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NEEDS ASSESSMENT REPORT

Burlington to Nanticoke Region

Date: May 15, 2017

Prepared by: Burlington to Nanticoke Study Team



Disclaimer

This Needs Assessment Report was prepared for the purpose of identifying potential needs in the Burlington to Nanticoke Region and to recommend which needs may require further assessment and/or regional coordination to develop wires options. 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	Burlington to Nanticoke		
LEAD	Hydro One Networks Inc. (“HONI”)		
START DATE	February 21, 2017	END DATE	May 15, 2017
1. INTRODUCTION			
<p>The first regional planning cycle for the Burlington to Nanticoke Region was completed in February 2017 with the publication of the Regional Infrastructure Plan (RIP).</p> <p>During the last Burlington to Nanticoke Region’s Need Assessment (NA) and Scoping Assessment (SA) phases, several sustainment needs to address assets reaching their end-of-life (EOL) were not identified, as the asset condition and other related information of some of the assets was not available. Since then, the extent and urgency of the sustainment needs in the region are better known to the Study Team, and the RIP recommended that a Needs Assessment be undertaken to identify these needs.</p> <p>The purpose of this Needs Assessment is to identify new and/or reconfirm the needs in the Burlington to Nanticoke Region that have emerged since the last RIP including the mid and long-term sustainment needs that have been identified in the last RIP.</p>			
2. REGIONAL ISSUE/TRIGGER			
<p>This NA is triggered from the recommendation in the Burlington to Nanticoke RIP to further assess some of the mid and long-term needs and to identify any new needs in the region. The NA will be followed by a Scoping Assessment.</p>			
3. SCOPE OF NEEDS ASSESSMENT			
<p>The scope of this Needs Assessment covers the Burlington to Nanticoke Region, and includes:</p> <ul style="list-style-type: none"> • Needs already identified in the mid and long-term in the RIP; and • Any new needs identified by the Study Team in the region. <p>The load forecast for the region was prepared and reviewed less than a year ago and is provided in Appendix A. The Study Team determined that updating the load forecast at this time is not necessary.</p>			
4. INPUTS/DATA			
<p>The Study Team that includes representatives from Local Distribution Companies (LDCs), the Independent Electricity System Operator (IESO), and Hydro One provided input and any relevant information for the Burlington to Nanticoke Region regarding system reliability, capacity needs, operational issues and major assets/facilities approaching EOL essential for regional planning.</p>			
5. ASSESSMENT METHODOLOGY			
<p>The Needs Assessment includes a review of information provided by the Study Team and lists all the potential</p>			

needs in the Burlington to Nanticoke Region. In general, needs to replace/refurbish equipment which is a) at the end of their useful life; b) cannot be eliminated and c) replaced with similar equipment do not require regional coordination. The Study Team looked at the available information for each identified need to determine if further regional coordination and broader study would be beneficial. Based on Study Team discussions, Accordingly some of the identified EOL equipment needs along with other needs will be further assessed as part of the Scoping Assessment phase.

6. RESULTS

I. Regional Supply Capacity

No new needs that require further regional planning have been identified at this time after the completion of RIP for this region.

II. System Reliability & Operation

No new needs that require to be assessed as part of regional coordination have been identified at this time after the completion of RIP for this region.

III. Aging Infrastructure

In Burlington to Nanticoke Region, assets in 10 stations and 4 HV underground cable double-circuit sections have been identified at or reaching End-of-Life (EOL). Some of these are to replace equipment with similar type of equipment. Refer to Section 7 for more details.

7. RECOMMENDATIONS

The Study Team recommendations are as follows:

- a) No regional coordination is required to replace EOL LV switchgears at Birmingham TS, Dundas TS, Brantford TS, Norfolk TS, and Burlington TS and EOL transformers at Caledonia TS, and Jarvis TS with similar equipment as discussed in Section 7. The replacement and/or refurbishment of these assets should be further planned and coordinated by Hydro One with the relevant LDCs.
- b) For EOL transformers and LV switchgears at Newton TS and Lake TS, and LV switchgears and auto-transformers at Beach TS further assessment should be undertaken. Scoping Assessment will determine for each of these needs if further regional coordination is required or not to develop a preferred plan.
- c) EOL HV cables H5K/H6K, K1G/K2G, and HL3/HL4 requires comprehensive review and should be further assessed as part of the Scoping Assessment phase.

The SA Study Team will decide on the scope, study and planning approach for the needs identified for further consideration in the Scoping Assessment.

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1 INTRODUCTION

The first regional planning cycle for the Burlington to Nanticoke Region was completed in February 2017 with the publication of the Regional Infrastructure Plan (RIP).

During the last Burlington to Nanticoke Region's Need Assessment (NA) and Scoping Assessment (SA) phases, several sustainment needs to address assets reaching their end-of-life (EOL) were not identified, as the asset condition and related information of these assets was not available at the time. Since then, the condition and urgency of the sustainment needs in the region are better known to the Study Team.

The purpose of this Needs Assessment is to reconfirm the mid and long-term sustainment needs in the Burlington to Nanticoke Region and/or any new needs in the region.

This report was prepared by the Burlington to Nanticoke Region Study Team, listed below in Table 1 led by Hydro One Networks Inc. The report captures the results of the assessment based on input provided by the Local Distribution Companies (LDCs), the IESO and Hydro One.

