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5. Detailed Project Description

5.1 Background

5.1.1 Standards and Codes

The UP Express Electrification system has been designed in accordance with industry best practices, including adherence to applicable codes and standards, including but not limited to:

- Ontario Electrical Safety Code;
- CSA Standards (Codes and Standards Group);
- American Railway Engineering and Maintenance-of-Way Association (AREMA) standards; and
- Ontario Building Code.

5.1.2 Electrification Performance Specifications

As the first step to establishing the high level requirements and mandatory criteria for design and implementation of an electrification system, Metrolinx established a comprehensive set of Electrification Performance Specifications (EPS). These EPS were based on the combination of available knowledge, experience, industry best practice and worldwide standards. These EPS outline the applicable design standards to be complied with and performance requirements to be met as part of delivering a safe, efficient and reliable electrified system. Accordingly, these specifications provided the context for the subsequent preparation of the UP Express Electrification preliminary design.

5.1.3 Electrification Conceptual Design

Building on the previous studies including the, 2010 GO Electrification Study, a conceptual electrification design was prepared which was comprised of the following five parts:

- *Part 1 – Network Wide Conceptual Design*
- *Part 2 - Lakeshore West Corridor Conceptual Design*
- *Part 3 - Kitchener Corridor Conceptual Design*
- *Part 4 - Lakeshore East Corridor Conceptual Design*
- *Part 5 - Union Station Rail Corridor Conceptual Design*

Part 1- Network Wide Conceptual Design provided the overall design basis for developing each of the corridor specific designs as listed above (i.e., Parts 2, 3, 4, and 5 respectively). More specifically, Part 1 set the foundation and established the following key common inputs for the individual corridor-specific designs:

- Basis of Design (existing infrastructure conditions, rolling stock assumptions, conceptual design principles and practices);
- Conceptual Design for:
    - Traction Power Supply System

  - Traction Power Distribution System
  - Grounding and Bonding
  - Signal System Compatibility
  - SCADA System
  - Operation Control Centre
  - Maintenance and Storage Facility
- Systems to support the conceptual design:
  - Electromagnetic Compatibility
  - Operations and Maintenance
  - System Integration
  - System Assurance
  - Safety and Security
  - Sustainability

As the UP Express route includes portions of both the existing Union Station (USRC) and Kitchener rail corridors, the preliminary design for UP Express electrification was prepared based on *Part 3 – Kitchener Corridor Conceptual Design* and *Part 5 – Union Station Rail Corridor Conceptual Design*.

5.2 Base Case Scenario

The following provides an overview of the base case scenario (i.e., existing conditions prior to implementing electrification) in order to describe the context within which the preliminary design for UP Express Electrification was prepared.

- The UP Express route begins at the future UP Express Union Station (just west of Union Station train shed), where it follows the Union Station Rail Corridor (USRC), then along the Kitchener (previously Georgetown) corridor to the new airport spur line (beginning at Highway 427), and into the new UP Express Terminal 1 Station at Toronto Pearson International Airport;
- The new airport spur line from Highway 427 to the future UP Express Terminal 1 Station at Toronto Pearson International Airport (currently under construction) will be in place;
- UP Express Service from UP Express Union Station to UP Express Pearson Station will be in operation as of 2015, and will operate initially with Tier 4 DMUs;
- The fourth track along the Georgetown South section of the Kitchener corridor will be in place; and
- Noise walls recommended as part of the Georgetown South Service Expansion and Union-Pearson Rail Link (GSSE-UPRL) EA will be in place.

5.2.1 Key Design Assumptions

As established through the *GO Transit Electrification Study* (Metrolinx, 2010) and confirmed through the *Traction Power Supply Report* (2012, LTK Engineering Services), UP Express electrification will be achieved through a 2x25 kV *ac* autotransformer fed electrification system, with a 1x25 kV system along the airport spur.

In addition, the following key assumptions were established as part of developing the preliminary design:

- The design will include the provision for a route for Double-Stacked Freight along the corridor (excluding the airport spur);
- The design will accommodate single level EMUs for the UP Express, as well as electric locomotive or bi-level EMU for GO Trains;
- The OCS will be designed to protect for the future track expansion to allow for increased service along the GO Kitchener, Milton and GO Barrie corridors;
- The OCS and the traction power facilities will be designed to accommodate the provision for the future electrification of the Kitchener and Lakeshore corridors;
- The OCS design will minimize attachments to bridges along the corridor;
- The airport spur from Highway 427 to UP Express Pearson Station will be electrified; and
- The Electrification Control Centre will be co-located with the new GO Transit Control Centre (GTCC) in Oakville.

5.3 Power Supply – Hydro One

As mentioned previously, Hydro One Networks Inc. (Hydro One) will provide the power supply components necessary to electrify the UP Express system. Therefore, Hydro One is carrying out a separate Class EA process to assess the potential effects of implementing a new Traction Power Substation and associated 230 kV connection cables from their existing high voltage transmission lines. These components will provide the required electrical power supply for UP Express electrification. A brief description of these power supply components has been included below for context purposes. More detailed information is contained in *Hydro One's Union Pearson Express Electrification Traction Power Substation Class Environmental Assessment – Draft Environmental Study Report, (March, 2014).*

5.3.1 230 kV connection cables

Electric power for the UP Express system will be provided by Hydro One by tapping 230 kV feeders (connection cables) from two 230 kV overhead transmission circuits emanating from the existing Hydro One Richview 230 kV substation. These two new 230 kV transmission connection line taps will connect to a new Traction Power Substation (TPS) at 175 City View Drive (see **Figure 5-1**).

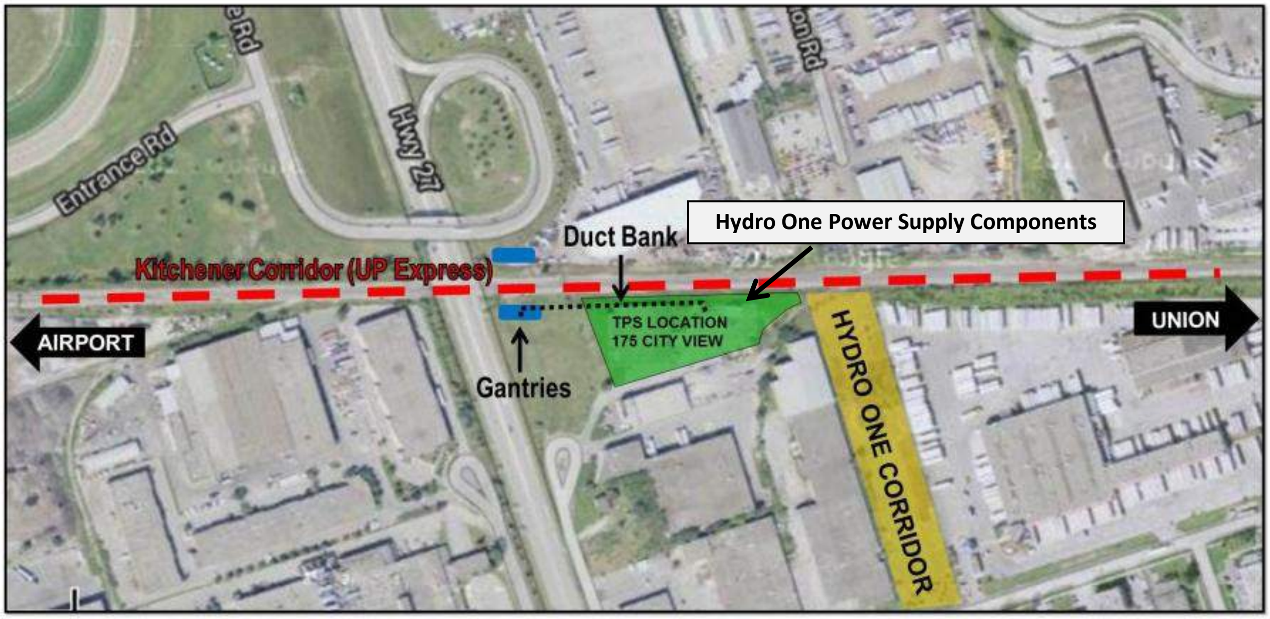
5.3.2 Traction Power Substation

The proposed Traction Power Substation (TPS) will transform the utility supply voltage of 230 kV (provided via the 230 kV connection cables) to the appropriate voltage, i.e., 50 kV and 25 kV for distribution to the UP Express EMU trains along the rail corridor. The TPS will contain two main transformers of 30 MVA capacity each.

5.3.2.1 TPS Grounding and Bonding

The grounding system for the new traction power substation has been described and assessed as part of Hydro One's Class EA for Minor Transmission Facilities process. Further details are documented in *Hydro One's Union Pearson Express Electrification Traction Power Substation Class Environmental Assessment – Draft Environmental Study Report* (*March 2014).*

FIGURE 5-1 HYDRO ONE POWER SUPPLY COMPONENTS



Note: conceptual graphic only

5.3.2.2 Gantries and 25kV Feeders at 175 City View Drive (Power Distribution Components)

It is noted that there are two power distribution components (see **Figure 5-1**) at the 175 City View Drive TPS, which have been described and assessed as part of this EPR, as they will be implemented by Metrolinx as part of the UP Express electrification undertaking:

- Set of two gantries within the rail corridor ROW
- 25 kV feeders that will be installed via underground duct banks

Section 5.5.5.5 below provides further detail on the design and proposed locations of the gantries and 25 kV feeders at the City View Traction Power Substation site.

5.4 Electrification System

5.4.1 2 x 25 kV System - UP Express Union Station to Highway 427

Electrification of the corridor from UP Express Union Station to Highway 427 will be achieved through a 2 x 25 kV distribution system attached to the OCS support structures. In locations where space is limited, such as bridges and above station platforms, an insulated feeder cable may be used. An insulated feeder provides the same function as the bare auto-transformer feeder, however as it is an insulated cable there is no requirement to maintain an electrical clearance to the cable.

The static wire maintains the metallic parts of the supporting structures at earth potential, and provides a return path for any fault currents that may occur while the system is in operation. An auto-transformer feeder wire and a static wire are generally located on either side of the railway corridor. The purpose of the auto-transformer feeder is to transmit traction power along the route. The voltages between the auto-transformer feeder and the rails and the OCS equipment are both 25 kV. The potential difference between the auto-transformer feeder and OCS equipment is 50 kV. In the UP Express system, power is therefore transmitted at 50 kV between the Traction Power Substation and the autotransformer preceding it, which increases the required feeding distance.

Essentially, the electrical power for UP Express will be transmitted at a voltage (i.e., 50 kV) higher than that necessary to power the EMU (i.e., 25 kV). As a result, there are lower currents involved in the transmission of power and therefore lower voltage drops in the catenary system.

5.4.2 1 x 25 kV System - Airport Spur

The electrification design for the UP Express Spur Link from Highway 427 to Pearson Airport was undertaken by AirLinx/AECOM. Based on the proposed configuration and length of the spur alignment, it was determined that a 1x25 kV OCS system would be implemented for the spur.

5.5 Power Distribution System

5.5.1 Overhead Contact System – UP Express Union Station to Highway 427

The overhead contact system (OCS) is a fundamental component of the overall traction power distribution system for the UP Express service. The OCS consists of a wiring system (i.e., messenger wire and contact wire) that provides efficient transfer of traction power to the pantograph (mounted on the EMU train), and then to the EMU electric drive motors (see **Figure 5-2**).

The catenary configuration is generally dependent on a combination of factors including: train speed, wire size, system height (i.e., maximum space between contact wire and messenger wire), climatic conditions and pole spacing.

In order to ensure efficient transmission of electric traction power to the trains, the contact wire and the pantograph mounted on the train must be in contact. The OCS for UP Express will be an auto-tensioned system; this means that tension in the overhead contact system wires remains constant throughout the range of climatic conditions. The tensioning is provided by a balance weight wheel.

5.5.1.1 Contact Wire Height

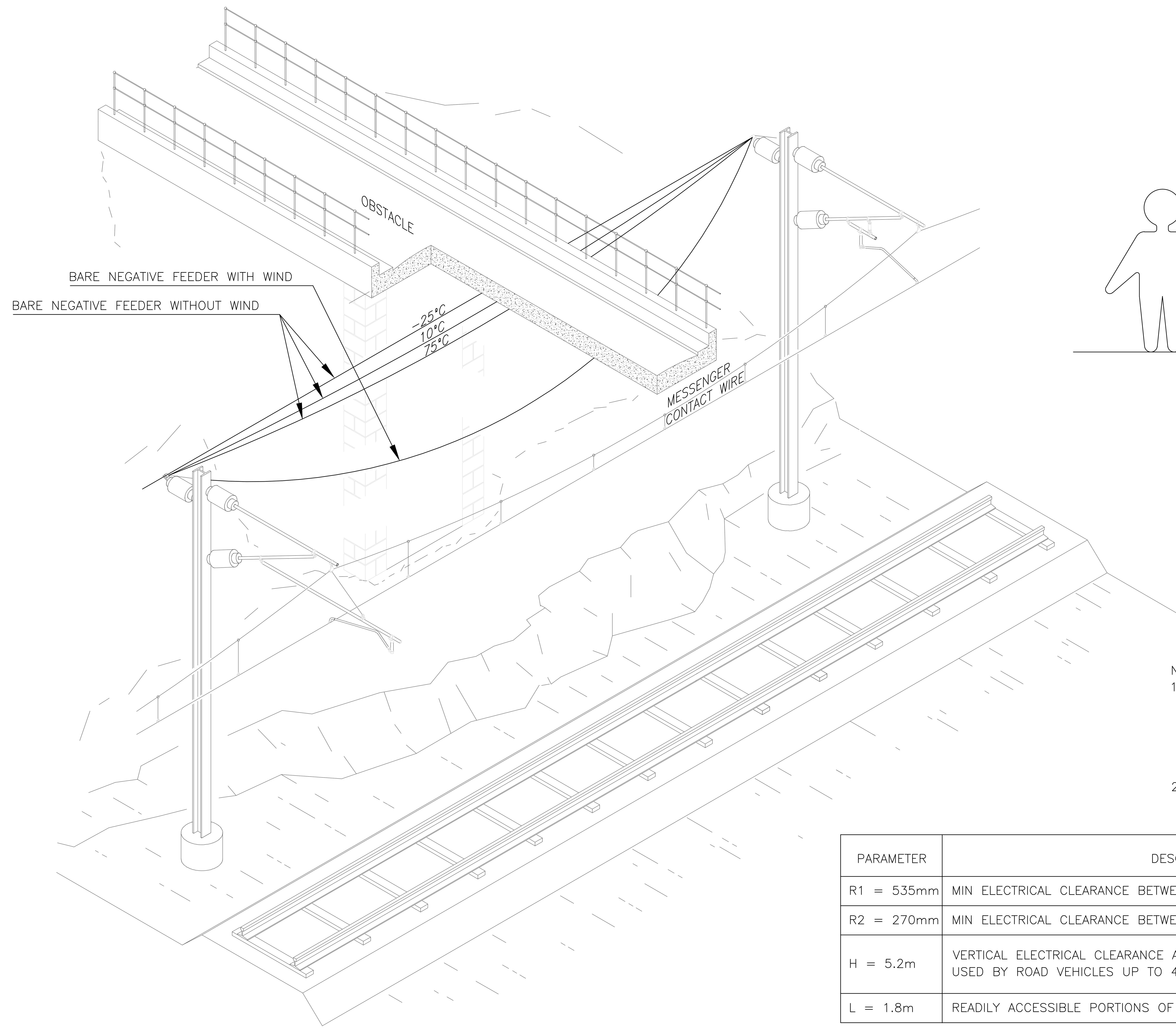
The contact wire height needs to be designed for UP Express trains, however it also needs to be designed to accommodate the multiple types of trains that operate within the corridor (i.e., Double Stacked Freight, GO Bi-levels, VIA, etc.). Therefore, the height of the contact wire for UP Express was designed to accommodate the highest vehicle vertical clearance, which is Double Stacked Freight.

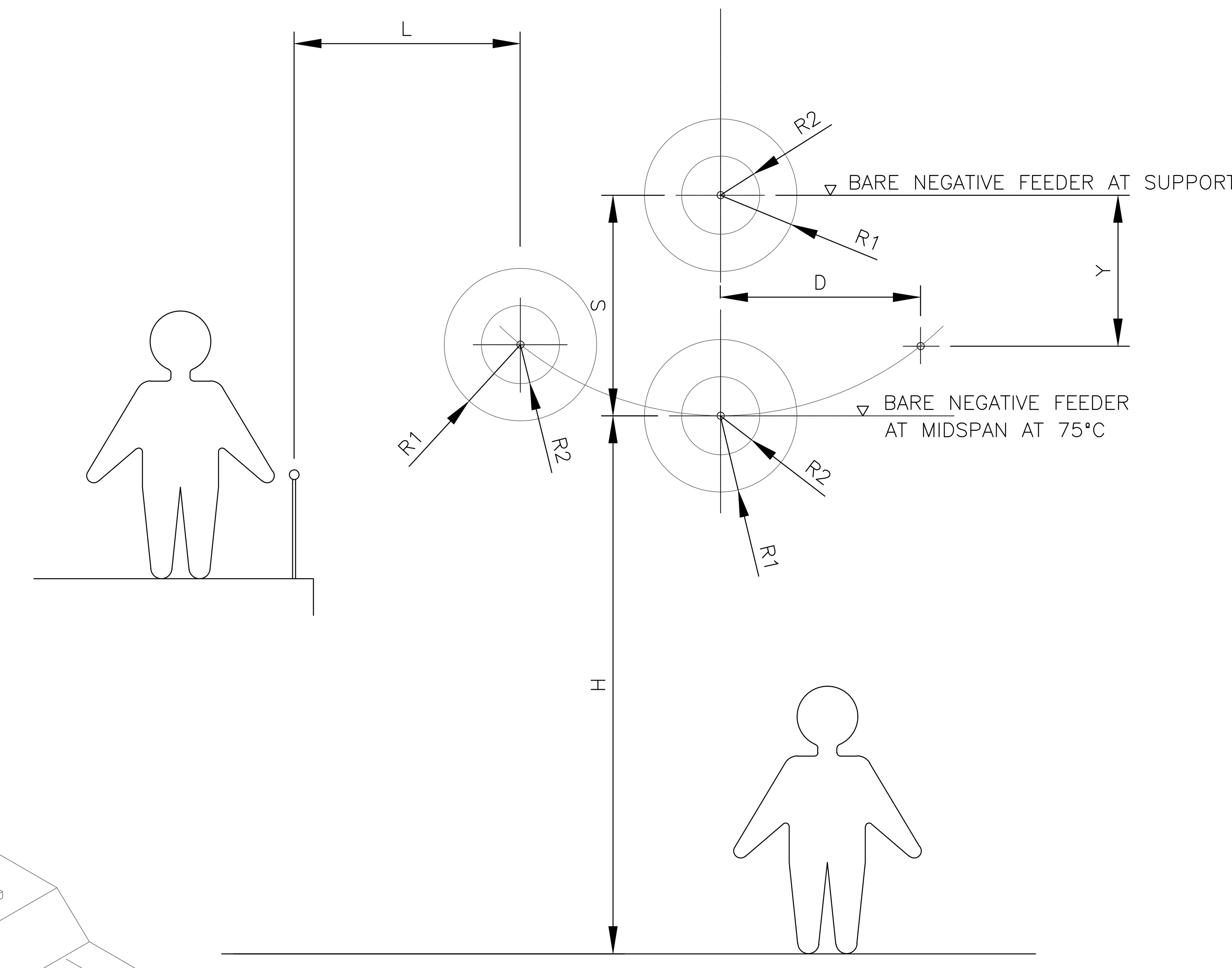
5.5.1.2 OCS Support Structures

The OCS will be suspended from a number of galvanized steel support structures (i.e., portals and cantilevers) placed along the corridor, including on bridges and overpasses where required. Generally, the number of tracks to be spanned dictates the type of structure required, i.e., portals are typically used when spanning three or more tracks, whereas cantilevers are used when one or two tracks are spanned (see **Figure 5-3** and **Figure 5-4** respectively). The majority of OCS support structures will be situated within the existing Metrolinx-owned rail Right-of-Way (ROW) along the corridor, except for a small number of locations where there is not enough horizontal clearance within the existing rail ROW to accommodate the structures. Therefore, property maybe required at these particular locations (see Section 6.9 of this EPR for more detailed information regarding easements).

<u>Height of OCS Support Structures</u>

As mentioned, the vertical clearance requirements associated with the OCS design were primarily determined by the required clearances for Double Stacked Freight (see **Figure 5-5**). Therefore, the portals/cantilevers used to support catenary wires over the electrified UP Express route will range between approximately 7.6m to 12m above the top of the highest rail.





NOTES
1. FOR A 65m SPAN:
   D = 739mm : HORIZONTAL DISPLACEMENT OF BARE NEGATIVE FEEDER AT MID SPAN AT 44°C (35m/s WIND)
   Y = 377mm : SAG OF BARE NEGATIVE FEEDER AT MID SPAN AT 44°C (35m/s WIND)
   S = 1087mm : SAG OF BARE NEGATIVE FEEDER AT MID SPAN AT 75°C (NO WIND)

2. STATIC WIRE IS OMITTED FOR CLARITY.

PARAMETER	DESCRIPTION	REFERENCE
R1 = 535mm	MIN ELECTRICAL CLEARANCE BETWEEN BARE NEGATIVE FEEDER AND LIVE PART AT +25kV	AREMA MANUAL CHAPTER 33 TABLE 33.2.2
R2 = 270mm	MIN ELECTRICAL CLEARANCE BETWEEN BARE NEGATIVE FEEDER AND EARTHED OBSTACLE	
H = 5.2m	VERTICAL ELECTRICAL CLEARANCE ABOVE GROUND OR RAILS (INCLUDING OVERLAND USED BY ROAD VEHICLES UP TO 4.15m HIGH)	CANADIAN STANDARD C22.3 No 1-10 TABLE 2
L = 1.8m	READILY ACCESSIBLE PORTIONS OF BRIDGES	CANADIAN STANDARD C22.3 No 1-10 TABLE 10

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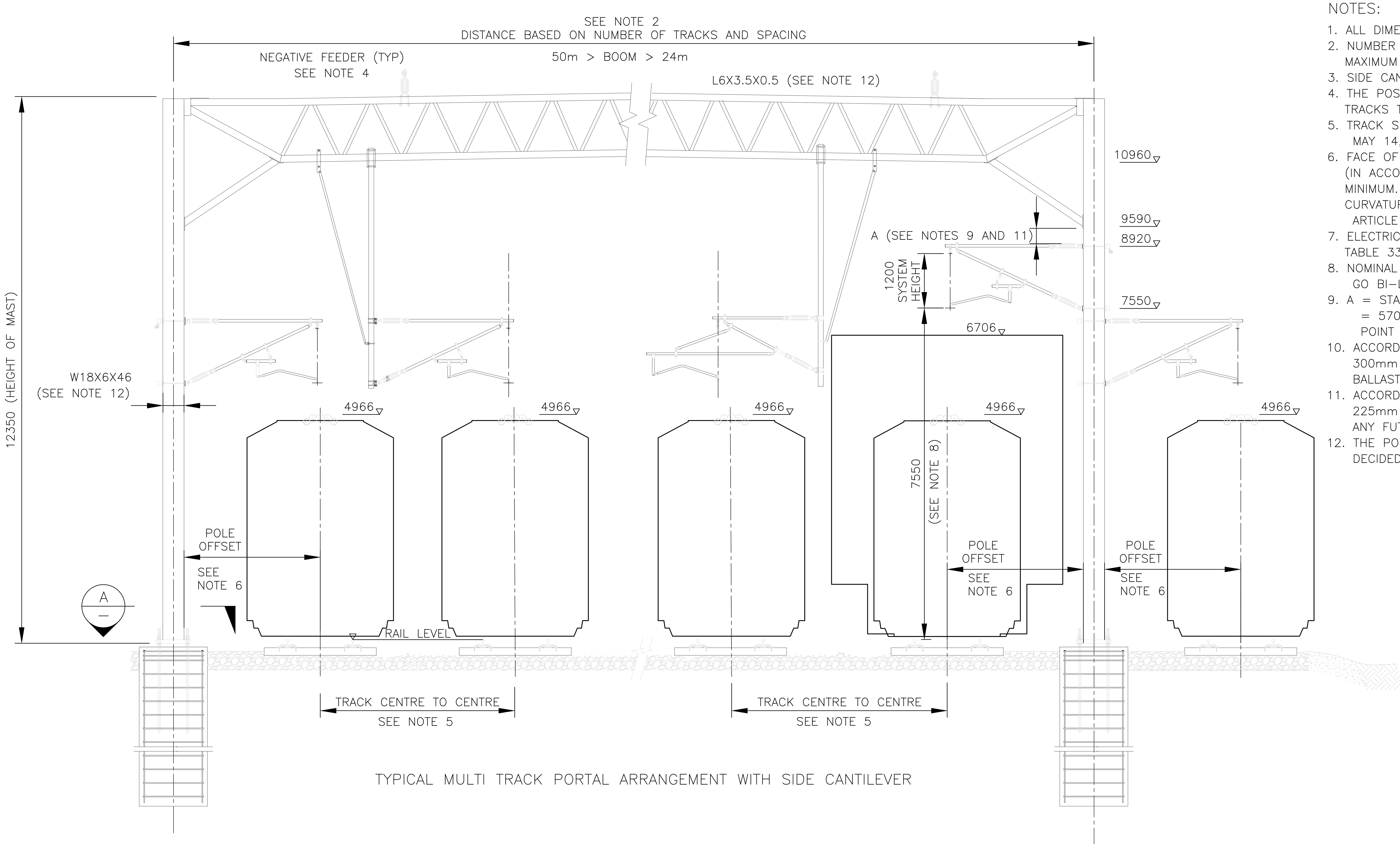
SCALE: NTS   FULL SIZE ONLY

METROLINX

GO ELECTRIFICATION
PRELIMINARY DESIGN
UP EXPRESS
CLEARANCE TO OBSTACLES

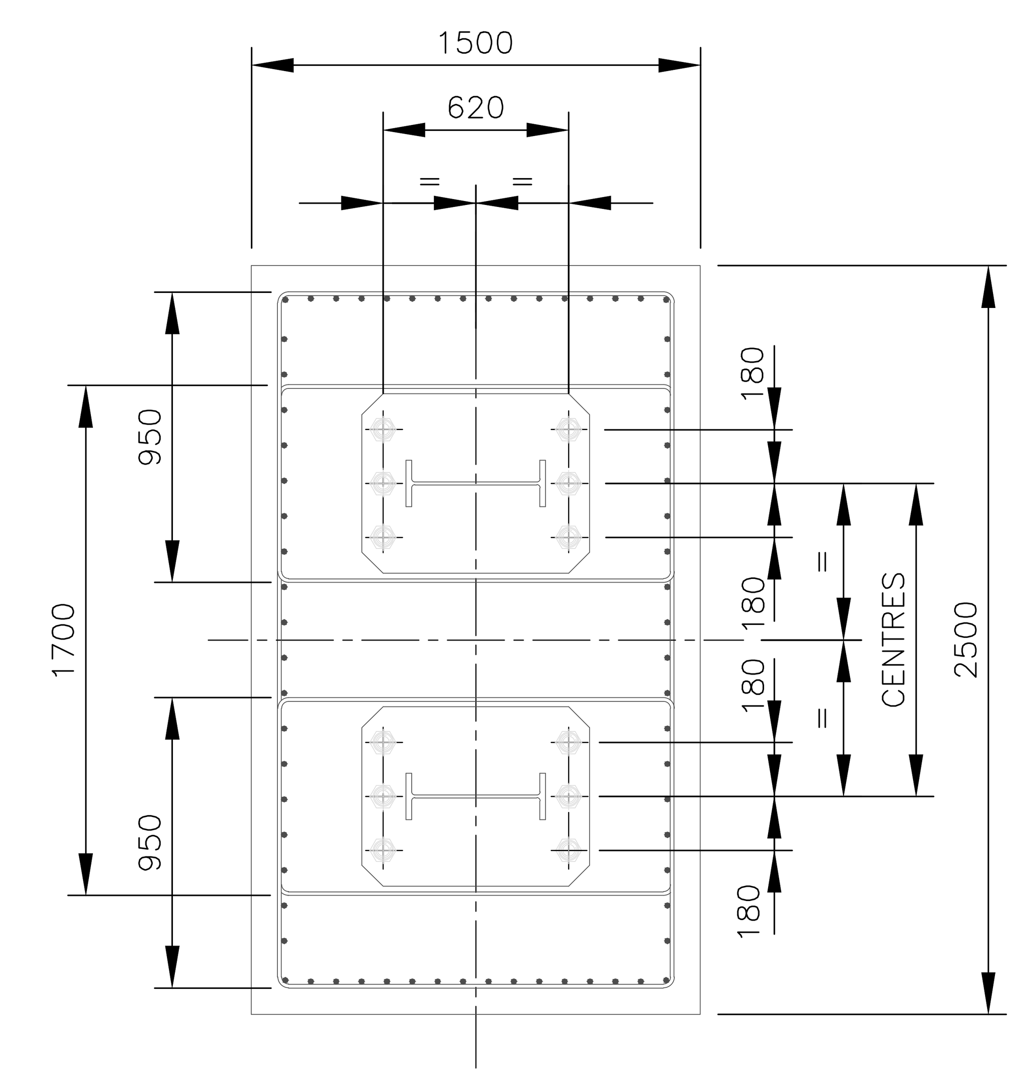
FIGURE 5 - 2



TYPICAL MULTI TRACK PORTAL ARRANGEMENT WITH SIDE CANTILEVER

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.
2. NUMBER OF TRACKS SHOWN IS TYPICAL ONLY AND CAN BE INCREASED UP TO A MAXIMUM BOOM LENGTH OF 50m.
3. SIDE CANTILEVER SUPPORTS CAN BE USED AS REQUIRED.
4. THE POSITION OF NEGATIVE FEEDER CONDUCTORS TO BE BASED ON THE POSITION OF TRACKS TO BE ELECTRIFIED.
5. TRACK SPACING (3960mm MIN) AS PER CANADIAN STANDARD TCE-05 DATED MAY 14, 1992.
6. FACE OF OCS STRUCTURE TO TRACK CENTRE LINE TO BE 2900mm NOMINAL (IN ACCORDANCE WITH AREMA CHAPTER 33 ARTICLE 4.2.3.2), 2700mm MINIMUM. ON CURVES LATERAL DISTANCE TO BE INCREASED BY 25mm PER DEGREE OF CURVATURE (BOTH AREMA CHAPTER 33 ARTICLE 4.2.3.3 AND CSA C22.3 NO.1-10 ARTICLE 5.4.3).
7. ELECTRICAL CLEARANCES BASED ON AREMA MANUAL CHAPTER 33 PART 2 TABLE 33-2-2.
8. NOMINAL CONTACT WIRE HEIGHT TO ALLOW DOUBLE STACK FREIGHT GAUGE. FOR GO BI-LEVEL GAUGE SEE DRAWING OC-UP-045.
9. A = STATIC CLEARANCE (270) + 300 (SEE NOTES 10 & 11)
   = 570 FROM THE HIGHEST LIVE PART OF CANTILEVER TO THE LOWEST POINT OF THE BOOM BRACE.
10. ACCORDING TO CSA C22.3 NO. 1-10 CLAUSE 5.3.1.1(c), AN ADDITIONAL 300mm VERTICAL CLEARANCE HAS BEEN ADDED TO PERMIT ANY FUTURE BALLAST ADJUSTMENT.
11. ACCORDING TO CSA C22.3 NO. 1-10 CLAUSE 5.3.1.1(d), AN ADDITIONAL 225mm VERTICAL CLEARANCE TO BE ADDED WHERE REQUIRED TO PERMIT ANY FUTURE RISE OF THE ROAD SURFACE.
12. THE POLE AND BOOM SIZES SHOWN ARE TYPICAL ONLY. FINAL SIZES TO BE DECIDED AT THE DETAILED DESIGN STAGE.



