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NEEDS ASSESSMENT REPORT

GTA North Region

Date: March 20, 2018

Prepared by: GTA North Region Study Team

Disclaimer

This Needs Assessment Report was prepared for the purpose of identifying potential needs in the GTA North Region and to recommend which needs may require further assessment and/or regional coordination to develop a preferred plan. The results reported in this Needs Assessment are based on the input and information provided by the Study Team.

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Executive Summary

REGION	GTA North		
LEAD	Hydro One Networks Inc. ("HONI")		
START DATE	December 1, 2017	**END DATE**	March 20, 2018

1. INTRODUCTION

The first cycle of the Regional Planning process for the GTA North Region was initiated in Q2 2014 and completed with the publication of the Regional Infrastructure Plan ("RIP") in February 2016. The RIP provided a description of needs and recommendations of preferred wires plans to address near-term needs. The RIP also identified some mid- and long-term needs that will be reviewed during this planning cycle.

The purpose of this Needs Assessment is to identify any new needs and reaffirm needs identified in the previous GTA North Region RIP.

2. REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the regional planning cycle should be triggered at least every five years. Due to the timing of the mid-term needs identified in the previous Integrated Regional Resource Plan ("IRRP") and RIP reports as well as new needs in the GTA North Region, the NA was triggered in advance of the regular 5-year review schedule.

3. SCOPE OF NEEDS ASSESSMENT

The scope of this NA covers the GTA North Region and includes:

- New needs identified by Study Team members; and,
- Review and reaffirm needs/plans identified in the previous RIP

The Study Team may also identify additional needs during the next phases of the planning process, namely Scoping Assessment ("SA"), IRRP and RIP, based on updated information available at that time.

4. INPUTS/DATA

The Study Team representatives from Local Distribution Companies ("LDC"), the Independent Electricity System Operator ("IESO"), and Hydro One provided input and relevant information for the GTA North Region regarding capacity needs, system reliability, operational issues, and major assets/facilities approaching end-of-life ("EOL").

5. ASSESSMENT METHODOLOGY

The assessment's primary objective is to identify the electrical infrastructure needs in the Region over the study period. The assessment reviewed available information including load forecasts, conservation and demand management (CDM) and distributed generation (DG) forecasts, system reliability and operation issues, and major high voltage equipment identified to be at or near the end of their useful life and requiring replacement/refurbishment.

A technical assessment of needs was undertaken based on:

- Station capacity and transmission adequacy;
- System reliability and operation; and,
- Major high voltage equipment reaching the end of its useful life with respect to replacing it with similar type equipment versus other options to determine the most technically feasible, resilient, and cost effective outcome.

6. RESULTS

I. Aging Infrastructure

In the GTA North Region, high voltage equipment at Woodbridge TS (T5 transformer) was identified to be approaching the end of its useful life and requires replacement in the near-term. Refer to section 7.1.1 for more details.

II. 230kV Connection Capacity

- A transformation capacity need for the Vaughan area was reaffirmed. Based on current extreme summer weather non-coincident peak net load forecast, the need for additional transformation capacity is beyond 2027. If CDM savings are not achieved as forecasted, the need date may be as early as 2027. Refer to section 7.2.3 for more details.

- A transformation capacity need for the Northern York Area was reaffirmed. Based on current extreme summer weather non-coincident peak net load forecast, the need for additional transformation capacity is beyond 2027. If CDM savings are not achieved as forecasted, the need date may be as early as 2024. Refer to section 7.2.6 for more details.

III. 230kV Transmission Supply Capacity

Transmission Supply Capacity needs were reaffirmed to connect new transformation capacity in Vaughan and Northern York Areas in the long term. Refer to sections 7.2.3 and 7.2.6 for more details.

IV. System Reliability & Operation

- A load restoration need for the loss of circuits V43+V44 (supplies Woodbridge TS, Vaughan #3 MTS, and Kleinburg TS), was identified during the previous NA for the GTA North Western Sub-Region and the Northwest GTA IRRP. The study team reaffirmed this need. Refer to section 7.2.1 for more details.
- A load restoration need for the loss of circuits, P45+P46 (supplies Buttonville TS, Markham #4 MTS, and future Markham #5 MTS), has been identified in the near term. Refer to section 7.1.2 for more details.
- A load security need was previously identified on the Parkway to Claireville corridor and was reassessed during this NA. The load on this corridor is slightly lower than it was when the previous assessment was completed, although it continues to exceed the 600MW limit. Refer to section 7.2.2 for more details.

V. Station Service Supply to York Energy Centre

A need for addressing station service supply to York Energy Centre was reaffirmed for the near to medium term. Refer to section 7.2.5 for more details.

