Burlington to Nanticoke

REGIONAL INFRASTRUCTURE PLAN

February 7, 2017

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Prepared and supported by:

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

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Disclaimer

This Regional Infrastructure Plan ("RIP") report was prepared for the purpose of developing an electricity infrastructure plan to address all near and mid-term needs (2015-2025) identified in previous planning phases and any additional needs identified based on new and/or updated information provided by the RIP Working Group.

The preferred solution(s) that have been identified in this report may be reevaluated based on the findings of further analysis. The load forecast and results reported in this RIP report are based on the information provided and assumptions made by the participants of the RIP Working Group.

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EXECUTIVE SUMMARY

THIS REGIONAL INFRASTRUCTURE PLAN ("RIP") WAS PREPARED BY HYDRO ONE WITH PARTICIPATION AND INPUT FROM THE RIP WORKING GROUP IN ACCORDANCE WITH THE ONTARIO TRANSMISSION SYSTEM CODE REQUIREMENTS. IT IDENTIFIES INVESTMENTS IN TRANSMISSION FACILITIES, DISTRIBUTION FACILITIES, OR BOTH, THAT SHOULD BE PLANNED, DEVELOPED AND IMPLEMENTED TO MEET THE ELECTRICITY INFRASTRUCTURE NEEDS WITHIN THE BURLINGTON TO NANTICOKE REGION.

The participants of the RIP Working Group included members from the following organizations:

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

In general, the RIP is the final phase of the regional planning process and, in this case, it follows the completion of the Integrated Regional Resource Plans ("IRRP") for Brant Sub-Region and Bronte Sub-Region in March 2015 and June 2016, respectively, and the Burlington to Nanticoke Region's Needs Assessment ("NA") in May 2014. This RIP provides a consolidated summary of the needs and recommended plans for the Burlington to Nanticoke Region for the near-term (up to 5 years) and the mid-term (5 to 10 years).

It should be noted that this RIP, in addition to advancing the work from the aforementioned IRRPs, also identifies additional needs related to sustainment and end-of-life facilities in the Hamilton area. Built over 50 years ago, the transmission assets in the Hamilton area are some of the oldest installations in the province. At the time of the Burlington to Nanticoke Need Assessment and Scoping Assessment phases, done in 2014, the detailed information on the condition and end-of-life issues related to these assets was not available. As such, a decision was made by the Working Group at that time to not initiate a coordinated planning exercise for the Hamilton subsystem. Since then, through the RIP process, the extent and urgency of the sustainment work in the Hamilton area, and also in Oakville and Brantford, are better known to the Working Group.

This RIP discusses those needs and the projects developed to address those needs. Implementation to address some of these needs is underway. The plans presented in this RIP to address new end-of-life needs have been developed by Hydro One and needs also confirmed by the LDC. Further details are being formalized by Hydro One through assessment and consultation with the LDC to develop implementation plans. The plans for Beach TS, Birmingham TS, Gage TS and Kenilworth TS were later also reviewed by the IESO as part of an ongoing study for the Hamilton area. However, new near and mid-term needs namely Horning TS, Elgin TS, and Bronte TS were not fully identified earlier in the regional planning process and did not undergo a review by the IESO in the earlier phases due to their scope or project status.

The RIP report also identifies long-term needs associated with the revised and better defined sustainment plan.

The needs and/or plans in the near-term (2016-2020) and the mid- to long-term (beyond 2020) are provided below in Table 1 and Table 2, respectively, along with their planned in-service date and estimated cost, where applicable. Table 1 identifies both the stakeholders involved in each project's development and which formal regional planning process it originated from. The table also indicates the needs identified after the completion of the NA and SA (Scoping Assessment) processes.

Table 1: Near-Term Needs/Plans in Burlington to Nanticoke Region

No.	Needs	Plans	Status	I/S Date	Cost ($M)
Projects Developed in Local Planning or an IRRP					
1	115 kV B7/B8 Transmission Line Capacity	Bronte TS: Load Transfer	Planning	2018	1-3
2	115 kV B12/B13 Transmission Line Capacity	Install Brant Switching Station	Planning	2019	12
3	Two New Feeders at Dundas TS #2	Dundas TS: Load Transfer	Planning	2019	8
4	Cumberland TS – Power Factor Correction	LDC is developing distribution option	Planning	TBD (1)	-
5	Kenilworth TS – Power Factor Correction	LDC is developing distribution option	Planning	TBD (1)	-
Projects Developed by HONI & the LDC(s), Reviewed by IESO					
6	Kenilworth TS EOL transformers & switchgear (2)	Reconfigure from 2 DESNs to single DESN	Planning	2018	19
7	Beach TS – EOL T3/T4 DESN Transformers (2)	Replace Beach TS T3/T4 Transformers	Committed	2019	17
8	Gage TS – EOL transformers & switchgear	Gage TS: Reduce from 3 DESNs to 2 DESNs	Planning	2019	37
9	115 kV B7/B8 – EOL Line Section from Burlington TS to Nelson Jct.(2)	Refurbish the EOL B7/B8 line section	Planning	2020	2
Projects Developed by HONI & the LDC(s)					
10	115 kV B3/B4 – EOL Line Section from Horning Mountain Jct. to Glanford Jct.(2)	Refurbish the EOL B3/B4 line section conductor	Planning	2018	8
11	Horning TS EOL transformers & switchgears (2)	Replace EOL transformers & refurbish switchgears	Committed	2018	37
12	Bronte TS – EOL T5/T6 DESN (2)	Replace EOL transformers & refurbish switchgear	Committed	2019	34

No.	Needs	Plans	Status	I/S Date	Cost ($M)
13	Elgin TS – EOL transformers & switchgears	Replace transformers and switchgears and reduce 2 DESNs to 1 DESN	Committed	2019	58
14	Mohawk TS (T1/T2) – Station Capacity and EOL T1/T2 Transformers	Mohawk TS Transformers Replacement	Committed	2019	14

(1) To Be Decided
(2) New needs identified by HONI

Table 2: Mid- and Long-Term Needs/Plans in Burlington to Nanticoke Region

No.	Needs/Plans	Planned I/S Date	Cost ($M)
1	Birmingham TS: 2 Metal Clad Switchgear Refurbishment (1)	2021	14
2	Dundas TS: T1/T2 switchyard refurbishment	2021	10
3	Newton TS: Station Refurbishment	2021	36
4	LV Switchgear Refurbishment at Brantford TS, Lake TS and Stirton TS	2022	46
5	Beach TS: Replace EOL T7/T8 Autotransformers and refurbish T5/T6 DESN switchgear	2025	60
6	EOL 115 kV Cables: - H5K/ H6K - K1G/ K2G - HL3/ HL4	TBD (2)	TBD (2)

(1) Preliminarily reviewed by HONI, LDC and the IESO
(2) To Be Decided

Further details of needs, alternatives, and recommended plans for the above needs are provided in Section 7. The preliminary plans and needs identified in Table 2 will be further assessed in the next planning cycle. A summary of the current recommendations for these mid- and long-term needs is provided in Section 8.

The RIP Working Group recommends the following outcomes and next steps:

a) Hydro One will continue to implement the committed and near-term projects for addressing the above needs as discussed in this report, while keeping the Working Group apprised of project status, and

b) The RIP recommends that an expedited Needs Assessment report should be developed to list these already identified needs in the mid and long term or any new needs to be followed by Scoping Assessment, led by the IESO for further assessment under the Burlington to Nanticoke regional planning Working Group.

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1. INTRODUCTION

THIS REPORT PRESENTS THE REGIONAL INFRASTRUCTURE PLAN (“RIP”) TO ADDRESS THE ELECTRICITY NEEDS OF THE BURLINGTON TO NANTICOKE REGION.

The report was prepared by Hydro One Networks Inc. (“Hydro One”) and documents the results of the needs, assessments and recommended plan. The members of the RIP WG included representative from Brantford Power Inc. (“Brantford Power”), Burlington Hydro Inc. (“Burlington Hydro”), Energy + Inc. (“Energy +”), Alectra Utilities Corporation (former Horizon Utilities Inc. “Alectra Utilities”), Hydro One Distribution, the Independent Electricity System Operator (“IESO”) and Oakville Hydro Electricity Distribution Inc. (“Oakville Hydro”) in accordance with the Regional Planning process established by the Ontario Energy Board (“OEB”) in 2013.

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 summer 2015 load of the Region was about 1831 MW. The boundaries of the Region are shown in Figure 1-1 below.

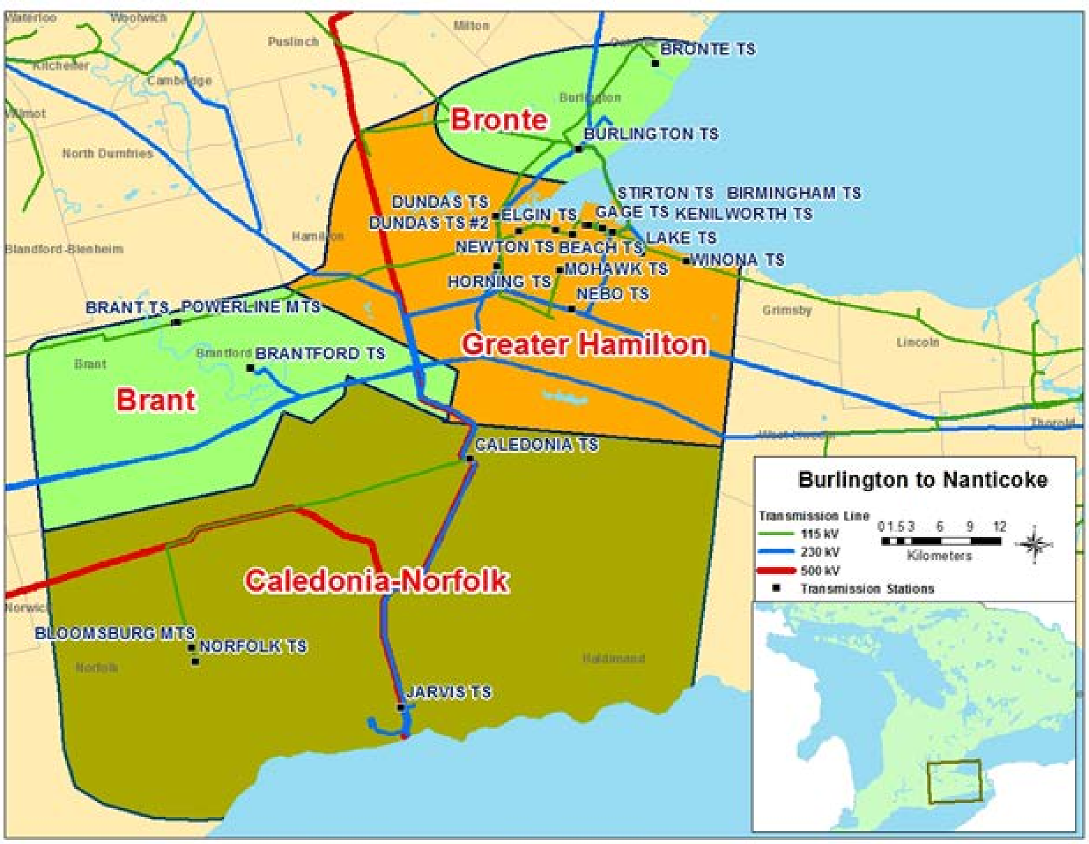

Figure 1-1 Burlington to Nanticoke Region

1.1 Objective and Scope

The RIP report examines the needs in the Burlington to Nanticoke Region. Its objectives are to:

- Provide a comprehensive summary of needs and wires plans to address the needs;
- Identify any new needs that may have emerged since previous planning phases e.g., Needs Assessment ("NA") and/or Integrated Regional Resource Plan("IRRP");
- Assess and develop a wires plan to address these new needs; and
- Identify investments in transmission and distribution facilities or both that should be developed and implemented on a coordinated basis to meet the electricity infrastructure needs within the region.

The RIP reviewed factors such as the load forecast, major high voltage sustainment issues emerging over the mid- and long-term, transmission and distribution system capability along with any updates with respect to local plans, conservation and demand management ("CDM"), renewable and non-renewable generation development, and other electricity system and local drivers that may impact the need and alternatives under consideration.

The scope of this RIP is as follows:

- A consolidated summary of the wires plan developed during LP (Local Planning), SA (Scoping Assessment), and/or as identified in IRRP.
- Discussion of any other major transmission infrastructure investment plans over the near and mid-term (0-10 years)
- Identification of any new needs and a wires plan to address these needs based on new and/or updated information.

1.2 Structure

The rest of the report is organized as follows:

- Section 2 provides an overview of the regional planning process.
- Section 3 describes the regional characteristics.
- Section 4 describes the transmission work completed over the last ten years.
- Section 5 describes the load forecast and study assumptions used in this assessment.
- Section 6 describes the results of the adequacy assessment of the transmission facilities and identifies needs.
- Section 7 discusses the needs and provides the alternatives and preferred solutions.
- Section 8 provides the conclusion and next steps.

