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PRELIMINARY SOILS REPORT
GEOTHERMAL and GEOTECHNICAL STUDIES
PROPOSED SECONDARY and MIDDLE SCHOOLS
835 - 8TH STREET, NEW WESTMINISTER, BC

Prepared for:

New Westminister School District #40
821 - 8th Street
New Westminister, BC.
V3M 3S9

Our File: V04 - 121
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File: V04-121

Associate Director, Business Management Services
School District #36 (Surrey)
7542 - 134th Street
Surrey, BC. V3W 7J1

Attention: Ms. Kerry Magnus, MAIBC

Dear Ms. Magnus,

RE: PRELIMINARY SOILS REPORT
GEOTHERMAL and GEOTECHNICAL STUDIES
PROPOSED SECONDARY and MIDDLE SCHOOLS
835 - 8TH STREET, NEW WESTMINSTER, BC

1.0 INTRODUCTION

In accordance with a letter of authorization dated May 21, 2004 signed by Ms. Kerry Magnus on the behalf of New Westminister School Board, Centennial Geotechnical Engineers Ltd. (CGE) completed a geothermal and geotechnical studies for a proposed secondary and a middle schools located at the subject property as shown in Figure 1.

The geothermal and geotechnical studies are completed in general accordance with the scope of work outlined in our proposal P04-128, dated May 10, 2004.

The purpose of the investigation was to identify subsurface conditions at the proposed schools' sites, and based on the findings provide preliminary recommendations for the geotechnical aspects including site preparation, earthwork, foundation design, lateral earth pressures, drainage and pavement structure design as well as present the preliminary hydrogeology and groundwater information for geothermal considerations.

This soils report presents the results of the initial subsurface investigation and provides our preliminary recommendations for the geothermal and geotechnical studies.

2.0 PROPOSED NEW SCHOOL BUILDINGS

As indicated in the preliminary architectural drawings prepared by Grant + Sinclair Architects Ltd., CGE understands that the proposed development will include construction of a new secondary school, a middle school and other sport facilities in the following areas:

- The proposed secondary school will be located near the northeast sector of the school property. The proposed building is L-shaped, 3 stories high with 1 level of underground parking over the majority of the structure. The final floor grade of the underground parking structure will be established at Elev. 88.8m (geodetic datum). However, portions of the building will be without the underground parking structure.

- The proposed middle school will be situated near the southwest corner of the school property. The proposed building would most likely consist of a two-storey structure without a basement.

- The proposed sport facilities including two soccer fields and two basketball courts will be constructed between the west side of the secondary school and the north side of the middle school.

The general layout and approximate locations of the proposed buildings and sport facilities are shown in Figure 2.

At the time of preparing the preliminary soils report, structural loading conditions for the two proposed buildings are not available.

3.0 SITE DESCRIPTIONS

General

The parcel of land slated for construction of the two new schools is partly owned by the School Board of New Westminster and City of New Westminster. This block of land is bounded on the west by Tenth Avenue, on the north by 6th Street, on the east by Eighth Avenue and on the south by 8th Street.

The parcel of land owned by City of New Westminster occupies the northwest quarter of the site. This site is currently occupied by an oval track and field, two grass soccer fields, a baseball diamond, a skateboard park, and a park.

The parcel of land owned by the New Westminster School Board occupies the south half of the site. There are three major blocks of buildings including the east wing with the Massey Theatre, the west wing with the Adult Academy Learning Centre, and a detached building between the two wings, several asphalt-paved parking lots, a basketball court and a main driveway along the north end of the site extending between Tenth Avenue on the west and Eight Avenue on the east.

The northeast quarter of the block of land is occupied by the Royal City Community Church and the Moody Park Arena operates by City of New Westminister.

The locations of the existing buildings, main driveway, parking lots, park and sport facilities are shown in Figure 3.

3.1 Proposed Secondary School Site

The proposed secondary school site is currently occupied by the skateboard park, the park, the baseball diamond, a soccer field, a small part of the east wing, the detached building, the main driveway and at least three parking lots.

The general site grade of the proposed redeveloped school site is relatively level, and slopes gently down from south to north towards the soccer fields. There is a slight difference in grade ranging from about 12 inches to 4 feet (0.3 to 1.2m) between the soccer fields and the main driveway. The site grades of the soccer fields and the baseball diamond are relatively level. However, there is a difference in grade of about 3 feet between the grass soccer fields and the park at the north.

According to the City of New Westminister Park's manager, the site grade of the park was raised during the latest renovation work that was performed several years ago. The area currently occupied by the park was once a local depression, and was subsequently filled with random fill ranging from about 6 to 10 feet (1.8 to 3m) thick obtained from regrading the oval track and field and the soccer fields. Beneath the grassy soccer fields, the area is underlain by about 12 inches (300mm) of river sand fill. An irrigation system is installed beneath the soccer fields.

The skateboard park mainly consists of a concrete lined depression with a concrete apron around the perimeter.

According to the Operation Manager of School Board of New Westminister, numerous sanitary and storm drain pipes, an underground electrical cable, a steam tunnel, water and gas lines are located beneath the developed areas of the school site. However, there are no accurate records pertaining to the locations of these underground utilities.

3.2 Proposed Middle School Site

The proposed middle school site is currently occupied by the west wing of the existing building, and the front lawn between Eight Street and the school building.

The existing site grades slopes gently down from the sidewalk along 8th Street for a distance of about 60 feet (18m) to the edge of a slope about 5 to 7 feet (1.5 2.1m) in height. The slope has an average gradient of about 3H:1V. Between the toe of the slope and the south side of the school building, the area is relatively flat.

The main service gas line to the school property is located near the main entrance to the existing secondary school.

3.3 Proposed Sport Facilities

The two new soccer fields are currently occupied by the grass playing fields, the basketball court, a parking lot, the west end of the main driveway, and a portion of the west wing of the classroom block.

The general site grade of the grassy soccer fields is relatively level. However, there is a slight difference in grade of about 12 inches to 4 feet (0.3 to 1.2m) between the playing field and the main driveway at the west and east ends, respectively.

PART 1: GEOTHERMAL EVALUATION

General

The geothermal evaluation was completed jointly by CGE and our subconsultant PCA Consultants Ltd. (PCA) of Richmond. The results of the hydrogeology and groundwater assessment as performed by PCA are presented in a report 'Hydrogeology and Groundwater Asessment, 835 - 8th Street, New Westminister, BC', dated July 2004, which is included in Appendix 1 of this report.

The following sections provide a brief description of the field investigation/testing program, geology of the general area, the condition of two aquifers, and a summary of the test results including groundwater level, hydraulic conductivity and transmissivity of an aquifer, and groundwater quality indicator parameters.

4.1 Field Investigation

The geothermal investigation was conducted using a 'Becker Hammer' drill rig provided by Dynamic Drilling under the supervision of the CGE field engineer on July 5, 2004.

The field investigation program included drilling of two test boreholes (MW #1 and MW #2) at the proposed soccer fields, at the approximate locations as shown in Figure 3. The test boreholes were terminated at the depths of about 47 to 60 feet (14.3 to 18.3m) below existing ground surfaces where groundwater was encountered. The logs of the test boreholes are presented in Appendix 1.

4.2 Monitoring Wells

A 2-inch (50mm) dia. monitoring well was installed in each test borehole. The well includes a 15-foot (4.6m) long screen at the bottom and a blank section above. The well was backfilled with pea gravel to at least 5 feet (1.5m) above the screen. Above the gravel backfill, a 2-foot (600mm) thick bentonite plug was installed. Cutting was used to backfill the hole to a depth of about 5 feet (1.5m) below ground surfaces. The remaining section was backfilled with bentonite chips. Details of the screen, the gravel backfill and bentonite sealing plug are presented in the logs of monitoring well, Figures A1 and A2 in Appendix 1 of this report.

The monitoring wells were developed by removing all or as much as possible the groundwater and/or sediment by bailing and a submersible pump.

4.3 Geology

In accordance with a surficial geology map M1464A, 1976 by Geological Survey of Canada, the surficial geology at the general area of the site comprises of Vashon Drift and Capilano sediments.

Vashon glacial drift including lodgment and minor flow till, lenses and interbeds of substratified glaciofluvial sand to gravel, and lenses and interbeds of glaciolacustrine laminated stony silt; up to 80 feet (24m) thick but in most places less than 25 feet (7.6m) thick; overlain by glaciomarine and marine deposits similar to Capilano deposits normally less than 10 feet (3m) but in places up to 30 feet (9m) thick.

The Capilano deposits are marine and glaciomarine stony to stoneless silt loam and clay loam with minor sand and silt normally less than 10 feet (3m) thick but up to 100 feet (30m) thick, containing marine shells.

4.4 General Subsurface Conditions

Soil Conditions

A detail description of the shallow soil conditions as encountered in the seventeen test boreholes performed for the geotechnical investigation at the school property is presented in the Section 5.2.1.

In general, the school property is underlain by a surficial layer of sand overlies very dense sandy till-like soils. The sandy till-like soil was encountered extending to the depths of about 40 and 36 feet (12.2 and 11m) below existing ground surfaces at monitoring wells 1 and 2, respectively.

At monitoring well 1 (MW #1), below the sandy till, a stratum of grey silty fine-grained water bearing sand was encountered between the depths of about 40 and 44 feet (12.2 to 13.4m) below ground surfaces. Underlying the water-bearing sand is a stratum of grey clayey silt soils.

At monitoring well 2 (MW #2), below the sandy till, the grey silty fine-grained water bearing sand was encountered between the depths of about 36 and 40 feet (11 and 12,2m) below ground surfaces. Underlying the water-bearing sand is a stratum of tannish brown clayey silt soils about 5 feet (1.5m) in thickness. A second layer of water-bearing silty fine-grained sand was encountered beneath the clayey silt stratum between the depths of about 45 and 57 feet (13.7 and 17.4m) below ground surfaces. Below the water bearing sand is a stratum of clayey silt soils.

Groundwater Level

The static groundwater levels in the monitoring wells were measured using a Dipper-T Water Level Meter manufactured by Heron Instruments by PCA.

At MW #1, a static groundwater table was measured at a depth of about 3.6 feet (1.1m) below the existing ground surface, or Elev. 91.046 m (geodetic datum) on July 9, 2004. The groundwater level at MW #1 was much higher than that of MW #2. We suspect that the high groundwater elevation might have been the result of perch water in the upper sand layers. In addition, very high inflow of groundwater was observed when MW #1 was being developed.

At MW #2, a static groundwater table was measured at a depth of about 26.5 feet (8.08m) below the existing ground surface, or Elev. 86.616 m (geodetic datum) on July 9, 2004. The position of the groundwater table indicates that the lower aquifer is confined, and is under a pressure of about 20 feet (6.1m) of water or 1,200 pounds per square foot (58 kPa).

In summary, the aquifers encountered in the two monitoring wells appear to be under confined flow.

4.5 Hydraulic Conductivity and Transmissivity

The conductivity assessment activities (Bail tests) for the site were performed during the period of July 13 to July 15, 2004 by PCA.

Several bail tests were attempted at MW #1. Extremely high water infiltration rates were encountered at MW #1 during the trials. The tests did not generate conclusive results and MW #1 was abandoned for any further assessment.

Monitoring Well MW #2 was selected as the initial assessment location for the determination of the transmissivity and hydraulic conductivity at the site. The recovery water level measurements from each of the assessment event in MW #2 were subsequently analyzed by using the Hvorslev method.

The bail test results indicated that the hydraulic conductivity (K) of Aquifer 2 ranged from about 2.97E-07 m/sec to 3.72 E-07 m/sec, with an averaged value of 3.35 E-07 m/sec. The calculated hydraulic conductivity values are within those reported in many of the engineering literatures (ranging from 1E-03 m/sec to1E-07m/sec) for unconsolidated deposits of silty fine-grained sand.

Based on the averaged hydraulic conductivity of 3.37E-07 m/sec (0.71 us gallons/day/ft ^{2}) and the average aquifer thickness of 12 feet (3.66m), the calculated transmissivity of the confined aquifer 2 was about 1.22 E-06m^2/sec or 8.5 us gallons/day per lineal foot of aquifer width.

4.6 Groundwater-Quality-Indicator Parameters

Groundwater-quality-indicator parameters including pH, temperature, conductivity and turbidity from each bail test were recorded at MW #2 over the two days of testing, and are presented in the following sections. The following pieces of data are extracted from the PCA report.

Temperature

The groundwater temperatures ranged from 14.9 to 16 degrees Celsius. The average groundwater temperature was estimated to be about 15.5 degrees Celsius.

The groundwater temperature of 15 degrees Celsius was typical for the Lower Mainland during the summer months.

pH value

The pH values of the groundwater ranged from 5.74 to 5.87, averaging 5.8 standard unit. The groundwater is considered slightly acidic.

Conductance

The conductance of the groundwater ranged from 285 to 264, averaging 275 (S).

Turbidity

The turbidity of the groundwater ranged from 143 to 131 ppm, averaging 137 ppm.

PART 2: GEOTECHNICAL STUDIES

General

The geotechnical studies included performance of a soils investigation and a laboratory testing program. Based on the results of the field/laboratory tests, liquefaction assessment of the subsurface soils was completed. In addition, preliminary recommendations including dewatering and drainage, excavation/shoring, earthwork, foundation design, lateral earth pressures, and pavement structure design are developed.

The following sections provide a summary of the soil conditions encountered at the proposed buildings' sites and sport facilities as well as our discussions on the results of the liquefaction assessment and preliminary recommendations on geotechnical aspects for the development.

5.1 Field Investigation

The geotechnical investigation was conducted using a track-mounted auger drill rig provided by Downrite Drilling under the supervision of our field engineer on June 3, 2004.

The soil's investigation program included drilling of a total of 17 test boreholes and 4 dynamic cone penetration sounding tests at the proposed buildings' sites. The terminated depths of the test boreholes ranged from about 8.5 to 25 feet (2.6 to 7.6m) below existing ground surfaces. The approximate locations of the test boreholes are shown in Figure 3.

Adjacent to some of the test boreholes (A3, A9, A13 and A16), dynamic cone penetration tests (DCPTs) were performed to determine the relative density/consistency of the soils. The DCPTs were completed by advancing a 2-1/4 inch (57mm) dia. cone attached to a string of 1-inch (25mm) dia. drill rods, using a 140-pound (63.6kg) hammer falling 30 inches (760mm). The DCPTs were terminated in a very dense stratum where the total number of blows per foot exceeds at least 60.

The stratigraphy in each test borehole was logged, and representative soil samples were obtained from the auger flights by the field engineer. The recovered soil samples were returned to our laboratory for further visual examination, moisture content tests and unconfined compressive strength measurements using a pocket penetrometer.

The logs of the test boreholes, the results of the dynamic cone penetration tests, moisture content tests and unconfined compressive strength values are presented in Figures B1 to B17, Appendix 2 of this report.

5.2 Subsurface Conditions

5.2.1 Soil Conditions

Subsurface conditions encountered in the test boreholes are presented in details in the Logs of Test Borehole in Appendix 2 of this report. The following sections provide a summary description of generalized soil's profile encountered at the test boreholes. However, soil conditions could vary between the test boreholes, and across the proposed building sites.

Soil Unit 1 Below the existing ground surfaces, a layer of loose, random fill consisting of a mixture of silty sand and gravel with some organic was encountered in the park area (A2, A3), the grassy playing fields (A4, A5, A6), the east end of the Massey Theatre (A12, A13) and the west wing of the Classroom Block (A7, A17).

The thickness of the random fill is not uniform, ranging from about 6.5 to 8 feet (2 to 2.4m) in the park, 4 to 8 feet (1.2 to 2.4m) in the grassy playing fields, 3.5 to 7 feet (1.1 to 2.2m) by the Massey Theatre, and 2.5 to 4.5 feet (.76 to 1.4m) at the west wing.

Soil Unit 2 Below the topsoil, a layer of loose, silty fine-grained sand stratum was encountered extending to the depths of about 4 to10 feet (1.2 to 3m) below ground surfaces. The upper 2 to 3 feet (0.6 to 0.9m) of the sand generally has a rusty brown colour, but grades to tannish brown thereafter.

The silty sand stratum was encountered at several test boreholes (A1, A12, A13, A14; A5, A6, A8; A7, A9). However, the thickness of the sand stratum is not uniform.

Soil Unit 3 Beneath the sand stratum, a layer of tannish grey clayey fine-grained sand with a trace of small pebbles and1-inch gravel was generally encountered at the north and east ends of the site (A1, A3, A12, A13, A14, and A5, A6, A8). The clayey sand is till-like, and has a compact relative density.

The thickness of the clayey sand is not uniform, ranging from about 3 to 4 feet (0.9 to 1.2m).

At test borehole A6, small seashells were found in this stratum.

Soil Unit 4 Beneath either Soil Unit 2 or 3 is a stratum of grey brown, medium plasticity clayey silt with a trace of small pebbles, about 4 to 8 feet (1.2 to 2.4m) thick.

This stratum was encountered in several test boreholes (A1, A2, A4, A15, A16; A9, A10). The consistency of the silt varies from firm to stiff.

Soil Unit 5 The clayey silty till-like soils (Soil Unit 4) generally grade to very stiff with depth, and without the small pebbles and fine gravel. The clayey silt stratum is generally 2 to 4 feet (.6 to 1.2m) thick. However, it is slightly thicker at A12 about 6.5 feet (2m).

The clayey silt stratum was encountered at test boreholes A1, A3, A12, A13, A14, A17; A5, A6; A7, A9, A10), and has a very stiff consistency.

Soil Unit 6 A layer of very dense, grey silty fine-grained sand with small pebbles till-like soils was encountered at the bottom of all the test boreholes.

Proposed Secondary Building Site

A total of eleven test boreholes including A1, A2, A3, A4, A11, A12, A13, A14, A15, A16 and A17 were performed around the footprint of this building site. A preliminary subsurface profile through the north/south and east/west directions is shown in Figures 4 to 6 inclusive.

Soil Unit 1 (random fill) was encountered at the north end (A2, A3), west middle (A4, A17) and the east end (A12, A13) of the site. Near the north end of the site (A2, A3), the random fill appears to be thicker varying from about 6 to 8 feet (1.8 to 2.4m). Near the west middle (A4, A17), the thickness of the random fill varies from about 4.5 to 8 feet (1.4 to 2.4m). Near the east end of the site, the random fill ranges from about 3.5 to 7 feet (1.1 to 2.2m) thick.

Soil Unit 2 (silty sand) was encountered at test boreholes A1, A14, A13 and A12. At test boreholes A1 and A14, the silty sand was encountered either beneath a layer of topsoil or the existing ground surface and extending to the depths of about 7 and 3.5 feet (2.2 and 1.1m), respectively. However, at test boreholes A12 and A13, this soil unit was encountered beneath the random fill extending from the depths of about 8.5 to 5.5 feet (2.6 to 1.7m) below existing ground surfaces, respectively.

Soil Unit 3 (clayey sand) was encountered at test boreholes A1, A3, A14, A13 and A12. This soil unit extends from the depths of about 7 to 14 feet (2.1 to 4.2m) below existing ground surfaces. At test borehole A14, the clayey sand was encountered at a slightly higher depth of about 3.5 feet (1.1m).

