figure, at 2H:1V side slopes and build the new south bound lanes.

4- Direct traffic from north-bound to the newly constructed southbound lanes and start the construction of the new northbound lanes and of the east approach and embankment fills.

FIGURE - 24

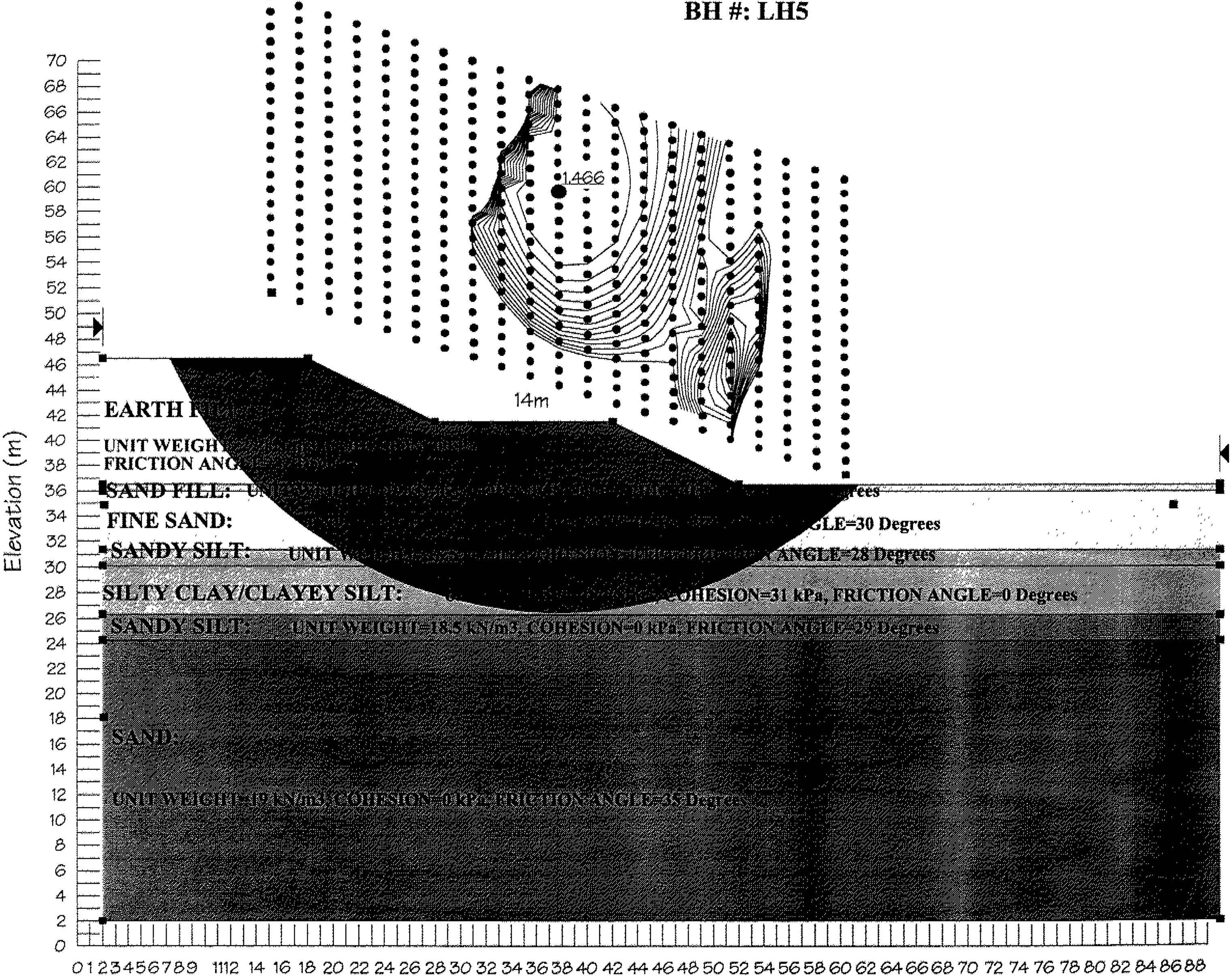
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR EAST ABUTMENT SIDE SLOPE
SHORT TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2.5H:1V WITH TWO 2m MIDHEIGHT BERM
BH #: LH5



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTABUT-LH5-S)/ Date: February 22, 1999

FIGURE - 25

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
EAST ABUTMENT SIDE SLOPE
SHORT TERM CONDITION
BISHOP METHOD
10m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH 14m BERM
BH #: LH5



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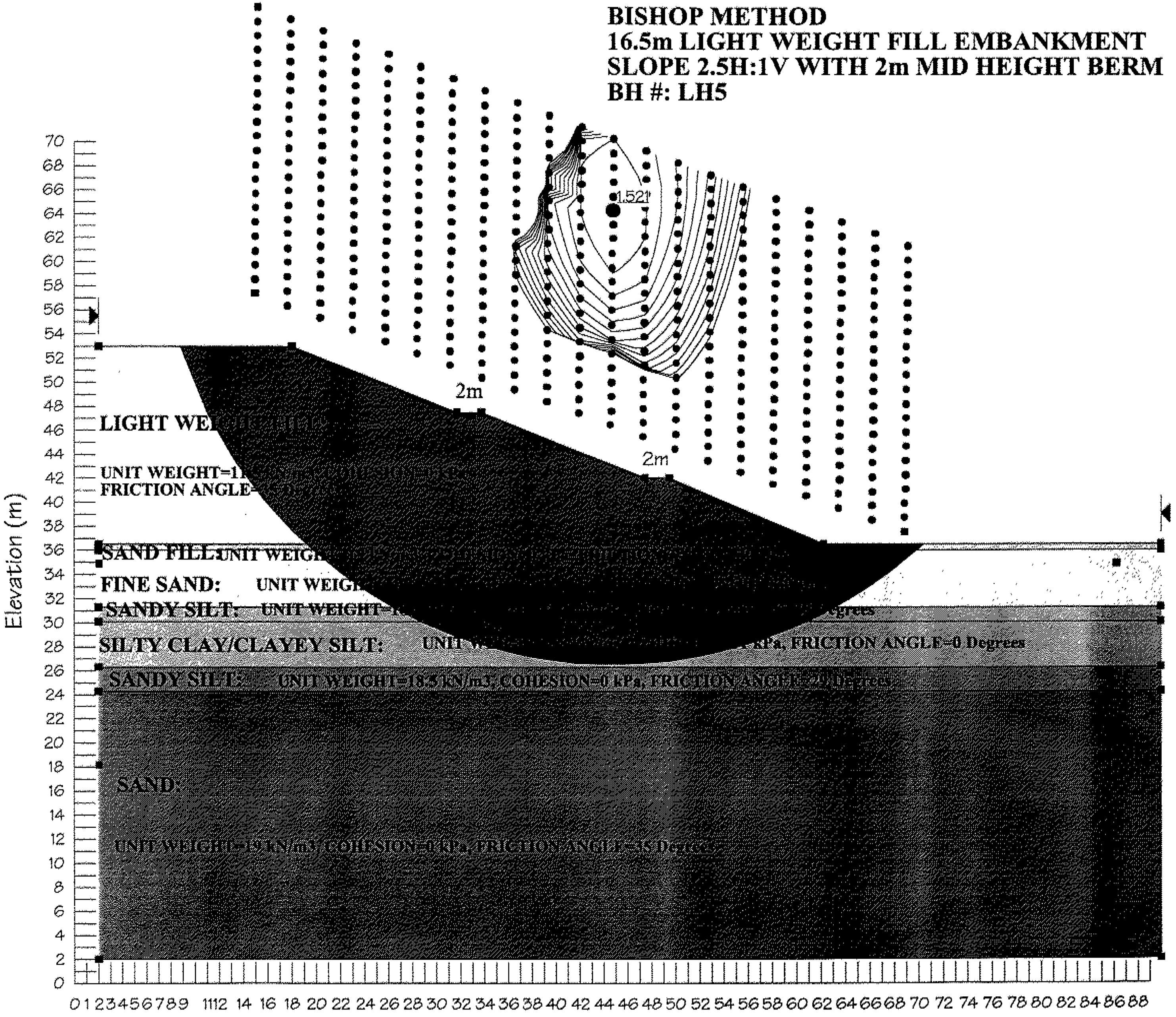
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTABUT-LH5-S-1)/ Date: February 22, 1999

FIGURE - 26

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
EAST ABUTMENT SIDE SLOPE
SHORT TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2.5H:1V WITH 2m MID HEIGHT BERM
BH #: LH5