SECTION A

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SCALE: NTS
FULL SIZE ONLY

METROLINX

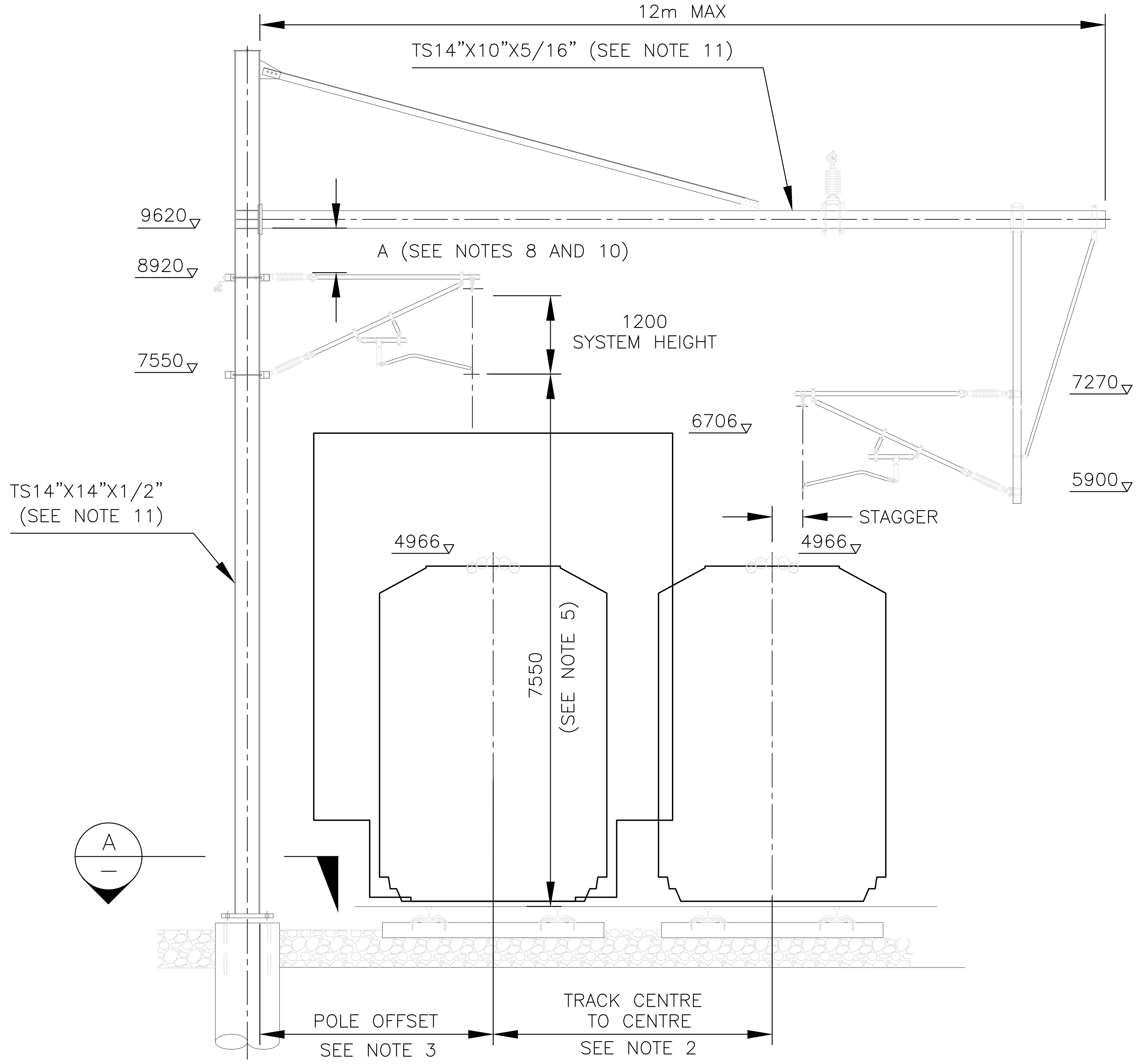
GO ELECTRIFICATION
PRELIMINARY DESIGN
UP EXPRESS
PORTAL (24M – 50M) (DOUBLE STACK FREIGHT GAUGE)

FIGURE 5 - 3

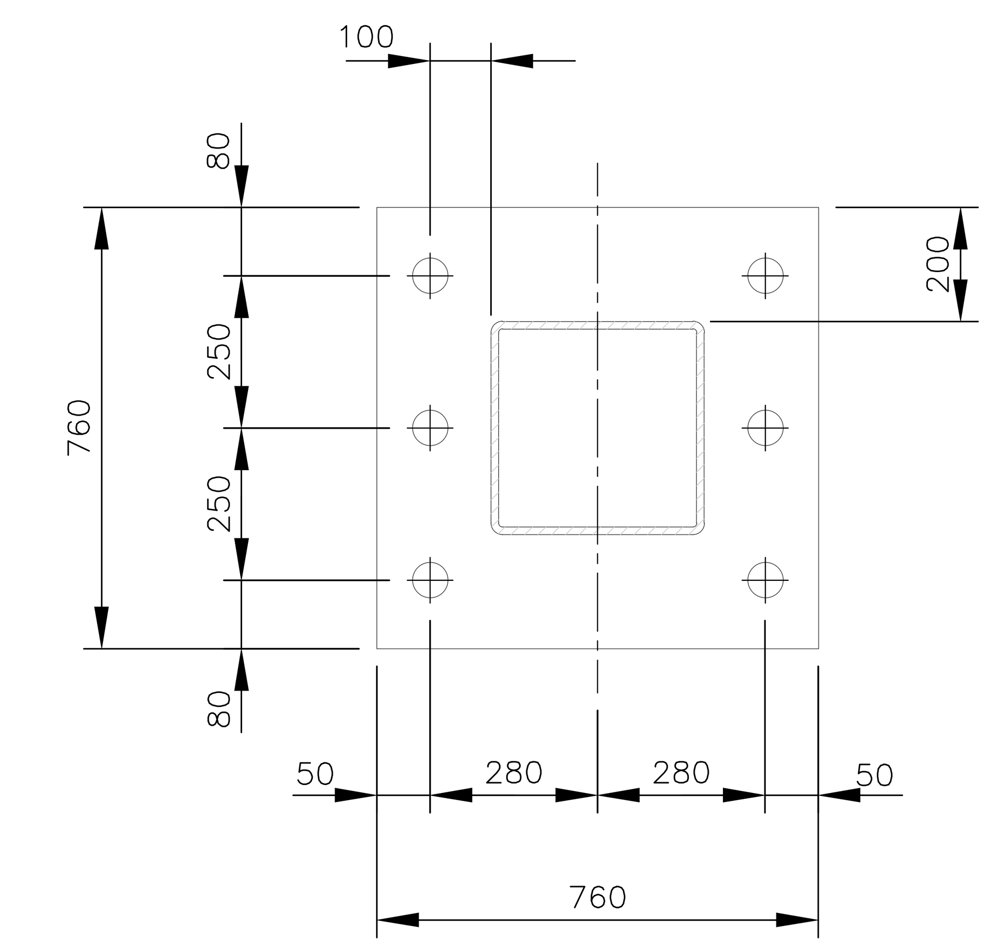
Filename: P:\Y362\2013\CA10013LS – Network Wide Preliminary Design\UP Express OCS\Toronto – Basic Design\EN007-DRG-GA-00000002.dwg
Plotted: January 21, 2014 by: Jun, Soo

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.
2. TRACK SPACING (3960mm MIN) AS PER CANADIAN STANDARD TCE-05 DATED MAY 14, 1992.
3. FACE OF OCS STRUCTURE TO TRACK CENTRE LINE TO BE 2900mm NOMINAL (IN ACCORDANCE WITH AREMA CHAPTER 33 ARTICLE 4.2.3.2), 2700mm MINIMUM. ON CURVES LATERAL DISTANCE TO BE INCREASED BY 25mm PER DEGREE OF CURVATURE (BOTH AREMA CHAPTER 33 ARTICLE 4.2.3.3 AND CSA C22.3 NO.1-10 ARTICLE 5.4.3).
4. NEGATIVE FEEDER IS SHOWN ON TOP OF THE BOOM BUT MAY BE INSTALLED ON THE MAST BASED ON SITE REQUIREMENTS.
5. NOMINAL CONTACT WIRE HEIGHT TO ALLOW DOUBLE STACK FREIGHT. GAUGE. FOR GO BI-LEVEL GAUGE SEE DRAWING OC-UP-046
6. TRACK CENTRES MUST MAKE DUE ALLOWANCE FOR SUPERELEVATION AND CURVATURE. (AS SPECIFIED IN CANADIAN STANDARD TCE-05).
7. ELECTRICAL CLEARANCES BASED ON AREMA MANUAL CHAPTER 33 PART 2 TABLE 33-2-2.
8. A = STATIC CLEARANCE (270) + 300 (SEE NOTES 9 & 10) = 570 FROM THE HIGHEST LIVE PART OF CANTILEVER.
9. ACCORDING TO CSA C22.3 NO. 1-10 CLAUSE 5.3.1.1(c), AN ADDITIONAL 300mm VERTICAL CLEARANCE HAS BEEN ADDED TO PERMIT ANY FUTURE BALLAST ADJUSTMENT.
10. ACCORDING TO CSA C22.3 NO. 1-10 CLAUSE 5.3.1.1(d), AN ADDITIONAL 225mm VERTICAL CLEARANCE TO BE ADDED WHERE REQUIRED TO PERMIT ANY FUTURE RISE OF THE ROAD SURFACE.
11. THE POLE AND BOOM SIZES SHOWN ARE TYPICAL ONLY. FINAL SIZES TO BE DECIDED AT THE DETAILED DESIGN STAGE.



TYPICAL TWO TRACK CANTILEVER ARRANGEMENT



SECTION A

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SCALE: NTS FULL SIZE ONLY

METROLINX

GO ELECTRIFICATION

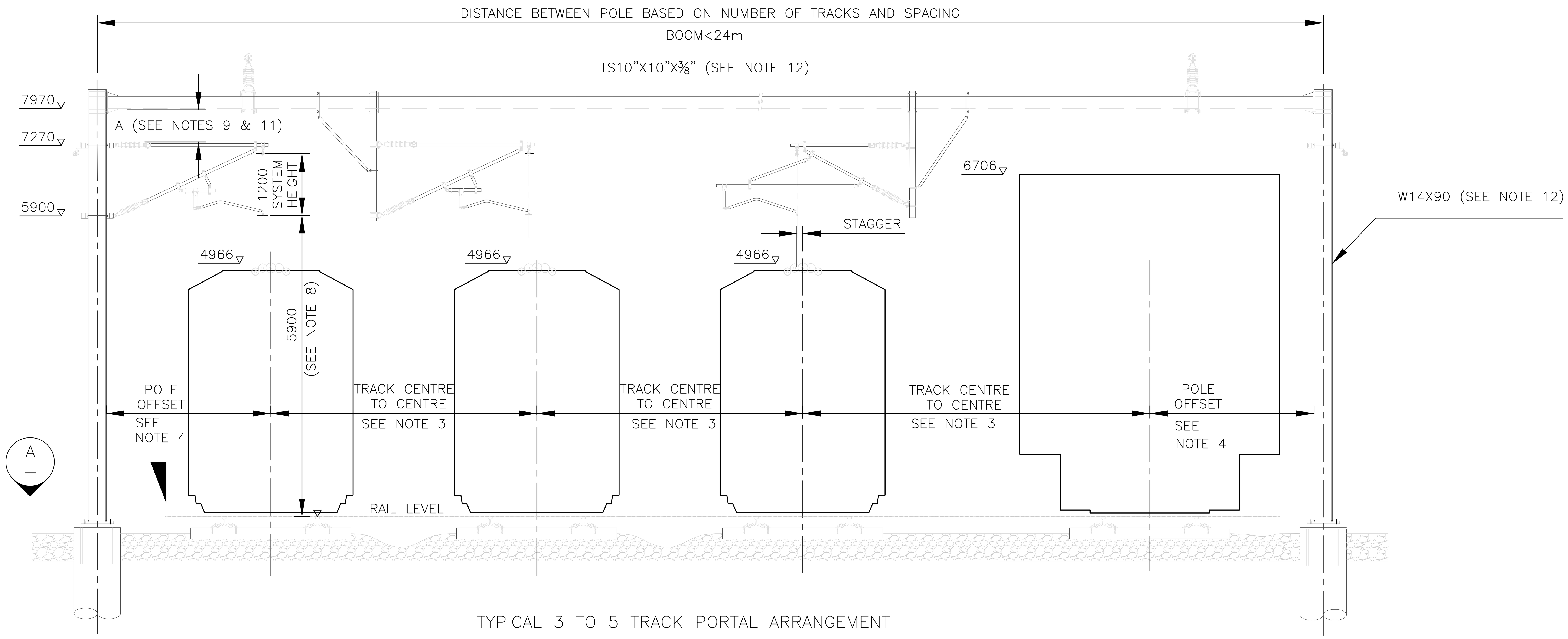
PRELIMINARY DESIGN

UP EXPRESS

TWO TRACK CANTILEVER (DS FREIGHT GAUGE)

FIGURE 5 - 4

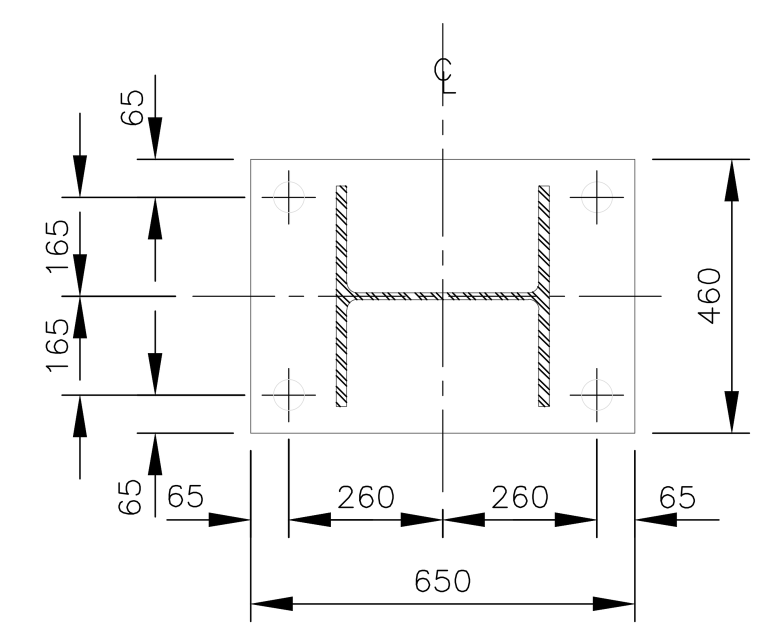
Filename: P:\Y362\2013\CA10013LS - Network Wide Preliminary Design\UP Express OCS\Toronto - Basic Design\EN007-DRG-ASS-00000023.dwg
Plotted: January 21, 2014 by: Jun, Soo



TYPICAL 3 TO 5 TRACK PORTAL ARRANGEMENT

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.
2. ALL THE DIMENSIONS ARE TAKEN FROM TOP OF HIGH RAIL.
3. TRACK SPACING (3960mm MIN) AS PER CANADIAN STANDARD TCE–05 DATED MAY 14, 1992.
4. FACE OF OCS STRUCTURE TO TRACK CENTRE LINE TO BE 2900mm NOMINAL (IN ACCORDANCE WITH AREMA CHAPTER 33 ARTICLE 4.2.3.2), 2700mm MINIMUM. ON CURVES LATERAL DISTANCE TO BE INCREASED BY 25mm PER DEGREE OF CURVATURE (BOTH AREMA CHAPTER 33 ARTICLE 4.2.3.3 AND CSA C22.3 NO.1–10 ARTICLE 5.4.3).
5. FOR FOUNDATION DETAILS REFER OC–UP–012 AND OC–UP–013.
6. TYPICAL FOUR TRACKS ARE SHOWN BUT CAN BE EXTENDED TO FIVE TRACKS.
7. ELECTRICAL CLEARANCES BASED ON AREMA MANUAL CHAPTER 33 PART 2 TABLE 33–2–2.
8. NOMINAL CONTACT WIRE HEIGHT TO ALLOW GO BI–LEVEL GAUGE. FOR DOUBLE STACK FREIGHT GAUGE SEE DRAWING OC–UP–048
9. A = STATIC CLEARANCE (270) + 300 (SEE NOTES 10 & 11)
   = 570 FROM THE HIGHEST LIVE PART OF THE CANTILEVER.
10. ACCORDING TO CSA C22.3 NO. 1–10 CLAUSE 5.3.1.1(c), AN ADDITIONAL 300mm VERTICAL CLEARANCE HAS BEEN ADDED TO PERMIT ANY FUTURE BALLAST ADJUSTMENT.
11. ACCORDING TO CSA C22.3 NO. 1–10 CLAUSE 5.3.1.1(d), AN ADDITIONAL 225mm VERTICAL CLEARANCE TO BE ADDED WHERE REQUIRED TO PERMIT ANY FUTURE RISE OF THE ROAD SURFACE.
12. THE POLE AND BOOM SIZES SHOWN ARE TYPICAL ONLY. FINAL SIZES TO BE DECIDED AT THE DETAILED DESIGN STAGE.



SECTION A

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SCALE: NTS FULL SIZE ONLY

METROLINX

GO ELECTRIFICATION
PRELIMINARY DESIGN
UP EXPRESS
PORTAL (UP TO 24M) (GO BI–LEVEL GAUGE)

FIGURE 5 - 5

Spacing of OCS Support Structures

The OCS support structures will be positioned along the track at a maximum spacing of 65m. The maximum 65m maximum span is dictated by two factors:

- The contact wire must always be in contact with the pantograph such that electric traction can be maintained. This factor is largely dependent on a number of variables such as: sway of the train, track tolerances, wiring configuration, etc. Lateral displacement of the contact wire at the mid-point between OCS structures can be caused by wind blowing on the wire or track curvature.

- The requirement to maintain sufficient space between two consecutive OCS structures in order to position a hanger between the messenger wire and the contact wire. Generally, OCS structure spacing is reduced at curves, at locations where vertical clearance is restricted, and/or in areas where there is increased exposure to wind.

During the detailed design phase, it is recognized that additional refinements will be made to the OCS design. Notwithstanding this, substantive changes to portal locations beyond a 5m range are not anticipated.

5.5.2 Overhead Contact System – Highway 427 to UP Express Pearson Station (Spur)

5.5.2.1 Contact Wire Height

With respect to the spur portion of the UP Express route, the contact wire height was based on the specifications of the UP Express DMUs which can be converted to electric trains, as these will be the only trains that will operate along this portion of the corridor.

5.5.2.2 OCS Support Structures

Height of OCS Support Structures

The vertical clearance requirements associated with the OCS design along the spur were determined by the required clearances for DMU UP Express train that will be initially operating on the spur.

Spacing of OCS Support Structures

The OCS support structures will be positioned along the track at a maximum spacing of 60m.

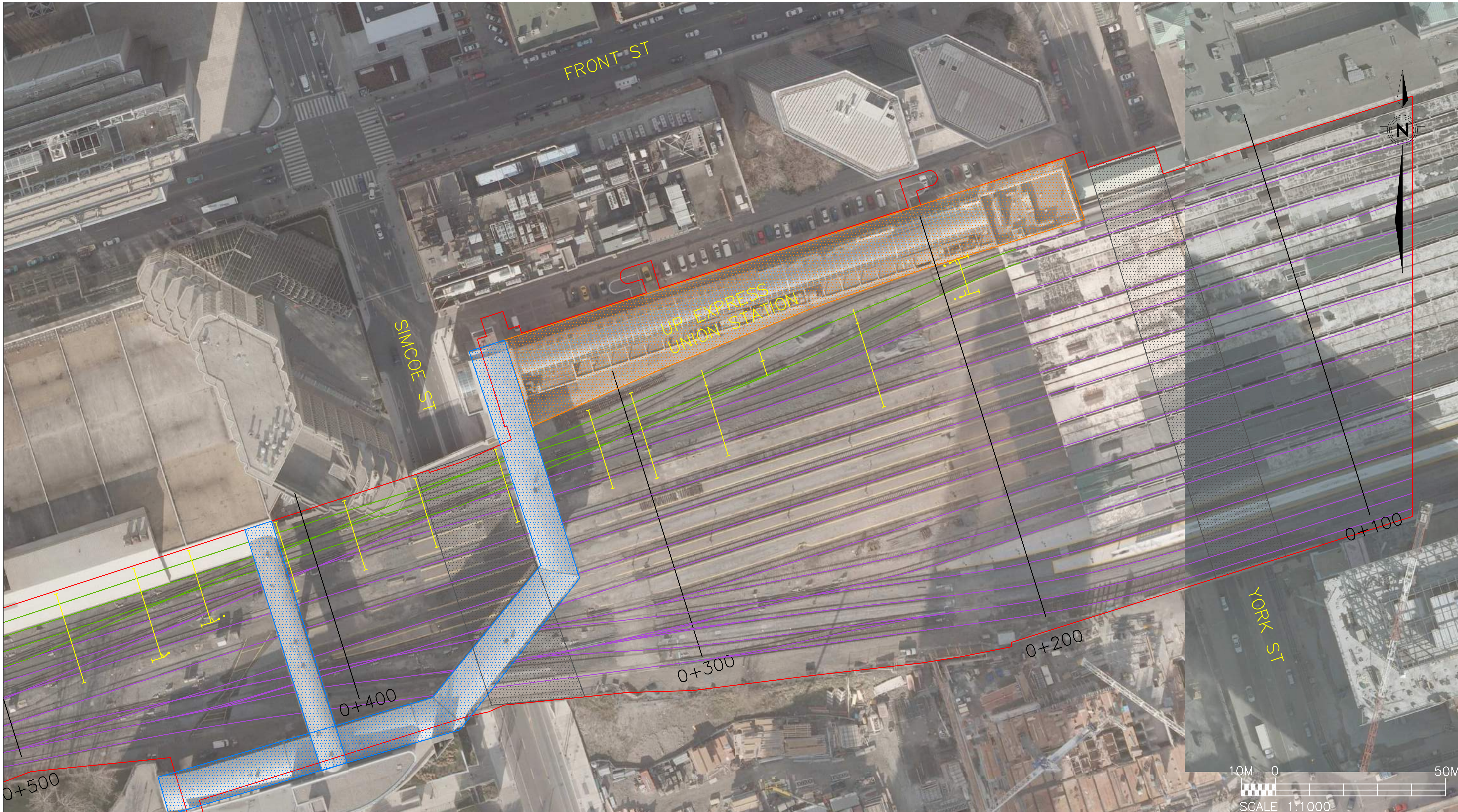
5.5.3 Summary of OCS Support Structures

Table 5-1 summarizes the number of OCS support structures required within each corridor section.

TABLE 5-1 OCS SUPPORT STRUCTURES BY CORRIDOR SECTION

Section	Length (km)	# of Structures*	Height (m)
1 – Union to Bloor	6.5	148	7.6 – 12
2 – Bloor to Weston	7.5	145	
3 – Weston to Hwy 427	7.8	171	
4 – Hwy 427 to Airport	3.2	96	~ 7.6
Total	***25km***	***560***	***7.6 – 12m***

**Based on preliminary design (approximate spacing of 65m along the mainline corridor.)*



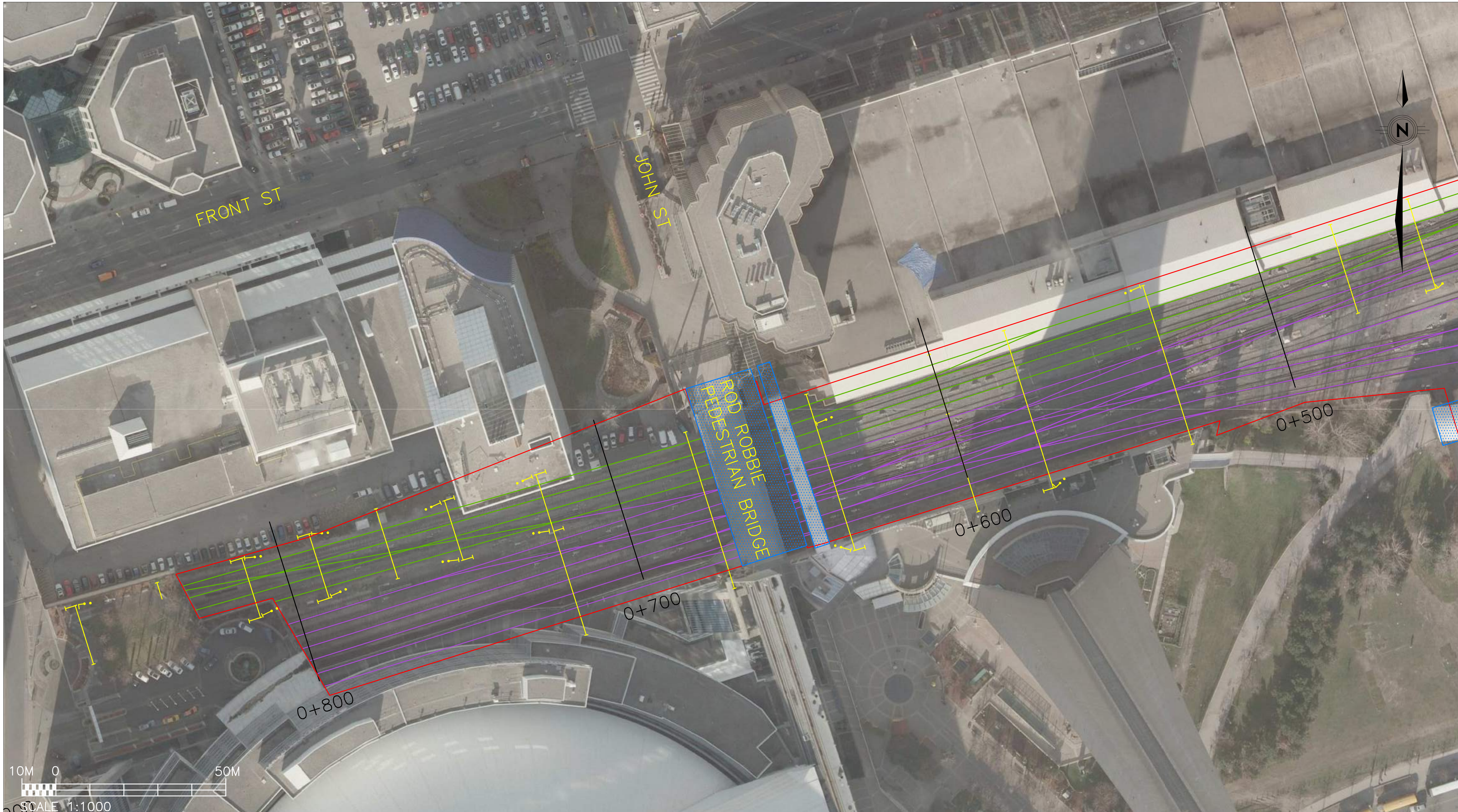
NOTES:

1. AERIAL PHOTOGRAPHS DATED 2011 FOR CITY OF TORONTO & 2013 FOR CITY OF MISSISSAUGA;
2. LARGE STRUCTURES MAY APPEAR TO STICK INTO METROLINX R.O.W. DUE TO ORTHOGONAL CORRECTION;
3. METRO TORONTO CONVENTION CENTRE OVERHANGS METROLINX R.O.W.;
4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

LEGEND:

- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

1	PRELIMINARY DESIGN



NOTES:

1. AERIAL PHOTOGRAPHS DATED 2011 FOR CITY OF TORONTO & 2013 FOR CITY OF MISSISSAUGA;
2. LARGE STRUCTURES MAY APPEAR TO STICK INTO METROLINX R.O.W. DUE TO ORTHOGONAL CORRECTION;
3. METRO TORONTO CONVENTION CENTRE OVERHANGS METROLINX R.O.W.;
4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

LEGEND:

- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
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2 PRELIMINARY DESIGN

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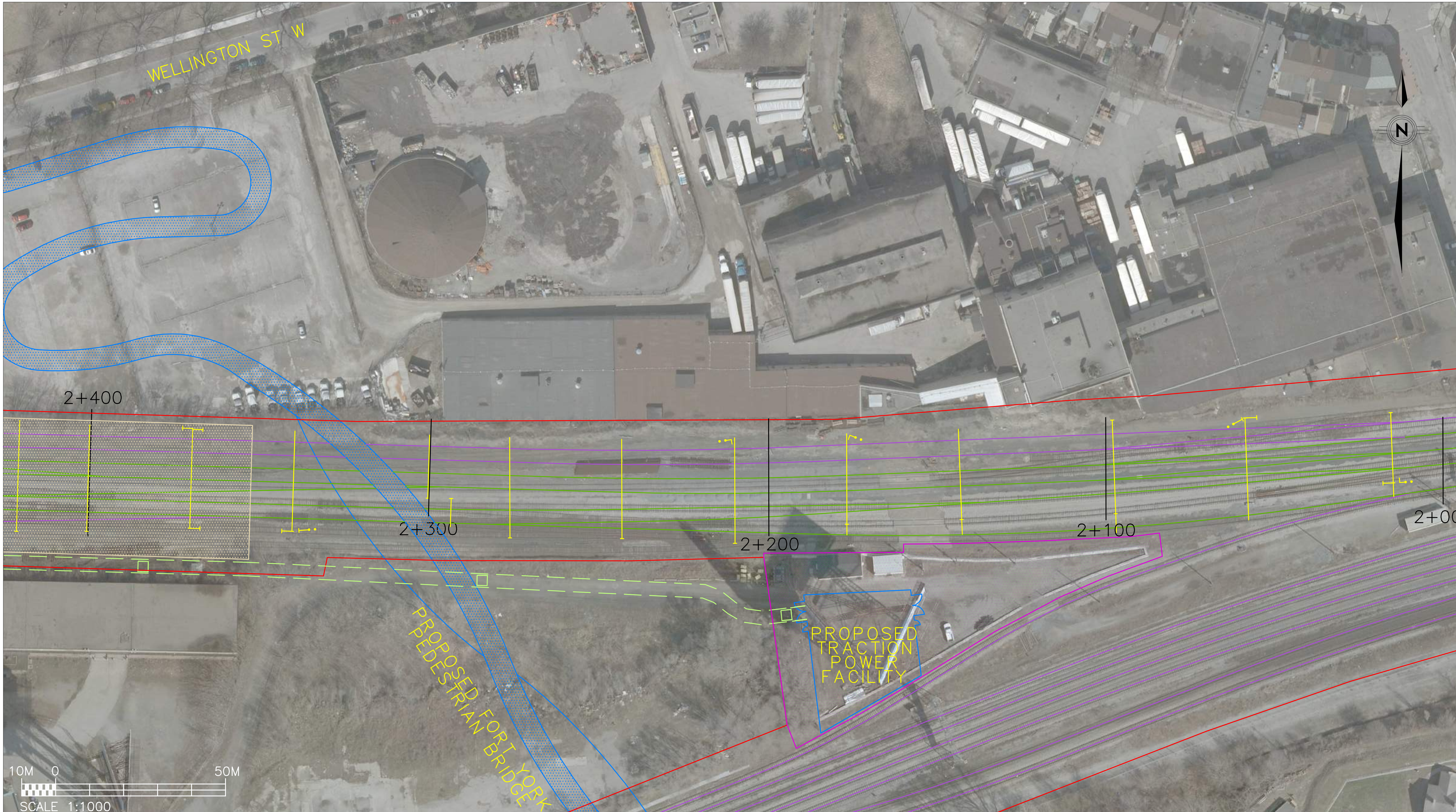

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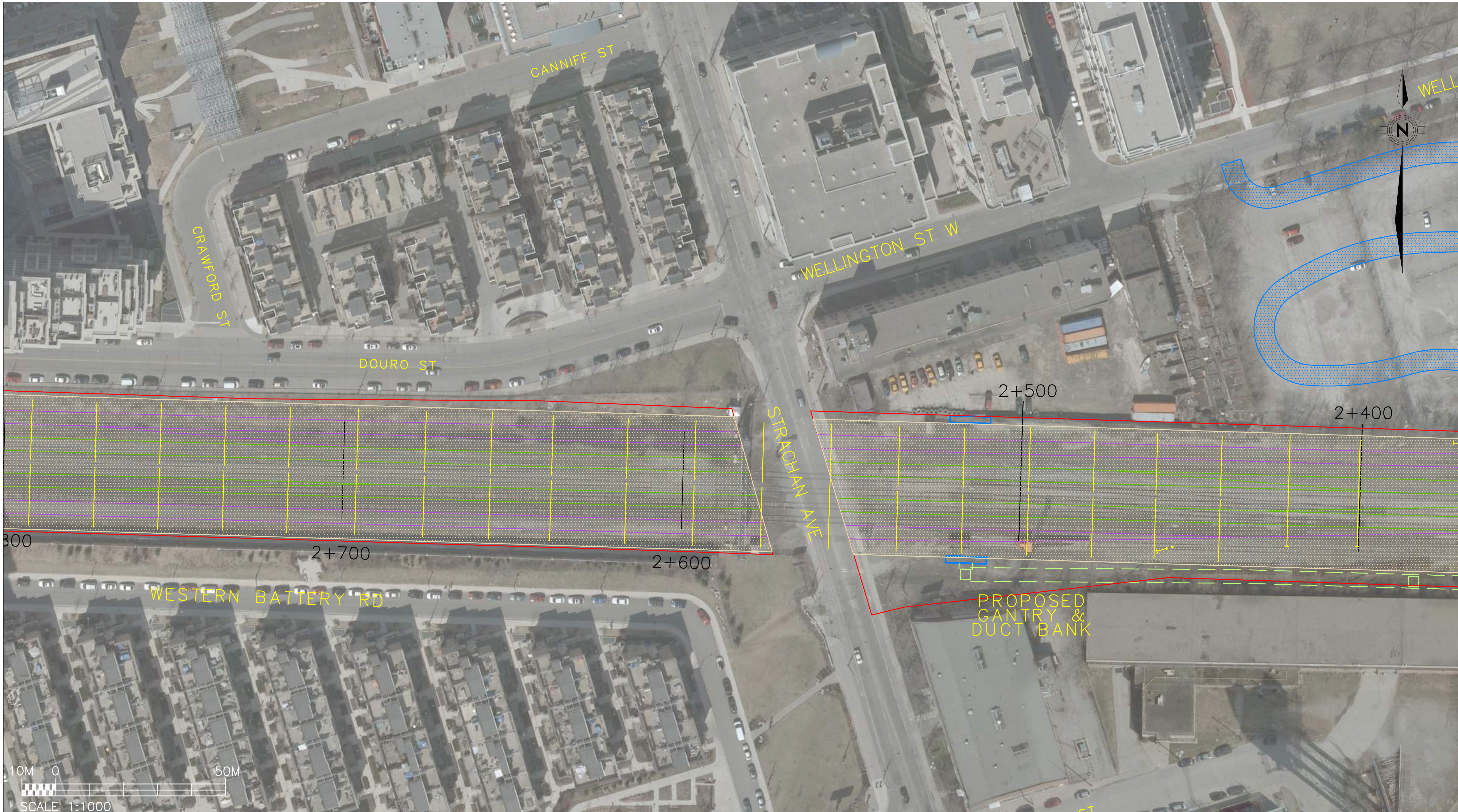

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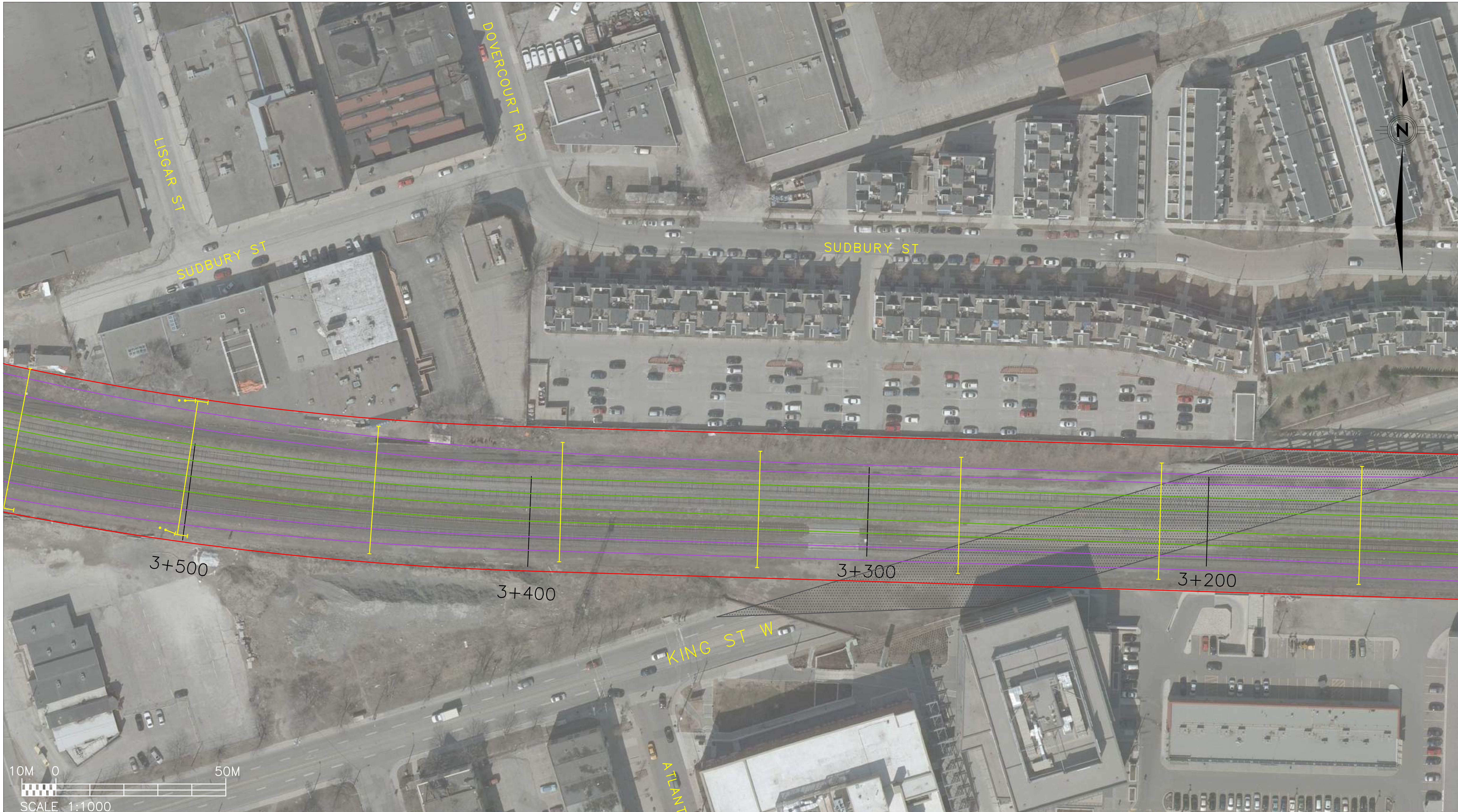