Soil Unit 4 (clayey silty till) was encountered at test boreholes A1, A2, A4, A16 and A15. This soil unit extending from the depths of about 8 to 10 feet (2.4 to 3.2m) below existing ground surfaces. However, at test boreholes A15 and A16, the clayey silty till was encountered at the ground surfaces and extending to the depths of about 4.5 to 5.5 feet (1.4 to 1.7m), respectively.

Soil Unit 5 (clayey silt) was encountered at test boreholes A1, A3, A4, A17, A16, A15, A14, A13 and A12. At test boreholes A1, A2 and A3, this soil unit was encountered at the depths of about 12 to 18 feet (3.6 to 5.5m) below existing ground surfaces. At test boreholes A4, A17, and A14, the clayey silt was encountered at the depths of about 4.5 to 8.5 feet (1.4 to 2.6m). At test boreholes A12 and A13, this soil unit was encountered at the depths of about 12 to 13.5 feet (3.6 to 4.1m). At test boreholes A15 and A16, the clayey silt was encountered at the existing ground surfaces. At test borehole A11, this soil unit was not encountered.

Soil Unit 6 (sandy till) was encountered at all the test boreholes. At test boreholes A2, A4, A14 and A13, the sandy till was generally encountered at the depths of about 11 to15 feet (3.3 to 4.6m). However, at test boreholes A1, A3 and A12, the till was encountered at the lower depths of about 18 to 21 feet (5.4 to 6.4m) below existing ground surfaces. At test boreholes A15, A16 and A17, this soil unit was encountered at the depths of about 4.5 to 7 feet (1.3 to 2.1m) below existing ground surfaces. At test borehole A11, the sandy till was encountered at the ground surface.

Proposed Middle School Site

A total of four test boreholes including A7, A9, A10 and A11 were performed adjacent to the footprint of this building site. A preliminary subsurface profile in the east/west direction is shown in Figure 7.

Soil Unit 1 (random fill) about 2.5 feet (0.76m) thick was encountered at test borehole A7.

Soil Unit 2 (silty sand) was encountered at test boreholes A7 and A9. At test borehole A7, this soil unit was encountered beneath the random fill extending to a depth of about 4 feet (1.2m) below existing ground surfaces. However, at test borehole A9, the silty sand stratum was encountered at the existing ground surface and extending to a depth of about 2.5 feet (0.76m).

Soil Unit 3 (clayey sand) was not encountered in these test boreholes.

Soil Unit 4 (clayey silty till) was encountered at test borehole A9, but not at the other three test boreholes. This soil unit extends from the depths of about 2.5 to 6 feet (.76 to 1.8m) below existing ground surfaces.

Soil Unit 5 (clayey silt) was encountered at test boreholes A7 and A10 but not the other two test boreholes. At test borehole A7, this soil unit extends from the depths of about 4 to 6 feet (1.2 to 1.8m) below existing ground surfaces. However, at test borehole A10, this soil unit was encountered from existing ground surface to a depth of about 2.5 feet (0.76m).

Soil Unit 6 (sandy till) was encountered at every test borehole. At test boreholes A7 and A9, this soil unit was encountered at a depth of about 6 feet (1.8m) below existing ground surfaces. However, at test boreholes A10 and A11, the sandy till was encountered at a depth of about 2.5 feet (0.76m) and at the ground surface, respectively.

Proposed Sport Facilities

A total of six test boreholes including A4, A5, A6, A7, A8 and A17 were performed around the footprint of the soccer fields and basketball courts.

Soil Unit 1 (random fill) was encountered at all these test boreholes except A8. The thickness of the random fill varies from about 2.5 to 8 feet (0.76 to 2.4m).

Soil Unit 2 (silty sand) was encountered at test boreholes A5, A6, A7 and A8 beneath the random fill, with the exception of test borehole A17. This soil unit extends from the depths of about 3 to10.5 feet (0.9 to 3.2m) below existing ground surfaces. However, at test borehole A8, the silty sand stratum was encountered from the existing ground surface to a depth of about 3 feet (0.9m).

Soil Unit 3 (clayey sand) was encountered at test boreholes A5, A6 and A8 beneath the silty sand stratum, with the exception of test boreholes A7 and A17. This soil unit extends from the depths of about 6 to9 feet (1.8 to 2.7m) below existing ground surfaces. However, at test borehole A6, this stratum was encountered between the depths of about 10.5 and 16 feet (3.2 to 4.8m).

Soil Unit 4 (clayey silty till) was encountered at test boreholes A4 and A5. This soil unit extends from the depths of about 8 to14 feet (2.4 to 4.3m) below existing ground surfaces.

Soil Unit 5 (clayey silt) was encountered at test boreholes A5, A6, A7 and A17. This soil unit extends from the depths of about 13.5 to 18.5 feet (4.1 to 5.6m) below existing ground surfaces at A5 and A6. However, at test boreholes A7 and A17, this stratum was encountered from about 4 to7 feet (1.2 to 2.1m).

Soil Unit 6 (sandy till) was encountered at all the test boreholes. Near the north end of the site (A4, A5 and A6), this soil unit was encountered at the depths of about 11 to18.5 feet (3.3 to 5.6m) below existing ground surfaces. Near the south end of the site (A7, A8 and A17), this soil unit was encountered at the depths of about 6.5 to 9 feet (2 to 2.7m).

5.2.2 Perched Groundwater Level

A perched groundwater table was encountered in the tan fine-grained sand stratum (Soil Unit 2) at the depths of about 5 to 8 feet (1.5 to 2.4m) below existing ground surfaces at the time of the soils investigation.

Where the tan sand stratum is presence, CGE anticipates that a perched water table would normally be encountered on the surface of the clayey silt/sandy till-like soils at the depths of about 4 to 5 feet (1.2 to 1.5m) below existing ground surfaces.

The perch groundwater level will fluctuate with seasonal precipitation. In addition, concentrated groundwater flow/seepage could occur in pockets of sandy granular soil, typically encountered in till-like soils.

5.3 Seismic Design Criteria And Liquefaction Evaluation

Seismic Design Criteria

The subject property is located within Seismic Zone 4, as defined in the maps contained in the Supplement to the current 1995 edition of the 'Commentary to the National Building Code'.

The earthquake-resistant objectives of the code require that structures, including foundations, be designed in such a manner to remain functional if subject to moderate earthquakes (usually 1 in a 100-year return period), and not collapse to endanger the occupants when subject to the major design earthquake. However, in the process the building may be extensively damaged and may not be useful following the earthquake. A major earthquake is generally taken as that having a 10% probability of exceedance in 50 years (Magnitude 7, 1 in a 475-year return period).

In the absence of a site specific seismic hazard calculation, the 1995 NBCC recommends a design peak firm ground horizontal acceleration of 0.21g for the Greater Vancouver area for the major earthquake with a probability of exceedence of 10% in 50 years (1 in 475-year recurrence interval).

Liquefaction Assessment

Based on the soil conditions encountered in the test boreholes and at this level of shaking, CGE completed a liquefaction assessment using the methodology proposed by NCEER1996.

The results of the analysis indicated that the unsaturated random fill/topsoil materials, firm clayey sand, stiff clayey silt, and very dense sandy till-like soils are not susceptible to liquefaction under the current design criteria.

The submerged portion of Soil Unit 2 - loose silty sand between the depths of about 4 and 8 feet (1.2 to 2.4m) at A1, A5, A6, A12, A13 and A14 would have a moderate risk of liquefaction during the design earthquake. We estimate that the post seismic settlements of Soil Unit 2 would be about 2 inches (50mm).

Foundation Factor

In accordance with the 1998 edition of the British Columbia Building Code, where the subgrade consists of 'rock, dense and very dense coarse-grained soils, very stiff and hard fine-grained soils; compact coarse-grained and firm and stiff fine-grained soils from 0 to 15m deep', the code recommends a foundation factor "F" of 1.0 (Table 4.1.9.C and Clause 4.1.9.1(11)).

5.4 Discussions and Preliminary Recommendations

General

Due to the presence of two confined aquifers, depressurization and dewatering would most likely be required for excavation of the 1-level underground parking structure. In addition, shoring will be required for supporting the vertical cut slopes of the bulk excavation for construction of the underground parking structure of the proposed secondary school.

Foundation design for the proposed secondary school will most likely include spread and strip footings, and piles. The floor slab of the proposed building will either be a slab-on-grade or structural slab. For the proposed middle school, foundation design will include spread and strip footings, and slab-on-grade construction.

5.4.1 Groundwater Control

As discussed in Section 4.4 - Groundwater Condition of this soils report, and Section 5.2.2 - Perched Groundwater Level, a perched water table was encountered in the silty sand (Soil Unit

2) stratum at the depths of about 5 to 8 feet (1.5 to 2.4m), and elevated hydraulic heads of about 36 and 20 feet (11 and 6.1m) of water were measured in MW #1 and MW #2, respectively in the confined aquifers. The hydraulic heads of 36 feet and 20 feet of water (11 and 6.1m) are equivalent to uplift pressures in the order of 2, 200 and 1,200 pounds per square feet (105 and 57 kPa), respectively.

To investigate the presence or absence of the confined aquifers beneath the proposed secondary school, CGE recommends that at least 3 to 4 test boreholes be performed to a depth of about 60 feet (18m) below existing ground surfaces. Standpipe piezometers should be installed in the test boreholes to monitor the groundwater level and hydrostatic pressure of the aquifers.

In order to minimize the potential impact of the uplift pressures to the temporary excavation and permanent foundation design of the proposed secondary school, a temporary and a permanent dewatering/depressurization system are most likely required. CGE will provide recommendations on the groundwater control systems upon completion of the field investigation.

5.4.1.1 Construction Dewatering/Depressurization

Depending on the magnitude of the hydrostatic uplift pressure of the confined aquifers and the depths of the bulk excavation, either a dewatering system with relief wells or a depressurization system with deep wells and pumps would be required.

The purpose of the groundwater control system is to reduce the uplift pressure and control upward seepage such that relatively dry and stable foundation subgrade can be achieved during construction of the underground parking structure.

Groundwater from the relief wells should be collected by perforated drain pipes installed below the floor slab of the underground parking structure, and directed to sumps for discharge into the City of New Westminister stormwater system.

5.4.1.2 Permanent Drainage System

For the proposed secondary school, the foundation and the floor slab of the underground parking structure will be below the perched groundwater table unless a permanent drainage system is installed. The permanent drainage system should consist of perimeter drain pipes and an underslab drainage network with a pumping facility to prevent groundwater seepage into the underground parking structure. In addition, the subgrade structure should be waterproofed to prevent groundwater penetration.

Underslab Drainage System

An underslab drainage system consisting of a granular drainage layer, minimum 18 inches thick (450mm) and underslab drain pipes should be installed beneath the floor slab of the underground parking structure.

The subfloor drain pipes should be installed at a maximum horizontal spacing of 30 feet (10m) beneath the basement floor to remove water that could otherwise pond under the slab. The underdrains will also reduce hydrostatic pressure (uplift) below the floor slab. The drains should consist of a minimum 6-inch (150mm) dia. perforated rigid PVC pipes bedded in a minimum of 18 inches (450mm) surround of 3/4-inch (19mm) drain rocks. Clean-outs should be provided to allow for periodic flushing of the underslab drains.

The pipes should be installed such that their top is located within the gravel drainage blanket. The drain pipes should discharge into a sump, which should be designed so as to prevent the possibility of water backing into these drains. Permission from City of New Westminister for discharge of storm water to the storm sewer is required.

Perimeter Drainage System

Perimeter drains should consist of 6-inch (150mm) dia. perforated rigid PVC pipes placed at or below the footing level around either the inside or outside perimeter of the basement structure. The drain pipes should be placed in a minimum 12-inch (300mm) surround of 3/4-inch (19mm) drain rocks. The drain pipes should be connected to a sump with permission from City of New Westminister for discharge to the storm sewer.

Through-wall drain holes, 4-inch (100mm) dia. should be used to connect the exterior backfill with the interior perimeter drains, if an internal drainage system is chosen. The drain rocks should be placed to at least 12 inches (300mm) above the weep holes. Approved filter cloth should be placed at each 'through wall' drain hole to prevent loss of soils. The drain holes should be located at a maximum horizontal spacing of 4 feet (1.2m).

In areas where vertical excavation is carried out it may be necessary to cast subgrade walls using the shotcrete face as a permanent shutter. Hydrostatic pressure should be included in the design of such walls. Otherwise, a geocomposite drainage blanket should be placed against the shotcrete face, extending from the final ground surface to the footing level. This drainage material would provide a path by which groundwater seeping from the soil behind the shotcrete face can flow vertically downward to be collected for discharge. The synthetic drainage blanket should have a minimum overlap of at least 6 inches (150mm).

Around the base of the elevator pit, a perforated drain pipe should be installed to prevent ingress of groundwater into the pit if it is not designed to be waterproof. Where the pit is designed to be waterproof, a drain pipe should be placed around the perimeter of the pit immediately below the slab-on-grade to prevent upward migration of water seepage to the basement.

5.4.2 Site Preparation

Initial site preparation will include demolition of the pavement structure of the existing parking lot and driveways, stripping of vegetation and topsoil, and relocation of any existing underground utilities encountered within the footprint of the proposed schools. The excavated soils should be disposed in approved landfill facilities.

All random fill and topsoil should be stripped to expose the native soils. Stripping should extend at least 5 feet (1.5m) beyond the footprint of the proposed buildings, sport facilities, fire access/service roads and parking lots.

Additional stripping would be required where subgrade soil is damaged or softened due to surface ponding or precipitation, or where unsuitable soils are encountered. The exposed subgrade surface should be either sloped or crowned to allow draining of infiltrated ground water and to prevent softening of subgrade. The subgrade surface should be examined and approved by the Geotechnical Engineer prior to fill placement or pouring of footings.

The fine-grained soils such as the native clayey silt and sandy till soils are sensitive to disturbance by construction traffic when saturated and in wet weather condition. The subgrade surface must be dry, free of ponding water and frozen soils prior to placement of any fill materials or footings. In addition, a layer of 3/4" clear crushed gravel, minimum 6 inches (150mm) thick should be placed on the final subgrade surface for protection against disturbance or softening.

Prior to any fill placement, the final subgrade surface should be proof-rolled using a heavy compactor. Where soft/disturbed soils are encountered, these soft materials should be overexcavated, and backfilled with structural fills compacted to at least 95% modified Proctor maximum dry density (MPMDD), ASTM D1557 as per recommendations discussed in Section 5.4.3 of this report.

Underground utilities will be encountered in the proposed buildings' sites. Where encountered, these utilities should be removed and relocated as per the 'Project' requirements. All utility backfill materials and sludge should be stripped to the subgrade approved by the Geotechnical

Engineer. The voids should be backfilled with site grading fill and structural fill as per our design recommendations.

5.4.3 Earthwork

It is a good practice to conduct a pre-construction condition survey of all the existing buildings located adjacent to the proposed development, prior to the excavation.

Excavation

As a safety measure, hoardings should be installed around the perimeter of the bulk excavation.

Excavation for the underground parking structure of the proposed secondary school should not proceed beyond the first stage of shoring soil anchor level (typically 3 to 4 feet below ground surfaces) without prior installation of pressure relief wells, if required.

Any excavation deeper than 4 feet (1.2m) must be carried out in accordance with the Industrial Health and Safety Regulations prepared by the Workers Compensation Board.

For temporary slopes of bulk excavation completed above the groundwater table and away from any adjoining buildings in random fills, topsoil and granular soils, the slopes should not be steeper than 1H:1V (horizontal: vertical). For excavation in dense till-like soils, temporary slopes of excavation should not exceed 1H:2V. The above recommended slope configurations should be flattened where seepage is encountered or under wet weather condition.

The excavated slopes should be protected by plastic sheets to minimize erosion due to surface runoff and precipitation. The stability of the slopes should be examined and approved by the Geotechnical Engineer prior to any workers entering the site.

Construction for the underground structure of the proposed building is expected to extend about 12 to 15 feet (3.6 to 4.6m) below existing site grades. Based on the results of the subsurface investigation, excavation would be carried out through the random fill, silty sand, clayey sand, silt, and sandy till soils. It is anticipated that it will be possible to excavate these soils using conventional methods such as ripping and excavating with a large excavator. However, large boulders are known to be presence in the till soils, and may require drilling/splitting.

Shoring System

For the proposed secondary school, the finished floor grade of the 1-level underground parking structure would range from about 12 to15 feet (3.6 to 4.6m) below existing ground surfaces. If the above recommended cut slope configurations cannot be achieved due to lack of space, the excavation will be completed vertically and supported using a shoring system.

A conventional shotcrete and soil anchors shoring system can be considered for support of vertical cut slopes where encroachment of soil anchors is permitted by the adjacent private and public properties' owners. If encroachment permission is not granted by these properties' owners, an internal shoring system using steel soldier piles, with either timber or shotcrete laggings and steel rakers will be required. However, the soldier pile/lagging system will require additional space of about 18 to 24 inches (450 to 600mm).

For excavation in close vicinity of any existing buildings, extreme care must be exercised to prevent undermining the foundation of the structures. Figure 8 shows the general guidelines for excavation adjacent to existing structures. The perimeter footing of the west exterior wall of the Massey Theater is located within the excavated zone where underpinning of the footing is required.

Regardless of what type of shoring system is used for support of excavation, minor ground movements/settlements in areas adjacent to the excavation will occur due to stress release from excavation. The ground adjacent to the excavation should be monitored on a regular basis for potential movements.

CGE will prepare excavation and shoring drawings for tendering and construction of the 1-level underground parking structure in a later day.

Structural Fills

Structural fills will be required for backfilling areas of overexcavation beneath the footprint of the proposed buildings, fire access/service roads, parking lots and soccer fields.

The fill materials should consist of free-draining, 3-inch (75mm) minus sand or gravel, containing less than 5% passing the No.200 sieve. The fill materials may be placed to within 12 inches (300mm) of the underside of footings, 8 to 18 inches (200 to 450mm) of the underside of floor slabs and to the underside of the pavement structure.

Beneath the footings, the final12 inches (300mm) of structural fill should consist of 3/4-inch (19mm) crushed sand and gravel (road mulch).

Beneath the floor slabs, the fill materials should consist of 3/4-inch clear crushed gravel.

The fill materials should be placed in horizontal lifts not exceeding 12 inches (300mm) in loose thickness. Each lift should be compacted to at least 95% MPMDD.

The on-site random fills, topsoil, and imported recycled asphalt and concrete are not suitable as structural fill, nor as backfill for the basements walls. Clean, native granular soils may be reused as general site grading fill, provided the materials can be compacted to achieve at least 95% MPMDD.

Backfill behind Basement Walls

Backfill behind the basement walls should consist of clean, free-draining sand and gravel with less than 5% fines passing No.200 sieve size. The fill materials should be placed in maximum 12 inches lift with each lift compacted to a minimum of 95% MPMDD.

If there is not sufficient room to operate a small plate tamper behind the basement walls, the backfill should consist of either clean 'birds-eye' gravel or 'pea' gravel. The gravel should be placed in 2-foot (600mm) lift, and compacted using a concrete 'pen' vibrator.

