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SPECIALISTS MANAGING THE EARTH

EGLINTON CROSSTOWN LIGHT RAIL TRANSIT (ECLRT) GEOTECHNICAL INVESTIGATION AIRPORT LINK, TORONTO, ONTARIO

IBI Group

PROJECT: TRANETOB01242AA

Final Report March 3 2010

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March 03, 2010

IBI Group
30 International Boulevard
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Attention: Mr. Fouad Mustafa, P. Eng.

Dear Sir,

RE: Geotechnical Assessment – Eglinton Crosstown LRT Airport Link

Please find attached the geotechnical assessment report for the proposed Eglinton Crosstown LRT Airport Link.

If you have any comments or enquiries please contact the undersigned.

For and on behalf of Coffey Geotechnics Inc.

Zuhtu Ozden, P.Eng.
Senior Principal

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1 INTRODUCTION

Coffey Geotechnics Inc. (Coffey) was retained by the Transit City Group (TCG), on behalf of Toronto Transit Commission (TTC) to conduct a Geotechnical study for the proposed Eglinton Crosstown Light Rail Transit (ECLRT) Airport Link. The study area extends from Eglinton Avenue West and Martin Grove Road intersection to Pearson International Airport. A total of seven alternative routes have been defined for the connection. Depending on the chosen transit route, ECLRT Airport Link may operate at grade, above grade and/or below grade.

Figure 1 shows the ECLRT Airport Link in relation to the main alignment. The presently proposed seven alternative routes are presented on Drawing No. 0-1.

The purpose of the geotechnical study was to collect geotechnical data from available sources (i.e. TTC archives, the Ministry of Transportation of Ontario and Coffey files) and to present these to aid with the assessment of the alternative routes.

The findings of the geotechnical study are presented herein.

2 PHYSIOGRAPHY AND DRAINAGE

According to Chapman and Putnam, the study area lies at the confluence of the Physiographic Regions known as the 'Peel Plain' and the 'South Slope'. Across the Peel Plain and the South Slope physiographic regions, in the general area, the predominant soil type is a glacial till containing relatively large amounts of shale and limestone, underlain by grey coloured shale bedrock. Layers of sand or sand & gravel, sandy silt to silty sand are not uncommon. In much of the Peel Plain, the surface of the glacial till deposits has been modified by a veneer of clay which sometimes has varved-like appearance.

From the published geological data, the Toronto area experienced at least three glacial and two interglacial periods, during which time a sequence of glacial and interglacial deposition took place. Towards the end of the last ice age, when Wisconsinan glacier withdrew from the Lake Ontario basin to the north and to the east, Lake Iroquois, the forerunner of the present Lake Ontario, was established. The entire sequence of these glacial, interglacial and lacustrine deposits is, however, seldom found intact and usually one or more of these units are absent at any one location.

Within the study area, the depth to the surface of the bedrock can be expected from 5 to 25 m. The bedrock underlying the project site is known to consist of grey shales of the Georgian Formation, belonging Upper Ordovician Period (i.e. approximately 460 million years old). According to Quaternary Geology of Toronto and Surrounding Area (P2204, Ontario Geological Survey), the study area is covered with tills deposited during the return of glaciers in the late Wisconsinan time. This group of tills was deposited between 22,000 and 13,000 years ago and includes dense sandy till underlying clayey silt to silt tills, or vice versa.

On a regional scale, in the general area the ground surface typically slopes gently to the south, towards Lake Ontario, some 12 km to the south of the project site. Extending south and west of Mimico Creek, ground surface is relatively flat, with elevations ranging typically between 160 and 154 m. East of the

Mimico Creek, however, ground surface elevations of about 165 m are more common. Within the site, drainage features are dominated by Mimico Creek which flows southerly through the subject site.