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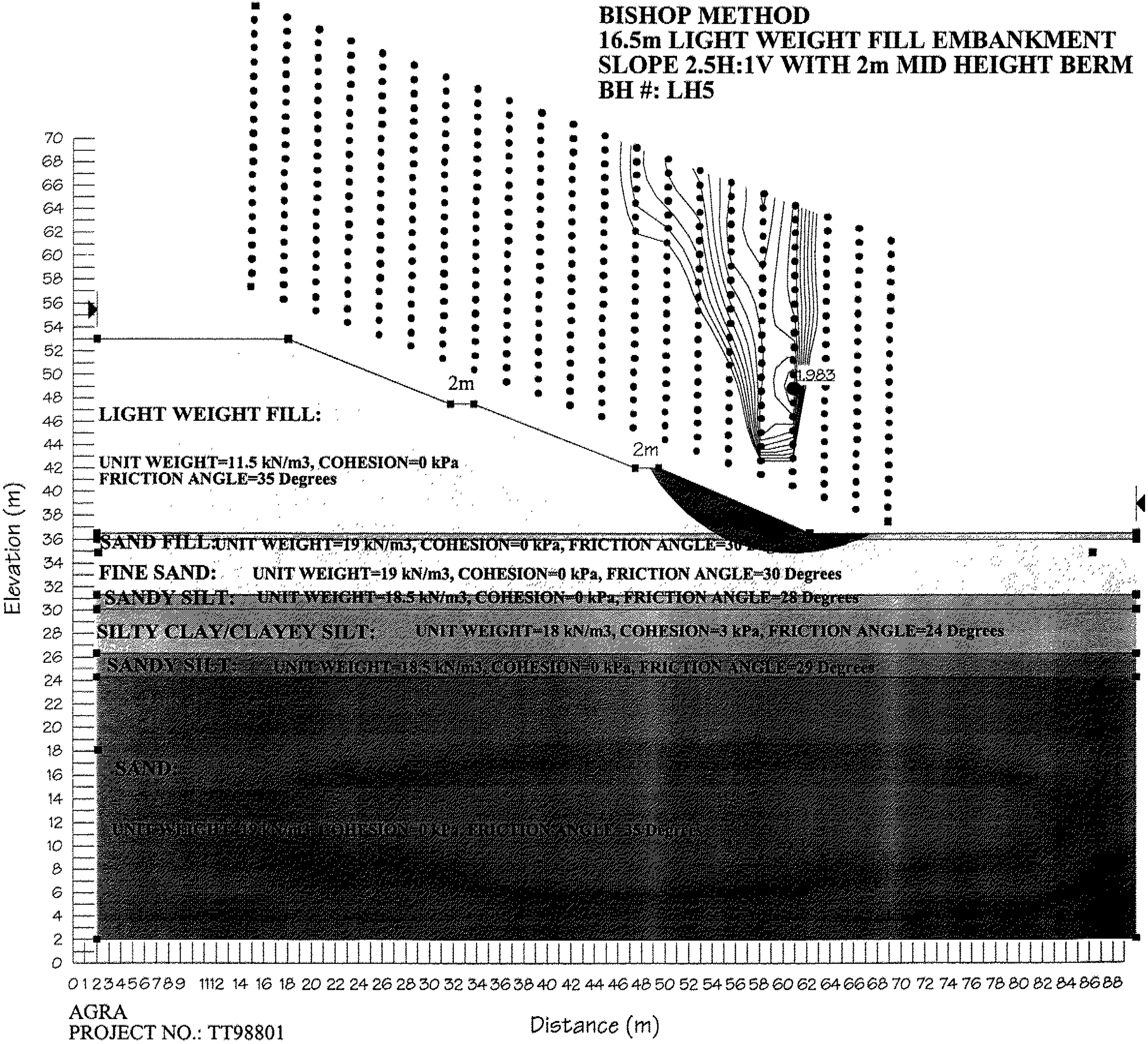
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTABUT-LH5-S-2)/ Date: February 22, 1999

FIGURE - 27

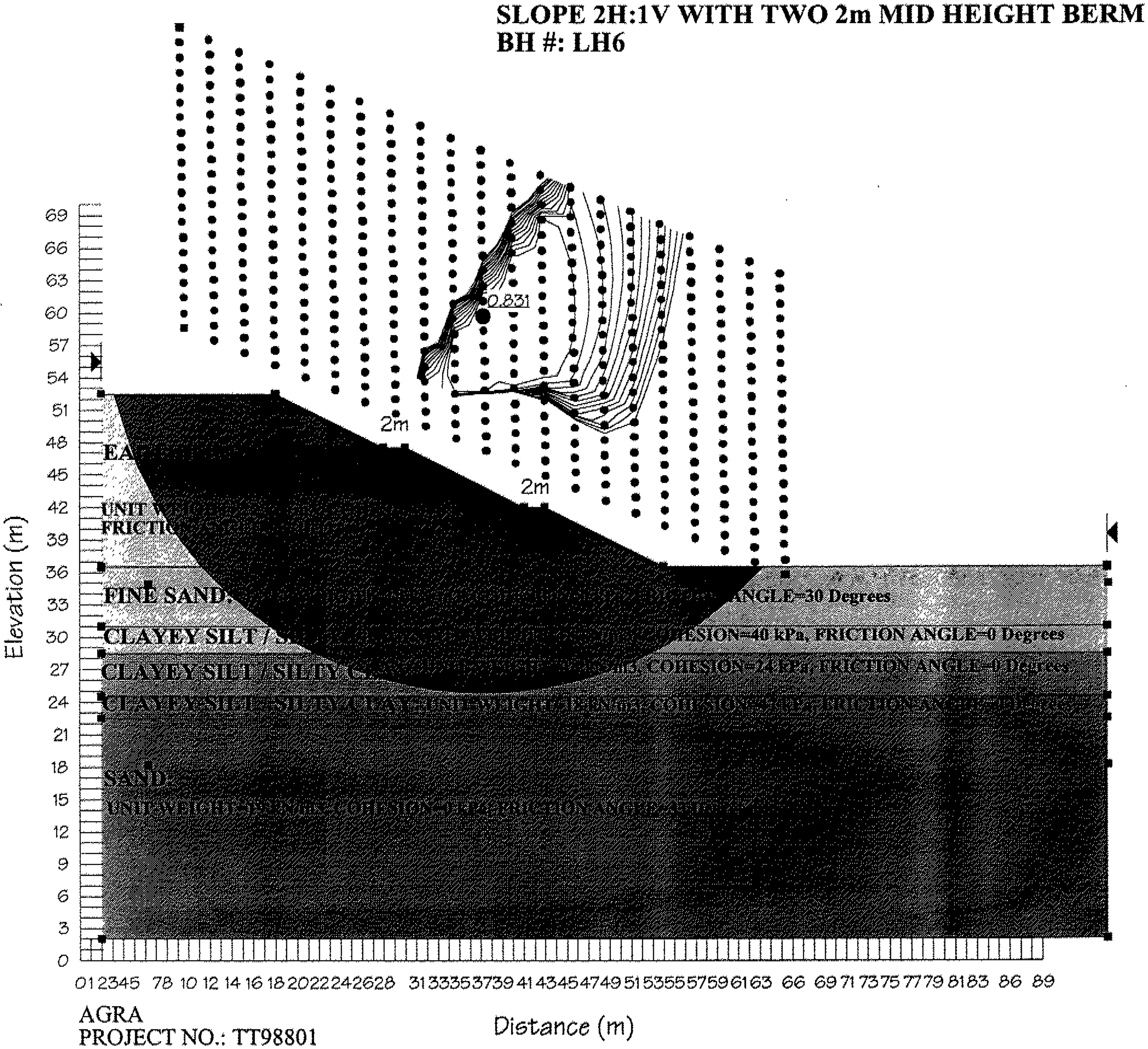
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
EAST ABUTMENT SIDE SLOPE
LONG TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2.5H:1V WITH 2m MID HEIGHT BERM
BH #: LH5



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTABUT-LH5-S-2)/ Date: February 22, 1999

