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LOCAL PLANNING REPORT

Greater London Sub-region Restoration
Region: London Area

Date: October 15, 2021
Revision: Final

Prepared by: Greater London Sub-region Local Planning Study Team

This report is prepared on behalf of the Greater London Sub-region Local Planning study team with the participation of representatives from the following organizations:

Organizations
Hydro One Networks Inc. (Lead Transmitter)
London Hydro Inc.

Disclaimer

This Local Planning Report was prepared for the purpose of developing and recommending a preferred solution(s) to address the local needs identified in the Needs Assessment (NA) report for the London Region that 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.

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LOCAL PLANNING EXECUTIVE SUMMARY

REGION	London Region (the "Region")		
LEAD	Hydro One Networks Inc. ("Hydro One")		
START DATE	December 10, 2020	**END DATE**	October 15, 2021

1. INTRODUCTION

To assess the transmission system supplying the London Region, a Needs Assessment study was conducted in 2020 and few needs were identified. However, it was determined during the Needs Assessment that no regional coordination is required to address these needs. The Study Team recommended that the Greater London sub-region load restoration need would be best assessed through Local Planning ("LP") led by Hydro One with participation of the affected LDC, London Hydro. The purpose of this Local Planning engagement was to develop and recommend a preferred solution that will address the Greater London sub-region restoration need referenced in the 2nd cycle Needs Assessment report for London Area.

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".

2. LOCAL NEED ASSESSED IN THIS REPORT

For the simultaneous loss of two transmission elements (W36/W37), previous assessment indicated that the load interrupted during peak periods would exceed 250 MW. Single element contingency under planned outage scenarios is beyond the scope of local planning. Diligently planning the routine maintenance outages during off peak seasons, a normal outage planning practice, can address the loss of load concerns over losing one circuit during the planned outage of the companion circuit.

Further, as identified in the Needs Assessment, the load interrupted is expected to be about 390 MW in 2029 following the simultaneous loss of the 230 kV supply circuits W36 /W37.

3. FINDINGS

The Local Planning Study Team have confirmed that several mitigation measures were implemented on the distribution system along with the completion of the Nelson TS 27.6kV conversion project. The completion of these measures impart flexibility and improve 4-hour restoration, however, London Hydro's 30-minute restoration capability is up to 60 MW, but may be less depending on feeder configurations at the time and load growth in the future.

Accordingly, the distribution solutions are not capable of addressing 30-minutes load restoration capacity under simultaneous loss of W36/W37.

To assess the situation further, Hydro One carried out historical reliability analysis of the forced outage data for transmission circuits W36 and W37 over the period 2000 to 2019 to compute the performance of these circuits over the twenty-year period (2000 to 2019) and the 10-year period (2010 to 2019). There was no common mode failure on these two circuits in the past 10 years contributing zero (0) hours of annual outage and only 0.00417 hours of total outage duration was observed over the last 20 years. This outage contribution was due to an event that resulted in the outage of one circuit for 5 minutes and other experiencing a transient disturbance. Hence, it can be concluded that there is a very small probability of losing both W36/W37 supply circuits simultaneously.

The current situation and load forecast do not warrant any action at this time. Three (3) transmission options were identified if the load grows in future.

4. CONCLUSION

Considering the very low probability of losing W36/37 simultaneously, the Local Planning Study Team agreed that no action is required at this time. Further, the Study team has agreed to monitor the performance and future load growth on the impacted stations so that the supply reliability and/or load restoration situation does not worsen.

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1 Introduction

As part of the OEB-mandated regional planning process, a Needs Assessment study for London area was conducted in May 2020 by Hydro One Transmission, Independent Electricity System Operator ("IESO"), Erie Thames Powerlines, Entegrus, Hydro One Distribution, London Hydro, St. Thomas Energy, Tillsonburg Hydro, and Woodstock Hydro. The study assessed the electricity infrastructure supplying the London Region for the ten-year period starting from 2019 and it identified only a few needs in the area. It was determined that the needs are local in nature and does not require any regional coordination.

This Local Planning report is prepared for the purposes of addressing the Greater London sub-region W36/W37 restoration need referenced in Needs Assessment for London Area. The Greater London sub-region Local Planning Study Team consists of London Hydro and Hydro One Networks Inc. (Transmission).

