APPENDIX F – HYDROGEOLOGICAL ASSESSMENT REPORT

HYDROGEOLOGICAL STUDY
PROPOSED EGLINTON CROSSTOWN LIGHT RAIL TRANSIT (ECLRT) AND AIRPORT LINK, TORONTO, ONTARIO

Transit City Group

ENVSETOB01224AB (ref: SPT1224B)
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Final Report March 3 2010

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March 3, 2010

Transit City Group
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Attention: Mr. Grant Kauffman

RE: Hydrogeological Study
Proposed Eglinton Crosstown Light Rail Transit (ECLRT) and Airport Link, Toronto, Ontario.

As part of an Environmental Assessment (EA), Coffey Geotechnics Inc. (Coffey) (formerly Shaheen & Peaker) was retained by the Transit City Group (TCG) to complete a Hydrogeological Investigation for the proposed Eglinton Crosstown Light Rail Transit (ECLRT) alignment, extending east-west along Eglinton Avenue for approximately 30.8 km from Sta. 96 + 800 just west of Renforth Drive, to Sta. 124 + 450 just east of Kennedy Road. The ECLRT will operate at-grade and below-grade along its alignment, traversing several rivers, valleys, ravines and north-south rapid transit corridors.

Coffey was later retained to investigate the Airport Link aspect of the ECLRT Hydrogeological Investigation. Originally, Coffey was presented with a number of proposed routes for the Airport Link and the initial investigation included the area in the vicinity of these proposed routes. The TCG has selected Option R2 as the preferred route for the Airport Link. Option R2 includes above-grade operations from Eglinton Avenue at Commerce Boulevard northward to the airport primarily following Silver Dart Drive. The **Key Plan** shows the study area.

The purposes of this report were to provide an overview of the geology and hydrogeology in the vicinity of the study area, and identify areas where dewatering may be required.

Thank you for asking Coffey to conduct this investigation. Should you have any questions regarding this report, please do not hesitate to contact our office.

For and on behalf of Coffey Geotechnics Inc.

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1 INTRODUCTION AND BACKGROUND

As part of an Environmental Assessment (EA), Coffey Geotechnics Inc. (Coffey) (formerly Shaheen & Peaker) was retained by the Transit City Group (TCG) to complete a Hydrogeological Investigation for the proposed Eglinton Crosstown Light Rail Transit (ECLRT) alignment which extends east-west along Eglinton Avenue for approximately 30.8 km from Sta. 96 + 800 just west of Renforth Drive, to Sta. 124 + 450 just east of Kennedy Road. The ECLRT will operate both at-grade and below-grade along its alignment, traversing several rivers, valleys, ravines and north-south rapid transit corridors. The **Key Plan** shows the study area location.

Coffey was also requested to include the Airport Link as part of the ECLRT Hydrogeological Investigation. Originally, Coffey was presented with a number of proposed routes for the Airport Link and the initial investigation included the area in the vicinity of these proposed routes. It is now Coffey's understanding that TCG has selected Option R2 as the preferred route for the Airport Link. Option R2 includes above-grade operations from Eglinton Avenue at Commerce Boulevard northward to the airport primarily along the current alignment of Silver Dart Drive.

The purposes of this report was to provide an overview of the geology and hydrogeology in the vicinity of the study area, and identify areas where dewatering may be required. This report is a consolidation of two previously provided draft reports, Hydrogeological Study, Proposed ECLRT Airport Link, Toronto, Ontario dated April 2009, and Hydrogeological Investigation, EA Study for Eglinton Crosstown LRT (from Renforth Avenue to Kennedy Road), Toronto, Ontario, dated October 2 2009.

Information used to prepare this report was gathered from the following sources:

- Coffey's field reconnaissance of the study area;
- Coffey's geotechnical cross-sections and borehole logs;
- Figures and information provided by the TTC;
- Published geological, geotechnical and hydrogeological reports;
- Published geological, topographic and groundwater maps (note: Topographic maps and GIS files for the study area were not provided by TTC) and borehole logs;
- MOE Water Well Records (WWR) database; and
- EcoLog ERIS (Environmental Risk Information System) Water Well Information System database.

This work was conducted in general accordance with our approved proposal date March 6, 2008.

At the time of preparation of this report, proposed construction methods and details were not available. Once these become available, these should be reviewed to assess impacts, if any, on the general recommendation presented herein.

1.1 Scope of Work

The scope of the assessment included:

- A background review of existing information;

- A field reconnaissance of the study area including a Water Well Survey;
- Data analyses and report preparation; and
- Impact assessment and mitigation.

2 PHYSICAL SETTING

2.1 Physiography and Drainage

2.1.1 The Airport Link

The Airport Link lies entirely within the South Slope Physiographic Region of Southern Ontario (Chapman and Putnam, 1984). In this area, the South Slope includes a strip of fluted till plain between the Peel Plain to the north and the Lake Iroquois Plain physiographic region to the south and east. This overall region is underlain by carbonate rich Palaeozoic rock with a variety of glacial deposits overlying the bedrock. In Etobicoke, ground moraine with irregular knolls and hollows are more common.