FIGURE - 28

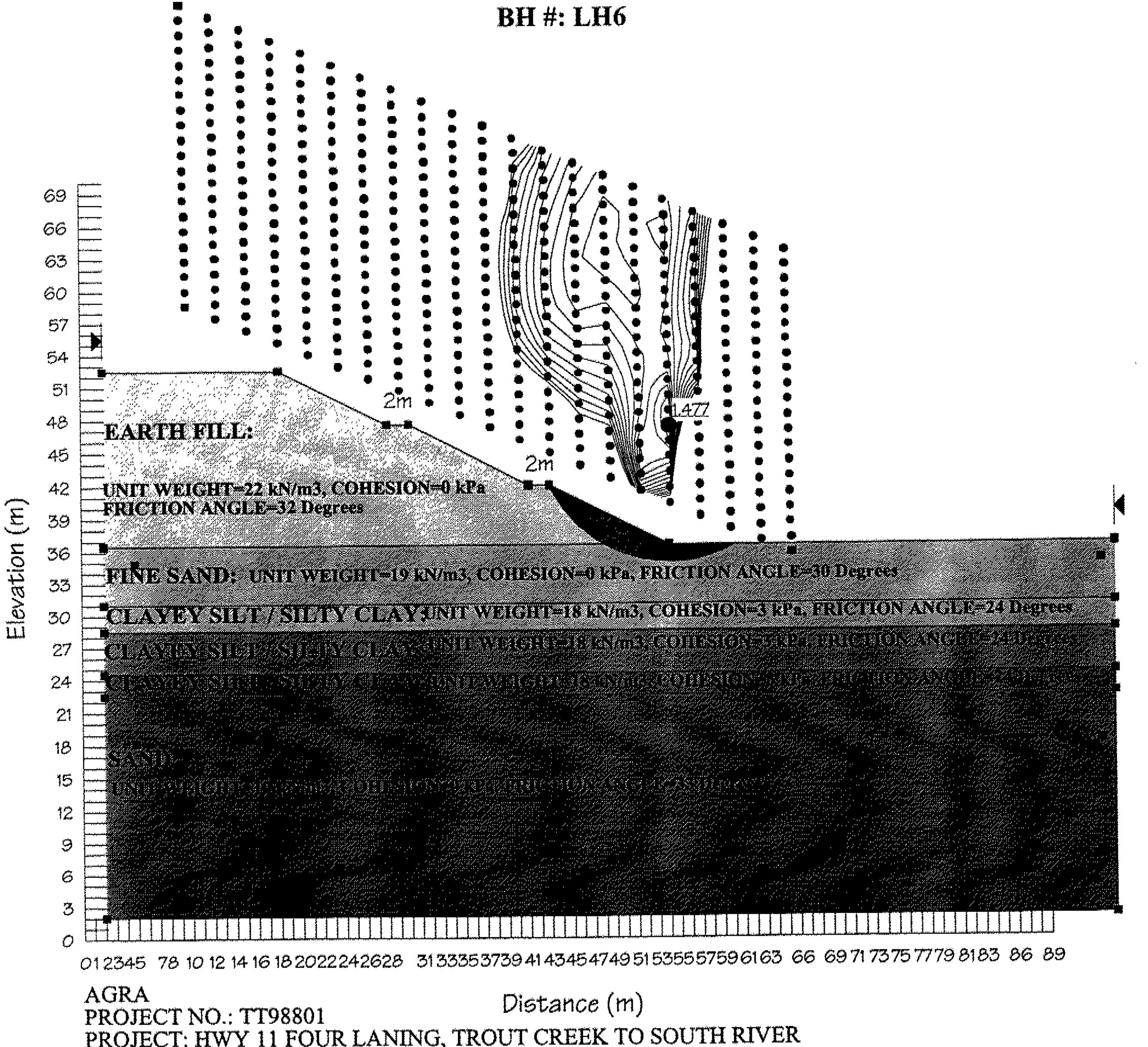
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
SHORT TERM CONDITION
BISHOP METHOD
16m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH TWO 2m MID HEIGHT BERM
BH #: LH6



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTAPP-LH6)

FIGURE - 29

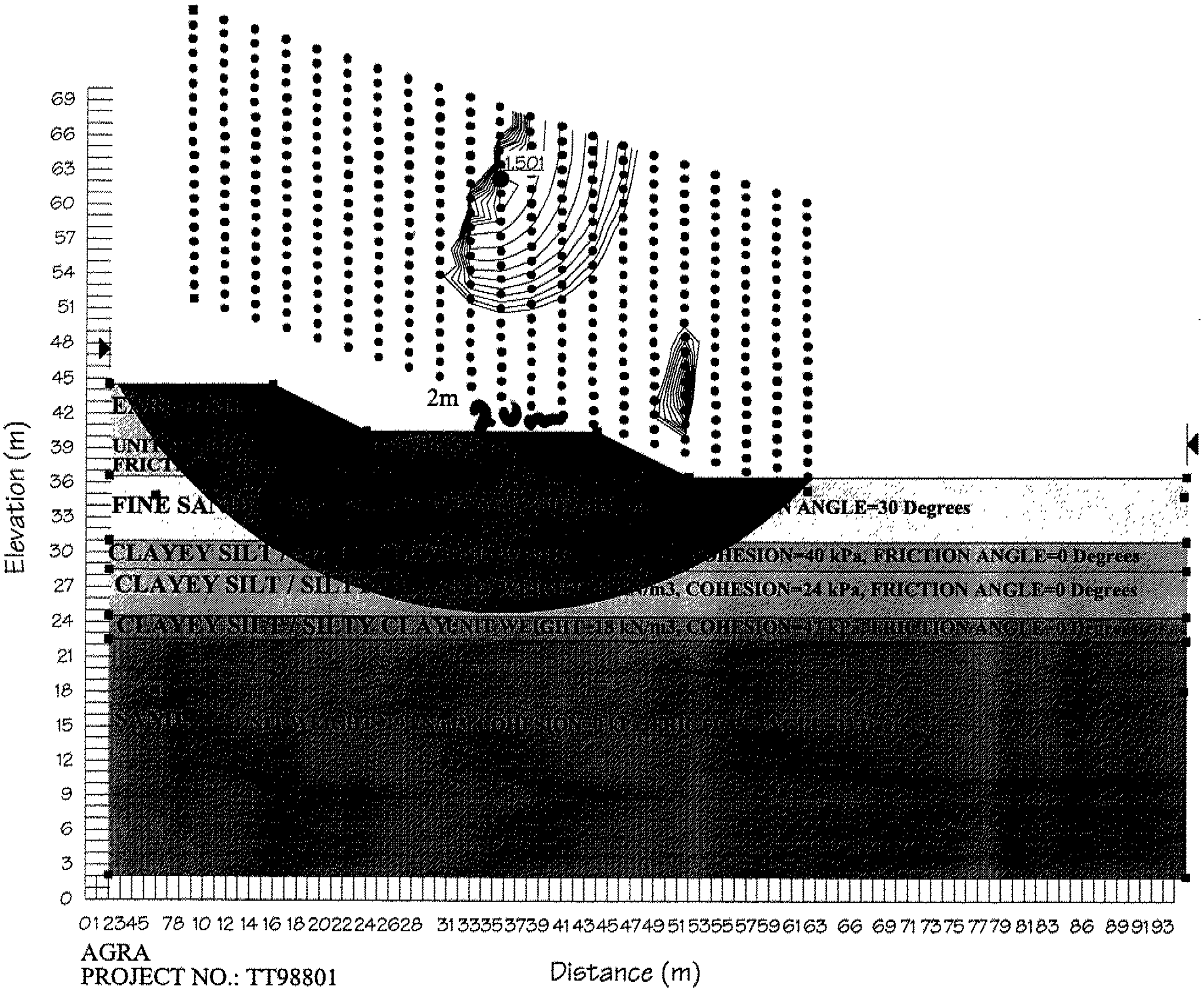
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
LONG TERM CONDITION
BISHOP METHOD
16m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH TWO 2m MID HEIGHT BERM
BH #: LH6



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTAPP-LH6)/ Date: February 23, 1999

FIGURE - 30

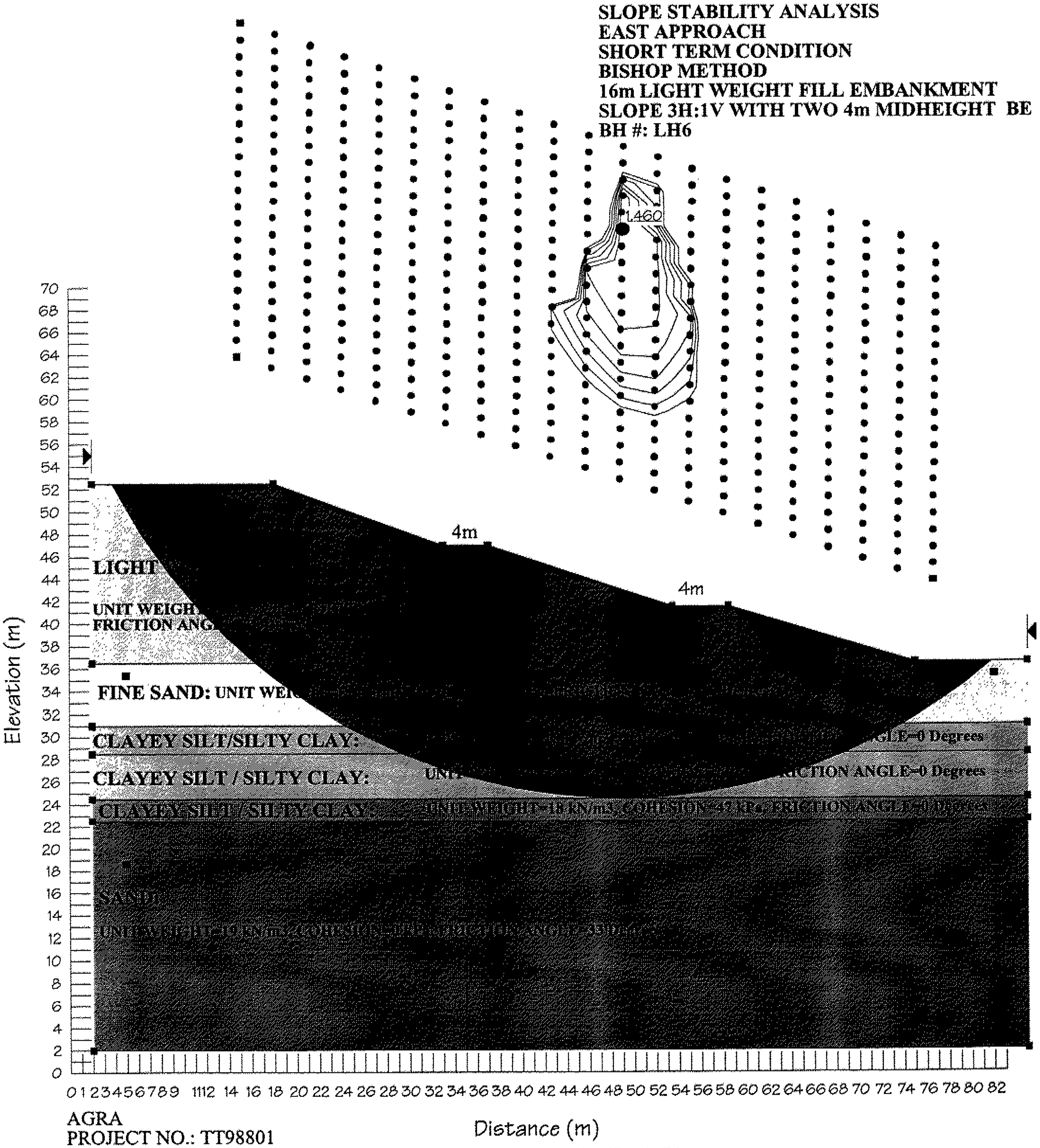
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
SHORT TERM CONDITION
BISHOP METHOD
8m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH 20m BERM
AT 4m HEIGHT
BH #: LH6



