G.I.-30 · SEPT. 1976

GEOCRES No. 40P8-118

DIST. _____ REGION _____

W.P. No. 363-94-00

CONT. No. _____

W. O. No. _____

STR. SITE No. 33-221

HWY. No. 8

LOCATION King St. Retaining Wall &
Franklin St. Bridge

No of PAGES - _____

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

memorandum

Ontario

TO: B. Thamabala, Bridge Office
K. Bentley, Planning and Design Section
H. Welker, District Engineer
J. Richards (2 copies), Construction Office
T. Kim, Pavements and Foundation Office
A. Ho, Structural Section

DATE: 1999-09-10

RE: **WP 363-94-00**
Site 33-221 Franklin Street Underpass
Hwy. 8, District 31 – London/Stratford

Attached are revised recommendations to the Foundation Investigation and Design for the above structure.

Any comments you may have should be forwarded to this office on or before September 27, 1999.

If no comments are received by this date, it will be assumed that you are in agreement with the contents of the reports.

This memo is design change. Need to digitize.

Tom

John F. Meyer
Structural Project Manager
For: Alfred Ho, Head
Structural Section
Southwestern Region, London
Telephone: (519) 873-4342
Facsimile: (519) 873-4350

Attachment

Cc: D. Terpstra (memo only)

memorandum

Ontario

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Attachment

Cc: D. Terpstra (memo only)

Document: \\MTOSRRDC01\USERS\MeyerJo\DATA\WP 363-94-00 TPM Hwy 8\SDR and GA Dwg Distribution Franklin St Revision.doc *(Friday, September 10, 1999 11:09)*

AGRA
ENGINEERING GLOBAL SOLUTIONS

AGRA Earth & Environmental Limited
440 Phillip Street
Unit 8
Waterloo, Ontario
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Tel (519) 885-6220
Fax (519) 885-3490

August 27, 1999

Morrison Hershfield
4 Lansing Square
North York, Ontario
M2J 1T1

ATTENTION: MR. DOUG HOFFMAN

Re: REVISED FOUNDATION RECOMMENDATIONS FOR RETAINING WALL
FOUNDATION INVESTIGATION AND DESIGN REPORT
PROPOSED KING STREET RETAINING WALL
AND FRANKLIN SREET BRIDGE, STRUCTURE 33-221
W.P. 363-94-00, AGREEMENT NO. 9730-7411-3178
HWY8/CONESTOGA PARKWAY INTERCHANGE AND
HWY 8 FROM CONESTOGA PARKWAY TO FERGUS AVENUE

The enclosed are our revised recommendations for the footing design for the retaining wall along King Street. Our report dated July 21, 1999 has suggested highest bearing elevations for footing design. The revised recommendations provide higher geotechnical soil bearing resistances at lower founding elevations.

The footing should bear on the undisturbed, dense to very dense native sand to silty fine sand and designed to the bearing resistances shown below:

Factored Geotechnical Resistance at ULS	**700 kPa**
Geotechnical Resistance at SLS	**350 kPa**

The footings should have a minimum width of 1.2 m. The SLS value given above is based on a maximum settlement of 25 mm under the footing. This can be achieved provided that the founding subgrade is undisturbed during construction.

Borehole No.	Existing Ground surface elevation (m)	Proposed Highest Footing Base (m)		Subgrade Material
		Below Existing Ground Surface	Elevation	
98-01	327.4	2.8	324.6	Sand
98-02	327.3	3.0	324.3	Sand
98-03	327.2	3.2	324.0	Sand/Sand and Gravel
98-04	327.1	4.2	322.9	Sand/Sand and gravel
98-05	327.0	3.7	323.3	Sand to Silty Sand
98-06	327.0	4.2	322.8	Sand and Gravel/Silty Sand
98-07	327.0	6.4	320.6	Sand
98-08	327.1	3.2	323.9	Sand to Silty Sand
98-09	326.9	4.6	322.3	Sand
98-10	326.8	4.0	322.8	Sand
98-10A	326.7	6.0	320.7	Sand
98-13	326.7	2.7	324.0	Sand to Silty sand
98-14	326.6	4.0	322.6	Sand to Silty sand
98-15	326.6	4.0	322.6	Sand
98-16	326.4	4.5	321.9	Sand to Silty sand
98-17	326.1	4.1	322.0	Sand
98-18	325.8	3.3	322.5	Sand
98-19	325.6	4.8	320.8	Sand
98-20	325.3	3.7	321.6	Sand
98-21	325.0	3.6	321.4	Sand
98-22	324.4	3.4	321.0	Sand

320 m

Alternatively where required, any unsuitable soils can be removed and replaced with properly compacted engineered fill (i.e. Granular "A" quality material) to the underside of the proposed footing. In this instance, the engineered fill should extend at least 0.6 m beyond the foot-print of the footing and should be uniformly compacted in suitably thin layers to at least 100 % of its standard Proctor maximum dry density.

It should also be pointed out that depending on the water table at the time of construction, in some areas, the soil conditions and/or the required footing elevations may dictate footing excavation be extended to below the water table (e.g. Boreholes 98-13, 98-14, 98-15, 98-16 and 98-17). Should this occur, careful dewatering will be required to prevent the disturbance of the founding soils.

All footing excavations should be carefully inspected by the geotechnical engineer to ensure that the footings are founded on undisturbed natural soils, which are capable of supporting the design pressures. It should be pointed out that where the footings are at relatively higher elevations (e.g. near the ends of the project and away from the Franklin Street Bridge where the existing pavement grades are relatively higher), the footings may need to be extended deeper than the maximum frost depth to ensure that they extend below any fill and/or upper weaker zones of the natural sand.

Other recommendations stated in the July 21, 1999 report are applicable.

If you have any questions, please do not hesitate to contact our office.

Yours truly,
AGRA Earth & Environmental Limited

Eric Y. Chung, M.Eng., P.Eng.
Kitchener-Waterloo Branch Manager

Zuhtu S. Ozden, P.Eng.
Designated MTO Contact

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FOUNDATION INVESTIGATION AND DESIGN REPORT
PROPOSED KING STREET RETAINING WALL
AND FRANKLIN SREET BRIDGE
STRUCTURE 33-221
W.P. 363-94-00, AGREEMENT NO. 9730-7411-3178
HWY8/CONESTOGA PARKWAY INTERCHANGE AND
HWY 8 FROM CONESTOGA PARKWAY TO FERGUS AVENUE

Submitted to:

Mr. Doug Hoffman, Principal
Morrison Hershfield Limited
4 Lansing Square
North York, Ontario
M2J 1T1

Distribution:

16 Copies - Morrison Hershfield Limited

2 Copies - AGRA Earth & Environmental Limited, Waterloo

June 26, 1999
Project No.: TK98-10-3

GEOCRES No 40P8-118

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1. INTRODUCTION

This report presents the results of a foundation investigation carried out by AGRA Earth & Environmental Limited (AGRA) on behalf of Morrison Hershfield Limited at the site of the proposed widening of Highway 8 from Fergus Avenue north to Dellroy Avenue (Structure 33-221).

The purpose of the investigation was to obtain information about the subsurface conditions at the site by means of boreholes and, based on this information, to provide geotechnical recommendations for the foundation elements of the new retaining wall along the east limit of Highway 8 and the proposed reconstruction of Franklin Street Bridge.

The existing east retaining wall will be demolished and relocated approximately 6 to 8 m to the east to accommodate the proposed S-E Ramp. The new retaining wall will have approximately the same length as that of the existing retaining wall, approximately 660 m from Station 11+060 north to Station 10+400 (Highway 8 stations). King Street will be cut some 1 to 6 m and the finished grade of the new pavement will match that of Highway 8 north bound. The deepest cut will be in the area of Franklin Street. The west retaining wall will not be reconstructed except near the west abutment of Franklin Street Bridge.

The Franklin Street Bridge will be demolished and reconstructed. The new bridge will be a two span post-tensioned structure, each span measuring 23.3 m long. The new bridge will be 5 m wider than the existing structure.

The work presented herein was undertaken under MTO W.P. 363-94-00, Agreement No. 9730-7411-3178, and authorized by Morrison Hershfield Limited, in a letter dated November 2, 1998.

E.M. Peto and Associates undertook previous investigation work at this site in 1964 for the existing retaining wall and Franklin Street Bridge. This information was reviewed to supplement the present investigation.

2. SITE DESCRIPTION

2.1 Site Location

The site is located in the City of Kitchener along Highway 8 from Fergus Avenue north to Dellroy Avenue including the Franklin Street Bridge (underpass) structure, which was constructed in 1966-1967. This section of Highway 8 is depressed due to the level crossing of Franklin Street between Kingsway and King Street. The existing grade along King Street slopes downwards in a northerly direction from Elevation 327.5 to 324.3 m within the 660 m long limits of the proposed retaining wall. At Franklin Street Bridge, the pavement grade on Highway 8 is near Elevation 321.0 m that is approximately 6 m below the grades of King Street and Kingsway. The existing retaining walls, which are 1 to 6 m high, were constructed to provide the grade separation.

Based on available drawings, the existing retaining walls were supported on spread footings. Franklin Street Bridge was also supported on spread footings with the bridge abutments incorporated into the retaining walls.

2.2 Physiography and Topography

The site is located within the Physiographic Region known as the Waterloo Sandhills. The area is characterized by a flat topography, heavy textured soil and poor drainage (Chapman and Putnam, 1984). The area also has a preponderance of fine sand, particularly on the surface. The hilly region is an extensive area of alluvial terraces of the Grand River spillway system which, although more nearly horizontal, contains similar but more uniform sandy and gravelly materials. Several till sheets underlie the area and are, in order from oldest to youngest, the Catfish Creek Till, Maryhill Till, and Port Stanley Till.

The elevation of the subject site ranges from 321 to 327 m above mean sea level and slopes gently to the north locally in the vicinity of the site, with the exception of an area of depressed pavement on Highway 8 underneath the Franklin Street Bridge.

3. INVESTIGATION PROCEDURES

3.1 Field Investigation

Between November 16, 1998 and February 11, 1999, a CME 75 truck mounted drill rig was used on site for drilling and Standard Penetration Testing (SPT, following the procedures of ASTM D 1586). The initial drilling involved twenty-two (22) boreholes drilled along King Street for the proposed retaining wall and at the Franklin Street Bridge. Subsequently, three (3) deep boreholes were drilled and sampled to obtain data for foundation design of the proposed reconstruction of the Franklin Street Bridge foundations resulted from the widening of the bridge by 5 m. The locations of the boreholes are shown on Drawings A, B and C.

The boreholes were numbered 98-01 through 98-22. The three (3) deep boreholes drilled at the Franklin Street Bridge were numbered 98-10A, 98-11A and 98-12A. The stations and depths of the boreholes are as follows:

Borehole No.	Station No.	Depth of Borehole (m)
98-01	11 + 055 22.0 LT	5.1
98-02	10 + 997 22.4 LT	5.1
98-03	10 + 979 22.4 LT	5.8
98-04	10 + 943 22.4 LT	6.6
98-05	10 + 895 22.4 LT	8.1
98-06	10 + 873 22.4 LT	8.1
98-07	10 + 839 22.4 LT	8.9
98-08	10 + 800 23.2 LT	9.6
98-09	10 + 774 21.6 LT	10.7

98-10	10 + 760 20.8 LT	17.2
98-10A	10 + 721 21.5 LT	32.2
98-11	10 + 747 4.0 RT	11.1
98-11A	10 + 745 4.1 RT	27.7
98-12	10 + 710 25.0 RT	8.1
98-12A	10 + 761 26.0 RT	21.8
98-13	10 + 702 20.8 LT	11.1
98-14	10 + 678 20.8 LT	12.7
98-15	10 + 634 20.8 LT	10.7
98-16	10 + 618 20.0 LT	11.1
98-17	10 + 591 19.6 LT	9.6
98-18	10 + 548 18.4 LT	9.2
98-19	10 + 525 18.4 LT	8.1
98-20	10 + 482 19.2 LT	7.3
98-21	10 + 455 19.6 LT	7.3
98-22	10 + 402 19.2 LT	5.1

The boreholes were drilled using hollow stem augers. Water and/or drilling mud were used to counter-balance the hydrostatic pressure within the hollow stem augers to prevent "blow back" of sands and silts during the borehole advancement and sampling operations.

Soil samples were retrieved at selected intervals of depths throughout the boreholes in conjunction with Standard Penetration Tests (SPT). Samples were generally taken at intervals of 0.75 m in the upper 6 m and thereafter at intervals of 1.5 m to the maximum depth of exploration.

Seepage and water levels were noted in each borehole during and at the completion of drilling and sampling. Standpipe piezometers were installed in Boreholes 98-05, 98-10, 98-11, 98-15, 98-19 and 98-21 for future monitoring of the groundwater levels. All boreholes were grouted with bentonite mix at completion of sampling.

The fieldwork was supervised by a member of our field engineering staff under the direction of the project engineer. Our field staff cleared the location of buried utilities and logged the boreholes. The soil samples obtained were placed in labeled containers and transported to our Waterloo Office for further examination and laboratory testing.

The stations, offsets and ground surface elevations at the as drilled borehole locations were surveyed by Morrison Hershfield Limited and provided to AGRA for the purpose of this report.

The results of the drilling, sampling, in-situ testing and water level measurements are summarized on the Record of Borehole sheets and are enclosed in Appendix "A".

3.2 Laboratory Analysis

Geotechnical laboratory testing consisted of natural moisture content determinations and visual classifications of all retrieved soil samples. In addition, grain size analyses, Atterberg Limits and laboratory standard Proctor tests were performed on selected samples. Several soil samples were submitted to AGRA Mississauga Laboratory to test the electro-chemical properties that include resistivity, pH, Chlorides and Sulphates.

The results of the laboratory testing are presented on the borehole logs enclosed in Appendix "A", and in Figures 1 to 15 in Appendix "B".

The electro-chemical test results are included in Appendix "C".

4. SUBSURFACE CONDITIONS

4.1 General Subsurface Conditions

In general, the subsurface deposits at the site consist of fine sand to silty fine sand, to depths of about 8 to 14 m depths below the ground surface. Several boreholes also contacted silt till underlying the sand deposits.

The six (6) deep boreholes for the Franklin Street Bridge contacted fine sand to silty sand underlain by silt, silt till and silty clay which are in turn underlain by a basal silt till at approximate Elevation 298 m. It appears that the upper silt till layer extends across the entire site, underlying the sand deposits. In the vicinity of the Franklin Street bridge, the till layer was interbedded by sand, silt and silty clay layers.

Surficial pavement structures, topsoil and fills were also contacted in the upper 2.5 to 4.0 m zone along King Street.

4.1.1 Pavement, Fill, Topsoil

All boreholes, with the exception of Boreholes 98-11 and 98-11A, were drilled within the pavement of King Street and Kingsway. Boreholes 98-11 and 98-11A were drilled in the median area of Highway 8 underneath Franklin Street Bridge.

The pavement structure consists of 80 to 120 mm of asphalt over typically 180 to 300 mm of crushed granular base. The crushed granular base is underlain by a discontinuous sand and gravel fill, which is assessed to be the granular sub-base course. This material extends typically to about 0.7 to 1.0 m below ground surface.

Fill materials were encountered underneath the pavement and consisted of generally silty sand with a trace of gravel. The fill materials are assumed to be related to the buried utility construction or backfill to the existing retaining walls. Five (5) typical grain size distributions of the silty sand fill are shown in Figure 1 of Appendix "B". Laboratory Standard Proctor test results of three (3) fill materials are provided on Figures 7, 8 and 9 of Appendix "B".

The fill was very loose to compact as indicated by "N" values in the range of 3 to 28 blows per 0.3 m. The upper portion of the fill (immediately underneath the pavement) is generally in compact condition while the lower portion is loose to very loose.

Locally at Borehole 98-12 and 98-12A (Franklin & Kingsway) the fill encountered was compact to dense, as indicated by "N" values of 12 to 32 blows per 0.3 m. This fill is the compacted backfill behind the west retaining wall.

There was a 180 mm thick topsoil layer contacted at the ground surface of Boreholes 98-11 and 98-11A, and then crushed granular fill to 0.7 m below grade.

The fill materials were generally in damp to moist condition with natural moisture contents measured between 5 and 15 %.

4.1.2 Sand to Silty Sand

The major native soil deposit underlying the site is a sand deposit, which is predominantly fine sand with traces to some silt. It is frequently bedded with silt to sandy silt layers and occasional sand and gravel seams/layers. The thickness and sequence of occurrence of the various minor inter-bedded deposits do not appear to follow any pattern. The deposit extends to depths of ± 8 to 14 m below the King Street grade, corresponding to Elevations ± 313 to 319 m.

Twenty-two (22) grain size analyses were performed and the results are shown in Figures 2, 3, 4 and 5 of Appendix "B". The majority of this deposit does not meet OPSS Granular "B" Type 1 specification. Laboratory Standard Proctor test results of four (4) sand materials are provided on Figures 10 to 13 of Appendix "B".

Standard penetration tests yielded "N" values from 7 to in excess of 100 blows per 0.3 m. The majority of the "N" values are in the range of 20 to 50, indicative of a compact to dense condition. There are however occasional loose layers in the upper stratum of the deposit, generally immediately below the fill soils.

The sand deposit was in damp to moist condition above the water table with moisture contents recorded in the range of 5 to 10 %. Below the water table, the material was wet to saturated with moisture contents measured between 15 and 25 %.

The electro-chemical properties of the sand deposit including resistivity, pH, Chlorides and Sulphates were tested and the results are provided on Appendix "C".

4.1.3 Silt

Immediately underlying the sand to silty sand in the deep boreholes, there is a discontinuous layer of grey silt contacted in Boreholes 98-10, 98-11, 98-11A and 98-12A. This layer was encountered below elevations ranging from 314.9 to 310.9 m and was 1.5 to 3.7 m thick. Standard penetration tests yielded "N" values from 18 to 80 blows per 0.3 m indicating a compact to very dense condition.

The silt layer was saturated with moisture contents measured between 12 and 18 %.

4.1.4 Upper Silt Till

A heterogeneous mixture of sand, silt, gravel and clay (glacial till) was encountered below the upper sand to silty sand or silt deposits in Boreholes 98-10, 98-10A, 98-11, 98-11A, 98-12, 98-14, 98-18 and 98-21. This upper till layer was underlain by sand, silt and silty clay deposits at Boreholes 98-10, 98-10A, 98-11and 98-11A . In Borehole 98-12A, this till deposit continued to at least Elevation 305 m. This silt till deposit was also contacted in the previous boreholes that were drilled for the existing retaining walls and Franklin Street Bridge in 1964.

The grain size distribution of a sample from Borehole 98-21 is shown on Figure 6 of Appendix "B".

Standard penetration tests yielded "N" values from 33 to over 100 blows per 0.3 m. The silt till is classified as dense to very dense. Natural moisture contents were between 8 and 15 %.

Boulders and/or cobbles are frequently embedded within glacial till deposits. The very high blow counts and augering resistance within the silt till may infer the presence of cobbles and boulders.

4.1.5 Silty Clay

A major stratum of grey silty clay was contacted below the upper till layer and above the basal till layer in the deep boreholes (Boreholes 98-10A and 98-11A) at Franklin Street Bridge.

This deposit was encountered at Elevation ±307 m and extended to Elevation ±298 m, and was approximately 9 m thick. It was not contacted in Borehole 98-12A.

Standard penetration tests yielded "N" values from 61 to over 100 blows per 0.3 m, indicating a hard consistency. The natural moisture contents were in the range of 12 to 19 %, indicative of damp to dry condition. The Liquid Limit and Plastic Limit were determined on one sample (see Figure 14 of Appendix "B") to be 38 and 18 %, respectively. Therefore, this deposit is considered to be pre-consolidated and has a hard consistency.

4.1.6 Lower Silt Till

A heterogeneous mixture of sand, silt, gravel and clay (glacial till) was found in the three (3) deep boreholes (98-10A, 98-11A and 98-12A) and contacted at Elevations 297.8, 297.9 and 312.6 m at Boreholes 98-10A, 98-11A and 98-12A, respectively.

The silt till was penetrated 3.3 to 7.4 m where boreholes were terminated. Standard penetration tests yielded "N" values from 85 to over 100 blows per 0.3 m. Based on these test results, the silt till is classified as very dense. Natural moisture contents were between 8 and 16 %. . The Liquid Limit and Plastic Limit were determined on one sample (see Figure 15 of Appendix "B") to be 25 and 14 %, respectively.

Boulders and/or cobbles are frequently embedded within glacial till deposits. The very high blow counts and augering resistance within the silt till may infer the presence of cobbles and boulders.

