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NEEDS ASSESSMENT REPORT

Greater Ottawa Region

Date: June 15, 2018

Prepared by: Greater Ottawa Region Study Team

Disclaimer

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

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Executive Summary

REGION	Greater Ottawa Region		
LEAD	Hydro One Networks Inc. ("HONI")		
START DATE	February 15, 2018	**END DATE**	June 15, 2018

1. INTRODUCTION

The first cycle of the Regional Planning process for the Greater Ottawa Region was initiated in Q2 2014. During the planning process, an Integrated Regional Resource Plan ("IRRP") was published in Apr 2015 which identified a number of near- and mid-term needs in the Ottawa Area Sub-region. The planning process was completed in Dec 2015 with the publication of the Regional Infrastructure Plan ("RIP") which provided a description of needs and recommendations of preferred wires plans to address near-term needs. The RIP also identified some mid- and long-term needs that will be reviewed during this planning cycle.

The purpose of this Needs Assessment ("NA") is to identify any new needs and to reaffirm needs identified in the previous Greater Ottawa RIP.

2. REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the regional planning cycle should be triggered at least every five years. In light of the timing of the mid-term needs identified in the previous Integrated Regional Resource Plan ("IRRP") and RIP reports as well as new needs in the Greater Ottawa Region, the Study Team triggered the NA for the Ottawa region.

3. SCOPE OF NEEDS ASSESSMENT

The scope of this NA includes:

- Review and reaffirm needs/plans identified in the previous RIP; and
- Identification and assessment of system capacity, reliability, operation, and aging infrastructure needs.

Note: Station and transmission supply capacity needs in the Ottawa Area Sub-region will be identified, reaffirmed, and assessed in the IRRP phase while those needs in the Outer Ottawa Sub-region along with non-growth related needs for the entire Greater Ottawa Region will be evaluated in this NA.

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

4. INPUTS/DATA

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

5. ASSESSMENT METHODOLOGY

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

replacement/refurbishment.

A technical assessment of needs was undertaken based on:

- Current and future station capacity and transmission adequacy;
- System reliability and operational concerns; and
- Any major high voltage equipment reaching the end of its useful life.

6. RESULTS

I. Outer Ottawa Sub-region – Station & Transmission Supply Capacity

- Station and Transmission supply capacities in Outer Ottawa Sub-region are adequate for the study period

Note: Station and Transmission supply capacity needs for the Ottawa Area Sub-region will be identified and assessed in the IRRP phase.

II. System Reliability & Operation

- Study Team has confirmed that as per Hydro One assessment, load restoration criteria for the following scenarios are met:
  - 30-minute load restoration for M32S/C3S & South March A1A2 contingency
  - 4-hour load restoration for M32S/C3S & South March A1A2; South March L6L7; M4G & M5G; D5A & B5D contingencies

- Study Team has confirmed that as per Hydro One, voltage regulation issues at following locations will require further assessment in the IRRP:
  - 115kV Circuit 79M1
  - Almonte TS/Terry Fox MTS

III. Aging Infrastructure

Outer Ottawa Sub-region:

- Arnprior TS – EOL transformers T1/T2 (2023-2024)
- Longueuil TS – EOL transformers T3/T4 (2024-2025)
- 115kV circuit S7M (2021-2022)

Ottawa Area Sub-region:

- Slater TS – EOL transformers T1/T2/T3 (2022-2023)
- Albion TS – EOL transformers T1/T2, switchgears, breakers (2028-2029)
- Merivale MTS Rebuild (2017-2020)
- Riverdale TS Switchgear Replacement (2021-2023)
- Limebank MTS Transformer Replacement (2022-2024)

7. RECOMMENDATIONS

The Study Team's recommendations for the above needs identified are as follows:

a) Equipment reaching EOL at Arnprior TS, Longueuil TS, and Slater TS, as well as 115kV circuit S7M cannot be eliminated or have their capacities reduced. Study Team determines that replacing EOL equipment is the most preferred option. Hydro One will coordinate replacement of above equipment with affected LDCs and develop the replacement plan.

b) Hydro One has determined that load restoration criteria would be met following contingencies identified in Section 7.2. No further actions are required.

c) Hydro One has determined that voltage regulation needs described in Section 7.3 will require updated load forecast in the Ottawa Area Sub-region, and further assessment will be conducted during the IRRP phase.

d) Hydro One will investigate tap changer issues at Longueuil TS and St. Isidore TS outside of the Regional Planning Process.

e) IRRP to be undertaken for the Ottawa Area Sub-region to further assess remaining and/or new needs in the area, including mid-term EOL need at Albion TS.

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List of Tables and Figures

1 INTRODUCTION

The first cycle of the Regional Planning process for the Greater Ottawa Region was completed in December 2015 with the publication of the Regional Infrastructure Plan ("RIP"). The RIP provided a description of needs and recommendations of preferred wires plans to address near and medium term needs. Additional medium and long term needs were recommended for further review during the next regional planning cycle.