This portion of the study area lies within the Mimico Creek Watershed. In general, drainage in this system is south eastwards towards Lake Ontario. The area is dissected by Mimico Creek and its tributaries. A number of small oxbows adjacent to the creek have also been formed by the meandering of the watercourse over time. **Figure 1** shows the location of Mimico Creek, which has been incised into the till plain, at an elevation of approximately 139 m (southern end of site) to 149 m above sea level (asl) (northern end of site).

The topography in the area varies from east to west. On a regional scale, the general area slopes gently south towards Lake Ontario, approximately 11 km from the area. Extending south and west of Mimico Creek, ground surface is relatively flat with ground surface elevations ranging between 154 and 160 m asl. However, towards the northeast and northwest corners of the area, ground surface elevations range between 154 and 160 m asl. To the east and north of Mimico Creek, ground surface elevations are about 165 m asl.

The airport area is dominated by poorly drained clayey surficial soil; however, southward flowing Mimico Creek provides good drainage of surface water across the study area. Drainage throughout the area is enhanced by roadside ditches and the urban stormwater management system.

Although Mimico Creek is the main water course, there is some potential that tributaries to the main channel may have been located within the area. It is assumed that any of the surface water bodies are now channelized and flow in either piped systems or open channels.

The main area of potential groundwater discharge is the Mimico Creek valley and its tributaries. Terrestrial and aquatic habitats in this area are supported by these water features. Over time, a high degree of evaporation from the deforested clayey surface has reduced recharge to underground water supplies.

Land use within the area of the proposed Airport Link is primarily industrial (manufacturing) and mixed commercial. The only recreational/parkland occurs east of the proposed alignment along Mimico Creek (e.g. The Royal Woodbine Golf Club is located in the northeast part of the study area). High-density residential land use occurs directly south of Eglinton Avenue West.

2.1.2 Eglinton Crosstown LRT (ECLRT)

The area of the ECLRT is located in the Iroquois Plain physiographic region (Chapman and Putnam, 1984). This complex area is characterized by shoreline, beach and lake plain deposits associated with Wisconsinan-aged glacial Lake Iroquois. Along the northern limit of Lake Iroquois, large sand and gravel deposits accumulated, particularly in the Humber Valley. In contrast, in the Don Valley, overlying pre-Iroquoian aged deposits of clay were exposed. These are much older than the overlying Lake Iroquios deposits.

As a result of rivers and streams being incised into the overburden along Eglinton Avenue, the topography of the study area varies significantly across the west to east transect of the proposed ECLRT. Going from west to east; the intersection of Eglinton Avenue and Kipling Avenue is at an elevation of approximately 159 m asl. Ground surface elevation then decreases to around 108 m asl at the Humber River and 99 m asl around the intersection of Jane Street. Near Old Forest Road the elevation then progressively increases to around 180 m asl where the terrain is generally flat. Ground surface then drops to about an of elevation 98 m asl at the West Don River and 100 m asl at the East Don River; elevation then progressively increases to around 164 m asl at Kennedy Road. On a regional scale, the general area slopes gently south towards Lake Ontario, approximately 7 km south of the subject site.

The study area spans the Mimico Creek, Humber River and Don River Watersheds and in general, drainage in this system is south eastwards towards Lake Ontario. The area is dissected by the following creeks and rivers and their tributaries going west to east: Mimco Creek, Humber River, Black Creek, West Don River, East Don River, Wilson Brook and Massey Creek. **Figures 2A, 2B, 2C** and **2D** shows the location of these watercourses with respect to the alignment. All rivers flow in a southeast direction towards Lake Ontario.

From the review of historical topographic maps and online map libraries, a number of historical surface water courses were noted within the area. As urbanization progressed these surface water courses were channelized into either open channels or closed pipe systems. In many cases, these water courses are now only visible where the open channels remain. In some cases the alignment of the water courses were changed. Thus, groundwater related construction issues may occur in the vicinity of the original channels.

Land use within the study site is classified primarily as high density residential. A number of commercial and industrial properties and recreational/ park land also occurs along the length of the study area.

2.2 Bedrock Geology

2.2.1 The Airport Link

The bedrock beneath the Airport Link is interpreted to be Upper Ordovician aged shale of the Georgian Bay Formation. This unit consists predominantly of blue-grey shale with some limestone, dolostone and siltstone layers or interbeds. The available data suggests that depth to bedrock varies across the area. Bedrock in the region reportedly occurs about elevation 125 to 155 m above sea level (asl). Near the southwest corner of the site (Convair Drive/Renforth Avenue) bedrock has been encountered between elevation 152.1 to 152.2 m asl. At the intersection of Mimico Creek and Eglinton Avenue West bedrock has

been encountered at about elevation 139 m asl. It was also noted that the till overlying the shale bedrock contained slabs of limestone which could give a false indication of bedrock.

Information collected from the MOE Water Well Records (WWR) indicates that the depth to bedrock across the area varies from 10 to 30 m below ground surface (bgs). The lack of shallower aquifers and the poor quality of water in the overburden resulted in the majority of private wells being drilled into the bedrock. Given that the depth of the proposed underground structures for the preferred alternative is expected to be shallow, it is not expected that bedrock at the site is geologically or hydrogeologically significant with respect to the proposed Airport Link LRT construction.

2.2.2 Eglinton Crosstown LRT (ECLRT)

The bedrock beneath Eglinton Avenue is interpreted to be Upper Ordovician shale of the Georgian Bay Formation. This unit consists predominantly of blue-grey shale with some limestone, dolostone and siltstone layers or interbeds. The available data and mapping suggest that bedrock in the region occurs at depths of about 20 to 130 m below ground surface.