Mimico Creek is a 33 km watercourse with its headwaters in Brampton, north of the site. The watershed lies between the Humber River to the east and the Etobicoke Creek to the west. It flows southeast, past Pearson Airport, through a shallow valley, surrounded by urban neighbourhoods. The creek is often encased in a concrete spillway to contain the fast flowing water that occurs during rainstorms. It empties into Lake Ontario, about 1 km west of the mouth of Humber River.

Within the project site, Mimico Creek, incised into the till plain, is at an elevation of about 150 m on the north end of the project area, dropping to about 140 m to the south.

Land use within the study area in primarily industrial and commercial. Recreational/parkland also occurs along Mimico Creek, such as the Royal Woodbine Golf Club. High-density residential land use is found directly south of Eglinton Avenue West.

3 REGIONAL GEOLOGY

The bedrock beneath the study area is interpreted to be Upper Ordovician shale of the Georgian Bay Formation which consists of blue-grey shale with some limestone, dolostone and siltstone layers or interbeds. Available data and mapping suggests that bedrock in the region occurs at an Elevation of about 120 to 150 m asl (above sea level).

The overburden in the area is generally the Quaternary aged Wildfield Till Complex or Halton Till. These units are characterized by dense to very dense silty sand/sand silt to stiff to hard clayey till with interbedded lenses of poorly graded sand and gravel. Glacially derived boulders originating from igneous and metamorphic rocks of the Canadian Shield may also be encountered.

In additional to natural soil deposits, emplaced fill may also be encountered in the study area. Fill may be encountered at depths of greater than 5 m. Alluvial deposits of sand and gravel with trace to some silt and clay can be expected in the flood plains of existing rivers and streams.

4 SUBSURFACE CONDITIONS

The seven alternative routes of ECLRT Airport Link defined above can be generalized into three alignments, presented in Drawing No. 0-2 in the discussion of subsurface conditions. Table 4.1 presents the routes that are included in each alignment. The subsurface information was gathered from available sources, namely the Ministry of Transportation of Ontario (i.e. GEOCRES) and Coffey's company files. Records of boreholes were reproduced by Coffey's technical staff from original records for ease of presentation.

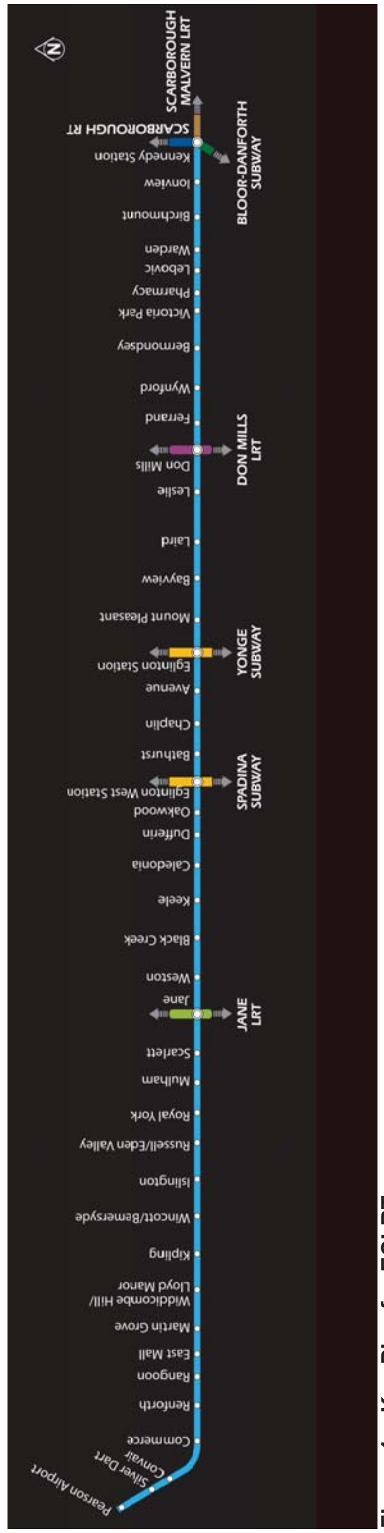

Figure 1 – Key Plan for ECLRT

Table 4.1 - Alternative routes included in alignments

	Alternative Routes
Alignment 1	27-1, 27-2
Alignment 2	R5
Alignment 3	R1, R2, R3, R4

The information gathered indicates that the overburden soils at the site can be grouped into the following categories:

- Fill
- Clay and silty clay
- Clayey silt till
- Sandy silt to silty sand till
- Silt/sandy silt
- Sand/silty sand
- Sandy gravel/gravelly sand

These deposits are briefly described in the following paragraphs.