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

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

Table 1: Greater Ottawa Region Study Team Participants

Company
Hydro One Networks Inc. (Lead Transmitter)
Hydro One Networks Inc. (Distribution)
Hydro Hawkesbury Inc.
Hydro Ottawa Limited
Independent Electricity System Operator ("IESO")
Ottawa River Power Corporation

2 REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the Regional Planning cycle should be triggered at least every five years. In light of the timing of the mid-term needs identified in the previous IRRP and RIP reports as well as new needs in the Greater Ottawa Region, the Study Team triggered the NA for the Greater Ottawa Region.

3 SCOPE OF NEEDS ASSESSMENT

The scope of this NA covers the Greater Ottawa Region and includes:

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

Note: Station and Transmission supply capacity needs for the Ottawa Area Sub-region will be identified and assessed in the IRRP phase. Only those for the Outer Ottawa Sub-region will be evaluated in this NA.

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

4 REGIONAL DESCRIPTION AND CONNECTION CONFIGURATION

The Greater Ottawa Region covers the municipalities bordering the Ottawa River from Arnprior in the west to Hawkesbury in the east and north of Highway 43. At the center of this Region is the City of Ottawa. Electrical supply to the Region is provided from 52 230kV and 115kV step-down transformer stations.

Bulk electrical supply to the Greater Ottawa Region is provided through the 500/230kV autotransformers at Hawthorne TS and a network of 230kV and 115kV transmission lines and step-down transformation facilities. The area has been divided into two Sub-regions:

- The Ottawa Area Sub-region comprises primarily the City of Ottawa. It is supplied by two 230/115 kV autotransformer stations (Hawthorne TS and Merivale TS), eight 230 kV and thirty-three 115 kV transformer stations stepping down to a lower voltage. Local generation in the area consists of the 74 MW Ottawa Health Science Non-Utility Generator ("NUG") located near the downtown area and connected to the 115 kV network. The Ottawa Area Sub-region is shown in Figure 1 below.

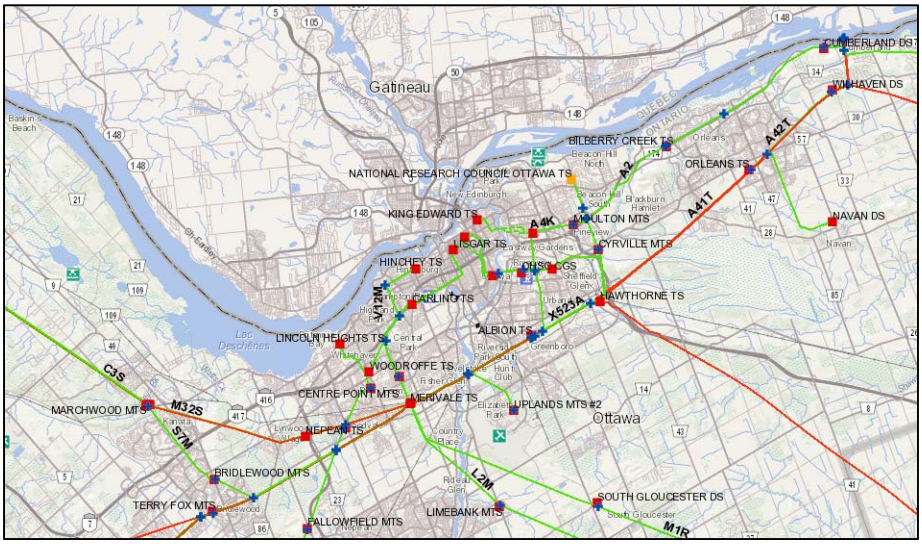

Figure 1: Ottawa Area Sub-region Map

Hydro Ottawa is the main LDC that serves the electricity demand for the City of Ottawa. Hydro One Distribution supplies load in the outlying areas of the sub-region. Both Hydro Ottawa and Hydro One Distribution receive power at the step-down transformer stations and distribute it to end users, including industrial, commercial and residential customers.

- The Outer Ottawa Sub-Region covers the remaining area of the Greater Ottawa Region. The eastern area (shown in Figure 2) is served by three 230 and five 115 kV step-down transformer stations. Hydro One Distribution and Hydro Hawkesbury are the LDCs in the area that distribute power from the stations to their end use customers. It also includes a large industrial customer, Ivaco Rolling Mills, in L'Orignal, Ontario.

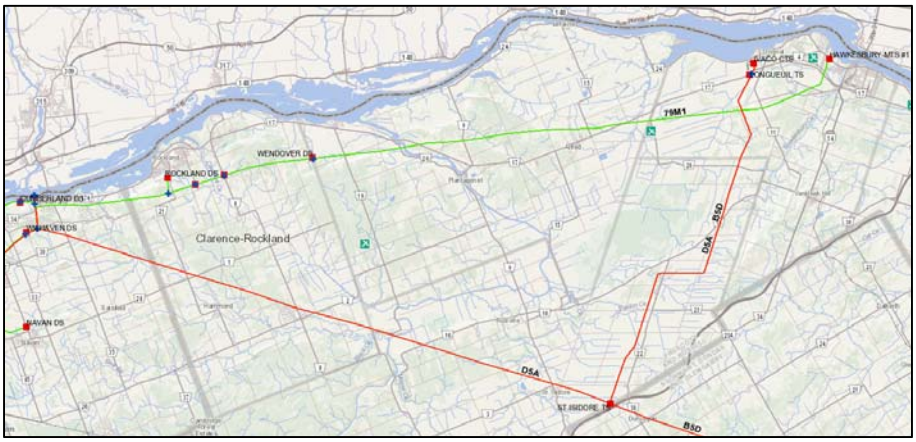

Figure 2: Outer Ottawa Sub-region Map (Eastern Part)

The western area of the Outer Ottawa Sub-Region (shown in Figure 3) is served by one 230 kV and two 115 kV step-down transformer stations. Hydro One Distribution is the LDC that supplies its end use customers from these stations. Ottawa River Power Corp. is the embedded LDC that supplies its customers from Almonte TS via Hydro One Distribution's 44kV feeders. The area includes the following generating stations: Barrett Chute GS, Chats Falls GS and Stewartville GS with a peak generation capacity of about 450 MW.