4.2 Groundwater Conditions

On completion of drilling, the following observations of groundwater levels were made:

Borehole No.	Depth of Borehole (m)	Station No.	Observation
98-01	5.1	11 + 055 22.0 LT	No free water upon completion
98-02	5.1	10 + 997 22.4 LT	No free water upon completion
98-03	5.8	10 + 979 22.4 LT	No free water upon completion
98-04	6.6	10 + 943 22.4 LT	Free water at 4.8 m, Elevation 322.3 m upon completion
98-05	8.1	10 + 895 22.4 LT	Water at 7.3 m, Elevation 319.7 m on 3/3/99, in standpipe
98-06	8.1	10 + 873 22.4 LT	Free water at 7.6 m, Elevation 319.4 m upon completion
98-07	8.9	10 + 839 22.4 LT	Free water at 8.3 m, Elevation 318.7 m upon completion
98-08	9.6	10 + 800 23.2 LT	Free water at 5.9 m, Elevation 321.2 m upon completion
98-09	10.7	10 + 774 21.6 LT	Free water at 7.0 m, Elevation 319.9 m upon completion
98-10	17.2	10 + 760 20.8 LT	Water at 9.6 m, Elevation 317.2 m on 1/26/99, in standpipe
98-10A	32.2	10 + 721 21.5 LT	Free water at 7.9 m, Elevation 318.8 m upon completion
98-11	11.1	10 + 747 4.0 RT	Water at 1.9 m, Elevation 319.0 m on 1/26/99, in standpipe
98-11A	27.7	10 + 745 4.1 RT	Free water at 1.9 m, Elevation 319.0 m upon completion
98-12	8.1	10 + 710 25.0 RT	Free water at 7.8 m, Elevation 319.1 m upon completion
98-12A	21.8	10 + 761 26.0 RT	Free water at 8.5 m, Elevation 318.4 m upon completion
98-13	11.1	10 + 702 20.8 LT	Free water at 7.3 m, Elevation 319.4 m upon completion
98-14	12.7	10 + 678 20.8 LT	Free water at 7.4 m, Elevation 319.2 m

			upon completion
98-15	10.7	10 + 634 20.8 LT	Water at 7.2 m, Elevation 319.4 m on 3/3/99, in standpipe
98-16	11.1	10 + 618 20.0 LT	Free water at 7.0 m, Elevation 319.4 m upon completion
98-17	9.6	10 + 591 19.6 LT	Free water at 6.8 m, Elevation 319.3 m upon completion
98-18	9.2	10 + 548 18.4 LT	Free water at 6.4 m, Elevation 319.4 m upon completion
98-19	8.1	10 + 525 18.4 LT	Water at 6.3 m, Elevation 319.3 m on 3/3/99, in standpipe
98-20	7.3	10 + 482 19.2 LT	Free water at 5.9 m, Elevation 319.4 m upon completion
98-21	7.3	10 + 455 19.6 LT	Water at 5.6 m, Elevation 319.4 m on 1/26/99, in standpipe
98-22	5.1	10 + 402 19.2 LT	Free water at 4.7 m, Elevation 319.7 m upon completion

The water table was some 5 to 9 m below the King Street grade, corresponding to Elevations 322.3 to 317.2 m. The water level at the depressed Highway 8 underneath the Franklin Street Bridge was 1.9 m below grade, corresponding to Elevation 319.0 m. These water levels indicate that the groundwater flows in a north-west direction towards Montgomery Creek. It may also flow locally towards the depressed Highway 8 and/or to the storm water system under Highway 8.

It is noted that the water table was measured at Elevation 320.0 m (1050 ft) in 1964 prior to construction of the retaining walls and the depressed Highway 8.

The water levels recorded indicate the static water level of the shallow water table. Fluctuation in the groundwater table can be expected seasonally and in response to major weather events.

5. DISCUSSION AND RECOMMENDATIONS

5.1 General

This section of the report provides our recommendations on the geotechnical aspects of foundation design of the proposed King Street Retaining Wall and Franklin Street Bridge structure (Structure 33-221), based on our interpretation of the factual information obtained during this investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction, they are provided only to highlight those aspects, which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction method and scheduling.

The proposed bridge structure over Franklin Street will be a 46.6 m long, two (2) span, post-tensioned concrete structure. The abutment walls will form part of the east and west retaining walls, retaining King Street and Kingsway, respectively.

The location and soil data of the retaining wall along King Street are schematically shown on Drawings A and B. Based on the proposed retaining wall profile, the height of the retaining wall will range from 1 to 6 m.

The soil data and profile of the replacement Franklin Street Bridge including the abutments and the central pier are provided on Drawing C. The design of an integral abutment bridge is feasible in light of the soil condition.

5.2 Franklin Street Bridge Foundations

The soils encountered at the subject site are considered suitable for the support of bridge foundation elements on either deep foundations or spread footings. We understand, however, an integral abutment type structure is preferred which will necessitate the use of steel H-piles.

If piles are used, steel HP310 X 110 piles driven to practical refusal are recommended. To achieve the necessary flexibility for an integral abutment design, the top 3 m of each pile below the abutment stem should be surrounded by two concentric CSPs, generally as Illustrated in Figure 16 of the MTO Report SO-96-01 "Integral Abutment Bridges".

In the case of spread footings, these can be founded on the native compact to dense fine sand to silty fine sand.

5.2.1 Pile Foundation

5.2.1.1 Axial Pile Capacity

Based on the soil information and the pile driving records of nearby existing structures, it is recommended that HP 310X110 piles are used to supported the proposed bridge structure. The piles should be driven into the very dense basal silt till which was encountered at Elevations 297.0 and 296.5 m at Boreholes 98-10A and 98-11A respectively, and at Elevation 308.0 m at Boreholes 98-12A. It is envisaged that the piles will meet practical refusal at Elevations 296.5 to 308.0 m, and can be considered to be essentially end-bearing in the very dense glacial till.

The following table summarizes the anticipated pile tip elevations for HP310X110 steel piles and recommended capacities at each foundation location:

Location	Reference Boreholes	Estimated Approximate Pile Tip Elevation (m)	Factored Axial Resistance at ULS (kN)	Axial Resistance at SLS (kN)
East Abutment	Boreholes 98-10 & 10A	297.0	1700	1200
Central Pier	Boreholes 98-11 & 11A	296.5	1700	1200
West Abutment	Boreholes 98-12 & 12A	308.0	1700	1200

The following axial resistances are estimated for HP310X79 steel piles:

Factored axial resistance at ULS = 1,150 kN
Axial resistance at SLS = 1,000 kN

Due to the anticipated hard driving conditions and the likelihood of encountering cobbles and boulders, the use of such relatively light piles is not recommended. Consequently, a heavy section steel pile such as the HP310X110 should be used.

The serviceability condition is based on the premise that the maximum total settlement will not exceed 25 mm.

The minimum pile spacing should be calculated in accordance with the OHBDC.

5.2.1.2 Lateral Pile Resistance For Piles

The lateral resistance of the piles and the depth to the point of contraflexure may be analyzed on the basis of an assumed value of k_s and a coefficient of horizontal subgrade reaction of 35 MN/m^3 for the native soils. The upper loose fill or the loose sand

surrounding the upper 3 m of the pile may be assumed to have a value of k_s = 1.2 MN/m^3.

As a guide, a HP 310X110 pile driven to the recommended tip elevations would have horizontal passive resistance in the order of 120 kN at ULS and 60 kN at SLS.

At the center pier location, the lateral capacities of the piles can be supplemented, if desired, by horizontal components of battered piles. If an integral abutment bridge type is not to be built, then battered piles could also be used at the abutment locations to resist unbalanced horizontal forces.

5.2.1.3 Pile Driving

The piles should be provided with driving shoes in accordance with OPSD 3301.00.

In accordance with MTO standard practice, the piles should be driven to predetermined elevations (e.g. to elevations recommended in the preceding section), after which driving should be controlled by the Hiley formula. An ultimate capacity of 3400 kN (2 times the factored axial resistance at ULS) can be used.

In accordance with the above criterion, we recommend that the piles be driven to about 1 m above the quoted design elevations and driving should then be monitored and controlled by employing the Hiley Dynamic Pile Driving Formula in accordance with MTO Standards SS 103-10 or SS 103-11. If the driven pile encounters refusal above the recommended elevations, the Engineer should be notified immediately.

The pile driving should be carried out using a hammer capable of delivering energy of at least 50 kJ but not exceeding 60 kJ.

During the driving process, piles, which have already been driven, should be monitored to determine if they are heaving due to the effects of driving adjacent piles. If this phenomenon occurs, the affected piles should be re-driven.

It is recommended that not less than 15 % of the piles and at least three (3) piles in each foundation element be re-struck one to two days after initial installation as a precaution against relaxation. If relaxation is deemed to have occurred, then all piles in that foundation element should be re-struck.

It is possible that the piles may drive several meters above or below the estimated tip elevations. This aspect should be taken into consideration when ordering piles.

The base of the pile caps should be provided with a minimum 1.5 m of earth cover for frost protection purposes.

MEETING AGENDA

Highway 8/Conestogan Parkway TPM for Detailed Design and Contract Administration
WP 363-94-00

Purpose: Progress Meeting No. 7

Place: Morrison Hershfield Office, Morrison Boardroom, Toronto

Date: Wednesday, August 18, 1999

Time: 10:00 A.M.

Invitees	Ministry Staff	Section	Consultant Staff	Responsibility
	Steven McInnis	Planning & Design	Doug Hoffman	Project Manager
	Ian Smythe	Planning & Design	Stanley Ma	Highway Design
	John Meyer	Structural	Edward Li	Structural PM
	Joel Foster	Environmental	Paul Draycott	Environmental
	Rob Sutton	Traffic	Bob Bee	Landscape

1) Bearing Capacity for Spread footing
(2) Bearing Capacity for Retaining Wall

Item		
1.0	**Review** of Previous Minutes	**D. Hoffman**
2.0	**Road Design – Status Update**	**S. Ma**
3.0	**Structural Design – Status Update**	**E. Li**
4.0	**PIC**	**P. Draycott**
4.1	Available Dates	P. Draycott
4.2	PIC Attendee List	D. Hoffman
4.3	PIC Displays	MH
4.4	Meetings with MPP's, Region & City	
5.0	**Management Issues**	**D. Hoffman**
5.1	Project Progress/Schedule/Recovery Plan	D. Hoffman
5.2	Future Meeting Schedule	D. Hoffman
5.3	QC Milestone Quality Review	D. Hoffman
6.0	**Other Business**	**All**

Friday - answers

5.2.2 Spread Footing Foundations

Based on the borehole results, spread footings may be used for the pier and abutments, designed to bear on the undisturbed, compact to dense native fine sand to silty fine sand at the elevation and bearing resistances shown below:

Borehole No. and Location	Existing Ground surface elevation (m)	Recommended Highest Footing Base (m)		Factored Geotechnical Resistance at ULS (kPa)	Geotechnical Resistance at SLS (kPa)	Subgrade Material
		Below Existing Ground Surface	Elevation			
98-12 & 98-12A West Abutment	326.9	4.5	322.4	750	300	Fine to Medium Sand
98-11 & 98-11A Central Pier	320.9	1.5	319.4	650	240	Medium Sand
98-10 & 98-10A East Abutment	326.7	4.2	322.5	750	300	Fine to medium Sand

The SLS value given above is based on a maximum settlement of 25 mm under the footing. This can be achieved provided that the founding subgrade is undisturbed during construction.

Under inclined loading conditions, the bearing resistance at ULS should be reduced in accordance with Clause 6-8.4.2 of OHBDC.

It should be pointed out that dewatering will likely be required for foundation excavations extending below Elevation 319.5 ± m (as further discussed in Section 5.6 of this report). For this reason, we recommend that foundation elevation be selected as high as possible above this elevation.

For frost protection, the footings should have a permanent earth cover of at least 1.5 m.

A storm sewer will be installed under the new median of Highway 8. The potential conflict between the new storm sewer and the pier footing should be examined in terms of their vertical and horizontal alignments. The pier footing should be founded below the new storm sewer or the new storm sewer should be located outside the influence zone of the pier footing.

5.3 Retaining Wall Foundations

The existing east retaining wall will be demolished and relocated approximately 6 to 8 m to the east to accommodate the proposed S-E Ramp. The new retaining wall will have approximately the same length as that of the existing retaining wall, approximately 660 m from Station 11+060 north to Station10+400 (Highway 8 stations). King Street will be cut some 1 to 6 m and the finished grade of the pavement will match that of Highway 8 north bound. The deepest cut will be in the area of Franklin Street. The west retaining wall will not be reconstructed except near the west abutment of Franklin Street Bridge.

5.3.1 Spread Footings

Strip footings may be used to support the new retaining wall. The footing should bear on the undisturbed, compact to dense native fine sand to silty fine sand and designed to the bearing resistances shown below:

Factored Geotechnical Resistance at ULS	**350 kPa**
Geotechnical Resistance at SLS	**200 kPa**

The SLS value given above is based on a maximum settlement of 25 mm under the footing. This can be achieved provided that the founding subgrade is undisturbed during construction. If the retaining walls are to be incorporated into the Franklin Street Bridge abutment walls, we recommend that consideration be given to mitigating measures (e.g. construction joints) to accommodate differential settlements between the abutments supported on piles and retaining walls on spread footing foundations.

The anticipated footing founding elevations are plotted on Drawings A and B. The footings are assumed to be founded at least 1.5 m below the finished asphalt grade for frost protection. The following table summarized the highest bearing depth and elevation for retaining wall footings at each borehole location.

Borehole No.	Existing Ground surface elevation (m)	Recommended Highest Footing Base (m)		Subgrade Material
		Below Existing Ground Surface	Elevation	
98-01	327.4	1.6	325.8	Sand
98-02	327.3	2.6	324.7	Sand
98-03	327.2	3.0	324.2	Sand
98-04	327.1	4.0	323.1	Sand and gravel
98-05	327.0	3.4	323.6	Sand to Silty Sand
98-06	327.0	3.4	323.6	Silty Sand

98-07	327.0	6.0	321.0	Sand
98-08	327.1	3.0	324.1	Sand to Silty Sand
98-09	326.9	4.5	322.4	Sand
98-10	326.8	3.8	323.0	Sand
98-10A	326.7	3.7	323.0	Sand
98-13	326.7	2.7	324.0	Sand to Silty sand
98-14	326.6	3.9	322.7	Sand to Silty sand
98-15	326.6	3.0	323.6	Sand
98-16	326.4	3.0	323.4	Sand to Silty sand
98-17	326.1	4.0	322.1	Sand
98-18	325.8	3.3	322.5	Sand
98-19	325.6	2.6	323.0	Sand
98-20	325.3	2.8	322.5	Sand
98-21	325.0	3.6	321.4	Sand
98-22	324.4	3.4	321.0	Sand

It is noted that the recommended footing founding elevations at Boreholes 98-21 and 98-22 (north end of the retaining wall) are lower than the minimum depth/elevation for frost cover. The footings in this area should be lowered to the recommended elevations to be founded on competent native bearing soils.

All footing excavations should be carefully inspected by the geotechnical engineer to ensure that the footings are founded on undisturbed natural soils, which are capable of supporting the design pressures. It should be pointed out that where the footings are at relatively higher elevations (e.g. near the ends of the project and away from the Franklin Street Bridge where the existing pavement grades are relatively higher), the footings may need to be extended deeper than the maximum frost depth to ensure that they extend below any fill and/or upper weaker zones of the natural sand.

Alternatively, any unsuitable soils can be removed and replaced with properly compacted engineered fill (i.e. Granular "A" quality material). In this instance, the engineered fill should extend at least 0.5 m beyond the foot-print of the footing and should be uniformly compacted in suitably thin layers to at least 100 % of its standard Proctor maximum dry density.

Under inclined loading conditions, the bearing resistance at ULS should be reduced in accordance with Clause 6-8.4.2 of OHBDC.

5.3.2 Sliding Resistance

The sliding resistance of the footings should be checked. The horizontal resistance against sliding between concrete and undisturbed, competent, native founding soil can be calculated using an angle of friction of 28 degrees. For concrete and properly compacted Granular "A" fill, this can be increased to 35 degrees.

5.4 Lateral Earth Pressures

The lateral earth pressures acting on the retaining wall (including the bridge abutments) will depend on the type and method of placement of the backfill materials and on the subsequent lateral movement of the structure. The lateral earth pressures to be used in the design should be computed in accordance with Section 6-7 of the OHBDC.

Granular backfill should be placed behind the abutment walls and wing walls to conform to the minimum requirements illustrated in OPSD 3501.00. The granular backfill should conform to OPSS Form 1010 for either Granular "A" or "B" Type 1. To maintain free draining characteristics in these granular fill materials, the maximum percentage passing the No. 200 sieve (75 μm) should be limited to 5 %.

The backfill should be placed in accordance with OPSS 501. A perforated subdrain should be installed behind the base of the walls as shown in OPSD 3501.00 to maintain the granular fill in a drained condition. The subdrain should be directed to a positive outlet to the municipal sewer or highway drainage system.

The lateral earth pressure, P_h, may be computed using the equivalent fluid pressures presented in Section 6-7.4 of the OHBDC, or employing the following equation based on unfactored earth pressure distributions:

$$P_h = K\ (\gamma h + q)$$

Where:

K = earth pressure coefficient, use value from table below

γ = unit weight of soil, = 21.2 kN/m^3 for Granular "B"
= 22.8 kN/m^3 for Granular "A"

h = depth below top of wall, m

q = unit surcharge pressure

Wall Type	Earth Pressure Coefficient (K)	
	Granular "A" $\phi = 35°$	Granular "B" $\phi = 30°$
Restrained Wall (K_o)	0.43	0.50
Unrestrained Wall (K_a)	0.27	0.33

The above parameters are based on a horizontal back slope behind the abutment and retaining walls. If concrete approach slabs are not provided, an additional load equivalent to 600 mm of fill should be superimposed on the wall loading to account for traffic surcharge loading.

A compaction surcharge equal to 16 kPa should be included in the lateral earth pressures for the structural design of the abutment and retaining walls in accordance with OHBDC 6-7.4.3.

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

If an integral abutment design is used, the ballast wall/pile cap will move against the retained fill in some circumstances. Accordingly, the design should be based on an earth pressure coefficient between the at rest (K_o) and passive (K_p), as outlined in the OHBDC.

A Retained Soil System (RSS) may be used for the abutment wall and wing walls. The supplier of the RSS should be responsible for design of the structure such as backfill, reinforcement, and internal and external stability. The following information should be included in the contract drawing:

- The length and location
- Height and space constraints
- Elevation of top and bottom of RSS
- Performance requirement (High Performance)
- Appearance requirement (High Appearance)

The electro-chemical properties of the soils are tested and the results provided on Appendix "C".

The grain size distributions of the excavated soils that are to be used as backfill are shown on Figures 2 to 5 of Appendix "B". Considering the grain size distribution and the soil stratigraphy, the excavated materials will consist of fine sand to silty fine sand with a silt content in the range of 10 to 15%. Overly silty materials should not be used as backfill.

If this excavated sand material is to be used as backfill, a Granular "B" core, at least 1.5 m thick immediately behind the facing of the RSS, bridge seats or other footing located close to the facing, should be provided to ensure drainage and to prevent frost penetration problems.

In this case, the earth pressures are based on the sand soil and the following parameters (unfactored) may be assumed.

Soil Unit Weight	20 kN/m^3
Coefficients of lateral earth Pressure:	
"active"	0.33
"at rest"	0.50

5.5 Demolition

It is understood that the existing Franklin Street Bridge abutments have been incorporated into the retaining walls. Prior to the demolition of the existing Franklin Street Bridge, it will be necessary to either remove the soil backfill behind the abutments in order to release the soil pressure or to provide structural support for the soil backfill. If structural support is considered, this could be in the form of "dead-man" anchor or soil anchor tie-back systems.

If the soil backfill behind the west abutment wall is to be excavated, temporary shoring walls will be required to support the excavation.

It is noted that there are many underground utilities running along Kingsway and King Street. The demolition of the bridge and excavation associated with such will be affected by these buried utilities.

Measures should be incorporated into the design and staging in order to ensure that the side slopes of any excavation made within the fine granular soils (fine sand to silty fine sand) are protected from erosion.

5.6 Excavation, Groundwater Control and Temporary Shoring

Excavation for this project will involve the construction of the pile cap or footings for the pier or abutments as well as the strip footings for the new retaining wall. Depending on the design that is finally selected, the anticipated maximum depth of excavation below existing grade is between 1 and 6 m.

Excavations to the depths of 6 m should not present any special difficulties using heavy excavation equipment. However, the buried utilities and local traffic along Kingsway and King Street are expected to be very close and thus may require shoring support.

Excavation of the east retaining wall will be carried out in the dry as the measured groundwater table will be below the anticipated excavation levels. However, the footing or pile cap excavation at and in the vicinity of Franklin Street will likely encounter wet to saturated sand subgrade depending on the final grade for footing excavation and the time of construction.

Groundwater control by means of pumping from filtered sump pits should handle surface water ingress and water table up to 0.5 m higher than the excavation level. Deeper excavation below the water table will require pre-draining involving pump wells or well points dewatering techniques. It should be pointed out that if the founding soil is disturbed, excessive settlements would occur after structural loads are applied.