Man-made ***fill*** deposits are not uncommon in the general area. The fill can be expected to have been derived from indigenous soils and as such can be variable but typically clayey silt till derivations. As significant portions of the study area found commercial/industrial usage, the fill and the upper zones of the natural soils may need to be checked for environmentally objectionable materials/chemicals.

Clay and silty clay were found in one borehole only, namely 30M11-61 BH1. While on the Record of Borehole Sheet they are not described as a glacial deposits, it is our opinion that significant portions of these soils are comprised of glacial soils (i.e. clayey silt till). Nevertheless, from regional geology, surficial clays/silty clays/clayey silts are not uncommon in the general area.

Clayey silt till is the predominant overburden throughout much of the study area. The deposit consists of clayey silt with some sand and gravel. This is a glacial deposit and as such exhibits a heterogeneous texture. Owing to its mode of deposition, the presence of occasional cobbles and boulders can be expected in the deposit. This is a practically impervious material but is interbedded with silt and sand seams/layers through which greater water seepage can be expected in excavations carried to below the groundwater table.

From the recorded N-values the consistency of this basically cohesive soil can be expected to range from soft to hard, but typically very stiff to hard, especially in the lower zones.

Sandy silt to silty sand till is another glacial deposit and as such consists of an unsorted, heterogeneous mixture of sand and silt with traces to some gravel and traces of clay size particles. Due to its mode of deposition, the presence of cobbles and boulders should always be anticipated in these deposits. As the deposit is coarser than the clayey silt till, it is a more pervious soil, in comparison. Similar to clayey silt till, the sandy silt to silty sand till is a pre-compressed material (primarily due to the weight of ice sheet that covered the area during the glacial periods) and is therefore a relatively competent soil (i.e. will carry relatively heavy loads). As well, it can stand at relatively steep side slopes above the water table, but below the water table, in time, it will gradually attain flat side slopes by ravelling-off. It will yield more water in excavations made below the groundwater table, in comparison with clayey silt tills, clays, silty clays or clayey silts.

Based on the recorded N-values, the compactness condition of the deposit in the general area is considered typically compact to very dense (generally dense to very dense).

Interglacial and/or surficial (recent) layers of ***silt to sandy silt*** are found in the study area, but to a much lesser extent then the glacial deposits. These were encountered more frequently in the southern portion of the study area. These are fine-grained granular materials, and as such they exhibit medium permeability characteristics. In open excavations, these soils will yield more water than glacial till or clayey soils and will attain flatter side slopes rather rapidly. In addition, these soils are dilatant materials (i.e. they will dilate and expand in the presence of water), a condition which can be recognized by the liverish, jelly-like appearance of the soil.

Similar to silts/sandy silt, the ***sand/silty sand*** deposits are generally interglacial soils but could also be of more recent origin (e.g. alluvial soils, especially near water courses). These soils were contacted sporadically, but more commonly mid-east portion of the site.

These deposits are considered to be more pervious soil types than the previously described materials and will yield moderate to considerable water into excavations carried to below the groundwater level.

Sandy gravel/gravelly sand are the coarsest soil types present at the site. Due to their coarse nature, they have a high permeability and will yield much water. Layers of sandy gravel/gravelly sand were contacted near the south-western extremity of the study area.