Mapping of bedrock contours by the Ministry of Natural Resources (1995) and the Ontario Department of Mines (1961), indicates that bedrock occurs around 122 m asl near the intersection of Martin Grove Road and Mimico Creek and progressively decreases eastward to 46 m asl between Jane Street and Keele Street. Bedrock elevation is then inferred to increase to an elevation of about 107 m asl at the intersection of Bathurst Steet and then decrease eastward to an elevation of about 61 m asl at the West Don River. The depth to bedrock and the presence of shallower aquifers in the overburden has resulted in few private wells being drilled to the bedrock.

Along the majority of the ECLRT alignment, bedrock is expected to be deeper than the maximum depth (approximately 30 m underneath Venn Crescent and Old Forest Hill Road) of excavation/tunneling that would be required to facilitate the deep alignment of the below-grade section of the ECLRT.

2.3 Overburden Geology

2.3.1 The Airport Link

The surficial soil in the area is generally the Quaternary-aged Wildfield/Halton Till Complex. These units are characterized as being dense to very dense olive brown to grey coloured sandy silt to clay till with interbedded lenses of poorly graded sand and gravel. The till typically has a very low permeability (on the order of 10^{-7} cm/sec). Glacially derived boulders (generally < 1 m diameter), originating from igneous and metamorphic rocks of the Canadian Shield, may also be encountered.

Previous geotechnical investigations in the area, confirm that the surficial soil underlying fill material is a brown to grey, very stiff clayey silt till with some fine-grained sand. Underlying this upper till unit, is a very dense sandy silt to silty sand till, with water bearing gravelly sand layers, was found to extend to bedrock. In the vicinity of the airport (adjacent to the study site to the west), geotechnical investigations have encountered deep beds (up to 3.1 m) of varved clay overlying till deposits.

In addition to naturally deposited soils, fill may be encountered at depths of greater than 5 m. Fill including industrial and building waste and engineering and landscape fill may also be encountered during

excavation in the study area. Deposits of alluvial sand and gravel with minor amounts of clay and silt can be expected in the flood plains of existing rivers and streams.

2.3.2 Eglinton Crosstown LRT (ECLRT)

It is expected that the majority of excavation/ tunneling works required to facilitate the ECLRT will occur in the overburden.

The surficial soil in the area is predominantly stratified clays, silt and sand. Deposits of alluvial sand and gravel with minor amounts of clay and silt can be expected in the flood plains of existing rivers and streams, and in the vicinity of glacial lakes and rivers that existed during the Pleistocene. Based on the results of geotechnical drilling in the study area, the clays, silts and sands may extend to depths of greater than 8 m.

In addition to naturally deposited soils, fill has been recorded in geotechnical boreholes at depths of up to 9 m and has been recorded predominantly as sand and silty sand. Fill including industrial and building waste and engineering and landscape fill may also be encountered during excavation in the study area. An abandoned landfill is known to be located in the southwest quadrant of the intersection of Eglinton Avenue and Black Creek Drive, where silty sand to sand and gravel fill reportedly (with variable proportions of foreign material) occurs to depth of up to 11m.

These naturally deposited alluvial soils and fill are typically underlain by hard and very dense clayey and sandy silt till deposits of the Late Wisconsinan Wildfield Till Complex and Halton Till. Thin lenses of poorly graded sand and gravel can be found interbedded within these Wisconsinan Tills. Glacially derived boulders (generally < 1m diameter), originating from igneous and metamorphic rocks of the Canadian Shield, may also be encountered.

Silt and clay deposited in a deep water glacial lake and shallow water sand of the Middle Wisconsian Thorncliffe Formation, conformably underly these sediments to depths of greater than 25 m. In some areas the total overburden thickness may be in excess of 65 m.

Deposits of beach cobble, sand and gravel, associated with the Pleistocene Lake Iroquois Shoreline, may be uncovered during excavation along Eglinton Avenue between Royal York Road and Caledonia Roads. Shallow water sand and silty sand deposits associated with Lake Iroquois, can also be found between Royal York Road and Keele Street and Laird Drive and Bermondsey Road. These deposits generally make good aquifers where present.

The surficial geology along the proposed ECLRT is presented on Figures 2A to 2D.

As identified in the Contamination Overview Study, conducted concurrently with this investigation, there is a potential for contaminated groundwater to be encountered during dewatering activities. If found to exceed applicable Ministry of Environment (MOE) Guidelines or Toronto Sewer Use By-Laws, treatment of groundwater will be necessary before discharge.

2.4 Hydrogeology

2.4.1 Airport Link

The hydrogeology in the area was evaluated using both the regional data collected, such as MOE water well records (WWR), and the results of a field reconnaissance. **Figure 1** shows the location of 51 water wells identified from the MOE database for the Airport Link. The well records are included as **Appendix A**. The majority of wells were reportedly used for commercial and domestic water supply purposes and were installed in the shale bedrock.

