Hydro One Networks Inc.
483 Bay Street
Toronto, Ontario
M5G 2P5

LOCAL PLANNING REPORT

BURLINGTON TO NANTICOKE REGION

Revision: Final

Date: October 28, 2015

Prepared by: Burlington to Nanticoke Region Local Planning Study Team

Burlington to Nanticoke Region Local Planning Study Team
Hydro One Networks Inc. (Lead Transmitter)
Burlington Hydro Inc.
Horizon Utilities Corporation
Hydro One Networks Inc. (Distribution)

Disclaimer

This Local Planning Report was prepared for the purpose of developing a plan to address the local needs for which straight forward wires-only options are the only alternatives and recommending a preferred solution(s) that were identified in the Needs Assessment (NA) report for the Burlington to Nanticoke Region. These local needs do not require further coordinated regional planning. The preferred solution(s) that have been identified through this Local Planning Report may be reevaluated based on the findings of further analysis. The load forecast and results reported in this Local Planning Report are based on the information and assumptions provided by study team participants as part of the NA process.

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Executive Summary

REGION	Burlington to Nanticoke Region (the "Region")		
LEAD	Hydro One Networks Inc. ("Hydro One")		
START DATE	September 15, 2014	**END DATE**	October 28, 2015

1. INTRODUCTION

The purpose of this Local Planning (LP) report is to develop wires-only options and recommend a preferred solution that will address the local needs identified in the Needs Assessment (NA) report for the Burlington to Nanticoke Region. The development of the LP report is in accordance with the regional planning process as set out in the Ontario Energy Board's (OEB) Transmission System Code (TSC) and Distribution System Code (DSC) requirements and the "Planning Process Working Group (PPWG) Report to the Board".

For needs that required further regional planning and coordination, were further assessed as part of the Scoping Assessment (SA) process to determine whether an Integrated Regional Resource Planning (IRRP) process, or the transmitter-led Regional Infrastructure Plan (RIP) process (wires solution), or both were required. There are two IRRPs in the region for the two sub-regions. A) Brant sub-region IRRP was completed in April 2015 B) Bronte sub-region IRRP is currently in progress.

2. LOCAL NEEDS ADDRESSED IN THIS REPORT

The Local needs addressed in this report include the following:

- Dundas TS T3/T4/T5/T6 Station Capacity
- Mohawk TS Supply Capacity
- Nebo TS T3/T4 Station Capacity
- Power factor at Cumberland TS
- Power factor at Kenilworth TS
- Power factor at Beach TS
- Reactive support for the Norfolk area
- System Reliability, Operation and Load Restoration

3. CONCLUSIONS AND RECOMMENDATIONS

1. **Dundas TS T3/T4/T5/T6 Station Capacity**
   There are 115/27.6 kV two (T3/T4 and T5/T6) DESNs at Dundas TS. The load at T3/T4 DESN has exceeded the supply capacity however the combined capacity of both DESNs is sufficient over the study period. By the end of the study period the combined load of both DESNs at Dundas is forecasted to be approaching the total capacity of the T3/T4 and T5/T6 DESNs.

   As a result, the study team recommended that the LDCs (Hydro One distribution and Horizon Utilities) will plan and undertake distribution load transfers from T3/T4 DESN to T5/T6 DESN to mitigate overloading of T3/T4 DESN at Dundas TS.

2. **Mohawk TS Supply Capacity**
   The load at Mohawk TS marginally exceeds station supply capacity and by the end of study period will marginally exceed the capacity of circuits supplying Mohawk TS. However, load growth in the area is small

   T1/T2 transformers at Mohawk TS are approaching end of life and are already scheduled for replacement in 2018 with the larger transformers which will address the issue of station supply capacity. In the interim, the study team recommended that Horizon Utilities manage the overloads (under contingency) by distribution loads transfers to other stations in the area.

3. **Nebo TS T3/T4 Station Capacity**
   The load at existing Nebo TS (T3/T4) DESN also exceeds marginally over station supply capacity. However, load growth in the area is small.

   The Nebo TS (T3/T4) transformers are approaching their end of life and are already scheduled for replacement with larger capacity transformers in 2022. The capacity of the new replacement transformers will be sufficient over the study period.

   In the interim, the study team recommended that Horizon Utilities manage the overload (under contingency) by distribution loads transfers to other stations in the area and also undertake any targeted and effective CDM to keep the loading within supply capacity of existing facilities.

4. **Power factor at Cumberland TS**
   The power factor at Cumberland TS under peak load conditions is lagging slightly below the ORTAC requirement of 0.9.

   The study team recommended that Burlington Hydro work with their load customers supplied by Cumberland TS and install capacitor banks on distribution system as required to meet the power factor requirement of 0.9. Burlington Hydro will provide an update of the plan by Q2 2016.

5. **Power factor at Kenilworth TS**
   The power factor at Kenilworth TS is lagging below the ORTAC requirement of 0.9.

   The study team recommended that Horizon Utilities 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. Horizon Utilities will provide an update of the plan by Q2 2016.

6. **Power factor at Beach TS (115 kV T3/T4 DESN)**
   The power factor at Beach TS is leading beyond the ORTAC requirement of 0.9.