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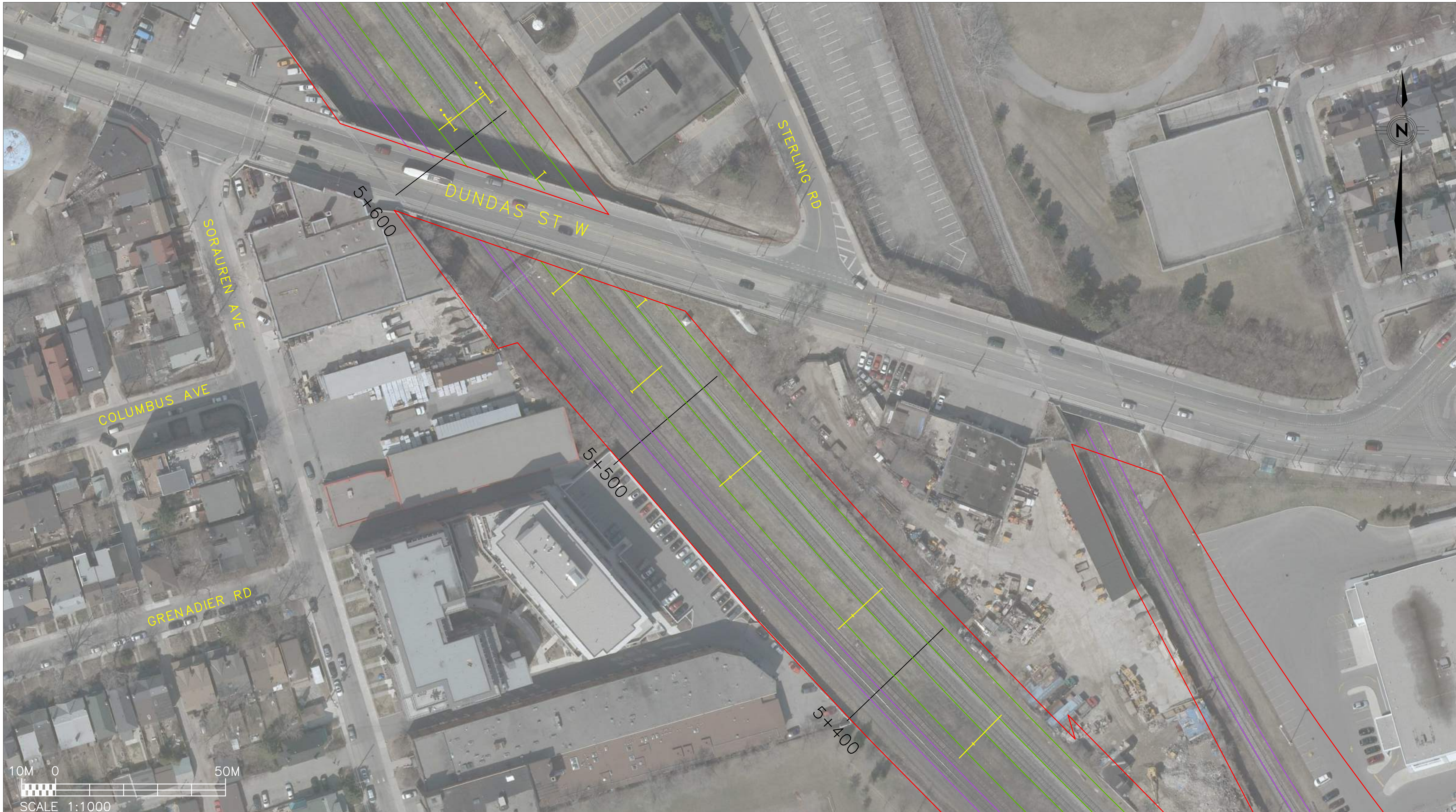

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- OVERHEAD CATENARY SYSTEM - PORTAL
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21 PRELIMINARY DESIGN

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23 PRELIMINARY DESIGN

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26 PRELIMINARY DESIGN

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31 PRELIMINARY DESIGN

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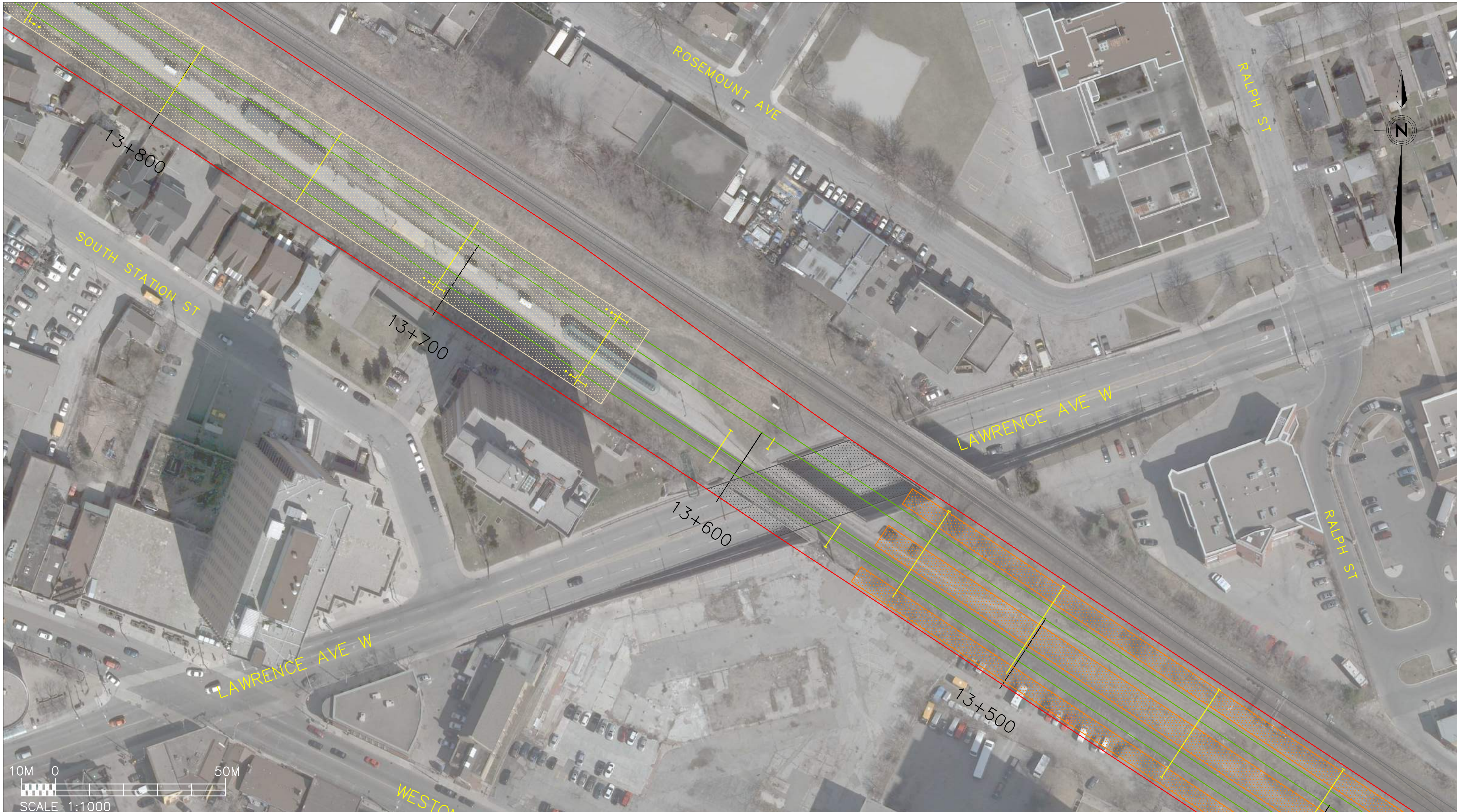
39 PRELIMINARY DESIGN



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4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

LEGEND:

- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

PRELIMINARY DESIGN

NOTES:
1. AERIAL PHOTOGRAPHS DATED 2011 FOR CITY OF TORONTO & 2013 FOR CITY OF MISSISSAUGA;
2. LARGE STRUCTURES MAY APPEAR TO STICK INTO METROLINX R.O.W. DUE TO ORTHOGONAL CORRECTION;
3. METRO TORONTO CONVENTION CENTRE OVERHANGS METROLINX R.O.W.;
4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

LEGEND:
- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

41 PRELIMINARY DESIGN

NOTES:
1. AERIAL PHOTOGRAPHS DATED 2011 FOR CITY OF TORONTO & 2013 FOR CITY OF MISSISSAUGA;
2. LARGE STRUCTURES MAY APPEAR TO STICK INTO METROLINX R.O.W. DUE TO ORTHOGONAL CORRECTION;
3. METRO TORONTO CONVENTION CENTRE OVERHANGS METROLINX R.O.W.;
4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

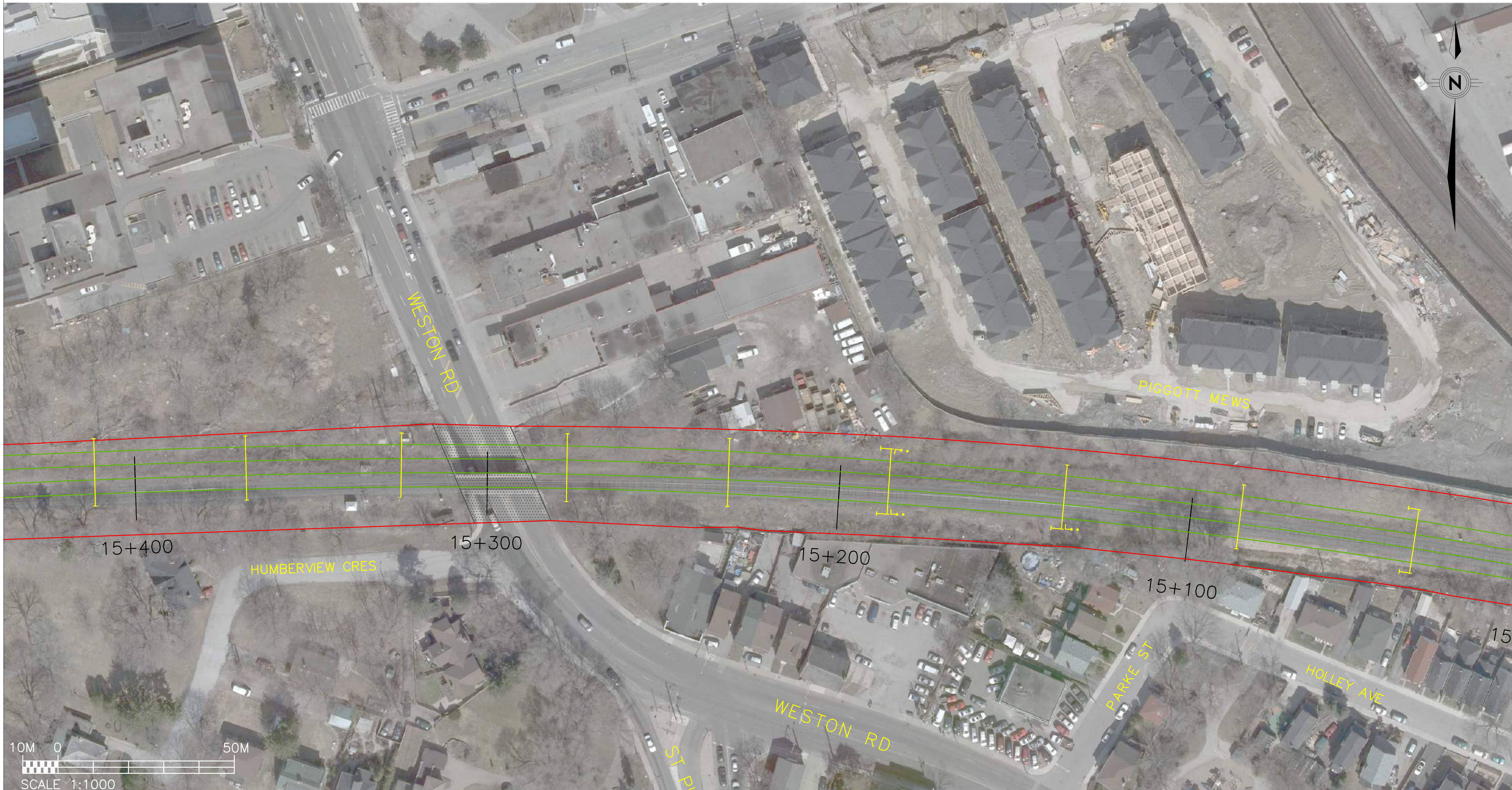
LEGEND:
- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

42 PRELIMINARY DESIGN

NOTES:
1. AERIAL PHOTOGRAPHS DATED 2011 FOR CITY OF TORONTO & 2013 FOR CITY OF MISSISSAUGA;
2. LARGE STRUCTURES MAY APPEAR TO STICK INTO METROLINX R.O.W. DUE TO ORTHOGONAL CORRECTION;
3. METRO TORONTO CONVENTION CENTRE OVERHANGS METROLINX R.O.W.;
4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

43 PRELIMINARY DESIGN

LEGEND:
- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS



NOTES:
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5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

LEGEND:
- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

44 PRELIMINARY DESIGN

NOTES:

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4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

LEGEND:

- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

45 PRELIMINARY DESIGN

NOTES:

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4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

LEGEND:

- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

46 PRELIMINARY DESIGN

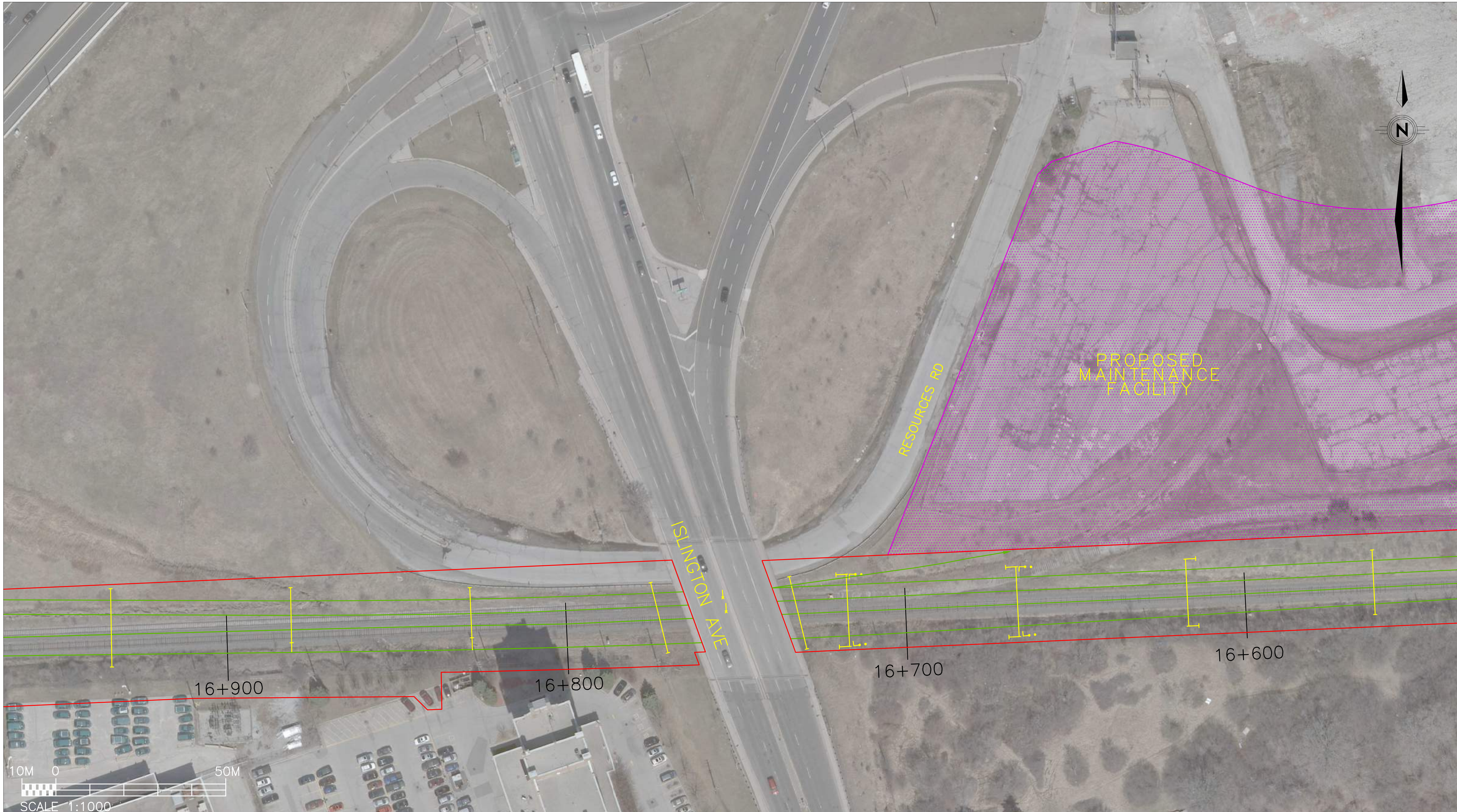
NOTES:

1. AERIAL PHOTOGRAPHS DATED 2011 FOR CITY OF TORONTO & 2013 FOR CITY OF MISSISSAUGA;
2. LARGE STRUCTURES MAY APPEAR TO STICK INTO METROLINX R.O.W. DUE TO ORTHOGONAL CORRECTION;
3. METRO TORONTO CONVENTION CENTRE OVERHANGS METROLINX R.O.W.;
4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

LEGEND:

- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

47 | PRELIMINARY DESIGN



NOTES:
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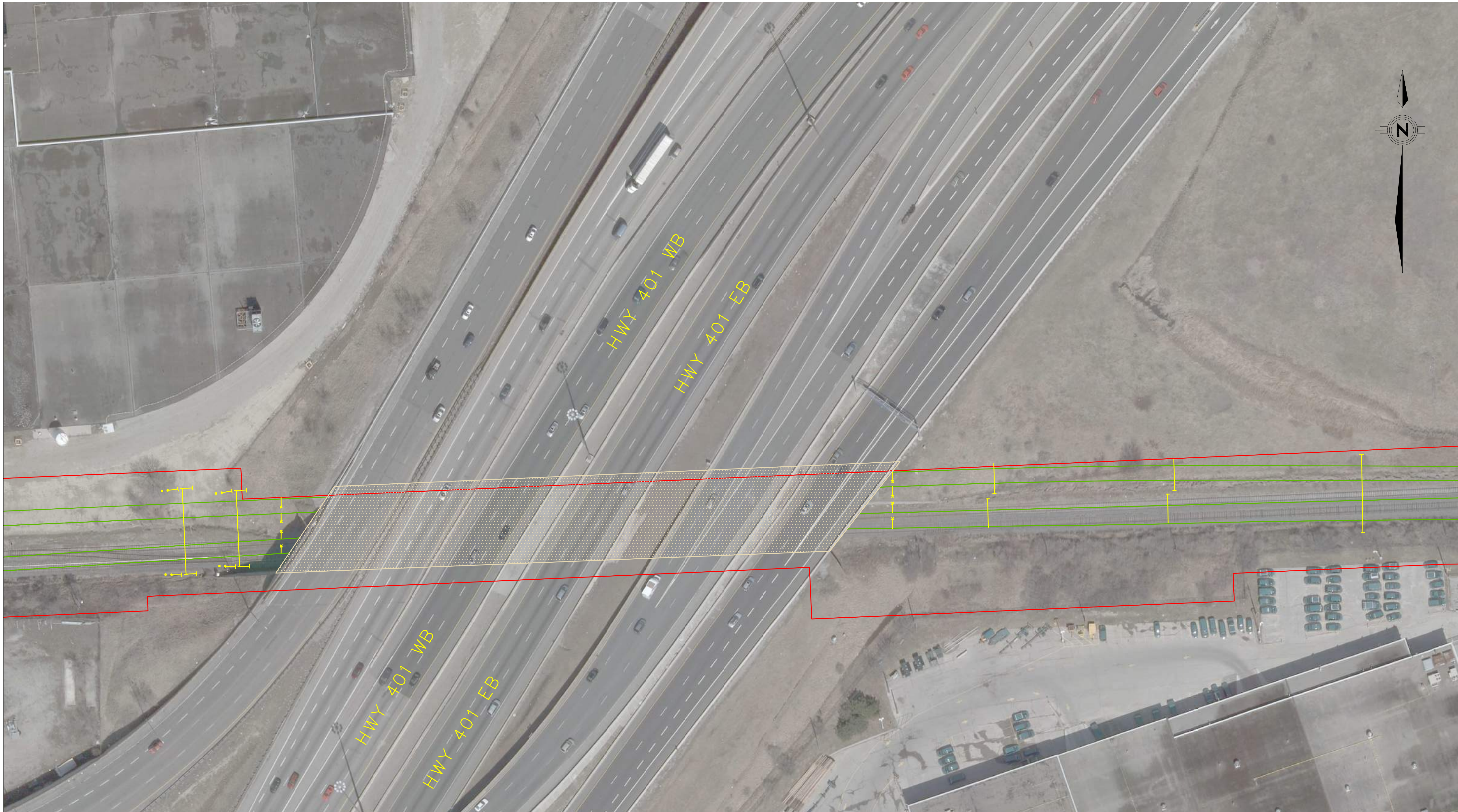
3. METRO TORONTO CONVENTION CENTRE OVERHANGS METROLINX R.O.W.;
4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

LEGEND:
- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

48 PRELIMINARY DESIGN



NOTES:
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2. LARGE STRUCTURES MAY APPEAR TO STICK INTO METROLINX R.O.W. DUE TO ORTHOGONAL CORRECTION;
3. METRO TORONTO CONVENTION CENTRE OVERHANGS METROLINX R.O.W. AND TRACK 'B';
4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

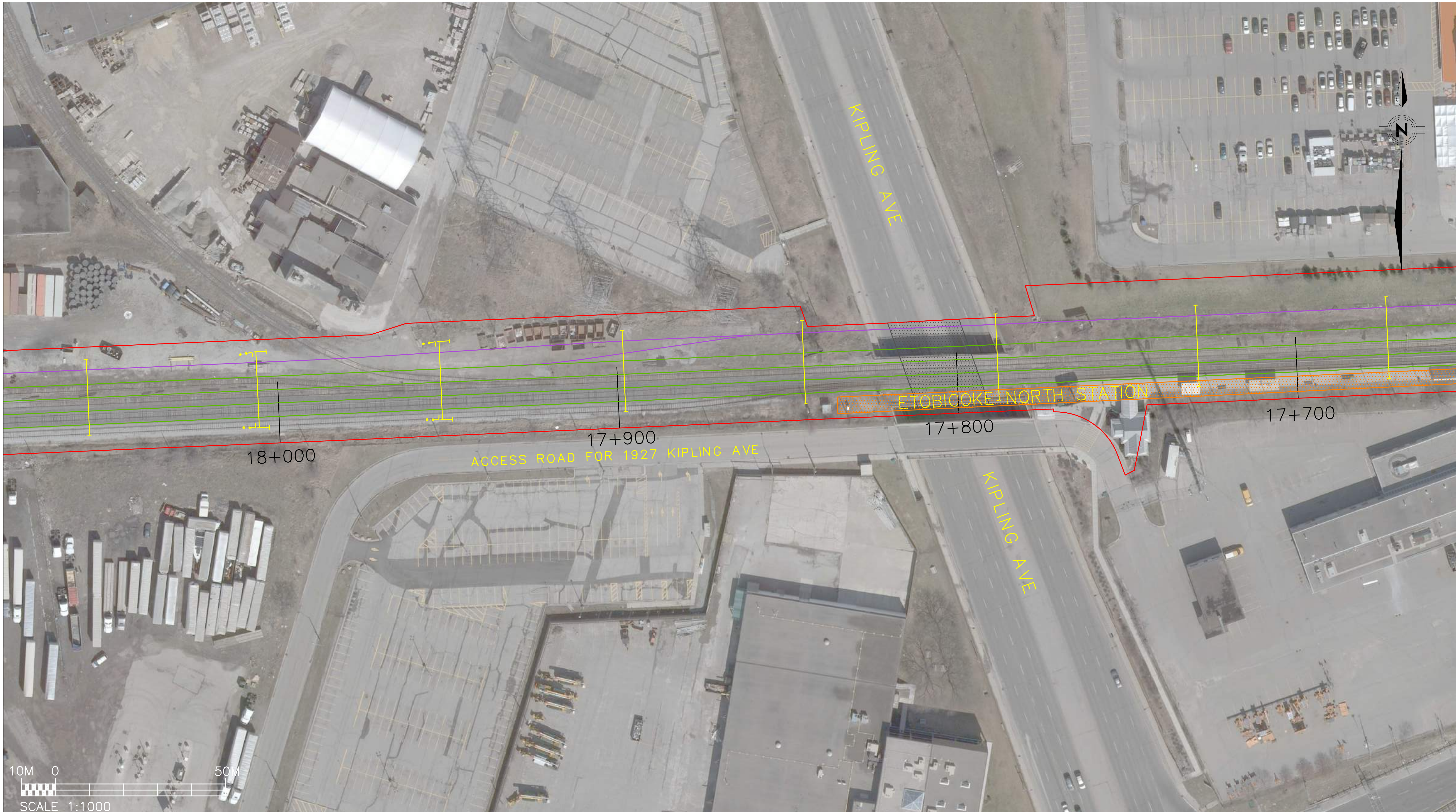
LEGEND:
- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

49 PRELIMINARY DESIGN

NOTES:
1. AERIAL PHOTOGRAPHS DATED 2011 FOR CITY OF TORONTO & 2013 FOR CITY OF MISSISSAUGA;
2. LARGE STRUCTURES MAY APPEAR TO STICK INTO METROLINX R.O.W. DUE TO ORTHOGONAL CORRECTION;
3. METRO TORONTO CONVENTION CENTRE OVERHANGS METROLINX R.O.W.;
4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

LEGEND:
- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

50 PRELIMINARY DESIGN



NOTES:
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3. METRO TORONTO CONVENTION CENTRE OVERHANGS METROLINX R.O.W.;
4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

LEGEND:
- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

51 PRELIMINARY DESIGN

NOTES:

1. AERIAL PHOTOGRAPHS DATED 2011 FOR CITY OF TORONTO & 2013 FOR CITY OF MISSISSAUGA;
2. LARGE STRUCTURES MAY APPEAR TO STICK INTO METROLINX R.O.W. DUE TO ORTHOGONAL CORRECTION;
3. METRO TORONTO CONVENTION CENTRE OVERHANGS METROLINX R.O.W.;
4. UP EXPRESS ELECTRIFICATION SYSTEM HAS NO IMPACT ON TTC SYSTEMS;
5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

LEGEND:

- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

PRELIMINARY DESIGN

NOTES:
1. AERIAL PHOTOGRAPHS DATED 2011 FOR CITY OF TORONTO & 2013 FOR CITY OF MISSISSAUGA;
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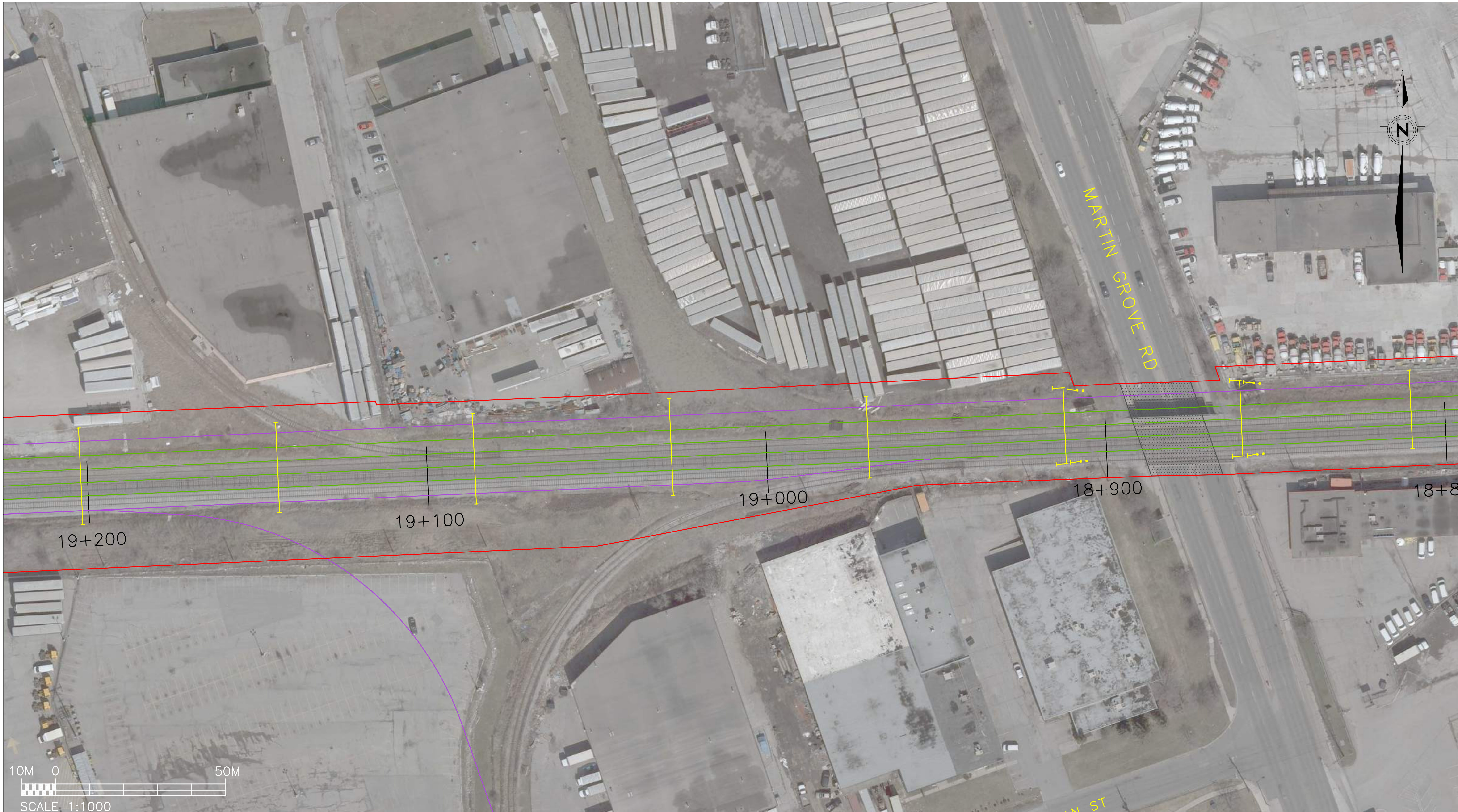
LEGEND:
- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

53 PRELIMINARY DESIGN



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LEGEND:
- METROLINX RIGHT-OF-WAY (R.O.W.)
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- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
- TRACTION POWER FACILITY
- TRACTION POWER FENCE LINE
- TRACTION POWER GANTRY
- TRACTION POWER DUCT BANK
- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
- OVERHEAD CATENARY SYSTEM - BRIDGE ATTACHMENT
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

54 PRELIMINARY DESIGN

NOTES:

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LEGEND:

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- RAIL BRIDGE
- RAIL TUNNEL
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- METROLINX-PROPOSED ELECTRIFIED TRACKS
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- TRACTION POWER GANTRY
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- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
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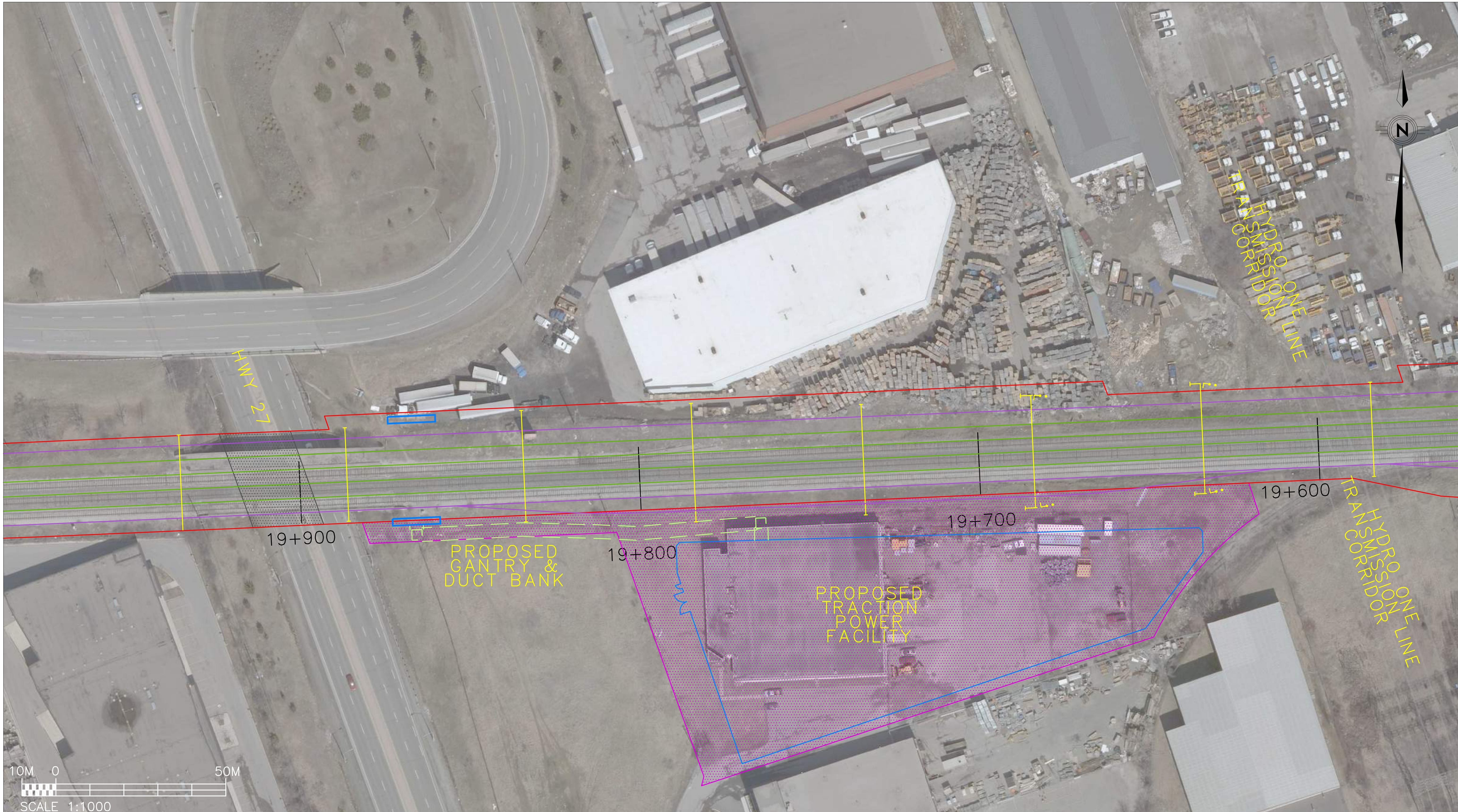
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

55 PRELIMINARY DESIGN



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LEGEND:
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- RAIL TUNNEL
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- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED ELECTRIFIED TRACKS
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- TRACTION POWER GANTRY
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- TRACTION POWER DUCT BANK MAINTENANCE HOLE
- OVERHEAD CATENARY SYSTEM - PORTAL
- OVERHEAD CATENARY SYSTEM - CANTILEVER
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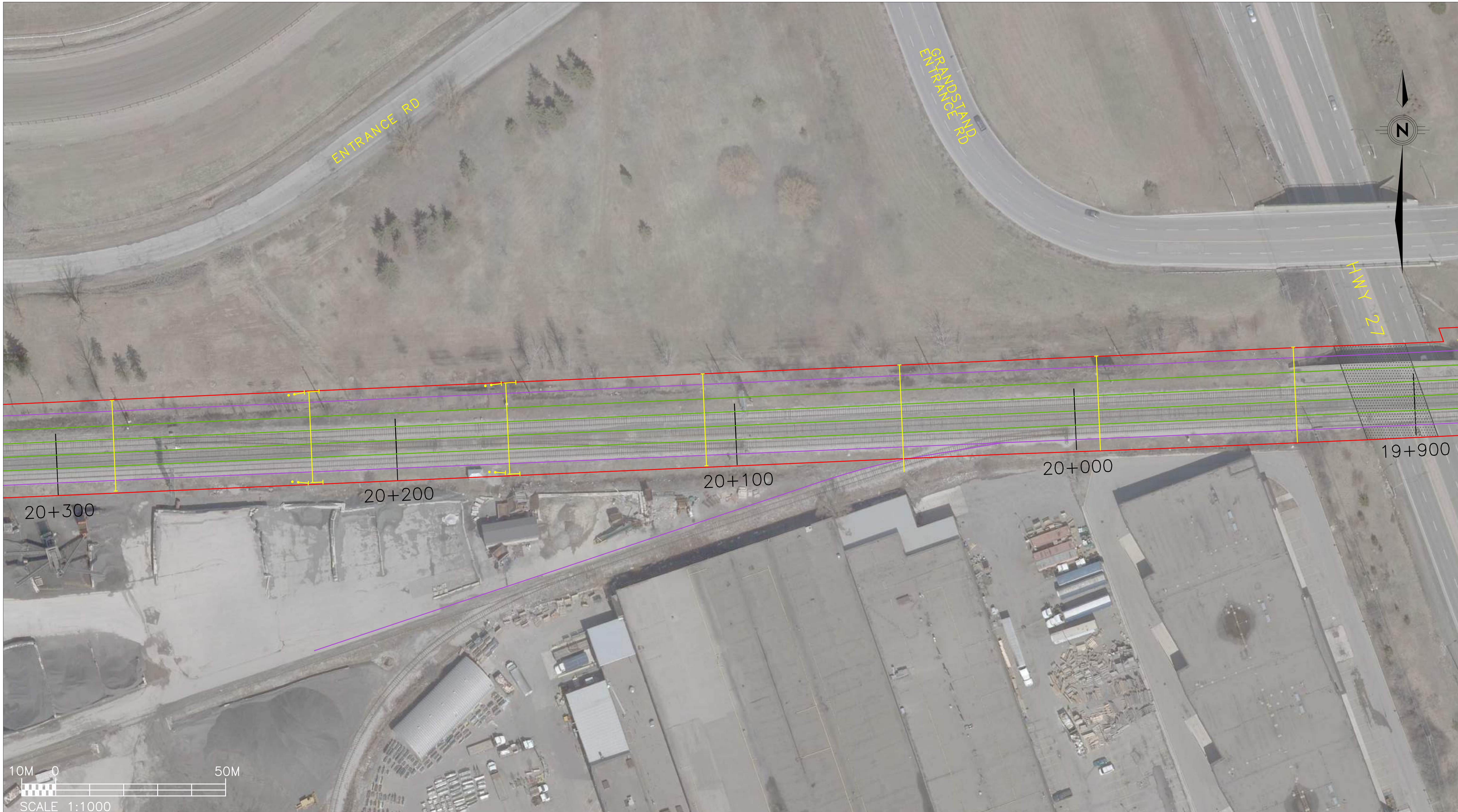
- OVERHEAD CATENARY SYSTEM - TENSIONING WEIGHTS

56 PRELIMINARY DESIGN



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5. TRACKS SHOWN ARE A COMBINATION OF EXISTING AND PROPOSED PLANS THAT ARE SUBJECT TO CHANGE.