Table 1: Burlington to Nanticoke Study Team Participants

Company
Brantford Power Inc.
Burlington Hydro Inc.
Energy + Inc.
Alectra Utilities Corporation (formerly Horizon Utilities Inc.)
Hydro One Networks Inc. (Distribution)
Independent Electricity System Operator (IESO)
Oakville Hydro Electricity Distribution Inc.
Hydro One Networks Inc. (Lead Transmitter)

2 REGIONAL ISSUE/TRIGGER

This NA is triggered from the recommendation in the Burlington to Nanticoke RIP to further assess some of the mid and long-term needs and to identify any new needs in the region. The NA will be followed by a Scoping Assessment.

3 SCOPE OF NEEDS ASSESSMENT

The scope of this Needs Assessment covers Burlington to Nanticoke Region, and includes:

- Needs already identified in the mid- and long-term in the RIP; and
- Any new needs provided/identified by the Study Team in the region that require regional coordination.

Since the load forecast (Appendix A) for the region was reviewed and prepared for the RIP, the study team determined that the load forecast does not require to be updated. The only significant step change anticipated up to 10 MW of new load at 230 kV CTS is anticipated in the next 5 years near Cumberland TS. There is a potential for incremental load at Elgin TS, Stirton TS and Newton TS in case Hamilton Light Rail Transit (LRT) project gets approved. However, the Hamilton LRT load impact is not known at this time.

4 REGIONAL DESCRIPTION AND CONNECTION CONFIGURATION

The Burlington to Nanticoke region covers the City of Brantford, municipality of Hamilton, counties of Brant, Haldimand and Norfolk. The portions of Cities of Burlington and Oakville south of Dundas Street are included in the Burlington to Nanticoke region up to Third Line road in the east. Electrical supply to the Region is provided from thirty-one 230 kV and 115 kV step-down transformer stations. The Burlington to Nanticoke Region can be divided into four sub-regions, Brant, Caledonia-Norfolk, Bronte and Greater Hamilton. The boundaries of the Region are shown below in Figure 1.

Bulk electrical supply to the Burlington to Nanticoke Region is provided through the 500/230 kV Nanticoke TS and Middleport TS and 230 kV circuits from Middleport TS, Nanticoke TS and Beck TS. The 115 kV network is supplied by 230/115 kV autotransformers at Burlington TS, Beach TS and Caledonia TS. The area loads are supplied by a network of 230 kV and 115 kV transmission lines and step-down transformation facilities. A single line diagram of the 500/230/115 kV area in the Burlington to Nanticoke Region is shown below in Figure 2 and 3.