   The study team reviewed this requirement and recommended that no action is required at this time.

7. **Reactive support in Norfolk Area**
   The coincident load at Norfolk TS and Bloomsburg TS can be managed by load transfer and kept below the area supply limit of 87MW. The study team recommended that Hydro One distribution can manage the overload in Norfolk area by distribution loads transfers to neighboring stations.

8. **System Reliability, Operation and Load Restoration**
   In some cases, double circuit lines in the Region carry loads in excess of 150 MW and 250 MW thresholds.

   The study team based on the historical reliability data for the circuits in the region recommended that no action is required at this time.

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1 Introduction

The Needs Assessment (NA) for the Burlington to Nanticoke Region ("Region") was triggered in response to the Ontario Energy Board's (OEB) Regional Infrastructure Planning process approved in August 2013. Prior to the new regional planning process coming into effect, planning activities were already underway in the Region to address some specific area supply needs. The NA for the Burlington to Nanticoke Region was prepared jointly by the study team, including LDCs (Local Distribution Company), Independent Electric System Operator (IESO), Ontario Power Authority (merged with IESO as of January 2015 and herein referred to as IESO), and Hydro One Networks Inc.. The NA report can be found on Hydro One's Regional Planning website. The study team identified needs that are emerging in the Burlington to Nanticoke Region over the next ten years (2014 to 2023) and recommended whether they should be addressed by the transmitter-led Local Planning (LP) process or to be further assessed by the IESO-led Scoping Assessment (SA) process.

This report was prepared by the Burlington to Nanticoke Region LP study team (Table 1) and led by the transmitter, Hydro One Networks Inc. (HONI). The report captures the results of the assessment based on information provided by IESO, LDCs and HONI.

Table 1: Local Planning Study Team Participants for Burlington to Nanticoke Region

No.	Company
1.	Hydro One Networks Inc. (Lead Transmitter)
2.	Burlington Hydro Inc.
3.	Horizon Utilities Corporation
4.	Hydro One Networks Inc. (Distribution)

Burlington to Nanticoke Region: Description and Connection Configuration

The Burlington to Nanticoke Region is located in Southern Ontario and comprises the municipalities of Burlington, Hamilton, Oakville, Brantford, Brant County, Haldimand County, and Norfolk County. The approximate boundaries of the Burlington to Nanticoke region and its four sub-regions (areas) are shown below in Figure 1.

The Burlington to Nanticoke 230 kV and 500 kV systems are part of East-West bulk power system transfers mainly from the generation located in Western Ontario towards the GTA. This region has two 500 kV stations, Nanticoke TS and Middleport TS, interconnected through two 500 kV circuits and connected to 500 kV Longwood TS and Milton TS. Both these 500 kV stations have transformation capacities to 230 kV systems. The Burlington to Nanticoke region's 230 kV system has three autotransformer stations at Burlington TS, Beach TS, and Caledonia

TS supplying the 115 kV transformer stations. The Dunnville TS has been included in the Niagara Region (Group 3, Region 17) instead of the Burlington to Nanticoke Region (Group 1, Region 1)- a change to the May 17, 2013 OEB Planning Process Working Group Report.

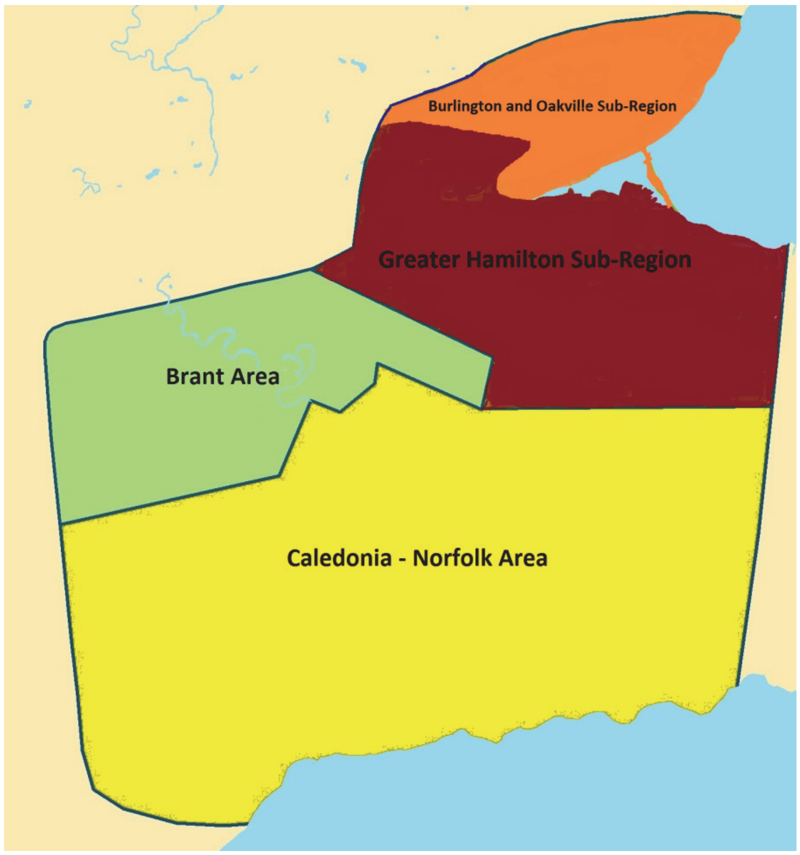

Figure 1: *Region and Sub-Region Approximate Boundaries*

The 230 kV interconnections of Burlington to Nanticoke Region to the rest of system consist of two circuits to Detweiler TS, three circuits to Buchanan TS and seven circuits to Beck TS. The 115 kV circuits are supplied from Burlington TS, Beach TS and Caledonia TS. A single line diagram of the 500kV, 230kV and 115 kV systems in the Burlington to Nanticoke Region is shown below in Figures 2 and 3.