2. REGIONAL PLANNING PROCESS

2.1 Overview

Planning for the electricity system in Ontario is done at essentially three levels: bulk system planning, regional system planning, and distribution system planning. These levels differ in the facilities that are considered and the scope of impact on the electricity system. Planning at the bulk system level typically looks at issues that impact the system on a provincial level, while planning at the regional and distribution levels looks at issues on a more regional or localized level.

Regional planning looks at supply and reliability issues at a regional or local area level. Therefore, it largely considers the 115 kV and 230 kV portions of the power system that supply various parts of the province.

2.2 Regional Planning Process

A structured regional planning process was established by the Ontario Energy Board ("OEB") in 2013 through amendments to the Transmission System Code ("TSC") and Distribution System Code ("DSC"). The process consists of four phases: the Needs Assessment [1] ("NA"), the Scoping Assessment ("SA"), the Integrated Regional Resource Plan ("IRRP"), and the Regional Infrastructure Plan ("RIP").

The regional planning process begins with the NA phase, which is led by the transmitter to determine if there are regional needs. The NA phase identifies the needs and the Working Group determines whether further regional coordination is necessary to address them. If no further regional coordination is required, further planning is undertaken by the transmitter and the impacted local distribution company ("LDC") or customer and develops a Local Plan ("LP") to address them. These needs are local in nature and can be best addressed by a straight forward wires solution.

In situations where identified needs require coordination at the regional or sub-regional levels, the IESO initiates the SA phase. During this phase, the IESO, in collaboration with the transmitter and impacted LDCs, reviews the information collected as part of the NA phase, along with additional information on potential non-wires alternatives, and makes a decision on the most appropriate regional planning approach. The approach is either a RIP, which is led by the transmitter, or an IRRP, which is led by the IESO. If more than one sub-region was identified in the NA phase, it is possible that a different approach could be taken for different sub-regions.

The IRRP phase will generally assess infrastructure (wires) versus resource (CDM and Distributed Generation) options at a higher or more macro level, but sufficient to permit a comparison of options. If the IRRP phase identifies that infrastructure options may be most appropriate to meet a need, the RIP phase will conduct detailed planning to identify and assess the specific wires alternatives and recommend

[1] Also referred to as Needs Screening

a preferred wires solution. Similarly, resource options that the IRRP identifies as best suited to meet a need are then further planned in greater detail by the IESO. The IRRP phase also includes IESO led stakeholder engagement with municipalities and establishes a Local Advisory Committee in the region or sub-region. The Brant Sub-Region IESO led IRRP was initiated prior to the new regional planning process and was completed in March 2015. The need for Bronte Sub-Region IRRP was identified during the Need Assessment for Burlington to Nanticoke region and was completed in June 2016.

The RIP phase is the fourth and final phase of the regional planning process and involves: discussion of previously identified needs and plans; identification of any new needs that may have emerged since the start of the planning cycle; and development of a wires plan to address the needs where a wires solution would be the best overall approach. This phase is led and coordinated by the transmitter and the deliverable is a comprehensive report of a wires plan for the region. Once completed, this report is also referenced in transmitter's rate filing submissions and as part of LDC rate applications with a planning status letter provided by the transmitter.

To efficiently manage the regional planning process, Hydro One has been undertaking wires planning activities in collaboration with the IESO and/or LDCs for the region as part of and/or in parallel with:

- Planning activities that were already underway in the region prior to the new regional planning process taking effect.
- The NA, SA, and LP phases of regional planning.
- Participating in and conducting wires planning as part of the IRRP for the region or sub-region.
- Working and planning for connection capacity requirements with the LDCs and transmission connected customers

Figure 2-1 illustrates the various phases of the regional planning process (NA, SA, IRRP, and RIP) and their respective phase trigger, lead, and outcome.

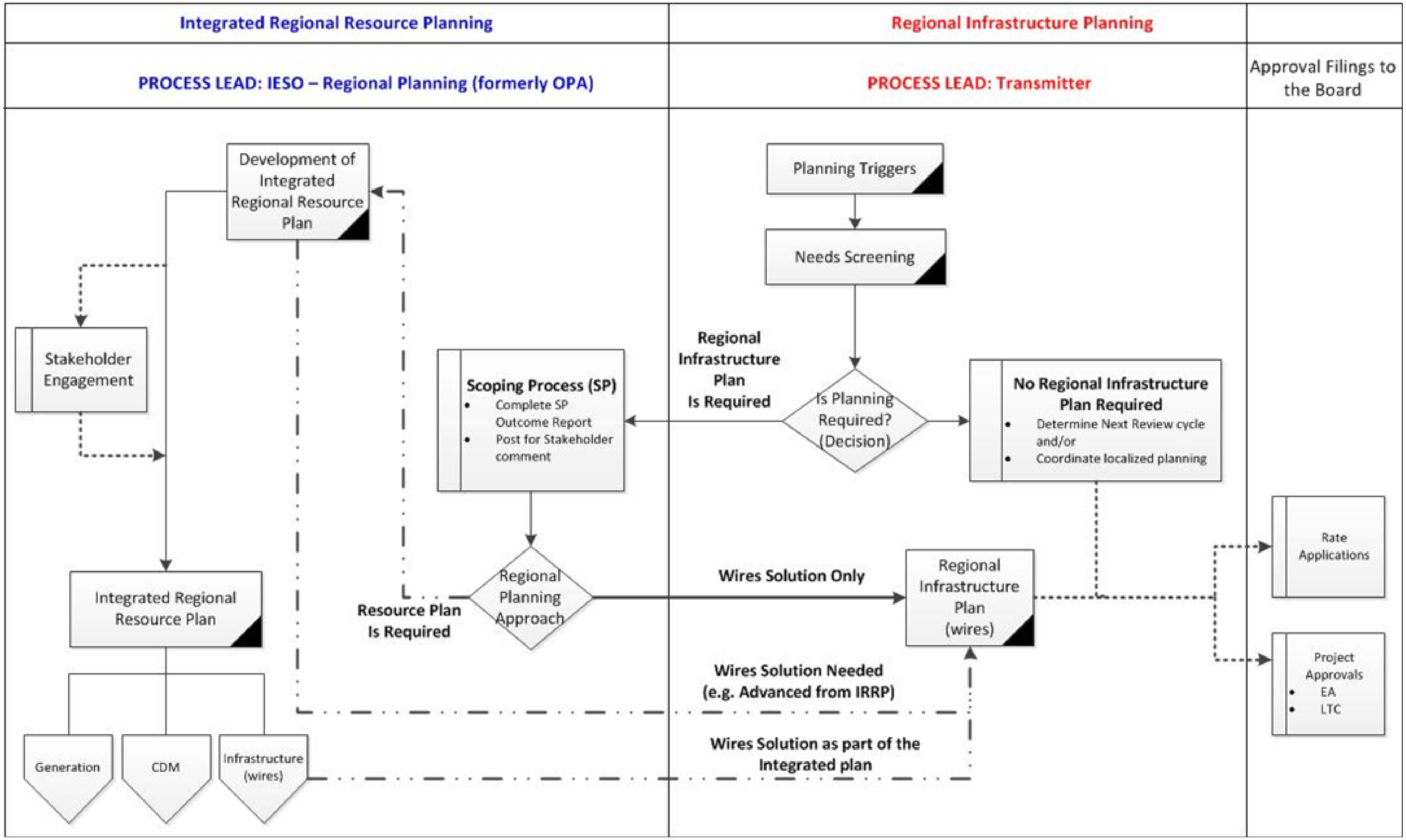

Figure 2-1 Regional Planning Process Flowchart

2.3 RIP Methodology

The RIP phase consists of a four step process (see Figure 2-2) as follows:

1. Data Gathering: The first step of the process is the review of planning assessment data collected in the previous phase of the regional planning process. Hydro One collects this information and reviews it with the Working Group to reconfirm or update the information as required. The data collected includes:
   - Net peak demand forecast at the transformer station level. This includes the effect of any distributed generation or conservation and demand management programs.
   - Existing area network and capabilities including any bulk system power flow assumptions.
   - Other data and assumptions as applicable such as asset conditions; load transfer capabilities, and previously committed transmission and distribution system plans.
2. Technical Assessment: The second step is a technical assessment to review the adequacy of the regional system including any previously identified needs. Depending upon the changes to load forecast or other relevant information, regional technical assessment may or may not be required or be limited to specific issue only. Additional near and mid-term needs may be identified in this phase.
3. Alternative Development: The third step is the development of wires options to address the needs and to come up with a preferred alternative based on an assessment of technical considerations, feasibility, environmental impact and costs.
4. Implementation Plan: The fourth and last step is the development of the implementation plan for the preferred alternative.

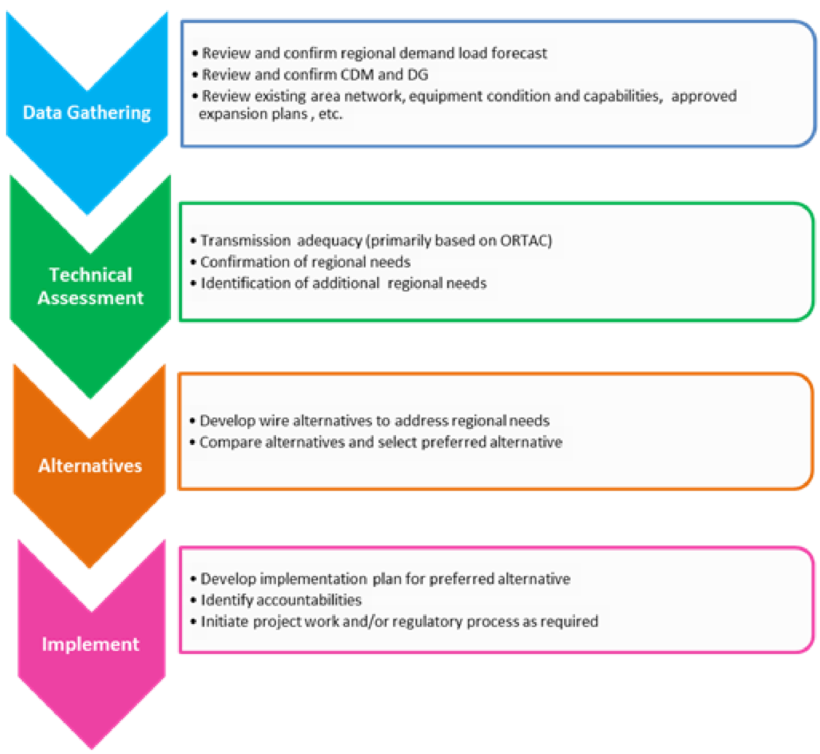

Figure 2-2 RIP Methodology

3. REGIONAL CHARACTERISTICS

THE BURLINGTON TO NANTICOKE REGION COVERS THE CITY OF BRANTFORD, MUNICIPALITY OF HAMILTON, COUNTIES OF BRANT, HALDIMAND AND NORFOLK. SOME OF THE ELECTRICAL INFRASTRUCTURE IN THE REGION IS ONE OF THE OLDEST INSTALLATIONS IN THE PROVINCE. 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.

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. The area has been divided into four sub-regions as shown in Figure 1-1 and described below:

- The Brant Sub-Region encompasses the County of Brant, City of Brantford and surrounding areas. Electricity supply to the sub-region is provided by:

  - Brant TS and Powerline MTS supplied by 115 kV double circuit line B12/B13.
  - Brantford TS supplied by the 230 kV double circuit transmission line M32W/M33W.

  The Brant Sub-Region transmission facilities are shown in Figure 3-1.

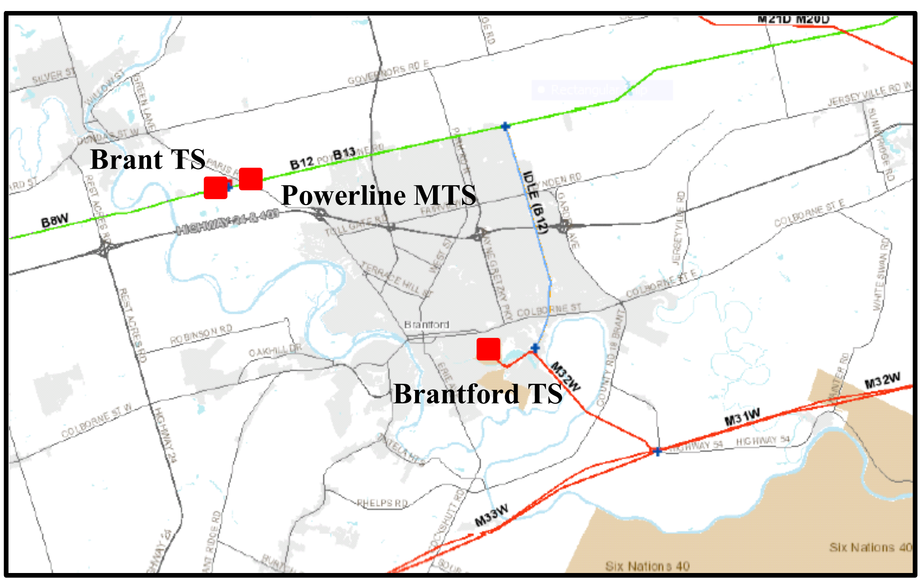

Figure 3-1 Brant Sub-Region

The total peak demand of the three stations was about 263 MW in 2015. Energy + Inc. and Brantford Power Inc. are the main LDCs that serve the electricity demand for the City of Brantford. Hydro One Distribution supplies load in the outlying areas of the sub-region. The electricity demand is comprised of residential, commercial and industrial customers.