A 150 mm thick lean concrete working mat should be placed on the bearing surface which will receive the foundations within four hours of excavation to facilitate placement of reinforcing steel and to protect the integrity of the bearing surface. All foundation excavations and bearing surfaces should be inspected and approved by the geotechnical engineer. We recommend that following the construction of the footing, backfill be placed to a height of at least 1.5 m above the footing to prevent disturbance and frost penetration.

All excavation should be carried out in compliance with the requirements of the Occupational Health and Safety Act (OHSA). For this purpose, the upper fill and fine sand soils are classified as Type 3 soils. Within the Type 3 soils and above the water table, the excavation should be cut no steeper than 1H: 1V throughout. Where the fill and/or the underlying soils are in a loose condition, the sides of the excavation may have to be somewhat flattened locally. Below the water table, much flatter side slopes may be required in the cohesionless soil types.

Temporary shoring due to space limitation will likely occur along the some portions of King Street to provide local traffic and access and also at Kingsway/Franklin for the west abutment foundation.

Temporary shoring can make use of conventional soldier piles and timber lagging. The soldier piles can be designed as a cantilever structure or supported by raker footings or soil anchor tie-back system.

Raker footings are typically shallow footings with minimum embedment. The following soil bearing pressure is recommended:

SLS	**50 kPa**

For preliminary design of temporary soil anchors, tentative bond strength of 60 kPa along the shaft of the soil anchor can be used. The bond strength should be confirmed by loading test of at least two anchors. In addition, all soil anchors should be proof-loaded to 133% of the design load during their installation.

The temporary shoring should be designed in accordance with OPSS 539 dated March 1999 for roadway protection measures.

5.7 Frost Protection

The design frost penetration depth for this project is 1.5 m. All pile caps and footings must be provided with at 1.5 m of soil cover for adequate frost protection.

6. STATEMENT OF LIMITATION

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

The Limitation of Report, as quoted in Appendix "D", is an integral part of this report.

Yours truly,
AGRA Earth & Environmental Limited

Eric Y. Chung, M.Eng., P.Eng.
Kitchener-Waterloo Branch Manager

REGISTERED PROFESSIONAL ENGINEER
E. Y. CHUNG
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EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE
e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

METRIC

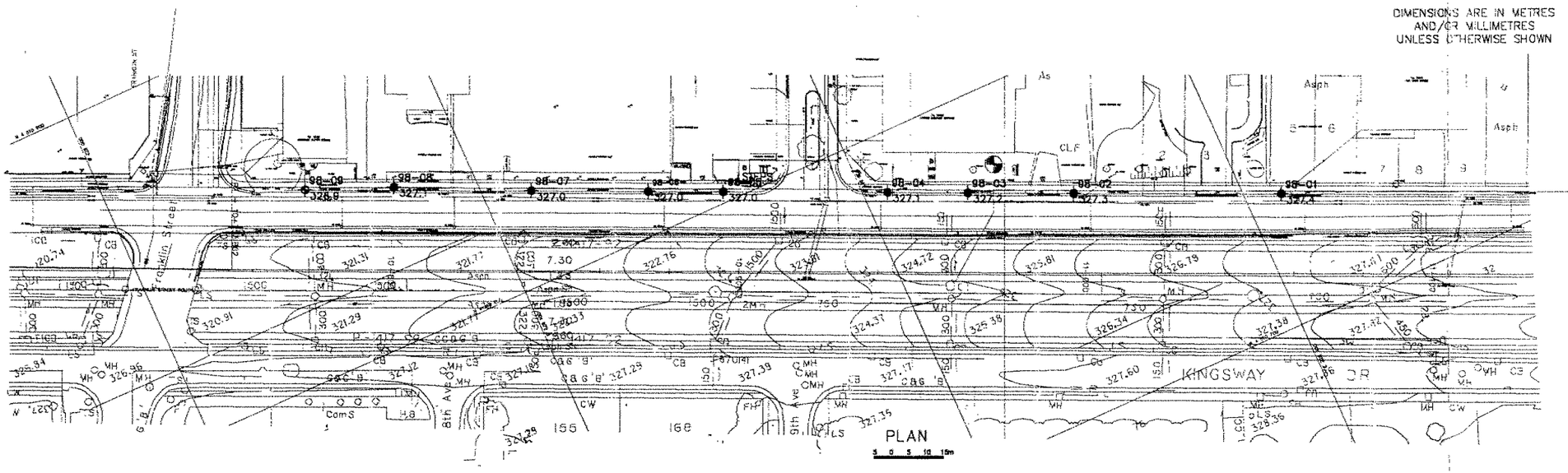
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

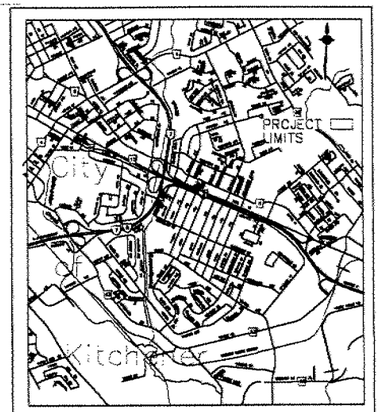
CONT No 000
WP No 363-94-00

???? 0000
BORE HOLE LOCATIONS & SOIL STRATA

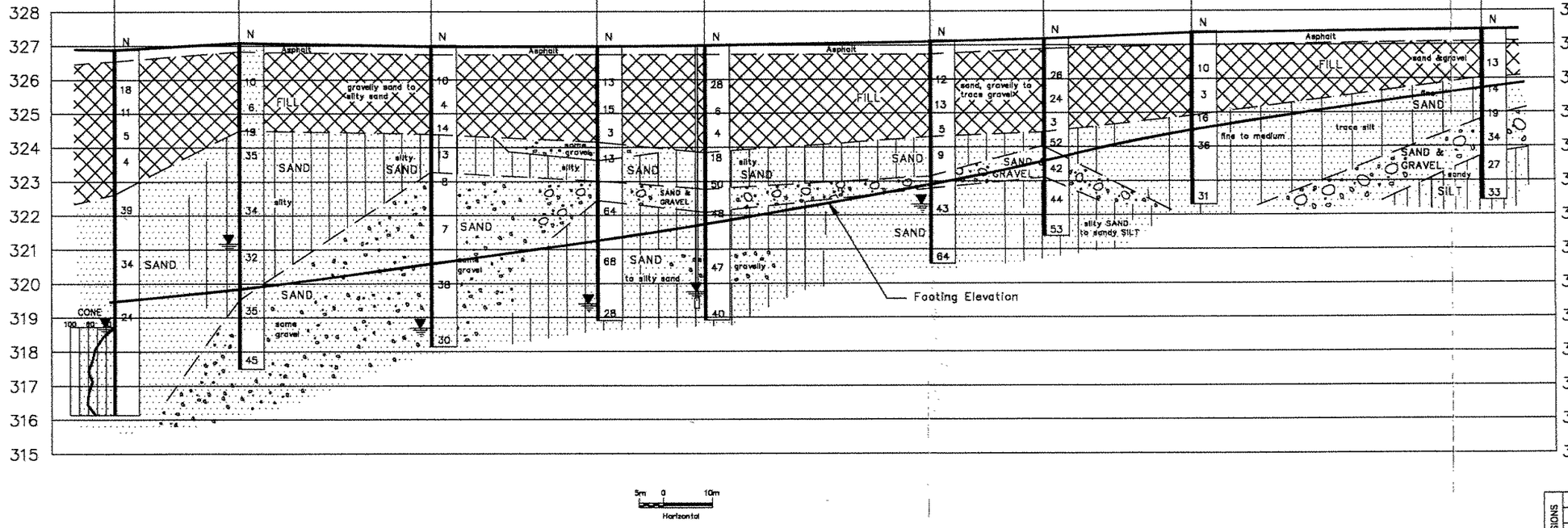
SHEET 000

AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS





KEYPLAN NTS



5m 0 10m
Horizontal

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
- W L at time of investigation
- Standpipe

No.	ELEVATION	CO-ORDINATES NORTH	EAST
98-01	327.4	4 810 735	228 310
98-02	327.3	4 810 761	228 256
98-03	327.2	4 810 774	228 228
98-04	327.1	4 810 784	228 207
98-05	327.0	4 810 803	228 164
98-06	327.0	4 810 812	228 144
98-07	327.0	4 810 826	228 113
98-08	327.1	4 810 843	228 088
98-09	326.9	4 810 853	228 054

— NOTE —
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes 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 GC2.01 of OPS Gen. Cond.

REVISIONS			
DATE	BY	DISCRIPTION	

GEOCRES 40P8-118

HWY No.	HWY 7 & 8		DIST 2
SUBM'D 00	CHECKED EYC	DATE June 1999	SITE 33-221
DRAWN LWM	CHECKED	APPROVED	DWG A

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No 000
WP No 363-94-00

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SHEET
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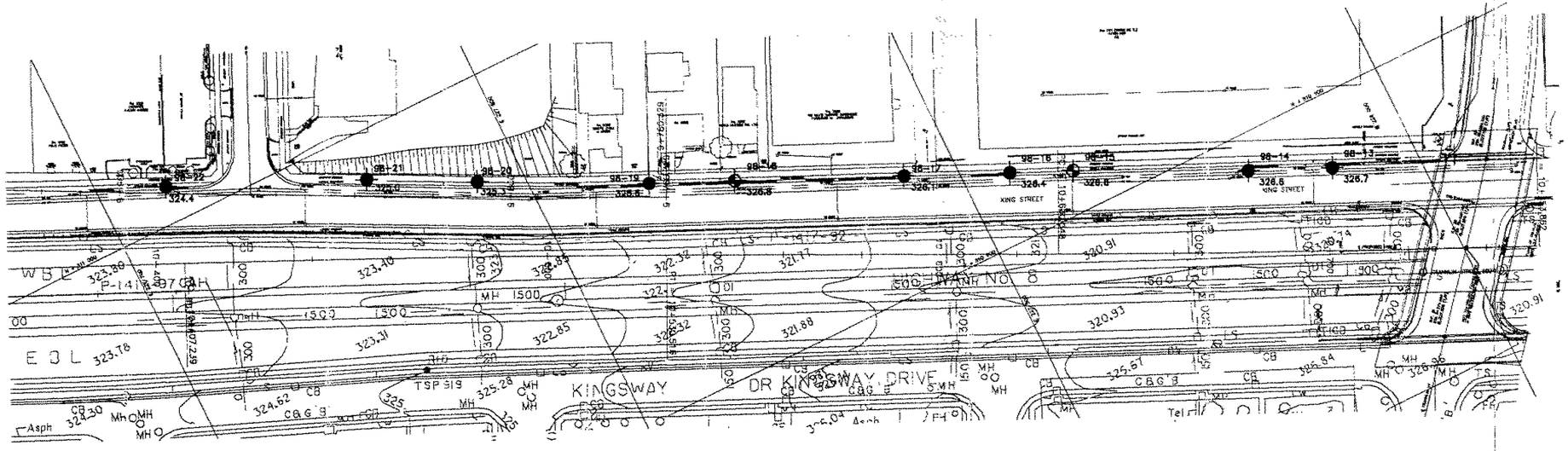
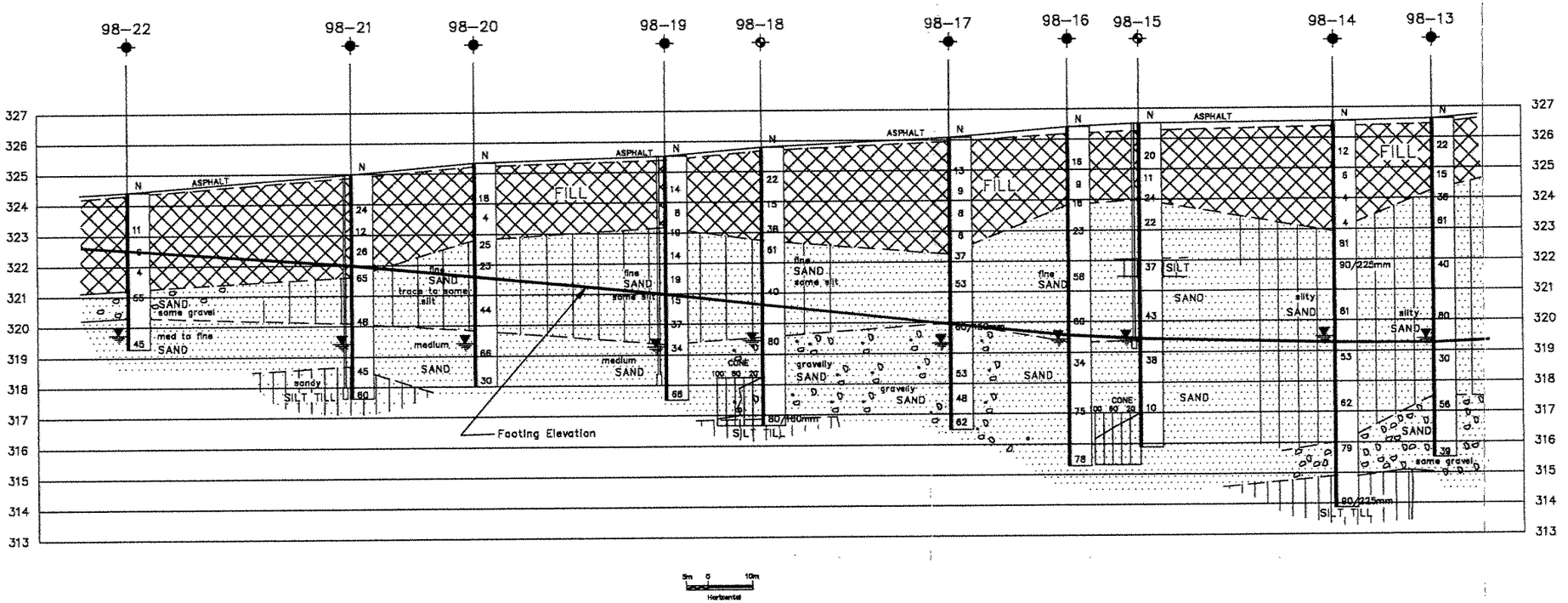
BORE HOLE LOCATIONS & SOIL STRATA

AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS



PLAN



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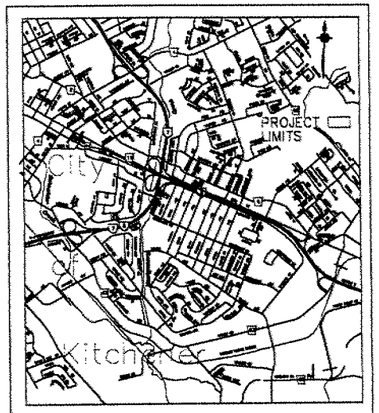


KEYPLAN NTS

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
- W L at time of investigation
- Standpipe

No.	ELEVATION	CO-ORDINATES NORTH	EAST
98-13	326.7	4 810 882	227 986
98-14	326.8	4 810 890	227 967
98-15	326.6	4 810 911	227 926
98-16	326.4	4 810 917	227 911
98-17	326.1	4 810 929	227 887
98-18	325.8	4 810 946	227 848
98-19	325.6	4 810 955	227 828
98-20	325.3	4 810 975	227 788
98-21	325.0	4 810 988	227 763
98-22	324.4	4 811 009	227 717

— NOTE —
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes 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 GC2.01 of OPS Gen. Cond.

REVISIONS		
DATE	BY	DISCRIPTION

GEOCRES 40P8-118

HWY No.	HWY 7 & 8		DIST 2
SUBM'D OO	CHECKED EYC	DATE June1999	SITE 33-221
DRAWN LWM	CHECKED	APPROVED	DWG B

METRIC

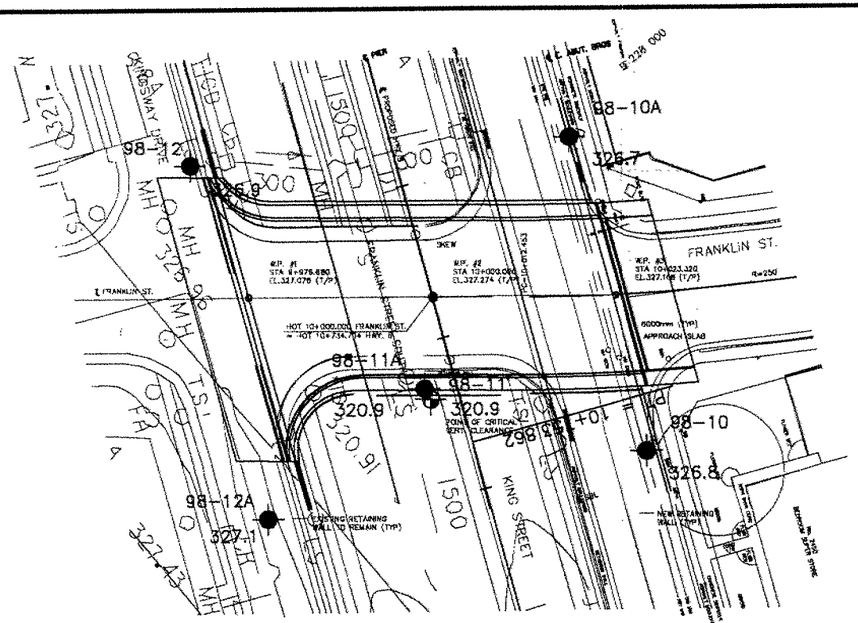
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No 000
WP No 363-94-00

FRANKLIN STREET
0000
BORE HOLE LOCATIONS & SOIL STRATA

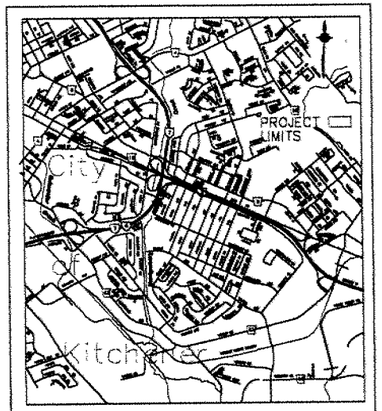
SHEET
000

AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

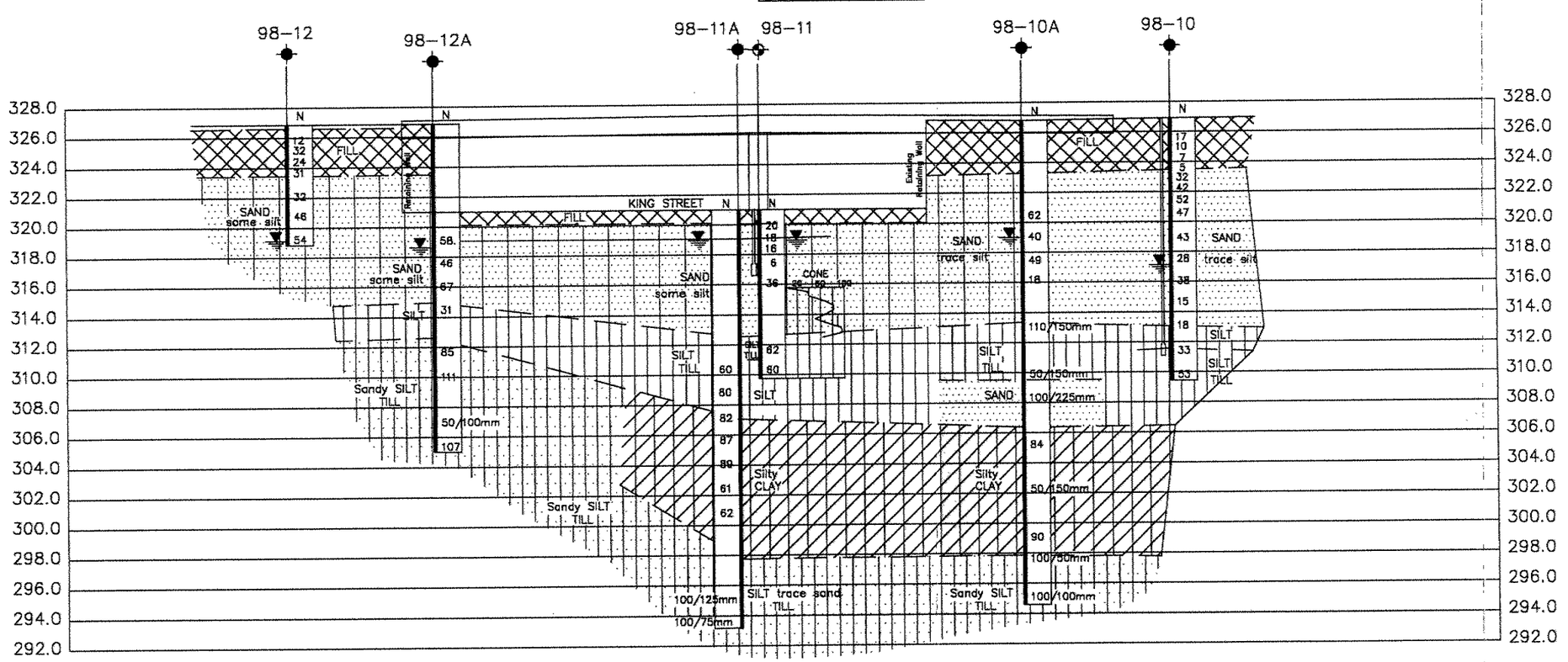


PLAN

5 0 10 20m



KEYPLAN NTS



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
- W L at time of investigation
- Standpipe