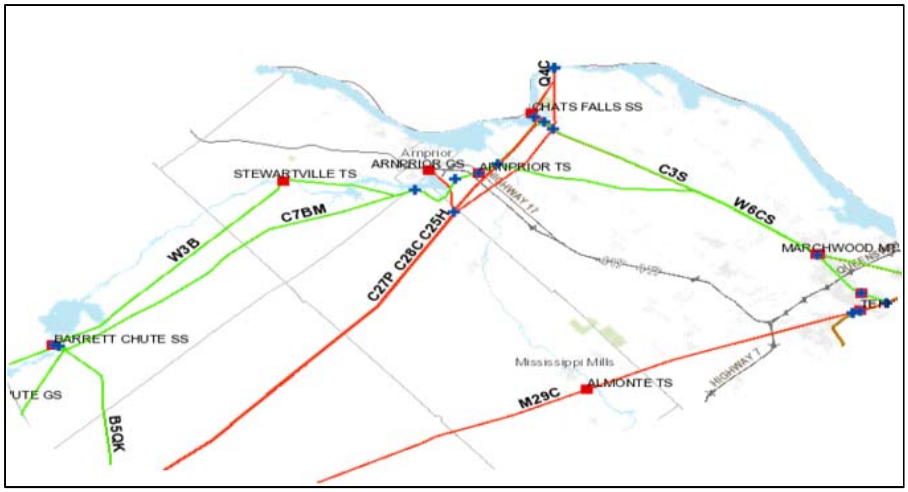

Figure 3: Outer Ottawa Sub-region Map (Western Part)

An electrical single line diagram for the Greater Ottawa Region facilities is shown in Figure 4.