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTAPP-LH6-2)/ Date: February 23, 1999

FIGURE - 31

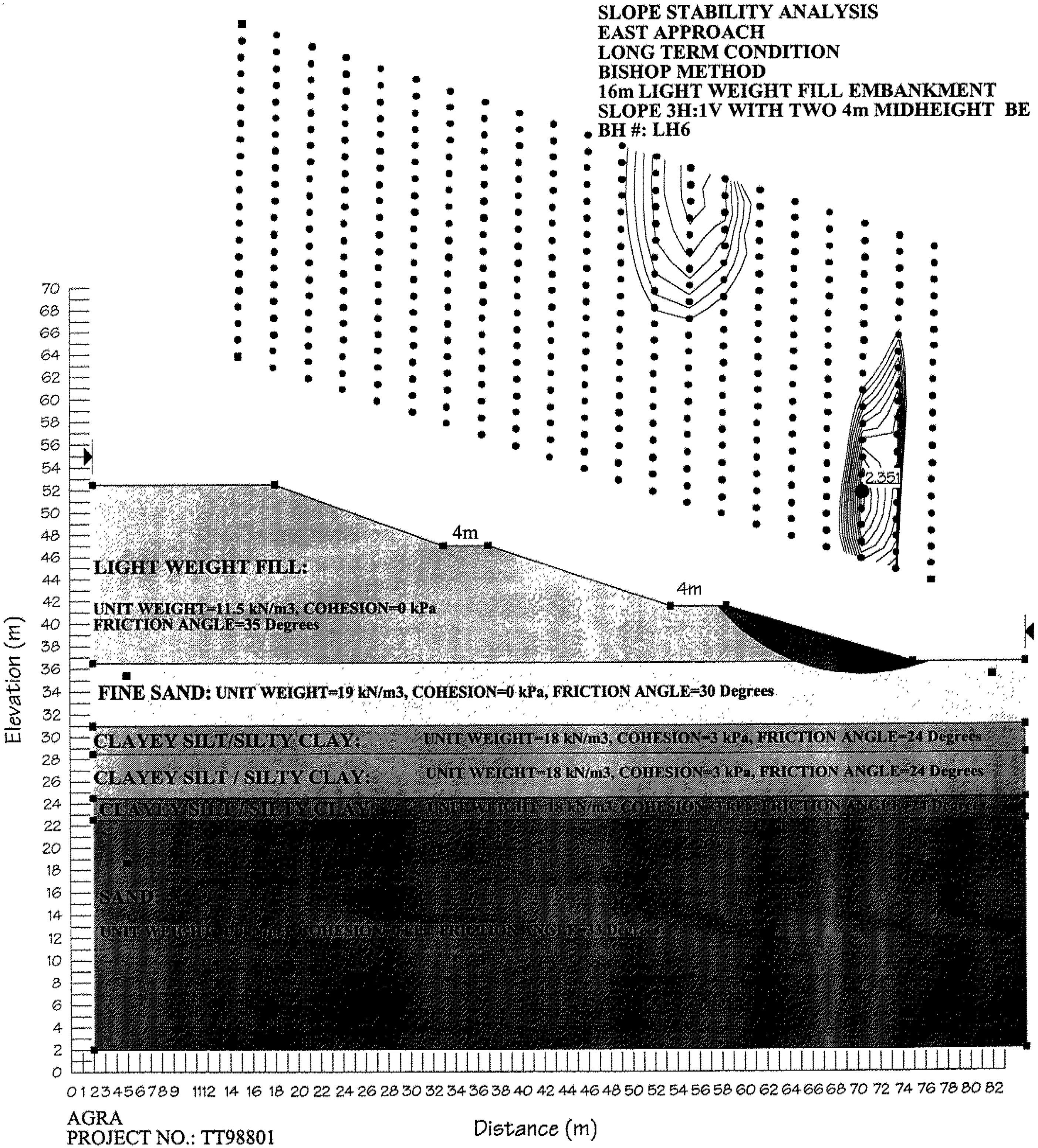
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
SHORT TERM CONDITION
BISHOP METHOD
16m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 3H:1V WITH TWO 4m MIDHEIGHT BE
BH #: LH6



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTAPP-LH6-1)/ Date: February 23, 1999

FIGURE - 32

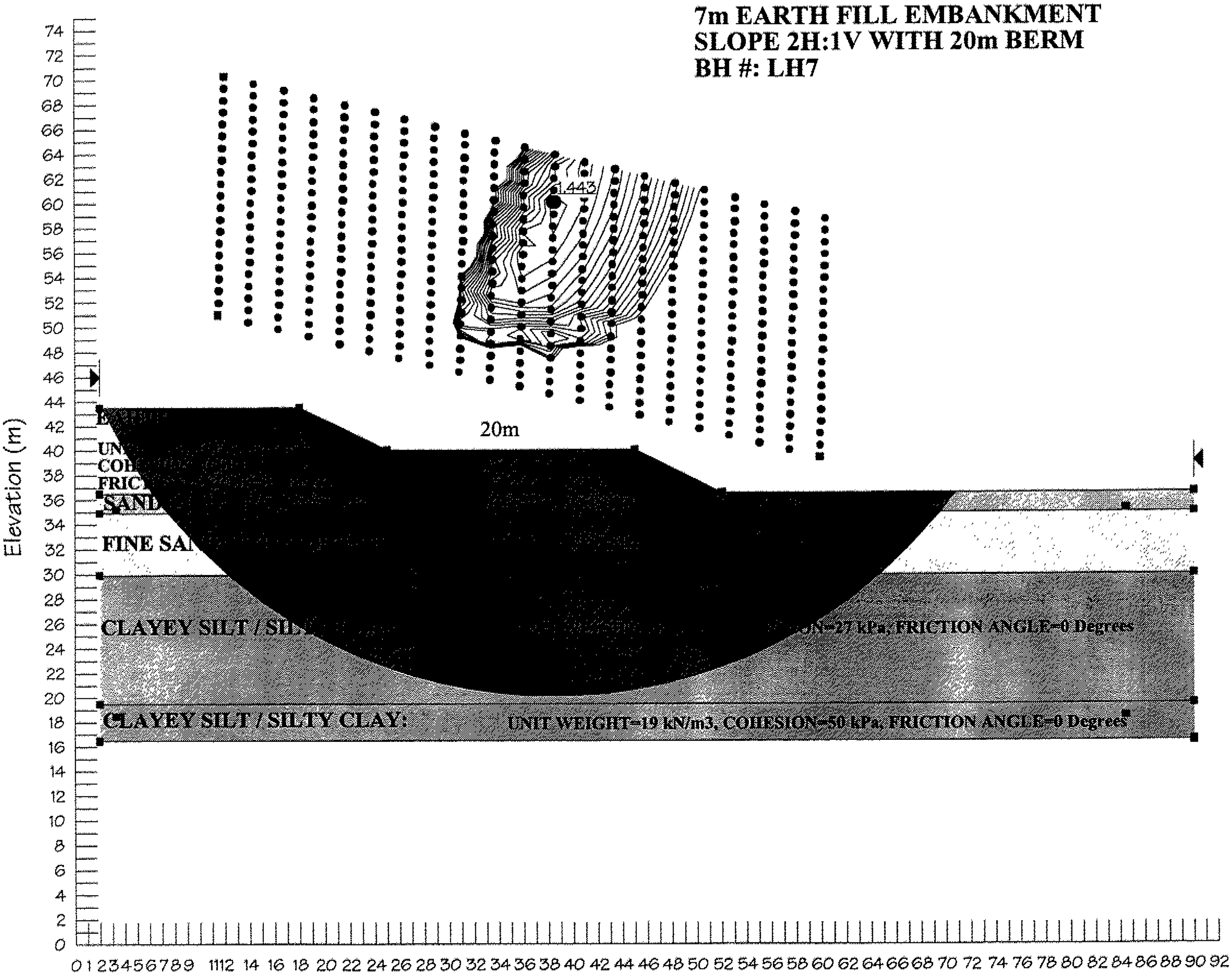
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
LONG TERM CONDITION
BISHOP METHOD
16m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 3H:1V WITH TWO 4m MIDHEIGHT BE
BH #: LH6