2.4.2 Eglinton Crosstown LRT (ECLRT)

The EcoLog ERIS Water Well Information System database, identified 51 water wells identified in the area; 31 of which are monitoring wells completed in the overburden; three (3) dewatering wells (WWIS-30, WWIS-31 and WWIS-32) completed in the overburden; one (1) commercial well (WWIS-29) completed in bedrock which was first encountered at 38.7 m in the vicinity of the Eglinton Avenue-Don Valley Parkway interchange (~150 m NW of the East Don River); two (2) domestic wells (WWIS-37 and WWIS-28) completed in the overburden; and, one (1) domestic well (WWIS-49) completed in bedrock which was first encountered at 17.1 m in the vicinity of the Eglinton Avenue W-Hwy 27 interchange. The remaining 13 water wells were identified as either a test hole, abandoned, or have unknown uses. **Appendix B** presents the EcoLog ERIS Water Well Information System Summary, with Inset 1-10 showing well locations.

The depth of the domestic well, which was identified between Martin Grove Road and Highway 27 along the Eglinton Avenue W alignment, is 27.7 m in depth with a reported static water level (SWL) of 12.2 m. The proposed ECLRT alignment in this area is at the surface and excavation required to facilitate construction is not expected to be greater that 5 m. This well and its reported SWL are therefore significantly deeper than the excavation required to facilitate construction of the surface ECLRT in this area.

A site reconnaissance conducted by Coffey field staff did not identify or confirm the presence of any water wells recorded in the MOE database. The majority of wells were installed in the 1940's and 1950's and it is thought that they were decommissioned as municipal water supplies became available in the area.

Pumping test data from the water well records indicated that the bedrock well yields were in the range of 1-24 gallons per minute (gpm). For the two overburden wells within 250 m of the site, the pumping rate was reportedly about 5 gpm and the industrial water supply well reportedly produced about 174 gpm.

It should be noted that the well locations and recorded elevations were taken from the well records of the MOE database and are not always accurate. Regional groundwater flow is expected to be southeast towards Lake Ontario and on a more local scale towards Mimico Creek.

Additional investigation of the wells is not required. Recommendations for a construction monitoring program to protect area water resources are provided in Section 4.3.

2.5 Distribution of Aquifers and Groundwater Flow

2.5.1 Airport Link

The shale bedrock at depth is a poor water-producing formation. Groundwater is sometimes encountered at shallower depths in the discontinuous granular sand and gravel units within the overburden. This granular type aquifer was identified in many of the WWRs. More permeable water bearing silt layers have also been noted in the upper 12 m of the overburden sequence; however, seepage from these layers is expected to be small. The upper weathered zone of bedrock may also be a water producing zone where the volume of water produced will depend on the number, frequency and openness of fractures. As a result of this variability in predicting hydrogeological conditions, site specific investigations at particular locations is required.

The distribution of these aquifers is complex and variable in the study area as a result of lateral and vertical facies changes. Productive sand and gravel aquifers are known to occur near the bottom of valleys eroded in the shale bedrock. Only some of these valleys have been identified and the extensions to these valleys and their tributaries are largely unknown.

The regional groundwater flow direction is generally expected to be southerly towards Lake Ontario. The general direction of drainage and groundwater flow on a local scale is generally towards Mimico Creek. Groundwater flow may also be influenced by utility trenches and other subsurface structures that intersect the water table. However, the actual effects of this flow system change can only be confirmed by long-term groundwater monitoring data in the study area.

Results from a geotechnical investigation in November 2007 at a site adjacent to the northern boundary of the area, documented the static water level being about 7.5 m bgs (Elevation 148.9 m asl). Just south west of the area (Convair Dr and Renforth Avenue), the results from another geotechnical investigation in June 2007, showed that the static water level was at a depth of about 3.9 to 8.5 m bgs (Elevation 158.7 to 161.6 m asl). Water Well data and recorded water levels from previous investigations in the area, indicated that static water levels were generally at least 0.3 mbgs across the study area. The water table appears to be a subdued expression of ground surface topography. It should be noted that groundwater levels can vary and are subject to seasonal fluctuations. Perched water within fill material may also be encountered.

Further targeted site investigations are needed to enable a more comprehensive understanding of the hydrogeologic conditions along the proposed alignment. Should underground structures be incorporated into the Airport Link alignment, further hydrogeologic assessment, including specific hydraulic conductivity testing, would be required prior to construction to evaluate dewatering needs, drainage control requirements and water discharge options. These studies will also be required as supporting documentation for any Permit to Take Water (PTTW) applications that may be needed.

2.5.2 Eglinton Crosstown LRT (ECLRT)

The shale bedrock is a poor water-bearing formation and water levels predominantly are associated within the sand and gravel aquifers of the overburden. More permeable water bearing silt layers have also been noted in the upper 5 m of the overburden sequence, however seepage from these layers is expected to be small.

The distribution of these aquifers is complex and variable along the length of the route due to lateral and vertical facies changes. Productive sand and gravel aquifers are known to occur near the bottom of valleys eroded in the shale bedrock. Only some of these valleys have been identified and the extensions to these valleys and their tributaries are largely unknown. A buried valley is known to exist below Black Creek and the hydraulic connection with sediments in higher areas east and west of the site results in upwards flow within the overburden and groundwater pressures that are artesian with respect to the surface of Eglinton Avenue (Golder, 1995).