7. RECOMMENDATIONS

The Study Team's recommendations are as follows:

a) Further regional coordination is not required to address the following needs:
   - EOL Woodbridge TS T5 transformer (discussed in section 7.1.1). The study team recommends that this EOL need be addressed by Hydro One and affected LDCs to coordinate the replacement plan. Hydro One will keep the study team informed of the status of the plan if any major changes occur.

b) As per the IESO's letter of support in April 2017, Hydro One will proceed with development and estimate work to connect a new 230/27.6kV DESN in the Markham-Richmond Hill area in coordination with Alectra (discussed in section 7.2.4). Further updates will be included in the next IRRP and RIP.

c) Further assessment and regional coordination is required in the IRRP and/or RIP, to develop a preferred plan for the following needs:
   - Load Restoration – P45+P46 (discussed in Section 7.1.2)
   - Load Restoration – V43+V44 (discussed in Section 7.2.1)
   - Load Security on V71P/V75P – Parkway to Claireville (discussed in Section 7.2.2)
   - Vaughan Transformation Capacity (discussed in Section 7.2.3)
   - Station Service Supply to York Energy Centre (discussed in Section 7.2.5)
   - Northern York Area Transformation Capacity (discussed in Section 7.2.6)
   - Transmission Supply Capacity in Vaughan and Northern York Area in long term (discussed in sections 7.2.3 and 7.2.6)

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1 INTRODUCTION

The first cycle of the Regional Planning process for the GTA North Region was completed in February 2016 with the publication of the Regional Infrastructure Plan ("RIP"). The RIP provided a description of needs and recommendations of preferred wires plans to address near and medium term needs. Additional medium and long term needs were recommended for further review during the next regional planning cycle.

The purpose of this Needs Assessment ("NA") is to identify new needs and reconfirm the needs identified in the previous GTA North regional planning cycle. Since the first regional planning cycle, some new needs in the region have been identified.

This report was prepared by the GTA North Region Study Team ("Study Team"), led by Hydro One Networks Inc. Participants of the Study Team are listed below in Table 1. The report captures the results of the assessment based on information provided by the lead transmitter, Local Distribution Companies ("LDC") and the Independent Electricity System Operator ("IESO").

Table 1: GTA North Region Study Team Participants

Company
Alectra Utilities Corporation (formerly Enersource Hydro Mississauga, PowerStream Inc., Hydro One Brampton)
Hydro One Networks Inc. (Distribution)
Hydro One Networks Inc. (Lead Transmitter)
Independent Electricity System Operator ("IESO")
Newmarket-Tay Power Distribution Ltd. ("Newmarket-Tay")
Toronto Hydro-Electric System Limited ("THESL")
Veridian Connections Inc. ("Veridian")

2 REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the Regional Planning cycle should be triggered at least every five years. Due to the timing of the mid-term needs identified in the previous IRRP and RIP reports as well as new needs in the GTA North Region, the study team recommended to trigger the next cycle in advance of the regular 5-year review schedule.

3 SCOPE OF NEEDS ASSESSMENT

The scope of this NA covers the GTA North Region and includes:

- Identification of new needs based on latest information provided by the Study Team; and,
- Confirmation/updates of existing needs and/or plans identified in the previous planning cycle.

The Study Team may identify additional needs during the next phases of the planning process, namely Scoping Assessment ("SA"), Local Planning ("LP"), IRRP, and/or RIP.

4 REGIONAL DESCRIPTION AND CONNECTION CONFIGURATION

The GTA North Region is approximately bounded by the Regional Municipality of York, and also includes parts of the City of Toronto, Brampton, and Mississauga. The region is divided into two sub-regions:

- York Sub-Region: This area includes Southern York area (the Municipalities of Vaughan, Markham, and Richmond Hill) and Northern York area (the Municipalities of Aurora, Newmarket, King, East Gwillimbury, Whitchurch-Stouffville, Georgina, and some parts of Durham and Simcoe regions are supplied from the same electricity infrastructure).
- Western Sub-Region: This area comprises the western portion of the City of Vaughan.

Electrical supply to the GTA North Region is primarily provided from three major 500/230 kV autotransformer stations, namely Claireville TS, Parkway TS, and Cherrywood TS, and a 230 kV transmission network supplying the various step-down transformation stations in the region. Local generation in the Region consists of the 393 MW York Energy Centre connected to the 230 kV circuits B82V/B83V in King Township.

Please see Figure 1 and Figure 2 for a map and single line diagram of the Sub-Region facilities.