1.1 Geographical Area and Existing Supply Network

The Greater London sub-region is located in southwestern Ontario and includes the city of London and parts of Middlesex County. The following seven dual element spot network ("DESN") transformer stations ("TS") serve this sub-region: Buchanan TS, Clarke TS, Highbury TS, Nelson TS, Talbot TS DESN 1, Talbot DESN 2, and Wonderland TS. The DESNs in the sub-region are served by 230 kV transmission circuits W36/37, N21/22W, W42/43L, and 115 kV circuits W5N/W6NL/W9L, and the 230/115 kV autotransformers at Buchanan TS. Only Nelson TS and Highbury TS in the sub-region are supplied through 115kV supply system. Talbot TS has two DESNs, T1/T2 and T3/T4.

The Greater London sub-region's electricity demand is a mix of residential, commercial and industrial loads. There is no major transmission connected generation facility except distributed generation in the sub-region. A map of the Greater London sub-region and schematic of the existing transmission system of the area are shown in Figure 1 and Figure 2, respectively.

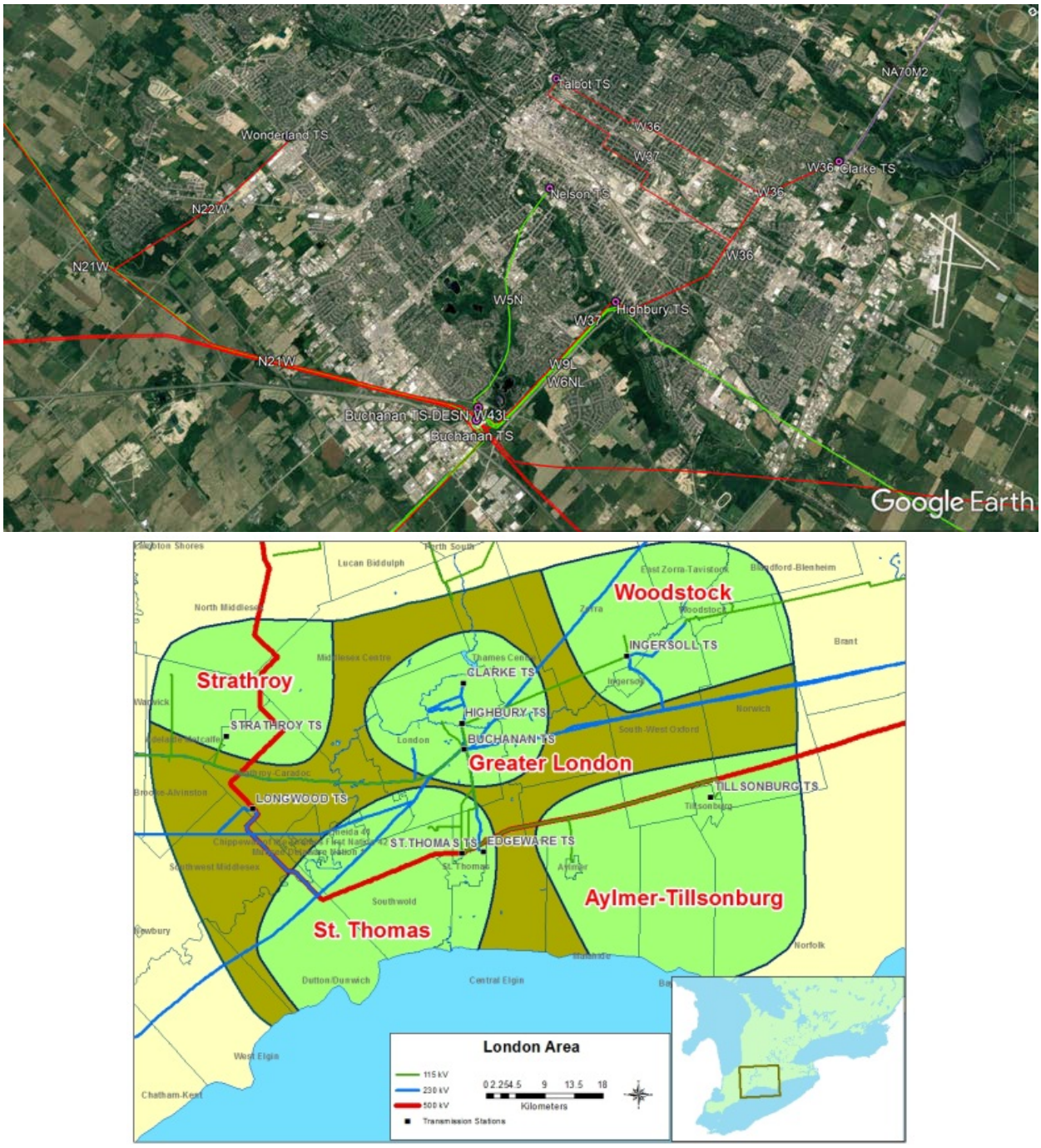

Figure 1 - Map of Greater London Sub-region and London Region

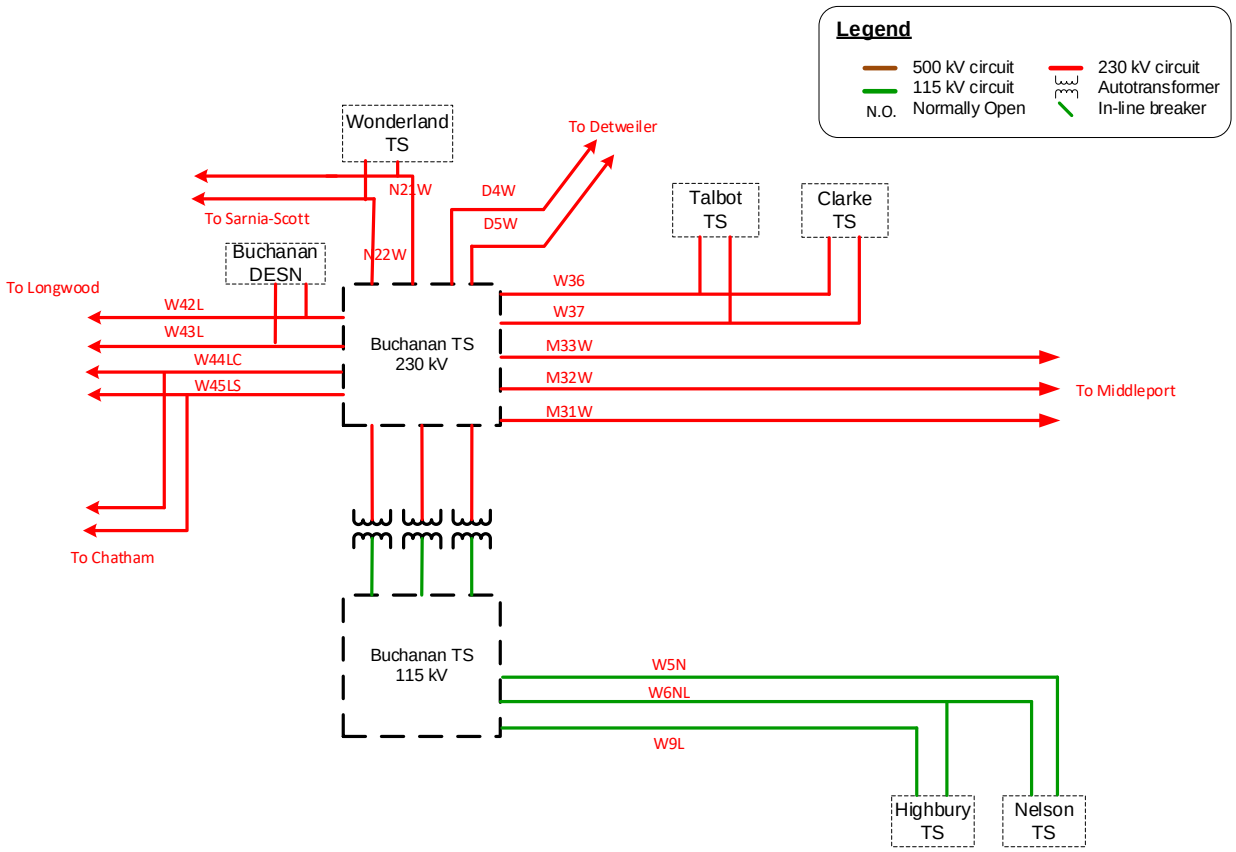

Figure 2 - Simplified schematic of Greater London sub-region transmission system

1.2 Planned and Committed Facilities

There are projects that have been recently completed along with investments that are currently under development or in execution to address immediate and near term needs and reliability issues within the Greater London sub-region. A brief summary of these projects is provided below.