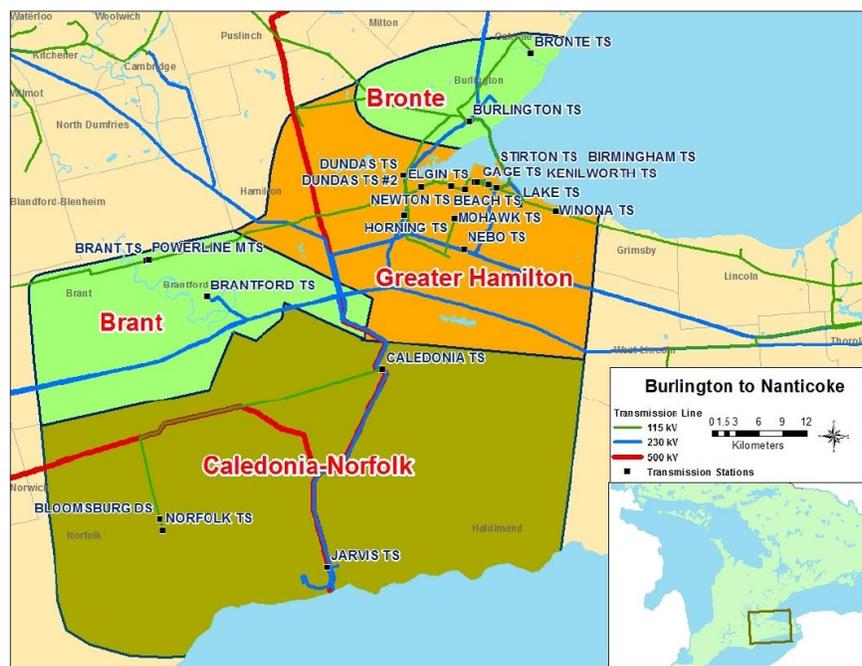


Figure 1: Burlington to Nanticoke Regional and Sub-Regional Boundaries

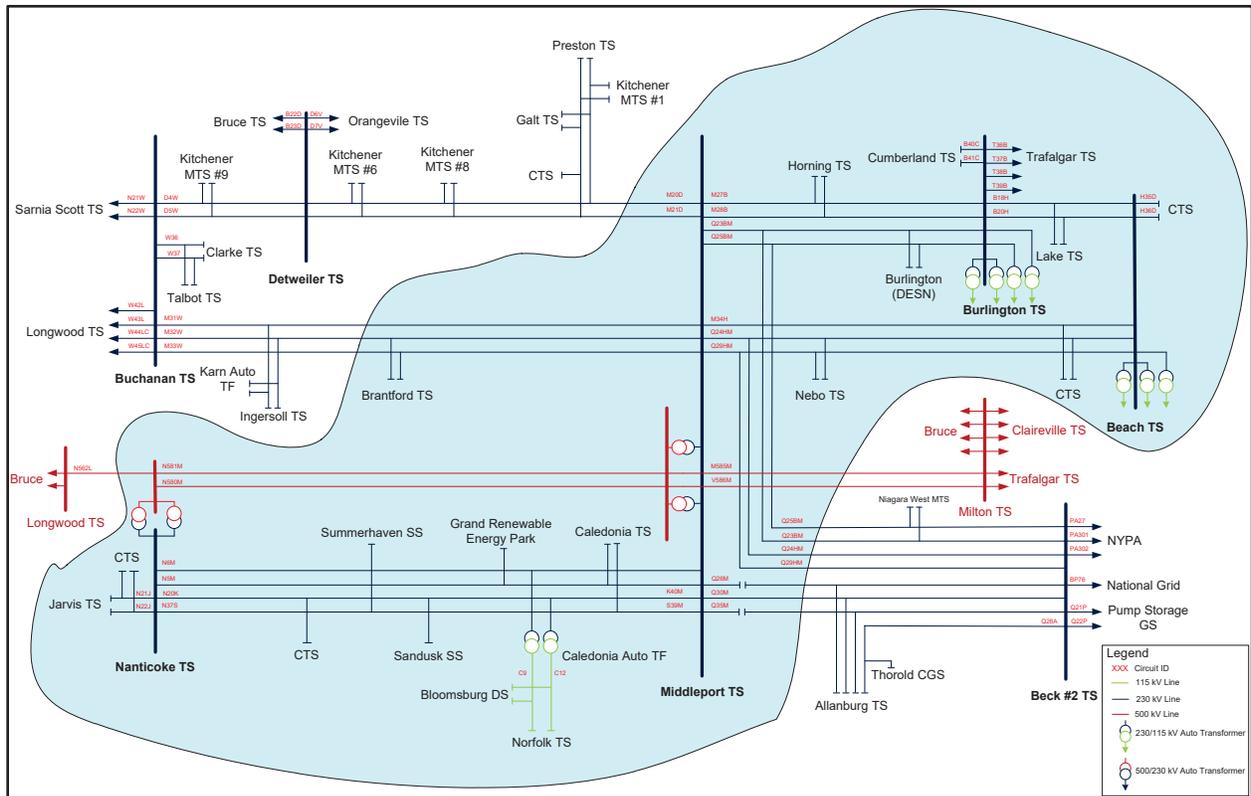


Figure 2: Burlington to Nanticoke Region – 230/500 kV Single Line Diagram

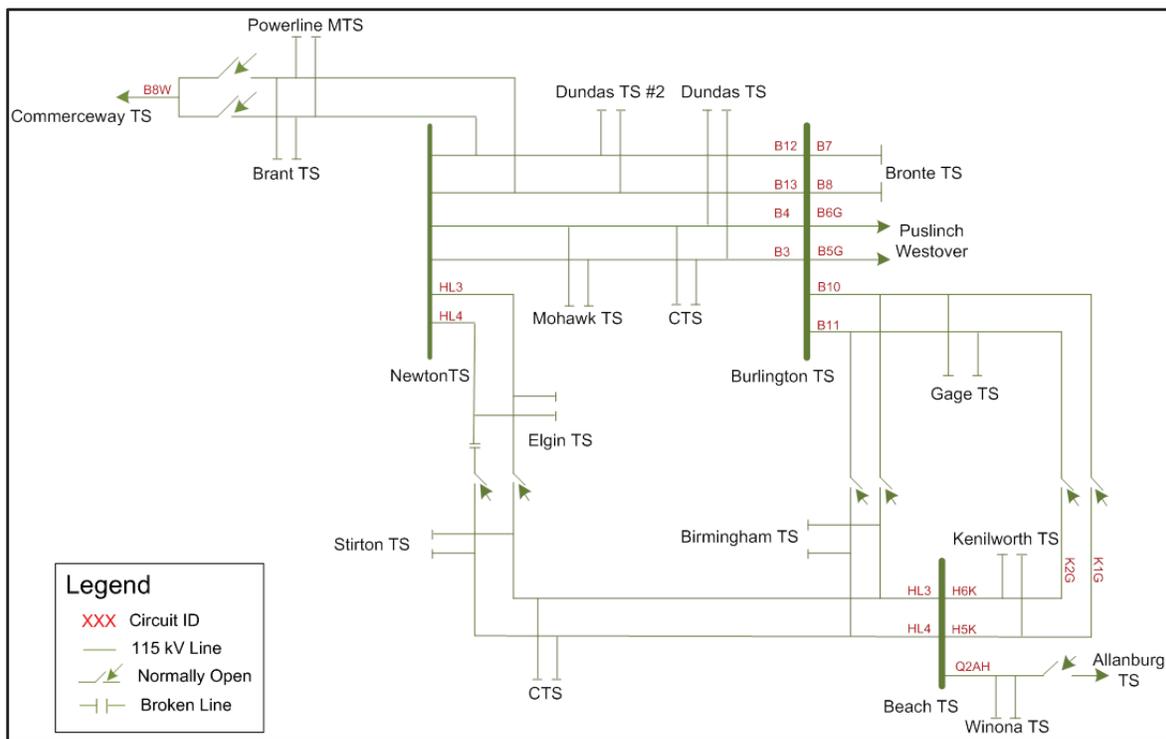


Figure 3: Burlington to Nanticoke Region – 115 kV Single Line Diagram

5 INPUTS AND DATA

Study Team participants, including representatives from LDCs and the IESO, provided all known information and input to Hydro One for the Burlington to Nanticoke Region. No new studies were conducted by the IESO for this assessment for reliability and operational needs due to compressed timelines. The information provided includes the following:

- Any known reliability, capacity needs, operating issues and/or major facilities approaching EOL; and
- Planned/foreseen transmission and distribution investments to be considered as part of the regional planning process.