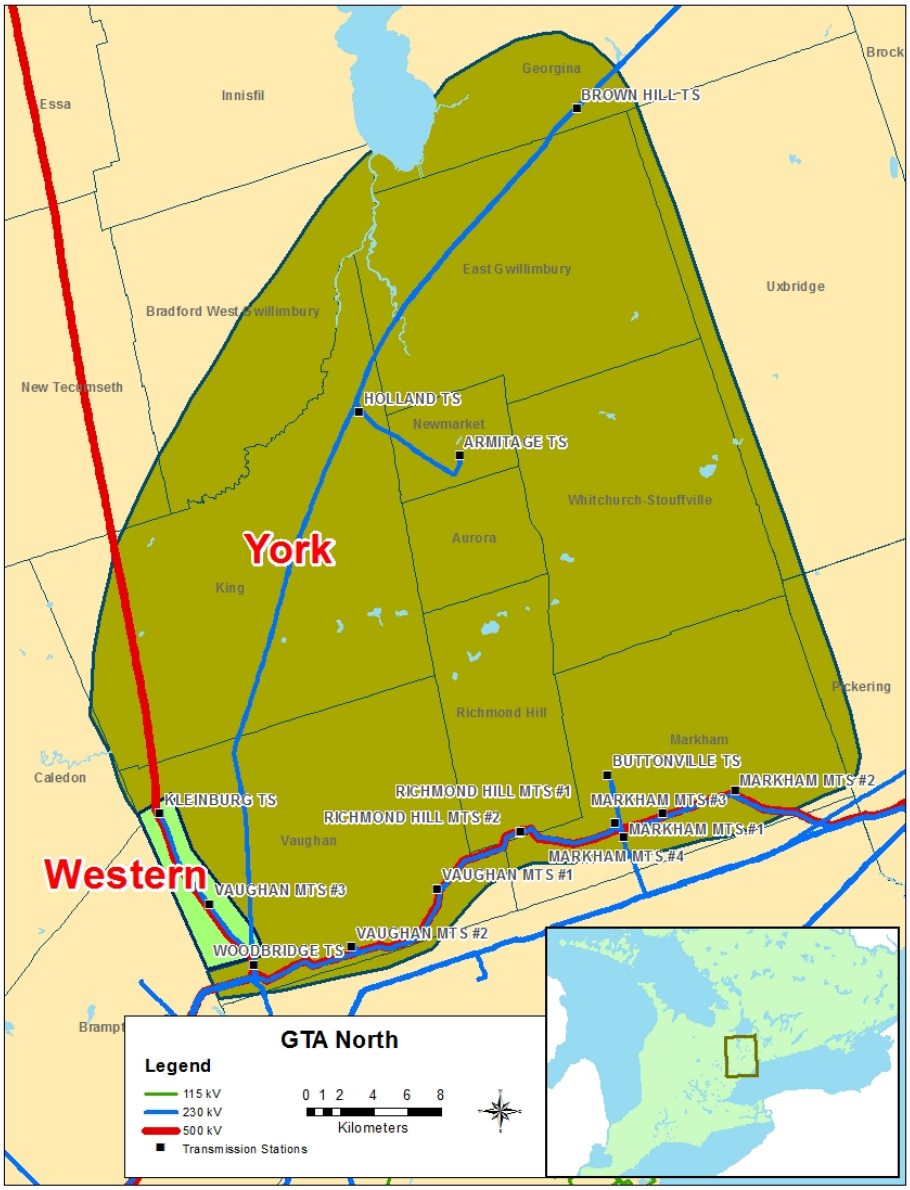

Figure 1: GTA North Region – Supply Areas

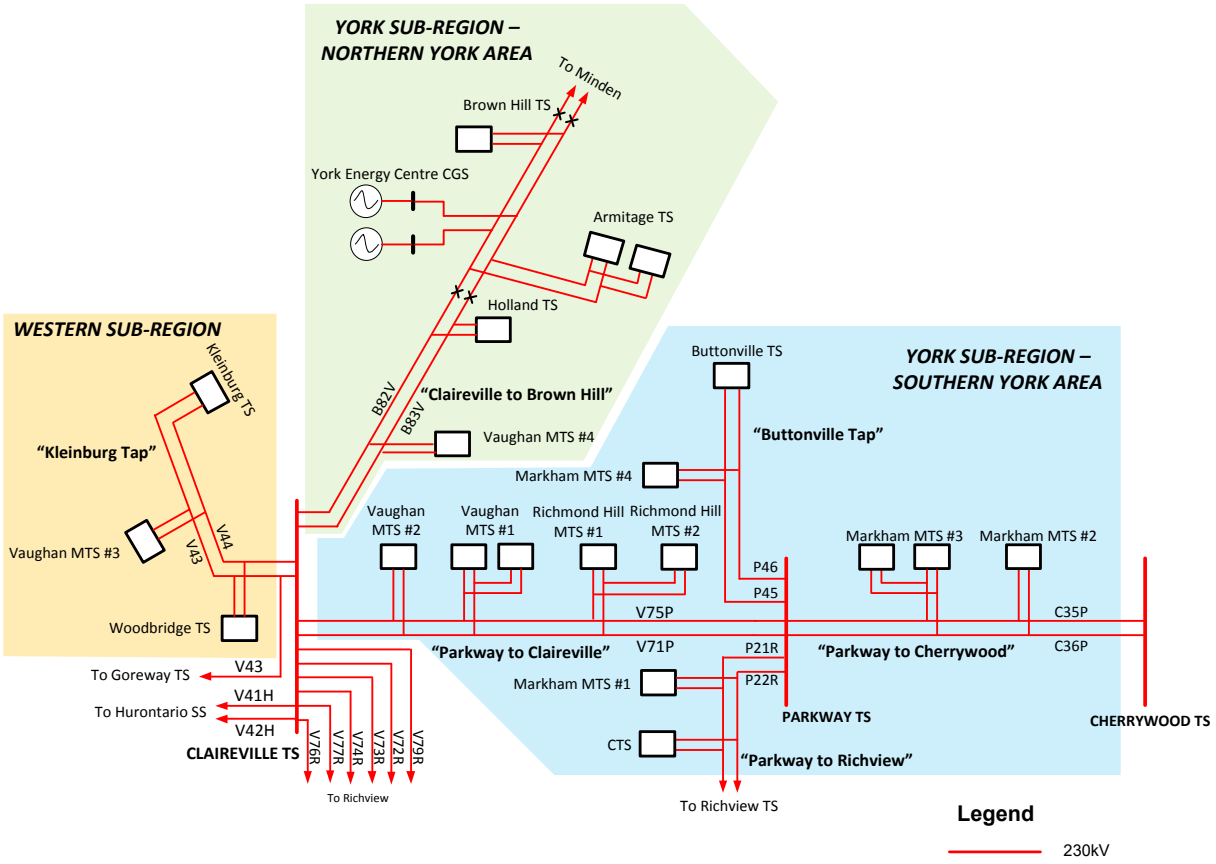

Figure 2: GTA North Transmission Single Line Diagram

5 INPUTS AND DATA

Study Team participants, including representatives from LDCs, IESO, and Hydro One provided information and input for the GTA North Region NA. The information provided includes the following:

- Load Forecast;
- Known capacity and reliability needs, operating issues, and/or major assets approaching the end of their useful life ("EOL"); and,
- Planned/foreseen transmission and distribution investments that are relevant to regional planning for the GTA North Region

6 ASSESSMENT METHODOLOGY

The following methodology and assumptions are made in this Needs Assessment:

Information gathering included:

i. Load forecast: The LDCs provided a load forecast for the region. The IESO provided a simplified Conservation and Demand Management ("CDM") and Distributed Generation ("DG") assumptions to determine their high-level impact on needs in the region. A GTA North Region

extreme summer weather coincident peak gross load forecast was produced by translating the LDC load forecast into load growth rates and applying onto the 2017 actual summer station coincident peak load, adjusted for extreme weather conditions (according to Hydro One's methodology). The CDM and DG assumptions were applied to this gross forecast to produce the net forecast. The extreme summer weather coincident peak net load forecast for the individual stations in the GTA North Region is given in Appendix A. A similar approach was used to develop the GTA North Region extreme summer weather non-coincident peak gross and net load forecast. It should be noted that the actual versus forecasted year to year demand can vary due to factors such as weather, economic development, etc.

ii. Relevant information regarding system reliability and operational issues in the region;

