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

LOCAL PLANNING REPORT

East Lake Superior Region: Supply Option Analysis for Batchawana and Goulais Bay Area

Revision: FINAL
Date: February 25th, 2021

Prepared by:

Hydro One Sault Ste. Marie LP.

Algoma Power Inc.

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Study Team

Organization
Hydro One Sault Ste. Marie LP. (Lead Transmitter)
Algoma Power Inc. (Distribution)

DISCLAIMER

This Local Planning Report was prepared for the purpose of developing wires-only options and recommending a preferred solution(s) to address the local needs identified in the Needs Assessment (NA) report for the East Lake Superior Region that do not require further coordinated regional planning. The preferred solution(s) that has 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	East Lake Superior Region (the "Region")		
LEAD	Hydro One Sault Ste. Marie LP. ("HOSSM")		
START DATE	September , 2019	**END DATE**	December, 2020

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 East Lake Superior (ELS) Region dated June 14, 2019. 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".

Based on Section 7 of the NA report, the study team recommended that no further coordinated regional planning is required to address the local needs of Batchawana and Goulais Bay area in the ELS region. These needs are local in nature and to be addressed by wires options through local planning led by the transmitter, Hydro One Sault Ste. Marie LP (HOSSM) with participation of the impacted LDC, Algoma Power Inc. (API).

2. LOCAL NEEDS ADDRESSED IN THIS REPORT

End-of-life asset needs as well as load restoration needs at Batchawana TS and Goulais TS is the local need addressed in this report.

3. OPTIONS CONSIDERED AND ANALYSIS METHODOLOGY

Hydro One Sault Ste. Marie LP (Transmitter) and Algoma Power Inc (LDC) have considered addressing the need to refurbish Batchawana TS & Goulais TS with the following options:

Option 1-A – Refurbish both Batchawana TS & Goulais Bay TS.
Option 1-B – Refurbish both Batchawana TS & Goulais Bay TS and convert to 25kV.
Option 2-A – Build one new TS (115/12.5kV) to replace Batchawana TS & Goulais Bay TS.
Option 2-B – Build one new TS (115/25kV) to replace Batchawana TS & Goulais Bay TS.
Option 3-A – Build one new TS (115/12.5kV) with 25kV "express feeder "to feed Batchawana area.
Option 3-B – Build one new TS (115/25kV) with 25kV "express feeder "to feed Batchawana area.

HOSSM (Transmitter) and Algoma Power Inc. (LDC) have evaluated the above options with the following objectives and criteria:

<u>Objective</u>
Overall least total life-cycle cost for Transmission and Distribution system, which included both capital and Operation, Administration and Maintenance (OM&A) cost. Cost incremental that contributed to increased reliability and system performance should be considered and justifiable.

<u>Criteria</u>
1. Meet the long term load forecast provide by API.
2. Address the needs of existing Transmission facilities per section 3, which included:
    - Aging infrastructure and equipment
    - Electrical clearance concerns
    - Ability to conduct regular maintenance with minimal interruption of supply
    - Provide standard transmission protection system that is coordinated with downstream distribution system protection
    - Ability to provide load restoration in acceptable timeframe
    - Minimizes LDC connection work required during planned outages
3. Status quo, or improved overall system reliability (Transmission and Distribution)
4. Status quo, or improved overall system performance (Transmission and Distribution)

Refer to Section 4 for further details.

4. CONCLUSION & PREFERRED SOLUTION

HOSSM (Transmitter) and Algoma Power Inc. (LDC) have agreed that Option 1-A – Refurbish Batchawana TS & Goulais Bay TS is the recommended option to be considered to meet the local need. Refer to Section 5 for details.

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1 Introduction

The 2nd cycle Needs Assessment (NA) for the East Lake Superior Region ("Region") was completed in June 2019 as part of the OEB-mandated regional planning process. The IESO subsequently carried out its Scoping Assessment and concluded that the end-of-life replacement assets needs in Batchawana TS and Goulais TS should be addressed through Local Planning between HOSSM and impacted local distribution customer (LDC). As part of the regional planning process, Hydro One Networks Inc. (HONI), on behalf of HOSSM, has engaged the impacted LDC, Algoma Power Incorporated (API) to explore different options and to arrive at a mutually agreeable solution to address the end-of-life asset needs at Batchawana TS and Goulais TS.

The purpose of this Local Planning report is to review future power supply requirements and facility needs at Batchawana TS and Goulais Bay TS, as well as to provide analysis of various supply options. A recommendation for the preferred supply option for Batchawana Bay and Goulais Bay area has been proposed in this report.

1.1 Background Information

Batchawana Transformer Station and Goulais Transformer Station (TS), built in 1970's and 1960's respectively by Great Lakes Power, are 115kV load facilities with single transformer to supply to the Batchawana Bay and Goulais Bay areas. The areas consists of a mixture of residential, commercial and farming load. Batchawana TS is located 47 km north of the city of Sault Ste. Marie, while Goulais TS is located 30 km north of the City of Sault Ste. Marie.

Due to the station's deteriorating equipment conditions, inadequate clearance and inability to schedule and perform maintenance without a station outage, Great Lake Power Transmission (GLPT) engaged a consultant to explore the feasibility of building a new 115kV facility with 2 transformers to replace Batchawana TS and Goulais TS . A final feasibility report (Feasibility Report) was prepared and submitted to GLPT in July 2016[1]. GLPT did not further materialize the proposal, nor conducted further customer engagement to finalize the transmission solution. In the same year, Hydro One Inc. received regulatory approval from Ontario Energy Board (OEB) to acquire GLPT, and renamed it Hydro One Sault Ste. Marie LP (HOSSM).

In 2018, as part of the filing requirements for HOSSM's 2019-2026 Transmission Rate Application (the Application), HOSSM engaged a separate consultant to conduct an Asset Condition Assessment (ACA). The ACA provided detailed condition assessments of the HOSSM system on an individual equipment basis, which provided the foundation of HOSSM's 2019 – 2026 Transmission System Plan (TSP). In the ACA and the TSP, both Batchawana and Goulais TS had been identified in near end-of-life condition. Together with the feasibility report, a plan of building a new 115kV transmission facility to replace both stations was proposed in the TSP. The rate application was filed with OEB in July 2018 and received OEB's decision on June 20th, 2019. In

OEB's decision, OEB accepted the TSP and ACA as filed, and found that HOSSM's regulatory requirements and commitments have been fulfilled for the proceeding. Note that the purpose of the ACA & TSP were to provide information to the OEB to demonstrate a utility's capital planning and prioritization process in support of its revenue requirement. OEB did not provide distinct approval of these individual documents. [2]

In parallel of the Application, Hydro One Networks Inc. (HONI) undertook an integration initiative to operationally integrate HOSSM into part of HONI. As a result of the integration, HONI started to provide services to HOSSM as of October 1st, 2018, including system planning and operating functions via an established Service Level Agreement. In Quarter 1 of 2019, HONI , on behalf of HOSSM, initiated the *Need Assessment* (*NA*) phase of the second cycle of the *East Lake Superior Regional Planning*.

Led by HONI, the *NA* phase of *East Lake Superior Regional Planning* collected and reviewed future power requirements of the region from all transmission connected customers, assessed regional transmission system capacity and supply reliability , identified system needs, as well as provided plans to meet the region's short to medium term needs. The *NA* concluded that the implementation and execution for replacement of end-of-life transmission assets in Batchawana TS and Goulais TS would be coordinated between HOSSM and impacted local distribution customer (LDC) as required. As part of the regional planning process, HONI (on behalf of HOSSM) has actively engaged the impacted LDC, Algoma Power Incorporated (API) to explore different options and to arrive at a mutually agreeable solution to address the end-of-life asset needs at Batchawana TS and Goulais TS.

1.2 East Lake Superior Region Description and Connection Configuration

The East Lake Superior Region are bounded by the town of Wawa in the North to the town of Bruce Mines in south and includes the city of Sault Ste. Marie and the township of Chapleau. Highway 127 roughly borders the Region geographically to the east, Highway 101 to the north, Lake Superior to the west and St. Mary's River and St. Joseph Channel to the south. A map of the region is shown below in Figure 1.