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTAPP-LH6-1)/ Date: February 23, 1999

FIGURE - 33

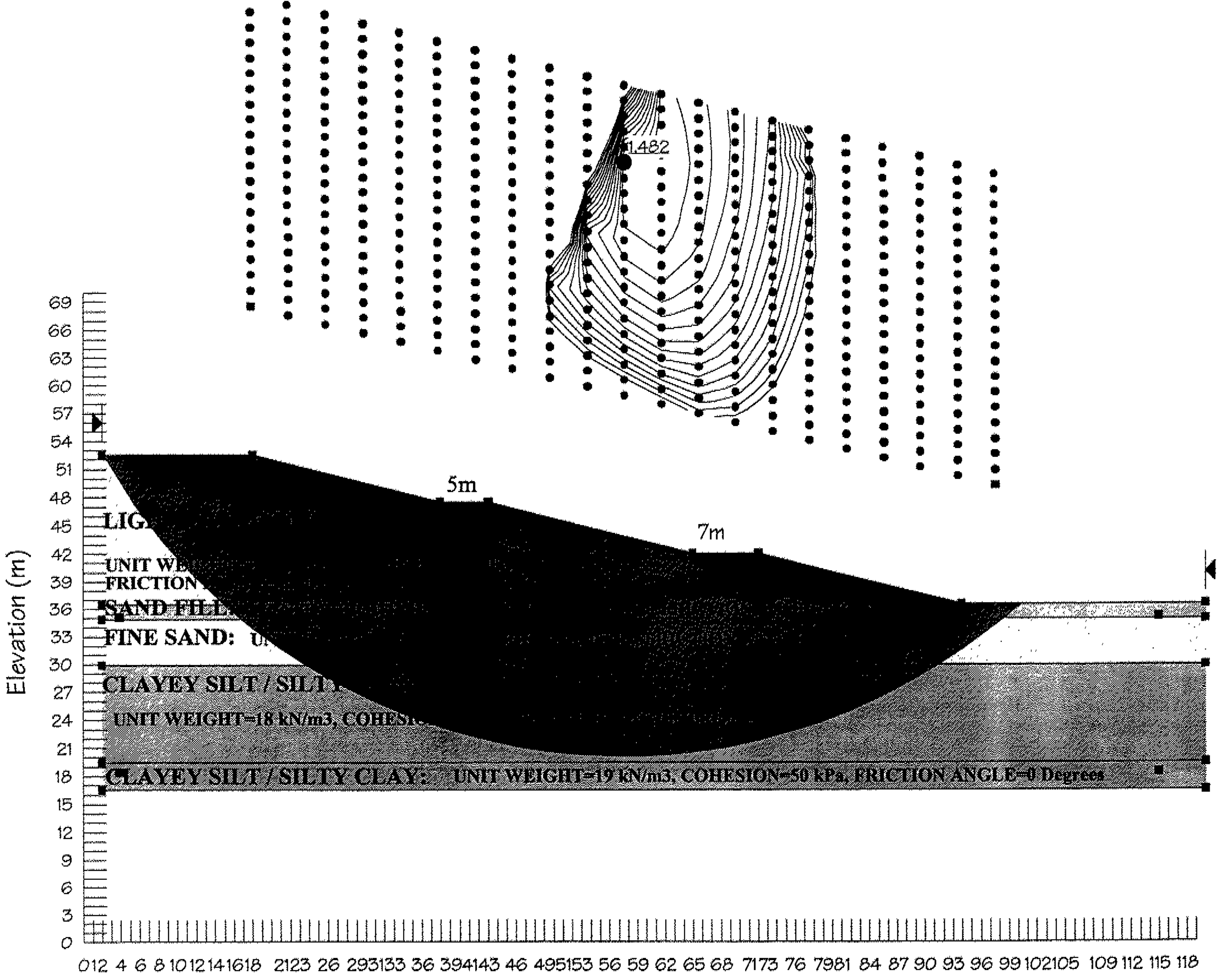
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR EAST APPROACH SIDE SLOPE
SHORT TERM CONDITION
7m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH 20m BERM
BH #: LH7



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTapproach9.6-X)/ Date: February 23, 1999

FIGURE - 34

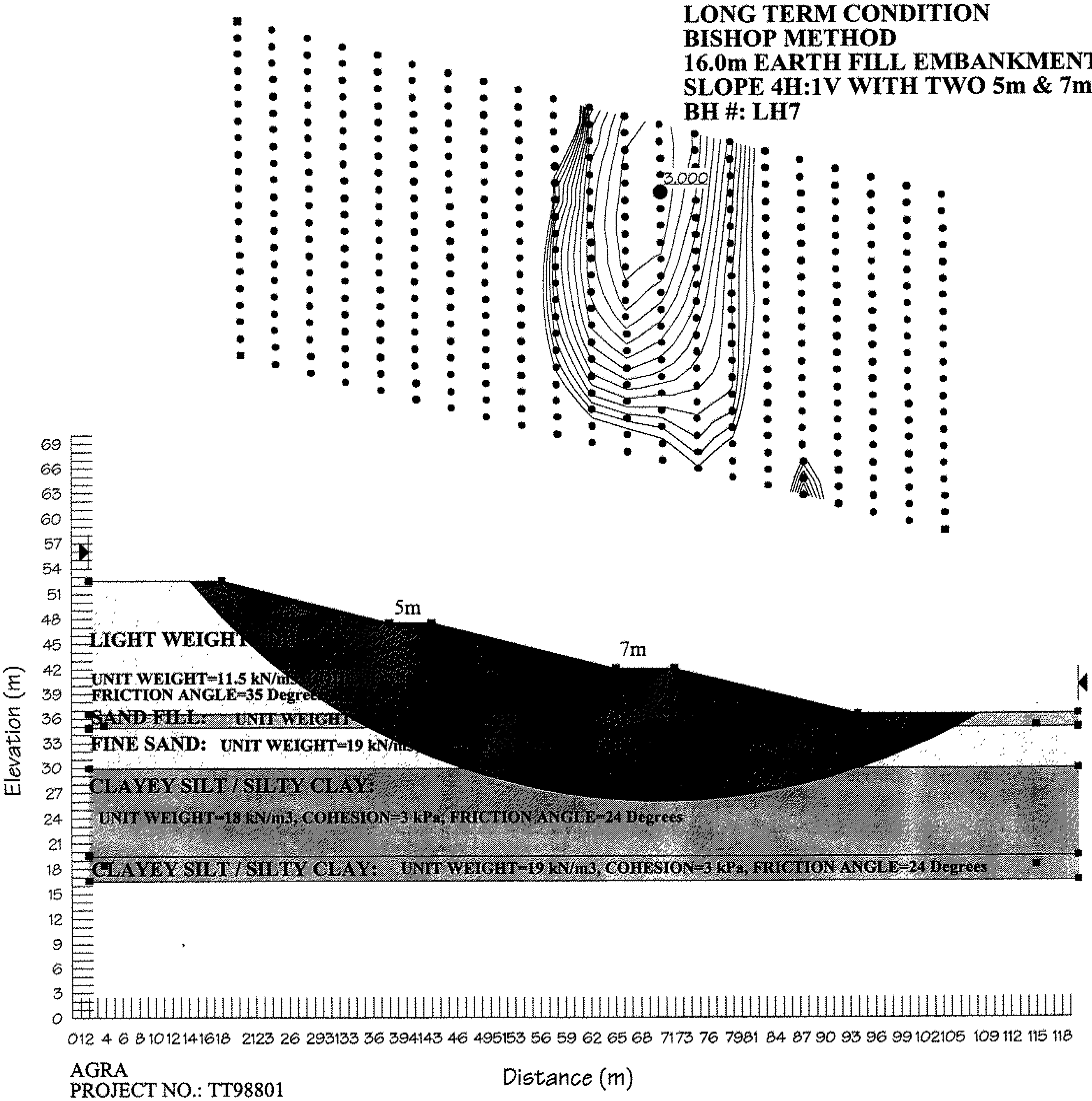
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
SHORT TERM CONDITION
BISHOP METHOD
16.0m EARTH FILL EMBANKMENT
SLOPE 4H:1V WITH TWO 5m & 7m BERM
BH #: LH7



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTAPPRO-LH7-1)/ Date: February 23, 1999