The needs identified in the Needs Assessment are further reviewed in the next sections to determine the scope and type of regional planning study if appropriate for each of the relevant sub-regions.

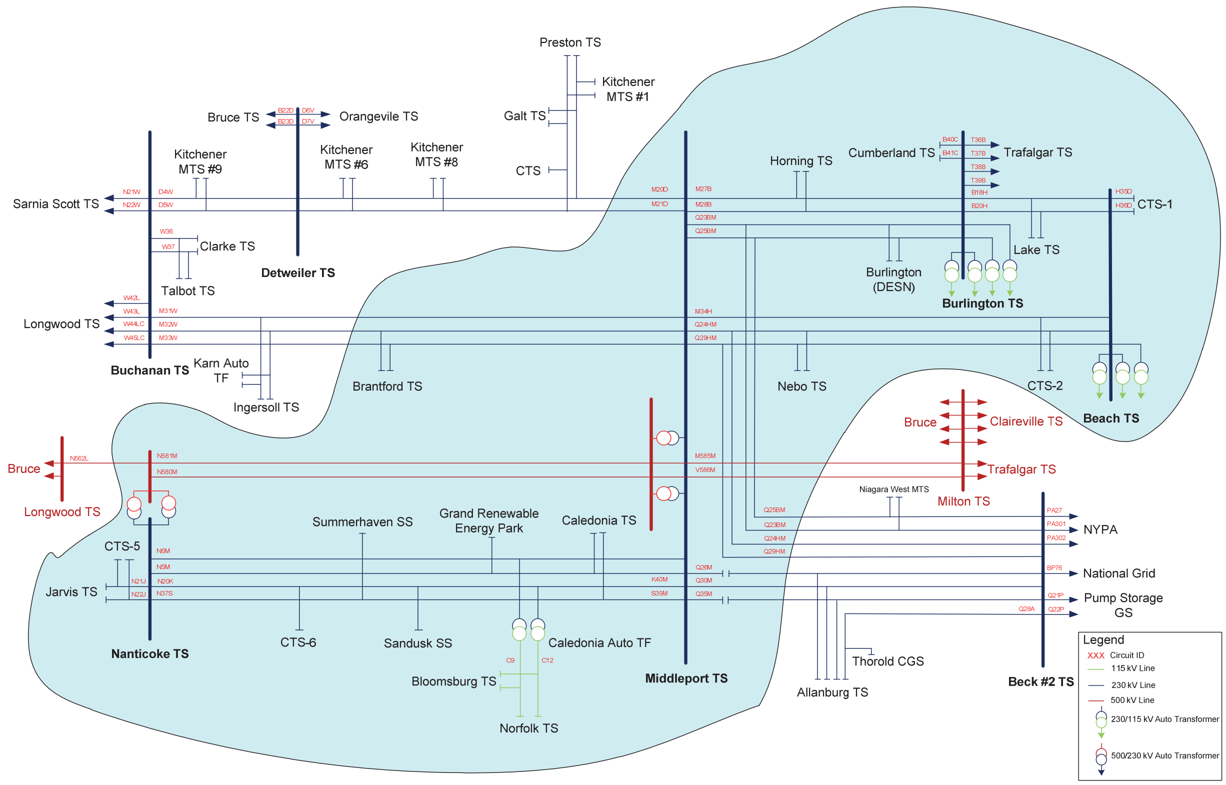

Figure 2: *Burlington to Nanticoke Region – 230 and 500 kV Single Line Diagram*

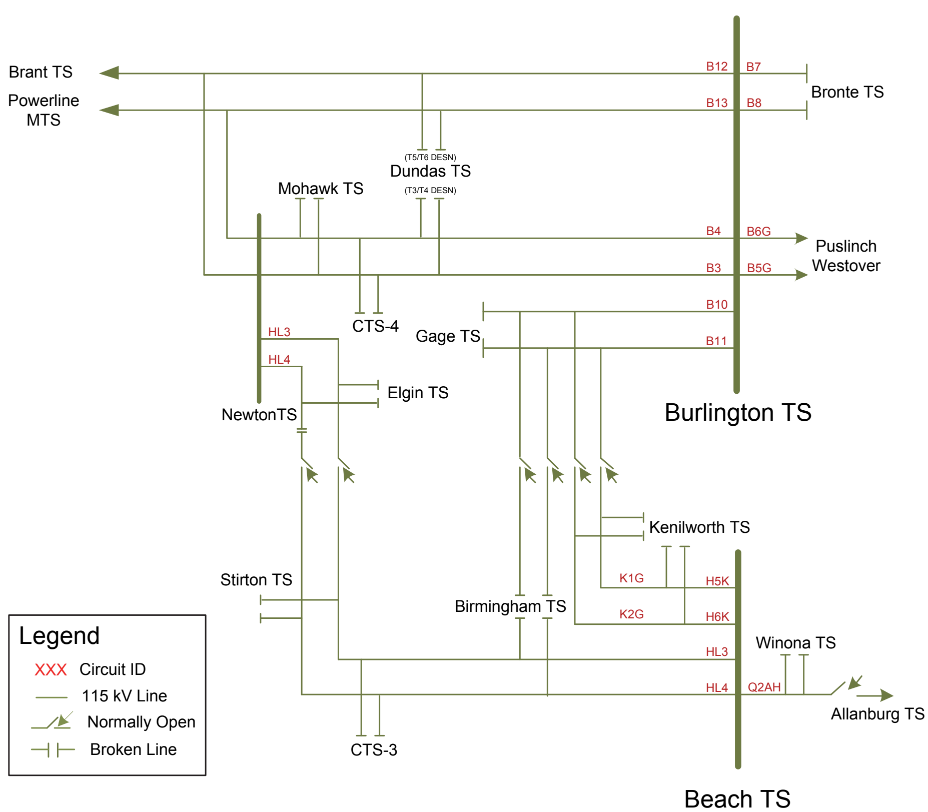

Figure 3: *Burlington and Beach 115 kV Single Line Diagram*

2 Burlington to Nanticoke Region Needs

The Brant Area (sub-region) assessment was in progress even prior to start of the Regional Planning process. An IRRP for this sub-region was completed on April 28, 2015.

Under Regional Planning process, the study team identified several needs after the Needs Assessment in the Burlington to Nanticoke Region that require further assessment and planning. The study team recommended that some of the near-term needs required "localized" wires only planning, while others required coordinated regional planning. The Needs Assessment is based upon the forecast prepared for the Burlington to Nanticoke Needs Assessment report given in Appendix –A. Where local planning was recommended to address the needs, Hydro One, as transmitter, with the impacted LDCs, further undertook planning assessments to develop options and recommend a wires only solution(s). For needs that required further regional planning and coordination, Scoping Assessment was done to determine if Integrated Regional Resource Planning (IRRP) or RIP process should be undertaken to address the needs. As a result, there are two IRRPs in the region for the two sub-regions. A) Brant sub-region IRRP was completed in April 2015 B) Bronte sub-region IRRP is currently under progress.

Brant IRRP identified that wires solution are required to provide additional capacity to serve the load as forecasted by the LDCs. The capacity needs at Bronte TS is part of the IRRP study that is still in progress while the issues with the loss of autotransformers at Burlington TS is being assessed as part of the Bulk System study led by the IESO.

The local needs identified and assessed in this region are as follow:

- Dundas TS T3/T4/T5/T6 Station Capacity
- Mohawk TS Supply Capacity
- Nebo TS T3/T4 Station Capacity
- Power factor at Cumberland TS
- Power factor at Kenilworth TS
- Power factor at Beach TS (115 kV T3/T4 DESN)
- Reactive support in Norfolk area
- System Reliability, Operation and Load Restoration

The load forecast provided in Appendix-A includes the forecast for Dundas TS, Mohawk TS and Nebo TS where capacity needs were identified in the Needs Assessment report. This forecast was prepared for the Burlington to Nanticoke Needs Assessment report and 2013 actual loads were used as a reference point. It is worth noting that the summer 2014 actual loads were lower than 2013 due to colder than normal summer and not used for planning purpose. The above listed needs are addressed in detail in the following sections and where applicable, the capital cost comparison for options for each need is provided in Appendix-B.

3 Dundas TS (T3/T4/T5/T6) Station Capacity

There are two 115/27.6 kV DESNs (T3/T4 and T5/T6) at Dundas TS with a total station capacity of 175.6 MW. The load at T3/T4 DESN exceeds its supply capacity.
The combined loading of the T3/T4 and T5/T6 DESNs at Dundas TS is forecasted to be 175.6 MW in 2023. The total capacity of the two DESNs at Dundas TS is thus sufficient over the study period i.e. until 2023.

3.1 Alternatives Considered

i. Transferring excess load from the overloaded T3/T4 DESN to the T5/T6 DESN

This was an obvious choice and no other option was considered to mitigate overloading of the Dundas TS T3/T4 DESN.

3.2 Next Steps

The study team recommends that Horizon Utilities and Hydro One Distribution develop a plan by the end of Q1 2016 and implement load balancing between the two DESNs by the end of 2016 as part of distribution planning. LDCs will provide a load balancing plan confirmation to Hydro One transmission by the end of Q1 2016.

4 Mohawk TS Supply Capacity

Mohawk TS and its supply circuits have load supplying capacity of 75.4 MW and 84.6 MW respectively. The load growth at Mohawk TS is slow with load forecast to increase from 83 MW in 2013 to 88.3 MW in 2023 exceeding station capacity by 12.9 MW.