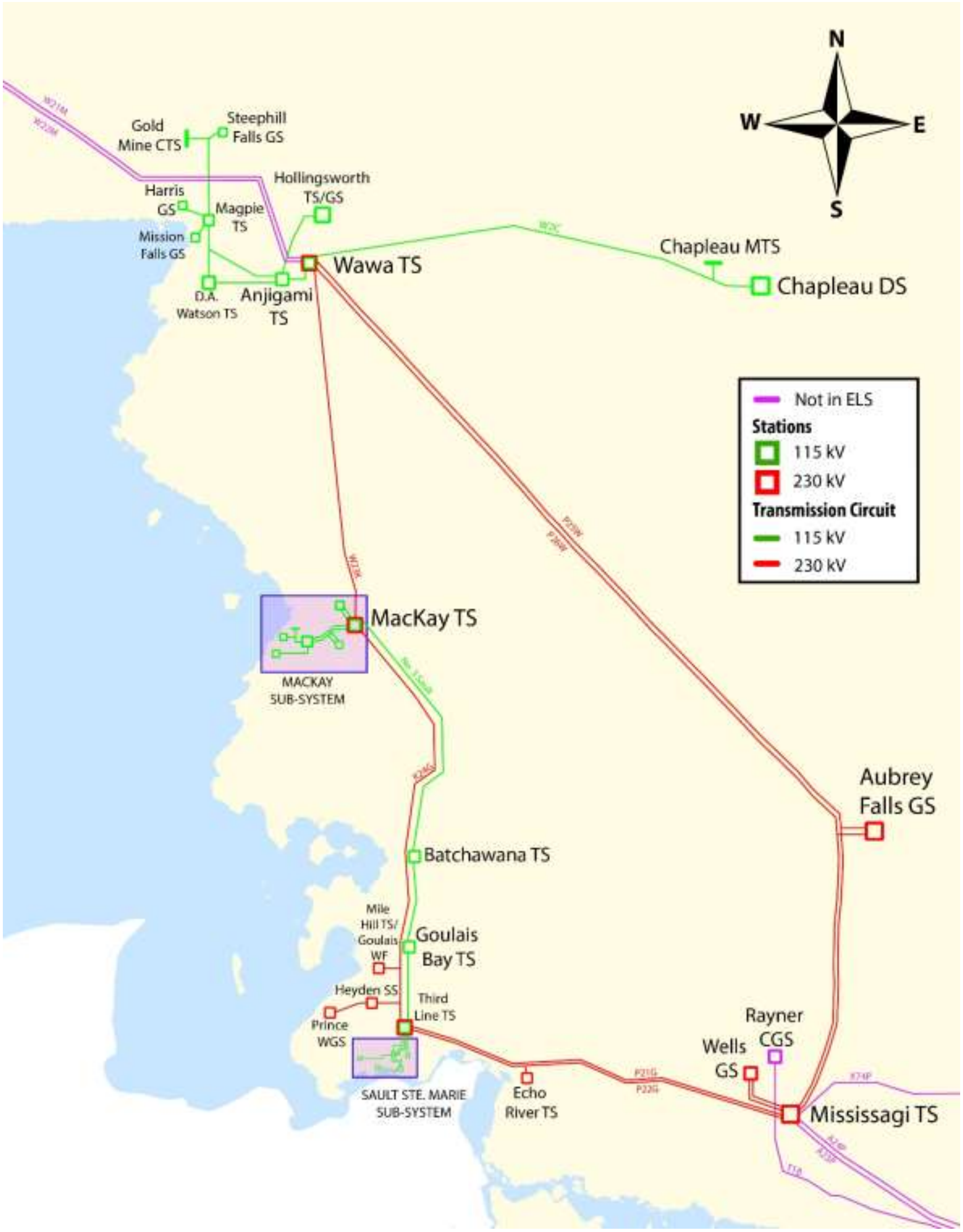

Figure 1: East Lake Superior Region Map

Electrical supply to the Region is provided primarily through 230/115 kV autotransformers at Third Line TS, Wawa TS and MacKay TS as well as the 230 kV and 115 kV transmission lines and step-down transformation facilities. The Region is defined electrically by the 230 kV transmission circuits bounded by Wawa TS to the northwest and Mississagi TS to the southeast.

This region has the following four local distribution companies (LDC):

Hydro One Networks (distribution)
Algoma Power Inc.
Sault Ste. Marie PUC
Chapleau PUC.

1.3 Transmission Study Area and Impacted Local Distribution Company (LDC)

The Transmission study area considered by this local planning report is Batchawana TS and Goulais Bay TS that are connected to No. 3 Sault transmission circuit at 115kV. It excludes the 115kV system at Third Line TS and Mackay TS. The single line diagram of the study area is shown Figure 2 and the geographical transmission map is shown is Figure 3.

The LDC in the area is Algoma Power Inc. (API). It is the sole customer supplied by Batchawana TS and Goulais TS. Batchawana TS supplies its load at 12.5kV, while Goulais TS supplies its load at both 12.5kV and 25kV.

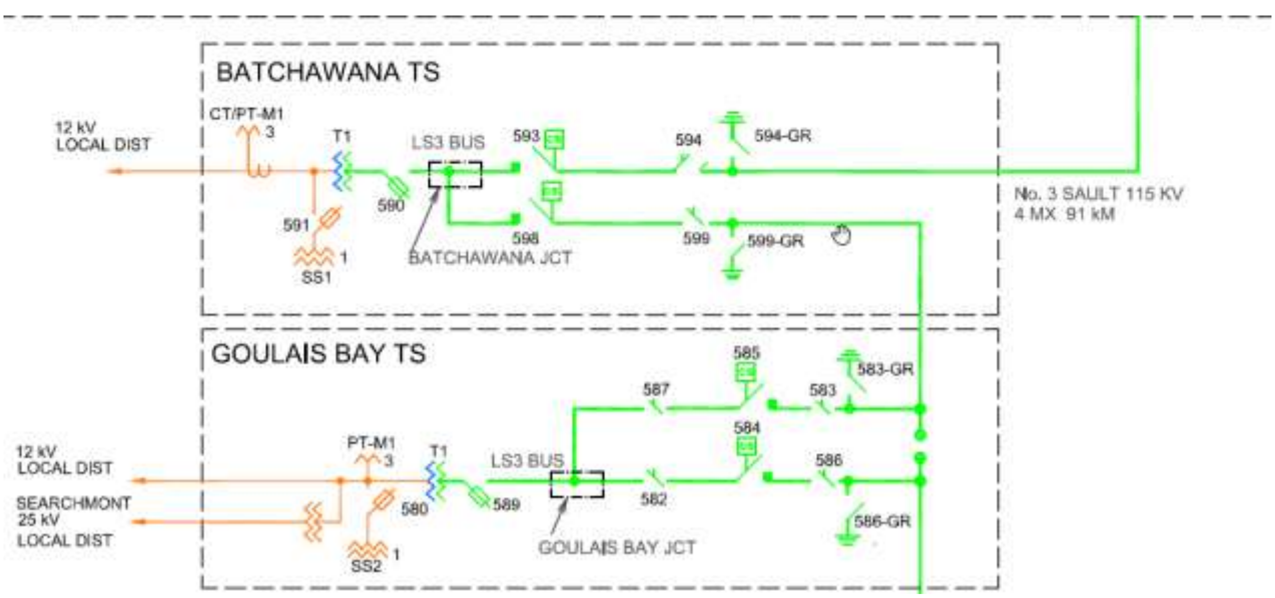

Figure 2: Single Line Diagram of Study Area

Figure 3: Geographical Transmission map of study area.

1.4 Distribution Study Area

The distribution system study area consists of the distribution systems fed directly by Batchawana TS and Goulais TS. While there exists a normally opened tie point with limited transfer capability between the two distribution systems, they operate largely as two separate distribution systems.