iii. List of major HV transmission equipment planned and/or identified to be refurbished and/or replaced due to the end of their useful life which is relevant for regional planning purposes. This includes HV transformers, autotransformers, HV Breakers, HV underground cables and overhead lines.

Technical assessment of needs was based on:

i. Station capacity and Transmission Adequacy assessment

ii. System reliability and operation assessment

iii. End-of-life equipment: Major high voltage equipment reaching the end of its useful life with respect to replacing it with similar type equipment versus other options to determine the most optimal, resilient, and economic outcome.

Note that the Region is summer peaking so the assessment is based on summer peak loads.

7 NEEDS

This section describes emerging needs that have been identified in the GTA North Region since the previous regional planning cycle and reaffirms the near, mid, and long-term needs already identified in the previous RIP and IRRP. The needs are summarized in Tables 2 and 3 below:

Table 2: New Needs

New Needs	Discussed in Section
End-of-Life Equipment – Woodbridge TS T5 transformer	7.1.1
Load Restoration – P45+P46 ("Buttonville Tap")	7.1.2

Table 3: Needs Identified in Previous RIP and IRRP(1)

Needs Identified in Previous RIP and IRRP	Discussed in Section	RIP Report Section
Load Restoration – V43+V44 ("Kleinburg Tap")	7.2.1	7.3.1
Load Security on V71P/V75P – Parkway to Claireville	7.2.2	7.1.2
Vaughan Transformation Capacity	7.2.3	7.1.3
Markham Transformation Capacity	7.2.4	7.1.4
Station Service Supply to York Energy Centre (YEC)	7.2.5	7.2.1
Northern York Area Transformation Capacity	7.2.6	7.2.2

(1) Includes needs identified in the previous RIP and IRRP that do not have final plans underway yet

7.1 New Needs

7.1.1 End-Of-Life (EOL) Equipment Needs

Hydro One has identified the following major high voltage equipment to be reaching the end of their useful life over the next 10 years. Based on the equipment condition assessment, this asset has been identified to be in poor condition and approaching the end of its useful life.