No.	ELEVATION	CO-ORDINATES NORTH	EAST
98-10	326.8	4 810 857	228 040
98-10A	326.7	4 810 875	228 003
98-11	320.9	4 810 840	228 018
98-11A	320.9	4 810 840	228 016
98-12	326.9	4 810 836	227 975
98-12A	326.9	4 810 814	228 016

— NOTE —
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

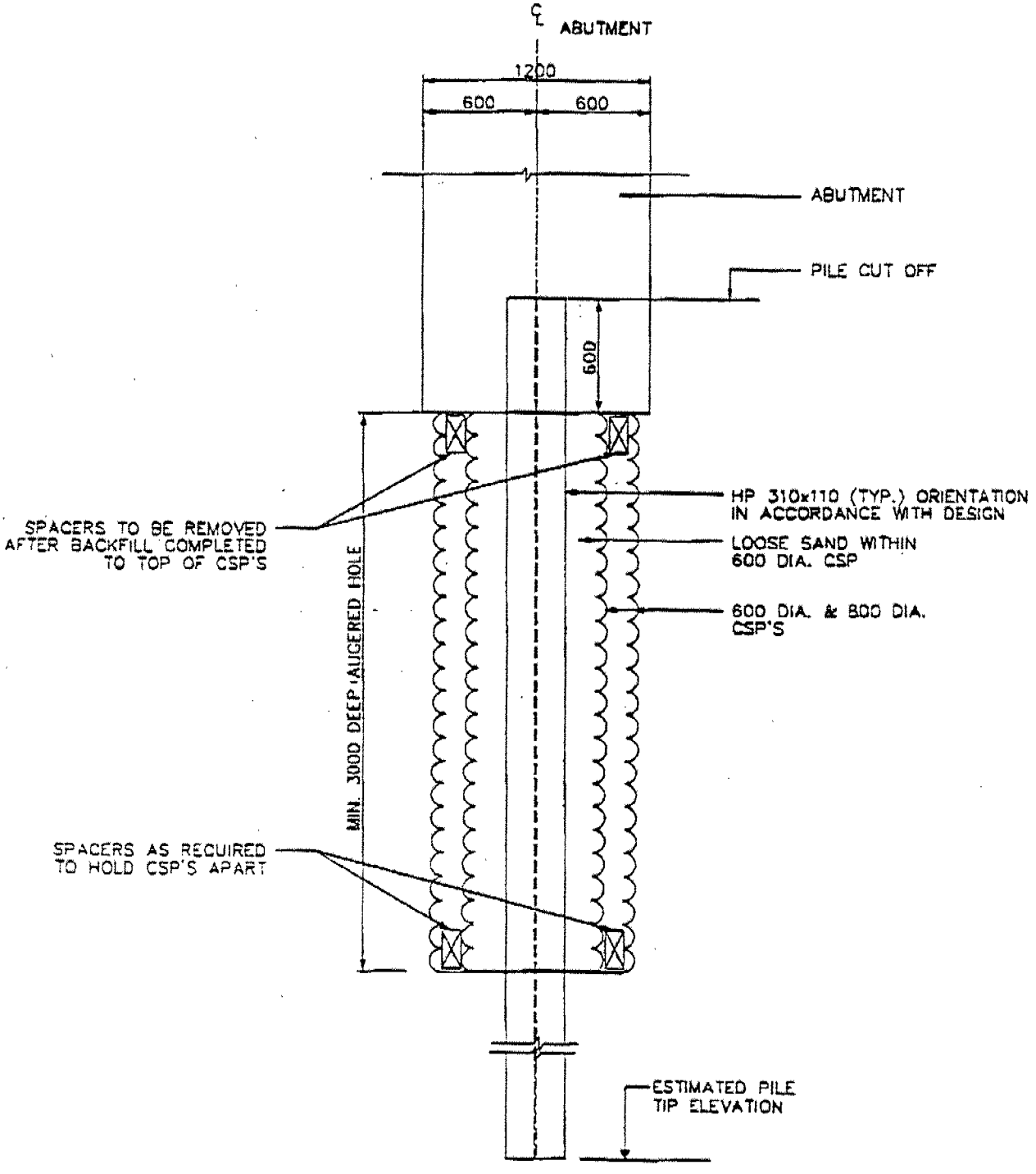
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC2.01 of OPS Gen. Cond.

REVISIONS			
DATE	BY	DISCRIPTION	

GEOCRES 40P8-118

HWY No.	HWY NO		DIST	DIST?
SUBM'D 00	CHECKED EYC	DATE June1999	SITE	33-221
DRAWN LWM	CHECKED	APPROVED	DWG	C

FIGURES



INTEGRAL ABUTMENT CSP DETAIL

FIG No 16

WP 363-94-00

APPENDIX "A"

Record of Borehole Sheets

AGRA
ENGINEERING GLOBAL SOLUTIONS

RECORD OF BOREHOLE No 98-01 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. South of Arlington Blvd., 4810735N,228310E ORIGINATED BY S.W

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W

DATUM GEODETIC DATE 18.11.98 - 18.11.98 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.4											
0.0	ASPHALT 100mm CRUSHED GRANULAR 200mm Compact, dark brown fine sand to silty sand FILL damp						327				
326.0			1	SS	13				○		3 78 19 0
1.4	Compact, brown fine SAND, some silt damp		2	SS	14		326		○		1 88 11 0
324.8			3	SS	19		325		○		
2.6	Compact, brown medium to coarse SAND damp										
324.3			4	SS	34		324		○		
3.1	Dense, brown SAND and GRAVEL damp										
323.6			5	SS	27		323		○		0 40 60 0
3.8	Compact to dense, brown SANDY SILT damp										
322.4			6	SS	33				○		
5.1	END OF BOREHOLE @ 5.1m NOTE: Borehole dry upon completion										

EXPRESS_3-221.GPJ EXPRESS.GDT 20/07/99

+ 3, - 3, Numbers refer to Sensitivity ε 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-02 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. South of Arlington Blvd., 4810761N,228256E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 18.11 98 - 18.11 98 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.3											
0.0	ASPHALT 120mm CRUSHED GRANULAR 200mm Compact, dark brown silty sand and gravel FILL moist						327				
326.1			1	SS	10				○		
1.2	Loose, dark brown silty sand, trace to some gravel FILL some asphalt inclusions moist		2	SS	3		326		○		
324.9											
2.4	Compact to dense, brown fine to medium SAND, trace thin gravelly seams damp		3	SS	16		325		○		3 87 10 0
			4	SS	36		324		○		
							323				
322.3			5	SS	31				○		
5.1	END OF BOREHOLE @ 5.1m NOTE. Borehole dry upon completion										

EXPRESS_3-221.GPJ EXPRESS.GDT 20/07/99

+3 3 Numbers refer to Sensitivity ε3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-03 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. South of Arlington Blvd., 4810774N,228228E ORIGINATED BY S.W

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W

DATUM GEODETIC DATE 18.11.98 - 18.11.98 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE · LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_p / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_l WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.2											
0.0	ASPHALT 120mm CRUSHED GRANULAR 200mm Compact, dark brown silty sand and gravel FILL moist						327				
325.9			1	SS	26						6 63 31 0
1.3	Compact, dark brown silty sand FILL moist		2	SS	24		326				
325.2											
2.0	Very loose, dark brown sand and gravel FILL moist		3	SS	3		325				
324.4											
2.8	Compact, brown fine to medium SAND damp		4	SS	52		324				
324.0											
3.2	Dense to very dense, brown GRAVELLY SAND, trace silt damp		5	SS	42		323				23 67 10 0
323.1											
4.1	Dense to very dense, light brown SILTY FINE SAND to SANDY SILT damp to moist		6	SS	44		322				
321.4			7	SS	53						
5.8	END OF BOREHOLE @ 5.8m NOTE: Borehole dry upon completion										

3 3 Numbers refer to Sensitivity

3% STRAIN AT FAILURE

EXPRESS 3-221.GPJ EXPRESS.GDT 20/07/99

RECORD OF BOREHOLE No 98-04 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. South of Arlington Blvd., 4810784N,228207E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 18.11.98 - 18.11.98 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ⊕ FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.1							327				
0.0	ASPHALT 120mm CRUSHED GRANULAR 250mm Compact, dark brown gravelly sand FILL moist										
325.6			1	SS	12		326				
1.5	Compact, dark brown fine sand, some silt FILL moist		2	SS	13				○		5 69 26 0
324.8							325				
2.3	Loose, brown sand, trace to some gravel FILL moist		3	SS	5				○		
324.3							324		○		0 55 45 0
2.8	Loose to compact, brown fine SAND and SILT moist to wet		4	SS	9						
323.1							323				
4.0	Dense, brown SAND and GRAVEL										
322.8											
4.3	Dense to very dense, brown fine SAND wet		5	SS	43	▼			○		
322.3							322				
4.8	saturated										
320.5			6	SS	64		321		○		
6.6	END OF BOREHOLE @ 6.6m NOTE. Water level recorded @ 4.8m upon completion										

3 3 Numbers refer to Sensitivity

3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-05 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. North of Arlington Blvd., 4810803N,228164E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 17.11.98 - 17.11.98 CHECKED BY E.Y.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
327.0											
0.0 / 326.2	ASPHALT 80mm CRUSHED GRANULAR 200mm Compact, dark brown gravelly sand FILL										
0.8 / 325.0	Compact, dark brown silty sand FILL moist		1	SS	28		326		○		
			2	SS	6		325		○		
2.0 / 323.8	Very loose, brown gravelly sand FILL moist		3	SS	4		324		○		
3.2 / 322.7	Compact, brown fine SAND to SILTY SAND moist to wet		4	SS	18				○		
			5	SS	50		323		○		
4.3 / 322.1	Compact to dense, brown GRAVELLY SAND		6	SS	48		322		○		
4.9 / 320.7	Dense, brown fine SAND to SILTY SAND damp		7	SS	47		321		○		
6.3 / 320.0	Dense to very dense, brown GRAVELLY SAND damp						320				
7.0 / 318.9	Compact to dense, brown fine SAND to SILTY SAND wet to saturated trace gravel		8	SS	40	▼	319		○		
8.1	END OF BOREHOLE @ 8.1m NOTE: Water level recorded @ 7.3 m (3/3/99)										

EXPRESS_3-221 GPJ EXPRESS.GDT 22/07/99

3 3 Numbers refer to Sensitivity

3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-06 1 OF 1 METRIC

W.P. 363-94-00 SITE 33-221 LOCATION King St. E. North of Arlington Blvd , 4810812N,228144E ORIGINATED BY S.W

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W

DATUM GEODETIC DATE 17.11.98 - 17.11.98 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.0											
0.0 / 326.2	ASPHALT 80mm CRUSHED GRANULAR 200mm Compact, dark brown gravelly sand FILL										
0.8 / 325.5	Compact, dark brown fine sand FILL moist		1	SS	13		326		○		
1.5 / 324.2	Loose, brown fine sand, trace gravel FILL moist		2	SS	15		325		○		
			3	SS	3				○		
2.8 / 323.6	Compact, brown SAND, some gravel, some silt damp		4	SS	13		324		○		
3.4 / 323.0	Compact, brown fine SAND to SILTY SAND damp						323				
4.0 / 322.4	brown SAND and GRAVEL damp										
4.6	Very dense, light brown fine SAND to SILTY SAND damp		5	SS	64		322		○		
			6	SS	68		321		○		
319.4						▼	320				
7.6 / 318.9	saturated		7	SS	28		319		○		
8.1	END OF BOREHOLE @ 8.1m NOTE: Water level recorded @ 7.6m upon completion										

EXPRESS 3-221.GPJ EXPRESS.GDT 20/07/99

+3, 3. Numbers refer to Sensitivity ○3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-07 1 OF 1 METRIC

W.P. 363-94-00 SITE 33-221 LOCATION King St. E. North of Arlington Blvd., 4810826N,228113E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 17.11.98 - 17.11.98 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_p / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_l WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.0											
0.0	ASPHALT 80mm CRUSHED GRANULAR 200mm Compact to loose, dark brown gravelly sand and silty sand FILL moist		1	SS	10		326				
			2	SS	4		325				
324.7											
2.3	wet		3	SS	14						
324.4							324				
2.6	Compact, brown fine SAND to SILTY SAND wet		4	SS	13						0 73 27 0
323.3											
3.7	Loose, brown SAND, some gravel, trace silt damp		5	SS	8		323				
			6	SS	7		322				
321.0											
6.0	dense damp		7	SS	38		321				
							320				
318.7						▼	319				
8.3	saturated		8	SS	30						15 83 2 0
318.2											
8.9	END OF BOREHOLE @ 8.9m NOTE: Water level recorded @ 8.3m upon completion										

3 3 Numbers refer to Sensitivity 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-08 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E., South of Franklin St., 4810843N,228088E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 17.11.98 - 17.11.98 CHECKED BY E.Y.C

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.1							327				
0.0 / 326.4	ASPHALT 80mm CRUSHED GRANULAR 200mm Compact, dark brown gravelly sand FILL										
0.7	Loose, dark brown fine sand to silty sand FILL moist		1	SS	10		326		○		
324.8			2	SS	6		325		○		10 54 36 0
2.3 / 324.5	wet sandy silt seam		3	SS	19				○		
2.6	Compact to dense, brown fine SAND to SILTY SAND damp		4	SS	35		324		○		0 88 12 0
			5	SS	34		323		○		
321.2						▼	322				
5.9	saturated		6	SS	32		321			○	
319.5							320				
7.6	Dense, brown medium to fine SAND, some gravel, trace silt saturated		7	SS	35		319		○		
317.5			8	SS	45		318		○		
9.6	END OF BOREHOLE @ 9.6m NOTE: Water level recorded @ 5.9m upon completion										

EXPRESS 3-221.GPJ EXPRESS.GDT 20/07/99

3 3 Numbers refer to Sensitivity (3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-09 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E., South of Franklin St., 4810853N,228054E ORIGINATED BY S.W

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 16.11.98 - 16.11.98 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE ⁄ LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
326.9											
0.0	ASPHALT 80mm CRUSHED GRANULAR 200mm Compact, dark brown gravelly sand FILL										
326.1							326				
0.8	Compact, dark brown fine sand to silty sand FILL moist		1	SS	18				○		
324.9			2	SS	11		325		○		
2.0	Loose, brown gravelly sand FILL damp		3	SS	5				○		
322.6			4	SS	4		324		○		
4.3	Dense, fine to medium SAND, occasional gravel damp		5	SS	39		323				
							322		○		
319.9			6	SS	34	▼	321		○		
7.0	Dense to very dense, brown fine SAND saturated						320				
			7	SS	24		319		○		0 96 4 0
316.2							318				Dynamic cone penetration tests carried out
10.7	END OF BOREHOLE @ 10.7m NOTE: Water level recorded @ 7.0m upon completion						317				

EXPRESS_3-221.GPJ EXPRESS.GDT 20/07/99

$\perp^{3}$ $/^{3}$ Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-10 1 OF 2 METRIC

W.P. 363-94-00 SITE 33-221 LOCATION King St. E., South of Franklin St. Bridge, 4810857N,228040E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 16.11.98 - 16.11.98 CHECKED BY E.Y.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	10 20 30		GR SA SI CL
326.8											
0.0	ASPHALT 80mm CRUSHED GRANULAR 200mm Compact to loose, brown gravelly sand FILL moist		1	SS	17		326				
			2	SS	10		325				
			3	SS	7		324				
323.4			4	SS	5						
3.4	Dense, brown fine to medium SAND, trace silt damp		5	SS	32		323				0 90 10 0
			6	SS	42		322				
			7	SS	52		321				
			8	SS	47		320				
319.2											
7.6	wet		9	SS	43		319				
			10	SS	28		318				
317.2											
9.6	saturated		11	SS	38		317				
			12	SS	15		316				
			13	SS	18		315				
312.9							314				
13.9	Compact, grey SILT saturated						313				
311.4							312				
15.4	Very dense, grey SILT TILL moist		14	SS	33		311				

Continued Next Page

+3, ×3 Numbers refer to Sensitivity ε3% STRAIN AT FAILURE

EXPRESS_3-221.GPJ EXPRESS.GDT 22/07/99

RECORD OF BOREHOLE No 98-10 2 OF 2 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E., South of Franklin St. Bridge, 4810857N,228040E ORIGINATED BY S.W

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W

DATUM GEODETIC DATE 16.11.98 - 16.11.98 CHECKED BY E.Y.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL ✕ LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
309.6			15	SS	53		310				
17.2	END OF BOREHOLE @ 17.2m NOTE: Water level recorded @ 9.6m (1/26/99)										

EXPRESS 3-221.GPJ EXPRESS.GDT 22/07/99

$+^{3}_{3}$ Numbers refer to Sensitivity $(\,)^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-10A

1 OF 3 **METRIC**

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. at Franklin St. Bridge, 4810875N,228003E ORIGINATED BY S.W

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W

DATUM GEODETIC DATE 09.02.99 - 10.02.99 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
326.7											
0.0	ASPHALT 100 mm CRUSHED GRANULAR 180 mm dark brown gravelly sand FILL moist SOIL STRATIGRAPHY INFERRED FROM BH98-10						326				Power Auger to 6.1 m
323.3							325				
3.4	brown medium to fine SAND, trace silt moist						324				
							323				
							322				
	Very dense		1	SS	62		321				
							320				
318.8			2	SS	40	▼	319				
7.9	saturated occasional gravelly seam						318				
			3	SS	49		317				
							316				
			4	SS	18		315				
313.6							314				
13.1	Very Dense, grey SILT TILL, some clay, trace sand and gravel moist		5	SS	110/150mm		313				
							312				
							311				

Continued Next Page

Numbers refer to Sensitivity

3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-10A 2 OF 3 METRIC

W.P. 363-94-00 SITE 33-221 LOCATION King St. E. at Franklin St. Bridge, 4810875N,228003E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 09.02.99 - 10.02.99 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS
309.6			6	SS	50/150mm	
17.1	Very dense, grey medium SAND saturated		7	SS	100/225mm	
306.6						
20.1	Hard, grey SILTY CLAY, some wet sand seams moist		8	SS	84	
			9	SS	50/150mm	
			10	SS	90	
297.8						
28.9	Very dense, grey SANDY SILT TILL, trace gravel damp		11	SS	100/50mm	

ELEVATION SCALE: 310, 309, 308, 307, 306, 305, 304, 303, 302, 301, 300, 299, 298, 297, 296, 295

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ kN/m³

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

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+3, ×3 Numbers refer to Sensitivity ○3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-10A 3 OF 3 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. at Franklin St. Bridge, 4810875N,228003E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 09.02.99 - 10.02.99 CHECKED BY E.Y.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL ⁄ LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
294.5			12	SS100/100mm					○		
32.2	END OF BOREHOLE @ 32.2m NOTE: Water level recorded @ 7.9m upon completion						294				

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3 3 Numbers refer to Sensitivity 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-11

1 OF 1

METRIC

W.P. 363-94-00 SITE 33-221 LOCATION Highway 8, South of Franklin St. Bridge, 4810840N,228018E ORIGINATED BY S.W

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 05.01.99 - 05.01.99 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
320.9											
0.0	TOPSOIL 180 mm CRUSHED GRANULAR 520mm										
320.2											
0.7	Compact, medium SAND moist		1	SS	20		320				
319.0			2	SS	18	▼	319				
1.9	Compact, brown medium SAND, some silt saturated		3	SS	16						2 85 13 0
			4	SS	6		318				Low 'N' Value due to Hyrdostatic Disturbance
							317				
316.3											
4.6	trace gravel, trace silt		5	SS	36		316				9 89 2 0
314.8							315				
6.1	Dense to very dense						314				Dynamic cone penetration tests carried out
312.4							313				
8.5	Very dense, grey SILT TILL damp		6	SS	62		312				Standard penetration tests resumed
310.9							311				
10.0	Very dense, grey SILT, tace fine sand, occasional gravel moist		7	SS	60		310				
309.8											
11.1	END OF BOREHOLE @ 11.1m NOTE: Water level recorded @ 1.9m (1/26/99)										

+3 , -3 Numbers refer to Sensitivity 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 98-11A 1 OF 2 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION Highway 8 at Franklin St. Bridge, 4810840N,228016E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 08.02.99 - 08.02.99 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
320.9						
0.0 / 320.2	TOPSOIL 180 mm CRUSHED GRANULAR 520mm					
0.7 / 319.0	brown, medium SAND moist SOIL STRATIGRAPHY INFERRED FROM BH98-11					
1.9 / 316.3	brown medium SAND, some silt saturated					▼
4.8 / 312.4	trace gravel, trace silt					
8.5 / 310.9	grey SILT TILL damp					
10.0 / 307.2	Very dense, grey SILT, trace fine sand, occasional gravel		1	SS	60	
			2	SS	80	
13.7	Hard, grey SILTY CLAY		3	SS	82	
	Hard, grey SILTY CLAY moist		4	SS	87	