LEGEND:

- METROLINX RIGHT-OF-WAY (R.O.W.)
- METROLINX STATION PLATFORMS
- PEDESTRIAN BRIDGES
- RAIL BRIDGE
- RAIL TUNNEL
- CP-OWNED NON-ELECTRIFIED TRACKS
- METROLINX-PROPOSED NON-ELECTRIFIED TRACKS
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57

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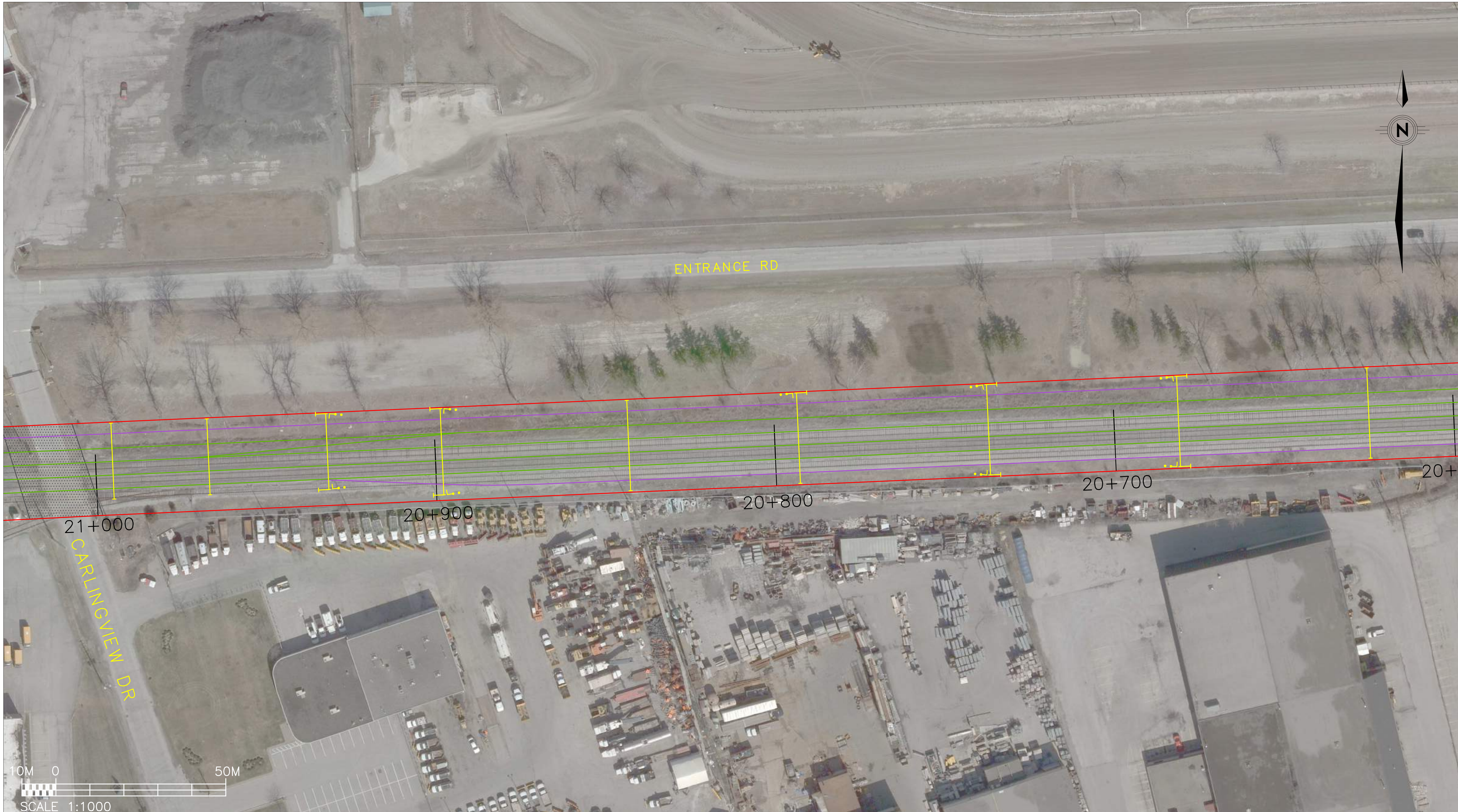

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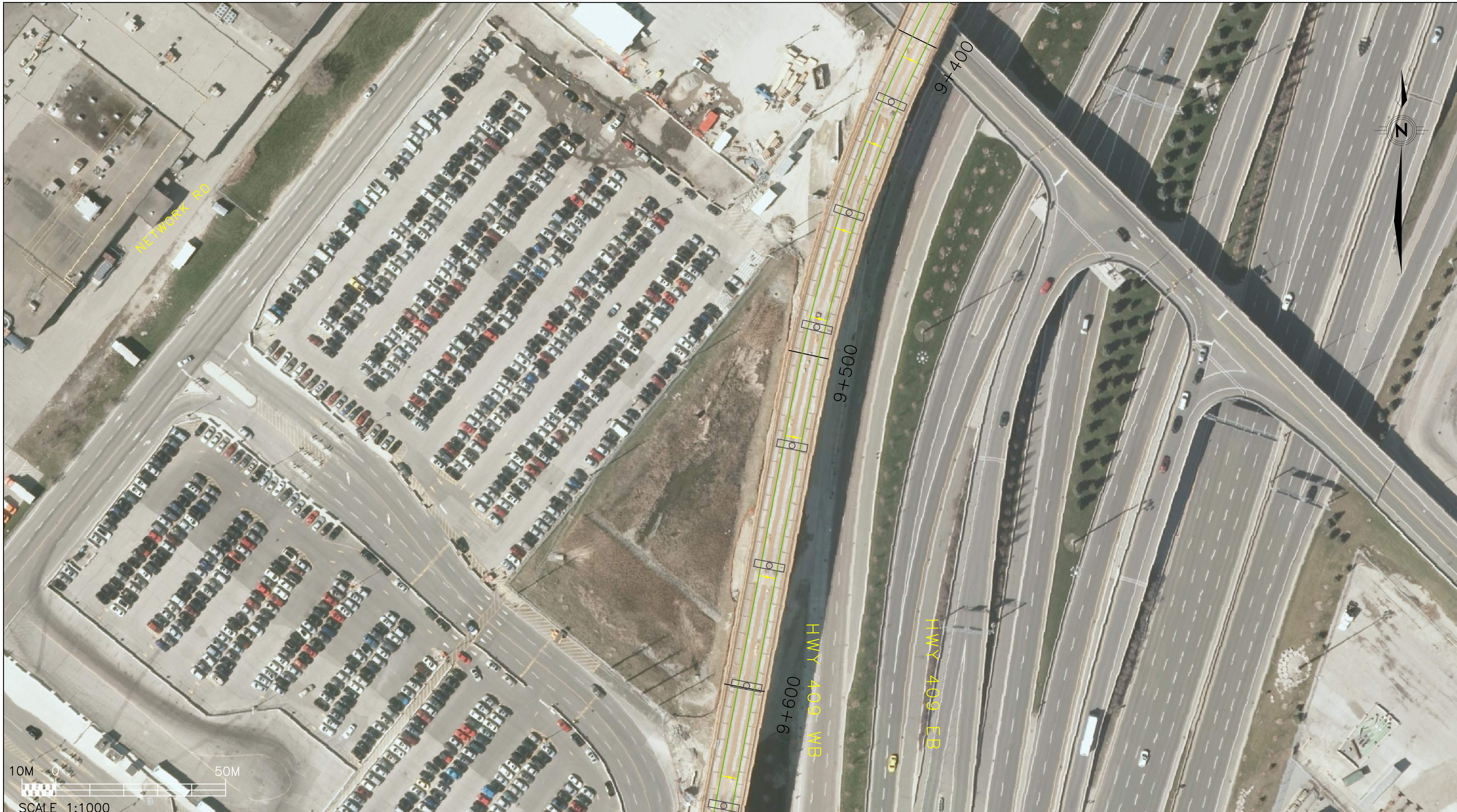

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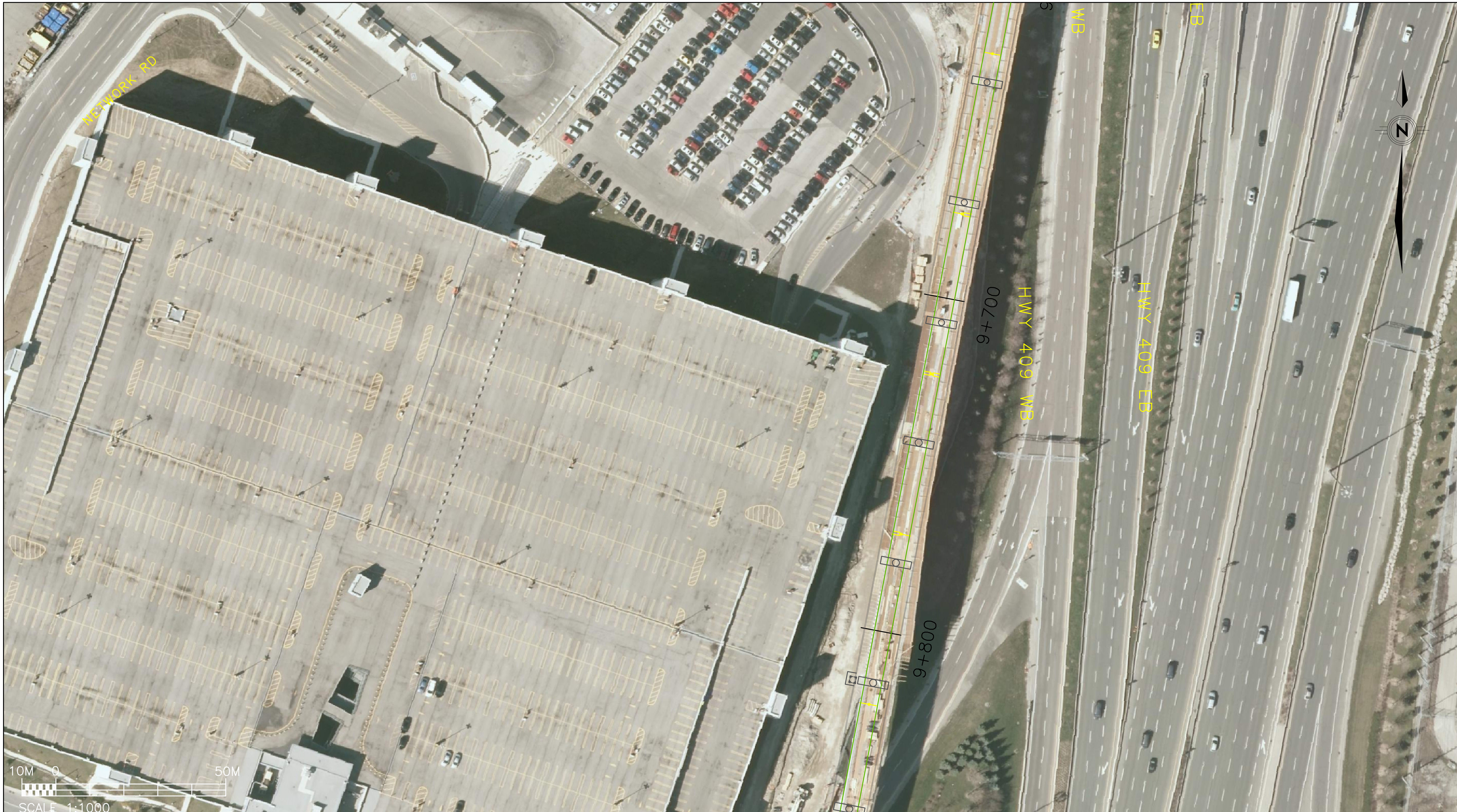

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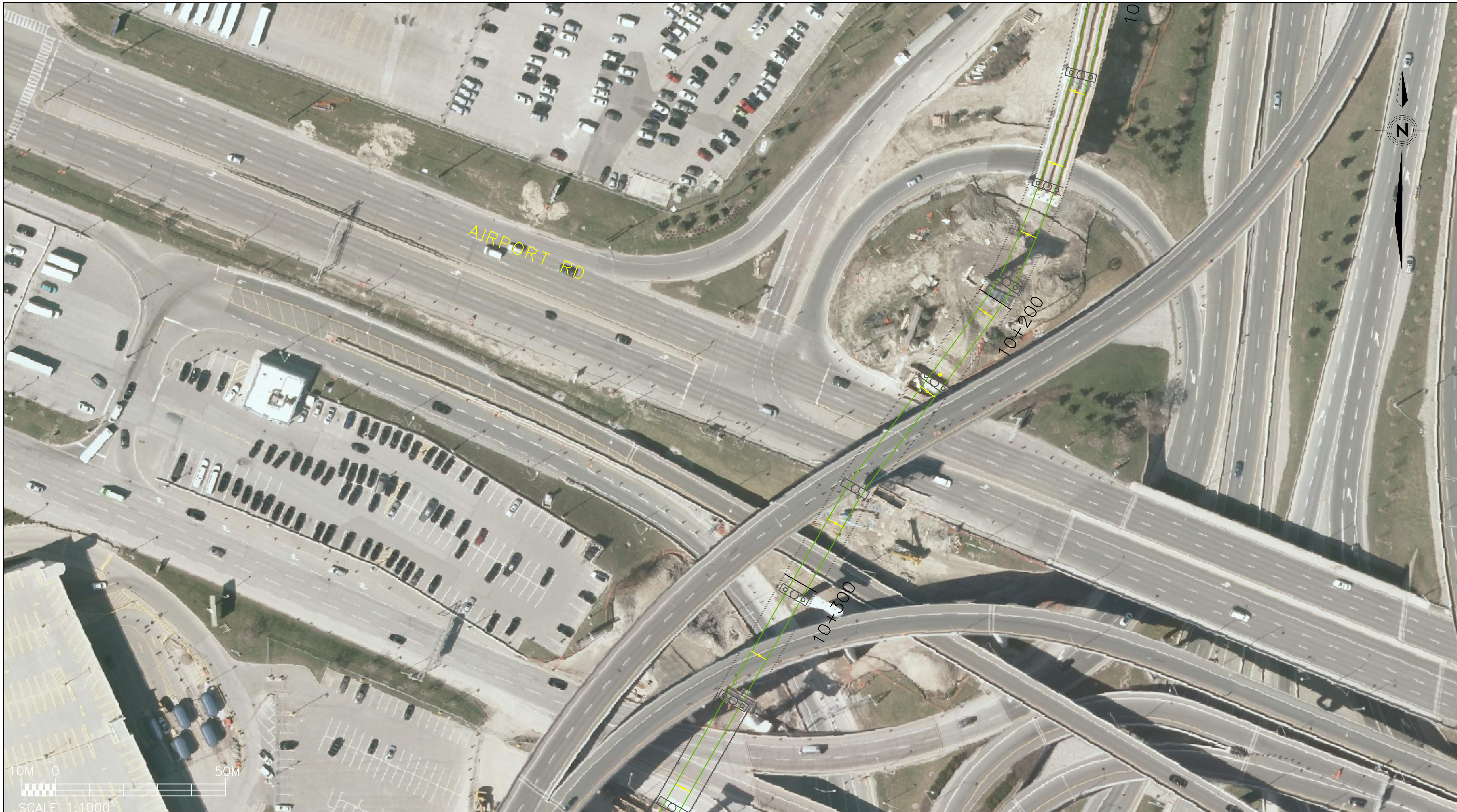

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72 PRELIMINARY DESIGN

5.5.4 Paralleling Stations

In order to ensure reliable traction power supply the electrified UP Express trains, paralleling stations need to be located approximately every 8 - 12 km along the electrified corridor. There are two paralleling stations required as part of the power distribution system for the electrified UP Express.

A paralleling station helps boost the OCS voltage. As the train moves away from the source of power, the OCS voltage drops. Electric trains can only operate if the OCS voltage remains within acceptable limits. One 10 MVA autotransformer will be installed at each paralleling station, along with a medium voltage switchgear for connections to the catenary. Paralleling stations help raise the OCS voltage and hence, facilitate operation of trains further away from the source of power. In addition, these facilities help reduce flow of return current in rails and therefore contribute to the overall safety of the system.

5.5.5 25 kV feeders and Gantries

5.5.5.1 25 kV Feeders

25 kV feeders are cables intended to convey power from the paralleling stations (and Hydro One Traction Power Substation[1]) to the gantries. In the case of the UP Express system, the feeders will be routed underground and encased in duct banks (see **Figure 5-6**) and will connect to the main gantry. The approximate dimensions of the underground duct banks are 4m wide, 1m deep. The length of the feeders/duct banks is dictated by the distance between the paralleling station and gantries.

The concrete encased duct banks will have a 75mm (3-inch) minimum protective cover on all sides. Underground duct banks will be sloped toward the adjacent underground structure (e.g., vault, manhole, or box) from which water may be drained from the manholes to perform maintenance. It is noted that underground duct banks will be equipped with a sump area for drainage by gravity or application of portable or fixed pumps, as required.

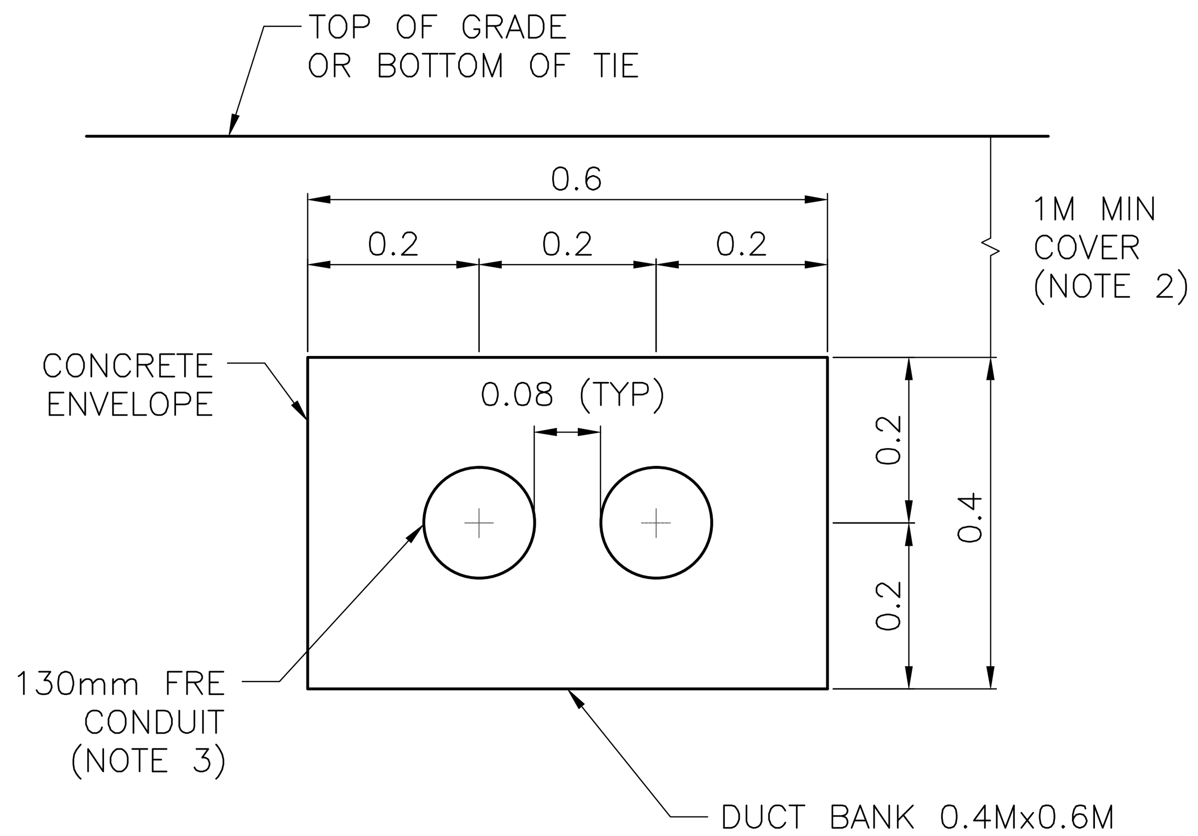
Vault and/or manholes will be installed to provide access to the duct banks/feeders at a maximum spacing of approximately 150m apart. The interior length, width, and depth of vaults and manholes will be sufficient for cable pulling and splicing and for cable expansion and contraction. In addition, the design of vaults and manholes will incorporate the following:

- Non-metallic racks or fiberglass cable support insulators
- Cable pulling hooks
- Grounding provisions

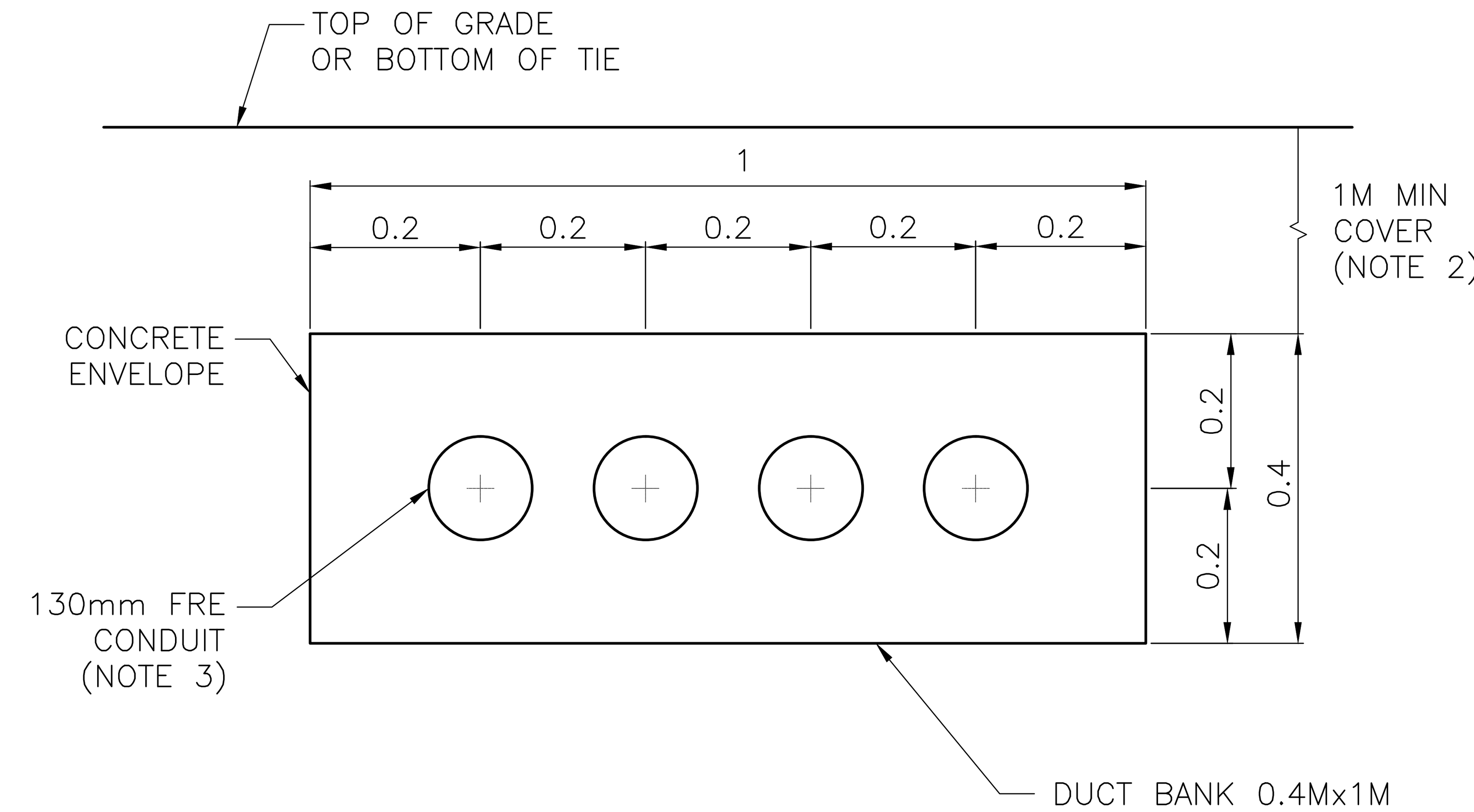
[1] Refer to the *Hydro One Union Pearson Express Electrification Traction Power Substation Class Environmental Assessment - Draft Environmental Study Report.*

METRIC

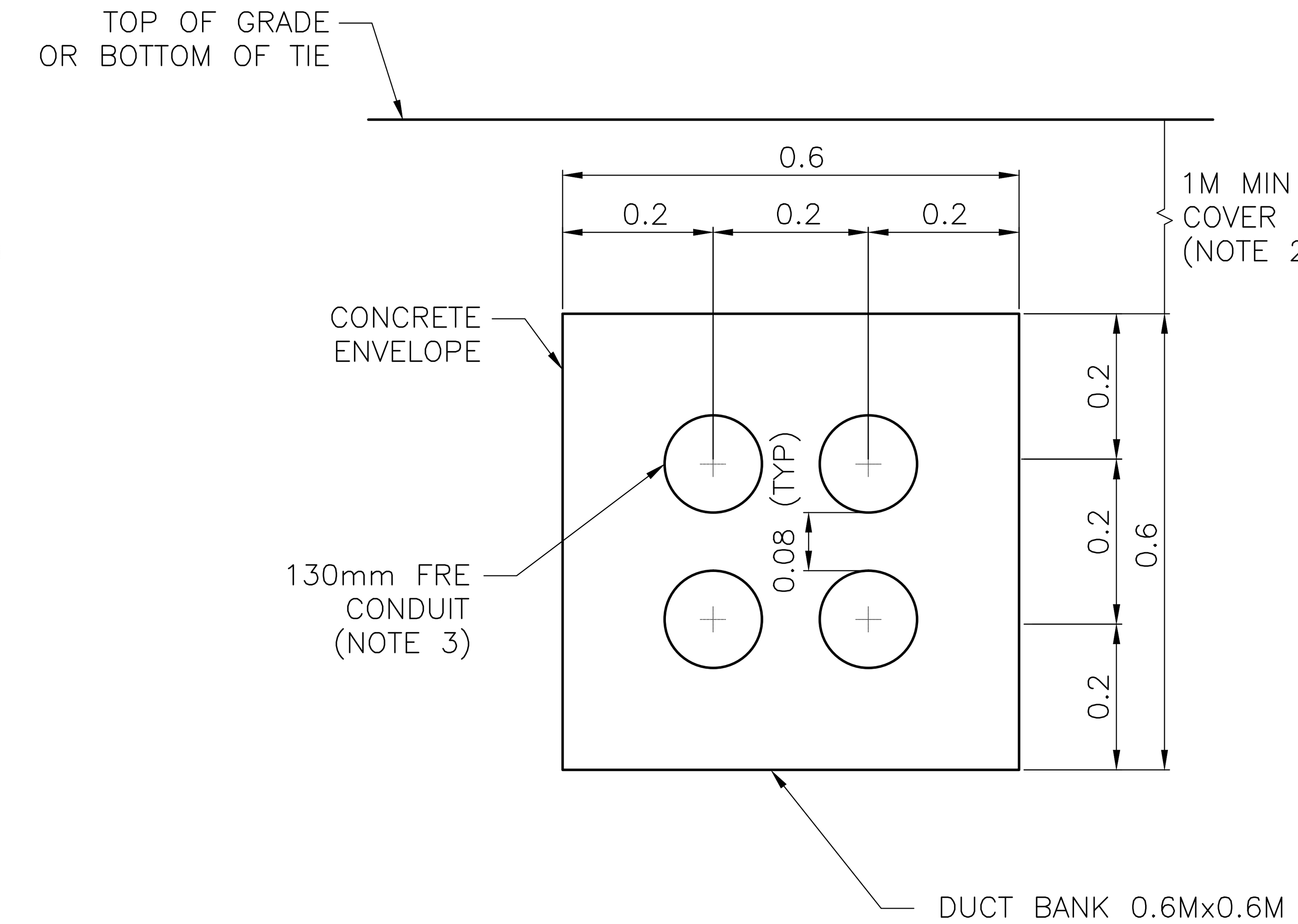
ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED.



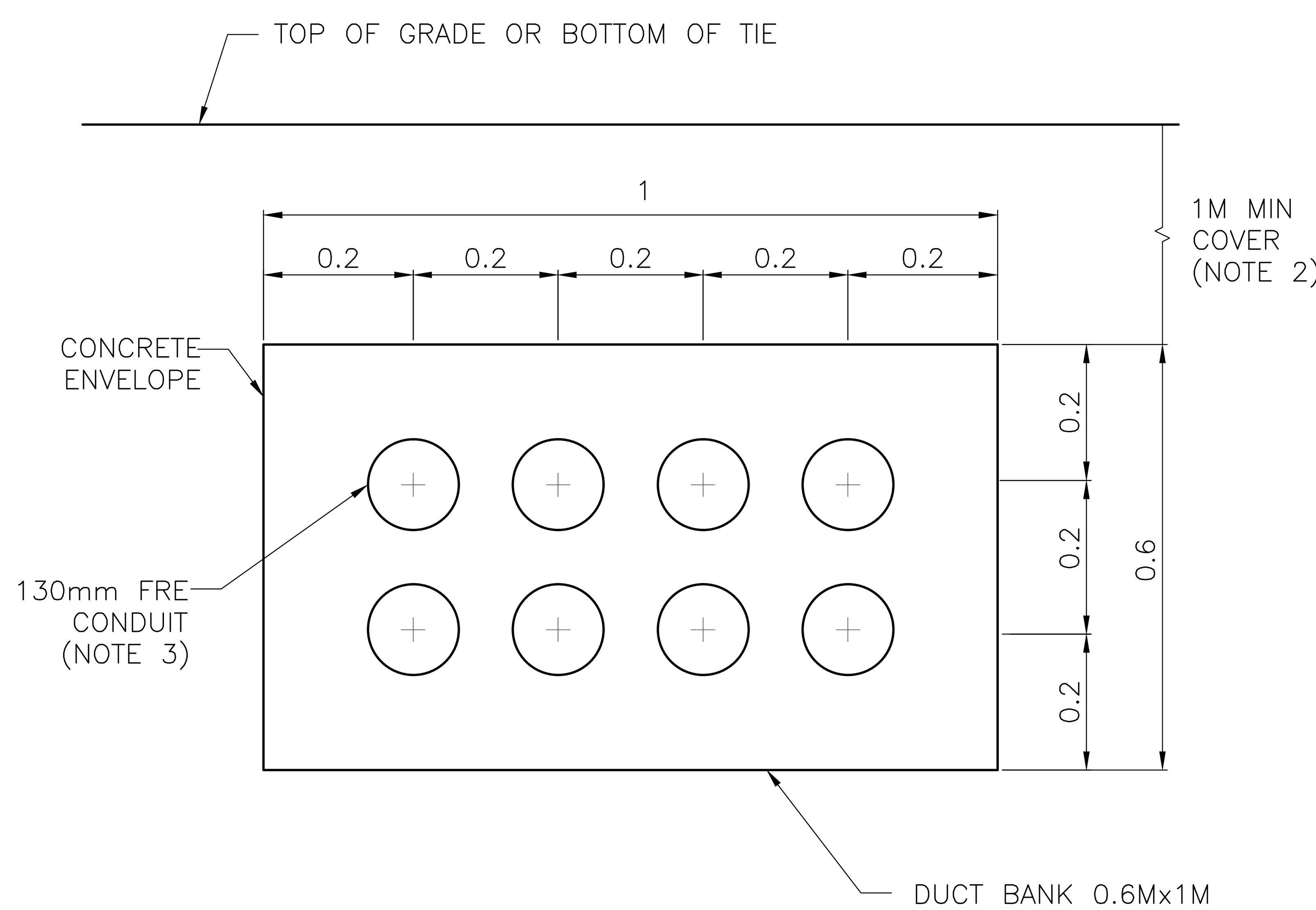
DETAIL A: 1x2–WAY DUCT BANK



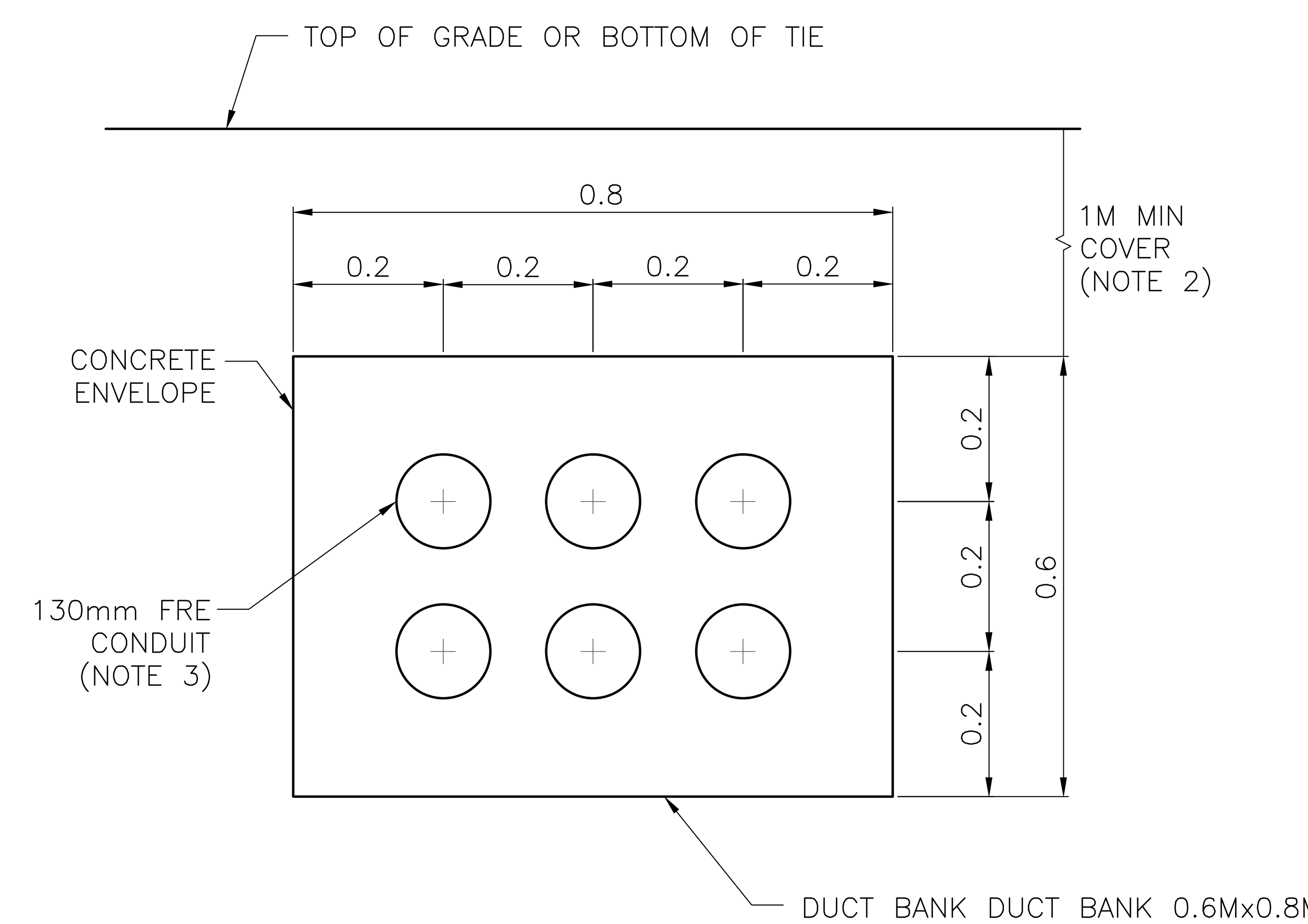
DETAIL B: 1x4–WAY DUCT BANK



DETAIL C: 2x2–WAY DUCT BANK



DETAIL D: 2x4–WAY DUCT BANK



DETAIL E: 2x3–WAY DUCT BANK

NOTES:

1. THIS DRAWING SHOWS TYPICAL DUCT BANK DETAILS FOR 130mm (5") CONDUIT FOR ILLUSTRATION PURPOSES. OTHER DUCT BANK CONFIGURATIONS MAY ALSO BE USED. DESIGN THE DUCT BANK TO SITE AND EQUIPMENT SPECIFIC REQUIREMENTS CONFORMING TO RELEVANT CODES, SPECIFICATIONS AND DESIGN CRITERIA.
2. A 1M (36") MINIMUM COVER SHALL BE MAINTAINED FROM TOP OF GRADE TO TOP OF DUCT BANK, WHEN NOT GOING UNDER RAILROAD TRACK, AND A MINIMUM 1.7M (5'-6") UNDER RAILROAD TRACKS FROM THE BOTTOM OF TIE.
3. THE CONDUIT MATERIAL MAY BE PVC OR FRE.
4. THE 25KV POSITIVE AND NEGATIVE FEEDERS AND TRACTION RETURN FEEDERS BETWEEN TRACTION POWER FACILITIES AND OCS/RAIL WILL BE ROUTED IN SEPARATE DUCT BANKS.

