Appendix – 2-Intervenor-45

Burlington hydro inc.

2021

System Performance Report

Burlington Hydro Inc.

2021 System Performance Report

Table of Contents

Introduction 2

1 Substation and Feeder Performance 4

1a. General 4

1b. Substations 5

1c. 27.6kV Feeders 6

1d. 13.8kV Feeders 7

1e. 4.16kV Feeders 8

2 Underground Distribution 9

3 System demand and critical loading issues 10

3a. Overall Demand/Load Growth 10

3b. 27.6 Feeder Loads and Transformer Station Capacity 10

4 System maintenance activities and priorities 14

5 Reliability statistics and observations 16

6 Future maintenance & operations recommendations 19

6a. 27.6kV Feeders 19

6b. 13.8kV Feeders 19

6c. 4.16kV Feeders 19

6d. Wood Pole Replacements 19

6e. Vault Washing 19

6f. Pad-Mounted Transformers & Switching Cubicles 20

7 Future Capital Budget recommendations 20

7a. Substation Power Transformers 20

7b. 27.6kV Feeders 20

7c. 13.8kV Feeders 20

7d. System Planing 20

Introduction

The 2021 System Performance Report is intended to provide a comprehensive overview of the performance of the Burlington Hydro distribution system during 2021. It is based on the format established for previous reports and contributes to BHI's Asset Management Strategy by identifying future maintenance and capital budget priorities to enhance the reliability and performance of the distribution system. The following specific attributes are reviewed and addressed:

1) Substation and Feeder performance at 4.16, 13.8 and 27.6 kV primary voltage levels

2) Underground Distribution

3) System demand and critical loading issues

4) System maintenance activities and priorities

5) Reliability statistics and observations

6) Future maintenance recommendations

7) Future Capital Budget recommendations

Information contained in the report was supplied by the Burlington Hydro Control Room and BHI senior management; it summarizes statistics and incidents that occurred in 2021. Data from previous years was used for comparison purposes and to identify any recurring issues. Recommendations were based on consultations with BHI engineering and operations staff.

1 Substation and Feeder Performance

1a. *General*

In 2021, BHI had no major performance issues at any of its 32 substation locations. More specific observations and commentary, on substations, are included in section 1b below.

The following table summarizes the number of feeders at each voltage level.

Primary Voltage	Number of Feeders	Percentage of Total
27.6kV	34	21.25
13.8kV	28	17.5
4.16kV	98	61.25
Total	160	100.00

Table 1- Number of Feeders at each voltage level

The analysis of feeder performance is based on the recording of feeder Auto-Reclosures, of feeder Lock-Outs and a review of causes of interruptions. Appendix A summarizes the performance of each feeder since 2011, as follows:

1. Appendix A1: Auto-Recloses (sorted by Total, since 2011)
2. Appendix A2: Auto-Recloses (sorted by no. in 2021)
3. Appendix A3: Lock-Outs (sorted by Total, since 2011)
4. Appendix A4: Lock-Outs (sorted by no. in 2021)

These Appendices also identify the voltages of each feeder, and they are color coded the same as the typical BHI GIS voltage level colors; Blue - 4.16 KV, Red – 13.8 KV and Brown – 27.6 KV.

A review of the actual numbers of Auto-Recloses and Lock-Outs for 2021 and 2020 when compared to the average number since 2012 is also worthy of note.

Auto-Reclosures	2020	2021	Previous 10-year Average 2012-2021
27.6kV	68	58	57.2
13.8kV	112	160	131.2
4.16kV	62	68	73.2
Total	242	286	261.6

Table 2- Auto-Recloses comparison between 2020, 2021 and the previous 10-year average (2012-2021)

Lock-Outs	2020	2021	Previous 10-year Average 2012-2021
27.6kV	22	10	20.6
13.8kV	11	15	24.1
4.16kV	18	17	29.5
Total	51	42	74.2

Table 3- Lock-Outs comparison between 2020, 2021 and the previous 10-year average (2012-2021)

Conclusions:

It is important to appreciate the difference in loading capacity at each voltage level. A typical 4.16 kV feeder may supply only 500 customers, whereas a 13.8 kV feeder may supply around 1500 and 27.6 kV 4000 customers. Therefore, the exposure of feeder length has a proportional relationship to the number of customers served. Also, it is acknowledged that both the 4.16 and 13.8kV customers experience momentary interruptions and outages when incidents occur on their 27.6kV supply feeder. Therefore Auto-Reclosures and Lock-Outs, at each voltage level, are not at all equal with respect to their impact on customers. With that background the following conclusions can be drawn from the above:

1. The total number of Auto-Reclosures increased in 2021 and is above than 10-year average, primarily due to the higher number of Auto-Reclosures at 13.8kV voltage level compared to the previous year.
2. The total number of Lock-Outs reduced in 2021 and is below 10-year average, primarily due to the lower number of Lock-Outs at 27.6 KV voltage level compared to the previous year.

More specific observations and commentary on these items are included in sections 1c, 1d and 1e below.

1b. *Substations*

There are no significant changes to the station and feeder loadings, in 2021. BHI Control Room Operators are aware of the system capabilities for station and feeder back-ups. At most times of the year these are not an issue, however there are the following potential vulnerabilities some of which have been previously noted:

1. Brant M.S. and Mount Forest MS should provide back-up to each other, but this was not possible under heavy load conditions. To improve the situation BHI did upgrade the 4.16 KV feeder egress cables at Brant MS in 2019 and the Station Transformer at Mount Forest M.S in 2021. Station Transformer at Mount Forest MS has shown significant signs of internal arching, based on the dissolved gas analyses, which initiated a process for the transformer to be taken out of service and replaced with a new transformer. However, the upgrade of the 4.16 KV feeder egress cables at Mount Forest MS was deferred to a future date. With this upgrade and additional potential system improvements in the area, the back-up capacity between Mount Forest MS and Brant MS will improve.