6 ASSESSMENT METHODOLOGY

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

- Information gathering included:
 - i. Load forecast developed during the RIP phase and re-affirmed by Study Team to be adequate for this Needs Assessment. If required, further review and update will be undertaken during the next phase(s) of the regional planning i.e. SA/IRRP/RIP.
 - 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 relevant for regional planning purposes.
- Technical assessment of needs is based on:
 - i. Station capacity and Transmission Adequacy Assessment.
 - ii. System reliability and operation assessment.
 - iii. End-of-life equipment: high-level assessment with respect to replacing equipment with similar type versus higher rating /downsizing/elimination of equipment or maintaining status quo.

7 NEEDS AND ALTERNATIVES

In addition to needs that have been identified in the previous Burlington to Nanticoke regional planning cycle, no new supply capacity, system reliability, and operation needs are identified by the Study Team at this time.

The needs identified in this Region are primarily to replace and/or refurbish aging equipment. Hydro One has identified the following station equipment and transmission line/cable assets to be reaching their EOL in the next 10 years and beyond:

EOL Asset	Replacement/ Refurbishment Timing^[1]	Details
Birmingham TS: 2 LV Metalclad Switchgear	2021-2022	EOL LV switchgears are identified in these stations, and are discussed further in Section 7.1
Dundas TS: T1/T2 DESN LV Switchgear	2021-2022	
Brantford TS: LV Switchgear	2022-2023	
Norfolk TS: LV Switchgear	2025-2026	
Burlington TS: LV Switchgear	2025-2026	
Beach TS: T5/T6 DESN LV Metalclad Switchgear	2025-2026	
Newton TS: T1/T2 Transformers and LV Switchgear	2021-2022	EOL Transformers and/ or other equipment are identified at these stations, and are discussed further in Section 7.2
Lake TS: T1/T2 Transformers and LV Switchgear	2022-2023	
Caledonia TS: T1/T2 Transformers	2022-2025	
Jarvis TS: T3/T4 Transformers	2022-2025	
Beach TS: T7/T8 Auto-transformers	2023-2026	
Stirton TS: 2 115 kV Switches and 2 LV Switchgear	- ^[2]	
115 kV Underground Cables: H5K/H6K, K1G/K2G, HL3/HL4	Beyond 2025	Discussed further in Section 7.2

[1] The replacement/ refurbishment timing associated with EOL asset needs is tentative.

[2] Further condition assessment of equipment does not require replacement or refurbishment these assets. Routine maintenance is undertaken.

Maintaining status quo is also not an option for any of the above EOL autotransformer, station transformer or LV switchgear due to risk of equipment failure, would result in increased maintenance cost and customer outages.

No additional lines or stations in the Burlington to Nanticoke region have been identified for major replacement/ refurbishment at this time. If and when new and/or additional information is available, it will be provided at the next planning phase underway at the time.

7.1 EOL LV Switchgear

7.1.1 Birmingham TS

Birmingham TS is located in the city of Hamilton in the Greater Hamilton Sub-Region. This station has two DESN units T1/T2 and T3/T4 having supply capacity of 76 MW and 91 MW and supplying peak loads of 32 MW and 46 MW respectively. Both the DESNs supply loads through four metalclad switchgears. The supply capacity of each Birmingham TS DESN is forecasted to be sufficient over and beyond the study period.

At Birmingham TS, the T1 transformer is 1974 built. The T4 transformer was replaced in 2006 while the T2/T3 transformers were replaced in 2010. The 13.8 kV BY and JQ metalclad switchgears associated T1/T2 DESN are of early 1970's vintage while the EZ and DK metalclad switchgear associated with T3/T4 DESN are 1981 and 1998 built respectively. The BY and JQ LV metalclad switchgears associated with T1/T2 transformers are over 45 years old and based on its asset condition assessment has been

identified at it EOL requiring refurbishment. At this time T1 transformers and/or any other HV/LV equipment at this station has not been identified as EOL over the next 10 years.

Birmingham TS currently supplies a large industrial customer with unique requirements of connection i.e. through multiple cables and high short-circuit levels for large motor starting. These unique customer's connection requirements allow neither consolidation of two Birmingham DESNs nor transferring all of T1/T2 DESN loads to any of the neighboring stations.

To address the EOL issues at Birmingham TS, regional coordination is not required. The replacement/refurbishment plan for the EOL equipment will be developed by Hydro One and coordinated with the affected LDC and/or customers. Tentative schedule and plan is to replace the equipment between the years 2021-22.

7.1.2 Dundas TS

Dundas TS is located in the city of Hamilton in the Greater Hamilton Sub-Region. Dundas TS has two DESN units T1/T2 and T5/T6 having supply capacities of 99 MW and 89 MW and supplying 85 MW and 63 MW peak loads respectively. The station capacity is forecasted to be sufficient over and beyond the study period.

At Dundas TS, the T5/T6 DESN was built in 2003 while the T1/T2 DESN transformers TS have recently been replaced in 2015. The Dundas TS T1/T2 27.6 kV MV switchgear is over 50 years old and condition assessment has identified it at its EOL requiring refurbishment. At this time none of the transformers and/or any other HV/LV equipment at this station has been identified as EOL over the next 10 years.

The total peak station load is well above the supply capacity of each of the DESNs and cannot be supplied from a single DESN and there is no nearby 27.6 kV supply station where the Dundas TS loads can be transferred.

To address the EOL issues at Dundas TS, regional coordination is not required. The replacement/refurbishment plan for the EOL equipment will be developed by Hydro One and coordinated with the affected LDC and/or customers. The LV switchgear replacements/refurbishment work at Dundas TS is tentatively planned to be undertaken in 2021-22.