ELEVATION SCALE: 320, 319, 318, 317, 316, 315, 314, 313, 312, 311, 310, 309, 308, 307, 306, 305

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ kN/m³

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

Power Auger to 10.7 m

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+3, ×3, Numbers refer to Sensitivity ε 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-11A 2 OF 2 METRIC

W.P. 363-94-00 SITE 33-221 LOCATION Highway 8 at Franklin St. Bridge, 4810840N,228016E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W

DATUM GEODETIC DATE 08.02.99 - 08.02.99 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			5	SS	89		304		○		
			6	SS	61		303				
			7	SS	62		302				
297.9							301		○		
23.1	Very Dense, grey SILT TILL, some clay, trace sand and gravel damp						300				Very hard augering @23.1 m
			8	SS	100/125mm		299		○		
293.2			9	SS	100/75mm		298				
27.7	END OF BOREHOLE @ 27.7m						297		○		
	NOTE: Water level recorded @ 1.9m upon completion						296				
							295				
							294				

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+3, -3 Numbers refer to Sensitivity ε3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-12 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION Kingsway Ave. North of Franklin St. Bridge, 4810836N,227975E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 21.11.98 - 21.11.98 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
326.9											
0.0	ASPHALT 120mm CRUSHED GRANULAR 220mm Compact, dark brown gravelly sand FILL damp										
325.7			1	SS	12		326		○		
1.2	Compact to dense, dark brown fine sand to silty sand FILL		2	SS	32		325		○		
324.0			3	SS	24				○		
2.9	wet layer						324				
323.4			4	SS	31				○		
3.5	Dense to Very dense, brown FINE to MEDIUM SAND, trace to some silt damp						323				
			5	SS	32		322		○		
			6	SS	46		321		○		
319.1							320				
7.8	saturated		7	SS	54	▼	319				0 86 (14)
318.8											
8.1	END OF BOREHOLE @ 8.1m NOTE: Water level recorded @ 7.8m upon completion										

EXPRESS 3-221.GPJ EXPRESS.GDT 20/07/99

Numbers refer to Sensitivity

3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-12A 1 OF 2 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION Kingsway Ave. at Franklin St. Bridge, 4810814N,228016E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 11.02.99 - 11.02.99 CHECKED BY E.Y.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
326.9											
0.0	ASPHALT 120 mm CRUSHED GRANULAR 220 mm dark brown gravelly sand FILL SOIL STRATIGRAPHY INFERRED FROM BH98-12						326				Power Auger to 7.6 m
325.7											
1.2	Compact to dense, dark brown fine sand to silty sand FILL						325				
323.4							324				
3.5	brown fine to medium SAND, trace to some silt wet						323				
319.1							322				
7.8	saturated		1	SS	58	▼	321				
316.5							320				
10.4	Very dense, brown GRAVELLY SAND saturated		2	SS	46		319				
314.9							318				
12.0	Dense, grey SILT wet to saturated		3	SS	67		317				
312.6							316				
14.4	Very dense, grey SANDY SILT TILL, some gravel, frequent wet-saturated sand seams damp		4	SS	31		315				
							314				
							313				
							312				
			5	SS	85		311				

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3 3 Numbers refer to Sensitivity 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 98-12A 2 OF 2 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION Kingsway Ave. at Franklin St. Bridge, 4810814N,228016E ORIGINATED BY S.W

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 11.02.99 - 11.02.99 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, ✓ LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
							310				
			6	SS	111		309				
							308				
			7	SS	50/100mm		307				
							306				
305.1			8	SS	107						
21.8	END OF BOREHOLE @ 21.8m NOTE: Water level recorded @ 8.5m upon completion										

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3 3. Numbers refer to Sensitivity 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-13

1 OF 1 **METRIC**

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. North of Franklin St., 4810882N,227986E ORIGINATED BY S.W

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W

DATUM GEODETIC DATE 21.11.98 - 21.11.98 CHECKED BY E.Y.C

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
326.7											
0.0	ASPHALT 120mm CRUSHED GRANULAR 220mm Compact, dark brown gravelly sand FILL										
326.0							326				
0.7	Compact, dark brown sand and silt FILL damp		1	SS	22						
			2	SS	15		325				
324.3											
2.4	Dense to very dense, brown fine SAND to SILTY SAND damp		3	SS	38		324				
			4	SS	61						0 87 13 0
							323				
			5	SS	40		322				
320.6							321				
6.1	trace gravel		6	SS	80						
319.4						▼	320				
7.3	saturated		7	SS	30		319				
317.5							318				
9.2	Very dense to dense, grey medium to coarse SAND, some gravel saturated		8	SS	56						15 82 3 0
							317				
315.6			9	SS	39		316				
11.1	END OF BOREHOLE @ 11.1m NOTE: Water level recorded @ 7.3m upon completion										

$+^{3}_{3}$ Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-14 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. North of Franklin St., 4810890N,227967E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 21.11.98 - 21.11.98 CHECKED BY E.Y.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL ⊢ FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
326.6											
0.0	ASPHALT 100mm CRUSHED GRANULAR 300mm Compact, brown gravelly sand FILL						326				
325.8											
0.8	Compact to loose, dark brown fine sand to silty sand FILL moist		1	SS	12		325		○		
			2	SS	6				○		
			3	SS	4		324		○		
322.9			4	SS	4				○		
3.7	Very dense, brown fine SAND to SILTY SAND damp		5	SS	81		323		○		
			6	SS	90/225mm		322		○		
			7	SS	81		321		○		
319.2						▼	320				
7.4	saturated		8	SS	53		319		○		
			9	SS	62		318		○		
315.9							317				
10.7	Very dense, grey medium to coarse SAND, trace gravel saturated		10	SS	79		316		○		
314.9											
11.7	Very dense, grey SILT TILL, some clay, trace sand, occasional gravel, frequent medium sand seams moist		11	SS	90/225mm		315				
313.9							314		○		
12.7	END OF BOREHOLE @ 12.7m NOTE. Water level recorded @ 7.4m upon completion										

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$_{L}3_{,}3$ Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-15 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. North of Franklin St., 4810911N,227926E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 19.11.98 - 19.11.98 CHECKED BY E.Y.C.

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL ▷ FIELD VANE ✕ LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
326.6											
0.0	ASPHALT 110mm CRUSHED GRANULAR 350mm Compact, rust to dark brown silty sand and sand FILL, with topsoil inclusions damp		1	SS	20		326		○		
			2	SS	11		325		○		
324.0			3	SS	24		324		○		
2.6	Compact, brown fine SAND, occasional gravel seams, trace silt damp		4	SS	22		323		○		3 94 3 0
322.0											
4.6	Dense, brown SILT wet		5	SS	37		322		○		
321.5											
5.1	Dense, brown medium to fine SAND wet		6	SS	43		321		○		
319.4							320				
7.2	Compact, grey saturated		7	SS	38		319		○		
			8	SS	10		318		○		Dynamic cone penetration tests carried out
315.9							317				
10.7	END OF BOREHOLE @ 10.7m NOTE: Water level recorded @ 7.2m (3/3/99)						316				

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+3, ×3. Numbers refer to Sensitivity ε3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-16 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. North of Franklin St., 480917N,227911E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 19.11.98 - 19.11.98 CHECKED BY E.Y.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
326.4											
0.0	ASPHALT 100mm CRUSHED GRANULAR 400mm Compact, rust to dark brown silty sand FILL, trace gravel, with topsoil inclusions		1	SS	16		326				
			2	SS	9		325				
323.8			3	SS	16		324				
2.6	Compact, brown fine SAND to SILTY SAND		4	SS	23		323				5 80 15 0
321.8							322				
4.6	very dense		5	SS	58						
320.3							321				
6.1	trace gravel		6	SS	60		320				
319.4						▼					
7.0	Dense, brown medium to fine SAND saturated		7	SS	34		319				
			8	SS	75		318				
							317				
315.3			9	SS	78		316				
11.1	END OF BOREHOLE @ 11.1m NOTE. Water level recorded @ 7.0m upon completion										

EXPRESS. 3-221.GPJ EXPRESS.GDT 20/07/99

3 3. Numbers refer to Sensitivity 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-17 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. North of Franklin St., 4810929N,227887E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 19.11.98 - 19.11.98 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
326.1						
0.0	ASPHALT 120mm CRUSHED GRANULAR 300mm Compact, dark brown gravelly sand and silt FILL					
325.0			1	SS	13	
1.1	Loose, rust to dark brown silty sand FILL damp to moist		2	SS	9	
			3	SS	8	
322.3			4	SS	6	
3.8	Dense to very dense, brown medium to fine SAND damp		5	SS	37	
			6	SS	53	
320.0						
6.1	Very dense to dense, brown GRAVELLY SAND damp		7	SS	60/150mm	▼
319.3						
6.8	saturated		8	SS	53	
			9	SS	48	
316.5			10	SS	62	
9.6	END OF BOREHOLE @ 9.6m NOTE: Water level recorded @ 6.8 m upon completion					

ELEVATION SCALE: 326, 325, 324, 323, 322, 321, 320, 319, 318, 317

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

UNIT WEIGHT γ kN/m³

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

$+^{3}_{,}$ $_{,}^{3}$ Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

EXPRESS 3-221.GPJ EXPRESS.GDT 20/07/99

RECORD OF BOREHOLE No 98-18 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. North of Franklin St., 4810946N,227848E ORIGINATED BY S.W

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W

DATUM GEODETIC DATE 18.11.98 - 18.11.98 CHECKED BY E.Y.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
325.8											
0.0	ASPHALT 110mm CRUSHED GRANULAR 350mm Compact, dark brown gravelly sand FILL										
	Compact, dark brown silty sand FILL moist		1	SS	22		325				
324.1											
1.7	Compact to very loose, brown fine sand to silty sand FILL damp		2	SS	15		324				
			3	SS	38		323				
322.7											
3.1	Compact to very dense, brown medium to fine SAND, trace to some silt damp		4	SS	61		322				
			5	SS	40		321				0 88 12 0
319.5							320				
6.3	Very dense, brown GRAVELLY SAND saturated		6	SS	80	▼	319				
			7	AS			318				Dynamic cone penetration tests carried out
316.9											
316.9	Very dense, grey Sandy SILT TILL		8	SS	80/100mm		317				Stanard penetration test resumed
9.2	END OF BOREHOLE @ 9.2m NOTE: Water level recorded @ 6.4m upon completion										

EXPRESS 3-221.GPJ EXPRESS.GDT 20/07/99

$+^{3}_{3}$ Numbers refer to Sensitivity $\varepsilon_{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-19 1 OF 1 METRIC

W.P. 363-94-00 SITE 33-221 LOCATION King St. E. North of Franklin St., 4810955N,227828E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 19.11.98 - 19.11.98 CHECKED BY E.Y.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
325.6											
0.0	ASPHALT 100mm CRUSHED GRANULAR 300mm Compact, dark brown gravelly sand FILL Compact to loose, rust to dark brown silty sand FILL, trace gravel damp		1	SS	14		325		○		
			2	SS	8		324		○		8 72 15 5
323.2									○		
2.4	Compact to very dense, brown fine SAND, frequent silty sand seams damp		3	SS	19		323		○		
			4	SS	14		322		○		
			5	SS	19				○		3 78 19 0
			6	SS	15		321		○		
			7	SS	37		320		○		
319.3			8	SS	34	▼			○		
6.3	Dense to very dense, brown medium to fine SAND saturated						319				
317.5			9	SS	66		318		○		
8.1	END OF BOREHOLE @ 8.1m NOTE: Water level recorded @ 6.3m (3/3/99)										

+3, ×3. Numbers refer to Sensitivity ○3% STRAIN AT FAILURE

EXPRESS 3-221.GPJ EXPRESS.GDT 22/07/99

RECORD OF BOREHOLE No 98-20 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. North of Franklin St., 4810975N,227788E ORIGINATED BY S.W

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 18.11.98 - 18.11.98 CHECKED BY E.Y.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL ▷ FIELD VANE ✕ LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
325.3											
0.0 / 324.6	ASPHALT 100mm CRUSHED GRANULAR 300mm Compact, dark brown gravelly sand FILL						325				
0.7 / 323.9	Compact, dark brown sandy silt FILL very moist to wet		1	SS	18				○		
1.4 / 322.8	Loose to compact, dark brown silty sand FILL damp		2	SS	4		324		○		
2.5	Compact to dense, brown fine SAND, trace to some silt damp		3	SS	25		323		○		
			4	SS	23		322		○		
319.8			5	SS	44		321		○		
5.5 / 319.4	Very dense to dense, brown fine to medium SAND wet					▼	320		○		
5.9	saturated		6	SS	66		319				
318.0			7	SS	30		318		○		
7.3	END OF BOREHOLE @ 7.3m NOTE: Water level recorded @ 5.9m upon completion										

EXPRESS 3-221.GPJ EXPRESS.GDT 20/07/99

$+^{3}_{3}$ Numbers refer to Sensitivity $\langle\rangle^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-21

1 OF 1

METRIC

W.P. 363-94-00 SITE 33-221 LOCATION King St. E. at Delroy Ave., 4810986N,227763E ORIGINATED BY S.W.

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W.

DATUM GEODETIC DATE 18.11.98 - 18.11.98 CHECKED BY E.Y.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE ✓ LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH 325.0	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
0.0	ASPHALT 110mm CRUSHED GRANULAR 260mm Compact, dark brown gravelly sand FILL, some silt damp										
323.9			1	SS	24		324		○		
1.1	Compact, dark brown fine sand FILL, some silt damp		2	SS	12		323		○		
321.6			3	SS	26		322		○		
3.4	Very dense, brown fine SAND, trace to some silt damp		4	SS	65				○		3 80 17 0
320.4							321				
4.6	Dense, grey SILT damp		5	SS	48				○		
320.1							320				
4.9	Dense to very dense, brown Medium to fine SAND wet										
319.4							319				
5.6	saturated, trace gravel										
318.7											
6.3	Very dense, grey SANDY SILT TILL, some clay, trace gravel moist		6	SS	45				○		3 25 55 17
317.7			7	SS	60		318		○		
7.3	END OF BOREHOLE @ 7.3m NOTE: Water level recorded @ 5.6m (1/26/99)										

EXPRESS 3-221.GPJ EXPRESS.GDT 22/07/99

+3, -3, Numbers refer to Sensitivity ○3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 98-22 1 OF 1 METRIC

W.P. 363-94-00 SITE:33-221 LOCATION King St. E. North of Delroy Ave., 4811009N,227717E ORIGINATED BY S.W

DIST 2 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.W

DATUM GEODETIC DATE 18.11.98 - 18.11.98 CHECKED BY E.Y.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL ◦ LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
324.4											
0.0 / 323.7	ASPHALT 100mm CRUSHED GRANULAR 300mm Compact, dark brown gravelly sand FILL						324				
0.7 / 323.2	Compact, dark brown sand FILL		1	SS	11				○		
1.2	Loose, dark brown sand FILL, trace gravel moist		2	SS	6		323		○		
			3	SS	4		322		○		
321.2											
3.2 / 320.3	Very dense, brown fine SAND, some gravel damp		4	SS	55		321		○		4 87 9 0
4.1 / 319.7	Dense, brown medium to fine SAND, trace gravel wet						320				
4.7 / 319.3	saturated		5	SS	45	▼			○		2 85 13 0
5.1	END OF BOREHOLE @ 5.1m NOTE: Water level recorded @ 4.7m upon completion										

$+^{3}_{3}$ Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

EXPRESS_3-221.GPJ EXPRESS.GDT 20/07/99

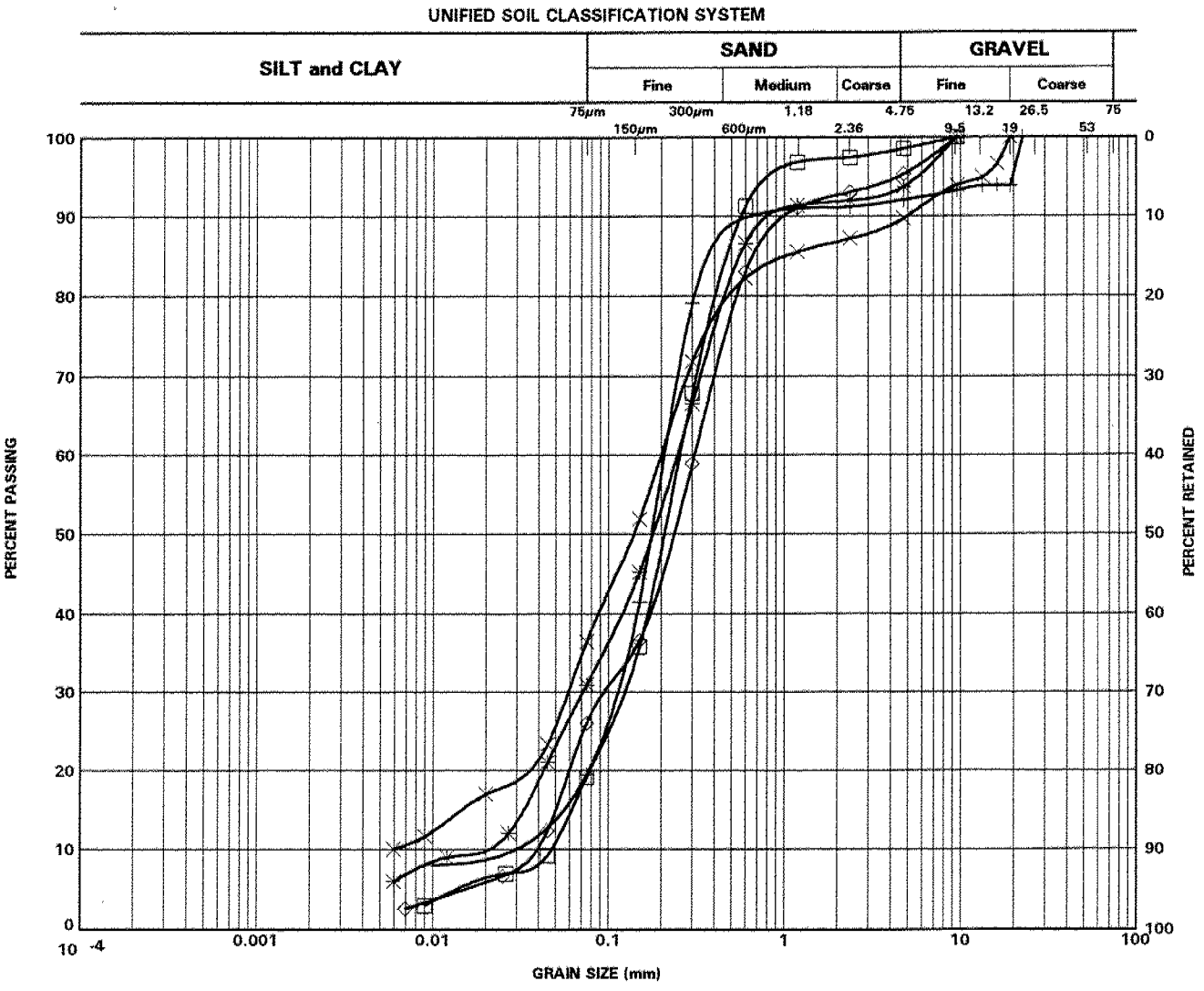
APPENDIX "B"