5.4.4 Foundation Design

The proposed secondary school may be supported by a combination of shallow footings where it includes the 1-level underground parking structure and piles for the non basement portion. The spread and strip footings may be placed on compacted structural fill overlying Soil Units 5 or Soil Unit 6, directly on Soil Unit 5, or on Soil Unit 6. The piles would consist of close-ended steel pipe piles driven in the very dense Soil Unit 6. Potential differential settlements shall be expected between the building supported on piles and shallow footings. The magnitude of differential settlements would depend on the structural loading conditions.

The proposed middle school may be supported using spread and strip footings founded either in Soil Unit 5 or Soil Unit 6.

CGE recommends that the shallow footings be placed below the potential frost penetration depth of 18 inches (450mm).

Adjacent footings should be located far enough to prevent stress influence. Figure 9 shows the general guidelines to prevent stress interference between adjacent footings.

Construction joint between the slab, basement walls and strip footings should be provided with water-stops to prevent groundwater seep into the underground parking structure, if these structural components are poured separately.

When final structural loading conditions are available, CGE shall review the information together with our design recommendations for foundation design and settlement estimates.

Proposed Secondary School

Shallow Foundation

Conventional shallow foundation including spread and strip footings can be used to support columns and load-bearing walls of the proposed building with the 1-level underground structure. The footings may be placed in compacted structural fill overlying the undisturbed very stiff clayey silt (Soil Unit 5) or very dense sandy till (Soil Unit 6), the very stiff clayey silt (Soil Unit 5), or the very dense sandy till-like soils (Soil Unit 6).

For footings placed in compacted structural fill, CGE recommends that a maximum allowable soil bearing pressure of 2,500 psf (120 kPa) be used for design. For footings placed directly in very stiff clayey silt, a maximum allowable soil bearing pressure of 4,000 psf (190 kPa) can be used for foundation design. For footings placed directly in the undisturbed very dense sandy till-like soils, a maximum allowable soil bearing pressure of 6,000 psf (290 kPa) can be used for foundation design.

The recommended allowable soil bearing pressures can be increased by one-third to account for temporary transient loads due to wind and seismic.

Deep Foundation

Due to the presence of the loose random fill, silty sand and the depths to the very dense sandy till stratum, the portions of the building which do not include the underground parking structure may be supported on end-bearing piles.

CGE recommends that columns, load-bearing walls and the floor slab for these portions of the proposed building be supported on close-ended steel pipe piles. The piles would be end-bearing, driven into the very dense sandy till-like soils to the depths of about 20 to 25 feet (6,1 to 7.6m) below existing ground surfaces.

The following table provides general design guidelines for different sizes of steel piles and allowable axial compressive capacity for piles driven in the very dense sandy till stratum.

Pile Diameter and thickness	Allowable Axial Compressive capacity	Pile Driving Energy
8-5/8" by 0.277"	70 kips	20,000 ft-pound
10" by 0.365"	90 kips	30,000 ft-pound
12-3/4" by 0.375"	110 kips	40,000 ft-pound

The piles shall consist close-ended steel pipe piles filled with concrete consisting of Type 10 Portland cement with a minimum compressive strength of 25 MPa. The piles may be driven using a static hammer with energy not exceeding those presented in the above table.

Final 'set' of at least 0.2 inches per blow (5 blows per inch) should be achieved for the last 6 (150mm) consecutive inches of driving. The minimum pile embedment lengths would range from about 20 to 25 feet (6.1 to 7.6m) below existing ground surfaces. It is possible that piles could penetrate a few feet in the very dense till stratum.

Due to the natural variability of the soils, actual pile penetrations may vary from the estimates provided above. It is recommended that at least 10 test piles be driven at various locations across the site to assess the driveability and approximate length of piles required to satisfy the final set. Provided these test piles meet the recommendations above and free of defects which could affect their load carrying performance, they may be used as part of the pile foundation system for the proposed building.

To avoid heaving of piles during driving, each pile should space at least 3 times the diameter of the pile. Pile caps should be structurally connected by grade beams to minimize lateral displacements during earthquake events.

If permanent site grading fill is to be placed in and around the proposed building, long-term aerial settlements will occur. Flexible connections to and from the proposed building should be provided for utility services such as gas line, water line, sanitary and storm pipes to handle differential settlements due to different types of foundation system. Services inside the footprint of the proposed building should be suspended to the pile caps for support. In addition, some long term maintenance of the areas surrounding the proposed building will be required.

Proposed Middle School

Conventional shallow foundation including spread and strip footings can be used to support columns and load-bearing walls of the proposed building.

The footings of the proposed building would most likely be placed either in the very stiff clayey silt (Soil Unit 5) or in the very dense sandy till-like soils (Soil Unit 6).

For footings placed in the very stiff clayey silt soils, a maximum allowable soil bearing pressure of 4,000 psf (190 kPa) can be used for design. For footings placed in the very dense sandy till-like soils, a maximum allowable soil bearing pressure of 6,000 psf (290 kPa) can be used for foundation design. The recommended allowable soil bearing pressures can be increased by one-third to account for temporary transient loads due to wind and seismic.

5.4.5 Foundation Subgrade Preparation

Foundation subgrade preparation will include excavation of the existing random fills, topsoil, the stratum of loose native silty sand, the compact clayey sand stratum, the firm clayey silt stratum where encountered, and any frozen soils (in sub-zero temperature), ice and snow.

The edges of the excavation should extend at least the same distance as the depth of overexcavation beyond the footprint of the proposed buildings. The excavation shall be backfilled with structural fill as per design recommendations presented in Section 5.4.3 of this report.

The native clayey silt and sandy till-like soils are susceptible to softening if exposed to rainfall and construction activities. To prevent the softening of the footing subgrade and to provide stable working surfaces, CGE recommends that a skim coat of lean concrete be applied at the footings locations. For protecting the subgrade surface of the floor slab, CGE recommends that at least 6 inches (150mm) of 3/4" (19mm) clear crushed gravel be placed on the final stripped surface as soon as possible after the excavation.

If the subgrade native soils are allowed to soften prior to placement of the protective cover, the softened materials should be removed and the areas of overexcavation backfilled with lean concrete.

5.4.6 Floor Slabs

For the slab-on-grade construction, the final stripped surface should be proof-rolled to determine presence of loose zones. Where soft/loose soils are encountered, the soils should be overexcavated to expose the dense native sand. The areas of overexcavation should be backfilled with structural fill materials, as specified in Section 5.4.3 of this report.

For the proposed secondary school, the final 18 inches (450 mm) of the structural fill beneath the floor slab of the 1-level underground parking structure should consist of 3/4-inch (19mm) clear crushed gravel. For the non-basement portion of the proposed secondary school, and the middle school, at least 8 inches of 3/4"clear crushed gravel should be placed beneath the floor slab. The fill materials should be compacted to at least 6 passes using a 1000-pound (450 kg) heavy plate tamper.

A vapour barrier consisting of a 6-mil plastic sheet should be placed on the gravel drainage blanket to prevent upward migration of moisture to the floor. The concrete floor should be cast on the plastic sheeting overlying the gravel drainage blanket.

5.4.7 Lateral Earth Pressures

The subgrade walls for the 1-level underground parking structure of the proposed secondary school building should be designed to withstand lateral earth pressures due to static, seismic and surcharge conditions.

Static Condition

For rigid (non-yielding) basement walls, where practically no wall movement is possible, the static earth pressure (triangular distribution) should be computed using an 'at-rest' pressure coefficient, K_o value of 0.47 corresponding to a friction angle of 32 degrees. We recommend that a total unit weight (γ_T) of 120 pcf (1920 kg/m3) be assumed for the native soils.

Seismic Condition

Based on Wood (1973) and the Mononobe-Okabe methods of analysis, for rigid non-yielding basement walls, the dynamic (seismic) lateral pressure per unit width of wall equals to$2\gamma_T HA_h$, where γ_T is the average total unit weight of native soils (120 pcf), H is the wall height, and A_h is the peak horizontal ground acceleration, 0.21g. The corresponding dynamic thrust equals to $\gamma_T H^2 A_h$ acts at a height of 0.6H above the base of the wall.

Surcharge Load

Compaction of backfill adjacent to the subgrade walls will induce a transient load to the walls. If a 500-pound (225 kg) compactor is operating at a distance of at least 2 feet (600mm) from the subgrade walls, an additional uniform lateral pressure of 100 psf (4.8 kPa) extending to a depth of 5 feet (1.5m) would be induced to the adjacent walls.

5.4.8 Fire Access/Services Roads and Parking Lots

CGE understands that final grade of the proposed fire truck access/service roads will be established close to the existing site grade.

Subgrade Preparation

Subgrade preparation for the fire access/services roads and parking lots will include removal of the existing pavement structure, random fills and topsoil to expose the stratum of native silty sand (soil unit 2), or the other strata including soil units 3, 4, 5 and 6. The limit of subgrade preparation should extend at least 5 feet (1.5m) beyond the edges of the proposed fire access/service roads. For earthwork requirements, refers to recommendations discussed in Section 5.4.3 of this report.

Underground utilities could be encountered in the school ground. Where encountered, these utilities should be removed and relocated as per the 'Project' requirements. All utility backfill materials and sludge should be stripped to the subgrade approved by the Geotechnical Engineer. The voids should be backfilled with compacted site grading fill.

Drainage

The long term performance of the pavement structure is highly dependent on the subgrade support conditions. The need for adequate drainage cannot be over emphasized. The finished pavement surface and the underlying subgrade must be free of depressions and sloped (minimum slope of 2.0%) or crowned to provide effective surface drainage.

Surface water should not be allowed to pond adjacent to the outside edges of the pavement areas. If groundwater is encountered at the subgrade, a subdrain pipe should be installed at least 12 inches (300mm) below the subbase course. The subdrain pipe should be discharged to the on-site storm water system.

Pavement Structure Design

Following subgrade preparation as per our recommendations, the pavement structure for the fire truck access/service roads should consist of a minimum of 3 inches (75mm) of asphalt concrete, 8 inches (200mm) of 3/4-inch (19mm) dia. crushed sand and gravel (road mulch) base course, and of 12 inches (300mm) of 3-inch (75mm) minus pit-run sand and gravel subbase course.

For general parking areas, the pavement structure should consist of a minimum of 3 inches (75mm) of asphalt concrete, 6 inches (150mm) of 3/4-inch (19mm) dia. crushed sand and gravel (road mulch) base course, and of 8 inches (200mm) of 3-inch (75mm) minus pit-run sand and gravel subbase course.

The base, subbase and site grading fill materials are to be compacted to at least 95% MPMDD.

Recycled asphalt blends and concrete blends are not recommended as site grading fill nor for construction of the pavement structure of the fire access/service roads and parking lots, without a formal approval by a professional engineer registered in the Province of British Columbia.

6.0 CLOSURE

This preliminary soils report was prepared for the exclusive use of New Westminster School Board, the Architect and Engineers involved in the design of the proposed secondary/middle schools in New Westminister. It should be made available to prospective contractors and/or the Contractor for information on factual data only and not as a warranty of subsurface conditions, such as those interpreted from the test borehole logs and discussions of subsurface conditions included in this report.

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

The analyses, conclusions and preliminary recommendations presented in this report are based on the site conditions as they presently exist and assume that the explorations are representative of the subsurface conditions throughout the site; ie., the subsurface conditions everywhere are not significantly differ from those enclosed by the explorations.

When the final soils investigation is completed and structural loading conditions are available, CGE will review the initial findings, complete settlement analysis, and revise the preliminary recommendations where necessary.

The scope of our services did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous or toxic substances in the soils, subsurface water, groundwater, on or below this site.

We trust that this preliminary soils report meets your current requirements. If there are any questions regarding this soils report, please do not hesitate to contact our office.

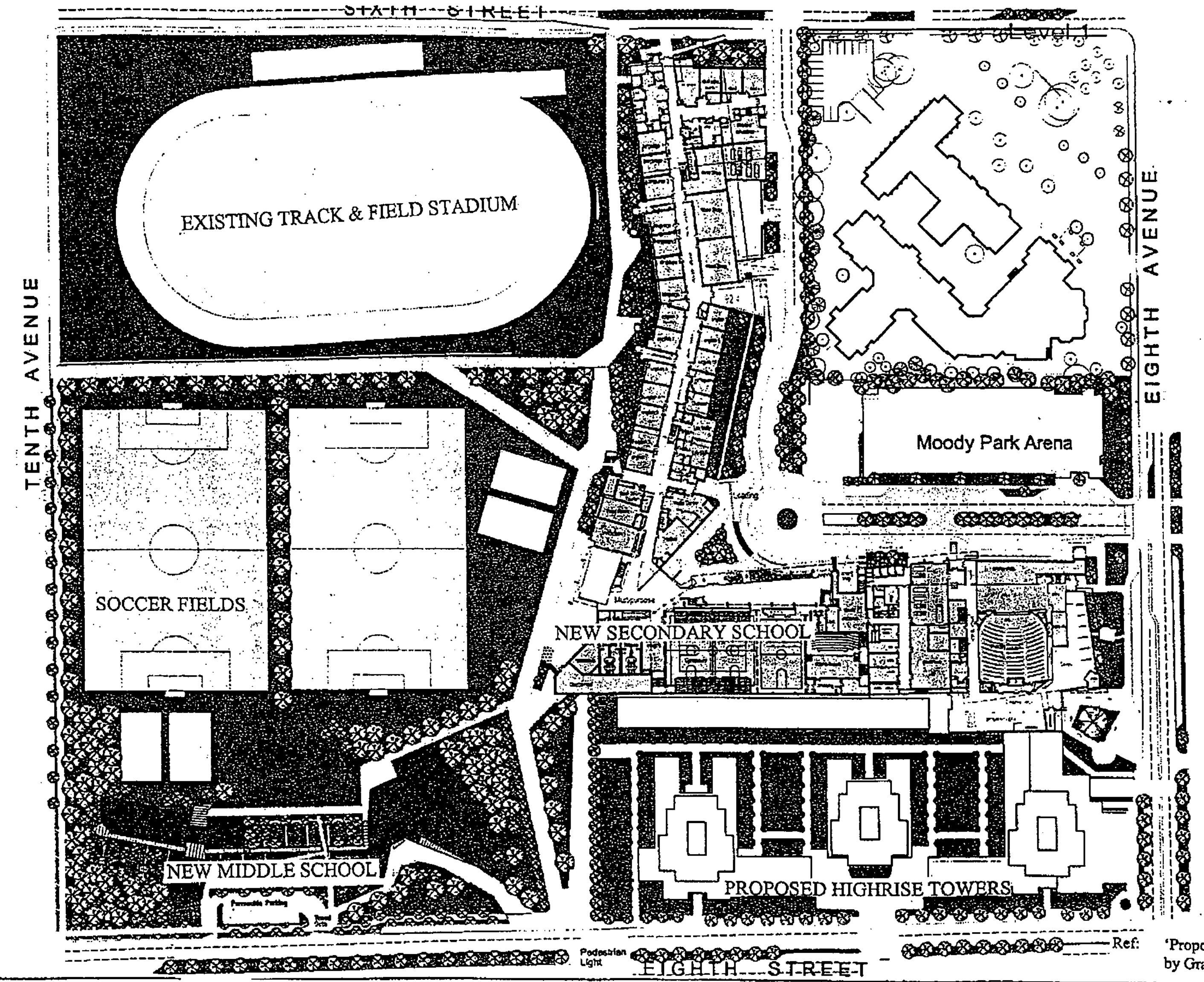
Yours very truly,

CENTENNIAL GEOTECHNICAL ENGINEERS LTD.

per:

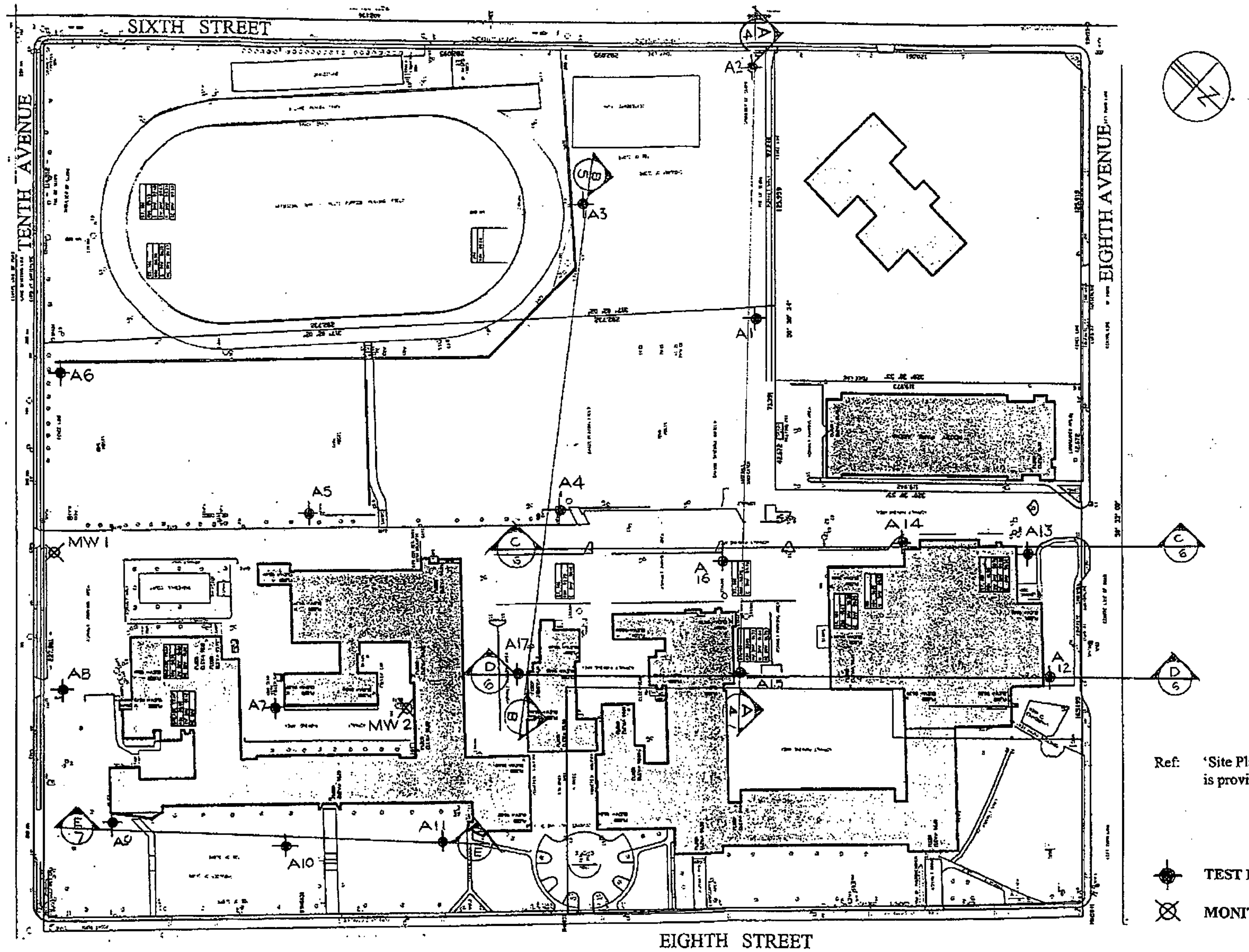
Louis W. H. Lui, P. Eng.
Principal

PROJECT No:	V04-121	CENTENNIAL GEOTECHNICAL ENGINEERS		
PROJECT:	PROPOSED SECONDARY SCHOOL			
LOCATION:	821 8th STREET NEW WESTMINISTER, BC.	VICINITY MAP		
		DATE: July 15, 2004	DRAWN BY:	FIGURE: 1