7.1.3 Brantford TS

Brantford TS is located in the city of Brantford in the Brant Sub-Region. Brantford TS is a single T3/T4 DESN station having a supply capacity of 188 MW and supplying peak load of 135 MW. The station loads are forecasted to grow up to 165 MW over the next 20 years. However the station capacity is forecasted to be sufficient over and beyond the study period.

Both the T3 and T4 supply transformers at this station have been replaced in 2011 and 2013 respectively. The Brantford TS LV switchgear is over 40 years old and based on its condition assessment has been

identified it as EOL requiring refurbishment. At this time none of the transformers and/or any other HV/LV equipment at this station has been identified as EOL over the next 10 years.

There is no nearby supply station to Brantford TS having spare supply capacity to accommodate its load.

To address the EOL issues at Brantford TS, regional coordination is not required. The replacement/refurbishment plan for the EOL equipment will be developed by Hydro One and coordinated with the affected LDC and/or customers. The LV switchgear replacements/refurbishment work at Brantford TS is tentatively planned to be undertaken between the years 2022-23.

7.1.4 Norfolk TS

Norfolk TS is located in the Caledonia- Norfolk area. Norfolk TS is a single T1/T2 DESN station having a supply capacity of 97 MW and supplying about 60 MW of peak load that includes load displacement impact of about 41 MW of DGs. The Norfolk TS station capacity is forecasted to be sufficient over and beyond the study period.

The T1/T2 transformers at Norfolk TS were replaced in 2009. Norfolk TS LV switchgear is over 50 years old and based on its condition assessment has identified it as EOL requiring refurbishment. At this time none of the transformers and/or any other HV/LV equipment at this station has been identified as EOL over the next 10 years.

None of the nearby supply station/s to Norfolk TS has spare supply capacity to accommodate its loads.

To address the EOL issues at Norfolk TS, regional coordination is not required. The replacement/refurbishment plan for the EOL equipment will be developed by Hydro One and coordinated with the affected LDC and/or customers. The LV switchgear replacements/refurbishment work at Norfolk TS is tentatively planned to be undertaken between the years 2025-26.

7.1.5 Burlington TS (DESN)

Burlington TS is located in the city of Burlington in the Bronte Sub-Region. Burlington TS (DESN) is a single T15/T16 DESN station having a supply capacity of 185 MW and supplying peak load of 150 MW. The station loads are forecasted to grow up to 171 MW over the next 20 years and expected to be sufficient over and beyond the study period.

The T15/T16 transformers at Burlington TS are of 1991 built and have not been identified for replacement over the next 10 years. Burlington TS LV switchgear is over 40 years old and based on its condition assessment identified to be at its EOL requiring refurbishment. At this time none of the transformers and/or any other HV/LV equipment at Burlington TS (DESN) station has been identified as EOL over the next 5-10 years.

None of the nearby supply station/s to Burlington TS has spare supply capacity to accommodate its load.

To address the EOL issues at Burlington TS (DESN), regional coordination is not required. The replacement/ refurbishment plan for the EOL equipment will be developed by Hydro One and coordinated with the affected LDC and/or customers. The LV switchgear replacements/ refurbishment work at Burlington TS is tentatively planned to be undertaken between the years 2025-26.

7.1.6 Beach TS (DESN)

Beach TS (DESN) is located in the city of Hamilton in the Greater Hamilton Sub-Region. Beach TS (DESN) has two DESN units T3/T4 and T5/T6 having supply capacities of 75 MW and 91 MW and supplying peak loads of 32 MW and 41 MW respectively. Both the DESNs supply loads through four metalclad switchgears. The supply capacity of each Beach TS DESN is forecasted to be sufficient over and beyond the study period.

The 115/13.8 kV T3/T4 DESN transformers have been identified by Hydro One approaching end of their useful life and are being replaced. The existing 115 kV T3/T4 DESN with existing non-standard transformers will be reconfigured to a 230 kV DESN by replacing them with the smallest standard 230/13.8 kV units. The project is currently underway, and is expected to be completed in 2019.

The T5/T6 transformers at Beach TS are of 1979 built while the metalclad switchgear associated with T3/T4 and T5/T6 DESNs are of 1991 and early 1980's built respectively. The condition assessment has identified J1J2 and Q1Q2 LV metalclad switchgears associated with T5/T6 DESN at its EOL requiring refurbishment. At this time none of the T5/T6 transformers and/or any other HV/LV equipment at Beach TS (DESN) station has been identified as EOL over the next 5-10 years.

To maintain existing number of supply points from this station, the two Beach TS DESNs cannot be consolidated at this time. Hydro One's tentative plan is to replace T5/T6 metalclads with new ones having provision to accommodate all existing supply positions from this station in the years 2024-26. This will allow two existing DESNs to be consolidated in future at the time of refurbishment of T3/T4 metalclads or T5/T6 transformers.

To assess the consolidation and address the EOL issues at Beach TS DESN station, the Study Team recommends that the replacement/ refurbishment of assets at Beach TS to be further assessed as part of the Scoping Assessment.

7.2 EOL Transformers and HV Cables¹

The needs discussed in this section have station transformers and HV cables that have been identified by Hydro One to be reaching at end of useful life.

7.2.1 Newton TS

Newton TS is a 115 kV/ 13.8 kV single T1/T2 DESN station in the Greater Hamilton Sub-Region. This station has a supply capacity of 78 MW supplying peak load of about 50 MW. The station loads are forecasted to remain at the same level; however, the potential impact of Hamilton Light Rapid Transit being serviced from this station is not available at this time.