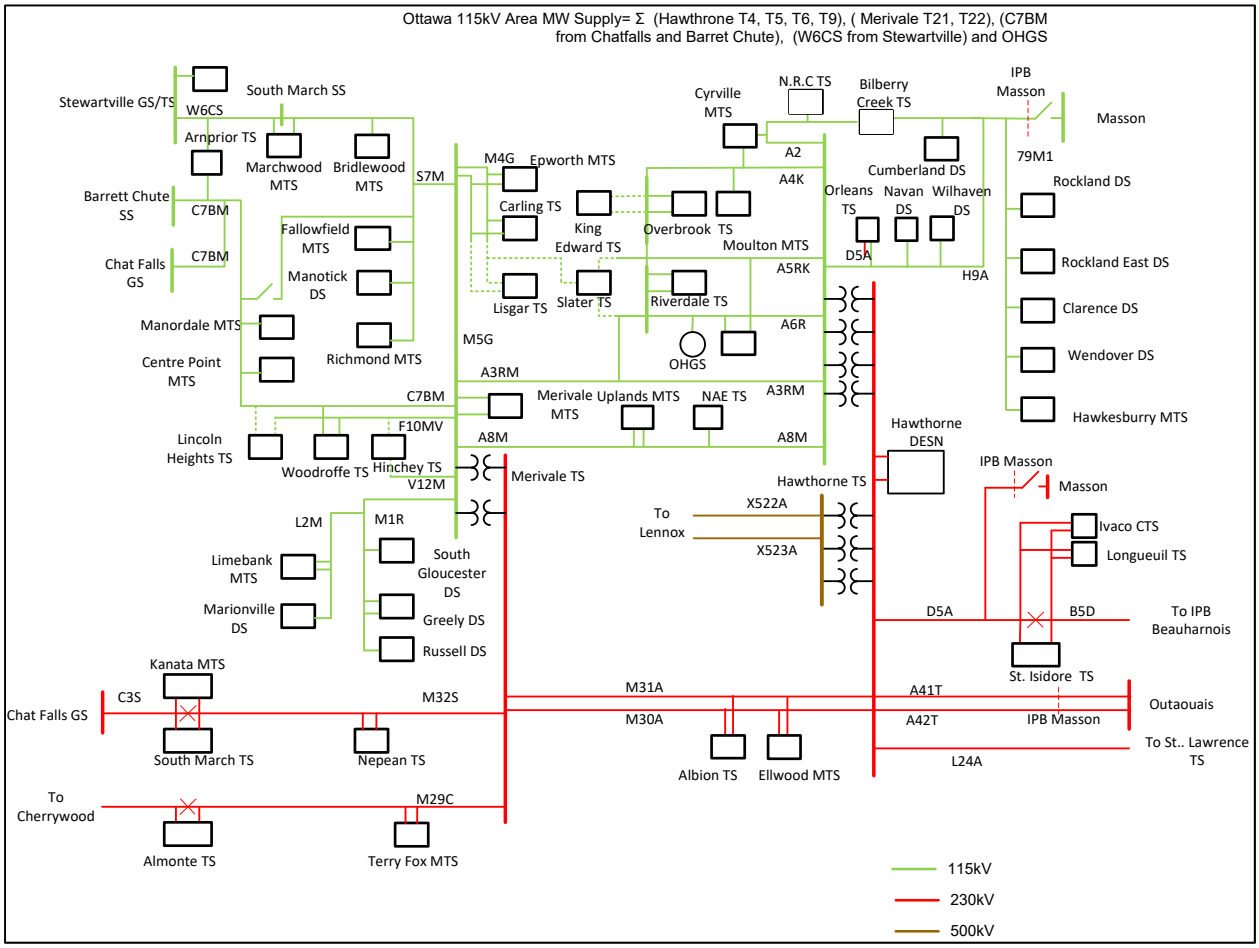

Figure 4: Greater Ottawa Region (Single Line Diagram)

5 INPUTS AND DATA

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

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

6 ASSESSMENT METHODOLOGY

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

Information gathering included:

i. Load forecast: The relevant LDCs provided a load forecast for the Outer Ottawa Sub-region. The IESO provided a Conservation and Demand Management ("CDM") and Distributed Generation ("DG") assumptions to determine their high-level impact on needs in the sub-region. The sub-region extreme winter weather coincident peak gross load forecast was produced by translating the LDC load forecast into load growth rates and applying onto the 2017 actual winter station coincident peak load, adjusted for extreme weather conditions (according to Hydro One's methodology). The CDM and DG assumptions were applied to this gross forecast to produce the net forecast. The extreme winter weather coincident peak net load forecast for the individual stations in the Outer Ottawa Sub-region is given in Appendix B. A similar approach was used to develop the Outer Ottawa Sub-region winter weather non-coincident peak gross and net load forecast. It should be noted that the actual versus forecasted year to year demand can vary due to factors such as weather, economic development, etc.

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

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

A technical assessment of needs was undertaken based on:

- Current and future station capacity and transmission adequacy;
- System reliability and operational concerns; and
- Any major high voltage equipment reaching the end of its useful life.

Note: Outer Ottawa Sub-region is winter peaking so the assessment is based on winter peak load. However, both summer and winter peak loads are presented in Appendix A & B for completeness.

7 NEEDS

This section describes emerging needs identified in the Greater Ottawa Region, and also reaffirms the near, mid, and long-term needs already identified in the previous regional planning cycle. The newly identified/emerging needs pertaining to this NA will be discussed further in the following sub-sections, while the status of the previously identified needs is summarized in Table 2 below.

Table 2: Needs Identified in the Previous Regional Planning Cycle

Type of Needs identified in previous IRRP and NA	Needs Details	Current Status
230/115kV Transformation Capacity	Hawthorne TS T5 and T6 – LTR exceeded[1]	The project is currently under execution. Its schedule was revised to allow for the replacement work of T7/T8 to be completed first. The current status of the project is as follow: T6 has been replaced. Protection upgrade and T5 replacement to be completed by 2021 to allow for the replacement of Hawthorne T7 and T8 in 2019.
	Merivale TS T22 – LTR exceeded[1]	On hold as South Nepean MTS project (described under **Station Capacity Needs**) is expected to provide loading relief by transferring load to 230kV network.
Transmission Circuit Capacity	S7M Circuit – Supply Capacity[1]	Line rating was increased and adequate to meet forecast load up to 2026. Capacity beyond 2026 will be addressed by the South Nepean MTS project
	A4K Circuit – Supply Capacity[1]	Riverdale JCT x Overbrook TS: Build New A6R Tap Project is currently under execution. The target I/S year is 2019

[1] **Further assessment and review to be conducted during the IRRP phase**

Station Capacity	Ottawa Center 115kV Area – Station Capacity[1]	Russell TS & Riverdale TS: Feeder ties to be completed by 2020 Overbrook TS: T1/T2 replacement is complete Lisgar TS: T1/T2 replacement project is cancelled at the request of Hydro Ottawa King Edward TS: T3 replacement to be completed by 2022.
	Hawthorne TS T7 and T8 – LTR exceeded	T7/T8 replacement with 125MVA capacity is currently under execution. The expected I/S year is 2019
	South West Area - Capacity[1]	Construction of the new supply circuit and station for the South Nepean MTS project is undergoing estimating and Environmental Assessment approvals. Target I/S year is 2021.
	Bilberry Creek TS - Refurbishment[1]	Decision to refurbish to be reviewed and assessed during the IRRP phase.
Supply Security, Reliability and Restoration	Orleans TS - Reliability[1]	Decision to improve reliability depends on the outcome for Bilberry Creek TS refurbishment. Further reviews to be conducted during the IRRP phase
	B5D+D5A Circuits – Restoration	This was the subject of a Local Planning report. See Section 7.2 for more details.
	Load Loss for S7M Contingency[1]	See Section 7.2 Load forecast for Bridlewood MTS, Fallowfield MTS, Manotick MTS, and Richmond DS need to be refreshed and reviewed during the IRRP phase.
Voltage Regulation	79M1 Circuit – Voltage Regulation[1]	Low voltage is still observed. Load forecast for stations supplied by 79M1 need to be refreshed and reviewed during the IRRP phase.
	Stewartville TS – Voltage Regulation	Loading on Stewart TS is expected to remain at around 25MW over the next 10 years. No further actions are required at this time.