Ref: 'Proposed Development Plan' is provided by Grant & Sinclair Architects

PROJECT No:	V04-121	CENTENNIAL GEOTECHNICAL ENGINEERS					
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS	PROPOSED DEVELOPMENT PLAN					
LOCATION:	835 - 8TH STREET, NEW WESTMINISTER, BC.	DATE:	July 23, 2004	DRAWN BY:	SCALE: 1:1500	FIGURE:	2

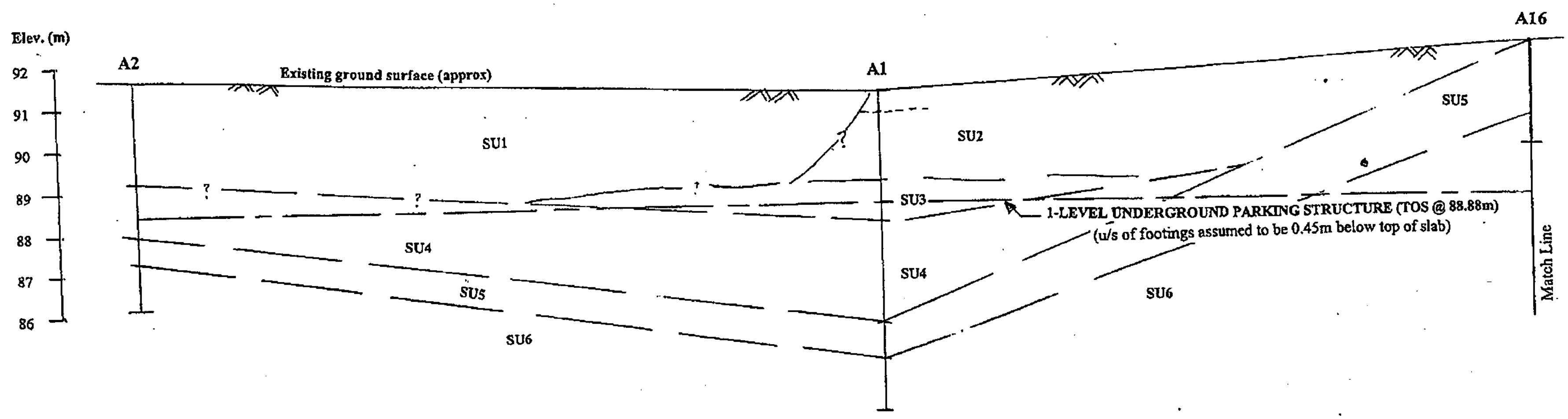


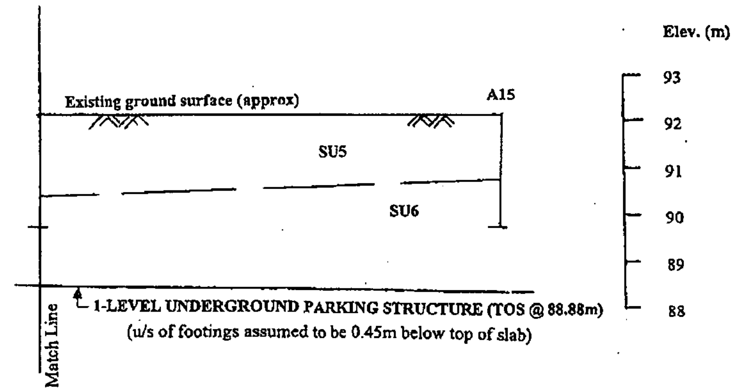
Ref: 'Site Plan' of the existing facilities is provided by Grant & Sinclair Architects

TEST BOREHOLE LOCATION (approx)

MONITORING WELL LOCATION (approx)

PROJECT No:	V04-121	CENTENNIAL GEOTECHNICAL ENGINEERS			
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS	SITE PLAN OF THE SCHOOL PROPERTY			
LOCATION:	835 - 8TH STREET, NEW WESTMINISTER, BC.	DATE: July 23, 2004	DRAWN BY:	SCALE: 1:1500	FIGURE: 3





DESCRIPTION OF SOIL UNITS:

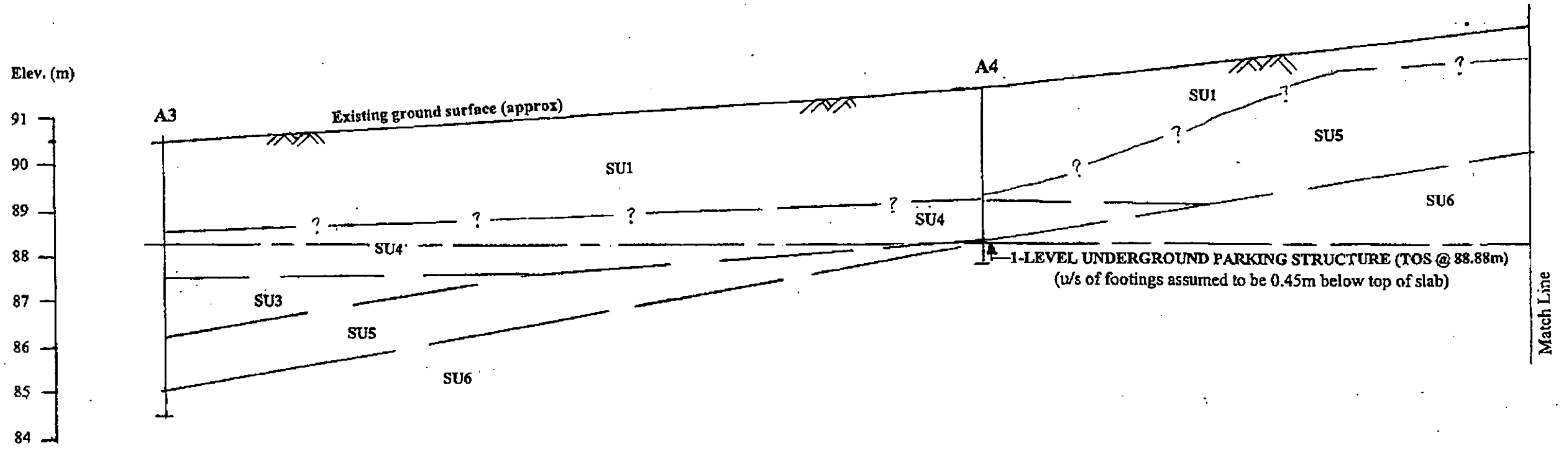
SOIL UNIT 1:	Random fill (loose)
SOIL UNIT 2:	Tannish brown, silty fine-grained sand (loose)
SOIL UNIT 3:	Tannish grey clayey fine-grained sand, trace of small pebbles, till-like (compact)
SOIL UNIT 4:	Grey clayey silt, trace of small pebbles (firm to stiff)
SOIL UNIT 5:	Grey clayey silt (very stiff)
SOIL UNIT 6:	Grey sandy till (very dense)

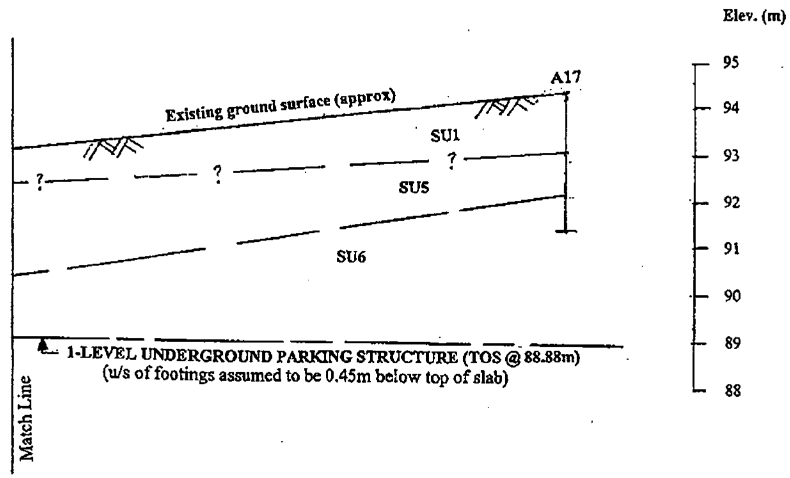
Note: The subsurface soil profiles are extrapolated from the logs of test boreholes. The soil conditions vary in thickness as well as aerial extent between test boreholes and across the site.

HORIZONTAL SCALE 1:500

VERTICAL SCALE 1:100

PROJECT No:	V04-121	CENTENNIAL GEOTECHNICAL ENGINEERS		
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS	SOIL PROFILE, A-A (north to south, east end), Secondary School		
LOCATION:	835 - 8TH STREET, NEW WESTMINISTER, BC.	DATE: July 23, 2004	DRAWN BY:	SCALE: / FIGURE: 4





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SOIL UNIT 1:	Random fill (loose)
SOIL UNIT 2:	Tannish brown, silty fine-grained sand (loose)
SOIL UNIT 3:	Tannish grey clayey fine-grained sand, trace of small pebbles, till-like (compact)
SOIL UNIT 4:	Grey clayey silt, trace of small pebbles (firm to stiff)
SOIL UNIT 5:	Grey clayey silt (very stiff)
SOIL UNIT 6:	Grey sandy till (very dense)

Note: The subsurface soil profiles are extrapolated from the logs of test boreholes. The soil conditions vary in thickness as well as aerial extent between test boreholes and across the site.

HORIZONTAL SCALE 1:500

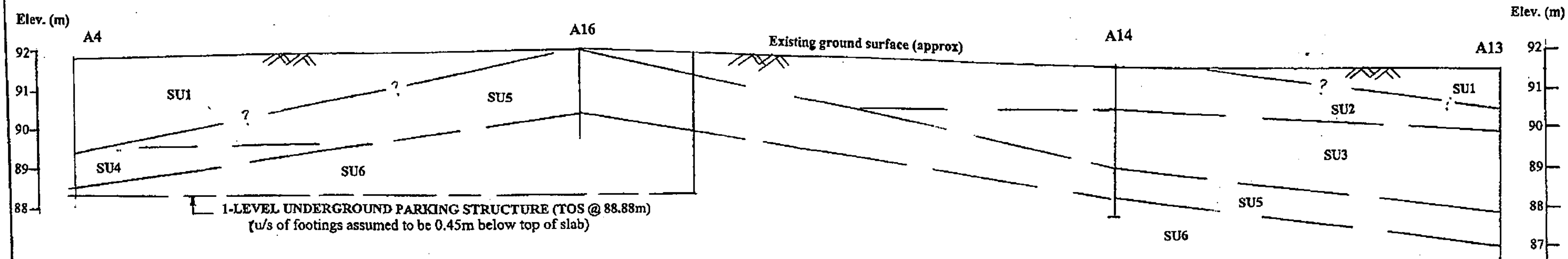
VERTICAL SCALE 1:100

PROJECT No:	V04-121
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS
LOCATION:	835 - 8TH STREET, NEW WESTMINISTER, BC.

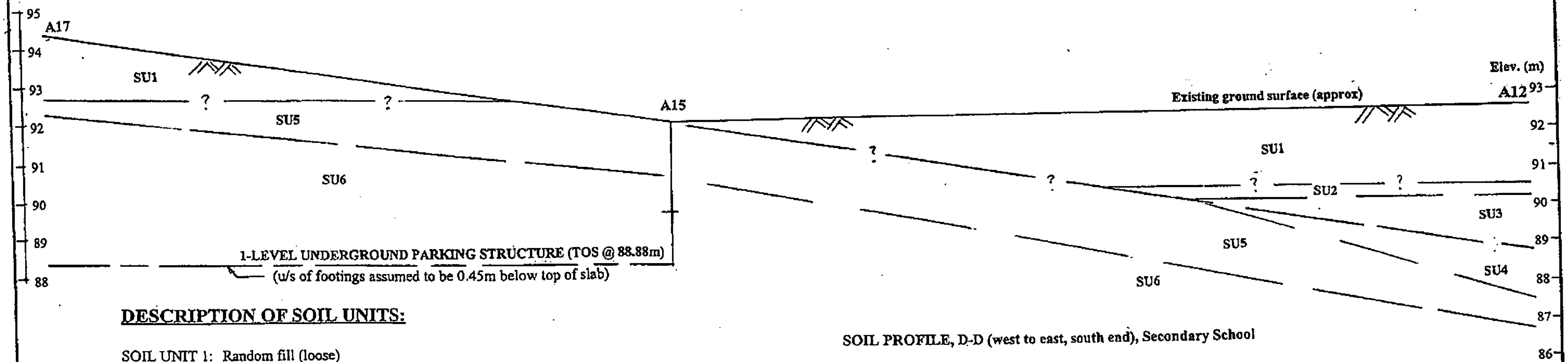
CENTENNIAL GEOTECHNICAL ENGINEERS

SOIL PROFILE, B-B (north to south, west end), Secondary School

DATE:	DRAWN BY:	SCALE:	FIGURE:
July 23, 2004			5



SOIL PROFILE, C-C(west to east, north end), Secondary School



SOIL PROFILE, D-D (west to east, south end), Secondary School

DESCRIPTION OF SOIL UNITS:

SOIL UNIT 1: Random fill (loose)

SOIL UNIT 2: Tannish brown, silty fine-grained sand (loose)

SOIL UNIT 3: Tannish grey clayey fine-grained sand, trace of small pebbles, till-like (compact)

SOIL UNIT 4: Grey clayey silt, trace of small pebbles (firm to stiff)

SOIL UNIT 5: Grey clayey silt (very stiff)

SOIL UNIT 6: Grey sandy till (very dense)

Note: The subsurface soil profiles are extrapolated from the logs of test boreholes. The soil conditions vary in thickness as well as aerial extent between test boreholes and across the site.

HORIZONTAL SCALE 1:500

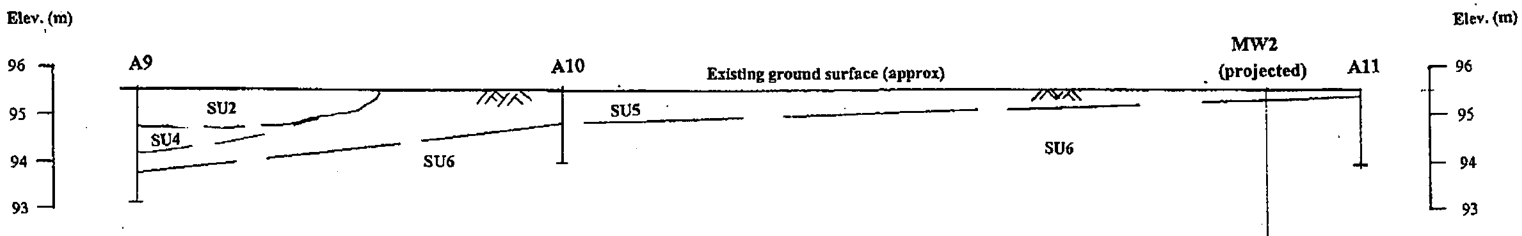
VERTICAL SCALE 1:100

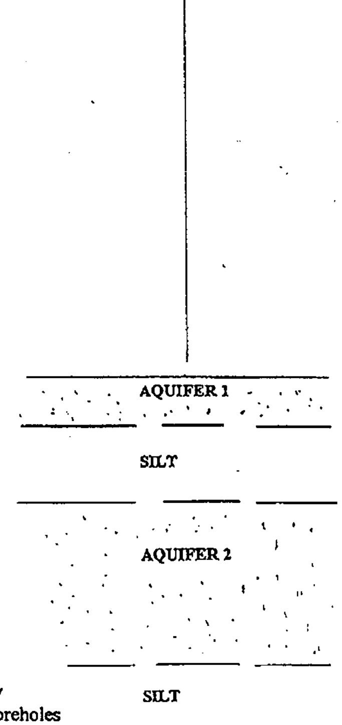
PROJECT No:	V04-121
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS
LOCATION:	835 - 8TH STREET, NEW WESTMINISTER, BC.

CENTENNIAL GEOTECHNICAL ENGINEERS

SOIL PROFILES C-C AND D-D

DATE:	DRAWN BY:	SCALE:	FIGURE:
July 23, 2004			6





DESCRIPTION OF SOIL UNITS:

SOIL UNIT 1:	Random fill (loose)
SOIL UNIT 2:	Tannish brown, silty fine-grained sand (loose)
SOIL UNIT 3:	Tannish grey clayey fine-grained sand, trace of small pebbles, till-like (compact)
SOIL UNIT 4:	Grey clayey silt, trace of small pebbles (firm to stiff)
SOIL UNIT 5:	Grey clayey silt (very stiff)
SOIL UNIT 6:	Grey sandy till (very dense)

Note: The subsurface soil profiles are extrapolated from the logs of test boreholes. The soil conditions vary in thickness as well as aerial extent between test boreholes and across the site.

HORIZONTAL SCALE 1:500

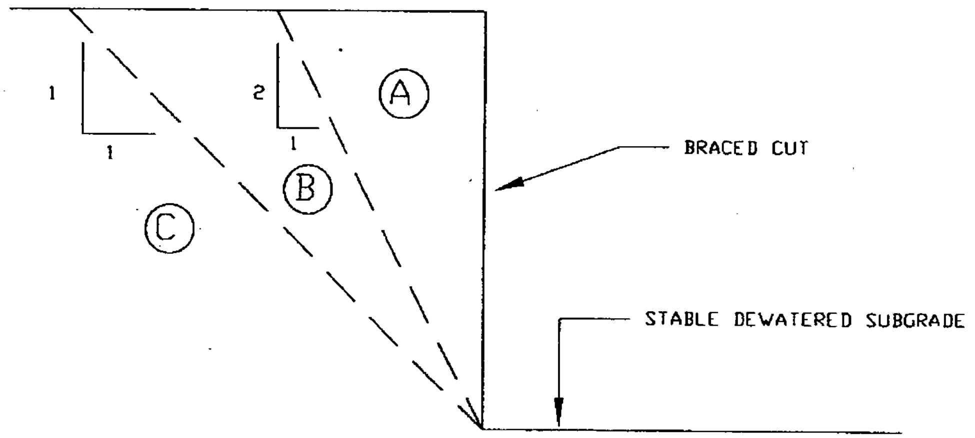
VERTICAL SCALE 1:100

PROJECT No:	V04-121
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS
LOCATION:	835 - 8TH STREET, NEW WESTMINISTER, BC.