Batchawana distribution system: The 7.2 kV distribution system supplied by the Batchawana TS is a single phase radial system that supplies mainly seasonal loads, as well as some commercial and residential loads. The distribution system has approximately 86.2 primary circuit kilometers, covering the area from the south of Havilland area all the way to the north-west of the Ryan area. Figure 4 shows the single line diagram of the Batchawana distribution system sub-system.

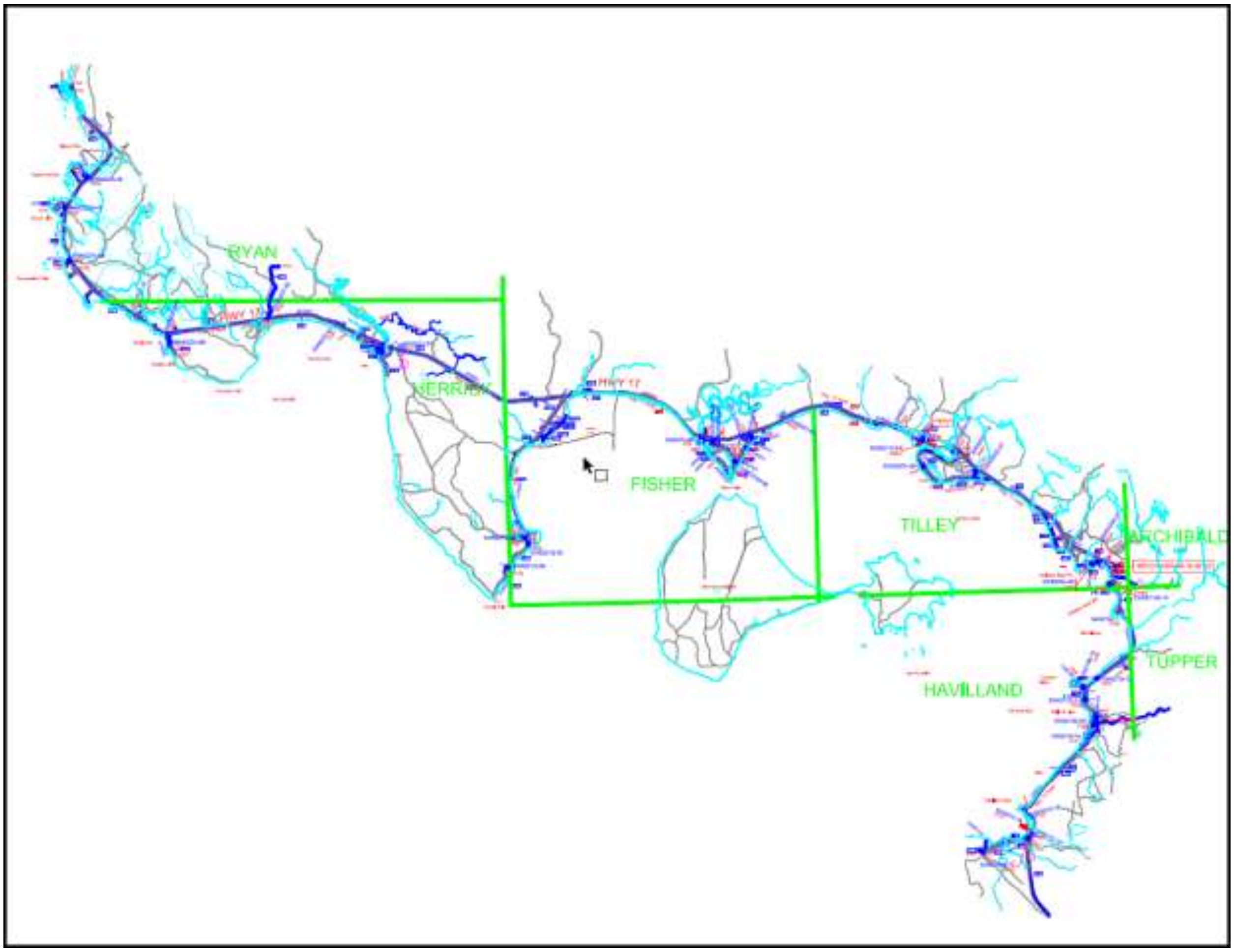

Figure 4: Single Line of Batchawana distribution system

Goulais distribution system: The 12.5kV and 25kV distribution system supplied by the Goulais TS is a hybrid system consisting of both three phase and single phase loads. The distribution system has approximately 285 primary circuit kilometers, covering the area from the south of Aweres to the north of Havilland and Ley. The 25kV distribution serves the area to the east in the Searchmont area and Hodgins township. Figure 5 shows the single line diagram of the Goulais distribution system sub-system.

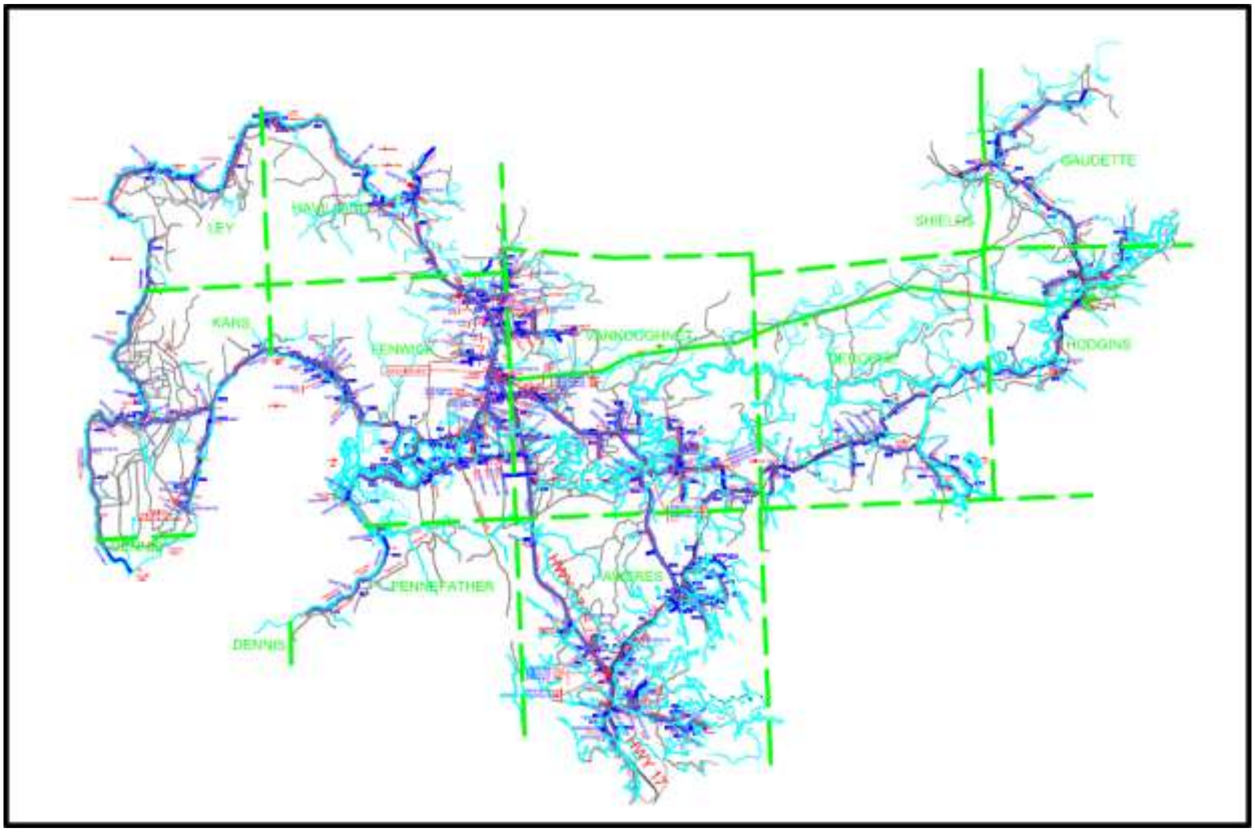

Figure 5: Single Line of Goulais distribution system

2 Load Forecast

API provided three (3) load growth scenarios using peak demand forecast covering the period 2020 – 2050 for Batchawana TS and Goulais TS. They are:

1. Annual trend line growth + Large customer expansion (285 kW for Batchawana TS , 500kW for Goulais TS)
2. Annual trend line growth + residential/seasonal electric vehicle (EV) penetration
3. Annual trend line growth + Large customer expansion + residential/seasonal electric vehicle(EV) penetration

In all scenarios, a fixed annual growth rate of 0.83% was applied to Batchawana TS, and a 0.6% annual growth rate was applied to Goulais TS. Residential EV penetration by 2050 is assumed to be 90%. Seasonal EV penetration by 2050 is assumed to be 70%. A coincident factor of 20% was assumed in the load forecast. Scenario 3 above was selected as it provides the most limiting case.