As was mentioned in Section 2 of this report, the ***bedrock*** underlying the site is known to consist of grey shales of the Georgian Bay Formation. It was contacted in many of the boreholes available to this study at depths ranging from 4 to 16.5 m below the ground surface but at one location, the borehole was terminated at 17 m without contacting the bedrock. A summary of bedrock surface depths/elevations at the borehole locations is given in Drawing No. 0-3.

It should be pointed out that at the contact between the overburden and the bedrock, there is, at many locations in the study area, a transition zone that is difficult to distinguish whether it is bedrock or overburden, because in many instances it resembles both. This transition zone, which is locally referred to as till-shale complex, is typically 0.5 to 1.0 m thick.

In addition, the upper zone of the bedrock is typically highly weathered. The highly weathered upper zone of the bedrock is generally 0.6 to 1.2 m thick and may contain hard limestone layers/seams/lenses.

In the underlying more sound bedrock, the sandstone and siltstone layers are harder in comparison with the shale itself and especially the limestone and dolostone layers/lenses are much harder. The hard layers are usually less than about 100 to 150 mm thick but some layers are much thicker. The thicker layers have been observed to be as much as 750 to 900 mm at some sites. The layers are actually lenses and they can vary significantly in thickness over short distances.

Bedding joints in the bedrock are very close-to-close, smooth planar in the shale and rough planar in the limestone. Significant vertical jointing is common.

Stress relief features such as folds and faults are common in the bedrock. In these features, the rock is heavily fractured and sheared, and contains layers of shale rubble and clay. Weathering is much deeper than the surrounding rock in these features and often there is a lateral migration of the stress relief features resulting in sound unweathered bedrock overlying the fractured and weathered bedrock. The stress relief features are usually in the order of 4 to 6 m wide, but the depth can vary from 4 to 5 m to in excess of 10 m. These features occur randomly.

Groundwater seepage in the bedrock below the top 1 m or so is generally small but occasionally large quantities of water have been encountered, as a result of water travelling through fractures and fissures in the rock, particularly where these connect to a large source of water.

Methane gas exists in the bedrock, normally below the top 1 m and more concentrated with depth. Appropriate care and monitoring is essential in all confined bedrock excavations, particularly caissons and tunnels. Occasionally, methane gas migrates upwards into the overburden soils immediately above the bedrock.

The sedimentary bedrock contains significant locked-in horizontal stresses. As a result, the rock tends to expand in the horizontal direction when stress relief occurs (e.g. a vertical excavation, tunnelling, etc.), thus imposing significant stresses on structures such as tunnel linings, basement walls, particularly in the deeper, sound sections of the bedrock.

Groundwater levels reported on the Record of Borehole Sheets show that the water levels recorded at the time of the drilling of the individual boreholes ranged from the existing ground level to 11 m below the ground surface. In most cases there is little indication whether these represent the stabilized groundwater levels. Based on these data, however, together with the change of the colour of the soil from brown to grey (where this information is available on the Record of Borehole Sheets), it is our opinion that the groundwater levels within the study area are typically between 1 and 5 m below the ground surface elevations.

4.1 Alignment 1

As shown on Drawing 0-2, a total of eleven borehole data is available along this approximately 4.0 km stretch. The overburden along Alignment 1 can be grouped into four groups: fill, clayey silt till, sandy silt to silty sand till and sand and silt. Shale bedrock was encountered in seven of the boreholes at depths between 4 to 16.5 m. The stratigraphic section of this alignment is presented on Drawings 1-0 to 1-8.

4.1.1 Fill

Emplaced fill up to 5 m in thickness was found along the alignment at four boreholes. Fill material generally consists of cohesive soils such as clayey silt and clayey till. Sand and gravel pavement fill was also detected at two boreholes which were drilled from paved surfaces.

4.1.2 Clayey Silt Till

Clayey silt till, found at various depths, constitutes the major overburden type (i.e. encountered in each and every borehole) along Alignment 1. The consistency of this cohesive deposit ranges from stiff to hard (but typically very stiff to hard) with N-values from Standard Penetration tests ranging from 8 blows/0.3 m to in excess of 100 blows. Borehole logs show cobbles and boulders may be detected in this deposit. The presence of shale fragments was also observed at depths near to the surface of bedrock.