CENTENNIAL GEOTECHNICAL ENGINEERS

SOIL PROFILE, E-E (west to east), Middle School

DATE:	DRAWN BY:	SCALE:	FIGURE:
July 23, 2004			7

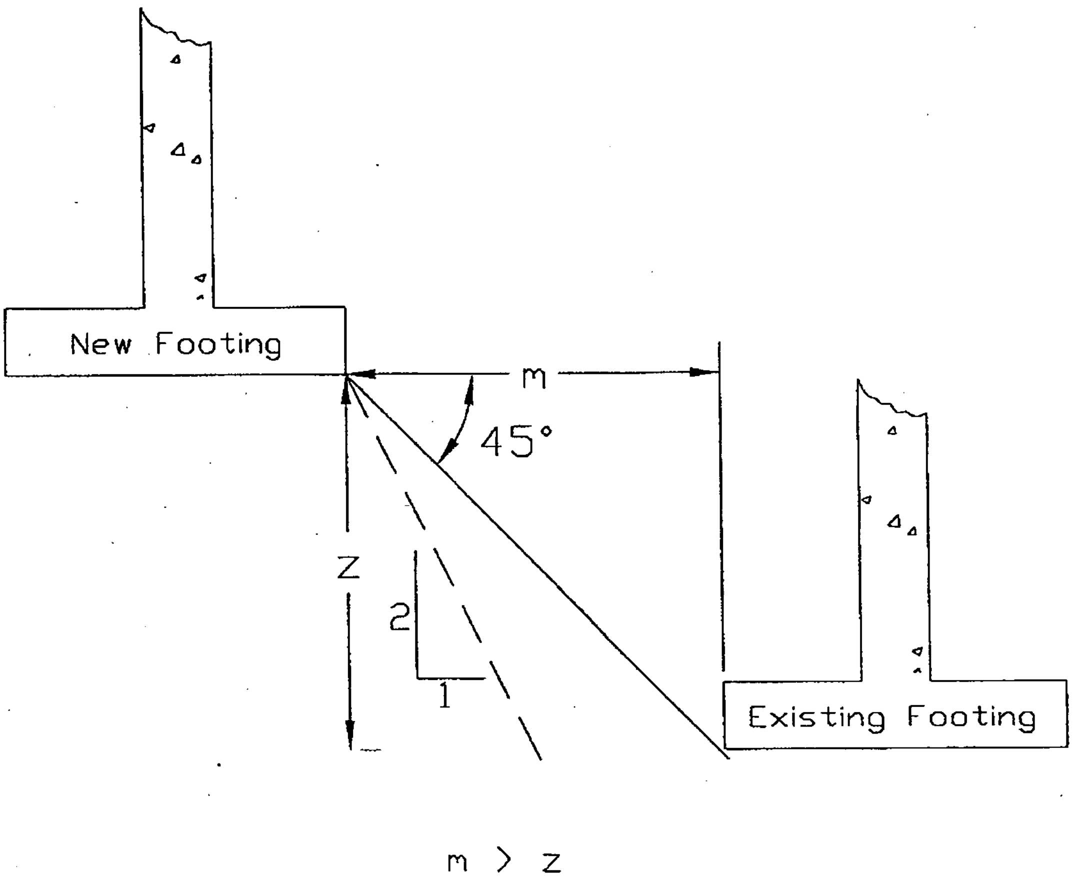


(A) FOUNDATIONS OF IMPORTANT STRUCTURES IN THIS ZONE GENERALLY MUST BE UNDERPINNED.

(B) FOUNDATIONS IN THIS ZONE GENERALLY NOT TO BE UNDERPINNED EXCEPT WHERE UNDERLAIN BY WEAKER CLAYS, OR STRUCTURE IS ESPECIALLY SENSITIVE.

(C) UNDERPINNING ELEMENTS TO RECEIVE THEIR SUPPORT IN THIS ZONE OR BELOW SUBGRADE LEVEL.

PROJECT No:	**V04-121**	**CENTENNIAL GEOTECHNICAL ENGINEERS**		
PROJECT:	**PROPOSED SECONDARY & MIDDLE SCHOOLS**			
LOCATION:	**835 8th STREET NEW WESTMINISTER, BC.**	**GENERAL GUIDELINES FOR UNDERPINNING**		
		DATE: July 15, 2004	**DRAWN BY:**	**FIGURE:** 8



SPACE REQUIREMENT TO AVOID INTERFERENCE BETWEEN OLD AND NEW FOOTINGS

NOT TO SCALE

PROJECT No:	**V04-121**	**CENTENNIAL GEOTECHNICAL ENGINEERS**		
PROJECT:	**PROPOSED SECONDARY & MIDDLE SCHOOLS**			
LOCATION:	**835 8th STREET NEW WESTMINISTER, BC.**	**GENERAL GUIDELINES TO AVOID STRESS INFLUENCE**		
		DATE: July 15, 2004	**DRAWN BY:**	**FIGURE:** 9

APPENDICES

I and II

APPENDIX 1

Hydrogeology and Groundwater Assessment

Hydrogeology and Groundwater Assessment
835-8th Street,
New Westminster, British Columbia

Prepared for:

Centennial Geotechnical Engineers Ltd.

Prepared by:

PCA Consultants Ltd.
Richmond, British Columbia

July 2004
(Project No. 24181)

TABLE OF CONTENTS

APPENDICES

1. Executive Summary

PCA Consultants Ltd. (PCA) completed a preliminary groundwater hydrogeological assessment for the property at 835–8th Street, New Westminster, B.C. (Site). The scope of work included a hydraulic conductivity assessment of the groundwater at the Site. Assessment findings and conclusions are summarized as follows:

Findings and Conclusions:

- The drill logs of Monitoring Wells MW #1 and MW #2 revealed that the stratigraphy of the Site in the vicinity of the monitoring wells consisted of a top layer of asphalt, followed by 5 layers of grey sand (medium to fine-grained) mixed with gravel, silt, sea-shells, clay and boulders (a total thickness of ≈12.0m), a layer of low to medium plasticity silt (≈1.0m to 1.5m), and a layer of tannish brown, silty fine to medium grained sand (≈ 3.5m).

  In MW #2, a layer of grey brown low plasticity till-like silt (≈1m) was found below the tannish brown sand layer. MW #1 was terminated before reaching the lower tilt-like silt layer.
- Since MW #1 and MW #2 were in close proximity and with similar soil profiles, the geological stratigraphy in the vicinity of these two boreholes could assume to be the same and/or identical. Based on this assumption, the drill logs inferred a confined aquifer between 2 silt layers at approximately 12m below grade. The approximate thickness of the confined aquifer was 3.65m.
- High infiltration rate of groundwater was encountered during the development and subsequent bail tests of Monitoring Well MW #1. The cause for the high inflow of groundwater could be from the perch water in the upper sand layers.
- The groundwater elevation in MW #1 was found to be much higher than that of MW #2 (more than 4m). Perch water and/or improper sealing of MW #1 might be part of the reasons for the significant difference in groundwater elevations between the 2 monitoring wells.
- Based on the bail test results of MW #2, the calculated hydraulic conductivity for the confined aquifer ranged from 2.98E-07 m/sec to 3.72E-07 m/sec.

  The calculated conductivity values for monitoring well MW #2 were within those reported in many of the engineering literatures (ranging from 1E-03 m/sec to 1E-07 m/sec) for unconsolidated deposit of silty sand.
- Based on an averaged hydraulic conductivity of 3.35E-07 m/sec (0.71 us-gallons/day/ft^2) and the average aquifer thickness of 3.65m, the calculated transmissivity of the confined aquifer was 1.22E-6 m^2/sec or 8.5 us-gallons/day per linear foot of aquifer width.

Recommendation:

- A minimum of 2 additional monitoring wells should be installed to characterize the groundwater flow direction and hydraulic gradient at the Site.
- Because hydraulic conductivity varies spatially within and between aquifers and bail/slug test results reflect aquifer conditions only in the immediate vicinity of the tested well, additional bail tests should be conducted in as many wells as possible to confirm the hydrogeological information of the identified aquifer at the Site.
- Groundwater chemistry or characteristics, including the various dissolved metals, should be determined to facilitate future HVAC designs.

2. Introduction

On June, 28, 2004, Centennial Geotechnical Engineers Ltd. (CGE) retained PCA Consultants Ltd. (PCA) to conduct a preliminary groundwater hydrogeological characterization program at the property with the civic address of 835-8th Street, New Westminster, British Columbia (Site). The Site is currently occupied by the New Westminster Secondary School. The primary objectives of the project were:

- To determine the groundwater hydraulic conductivity at the Site, and
- To obtain the general chemical and physical characteristics of the groundwater at the Site.

PCA scope of work included:

- Arranging for the rentals of groundwater monitoring instruments.
- Conducting a groundwater hydraulic conductivity assessment by using the "Bail/Slug Testing" methodology.
- Analyzing the bail/slug-testing data by the **Hvorslev** method.
- Preparation of a project memorandum on the technical findings.

This project memorandum summarizes the groundwater hydrogeological assessment findings and conclusions for the Site

3. Groundwater Hydrology Assessment

3.1 Background

CGE retained Downrite Drilling to advance several boreholes at the Site for the geotechnical assessment of the Site. Subsequently, Dynamic Drilling Inc. was instructed by CGE to install a 50mm ∅ PVC piezometer in 2 designated boreholes for groundwater characterization. Drill logs of these 2 monitoring wells were prepared by CGE and are attached in Appendix A. Approximate locations of these monitoring wells are shown in Drawing 24181-00-001 in Appendix B.

3.2 Groundwater Hydrology Assessment Methodology

Groundwater elevation surveys were conducted during the period of July 9, 2004 to July 15, 2004. A *Dipper-T Water Level Meter* by Heron Instruments was used to measure the static water level in the monitoring wells. The water meter employed a high accuracy, NIST traceable, non-stretch, flat Tefzel coated steel tape, permanently marked in 1mm and 1/100 feet lengths. The meter was equipped with a shrouded stainless steel probe, which served as a switch, closing upon contact with the water.

Various "Bail/Slug Testing" methods have been used over the years to obtain a cost-effective quick estimate of the hydraulic properties of aquifers. Theories and assumptions for these testing methodologies are presented in many groundwater references and will not be repeated in this report. Conductivity assessment activities for the Site were performed during the period of July 13, 2004 to July 15, 2004 and the procedures used in this assessment program were as follows:

- Review drill log of the monitoring wells to establish the conductivity assessment program.
- Obtain general information about the monitoring wells, including total depth, location of screen, diameter, height of water column above the screen, and well completion information. In addition to the information presented in the drill logs, CGE and SDS were contacted for data on auger size and other relevant groundwater monitoring well placement procedures.
- Arrange the rental of a data logger and a pressure sensor suitable for the groundwater assessment activities. Water level measuring and recording equipment used in this assessment program was a BH1000 Datatrapper c/w a 18m-pressure sensor supplied by RST Instruments Inc. Calibration of the pressure sensor was conducted at RST Instrument Inc. laboratory prior to taking to the field.
- Set up the data logger to collect groundwater level information at a predetermined time interval. In this assessment, the data logger was pre-programmed to collect data in every 4 or 6 seconds and for a continuous monitoring period of approximately 15 to 25 hours.
- Remove the monitoring well cap and take a static water level measurement.
- Remove all or as much as possible the groundwater and/or sediment in the monitoring well by bailing or by a submersible pump. If possible, the initial groundwater level, i.e. prior to the starting of a monitoring event, should be below the tip of the pressure sensor.
- Lower the pressure sensor into the monitoring well and initiate the data logger to collect the data on the recovery of the water level in the monitoring well.
- Record the static water level measurement at the end of each of the monitoring event. Compare the initial and final static water levels for each event.

- Repeat the monitoring activities for a second time to make sure the data behave similarly.
- Replace monitoring well cap and security cover.
- Download the collected water level measurements from the data logger.
- Use the **Hvorslev** method to determine the hydraulic conductivity at each of the selected monitoring wells used in the assessment program.

4. Hydrogeological Assessment Results

4.1 Groundwater Level Survey Results

Results from the groundwater level survey event are summarized in the following table. The groundwater elevations presented in the summary tables are referenced to Universal Transverse Mercator (UTM) Monuments 89H5543 (94.201m), 89H5542 (86.311m), 89H6031 (98.778), 89H6032 (98.134m), and 89H5541 (91.438m). All measurements are reported in meters.

Monitoring Well ID	Date of Groundwater Elevation Survey					
	July 9	July 9	July 13	July 13	July 14	July 15
	16:10-17:00	19:30-19:45	12:30	18:30	09:25-10:30	11:55-12:05
MW #1	91.046	91.037	91.045	91.035	91.035	91.029
MW #2	86.616	86.695	86.700	86.686	86.685	86.673

The groundwater level measurements revealed that the groundwater level at MW #1 was much higher than that of MW #2.

However, this finding should not be used to establish the hydraulic gradient because MW #1 was not probably sealed and the higher groundwater elevation might have been the result of perch water in the upper sand layers. Furthermore, very high inflow of groundwater was observed when MW #1 was being developed.

4.2 Groundwater Hydraulic Conductivity Assessment Results

Monitoring Well MW #2 was selected as the initial assessment location for the determination of the hydraulic conductivity at the Site. Bail tests for MW #2 were conducted on July 13, 2004 and July 14, 2004.

Each of the testing/assessment events generated over 14000 data points. For easy comprehension and trending presentation of the results, selected recovery water levels from each of the 2 conductivity assessment events at MW #2 are presented in the following tables. Key information and records of the field logs are attached in Appendix C.

MW#2 Bail Test Recovery Data – July 13, 2004 to July 14, 2004

Time	Water Elevation (mm)	Time	Water Elevation (mm)
17:00:00	607.76	18:00:00	1157.73
17:01:00	675.38	19:00:00	1186.06
17:02:00	723.67	20:00:00	1189.28
17:03:00	768.11	21:00:00	1193.79
17:04:00	802.24	22:00:00	1187.99
17:05:00	831.22	23:00:00	1189.92
17:08:00	905.92	00:00:00	1187.99
17:10:00	941.34	01:00:00	1186.71
17:12:00	967.10	02:00:00	1184.13
17:14:00	993.51	03:00:00	1186.06
17:16:00	1014.76	05:00:00	1185.42
17:18:00	1030.21	08:00:00	1184.13
17:30:00	1099.12	09:00:00	1187.99

MW#2 Bail Test Recovery Data – July 14, 2004 to July 15, 2004

Time	Water Elevation (mm)	Time	Water Elevation (mm)
10:10:00	757.81	11:00:00	1145.49
10:11:00	798.38	12:00:00	1177.05
10:12:00	829.92	13:00:00	1186.06
10:13:00	859.56	14:00:00	1191.86
10:14:00	884.03	15:00:00	1195.08
10:15:00	906.57	16:00:00	1195.08
10:16:00	924.60	17:00:00	1195.08
10:18:00	958.09	18:00:00	1196.36
10:20:00	984.49	19:00:00	1200.23
10:25:00	1034.08	21:00:00	1195.72
10:30:00	1066.28	00:00:00	1187.35
10:35:00	1090.75	05:00:00	1184.77
10:40:00	1106.20	10:00:00	1179.62
10:45:00	1118.44	11:45:00	1176.40

Figures D-1 and D-2 in Appendix D are the graphical presentation of the bail test field recovery results for MW #2.

Several bail tests were also attempted at Monitoring Well MW#1. Extremely high infiltration rate was encountered at MW #1 during the trials. The tests did not generate conclusive results and MW #1 was abandoned for any further assessment.

The recovery water level measurements from each of the assessment events in MW #2 were subsequently analyzed by using the **Hvorslev** method. The **Hvorslev** analytical and evaluation procedures involved the following steps:

- Determine the initial and final water levels during the assessment event.
- Normalize the instantaneous water level measurements with the difference of the final and initial water levels.
- Plot the normalized water level data versus time on semilogarithmic paper.
- Determine graphically the time for complete equalization of the head difference in the assessment event. The graphically derived data were subsequently compared with the digital results generated from the field recovery data.
- Calculate the groundwater hydraulic conductivity by using the time of complete equalization.

Figures E-1 and E-2 in Appendix E are the **Hvorslev** plots of the groundwater hydraulic conductivity assessment events for the Site.

4.3 Groundwater-Quality-Indicator Parameters

Groundwater-quality-indicator parameters (pH, Temperature, Conductivity and Turbidity) from each bail test were recorded and summarized in the following tables.

Bail Test – July 13, 2004

Time	pH (Standard Unit)	Temperature (°C)	Conductance (μS)	Turbidity (ppm)
16:32	5.58	17.9	282	145
16:37	5.74	15.9	257	129
16:39	5.81	15.3	261	129
16:41	5.84	15.2	282	141
16:56	5.71	15.8	345	172
Average	**5.74**	**16.0**	**285**	**143**

Bail Test – July 14, 2004

Time	pH (Standard Unit)	Temperature (°C)	Conductance (μS)	Turbidity (ppm)
9:30	6.05	16.1	280	136
9:40	5.91	14.9	226	113
9:50	5.81	14.6	228	113
9:55	5.75	14.5	268	135
10:00	5.81	14.5	317	158
Average	**5.87**	**14.9**	**264**	**131**

5. Data Interpretations and Discussions

The current groundwater characterization investigation revealed the following findings.

- The calculated groundwater hydraulic conductivity for the Site were summarized and presented in the following table.

Monitoring Well ID	Date	Equalization Time (T_0 in sec)	Conductivity (K in m/sec)
MW #2	7/13 to 7/14	758	3.72 E-07
MW #2	7/14 to 7/15	945	2.98 E-07
MW #2 (Averaged Values)		**852**	**3.35 E-07**

- The average groundwater-quality-indicator parameters of the groundwater at MW #2 were as follows:

pH (Standard Unit)	Temperature (°C)	Conductance (μS)	Turbidity (ppm)
5.8	15.5	275	137

The groundwater was slightly acidic.

The groundwater temperature was around 15°C and was typical for the Lower Mainland during the summer months.

6. Conclusions and Recommendations

Based on the information obtained from the current groundwater characterization program, PCA derives the following conclusions and recommendations for the Site.

- The average groundwater hydraulic conductivity for the confined aquifer within the 2 silt layers was calculated to be 3.35E-07 m/sec.
- The calculated conductivity values for monitoring well MW #2 were within those reported in many of the engineering literatures (ranging from 1E-03 m/sec to 1E-07 m/sec) for unconsolidated deposit of silty sand.
- Based on an averaged hydraulic conductivity of 3.35E-07 m/sec (0.71 us-gallons/day/ft^2) and the average aquifer thickness of 3.65m, the calculated transmissivity of the confined aquifer was 1.22E-6 m^2/sec or 8.5 us-gallons/day per linear foot of aquifer width.
- A minimum of 2 additional monitoring wells should be installed to characterize the groundwater flow direction and hydraulic gradient at the Site.
- Because hydraulic conductivity varies spatially within and between aquifers and bail/slug test results reflect aquifer conditions only in the immediate vicinity of the tested well, additional bail tests should be conducted in as many wells as possible to confirm the hydrogeological information of the identified aquifer at the Site.
- Groundwater chemistry or characteristics, including the various dissolved metals, should be determined to facilitate future HVAC designs.

7. Closure

Information presented in this report is based on the findings from this preliminary groundwater hydrogeological assessment project. The report has been prepared for the exclusive use of Centennial Geotechnical Engineers Ltd., which includes distribution as required for the purposes for which this assessment was commissioned.

This assessment project has been conducted in accordance with generally accepted engineering practices and in accordance with the intended scope of the project. No other warranty is made, either expressed or implied. Reference should also be made to the Terms and Conditions for Environmental Services in Appendix F.

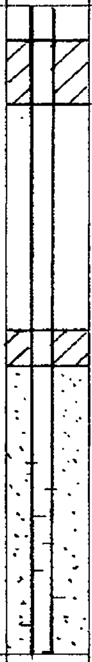
PCA trusts that this report satisfies the present requirements of Centennial Geotechnical Engineers Ltd.