With the above assumptions and scenarios, load forecast by 2050 for respective stations are:

Batchawana TS : The baseline (2019) winter peak demand was 1.5MW . The station's load is forecasted to grow at 0.83% annually, up to 2.43MW by 2050. API indicated that maximum of 4MW load transfer from Goulais TS to Batchawana TS is possible upon API's completion of the 3 phase tie switch[1], putting maximum demand to 6.43MW with load transfer.

Goulais TS : The baseline (2019) winter peak demand was 8.1MW . The station's load is forecasted to grow at 0.6% annually, up to 10.67MW by 2050. API indicated that maximum of 2.5MW load transfer from Batchawana TS to Goulais TS is possible upon API's completion of the 3 phase tie switch[2], putting the maximum demand of 13.17 MW with load transfer.

Detail load forecast can be found in Appendix A.

3 Area Needs

3.1 Batchawana TS

Batchawana TS is an 115kV facility located approximately 47km north of the city of Sault Ste. Marie along Hwy 17. It consists of 2 single phase units (1 at 1.5MVA, 1 at 2.8MVA). Both units do not have limited time rating (LTR). Existing transformers capacity is expected to be able to handle forecasted load without load transfer capability from the station by 2050. However, it would not be able to handle load transfer requirements as indicated by API. The existing configuration also does not permit API to connect any 3-phase loads.

The ACA conducted in 2018 has concluded that the existing transformers are in Fair condition [3]. However, the Feasibility Report has identified other deteriorating equipment and infrastructures that requires attention. They include:

- Degraded structure foundations
- Rusty structures

Other needs of the station includes:

- Clearance to live components in station is not meeting modern limits of approach standard [1].

[1] The existing tie switch is a single phase, normally open tie switch. API indicated that they are exploring options to upgrade it to a three phase tie switch

[2] The existing tie switch is a single phase, normally open tie switch. API indicated that they are exploring options to upgrade it to a three phase tie switch

- The station does not currently have modern transmission protections, and relies on a transformer high side fuses to provide protection. Fuse replacement takes substantial time which leads to longer restoration time [1].
- The following equipment cannot be maintained without customer outages: Main Power Transformer T1, disconnect switch #590, circuit switchers #593 and #598, LS3 bus [1].
- In the event of transformer failure, the restoration timeline could be extensive as there is no spare or load transfer capability at Batchawana TS.

Pictures in Appendix B illustrates asset degradation at Batchawana TS.

3.2 Goulais TS

Goulais TS is an 115kV facility located approximately 30km north of the city of Sault Ste. Marie along Hwy 17. It consists of a 3 single phase units (5MVA each), for a total of 15MVA. The single phase units do not have limited time rating (LTR). Existing transformers capacity is expected to be able to handle forecasted load with load transfer capability from the station by 2050.

The ACA conducted in 2018 had concluded that the existing transformers are in Poor to Fair condition [3]. The Feasibility Report and ACA have identified other deteriorating equipment and infrastructures that requires replacement. They include:

- Outdoor Batteries requires frequent maintenance.
- Degraded structure foundations
- Rusty structures

Other needs of the station includes:

- Clearance to live components in station is also not meeting modern limits of approach standard [1].
- The station do not currently have any protections installed, and rely on a transformer high side fuse to provide protection. Fuse replacement takes time and lead to longer restoration time [1].
- The following equipment cannot be maintained without customer outages: T1, disconnect switch #589, LS3 bus [1].

- In the event of transformer failure, the restoration timeline could be extensive as the there is no spare or load transfer capability at Goulais TS.

- Currently, any maintenance requirements on T1 require API to physical disconnect leads off of it's 12.5kV bus, which requires significant effort and an outage to the 12.5kV bus and all downstream customers.

Pictures in Appendix C illustrates asset degradation at Goulais TS.

With the rural and radial nature of API's distribution system, API recognized there could be a need to convert the distribution voltage from 12.5kV to 25kV, which is dependent on actual load level increases in future years. As a result, API is working with HOSSM to consider transmission options capable of dual secondary voltage (12.5kV and 25kV), that would permit a voltage conversion in the future if needed.

3.3 Distribution System Needs

The distribution system needs are based on capacity, reliability and supply configuration-based needs.

API's distribution system needs include the following:

- 3-Phase supply from both the Batchawana TS and Goulais TS
- Status quo or better on supply reliability
- No negative impact on the distribution reliability and power quality
- Adequate transformation capacity to meet the distribution system's load term forecasted needs

Currently, API supply both 12.5kV and 25kV load from Goulais Bay TS using its 12.5/25kV transformer. There is a distribution system requirement to keep this dual voltage supply configuration.

4 Supply Alternatives Considered and Analysis Methodology

4.1 Supply Alternatives

Based on asset needs in both Goulais TS and Batchawana TS, the following options were considered and explored in collaboration with API:

- **Option 1** - Refurbish both Goulais TS and Batchawana TS; each station to have a single 3-phase transformer with provision for a Mobile Unit substation (MUS) connection facility in each station. Both distribution sub-systems will be supplied at: a) 12.5 kV or b) 25kV[3]. Transformer capacity of Batchawana TS and Goulais TS would be:
  - Batchawana TS : 7.5/10/12.5 MVA
  - Goulais TS : 10/13/16 MVA

- **Option 2** - Consolidate Goulais TS and Batchawana TS by building a "New" TS[4] . "New" TS will be equipped with two (2) 20MVA 3-phase transformers[1] to supply both distribution sub-systems at either a) 12.5 kV or b) 25kV[5]. The "New" TS is expected to be located closer to existing Goulais TS.

- **Option 3** - Consolidate Goulais TS and Batchawana TS by building a "New" TS with dedicated 25kV "express feeder" between Goulais bay area and Batchawana bay area. The "New" TS is expected to be located closer to existing Goulais TS. "New" TS will be equipped with two (2) 20MVA 3 phase transformer[1] to supply both distribution sub-systems at either a) 12.5 kV or b) 25kV[6] . An additional 25/12.5kV unit is required on the distribution system in the vicinity of Batchawana Bay to convert voltage from the incoming 25kV dedicated "express feeder" to 12.5kV.

Single line diagram for option 2 – 3 are available in Appendix D.

Depending on the chosen distribution voltage, each options would require specific distribution system upgrades. A total 6 different scenarios (2 scenarios for each of the 3 options above) for two (2) voltage permutations (12.5 kV vs 25 kV), are summarized in Table 1 below.

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[3] Depending on the final choice of distribution system supply voltage, the LDC will require a transformer to convert voltage to/from 25kV from/to 12.5kV to supply its 25kV/12.5kV customers on different feeders

[4] The "New" TS was referred to as "Greenfield TS" in [1].