4.1.3 Sandy Silt to Silty Sand Till

The boreholes show the presence of a coarser till deposit (in comparison with clayey silt till) consisting of predominantly sand and silt found at various depths along the alignment. N-values from Standard Penetration tests range between 14 blows/0.3 m and in excess of 100 blows/0.3 m. This soil unit is considered to be compact to very dense in compactness condition.

4.1.4 Silt and Sand

Deposits of silt and sand in varying proportions were detected at various depths in boreholes located along the alignment. These deposits are in a loose to very dense in condition, but typically compact, based on N-values which range from 7 blows/0.3 m to in excess of 100 blows.

4.1.5 Bedrock

At the borehole locations, shale bedrock was detected at depths between 4.1 and 16.5 m depths below the ground surface or at El. 134.6 and 151.7 m. From the available borehole data, it can be surmized that the bedrock surface dips down towards the Mimico Creek, and also from north to south.

4.1.6 Groundwater Conditions

Based on the findings of the boreholes, the groundwater table along the proposed route is generally between 1 and 6 m below the ground surface.

4.2 Alignment 2

Alignment 2, as shown on Drawing 0-2, is approximately 4.2 km long and is covered by twelve boreholes. Four major groups of soils are found in the subsurface of Alignment 2. These groups are: fill, clayey silt till, silty sand to sandy silt till and silt and sand. Shale bedrock was detected in several boreholes between depths 4.1 to 16.5 m below the ground surface. The stratigraphic section of Alignment 2 is presented on Drawings 2-0 to 2-8.

4.2.1 Fill

Fill material was detected at two boreholes along the alignment. The fill was found to extend to a depth of about 2m and consists of clayey silt at one location and sand and gravel road base in the other.

4.2.2 Clayey Silt Till

Clayey silt till was found at various depths in all boreholes, except for one borehole, along the alignment. Standard Penetration tests in this cohesive soil yielded N-values which range between 8 blows/0.3 m and 100 blows /0.05 m penetration. These values indicate that the deposit is stiff to hard in consistency. Shale fragments are often found in this deposit near the bedrock surface.

4.2.3 Silty Sand to Sandy Silt Till

A deposit of silty sand to sandy silt till was found at various depths in the majority of the boreholes along the alignment. Standard Penetration Tests conducted in this deposit yielded N-values between 7 blows/0.3 m and 100 blows/0.05 m. These results indicate that this deposit is loose to very dense in compactness, but generally compact to very dense.

4.2.4 Silt and Sand

Silt and sand deposits in varying proportions were found at various depths in three boreholes along the south-east portion of the alignment. The thickness of the deposit ranges from about 1 to 4 m. Standard Penetration tests yielded N-values between 22 blows/0.3 m and 54 blows/0.15 m of penetration, indicating that these deposits are compact to very dense.

4.2.5 Bedrock

Shale bedrock was detected in eight boreholes between depths 4.1 to 16.5 m (El. 134.6 and 151.7 m).

4.2.6 Groundwater Conditions

Water level observations and the change of colour of the soil from brown to grey as shown on the Records of Borehole Sheets indicate that the groundwater table at the site is generally between 1 and 5 m below the prevailing ground surface levels.

4.3 Alignment 3

Alignment 3 is approximately 4.8 km long and is covered by eighteen boreholes. The overburden along Alignment 3 can be divided into five major groups: fill, clayey silt till, silty sand to sandy silt till, silt and sand and gravelly sand to sandy gravel. Shale bedrock was encountered at 5.6 to 16.5 m below the ground surface. Stratigraphic section of Alignment 3 is presented on Drawings 3-0 to 3-10.