- The Bronte Sub-Region covers the City of Burlington and the western part of the City of Oakville up to Third Line. Electricity supply to the sub-region is provided by:

  - Bronte TS supplied by 115 kV double circuit line B7/B8.
  - Burlington TS supplied by 230 kV double circuit line Q23BM/ Q25BM.
  - Cumberland TS supplied from 230 kV double circuit transmission line B40C/B41C.

  The Bronte Sub-Region transmission facilities are shown in Figure 3-2.

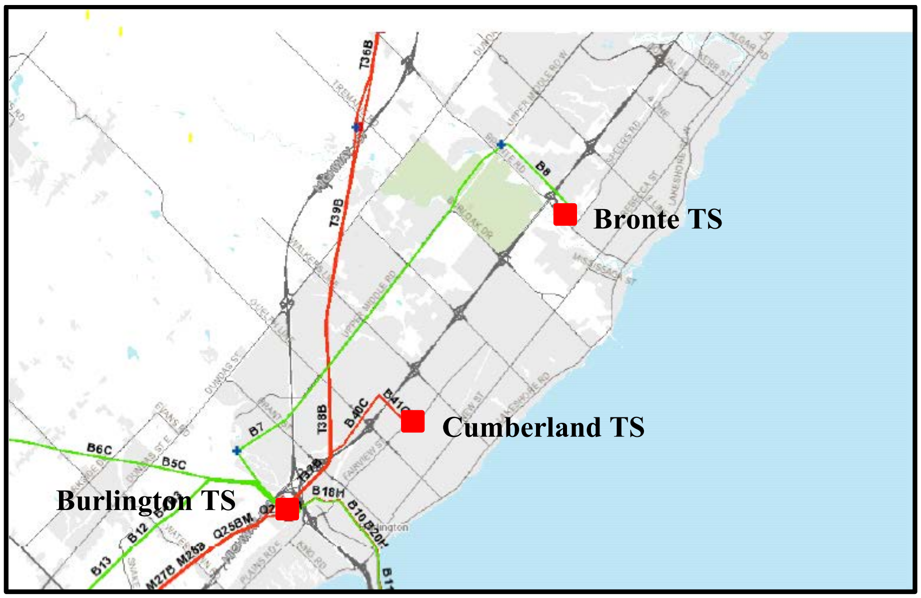

Figure 3-2 Bronte Sub-Region

The area is served by Burlington Hydro and Oakville Hydro. The electricity demand is comprised of residential, commercial and industrial customers. The total peak station demand of the three stations was about 402 MW in 2015.

- The Greater Hamilton Sub-Region encompasses the City of Hamilton that includes Townships of Flamborough and Glanbrook and towns of Dundas and Stoney Creek. Some of the electrical infrastructure in the sub-region was built over 50 years ago and is one of the oldest installations in the province. Electricity supply to the sub-region is grouped as follows:

  - Beach TS 115 kV area which includes five 115 kV step down stations Beach TS T3/T4 DESN, Birmingham TS, Kenilworth TS, Stirton TS, Winona TS and a CTS supplied from the 230/115 kV autotransformers at Beach TS.

- Burlington TS 115 kV area which includes Dundas TS, Dundas #2, Elgin TS, Gage TS, Mohawk TS, Newton TS and one customer owned CTS supplied from the 230/115 kV autotransformers at Burlington TS.

- 230 kV area which includes Beach TS T5/T6 DESN, Horning TS, Nebo TS, Lake TS and two customer owned stations supplied from 230 kV circuits connecting into Beach TS and Burlington TS.

The Greater Hamilton Sub-Region transmission facilities are shown in Figure 3-3.

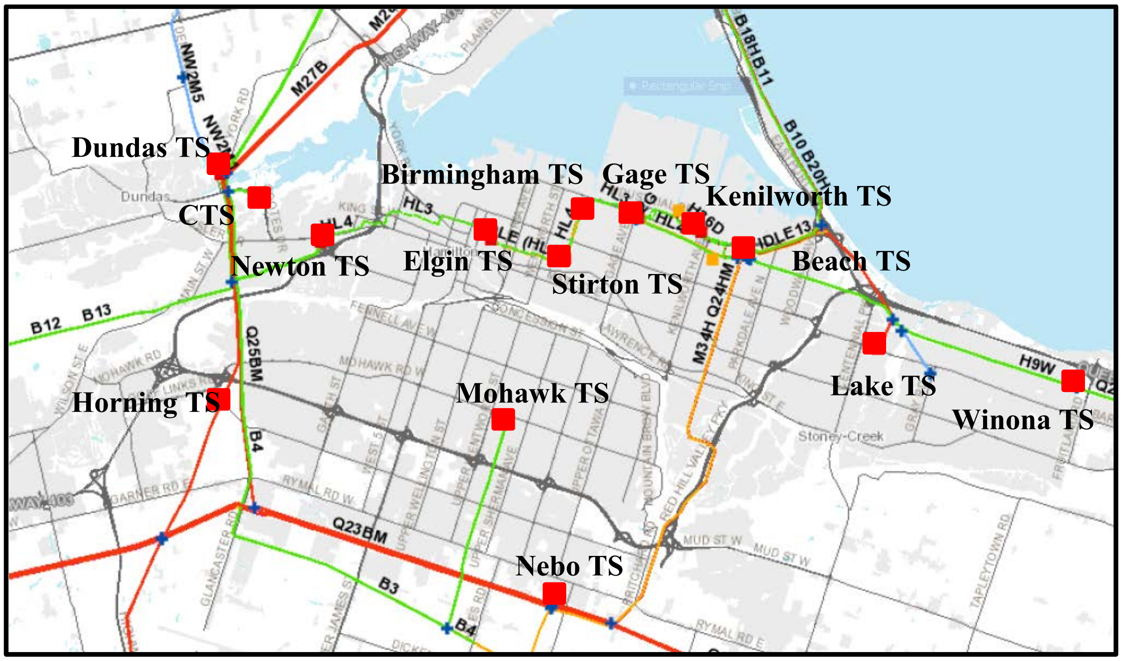

Figure 3-3 Greater Hamilton Sub-Region

The total peak station demand of the Greater Hamilton Sub-Region was about 1394 MW in 2015. The area is served by Alectra Utilities, Hydro One Distribution and CTSs comprises a significant number of large industrial customers along with commercial and residential customers.

- The Caledonia Norfolk Sub-Region covers the eastern part of Norfolk County and the western part of Haldimand County. Electricity supply to the Sub-region is provided by:

- Caledonia TS supplied by 230 kV double circuit line N5M/S39M.
- Jarvis TS supplied from the 230 kV double circuit line N21J/N22J.
- Bloomsburg DS and Norfolk TS supplied from 115 kV double circuit transmission line C9/C12.

The Caledonia Norfolk Sub-Region transmission facilities are shown in Figure 3-4.

The area is served by Hydro One Distribution. The electricity demand mix is comprised of residential, commercial and industrial uses. The peak demand of the stations in the Sub-Region was approximately 334 MW in 2015.

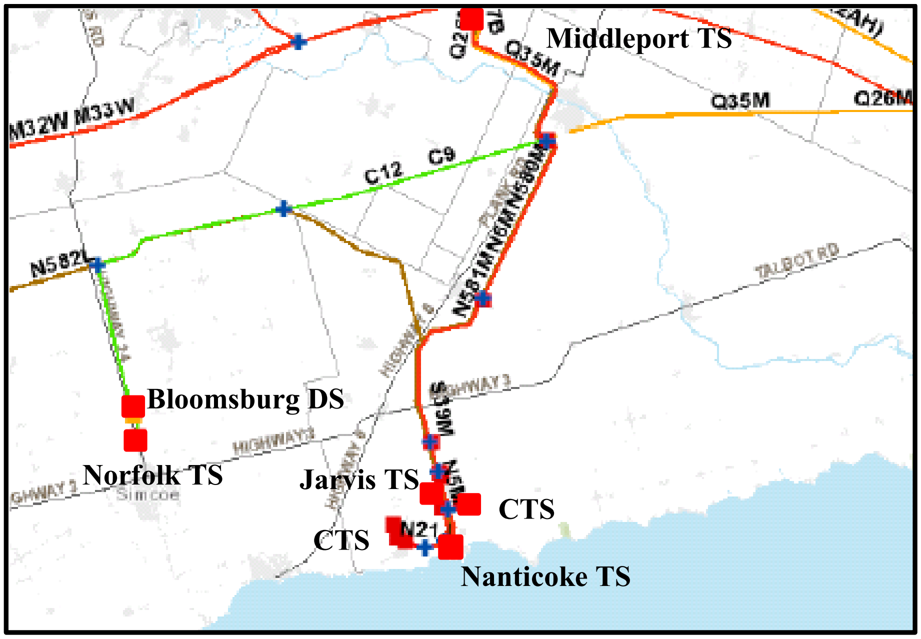

Figure 3-4 Caledonia Norfolk Sub-Region

Electrical single line diagrams for the Burlington to Nanticoke Region 500 kV/ 220 kV facilities and 115 kV facilities are shown below in Figure 3-5 and Figure 3-6.

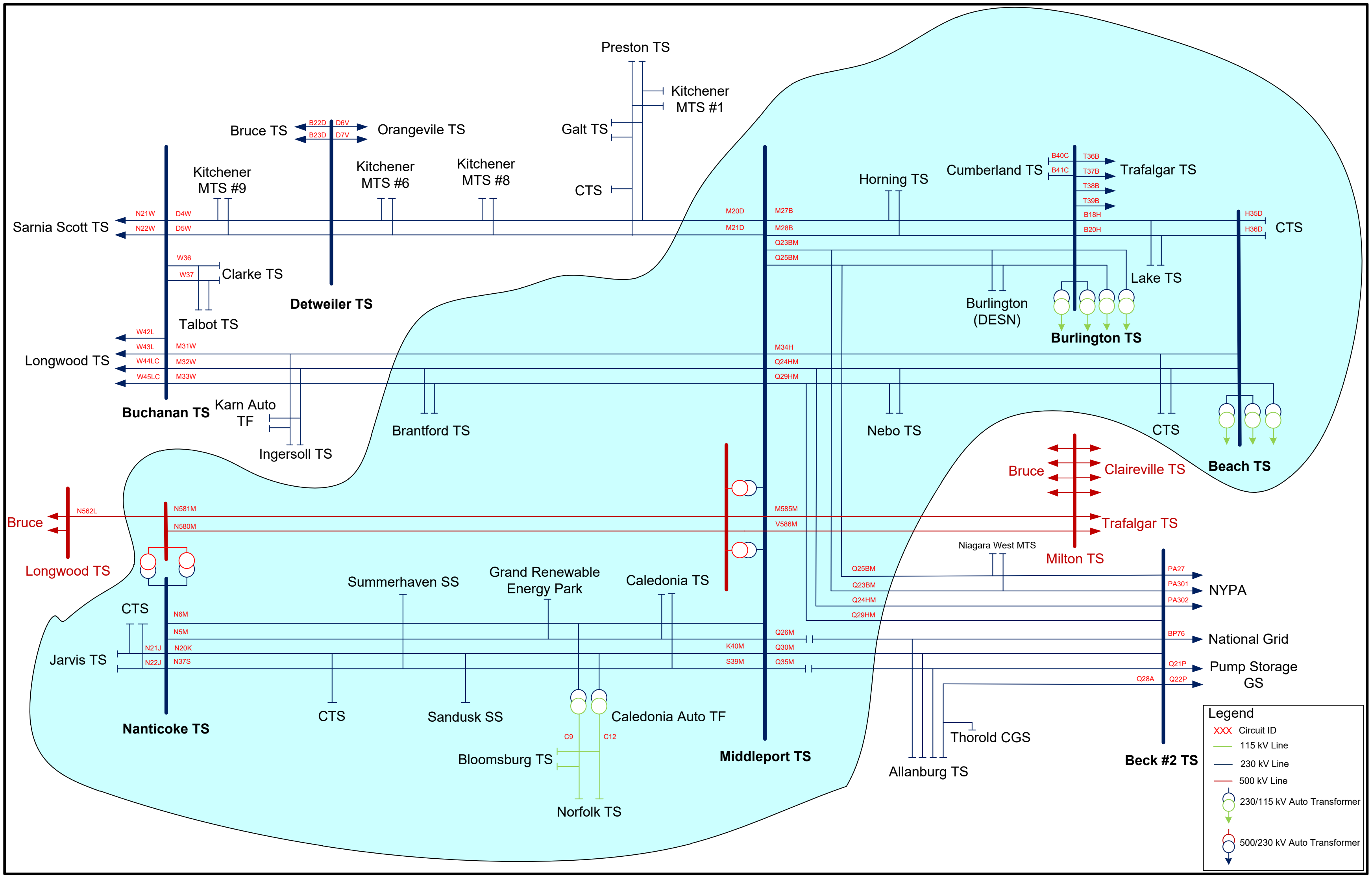

Figure 3-5 Burlington to Nanticoke Region 500 & 230 kV and Caledonia-Norfolk 115 kV Network