[5] Depending on the final choice of distribution system supply voltage, the LDC will require a transformer to convert voltage to/from 25kV from/to 12.5kV to supply its 25kV/12.5kV customers on different feeders

[6] Depending on the final choice of distribution system supply voltage, the LDC will require a transformer to convert voltage to/from 25kV from/to 12.5kV to supply its 25kV/12.5kV customers on different feeders

Table 1: Summary of Supply Alternatives with details on Distribution system

	Options					
	Option 1-A	**Option 1-B**	**Option 2-A**	**Option 2-B**	**Option 3-A**	**Option 3-B**
Supply Configuration Description	Refurbishment 12.5kV for both Goulais TS Batchewana TS	Refurbishment 25kV for both Goulais TS and Batchewana TS	Build “New” TS at 115/12.5 kV	Build “New” TS at 115/25 kV	Build “New” TS at 115/12.5 kV with 25kV “express feeder” to Batchewana TS	Build “New” TS at 115/25 kV with 25kV “express feeder” to Batchewana TS
Supply Voltage - “NEW” TS			7.2/12.5kV 3PH	14.4/25kV 3PH	7.2/12.5kV 3PH	14.4/25kV 3PH
Distribution Area Voltage-Goulais	7.2/12.5kV 3PH	14.4/25kV 3PH	7.2/12.5kV 3PH	14.4/25kV 3PH	7.2/12.5kV 3PH	7.2/12.5kV 3PH
Distribution Area Voltage-Batchewana	7.2/12.5kV 3PH	14.4/25kV 3PH	7.2/12.5kV 3PH	14.4/25kV 3PH	14.4/25kV 3PH (Express), 7.2/12.5kV 3PH (distribution)	14.4/25kV 3PH (Express), 14.4/25kV 3PH (distribution)
Distribution Configuration -Goulais Load	Status Quo	Convert entire system voltage to 14.4/25kV	Extend 3PH from Greenfield TS and connect to existing 3PH Goulais feeders	Convert entire system voltage to 14.4/25kV; Extend 3PH from Greenfield TS and connect to existing 3PH Goulais feeders	Extend 3-phase from “New” TS	Install 3PH stepdown transformer (12MVA, 25:12.5); Extend 3PH from “New” TS and connect to existing 3PH 12.5kV Goulais feeders
Distribution Configuration -Searchmont area Load	Status Quo	Status Quo	Install 3PH stepup transformer (3-5MVA, 12.5:25) near “New” TS site; Extend 3PH 25kV from stepup transformer to existing Searchmont 25kV (at Goulais TS site)	Extend 3PH 25kV from “New” TS site to existing Searchmont 25kV (at Goulais TS site)	See note for Batchewana Load	Extend 3PH 25kV from “New” TS site to existing Searchmont 25kV (at Goulais TS site)

Distribution Configuration -Batchawana Load	Status Quo	Convert entire system voltage to 14.4/25kV	Extend 3-phase from Greenfield TS site to Batchewana TS site	Extend 3-phase from Greenfield TS site to Batchewana TS site; Convert entire system voltage to 14.4/25kV	Install 3PH stepup transformer (5MVA, 12.5:25); Extend 3PH to existing Searchmont 25kV and to Batchewana TS site. Install 3PH stepdown transformer (3MVA, 25:12.5) near Batchewana	Extend 3-phase from Greenfield TS site to Searchomont 25kV and to Batchewana TS site; Install 3PH stepdown transformer (3MVA, 25:12.5) near Batchewana

4.2 Analysis Methodology

HOSSM and API evaluated each scenario with the following objectives and criteria:

<u>Objective</u>

- Overall least total life-cycle cost for Transmission and Distribution system, which included both capital cost and operation, administration and maintenance (OM&A) cost. Cost incremental that contributed to increased reliability and system performance should be considered and justifiable.

<u>Criteria</u>

1. Meet the long term load forecast provide by API.
2. Address the needs of existing Transmission facilities per section 3 , which included:
    - Aging infrastructure and equipment
    - Electrical clearance concerns
    - Ability to conduct regular maintenance with minimal interruption of supply
    - Provide standard transmission protection system that is coordinated with downstream distribution system protection
    - Ability to provide load restoration in acceptable timeframe
    - Minimize LDC connection work required during planned outages.
3. Status quo , or improved overall system reliability (Transmission and Distribution)

4. Status quo , or improved overall system performance (Transmission and Distribution)

Other Considerations

Other project risks that are not objectives nor criteria, but are taking into consideration includes:

- Potential outage requirements during project execution
- Potential environmental impact
- Potential regulatory implications, such as OEB section 92 application.

4.2.1 Meeting long term load forecast & Address Assets Needs

All 6 scenarios will satisfy criteria 1 and 2 above.

4.2.2 System Reliability Analysis

System reliability is further split into Transmission supply reliability and Distribution system reliability, with each subdivided into interruption duration and frequency.

Transmission Supply Reliability – Interruption Duration

Transmission Supply Reliability for Option 1 is considered to be status quo, with marginal improvement as the MUS connection facility will facilitate a faster restoration upon transformer contingency. The MUS would also allow outages to be scheduled to facilitate planned maintenance activities. However, as MUS would not permanently be located on-site and requires time for transportation and connection, hence the outage duration is expected to be longer compared to option 2 and 3. Option 2 and option 3, from a station asset point of view, will increase Transmission supply reliability in the study area as the “New” TS will be equipped with two transformers to provide redundant transformation, and hence reduce outage duration upon loss of a single transformer.

Transmission Supply Reliability – Interruption Frequency

Under all options the station(s) will remain supplied solely by one (1) 115kV circuit – Sault #3 Circuit. Sault #3 is about 90km long. Due to its higher environmental exposure compared to a station, the frequency of interruption for all options will not materially change.

Distribution Supply Reliability – Interruption Duration

API's distribution system in the Batchawana and Goulais areas are rural and remote and in some part, located off the shores of Lake Superior. As a result, during major events, such as storms (winter or summer), interruption duration could be long if the storm is severe. The majority of API's pole line is also not road accessible, and requires special off road vehicles for accessing and repair any issues. In options 2 and 3, API would see an increase in outage duration for any permanent faults along the new 3-phase line extension between the existing two TS sites.

Option 1 would permit API to transfer load between the two stations, and result in increased distribution reliability during planned and unplanned outages compared to that of Option 2 and 3.

Distribution Supply Reliability – Frequency of Interruption

Option 2 and option 3 will decrease Distribution supply reliability in the study area as the "New" TS consolidates Transmission supply point from existing two (2) stations to only one (1). This eliminates feeder sections that are supplied from either Batchawana or Goulais TS. Longer portions of distribution feeders increases the exposure level and probability of causing customers' interruption increases. API would be exposing approximately 840 customers to a new 10 km radial feeder and approximately 620 customers to an additional 10 km radial feeder.

Option 2 and 3 would not permit API to perform any load transfers that option 1 can afford during any planned maintenance work (e.g. pole change, line clearing) that take place at regular intervals.

Transmission vs Distribution

It is expected that the probability of distribution interruption will be greater than that of transmission, as the distribution system has more circuit kilometers compared to that of transmissions, and cover a larger geographical area compared to the transmission study area.,

Table 2 summarized system reliability assessment for Transmission and Distribution system.

Table 2: System reliability comparison among all alternatives

	System Reliability Comparison					
	Option 1-A	**Option 1-B**	**Option 2-A**	**Option 2-B**	**Option 3-A**	**Option 3-B**
Transmission Reliability - Duration	Status Quo – Marginal Improvement	Status Quo – Marginal Improvement	Increased	Increased	Increased	Increased
Transmission Reliability – Frequency	Status Quo	Status Quo	Status Quo	Status Quo	Status Quo	Status Quo
Distribution Reliability - Duration	Status Quo	Status Quo	Decreased	Decreased	Decreased	Decreased
Distribution Reliability – Frequency	Status Quo	Status Quo	Decreased	Decreased	Decreased	Decreased
Overall	**Marginally Improved**	**Marginally Improved**	**Marginally degraded**	**Marginally degraded**	**Marginally degraded**	**Marginally degraded**

4.2.3. System Performance Analysis

System Performance is evaluated based on voltage performance and system loss.