APPENDIX A

Drill Logs of Monitoring Wells

DATE DRILLED: July 5, 2004	INSPECTOR: R.Y.	AUGER HOLE	MW 1
DRILL METHOD: AUGER	SURFACE ELEVATION: 92.22m	SHEET 1	OF 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type
0	**SAND** - Grey, sandy gravel	GM	
	SAND - Grey, silty, fine-grained	SM	
10	**SAND** - Grey, clayey, some seashells	SC	
	SAND - Grey, silty, fine-grained, some 2 to 3" gravel, till-like - grades to dense at 16 feet	SM/GM	
20			
	- some boulders at 26 feet		
30			
40	**SAND** - Grey, silty, fine to medium-grained	SM	
	SILT - Grey, clayey, low to medium plasticity	ML	
50	**BOTTOM OF MW AT 47 FEET**		
60			
70			
80			
90			
100			



DYNAMIC CONE PENETRATION TEST

BLOWS / FOOT

0 10 20 30 40 50

GRAB SAMPLE [x] WATER TABLE

PROJECT No:	V04-121
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS
LOCATION:	835 - 8TH STREET NEW WESTMINISTER, BC

CENTENNIAL GEOTECHNICAL ENGINEERS

MONITORING WELL LOG

DATE:	DRAWN BY:	FIGURE:
JULY 12, 2004	CL	A1

DATE DRILLED:	July 5, 2004	INSPECTOR: R.Y.	AUGER HOLE	MW 2
DRILL METHOD:	AUGER	SURFACE ELEVATION: 94.94m	SHEET 1 OF 1	

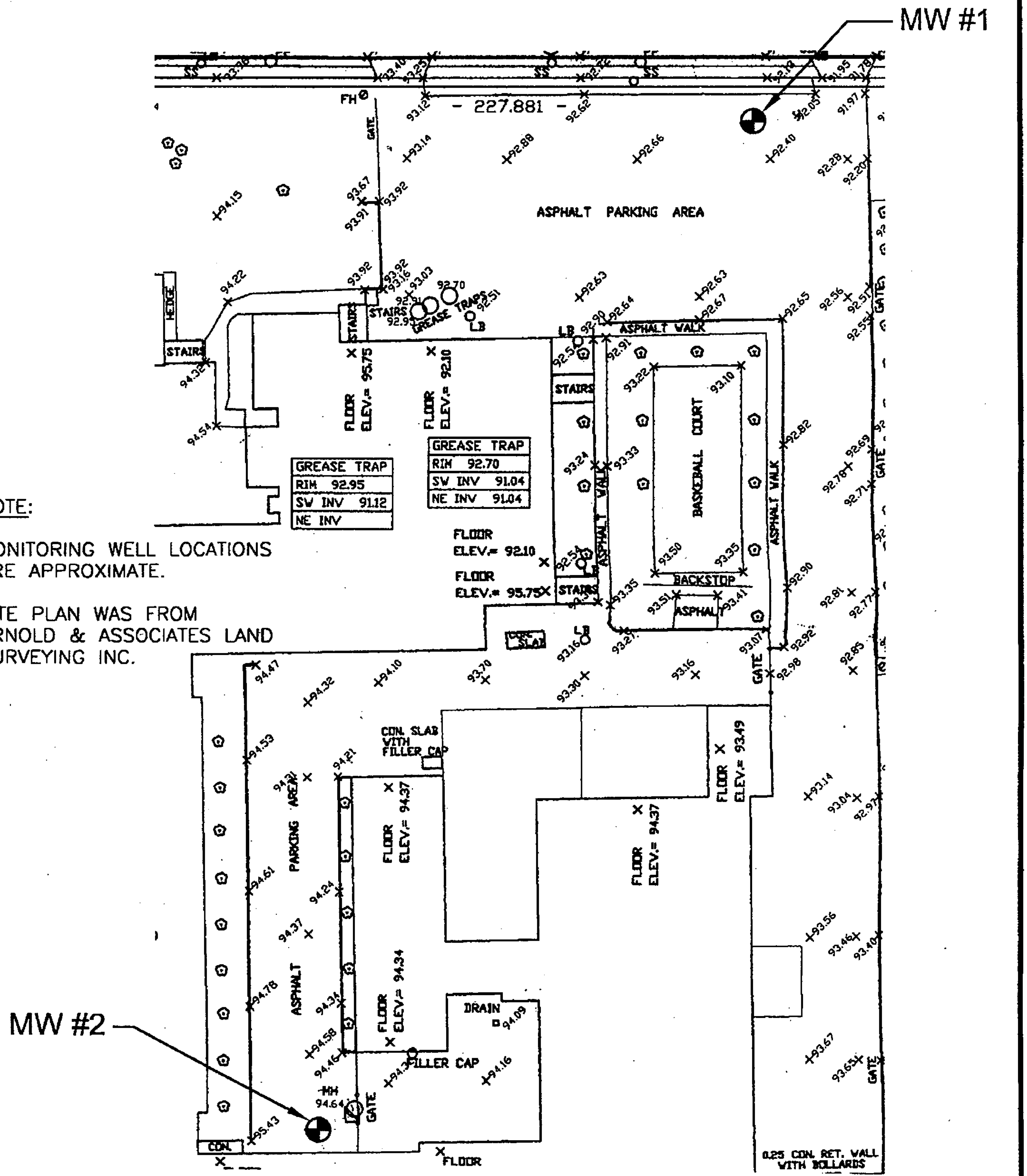
DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	DYNAMIC CONE PENETRATION TEST BLOWS / FOOT (0 10 20 30 40 50)
0	**SAND** - Grey, sandy gravel	GM		
	SAND - Grey, silty, fine-grained	SM		
10	**SAND** - Grey, clayey, some sea shells	SC		
	SAND - Grey, silty, fine-grained, some 2 to 3" gravel, till-like - grades to dense at 16 feet - some boulders at 29 feet	SM/GM		
20				
30				
	SAND - Grey, silty, fine to medium-grained	SM		
40	**SILT** - Tannish brown, clayey, low plasticity, till-like	ML		
	SAND - Tannish brown, silty, fine to medium-grained	SM		
50				
	SILT - Grey brown, clayey, low plasticity, till-like	ML		
60				
	BOTTOM OF MW AT 60 FEET			
70				
80				
90				
100				

GRAB SAMPLE [X] WATER TABLE ▽

PROJECT No:	V04-121	CENTENNIAL GEOTECHNICAL ENGINEERS		
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS	MONITORING WELL LOG		
LOCATION:	835 - 8TH STREET NEW WESTMINISTER, BC	DATE: JULY 12, 2004	DRAWN BY: CL	FIGURE: A2

APPENDIX B

Groundwater Monitoring Well – Site Plan
Drawing 24181-00-001



NOTE:

MONITORING WELL LOCATIONS ARE APPROXIMATE.

SITE PLAN WAS FROM ARNOLD & ASSOCIATES LAND SURVEYING INC.

PCA CONSULTANTS LTD — Environmental & Waste Management Consultants, *120-10691 Shellbridge Way, Richmond B.C. Tel. (604) 303-9313*	PROJECT: 835 - 8TH STREET, NW, B.C. GROUNDWATER HYDROLOGY ASSESSMENT
	TITLE: GROUNDWATER MONITORING WELL LOCATION - SITE PLAN
CLIENT: CENTENNIAL GEOTECHNICAL ENGINEERS LTD.	PROJECT No. 24181 — DWG. No. 24181-00-001 — REV. A

APPENDIX C

Field Log Summaries

MW #2 - Bail Test Recovery Data Summary (7/14 to 7/15)

Serial#:	88,054,021.00				
Download#:	155.00				
Logger Date/Time:	38,183.49				
PC Date/Time:	38,183.49				
Sample Start Date/Time:	38,182.42				
Sample Interval:	0.00				
Multiplication Factor:	0.64				
Offset:	-24.00				
Units:	mm				
Total Records:	15,387.00				
Datum Line (H0)	**mm**	**757.800**			
Reference Time	**Sec**	**0.000**			
Max. Height (H)	**mm**	**1204.710**	**1,204.71**	**1204.710**	
Radius of Well (r)	**mm**	25.400		25.000	
Length of Well (L)	**mm**	4572.000		4572.000	
Effective Radius (R) (well+packing)	**mm**	84.138		84.138	
		Data T0		**Graph T0**	
T0 (from Graph)	**Sec**	**945.000**	**Sec**	**930.000**	
Hydraulic Conductivity Hvorslev Method K = r^2 Ln(L/R)/(2 L T0)	**=**	**2.982935E-04**	**mm/sec**		
		2.98E-07	**m/sec**	**0.63** gal/day/ft^2	
		2.58E-04	**m/day**		

Hydraulic Conductivity for unconfinec Silty Sand Range = 1E-03 to 1E-07 m/sec

MW #2 - Bail Test Recovery Data Summary (7/13 to 7/14)

Serial#:	88054021			
Download#:	152			
Logger Date/Time:	7/14/04 9:24			
PC Date/Time:	7/14/04 9:24			
Sample Start Date/Time:	7/13/04 17:00			
Sample Interval:	0:00:04			
Multiplication Factor:	0.643992			
Offset:	-24			
Units:	mm			
Total Records:	14761			
Datum Line (H0)	**mm**	**607.76**		
Reference Time	**Sec**	**0**		
Max. Height (H)	**mm**	**1194.43**	1,194.43	1194.43
Radius of Well (r)	**mm**	**25.4**		25
Length of Well (L)	**mm**	**4572**		4572
Effective Radius (R) (well+packing)	**mm**	**84.138**		**84.138**
		Data T0		Graph T0
T0 (from Graph)	**Sec**	**758** Sec		720

Hydraulic Conductivity — Hvorslev Method: K = r^2 Ln(L/R)/(2 L T0) = **3.718830E-04 mm/sec**

3.72E-07 m/sec 0.79 gal/day/ft^2

3.21E-04 m/day

Hydraulic Conductivity for unconfined Silty Sand Range = 1E-03 to 1E-07 m/sec

APPENDIX D

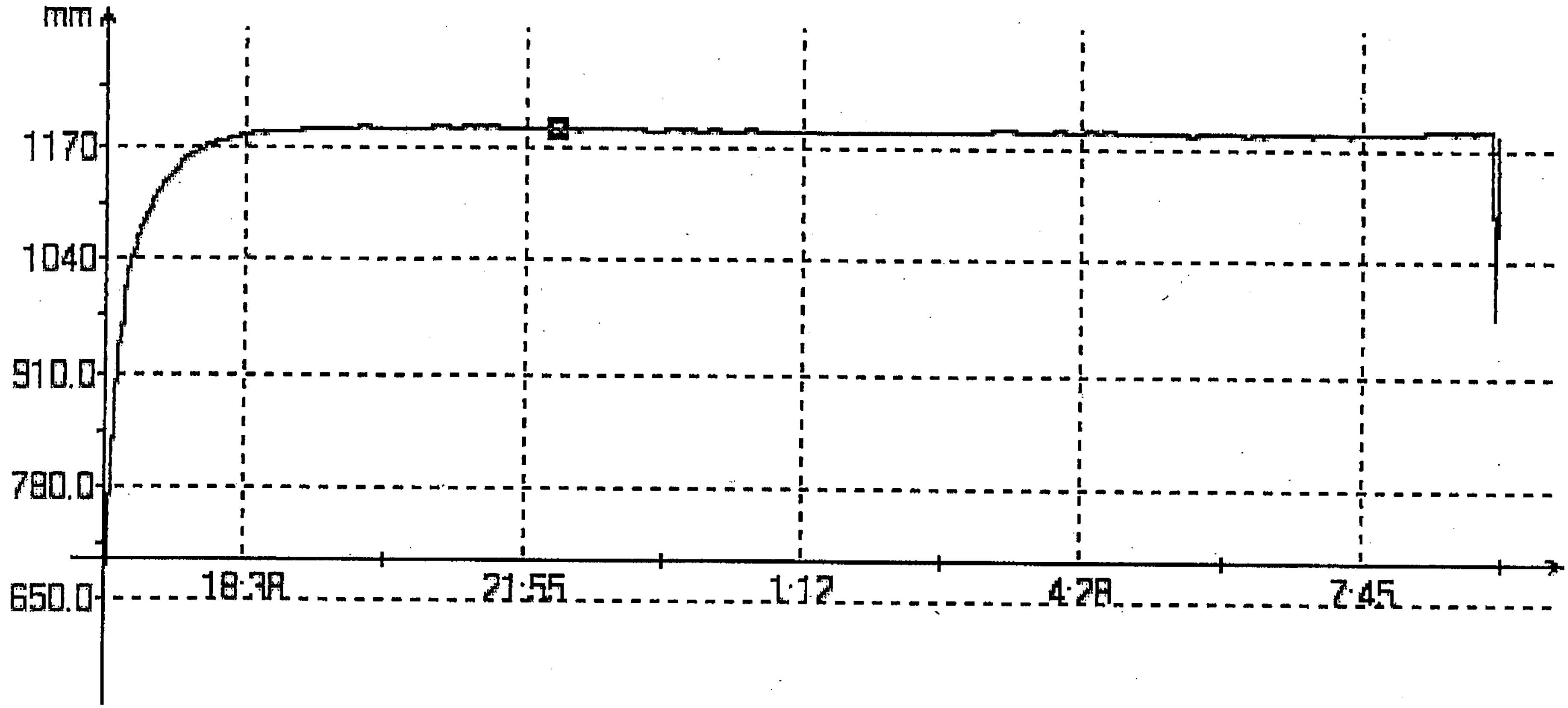
Field Recovery Drawings

Figure D – 1
Figure D – 2

File Name: 04Jul14.R52

FIG. D-1

MW #2 - Slug Test Results (July 13 to July 14)

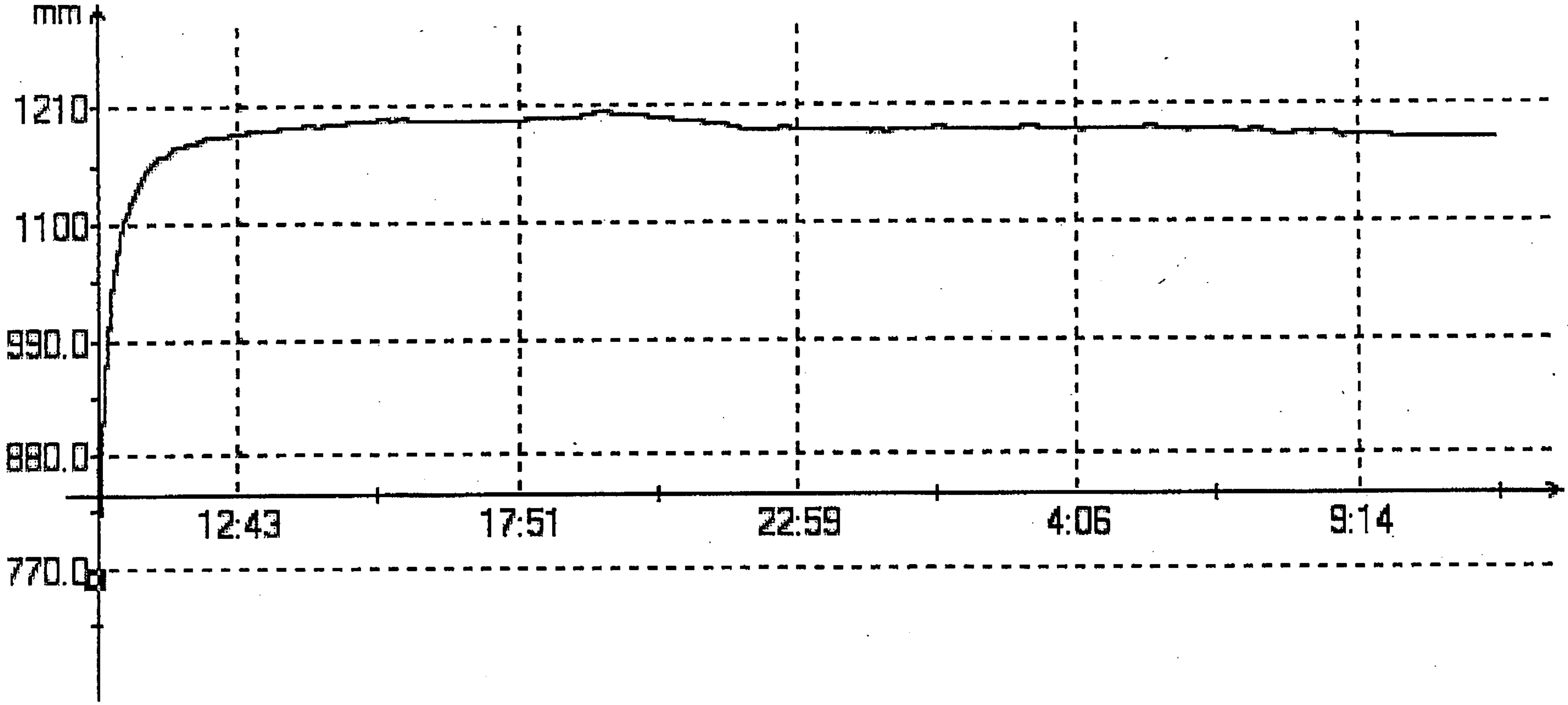


Serial#	88054021
Download#	152
Sample Start Time:	2004/07/13 17:00:00
Last Sample Time:	2004/07/14 09:24:00
Sample Interval:	00:00:04
Mult Factor:	0.6439920
Offset:	-24.0000000
Units:	mm
Records Displayed:	14761
Min reading:	802.2417360
Max reading:	1194.4328640
Difference:	392.1911280
Avg:	1178.2047546

File Name: 04Jul15.R55

FIG. D-2

MW #2 - Slug Test Results [July 14 to July 15]