FIGURE - 35

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
LONG TERM CONDITION
BISHOP METHOD
16.0m EARTH FILL EMBANKMENT
SLOPE 4H:1V WITH TWO 5m & 7m BERM
BH #: LH7



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTAPPRO-LH7-1)/ Date: February 23, 1999

ENCLOSURES

LOG OF BOREHOLE LH1

ENCL. No.: 1

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 3rd, 1998

LABORATORY DATA						*SAMPLES*			SYMBOL	MATERIAL DESCRIPTION		ELEV. m	DEPTH m	WATER DATA	REMARKS
PL %	W %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value							
											SURFACE EL. 314.9 m				
	76					1	SS	2		organic,v.loose	0.3m organic TOPSOIL				STATION 10+000 Lindsay's Hill Road C/L

	21					2	SS	7		tr.org.,loose		314	1		

	20									silty					
					9	3	SS	10			FINE SAND	313	2		
	20				15						traces of silt				
					18	4	SS	14		compact	brown, wet				0 92 (8)
					15					----					
												312	3		
					19	5	SS	4		v.loose					
	17				18										0 92 (8)
					19										
	17				16	6	SS	4				311	4		
					18										
20	34	34			32					firm to					
					36	7	SS	5		soft		310	5		0 2 76 22
				20	44										
24	39	43								------					
				St=1.3	64	8	SS	4			SILTY CLAY to CLAYEY SILT				
					103						occ.silt & sand seams				
				15	104					soft	grey	309	6		
20	34	34		St=2.0	138	9	SS	4							0 2 54 44
				16	44										
												308	7		
15	24	18		St=1.1	42	10	TW	-							
					41						SILT				
				31	41						with sandy silt & clayey silt seams				
19	24	21		St=1.3	40	11	SS	7			grey,wet	307	8		
				35	40										
				St=1.4	40										
					56										
					56							306	9		
	13				47	12	SS	5							14 68 18 0
					49					loose to compact					
					58							305	10		
					61										
					49										
	9				53	13	SS	21				304	11		12 75 (13)
					56										
					68					cobbles					
					85										
					118						SAND	303	12		
	11				127	14	SS	22			traces to some silt & gravel				
					50						grey, wet				
					49							302	13		
					53										
					77					----					
	9				70	15	SS	21				301	14		
					145					more					
					90	16	SS	15		gravel					
					91										Auger refusal on
												300	15		boulder @14.6m.
					74						--------				Install NQ casing
	15				75	17A	SS	32							
					76	17B	SS			----					and continue using
					92					silt &		299	16		washboring
					115					clayey silt					method.
					89					seams,dense					
	14				85	18	SS	69		to v.dense		298	17		8 85 (7)
					200/20										
												297	18		St: Sensitivity

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 2 BH No. LH1

LOG OF BOREHOLE LH1

ENCL. No.:

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 3rd, 1998

LABORATORY DATA						*SAMPLES*								
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 314.9 m				
	9					19	SS	52						
						20	SS	100/3	o0Oo	frequent cobbles & boulders	296 295	19 20		Refusal to further washboring at 19.2m.Continue with NQ casing. Cored between 19.2m and 20.7m, intermittent cobbles and boulders. Attempted to core twice after dynamic cone refusal at 21.0m but casing silted-in, could not core.
										End of Borehole @20.7m. Dynamic Cone Penetration Test conducted from 20.7m to 21.0m. Refusal @21.0m (100 blows/1cm). Notes:Water level @0.0m on completion. Standpipe piezometer installed to 18.3m W.L.in piezometer @0.75m on Dec.15/98.				

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 2 OF 2 BH No. **LH1**

LOG OF BOREHOLE LH2

ENCL. No.: 2

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 6th, 1998

SURFACE EL. 315.8 m

LABORATORY DATA PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	*SAMPLES* No.	TYPE	N-Value		REMARKS Gr	Sa	Si	Cl %
	22					1	SS	4	v.loose				
	20					2	SS	9	loose	0	86	13	1
	19				27 28	3	SS	22	compact				
	18				27 29 28	4	SS	12		1	91	8	0
	19				33 26	5	SS	15					
	14				28	~~6A~~	~~SS~~	~~13~~					
	24				25 24	~~6B~~	~~SS~~						
17	22	19			30 28	7	SS	16		0	15	79	6
	27			65 St=2.5	26 25 27	8	SS	11	compact				
16	21	18		30 St=1.3	28 31	9	SS	6	loose	0	11	83	6
	13				26 23 27	10	SS	6					
	11				30 40 35 31 39	11	SS	11	loose to compact	3	84	(13)	
	11				43 52 45 41 47	12	SS	5					
	19				49 55 52 58 65	13	SS	18	compact	17	70	(13)	
	8				100/9	14	SS	17					
	12					15	SS	25	loose				
	12					16	SS	7		6	85	(9)	
	9					17	SS	6					

MATERIAL DESCRIPTION

organic stain

FINE SAND
traces of silt
brown, wet

SILT
with sandy silt & silty clay seams
occ.sand seams
brown, wet

SAND
traces to some silt & gravel
occ.cobble
grey, wet

ELEV. m	DEPTH m
315	1
314	2
313	3
312	4
311	5
310	6
309	7
308	8
307	9
306	10
305	11
304	12
303	13
302	14
301	15
300	16
299	17
298	18

STATION
9+966
Lindsay's Hill
Road C/L

St:
Sensitivity

Vertical Scale: 1:100

AGRA

Checked: HS

SHEET 1 OF 2 BH No. LH2

LOG OF BOREHOLE LH2

ENCL. No.: -

REF. No.:	**TT98801**	*DRILLING DATA*	
CLIENT:	**DELCAN**		
PROJECT NAME:	**HWY 11, FOUR LANING**	Method:	**HolSt Augering**
LOCATION	**TROUT CREEK,ONTARIO**	Diameter:	**150 mm**
DATUM:	**Geodetic**	Date:	**November 6th, 1998**

LABORATORY DATA						*SAMPLES*			SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value		**SURFACE EL. 315.8 m**				Gr Sa Si Cl %
	11					18	SS	53		SAND & GRAVEL v.dense grey, wet	297	19		42 52 (6)
						19	SS	100/0		PINK GRANITE	296	20		
						20	RC	REC.=95% R.Q.D.=70%			295	21		REC.: Recovery R.Q.D.: Rock Quality Designation
						21	RC	REC.=95% R.Q.D.=80%			294 293	22 23		

End of Borehole

Notes:Water level @1.8m on completion.
Standpipe piezometer installed to 23.0m
W.L.in piezometer @1.3m on Dec.15/98.

Vertical Scale: **1:100**

AGRA

Checked: **HS**

SHEET **2** OF **2** BH No. **LH2**

LOG OF BOREHOLE LH3

ENCL. No.: 3

REF. No.:	**TT98801**	*DRILLING DATA*	
CLIENT:	**DELCAN**		
PROJECT NAME:	**HWY 11, FOUR LANING**	Method:	**HolSt Augering**
LOCATION	**TROUT CREEK,ONTARIO**	Diameter:	**150 mm**
DATUM:	**Geodetic**	Date:	**November 9th, 1998**

SURFACE EL. 316.7 m

LABORATORY DATA						*SAMPLES*			**MATERIAL DESCRIPTION**	**REMARKS**
PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value		
	27					1	SS	13	0.2m organic TOPSOIL	STATION 9+946 Lindsay's Hill Road C/L
	15					2	SS	8	loose	
	16					3	SS	23	FINE SAND traces of silt brown, compact damp wet	
	21					4	SS	15		0 97 (3)
	21					5	SS	18		
	19					6	SS	14		
15	22	20				7	SS	12	CLAYEY SILT to SILTY CLAY with silt seams grey, wet firm to stiff	0 7 88 5
	28					8	SS	7		
			20.5	37		~~8B~~	~~TW~~	~~-~~		
	14			St=1.4		9	SS	8	sand seams	TW8B: Consolidation test, Fig.No.4
	21					10	SS	-		
	16					11	SS	10		
	15					12	SS	24		31 61 8 0
	10					13	SS	75	v.dense SAND traces to some silt,some gravel grey, wet, compact occ.cobble	Sample 11: No recovery Refusal to futher augering @8.1m.Move borehole 1.5m west. Auger to 5.5m take shalby the (TW) sample. Auger to 9.1m and continue borehole.
	8					14	SS	25		
	10					15	SS	26		
	17					16	SS	11		
	13					17	SS	30		

ELEV. m	DEPTH m
316	1
315	2
314	3
313	4
312	5
311	6
310	7
309	8
308	9
307	10
306	11
305	12
304	13
303	14
302	15
301	16
300	17

WATER DATA

End of Borehole
Notes:Water level @2.3m and hole caved at 4.6m on completion.
Standpipe piezometer installed to 17.2m
W.L.in piezometer @2.2m on Dec.15/98.