Table 4: End-of-Life Equipment – GTA North Region

EOL Equipment[1]	Replacement Timing[2]
Woodbridge TS: T5 Transformer	2022-2023

(1) No other major HV station equipment or lines in the GTA North region have been identified for replacement/refurbishment at this time
(2) The replacement/refurbishment timing and prioritization are subject to change

The end-of-life equipment assessment for the above asset considered the following options:

1. Maintaining the status quo
2. Replacing equipment with similar equipment with *lower* ratings and built to current standards
3. Replacing equipment with similar equipment with *lower* ratings and built to current standards by transferring some load to other existing facilities
4. Eliminating equipment by transferring all of the load to other existing facilities
5. Replacing equipment with similar equipment and built to current standards (i.e., "like-for-like" replacement)
6. Replacing equipment with *higher* ratings and built to current standards

Woodbridge TS

Woodbridge TS comprises one DESN unit, T3/T5 (75/125 MVA), with two secondary winding voltages at 44 kV and 28 kV, each with a summer 10-Day LTR of 80 MW. The station's 2017 actual non-coincident summer peak load (adjusted for extreme weather) was 156 MW. Transformer T5 is currently about 45 years old and has been identified to be at its EOL. The companion DESN transformer, T3, is about 29 years old and is not at its EOL. Woodbridge TS supplies both Alectra and THESL.

The 44kV and 28kV load at Woodbridge TS is forecasted to be over 80% and 90% of their respective LTRs in the near and medium term. The closest station is Vaughan MTS #3 (owned by Alectra) and its load is forecasted to be over 95% of its LTR in the medium term. Therefore, downsizing T5 and consolidating load within the station and/or with area stations is not a prudent or viable option given medium term load growth at these stations and based on its historical loading. It is also important to note that the station is configured as a dual secondary yard (230/44-28kV) and the standard lower rated unit has only one secondary. Consequently, replacing T5 with a lower rated unit would result in significant re-configuration of the station and greater cost compared to replacing the EOL transformer with a similar unit of same ratings. Moreover, downsizing capacity today and then later upgrading within the lifetime of the transformer due to eventual load growth will also be significantly more costly. For example it may

cost an additional $5-$10 million for the replacement of the transformer plus the incremental cost for the LDC to reconfigure feeders at a later stage. It should also be noted that maintaining capacity, as opposed to downsizing, is a more resilient option as it provides additional flexibility during emergency conditions through load transfers.

With respect to maintaining status quo, the T5 transformer is in poor condition so this is not an option due to the risk of equipment failure, customer outages, increased maintenance cost, and environmental impact. Upgrading T5 is also not an option since it's already at the maximum size.

Based on the above, the study team recommends that this need be addressed by Hydro One and affected LDCs to coordinate the replacement plan. Hydro One will keep the study team informed of the status of the plan if any major changes occur. The timing of replacement for the EOL equipment is 2022-2023.

7.1.2 Load Restoration – P45+P46 ("Buttonville Tap")

This load restoration need is based on the ORTAC load restoration criteria that requires any load loss exceeding 250 MW to be restorable within 30 minutes. Based on the extreme summer weather coincident peak net load forecast, for the loss of 230kV circuits, P45 and P46 (stations connected are Buttonville TS and Markham #4 MTS), the load interrupted by configuration is expected to exceed 250 MW beginning in 2021 and restoration within 30 minutes needs to be assessed.

It should also be noted that a new station, Markham #5 MTS, is being planned for connection to circuits P45 and P46, with a projected need date in the 2025-2026[1] timeframe and an initial load of 26 MW based on the extreme summer weather coincident peak net load forecast (see Section 7.2.4 for more details). This load should also be taken into account for the load restoration need analysis.

The study team recommends that further assessment and regional coordination in the IRRP and RIP phase is required to review options and identify a preferred restoration plan.

7.2 Needs Identified in Previous RIP and/or IRRP

The following section summarizes the needs identified in the previous 2016 GTA North RIP report and 2015 York Region IRRP that do not have final plans underway yet. The Study Team reaffirms these needs and an update is provided below.

7.2.1 Load Restoration – V43+V44 ("Kleinburg Tap")

The load restoration need for 230 kV radial circuits, V43 and V44 (supplying Woodbridge TS, Vaughan #3 MTS, and Kleinburg TS), was identified during the previous NA for the GTA North Western Sub-Region and also in the Northwest GTA IRRP as load restoration times as per the ORTAC may not be met

[1] The need date will be further refined by Hydro One and Alectra through the project development process. Refer to section 7.2.4 for more details.

for the loss of V43 and V44. The study team recommended that this need be addressed in IESO's GTA West bulk system planning initiative.

The subsequent GTA West bulk system study did not address the restoration need. As a result, the study team recommends that the need be revisited as part of the next GTA North IRRP.

7.2.2 Load Security on V71P/V75P – Parkway to Claireville

In the previous York Region IRRP, the study team recommended the installation of inline switches at the Vaughan MTS #1 junction in order to improve the capability of the system to restore load in the event that both 230 kV circuits V71P/V75P are lost. While the installation of these switches will improve the load restoration capabilities and overall reliability on the Parkway to Claireville corridor, it does not address the load security need on V71P/V75P.