Groundwater is under some confining pressure in both the bedrock and overlying galciolacustrine aquifers. Semi-confined to confined aquifers within glaciolacustrine deposits are known. In the vicinity of Allen Road a main water table associated with glaciolacustrine deposits (poorly graded granular soils) was identified at an elevation of around 157 m asl, with a higher water table also identified in the overlying Wisconsin tills around 167 m asl (Golder, 1994).

Regional groundwater flow direction is generally expected to be in a southerly direction towards Lake Ontario. The general direction of drainage and groundwater flow on a local scale is expected to be towards the closest watercourse. Groundwater flow may also be influenced by utility trenches and other subsurface structures and can only be confirmed by long-term groundwater monitoring data in the area.

Borehole logs and well data indicated that static water levels were generally 1-10 m bgs across Eglinton Avenue. Inferred shallow groundwater table contours published by the Ministry of Natural Resources (1985), indicate that the groundwater elevation increases from around 123 m asl at Don Mills Road to 165 m asl at Dufferin Steet and then decreases to elevation 126 m asl at Keele Street and 100 m asl at Jane Street. Inferred groundwater contours indicate that groundwater occurs at around elevation 90 m asl in the vicinity of the Don Valley Parkway and increases to around elevation 103 m asl near Yonge Street, then 109 m asl near the intersection of Allen Road.

Groundwater contours in between Keele Street and Dufferin Street, suggest that the groundwater flow direction in this area is towards the south west and Black Creek. Near the intersection of Black Creek and Eglinton Avenue, groundwater occurs at around 106 m asl. From Bayview Avenue to Leslie Street, groundwater flow direction is inferred towards the east and the west branches of the Don Rivers. Where Eglinton Avenue crosses the West Don River, groundwater occurs at around elevation 109 m asl.

Coffey conducted a Geotechnical Investigation, concurrently with this hydrogeological study. Subsurface conditions and groundwater levels encountered during the Geotechnical work are presented under separate cover. The Geotechnical Investigation provides a more comprehensive understanding of the groundwater conditions underneath the study area. This report should be read in conjunction with the Coffey reports.

3 DEWATERING

3.1 Airport Link

The Airport Link (Option R2) is at-grade and no tunnelling or deep excavations are expected. The construction of a new bridge over Highway 401 is understood to be part of the proposed design for the LRT system. It is unlikely that extensive dewatering will be needed in the area. However, if groundwater is encountered, it may be possible to control drainage by pumping from sumps. Some water treatment (e.g. filtration) will likely be needed before discharge to either the municipal sewer (storm or sanitary) or to the natural environment (e.g. Mimico Creek).

If underground structures are incorporated into the Airport Link alignment, further hydrogeologic assessment will be required prior to construction to evaluate dewatering needs, drainage control requirements and water discharge options. These studies will also be required as supporting documentation for any PTTW applications that may be needed.

3.1 Eglinton Crosstown LRT (ECLRT)

Based on initial data of the proposed deep alignment of the below-grade section of the ECLRT, the range of maximum depths of required excavation is expected to be 17 m bgs (at Colin Avenue) to 30 m bgs (at Old Forest Hill Road and Venn Crescent). Since the groundwater table is likely to be above the base of the proposed depth of alignment at many below-grade localities, seepage cut-off and depressurization of aquifers will be required to control groundwater, stabilize the base of excavations and for tunneling. It can be expected that groundwater will need to be controlled by methods such as pumping from sumps, eductors or well points or in some cases by deep well dewatering systems. For the majority of the alignment, the base of the excavation is likely to be in glaciolacustrine (silt, clay and sand) deposits of the Thorncliffe Formation. Care must be taken to prevent the removal of fine soil particles during pumping. Also there is a potential to encounter contaminated groundwater. Further hydrogeologic assessments will be required prior at locations requiring dewatering to estimate discharge rates, predict impacts and evaluate treatment/discharge options. These studies are also needed to support PTTW applications.

A pumping test was carried out by Peto MacCallum Ltd. (1995) some 40m to the east of the corner of Black Creek Drive and Eglinton Avenue on the southern side of Eglinton Avenue. Pumping from a 150mm well, screened over the elevation interval 70 m asl to 75 m asl, was carried out at a rate of 0.065 L/s for a period of 71 hours between March 29 and April 1, 1995. During the test, piezometric levels were recorded at four observation piezometers. Ground surface at the pumping well was at 112.26 m asl and the piezometric level in the well was recorded at 116.13 m asl on 26 May, 1995 and 22 June, 1995. The measured piezometric level was 3.87 m above ground level. The consistent piezomtetric levels recorded for 26 May, 1995 and 22 June, 1995 are interpreted to indicate that piezometric conditions at the screen level had stabilised following the pumping test.

A plan prepared by Peto MacMallum Ltd. shows the location of four observation piezometers at horizontal distances ranging from approximately 3 m to 35 m from the pumping well. Appendix A-1 of the report by Peto MacCallum Ltd., which reportedly contained the detailed results of the pump test, was not available for review. Despite this, it is assessed from the results contained in the report, the borehole logs and the piezometric monitoring results for the piezometers (contained in Appendix D of the report) that the test was not sufficient for evaluation of dewatering requirements at the launch site for the TBM for the following reasons:

- Pumping was carried out at a low rate 0.065 L/s which would not be sufficient to result in sufficient drawdown at the observation piezometers to allow accurate interpretation;
- The depth of the screened interval was well below the level anticipated for excavation for launching of TBMs for tunnel construction;
- The area tested is some 150m west of the location of the launch area anticipated to be used for launching of the TBMs (on the opposite side of Black Creek); and
- A discussion of the influence of Black Creek was not provided.