The T1/T2 transformers and the switchgear are of 1950's vintage. A condition assessment has identified that both transformers and switchgear at Newton TS at its EOL requiring refurbishment. The scope of refurbishment is yet to be finalized by the end of 2017.

Hydro One's tentative plan is to refurbish Newton TS with new and similar type of equipment built to current standards. This includes two new 75 MVA standard transformers replacing existing non-standard 67 MVA transformers and refurbishing the LV switchgear. This will address the needs at Newton TS and maintain station's operability along with reliability of supply. This refurbishment work at Newton TS is tentatively planned to be undertaken between the years 2021-22.

To address the EOL issues at Newton TS, the Study Team recommends that the replacement/refurbishment of assets at Newton TS to be further assessed as part of the Scoping Assessment.

7.2.2 Lake TS

Lake TS is located in the Greater Hamilton Sub-Region. Lake TS has two DESN units T1/T2 (230/ 27.6 kV) and T3/T4 (230/ 13.8 kV) supplying Alectra Utilities and Hydro One loads. The supply capacity of T1/T2 and T3/T4 DESNs is 113 MW and 94 MW respectively and each DESN supplies peak load of about 55 MW. The load at each of the Lake TS DESNs is forecasted to remain at the same level in the foreseeable future.

The T1/T2 transformers are of 1971 built while the associated switchgear components vintage range from 1950's to 1970's. Lake TS T3/T4 transformers and associated metalclad switchgear are of 1982 built. The condition assessment has identified T1/T2 transformers and both 27.6 kV and 13.8 kV LV switchgear at Lake TS at its EOL requiring refurbishment/ replacement. At this time, T3/T4 transformers and/or remaining equipment at this station has not been identified as EOL over the next 5-10 years. The scope of refurbishment at Lake TS is yet to be finalized by the end of 2017.

¹ The station where HV equipment requires replacements, the age and justification for EOL assets is provided in Appendix B

Hydro One's tentative plan is to replace existing 83 MVA T1/T2 (230/ 27.6 kV) transformers with similar units and refurbish both 27.6 kV and 13.8 kV LV switchgears replacing/ refurbishing with similar type of equipment built to current standards. This plan will address the needs at Lake TS and maintain station's operability along with reliability of supply. This refurbishment work at Lake TS is tentatively planned to be undertaken between the years 2022-24.

To address the EOL issues at Lake TS, the Study Team recommends that the replacement/ refurbishment of assets at Lake TS to be further assessed as part of the Scoping Assessment.

7.2.3 Caledonia TS

Caledonia TS is located in the Caledonia- Norfolk Sub-Region. Caledonia TS is a single T1/T2 DESN station having a supply capacity of 99 MW and supplying about 45 MW of peak load that includes load displacement impact of 22 MW of DGs. The loads at Caledonia TS are currently forecasted to stay at the same level in the foreseeable future and the station capacity to be sufficient over and beyond the study period.

The Caledonia TS T1/T2 transformers are of 1972 built and the switchgear is of the same vintage. The condition assessment has identified that both T1/T2 transformers are at their EOL requiring refurbishment. At this time none of other HV/LV equipment at this station has been identified as EOL over the next 5-10 years.

There is no nearby supply station to Caledonia TS where this station's loads can be transferred.

To address the EOL issues at Caledonia TS, regional coordination is not required. The Study Team recommends replacement of existing 83 MVA EOL 230/ 27.6 kV T1/T2 DESN transformers with similar units. The replacement/ refurbishment plan for the EOL equipment will be developed by Hydro One and coordinated with the affected LDC and/or customers. This transformer replacement need with similar units at Caledonia TS is tentatively planned to be undertaken between the years 2022-25.

7.2.4 Jarvis TS

Jarvis TS is located in the Caledonia- Norfolk Sub-Region. Jarvis TS is a single T3/T4 DESN station having a supply capacity of 99 MW and supplying about 65 MW of peak load that includes load displacement impact of about 5.5 MW of DGs. The loads at Jarvis TS are currently forecasted to stay at the same level in the foreseeable future and the station capacity to be sufficient over and beyond the study period.

The T3/T4 transformers are of 1972 built and the switchgear is of almost the same vintage. The condition assessment has identified that both T3/T4 transformers at its EOL requiring refurbishment. At this time none of other HV/LV equipment at this station has been identified as EOL over the next 5-10 years.

There is no nearby supply station to Jarvis TS where this station's loads can be transferred.

To address the EOL issues at Jarvis TS, regional coordination is not required. The existing 83 MVA EOL 230/ 27.6 kV T3/T4 DESN transformers are planned to be replaced with similar units. The replacement/ refurbishment plan for the EOL equipment will be developed by Hydro One and coordinated with the affected LDC and/or customers. This transformer replacement at Jarvis TS is tentatively planned to be undertaken in the years by 2022-25.

7.2.5 Beach TS (Bulk System Station)

Beach TS (Bulk System Station) is located in the city of Hamilton in the Greater Hamilton Sub-Region. Beach TS (Bulk System Station) is a major switching and autotransformer station in Hamilton area. Station facilities include a 230 kV switchyard, three 230/115 kV autotransformers (T1/T7/T8) and a 115 kV switchyard.

At Beach TS (Bulk System Station), the T1 autotransformer is of 1975 built while the T7/T8 autotransformers are of 1965 vintage. The condition assessment has identified T7/T8 autotransformers as EOL requiring replacement/ refurbishment. At this time T1 autotransformer has not been identified as EOL over the next 5-10 years.