At present the load at Mohawk TS exceeds station supply capacity and by the end of study period will marginally exceed the capacity of circuits supplying Mohawk TS.

4.1 Alternatives Considered

The mitigation options considered to address the overloading at Mohawk TS were:

i. Transfer excess load from Mohawk TS to adjacent area stations (Horning TS and Nebo TS) to reduce the loading levels under contingency conditions. There is adequate transfer capability between the stations for this purpose.

ii. Mohawk TS (T1/T2) transformers are approaching end of life and are already scheduled for replacement in 2018. The replaced T1/T2 transformers will be of higher capacity (about 90 MW) and sufficient beyond the study period.

4.2 Preferred Alternative

The preferred alternative is to replace the existing transformer with higher load supply capacity which is already scheduled to be complete in 2018. The capacity of new transformers will be sufficient over the study period and beyond.

Horizon Utilities will manage the loading at Mohawk TS within station and its supply circuit capacities during the study period by implementing operating measures such as load transfers.

4.3 Next Steps

Hydro One transmission will continue with the end of life replacement of transformers. In the interim, Horizon Utilities will develop a distribution load transfer plan to manage the load at Mohawk TS.

5 Nebo TS (T3/T4 DESN) Station Capacity

The 2013 summer peak load of Nebo TS 230 kV/13.8 kV T3/T4 DESN was 52.8 MW and exceeds the station supply capacity of 50.7 MW. The station load growth is slow with load forecasted to increase from 52.8 MW in 2013 to 54.2 MW in 2023 thus exceeding the station capacity by 3.5 MW.

5.1 Alternatives Considered

The mitigation options considered to address the overloading at Nebo TS were:

i. Transfer excess load to adjacent area station (Mohawk TS) to reduce loading under contingency conditions.

ii. Install additional new switchgear to utilize the capacity of the idle winding on the existing T3/T4 transformers. This will provide sufficient additional capacity to meet the currently projected load growth over and beyond the study period.

iii. Nebo TS (T3/T4) transformers are approaching end of life and are already scheduled for replacement in 2022. The replaced T3/T4 transformers will be of higher capacity (about 65 MW), which is sufficient over and beyond the study period.

5.2 Preferred Alternative

The preferred alternative is to transfer loads to neighboring stations until the transformers at Nebo TS are replaced in 2022. This is the most economical solution as it does not require any capital investments.

5.3 Next Steps

Hydro One will continue with the replacement of transformers reaching end of life. In the interim, Horizon Utilities will manage any overloading under contingency through distribution load transfer. Horizon Utilities will share details of load transfer plans with the study team by the end of Q2 2016 to manage overloading under emergency situations.

6 Power Factor at Cumberland TS

Cumberland TS is a 230/ 27.6 kV station having a load supplying capacity of 174.4 MW and 2013 peak load of about 135.2 MW. Under peak load conditions the power factor of Cumberland TS is 0.88 marginally below the ORTAC requirement of 0.9 lagging. An additional 8 MVARs of capacitor banks are required to meet power factor requirement.

6.1 Alternatives Considered

The options considered to improve the power factor at Cumberland TS were:

i. Installation of 20 MVAr capacitor bank (Hydro One standard size) at Cumberland TS.

ii. Installation of 8 MVAr of capacitor banks on the distribution system.

iii. Burlington Hydro to work with their existing load customers supplied by Cumberland TS to improve power factor.

6.2 Preferred Alternative

The preferred alternative is for Burlington Hydro to plan and work with their load customers supplied from Cumberland TS, and, if required, install capacitor banks on distribution system to meet the power factor requirement of 0.9. This is the most economical solution to improve the power factor at Cumberland TS.

6.3 Next Steps

The study team recommended Burlington Hydro to work with the load customers supplied by Cumberland TS to improve power factor and if needed develop a plan to install capacitor banks on distribution system. Burlington Hydro will develop and provide a distribution plan to Hydro One transmission by the end of Q2 2016.

7 Power Factor at Kenilworth TS

At present power factor at Kenilworth TS is lagging below ORTAC requirement of 0.9 lagging. Majority of the Kenilworth TS load is supplied to a large industrial customer.

7.1 Alternatives Considered

i. Installation of 20 MVAr capacitor bank (Hydro One standard size) at Kenilworth TS.

ii. Horizon Utilities to work with its load customer/s supplied at Kenilworth TS to improve power factor and/or install a 12MVar of capacitor banks on distribution system.

7.2 Preferred Alternative

The preferred alternative is for Horizon Utilities to work with the load customers supplied by Kenilworth TS and if needed install capacitor banks on distribution system to improve the power factor. This is the most economical solution for improving the power factor.

7.3 Next Steps

Horizon Utilities is requested to work with its load customer/s supplied at Kenilworth TS to improve power factor and if needed develop a plan to install capacitor bank on distribution system. Horizon Utilities will provide an update of their distribution plan to the study team by the end of Q2 2016 to improve power factor at Kenilworth TS.

8 Power Factor at Beach TS (115 kV T3/T4 DESN)

The power factor at Beach TS is leading beyond 0.9 while it is required to remain between 0.9 lagging and 0.9 leading.

8.1 Alternatives Considered

The study team reviewed this requirement and recommended that operating measures are in place and no further action is required.