Vertical Scale: **1:120**

AGRA

Checked: **RM**

SHEET **1** OF **1** BH No. **LH3**

LOG OF BOREHOLE LH4

ENCL. No.: 4

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 9th, 1998

SURFACE EL. 316.9 m

LABORATORY DATA PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	Lab Compr kPa	*SAMPLES* No.	TYPE	N-Value
	10					1	SS	5
	12					2	SS	26
	23					3	SS	11
	19					4	SS	16
	22					5	SS	18
	12					6A	SS	26
	18					6B	SS	
	23					7	SS	14
	20					8A	SS	9
						8B	SS	
	15					9	SS	21
	13					10	SS	14
	16					11	SS	20
	19					12	SS	9
	12					13	SS	31
	13					14	SS	32
	13					15	SS	11
						16	SS	200/1

MATERIAL DESCRIPTION

organic stain

loose

FINE SAND
brown, wet
loose to compact

occ.gravel

SANDY SILT
occ.sand seams & clayey zones
grey, wet

compact

loose

compact

compact

SAND
traces to some silt & gravel
occ.cobble

loose

dense

compact

possible BEDROCK

End of Borehole
Auger refusal
Notes:Water level @3.0m and hole caved at 3.0m on completion.
Standpipe piezometer installed to 14.7m
W.L.in piezometer @2.6m on Dec.15/98.

ELEV. m	DEPTH m
316	1
315	2
314	3
313	4
312	5
311	6
310	7
309	8
308	9
307	10
306	11
305	12
304	13
303	14

WATER DATA

REMARKS

STATION
9+925
Lindsay's Hill
Road C/L

N=200/1:
200 blows for 1cm penetration.

Vertical Scale: 1:120

AGRA

Checked: RM

SHEET 1 OF 1 BH No. LH4

LOG OF BOREHOLE LH5

ENCL. No.: 5

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 9th, 1998

LABORATORY DATA / *SAMPLES* / **MATERIAL DESCRIPTION** / **REMARKS**

PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	REMARKS
	115					1	SS	0	
	19					2	SS	6	0 94 (6)
	24					3	SS	13	
	18					4	SS	11	
	19					5	SS	12	0 97 (3)
	22					6	SS	4	0 97 (3)
	20					7	SS	21	
18	27	21				8	SS	11	STATION 10+040 Lindsay's Hill Road C/L
						9	TW		
23	38	33		37 St=2.5		10	SS	0	0 2 71 27
				29 St=2.6		11	SS	2	
21	38	37	17.8	33 St=2.7	20	12	TW		0 0 62 38
				25 St=2.5		13	SS	5	0 0 72 28
16	28	19				14	SS	14	0 7 85 8 TW12: Consolidation test, Fig.No.5
	17					15	SS	18	
	19					16	SS	43	2 65 31 2
	16					17	SS	25	
	11					18	SS	33	
	18					19	SS	26	6 70 22 2
	19					20	SS	35	
	11					21	SS	134	23 63 (14)

SURFACE EL. 314.5 m

0.2m organic TOPSOIL

v.loose
------
loose

compact

FINE SAND
traces of silt
brown, wet
loose to compact

----
v.loose
----
compact

SILT
with sandy silt & silty clay seams
grey, wet, compact

SILTY CLAY to CLAYEY SILT
grey, wet
firm

SILT
occ.clayey zones
grey, wet
compact

SAND
traces to some silt
occ.gravel & cobbles
compact to dense

-----
frequent
cobbles

gravelly

ELEV. m: 314, 313, 312, 311, 310, 309, 308, 307, 306, 305, 304, 303, 302, 301, 300, 299, 298, 297, 296, 295, 294, 293

DEPTH m: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

WATER DATA

Vertical Scale: 1:120

AGRA

Checked: RM

SHEET 1 OF 2 BH No. LH5

LOG OF BOREHOLE LH5

ENCL. No.:

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 9th, 1998

LABORATORY DATA						*SAMPLES*								
PL %	W %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value	SYMBOL	**MATERIAL DESCRIPTION**	ELEV. m	DEPTH m	WATER DATA	**REMARKS**
										SURFACE EL. 314.5 m				
						22	SS	100/3		SAND traces to some silt occ.gravel & cobbles compact to dense	292 291	23 24		Install NW casing and continue borehole by washboring below 21.8m.
						23	SS	100/1						
						24	RC	REC.=96% R.Q.D.=95%		PINK GRANITE	290 289	25 26		REC.: Recovery R.Q.D.: Rock Quality Designation
						25	RC	REC.=97% R.Q.D.=96%			288 287	27		

End of Borehole

Notes: Water level @0.0m on completion.

Standpipe piezometer installed to 21.3m

W.L.in piezometer @0.1m on Dec.15/98.

Vertical Scale: 1:120

AGRA

Checked: RM

SHEET 2 OF 2 BH No. LH5

LOG OF BOREHOLE LH6

ENCL. No.: 6

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 14th, 1998

SURFACE EL. 314.4 m

LABORATORY DATA PL %	w %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	*SAMPLES* No.	TYPE	N-Value
						1	SS	3
	24					2	SS	7
	23					3	SS	10
	26					4	SS	9
	19					5	SS	5
	17					6	SS	24
	23					7	SS	13
	23					8	SS	14
16	24	20		51 St=2.3		9	SS	7
			18.6	35 St=2.3	25	9A	TW	-
	31			39 St=2.4		9B 10	TW SS	2
				49 St=3.4				
22	38	34				11	SS	2
				22 St=2.1				
22	39	31				12	SS	2
				26 St=2.5				
22	34	33				13	SS	17
				47 St=3.8				
						14	SS	17
						15	SS	52

MATERIAL DESCRIPTION

v.loose — 0.2m organic TOPSOIL

FINE SAND
traces of silt
brown, wet
loose to compact

stiff to firm freq.silt seams

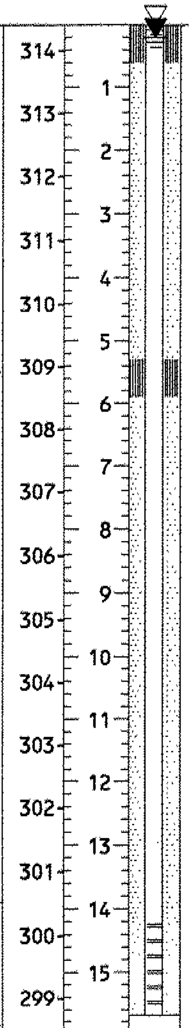
SILTY CLAY to CLAYEY SILT
occ.sandy silt seams
grey, wet
firm to soft

stiff to v.stiff

compact / v.dense

SAND
traces of silt
grey, wet

End of Borehole
Notes:Water level @0.0m and hole caved at 6.2m on completion.
Standpipe piezometer installed to 15.7m
W.L.in piezometer @0.2m on Dec.15/98.



REMARKS

STATION
10+060
Lindsay's Hill
Road C/L

0 7 87 6

TW9A:
Consolidation test,
Fig.No.6

Vertical Scale: 1:120

AGRA

Checked: RM

SHEET 1 OF 1 BH No. LH6

LOG OF BOREHOLE LH7

ENCL. No.: 7

REF. No.:	TT98801	*DRILLING DATA*	
CLIENT:	DELCAN		
PROJECT NAME:	HWY 11, FOUR LANING	Method:	HolSt Augering
LOCATION	TROUT CREEK,ONTARIO	Diameter:	150 mm
DATUM:	Geodetic	Date:	November 14th, 1998

LABORATORY DATA						*SAMPLES*			SYMBOL	MATERIAL DESCRIPTION	REMARKS
PL %	W %	LL %	UNIT WT kN/m3	UNDR STRNG Field Vane kPa	UNDR STRNG Lab Compr kPa	No.	TYPE	N-Value		SURFACE EL. 314.4 m	
						1	SS	3		PEAT	STATION 10+080 Lindsay's Hill Road C/L
	175					2	SS	11			
						3	SS	8		loose	
	22					4	SS	13		---- compact	
	21					5	SS	12		FINE SAND occ.sandy silt seams brown, wet	
	17					6	SS	14			
	20					7	SS	8		----- loose	
	26					8	SS	22		----- compact	
	16					9	SS	24			
	33					10A	SS	5			
18	33	30	19.3	21 St=1.2	12	10B	TW	-			TW10B: Consolidation test, Fig.No.7
				46 St=3							
	33					11	SS	5			
				25 St=2						SILTY CLAY to CLAYEY SILT occ.silt & sand seams grey, wet soft to firm	
20	37	33				12	SS	4			
				19 St=1.4							
	38					13	SS	3			
				24 St=1.9							
23	37	33				14	SS	6			Extend borehole using tricone
				24 St=2.1							
	38					15	SS	4			
				27 St=1.6							
	32					16	SS	13		----- stiff to v.stiff	
	28					17	SS	16			GROUNDWATER IN OPEN BORE on completion: 0.0m IN PIEZOMETER: Dec.15/98 0.3m
20	28	25				18	SS	23		more silty	
										End of Borehole	

ELEV. m: 314, 313, 312, 311, 310, 309, 308, 307, 306, 305, 304, 303, 302, 301, 300, 299, 298, 297, 296, 295