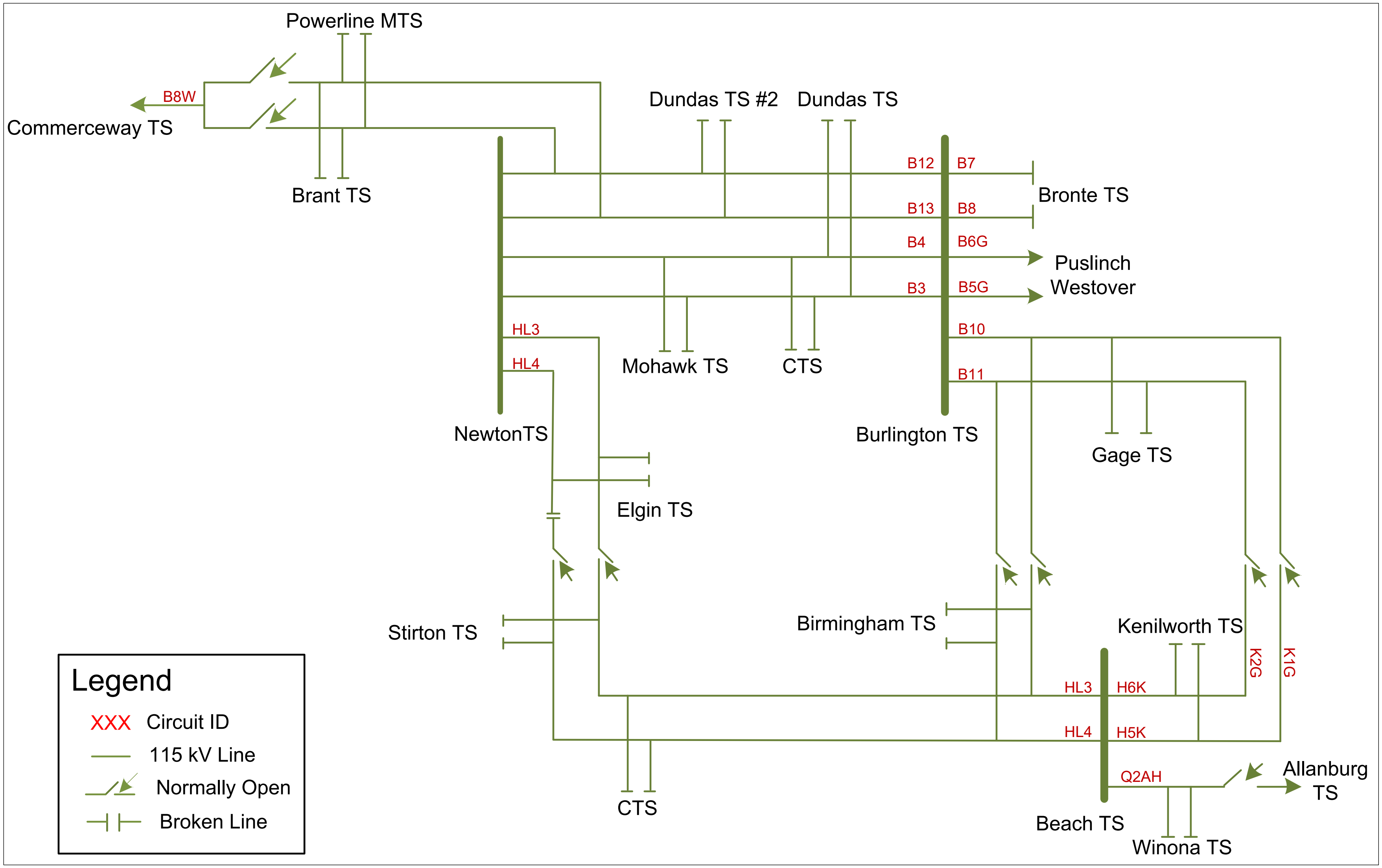

Figure 3-6 115 kV Network Supplied by Burlington TS and Beach TS

4. TRANSMISSION FACILITIES COMPLETED OVER LAST TEN YEARS

OVER THE LAST 10 YEARS A NUMBER OF TRANSMISSION PROJECTS HAVE BEEN PLANNED AND COMPLETED BY HYDRO ONE, IN CONSULTATION WITH THE LDCs AND/OR THE IESO, AIMED TO MAINTAIN OR IMPROVE THE RELIABILITY AND ADEQUACY OF SUPPLY IN THE BURLINGTON TO NANTICOKE REGION.

A brief listing of some of the major projects completed over the last ten years are as follows:

- Bronte TS (2008) - added a new low voltage breaker between T5/T6 DESN and T2 DESN units at Bronte TS.
- Burlington TS (2009) - replaced 230 kV/115 kV autotransformer T6 following failure.
- 2nd 115 kV Supply to Norfolk TS and Bloomsburg DS (2009) – Built 12 km of new 115 kV circuit to provide 2nd supply to Norfolk TS and Bloomsburg DS.
- Jarvis TS (2011) and Caledonia TS (2012) – installed LV reactors to reduce short circuit levels below the TSC limits and to allow increased generation connection capability at these stations.
- Nebo TS (2013) – replaced T1/T2 230 kV/ 27.6 kV transformers with larger size standard units and added six new breaker positions to meet customer needs.
- Burlington TS (2016) – installed an additional 230 kV circuit breaker to reduce probability of the simultaneous loss of two autotransformers at this station improving supply reliability to the stations supplied from 115 kV Burlington TS bus.
- Transformer replacement at stations: Bronte TS (2006), Norfolk TS (2009), Birmingham TS (2010), Cumberland TS (2012), Brantford TS (2013), Kenilworth TS (2014), Dundas TS (2015) and Brant TS (2016).
- Feeder Positions – added four new breaker positions at Horning TS (2006) and two new feeder breaker positions at Bronte TS (2008) to meet the customer needs.

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5. FORECAST AND OTHER STUDY ASSUMPTIONS

5.1 Load Forecast

The load in the Burlington to Nanticoke Region is growing at a slow rate with a decline of industrial loads in the region. Currently, load is forecast to increase at an average annual rate of approximately 0.24% up to 2035. The growth rate varies across the Region – with the highest growth rate of 1.37% in the Brant Sub Region.

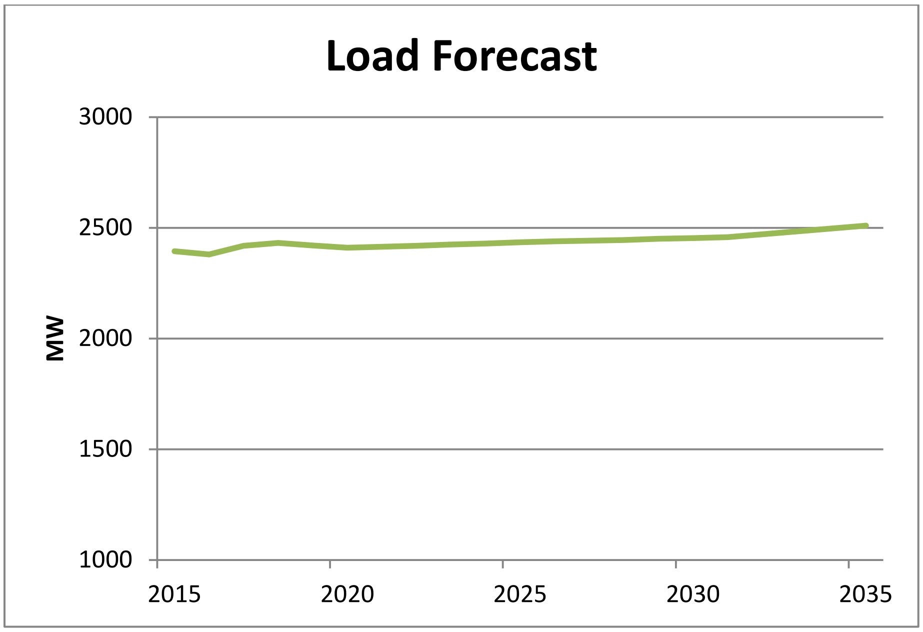

Figure 5-1 Burlington to Nanticoke Region Summer Extreme Weather Peak Forecast

Figure 5-1 shows the Burlington to Nanticoke Region peak summer non-coincident load forecast. This forecast is based on the 2015 extreme weather corrected loads. The non-coincident forecast represents the sum of the individual station's peak load and is used to determine the need for stations and line capacity. Regional non-coincident load forecast for the individual stations in the Burlington to Nanticoke Region is given in Appendix D.

The RIP load forecast was developed as follows:

- Load forecast for stations in the Bronte Sub region was taken from the IESO Bronte Sub- Region IRRP completed on June 30, 2016.
- Load forecast for Brant TS and Powerline MTS in the Brant Sub-Region was prepared by input and discussions with the LDCs recently (2016) as part of detailed planning for Brant switching station.
- Load forecast for the remaining stations was developed using the summer 2015 actual peak load adjusted for extreme weather and applying the station net growth rates provided by the LDCs. The net station loads account for CDM measures and connected DG in the region.

5.2 Other Study Assumptions

The following other assumptions are made in this report.

- The study period for the RIP assessments is 2015-2025.
- All planned facilities listed in Section 4 are assumed to be in-service.
- Where applicable, future industrial loads have been reduced based on historical information.
- Summer is the critical period with respect to line and transformer loadings. The assessment is therefore based on summer peak loads.
- Station capacity adequacy is assessed by comparing the non-coincident peak load with the station's normal planning supply capacity, assuming a 90% lagging power factor for stations having no low-voltage capacitor banks and 95% lagging power factor for stations having low-voltage capacitor banks.
- Normal planning supply capacity for transformer stations in this sub-region is determined by the Hydro One summer 10-Day Limited Time Rating (LTR).
- Adequacy assessment is conducted as per Ontario Resource Transmission Assessment Criteria (ORTAC).

6. ADEQUACY OF FACILITIES

THIS SECTION REVIEWS THE ADEQUACY OF THE EXISTING TRANSMISSION AND DELIVERY STATION FACILITIES SUPPLYING THE BURLINGTON TO NANTICOKE REGION OVER THE 2015-2025 PERIOD.

Within the current regional planning cycle three regional assessments have been conducted for the Burlington to Nanticoke Region. These studies are:

1) NA Report - Burlington to Nanticoke Region, May 23 , 2014
2) IRRP Report - Brant Sub-Region, April 28, 2015
3) Local Planning ("LP") Report – Burlington to Nanticoke Region, October 28, 2015
4) IRRP Report - Bronte Sub-Region, June 30, 2016

The NA and IRRP reports identified a number of needs to meet the forecast load demands and EOL asset issues. A review of the loading on the transmission lines and stations in the Burlington to Nanticoke Region was also carried out as part of the RIP report using the latest regional forecast as given in Appendix D. Sections 6.1 to 6.5 present the results of this review. Further description of assessments, alternatives and preferred plan along with status is provided in Section 7.

6.1 500 and 230 kV Transmission Facilities

The 500 kV and most of the 230 kV transmission circuits in the Burlington to Nanticoke Region are classified as part of the Bulk Electricity System ("BES"). They connect the Region to the rest of Ontario's transmission system. A number of these circuits also serve local area stations within the region and the power flow on them depends on the bulk system transfers as well as local area loads. In addition there are three 230 kV double circuit lines H35D/ H36D, B40C/ B41C and N21J/ N22J that supply only local loads. The circuits supplying local loads in the region are as follows (refer to Figure 3-5):

1. Middleport TS to Burlington TS 230 kV transmission circuits M27B/ M28B - supply Horning TS.
2. Middleport TS to Beck #2 TS to Burlington TS 230 kV transmission circuits Q23BM/ Q25BM /Q24HM/ Q29HM - supply Burlington (DESN) TS, Nebo TS and one customer owned CTS.
3. Middleport TS to Buchanan TS 230 kV transmission circuits M32W/ M33W - supply Brantford TS.
4. Middleport TS to Nanticoke TS 230 kV transmission circuits N5M/ S39M / N20K - supply Caledonia TS and one customer owned CTS.
5. Burlington TS to Beach TS 230 kV transmission circuits B18H/ B20H - supply Lake TS.
6. Nanticoke TS to Jarvis TS 230 kV transmission circuits N21J/ N22J - supply Jarvis TS and one customer owned CTS.
7. Beach TS to one customer owned CTS 230 kV transmission circuits H35D/ H36D.
8. Burlington TS to Cumberland TS 230 kV transmission circuits B40C/ B41C - supply Cumberland TS.