4.2.3.1 Distribution Voltage Performance Analysis

API evaluated the distribution voltage performance under different scenarios and summarized its respective voltage re-enforcement requirements. In this evaluation, performance of Option 1-A is chosen as the baseline for benchmarking purpose because this represents the existing situation. Table 3 below summarized voltage support requirements in different scenarios

It is observed that except for option 2-B, all options required some voltage support throughout the distribution system to provide adequate voltages for the anticipated load growth within the the period 2020 – 2050, as well as to accommodate different Transmission supply configuration options..

Option 2-A would require the most voltage support among all considered alternatives, followed by 3-A and 3-B.

Table 3: Distribution voltage performance and support requirements comparison

Distribution Voltage Performance and Support Requirement Comparison					
Option 1-A	**Option 1-B**	**Option 2-A**	**Option 2-B**	**Option 3-A**	**Option 3-B**
7.2/12.5kV 3PH	14.4/25kV 3PH	7.2/12.5kV 3PH	14.4/25kV 3PH	7.2/12.5kV 3PH	14.4/25kV 3PH
Voltage support required based on load forecast	Voltage Support only required to maximize load transfer capabilities between Batchewana TS and Goulais TS	Voltage support required based on load forecast. Additional voltage support required to accommodate single supply station in Batchewana. Potential additional voltage support required in Goulais depending on location of Greenfield TS	Not required	Voltage support required based on load forecast. Potential additional voltage support in Goulais depending on location of Greenfield TS	Voltage support required based on load forecast. Potential additional voltage support in Goulais depending on location of Greenfield TS

4.2.3.2 Distribution System Losses Analysis

API evaluated the distribution system losses based on proposed voltage of different options[7]. Option 1-A is chosen as benchmark for comparison purpose.

According to the analysis, it is observed that Option 2-A, 3-A and 3-B – options which consolidates Batchawana and Goulais TS and supply the area at 12.5kV – would result in higher active power losses in the study area compared to the benchmark due to the loss of a second Transmission infeed to the distribution system. This results in using longer distribution feeders to connect load to electrical source. A consolidated supply configuration only reduces system losses if the distribution voltage is also upgrade to 25kV.

The difference in active power losses between a consolidated Transmission infeed ("New" TS) vs two (Batchawana and Goulais) becomes non-material if distribution voltage is upgraded to 25kV. Based on the study, option 2-B (consolidation – 25kV) have 0.6% higher losses compared to option 1-B (keep Batchawana and Goulais – 25kV). In conclusion, system loss performance is more sensitive to the choice of distribution voltage instead of supply configuration.

Table 4: Distribution system losses comparison

	System Loss Comparison					
	Option 1-A	**Option 1-B**	**Option 2-A**	**Option 2-B**	**Option 3-A**	**Option 3-B**
Supply Voltage	7.2/12.5kV 3PH	14.4/25kV 3PH	7.2/12.5kV 3PH	14.4/25kV 3PH	7.2/12.5kV 3PH	14.4/25kV 3PH
Active Power Losses	10.24%	5.00%	17.71%	5.60%	12.46%	12.46%
Distribution System Loss Impact	Status Quo	Overall decrease in Active System Loss by 51%	Increase in Active System Loss by ~73%	Overall decrease in Active System Loss by 45%	Increase in active losses by ~22%	Increase in active losses by ~22%

[7] Evaluation performed by 3rd party

4.2.4 Cost Analysis

Depending on the different distribution voltage, each scenario would require specific distribution system upgrades. HOSSM and API had utilized their respective internal planning allowance to estimate the cost for various scenarios. Cost estimates are intended for the purpose of option comparison, and are not within sufficient accuracy to be relied upon for project financing. Table 5 summarized capital and OM&A costs for each scenarios.

Cost to build the "New" TS is based on recently completed HONI High Voltage Distribution Station (HVDS) projects[8] with real estate allowance, which HOSSM believe would represent a more realistic cost estimations compared to costs provided in [1]. Voltage support requirements in Distribution system, and its associated costs, are based on API's Supply Configuration Alternative analysis.

Based on Table 5, it is observed that all options have comparable capital costs among scenarios supplying the same distribution voltage (12.5 kV, 25kV), regardless of supply configurations (Consolidation vs Individual stations rebuild). There are sizable cost incremental (30-40% more) when options are upgrade to 25kV, compared to remaining at 12.5kV in the distribution system. Option 2 and 3 (Consolidation) show clear OM&A advantage over option 1 (Individual stations rebuild) as maintaining one station would be more economic than maintaining two. The combined suggested that Consolidation resulted in slightly lower total life cycle cost compared to that of Individual comparable distribution voltage. Overall, Individual stations rebuild (Option 1) is about 10% - 12.5% more expensive compared to consolidation options with the same distribution voltage, however it provides improvements to system reliability and performance.

[8] Assumed 2X the cost form a HVDS project completed in 2018 to account for 2 transformers, plus real estate expansion allowance.

Table 5: Total life cycle cost comparison for various options

		Cost Comparison ($M)					
	Description	Option 1-A	Option 1-B	Option 2-A	Option 2-B	Option 3-A	Option 3-B
Transmission Cost	New Substation to replace exciting stations	-	-	$14.4	$14.4	$14.4	$14.4
	Refurbish the existing Goulais TS	$9.1	$9.1	-	-	-	-
	Refurbish the existing Batchewana TS	$6.2	$6.2	-	-	-	-
Distribution Tie-Line Reinforcement	Install three-phase tie switch to allow load transfer	-	-	$4.0	$4.0	$4.0	$4.0
12.5/25kV Power Transformer	Two 12MVA, 25/12.5kV transformers and relevant buswork, site, concrete work, .etc	-	-	-	-	-	$1.5
	Two 5MVA, 12.5/25kV transformers and relevant buswork, site, concrete work, .etc	-	-	-	-	$0.6	-
	One 2MVA, 25kV/12.5kV Transformer Bank to step the voltage down at Batchewana	-	-		-	$ 0.3	$ 0.3
Voltage Reinforcement	Several Shunt capacitors and voltage regulators installation for voltage profile control	-	-	$ 0.9	-		-

	Reinforcements with normal configuration for voltage profile control	$ 0.6	-	-	-	$ 0.6	$ 0.6
	Several shunt capacitors/regulars to support voltage under back up operation	-	$ 0.7	-	-		-
	Several Shunt capacitors installation for voltage profile control	-	-	-	-	$ 0.1	$ 0.1
Voltage Conversion Requirement	Replace of distribution transformers with 12.5kV primary voltage to 25kV	-	$ 3.4	-	$ 3.4		-
	Insulator Upgrade to 28kV	-	$ 5.0	-	$5.0		-
TOTAL CAPITAL COST (ESTIMATED)		**$15.9**	**$24.4**	**$ 19.3**	**$26.8**	**19.7**	**$ 20.6**
Maintenance Cost (50 year lifecycle)		$7.1	$7.1	$4.7	$ 4.7	$4.7	$4.7
Total Life Cycle Cost (50 year life cycle)		**$ 23.0**	**$ 31.5**	**$ 24.0**	**$ 31.5**	**$ 24.4**	**$ 25.3**

4.2.5 Cost- Benefit Analysis

Previous sections provided analysis on different criteria based on different scenarios. Table 6 below illustrates a summary of cost-benefit analysis, where cells in green indicated an improvement, while cells in red indicated a degradation. It is observed that Options 1-A (Rebuild Batchawana and Goulais- 12.5kV) achieves the best balance between costs and meeting various evaluation criteria. Other options that builds a "New" TS are either more expensive, or unable to provide the same level of system reliability and performance despite being more economical.

Although option 1-B provides the best system reliability and performance among all options, option 1-A is the least cost option that would meet all transmission and distribution needs...