Filename: T:\52713USLS –Metrolinx Electrification\working\TRACTION POWER\PRELIMINARY DESIGN\UPE\TP–UPE–400.dwg
Plotted: November 26, 2013 by: Burdeynik, Stanislav

METROLINX PROJECT NO. 109503

REFERENCE DRAWINGS		ISSUE			REVISIONS		
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SCALE: NTS FULL SIZE ONLY

METROLINX

GO ELECTRIFICATION
PRELIMINARY DESIGN
UNION PEARSON EXPRESS
TYPICAL DUCT BANK DETAILS

FIGURE 5 - 6

5.5.5.2 Catenary Feeding Gantries

A set of two catenary feeding gantries (referred to as the main and strain gantry) are required in the vicinity of each paralleling station (as well as in the vicinity of the Hydro One Traction Power Substation – 175 City View Drive). The gantries will be approximately 13m, above the tope of rail, and 14m long, and their primary function is to convey power to the overhead contact system (see **Figure 5-7**). For this reason, the gantries are located parallel to each other on either side of the tracks (within the rail ROW).

Further detail on the proposed site plan (including locations of gantries and underground feeders) for each paralleling station is provided below. In addition, a description of the gantry and underground feeders at the 175 City View Drive. Traction Power Substation has also been provided, as these components are part of the traction power distribution system.

5.5.5.3 Paralleling Station - Ordnance Street

The Ordnance Street paralleling station is situated west of UP Express Union Station (on Metrolinx-owned property) at the junction of the Kitchener and Lakeshore West corridors (see **Figure 5-8)**. The approximate footprint size of the paralleling station facility is 45m x 20m. Currently, the Ordnance site contains a number of Metrolinx facilities such as signal bungalows, air quality monitoring station, power substation for switches, and a pumping station. In addition, there is a multi-story advertisement sign located on the site.

Due to the irregular shape of this site, the control room will be located on top of the switchgear room to reduce space requirements. The switchgear room will therefore need to be structurally designed to bear the load of the control room and equipment located therein.

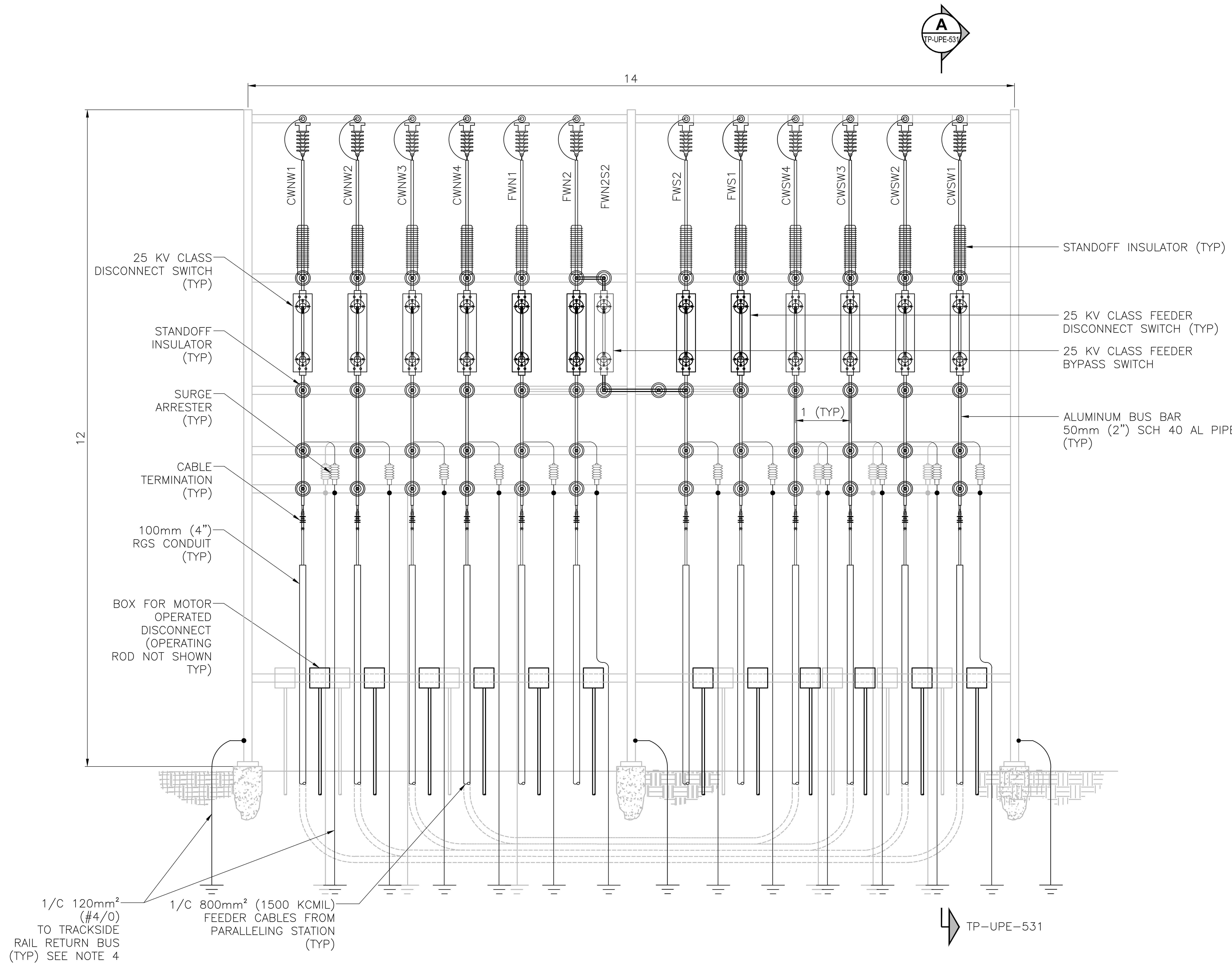
The existing access road which is currently routed to the tip of Ordnance site will be rerouted to the north side of the property, along the rail corridor. The main access to the Ordnance paralleling station is proposed as part of the newly aligned access road a(see **Figure 5-8**). The design of the realigned access road is being coordinated with Build Toronto and the developer of the site. As a result, no new access roads are anticipated to be required for UP Express electrification construction or operations/maintenance activities.

The track configuration on the Kitchener corridor, in the vicinity of the Ordnance Street site, has special track-work (crossovers). From a design perspective, gantries cannot be located at crossover locations, therefore the gantries need to be situated either east or west of the paralleling station site. East of the Ordnance site, the Kitchener and Lakeshore West rail tracks merge into the USRC, therefore, the gantries could not be located there. As a result, the proposed gantry locations are west of the Ordnance Street site, in close proximity to Strachan Avenue within the existing Metrolinx-owned rail ROW.

The length of the underground duct banks will be approximately 330m and will be routed parallel to the rail ROW under the realigned access road, from the paralleling station facility to the gantries. It is noted that a property easement may be required from Build Toronto for installation of the duct banks, however this is currently under negotiation/review between Build Toronto and Metrolinx.

METRIC

ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED.



NOTES:

1. THIS IS A TYPICAL MAIN GANTRY ARRANGEMENT FOR FEEDING A FOUR TRACK ALIGNMENT AT-GRADE. CARRY OUT DETAILED DESIGN FOLLOWING ALL RELEVANT STANDARDS, CODES, REGULATIONS, GUIDELINES AND OTHER INSTRUCTIONS.
2. IN THE CONNECTION TO DIFFERENT BUSES, "CW" STANDS FOR CATENARY WIRES AND "FW" FOR FEEDER WIRES. W1, W2, W3 AND W4 STAND FOR TRACKS WESTON 1, WESTON 2, WESTON 3 AND WESTON 4 RESPECTIVELY. "N" STANDS FOR SECTION TO THE NORTH OF SECTION BREAK AND "S" FOR SECTION TO THE SOUTH. REFER TO DWG. TP-UPE-130 FOR FULL-LINE DIAGRAM OF KODAK PS.
3. PROVIDE DISCONNECT SWITCH NUMBERS SAME AS ON THE DWG. TP-UPE-130.
4. THE GANTRY COLUMNS AND BEAMS WILL BE INTERCONNECTED ELECTRICALLY FOR GROUNDING OF THE GANTRY STRUCTURE.
5. BOND THE DISCONNECT SWITCH HANDLES TO THE GROUND GRID.

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GO ELECTRIFICATION

PRELIMINARY DESIGN

UNION PEARSON EXPRESS

KODAK PARALLELING STATION MAIN GANTRY ELEVATION (PARALLELING STATION SIDE)

FIGURE 5 - 7

FIGURE 5-8

SKETCH SHOWING DUCT BANKS, GANTRIES AND ACCESS ROAD TO ORDNANCE PS

5.5.5.4 ***Paralleling Station - 3500 Eglinton Avenue West***

The 3500 Eglinton Avenue West paralleling station is situated at the approximate mid-way point along the UP Express route, on Metrolinx-owned property formerly known as the "Kodak Heights Site". As previously mentioned, this particular site has also been identified by Metrolinx as the preferred location for the planned Eglinton Crosstown Maintenance and Storage Facility (MSF). Therefore, as part of the UP Express Electrification TPAP, coordination between the UP Express Electrification and Eglinton Crosstown MSF Project Teams was necessary in order to determine potential locations for accommodating the paralleling station on this site. Subsequently, the approximate location for the paralleling station on the 3500 Eglinton Avenue West site was identified in coordination with the Eglinton Crosstown MSF team, as shown in **Figure 5-9** As the Eglinton Crosstown MSF project moves into the next phase of design/construction, the final location for the paralleling station will be confirmed. Notwithstanding this, for purposes of the UP Express Electrification EA, the paralleling station location was assumed to be at the east end of Industry Rd. (see **Figure 5-10**), as this represents the 'worst case scenario' from an impact assessment perspective (i.e., results in longest possible duct bank length along Industry Road)

The main access gate for the 3500 Eglinton Avenue West paralleling station is proposed at the northwest corner of the site. Access to the site during construction and operation is anticipated to be via existing local roads, i.e., Ray Avenue and/or Industry Road. Therefore, no new access roads are anticipated to be required for either construction or operations/maintenance purposes.

The length of the underground duct banks will be approximately 300m along Ray Avenue and 250m along Industry Street, and will be installed underneath the Ray Avenue and Industry Street from the paralleling station facility to the gantries. It is noted that a property easement will be required from the City of Toronto for installation of the duct banks under City roads. In addition, the duct bank will cross under the CP and Metrolinx rail corridors. The catenary feeding gantries are proposed slightly east of Ray Avenue within the UP Express rail corridor ROW (**Figure 5-10**).

5.5.5.5 Gantries and 25 kV feeders at CityView Drive Traction Power Substation

As previously mentioned, gantries and 25 kV feeders are required at the Traction Power Substation location as part of the traction power distribution system to be implemented by Metrolinx. The length of the underground duct banks will be approximately 100m and will be routed parallel to the rail ROW, from the traction power substation[2] to the gantries. A property easement may be required from the City of Toronto for access to the gantry.
It is noted that a new signal bridge is to be installed immediately to the east of the 175 City View Drive site. A minimum distance of approximately 150m needs to be maintained between the last stop signal and the phase break[3] to prevent stalling of trains. Based on the location of this phase break, the catenary feeding gantries are to be located west of the City View Drive site, on the east side of Highway 27 bridge (see **Figure 5-11**).

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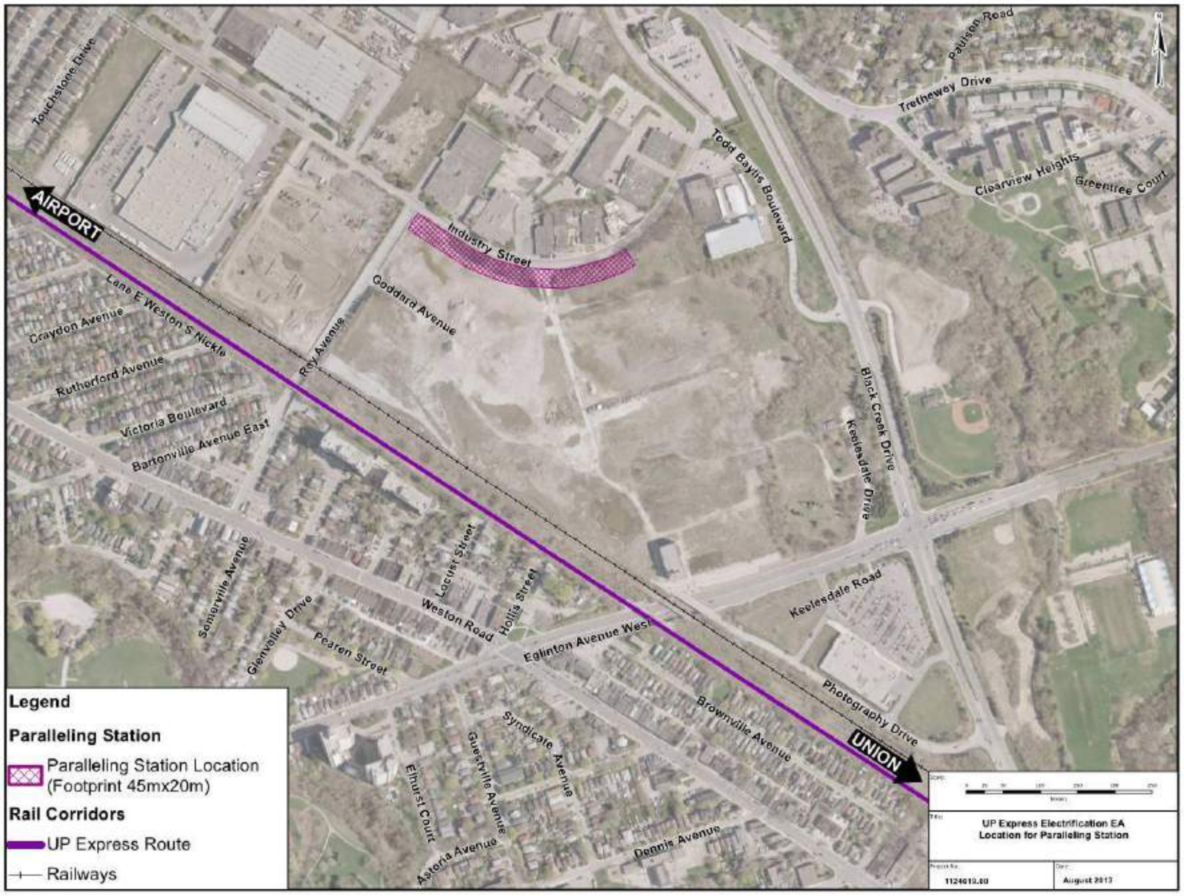
[2] Refer to the *Hydro One Union Pearson Express Electrification Traction Power Substation Class Environmental Assessment - Draft Environmental Study Report.*

[3] A phase break is an arrangement of wires that form a neutral section located between two sections of OCS that are fed from different phases or at different frequencies/voltages, where the pantograph passes through without shorting.

FIGURE 5-9 GENERAL LOCATION OF PARALLELING STATION AT 3500 EGLINTON AVENUE WEST

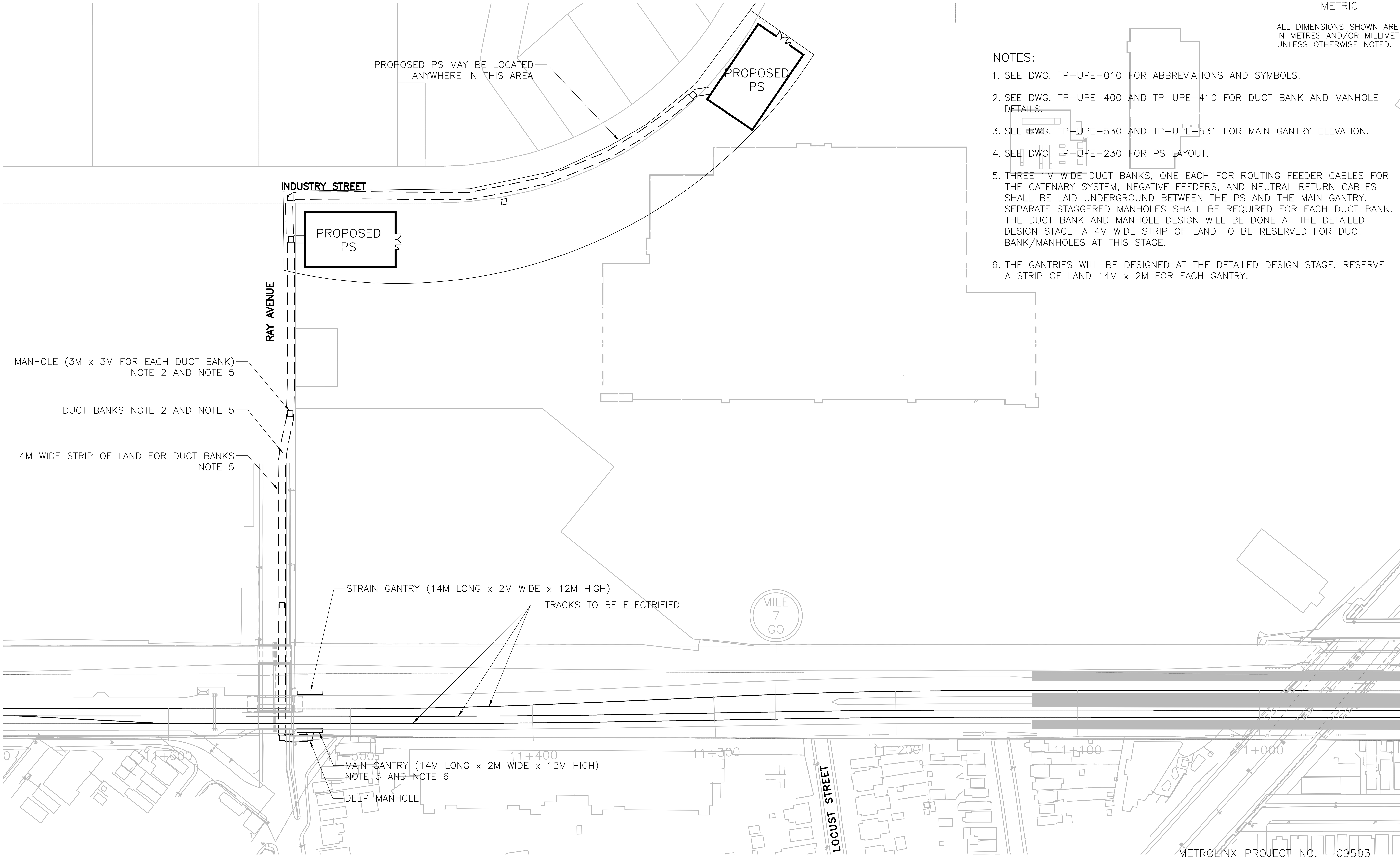


METRIC

ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED.

NOTES:

1. SEE DWG. TP-UPE-010 FOR ABBREVIATIONS AND SYMBOLS.
2. SEE DWG. TP-UPE-400 AND TP-UPE-410 FOR DUCT BANK AND MANHOLE DETAILS.
3. SEE DWG. TP-UPE-530 AND TP-UPE-531 FOR MAIN GANTRY ELEVATION.
4. SEE DWG. TP-UPE-230 FOR PS LAYOUT.
5. THREE 1M WIDE DUCT BANKS, ONE EACH FOR ROUTING FEEDER CABLES FOR THE CATENARY SYSTEM, NEGATIVE FEEDERS, AND NEUTRAL RETURN CABLES SHALL BE LAID UNDERGROUND BETWEEN THE PS AND THE MAIN GANTRY. SEPARATE STAGGERED MANHOLES SHALL BE REQUIRED FOR EACH DUCT BANK. THE DUCT BANK AND MANHOLE DESIGN WILL BE DONE AT THE DETAILED DESIGN STAGE. A 4M WIDE STRIP OF LAND TO BE RESERVED FOR DUCT BANK/MANHOLES AT THIS STAGE.
6. THE GANTRIES WILL BE DESIGNED AT THE DETAILED DESIGN STAGE. RESERVE A STRIP OF LAND 14M x 2M FOR EACH GANTRY.



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		1	13/12/02	Submitted for PM Review			

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CHECKED BY: YXH 14/02/07	APPROVED BY: ZBT 14/02/07
SCALE: NTS	FULL SIZE ONLY

PARSONS BRINCKERHOFF

METROLINX

GO ELECTRIFICATION
PRELIMINARY DESIGN
UNION PEARSON EXPRESS
KODAK PARALLELING STATION SITE PLAN WITH 3 ELECTRIFIED TRACKS

CONTRACT NO.		REV.	SHEET
RQQ-2011-PP-032	FIGURE 5 -10	2	31/58

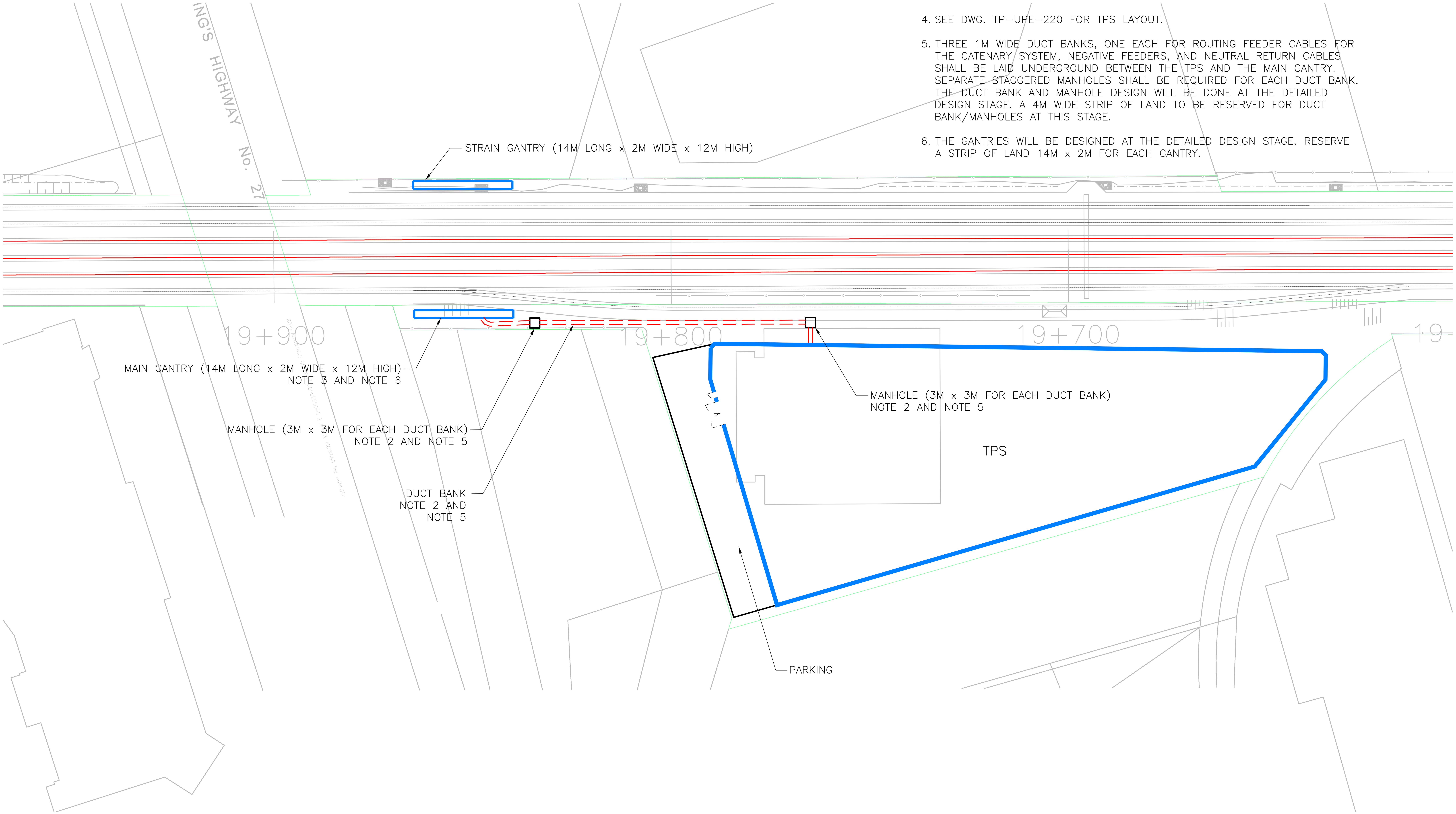
Filename: P:\Y362\2013\CA10013LS – Network Wide Preliminary Design\UP Express OCS\UPE TPS\TP-UPE-331.dwg
Plotted: March 19, 2014 by: Jun, Soo

NOTES:

1. SEE DWG. TP–UPE–010 FOR ABBREVIATIONS AND SYMBOLS.
2. SEE DWG. TP–UPE–400 AND TP–UPE–410 FOR DUCT BANK AND MANHOLE DETAILS.
3. SEE DWG. TP–UPE–520 AND TP–UPE–521 FOR MAIN GANTRY ELEVATION.
4. SEE DWG. TP–UPE–220 FOR TPS LAYOUT.
5. THREE 1M WIDE DUCT BANKS, ONE EACH FOR ROUTING FEEDER CABLES FOR THE CATENARY SYSTEM, NEGATIVE FEEDERS, AND NEUTRAL RETURN CABLES SHALL BE LAID UNDERGROUND BETWEEN THE TPS AND THE MAIN GANTRY. SEPARATE STAGGERED MANHOLES SHALL BE REQUIRED FOR EACH DUCT BANK. THE DUCT BANK AND MANHOLE DESIGN WILL BE DONE AT THE DETAILED DESIGN STAGE. A 4M WIDE STRIP OF LAND TO BE RESERVED FOR DUCT BANK/MANHOLES AT THIS STAGE.
6. THE GANTRIES WILL BE DESIGNED AT THE DETAILED DESIGN STAGE. RESERVE A STRIP OF LAND 14M x 2M FOR EACH GANTRY.

METRIC

ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED.



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METROLINX

GO ELECTRIFICATION
PRELIMINARY DESIGN
UNION PEARSON EXPRESS
175 CITYVIEW TPS SITE PLAN WITH 3 ELECTRIFIED TRACKS

FIGURE 5 - 11

Filename: T:\52713USLS - Metrolinx Electrification\working\TRACTION POWER\PRELIMINARY DESIGN\UPE\TP-UPE-321.dwg
Plotted: September 30, 2013 by: Burdeynik, Stanislav

5.6 Grounding and Bonding System

This section describes the grounding system design for the UP Express electrification project:

- City View traction power substation (TPS)
- Kodak paralleling station (PS)
- Ordnance PS
- Terminal 1 at Pearson Airport
- Etobicoke North Station
- Weston Station
- Mount Dennis Station
- Bloor Station
- Union Station.

This report also describes the requirements for the grounding and bonding system design for wayside structures and equipment.

To ensure safe touch-and-step potential in accordance with permissible limits (as per applicable international electrical safety codes and standards including CSA, EN and IEEE), a grounding and bonding system will be implemented as part of UP Express electrification. Touch potential is defined as the voltage between an energized object and the feet of a person in contact with the object. Step potential is defined as the voltage between the feet of a person standing near an energized grounded object.

With this in mind, grounding and bonding systems serve two primary functions:

- Minimize touch voltage, step voltage and ground return currents caused by the electrified system to provide for the safety of passengers, operating personnel and other wayside public, and to provide protection from the risk of electrical shock; and
- Provide the means to carry electric currents into the earth under normal and fault conditions without exceeding operating and equipment limits, or adversely affecting continuity of service.

The grounding and bonding system for UP Express has been designed according to the applicable standards (i.e., IEEE Standard, Ontario Electrical Safety Code, Ontario Energy Board requirements, CAN/CSA C22.1; C22.3 – Canadian Electrical Code, EN 50122-1 etc.). Proper grounding and bonding systems will be engineered and installed throughout the entire electrified corridor to provide proper return circuits for the normal traction power currents and fault currents, with grounding connections. The Canadian Railway Electrification Guidelines CAN/CSA-C22.3 No. 8-M91 (Reaffirmed 2003) suggests that every metallic structure within 10m from the nearest rail must be grounded to a local ground electrode and then bonded to the OCS static wire.

Most of the electrified railways in North America, Europe and Asia have grounding and bonding systems designed in accordance with the Europeans Standard EN 50122-1. EN50122-1 standards require the metallic structures within 4 m from the centre of the electrified track be connected to the static wire. The European standard EN 50122-1 is directly applicable to the grounding and bonding specifically of electrified rail transit systems that run on 2x25 kV and 1x25 kV.

In terms of grounding and bonding requirements, the main differences between the CAN/CSA C22.1; C22.3 – Railway Electrification Guidelines and EN 50122-1 is the distance from the outermost electrified rail to the metallic structures that need be connected to the static wire.

The decision to implement the Canadian Railway Electrification Guidelines or the European standard will be assessed during the detail design. To be conservative, the Grounding and Bonding requirements described in section 5.6 are based on the Canadian Railway Electrification Guidelines.

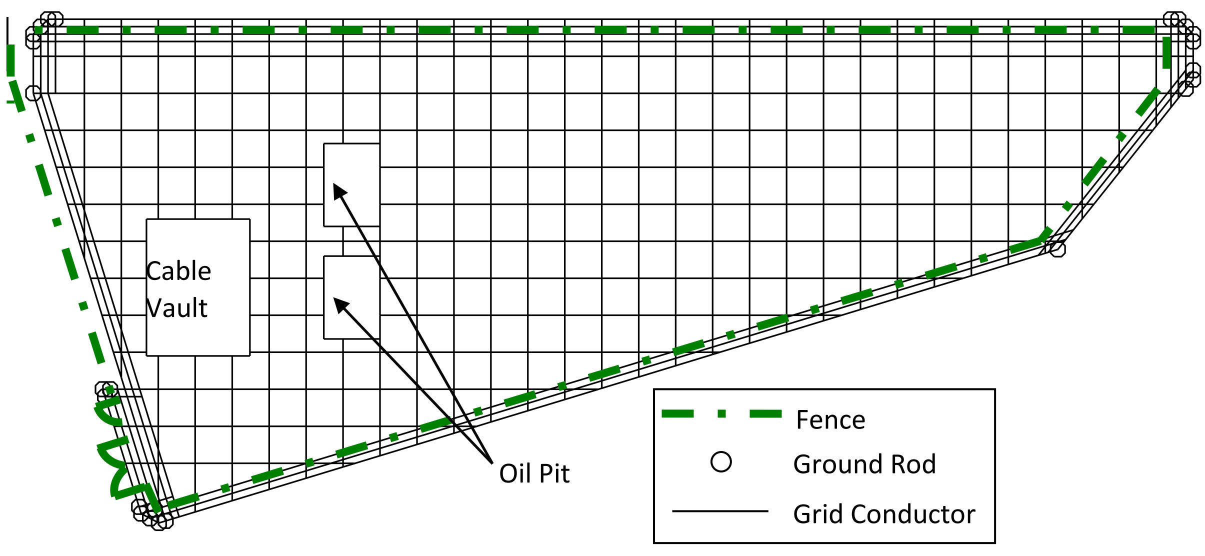
5.6.1 Traction Power Facility Grounding & Bonding Design

5.6.1.1 City View TPS Grounding and Bonding

The substation will be enclosed by a metallic perimeter fence. The perimeter fence will be 1m (3') within the perimeter of the ground grid and bonded to the ground grid at regular intervals. The horizontal ground grid conductors will be placed at a depth of 0.5m.

A cable vault will be provided underneath the 2x25kV switchgear room at a depth of 1.4m (4.6') below grade. Furthermore, an oil containment pit will be provided underneath the liquid-fill transformers. The ground grid layout was adjusted to avoid both the cable vault and the oil containment pit. The layout of the ground grid for City View TPS is shown in Error! Reference source not found.

FIGURE 5-12 CITY VIEW TPS GROUND GRID LAYOUT



The required conductor size for soft-drawn copper (a single phase-to-ground fault current of 60.0 kA) and a clearing time of 0.2 seconds at the City View TPS is determined based on *IEEE 80 Eq. 42*.
A (120 mm^2 (4/0 AWG) grid conductor will be specified to provide additional mechanical strength and electrical performance. The vertical ground rods will be copper-clad steel rods 19 mm (0.75") in diameter and 3m (10') in length.