Laboratory Test Results

AGRA
ENGINEERING GLOBAL SOLUTIONS

AGRA
ENGINEERING GLOBAL SOLUTIONS

GRAIN SIZE DISTRIBUTION



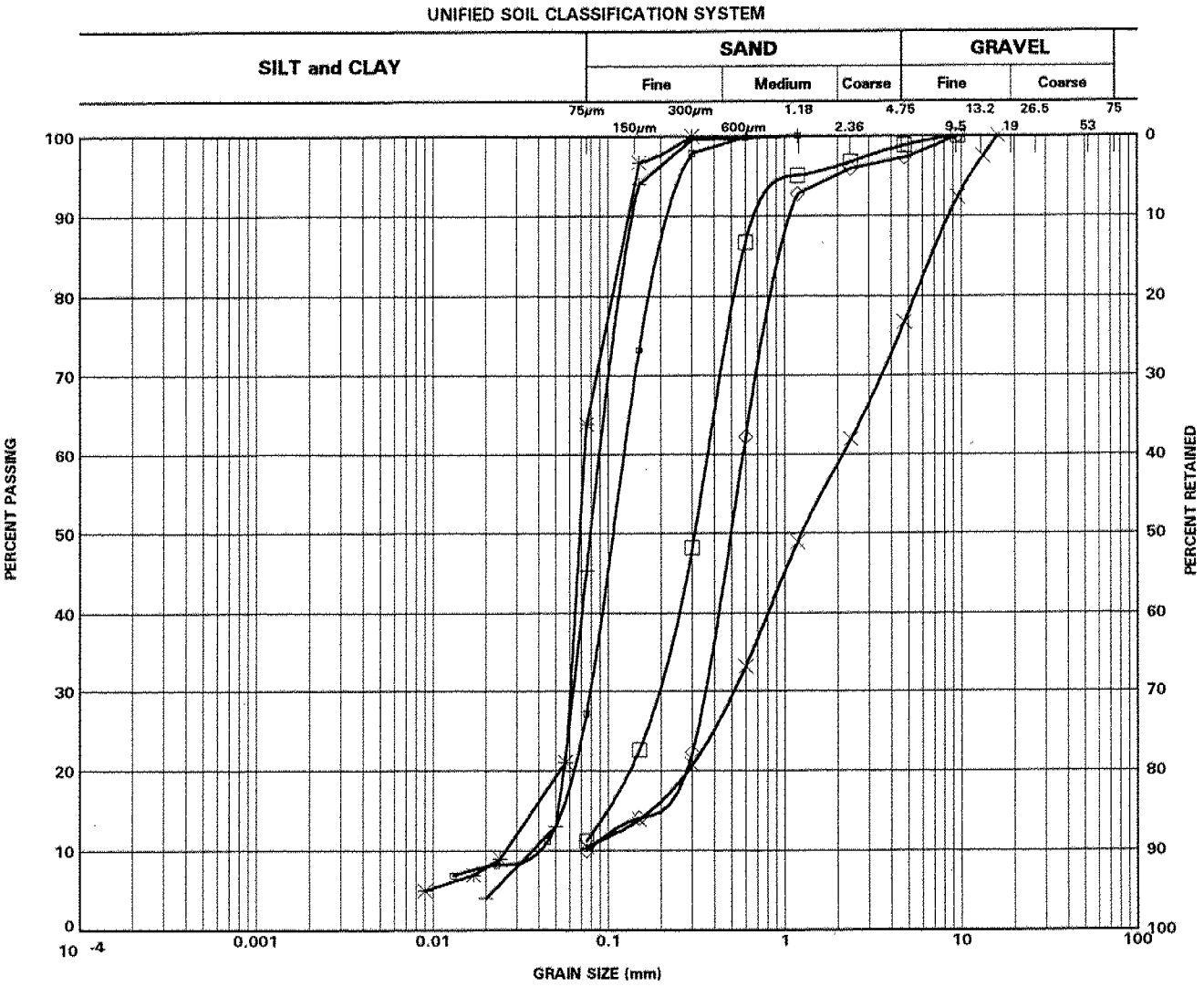
LEGEND		
SYMBOL	BOREHOLE	DEPTH (m)
□	98-01	0.5
✳	98-03	0.8
◇	98-04	3.1
×	98-08	3.1
+	98-19	3.1

SILTY SAND FILL

WP 363-94-00	SITE 33-221	Figure No. 1

AGRA
ENGINEERING GLOBAL SOLUTIONS

GRAIN SIZE DISTRIBUTION



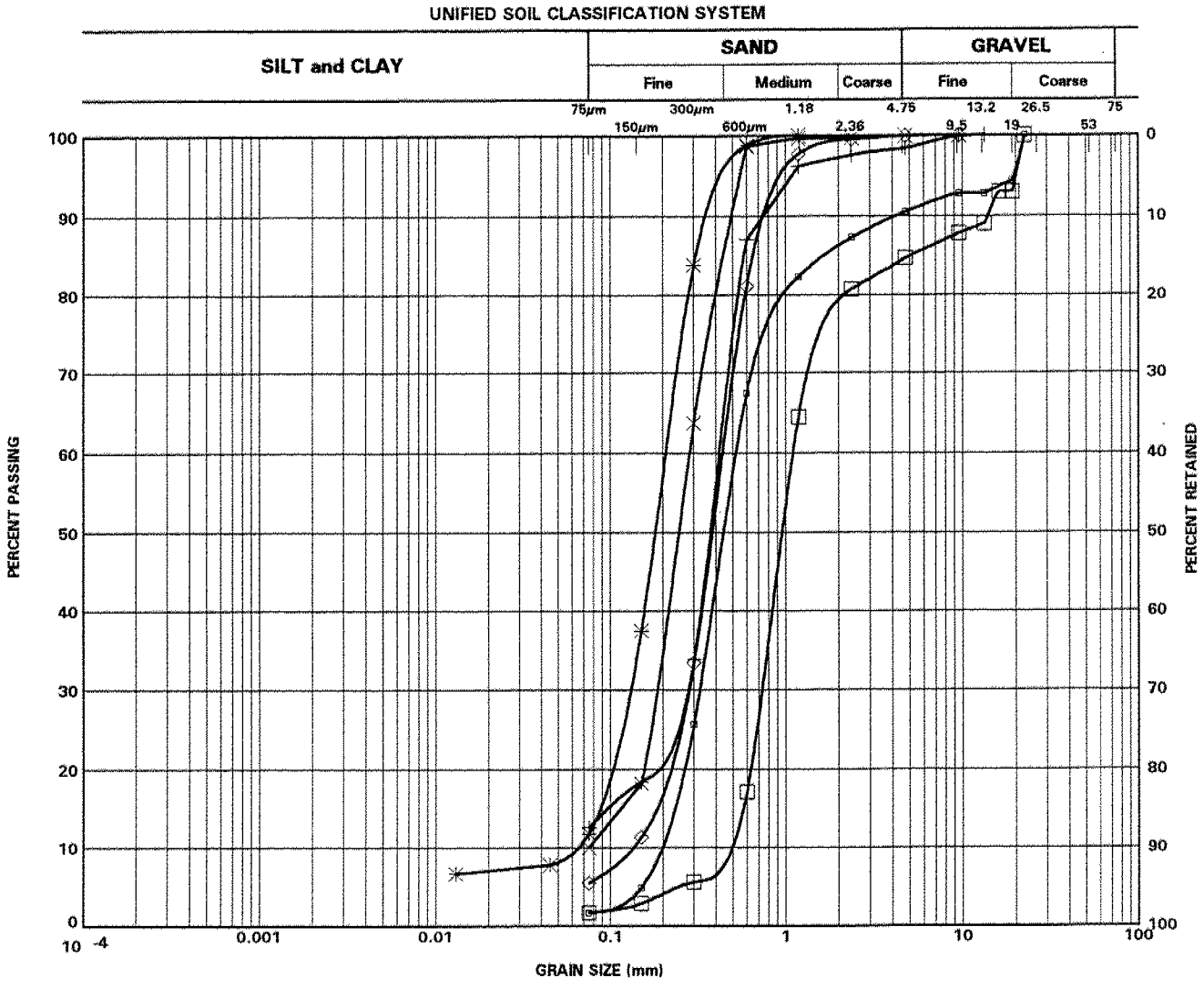
LEGEND		
SYMBOL	BOREHOLE	DEPTH (m)
□	98-01	3.1
✳	98-01	3.8
◇	98-02	3.1
×	98-03	3.8
+	98-04	3.1
▫	98-07	3.1

SAND to SILTY SAND

WP 363-94-00	SITE 33-221	Figure No. 2

AGRA
ENGINEERING GLOBAL SOLUTIONS

GRAIN SIZE DISTRIBUTION



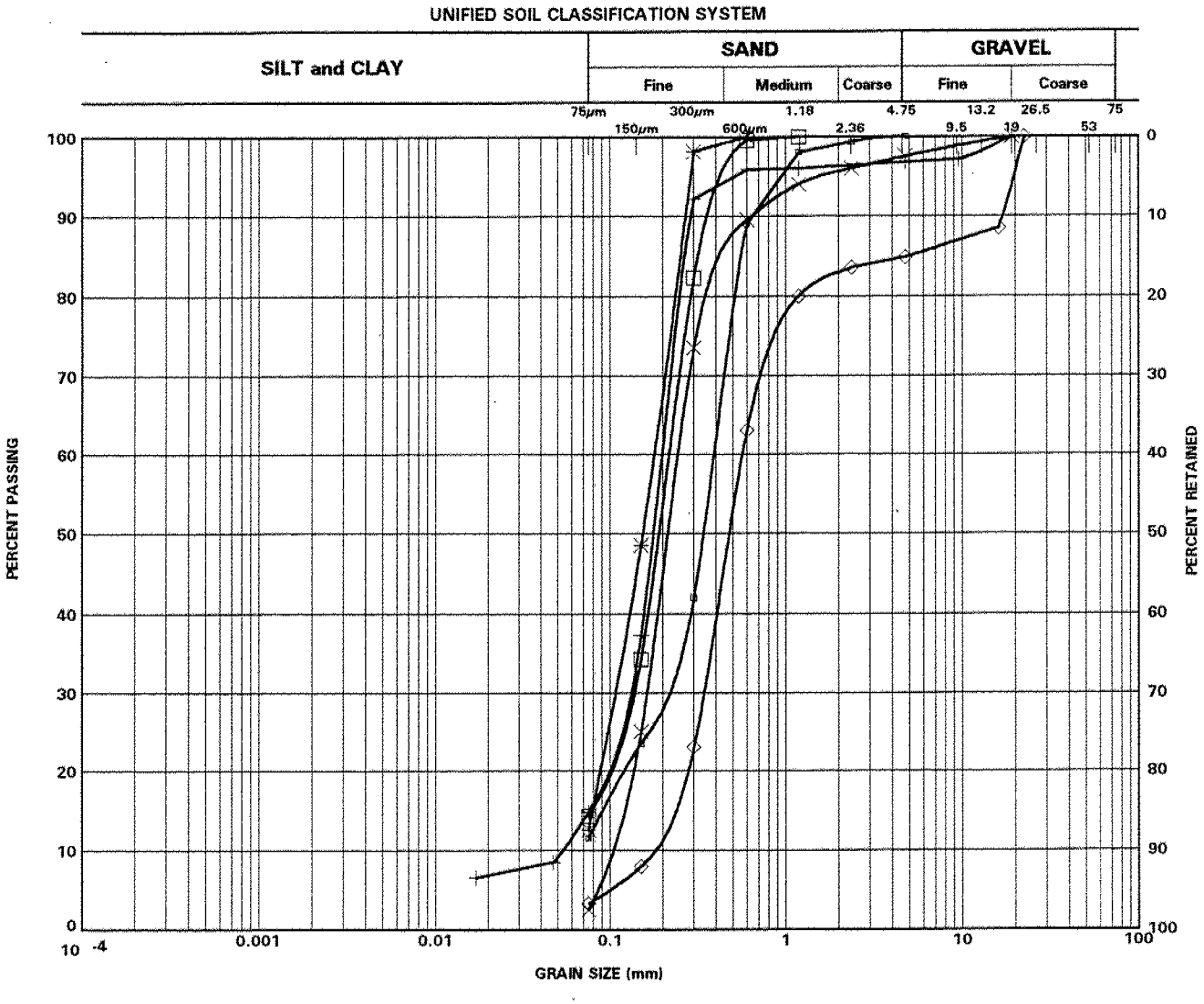
LEGEND		
SYMBOL	BOREHOLE	DEPTH (m)
□	98-07	8.4
✳	98-08	3.1
◇	98-09	7.6
×	98-10	3.8
+	98-11	2.3
▫	98-11	4.6

SAND to SILTY SAND

WP 363-94-00	SITE 33-221	Figure No. 3

AGRA
ENGINEERING GLOBAL SOLUTIONS

GRAIN SIZE DISTRIBUTION



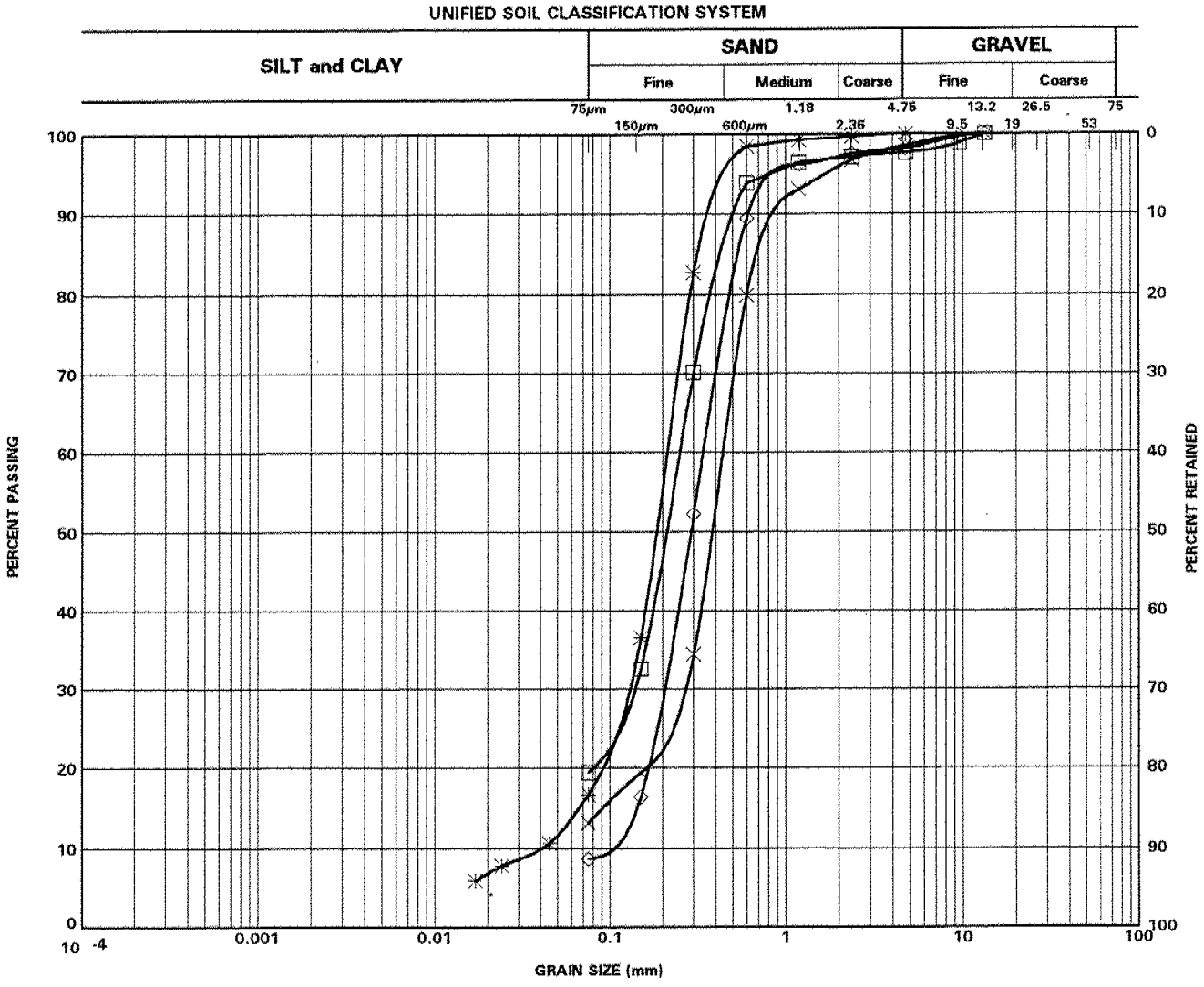
LEGEND		
SYMBOL	BOREHOLE	DEPTH (m)
□	98-12	7.6
✳	98-13	3.1
◇	98-13	9.1
×	98-15	3.1
+	98-16	3.1
▫	98-18	4.6

SAND to SILTY SAND

WP 363-94-00	SITE 33-221	Figure No. 4

AGRA
ENGINEERING GLOBAL SOLUTIONS

GRAIN SIZE DISTRIBUTION



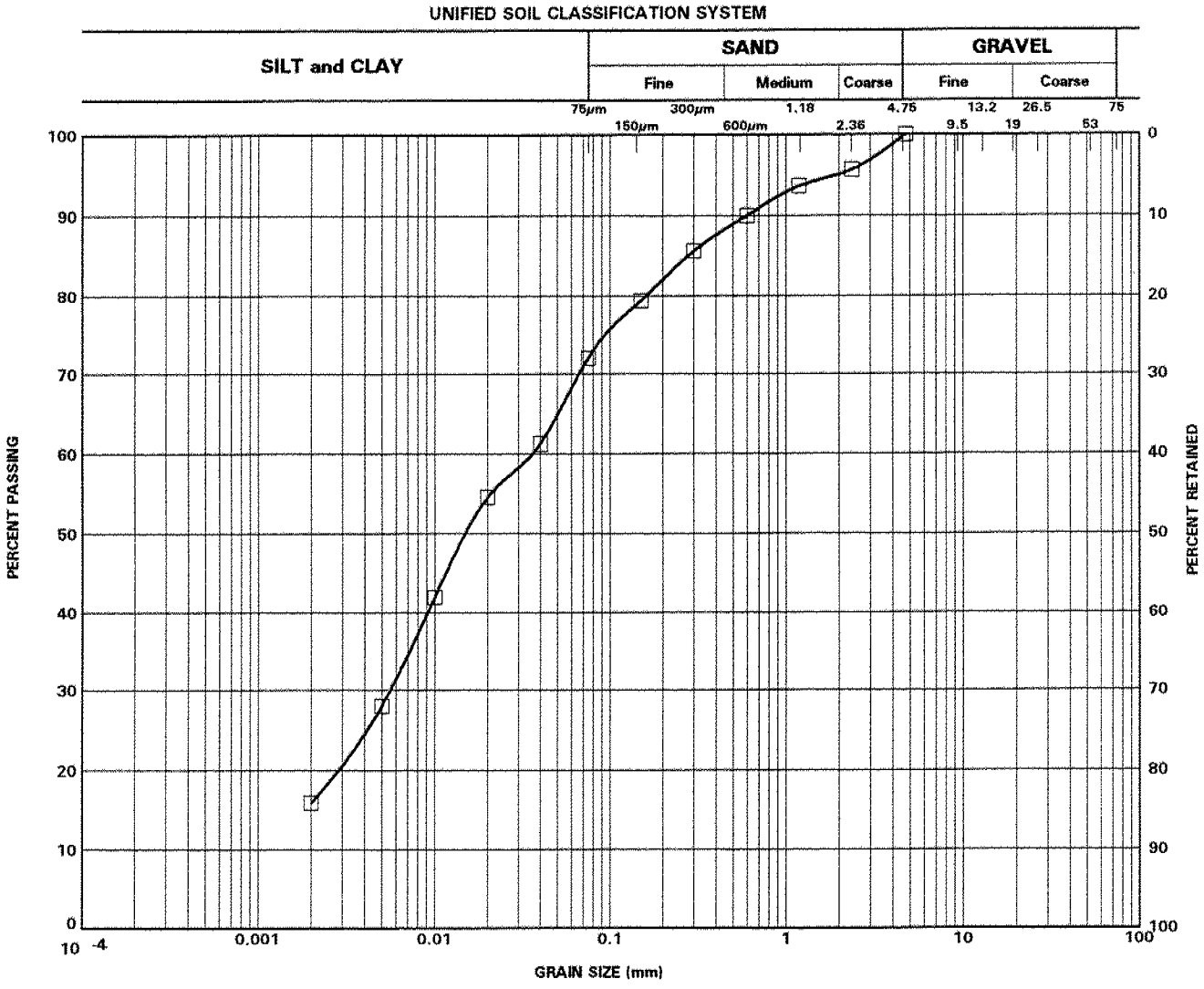
LEGEND		
SYMBOL	BOREHOLE	DEPTH (m)
□	98-19	3.7
✳	98-21	3.1
◇	98-22	3.1
×	98-22	4.6