Since the previous GTA North RIP, the IESO completed an addendum to its expedited SIA for the in-line switches at Grainger Junction project. The addendum indicated that an exemption for this project with respect to the 600 MW load security limit would not be required. However, it advised that the load security issue on the Parkway to Claireville corridor must be re-assessed as part of the next regional planning cycle.

The Study Team reassessed the load security issue during this regional planning cycle. Based on the extreme summer weather coincident peak net load forecast, the load on the Parkway to Claireville corridor is around 695 MW, which is lower than the previous RIP forecast (refer to RIP report, Appendix D), however continues to exceed the 600 MW limit. As a result, the study team reaffirms this need and recommends further assessment and regional coordination in the next IRRP and RIP phase to review options and develop a preferred plan.

7.2.3 Vaughan Transformation Capacity

In the previous RIP, the study team recommended that the need for additional transformation capacity in Vaughan, along with associated transmission capacity[2], be further assessed in the next regional planning cycle and to refine the need timing as Alectra advised they were updating their load forecast and the need date may change (for more details, refer to section 7.1.3 of the RIP report). Based on the current extreme summer weather non-coincident peak net load forecast, the need for additional transformation capacity is beyond 2027. If CDM savings are not achieved as forecasted, then the need date can be as early as 2027.

The Study Team reaffirms this need and recommends further assessment and regional coordination in the IRRP and RIP phase to review options and develop a preferred plan.

7.2.4 Markham Transformation Capacity

[2] There are long-term transmission supply needs associated with new transformation capacity

In the previous RIP, the study team recommended to continue the assessment of wires and non-wires options to address the need for additional transformation capacity in the Markham-Richmond Hill area and to refine the need timing. During the RIP, Alectra advised that they were updating their load forecast and the need date may change (for more details, refer to section 7.1.4 of the RIP report). In April 2017, the IESO issued a letter of support to Hydro One Transmission and Alectra to proceed with wires planning for a new 230/27.6kV DESN and the associated distribution and/or transmission lines to connect the new transformer station. In the hand-off letter, the IESO concluded that it is not feasible to rely entirely on distributed energy resources to defer the near-term supply need in the area and that a new station and associated connection lines would be required by 2023 to meet the growth projections in the Markham-Richmond Hill area. Based on the current extreme summer weather non-coincident peak net load forecast, the need for additional transformation capacity is projected to be in the 2025-2026[3] timeframe. If CDM savings are not achieved as forecasted, then the need date can be as early as 2024.

The Study Team reaffirms this need and Hydro One and Alectra are currently in the process of selecting a preferred location to connect to 230 kV circuits P45/P46. Following this, Hydro One will proceed with development and estimate work to meet the need date. Further updates will be included in the next IRRP and RIP.

7.2.5 Station Service Supply to York Energy Centre

In the previous RIP, a need for addressing station service supply to York Energy Centre (currently supplied from Holland TS) in the event of a (i) low-voltage breaker failure at Holland TS or (ii) double circuit 230 kV contingency was identified (for more details, refer to section 7.2.1 of the RIP report). These events can result in an interruption to the station service supply to York Energy Centre and therefore the loss of all generation output until the station service can be restored from the alternate source.

Since the RIP, the IESO completed a System Impact Assessment (SIA) for the new 230 kV in-line breakers at Holland TS and it found that the use of load rejection will no longer be a suitable means to address (i) and (ii) in the near to medium term as the amount of load rejection required to address overloads and voltage collapse will exceed the permissible amount of 150 MW allowed by ORTAC load security criteria.

The Study Team reaffirms this need and recommends further assessment and regional coordination in the IRRP and RIP phase to review options and develop a preferred plan.

7.2.6 Northern York Area Transformation Capacity

In the previous RIP, the study team recommended that the need for additional transformation capacity in the Northern York Area, along with associated transmission capacity[4], be further assessed in the next regional planning cycle (for more details, refer to section 7.2.2 of the RIP report). Based on the current

[3] The need date will be further refined by Hydro One and Alectra through the project development process
[4] There are long-term transmission supply needs associated with new transformation capacity

extreme summer weather non-coincident peak net load forecast, the combined loading on Armitage TS and Holland TS will not exceed their combined summer 10-Day LTR during the study period (combined load is over 97% of its combined LTR in 2027). There is 44 kV transfer capability between these stations on the distribution system so the timing of the need is based on the combined capability of both stations. However, if CDM savings are not achieved as forecasted, then the need date may be as early as 2024.

The Study Team reaffirms this need and recommends further assessment and regional coordination in the IRRP and RIP phase to review options and develop a preferred plan.