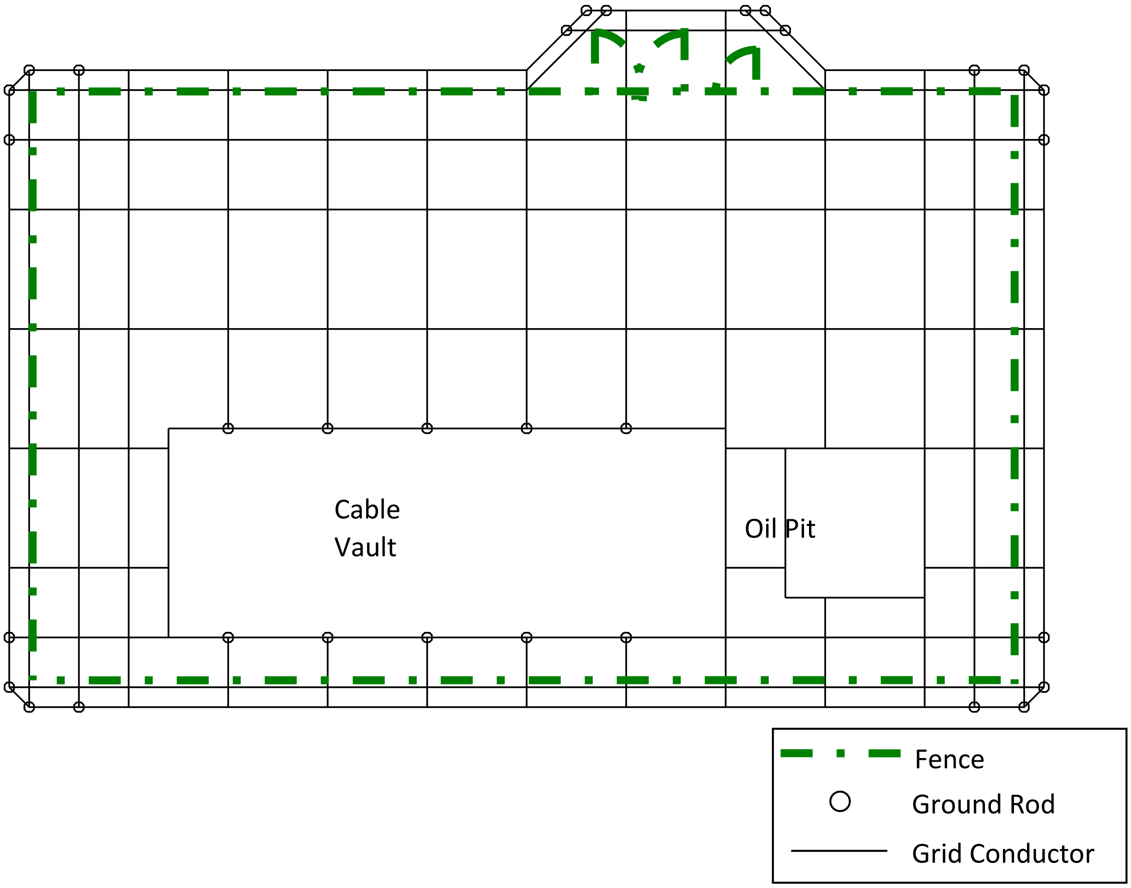
5.6.1.2 3500 Eglinton Paralleling Station – Grounding and Bonding

The Paralleling Station will be enclosed by a metallic perimeter fence. The perimeter fence will be 1m (3') within the perimeter of the ground grid and bonded to the ground grid at regular intervals. The horizontal ground grid conductors will be placed at a depth of 0.5m.

A cable vault will be provided underneath the 2x25kV switchgear room at a depth of 1.4m (4'6") below grade. Furthermore, an oil containment pit will be provided underneath the liquid-fill autotransformer. The ground grid layout was adjusted to avoid both the cable vault and the oil containment pit.

The required conductor size for soft-drawn copper (a single phase-to-ground fault current of 4.374kA) and a clearing time of 0.5 seconds at the Paralleling Station was determined based on *Eq. 42* of *IEEE 80*.

FIGURE 5-13 3500 EGLINTON PARALLELING STATION GROUND GRID LAYOUT

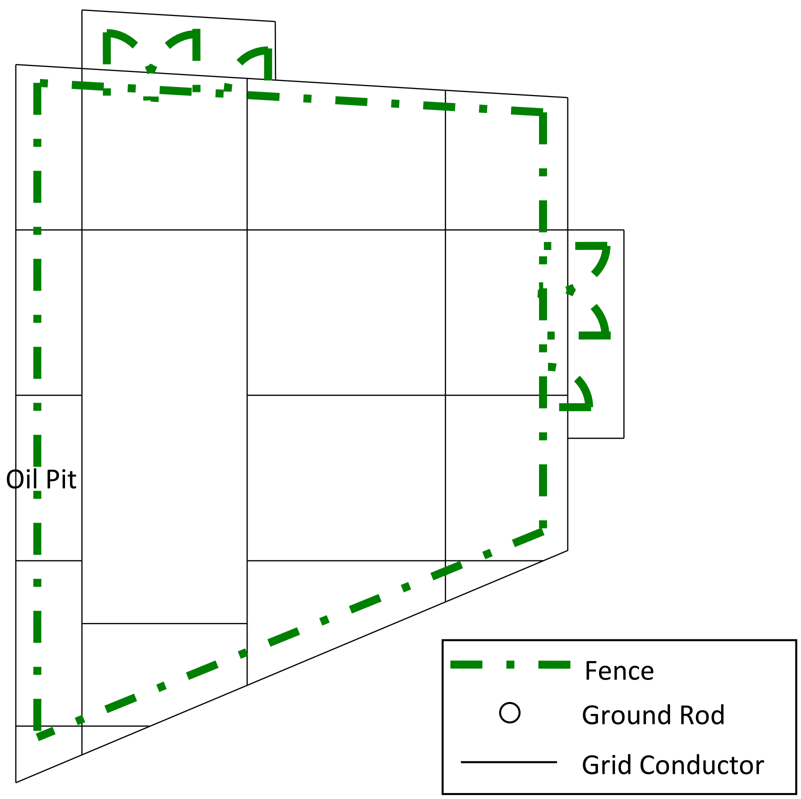


5.6.1.3 Ordnance PS Grounding and Bonding

The Paralleling Station will be enclosed by a metallic perimeter fence. The perimeter fence must be 1m (3') within the perimeter of the ground grid and bonded to the ground grid at regular intervals. The horizontal ground grid conductors will be placed at a depth of 0.5m.

A cable vault will be provided underneath the 2x25kV switchgear room at a depth of 1.4m (4'6") below grade. Furthermore, an oil containment pit will be provided underneath the liquid-fill autotransformer. The ground grid layout was adjusted to avoid both the cable vault and the oil containment pit.

FIGURE 5-14 ORDNANCE PARALLELING STATION GROUND GRID LAYOUT



A 120 mm^2 (4/0 AWG) ground grid conductor will provide additional mechanical strength and electrical performance. The vertical ground rods will be copper-clad steel rods 19mm (0.75") in diameter and 3m (10') in length.

5.6.2 Passenger Train Station Grounding & Bonding Design

5.6.2.1 Terminal 1 Station at Pearson Airport

The grounding and bonding design for the electrification of this station has be completed as part of the construction contract for the spur.

5.6.2.2 Etobicoke North Station

Because the UP Express trains will not be stopping at Etobicoke North station and due to modifications and upgrades, the grounding and bonding design for this station is deferred. Grounding and bonding equipment has not been detailed. However, the typical data for Weston and Bloor Stations will apply to the future design of this station.

5.6.2.3 Weston Station

The Weston Station grounding system is comprised of bare horizontal copper conductors and vertical copper clad steel ground rods will be formed at a depth of 0.5m in the native soil to cover the whole area of the train station.

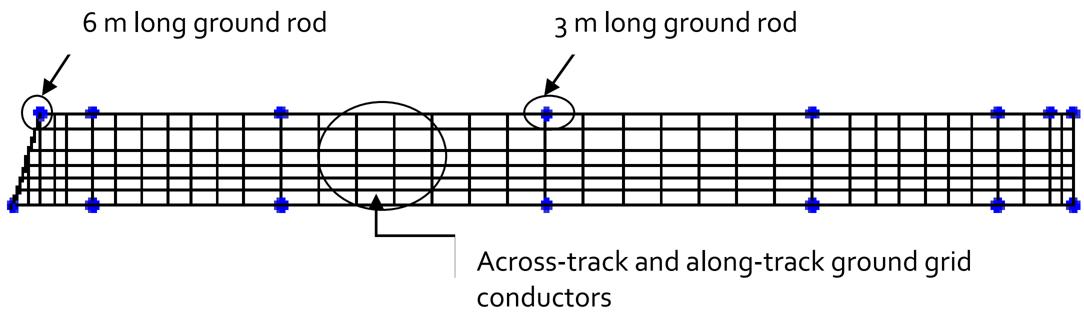
At some locations a combination of native soil and other granular material may be used. The introduction of granular material with higher resistivity will require the grid conductors are buried in undisturbed native soil to a minimum depth of 0.1m, with all external backfill material laid on top of this native soil cover.

The backfill soil will be compacted to the density of undisturbed native soil by using a mechanical tamper. All metallic equipment located on the platforms will be bonded to the ground grid.

Different combinations of grounding conductor and ground rod layouts and sizes were analyzed to obtain the configuration that produces safe touch and step potentials. The Figure below shows a design scenario that would satisfy the step and touch potential limits. The ground grid consists of 38 across-track and 7 along-track ground conductors and a total of 15 ground rods.

The four rods in each corner have a length of 6m and the rest have a length of 3m. Generally, large magnitudes of voltage are found in the corners of a ground grid. This can be mitigated through the use of longer ground rods which allow more current to pass through into the earth thus decreasing the voltage at that location.

FIGURE 5-15 GRID LAYOUT



Once the 6m long rods were placed, eleven 3.1m long rods were also placed on either side of the grid to help evenly distribute the voltage in the grid. The type of ground rods specified for this grid are copper-clad steel rods.

The conductors used for this grid are 120mm^2 (4/0 AWG) bare stranded copper and the grid would be buried minimum 0.5m below grade. The north and south platforms have conductors extending 1m beyond the platform edge on one side. On the other side of the north and south platforms and on both sides of the center platform the conductors are placed along the platform edge.

The placement of the ground rods was also chosen based on locations where high levels of step and touch potential were identified in the grid. Since the corners showed the largest magnitude of voltage, 6.1m long rods were placed at these locations, and calculation results indicated safe voltages. All other rods are 3.1m long, total 11, and are distributed as shown in figure below.

5.6.3 Mount Dennis Station

Metrolinx is developing a new Station at Mount Dennis on GO Kitchener line. This station will part of the Mount Dennis mobility hub which will include connections to the Eglinton Crosstown LRT and local buses. This Station will not be a station for the UP Express service however, grounding and bonding will be implemented as part of the station construction.

5.6.4 Bloor Station

The Bloor Station grounding grid system is comprised of bare horizontal copper conductors and vertical copper clad steel ground rods will be formed at a depth of 0.5m in the native soil to cover the whole area of the train station.

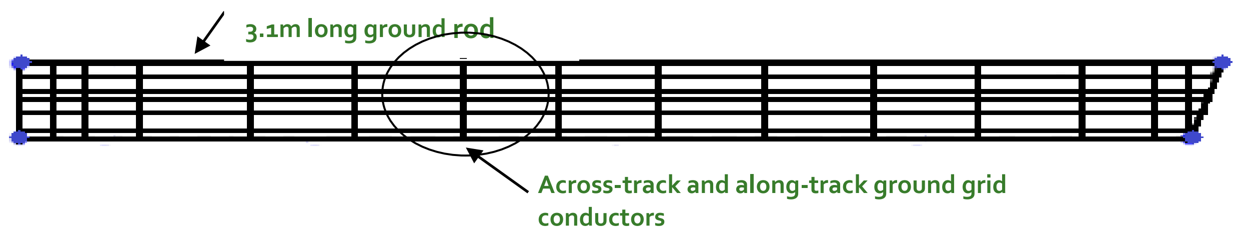
At some locations a combination of native soil and other granular material may be used. The introduction of granular material with higher resistivity will require the grid conductors are buried in undisturbed native soil to a minimum depth of 0.1m, with all external backfill material laid on top of this native soil cover.

The backfill soil will be compacted to the density of undisturbed native soil by using a mechanical tamper. All metallic equipment on the platforms will be bonded to the ground grid. Different combinations of grounding conductor and ground rod layouts and sizes were analyzed to obtain the configuration that produces safe step and touch potentials.

Figure below shows the final design scenario that satisfied the step and touch potential limits. The final design consists of 16 across-track and 7 along-track ground conductors and a total of 4 ground rods. The four rods in each corner have a length of 3.1m.

Generally, large magnitudes of voltage are found in the corners of a ground grid. Copper-clad steel rods are specified for ground rods for this grid.

FIGURE 5-16 GRID LAYOUT



The conductors used for this grid are 120mm^2 (4/0 AWG) bare-stranded copper. The grid is buried a minimum of 0.5m below grade. The north and south platforms have conductors extending 1m beyond the platform edge on both sides.

The placement of the ground rods was also chosen based on locations where high levels of step and touch potential were identified in the grid. Since the corners showed the largest magnitude of voltage, 3.1m long rods were placed at these locations, and calculations indicated safe voltages.

5.6.5 UP Express Union Station

UP Express Union Station grounding system will be placed under the Structure South building. The system will be comprised of bare horizontal copper conductors and vertical copper clad steel ground rods will be formed at a depth of 0.5m in the native soil.

All metallic equipment located within the pantograph zone and on the platforms up will be bonded to the ground grid.

5.6.6 Grounding of Wayside Structures & Equipment

The following wayside equipment located within the electrified railway ROW and on the Metrolinx property will require grounding and bonding provisions:

- Bridges
- Overhead contact system (OCS)
- Running rails/ railway tracks
- Signal bridges
- Wayside power control cubicles/signal cases
- Catenary feeding gantries
- Trenches and retaining walls
- Screens, noise walls, metallic fences/gates and safety barriers
- Third party utilities

5.6.6.1 Bridges

In the case of concrete bridges, if the vertical clearance between OCS conductors and concrete overpasses is less than 1m (3'3"), protection panels (flash plates) will be installed above the OCS, attached to the underside of the bridge across the entire pantograph envelope, and interconnected to the static wire at no less than two locations. For steel overpasses, the steel girders will be interconnected and bonded to the static wire at no less than two locations and no flash plates will be required.

Metallic protection bridge barriers will be grounded by bonding to the static wire (aerial ground wire) at no less than two locations. All other metallic items on the bridge or overpass (including a road crash fence, handrails, stair cases and security fences) within the lateral range of not less than 3.05m (10') beyond any energized and un-insulated equipment will be bonded to the static wire.

5.6.6.2 Disconnect Switches & Surge Arresters

Disconnect switch assembly that includes the metal frame of the disconnect switch, the operating handle, and the housing of the operating mechanism, located on the electrified railway ROW and within the Metrolinx property will be grounded by means of a copper braid of no less than $50mm^2$ to a grounding terminal at the base of the structure on which the disconnect switch is mounted. Each structure carrying a disconnect switch will be provided with a ground mat at least of $1m^2$ buried approximately 300mm below the surface under the operating mechanism or handle of the disconnect switch to ensure a ground resistance of not more than 5 ohms. The surge arresters will be grounded by a local ground rod. The ground leads from surge arresters will have a maximum ground resistance of 5 ohms.

5.6.6.3 Running Rails

The running rails of the electrified tracks will be connected to the earth through the neutral points of impedance bonds at frequent locations (approximately 1 km apart), and particularly at train stations and traction power facility locations. At these locations the neutral points of impedance bonds are connected to the static wire. This aspect will be coordinated with the signal system design to ensure that broken rail protection is not compromised.

The snow melters will also be grounded through the central tap of the impedance bonds.

5.6.6.4 Signal Bridges

Signal bridges installed in close proximity of the impedance bonds will be bonded to the traction return system by direct connection to the neutral leads of the impedance bond adjacent to the signal. There will be no other electrical connections between the signal mast and other structures or other rails or neutral leads unless specified.

At all other locations signal bridges will not be electrically connected to any neutral leads or any portion of any track structure that is part of the signal system. These structures will not be bonded to the static wire of the OCS but will be connected to ground rods in at-grade locations, or to grounding plates at aerial structures, tunnels, or trench/retaining wall locations.

5.6.6.5 Wayside Power Control Cubicles & Cases

Grounding of wayside power control cubicles (WPCs) and signal cases will be localized. Copperweld ground rods will be used for grounding. The ground resistance will not exceed 15 ohms as measured from the equipment to the ground. Bonding conductors will be continuous and routed in the shortest, straight-line path possible.

5.6.6.6 Catenary Feeding Gantries

Each of the catenary feeding gantries at TPFs will be bonded to the static wire by two 120mm^2 (4/0 AWG) bare copper conductors. The gantries will also be structurally supported on reinforced concrete and anchor bolt foundations where the concrete is in contact with the adjacent soil. This arrangement will help reduce the ground resistance of the gantries.

5.6.6.7 Screen, Noise, Wind and Safety Barriers

Screen, noise, wind and safety barriers on Metrolinx property and located within the 10m zone will be electrically bonded to the static wire at no fewer than two locations. Such equipment within the Metrolinx right-of-way, but outside of the 10m zone will be grounded to keep touch potentials within safe limits but will not be bonded to the static wire.

5.6.6.8 Metallic Fences & Gates within 10m of the Electrified Railway

Metallic fences, fence posts and gates built within the 10m zone, will have ground electrodes installed on either side of a gate, or at either opening in the fence.

Fence posts at the fence openings will be bonded to form a continuous path, and gates will be bonded with flexible metal bonding straps to support posts and will eliminate reliance on hinges for electrical continuity.

Metallic fences will be made electrically continuous and conductors that connect the fences will be exothermically welded to fence posts and to any fence material support members (top and bottom) between posts. Metallic fences will be electrically bonded to the OCS static wire.

Metallic fences on the electrified rail corridor property boundary require additional grounding. As per the Ontario Electrical Safety Code, metallic fences parallel to the electrified rail corridor require an underground copper conductor (counterpoise) to be buried one meter away from the fence, outside the rail corridor. The underground copper conductor will be buried parallel to the metallic fence. This underground (counterpoise) conductor should be connected to the Metrolinx fence at frequent locations as identified in the applicable local standards, in addition to providing ground rods for the metallic fence. This arrangement would protect the general public outside the Metrolinx fence from touch potential hazard, and consequently, from step potential hazard.

5.6.6.9 Metallic Fences & Gates outside 10m of the Electrified Railway

Metallic fences and gates outside of the 10m zone would not be bonded to the OCS static wire. These structures should be grounded as per the applicable local standards.

5.6.7 Third Party Grounding Interface

5.6.7.1 CP and CN Tracks

CP and CN rail tracks that are within the 10m zone will be provided with impedance bonds and the neutral points of these impedance bonds will be bonded to the neutral point of the nearest impedance bonds of Metrolinx tracks. Fences between the CP and Metrolinx tracks that run in parallel will be erected and grounded within the Metrolinx property and connected to the OCS static wire.

5.6.7.2 Pipelines and Utilities

Existing pipelines and utilities running parallel and crossing the UP Express route will be exposed to induced voltages from the OCS operating and fault currents. The degree of exposure will depend on whether the pipeline is located on the surface or buried, the type of coating on the pipe, and cathodic protection. The existing as well as future pipelines crossing the railway will be grounded to the static wire on each track side. Grounding connections to the pipelines will be made within the Metrolinx ROW.

5.6.7.3 Metallic Fences/Gates

The Electrical Safety Code requires that metallic fences and gates be grounded and bonded. Metallic fences and gates located within 10m of the electrified railway will require grounding and bonding as described above. Fences and gates outside of 10m zone will not be connected to the OCS static wire.

5.6.7.4 Structures & Buildings

There are over 100 residential and commercial properties along the GTS corridor that are encroaching within the 10m zone. Most of them have no temporary or permanent structures built in the 10m zone.

During the detailed design, Metrolinx will undertake a site inventory to determine if these existing structures have any metallic components that would require grounding and bonding.

In general, for the identified metal structures and metal roofs within the 10m zone, grounding and bonding to a local ground electrode in accordance with normal building practices and relevant standards such as Ontario Electrical Safety Code will be required. In addition these structures and metal roofs that are in the 10m zone will be connected to the OCS static wire. According to the Code, metal structures and metal roofs shall have electrical continuity between parts of the roof and, if necessary, additional connections shall be implemented by running a copper wire around the roof to ensure continuity.

Metal structures and metal roofs outside of 10m zone will be grounded to a local ground electrode in accordance with normal building practices and relevant standards such as Ontario Electrical Safety Code, however these metal structures and metal roofs will not be connected to the OCS static wire.

5.7 Bridges and Rail Overpasses

There are a total of 23 bridges (i.e., rail under road) and 21 rail overpass structures (i.e., rail over road or water) along the UP Express route. There are also two future/planned bridges, including Fort York Pedestrian Bridge and King Street Pedestrian Bridge, both of which are located in Section 1 of the corridor. As part of electrifying the UP Express, there are three primary modifications to bridges that will be required on some bridges:

- *Installation of OCS*
  - to allow for electrification through/under the structure
- *Installation of Bridge Protection Barriers*
  - to protect pedestrians and equipment
- *Grounding and Bonding (as described in Section 5.6.5)*
  - to prevent damage from flashovers to the bridge structures
  - to prevent the step and touch potential from exceeding permissible limits as defined in the applicable standards (CSA, EN and IEEE).

Table 5-2 provides a summary of the proposed OCS design/method, protection barrier requirements, and grounding and bonding provisions for each bridge structure along the corridor. Similarly, **Table 5-3** provides a summary of the proposed OCS design/method and requirements for OCS structure attachments for each rail overpass structure.

TABLE 5-2 SUMMARY OF BRIDGE MODIFICATIONS - UP EXPRESS ELECTRIFICATION

Structure Name	EA Study Area Section	Ch. (km)	Min. Clearance	Bridge Owner[4]	Proposed OCS Method	Flash Plate To Be Attached To Bridge?	Wires To Be Attached To Bridge?	Bridge Protection Barrier to Be Added or Modified?
Skywalk Pedestrian Bridge	Section 1	0+332	7.617	Private Owner	Free run without attachment	Yes	No	No
MTCC Pedestrian Bridge	Section 1	0+412	11.431	Private Owner	Free run without attachment	No	No	No
CN Tower Pedestrian Bridge	Section 1	0+641	7.682	Canada Lands Company	Free run without attachment	Yes	No	No
Rogers Centre Pedestrian Bridge	Section 1	0+667	7.431	City of Toronto	Free run without attachment	No	No	No
Peter Street/Blue Jays Way Bridge	Section 1	0+875	8.370	City of Toronto	Free run without attachment	No	No	Yes

[4] *Bridge ownership may be governed by Board Orders.*

Structure Name	EA Study Area Section	Ch. (km)	Min. Clearance	Bridge Owner[4]	Proposed OCS Method	Flash Plate To Be Attached To Bridge?	Wires To Be Attached To Bridge?	Bridge Protection Barrier to Be Added or Modified?
Spadina Avenue Bridge	Section 1	1+102	7.168	City of Toronto / TTC	Attach to bridge with tunnel arms on Track B	Yes	Yes	Yes
Track C1 and C2 Flyover	Section 1	1+250	7.400	Metrolinx	Attach to the bridge with tunnel Arms	Yes	Yes	Yes
Portland Ave Pedestrian Bridge	Section 1	1+542	11.978	City of Toronto	Free run without attachment	No	No	Yes
Bathurst Street Bridge	Section 1	1+730	7.300	Metrolinx	Free run except for attachment for OCS over crossover track.	No	No	Yes
**Fort York Pedestrian Bridge*	Section 1	2+301	7.500	City of Toronto	N/A Assume 7.4 m clearance	No	No	Yes
Strachan Avenue Grade Separation	Section 1	2+544	7.400	City of Toronto	OCS attachments to be installed to concrete bridge deck for tracks W2, W3 and W4.	Yes	Yes	Yes
**King St. Pedestrian Bridge*	Section 1	N/A	N/A	N/A	N/A Assume 7.4m clearance	N/A	N/A	N/A

Structure Name	EA Study Area Section	Ch. (km)	Min. Clearance	Bridge Owner[4]	Proposed OCS Method	Flash Plate To Be Attached To Bridge?	Wires To Be Attached To Bridge?	Bridge Protection Barrier to Be Added or Modified?
Dundas Street Bridge	Section 1	5+579	7.270	City of Toronto	Free run without attachment	No	No	Yes
Wallace Ave Pedestrian Bridge	Section 2	6+832	7.459	City of Toronto	Free run without attachment	Yes	No	Yes
Galt Junction / West Toronto Diamond (WTD)	Section 2	7+680	6.909	Metrolinx	Attach to bridge with tunnel arms	Yes	Yes	Yes
Old Weston Rd / West Toronto Diamond (WTD)	Section 2	7+984	6.730	Metrolinx	Attach to bridge with tunnel arms	Yes	Yes	Yes
Rogers Road Bridge	Section 2	9+850	6.856	City of Toronto	Free run without attachment	Yes	No	Yes
Jane Street Bridge	Section 2	12+348	7.049	City of Toronto	Free run without attachment	No	No	Yes

Structure Name	EA Study Area Section	Ch. (km)	Min. Clearance	Bridge Owner[4]	Proposed OCS Method	Flash Plate To Be Attached To Bridge?	Wires To Be Attached To Bridge?	Bridge Protection Barrier to Be Added or Modified?
Weston Tunnel	Section 3	13+808	7.400	Metrolinx	Attach to tunnel with tunnel arms	Yes	Yes	No
John Street Pedestrian Bridge	Section 3	13+808	7400	Metrolinx	No OCS attachments to the bridge are required.	Yes	No	Yes
King Street	Section 3	14+050	7400	Metrolinx	OCS attachments required over Lines W2, W3, and W4	Yes	Yes	No
Church Street	Section 3	14+410	7400	Metrolinx	OCS attachments required over Lines W2, W3, and W4	Yes	Yes	No
Islington Avenue Bridge	Section 3	16+737	7.066	City of Toronto	Attach to bridge with resilient arm at Track W1 and tunnel arms at Track W2. Free run without attachment at W3 and W4.	No	Yes	Yes
Hwy 401 Tunnel	Section 3	17+042	7.176	MTO	Attach to tunnel with tunnel arms at Tracks W2,W3 and W4 and a resilient arm at Track W1.	Yes	Yes	Yes
Hwy 427 Bridge	Section 2	21+691	7.042	MTO	Attach to bridge with resilient arms in bridge beam pockets	Yes	Yes	Yes

TABLE 5-3 SUMMARY OF RAIL OVERPASS MODIFICATIONS - UP EXPRESS ELECTRIFICATION

Structure Name	EA Study Area Section	Ch.(km)	Bridge Length (m)	Bridge Owner	Proposed OCS Method	OCS Structure(s) to be attached?
Lower Simcoe Street Subway	Section 1	0+340	20	Metrolinx	No attachment to bridge	No
King Street West	Section 1	3+250	25.00	Metrolinx	Attach 4 Track portal to the bridge piers via wall brackets	Yes
Queen Street	Section 1	3+958	30.50	Metrolinx	Span with no attachment to bridge	No
Dufferin Street	Section 1	4+025	25.00	Metrolinx	Span with no attachment to bridge	No
Brock Avenue	Section 1	4+450	20.00	Metrolinx	Span with no attachment to bridge	No
Lansdowne Avenue	Section 1	5+021	23.00	Metrolinx	Span with no attachment to bridge	No
Bloor Street West	Section 1	6+360	18.00	Metrolinx	Span with no attachment to bridge	No
Dupont Street	Section 2	7+402	23.00	Metrolinx	Span with no attachment to bridge	No
St. Clair Avenue West	Section 2	8+559	22.00	Metrolinx	Span with no attachment to bridge	No
Black Creek	Section 2	10+300	180.00	Metrolinx	Attach 4 Track portal to the bridge piers	Yes
Eglinton Avenue	Section 2	10+973	25.00	Metrolinx	Attach 4 Track portal to the bridge piers via wall brackets	Yes
Ray Avenue	Section 2	11+540	15.00	Metrolinx	Span with no attachment to bridge	No
Denison Road East	Section 2	12+795	52.00	Metrolinx	Span with no attachment to bridge	No

Structure Name	EA Study Area Section	Ch.(km)	Bridge Length (m)	Bridge Owner	Proposed OCS Method	OCS Structure(s) to be attached?
Lawrence Avenue	Section 3	13+582	33.00	Metrolinx	Span with no attachment to bridge	No
Weston Road	Section 3	15+304	35.00	Metrolinx	Span with no attachment to bridge	No
Humber River	Section 3	15+514	185.00	Metrolinx	Attach 4 Track portal to the bridge piers via wall brackets	Yes
Weston Golf Club Pedestrian Tunnel	Section 3	16+024	7.00	Metrolinx / Private Owner	Span with no attachment to bridge	No
Kipling Avenue	Section 3	17+800	40.00	Metrolinx	Span with no attachment to bridge	No
Martin Grove Rd.	Section 3	18+912	15.00	Metrolinx	Span with no attachment to bridge	No
Highway 27	Section 3	19+900	20.00	Metrolinx	Span with no attachment to bridge	No
Carlingview	Section 3	21+000	15.00	Metrolinx	Span with no attachment to bridge	No

*** Ownership may be governed by Board Orders.*

5.7.1 OCS Design – Bridges and Rail Overpasses

In order to run OCS wires under bridges without attachments, there must be sufficient clearance between the messenger wire/catenary and the lowest structure of the bridge. Where sufficient clearance does not exist, attachments (e.g., tunnel arms, portal structures) on the structure are required in order to support the OCS.

There are three design options for installing OCS to bridge/rail overpass structures:

1. Install attachments to bridge to support OCS wires running under the bridge (see **Figure 5-17**)

2. Install attachments to bridge (e.g., Humber River) (see **Figure 5-18**)

3. Attach to tunnel with tunnel arm(s) (e.g., Highway 427) (see **Figure 5-19**)

5.7.1.1 Loadings

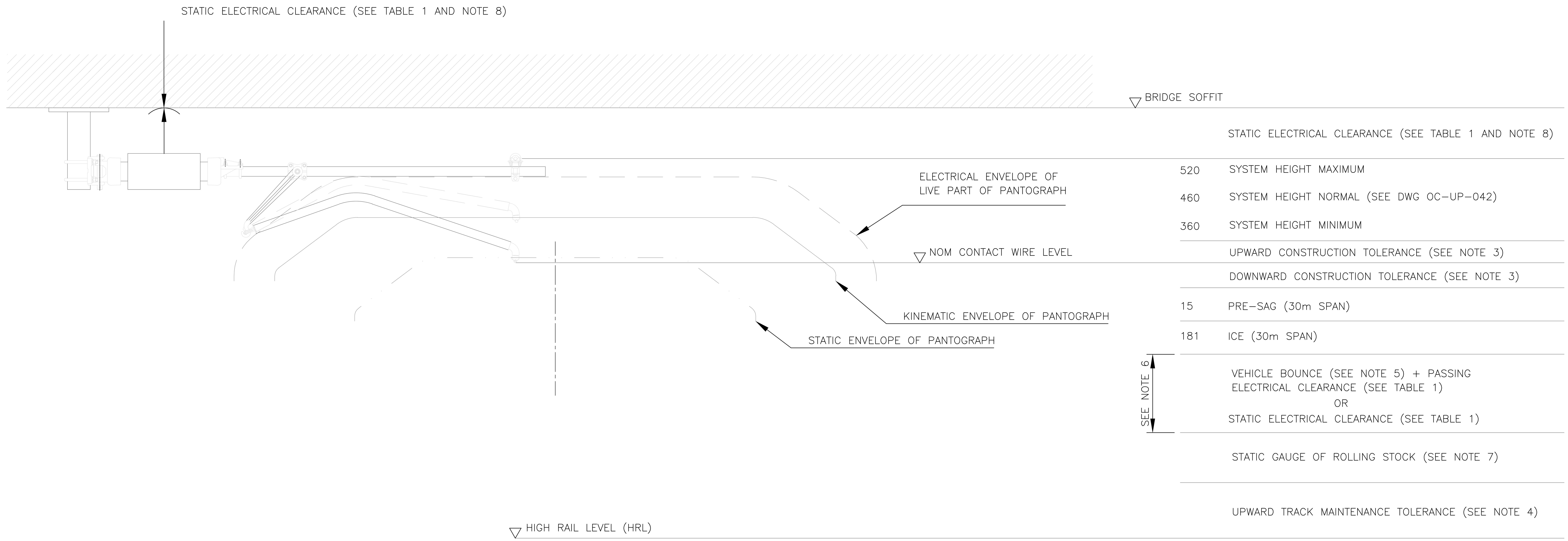
For both OCS attachment options, the attachment loading analysis is performed. This analysis is to give the asset/bridge owner an indication of the typical loadings/type of attachment that will be utilized in these locations.

A typical example of the loading that is imparted by the OCS is shown in **Figure 5-20** and summarized below.

- The total load transferred from the catenary wires to the bridge is 10kN pull and 4.2kN shear (with each bolt taking 5kN pull and 1.05kN shear).

- The total load transferred from the auxiliary wires to the bridge is 9.4kN pull and 4.6kN shear (with each bolt taking 4.7kN pull and 1.15kN shear).

- Typically, 4 x resin bonded anchor bolts, 28mm diameter x 175mm in length would be used at each OCS attachment location where concrete is present. The final size will be confirmed at detailed design and all fixings will be proof tested to ensure adequate installation.



NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.
2. PRE-SAG OF THE CONTACT WIRE WITH ICE ON CATENARY IS BASED ON 30m SPAN.
3. CONSTRUCTION TOLERANCE FOR OCS IS 25mm NORMAL OR 13mm MINIMUM AS PER AREMA FIGURE 33-2-3.
4. TRACK MAINTENANCE TOLERANCE IS 25mm NORMAL OR 13mm MINIMUM AS PER AREMA FIGURE 33-2-3.
5. VEHICLE BOUNCE IS 65mm AS PER AREMA FIGURE 33-2-3 UNLESS SPECIFIC BOUNCE IS PROVIDED.
6. IF VEHICLE BOUNCE + PASSING ELECTRICAL CLEARANCE IS LESS THAN STATIC ELECTRICAL CLEARANCE USE THE STATIC ELECTRICAL CLEARANCE.
7. STATIC GAUGE OF ROLLING STOCK IS 4966mm (FOR GO BI-LEVEL VEHICLE SEE DWG OC-UP-010).
8. STATIC ELECTRICAL CLEARANCE MUST BE MAINTAINED FROM THE TOP OF THE MESSENGER WIRE AS WELL AS FROM THE TOP OF THE INSULATOR.

TABLE 1 (SEE AREMA TABLE 33-2-2)

CLEARANCE	NORMAL MINIMUM	ABSOLUTE MINIMUM
PASSING	205	155
STATIC	270	205

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UP EXPRESS

CLEARANCE FOR BRIDGE-BRIDGE ARM

FIGURE 5 -17

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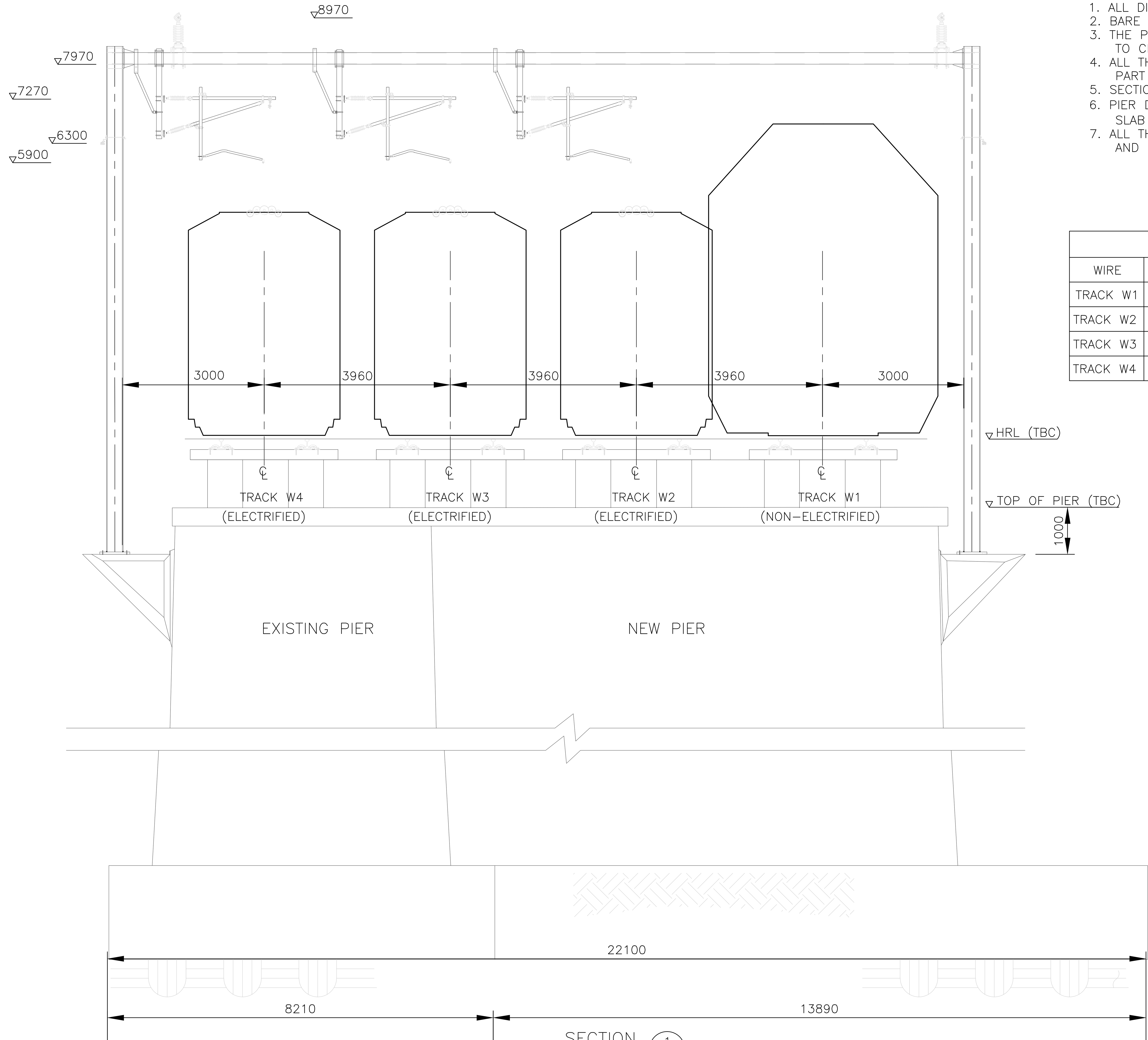

SECTION 1/–
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NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.
2. BARE NEGATIVE FEEDER TO BE USED.
3. THE POSITION OF THE PORTAL AND WALL BRACKETS ARE SUBJECTED TO CHANGE IN DETAIL DESIGN STAGE.
4. ALL THE CLEARANCES ARE TAKEN FROM AREMA CHAPTER 33, PART 2, TABLE 33–2–2.
5. SECTIONS ARE SHOWN IN INCREASING CHAINAGE.
6. PIER DETAILS ARE TAKEN FROM "HUMBER BRIDGE, CONCRETE DECK SLAB LAYOUT, DRAWING NUMBER AA345–9.6–2.24 A. DATED 29/10/10"
7. ALL THE CONTACT WIRE HEIGHTS ARE MEASURED FROM INDIVIDUAL TRACKS AND NEGATIVE FEEDER HEIGHTS ARE FROM TOP OF HIGH RAIL.