Hydro One's tentative current plan is to replace EOL Beach TS T7/T8 autotransformers with similar units. This plan will address the needs at Beach TS and maintain station's operability and reliability of supply. This refurbishment work at Beach TS (Bulk System Station) is currently planned to be undertaken between the years 2023-26.

To address the EOL autotransformers at Beach TS, the Study Team recommends that the replacement/ refurbishment of autotransformers at Beach TS to be further assessed as part of Scoping Assessment to develop a preferred recommendation.

7.2.6 EOL 115 kV Cables

Underground cables in Hamilton area (listed below) are expected to be approaching EOL over the long term between the years 2027-32.

- 115 kV H5K/H6K Cable (Beach TS to Kenilworth TS)
- 115 kV K1G/K2G Cable (Kenilworth TS to Gage TS)
- 115 kV HL3/HL4 Cable (Newton TS to Elgin TS)
- 115 kV HL3/HL4 Cable (Elgin TS to Stirton TS)

All above circuits consist of 3 cables i.e. one cable for each of the 3 phases. One out of three phase cables of HL4 circuit from Elgin TS to Stirton TS was damaged about 20 years back. Since then, the HL4 circuit from Elgin TS to Stirton TS is out of service.

In light that replacement of the high voltage underground cables can be complicated, affect upstream transmission system and expensive. Alternative/s are required to be developed and assessed ahead of time. The options to address this issue will require to be further developed. No other lines or cables in the Burlington to Nanticoke region have been identified as EOL over the next 5-10 years for major replacement/ refurbishment at this time.

To address the need for cable replacement in Hamilton area, the Study Team recommends it to be further assessed and develop the scope as part of Scoping Assessment for IRRP and RIP to develop options and a preferred plan.

8 RECOMMENDATIONS

The Study Team recommendations are as follows:

- a) No further regional coordination is required to replace EOL LV switchgears at Birmingham TS, Dundas TS, Brantford TS, Norfolk TS, and Burlington TS and EOL transformers at Caledonia TS, and Jarvis TS with similar equipment as discussed in Section 7. The replacement and/or refurbishment of these assets should be further planned and coordinated by Hydro One with the relevant LDCs.
- b) For transformers and LV switchgears at Newton TS and Lake TS, and LV switchgears and auto-transformers at Beach TS further assessment should be undertaken to assess these needs. Scoping Assessment will determine for each of these needs if further regional coordination is required or not to develop a preferred plan. See table below.
- c) EOL HV cables H5K/H6K, K1G/K2G, and HL3/HL4 requires comprehensive review and should be further assessed as part of the scoping process. See table below.

No Regional Coordination Required	Further Assessment Required
<ul style="list-style-type: none"> • Birmingham TS: 2 LV Metalclad Switchgear • Dundas TS: T1/T2 DESN LV Switchgear • Brantford TS: LV Switchgear • Norfolk TS: LV Switchgear • Burlington TS: LV Switchgear • Caledonia TS: T1/T2 Transformers • Jarvis TS: T3/T4 Transformers 	<ul style="list-style-type: none"> • Beach TS: T5/T6 DESN LV Metalclad Switchgear • Newton TS: T1/T2 Transformers and LV Switchgear • Lake TS: T1/T2 Transformers and LV Switchgear • Beach TS: T7/T8 Auto-transformers • 115 kV Underground Cables: H5K/H6K, K1G/K2G, HL3/HL4

The SA Study Team will decide if a regional or sub-regional approach is required for the needs recommended to be assessed and scoped in Scoping Assessment. The Scoping Assessment is expected to be completed by the end of 2017.

9 REFERENCES

- [1] Burlington to Nanticoke Regional Infrastructure Plan. February 7, 2017.
http://www.hydroone.com/RegionalPlanning/Burlington/Documents/RIP%20Report_Burlington%20to%20Nanticoke.pdf
- [2] Hydro One, “Needs Screening Report, Burlington to Nanticoke Region”, 23 May 2014.
<http://www.hydroone.com/RegionalPlanning/Burlington/Documents/Needs%20Assessment%20Report%20-%20Burlington%20to%20Nanticoke%20Region.pdf>
- [3] Hydro One, “Local Planning Report – Burlington to Nanticoke Region”, 28 October 2015.
<http://www.hydroone.com/RegionalPlanning/Burlington/Documents/Local%20Planning%20Report%20-%20Burlington%20to%20Nanticoke%20Region.pdf>
- [4] Planning Process Study Team Report to the Board.
http://www.ontarioenergyboard.ca/OEB/_Documents/EB-2011-0043/PPWG_Regional_Planning_Report_to_the_Board_App.pdf

APPENDIX A: AREA STATIONS NON COINCIDENT NET LOAD FORECAST (MW)