SAND to SILTY SAND

WP 363-94-00	SITE 33-221	Figure No. 5

AGRA
ENGINEERING GLOBAL SOLUTIONS

GRAIN SIZE DISTRIBUTION

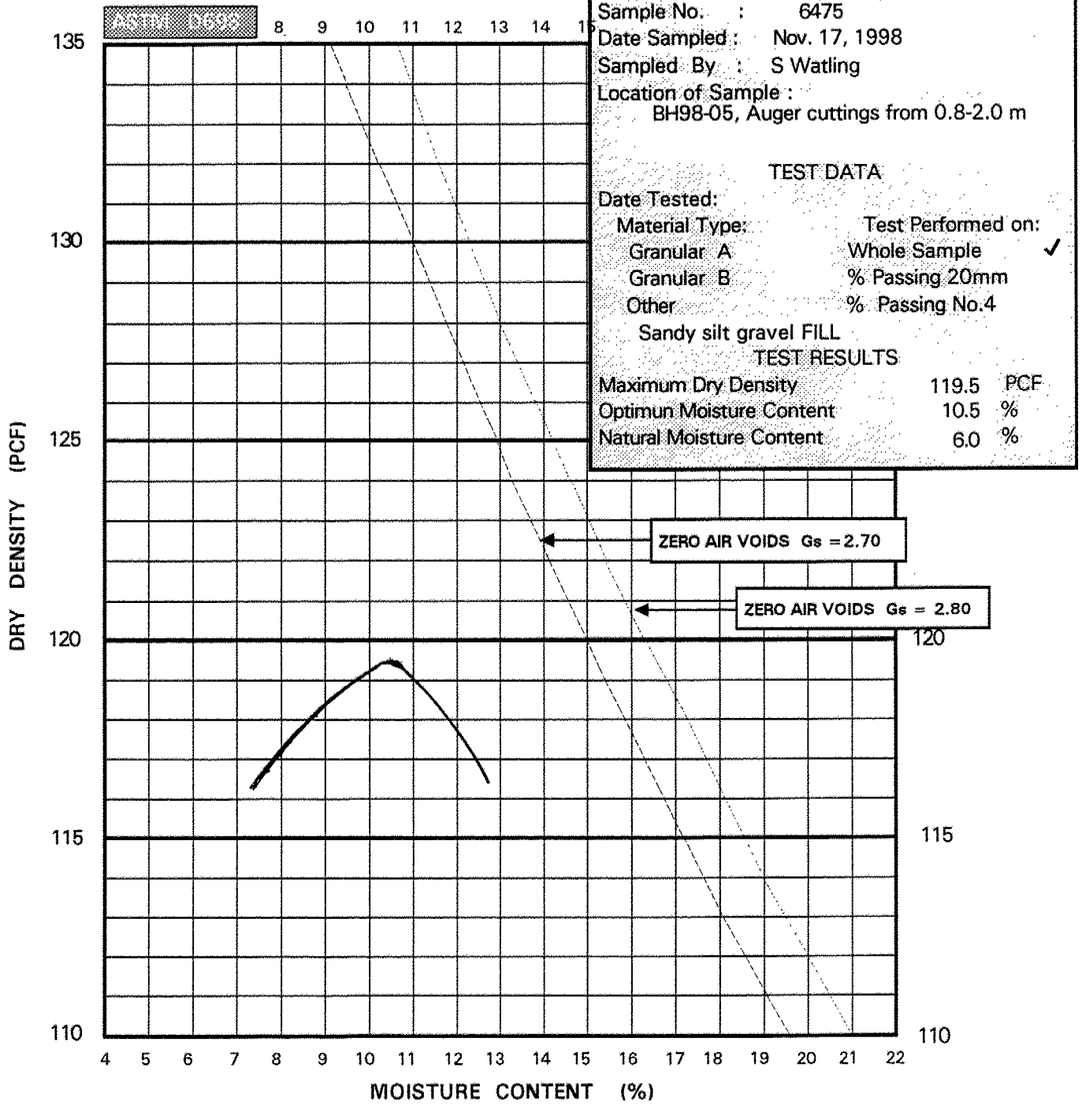


LEGEND		
SYMBOL	BOREHOLE	DEPTH (m)
□	98-21	6.1

SILT TILL

WP 363-94-00	SITE 33-221	Figure No. 6

STANDARD PROCTOR TEST RESULTS



SAMPLE DATA

Sample No. : 6475
Date Sampled : Nov. 17, 1998
Sampled By : S Watling
Location of Sample :
BH98-05, Auger cuttings from 0.8-2.0 m

TEST DATA

Date Tested:

Material Type:	Test Performed on:
Granular A	Whole Sample ✓
Granular B	% Passing 20mm
Other	% Passing No.4

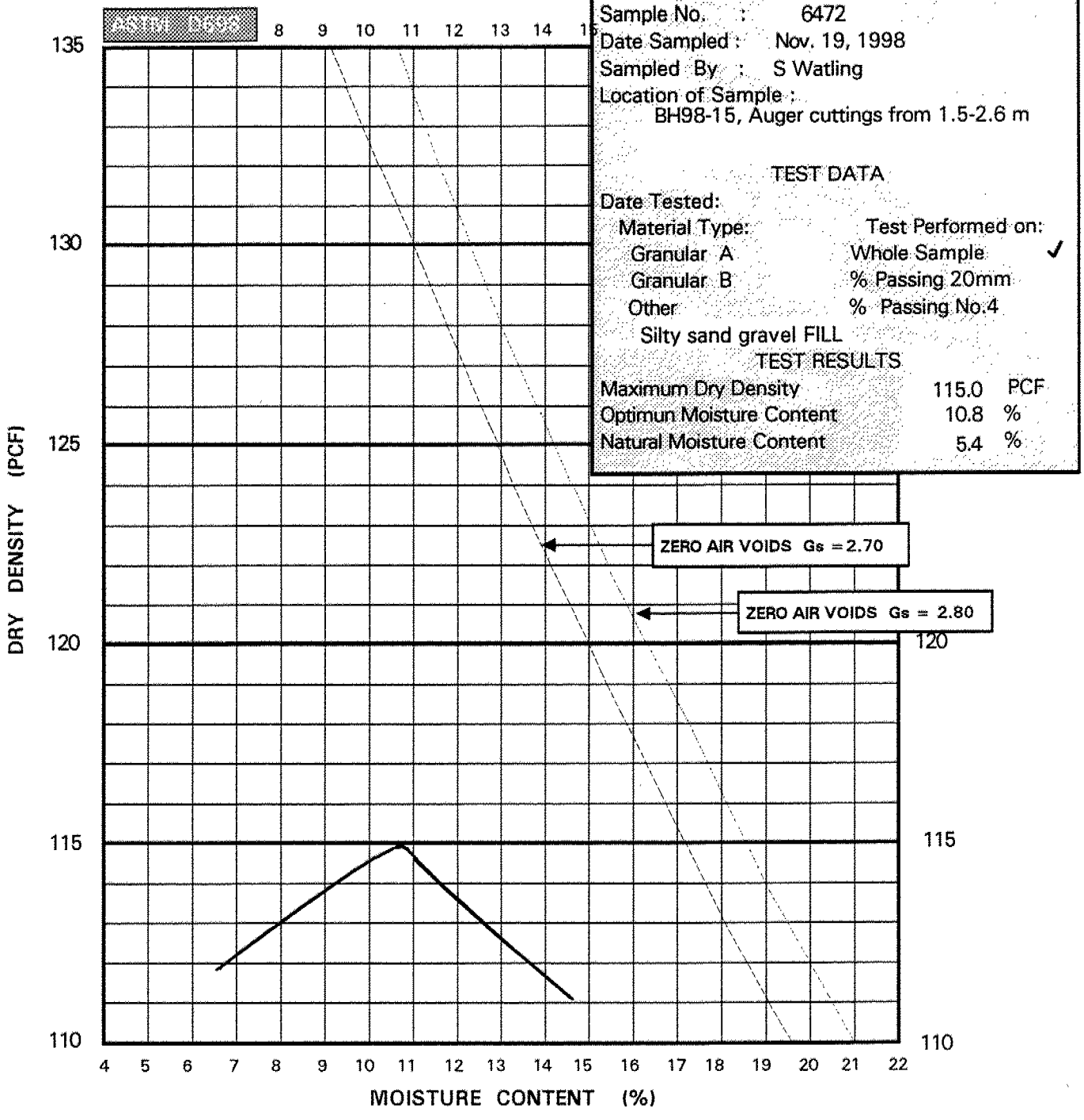
Sandy silt gravel FILL

TEST RESULTS

Maximum Dry Density	119.5	PCF
Optimun Moisture Content	10.5	%
Natural Moisture Content	6.0	%

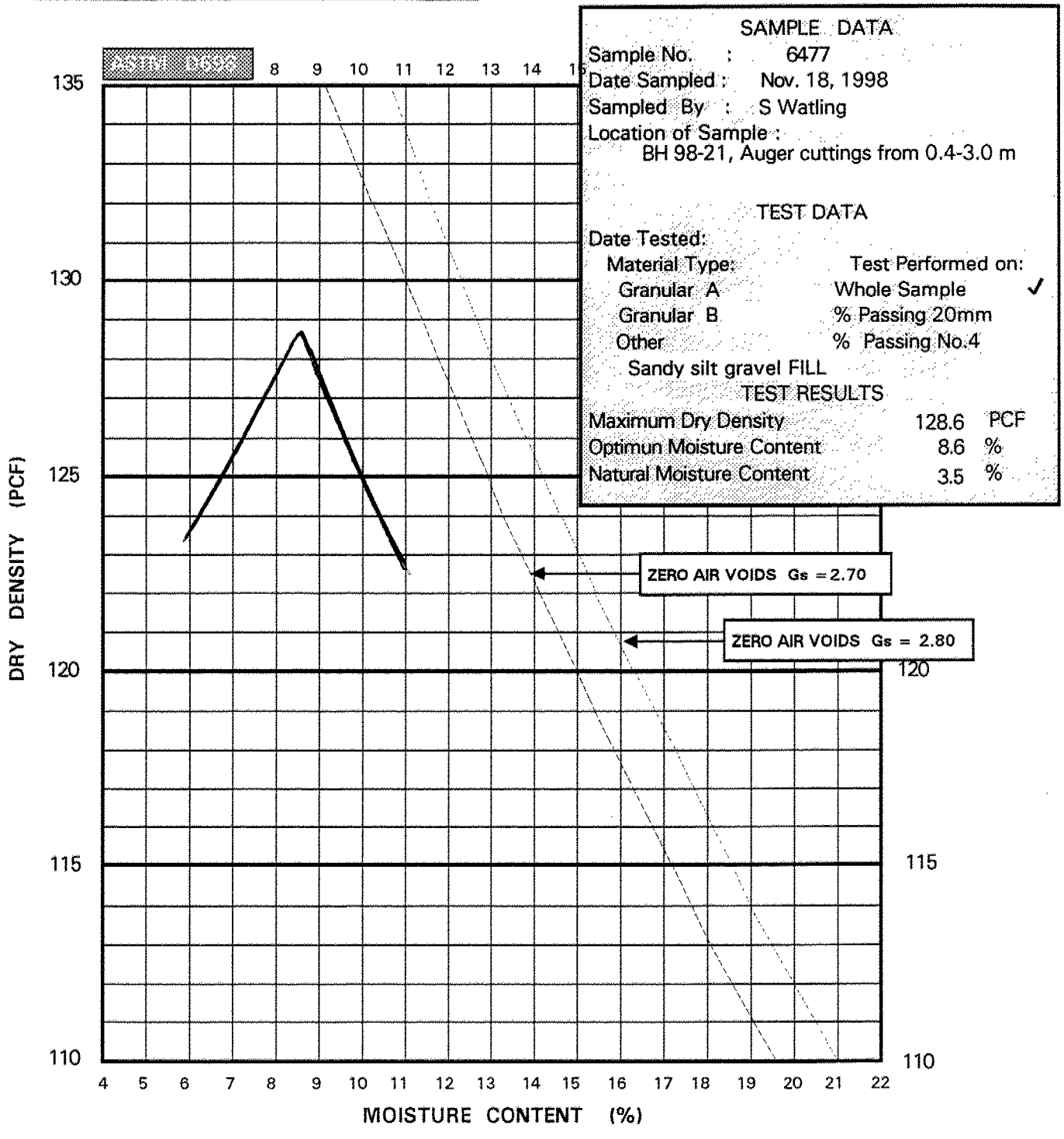
REFERENCE NO.	TK98-10-3 W.P. 363-94-00	COMMENTS
PROJECT	King St. Retaining Wall & Franklin St. Bridge	
LOCATION	Kitchener, Ontario	AGRA Earth & Environmental
CLIENT	Morrison Hershfield	

STANDARD PROCTOR TEST RESULTS



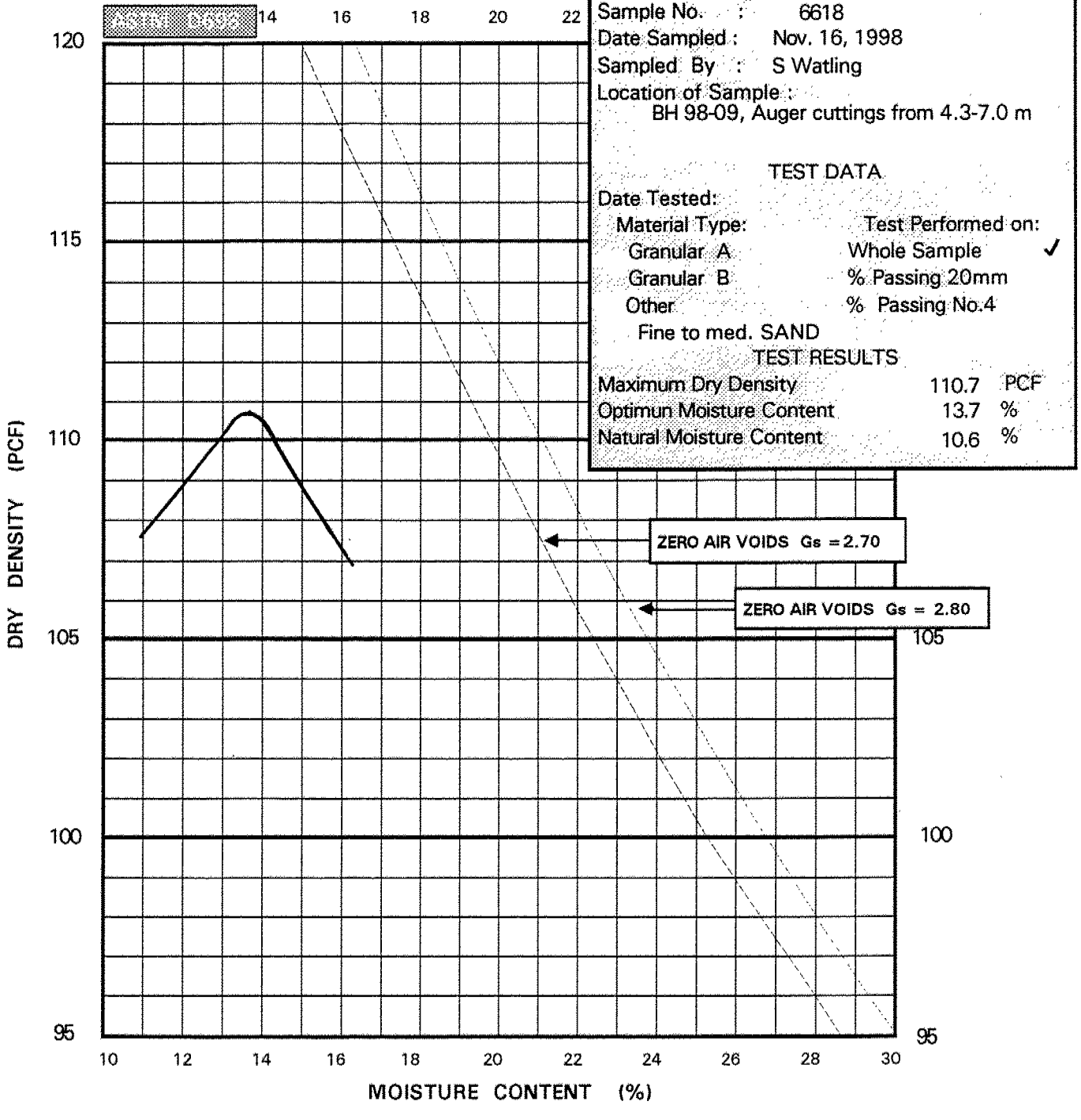
REFERENCE NO.	TK98-10-3 W.P. 363-94-00	COMMENTS
PROJECT	KingSt. RetainingWall & Franklin St. Bridge	
LOCATION	Kitchener, Ontario	AGRA Earth & Environmental
CLIENT	Morrison Hershfield	

STANDARD PROCTOR TEST RESULTS



REFERENCE NO.	TK98-10-3 W.P. 363-94-00	COMMENTS
PROJECT	King St. Retaining Wall & Franklin St. Bridge	
LOCATION	Kitchener, Ontario	AGRA Earth & Environmental
CLIENT	Morrison Hershfield	

STANDARD PROCTOR TEST RESULTS



SAMPLE DATA

Sample No. : 6618
Date Sampled : Nov. 16, 1998
Sampled By : S Watling
Location of Sample :
BH 98-09, Auger cuttings from 4.3-7.0 m

TEST DATA

Date Tested:

Material Type:	Test Performed on:
Granular A	Whole Sample ✓
Granular B	% Passing 20mm
Other	% Passing No.4

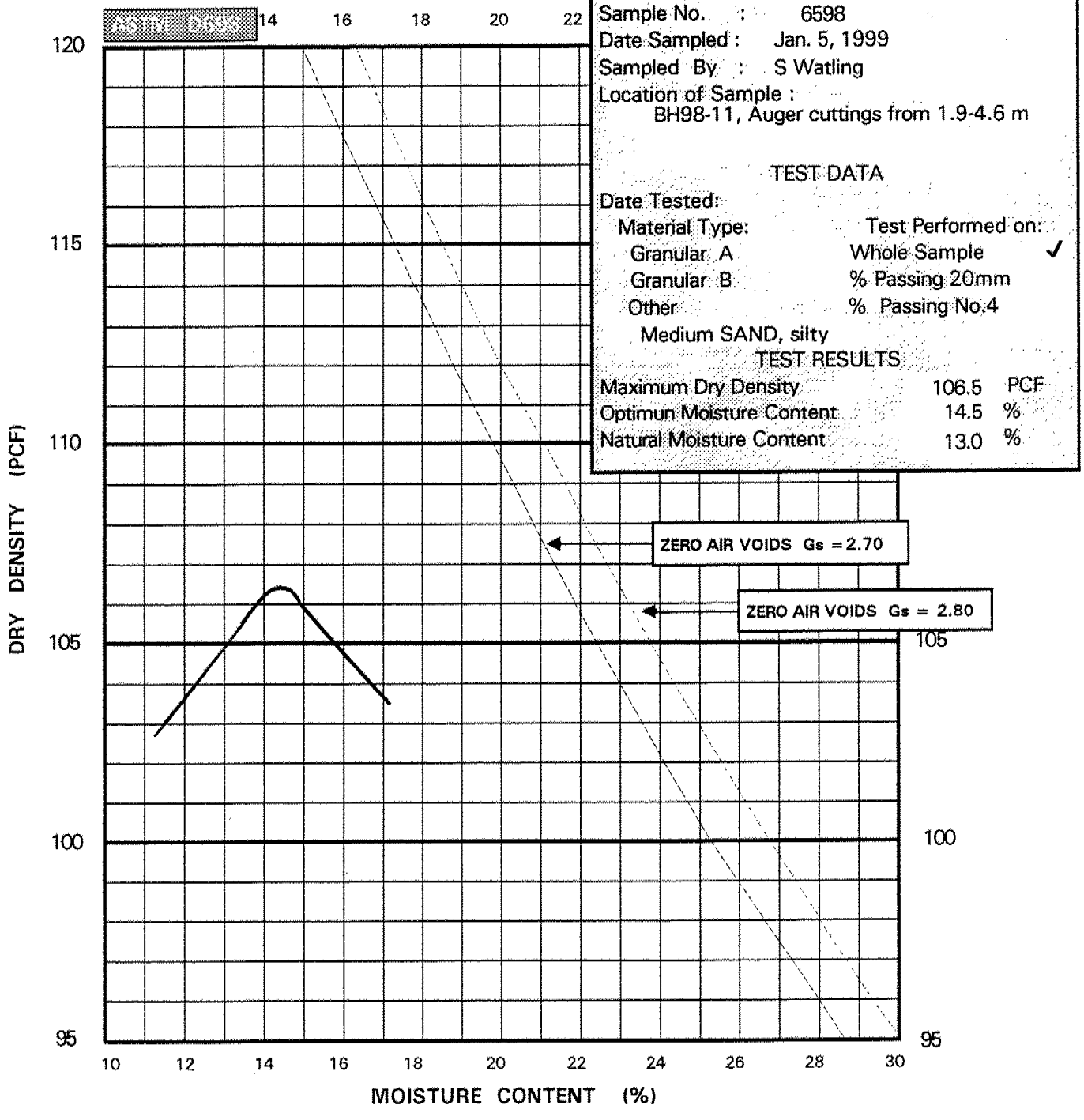
Fine to med. SAND

TEST RESULTS

Maximum Dry Density	110.7	PCF
Optimun Moisture Content	13.7	%
Natural Moisture Content	10.6	%

REFERENCE NO.	TK98-10-3 W.P. 363-94-00	COMMENTS
PROJECT	King St. Retaining Wall & Franklin St. Bridge	
LOCATION	Kitchener, Ontario	AGRA Earth & Environmental
CLIENT	Morrison Hershfield	

STANDARD PROCTOR TEST RESULTS



SAMPLE DATA

Sample No. : 6598
Date Sampled : Jan. 5, 1999
Sampled By : S Watling
Location of Sample :
BH98-11, Auger cuttings from 1.9-4.6 m

TEST DATA

Date Tested:

Material Type:	Test Performed on:
Granular A	Whole Sample ✓
Granular B	% Passing 20mm
Other	% Passing No.4