HEIGHTS					
WIRE	CW	MW	SW	FW	COMMENTS
TRACK W1	–	–	6300	8970	–
TRACK W2	5900	7100	–	–	–
TRACK W3	5900	7100	–	–	–
TRACK W4	5900	7100	6300	8970	–

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GO ELECTRIFICATION
PRELIMINARY DESIGN
UP EXPRESS
HUMBER RIVER–SECTION 1

FIGURE 5 -18

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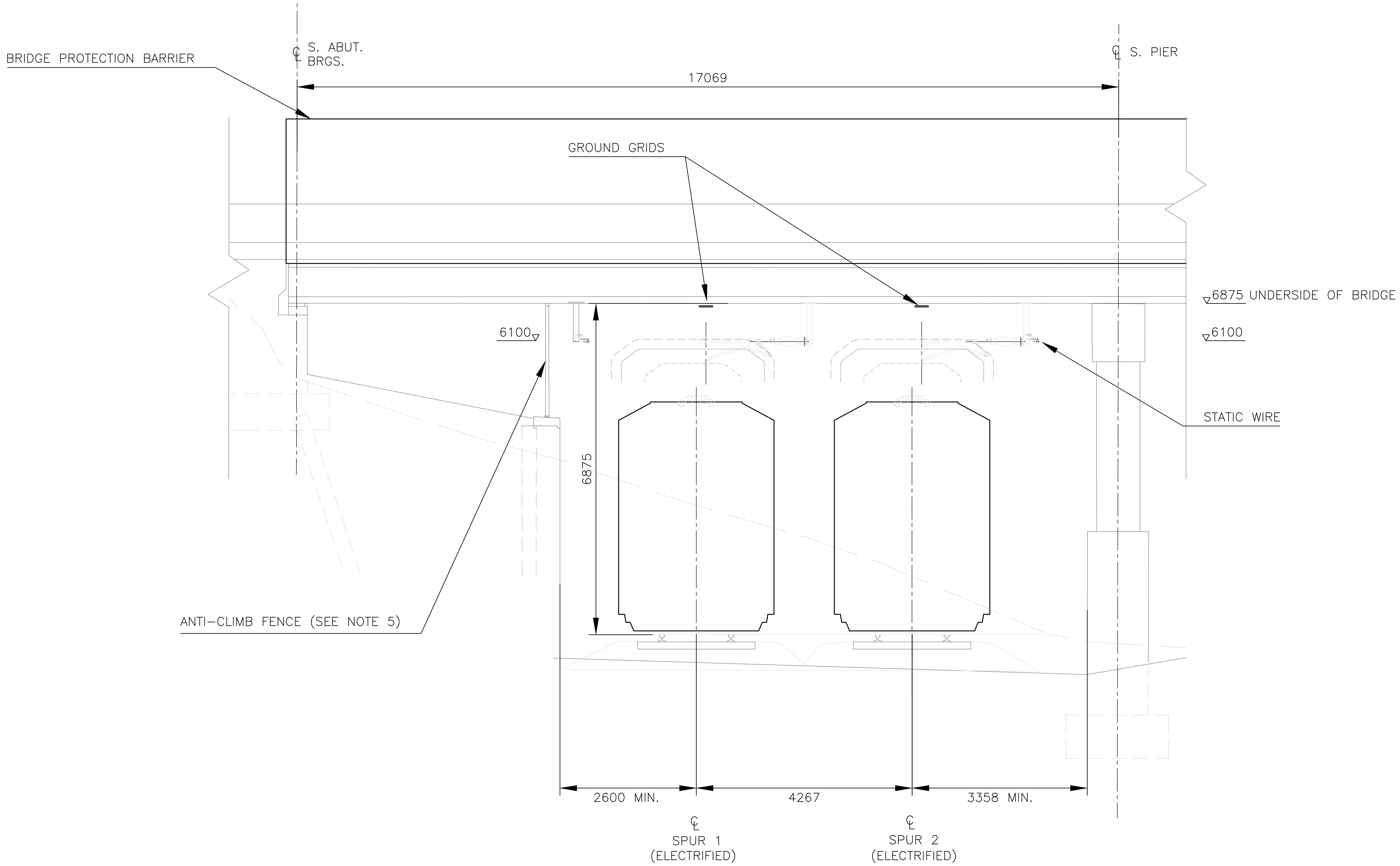

SECTION 1
SCALE: 1:50

NOTES

1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED
2. SOFFIT HEIGHTS AND HORIZONTAL DIMENSIONS (SECTION CUT) ARE TAKEN FROM GEORGE TOWN SOUTH CORRIDOR, RETAINING WALL AT HIGHWAY 427 OVERHEAD, GENERAL ARRANGEMENT, DWG NO. S-001 REV 0 DATED 23/08/2011
3. BALLAST CONSTRUCTION AND SUB-BALLASTS ARE NOT CONSIDERED. VERTICAL DIMENSIONS ARE PROPOSED ONLY AND TO BE CONFIRMED BY SURVEY BEFORE ANY DETAIL DESIGN.
4. CONTACT WIRE HEIGHT IS NOMINAL ONLY.
5. ANTI-CLIMB FENCE INSTALLED ON RETAINING WALL TO STOP PUBLIC ACCESS.
6. OCS HEIGHTS ARE SUBJECTED TO CHANGE AT DETAIL DESIGN STAGE.

TABLE 1 – WIRE HEIGHTS ANALYSIS

PARAMETERS	ARL SPUR
BRIDGE TO HIGH RAIL CLEARANCE	6875
GROUND GRID DEPTH	13
STATIC ELECTRICAL CLEARANCE	477
CATENARY UPWARD INSTALLATION TOLERANCE	25
SYSTEM HEIGHT	460
CATENARY DOWNWARD INSTALLATION TOLERANCE	25
SAG OF CONTACT WIRE WITH ICE ON CATENARY	196
STATIC ELECTRICAL CLEARANCE	623
BOUNCE	65
STATIC VEHICLE GAUGE HEIGHT	4966
TRACK MAINTENANCE ALLOWANCE	25
CONTACT WIRE HEIGHT	5900

HEIGHTS					
WIRE	CW	MW	SW	IFW	COMMENTS
SPUR 1	5900	6360	6100	–	–
SPUR 2	5900	6360	6100	–	–

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GO ELECTRIFICATION
PRELIMINARY DESIGN
UP EXPRESS
HIGHWAY 427 BRIDGE – SECTION 1

FIGURE 5 -19

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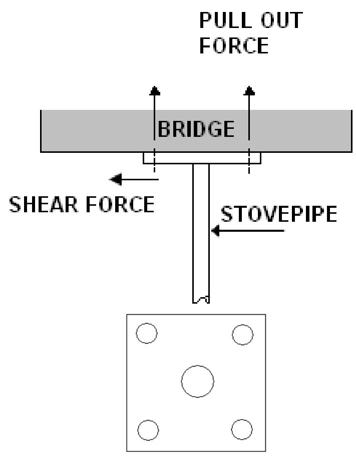
Plotted: January 8, 2014 by: Jun, Soo

FIGURE 5-20 EXAMPLE OF OCS LOADING



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5.7.2 Bridge Protection Barriers

The purpose of a bridge protection barrier is to protect pedestrians on bridges from direct contact with adjacent live parts of the OCS for voltages up to 25 kV to ground. In addition, these barriers protect against damage of the OCS passing under bridges by providing an obstacle to debris that may be thrown onto the railway from overhead. **Figure 5-21** depicts an example of a bridge barrier.

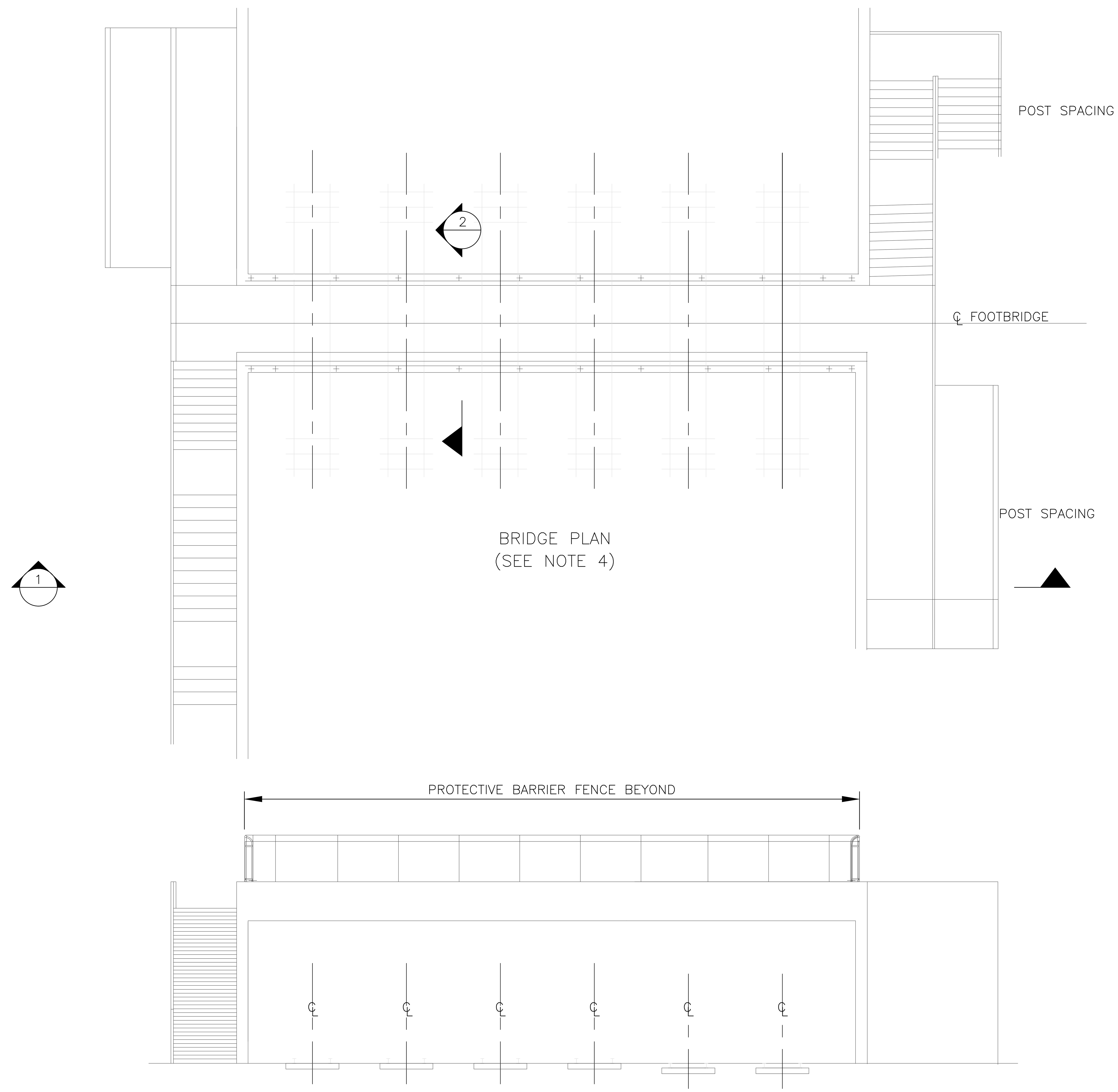
The length of the protection barrier will extend a minimum of approximately 3m laterally beyond the live parts of the overhead contact line, outside of the bridge. The barriers will be made of a solid or mesh metal, and will be a minimum height of approximately 2m (barriers of greater heights may be required in areas where vandalism is prevalent). Where walkways are provided on bridges, a curved fence may also be installed on top of the solid barrier for additional safety and security. High voltage signage will also be provided as an additional safety measure.

Metallic protection barriers will be grounded by bonding to the static wire at a minimum of two locations, as previously described in Section 5.6.5.

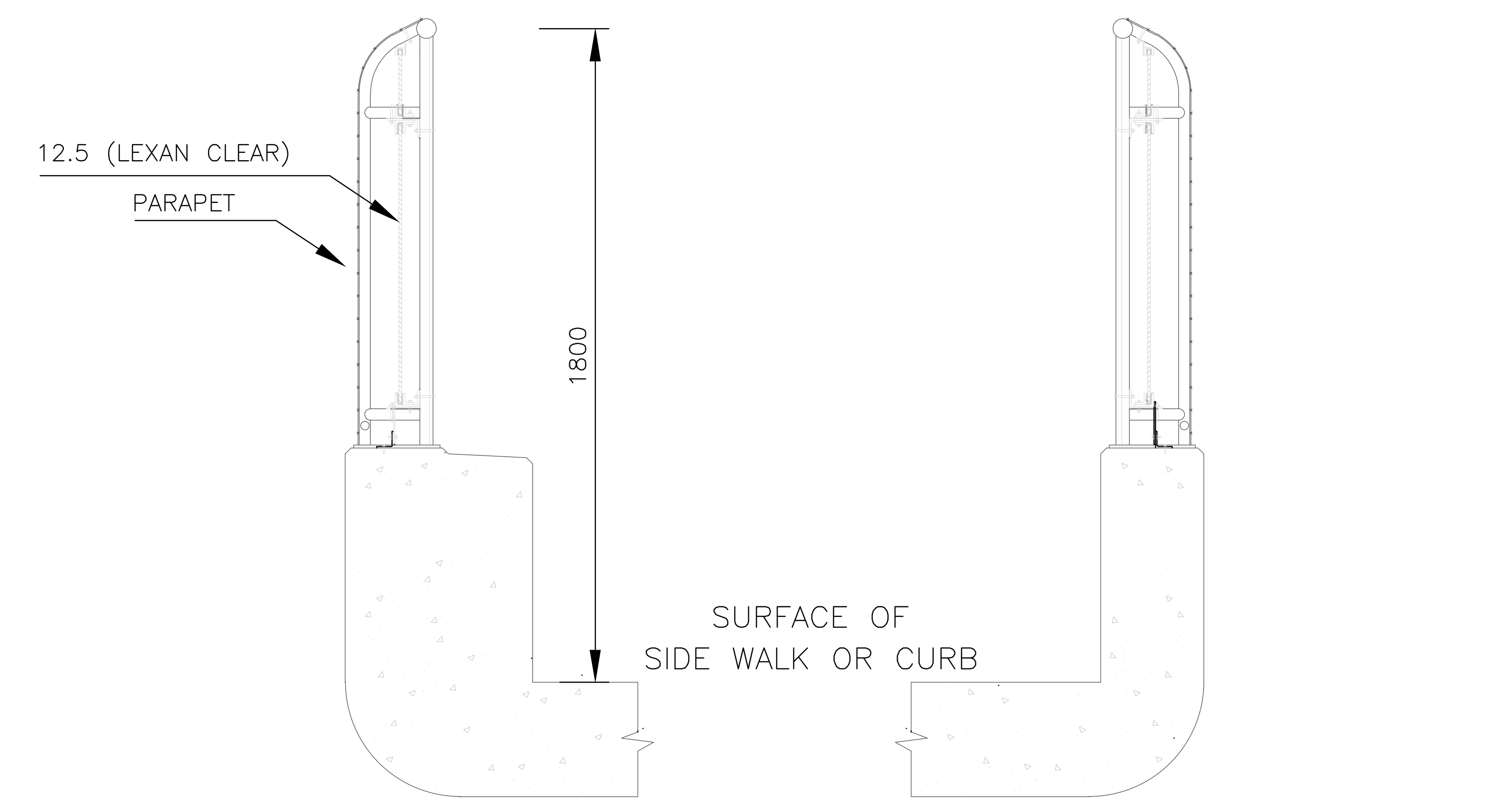
FIGURE 5-21 EXAMPLE OF A BRIDGE BARRIER

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.
2. PROTECTIVE BARRIER SHAPES ARE ALUMINIUM DESIGNATION 6061–T6 EXCEPT AS NOTED.
3. LEXAN IS 1/2" MR10 SHEET (CLEAR) WITH MAR–RESISTANT MARGARD 11 UV ABRASION RESISTANT COATING.
4. THE ARRANGEMENT SHOWN IS TYPICAL ONLY AND CAN BE MODIFIED ON CASE TO CASE BASIS.
5. TYPICAL DIMENSIONS ARE TAKEN FROM THE DETAIL PROVIDED BY THE SUPPLIER.
6. FOR AN ALTERNATIVE BRIDGE PROTECTION BARRIER ARRANGEMENT REFER TO DRAWING OC–UP–052.
7. BRIDGE ABUTMENTS AND WINDWALLS THAT CAN BE ACCESSED BY PEDESTRIAN AND ARE WITHIN 3050 mm OF ANY LIVE LINE, A SOLID BARRIER IS REQUIRED.
8. LENGTH OF PROTECTION BARRIER SHALL EXTEND A MINIMUM OF 3050mm BEYOND THE LIVE PART OF THE OVERHEAD CONTACT LINES OUTSIDE OF THE BRIDGE.



SECTION 1



SECTION 2

(SEE NOTE 4)

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GO ELECTRIFICATION

PRELIMINARY DESIGN

UP EXPRESS

BRIDGE PROTECTION BARRIER

FIGURE 5 -22

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Plotted: January 21, 2014 by: Jun, Soo

5.8 Stations

The UP Express service will stop at four stations as follows:

- UP Express Union Station (future)
- UP Express Bloor Station (existing)
- UP Express Weston Station (existing)
- UP Express Pearson Station (future)

As part of implementing electrification, these four stations will require the following modifications:

- Addition of OCS support structures; and
- Grounding and bonding (as previously described in Section 5.6.5).

Etobicoke North Go Station is also located along the route but UP Express services will pass through without stopping. Grounding and bonding provisions for the planned Mount Dennis Station have been included in the requirements for the new station design (which will be developed as part of the Eglinton Crosstown project).

5.8.1 UP Express Union Station

5.8.1.1 OCS Support Structures

The future UP Express Union Station platforms will be located just west of Union Station. The proposed configuration for this station is a singular platform on the most northern track within the USRC. Four OCS structures (i.e., portals, twin track cantilevers) approximately 8m high will need to be attached to the north and south station platforms, as summarized in **Table 5-4** below.

TABLE 5-4 SUMMARY OF PROPOSED OCS ATTACHMENTS AT UP EXPRESS UNION STATION

Chainage (km)	OCS Support Structure Type	Proposed Attachment on South Platform	Proposed Attachment on North Platform
0.153	Twin Track Cantilever	Foundation to platform area spanning across 2 tracks	N/A
0.178	Single Track Cantilever	Foundation to platform area	Foundation installed between northern tracks 1&2
0.202	Portal	Foundation to platform area	Foundation installed between northern tracks 1&2
0.227	Back to back Twin Track Cantilever	N/A	Foundation installed between northern tracks 1&2

0.260	Back to back Twin Track Cantilever	N/A	Foundation installed between northern tracks 1&2
0.310	Portal	Foundation to platform area spanning across 4 tracks	Foundation installed between northern tracks

5.8.2 UP Express Bloor Station

5.8.2.1 OCS Support Structures[5]

Bloor Station is situated between 6.354 km and 6.819 km and is approximately 465 m in length. Bloor station is currently undergoing modifications to upgrade the existing station area. The proposed station platform configuration for Bloor Station is two island platforms, one between tracks 1 and 2, and the other between tracks 3 and 4.

OCS support structures are to be placed over the three tracks to be electrified via attachments and reinforcement to the station canopy columns in the platform areas, wherever possible. Specifically, six portal attachments to the canopy columns on the south platform and five portal attachments to the canopy columns on the north platform are required, as summarized in **Table 5-5** below (Figure 5-23).

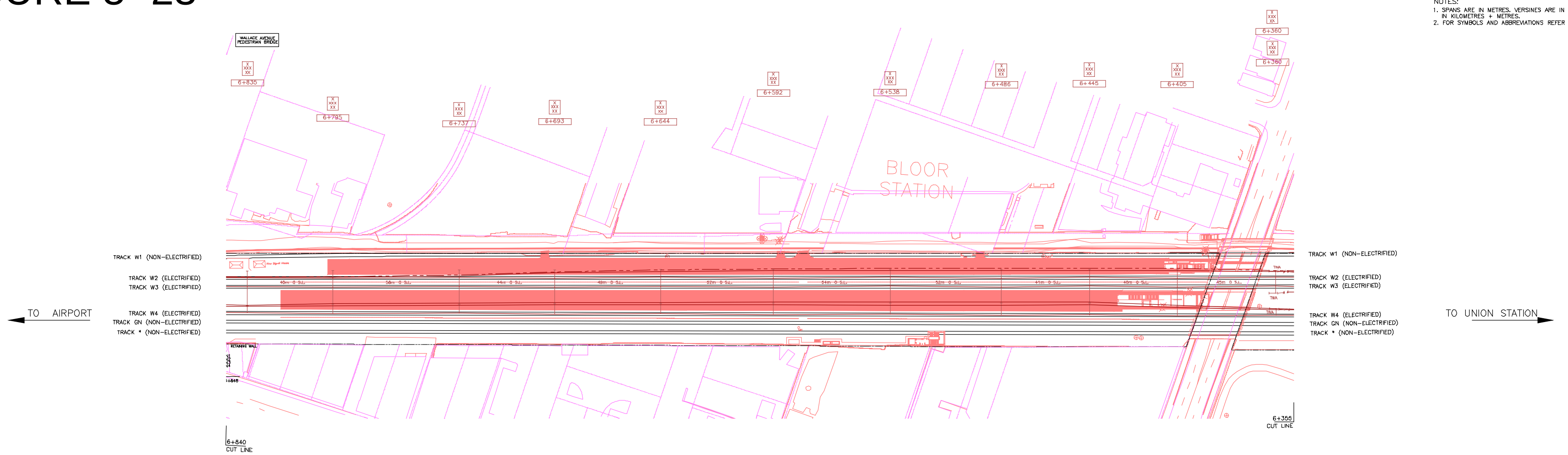
TABLE 5-5 SUMMARY OF PROPOSED OCS ATTACHMENTS AT UP EXPRESS BLOOR STATION

Chainage (km)	OCS Support Structure Type	Proposed Attachment on South Platform	Proposed Attachment on North Platform
6.405	Portal	Attachment to Canopy Column	Attachment to Canopy Column
6.445	Portal	Attachment to Canopy Column	Attachment to Canopy Column
6.486	Portal	Attachment to Canopy Column	Attachment to Canopy Column
6.538	Portal	Attachment to Canopy Column	Attachment to Canopy Column
6.592	Portal	Attachment to Canopy Column	Attachment to Canopy Column
6.644	Portal	Attachment to Canopy Column	Foundation in platform area
6.693	Portal	Foundation in platform area	Foundation in platform area
6.737	Portal	Foundation in platform area	Foundation in platform area
6.795	Portal	Foundation in platform area	Foundation in platform area

[5] Further study during detailed design will be required to confirm whether canopy columns can bear the load of OCS attachments.

FIGURE 5 -23

NOTES:
1. SPANS ARE IN METRES. VERSINES ARE IN MILLIMETRES. CHAINAGES ARE IN KILOMETRES + METRES.
2. FOR SYMBOLS AND ABBREVIATIONS REFER TO DRAWING OC-UP-002.



METROLINX PROJECT NO. 109503

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		03	14/01/20	FINAL DRAFT			
		02	13/11/27	FIRST ISSUE			
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PARSONS BRINCKERHOFF

METROLINX

GO ELECTRIFICATION
PRELIMINARY DESIGN
UP EXPRESS
BLOOR STATION

CONTRACT NO.	DWG. NO.	REV.	SHEET
RQQ-2011-PP-032	OC-UP-301	03	01/02

5.8.3 UP Express Weston Station

5.8.3.1 OCS Support Structures

Weston Station is situated between 13.625 km and 13.148 km. The proposed station platform configuration for Weston Station is one island platform and two side platforms. The island platform is located between tracks 2 and 3, and the side platforms are adjacent to tracks 1 and 4. Track 1 depicted is still to be constructed.

A total of nine portal structures are proposed at the Weston Station location. Specifically, six OCS structures are to be supported by poles attached and reinforced to the top of various canopy columns located on the Weston 4 platform, and three additional portals will need to be installed in the immediate vicinity of the station/platform area, as summarized in **Table 5-6** below.

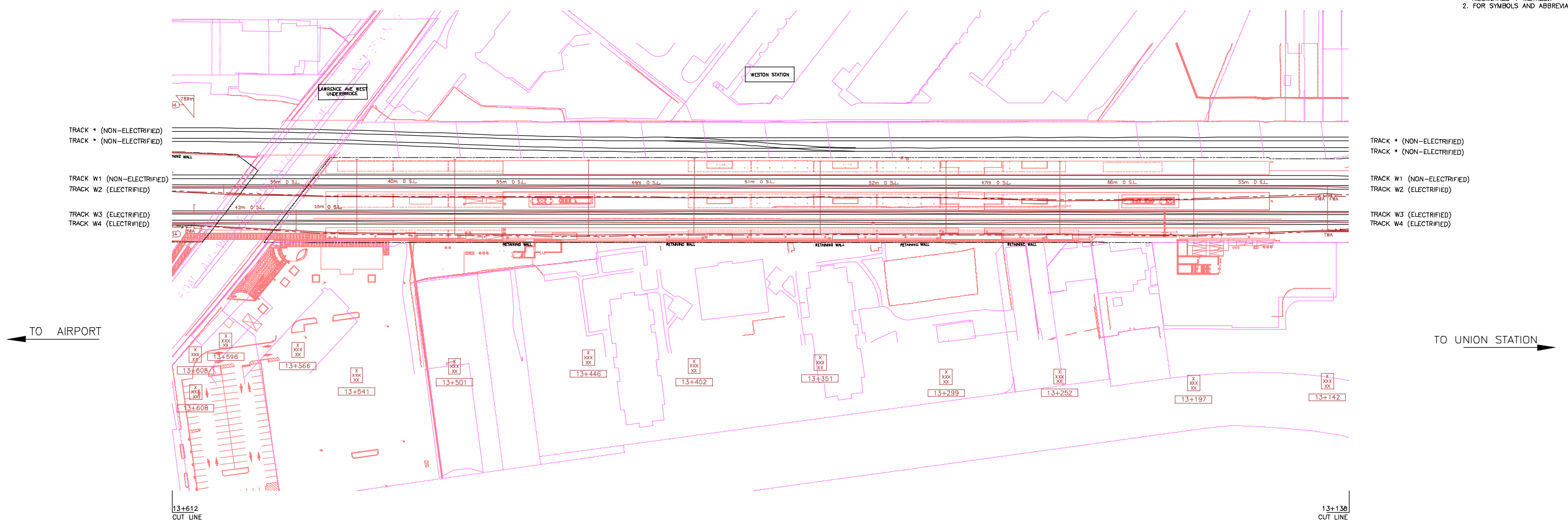
TABLE 5-6 SUMMARY OF OCS ATTACHMENTS AT UP EXPRESS WESTON STATION[6]

Chainage (km)	OCS Support Structure Type	Proposed Attachment at Pole leg A (Weston 4)	Proposed Attachment at Pole leg A (Weston 1)
13.142	Portal	Pile foundation - out of station limits	Pile foundation - out of station limits
13.197	Portal	Pile foundation to platform area	Pile foundation - behind platform 1, close to property boundary
13.252	Portal	Attachment to canopy column	Pile foundation - behind platform 1, close to property boundary
13.299	Portal	Attachment to canopy column	Pile foundation - behind platform 1, close to property boundary
13.351	Portal	Attachment to canopy column	Pile foundation - behind platform 1, close to property boundary
13.402	Portal	Attachment to canopy column	Pile foundation - behind platform 1, close to property boundary
13.446	Portal	Pile foundation to platform area	Pile foundation - behind platform 1, close to property boundary
13.501	Portal	Attachment to canopy column	Pile foundation - behind platform 1, close to property boundary
13.541	Portal	Attachment to canopy column	Pile foundation - behind platform 1, close to property boundary
13.566	Two Track Cantilever	Pile foundation away from platform area	N/A

[6] Further study during detailed design will be required to confirm whether canopy columns can bear the load of OCS attachments.

FIGURE 5 -24

NOTES:
1. SPANS ARE IN METRES. VERSINES ARE IN MILLIMETRES. CHAINAGES ARE IN KILOMETRES + METRES.
2. FOR SYMBOLS AND ABBREVIATIONS REFER TO DRAWING OC-UP-002



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PARSONS BRINCKERHOFF

METROLINX

GO ELECTRIFICATION
PRELIMINARY DESIGN
UP EXPRESS
WESTON STATION

CONTRACT NO.	DWG. NO.	REV.	SHEET
RQQ-2011-PP-032	OC-UP-302	03	02/02

5.8.4 UP Express Pearson Station

5.8.4.1 OCS Support Structures

The UP Express station at Toronto Pearson International Airport Terminal 1 (T1) will be located between Terminal 1 and the parking garage, and directly adjacent to the Automated People Mover service.
T1 station is the northernmost station on the Union Pearson Express route. It will have two active tracks, allowing trains to berth at the station and will also facilitate cleaning and servicing. The platform will be enclosed and will feature platform-vehicle doors, ticket-vending machines and fare card validators.
A total of six OCS structures are proposed at the T1 station platforms, three single track cantilevers supported by poles per track for two tracks.

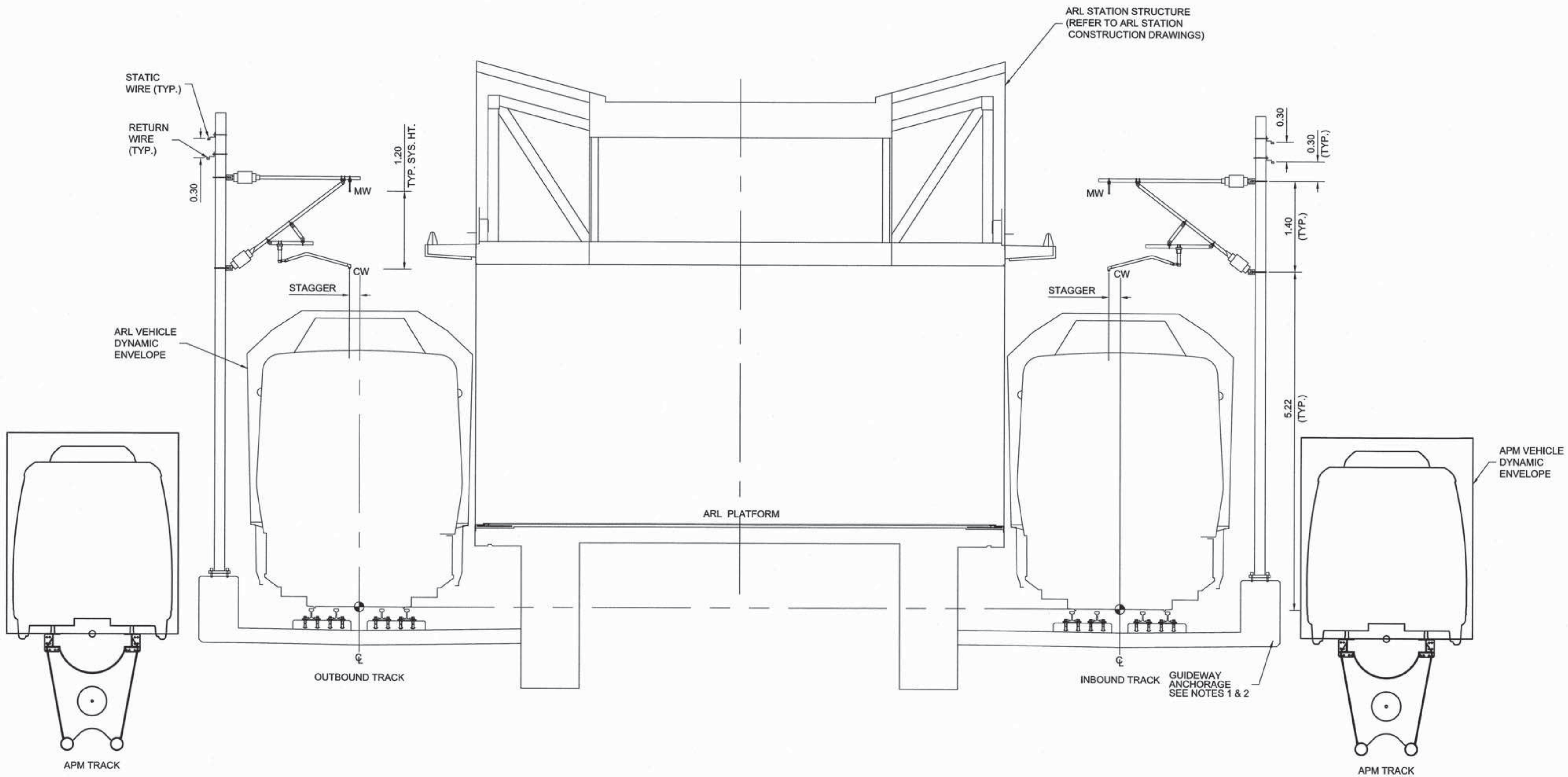
Figure 5-25 illustrates the Typical OCS Support Structures for UP Express Pearson Station.

Figure 5-26 illustrates the UP Express Pearson Station layout.

D SIZE 22" x 34" (558.8mm x 863.6mm)

METRIC

ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED.



TYPICAL CROSS SECTION: SIDE POLES IN STATION AREA

NOTES:
1. REFER TO DWG O-200 AND O-201 FOR ANCHORAGE TYPES AND SIZES. FOR LOCATION AND TYPE OF EACH ANCHORAGE, REFER TO ANCHORAGE SCHEDULE ON DWG O-202 AND O-203.
2. FOR ANCHORAGE, STRUCTURAL AND REINFORCING DETAILS SEE GUIDEWAY SUPERSTRUCTURE CONSTRUCTION DRAWINGS.