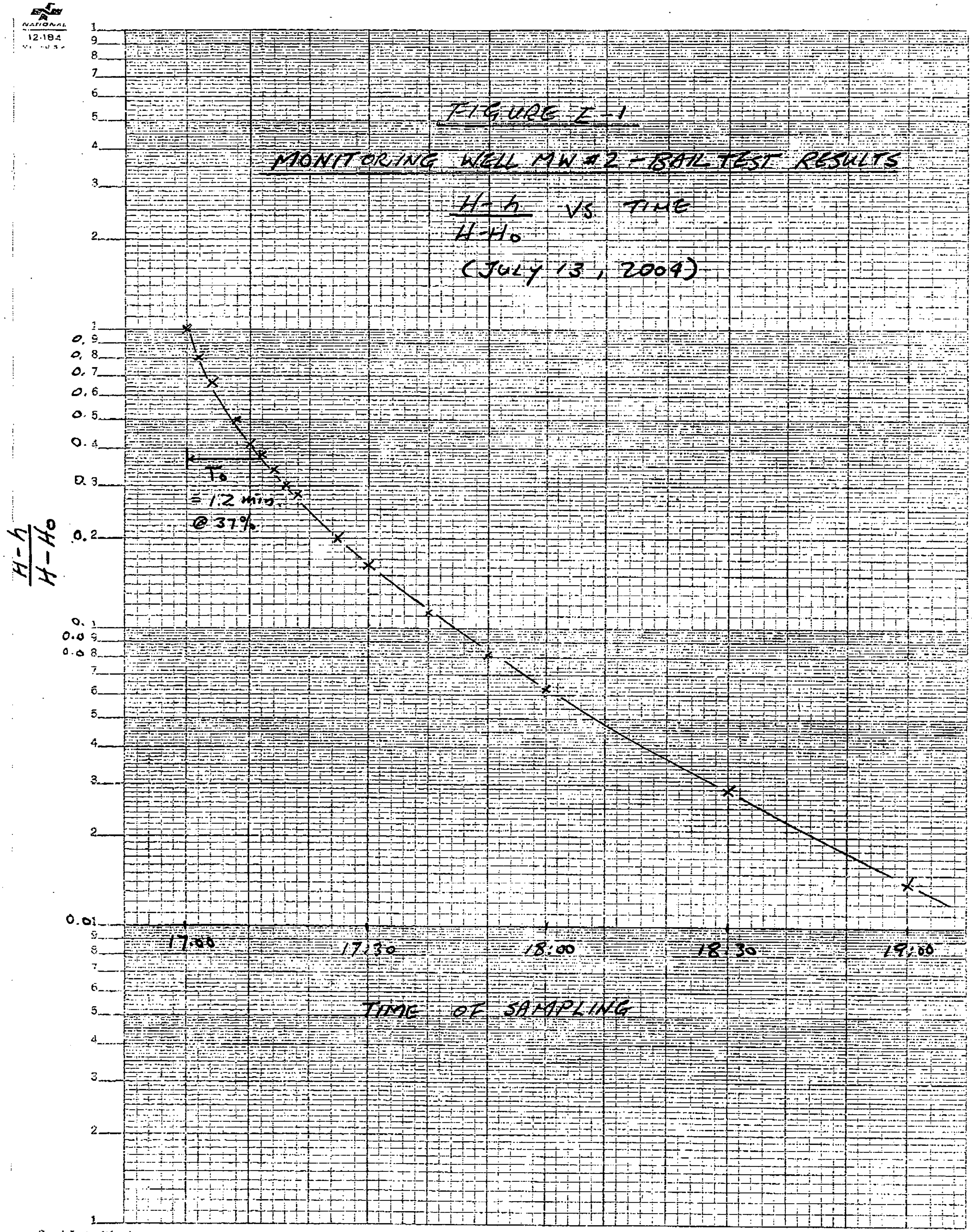


Serial#	88054021
Download#	155
Sample Start Time:	2004/07/14 10:10:00
Last Sample Time:	2004/07/15 11:48:36
Sample Interval:	00:00:06
Mult Factor:	0.6439920
Offset:	-24.0000000
Units:	mm
Records Displayed:	15387
Min reading:	918.1602960
Max reading:	1204.7367360
Difference:	286.5764400

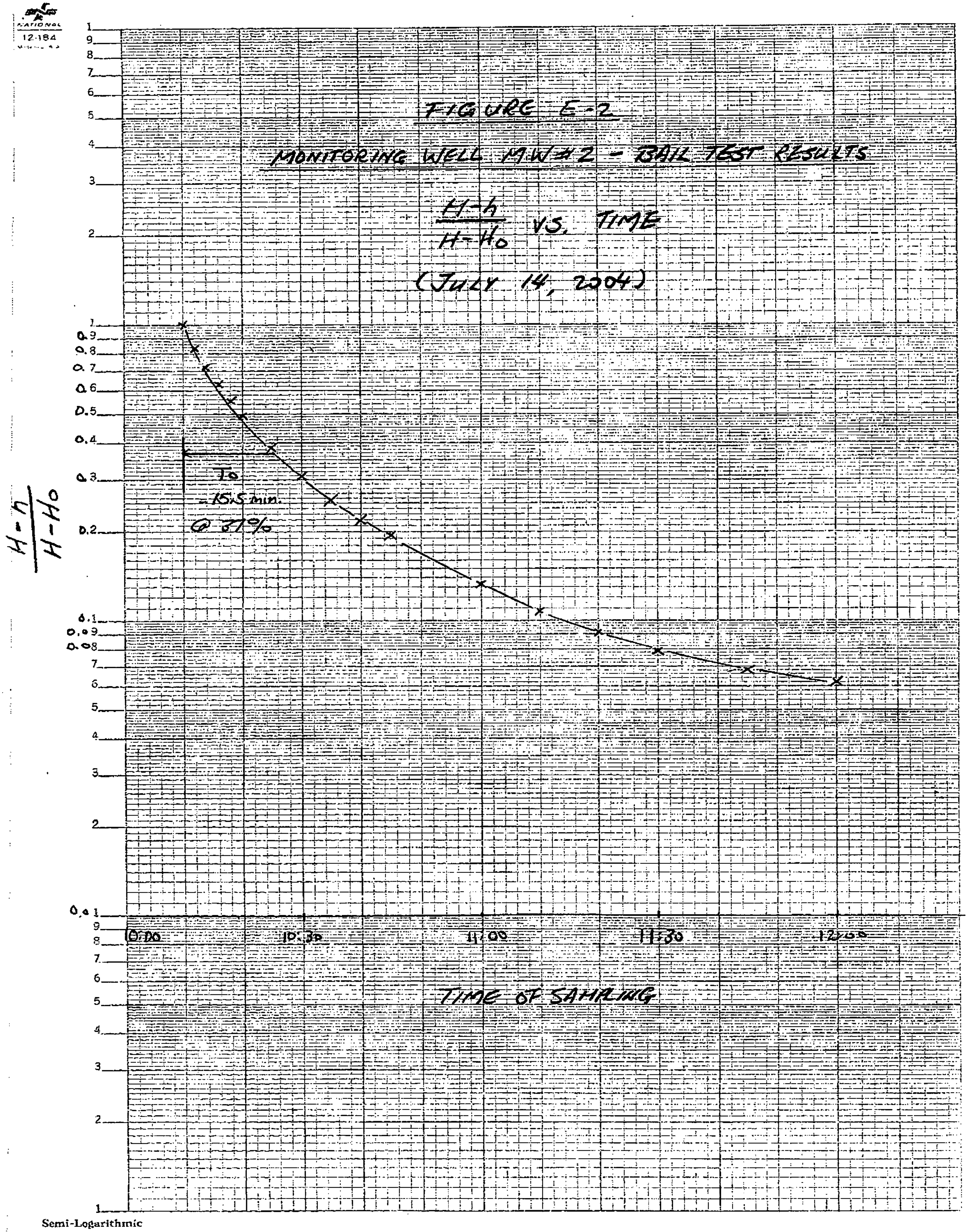
APPENDIX E

Hvorslev Method Drawings

Figure E – 1
Figure E – 2



Semi-Logarithmic
4 Cycles x 10 to the inch



Semi-Logarithmic
4 Cycles x 10 to the inch

APPENDIX F

Terms and Conditions for Environmental Services

TERMS AND CONDITIONS
FOR
ENVIRONMENTAL SERVICES

1. PCA shall provide and exercise the degree of skill, care and diligence required by customarily accepted professional practices and procedures normally provided in the performance of the services contemplated at the time and the location in which the services are performed.

2. PCA shall use reasonable efforts to perform the services within prescribed time schedules. PCA shall not however, be responsible for any delays caused by circumstances beyond its control.

3. PCA may engage as subconsultants any person, firm or corporation with appropriate recognized professional status or with special skills or knowledge to assist in performing the services.

4. The Client acknowledges and agrees that PCA shall not, and in any event, is not able to, give any warranties, express or imply, about the existence or absence of any contaminants or hazardous materials on the site. If PCA is required to give the Client an opinion, PCA shall provide an opinion based on the evidence available to PCA within the scope of investigation authorized by the Client.

5. The Client shall obtain all the permits, authorizations or consents and give any required notices necessary to enable PCA to perform the services including, but not limited to, any consents necessary to allow PCA, its agents, employees and equipment the necessary access to, and use of, the Site.

6. Any documents provided by the Client to PCA shall be deemed to the property of the Client and, on the written demand of the Client, PCA shall, as soon as practicable, return all of the Client's documents to him. Any information collected and documents prepared by PCA while performing the services shall be deemed to be the property of PCA.

7. Both PCA and the Client shall take reasonable care to prevent disclosure of any reports or documents prepared by PCA, or information obtained for or contained in any reports or documents, to any person except those persons who require access to such information to discharge their responsibilities in relation to the services performed by PCA.

8. If PCA becomes aware of any contamination or hazardous materials on the site, which could damage property or endanger health or lives, PCA shall notify the Client as soon as possible and appropriate authorities as required.

9. The Client shall provide PCA with accurate and complete delineations of the location of all subsurface structures and utilities at, on or near the site, except as otherwise may be agreed.

10. Where the services to be performed require taking samples from the Site, the Client shall be responsible for payment of appropriate storage and disposal for any contaminated samples taken from the Site. The Client shall be responsible for all costs incurred to decontaminate any equipment (used by PCA or his agents in the performance of the services), which is contaminated by conditions encountered at the Site.

11. PCA shall not be responsible for any costs, damages or loss suffered by any person, including the Client, its employees, agents or related companies, as a result of:

    (a) any decisions taken by the Client without the advice of PCA, or contrary to the advice of PCA, pertaining to activities during, or subsequent to, the services being performed by PCA;

    (b) any subsurface exploration or sample-taking on the site by PCA including cross-contamination;

(c) the disclosure, as permitted or required by law of any opinion, information or report prepared by PCA,

(d) the failure of the Client, or other agencies, to accurately identify the location of all subsurface structures or utilities.

Nor shall PCA be responsible or liable for any indirect or consequential losses, damages, costs or expenses incurred by any person including the Client, relating to or as a result of services provide by PCA.

12. The Client shall assume the defence of, and indemnify and save harmless, PCA, its agents and employees, from all claims or liability by any third parties relating to or arising out of the performance of the services, except where the claim or liability arises out of negligence or willful misconduct of PCA, and the Client whenever it is bound to indemnify PCA shall reimburse PCA for time spent and expenses incurred by PCA in defence of any such claims.

APPENDIX 2

Logs of Test Borehole for Geotechnical Studies

DATE DRILLED:	June 3, 2004	INSPECTOR:	LL	AUGER HOLE	A1
DRILL METHOD:	AUGER	SURFACE ELEVATION:	91.1m ±	SHEET 1	OF 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content	DYNAMIC CONE PENETRATION TEST BLOWS / FOOT (0 10 20 30 40 50)
0	**TOPSOIL** - Dark brown, silty sand, some organic matters (loose)	SM			
2.5	**SAND** - Tannish brown, silty, fine-grained (loose)	SM	[x]	23.5	
	- grades to tan grey mottled ▽		[x]	23.3	
5					
7.5	**SAND** - Tan grey mottled, clayey, fine-grained, trace pebbles & 1" gravel med plasticity (compact)	SC	[x]	23.6	
10	**SILT** - Grey, clayey, med plasticity, trace small pebbles & 1" gravel (firm)	ML	[x]	32.7	
12.5					
15					
17.5	**SILT** - Grey, clayey, medium plasticity (very stiff) unconfined compressible strength pp ~ 4 tsf	ML	[x]	24	
20					
	SAND - Grey, silty, fine-grained, small pebbles & occ. 1.5-2" gravel, till-like (very dense)	SM	[x]	10.3	
22.5	Note: unconfined compressible strength for disturbed sample (PP), tsf				
25	TEST BOREHOLE TERMINATED AT REFUSAL, 25 FEET		[x]	10.3	

PP, TSF — GRAB SAMPLE [x] — WATER TABLE ▽

PROJECT No:	V04-121	**CENTENNIAL GEOTECHNICAL ENGINEERS**
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS	
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.	BOREHOLE LOG
		DATE: June 17, 2004 — DRAWN BY: CL — FIGURE: B1

DATE DRILLED: June 3, 2004	**INSPECTOR:** LL	**AUGER HOLE** A2	
DRILL METHOD: AUGER	**SURFACE ELEVATION:** 91.7m±	**SHEET** 1 **OF** 1	

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content	DYNAMIC CONE PENETRATION TEST BLOWS / FOOT (0 10 20 30 40 50)
0	**FILL -** Random, brown, silty sand & gravel, some organic matters (loose)	SM			
2.5			[x]	20.3	
5					
7.5			[x]	24.8	
	SILT - Tan grey mottled, clayey, occ. small pebbles, med plasticity, crumbly, till-like, pp ~ 2tsf (stiff)	ML	[x]	25.6	
10					
12.5	**SILT -** Grey, clayey, med plasticity, trace pebbles & 1" gravel, till-like, pp~ 4tsf (very stiff)	ML	[x]	15.9	
15	**SAND -** Grey, silty, fine-grained, small pebbles & occ. 1.5-2" gravel, till-like (very dense)	SM	[x]	12.9	
17.5			[x]	8.7	
	TEST BOREHOLE TERMINATED AT REFUSAL, 18 FEET				
20					
22.5					
	see note on Figure B1				
25					

PP, TSF GRAB SAMPLE [x] WATER TABLE ▽

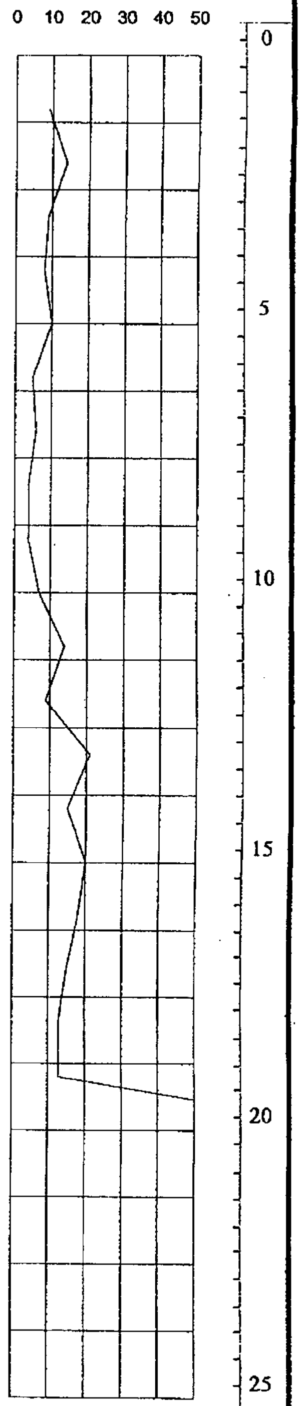
PROJECT No: V04-121	**CENTENNIAL GEOTECHNICAL ENGINEERS**
PROJECT: PROPOSED SECONDARY & MIDDLE SCHOOLS	
LOCATION: 835 8th STREET, NEW WESTMINSTER, BC.	**BOREHOLE LOG**
	DATE: June 17, 2004 / **DRAWN BY:** CL / **FIGURE:** B2

DATE DRILLED:	June 3, 2004	INSPECTOR:	LL
DRILL METHOD:	AUGER	SURFACE ELEVATION:	90.7m±

AUGER HOLE A3
SHEET 1 OF 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content
0	FILL - Random, brown, silty sand & gravel, some organic matters (loose)	SM		
2.5 – 5			[x]	23.3
7.5	SILT - Tan grey mottled, clayey, occ. small pebbles, med plasticity crumbly, pp 1 - 1.5tsf (firm)	ML	[x]	30.4
10	SAND - Grey, clayey, fine-grained, trace pebbles, low to med plasticity, crumbly, pp 2 - 2.5tsf, till-like (compact)	SC	[x]	22.1
12.5 – 15	SILT - Grey, clayey, med plasticity, pp~ 4 tsf (v. stiff)	ML	[x]	23
17.5 – 20	SAND - Grey, silty, fine-grained, small pebbles & occ. 1.5-2" gravel, till-like (very dense)	SM	[x]	11.3
20 – 25	TEST BOREHOLE TERMINATED AT REFUSAL, 20 FEET see note on Figure B1			

DYNAMIC CONE PENETRATION TEST
BLOWS / FOOT



PP, TSF GRAB SAMPLE [x] WATER TABLE ▽

PROJECT No:	V04-121
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.

CENTENNIAL GEOTECHNICAL ENGINEERS

BOREHOLE LOG

DATE:	DRAWN BY:	FIGURE:
June 17, 2004	CL	B3

DATE DRILLED: June 3, 2004	INSPECTOR: LL	AUGER HOLE A4
DRILL METHOD: AUGER	SURFACE ELEVATION: 91.8m±	SHEET 1 OF 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content	DYNAMIC CONE PENETRATION TEST BLOWS / FOOT (0 10 20 30 40 50)
0	FILL - Random, brown, silty sand & gravel, some organic matters (loose)	SM			
2.5			[x]	22.9	
5					
7.5	SILT - Tan grey mottled, clayey, occ. small pebbles, med plasticity, crumbly, pp 1 - 1.5 tsf (firm)	ML	[x]	27.3	
10	SAND - Grey, silty, fine-grained, small pebbles & occ. 1.5-2" gravel, till-like (very dense)	SM	[x]	9.3	
12.5	TEST BOREHOLE TERMINATED AT REFUSAL, 13 FEET				
15					
17.5					
20					
22.5					
25	see note on Figure B1				

PP, TSF GRAB SAMPLE [x] WATER TABLE ▽

PROJECT No:	V04-121
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.