Medium SAND, silty

TEST RESULTS

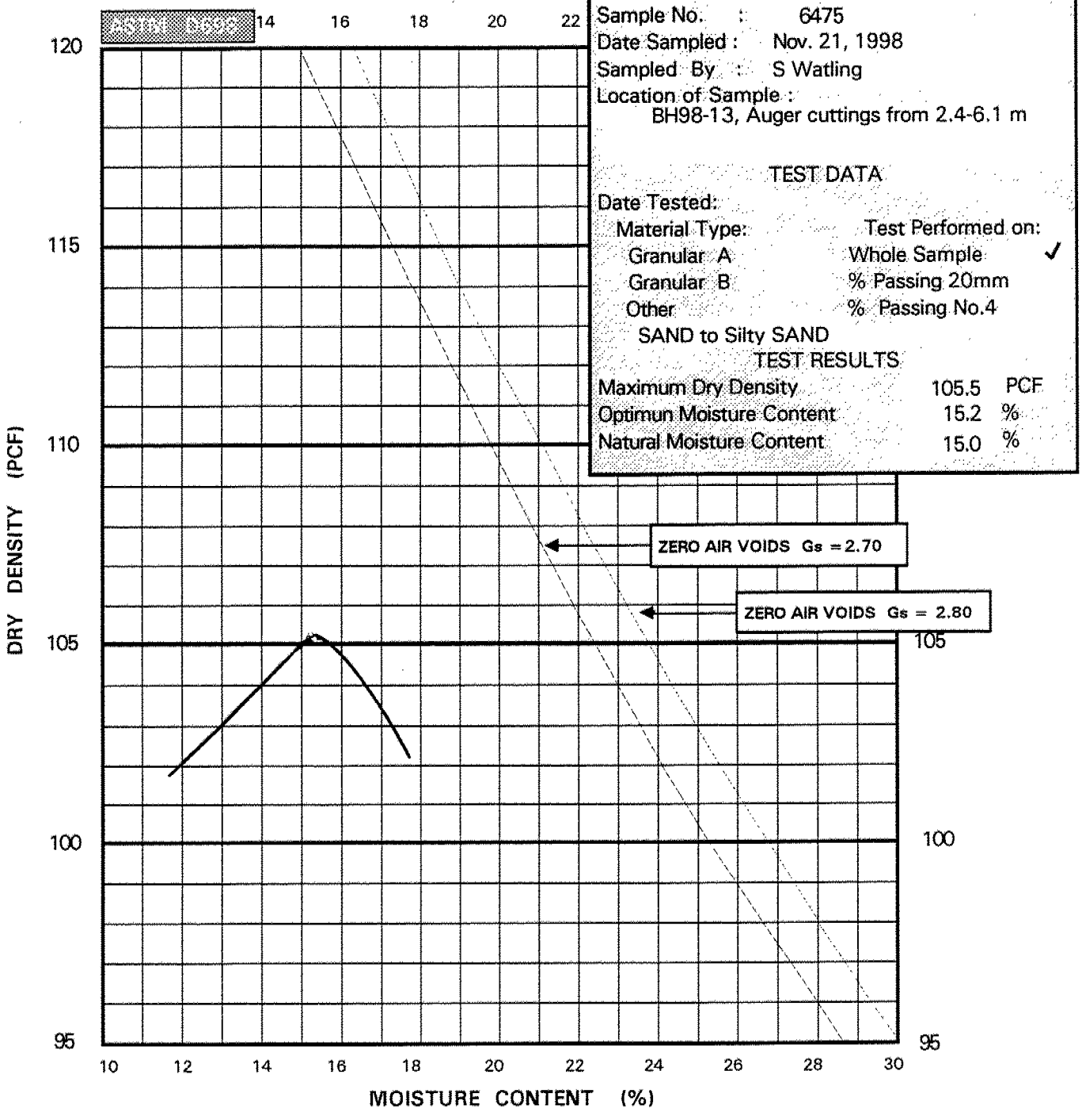
Maximum Dry Density	106.5	PCF
Optimun Moisture Content	14.5	%
Natural Moisture Content	13.0	%

REFERENCE NO.	TK98-10-3 W.P. 363-94-00
PROJECT	King St. Retaining Wall & Franklin St. Bridge
LOCATION	Kitchener, Ontario
CLIENT	Morrison Hershfield

COMMENTS

AGRA Earth & Environmental

STANDARD PROCTOR TEST RESULTS



SAMPLE DATA

Sample No. : 6475
Date Sampled : Nov. 21, 1998
Sampled By : S Watling
Location of Sample :
BH98-13, Auger cuttings from 2.4-6.1 m

TEST DATA

Date Tested:

Material Type:	Test Performed on:
Granular A	Whole Sample ✓
Granular B	% Passing 20mm
Other	% Passing No.4

SAND to Silty SAND

TEST RESULTS

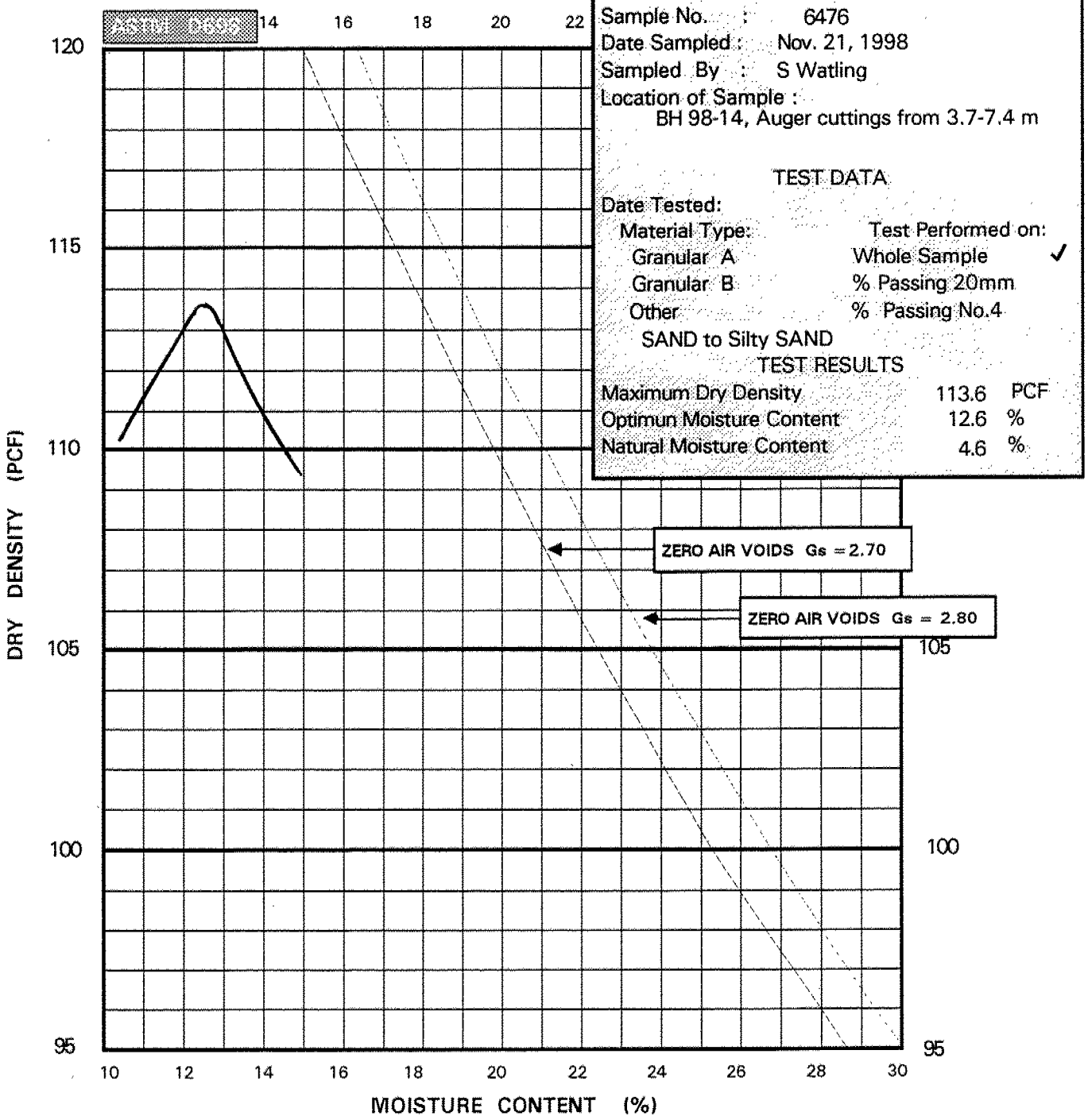
Maximum Dry Density	105.5	PCF
Optimun Moisture Content	15.2	%
Natural Moisture Content	15.0	%

REFERENCE NO.	TK98-10-3 W.P. 363-94-00
PROJECT	King St. Retaining Wall & Franklin St. Bridge
LOCATION	Kitchener, Ontario
CLIENT	Morrison Hershfield

COMMENTS

AGRA Earth & Environmental

STANDARD PROCTOR TEST RESULTS



SAMPLE DATA

Sample No. : 6476
Date Sampled : Nov. 21, 1998
Sampled By : S Watling
Location of Sample :
BH 98-14, Auger cuttings from 3.7-7.4 m

TEST DATA

Date Tested:

Material Type:	Test Performed on:
Granular A	Whole Sample ✓
Granular B	% Passing 20mm
Other	% Passing No.4

SAND to Silty SAND

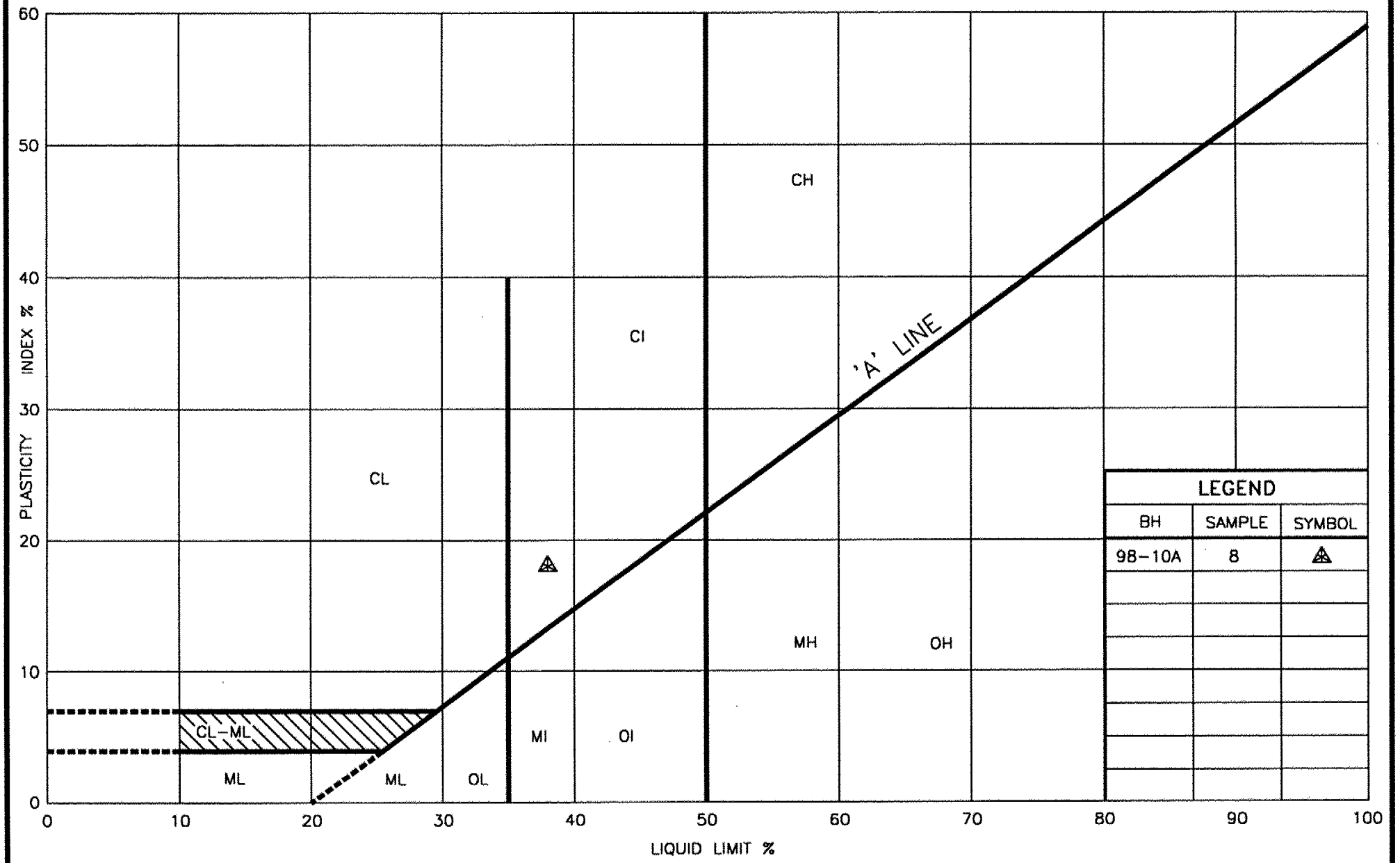
TEST RESULTS

Maximum Dry Density	113.6	PCF
Optimun Moisture Content	12.6	%
Natural Moisture Content	4.6	%

REFERENCE NO.	TK98-10-3, W.P. 363-94-00
PROJECT	King St. Retaining Wall & Franklin St. Bridge
LOCATION	Kitchener, Ontario
CLIENT	Morrison Hershfield

COMMENTS

AGRA Earth & Environmental



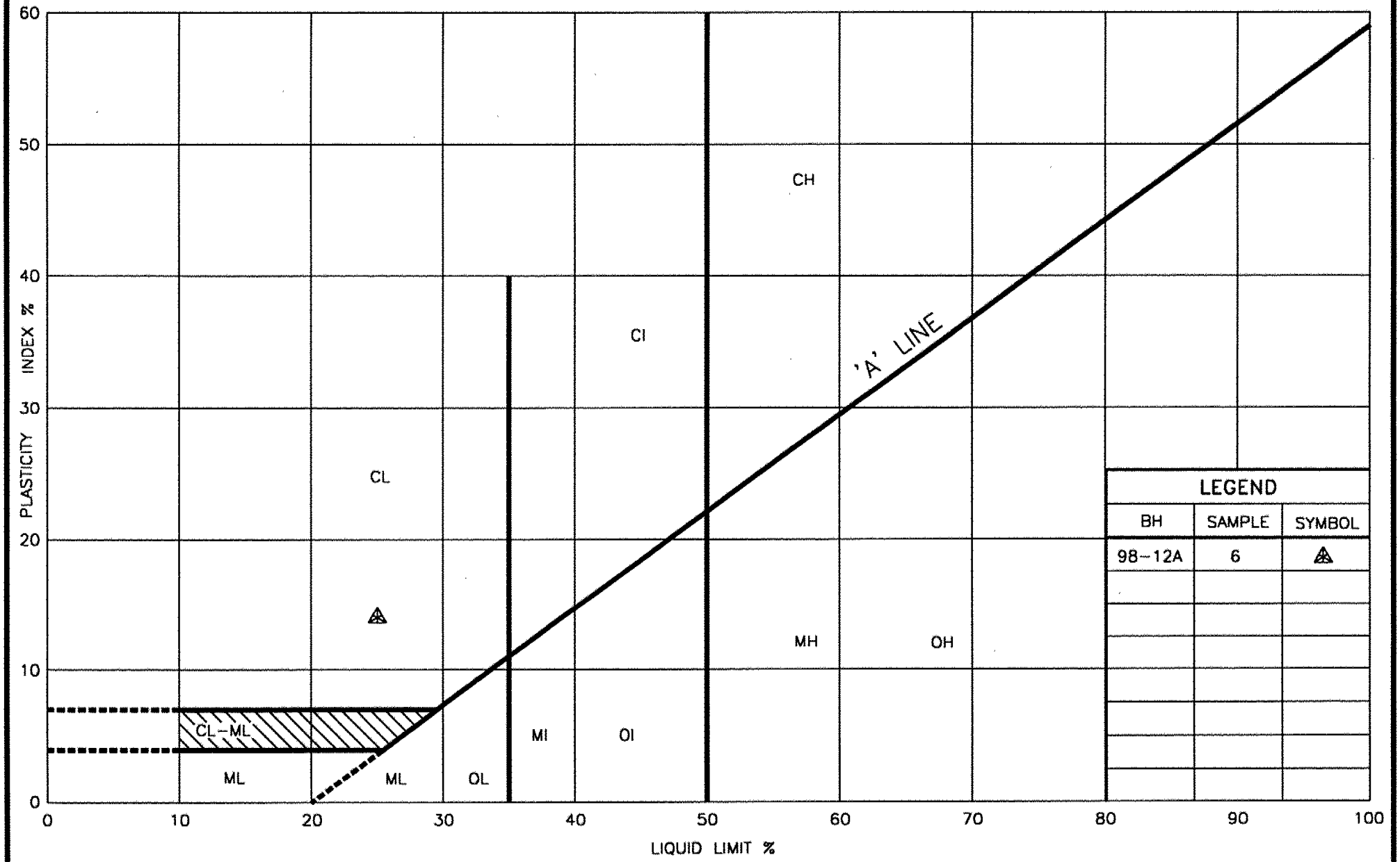
AGRA
ENGINEERING GLOBAL SOLUTIONS

Silty Clay

FIG No.: 14

W P 363-94-00

Site: 33-221



AGRA
ENGINEERING GLOBAL SOLUTIONS

Heterogeneous Mixture of Sand, Silt, Gravel & Clay

FIG No.: 15

W P 363-94-00

Site: 33-221

APPENDIX "C"

CHEMICAL TEST RESULTS

AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

AGRA Earth & Environmental Limited
160 Traders Blvd.
Unit 4
Mississauga, Ontario
Canada L4Z 3K7
Tel (905) 890-0785
Fax (905) 890-1141

AGRA Earth and Environmental Ltd.
440 Philip Street, Unit 8
Waterloo, Ontario N2L 5R9

Date: December 16, 1998

Page: 1 of 1

Project Name : -

Sample Type: Soil (Sand)

Project No. : TK 98-10-3

Lab Ref.: F98-1900

Contact : Steve

Final

CERTIFICATE OF ANALYSIS

Lab # / Unit	Sample ID		pH	Sulphate (ug/g)	Chloride (ug/g)
Method Detection Limit				**1**	**1**
S9813206	BH4, SA3	(18/11/98)	8.9	8	130
S9813207	BH10, SA6	(16/11/98)	9.0	2	67
S9813208	BH19, SA6	(19/11/98)	9.1	7 (8)	83 (85)
Lab Blank			5.2	<1	<1
Q.C. Standard Actual (ppm)			6.0	16.4	2.7
Q.C. Standard Expected (ppm)			6.0	16.0	2.8

Cynthia Ridge, C. Chem.
Q.A./Q.C. Officer

Suman Punam, C. Chem.
Laboratory Manager

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440 Philip Street, Unit 8
Waterloo, Ontario N2L 5R9

Date: February 5, 1999

Page: 1 of 1

Project Name : Hwy. 748

Sample Type: Soil (Sand)

Project No. : -

Lab Ref.: F99-0047

Contact : Steve Yonemitsu

Final

Lab # / Unit	Sample ID		Chloride (µg/g)
Method Detection Limit			**1**
S9900226	BH21	(13/01/99)	100
S9900227	BH13	(13/01/99)	88
S9900228	BH5	(13/01/99)	150 (150)
Lab Blank			<1
Q.C. Standard Actual (ppm)			2.7
Q.C. Standard Expected (ppm)			2.8

Cynthia Ridge, C. Chem.
Q.A./Q.C. Officer

Suman Punani, C. Chem.
Laboratory Manager

RESISTIVITY

PROJECT NO.: TK98-10-3 **DATE :** Jan 5/99

LOCATION:

SAMPLE 6521 (Sand)

		TEST RESULTS
Volts	**(mv)**	12400
Initial Volts	**(mv)**	10
Amps	**(mA)**	1.06

RESISTIVITY = **11,708** ohm-cm

SAMPLE 6522

		TEST RESULTS
Volts	**(mv)**	12420
Initial Volts	**(mv)**	10
Amps	**(mA)**	2.12

RESISTIVITY = **5,863** ohm-cm

SAMPLE 6523

		TEST RESULTS
Volts	**(mv)**	12130
Initial Volts	**(mv)**	6.3
Amps	**(mA)**	0.79

RESISTIVITY = **15,362** ohm-cm

APPENDIX "D"

Statement of Limitations

LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. 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 Soils Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes.

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 conclusion as to how the subsurface conditions may affect their work.

The benchmark and elevations mentioned in this report were obtained strictly for use in the geotechnical design of the project and by this office only, and should not be used by any other parties for any other purposes.

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 Earth & Environmental Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This report does not reflect the environmental issues or concerns unless otherwise stated in the report. 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.