Table 6: Cost benefit summary

Cost Benefit	Option 1-A	Option 1-B	Option 2-A	Option 2-B	Option 3-A	Option 3-B
System Reliability	Marginally improved	Marginally improved	Marginally degraded	Marginally degraded	Marginally degraded	Marginally degraded
Voltage support Requirements	Benchmark	Minor	Major	None	Some	Some
Active Power loss	Benchmark (10.24%)	5.00%	17.71%	5.60%	12.46%	12.46%
Capital Cost	$15.90	$24.40	$19.30	$26.80	$19.7	$20.60
OM&A Cost (50 years)	$7.10	$7.10	$4.70	$4.70	$4.70	$4.70
Total Cost ($M)	**$23.00**	**$31.50**	**$24.00**	**$31.50**	**$24.40**	**$25.30**

4.2.6 Discussion on Common Project Execution Risks

In addition to meeting the objective and criteria, the working group considered other commonly known project risks, as the ultimate recommendation should not introduce major misalignment with these risks. It is not the scope of this planning report to predict future outcome of these project risks, but rather, to provide an overview and discuss its implication.

Compared to station expansion, it is anticipated that building a "New" TS would, in general, trigger larger real estate and easements right requirements and a more complex environmental assessment. These risks introduce cost and schedule uncertainty to the project.

The working group also recognized that the existing station configuration, inadequate electrical clearances, extremely limited load transfer capability between stations, and small station footprints in both Batchawana TS and Goulais TS could constraint outage availability during construction, which would lead to a longer and more complex construction schedule. In contrast, building a new TS on a "greenfield" site would have fewer outage constraints, and would possibly resulted in a more compressed construction schedule.

5 Conclusion and Recommended Solution.

As a recommendation of the 2019 *Need Assessment*, HOSSM and API have conducted a coordinated review and evaluation on the supply options to the Batchawana and Goulais Bay area. The working group reviewed the study area, facilities needs and future load forecast. Six scenarios were developed based upon these foundations and presented in this review. They include 1) Refurbish both Batchawana TS and Goulais TS, 2) Build a "New" TS to replace both Batchawana TS and Goulais TS, and 3) Build a "New" TS with a dedicate 25kV feeder to supply between the Batchawana and Goulais areas to replace both existing stations.

These six scenarios were evaluated based on system reliability, system performance, and total life-cycle cost to determine the optimal solution that balances cost with various system benefits. The agreed upon option is Option 1-A as it will allow HOSSM to address deteriorating asset condition at Batchawana TS and Goulais TS in the short to medium time frame, to meet load forecast, as well as to maintain the long term supply reliability to API customers.

The analysis also concludes that the choice of distribution voltage (12.5kV vs 25kV) has a more dominant impact on both system performance and cost over the choice of supply configuration. A consolidation of Batchawana TS and Goulais TS into a single station would have also resulted in a marginal degradation of overall system reliability and more observable shortfalls in distribution system performance compared to present day's benchmark. A cost-benefit analysis reveals that Option 1-A provides the lowest total life cycle cost and achieve the best balance between cost vs system benefits. Therefore, Option 1-A is recommended.

6 References

[1] *Development of Greenfield Transmission Station Feasibility Study, Report No 15-079-01, Revision C*. OneLine Engineering , Great Lake Power Transmission , (2016), Sault Ste. Marie, Ontario.

[2] *Decision and Order EB-2018-0218, Hydro One Sault Ste. Marie LP, Application for electricity transmission revenue requirement beginning January 1, 2019 and related matters* , Ontario Energy Board (2019), Ontario.

[3] *Asset Condition Assessment for the Hydro One Sault Ste. Marie Transmission System*. Metsco, (2018), Toronto, Ontario.

Appendix A: Load Forecast for Goulais TS & Batchawana TS (2020-2050)

Goulais TS Load Forecast (2020-2050) [MW]:

Scenarios	GROWTH RATE	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Annual Trendline Growth	0.60%	8.10	8.15	8.19	8.24	8.29	8.34	8.39	8.44	8.50	8.55	8.60	8.65	8.70	8.75	8.81	8.86	8.91	8.97
Annual Trendline Growth+Large Customer Expansion(500kW)	0.60%	8.10	8.15	9.52	9.73	10.28	10.55	10.60	10.65	10.71	10.76	10.81	10.86	10.91	10.96	11.02	11.07	11.12	11.18
Annual Trendline Growth+Residential/Seasonal EV Penetration	0.60%	8.10	8.15	8.31	8.37	8.44	8.50	8.57	8.63	8.70	8.76	8.83	8.90	8.96	9.03	9.10	9.16	9.23	9.30
Annual Trendline Growth+Residential/Seasonal EV Penetration+Large Customer Expansion(500kW)	0.60%	8.10	8.15	9.64	9.96	10.52	10.82	10.88	10.95	11.02	11.08	11.15	11.22	11.29	11.35	11.42	11.49	11.56	11.63

Scenarios	GROWTH RATE	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Annual Trendline Growth	0.60%	9.02	9.08	9.13	9.19	9.24	9.30	9.35	9.41	9.46	9.52	9.58	9.64	9.69	9.75
Annual Trendline Growth+Large Customer Expansion(500kW)	0.60%	11.23	11.29	11.34	11.40	11.45	11.51	11.56	11.62	11.67	11.73	11.79	11.85	11.90	11.96
Annual Trendline Growth+Residential/Seasonal EV Penetration	0.60%	9.37	9.44	9.51	9.58	9.65	9.72	9.79	9.86	9.93	10.01	10.08	10.15	10.22	10.29
Annual Trendline Growth+Residential/Seasonal EV Penetration+Large Customer Expansion(500kW)	0.60%	11.70	11.77	11.84	11.91	11.98	12.05	12.12	12.20	12.27	12.34	12.42	12.49	12.56	12.64

Batchawana TS Load Forecast (2020-2050) [MW]

Scenarios	GROWTH RATE	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Annual Trendline Growth	0.83%	1.58	1.59	1.60	1.62	1.63	1.64	1.66	1.67	1.69	1.70	1.71	1.73	1.74	1.76	1.77	1.79	1.80	1.82
Annual Trendline Growth+Large Customer Expansion(285kW)	0.83%	1.58	1.88	1.89	1.90	1.92	1.93	1.94	1.96	1.97	1.99	2.00	2.01	2.03	2.04	2.06	2.07	2.09	2.10
Annual Trendline Growth+Residential/Seasonal EV Penetration	0.83%	1.58	1.59	1.61	1.62	1.64	1.66	1.68	1.69	1.71	1.73	1.75	1.76	1.78	1.80	1.82	1.83	1.85	1.87
Annual Trendline Growth+Residential/Seasonal EV Penetration+Large Customer Expansion(285kW)	0.83%	1.58	1.88	1.89	1.91	1.93	1.94	1.96	1.98	2.00	2.01	2.03	2.05	2.07	2.08	2.10	2.12	2.14	2.16

Scenarios	GROWTH RATE	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Annual Trendline Growth	0.83%	1.83	1.85	1.86	1.88	1.89	1.91	1.93	1.94	1.96	1.97	1.99	2.01	2.02	2.04
Annual Trendline Growth+Large Customer Expansion(285kW)	0.83%	2.12	2.13	2.15	2.16	2.18	2.19	2.21	2.23	2.24	2.26	2.27	2.29	2.31	2.32
Annual Trendline Growth+Residential/Seasonal EV Penetration	0.83%	1.89	1.91	1.93	1.95	1.97	1.99	2.00	2.02	2.04	2.06	2.08	2.10	2.12	2.14
Annual Trendline Growth+Residential/Seasonal EV Penetration+Large Customer Expansion(285kW)	0.83%	2.18	2.19	2.21	2.23	2.25	2.27	2.29	2.31	2.33	2.35	2.37	2.39	2.41	2.43

Appendix B: Asset Pictures at Batchawana TS [1]