We recommend that a further pump test is carried out at the location proposed for launching of the TBMs with screening of the permeable horizons in the upper 12 m of the soil profile for assessment of dewatering requirements for excavations within the anticipated launch area.

4 PREDICTED IMPACTS

4.1 Surface Water and Groundwater Resources

4.1.1 Airport Link

Municipal water is supplied to the area; therefore, no impacts to local water supplies are expected from the construction.

More detailed hydrogeologic assessment may be needed once the final design of the Airport Link is complete, particularly in the area of the proposed overpass over Highway 401.

4.1.2 Eglinton Crosstown LRT (ECLRT)

Municipal water is supplied to the area; therefore, no impacts to local water supplies are expected.

The highest potential to impact ecological features will be where construction is being conducted along or across surface water bodies and nearby areas. Significant and prolonged dewatering, should it be needed, has the highest potential to affect nearby surface water features if a hydraulic connection between the feature and the formation being dewatered is established.

More detailed hydrogeologic assessment must be done once the ECLRT designs have been finalized. This is likely to involve hydrogeological and dewatering assessment with a focus on areas where deeper excavations or underground structures are proposed.

A groundwater monitoring and mitigation plan should be developed for an area within a 100 m radius of construction. The plan should include water level and water quality monitoring pre-construction, during construction and post-construction.

4.2 Existing Buildings

4.2.1 Airport Link

From the site reconnaissance, it appears as though existing structures in the area of the Airport Link (Option R2) are most likely to have shallow foundations built above the local water table, and are not expected to be affected by dewatering. As, dewatering is not expected for the Airport Link, an impact on

existing buildings along the proposed route is not expected. However, influence on the existing 401 structures should be confirmed once the alignment has been finalized.

4.2.2 Eglinton Crosstown LRT (ECLRT)

Eglinton Avenue is lined with a variety high density residential and commercial structures and commercial/industrial land uses. There is a potential for buildings to have foundations built below the local water table, and a potential exists for these foundations to be affected by dewatering. Also, underground infrastructure (i.e. Yonge Subway Line and Spadina Subway) is also located in an area where the proposed ECLRT will be underground. Further investigation to determine the radius of influence of any required dewatering will be necessary to fully consider the impacts to nearby structures and infrastructure. It will also be necessary to develop and implement appropriate monitoring programs including settlement monitoring that clearly outline a mitigation plan.

4.3 Quality Control and Conservation

In the case that construction dewatering is necessary, a water quality and quantity monitoring plan may be required to ensure that there are no adverse affects to groundwater resources or the environment. A contingency plan may also be required in the case that adverse affects are reported.

As identified in the Contamination Overview Study, conducted concurrently with this investigation, there is a potential for contaminated groundwater to be encountered during dewatering activities. If found to exceed applicable Ministry of Environment (MOE) Guidelines or Toronto Sewer Use By-Laws, treatment of groundwater may be necessary before discharge.

In conformance with Regulation 903 of the Ontario Water Resources Act, the installation and eventual decommissioning of any wells and pumping systems should be carried out by a licensed contractor under the supervision of a licensed water well technician.

To reduce the risk that the effects of the dewatering are not widespread, the following monitoring and mitigation plan is recommended.

Table 4 – Groundwater and Surface Water Monitoring

Period	Water Level Monitoring Location	Water Level Monitoring Frequency	Method	Triggers for Mitigation	Mitigation/Comments
WATER LEVELS					
Pre-construction	On-site monitoring wells	Prior to construction Daily for one week	Manual	None	Completed to develop base line water level hydrographs.
During Construction	On-site monitoring wells (or replacements)	Daily while construction is within 50 m of well.	Manual or data logger. ▫Manual check once per week. ▫Data logger down-loaded by-weekly	Water level drop exceeds 75% of available drawn	Should an impact attributable to the dewatering be noted, more frequent monitoring will be considered. ▫Mitigation could include reduced pumping, providing a temporary water supply well replacement or hook up to watermain.
	Discharge volume	Daily	Manual with totalizing flow meter in-line.	Flow exceeds PTTW	Reduce flow to PTTW maximum

Period	Flow and Location	Flow Monitoring Frequency	Method	Triggers for Mitigation	Mitigation/Comments
WATER QUALITY					
During Construction	Groundwater discharge from dewatering	Biweekly from dewatering along alignment Assuming water quality is suitable, monthly for the remainder of the dewatering period.	Initial sample for general inorganics listed in PWQO. Field monitoring of TSS/turbidity	Discharge quality for TSS/turbidity exceeds PWQO	Should an impact that is attributable to the construction project be noted, more frequent monitoring will be considered. Additional remediation such as enhanced sediment control will be considered if needed.