	Almonte TS/Terry Fox MTS –Voltage Regulation[1]	See Section 7.3
Additional Needs Identified	Merivale TS T22 – Continuous ratings exceeded	On hold as South Nepean MTS project is expected to provide loading relief by moving load to 230kV network.
	King Edward TS – Capacity	King Edward T3 replacement is scheduled for completion by 2022.

7.1 End-Of-Life (EOL) Equipment Needs

Study Team has identified the following major high voltage equipment to be reaching the end of their useful life over the next 10 years.

Table 3: End-of-Life Equipment – Greater Ottawa Region

Outer Ottawa Sub-region EOL Equipment(1)	**Replacement Timing(2)**
Arnprior TS – EOL transformers T1/T2	2023-2024
Longueuil TS – EOL transformers T3/T4	2024-2025
Ottawa Area Sub-region EOL Equipment(1)	
115kV S7M Sections: Manotick Jct x Fallowfield MTS STR 673N Jct x Fallowfield MTS Manotick Jct x Richmond MTS STR 673N Jct x Manordale MTS	2021-2022
Slater TS – EOL transformers T1/T2/T3	2022-2023
Albion TS – EOL switchgear, breakers	2028-2029
Merivale MTS Rebuild(3)	2017-2020
Riverdale Switchgear Replacement(3)	2021-2023
Limebank Transformer Replacement(3)	2022-2024

(1) No other major HV station equipment or lines in the Greater Ottawa Region have been identified for replacement/refurbishment at this time
(2) The replacement/refurbishment timing and prioritization are subject to change
(3) LDC owned assets

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

1. Maintaining the status quo
2. Replacing equipment with similar equipment with *lower* ratings and built to current standards
3. Replacing equipment with similar equipment with *lower* ratings and built to current standards by transferring some load to other existing facilities
4. Eliminating equipment by transferring all of the load to other existing facilities

5. Replacing equipment with similar equipment and built to current standards (i.e., "like-for-like" replacement)
6. Replacing equipment with *higher* ratings and built to current standards

Outer Ottawa Sub-region

- **Arnprior TS – EOL Transformers T1/T2**

Arnprior TS is a 115/44 kV DESN connected to W6CS and C7BM 115 kV circuits, supplying Hydro One Distribution. Transformers T1 and T2, built in 1960 and 1957, respectively, are rated at 42MVA each and have been identified to be at the end of their service life. The DESN 10-day LTR is 46MW in the summer and 54 MW in the winter.

The station's net non-coincident winter peak load in 2017 (adjusted for extreme weather) was 52 MW. The load is expected to remain relatively flat throughout the study period (2018-2027). Considering the load growth at the station, replacing the EOL transformers with standard size units of 42MVA to maintain the capacity of the station is recommended. Transformer capacity upsizing is not an option since 42MVA is currently the largest size at the 115/44kV voltage level.

The study team recommends that this need be addressed by Hydro One and Hydro One Distribution to coordinate the replacement plan. The replacement of the EOL equipment is expected to be completed by 2023-2024.

- **Longueuil TS – EOL Transformers T3/T4**

Longueuil TS is a 230/44kV DESN connected to 230kV B5D and D5A circuits, supplying Hydro One Distribution. The transformer T3 and T4, built in 1965 and 1964, respectively, are rated 93MVA each and have been identified to be at the end of their service life. The DESN 10-day LTR is 88MW in the summer and 95MW in the winter.

The station's net non-coincident winter peak load in 2017 (adjusted for extreme weather) was 52MW. The load is expected to remain relatively flat throughout the study period (2018-2027). Considering the load growth at the station, replacing the EOL transformers with similarly size units is recommended.

The study team recommends that this need be addressed by Hydro One and Hydro One Distribution to coordinate the replacement plan. The replacement of the EOL equipment is expected to be completed by 2024-2025.

Ottawa Area Sub-region

- **S7M 115kV Line Refurbishment**
  - **Manotick Jct x Fallowfield MTS**
  - **STR 673N Jct x Fallowfield MTS**
  - **Manotick Jct x Richmond MTS**
  - **STR 673N Jct x Manordale MTS**

The 115 kV conductors spread across multiple S7M line sections totaling 13.9 km has been identified at or near their end of service life. Refurbishment of these line sections is recommended, which includes replacement of conductors, wood poles, insulators, and other components. Refurbishments of Manotick Jct x Fallowfield MTS and STR 673N Jct x Fallowfield MTS are expected to be completed as part of the South Nepean MTS project, while refurbishments of Manotick Jct x Richmond MTS and STR 673N Jct x Manordale MTS are covered under a separate sustainment project. The refurbishment is expected for completion between 2021 and 2022.

- **Slater TS – EOL Transformers T1/T2/T3**

Slater TS is a 115/13.8/13.8kV station connected to 115kV A3RM, M4G, and A5RK circuits, supplying Hydro Ottawa. Transformers T1, T2, and T3, rated at approximately 65MVA each, were built in the 1960s, and have been identified to be at the end of their service life. The station 10-day LTR is 98MW in the summer and 102MW in the winter. T1 is already planned for replacement in 2018 with a standard size 100MVA unit.