Corrosion on Transformer T1 at Batchawana TS

Low clearance fence

Rusty structures

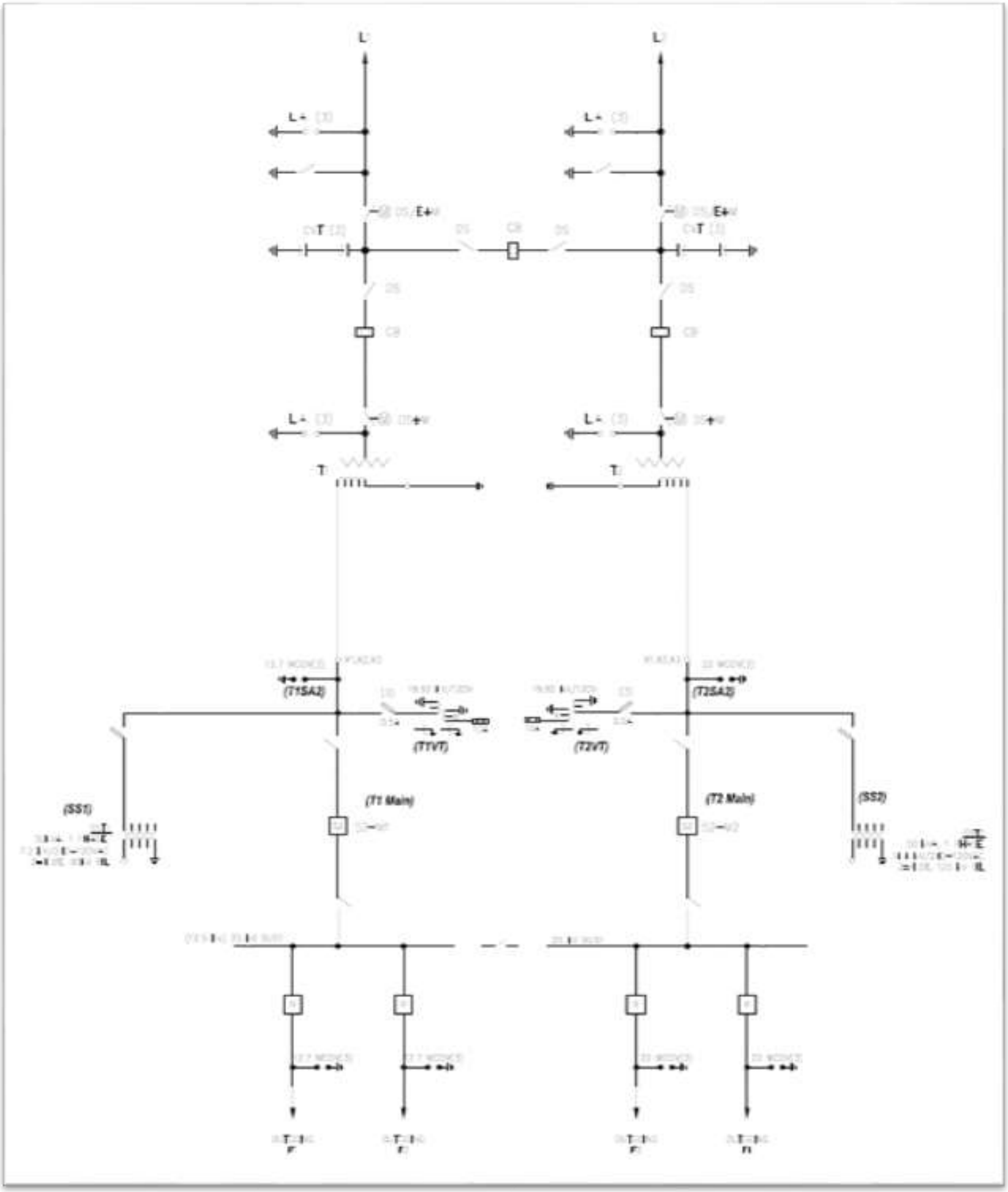
Degraded Foundations

Appendix C: Asset Pictures at Goulais Bay TS [1]

Detached and degraded foundations (left and right picture)

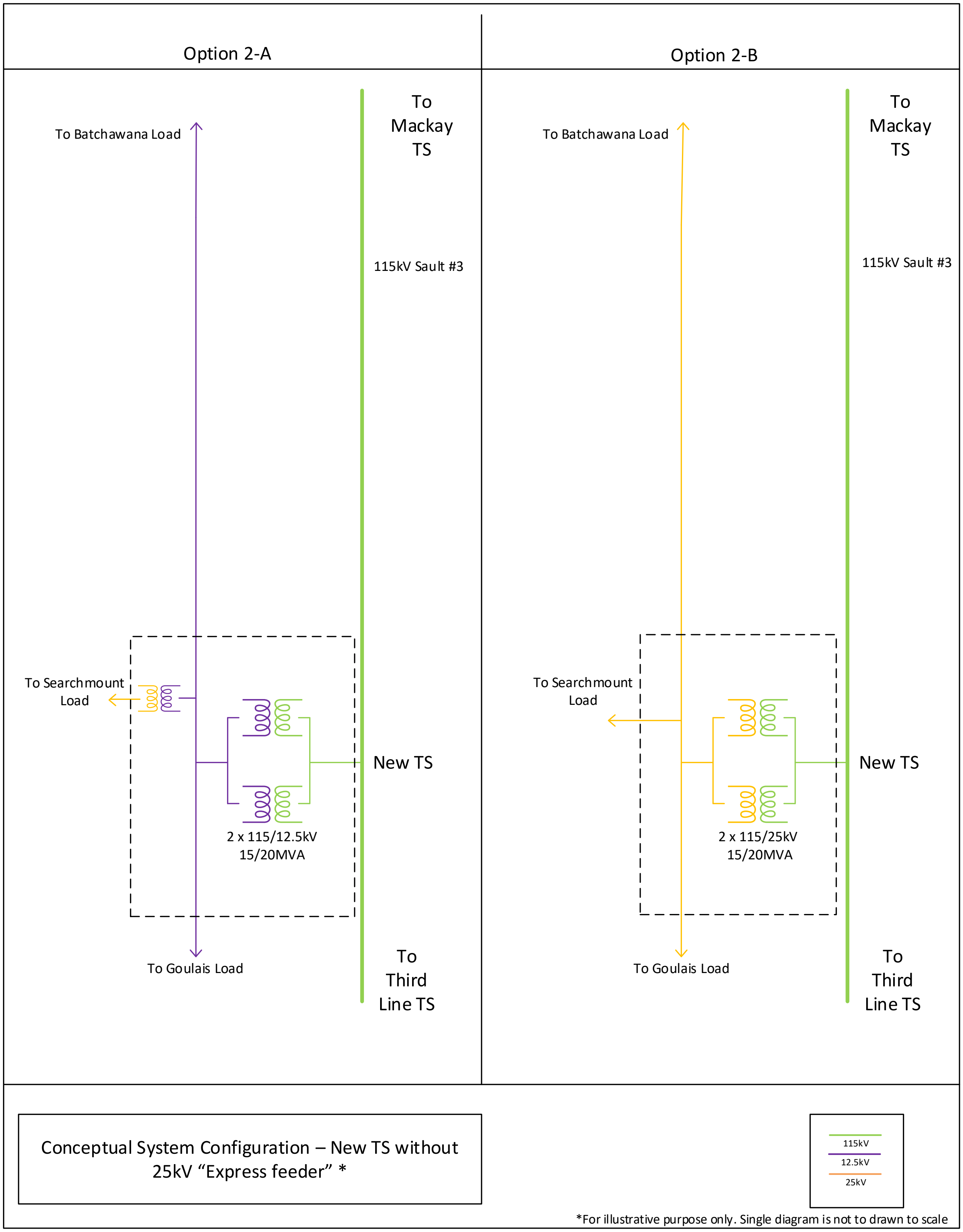
Goulais T1 with signs of oil leak

Appendix D: Single Line Diagram for New TS[1]



Single line diagram that illustrates the recommended station configuration from Feasibility Report in [1].

Appendix E: Conceptual System Configuration for New TS (Option 2)



Appendix F: Conceptual System Configuration for New TS with 25kV Express Feeder (Option 3)