8 RECOMMENDATIONS

The Study Team's recommendations to address the needs identified are as follows:

a) Further regional coordination is not required to address the EOL Woodbridge TS T5 transformer (discussed in sections 7.1.1). From a cost, loading, station configuration, and customer connection needs perspective, this asset should not be eliminated or have its capacity reduced. The study team recommends that this EOL need be addressed by Hydro One and affected LDCs to coordinate the replacement plan. Hydro One will keep the study team informed of the status of the plan if any major changes occur.

b) As per the IESO's letter of support in April 2017, Alectra and Hydro One will continue to develop a new 230/27.6kV DESN in the Markham-Richmond Hill area (discussed in section 7.2.4). Further updates will be included in the next IRRP and RIP.

c) Further assessment and regional coordination is required in the IRRP and/or RIP, to develop a preferred plan for the following needs:

- Load Restoration – P45+P46 (discussed in Section 7.1.2)
- Load Restoration – V43+V44 (discussed in Section 7.2.1)
- Load Security on V71P/V75P – Parkway to Claireville (discussed in Section 7.2.2)
- Vaughan Transformation Capacity (discussed in Section 7.2.3)
- Station Service Supply to York Energy Centre (discussed in Section 7.2.5)
- Northern York Area Transformation Capacity (discussed in Section 7.2.6)
- Transmission Supply Capacity in Vaughan and Northern York Area in long term (discussed in sections 7.2.3 and 7.2.6)

The table below summarizes the above recommendations.

Table 5: Summary of Recommendations

Further Regional Coordination Not Required	Further Regional Coordination Required
EOL Station Equipment: • Woodbridge TS: T5	**Load Restoration:** • P45+P46 (Buttonville TS, Markham #4 MTS,

Further Regional Coordination Not Required	Further Regional Coordination Required
IESO Letter of Support: • Markham Transformation Capacity (Markham #5 MTS)	and future Markham #5 MTS) • V43+V44 (Woodbridge TS, Vaughan #3 MTS, and Kleinburg TS) **Load Security:** • V71P/V75P (Parkway to Claireville) **Transformation Capacity:** • Vaughan #5 MTS • Northern York Area **Station Service Supply:** • York Energy Centre **Transmission Supply Capacity (long term)** • Vaughan #5 MTS • Northern York Area

9 REFERENCES

[1]. Hydro One, "GTA North Regional Infrastructure Plan", 5 February 2016.
https://www.hydroone.com/abouthydroone/CorporateInformation/regionalplans/gtanorth/Documents/RIP%20Report%20GTA%20North.pdf

[2]. IESO, "York Region Integrated Regional Resource Plan", 28 April 2015.
http://www.ieso.ca/-/media/files/ieso/document-library/regional-planning/york/2015-york-region-irrp-report.pdf?la=en

[3]. IESO, "Northwest GTA Integrated Regional Resource Plan", 28 April 2015.
http://www.ieso.ca/-/media/files/ieso/document-library/regional-planning/northwest-greater-toronto/2015-northwest-gta-irrp-report.pdf?la=en

[4]. Hydro One, "GTA North Western Subregion Needs Screening", 27 June 2014.
https://www.hydroone.com/abouthydroone/CorporateInformation/regionalplans/gtanorth/Documents/Needs%20Assessment%20Report%20-%20GTA%20North%20-%20Western%20Subregion.pdf

[5]. OEB, "Planning Process Working Group Report to the Board", 17 May 2013.
http://www.ontarioenergyboard.ca/OEB/_Documents/EB-2011-0043/PPTECHNICAL__STUDY TEAM_Regional_Planning_Report_to_the_Board_App.pdf

[6]. IESO, "System Impact Assessment Report, New 230 kV In-line Breakers at Holland TS", 25 April 2016.
http://www.ieso.ca/-/media/Files/IESO/caa/CAA_2015-539_Final_Report.pdf

[7]. IESO, "Expedited System Impact Assessment, 230 kV Circuits V71P and V75P – Add In-line Load Interrupting Switches at Grainger Junction, Addendum".
http://www.ieso.ca/-/media/Files/IESO/caa/CAA_2016-EX846_Addendum_1.pdf

[8]. IESO, "Ontario Resource and Transmission Assessment Criteria (ORTAC) – Issue 5.0"
http://www.ieso.ca/-/media/files/ieso/Document%20Library/Market-Rules-and-Manuals-Library/market-manuals/market-administration/IMO-REQ-0041-TransmissionAssessmentCriteria.pdf

Appendix A: GTA North Region Load Forecast (2017 to 2027)

Stations Net Coincident Peak Load Forecast (MW)