CENTENNIAL GEOTECHNICAL ENGINEERS

BOREHOLE LOG

DATE:	DRAWN BY:	FIGURE:
June 17, 2004	CL	B4

DATE DRILLED:	June 3, 2004	INSPECTOR:	LL	AUGER HOLE A5
DRILL METHOD:	AUGER	SURFACE ELEVATION:	92.1m ±	SHEET 1 OF 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content	DYNAMIC CONE PENETRATION TEST BLOWS / FOOT (0 10 20 30 40 50)
0	FILL - Random, dark brown, silty sand, some organic matters (loose)	SM			
2.5			x	10.3	
	6-inch topsoil				
	SAND - Tannish brown, silty, fine-grained (loose)	SM	x	31	
5					
7.5	SAND - Tan grey mottled, clayey, fine-grained, trace pebbles, crumbly, low to med plasticity, till-like, pp 2 - 2.5 tsf (compact)	SC	x	23.1	
10	SILT - Grey brown mottled, clayey, med plasticity, pp 1.5 - 2 tsf (firm)	ML	x	29.8	
12.5					
15	SILT - Grey, clayey, med plasticity, pp ~ 4 tsf (very stiff)	ML	x	22.2	
	SAND - Grey, silty, fine-grained, small pebbles & occ. 1.5-2" gravel, till-like (very dense)	SM	x	12	
17.5	TEST BOREHOLE TERMINATED AT REFUSAL, 16 FEET				
20					
22.5					
25	see note on Figure B1				

PP, TSF   GRAB SAMPLE [x]   WATER TABLE ▽

PROJECT No:	V04-121	CENTENNIAL GEOTECHNICAL ENGINEERS
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS	
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.	BOREHOLE LOG
		DATE: June 17, 2004 / DRAWN BY: CL / FIGURE: B5

DATE DRILLED:	June 3, 2004	INSPECTOR:	LL	AUGER HOLE A6
DRILL METHOD:	AUGER	SURFACE ELEVATION:	92.1m±	SHEET 1 OF 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content	DYNAMIC CONE PENETRATION TEST BLOWS / FOOT (0 10 20 30 40 50)
0	FILL - 12 inches of river sand over Random fill, dark brown silty sand & gravel, some organic (loose)	SM	x	30.3	
2.5	SAND - Rusty brown, silty, fine-grained (loose)	SM	x	26.9	
5	(water table)				
	SAND - Tannish grey mottled, silty, fine-grained (loose)	SM	x	24.2	
7.5					
10	- occ. fine gravel		x	20.4	
	SAND - Grey, clayey, fine-grained, trace pebbles & seashell, med plasticity, pp - 2 tsf (compact)	SC	x	20.7	
12.5					
15					
	SILT - Grey, clayey, med plasticity, pp ~ 4 tsf (very stiff)	ML	x	22.1	
17.5					
	SAND - Grey, silty, fine-grained, small pebbles & occ. 1.5-2" gravel, till-like (very dense)	SM	x	14	
20	TEST BOREHOLE TERMINATED AT REFUSAL, 20 FEET				
22.5					
25	see note on Figure B1				

PP, TSF GRAB SAMPLE [x] WATER TABLE ▽

PROJECT No:	V04-121	CENTENNIAL GEOTECHNICAL ENGINEERS
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS	BOREHOLE LOG
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.	DATE: June 17, 2004 / DRAWN BY: CL / FIGURE: B6

DATE DRILLED:	June 3, 2004	**INSPECTOR:** LL	**AUGER HOLE** A7
DRILL METHOD:	AUGER	**SURFACE ELEVATION:** 94.2m ±	**SHEET** 1 **OF** 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content	DYNAMIC CONE PENETRATION TEST BLOWS / FOOT (0 10 20 30 40 50)
0	**FILL -** Random, dark brown, silty sand, some organic matters (loose)	SM			
2.5	**SAND -** Tannish brown, silty, fine-grained (compact)	SM			
	SILT - Tan grey mottled, clayey, med plasticity, pp ~ 4 tsf (very stiff)	ML	[x]	24.9	
5					
	SAND - Grey, clayey/silty, fine-grained, small pebbles & occ. 1.5-2" gravel till-like (very dense)	SM/SC	[x]	13.9	
7.5					
	TEST BOREHOLE TERMINATED AT REFUSAL, 8 FEET				
10					
12.5					
15					
17.5					
20					
22.5					
25	see note on Figure B1				

PP, TSF **GRAB SAMPLE** [x] **WATER TABLE** ▽

PROJECT No:	V04-121	**CENTENNIAL GEOTECHNICAL ENGINEERS**	
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS		
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.	**BOREHOLE LOG**	
		DATE: June 17, 2004 / **DRAWN BY:** CL	**FIGURE:** B7

DATE DRILLED:	June 3, 2004	INSPECTOR:	LL	AUGER HOLE A8
DRILL METHOD:	AUGER	SURFACE ELEVATION:	93.1m ±	SHEET 1 OF 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE Sample Type	SAMPLE Moisture Content	DYNAMIC CONE PENETRATION TEST BLOWS / FOOT (0 10 20 30 40 50)
0	**SAND -** Tannish brown, silty, fine-grained (compact)	SM	[X]	15.9	
2.5	**SAND -** Tan brown mottled, clayey, small pebbles, crumbly low plasticity, till-like, pp 2 - 2.5 tsf (compact)	SC	[X]	19.1	
5					
7.5					
	SAND - Grey, silty, fine-grained, small pebbles, till-like (v dense)	SM	[X]	8.7	
10	TEST BOREHOLE TERMINATED AT REFUSAL, 10 FEET				
12.5					
15					
17.5					
20					
22.5					
25	see note on Figure B1				

PP, TSF GRAB SAMPLE [x] WATER TABLE ▽

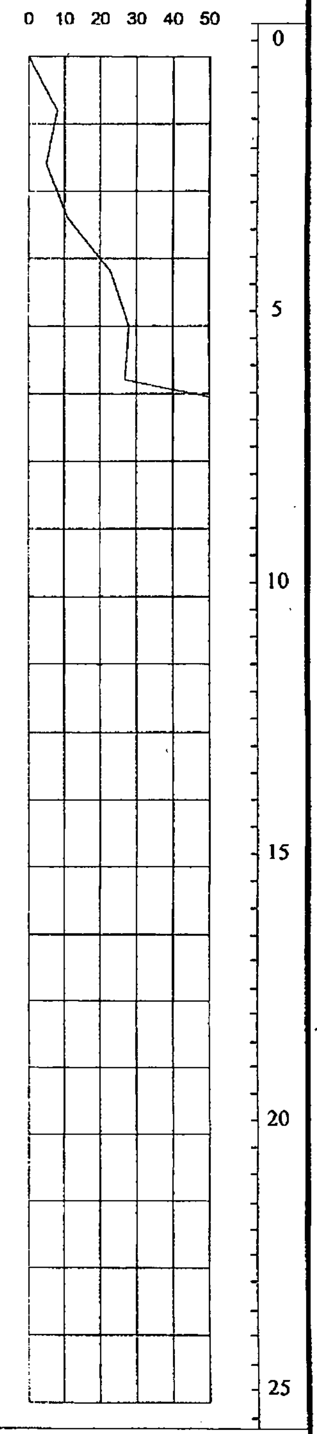
PROJECT No:	V04-121	CENTENNIAL GEOTECHNICAL ENGINEERS
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS	
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.	BOREHOLE LOG
DATE: June 17, 2004	DRAWN BY: CL	FIGURE: B8

DATE DRILLED:	June 3, 2004	INSPECTOR:	LL	AUGER HOLE A9
DRILL METHOD:	AUGER	SURFACE ELEVATION:	95.4m ±	SHEET 1 OF 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content
0	SAND - Rusty brown, silty, fine-grained (compact)	SM	X	22.6
2.5	SILT - Tan brown mottled, clayey, crumbly, occ. small pebbles, low plasticity, till-like, pp - 2 tsf (stiff)	ML	X	30.5
5	- grades to grey, not crumbly, med plasticity, pp ~ 4 tsf, very stiff		X	22.6
	SAND - Grey, silty, fine-grained, small pebbles, till-like (v dense)	SM	X	9.9
7.5				
	TEST BOREHOLE TERMINATED AT REFUSAL, 8 FEET			
10				
12.5				
15				
17.5				
20				
22.5				
25	see note on Figure B1			

DYNAMIC CONE PENETRATION TEST

BLOWS / FOOT



PP, TSF GRAB SAMPLE [X] WATER TABLE ▽

PROJECT No:	V04-121	CENTENNIAL GEOTECHNICAL ENGINEERS		
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS			
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.	BOREHOLE LOG		
		DATE: June 17, 2004	DRAWN BY: CL	FIGURE: B9

DATE DRILLED:	June 3, 2004	INSPECTOR:	LL	AUGER HOLE A10
DRILL METHOD:	AUGER	SURFACE ELEVATION:	95.6m ±	SHEET 1 OF 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content	DYNAMIC CONE PENETRATION TEST: BLOWS / FOOT (0 10 20 30 40 50)
0	6" topsoil SILT - Tan brown mottled, clayey, till-like, pp~ 4 tsf (very stiff)	ML	[x]	24.9	
2.5	SAND - Grey, silty, fine-grained, small pebbles, till-like (v dense)	SM	[x]	10	
5	TEST BOREHOLE TERMINATED AT REFUSAL, 5 FEET				
7.5					
10					
12.5					
15					
17.5					
20					
22.5					
25	see note on Figure B1				

PP, TSF GRAB SAMPLE [x] WATER TABLE ▽

PROJECT No:	V04-121	CENTENNIAL GEOTECHNICAL ENGINEERS
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS	
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.	BOREHOLE LOG

DATE:	DRAWN BY:	FIGURE:
June 17, 2004	CL	B10

DATE DRILLED:	June 3, 2004	INSPECTOR:	LL	AUGER HOLE A11
DRILL METHOD:	AUGER	SURFACE ELEVATION:	95.6m ±	SHEET 1 OF 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE Sample Type	SAMPLE Moisture Content	DYNAMIC CONE PENETRATION TEST BLOWS / FOOT (0 10 20 30 40 50)
0	6" topsoil				
	SAND - Grey, silty, fine-grained, small pebbles, till-like (v dense)	SM	[x]	8.4	
2.5					
			[x]	7.6	
5					
	TEST BOREHOLE TERMINATED AT REFUSAL, 5 FEET				
7.5					
10					
12.5					
15					
17.5					
20					
22.5					
25					

GRAB SAMPLE [x] WATER TABLE ▽

PROJECT No: V04-121
PROJECT: PROPOSED SECONDARY & MIDDLE SCHOOLS
LOCATION: 835 8th STREET, NEW WESTMINSTER, BC.

CENTENNIAL GEOTECHNICAL ENGINEERS

BOREHOLE LOG

DATE:	DRAWN BY:	FIGURE:
June 17, 2004	CL	B11

DATE DRILLED:	June 3, 2004	INSPECTOR:	LL	AUGER HOLE	A12
DRILL METHOD:	AUGER	SURFACE ELEVATION:	92.6m ±	SHEET 1	OF 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content	DYNAMIC CONE PENETRATION TEST BLOWS / FOOT (0 10 20 30 40 50)
0	FILL - Dark brown, silty sand, some gravel & organic matters (loose)	SM			
2.5			[x]	22.3	
5					
7.5	SAND - Tannish brown, silty, fine-grained, saturated (loose)	SM	[x]	25.6	
	SAND - Tan brown mottled, clayey, fine-grained, trace pebbles & 1" gravel crumbly (compact)	SC	[x]	27.2	
10					
12.5					
	SILT - Grey brown mottled, clayey, med plasticity, pp 2 - 2.5 tsf (stiff)	ML	[x]	25.5	
15					
17.5					
	- grades to grey, very stiff		[x]	24.5	
20	SAND - Grey, silty, fine-grained, small pebbles & occ. 1.5-2" gravel, till-like (very dense)	SM	[x]	10.9	
22.5					
	TEST BOREHOLE TERMINATED AT REFUSAL, 23 FEET				
25	see note on Figure B1				

PP, TSF GRAB SAMPLE [x] WATER TABLE ▽

PROJECT No:	V04-121
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.

CENTENNIAL GEOTECHNICAL ENGINEERS

BOREHOLE . LOG

DATE:	DRAWN BY:	FIGURE:
June 17, 2004	CL	B12

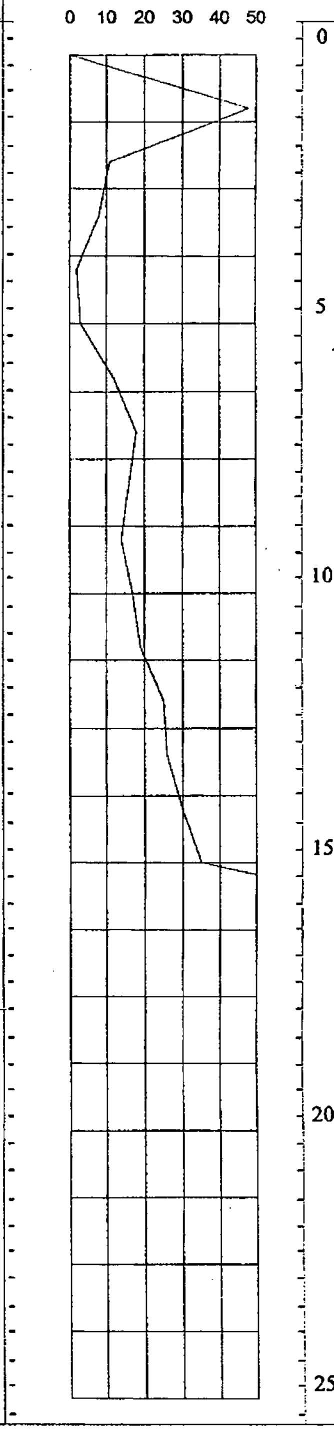
DATE DRILLED:	June 3, 2004	INSPECTOR:	LL	AUGER HOLE	A13
DRILL METHOD:	AUGER	SURFACE ELEVATION:	91.6m +	SHEET	1 OF 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content
0 – 3.5	**FILL -** Dark brown, silty sand, some gravel & organic matters (loose)	SM	[x]	79.9
3.5 – 5.5	**SAND -** Tannish brown, silty, fine-grained, saturated (loose)	SM	[x]	29.6
5.5 – 12	**SAND -** Tan brown mottled, clayey, fine-grained, trace pebbles & 1" gravel crumbly, till-like, pp 3 - 3.5 tsf (compact)	SC	[x]	22.4
12 – 15	**SILT -** Grey brown, clayey, med plasticity (very stiff)	ML	[x]	24.6
15 – 18	**SAND -** Grey, silty, fine-grained, small pebbles & occ. 1.5-2" gravel, till-like (very dense)	SM	[x]	10.4
	TEST BOREHOLE TERMINATED AT REFUSAL, 18 FEET			
	see note on Figure B1			

Depth scale (ft): 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5, 25

DYNAMIC CONE PENETRATION TEST

BLOWS / FOOT



PP, TSF GRAB SAMPLE [x] WATER TABLE ▽

PROJECT No:	V04-121	CENTENNIAL GEOTECHNICAL ENGINEERS
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS	
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.	BOREHOLE LOG
DATE: June 17, 2004	DRAWN BY: CL	FIGURE: B13

DATE DRILLED:	June 3, 2004	INSPECTOR: LL	AUGER HOLE A14
DRILL METHOD:	AUGER	SURFACE ELEVATION: 91.4m ±	SHEET 1 OF 1

DEPTH (ft)		DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE Sample Type	SAMPLE Moisture Content	DYNAMIC CONE PENETRATION TEST BLOWS / FOOT (0 10 20 30 40 50)
0		3" asphalt concrete, 2" gravel				
	SAND -	Tannish brown, silty, fine-grained (loose)	SM	[x]	20.8	
2.5						
	SAND -	Tan brown mottled, clayey, fine-grained, trace pebbles, crumbly, pp 3 tsf, till-like (compact)	SC	[x]	22.9	
5						
7.5						
	SILT -	Grey brown mottled, clayey, med plasticity, pp 3 - 3.5 tsf (very stiff)	ML	[x]	27.7	
10						
	SAND -	Grey, silty, fine-grained, small pebbles & occ. 1.5-2" gravel, till-like (very dense)	SM			
12.5						
		TEST BOREHOLE TERMINATED AT REFUSAL, 12.5 FEET				
15						
17.5						
20						
22.5						
		see note on Figure B1				
25						

PP, TSF GRAB SAMPLE [x] WATER TABLE ▽

PROJECT No:	V04-121	CENTENNIAL GEOTECHNICAL ENGINEERS
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS	
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.	BOREHOLE LOG

DATE:	DRAWN BY:	FIGURE:
June 17, 2004	CL	B14

DATE DRILLED:	June 3, 2004	INSPECTOR:	LL	AUGER HOLE A15
DRILL METHOD:	AUGER	SURFACE ELEVATION:	92.1m ±	SHEET 1 OF 1

DEPTH (ft)		DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content	DYNAMIC CONE PENETRATION TEST BLOWS / FOOT (0 10 20 30 40 50)
0		4" asphalt concrete over 4" gravel				
	SILT -	Tan brown mottled, clayey, med plasticity, till-like, pp ~ 4 tsf (very stiff)	ML			
2.5				[x]	18.2	
5	SAND -	Grey, silty, fine-grained, small pebbles, till-like (v dense)	SM	[x]	23.7	
7.5						
		TEST BOREHOLE TERMINATED AT REFUSAL, 8 FEET				
10						
12.5						
15						
17.5						
20						
22.5						
25		see note on Figure B1				

PP, TSF — GRAB SAMPLE [x] — WATER TABLE ▽

PROJECT No:	V04-121	CENTENNIAL GEOTECHNICAL ENGINEERS
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS	
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.	BOREHOLE LOG

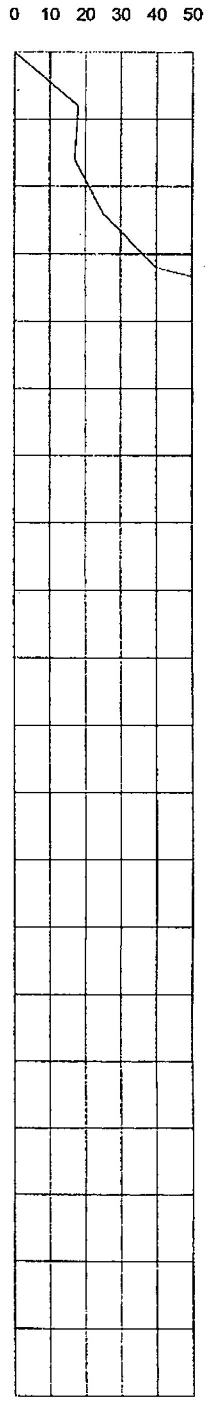
DATE:	DRAWN BY:	FIGURE:
June 17, 2004	CL	B15

DATE DRILLED:	June 3, 2004	INSPECTOR:	LL	AUGER HOLE A16
DRILL METHOD:	AUGER	SURFACE ELEVATION:	92.1m±	SHEET 1 OF 1

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content
0	3" asphalt concrete over 3" gravel			
	SILT - Tan brown mottled, clayey, med plasticity, till-like, pp ~ 4 tsf (very stiff)	ML		
2.5			[x]	20
5				
	SAND - Grey, silty, fine-grained, small pebbles, till-like (v dense)	SM	[x]	9.1
7.5				
	TEST BOREHOLE TERMINATED AT REFUSAL, 8 FEET			
10				
12.5				
15				
17.5				
20				
22.5				
	see note on Figure B1			
25				

DYNAMIC CONE PENETRATION TEST

BLOWS / FOOT



GRAB SAMPLE [x] WATER TABLE ▽

PROJECT No:	V04-121
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.

CENTENNIAL GEOTECHNICAL ENGINEERS

BOREHOLE LOG

DATE:	DRAWN BY:	FIGURE:
June 17, 2004	CL	B16

DATE DRILLED:	June 3, 2004	INSPECTOR:	LL	AUGER HOLE	A17
DRILL METHOD:	AUGER	SURFACE ELEVATION:	94.4m±	SHEET 1 OF 1	

DEPTH (ft)	DESCRIPTION OF SOIL AND OBSERVATIONS	Soil Class. Symbol	SAMPLE: Sample Type	SAMPLE: Moisture Content	DYNAMIC CONE PENETRATION TEST BLOWS / FOOT (0 10 20 30 40 50)
0	**FILL** - Random, brown, silty sand & gravel, some organic matters (loose)	SM	[x]	20	
5	**SILT** - Tan grey mottled, clayey, med plasticity (very stiff)	ML			
7.5	**SAND** - Grey, silty, fine-grained, small pebbles & occ. 1.5-2" gravel, till-like (very dense)	SM	[x]	7	
10	TEST BOREHOLE TERMINATED AT REFUSAL, 10 FEET				

Depth scale (ft): 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5, 25

PP, TSF GRAB SAMPLE [x] WATER TABLE ▽

PROJECT No:	V04-121
PROJECT:	PROPOSED SECONDARY & MIDDLE SCHOOLS
LOCATION:	835 8th STREET, NEW WESTMINSTER, BC.

CENTENNIAL GEOTECHNICAL ENGINEERS

BOREHOLE LOG

DATE:	DRAWN BY:	FIGURE:
June 17, 2004	CL	B17