8.2 Next Steps

The study team recommended that no action is required at this time.

9 Reactive support for the Norfolk area

Reactive support is required post single line contingency (for the loss of one of C9 or C12 circuits) in Norfolk area (Norfolk TS and Bloomsburg TS) when the total combined coincident load of Norfolk TS and Bloomsburg TS exceeds 87 MW. The 2013 coincident peak load of Norfolk TS and Bloomsburg TS was 85.8 MW and is forecasted to approach 87 MW by the year 2021 and 92.3 MW in 2023, exceeding Norfolk area supply limit by 5.3 MW as provided in Appendix-C.

9.1 Alternatives Considered

The following options were considered to address low voltage issue at Norfolk TS and Bloomsburg TS:

i. Installation of 20 MVAr capacitor bank at Bloomsburg TS.

ii. Installation of capacitor banks on distribution system in Norfolk area.

iii. Norfolk TS and Bloomsburg TS loads of about 6MW can be seasonally or permanently transferred to Jarvis TS.

9.2 Preferred Alternative

The preferred alternative is to transfer 6.0 MW of load from Norfolk TS and Bloomsburg TS to Jarvis TS which is sufficient to offset the 5.3 MW of load in excess of 87 MW in 2023. For the study period beyond 2021 (till 2023) the coincident load at Norfolk TS and Bloomsburg TS can be kept below the area supply limit of 87 MW through load transfers, if required. This solution requires the least investment and therefore was chosen as being the most economical.

9.3 Next Steps

Hydro One distribution will further investigate the load transfer capability from Norfolk and Bloomsburg TS to Jarvis TS and develop a distribution load transfer/s plan. Hydro One distribution will provide an update to Hydro One transmission by the end of Q2 2016.

10 System Reliability, Operation and Load Restoration

Load loss of 150 MW or more should be restored within 4 hours and 250 MW or more within 30 minutes or as agreed between the transmitter and the LDC.

By the year 2023, at peak load times only, the following circuits in the region are expected to supply loads of over 250 MW:

- Q24HM+Q29HM
- B3+B4

And over 150 MW:

- N21J+N22J
- M32W+ M33W
- Q23BM+Q25BM
- H35D+H36D
- HL3+HL4 (Load connected to Beach TS)
- B7+B8

10.1 Further Review and Assessment

The table below contains historic reliability data of last 25 years for the circuits in the region.

Table 2: Common Mode Reliability Statistics for Circuits Carrying more than 150 MW

No.	Circuits	No. of Momentary Outages	No. of Sustained Outages	Longest Outage Duration (Min)	Average Outage Duration (Min)
1	Q24 HM/ Q29HM	1	0	0	0
2	M32W/ M33W	1	1	3	3
3	N21J/ N22J	0	1	9	9
4	Q23BM/ Q25BM	0	1	7	7
5	H35D/ H36D	0	0	0	0
6	B7/ B8	0	0	0	0
7	B3/ B4	6	3	8	5.3
8	HL3/ HL4	0	1	3	3

During the past 25 years, the eight (8) pair of circuits in the above had only eight (8) momentary and seven (7) non-momentary outages. The longest non-momentary outage was nine (9) minutes which is well within the most stringent ORTAC restoration criteria of 30 minutes.

Based on the above information, Hydro One transmission and the relevant LDC/s agree that reliability and load restoration in the above area has a :

a) Historically good supply reliability and load restoration, and
b) Restoration time gains will be insignificant by line sectionalizing, and
c) Any infrastructure investments will have little or no benefit but result in cost for rate payers

As a result, no further action is required, unless there is a significant change in system conditions or configuration.

10.2 Next Steps

Based on the historical reliability data for the circuits in the region, the study team recommends that no action is required at this time.

11 References

i) Planning Process Working Group (PPWG) Report to the Board: The Process for Regional Infrastructure Planning in Ontario – May 17, 2013
ii) IESO Ontario Resource and Transmission Assessment Criteria (ORTAC) – Issue 5.0
iii) Burlington to Nanticoke Region Needs Assessment Report
iv) Burlington to Nanticoke Region Scoping Assessment Report

12 Acronyms

BES	Bulk Electric System
BPS	Bulk Power System
CDM	Conservation and Demand Management
CIA	Customer Impact Assessment
CGS	Customer Generating Station
CTS	Customer Transformer Station
DESN	Dual Element Spot Network
DG	Distributed Generation
DSC	Distribution System Code
GS	Generating Station
GTA	Greater Toronto Area
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Planning
kV	Kilovolt
LDC	Local Distribution Company
LTE	Long Term Emergency
LTR	Limited Time Rating
LV	Low-voltage
MW	Megawatt
MVA	Mega Volt-Ampere
NA	Needs Assessment
NERC	North American Electric Reliability Corporation
NGS	Nuclear Generating Station
NPCC	Northeast Power Coordinating Council Inc.
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 Planning
SIA	System Impact Assessment
SA	Scoping Assessment
SS	Switching Station
TS	Transformer Station
TSC	Transmission System Code
ULTC	Under Load Tap Changer