Distribution Projects:

London Hydro confirmed the implementation of several measures identified as recommended in the 1st cycle of regional planning and installed ten (10) automated switches and two additional feeder extensions to non-Clarke and non-Talbot stations.

Transmission Projects:

The following transmission projects have been recently completed or are under development or execution:

1) Nelson TS – Transformer replacement and voltage conversion from 13.8kV to 27.6kV was recently completed
2) Buchanan TS – Like-for-like replacement of the autotransformer T3 and existing 115 kV switchyard, scheduled to be completed in 2025. Project scope will be refined upon asset condition verification.
3) Clarke TS - Transformer replacement, a like-for-like replacement is planned for 2028.

4) Talbot TS – Transformers replacement (T3/T4), a like-for-like replacement is planned for 2028.
5) Wonderland TS – Like-for-like replacement of the 27.6 kV switchyard is planned for 2025.

2 Load Forecast

The assessment uses the ten (10) year electricity load forecast prepared for the Needs Assessment with input from LDCs and the IESO. The aggregate loads for the Talbot TS and Clarke TS determines the total load served by the W36/W37 lines, as shown in Table 1.

The resultant net load forecast on a station basis is tabulated in Table 1.

Table 1 - Ten-Year Load Forecast for Clarke and Talbot Transformer Stations (MW)

Transformer Stations	LTR - Summer	Quantities	Historical Data - Unadjusted (MW)			Reference	Near Term Forecast (MW)					Medium Term Forecast (MW)				
			2017	2018	2019	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Clarke TS	103.95	Gross				114.79	116.57	118.38	120.22	122.09	123.98	125.91	127.86	129.85	131.87	133.92
		DG					2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61
		CDM					0.96	1.07	1.33	1.69	1.96	2.27	2.50	2.88	3.11	3.20
		Net	103.75	97.34	106.94		113.00	114.70	116.28	117.78	119.41	121.02	122.75	124.36	126.15	128.11
Talbot T1/T2	113.49	Gross				112.00	111.96	111.91	111.87	111.83	111.78	111.74	111.70	111.66	111.61	111.57
		DG														
		CDM					0.92	1.01	1.24	1.55	1.76	2.02	2.18	2.48	2.63	2.66
		Net	110.14	127.33	104.34		111.04	110.90	110.63	110.28	110.02	109.72	109.52	109.18	108.98	108.91
Talbot T3/T4	161.64	Gross				172.58	171.82	171.06	170.31	169.56	168.81	168.06	167.32	166.58	165.85	165.12
		DG					12.13	12.13	12.13	12.13	12.13	12.13	12.13	12.13	12.13	0.37
		CDM					1.41	1.54	1.88	2.35	2.66	3.04	3.27	3.69	3.91	3.94
		Net	153.94	162.62	160.78		158.28	157.39	156.30	155.08	154.02	152.90	151.92	150.76	149.81	160.80
Total	379	**Net Load**	368	387	372		382	383	383	383	383	384	384	384	385	398

Further, the historic ten (10) year hourly load profile was assessed to determine the number of peak load instances and their durations. It was determined that peak loads beyond 350 MW occur less than five times in a month on an average in the summer, and only last for 2-3 hours. The assessment of the low probability of simultaneously losing both W36/W37 lines during peak load scenarios is detailed in the section below.

3 Assessment and Findings

3.1 Background

The Ontario Resource and Transmission Assessment Criteria ("ORTAC") outlines the supply reliability planning requirements to ensure loading on the transmission network does not exceed equipment ratings under both normal and contingency operating conditions. Among other things, the supply restoration criteria in ORTAC requires that in the planning of electrical services to an area, the delivery system needs to have sufficient ability to restore interrupted load in a reasonable time following the critical double-element of [N–2] contingency. Specifically, the *transmission system* must be planned such that, ORTAC design criteria contingencies on the *transmission system*, affected loads can be restored within the restoration times as follows:

- Any load interrupted over 250 MW require restoration within 30 minutes
- For load interrupted over 150 MW and less than 250 MW require restoration within 4 hours
- With the remaining load (150MW or less) restored in 8 hours.