5 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of a background hydrogeological review and site reconnaissance, the following summarizes our conclusions and recommendations:

- On a regional scale, the topography of the study area slopes southward towards Lake Ontario. In the area of the Airport Link, the ground surface is relatively flat with elevations ranging between 154 and 160 m asl. Due to the incision of rivers and streams along Eglinton Avenue, the topography in this part of the study area varies significantly across the west to east transect of the proposed ECLRT. Going from west to east; the intersection of Eglinton Avenue and Kipling Avenue is at an elevation of approximately 159 m asl; the surface elevation then decreases to around 108 m asl at the Humber River and 99 m asl around the intersection of Jane Street. Near Old Forest Road the elevation then progressively increases to around 180 m asl where the terrain is generally flat, and then drops off to around 98 m asl at the West Don River and 100 m asl at the East Don River; surface elevation then progressively increases to around 164 m asl at Kennedy Road.

- The Airport Link is entirely within the South Slope Physiographic Region of Southern Ontario (Chapman and Putnam, 1984). The South Slope includes a strip of fluted till plain in between the Peel Plain to the north and the Lake Iroquois Plain physiographic region to the south and east. This overall region is underlain by carbonate rich Palaeozoic rock with a variety of glacial deposits overlying the bedrock. In Etobicoke, ground moraine with irregular knolls and hollows are more common. The ECLRT alignment is located primarily in the Iroquois Plain physiographic region (Chapman and Putnam, 1984). This complex area is characterized by shoreline, beach and lake plain deposits associated with the Pleistocene-aged glacial Lake Iroquois. Along the northern border of Lake Iroquois, large sand and gravel deposits accumulated, particularly in the Humber Valley. In the Don Valley at the east end of the study area, pre-Iroquoian deposits of clay were exposed.

- The surficial soil in the area of the Airport Link is generally the Quaternary-aged Wildfield/Halton Till Complex. These units are characterized as being dense to very dense olive brown to grey coloured sandy silt to clay till with interbedded lenses of poorly graded sand and gravel. The till typically has a very low permeability (on the order of 10^{-7} cm/sec). Glacially derived boulders (generally < 1 m diameter) originating from igneous and metamorphic rocks of the Canadian Shield may also be encountered. The surficial soil along the ECLRT alignment is predominantly stratified clays, silt and sand. Deposits of alluvial sand and gravel with minor amounts of clay and silt can be expected in the flood plains of existing rivers and streams, and in the vicinity of glacial lakes and rivers that existed during the Pleistocene. Based on the results of geotechnical drilling in the study area, the clays, silts and sands may extend to depths of greater than 8 m. In addition to naturally deposited soils, fill may be encountered at depths of greater than 5 m. Fill, including industrial and building waste and engineering and landscape fill, may also be encountered during excavation in the study area. These alluvial soils and fills are topically underlain by till deposits, known to contain boulders. It is expected that the majority of excavation/tunneling works required to facilitate the ECLRT will occur in the overburden.

- The bedrock beneath the study area is interpreted to be Upper Ordovician aged shale of the Georgian Bay Formation. This unit consists predominantly of blue-grey shale with some limestone, dolostone and siltstone layers or interbeds. The available data suggests that bedrock in the area of the Airport Link occurs at an elevation of about 125 to 155 m asl and beneath ECLRT alignment at an elevation of 20 to 130 m asl. Based on the preliminary designs provided, bedrock is expected to be deeper than the maximum depth (approximately 30 m beneath Venn Crescent and Old Forest Hill Road) of excavation/ tunnelling that is proposed.

- The study area spans the Mimico Creek, Humber River and Don River Watersheds and in general, drainage in these systems is south eastwards towards Lake Ontario. The study area is dissected by the following creeks and rivers and their tributaries (from west to east): Mimco Creek, Humber River, Black Creek, West Don River, East Don River, Wilson Brook and Massey Creek. The general direction of drainage and shallow groundwater flow on a local scale is expected to be towards the closest watercourse. Groundwater flow may also be influenced by utility trenches and other subsurface structures that intersect the water table and can only be confirmed by long-term groundwater monitoring data in the study area.

- In the area of the Airport Link, regional groundwater flow is expected to be southwards towards Lake Ontario and on a more local scale towards Mimico Creek. The main water bearing zones of concern appear to be discontinuous granular (sand and gravel) layers or lenses within the silty till deposits. The upper weathered zone of bedrock may also be a water producing zone. The volume of water produced from this upper bedrock will depend on the number, frequency and openness of fractures. The available data suggests that static water levels are generally 0.3 -10 m below ground surface (bgs) across the study area.

- For shallow excavations below the water table, dewatering systems may or may not be needed. For some excavations or sections of the excavation, drainage may be handled by pumping from sumps in the excavation. In areas where a large volume of water is anticipated, consideration should be given to use of the well points and/or eductors along the sides of the excavations.

- The Airport Link alignment (Option R2) is at-grade and no tunnelling or deep excavations are expected. The construction of a new bridge over Highway 401 is understood to be in the proposed design of the LRT system. It is unlikely that extensive dewatering will be needed in the area.

However, if groundwater is encountered, it may be possible to control drainage by pumping from sumps. Some water treatment (e.g. filtration) will likely be needed before discharge to either the municipal sewer (storm or sanitary) or to the natural environment (e.g. Mimico Creek).