Appendix A – Load Forecast

Appendix A – Middleport Nanticoke Region Forecast

Non-Coincident Peak Station Loads

Station				LTR in MW (P.f =0.9)	Dist. Load (MW)	Forecasted Loads (MW)-------->									
No.	Name	DESN	BUS		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	Bronte TS	T2		75.0	69.9	70.4	70.9	71.4	71.9	72.5	73.0	73.5	74.0	74.5	75.0
2	Bronte TS	T5/T6		90.9	84.9	85.7	86.5	87.4	88.2	89.0	89.8	90.6	91.5	92.3	93.1
3	Burlington TS DESN	T15/T16		175.5	166.1	166.1	166.1	166.1	166.1	166.1	166.1	166.1	166.1	166.1	166.1
4	Cumberland TS	T3/T4		174.4	135.2	136.4	137.7	138.9	140.2	141.4	142.7	143.9	145.2	146.4	147.6
5	Caledonia TS	T1/T2		99.0	51.1	52.3	53.5	54.6	55.8	57.0	58.1	59.3	60.4	61.6	62.8
6	Jarvis TS	T3/T4	BY	99.4	82.9	83.5	84.1	84.8	85.4	86.0	86.6	87.2	87.8	88.4	89.0
7	Beach TS	T3/T4	B1B2	71.1	7.3	7.3	7.3	7.3	7.3	7.4	7.4	7.4	7.4	7.4	7.5
8	Beach TS	T3/T4	Y1Y2		18.8	18.9	18.9	19.0	19.0	19.0	19.1	19.1	19.2	19.2	19.3
9	Beach TS	T5/T6	Q1Q2	90.5	26.2	26.3	26.3	26.4	26.5	26.5	26.6	26.7	26.7	26.8	26.9
10	Beach TS	T5/T6	J1J2		23.3	23.4	23.4	23.5	23.6	23.6	23.7	23.8	23.8	23.9	23.9
11	Birmingham TS	T1/T2	BY	76.3	28.8	28.9	28.9	29.0	29.1	29.2	29.2	29.3	29.4	29.4	29.5
12	Birmingham TS	T1/T2	QJ		19.4	19.4	19.5	19.5	19.6	19.6	19.7	19.8	19.8	19.9	19.9
13	Birmingham TS	T3/T4	EZ	90.9	18.4	18.4	18.5	18.5	18.6	18.6	18.7	18.7	18.8	18.8	18.8
14	Birmingham TS	T3/T4	DK		28.4	28.4	28.5	28.6	28.6	28.7	28.8	28.9	28.9	29.0	29.1
15	Dundas TS	T3/T4		87.0	110.5	111.6	112.8	113.9	115.0	116.1	117.2	118.3	119.5	120.6	121.7
16	Dundas TS #2	T5/T6		88.6	48.3	48.8	49.4	50.0	50.5	51.1	51.6	52.2	52.8	53.3	53.9
17	Elgin TS	T1/T2	DK	79.9	33.6	33.7	33.8	33.8	33.9	34.0	34.1	34.2	34.3	34.4	34.5
18	Elgin TS	T1/T2	QJ		32.6	33.0	33.5	33.9	34.3	34.8	35.2	35.6	36.0	36.5	36.9
19	Elgin TS	T3/T4	EZ	40.2	20.1	20.1	20.2	20.2	20.2	20.3	20.3	20.4	20.4	20.5	20.5
20	Gage TS	T3/T4	ZY	56.7	26.8	26.8	26.9	27.0	27.0	27.1	27.2	27.2	27.3	27.4	27.5
21	Gage TS	T5/T6	DJ	56.7	13.3	13.3	13.3	13.4	13.4	13.4	13.4	13.5	13.5	13.5	13.6
22	Gage TS	T8/T9	EK	123.5	13.9	13.9	13.9	14.0	14.0	14.0	14.1	14.1	14.1	14.2	14.2