Based on the previous RIP forecast, Slater TS peak load is expected to be around 130-135MW during the study period.

The study team recommends that this need be addressed by Hydro One and Hydro Ottawa to coordinate the replacement plan. The replacement of the EOL equipment is expected to be completed by 2022-2023.

- **Albion TS – EOL T1/T2, switchgears, breakers**

Albion TS is a 230/13.8/13.8kV station connected to 230kV M30A and M31A circuits, supplying Hydro Ottawa. The transformers T1 and T2 rated at 45MVA each, were built in the 1970s, and have been identified to be approaching end of their service lives. The station 10-day LTR is 90MW in the summer and 100MW in the winter.

Based on the previous RIP forecast, Albion TS peak load is expected to be around 73-75MW during the study period.

The study team recommends that this need be assessed further during the IRRP phase once the updated load forecast has been released. Albion T1 and T2, along with associated metal-clad switchgears and breakers are currently scheduled for replacement in 2028, but this timeline is subject to change depending on the outcome of the IRRP assessment.

- **Merivale MTS Rebuild**

Merivale MTS is a 115/8.3kV station connected to 115kV circuits A3RM and A8M. Transformers T1 and T2, both rated at 10MVA, were built in the 1960s, and they have been identified approaching their end of service life.

The station's actual peak load in 2017 was 14.4MW. Considering the station's current load and future load growth, the study team recommends that Hydro Ottawa continues with refurbishing Merivale MTS. The work is expected to be completed between 2018 and 2020.

- **Riverdale TS 13.8kV Switchgear Replacement**

Riverdale TS is a 115/13.8kV station connected to 115kV circuits A3RM, A5RK, and A6R. The station 10-day LTR is 117.6MW in the summer and 122.2MW in the winter. Switchgears on Riverdale TS 13.8kV side have been identified approaching their end of service life.

The station's actual peak load in 2017 was 70.8MW. Considering the station's current load and future load growth, the study team recommends that Hydro Ottawa continues with the 13.8kV switchgear replacement plan. The work is expected to be completed between 2021 and 2023.

- **Limebank MTS Transformer Replacement**

Limebank MTS is a 115/27.6kV station connected to 115kV circuit L2M. Transformers T1 and T2, each rated at 33MVA, were built in the 1980s and they have been identified approaching the end of their service life.

The station's actual peak load in 2017 was 46.8MW. Considering the station's current load and future load growth, options including elimination of or down-sizing the transformer are not feasible. The study team recommends that Hydro Ottawa continues with the transformer and related equipment replacement plan. The work is expected to be completed between 2022 and 2024.

7.2 Load Restoration Needs

- **Load Restoration – M32S/C3S & South March A1A2**

Based on the 2035 load forecast provided in the 2015 RIP report, a fault on M32S/C3S followed by the breaker failure of South March A1A2 will result in a total load loss of 279MW at Kanata MTS, South Nepean MTS, and South March MTS under peak loading conditions. 29MW needs to be restored within 30 minutes and an additional 100MW needs to be restored within 4 hours in order to respect Ontario Resource and Transmission Assessment Criteria's ("ORTAC") Load Restoration Criteria.

Circuits C3S and M32S have a number of disconnect switches that can be used to restore load. Hydro One expected to be able to meet the restoration time requirements; however restoration cannot be guaranteed for every possible situations.

- **Load Restoration – South March L6L7; M4G & M5G; D5A & B5D**

  - South March L6L7

Based on the 2035 load forecast provided in the 2015 RIP report, a fault on either S7M or W6CS followed by L6L7 breaker failure at South March SS would result in a total load loss of 210MW at Marchwood MTS, Bridlewood MTS, Fallowfield MTS, Richmond MTS, and Manotick DS under peak loading conditions. 60MW of load needs to be restored within 4 hours post contingency in order to respect ORTAC's Load Restoration Criteria.

Marchwood MTS can be restored by isolating breaker L6L7. The remaining 4 stations can be restored by using line switches on circuit S7M. Hydro One expects to be able to meet the restoration time requirements; however restoration cannot be guaranteed for every possible situation.

It should be noted that the 2015 RIP load forecast did not incorporate the planned 230kV South Nepean MTS. Based on a recent study, a significant portion of load at Fallowfield MTS is going to be supplied by the new MTS. However, this new configuration may still result in the need to restore more than 150MW following the L6L7 breaker fail situation described above, but Hydro One still expects to meet the 4-hour post contingency load restoration requirement. If the South Nepean MTS project does not proceed as planned, additional system upgrades may be required to accommodate the load restoration following the L6L7 breaker failure.

  - M4G & M5G

The loss of both M4G and M5G would result in the loss of Lisgar TS, Carling TS, and Nepean Epworth MTS totaling 206MW under peak loading conditions. 56MW needs to be restored within 4 hours in order to respect ORTAC's Load Restoration Criteria. Circuits M4G and M5G have a number of switches that could be used for partial load restoration. Hydro One is expected to be able to meet the restoration time requirements; however restoration cannot be guaranteed for every possible situation.