Bulk system planning is conducted by the IESO and is informed by government policy, including policy outlined in the long term energy plan ("LTEP"). Government engagement on the next LTEP is currently underway, with a new LTEP expected to be issued in Q2/Q3 2017. Bulk system needs, options and recommendations for Power System facilities serving this region will be determined by the IESO as part of the implementation plan for the 2017 LTEP.

6.2 230/115 kV Transformation Facilities

Almost half of the Region's load is supplied from the 115 kV transmission systems. The primary source of 115 kV supply is from three 230/115 kV autotransformers at Burlington TS, Beach TS and Caledonia TS.

Table 6-1 summarizes the loading levels for all three 230 /115 kV auto transformers in the Burlington to Nanticoke region.

Table 6-1 Adequacy of 230/115 kV Autotransformer Facilities

Overloaded Facilities	MVA Load Meeting Capability	2015 MVA Loading	Need Date
Burlington TS 230/115 kV autotransformers	912	745	- (1)
Beach TS 230/115 kV autotransformers	582	348	- (1)
Caledonia TS 230/115 kV autotransformer	187	88	- (1)

(1) Adequate over the study period (2015- 2025)

The autotransformers in the Burlington to Nanticoke region are of adequate capacity over the study period (2015-2025). The Needs Assessment identified a stuck breaker scenario at Burlington TS that could result in simultaneous loss of two of the four autotransformers at Burlington TS. This is a low probability scenario under which the loading on the remaining two autotransformers could exceed their short time emergency rating.

However, recently an additional 230 kV breaker has been added to the scheme reducing the possibility of simultaneous loss of two autotransformers at Burlington TS under a single contingency scenario. In addition, installation of the new 230/115 kV autotransformers at Cedar TS and 115 kV switching at Brant TS, to be in-service by 2019, will further reduce loading on the Burlington TS autotransformers.

The loading on the Burlington TS 230/115 kV autotransformers, for the simultaneous loss of two autotransformers, is therefore expected to remain within the short term rating of the two remaining in-service autotransformers at Burlington TS. No further action is required.

6.3 115 kV Transmission Facilities

The 115 kV transmission facilities can be divided in three main sections: Please see Figure 3-5 and 3-6 for the single line diagrams.

1. Burlington 115 kV – has twelve 115 kV circuits B3/B4, B5/B6, B7/B8, B10/B11, B12/B13 and HL3/HL4. All circuits are adequate over the study period except for sections of the B7/B8 and B12/B13 circuits as given below in Table 6-2. These needs have been identified in the earlier phases of the regional planning process and are being addressed by Hydro One as per the recommendations in respective IRRPs and further discussed in this RIP (Section 7).

   The loading on the limiting sections of 115 kV circuits is summarized below in Table 6-2.

Table 6-2 Limiting Sections of 115 kV Circuits

Line Section	Overloaded Circuit	Reference Section	Capacity (MW)	Contingency	2015 Loading (MW)	Need Date
Palermo Jct. to Bronte TS	B7/ B8	Section 7.1	135	B7	129	2018
Horning Mountain Jct. to Brant TS	B12/B13	Section 7.5	125	B12/B13	119	2019

   The HL3/ HL4 115 kV double circuit cable consist of two sections:
   i. HL3/ HL4 Newton TS to Elgin TS
   ii. HL3/ HL4 Elgin TS to Stirton TS (HL4 is idle)

   These cables provide normal and backup supply to Elgin TS. The supply capacity of 115 kV HL3/ HL4 cables is adequate over the study period (2015-2025).

2. Beach 115 kV– has five 115 kV circuits H5K/ H6K, HL3/ HL4 and Q2AH expected to be adequate over the study period. There are two associated 115 kV double circuit cable sections:
   i. K1G/ K2G Kenilworth TS to Gage TS
   ii. H5K/ H6K Kenilworth TS to Beach TS

   These cables provide normal and backup supply to Kenilworth TS. The supply capacity of Beach 115 kV cables and lines is adequate over the study period (2015-2025).

3. Norfolk Caledonia – has two 115 kV circuits C9 and C12 supplying Norfolk TS and Bloomsburg DS. The need of additional supply capacity for C9/C12 double circuit line was identified during the earlier phases of the regional planning cycle.

   The updated load forecast and further assessment as part of this RIP shows that the combined load of Norfolk TS and Bloomsburg DS will remain below the supply capacity of 87 MW of C9/ C12 line during the study period and no further action is required.

The list of all the 230 kV and 115 kV circuits is given in Appendix A.

6.4 Step-Down Transformation Facilities

There are a total of 31 step-down transmission connected transformer stations in the Burlington to Nanticoke Region. The stations have been grouped based on the geographical area and supply configuration. The station loading in each area and the associated station capacity is provided in Table 6-3 below. The complete list of all the stations in the Burlington to Nanticoke region and their supply circuits is given in Appendix B.

Table 6-3 Adequacy of Step-Down Transformer Stations

Area/Supply	Capacity (MW)	2015 Loading (MW)	Need Date
Brant Sub-Region	403	263	-(2)
Bronte Sub-Region	530	402	-(2)
Greater Hamilton Sub-Region (1)	1919	1108	-(2)
Caledonia Norfolk Sub-Region (1)	351	211	-(2)

(1) Excludes Customer Transformer Stations (CTS)
(2) Adequate over the study period (2015-2025)

Dundas TS has two DESN units T1/T2 and T5/T6. During the earlier phases of the Regional Planning cycle T1/T2 DESN at Dundas TS was found to be loaded over its supply capacity due to unbalanced loading between the two Dundas TS DESNs. The current loading at both DESNs at Dundas TS is within each DESN's supply capacity. Further assessment as part of this RIP based on current forecast confirms that the loads on each of the Dundas TS DESNs will remain within its supply capacity during the study period. No further action is required.

Nebo TS 13.8 kV T3/T4 DESN was also identified as marginally over loaded during an earlier phase of the regional planning cycle. Further assessment as part of this RIP based on updated forecast confirms that the loads on the Nebo TS T3/T4 DESN will remain within its supply capacity during the study period. No further action is required.

6.5 System Reliability and Load Restoration

In case of contingencies on the transmission system, ORTAC provides the load restoration requirements relative to the amount of load affected. Planned system configuration must not exceed 600 MW of load curtailment/rejection. In all other cases, the following restoration times are provided for load to be restored for the outages caused by design contingencies.

a. All loads must be restored within 8 hours.
b. Load interrupted in excess of 150 MW must be restored within 4 hours.
c. Load interrupted in excess of 250 MW must be restored within 30 minutes.

It is expected that all loads can be restored within 8 hours in the Burlington to Nanticoke Region over the study period. None of the transmission circuits in the Burlington to Nanticoke region will be supplying total loads in excess of 250 MW. The following double circuit lines in the Burlington to Nanticoke Region are expected to supply the loads in excess of 150 MW at peak times:

- B12/ B13
- B3/ B4
- H35D/ H36D
- HL3/ HL4
- M32W/ M33W
- Q23BM/ Q25BM
- Q24HM/ Q29HM

Based on the historical performance and reliability data for these circuits in the region, the Working Group recommended that no action is required at this time.

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7. REGIONAL NEEDS & PLANS

THIS SECTION DISCUSSES THE ELECTRICAL INFRASTRUCTURE NEEDS FOR THE BURLINGTON TO NANTICOKE REGION AND SUMMARIZES THE REGIONAL PLANS FOR ADDRESSING THESE NEEDS. THESE NEEDS INCLUDE NEEDS PREVIOUSLY IDENTIFIED IN THE NEEDS ASSESSMENT, SCOPING ASSESSMENT, IRRPS FOR THE BRANT, AND BRONTE SUB-REGIONS, ASSESSMENTS CARRIED OUT IN SECTION 6 AS WELL AS EMERGING NEEDS DUE TO AGING INFRASTRUCTURE AND END OF LIFE ISSUES.

This section outlines and discusses infrastructure needs and plans identified for the Burlington to Nanticoke Region and recommended plans and/or next steps for the near-term (up to 5 years) and the mid-to long-term (beyond 5 years).

It should be noted that this RIP, in addition to advancing the work from the aforementioned IRRPs, also identifies additional needs related to sustainment and end-of-life facilities in the Hamilton area. Built over 50 years ago, the transmission assets in the Hamilton area are some of the oldest installations in the province. At the time of the Burlington to Nanticoke Need Assessment and Scoping Assessment phases, done in 2014, the detailed information on the condition and end-of-life issues related to these assets was not available. As such, a decision was made by the Working Group at that time to not initiate a coordinated planning exercise for the Hamilton subsystem. Since then, through the RIP process, the extent and urgency of the sustainment work in the Hamilton area, and also in Oakville and Brantford, are better known by the Working Group.

This RIP discusses those needs and the projects developed to address those needs. Implementation to address some of these needs is already or nearly underway. The plans presented in this RIP to address new end-of-life needs have been developed by Hydro One and needs also confirmed by the LDC. Further details are being formalized by Hydro One through assessment and consultation with the LDC to develop implementation plans. The plans for Beach TS, Birmingham TS, Gage TS and Kenilworth TS were later reviewed by the IESO as part of an ongoing study for the Hamilton area. However, new near and mid-term needs namely Horning TS, Elgin TS, and Bronte TS were not fully identified earlier in the regional planning process and did not undergo a review by the IESO in the earlier phases due to their scope or project status.

The RIP report also identifies long-term needs associated with the revised and better defined sustainment plan. These needs will be assessed in the next planning cycle. A summary of all of these needs in the near-term (2016-2020) and mid to long-term (beyond 2020) are listed in Table 7-1 and Table 7-2, respectively, along with their in-service date, where applicable. Table 7-1 identifies both the stakeholders involved in each project's development and which formal regional planning process it originated from and provide reference to sub-sections with further details for each of the need. The table also indicates the needs identified after the completion of the NA and SA processes.

Table 7-1 Identified Near-Term Needs in Burlington to Nanticoke Region

No.	Needs	Section	Timing
Projects Developed in Local Planning or an IRRP			
1	115 kV B7/B8 Transmission Line Capacity	7.1	2018
2	115 kV B12/B13 Transmission Line Capacity	7.2	2019
3	Two New Feeders at Dundas TS	7.3	2019
4	Cumberland TS – Power Factor Correction	7.4	TBD
5	Kenilworth TS – Power Factor Correction	7.5	TBD
Projects Developed by HONI & the LDC(s), Reviewed by IESO			
6	Kenilworth TS – EOL transformers & switchgear (1)	7.6	2018
7	Beach TS – EOL T3/T4 DESN Transformers (1)	7.7	2019
8	Gage TS – EOL transformers & switchgear	7.8	2019
9	115 kV B7/B8 – EOL Line Section from Burlington TS to Nelson Jct. (1)	7.9	2020
Projects Developed by HONI & the LDC(s)			
10	115 kV B3/B4 – EOL Line Section from Horning Mountain Jct. to Glanford Jct. (1)	7.10	2018
11	Horning TS – EOL transformers & switchgears (1)	7.11	2018
12	Bronte TS – EOL T5/T6 DESN (1)	7.12	2019
13	Elgin TS – EOL transformers & switchgears	7.13	2019
14	Mohawk TS (T1/T2) – Station Capacity & EOL T1/T2 Transformers	7.14	2019

(1) New needs identified by HONI

The mid- and long-term (2021-2025) electrical infrastructure needs in the Burlington to Nanticoke Region are summarized below in Table 7-2. Where available, a preliminary plan to address that need is provided in the corresponding sub-section.

Table 7-2 Identified Mid- and Long-Term Needs in Burlington to Nanticoke Region

No.	Needs	Section	Timing
1	Birmingham TS EOL Metalclad Switchgears	7.15	2021
2	Dundas TS EOL T1/T2 Switchgear	7.16	2021
3	Newton TS EOL Transformers, Switchgears, Breakers	7.17	2021
4	Brantford TS EOL Switchgear	7.18	2022
5	Lake TS EOL Switchgear	7.18	2022

No.	Needs	Section	Timing
6	Stirton TS EOL Switchgear	7.18	2022
7	Beach TS EOL T7/T8 Auto-transformers and T5/T6 Switchgear	7.19	2025
8	EOL Cables in Hamilton area: H5K/H6K, K1G/K2G, HL3/HL4	7.20	TBD

The needs identified in the Burlington to Nanticoke Region in the above Tables 7-1 and Table 7-2 are further discussed below.