Additionally, the maximum amount of load that can be interrupted under the security criterion for a [N–2] contingency is 600 MW. Note that the 30-minute timeline is generally meant to account for the distribution and transmission remote switching capabilities from the control rooms. The 4 hour duration is to account for transmission and distribution restoration activities in the field such as opening transmission connection loops or replacing insulators strings etc. and the 8 hour duration is for extensive repair to physical damage and restoration. The accessibility and repair times depends on the severity of weather and amount resultant damage. Note that ORTAC does not apply to a major events or force majeure conditions e.g. loss of multiple towers due to major storm, etc.

3.2 Load Restoration Issue

For the Greater London sub-region, the critical line section for [N–2] contingency analysis is W36/W37, which supplies one (1) DESN at Clarke TS and two (2) DESNs at Talbot TS. This 230 kV double circuit line, W36 and W37, originates from Buchanan TS and running to Clarke TS, supplying Talbot in between. Note that the two lines run along an isolated corridor for about seven (7) kilometers until the Second Street and Dundas Street East intersection (Dundas Street Junction), where W37, through an underground section of about six (6) kilometers, reaches Talbot TS. Less than 1.8 kilometers of line section running along Second Street from Dundas Street East to Oxford Street may be exposed to some risk resulting from vehicular traffic. At Oxford Street (Oxford Street Junction), W36, through an underground line section of about seven (7) kilometers, supplies Talbot TS. The double circuit line W36/W37 from Oxford Street runs along an isolated corridor for about two (2) kilometers to supply Clarke TS. Note that the supply taps to Talbot runs through two separate underground corridors.

Should the simultaneous loss of W36/W37 occur, all of the loads supplied by the Clarke and Talbot DESNs, which amounts to 382 MW (forecasted) in 2020 (Table 1), would be interrupted by configuration. In accordance with ORTAC, the system is required to restore 142 MW within 30 minutes, 100 MW within 4 hours and the remaining 150 MW within 8 hours. Note that the actual coincident peak for the Clarke and Talbot DESNs was 373 MW in July 2020.

3.3 Current Status

The Study Team has confirmed that, despite the implementation of several mitigation measures and completing the Nelson TS 27.6kV conversion project, the 30-minute restoration capacity cannot be met. After assessing the restoration capabilities, based on real time practical switching practices and experience, the Study Team concluded that the completion of the recommended actions does impart flexibility and improve 4-hour restoration; but due to practical limitations of only accomplishing 3 to 6 feeder reconfiguration operations in 30 minutes, considering at

minimum utilization of two (2) automated devices per feeder to isolate, reconfigure and re-energize, 30-minute restoration capability at best would be 60 MW at the present time.

Accordingly, the distribution solutions implemented thus far are not capable of addressing the 30-minute load restoration capacity under simultaneous loss of W36/W37. The 4 hour and 8 hour restoration needs are not an issue at this time, based on system peaks only lasting 2-3 hours, thereby able to ride through the contingency until repairs may be performed.

Also removing Highbury TS's LTR restriction due to the existing metalclad switchgear bushing limitation may increase the 30-minute load restoration capability for the sub-region, however, addressing the LTR restriction requires metalclad replacement, which at this time is not at end-of-life. Though the load growth or the asset condition does not warrant metalclad replacement at this time, removing the Highbury LTR restriction will provide operational flexibility.

As W36/W37 forms part of the local transmission supply system, the cost recovery of any investment for mitigation measures to address the violation of ORTAC criteria, shall be borne by the LDC or the customer in accordance with the Transmission System Code.

3.4 Further Assessment

To assess the situation further, Hydro One carried out historical reliability analysis of the forced outage data for circuits W36 and W37 over the period 2000 to 2019 to compute the performance of these circuits over the twenty-year period (2000 to 2019) and the 10-year period (2010 to 2019). There were no common mode failures on the two circuits in past 10 years contributing zero (0) hours of annual outage and it observed 0.00417 hours of total annual outage duration over past 20 years. This contribution was due to one single event that resulted in an outage of one circuit for 5 minutes and other experiencing a transient disturbance. The Study Team concludes that there is a very small probability of losing both W36/W37 supply circuits simultaneously. Single element contingency under planned outage scenarios is beyond the scope of local planning. Diligently planning the routine maintenance outages during off peak seasons, a normal outage planning practice, can address the loss of load concerns over losing one circuit during the planned outage of the companion circuit.