4.3.1 Fill

Fill materials, consisting of clayey silt or sand and gravel, were contacted at several boreholes. The fill was found to extend to a maximum depth of 5 m below the ground surface.

4.3.2 Clayey Silt Till

Clayey silt till deposit was found in all boreholes at various depths along this alignment. Shale fragments were contacted at depths near the surface of the bedrock. N-values from Standard Penetration tests conducted in this deposit range between 8 blows/0.3 m and 75 blows/0.03 m, which indicate that the deposit is stiff to hard in consistency, but generally very stiff to hard.

4.3.3 Silty Sand to Sandy Silt Till

A silty sand to sandy silt till deposit was contacted at various depths in approximately one-half of the boreholes along the alignment. Standard Penetration Tests conducted in this deposit yielded N-values between 50 blows/0.3 m to 100 blows/0.04 m. These results indicate that this deposit is generally in a very dense condition.

4.3.4 Silt and Sand

Layers of silt and sand in varying proportions were contacted in the boreholes along the alignment. The thickness of these deposits was found to range from about 1 to 4 m. N-values recorded in these deposits range from 22 blows/0.3 m to 100 blows/0.1 m of penetration, indicating that the deposits are compact to very dense.

4.3.5 Gravelly Sand to Sandy Gravel

A deposit of gravelly sand to sandy gravel was contacted in several of the boreholes along the alignment, but generally near the south-westerly portion. Standard Penetration tests conducted in this deposit yielded N-values of between 100 blows/0.18 m and 50 blows/0.03 m of penetration, indicating that this coarse-grained soil unit is in a very dense in condition.

4.3.6 Bedrock

Shale bedrock was encountered along the alignment at depths which range from 5.6 to 16.5 m depths (El. 132.5 and 152.2 m). From the available data, the bedrock surface appears to be at about El. 145 to 152 m throughout much of the study alignment but drops to about El. 132 to 135 m towards and near the Mimico Creek Valley.

4.3.7 Groundwater Condition

From available data, the groundwater level was along the alignment is generally 1 to 5 m below the ground surface.

5 POTENTIAL GEOTECHNICAL RISKS

Major excavations are only expected for the construction of stations, since the proposed routes are mainly at-grade and unlikely to involve underground (i.e. tunnelling) constructions. Methods routinely employed for excavation of basements in Toronto except that a cover may need to be provided to allow continuous operations of the ground structures and roads. The sides of excavations may be supported by using either diaphragm walls or secant pile walls depending on the requirement. Routine shoring may also be employed depending on the support requirement.

Where excavations and/or personnel entry are required in confined areas (i.e. caisson type foundation excavations/inspections), the presence of methane gas will need to be investigated, to avoid possible problems due to methane gas inhalation by personnel and/or potential explosions. As mentioned before, methane typically emanates from the bedrock but can also migrate to the overlying overburden.

While tunnelling is unlikely to be used for the airport link from Commerce Boulevard, some common type foundations may be employed at station locations, depending on the subsurface condition and structure type.

Groundwater levels are generally 1 to 5 m below the ground surface. Dewatering measures may be required depending on the depth of excavations for both the proposed alignments and stations. Major issues are not expected since the proposed alignments are mostly at-grade. Dewatering requirements in the clayey overburden (e.g. clayey silt till), which is predominant across the site, should be routine and should not present major problems, as these soils are practically impervious. An increased dewatering effort would be required within the relatively more pervious sandy silt to silty sand tills and particularly silts, silty sands and sands. Sandy gravel/gravelly sand deposits, contacted primarily near the south-western extremity of the site, are the coarsest grained soil types and as such they will necessitate aggressive dewatering for excavations extending below the groundwater level.

6 LIMITATIONS

The assessment presented in this report is based upon background geotechnical investigations conducted by others. The results of this background work have been assumed to be reliable. The interpretations presented are based on limited borehole coverage and departures from the interpreted conditions can be expected. For this reason, further investigation must be carried out to provide detailed test results to support further engineering and design work.

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