DEPTH m: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

WATER DATA

Vertical Scale: 1:120

AGRA

Checked: RM

SHEET 1 OF 1 BH No. LH7

CONT. No. –
W.P. No. 772–93–01

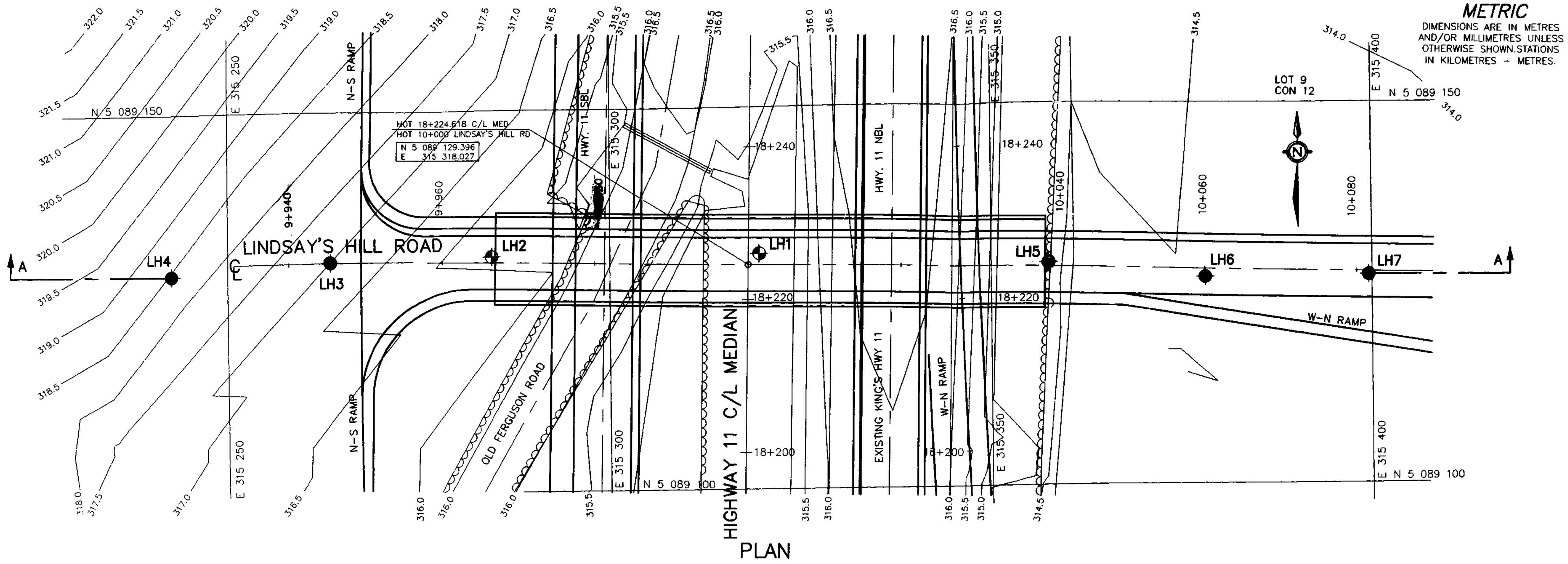
LINDSAY'S HILL ROAD UNDERPASS

BORE HOLE LOCATIONS&SOIL STRATA

SHEET

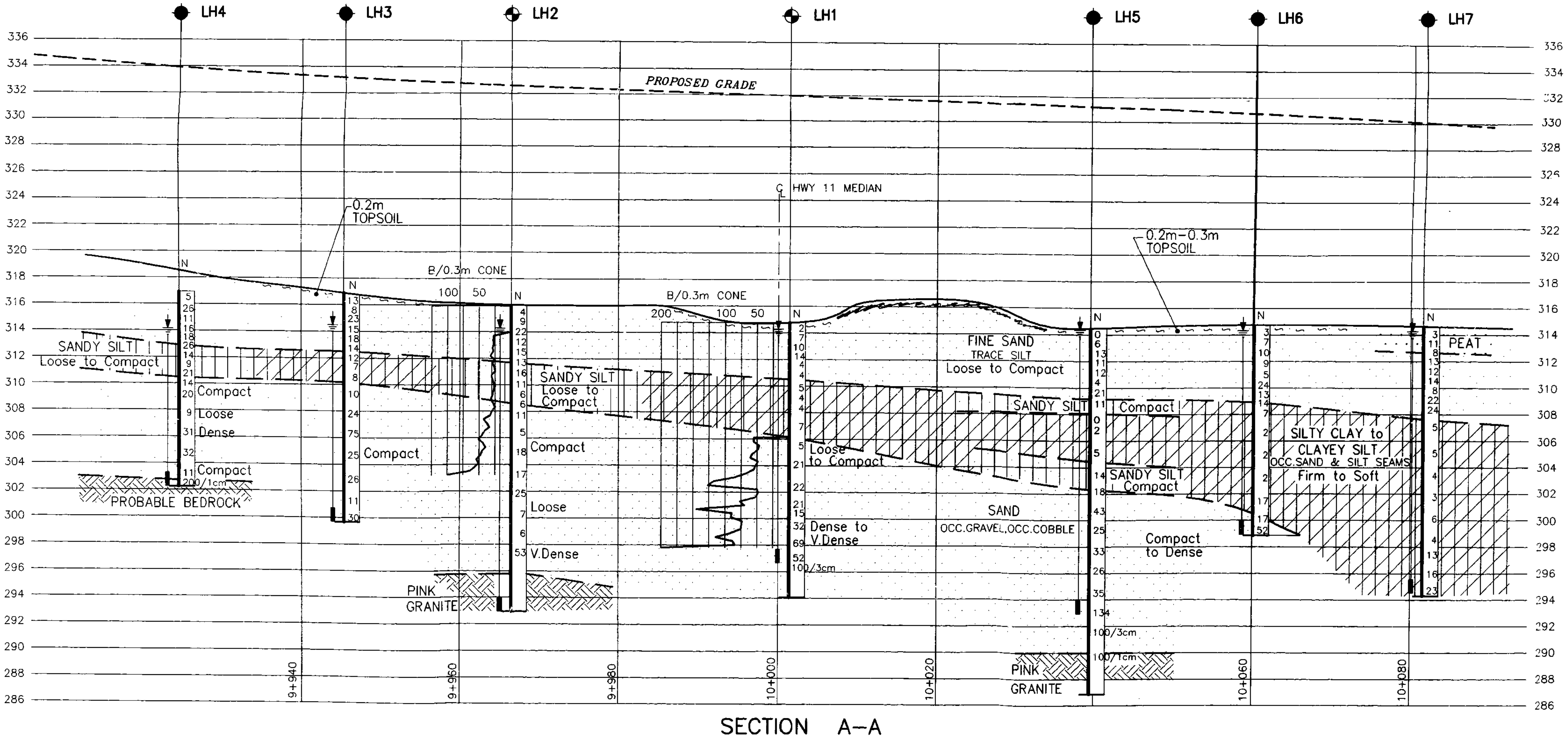
AGRA Earth & Environmental Ltd.

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.STATIONS IN KILOMETRES – METRES.



PLAN

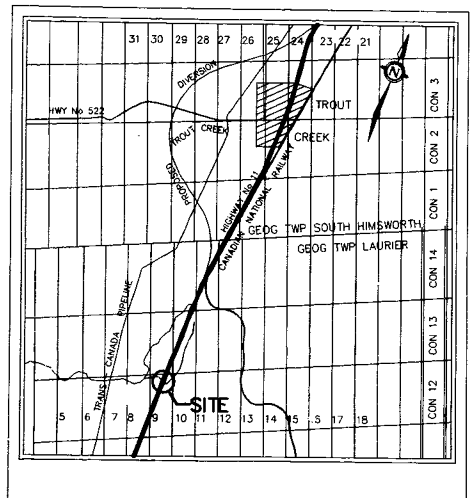
5m 0 5m



SECTION A–A

5m 0 5m HOR
3m 0 3m VER

REF.Hwy 11 Bridge Site Plan
Dwg. by MTO; Oct.1998



KEY PLAN

1 km 0 1 km

LEGEND

●	Bore Hole
⊕	Dynamic Cone Penetration Test (Cone)
◐	Bore Hole & Cone
'N'	Blows/0.3m (Std Pen Test, 475 J/blow)
CONE	Blows/0.3m (60° Cone, 475 J/blow)
▼	WL at time of investigation Nov. 98
↓	WL in Piezometer
▮	Piezometer

No	ELEVATION	CO–ORDINATES NORTH	CO–ORDINATES EAST
LH1	314.9	5 089 131	315 319
LH2	315.8	5 089 131	315 285
LH3	316.7	5 089 130	315 264
LH4	316.9	5 089 129	315 242
LH5	314.5	5 089 129	315 357
LH6	314.4	5 089 127	315 378
LH7	314.4	5 089 127	315 400

–NOTE–
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Matelials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen.Cond.

REV.	DATE	BY	DESCRIPTION

HWY No 11			DIST PARRY SOUND
SUBM'D HS	CHECKED	DATE Jan.19,1999	SITE 44–375
DRAWN MA	CHECKED	APPROVED	DWG 1

FILE: