Appendix M: Groundwater Report

407 TRANSITWAY - KENNEDY ROAD TO BROCK ROAD

MINISTRY OF TRANSPORTATION - CENTRAL REGION

August 20, 2015 Project No. 14-1181-0001

Sowel Kang, M.E.S. - Environmental Planner
LGL Limited
22 Fisher Street
King City, ON L7B 1A6

SECONDARY SOURCE GROUNDWATER ASSESSMENT 407 TRANSITWAY FROM KENNEDY ROAD TO BROCK ROAD

Dear Ms. Kang,

Introduction

Golder Associates Ltd. (Golder) was retained by LGL Limited as a sub-consultant to the project team led by Parsons Inc. for the Planning and Preliminary Design of Group Work Project 13-20003 and Assignment No. 2013-E-0027. In general terms, this project involves the environmental assessment, planning and preliminary design of the 407 Transitway from east of Kennedy Road in the Town of Markham to east of Brock Road in the Town of Pickering as shown on the attached Figure 1. The project consists of the proposed 18 km section of the Transitway and eight (8) potential station locations. The SSGI study area consists of a 1,000 m wide corridor centred on the existing 407 Transitway (the "study area"). The eight potential stations are proposed to be located at McCowan Road, Markham Road, 9th Line, Donald Cousens Pkwy/Reesor Road, York Durham Line, Whites Road (Sideline 26), Dixie Road/Rossland Road (Sideline 22) and Brock Road. It is noted that interchanges for Whites Road (Sideline 26) and Dixie Road/Rossland Road (Sideline 22) currently do not exist. The purpose of the review has been to identify hydrogeological constraints to the construction of the preferred route and station sites within the study area and to assess the potential for impact on existing groundwater resources as a result of the construction of the preferred alternative.

Method of Investigation

Our method of investigation for this assessment consisted of a desk-top review of existing hydrogeological information, supplemented with a windshield field reconnaissance of the study area. The information reviewed as part of this assessment was:

- *407/Transitway Environmental Assessment, Markham Road Easterly to Highway 7 East of Brock Road*, Ministry of Transportation, Ontario dated February, 1997;
- *407 East Individual Environmental Assessment (IEA) and Preliminary Design Study, Hydrogeology Impact Assessment of the Recommended Design,* Ministry of Transportation, August 2009;

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- *Hydrogeology Assessment (Chapter B, Section 3) of the Final Master Environmental Servicing Plan Amendment, Seaton Community,* The Sernas Group, July, 2013;
- Information contained in water well records for the study area available from the Ontario Ministry of the Environment and Climate Change (MOECC);
- Quaternary geological mapping for the study area available from the Ontario Geological Survey;
- Topographic Mapping (National Topographic Survey Map 30M14, Markham 1:50,000);
- Aerial photographs;
- Wellhead protection area mapping available on-line from the Regional Municipality of York and the Regional Municipality of Durham; and,
- A limited "windshield reconnaissance" of the study area on June 11, 2015 along publically accessible roads to visually corroborate the background information reviewed.

The objectives of the assessment were to identify the following:

- General groundwater usage including aquifers, well types and locations;
- Areas of high water table and up-welling;
- Areas of groundwater recharge and discharge;
- Areas of high overburden permeability;
- Locations and usage of large volume wells;
- Wells with known quality and quantity problems; and,
- Groundwater dependent commercial enterprises.

Based on the above information, an assessment was carried out to determine to the extent possible, the following:

- Areas of groundwater altered by physical intrusion and the likelihood of interception, drawdown, compaction and impoundment of groundwater;
- Areas of obstruction to groundwater recharge and discharge;
- Likelihood and significance of releases of contaminants to groundwater;
- Likelihood and significance of interference with wells; and,
- Impacts of areas of high groundwater table on the project.

This groundwater assessment presents a generalized interpretation of hydrogeological conditions and has been based on available background information in addition to a limited windshield reconnaissance as outlined above. Hydrogeological conditions within the study area will vary locally and are subject to confirmation with actual site specific investigations including (but not limited to) boreholes, monitoring wells, test pits, groundwater hydraulic testing, chemical analysis, etc.

Existing Conditions

Preferred Alignment

The preferred alignment and proposed potential station locations are shown on two figures provided by LGL and included in Appendix A of this report. The preferred alignment lies north of 407 Transitway at Kennedy Road but crosses 407 Transitway approximately 300 m to the east. From this point, the preferred alignment lies parallel and south of 407 Transitway within the study area.

Geology

Six hydrogeologic cross sections along 407 Transitway based on MOECC water well records are presented on Figures 2 to 7 following the text of this report. The ground surface shown on the sections is based on borehole or well elevations and is not intended to accurately represent the ground surface elevation in any one particular location.

The west portion of the study area is relatively flat lying with ground surface elevations typically in the range of 180 to 190 m above sea level, with the exception of relatively deeply incised stream valleys associated with the Rouge River system. The west portion lies within the urbanized area of the Town of Markham. The eastern portion of the study area is rural agricultural land with relatively sparse residential and farm infrastructure. The study area rises gently in elevation to the east beyond Donald Cousens Parkway to an elevation greater than 220 m above sea level between York-Durham Line and Brock Road. From Brock Road to Westney Road the elevation drops down to approximately 150 m in the valley land associated with the Duffins Creek system.

Surface geology mapping as presented on the Ontario Geological Survey Preliminary Map 2204, Geological Series "Quaternary Geology, Toronto and Surrounding Area, Southern Ontario, scale 1:100,000" (D.S. Sharpe, 2000) was reviewed by Golder. A summary of the quaternary geology mapping is presented on Figures 8 and 9 following the text of the report. Based on the Quaternary geology mapping the west portion of the transitway, in the vicinity of Kennedy Road and McCowan Road, crosses shallow glacial lake sediments of sand, silt and clay. East of McCowan Road, the shallow geology is expected to transition to glacial deposits of till, typically relatively fine grained clayey silt till to sandy silt till. The till deposits predominate in the study area to east of Brock Road, with the exception of recent stream deposits associated with the valley corridors which cross the alignment. East of Brock Road, glacial lake deposits of silt, sand and gravel are expected to be encountered in the lower elevations associated with the Duffins Creek valley.

Numerous streams and ponds are noted within or crossing the preferred alignment throughout the study area. The presence of surface water bodies suggests the possible presence of a relatively shallow groundwater table.

Shallow, local groundwater flow within the study area is expected to reflect local topography and be toward surface water features. Deeper regional groundwater flow is expected to be to the south.

Groundwater Recharge and Discharge

Based on the surficial geology of the study area, significant areas of groundwater recharge are not expected within most of the study area. A relatively higher level of groundwater recharge is likely occurring associated with the relatively sandier portions of the glacial lake sediments in the vicinity of Kennedy Road and McCowan Road.

Groundwater discharge in the study area is expected to be limited primarily to the lower elevation stream valley areas, with potentially a minor component within shallow stream features in the till deposits.

Existing Groundwater Use

Based on a plot of MOECC water well records, water wells have been in use historically throughout the study area; however, given the expansion of the urban area of the Town of Markham, it is not expected that water wells are in use within the study area west of Donald Cousens Parkway. East of Donald Cousens Parkway, water well use is expected to be associated with either with residences and/or farm infrastructure. A large cluster of private wells associated with the Hamlet of Brougham is present approximately 500 m north of the study area at Brock Road.

Based on a review of the well records, a total of 97 supply wells are recorded within the study area east of Donald Cousens Parkway. Of the 97 wells, 30 are relatively shallow, large diameter bored wells that are typically less than 15 m in depth. Approximately half of the shallow bored wells are recorded in the vicinity of Brougham. The remaining 67 wells are small diameter, steel cased drilled wells.

The geology reported in the well records is generally consistent with the published mapping with relatively fine grained clay and till deposits typically reported at ground surface. Confined sand and gravel aquifers are typically reported at elevations in the range of 150 to 160 m above sea level or typically 20 m to 50 m below the existing ground surface in the western and central portions of the study area. Water levels in the wells drilled into this confined aquifer are above the top of the aquifer indicating that the confined aquifer is under artesian pressure. In the eastern portion of the study area in the immediate vicinity of Brock Road, the well records indicate the presence of a shallower confined aquifer, the top of which is typically at elevations of 185 m to 190 m above sea level or approximately at least 10 m below the existing ground surface. Well pumping tests report pumping rates typical of residential well yield demands in the order of 22.5 L/min to 45 L/min.

Based on mapping available on-line from the Regional Municipalities of York and Durham, there are no wellhead protection areas or municipal wells within the study area.

The 1997 EA provides an overview of hydrogeologic conditions and concluded that the most significant groundwater issues were the potential for degradation of water quality in shallow wells, particularly in the vicinity of the relatively shallow aquifer around Brock Road and physical interference with areas of groundwater discharge in the stream valleys.

Groundwater Impact Assessment

The groundwater impact assessment is based on similar transportation construction projects with consideration of the potential works to be undertaken. Construction activities associated with the development of the Transitway are expected to consist of construction of the Transitway road bed and pavement, drainage infrastructure, bridges and culverts for road and stream crossings, station access roads and parking areas, station buildings and shelters and related utilities for the stations. Most physical interaction with groundwater is expected to be as a result of deep excavations below the water table. Most excavation activities for the project are expected to be relatively shallow; however, deeper excavations may be necessary for bridge and buried utility and sewer construction. Once final designs are selected, the potential impact of the proposed construction works should be reassessed and further investigation and monitoring carried out as necessary based on the final design.

Physical Alteration of Existing Groundwater Regime

Based on potential construction works and the hydrogeologic conditions, potential alterations to the groundwater regime include:

- Profile lowering and drainage improvements which have the potential to permanently dewater or lower the local water table;
- Bridge construction may cause temporary impact to local groundwater discharge to water courses; however, this impact is expected to be negligible post-construction once water table conditions equilibrate around the new structures;
- Impacts associated with any positive dewatering implemented during construction. There is a strong possibility of positive dewatering being needed for bridge crossings for the deeper stream valleys and may be required elsewhere for culvert and buried utility construction. The measured impacts and effective radius of influence from the dewatering will be dependent on the hydrogeologic conditions and the final detail design of the Transitway. The detail design should be reviewed by a qualified hydrogeologist and additional investigation completed as necessary to determine actual project dewatering requirements. The impacts associated with the construction dewatering activities are expected to be temporary.

Impact on Groundwater Recharge and Discharge

A reduction in groundwater recharge to the subsurface will occur as a result of the expansion or construction of impermeable pavement surfaces. It is expected that new impermeable surfaces associated with the transitway road and the station locations will reduce the overall recharge within the study area. Recharge lost to impermeable surfaces can in part be mitigated by direction of runoff to ground surfaces, by the construction of permeable pavements or by other low-impact development infiltration techniques. The effectiveness of any of these measures should be assessed through direct investigation during the detail design phase of the project.

Based on the relatively large regional areas from which the local watersheds and aquifers derive recharge and the relatively low rate of groundwater recharge currently expected in most of the study area, the effect of the potential reduction in overall groundwater recharge is not expected to be significant. It is unlikely that the potential reduction in recharge would produce a measurable effect on groundwater recharge and discharge functions, including baseflow in streams and water well supply quantity.

Discharge functions within the study area may be reduced depending on the final design of the proposed works. Profile lowering activities could reduce the existing hydraulic gradients to an extent where a reduction in groundwater discharge is possible. Given the relatively small area of the construction activities compared to overall drainage basin areas, a localized decrease in discharge is not expected to be measureable.

Discharge functions at the bridge construction locations may be impacted temporarily during construction activities; however, this impact is expected to be negligible post-construction once water table conditions equilibrate around the new structures.

Water Well Interference

Concerns regarding water well supply interference will be for only those wells that remain in active use. There is no information available to confirm if the wells in the water well records still exist or are currently in operation but it is expected that wells are only in use east of Donald Cousens Parkway. Typically the most susceptible wells to either quantity or quality interference related to highway construction activities are the shallow overburden wells using the water table aquifer in close proximity to the construction. Typically shallow unconfined overburden wells are under reported in the water well records and more shallow bored wells may be present than reported. Based on the well records approximately 30 shallow bored wells are present in the east portion of the study area.

In the case of the construction of the transitway, it is expected that the greatest potential for well interference would be associated with deep excavations (i.e., below 3 m in depth) and/or construction dewatering. We anticipate that deep excavations and/or dewatering may be needed for construction of bridges and culverts and station locations. As such potential for temporary interference effects exist in shallow wells in the immediate vicinity of these activities. Should dewatering or deep excavation be required it is recommended that a door-to-door water well survey be conducted within 250 m of locations at which the dewatering or deep excavation may occur. This pre-construction survey would ensure that conditions of the domestic water supply wells are documented prior to construction in the event there is an impact to the water supply. The preconstruction survey should be followed by monitoring of water levels in selected wells during dewatering activities to confirm any decline in water level within the domestic water supply wells.

Profile lowering, ditch relocations, embankments, drainage improvements and utility installations which intersect the water table may result in permanent water table lowering in the vicinity of the construction. If deep excavations or permanent utility installations below the water table are to be constructed, then some long term lowering of the water table in the vicinity of these installations may result from interception and diversion of groundwater flow along granular pipe bedding material. The risk of these effects is expected to be highest in areas of high water table as identified above. These effects can be mitigated through matching the hydraulic characteristics of the trench backfill to the surrounding native soil and by the placement of trench plugs to block the preferential migration of groundwater along the granular pipe bedding.

This may result in a corresponding reduction in the groundwater supplies in nearby shallow wells. If such design features are anticipated, the actual soil and groundwater conditions in those areas should be assessed along with a door-to-door water well survey to identify wells, if any, which may potentially be impacted.

It should be noted that any pumping of water above 50,000 litres per day requires a Permit to Take Water from the MOECC.

Potential for Groundwater Contamination

Shallow wells located near the study area may be susceptible to impact by de-icing salt application. Chloride, which is highly mobile in the subsurface, is a major constituent of road salt. Chloride at high concentrations (greater than 250 mg/L) may produce an aesthetic impact on the taste of water. Sodium, which is the other major constituent of road salt, is less mobile in the subsurface, but elevated concentrations may be of concern to persons suffering from hypertension or other medical conditions.

Because of the mobility of road salt constituents, mitigation of road salt impacts is difficult. However, where practical, road salt application within the right-of-way should be at the minimum levels allowed within the context of MTO's standard road salt application procedures. Given that the project consists of the construction of a new road alignment, a new area of salt application will result from the construction of the project. As such, it is recommended that pre-construction water quality be documented in shallow wells in the vicinity of the project.

Mobile vehicle re-fuelling during construction presents a risk of impact to local wells as a result of accidental releases of fuel. It is our opinion that shallow wells are the most susceptible to fuel impacts. In general, only large volume releases (i.e., greater than 100 L) are likely to have an adverse impact on local water well supplies. This risk can be minimized or managed by allowing re-fuelling only in designated areas, preferably situated on a paved, impermeable surface and by having an emergency response plan in place to clean up all releases of fuel.

Impact of High Water Table

Areas of high water table (i.e., less than 3 metres below ground surface) may affect construction progress and technique. Based on topography, geology and field observations there is the potential for a high water table to be present within the study area. The shallow geology of the study area is primarily relatively medium to fine grained till, with surficial areas of clay to silt to sand, particularly in the area of Kennedy Road and McCowan Road. In areas of relatively fine grained soils such as till or clay the presence of the high water table should not represent a significant constraint for construction. For areas of relatively coarse silt and sand such as those thought to exist in the area of Kennedy Road and McCowan Road, the presence of a high water table could impact on construction techniques and progress. Excavation and construction below the water table in saturated sandy and/or silty soils may present challenges, including the need for de-watering. It is recommended that the Transitway detail design and future subsurface investigation data be reviewed to further assess the impact of the suspected areas of high water table.

Summary

Based on the review of available published information, our windshield reconnaissance, and the expected construction activities, there is potential for impact to groundwater resources as a result of:

- Construction de-watering;
- Installation of structures and buried utilities below the water table;
- Road profile lowering in areas of high water table;
- Increased use of road salt over a larger area associated with the new Transitway alignment.

It is recommended that the potential impacts be re-assessed along with more detailed site specific hydrogeological data at the detail design stage of the project and appropriate mitigation measures incorporated into the design. Based on the findings of the re-assessment, Permits to Take Water for construction should be applied for and a pre-construction construction survey and baseline water quality assessment be implemented as necessary. Groundwater impacts not associated with water wells are not expected to be significant.

We trust that this update meets your requirements. Should you have any questions please contact the undersigned.

Yours truly,

GOLDER ASSOCIATES LTD.

Shawn Lytle, P.Geo.
Senior Hydrogeologist, Principal

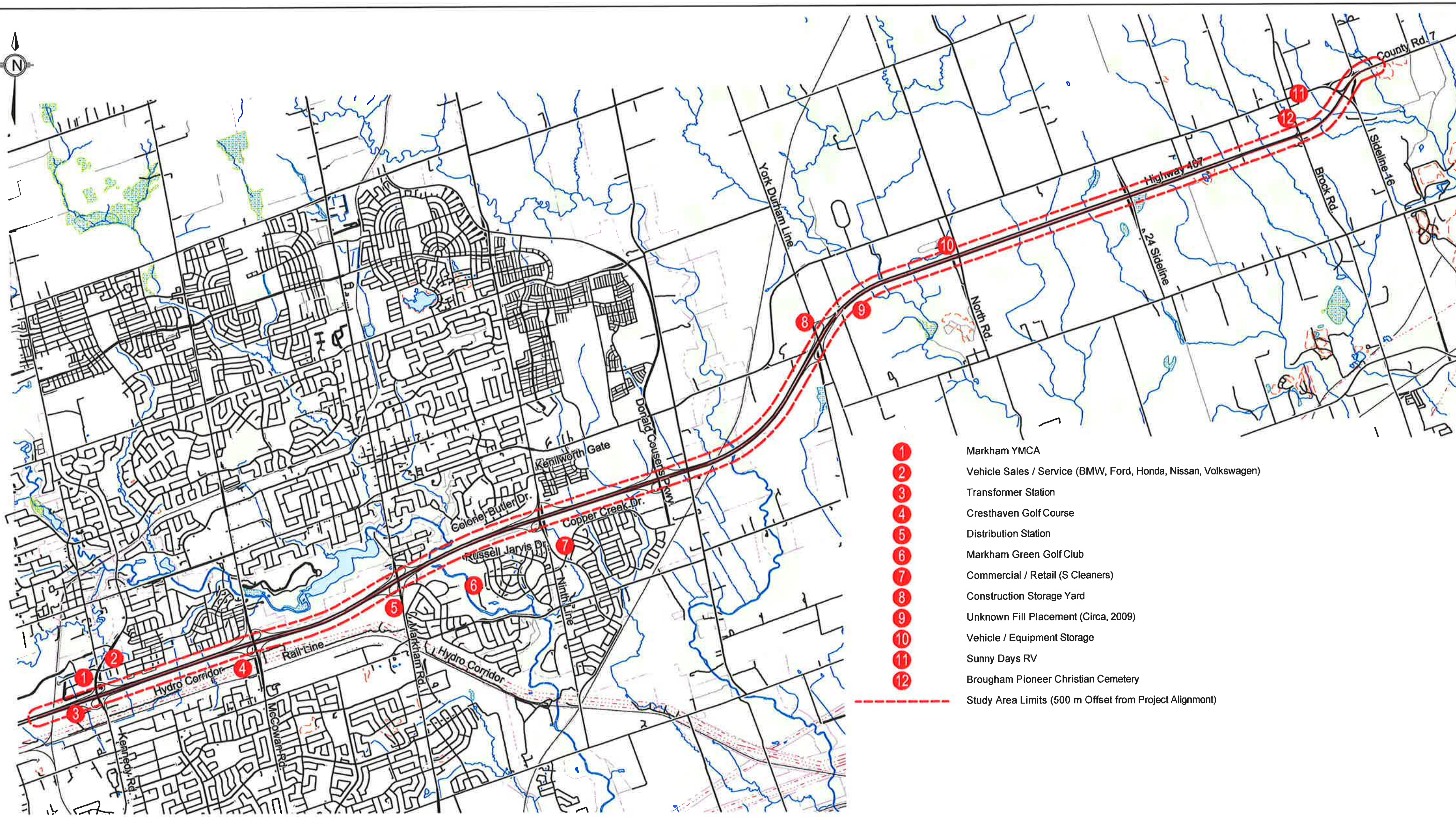
SDL/plc

Attachments: Figures 1 through 9
Appendix A – Preferred Alignment

Sowel Kang, M.E.S. - Environmental Planner
LGL Limited
14-1181-0001
August 20, 2015

Figures

Golder Associates



0 250 500 1000 2500

SCALE 1:50000 metres

CLIENT LGL LIMITED ENVIRONMENTAL RESEARCH ASSOCIATES	PROJECT 407 TRANSITWAY KENNEDY ROAD TO BROCK ROAD
CONSULTANT Golder Associates YYYY-MM-DD: 2015-05-29 PREPARED: STB DESIGN: REVIEW: APPROVED:	TITLE **AREA LOCATION MAP**
	PROJECT No. 14-1181-0001 · Phase - · Rev. AA · Figure 1

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PREPARED	JPR
DESIGN	
REVIEW	
APPROVED	

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TITLE
WELL LOCATION PLAN MAP 1

PROJECT No.	Phase	Rev.	Figure
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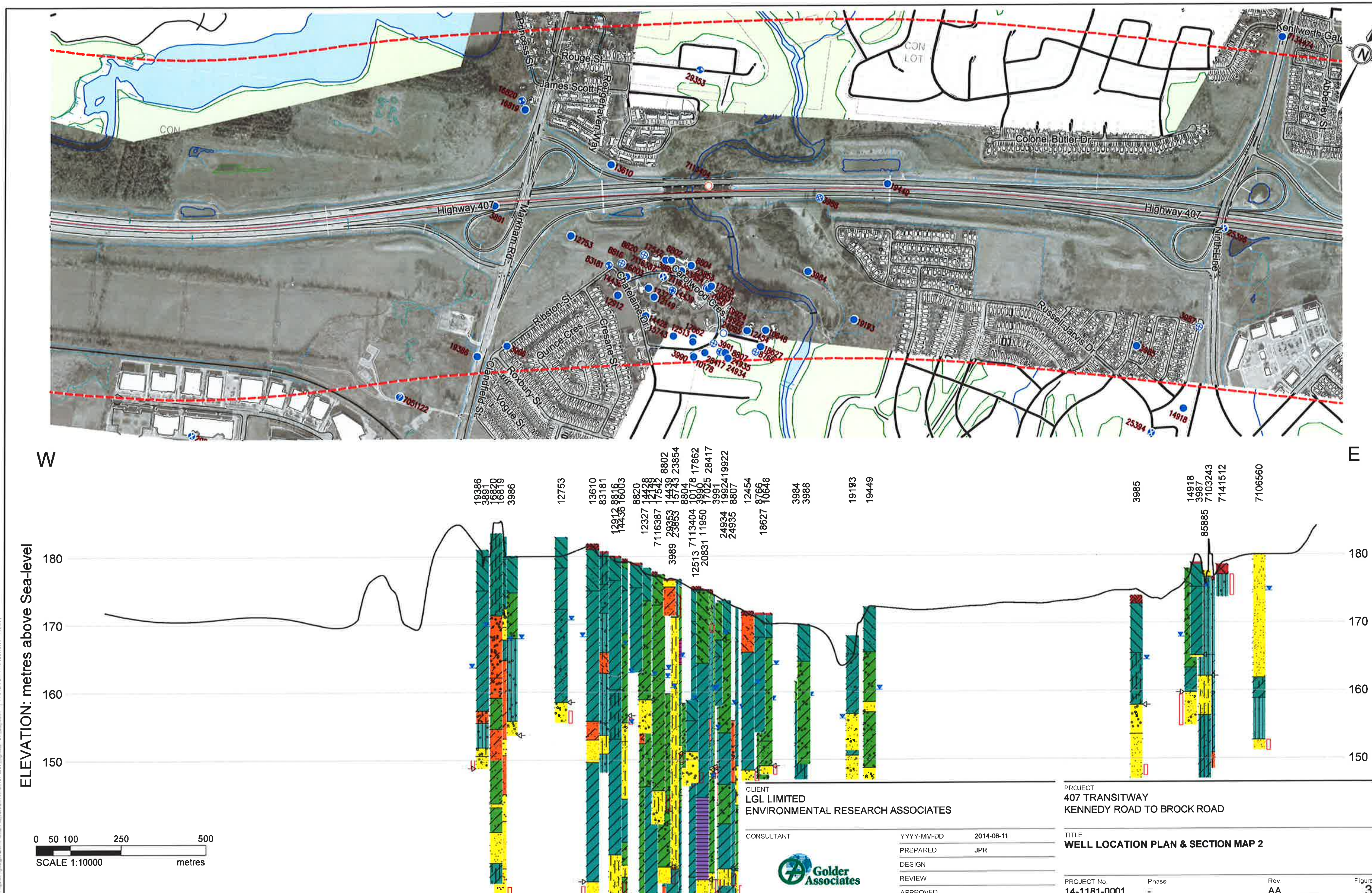

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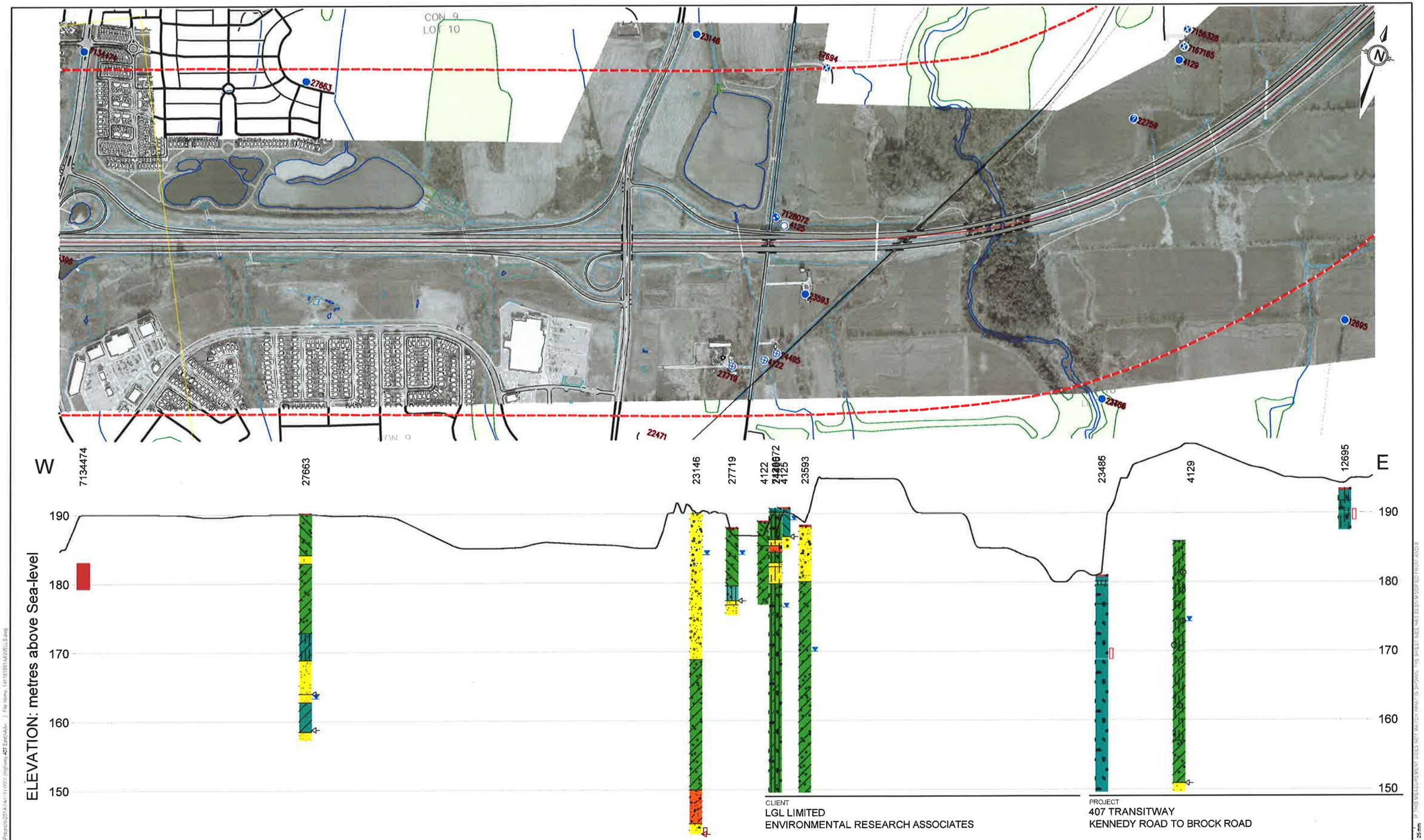
TITLE
WELL LOCATION PLAN & SECTION MAP 2

PROJECT No	Phase	Rev.	Figure
14-1181-0001	-	AA	3



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KENNEDY ROAD TO BROCK ROAD

TITLE
WELL LOCATION PLAN & SECTION MAP 3

PROJECT No.	Phase	Rev.	Figure
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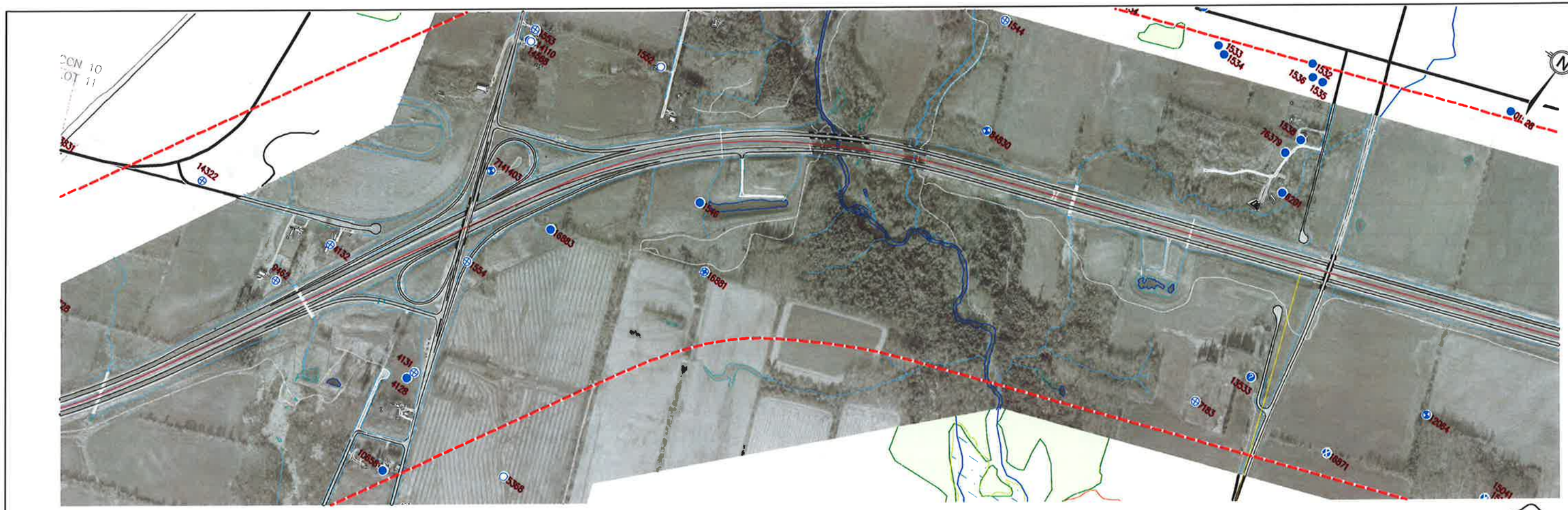

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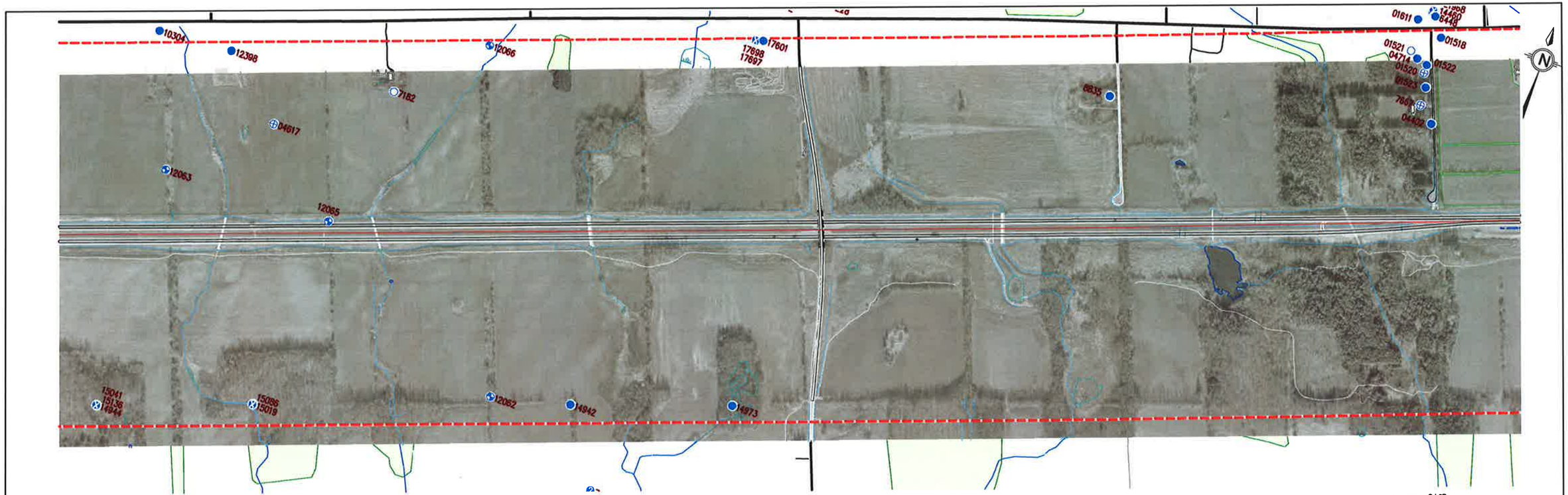
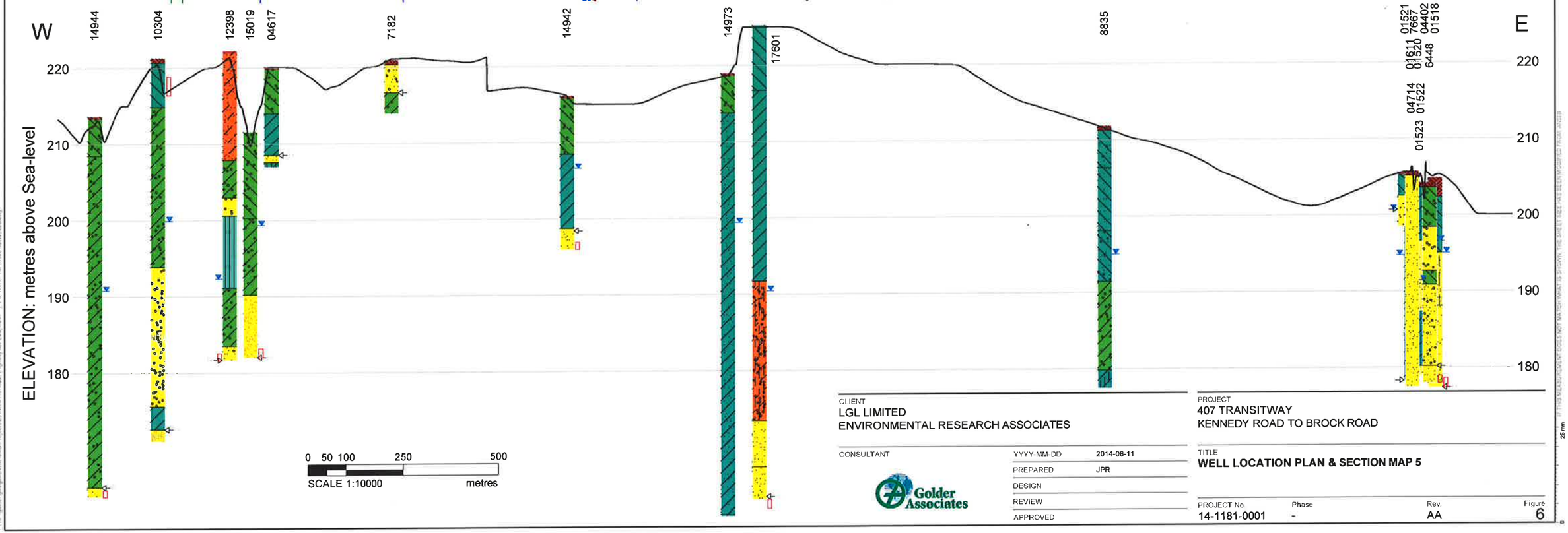
KENNEDY ROAD TO BROCK ROAD

TITLE
WELL LOCATION PLAN & SECTION MAP 4

PROJECT No.	Phase	Rev.	Figure
14-1181-0001	-	AA	5





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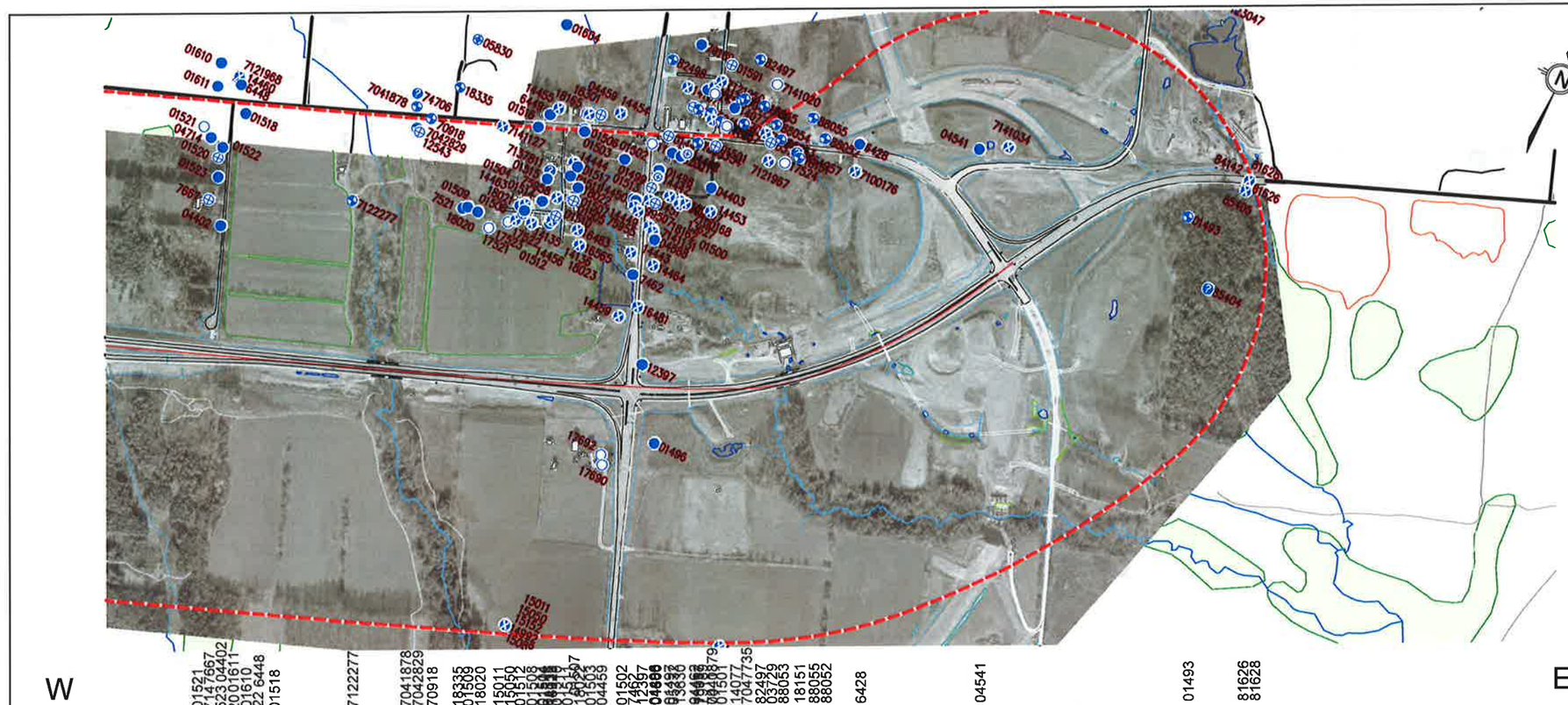
TITLE
WELL LOCATION PLAN & SECTION MAP 5

PROJECT No	Phase	Rev.	Figure
14-1181-0001	-	AA	6



W

E

ELEVATION: metres above Sea-level

200

190

180

170

160

0 50 100 250 500

SCALE 1:10000 metres

PLAN LEGEND

- Shallow Dug or Bored <10 m
- Sandpoint
- Deep Bored Well >10 m
- Drilled Overburden Well
- Test or Observation Well
- Drilled Bedrock Well
- Municipal / Public Supply
- Record of Abandonment
- Information Unrecorded

SOIL PATTERN LEGEND AND GENERIC SHADING

- Unoxidized Clay Blue, Grey White, or Undefined
- Oxidized Clay Brown, Red, Yellow
- Silt
- Sand
- Gravel
- Stones, Pebbles
- Boulder
- Till
- Shale
- Limestone
- Crystalline Rock
- Unknown
- Peat/loam
- Sands & Gravels
- Granular Till
- Silt
- Silt Clayey
- Clay
- Till
- Limestones
- Shales
- Precambrian

SECTION WELL SYMBOLS

- Screen
- Recorded Static Water Level
- 23453 MOE Recorded Private Well
- Water Producing Zone
- Flowing Well

NOTES:

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TITLE
WELL LOCATION PLAN & SECTION MAP 6

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Golder Associates

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PROJECT No. 14-1181-0001 | Phase - | Rev. AA | Figure 7

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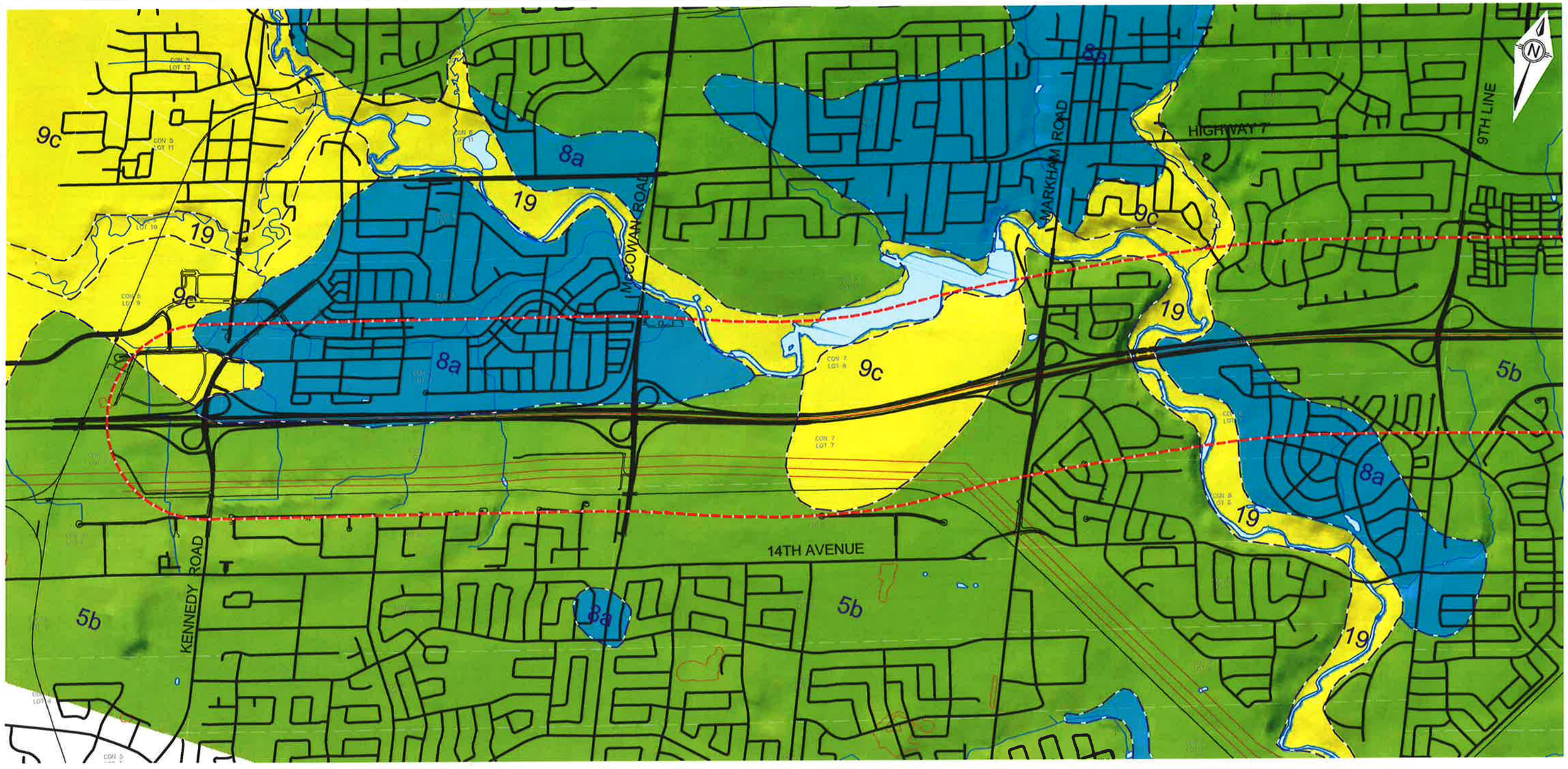

LEGEND

Study Area Limits (500 m Offset from Project Alignment)

19	Fluvial Silt, Sand, Gravel
9c	Glaciolacustrine Silt & Sand Deposits
8a	Glaciolacustrine Deep Water Deposits
5b	Ablation Till

NOTES

1. Datum UTM NAD 83 Zone 17
2. Ontario Geological Survey, 2006 Digital Compilation, Queen's Printer

0 100 200 500 1000

SCALE 1:20000 metres

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KENNEDY ROAD TO BROCK ROAD

TITLE
QUATERNARY GEOLOGY

PROJECT No.	Phase	Rev.	Figure
14-1181-0001	-		8

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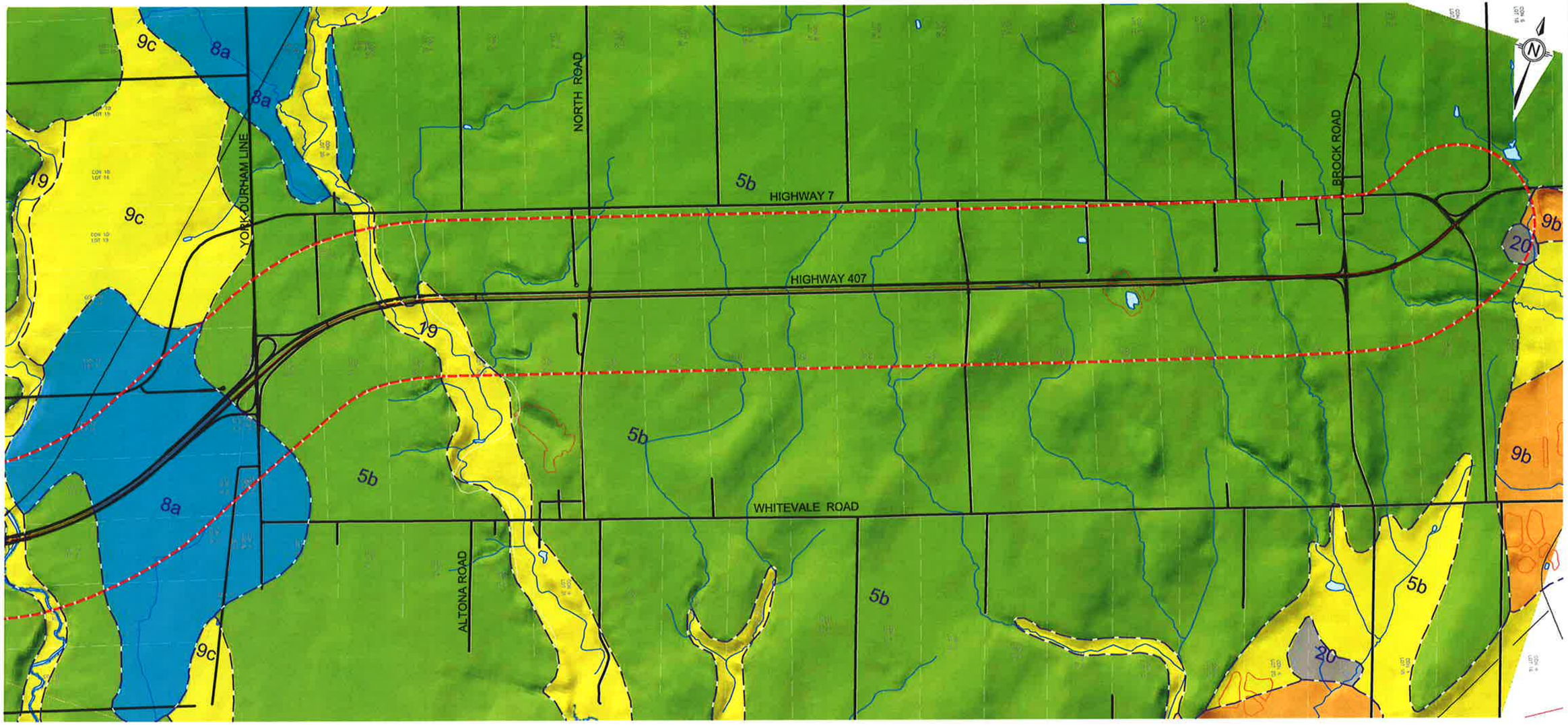

LEGEND

Study Area Limits (500 m Offset from Project Alignment)

	20	Organic Deposits
	19	Fluvial Silt, Sand, Gravel
	9b	Silty Sand and Gravel Till
	9c	Glaciolacustrine Silt & Sand Deposits
	8a	Glaciolacustrine Deep Water Deposits
	5b	Ablation Till

NOTES

1. Datum UTM NAD 83 Zone 17
2. Ontario Geological Survey, 2006 Digital Compilation, Queen's Printer

0 100 250 500 1000

SCALE 1:25000 metres

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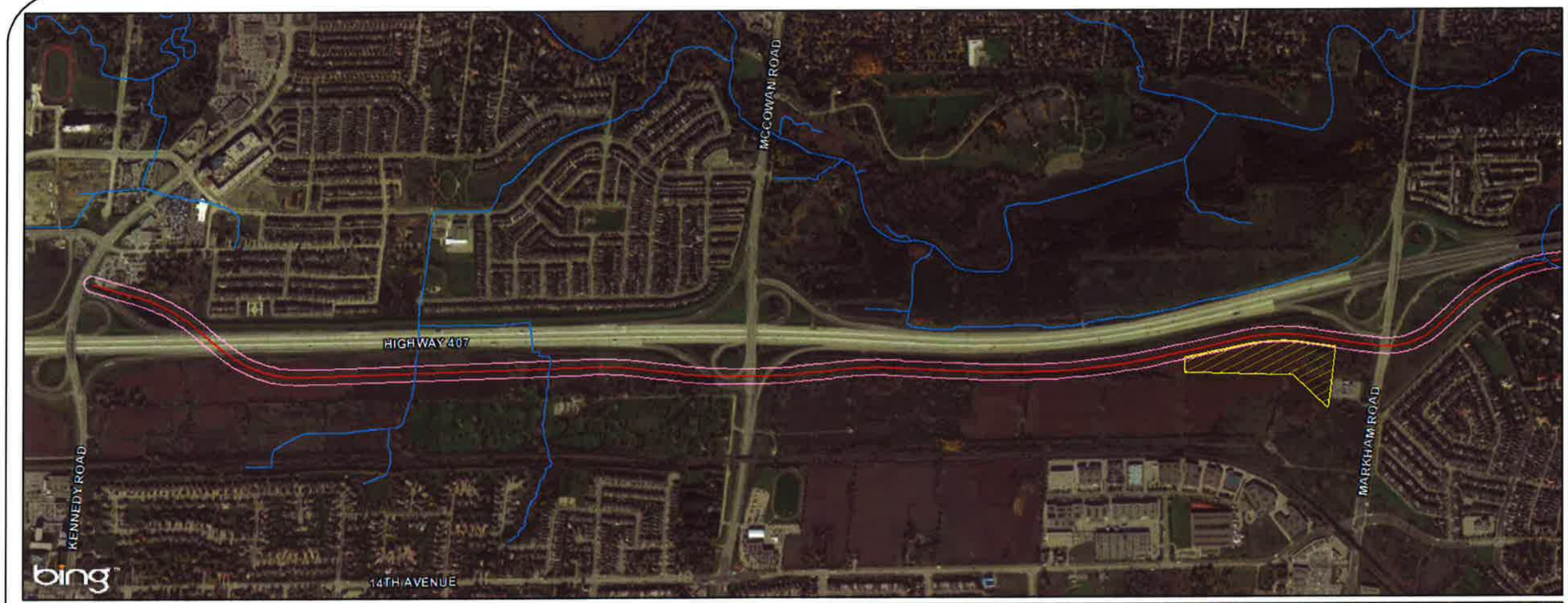
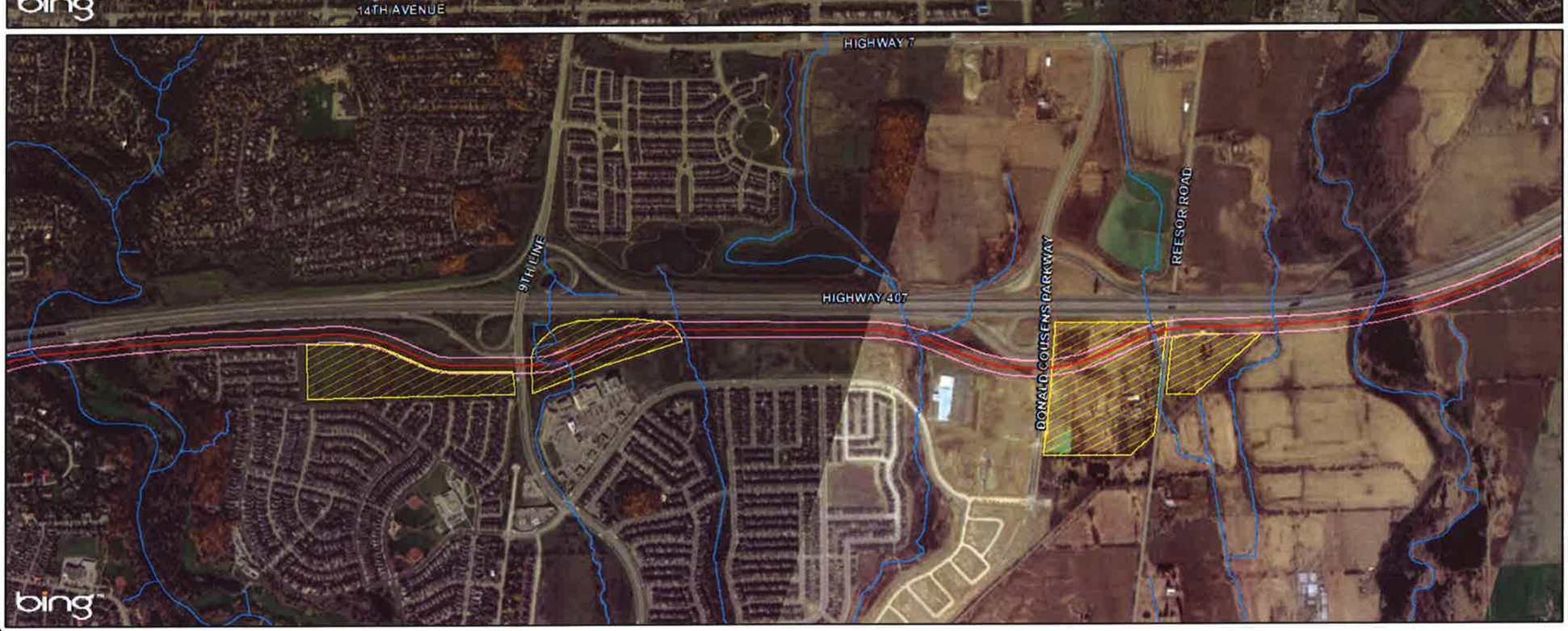
KENNEDY ROAD TO BROCK ROAD

TITLE
QUATERNARY GEOLOGY

PROJECT No.	Phase	Rev.	Figure
14-1181-0001	-	AA	9

Appendix A





C:_TA\TA8429 - 407 Transitway Kennedy to Brock\Maps\Alignment and Stations\AlignmentAndStations1.mxd

LEGEND

- Station
- Alignment
- Alignment 25 metre Buffer
- Watercourse

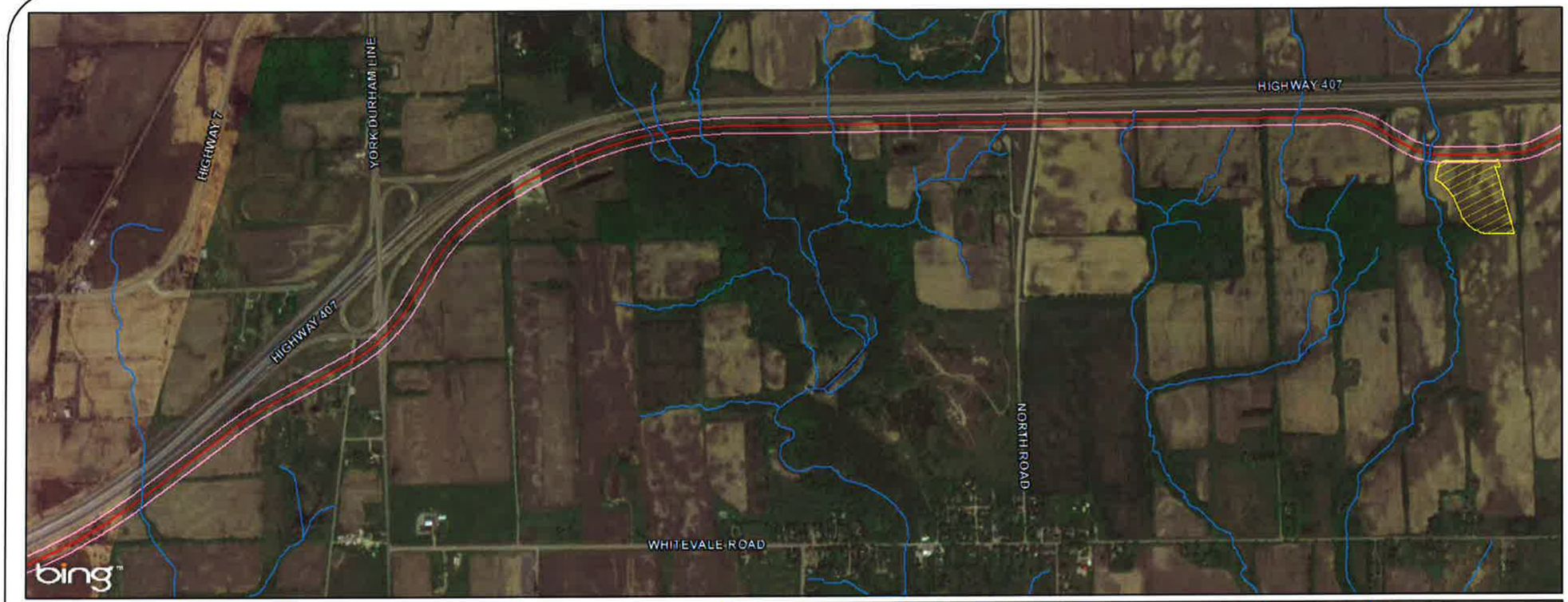
200 100 0 200 Metres

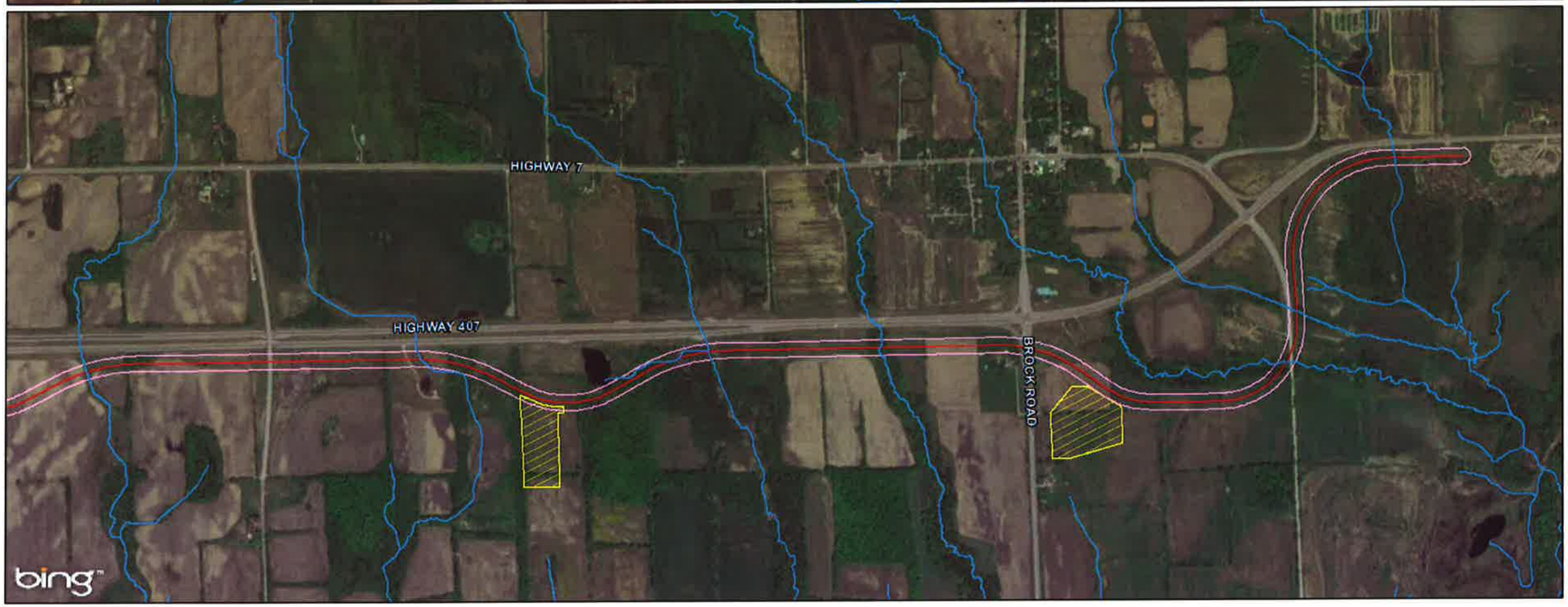
N

407 TRANSITWAY - KENNEDY TO BROCK ALIGNMENT AND STATIONS

LGL LIMITED
environmental research associates

Project: TA8429	**Figure:** 1
Date: June, 2015	**Prepared By:** MWF
Scale: 1 : 15,000	**Checked By:** SK





LEGEND

- Station
- Alignment
- Alignment 25 metre Buffer
- Watercourse

200 100 0 200 Metres

N

407 TRANSITWAY - KENNEDY TO BROCK
ALIGNMENT AND STATIONS

LGL LIMITED
environmental research associates

Project: TA8429	**Figure:** 2
Date: June, 2015	**Prepared By:** MWF
Scale: 1 : 15,000	**Checked By:** SK

C:_TA\TA8429 - 407 Transitway Kennedy to Brock\Maps\Alignment and Stations\AlignmentAndStations2.mxd