LICENSED PROFESSIONAL ENGINEER
S. BRASIC
28/3/13
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Number: 100164374-02 13/3/22
Limitations: Design for an overhead contact system for the electrification of the air Rail Link spur for the AirLINX Transit Partners and Metrolinx at the Lester B. Pearson International Airport in Mississauga, Ontario.
Collaborator: Srdjan Brasic, P.Eng.
Expiry Date: May 31, 2013
Association of Professional Engineers of Ontario

NOT FOR CONSTRUCTION

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TMG	HAR
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JMH	JCS
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SUBMITTED BY: AirLINX TRANSIT PARTNERS, AECOM

SUBMITTED TO: METROLINX An agency of the Government of Ontario, Ontario Infrastructure Ontario

AIRPORT RAIL LINK SPUR
FUTURE ELECTRIFICATION
TYPICAL SECTION: SIDE SUPPORTS IN STATION AREA

CONTRACT NO.		REV.
OIPC-11-508-P001	FIGURE 5-25	-

D SIZE 22" x 34" (558.8mm x 863.6mm)

METRIC

ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED.

(ARL 05)

ARL10757OB	
STATIONING	10+757.123
OFFSET	2.06
5.22	6.42
SW HT. (M)	7.22
RW HT. (M)	6.92

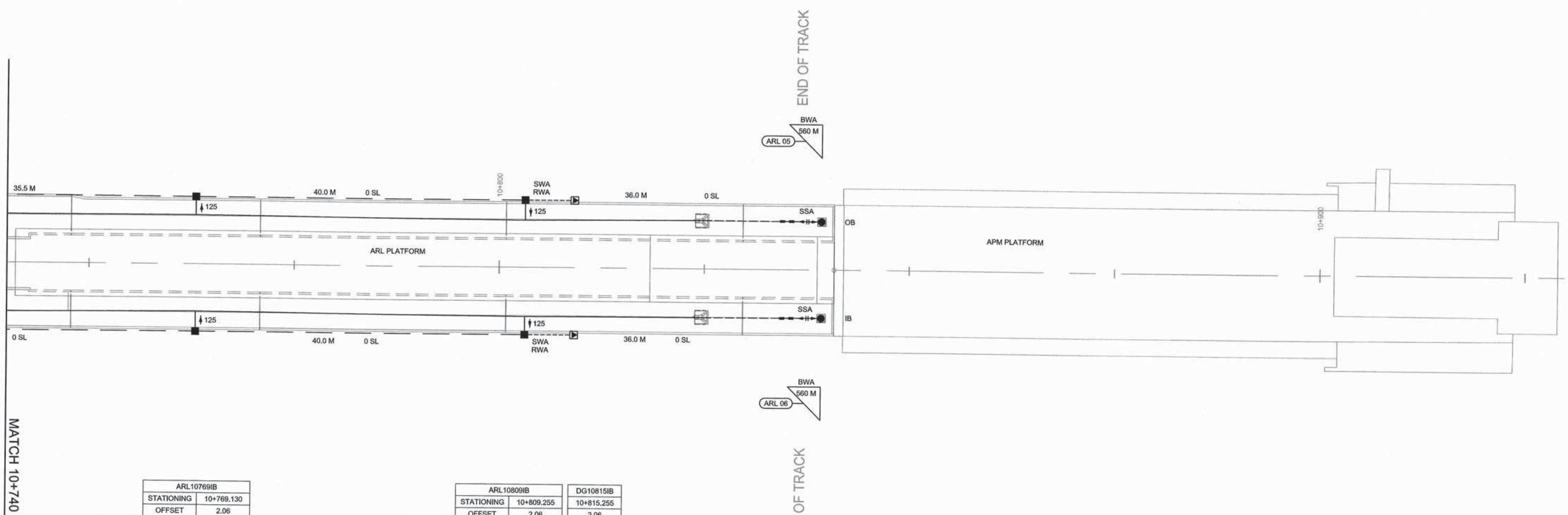
(ARL 05)

ARL10797OB	
STATIONING	10+797.248
OFFSET	2.06
5.22	6.42
SWA	7.22
RWA	6.92

DG10803OB
10+803.248
2.06

(ARL 05)

ARL10833OB	
STATIONING	10+833.374
OFFSET	0
BWA	6.02



(ARL 06)

ARL10769IB	
STATIONING	10+769.130
OFFSET	2.06
5.22	6.42
SW HT. (M)	7.22
RW HT. (M)	6.92

(ARL 06)

ARL10809IB	
STATIONING	10+809.255
OFFSET	2.06
5.22	6.42
SWA	7.22
RWA	6.92

DG10815IB
10+815.255
2.06

(ARL 06)

ARL10845IB	
STATIONING	10+845.382
OFFSET	0
BWA	6.02

NOTE:
1. STRUCTURE STATIONING IN THE STATION PLATFORM AREA IS BASED ON ADJACENT TRACK STATIONING. "OB" REFERS TO OUTBOUND TRACK AND "IB" REFERS TO INBOUND TRACK.

LICENSED PROFESSIONAL ENGINEER
S. BRASIC
28/3/13
PROVINCE OF ONTARIO

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CHECKED BY:	APPROVED BY:
JMH	JCS
SCALE: 1:50	FULL SIZE ONLY

SUBMITTED BY: AirLINX TRANSIT PARTNERS / AECOM

SUBMITTED TO: METROLINX An agency of the Government of Ontario / Ontario Infrastructure Ontario

AIRPORT RAIL LINK SPUR
OCS LAYOUT PLAN
STA 10+740 TO ARL STATION TERMINUS

CONTRACT NO. OIPC-11-508-P001 | FIGURE 5-26 | REV. -

5.9 Signalling System

To ensure that UP Express electrification would not impact signaling on the GO corridors, Pearson Airport Spur, and the adjacent MacTier Subdivision, additional signal compatibility equipment is required. This equipment acts mainly as an interface between existing equipment and tracks to ensure safe and reliable operation under electrification, and will be placed in signal enclosures installed next to existing signal houses.

Future USRC signaling which will include the USRC portion of UP Express line will be electrification compatible, therefore no additional signaling equipment would be required to ensure the UP Express signaling compatibility.

Table 5-7 identifies the location and size of existing signal houses and the additional enclosures required for the equipment in order to make the signal system compatible with electrification. There is also an enclosure required at 18+877 km where no signal house exists.

With respect to the spur (Highway 427 to UP Express Pearson Station), the signaling system will be the same as it is along the GTS corridor and there it will be necessary to make the spur signaling system electrification compatible.

TABLE 5-7 SUMMARY OF ADDITIONAL SIGNAL ENCLOSURES REQUIRED FOR UP EXPRESS ELECTRIFICATION

UP Express	Exiting Signal House	Existing Signal House Size	Signal Enclosure required for Electrification	Signal Enclosure Size	Chainage (km)
USRC Interlocking	Future Design	-	-	-	
	Bathurst West R.C. 1.89	8'x16'x7'	-	-	3.042
Strachan Interlocking	Strachan R.C. 1.90	8'x16'	Elec. 1.90	4'x4'	3.058
Automatic 235/236	GO Weston R.C. 2.35	8'x16'	Elec. 2.35	4'x8'	3.782
Automatic 297/298	GO Weston R.C. 2.98	8'x16'	Elec. 2.98	4'x8'	4.796
Automatic 361/362	GO Weston R.C. 3.61	8'x12'	Elec. 3.61	4'x6'	5.810
Automatic 417/418	GO Weston R.C. 4.17	8'x12'	Elec. 4.17	4'x6'	6.711
Automatic 469/470	GO Weston R.C. 4.69	8'x12'	Elec. 4.69	4'x6'	7.548
Automatic 533/534	GO Weston R.C. 5.33	8'x10'	Elec. 5.33	4'x4'	8.578
Black Creek Interlocking	Black Creek East R.C. 5.85	8'x10'	Elec. 5.85	4'x4'	9.414
	Black Creek Centre R.C. 6.34	8'x10'			10.203
	Black Creek West R.C. 6.60	8'x10'	Elec. 6.60	4'x4'	10.621
Nickle Interlocking	Nickle East R.C. 7.15	8'x16'	Elec. 7.15	2'x4'	11.506

UP Express	Exiting Signal House	Existing Signal House Size	Signal Enclosure required for Electrification	Signal Enclosure Size	Chainage (km)
	Nickle Centre R.C. 7.32	8'x16'			11.780
	Nickle West R.C. 7.50	8'x16'	Elec. 7.50	2'x4'	12.070
Automatic 795/796	GO Weston R.C. 7.95	8'x10'	Elec. 7.95	4'x4'	12.794
Automatic 849/850	GO Weston R.C. 8.49	8'x10'	Elec. 8.49	4'x4'	13.663
Automatic 919/920	GO Weston R.C. 9.20	8'x10'	Elec. 9.20	4'x4'	14.806
Humberview Interlocking	Humberview East R.C. 9.72	8'x16'	Elec. 9.72	2'x4'	15.642
	Humberview Centre R.C. 10.02	8'x16'			16.125
	Humberview West R.C. 10.24	8'x16'	Elec. 10.24	2'x4'	16.479
Automatic 1085/1086	GO Weston R.C. 10.85	8'x10'	Elec. 10.85	4'x4'	17.461
Automatic 1157/1158	GO Weston R.C. 11.58	8'x10'	Elec. 11.58	4'x4'	18.636
Switch Circuit Controller	S.C.C. 11.73		Elec. 11.73	2'x2'	18.877
Automatic 1223/1224	GO Weston R.C. 12.24	8'x10'	Elec. 12.24	4'x4'	19.698
Woodbine Interlocking	Woodbine East R.C. 12.90	8'x16'	Elec. 12.90	2'x4'	20.760
	Woodbine Centre R.C. 13.20	8'x16'			21.243
	Woodbine West R.C. 13.65	8'x16'			21.967
	Woodbine ARL R.C. 1.72	8'x10'	UP Express.Elec. 1.72	2'x2'	2.768

Additional signal enclosures and electrification compatibility equipment will also be required to avoid electrification impacts to neighbouring railroad signalling systems, as follows:

- **Newmarket Sub:** one 6 x 6' signal enclosure is required at milepost 3.45 where the Newmarket Sub. tracks diverge from the UP Express tracks approximately 100 m off the main tracks.
- **CP Galt Sub:** no additional signal houses are required.
- **CP North Toronto Sub:** no additional signal houses are required.
- **CP MacTier Sub:** runs in parallel to the UP Express electrified tracks from milepost 4.7 to milepost 9.20; six 6'x6' signal enclosures are anticipated to be located along this segment.

Where conflicts are identified with respect to signal enclosures, further review and refinement will be carried out during the detailed design phase.

5.10 SCADA System

The Supervisory Control and Data Acquisition (SCADA) system is the master monitoring and control system for the electrification system. The SCADA system control will include the following functions:

- Closing and opening operations of all circuit breakers and motorized disconnect switches
- Controlling of electrical lockout relays
- Indicating status of all circuit breakers, disconnect switches and grounding switches
- Indicating status of protective relaying, ac auxiliary power equipment and dc auxiliary power equipment, including the station battery and battery charger
- Indicating status of the communication system
- Enabling/disabling automatic reclosing of circuit breakers
- Metering of substation power demand and energy consumption
- Predicting the maximum demand
- Recording maintenance clearance permits and maintenance status
- Coordinating work permit, power removal and out-of-service equipment tagging
- Coordinating catenary power removal with railroad operations and track blocking
- Tripping the alarm for the circuit breaker and low substation voltages
- Tripping the alarm for the facility intrusion and smoke/fire alarms
- Recording the sequence of events

The current design is for the SCADA master station to l be co-located with Metrolinx's existing Operations Control Centre (OCC). Remote terminal units (RTUs) with Human-Machine Interfaces (HMIs) (i.e., switches, buttons, controls) are located inside the control rooms of the paralleling station facilities. RTUs are also deployed inside the ten wayside power cubicles (WPCs) to control the wayside motorized disconnection switches.

The SCADA system at each paralleling station contains a device to control the traction power within the section served by the facility. The SCADA system equipment typically consists of remote terminal units and console workstation. SCADA equipment will be installed inside each paralleling station control room and rack-mounted. The equipment rack will be included in the space footprint of each paralleling station site. The SCADA remote terminal units control the motorized disconnect switches within a predefined area of each section. The console workstation is used for maintenance and emergency response purposes.

5.10.1 Operations Control Centre

The SCADA system will contain the major components that support SCADA daily operations. SCADA equipment will include: SCADA servers, SCADA database, SCADA MIMIC server, and SCADA maintenance workstation.

The SCADA workstation provides a graphical representation of the field equipment status, RTU status and alarm history. The software platform allows visualization, through a graphic user interface, of all data processing and operator controls over the remote site equipment.

5.10.2 Wayside Power Control Cubicles

In order to power off the electrified system, disconnect switches will be mounted on the OCS structure poles according to the sectionalizing plan. Some of the disconnect switches will be manually operated and some will be motor operated. Motor operated disconnect switches (MOD) are installed at strategic locations and these can be controlled remotely from the OCC.

There are two alternative options for drawing low voltage (LV power) for the WPCs:

- Low voltage power supply be drawn from auxiliary transformers which will step down 25 kV ac NF supply to 480V ac.
- LV power be drawn from other Metrolinx facility (e.g., signal bungalows) located close by

The exact source of low voltage power for each WPC will be determined during detailed design.

5.11 Maintenance

Electrification of the UP Express will necessitate new maintenance procedures/activities that will need to be implemented by Metrolinx during the operation of the electrified system. This section has been divided into two main parts as follows: 1) EMU Maintenance (discusses maintenance requirements associated with UP Express EMUs), and 2) Other Maintenance (describes all other maintenance activities associated with the electrified system components such as OCS, Traction Power Facilities, etc.).

5.11.1 EMU Maintenance Facility

Maintenance of the UP Express EMU trains will require a maintenance facility that can handle the needs of a relatively small fleet of trains which will have limited daily maintenance windows. In order to maintain the dedicated fleet of electric UP Express trains, a maintenance shop and yard storage capacity will be required. Based on a review of potential maintenance facility options (as described in Chapter 2 of this EPR), a new EMU Maintenance Facility is proposed at 50 Resources Rd. (see **Figure 5-27**).

It is noted that a conceptual level design for the EMU Maintenance Facility was prepared as part of the UP Express Electrification EA (see Appendix H – EMU Maintenance Facility Conceptual Design Report).

The new EMU maintenance shop and yard will be used for an UP Express EMU fleet of up to 21 cars. The shop facilities will correspond to Metrolinx/GO Transit's Category A type maintenance shop, and will include the following main components:

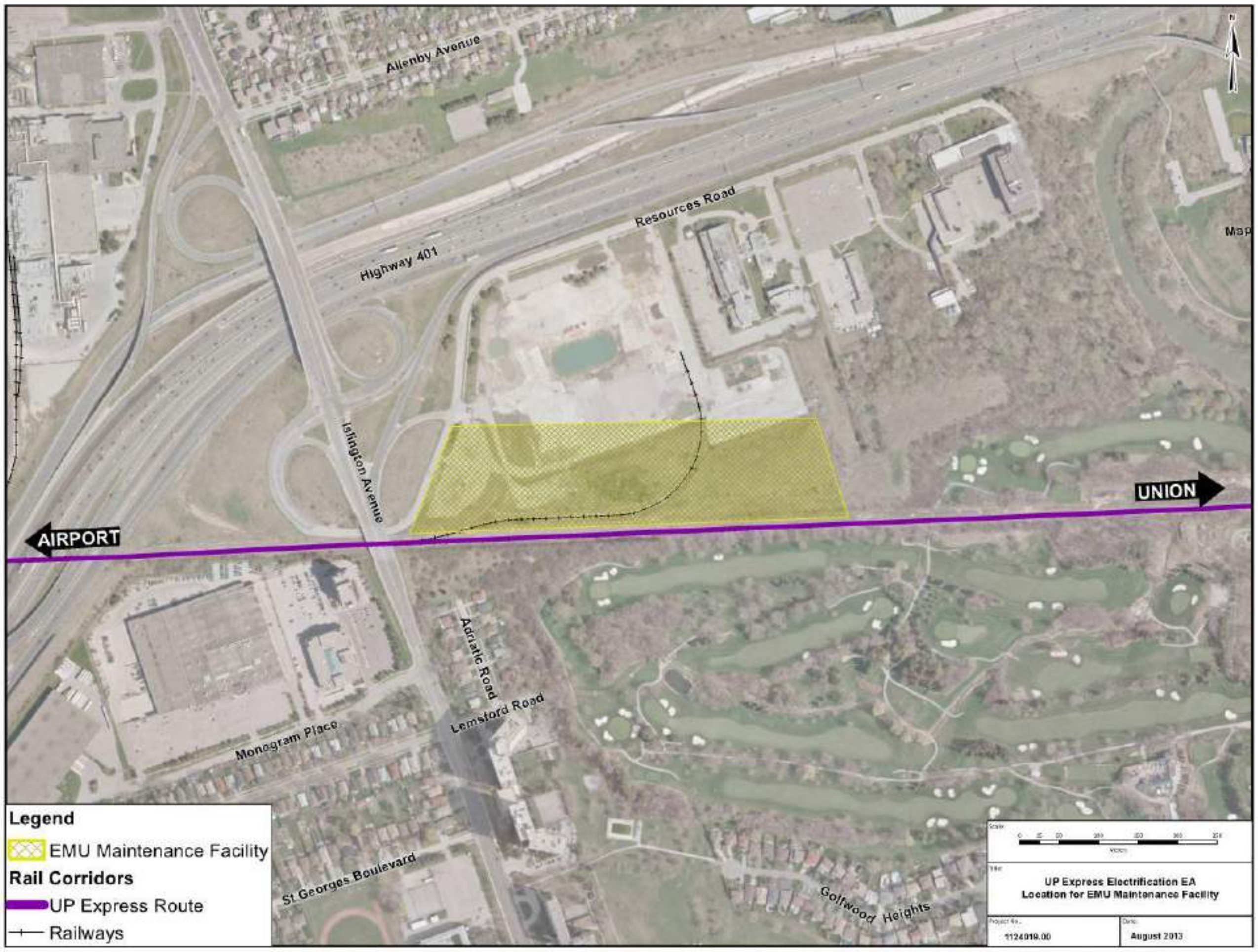
- Storage yard for EMUs and electrification Maintenance of Way (MoW) equipment;
- Main building housing the administrative, transportation and building plant maintenance groups, workshops for railcars;
- Bi-directional train washer, enclosed to permit cold-weather train washing;
- Combined OCS and wayside electrification building;
- Two yard storage tracks, collectively storing 4 trainsets (12 railcars);
- Yard roadways; and
- Employee parking.

The maintenance facility will host three primary functions:

- Maintenance of the UP Express trainsets, entailing maintenance crew, facilities and equipment;
- Reporting location and dispatch base for the on-train crew (engineers and conductors) assigned to UP Express; and
- Maintenance centre for work crews maintaining the Overhead Catenary System (OCS) and the wayside electrification equipment.

The maintenance facility will operate 24 hours per day, seven days per week, and staffing levels will vary by time of day and day of the week.

FIGURE 5-27 MAINTENANCE FACILITY AT RESOURCES ROAD



5.11.1.1 EMU Maintenance Facility Conceptual Site Layout

Resources Road is approximately five hectares in size, and is located along the UP Express mainline tracks. The trapezoidal site is located on the north side of the tracks, east of Islington Avenue and south of Resources Road. Resources Road itself is located adjacent to and immediately south of Highway 401. The location of the maintenance facility will allow UP Express EMUs to be launched into service in both directions, to UP Express Union Station and/or to UP Express Pearson Station in the morning, and back again at the end of service. All EMU inspection, servicing and repair work will be done on the maintenance facility site.

The EMU maintenance facility has been planned as a double-ended yard. This means the yard allows trains to access it from both the east and west ends of the yard. Providing access to/from the maintenance facility to both the east and west is critical for efficiently launching trains into service in the morning, at the start of service, and replacing disabled en route trains at short notice. All exterior yard tracks will be electrified, except for the track leading to the OCS/Wayside Electrification Building. A conceptual site plan layout is provided in **Figure 5-28**.

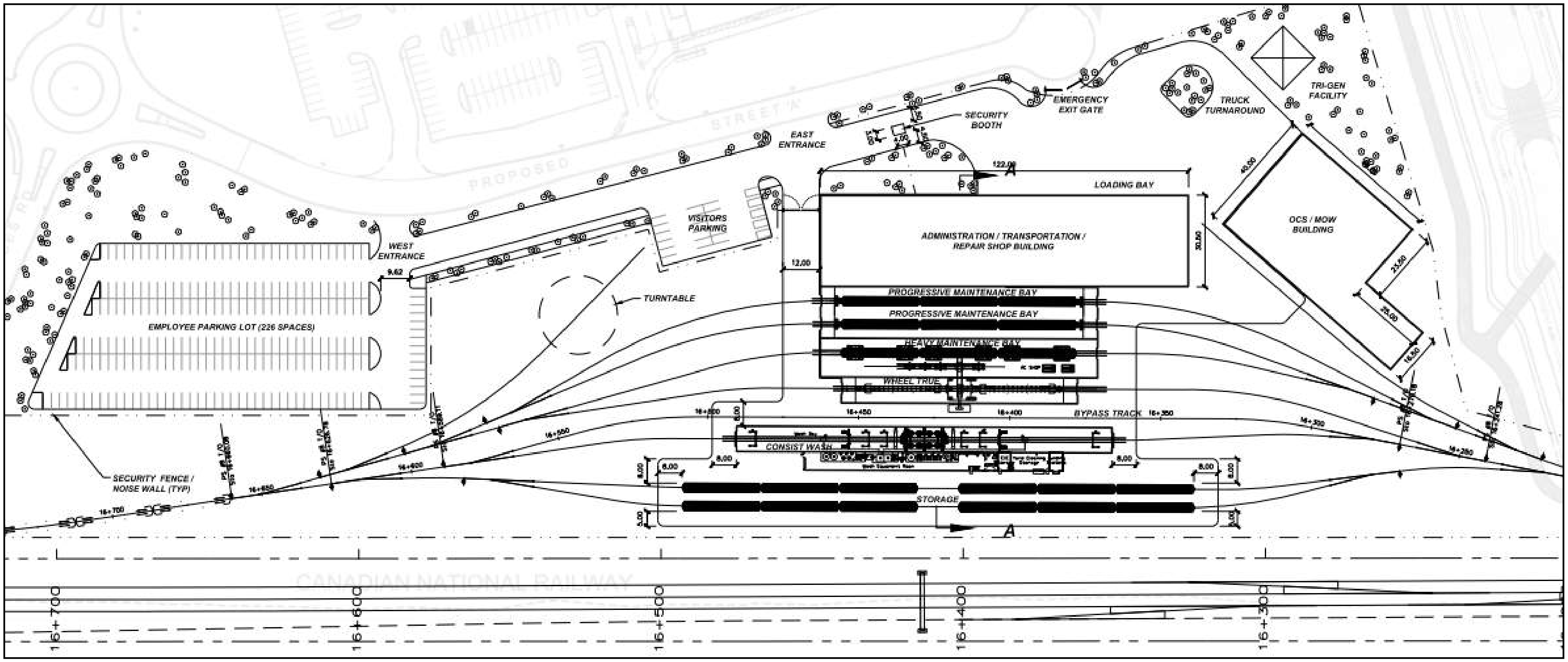
Roadway access into the maintenance facility site will be located on the north side. f the facility. The conceptual layout of the yard roadway has been planned to separate the private vehicles used by staff and visitors from large trucks and commercial vehicles serving the site. Within the maintenance facility, an internal roadway system provides access to the employee parking lot, shop building, train washer, train storage tracks, MOW building, and other areas of the yard.

The main building will occupy a footprint of approximately 11,660 square meters and will be multi-purpose where most of the activities of maintenance facility take place. This area includes offices, training rooms, locker rooms, toilets, lunchroom, yard control room, transportation assembly and dispatch room, storeroom, and various repair shops such as for HVAC, pantograph, electronics, traction motor, hydraulics, etc.

A bidirectional train washer is located in a separate enclosed structure from the main building to enable train washing to occur in all types of weather, including the cold winter months. A bidirectional train washer allows trains to be washed whether they enter the washer via the east or west end. Based on the current conceptual design, the train washer is located between the train storage tracks and the main building.

Two train storage tracks are located at the south end of the site, parallel and adjacent to the mainline tracks. Both train storage tracks are double-ended, allowing trains to enter these tracks from the east and west ends of the yard. Two train storage tracks, each holding two-trainsets (of three cars each) provides overnight storage capacity for 12 EMU railcars. The train storage tracks are located just north of the mainline tracks for easy access.

FIGURE 5-28 CONCEPTUAL SITE LAYOUT – EMU MAINTENANCE FACILITY



A 24,000 square foot OCS/Wayside Electrification Building (WEM) is located east of the main building and will house the following functions:

- OCS administrative offices – Supervisors and clerical offices;
- OCS maintenance functions – Repair shop, machine shop, welding, OCS material storage, specialized tool storage, OCS vehicle loading/unloading area;
- WEM administrative offices – Supervisors and clerical offices; and
- WEM maintenance functions – Repair shop, machine shop, material storage, specialized tool storage, vehicle loading/unloading area.

The EMU maintenance facility will contain a tri-generation facility which is proposed to run at all times (except during periods of maintenance) as the preferred power source. Based on the current conceptual design, the tri-generation facility is to be located in the northeast corner of the Resources Road site.

A 3m high fence or wall will provide site perimeter control along the west, north and east ends of the site. Thisl is needed to provide site security, to prevent people and animals from wandering onto the site, and to screen portions of the maintenance facility from public view.

5.11.1.2 Maintenance Activities

The following types of maintenance activities will be carried out on the UP Express EMUs at the new maintenance facility:

- **Daily Inspections -** Daily inspections are general visual inspections to identify any obvious defect or damage to equipment prior to trainsets entering revenue service. These types of inspections can be done on a yard storage track and usually take less than an hour per UP Express trainset to complete.
- **Light Repairs -** This involves quick, small-scale repairs, such as replacing light bulbs, seat cushion change outs, windows and other small replaceable units. These repairs can be performed when the trainset is parked anywhere at the Maintenance Facility and do not require special facilities.
- **Progressive Maintenance (PM) Inspections** - More detailed inspections that occur on weekly cycles. This type of inspection requires bringing each UP Express trainset to a PM bay inside the maintenance shop.

5.11.2 OCS Maintenance

There are three types of OCS maintenance procedures, which are described as follows:

5.11.2.1 Track Patrol Inspection

An important factor in the maintenance of the OCS is an early warning system based on regular inspection that allows faults to be detected and rectified as part of the planned routine maintenance rather than as an emergency. These inspections can be carried out either via visual inspections involving follow-up reporting, or visual inspection with remedial site work. The preferred frequency of track patrol is at four weekly intervals during the first year after commissioning on each section of the electrified line.

5.11.2.2 Routine Maintenance

Routine maintenance is described as the repetitive, periodic overhaul and reconditioning of the OCS to maintain its reliability. Initial operation of the OCS after commissioning requires high level performance monitoring and inspection. After approximately two years of operation, an effective and economic schedule will be established for activities such as protective greasing, examination and cleaning of insulators, contact wire height and stagger checking, contact wire wear checks, etc.

5.11.2.3 Planned Maintenance

Planned maintenance refers to performing detailed inspections in accordance with maintenance procedures related to the OCS. Planned maintenance will include the periodicity of inspection maintenance, the work to be carried out for major OCS maintenance, and the certification to ensure maintenance work has been carried out appropriately with full reporting records.

5.11.3 Paralleling Stations Maintenance

5.11.3.1 Paralleling Stations

A comprehensive equipment monitoring system at different levels will be incorporated in the design of the paralleling station equipment. The paralleling station equipment status will be amenable to be monitored by the traction electrification SCADA system at the operations control centre (OCC), by the fault indicators at the control and relay panels, and by the monitoring PCs on-site at the paralleling stations and wayside power control cubicles. The information from the fault monitoring systems will enable maintenance staff to promptly identify, pinpoint and rectify equipment failures/defects.

Heavy paralleling station equipment such as high voltage switchgears and transformers will have a 30 year life cycle and replacement during this lifecycle is not anticipated. However, if a catastrophic failure occurs on heavy paralleling station equipment and replacement of the equipment is required, a specialized contracting party will be retained to remove and replace the faulty equipment.

The paralleling stations will be equipped with oil filled transformers, therefore an oil containment system for the maintenance of autotransformers will be provided, and will conform to applicable codes and standards. All facilities will be fully equipped with spill containment.

5.11.4 Grounding and Bonding Maintenance

Preventive maintenance of grounding and bonding equipment includes regular cleaning normally performed on a monthly basis, annually conducted connection inspections and continuity checks, visual inspections performed every six months looking for signs of overheating. Soil and ground resistance testing and verifying proper operation and integrity of grounding and bonding devices will be performed after every major repair of the ground grid system. Corrective maintenance is mainly based on replacing faulty equipment such as impedance bonds and damaged grounding electrodes, damaged grounding and bonding conductors and connections.

5.11.5 Signalling and SCADA Maintenance

5.11.5.1 Signalling System Maintenance

Maintaining the signal equipment in an electrified environment often requires working in close proximity of catenary system and live wires. The high current within the rails is another aspect of an electrified environment which requires special precautions during the maintenance regime. It is important that maintenance personnel are well trained and are fully aware of maintenance procedures. The precautions to be made in an electrified environment in order to maintain signaling equipment are detailed in the safety requirements section of the Electrification Performance Specifications.

5.11.5.2 SCADA System Maintenance

SCADA system equipment is either collocated with GO Transit Operation Control Centre, or collocated at TPF sites. Monthly preventive maintenance for SCADA system will be planned and carried out at planned SCADA equipment locations without interruption to revenue service operations. The minimization of downtime will be achieved by:

- Checking field inputs to the Supervisory Control and Data Acquisition system (SCADA) and Wayside Power Control Cubicles (WPCs);
- Carefully defining and continually reassessing the degree of maintenance necessary for each SCADA and WPC component;
- Maintaining adequate supplies of spare parts, consumables, tools, and test equipment at all times;
- Operating an effective equipment fault and maintenance management (tracking) system; and
- Ensuring that the maintenance training is effective and up-to-date.

5.12 Construction Methods

The following section provides a summary of the proposed construction methods/activities related to the various UP Express Electrification project components.

5.12.1 Overhead Contact System (OCS)

There are three main construction activities associated with OCS construction described as follows:

5.12.1.1 OCS Foundation Installation

The OCS foundation sizes are dependent on the type of OCS structure to be installed (i.e., portal, cantilever), however typical sizes are estimated to be as follows be: 600mm diameter (single track cantilever), 800mm diameter (two track cantilever), 1200mm diameter (portal structure<24 meters wide), 1500 x 2500 (portal structure>24 meters wide). Excavation will be required to install OCS foundations at an approximate depth of 5m.

5.12.1.2 Install OCS Support Structures

Once foundations have been established, OCS support structures will be installed. For both portal and cantilevers, the structures are pre-assembled and ready to lift using a rail crane. For cantilevers, brackets can be installed on the poles before sending to the site, whereas portals are more complex to install, as they require access to all lines (similar to a signal bridge).

5.12.1.3 Install OCS Wiring

The installation of OCS wiring involves running the contact and messenger wires together under tension along the corridor. This is typically completed using a four vehicle wiring unit, where the base vehicle dispenses wire, the second vehicle with working platform is equipped to allow messenger to be installed onto cantilever, the third vehicle with working platform is equipped to allow contact wire to be installed, and a fourth vehicle installs hangers.

5.12.1.4 Installation of Grounding and Bonding of the OCS along Rail ROW

Grounding and bonding within the rail ROW is required for OCS support structure locations. The construction of grounding and bonding elements will occur concurrently with OCS structure foundation installation, since each OCS structure will be individually grounded and interconnected through the static wire.

5.12.2 Paralleling Stations

Paralleling station equipment such as switchyard components, switchgear room, control room and power transformers will be prepackaged off site. Heavy truck and machinery will be required to carry and install the prepackaged equipment to each respective site.

The following activities are required for paralleling station construction / installation.

5.12.2.1 Site Preparation and Construction

The following site preparation and construction activities will be required:

- Site clearing
- Install building foundation
- Install prepackaged equipment
- Construct building
- Grounding and bonding

Access to the sites will be via existing local roads (no new access roads are proposed). In addition, the need for additional construction staging areas outside the limits of the paralleling station sites will be assessed during detailed design.

5.12.2.2 Grounding and Bonding of Paralleling Stations

The grounding and bonding material for the paralleling stations will be delivered to the site by heavy truck. The following activities are required as part of installing the grounding and bonding material:

- Excavate the soil to the required depth (approximately 1m)
- Install grounding mats, conductors and rods, as per design
- Connect the grounding system internally and with adjacent existing grounding system, where required
- Backfill the grounding system, as per design
- Install the junction boxes and connect grounding conductors, where required

5.12.3 Underground 25 kV Feeders/Duct Banks

The following activities are required as part of installing the 25 kV feeders and associated underground duct banks:

- Excavate soil via open cut method to install duct banks (Ordnance paralleling station site, 175 City View Drive site)
- Excavation under Industry Road and Ray Avenue will be required for the 3500 Eglinton Avenue West site as in order to install duct banks under the road ROW
- Install underground cables (25 kV feeders) within duct banks

- Connect feeders to main gantry
- Backfill/restore road(s), as per design

5.12.4 Gantries

Construction activities associated with installing gantries are anticipated to include the following:

- Site preparation
- Install gantry foundations
- Heavy trucks will transport the gantry structure pieces to the site
- Assembly of the main and strain gantries will be done on site
- Connect 35 kV feeders (routed in underground duct banks) to the main gantry

5.12.5 Bridges and Rail Overpasses

5.12.5.1 Bridge Structures

OCS attachments to bridge structures (rail under road), will be done via railcar with a raising working platform from track level to install attachments to the bottom of the bridge structure.

With regard to installation of grounding grids/flash plates, this may be done via railcar by raising the working platform from track level to attach the flash plates to the bottom of the overhead structure.

With regard to construction of bridge protection barriers, this will be completed on top of the bridge structure, in the same manner as other bridge related civil construction works. It is noted that temporary road (traffic lanes may be reduced) and/or pedestrian walkway closures may be required during construction of the protection barriers.

5.12.5.2 Rail Overpass Structures

Where required, OCS attachments to rail overpass structures (rail over road), will be done via attaching steel brackets to the outside face of the structure.

Humber River Rail Overpass Structure

With regard to Humber River rail overpass structures (rail over water), it is anticipated that OCS portal structure will be attached via steel brackets attached to the outside face of the piers. The brackets will be installed on the bridge piers using rope access process, to avoid the need for scaffolding built up around the pier from ground level. Access to the outside face of the pier will be from the bridge deck with materials being brought to the construction site using rail mounted vehicles and then lowered over the side of the bridge.

Black Creek Rail Overpass

With regard to Black Creek rail overpass structure (rail over water), it is anticipated that OCS portal structure will be attached via steel brackets attached to the outside face of the piers (as described above for Humber River bridge), or from the road (to be confirmed during detailed design).

5.12.6 Stations

Construction activities associated with installing OCS support structures as well as grounding and bonding at passenger stations include the following:

5.12.6.1 OCS Installation

- The preferred method for installation of the OCS structure foundation at station platforms is concrete side bearing cast in place
- OCS support structures that may be supported by the platform canopies will be installed as extensions to existing canopy poles which will be designed to support the additional loads of the OCS structure

5.12.6.2 Grounding and Bonding

Grounding and bonding material will be delivered to the site using heavy trucks and machinery. In order to install grounding and bonding, the following activities are required:

- Clear site
- Excavate the soil to the required depth
- Install grounding mats, conductors and rod, as per design
- Connect the grounding system internally and with adjacent existing grounding system, where required
- Backfill the grounding system as per design
- Install junction boxes and connect grounding conductors, where required.

5.12.7 EMU Maintenance Facility

Construction activities related to the new EMU maintenance facility will include the following:

5.12.7.1 Site Preparation and Construction

- Clear site/site grading
- Install building foundations
- Construct buildings and shops
- Rail and track construction
- Install security fence
- Grounding and bonding of maintenance facility buildings and electrified tracks
- OCS installation at maintenance facility

Access to the Resources Road site is anticipated to be via a new road being constructed between the Lowes retail store and the maintenance facility site (via the east end of the new Lowe's Place Road) (to be confirmed as part of the EMU Maintenance Facility preliminary design phase).