7.1 115 kV Circuit B7/B8 Transmission Line Capacity (Burlington TS to Bronte TS)

7.1.1 Description

Bronte TS is radially supplied by the 115 kV double circuit B7/ B8 line from Burlington TS. The supply capacity of Bronte area is limited to 135 MW due to loading on B7/B8 exceeding its thermal capacity following a loss of either of the circuits starting in 2018. In 2021, the post contingency voltage drop for the loss of either circuit will also exceed the ORTAC limit of 10% at Bronte TS. The load in Bronte area is forecasted to exceed the 135 MW supply limit and reach about 150 MW during the study period.

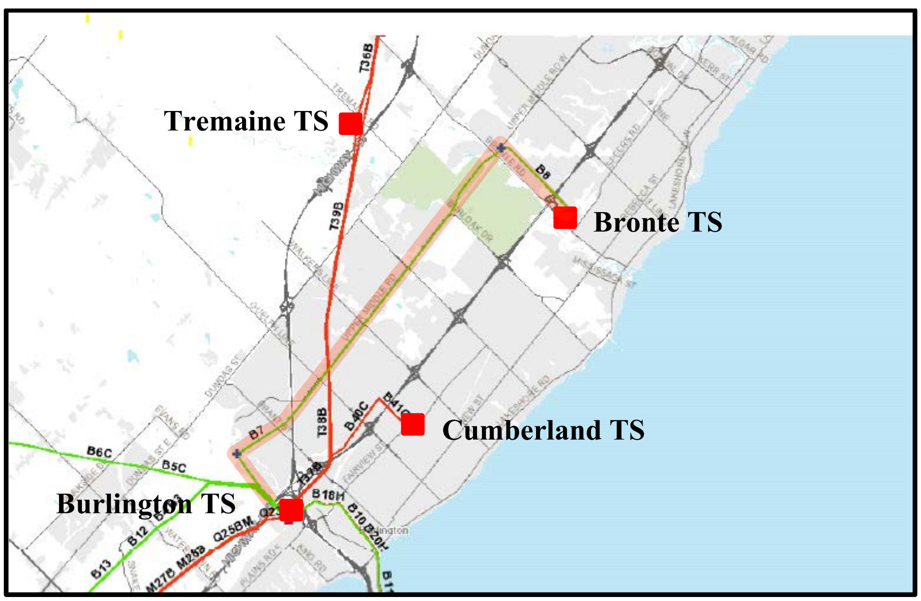

Figure 7-1 Bronte TS Supply Circuits B7/B8

7.1.2 Recommended Plan

The Working Group considered and reviewed different options to provide relief to the 115 kV circuits supplying Bronte TS as part of the Bronte area IRRP. The options included: a) upgrading of transmission system to mitigate the limitation on the 115 kV B7/ B8 circuits and b) Distribution option to transfer load from Bronte TS to neighboring station(s). Upgrading of transmission system was neither economical nor a practical solution.

Consistent with the WG recommendations in the IRRP, the most cost effective and preferred alternative is for LDC(s) to transfer loads from Bronte TS to other neighboring stations and to maintain Bronte TS loading below 135 MW.

Hydro One and the affected LDCs will develop a plan by the end of 2017 for transferring approximately 15 MW of load from Bronte TS to the neighboring station(s). The estimated cost of investments for the distribution load transfer is currently expected to be in the order of $1-3 million.

7.2 115 kV Circuit B12/B13 Transmission Line Capacity (Burlington TS to Brant TS)

7.2.1 Description

Brant TS and Powerline MTS in Brant County are supplied by the 115 kV double circuits B12/B13 line from Burlington TS. The Brant area is experiencing higher growth with a number of new industrial customers planning to connect over the next few years. The combined load of Brant TS and Powerline MTS was 119 MW in summer 2015 and exceeds the 104 MW supply capacity of the B12/B13 line.

7.2.2 Recommended Plan

As per the IRRP recommendations, first phase was to provide additional capacity for the Brant Area's 115 kV supply that included installation of 40 MVAR capacitor banks at Powerline MTS in July 2015. This has increased the line supply capacity to 125 MW.

In addition, the IRRP Working Group considered other options to provide additional 115 kV capacity to supply Brant TS and Powerline MTS to address future load growth over the near-term. The most economical option that was recommended by the WG is to install a three breaker switching station at Brant TS and using the existing backup supply from 115 kV circuit B8W (from Karn TS) as third supply. A single line diagram of the new switching facilities at Brant TS is shown below in Figure 7.2.

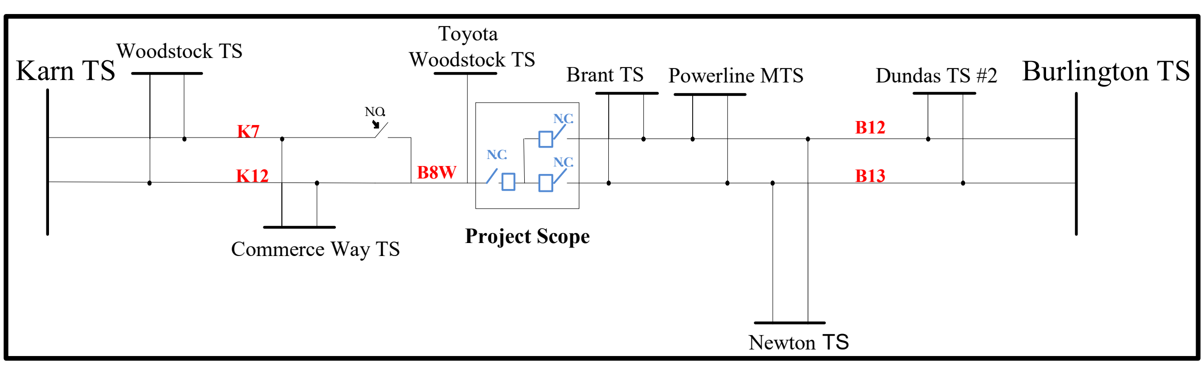

Figure 7-2 Brant Sub-Region Proposed Configuration

Hydro One has initiated detailed engineering work and design. The project is expected to be in-service by spring 2019 and is estimated to cost approximately $12 million. The installation of the switching station will reclassify some of the line connection assets as Network Assets. The project cost will be recoverable from the rate revenue and/or capital contribution from the LDCs in accordance with the TSC.

7.3 Two New Feeders at Dundas TS

7.3.1 Description

Dundas TS has two DESN units T1/T2 and T5/T6 with a total 2015 summer peak load of 148 MW and a station supply capacity of 188 MW. The station capacity is forecasted to be sufficient over and beyond the study period.

A LDC currently supplied from the T1/T2 DESN is planning to transfer load to T5/T6 DESN and supplied from two existing spare breaker positions to meet increased load needs. This will also help in balancing the loads between the two Dundas TS DESNs.

7.3.2 Alternatives, Recommended Plan and Current Status

The following alternatives were considered to address customer's needs:

- Maintain status quo: This alternative was considered and rejected as it does not address the customer's needs.
- Transfer customer load to T5/T6 DESN: Move portion of LDC customer loads from T1/T2 DESN to T5/T6 DESN utilizing two spare breaker positions at T5/T6 DESN. This will require reconfiguring of distribution assets by the LDC and will also help improving load balancing between two Dundas TS DESNs.

The preferred plan is to proceed with moving portion of the LDC's customer load from T1/T2 DESN to T5/T6 DESN utilizing two spare breaker positions. The transfer of load from T1/T2 DESN to T5/T6 DESN is planned to be completed in 2019 at an estimated cost of $8 million.

7.4 Cumberland TS Power Factor Correction

7.4.1 Description

The Cumberland TS supplies up to 123 MW of loads in the city of Burlington. The historical loading data of Cumberland TS indicated that under peak load conditions the power factor at Cumberland TS is lagging slightly below the ORTAC requirement of 0.9.

7.4.2 Recommended Plan and Current Status

The Needs Assessment identified this need and it was recommended that Burlington Hydro to work with their load customers supplied by Cumberland TS and install capacitor banks on distribution system as required to meet the minimum power factor requirements of 0.9.

Burlington Hydro is currently perusing different options to improve the power factor of customer loads supplied by Cumberland TS to meet ORTAC requirement. This issue will be further reviewed during the next regional planning cycle.

7.5 Kenilworth TS Power Factor Correction

7.5.1 Description

There are two supply stations inside Kenilworth TS T1/T4 and T2/T3 supplying about 60 MW of loads in the city of Hamilton. The historical loading data of Kenilworth TS indicated that under peak load conditions the power factor at Kenilworth TS is lagging below the ORTAC requirement of 0.9.

7.5.2 Alternatives and Recommended Plan

The Needs Assessment identified this need and it was recommended that Alectra Utilities to install capacitor bank on distribution system and/or work with load customers supplied by Kenilworth TS to meet ORTAC power factor requirement of 0.9.

Alectra Utilities is currently perusing option on cost and location to install equipment to improve power factor to meet ORTAC requirement. This issue will be further reviewed during the next regional planning cycle.

7.6 Kenilworth TS End of Life Assets

7.6.1 Description

There are two DESN units T1/T4 and T2/T3 inside Kenilworth TS supplying loads in the city of Hamilton and built in 1950's and 1960's respectively. The load at Kenilworth TS is currently about 60 MW. The T1/T4 transformers are rated at 67 MVA each while the T2/T3 transformers are 100MVA and 120 MVA, respectively, which are non-standard as per current standards. Non-standard and obsolete equipment results in complexity with failures and difficulty in getting similar spare equipment along with their installation. The original 120 MVA T2 transformer was replaced with a standard 100 MVA transformer unit in 2014 due to failure. In addition, one of the three metalclad switchgears at Kenilworth TS is presently out of service while the second in-service metalclad switchgear is approaching end of its useful life. As a result, near-term plan is developed to address the failure and EOL issues.

7.6.2 Alternatives and Recommended Plan

The following alternatives are considered to address end of life issue at Kenilworth TS:

- Maintain status quo: This alternative was considered and rejected as it does not address the risk of failure due to asset condition and would result in increased maintenance expenses and reduce supply reliability to the customers.
- "Like-for-Like" replacement of the assets: This alternative would require maintaining four transformers and the associated three switchgears which is not justifiable based on the load forecast.
- Station/load consolidation: Moving loads to neighboring station(s) and retiring Kenilworth TS. This alternative was considered but is not feasible due to: a) unique electrical characteristics and requirements of industrial costumer load in the area, and b) higher costs associated with reconfigurations and transfer of customer loads.
- Reconfiguration of the station reducing to two supply transformers and two switchgears: This option will reconfigure and adequately downsize the station. In this configuration, station will be reduced from four transformers to only two transformers supplying two switchgears.

The preferred plan is for Hydro One to proceed with the reconfiguration of the station and reduce it to two transformers and two switchgears only. The recently replaced transformer and one of the existing metalclad switchgear will be utilized while one transformer and switchgear will be required to be replaced. The new transformer will be a standard unit similar to T2 that was replaced in 2014. This refurbishment project is currently planned to be completed by the year 2018 at an estimated cost of $19 million.

7.7 Beach TS EOL T3/T4 DESN Transformers

7.7.1 Description

Beach TS has two DESN units T3/T4 and T5/T6 supplying loads in the city of Hamilton and built in 1950's and 1960's respectively. The T3/T4 DESN is supplied by the 115 kV bus while the T5/T6 DESN is supplied from the 230 kV bus at Beach TS. The 115/13.8 kV T3/T4 DESN transformers have been identified by Hydro One approaching the end of their useful life and require replacement. The load at Beach TS T3/T4 DESN is currently about 32 MW and is forecasted to stay at the same level in the foreseeable future.

7.7.2 Alternatives and Recommended Plan

The following alternatives are considered to address Beach TS T3/T4 supply transformer end of life issue:

- Continue to maintain the assets (status quo): This alternative was considered and rejected as it does not address the risk of failure due to asset condition and would result in increased maintenance expenses and reduce supply reliability to the customers.
- "Like-for-Like" replacement of the assets: Replacing existing EOL 115/ 13.8 kV T3/T4 DESN transformers with similarly sized units.

- Reconfigure 115 kV T3/T4 transformers to a 230 kV configuration by replacing the existing non-standard 115/ 13.8 kV (67 MVA + 75 MVA) transformers with standard 100 MVA 230/13.8 kV units.

Keeping the existing supply configuration at 115 kV of T3/T4 transformers at Beach TS is not possible as it does not meet safety clearance requirements. In light of this and the fact that moving the transformer supply configuration from 115 kV to 230 kV bus is similar in cost plus has other long-term advantages, such as the 230 kV supply option will result in reduced loading levels of 230/115 kV Beach TS autotransformers resulting in freeing up capacity and improve supply reliability.