- Based on initial data of the proposed deep alignment of the below-grade section of the ECLRT along Eglinton Avenue, the range of depths for the required excavation is expected to be 17 m (at Colin Avenue) to 30 m (at Old Forest Hill Road and Venn Crescent) bgs. Since the groundwater table is likely to be above the base of the excavations along the alignment seepage cut-off and depressurization of aquifers is likely to be required to control groundwater and stabilize excavations. During construction, groundwater will have to be controlled by methods such as pumping from sumps, eductors or well points. For the majority of the alignment, the base of the excavation is likely to be in glaciolacustrine (silt, clay and sand) deposits such as the Thorncliffe Formation. It should be noted, that for shoring, excavation and tunnelling, care must be taken to prevent the removal of fine soil particles during pumping. In addition, the exposure to contaminated groundwater that may be encountered must be minimized. Further hydrogeologic assessments will be required prior to construction to support a PTTW application.
- As dewatering is not expected in the area of the Airport Link, impacts to the quality and quantity of groundwater and surface water as well as sub-grade foundations of existing buildings are not expected.
- Municipal water is supplied to the area from a lake-based system. Therefore no impacts to local water supplies are expected from construction.
- Eglinton Avenue is lined with a variety of high density residential structures and commercial/industrial land uses. There is a potential for buildings to have foundations built below the local water table, and a potential exists for these foundations to be affected by dewatering. Also, underground infrastructure (i.e. Yonge Subway Line and Spadina Subway Line) is also located in an area where the proposed ECLRT will be underground. Further investigation to determine the radius of influence of any required dewatering will be necessary to fully consider the impacts to surrounding infrastructure and buildings.
- The highest potential to impact ecological features will be where construction is at or near surface water bodies. Significant and prolonged dewatering, should it be needed, has the highest potential to affect nearby surface water features if a hydraulic connection between the feature and the formation being dewatered is established.
- Along the ECLRT alignment, there are several suspected former stream channels that are no longer apparent. These buried or channelized features may also be areas requiring further attention from a dewatering perspective.
- In the case that construction dewatering is necessary, a water quality and quantity monitoring plan may be required to ensure that there are no adverse affects to groundwater resources or the environment. A contingency plan may also be required in the case that adverse affects are reported.
- As identified in the Contamination Overview Study, conducted concurrently with this investigation, there is a potential for contaminated groundwater to be encountered during dewatering activities. If found to exceed applicable Ministry of Environment (MOE) Guidelines or Toronto Sewer Use By-Laws, treatment of groundwater will be necessary before discharge.

- In conformance with Regulation 903 of the Ontario Water Resources Act, the installation and eventual decommissioning of any wells and pumping systems should be carried out by a licensed contractor under the supervision of a licensed water well technician.

6 QUALIFICATIONS OF CONSULTANT

Coffey Geotechnics Inc. (formerly Shaheen & Peaker) is a consulting engineering company registered in Ontario with a complement of over 100 engineers, hydrogeologists, geologists, environmentalists, technologists and support staff. The firm was established in September 1992 and specializes in all aspects of geotechnical, environmental, construction materials, pavements, noise and vibrations, acoustics and mining. The company has its head office in Etobicoke with branch offices in Oshawa, Newmarket, Markham, Burlington, Niagara Falls, Barrie and Montreal with affiliates in Vancouver. The facility at Etobicoke has a fully equipped laboratory to test soil, concrete and concrete products and asphalt. The laboratory is certified with the CTA and CSA. Since its conception, the firm has carried out over 6000 projects across Canada, United States and overseas.

Miranda Shmanka, B.E.S. is an Environmental Officer with Coffey Geotechnics Inc.. Miranda has a Bachelors Degree in Environmental Studies from the University of Waterloo and a post-graduate certificate in Environmental Control from Sheridan Institute of Technology and Advanced Learning. Miranda conducts Phase I Environmental Site Assessments (ESA), Phase 2 Environmental Soil & Groundwater Investigations (ESGI), Hydrogeological Investigations and MTO Contamination Overview Studies for Coffey Geotechnics.

Natalie Tkach is a Hydrogeologist with Coffey. Natalie has a M.Sc.Eng. (Hydrogeology and Geological Engineering) from the South Russian State Technical University (1993) and is a licensed Professional Geoscientist (Ontario). Natalie has over 10 years of international experience in the fields of hydrogeology, hydrology and mining geology. She has completed several hydrogeological assessments involving water balance studies, well testing, impact evaluation, and groundwater control.

David Sawicki is a Consultant (Hydrogeologist) with Coffey. David has a B.Sc. in Geological Engineering, is a licensed Professional Engineer (Ontario) and a designated Consulting Engineer. He has more than 30 years experience completing a variety of hydrogeological projects related to groundwater resource assessment, groundwater development, groundwater quality assessment, environmental site assessment (Phase I to IV) and hydrogeological Peer Review. He has presented expert evidence at litigation proceedings and at environmental hearings.

Robert Powell is a Principal Geotechnical Engineer with Coffey. Robert has over 25 years of experience in Geotechnical Engineering Consulting. He has worked extensively on Slope Stability Studies, Foundation Engineering, Environmental Assessments, Mine Tailings Projects, Dam Safety Reviews and Forensic Evaluations. Mr. Powell has been involved on numerous geotechnical and environmental projects throughout North and South America.

This report was prepared by Miranda Shmanka, Nataliya Tkach and David Sawicki and reviewed by Robert D. Powell.

For and on behalf of Coffey Geotechnics Inc.

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Reviewed by:

Robert D. Powell, P. Eng., P.E
Principal Geotechnical Engineer

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Figures