  - D5A & B5D

This was the subject of a Local Planning report. Conclusions are still valid. Please see:
https://www.hydroone.com/abouthydroone/CorporateInformation/regionalplans/greaterottawa/Documents/Local%20Planning%20Report%20-%20B5D-D5A%20Load%20Restoration.pdf

Hydro One confirms that load restoration criteria would be met.

7.3 Voltage Regulation Needs

- Voltage Regulation on 115kV Circuit 79M1

The 115kV circuit 79M1 supplies Rockland DS, Rockland East DS, Clarence DS, Wendover DS, and Hawkesbury MTS #1. The voltage on circuit 79M1 is observed to be low throughout the study period, and it is also dependent on the loading of the stations supplied by 115kV circuit H9A. The load forecast for these stations will be refreshed as part of the Greater Ottawa Region IRRP. Hydro One will review the forecast and its impact on 79M1 once the forecast is finalized and will continue to monitor the situation. It is also worth noting that the presence of an upcoming wind farm connecting to the circuit 79M1 in 2019 would contribute to the improvement of the voltage in the area.

- Almonte TS/Terry Fox MTS –Voltage Regulation

Circuit E34M/T33E is a 290 km line between Clarington TS in Oshawa, and Merivale TS in Ottawa. If the circuit E34M is open at the Merivale TS end, Terry Fox MTS and Almonte TS will need to be supplied radially by Clarington TS. However, studies have shown that Clarington TS will not be able to provide adequate support for Almonte TS and Terry Fox MTS during peak loading period, which would in turn result in voltages below the minimum allowable levels. With the consideration of the future South Nepean MTS project connecting to E34M, once the load forecast for Terry Fox MTS is finalized in IRRP, this need will be revisited again during the IRRP phase.

7.4 Station and Transmission Capacity Needs in the Outer Ottawa Sub-region

- Station and Transmission supply capacities in Outer Ottawa Sub-region is adequate for the study period

Note: Station and Transmission supply capacity needs for the Ottawa Area Sub-region will be identified and assessed in the IRRP phase.

7.5 Other Needs

- Tap Changer Operations at Longueuil TS and St. Isidore TS

Longueuil TS and St. Isidore TS are seeing a high number of tap changer operations on a daily basis. This issue is being investigated by Hydro One outside of the Regional Planning Process.

8 RECOMMENDATIONS

The Study Team's recommendations for the above needs identified are as follows:

a) Equipment reaching EOL at Arnprior TS, Longueuil TS, and Slater TS, as well as 115kV circuit S7M cannot be eliminated or have their capacities reduced. Study Team determines that replacing EOL equipment is the most preferred option. Hydro One will coordinate replacement of above equipment with affected LDCs and develop the replacement plan.

b) Hydro One has determined that load restoration criteria would be met following contingencies identified in Section 7.2. No further actions are required.

c) Hydro One has determined that voltage regulation needs described in Section 7.3 will require updated load forecast in the Ottawa Area Sub-region, and further assessment will be conducted during the IRRP phase.

d) Hydro One will investigate tap changer issues at Longueuil TS and St. Isidore TS outside of the Regional Planning Process.

e) IRRP to be undertaken for the Ottawa Area Sub-region to further assess remaining and/or new needs in the area, including mid-term EOL need at Albion TS.

9 REFERENCES

[1] Greater Ottawa Regional Infrastructure Plan

[2] Planning Process Working Group Report to the Board

[3] Ontario Resource and Transmission Assessment Criteria (ORTAC) – Issue 5.0

Appendix A: Outer Ottawa Sub-region Summer Load Forecast (2018-2027)

* LTR based on 0.9 power factor

Summer Net Non-Coincident Load Forecast (MW) – Extreme Weather Corrected

Station	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Summer 10-day LTR (MW)
Almonte TS	45.2	45.2	47.2	43.6	44.4	44.9	45.3	45.3	45.3	45.2	45.1	104
Arnprior TS	44.2	44.3	44.1	44.1	44.5	45.0	45.5	45.6	45.6	45.6	45.6	47
Clarence DS	2.6	2.7	2.7	2.7	2.7	2.8	2.8	2.8	2.8	2.8	2.8	3
Longueuil TS	39.7	39.8	39.6	39.3	39.5	39.8	40.0	39.9	39.7	39.4	39.1	88
Rockland DS	7.6	7.6	7.7	7.8	7.8	7.9	7.9	7.9	7.9	7.8	7.8	13
Rockland East DS	11.8	11.8	11.9	12.0	12.1	12.2	12.3	12.3	12.2	12.2	12.2	8[2]
St. Isidore TS	39.9	39.9	40.0	39.8	40.0	40.3	40.6	40.6	40.5	40.3	40.2	47
Stewartville TS	24.3	26.7	25.6	26.0	26.2	25.1	25.3	25.3	25.2	25.1	25.0	50
Wendover DS	12.4	12.3	9.2	9.4	11.0	11.1	11.3	11.3	11.3	11.2	11.2	14
Ivaco CTS	77.5	78.4	79.5	80.6	81.7	82.7	83.8	84.9	86.0	87.0	87.0	100
Hawkesbury MTS #1	12.0	12.0	12.1	12.1	12.2	12.2	12.2	12.3	12.3	12.3	12.0	11[2]