Appendix A- Continued…………

Station				LTR in MW (P.f =0.9)	Dist. Load (MW)	Forecasted Loads (MW)-------->									
No.	Name	DESN	BUS		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
23	Horning TS	T1/T2	B1B2	102.2	49.1	49.2	49.4	49.6	49.7	49.9	50.1	50.2	50.4	50.6	50.7
24	Horning TS	T1/T2	Q1Q2		23.5	24.6	25.6	26.6	27.6	28.7	29.7	30.7	31.7	32.8	33.8
25	Kenilworth TS	T1/T4	EJ	35.6	29.9	30.0	30.1	30.2	30.2	30.3	30.4	30.5	30.5	30.6	30.7
26	Kenilworth TS	T2/T3	B1Y1	64.8	31.0	31.1	31.1	31.2	31.3	31.4	31.5	31.6	31.6	31.7	31.8
27	Lake TS	T1/T2	BY	93.7	62.0	62.8	63.5	64.3	65.0	65.8	66.5	67.3	68.0	68.8	69.5
28	Lake TS	T3/T4	J1J2	113.1	30.8	30.8	30.9	31.0	31.1	31.1	31.2	31.3	31.4	31.4	31.5
29	Lake TS	T3/T4	Q1Q2		28.2	28.6	28.9	29.3	29.6	29.9	30.3	30.6	30.9	31.3	31.6
30	Mohawk TS	T1/T2	B1B2	75.4	41.5	41.9	42.3	42.7	43.2	43.6	44.0	44.4	44.9	45.3	45.7
31	Mohawk TS	T1/T2	Y1Y2		41.5	41.6	41.7	41.8	41.9	42.0	42.1	42.2	42.3	42.4	42.6
32	Nebo TS	T1/T2		178.3	90.0	96.7	103.3	110.0	116.6	123.3	130.0	136.6	143.3	149.9	156.6
33	Nebo TS	T3/T4		50.7	52.8	52.9	53.1	53.2	53.4	53.5	53.7	53.8	53.9	54.1	54.2
34	Newton TS	T1/T2	B	73.8	23.9	24.4	24.8	25.3	25.7	26.2	26.6	27.0	27.5	27.9	28.4
35	Newton TS	T1/T2	Y		22.5	22.6	22.6	22.7	22.7	22.8	22.8	22.9	22.9	23.0	23.0
36	Stirton TS	T3/T4	BY	105.8	23.7	23.8	23.9	23.9	24.0	24.0	24.1	24.2	24.2	24.3	24.4
37	Stirton TS	T3/T4	QZ		27.1	27.2	27.2	27.3	27.4	27.5	27.5	27.6	27.7	27.8	27.8
38	Winona TS	T1/T2		88.6	46.1	46.6	47.2	47.8	48.3	48.9	49.4	50.0	50.6	51.1	51.7
39	Norfolk TS	T1/T2		91.4	57.4	58.6	59.9	61.1	62.4	63.6	64.9	66.1	67.4	68.7	69.9
40	Bloomsburg TS	T1/T2			47.3	47.8	48.3	48.7	49.2	49.7	50.2	50.6	51.1	51.6	52.1

Appendix B - Capital Cost Comparison of Mitigation Options

Appendix B – Capital Cost Comparison of Mitigation Options

A. Reactive Support at Bloomsburg MTS **(All Costs in $ Million)**

Mitigation Options	No.	Unit Cost	Cost Calculation	Total Cost
Capacitor bank at Bloomsburg TS (20MVAr)	1	2.2	1 x 2.2	2.2
Load Transfers	0	0	0	0
Monitor loading trends	0	0	0	0

B. Dundas TS T3/T4/T5/T6 Station Capacity **(All Costs in $ Million)**

Mitigation Options	No.	Unit Cost	Cost Calculation	Total Cost
Load balancing between two DESNs	0	0	0	0

C. Power factor at Cumberland TS **(All Costs in $ Million)**

Mitigation Options	No.	Unit Cost	Cost Calculation	Total Cost
Capacitor bank at Cumberland TS (20MVAr)	1	2.2	1 x 2.2	2.2
Capacitor banks on distribution system (0.9 MVAr)	9	0.03	9 x 0.03	0.27
Load customers to improve power factor	0	0	0	0

D. Mohawk TS T1/T2 Station Capacity **(All Costs in $ Million)**

Mitigation Options	No.	Unit Cost	Cost Calculation	Total Cost
Targeted CDM	0	0	0	0
Load transfers	0	0	0	0
New T1/T2 transformers at Mohawk TS*	1	15	1 x 15	15

*- Already scheduled for replacement (approaching end of expected useful life)

Appendix B – Continued………..

E. Nebo TS T3/T4 Station Capacity **(All Costs in $ Million)**

Mitigation Options	No.	Unit Cost	Cost Calculation	Total Cost
Targeted CDM	0	0	0	0
Load transfers	0	0	0	0
Switchgear to utilize spare winding	1	5.5	1x 5.5	5.5
New T3/T4 transformers at Nebo TS*	1	14	1 x 14	14

*- Already scheduled for replacement (approaching end of expected useful life)

F. Power factor at Kenilworth TS **(All Costs in $ Million)**

Mitigation Options	No.	Unit Cost	Cost Calculation	Total Cost
Capacitor bank at Kenilworth TS (20MVAr)	1	2.2	1 x 2.2	2.2
Capacitor banks on distribution system (0.9 MVAr)	14	0.03	14 x 0.03	0.42
Load customers to improve power factor	0	0	0	0

G. Power Factor at Beach TS (115 kV T3/T4 DESN) **(All Costs in $ Million)**

Mitigation Options	No.	Unit Cost	Cost Calculation	Total Cost
No action required	0	0	0	0

H. System Reliability, Operation and Load Restoration **(All Costs in $ Million)**

Mitigation Options	No.	Unit Cost	Cost Calculation	Total Cost
Monitor loading trends	0	0	0	0

Appendix C – Norfolk Area Forecast - Coincident Load on 115kV circuit C9/C12

Appendix C – Norfolk Area Forecast - Coincident Load on 115kV circuit C9/C12

(All Values in MW)

	Forecasted Peak Loads										
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Norfolk TS	49.2	40.9	42.4	43.6	44.7	46.1	47.3	48.5	49.8	51.1	52.6
Bloomsburg TS	36.6	36.8	37.0	37.1	37.4	37.8	38.2	38.5	39.0	39.4	39.7
Total	85.8	77.7	79.4	80.6	82.1	83.9	85.5	86.9	88.8	90.5	92.3