Station Name	LTR*	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Kleinburg TS (28kV)	97	55	51	52	52	52	52	52	52	52	52	51
Kleinburg TS (44kV)	99	87	83	83	84	84	84	85	84	84	84	83
Vaughan MTS #3 (28kV)	153	162	124	140	147	147	146	146	145	144	142	147
Woodbridge TS (44kV)	80	45	46	47	47	47	47	47	47	46	46	45
Woodbridge TS (28kV)	80	85	71	70	69	69	69	70	69	68	68	67
Holland TS (44kV)	168	126	123	128	132	136	137	139	140	141	140	141
Armitage TS (44kV)	317	265	262	266	270	274	278	282	285	287	288	291
Brown Hill TS (44kV)	184	49	47	47	48	48	49	50	50	50	50	50
Richmond Hill MTS (28kV)	254	256	232	229	236	244	243	242	249	254	254	254
Vaughan MTS #1 (28kV)	306	302	257	254	253	270	276	291	289	287	284	294
Vaughan MTS #2 (28kV)	153	113	124	131	139	147	146	146	145	144	142	147
Vaughan MTS #4 (28kV)	153	0	44	52	69	78	110	127	145	144	142	147
Vaughan MTS #5 (28kV)**	153	0	0	0	0	0	0	0	0	0	0	0
Buttonville TS (28kV)	166	126	123	136	136	141	141	140	139	138	137	136
Markham MTS #1 (28kV)	81	78	80	79	78	78	78	77	80	81	81	81
Markham MTS #2 (28kV)	101	114	92	98	97	97	96	96	99	101	101	101
Markham MTS #3 (28kV)	202	154	197	196	194	193	193	192	198	202	202	202
Markham MTS #4 (28kV)	153	70	89	91	104	112	129	146	150	153	153	153
Markham MTS #5 (28kV)	153	0	0	0	0	0	0	0	0	26	86	77

* LTR based on 0.9 power factor

** Based on the non-coincident net forecast, the need date for Vaughan MTS #5 is beyond 2027.

Stations Net Non-Coincident Peak Load Forecast (MW)

Station Name	LTR*	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Kleinburg TS (28kV)	97	62	59	59	59	59	59	59	59	59	59	58
Kleinburg TS (44kV)	99	87	83	83	84	84	84	85	84	84	84	83
Vaughan MTS #3 (28kV)	153	162	124	140	147	147	146	146	145	144	142	147
Woodbridge TS (44kV)	80	64	66	68	67	67	67	67	66	66	65	65
Woodbridge TS (28kV)	80	92	77	76	75	75	75	76	75	74	74	73
Holland TS (44kV)	168	132	128	134	138	142	144	145	146	147	147	147
Armitage TS (44kV)	317	295	291	296	300	304	309	313	316	318	319	323
Brown Hill TS (44kV)	184	78	75	75	77	77	78	80	80	80	80	80
Richmond Hill MTS (28kV)	254	256	232	229	236	244	243	242	249	254	254	254
Vaughan MTS #1 (28kV)	306	302	257	254	253	270	276	291	289	287	284	294
Vaughan MTS #2 (28kV)	153	113	124	131	139	147	146	146	145	144	142	147
Vaughan MTS #4 (28kV)	153	0	44	52	69	78	110	127	145	144	142	147
Vaughan MTS #5 (28kV)**	153	0	0	0	0	0	0	0	0	0	0	0
Buttonville TS (28kV)	166	135	132	146	146	152	151	151	150	148	147	145
Markham MTS #1 (28kV)	81	78	80	79	78	78	78	77	80	81	81	81
Markham MTS #2 (28kV)	101	114	92	98	97	97	96	96	99	101	101	101
Markham MTS #3 (28kV)	202	154	197	196	194	193	193	192	198	202	202	202
Markham MTS #4 (28kV)	153	70	89	91	104	112	129	146	150	153	153	153
Markham MTS #5 (28kV)	153	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26	86	77

* LTR based on 0.9 power factor

** Based on the non-coincident net forecast, the need date for Vaughan MTS #5 is beyond 2027.

Appendix B: Acronyms

Acronym	Description
A	Ampere
BES	Bulk Electric System
BPS	Bulk Power System
CDM	Conservation and Demand Management
CIA	Customer Impact Assessment
CGS	Customer Generating Station
CSS	Customer Switching Station
CTS	Customer Transformer Station
DCF	Discounted Cash Flow
DESN	Dual Element Spot Network
DG	Distributed Generation
DSC	Distribution System Code
GATR	Guelph Area Transmission Reinforcement
GS	Generating Station
GTA	Greater Toronto Area
HV	High Voltage
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Plan
kV	Kilovolt
LDC	Local Distribution Company
LP	Local Plan
LTE	Long Term Emergency
LTR	Limited Time Rating
LV	Low Voltage
MTS	Municipal Transformer Station
MW	Megawatt
MVA	Mega Volt-Ampere
MVAR	Mega Volt-Ampere Reactive
NA	Needs Assessment
NERC	North American Electric Reliability Corporation
NGS	Nuclear Generating Station
NPCC	Northeast Power Coordinating Council Inc.
NUG	Non-Utility Generator
OEB	Ontario Energy Board
OPA	Ontario Power Authority
ORTAC	Ontario Resource and Transmission Assessment Criteria
PF	Power Factor
PPWG	Planning Process Working Group
RIP	Regional Infrastructure Plan
ROW	Right-of-Way
SA	Scoping Assessment
SIA	System Impact Assessment
SPS	Special Protection Scheme
SS	Switching Station
STG	Steam Turbine Generator
TPS	Traction Power Station
TS	Transformer Station
TSC	Transmission System Code
UFLS	Under Frequency Load Shedding
ULTC	Under Load Tap Changer
UVLS	Under Voltage Load Rejection Scheme
YEC	York Energy Centre