[2] The LDC will have the capability to take necessary corrective actions in order to alleviate any overloading conditions when one transformer within the station is out of service

Summer Net Coincident Load Forecast (MW) – Extreme Weather Corrected

Station	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Summer 10-day LTR (MW)
Almonte TS	45.2	45.2	47.2	43.6	44.4	44.9	45.3	45.3	45.3	45.2	45.1	104
Arnprior TS	37.0	37.2	37.0	37.0	37.3	37.7	38.1	38.2	38.2	38.2	38.2	47
Clarence DS	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.7	2.7	3
Longueuil TS	39.7	39.8	39.6	39.3	39.5	39.8	40.0	39.9	39.7	39.4	39.1	88
Rockland DS	7.2	7.2	7.2	7.3	7.4	7.4	7.5	7.4	7.4	7.4	7.4	13
Rockland East DS	10.9	10.5	10.5	10.5	10.6	10.7	10.7	10.6	10.6	10.6	10.5	8[2]
St. Isidore TS	39.9	39.9	40.0	39.8	40.0	40.3	40.6	40.6	40.5	40.3	40.2	47
Stewartville TS	23.9	26.4	25.3	25.7	25.8	24.8	25.0	24.9	24.9	24.8	24.7	50
Wendover DS	12.1	12.1	9.0	9.1	10.8	10.8	11.1	11.0	11.0	10.9	10.9	14
Ivaco CTS	77.5	78.4	79.5	80.6	81.7	82.7	83.8	84.9	86.0	87.0	87.0	100
Hawkesbury MTS #1	12.0	12.0	12.1	12.1	12.2	12.2	12.2	12.3	12.3	12.3	12.0	11[2]

Appendix B: Outer Ottawa Sub-region Winter Load Forecast (2018-2027)

* LTR based on 0.9 power factor

Winter Net Non-Coincident Load Forecast (MW) – Extreme Weather Corrected

Station	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Winter 10-day LTR (MW)
Almonte TS	48.5	48.4	50.4	46.6	47.3	47.6	48.0	48.0	47.9	47.8	47.7	122
Arnprior TS	51.9	51.9	51.2	50.8	51.1	51.5	51.9	52.0	51.9	51.8	51.8	54
Clarence DS	2.5	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.5	2.5	2.5	4
Longueuil TS	51.9	51.9	51.8	51.7	51.9	52.2	52.5	52.5	52.4	52.2	52.1	95
Rockland DS	9.4	9.5	9.5	9.6	9.6	9.7	9.7	9.7	9.7	9.6	9.6	16
Rockland East DS	12.1	12.1	12.2	12.3	12.3	12.4	12.4	12.4	12.4	12.3	12.3	10[2]
St. Isidore TS	50.9	50.9	50.8	50.4	50.7	51.0	51.3	51.3	51.1	51.0	50.8	53
Stewartville TS	26.5	26.3	25.0	25.3	25.4	24.2	24.4	24.3	24.2	24.1	24.1	57
Wendover DS	14.7	14.6	11.3	11.4	13.1	13.2	13.4	13.4	13.3	13.3	13.3	14[2]
Ivaco CTS	79.8	80.8	81.9	83.0	84.1	85.2	86.3	87.4	88.5	89.6	89.6	100
Hawkesbury MTS #1	17.6	17.4	17.6	17.6	17.4	17.4	17.3	17.2	17.1	17.0	17.6	11[2]

Winter Coincident Load Forecast (MW) – Extreme Weather Corrected

Station	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Winter 10-day LTR (MW)
Almonte TS	37.5	37.5	39.0	36.1	36.6	36.9	37.1	37.2	37.1	37.0	36.9	122
Arnprior TS	40.5	40.5	40.0	39.7	39.9	40.3	40.6	40.6	40.6	40.5	40.5	54
Clarence DS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	4
Longueuil TS	50.6	50.6	50.5	50.4	50.6	50.9	51.2	51.2	51.1	50.9	50.8	95
Rockland DS	9.4	9.5	9.5	9.6	9.6	9.7	9.7	9.7	9.7	9.6	9.6	16
Rockland East DS	10.8	10.8	10.9	11.0	11.0	11.1	11.2	11.1	11.1	11.1	11.0	10[2]
St. Isidore TS	47.9	47.9	47.9	47.5	47.7	48.0	48.3	48.3	48.2	48.0	47.9	53
Stewartville TS	26.3	26.0	24.8	25.0	25.1	24.0	24.1	24.1	24.0	23.9	23.8	57
Wendover DS	14.7	14.6	11.3	11.4	13.1	13.2	13.4	13.4	13.3	13.3	13.3	14[2]
Ivaco CTS	79.8	80.8	81.9	83.0	84.1	85.2	86.3	87.4	88.5	89.6	89.6	100
Hawkesbury MTS #1	17.6	17.4	17.6	17.6	17.4	17.4	17.3	17.2	17.1	17.0	17.6	11[2]

Appendix C: 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
DESN	Dual Element Spot Network
DG	Distributed Generation
DS	Distribution Station
GS	Generating Station
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
SA	Scoping Assessment
SIA	System Impact Assessment
SPS	Special Protection Scheme
SS	Switching Station
STG	Steam Turbine Generator
TS	Transformer Station