The only single element failure that may result in the simultaneous loss of both W36/W37 is the failure of the steel poles that carry two circuits. The probability of damaging or completely knocking down the 230kV steel towers (white poles shown in street views below) is very low and highly unlikely. As discussed, less than 1.8 kilometers of line section running along Second Street from Dundas Street East to Oxford Street in the city of London, may be exposed to some risk resulting from vehicular traffic. Such poles are resilient and protected by guardrails in locations where they have most likelihood of coming in contact of vehicular traffic.

As the probability of simultaneous loss of W36/W37 is very low based on historical performance

data and considering the economics of mitigation measures, the Study Team recommends no action is required at this time. In the event of simultaneous loss of both 230kV circuits, the risk can be managed by Hydro One and London Hydro as it is expected to restore the power in 8 hours working in close coordination.

Figure 3 - Steel Tower carrying 230kV double circuits – running through isolated corridor

Figure 4 - Steel Tower carrying 230kV double circuits in the city of London – ~1.8km section

Figure 5 - Steel Tower carrying 230kV double circuits with guardrails around it

3.5 Future Considerations and Options Assessment

The current situation and load forecast do not warrant any additional actions at this time. However, if the load grows in future and imposes a need of additional load supply capacity, the following load supply capacity reinforcement options can be analyzed:

Transmission Options

- Depending upon the load growth pocket, the existing W36/W37 circuits may be reconductored ($15-$20 M) to provide the additional supply capacity to Clarke TS, 2nd DESN at Clarke ($30M). Note that this option does not serve the load restoration needs however, the probability of losing both circuit being very low, this option provides most economical solution to cater increased demand in future.
- Building a second DESN at Nelson and re-termination of 115 kV supply circuits at Buchanan to attain higher supply capacity on 115kV system ($50 -$60M). If the load further grows, the 115kV supply to Nelson TS has a potential for conversion to 230 KV at an additional cost ($40-60 M).
- Running 230kV cables from Wonderland TS to Talbot TS (additional supply circuits) for about 6 km and termination facilities at the two stations ($100 -$150M)

In addition, the following alternatives were reviewed, and deemed technically and economically infeasible:

- Transmission interconnection to the 115kV supply system in the north east, the St. Mary's area, served by a single 115kV circuit, L7S.
- Tapping the D4W/D5W lines between Buchanan TS and Detweiler TS to reinforce W36/W37 due to geographic and other technical limitations

It is worth noting that removing the Highbury TS LTR restriction may only add about an estimated 20MW to the existing station capacity and is not economical at this time, as this requires full metalclad replacement at the station. In addition, the load growth or the asset condition does not warrant metalclad replacement. However, the study team acknowledge that removing Highbury LTR restriction will provide operational flexibility and will continue to monitor the situation.

Note: The costs provided above are high level planning allowances only and subject to change. No detailed project definition or estimating activities have been completed.

Distribution Option

London Hydro indicated that there is no viable distribution option to increase the current 30-minute restoration capacity during this regional planning cycle.

4 Conclusion

The Study Team acknowledge the load restoration concerns with the simultaneous loss of W36/W37 double circuit lines. Considering the low probability of losing W36/37 simultaneously, the Local Planning Study Team recommends that no action is required at this time. However, the Study team has agreed to monitor the performance and future load growth on the impacted stations so that the supply reliability and/or load restoration situation does not worsen.

5 References

[1] Planning Process Working Group (PPWG) Report to the Board: The Process for Regional Infrastructure Planning in Ontario – May 17, 2013

[2] Ontario Resource and Transmission Assessment Criteria

[3] London Region Needs Assessment Report

Appendix A: Acronyms

DSC	Distribution System Code
IESO	Independent Electricity System Operator
kV	Kilovolt
LDC	Local Distribution Company
LP	Local Planning
LTR	Limited Time Rating
MW	Megawatt
MVA	Mega Volt-Ampere
OEB	Ontario Energy Board
ORTAC	Ontario Resource and Transmission Assessment Criteria
PPWG	Planning Process Working Group
TSC	Transmission System Code