Sub-Region	Station	LTR	2015*	2016	2017	2018	2019	2020	2021	2023	2025	2027	2029	2031	2033	2035	
Brant 115 kV	Brant TS	101	59	61	63	67	68	69	70	72	74	76	79	81	84	86	
	Powerline MTS	114	69	67	70	71	72	73	75	77	80	83	86	89	92	95	
	Total	215	128	128	134	138	140	143	145	149	154	159	165	170	175	181	
Brant 230 kV	Brantford TS	188	135	134	153	156	156	156	156	157	157	158	159	160	163	165	
	Total	188	135	134	153	156	156	156	156	157	157	158	159	160	163	165	
Bronte 115 kV	Bronte TS (T2)	75	59	60	62	63	64	65	66	67	68	68	68	68	69	70	
	Bronte TS (T5/T6)	96	70	71	72	74	75	76	77	79	80	80	80	80	81	82	
	Total	171	129	131	134	138	139	141	143	146	148	148	148	148	150	152	
Bronte 230 kV	Burlington (DESN) TS	185	151	153	154	154	155	156	157	159	160	163	165	168	170	171	
	Cumberland TS	174	123	122	122	122	123	124	124	126	127	129	131	133	135	136	
	Total	359	273	275	276	277	278	279	281	284	288	291	296	301	304	307	
Greater Hamilton 115 kV	Beach TS (T3/T4)	75	32	32	32	31	31	31	31	31	30	30	30	30	30	30	
	Birmingham TS (T1/T2)	76	32	31	31	31	31	30	30	30	30	30	30	29	30	30	
	Birmingham TS (T3/T4)	91	46	46	46	45	45	45	44	44	44	44	43	43	43	43	
	Dundas TS	99	85	91	93	93	93	84	84	84	84	85	85	85	86	87	
	Dundas TS #2	89	63	65	68	70	72	72	71	71	71	70	70	69	70	70	
	Elgin TS (T1/T2)	80	63	62	62	62	61	59	58	58	58	57	57	57	57	57	
	Elgin TS (T3/T4)	42	22	22	22	21	21	21	21	21	21	21	21	21	21	21	
	Gage TS (T3/T4)	60	22	22	22	21	21	21	21	21	21	21	21	21	20	21	21
	Gage TS (T5/T6)	57	11	11	11	11	11	11	11	10	10	10	10	10	10	10	
	Gage TS (T8/T9)	123	15	15	15	15	15	15	15	15	14	14	14	14	14	14	
	Kenilworth TS (T1/T4)	36	29	28	28	28	28	28	28	27	27	27	27	27	27	27	
	Kenilworth TS (T2/T3)	64	31	31	31	31	30	30	30	30	30	30	29	29	29	29	
	Mohawk TS	80	84	83	83	83	83	82	82	82	81	81	80	79	80	80	
	Newton TS	78	47	47	48	47	47	47	47	47	46	46	46	45	45	45	46
	Stirton TS	112	50	50	50	49	49	49	49	49	48	48	48	47	47	47	48
	Winona TS	89	46	48	51	51	50	50	50	49	49	49	49	49	48	48	49
Total CTS		59	59	60	60	61	61	61	61	61	61	61	61	61	61	61	
Total		736	745	752	750	749	735	732	729	726	723	719	715	719	723		
Greater Hamilton 230 kV	Beach TS (T5/T6)	91	41	44	43	43	47	47	47	46	46	46	46	45	45	46	
	Horning TS	102	71	73	76	76	76	75	75	75	74	74	73	73	73	73	
	Lake TS (T1/T2)	113	57	57	56	56	55	55	55	54	54	54	53	53	53	54	
	Lake TS (T3/T4)	94	55	54	54	55	55	54	54	54	54	53	53	53	53	53	
	Nebo TS (T1/T2)	178	119	113	116	119	123	123	124	127	129	131	133	136	140	144	
	Nebo TS (T3/T4)	51	50	49	50	51	51	50	50	50	49	49	49	49	49	49	
	Total CTS		265	265	265	265	244	244	244	244	244	244	244	244	244	244	
	Total		658	655	661	665	651	650	650	650	651	652	652	652	652	658	663
Caledonia Norfolk 115 kV	Norfolk TS	97	59	56	55	55	54	54	54	53	53	53	52	52	52	52	
	Bloomsburg DS	56	42	30	29	27	27	27	27	27	27	27	27	27	27	27	
	Total	153	101	87	85	82	82	81	81	80	80	80	79	78	79	80	
Caledonia Norfolk 230 kV	Caledonia TS	99	45	41	42	42	42	42	43	44	45	45	46	47	48	50	
	Jarvis TS	99	66	62	61	61	61	61	61	62	62	63	63	63	64	66	
	Total CTS		123	123	123	123	123	123	123	123	123	123	123	123	123	123	
	Total		233	226	226	226	226	226	227	228	230	231	232	233	235	238	
Regional Total			2394	2379	2419	2432	2421	2411	2415	2425	2434	2442	2450	2458	2483	2509	

* 2015 are actual loads. All other loads i.e. from 2016-2035 are forecasted loads.

APPENDIX B: HV EQUIPMENT REPLACEMENT

No.	Station	Equipment	Year Built	Reason for EOL
1.	Newton TS	T1/T2 Transformers	1956	Deteriorated asset condition and performance.
		LV Switchgear	1950-1970	Deteriorated asset condition, maintainability, and obsolescence.
2.	Lake TS	T1/T2 Transformers	1971	Deteriorated asset condition and performance.
		LV Switchgears	1950-1982	Deteriorated asset condition, maintainability, and obsolescence.
3.	Caledonia TS	T1/T2 Transformers	1972	Deteriorated asset condition and performance.
4.	Jarvis TS	T3/T4 Transformers	1972	Deteriorated asset condition and performance.
5.	Beach TS	T7/T8 Autotransformers	1965	Deteriorated asset condition and performance.
6.	115 kV Cables	H5K/ H6K	1973	-*
		K1G/ K2G	1973	-*
		HL3/ HL4 (Newton TS to Elgin TS)	1975	-*
		HL3/ HL4** (Elgin TS to Stirton TS)	1968	-*

* Further assessment required.

** HL4 is out-of-service.

APPENDIX C: LIST OF 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
TS	Transformer Station
TSC	Transmission System Code
UFLS	Under Frequency Load Shedding
ULTC	Under Load Tap Changer
UVLS	Under Voltage Load Rejection Scheme