The preferred plan is for Hydro One to proceed with reconfiguring the 115 kV T3/T4 DESN to a 230 kV configuration by replacing the existing non-standard transformers with standard 100 MVA 230/13.8 kV units is the most suitable option. The project is currently underway, and is expected to be completed in 2019. The cost of this investment is currently estimated at about $17 million.

7.8 Gage TS End of Life T3/T4/T5/T6 Transformers and a Switchgear

7.8.1 Description

Gage TS has three DESNs (T3/T4, T5/T6, and T8/T9) predominantly supplying large industrial customer loads in Hamilton. T3/T4 and T5/T6 DESNs were built in the 1940's with each transformer rated at 63 MVA LTR, while T8/T9 DESN was built in 1960's with each transformer rated at 137 MVA LTR. These transformers are non-standard with unique electrical characteristics with high short circuit requirements of the customer. The transformers T3, T4, T5, and T6, as well as T5/T6 DESN at Gage TS have been identified by Hydro One at their EOL and have been previously deferred to better understand customer load requirements. Transformer T5 has failed multiple times and breakers in the T5/T6 DESN have experienced recurring problems. No issues or refurbishment needs have been identified at T8/T9 DESN at this time.

The load at Gage TS has reduced over the years to approximately 48 MW, and is currently expected to stay at this level over the study period. The existing station capacity (of the three DESNs) is about 240 MW. Although there seems to be over-capacity at Gage TS, unique short-circuit and connection requirements of industrial loads at this station limits the feasibility of some of the alternatives/solutions.

7.8.2 Alternatives, Recommended Plan and Current Status

The following alternatives were considered to address end of life issues at Gage TS:

- Maintain status quo: This alternative was considered and rejected as it does not address the risk of failure due to asset condition, safety issues and would result in increased maintenance expenses and will not meet Hydro One's obligation to provide reliable supply to the customers.
- "Like-for-Like" replacement of the assets: This alternative would continue maintaining six transformers and the associated three switchgears. This option is extremely costly and cannot be justified since the load has significantly reduced at this station.

- Station/load consolidation: Moving loads to neighboring station(s) and retiring Gage TS. This alternative is not feasible due to: a) unique costumer load requirements (i.e., high short circuit currents are required to operate customer's large arc furnaces and large motors without significant impact to power quality), and b) higher costs associated with reconfigurations of LV cables and transfer of customer loads to other stations.
- Reconfiguration of the station and downsize the station from three DESN to two DESN station: In this option, the station will be reconfigured and downsized from the existing six transformers to four transformers.

The preferred plan is for Hydro One to proceed with the reconfiguration of the station and reduce it from 3 DESNs to 2 DESNs. Under this plan, T3/T4 and T5/T6 DESNs will be replaced by a single T10/T11 DESN with two 100 MVA standard units and switchgear currently supplied by T5/T6 transformers will also be replaced. This option will also provide future flexibility to eliminate T8/T9 DESN when it approached EOL.

The refurbishment of Gage TS is currently expected to be completed in 2019 at an estimated cost of $37 million.

7.9 115 kV Circuit B7/B8 End of Life Section (Burlington TS to Nelson Junction)

7.9.1 Description

The 115 kV double circuit line B7/B8 line supplies about 130 MW of Burlington and Oakville area loads through Bronte TS. The line section from Burlington TS to Nelson junction (about 2.3 km) was built in 1920's. Hydro One has identified that the conductor on this line section from Burlington TS to Nelson junction has reached end of useful life.

7.9.2 Alternatives and Recommended Plan

The following alternatives are considered to address 115 kV B7/B8 end of life line section from Burlington TS to Nelson junction:

- Maintain status quo: This alternative was considered and rejected as it does not address the EOL issue, risk of failures resulting in poor supply reliability and would result in increased maintenance expenses.
- Refurbishment of EOL line section: Refurbish 2.3 km of EOL line conductor section of B7/B8 line section.

The preferred plan is to proceed with the refurbishment of the 115 kV B7/ B8 line section from Burlington TS to Nelson junction supplying Bronte TS using similar ACSR conductor. The refurbishment work is planned to be completed by the year 2020 and estimated to cost approximately $2 million.

7.10 115 kV B3/B4 End of Life Line Section (Horning Mountain Jct. to Glanford Jct.)

7.10.1 Description

The 115 kV B3/B4 line supplies Hamilton area loads through Dundas TS (T1/T2 DESN), a CTS and Mohawk TS. Mohawk TS is supplied from B3/B4 line through about 16 km long line-tap supplying about 84 MW of load. A section of this line tap has a solid copper conductor from Horning Mountain Jct. to Glanford Jct. which is approximately 100 year old and has reached end of useful life.

7.10.2 Alternatives and Recommended Plan

The following alternatives are considered to address the above need:

- Continue to maintain the assets (status quo): This alternative was considered and rejected as it does not address the frequent failure, increased maintenance expenses and poor supply reliability.
- Refurbishment of EOL line section: Replace EOL copper conductor with 605 kcmil ACSR conductor Mohawk TS line tap section.

The preferred plan is for Hydro One to replace this EOL copper conductor with 605 kcmil ACSR from Horning Mountain Jct. to Glanford Jct. supplying Mohawk TS. This work is currently planned to be completed by 2018 at an estimated cost of $8 million.

7.11 Horning TS End of Life Assets

7.11.1 Description

Horning TS is a 230/13.8 kV DESN station built in 1967 and supplies Alectra Utilities loads in the Hamilton area. It has two station supply transformers of 100 MVA each supplying load through its two metalclad switchgears. Recent equipment failures in 2016 due to aging low voltage switchgear have adversely impacted supply to customers in the Hamilton area along with safe operations.

In addition, both the transformers and both low voltage switchgears at Horning TS are approaching end of expected useful life and have been identified by Hydro One for replacement. The load at Horning TS is currently about 70 MW and is forecasted to stay at the same level during the study period.

7.11.2 Alternatives and Recommended Plan

The following alternatives are considered to address Horning TS end of life issue:

- Continue to maintain the assets (status quo): This alternative was considered and rejected as it does not address the risk of failure due to asset condition and would result in increased maintenance expenses and reduce supply reliability to the customers.

- "Like-for-Like" replacement of the assets: This alternative would continue maintaining current station configuration and only replace existing transformers will similar units and refurbish both metalclad switchgears.

The preferred plan is for Hydro One to proceed with Like-for-Like replacements replacing supply transformers with similar 100 MVA units and refurbishing EOL low voltage metalclad switchgears. The new replaced transformers and refurbished switchgear will provide sufficient capacity to serve the load over the study period. The project is currently underway, and is expected to be completed in 2018. The cost of this investment is estimated to be about $37 million.

7.12 Bronte TS End of Life T5/T6 DESN

7.12.1 Description

Bronte TS was placed in service in 1963 and is radially supplied from Burlington TS via 115 kV B7/ B8 circuits. The total load at Bronte TS is currently about 129 MW and is forecasted to stay at about 135 MW with load transfers as proposed in section 7.1.

There are three transformers, T2 (single transformer configuration), and T5/T6 DESN (83 MVA), at Bronte TS supplying loads in the cities of Oakville and Burlington. Transformer T2 was replaced in 2006 and the T5/T6 DESN transformers at Bronte TS and LV switchgear is approaching end of expected useful life. Hydro One has identified that these transformers require replacement.

7.12.2 Alternatives and Recommended Plan

The following alternatives are considered to address end of life Bronte TS T5/T6 DESN refurbishment:

- Continue to maintain the assets (status quo): This alternative was considered and rejected as it does not address the risk of failure due to asset condition and would result in increased maintenance expenses and reduce supply reliability to the customers.
- "Like-for-Like" replacement of the assets: Replacing existing EOL 115/ 27.6 kV T5/T6 DESN transformers with similar size standard units and refurbish switchgear.

The preferred plan is for Hydro One to proceed with Like-for-Like replacement. This will include replacing existing 83 MVA T5/T6 transformers with similar units and refurbishing associated switchgear. This investment is estimated to be approximately $34 million with planned in-service of 2019.

7.13 Elgin TS End of Life Assets

7.13.1 Description

Elgin TS has two DESNs (T1/T2 and T3/T4) built in 1960's supplying loads in the city of Hamilton through three switchgears. The current load at Elgin TS is approximately 85 MW, and is currently expected to stay at this level over the study period.

The T1/T2 transformers are 75 MVA units while the T3/T4 units are non-standard 33 MVA units. All existing four transformers (T1, T2, T3, and T4) and three switchgears at Elgin TS have been identified by Hydro One as approaching end of their useful life. This need was identified in the Needs Assessment phase.

7.13.2 Alternatives, Recommended Plan and Current Status

The following alternatives were considered to address end of life issues at Elgin TS:

- Maintain status quo: This alternative was considered and rejected as it does not address the risk of failure due to asset condition, safety issues and would result in increased maintenance expenses and will not meet Hydro One's obligation to provide reliable supply to the customers.
- "Like-for-Like" replacement of the assets: This alternative would continue maintaining four transformers and the associated three switchgears. This option is extremely costly and cannot be justified with load forecast not showing any growth at this station.
- Reconfiguration and downsize the station from two DESNs to one DESN station: In this option, the station will be reconfigured and downsized from the existing four transformers to two transformers.

The preferred plan is for Hydro One to proceed with the reconfiguration of the station and reduce it to two transformers and two switchgears only. Under this plan, T1/T2 and T3/T4 DESNs will be replaced by a single T5/T6 DESN with two 100 MVA standard units and four new switchgears. This will maintain adequate supply capacity to the loads through the four new switchgears. The cost of this investment is expected to be $58 million with a planned in service of 2019.

7.14 Mohawk TS Station Supply Capacity & End of Life T1/T2 Transformers

7.14.1 Description

Mohawk TS is a 115/13.8 kV step down transformer station supplied from 115 kV circuit B3/B4 from Burlington TS supplying loads in the city of Hamilton. The station supply capacity is limited to 80 MW by the LTR of transformers. The 2015 summer peak load was 84 MW and the station is marginally over its supply limits during peak load periods. In addition, transformers at Mohawk TS are over 50 years old and condition assessment has identified Mohawk TS transformers approaching end of their useful life.

7.14.2 Alternatives and Recommended Plan

The following alternatives were considered to address Mohawk TS end of life transformer issue:

- Maintain status quo: This alternative was considered and rejected as it does not address the risk of failure due to asset condition, poor supply reliability and would result in increased maintenance expenses. In addition option will not address the capacity needs at the station,
- Transformer replacement: Replacing the existing non-standard (67 MVA) end of life transformers with new standard (75 MVA) units.

The preferred plan is for Hydro One to proceed with the replacement of existing nonstandard supply transformers at Mohawk TS with the standard 75 MVA units. This will address the issue of: a) EOL transformers, b) replace non-standard equipment with standard units, and c) will provide sufficient station supply capacity. In the interim, Alectra Utilities will manage the overloads (under contingency) by distribution loads transfers. The transformer replacement project is currently expected to be in service by 2019 at an estimated cost of $14 million.

7.15 Birmingham TS End of Life Switchgear

7.15.1 Description

Birmingham TS is located in the city of Hamilton having two DESN units T1/T2 and T3/T4 of 75 MVA each. Both the DESNs at Birmingham TS can supply a total load of about 185 MVA (LTR). The Birmingham TS currently supplies a large industrial customer with unique connection requirements. The load at Birmingham TS is forecasted at about 75 MW.

At this time transformers and/or other HV equipment at this station has not been identified as EOL over the study period. However, two 13.8 kV LV metalclad switchgears are at EOL and have been identified by Hydro One for refurbishment.

7.15.2 Recommended Plan

The two end of life 13.8 kV LV end of life metalclad switchgears at Birmingham TS are required to be replaced to meet the unique connection needs of the customer at this station. Not replacing the end of life switchgears will increase the risk of failure due to asset condition and adversely impact supply to a large industrial customer. Currently Hydro One plans to complete this by 2021. This need will be further reviewed in the next regional planning cycle.

7.16 Dundas TS End of Life Switchgear

7.16.1 Description

Dundas TS has two DESN units T1/T2 and T5/T6 with a total 2015 summer peak load of 148 MW and station capacity of 188 MW. The station capacity is forecasted to be sufficient over and beyond the study period. The T1/T2 transformers at Dundas TS have recently been replaced in 2015. The Dundas TS T1/T2 27.6 kV MV switchgear has been identified by Hydro One at end of life requiring refurbishment.

7.16.2 Alternatives and Recommended Plan

Hydro One has identified MV 27.6 kV T1/T2 switchgear at Dundas TS at end of life requiring refurbishment. Keeping status quo not refurbishing this switchgear will increase the risk of failure due to asset condition reducing supply reliability to the customers and would result in increased maintenance expenses.

The refurbishment switchgear is currently planned by Hydro One to be completed by 2021. This need is recommended to be further reviewed in the next regional planning cycle.

7.17 Newton TS End of Life Transformers and Switchgear

7.17.1 Description

Newton TS is a 115 kV/ 13.8 kV DESN station having transformers built in 1956 and supplies Alectra Utilities loads in the city of Hamilton. It has two station supply transformer of 67 MVA each supplying loads through its 13.8 kV switchyards. The customer load at the station is about 50 MW and is forecasted to stay at the same level in the foreseeable future. Hydro One in initial assessment has identified that both transformers and switchgear requiring refurbishment. The scope of refurbishment is subject to final asset condition assessment of Newton TS to be completed in 2017.

7.17.2 Alternatives and Recommended Plan

The following alternatives are considered to address Newton TS end of life asset issue:

- Maintain status quo: This alternative was considered and rejected as it does not address the risk of failure due to asset condition and would result in increased maintenance cost.
- Replacement of the assets: Replace existing EOL non-standard transformers with similarly sized units and refurbish switchgear to current standards.

The current plan is to refurbish Newton TS with new equipment built to current standards including two 75 MVA units replacing existing 67 MVA transformers and LV switchgear. This is the preferred alternative since it addresses the needs at Newton TS and maintaining station's operability and reliability of supply. This refurbishment work at Newton TS is planned by Hydro One to be completed by 2021. This need is recommended to be further reviewed in the next regional planning cycle.

7.18 Mid-Term End of Life LV Switchyard Refurbishment

7.18.1 Description

Hydro One has identified the LV switchyards reaching end-of-life by 2022 and need to be refurbished at the following stations:

1. Brantford TS
2. Lake TS
3. Stirton TS

7.18.2 Recommended Plan

The Working Group is recommending that these needs to be further reviewed in the next regional planning cycle.

7.19 Beach TS End of Life T7/T8 Autotransformers and T5/T6 DESN LV Switchgear

7.19.1 Description

Beach TS is a major switching and transformer station in East Hamilton. Station facilities include a 230 kV switchyard, three 230/115 kV autotransformers (T1/T7/T8), a 115 kV switchyard, a 230/13.8 kV DESN T5/T6 and a 115/13.8 kV DESN T3/T4.

Hydro One has determined that autotransformers T7 and T8 and the T5/T6 DESN LV Metalclad switchgear are expected to reach end of life by 2025 and will need to be replaced.

7.19.2 Recommended Plan

The Working Group is recommending that this need be further reviewed in the next regional planning cycle.

7.20 End of Life Cables in Hamilton Area: HL3/HL4, K1G/K2G, H5K/H6K

Underground cables in Hamilton area (listed below) are expected to be approaching end-of-life over the next 10 years or so.

- 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)

In light that replacement of the high voltage underground cables can be complicated, affect upstream transmission system and expensive requires alternative/s to be developed and assessed ahead of time. The WG has recommended further review of the cable replacement needs and development of a tentative plan in the next regional planning cycle.

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8. CONCLUSION AND NEXT STEPS

THIS REGIONAL INFRASTRUCTURE PLAN (RIP) REPORT CONCLUDES THE REGIONAL PLANNING PROCESS FOR THE BURLINGTON TO NANTICOKE REGION.

A list and summary of all the needs and/or plans in the near-term (2016-2020) and mid to long term (beyond 2020) is provided below in Table 8-1 and Table 8-2, respectively, along with their in-service date and estimated cost, where applicable. Where available, preliminary plans to address the mid- to long-term needs were also provided.

Table 8-1 Near-Term Needs/Plans in Burlington to Nanticoke Region

No.	Needs	Plans	Status	I/S Date	Cost ($M)
Projects Developed in Local Planning or an IRRP					
1	115 kV B7/B8 Transmission Line Capacity	Bronte TS: Load Transfer	Planning	2018	1-3
2	115 kV B12/B13 Transmission Line Capacity	Install Brant Switching Station	Planning	2019	12
3	Two New Feeders at Dundas TS	Dundas TS: Load Transfer	Planning	2019	8
4	Cumberland TS – Power Factor Correction	LDC is developing distribution option	Planning	TBD	-
5	Kenilworth TS – Power Factor Correction	LDC is developing distribution option	Planning	TBD	-
Projects Developed by HONI & the LDC(s), Reviewed by IESO					
6	Kenilworth TS EOL transformers & switchgear (1)	Reconfigure from 2 DESNs to single DESN	Planning	2018	19
7	Beach TS – EOL T3/T4 DESN Transformers (1)	Replace Beach TS T3/T4 DESN Transformers	Committed	2019	17
8	Gage TS – EOL transformers & switchgear	Gage TS: Reduce from 3 DESNs to 2 DESNs	Planning	2019	37
9	115 kV B7/B8 – EOL Line Section from Burlington TS to Nelson Jct. (1)	Refurbish the EOL B7/B8 line section	Planning	2020	2
Projects Developed by HONI & the LDC(s)					
10	115 kV B3/B4 – EOL Line Section from Horning Mountain Jct. to Glanford Jct. (1)	Refurbish the EOL B3/B4 line section conductor	Planning	2018	8
11	Horning TS EOL transformers & switchgears (1)	Replace EOL transformers & refurbish switchgears	Committed	2018	37

No.	Needs	Plans	Status	I/S Date	Cost ($M)
12	Bronte TS – EOL T5/T6 DESN [1]	Replace EOL transformers & refurbish switchgear	Committed	2019	34
13	Elgin TS – EOL transformers & switchgears	Replace transformers and reduce 2 DESNs to 1 DESN	Committed	2019	58
14	Mohawk TS (T1/T2) – Station Capacity and EOL T1/T2 Transformers	Mohawk TS Transformers Replacement	Committed	2019	14

[1] New needs identified by HONI

Table 8-2 Mid- and Long-Term Needs/Plans in Burlington to Nanticoke Region

No.	Needs/Plans	Planned I/S Date	Cost ($M)
1	Birmingham TS: 2 Metal Clad Switchgear Refurbishment [1]	2021	14
2	Dundas TS: T1/T2 switchyard refurbishment	2021	10
3	Newton TS: Station Refurbishment	2021	36
4	LV Switchgear Refurbishment at Brantford TS, Lake TS and Stirton TS	2022	46
5	Beach TS: Replace EOL T7/T8 Autotransformers and refurbish T5/T6 DESN switchgear	2025	60
6	EOL 115 kV Cables: - H5K/ H6K - K1G/ K2G - HL3/ HL4	TBD [2]	TBD [2]

[1] Preliminarily reviewed by HONI, LDC and the IESO
[2] To Be Decided

It is the recommendation of RIP Working Group:

a) Hydro One will continue to implement the committed and near-term projects for addressing the above needs as discussed in this report, while keeping the Working Group apprised of project status, and
b) The RIP recommends that an expedited Needs Assessment report should be developed to list these already identified needs in the mid and long term or any new needs to be followed by Scoping Assessment, led by the IESO for further assessment under the Burlington to Nanticoke regional planning Working Group.

9. REFERENCES

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[3]. Hydro One, "Needs Screening Report, Burlington to Nanticoke Region", 23 May 2014.
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[5]. Hydro One, "OPA Letter – Brant Area Regional Planning", 06 February 2014.
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[6]. Independent Electricity System Operator, "Review of Ontario Interties", 14 October 2014.
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APPENDIX A: TRANSMISSION LINES IN THE BURLINGTON TO NANTICOKE REGION

No.	Location	Circuit Designations	Voltage (kV)
1	Beach TS - CTS	H35D, H36D	230
2	Beach TS - Burlington TS	B18H, B20H	230
3	Beach TS - Middleport TS	M34H	230
4	Beach TS - Middleport TS - Beck #2 TS	Q24HM, Q29HM	230
5	Burlington TS - Cumberland TS	B40C, B41C	230
6	Burlington TS - Middleport TS	M27B, M28B	230
7	Burlington TS - Middleport TS - Beck #2 TS	Q23BM, Q25BM	230
8	Middleport TS - Beck #2 TS	Q30M	230
9	Middleport TS - Buchanan TS	M31W, M32W, M33W	230
10	Middleport TS - Detweiler TS	M20D, M21D	230
11	Middleport TS - Nanticoke TS	N5M, N6M	230
12	Middleport TS - Summerhaven SS	S39M	230
13	Middleport TS - Sandusk SS	K40M	230
14	Nanticoke TS - Jarvis TS	N21J, N22J	230
15	Summerhaven SS - Nanticoke TS	N37S	230
16	Sandusk SS - Nanticoke TS	N20K	230
17	Beach TS - Gage TS	B10, B11	115
18	Beach TS - Kenilworth TS	H5K, H6K	115
19	Beach TS - Newton TS	HL3, HL4	115
20	Beach TS - Winona TS	Q2AH	115
21	Beach TS - CSS	H9W	115
22	Burlington TS - Brant TS	B12, B13	115
23	Burlington TS - Bronte TS	B7, B8	115
24	Burlington TS - Cedar TS	B5G, B6G	115
25	Burlington TS - Newton TS	B3, B4	115
26	Caledonia TS - Norfolk TS	C9, C12	115
27	Kenilworth TS - Gage TS (Idle)	K1G, K2G	115

APPENDIX B: STATIONS IN THE BURLINGTON TO NANTICOKE REGION

No.	Station	Voltage (kV)	Supply Circuits
1	CTS	230	H35D, H36D
2	Beach TS	230	Beach TS 230 kV Bus (1)
3	Beach TS	115	Beach TS 115 kV Bus (2)
4	Birmingham TS	115	HL3, HL4
5	Bloomsburg DS	115	C9, C12
6	Brant TS	115	B12, B13
7	Brantford TS	230	M32W, M33W
8	Bronte TS	115	B7, B8
9	Burlington TS DESN	230	Q23BM, Q25BM
10	Caledonia TS	230	N5M, S39M
11	Cumberland TS	230	B40C, B41C
12	CTS	230	Q24HM, Q29HM
13	Dundas TS	115	B3, B4
14	Dundas TS #2	115	B12, B13
15	Elgin TS	115	HL3, HL4
16	Gage TS	115	B10, B11
17	Horning TS	230	M27B, M28B
18	CTS	230	N20K
19	Jarvis TS	230	N21J, N22J
20	Kenilworth TS	115	H5K, H6K
21	Lake TS	230	B18H, B20H
22	CTS	115	B3, B4
23	Mohawk TS	115	B3, B4
24	Nebo TS	230	Q24HM, Q29HM
25	Newton TS	115	Newton TS 115 kV Bus (3)
26	Norfolk TS	115	C9, C12
27	Powerline MTS	115	B12, B13
28	CTS	115	HL3, HL4
29	Stirton TS	115	HL3, HL4
30	CTS	230	N21J, N22J
31	Winona TS	115	Q2AH

(1) Beach TS 230 kV bus is supplied by five 230 kV B18H, B20H, Q24HM, Q29HM and M34H circuits

(2) Beach TS 115 kV bus is supplied by three 230 kV/ 115 kV autotransformers at Beach TS

(3) Newton TS 115 kV bus is supplied by four 115 kV B3, B4, B12 and B13 circuits

APPENDIX C: DISTRIBUTORS IN THE BURLINGTON TO NANTICOKE REGION

Distributor Name	Station Name	Connection Type
Energy + Inc.	Brant TS	Dx, Tx
	Brantford TS	Dx
Brantford Power Inc.	Brant TS	Tx
	Brantford TS	Tx
Brantford Power Inc. and Energy + Inc.	Powerline MTS	Tx
Burlington Hydro Inc.	Bronte TS	Tx
	Burlington TS	Tx
	Cumberland TS	Tx
Haldimand County Hydro Inc.	Caledonia TS	Dx, Tx
	Jarvis TS	Dx, Tx
Alectra Utilities Corporation	Beach TS	Tx
	Birmingham TS	Tx
	Dundas TS	Dx, Tx
	Dundas TS #2	Tx
	Elgin TS	Tx
	Gage TS	Tx
	Horning TS	Tx
	Kenilworth TS	Tx
	Lake TS	Dx, Tx
	Mohawk TS	Tx
	Nebo TS	Dx, Tx
	Newton TS	Tx
	Stirton TS	Tx
	Winona TS	Tx
Hydro One Networks Inc.	Brant TS	Tx
	Caledonia TS	Tx
	Dundas TS	Tx
	Dundas TS #2	Tx
	Jarvis TS	Tx
	Lake TS	Tx
	Nebo TS	Tx
	Norfolk TS	Dx, Tx
	Bloomsburg DS	Dx, Tx
Oakville Hydro Electricity Distribution Inc.	Bronte TS	Tx

APPENDIX D: 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	20	21	21
	Gage TS (T3/T4)	60	22	22	22	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	46	46	46	45	45	45	46
	Stirton TS	112	50	50	50	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	48	48	49
	Total CTS		59	59	60	60	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)	94	57	57	56	56	55	55	55	54	54	54	53	53	53	54
	Lake TS (T3/T4)	113	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	50	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	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

APPENDIX E: 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