2. The Primary 27.6 KV metal clad switchgear at Tayandaga MS has reached its end of life and was replaced with two (2) remotely supervised Vista units in 2021, which added more automation to the 27.6 KV feeders supplying Tayandaga MS and improved the safety and system reliability.

BHI expects to operate most of its substations indefinitely, as conversion to a higher voltage is cost prohibitive. The transformers, switchgears, breakers, relays, and buildings are well maintained, but many of them are over 30 years old and generally supply power to the older neighborhoods. Currently ten (10) Power Transformers are closely monitored due to the results of the Dissolved Gus Analysis (DGA) and quarterly oil test is performed throughout the year. Majority of the substations, twenty (20) are equipped with a single power transformer and twelve (12) have double transformation. Approximately twenty-five (25) of the transformers are over 40 years old and therefore present the highest risk particularly when the current insurance coverage applies to a depreciated value only and falls to zero for units over 40 years old. In 2011 an annual replacement program was initiated and since then eleven (11) Station Transformers have been replaced with new transformers, including one in 2021.

1c. 27.6kV Feeders

Appendix B contains the 27.6kV Feeder Outage Reports for all 27.6kV feeders experiencing 5 or more Auto-Reclosures or 2 or more Lock-Outs, during 2021. The following is a commentary on each of these feeders.

Feeder (TS)	No. of 2021 Auto-Reclosures (2020)	No. of 2021 Lock-Outs (2020)	Comments/Cause	
			Auto-Reclosures	Lock-Outs
39M36 (Burlington)	6 (0)	0 (1)	Unknown (4) Squirrel (1) Defective Customer Equipment (1)	
39M2 (Cumberland)	0 (1)	2 (1)		Unknown (1) High Winds/Tree (1)

Table 4- 27.6 kV Feeders experiencing 5 or more Auto-Reclosures or, 2 or more Lockout

In total the BHI 27.6kV feeders experienced 10 Lock-Outs and 58 Auto-Reclosures, during 2021 and mainly they were caused by High Winds/T-Storm for the Lock-Outs, and Unknown cause, T-Storm, and Wildlife for the Auto-Reclosures. The following table compares the preceding 10 years of Lock-Outs.

YEAR	Number of 27.6 kV Lockouts
2012	15
2013	30
2014	20
2015	33
2016	23
2017	14
2018	20
2019	19
2020	22
2021	10

Table 5- Number of 27.6 kV Lockouts per year

1d. 13.8kV Feeders

The performance of certain 13.8kV feeders continues to be monitored closely. Appendix C contains the 13.8kV Feeder Outage Reports for all 13.8kV feeders experiencing 5 or more Auto-Reclosures or 2 or more Lock-Outs, during 2021. The following is a commentary on each of these feeders.

M.S. Feeder	No. of 2021 Auto-Reclosures (2020)	No. of 2021 Lock-Outs (2020)	Comments/Cause	
			Auto-Reclosures	Lock-Outs
Interchange F1	12 (8)	3 (0)	High Winds/Tree (3) Defective Transformer (2) Unknown (5) Squirrel (1) Defective U/G Primary (1)	Defective Transformer (1) Unknown (1) Pole Fire (1)
Interchange F2	6 (2)	0 (0)	Defective Transformer (1) Unknown (4) Broken Pole (1)	
Lowville F1	17 (5)	0 (1)	High Winds/Tree (3) Squirrel (6) Unknown (5) Bird (1) Broken Pole (2)	
Lowville F2	6 (3)	3 (1)	Unknown (4) Bird (1) Tree/Limb (1)	Unknown (2) Tree/Limb (1)
Lowville F3	29 (5)	2 (0)	Squirrel (1) Unknown (24) Tree/Limb (2) Broken Pole (2)	Unknown (2)
Orchard F1	7 (0)	0 (2)	Squirrel (1) Unknown (6)	
Palmer F1	10 (7)	0 (0)	Squirrel (1) Unknown (9)	
Palmer F3	10 (8)	0 (0)	Squirrel (1) Defective U/G Primary (4) Unknown (5)	
Towerline F2	5 (4)	3 (0)	Squirrel (1) Unknown (3) Bird (1)	Burned Off Tap (2) Defective U/G Primary (1)

Towerline F3	5 (2)	0 (0)	Defective U/G Primary (2) Cold Load (1) Unknown (2)	
Towerline F4	9 (6)	0 (0)	Defective Connection (1) Unknown (7) Bird (1)	
Tyandaga F1	6 (4)	0 (1)	T-Storm (1) Dig-In (1) Unknown (4)	
Tyandaga F2	9 (10)	0 (0)	Squirrel (2) Defective U/G Primary (3) Unknown (4)	
Tyandaga F3	9 (6)	2 (2)	Defective Transformer (3) Squirrel (2) High Winds (1) Unknown (3)	T-Storm (2)

Table 6- 13.8 kV Feeders experiencing 5 or more Auto-Reclosures or, 2 or more Lockout

The 13.8kV feeders had increased number of Lock-Outs and increase in number of Auto-Reclosures in 2021. A review of the above comments identifies Defective Equipment/Cable, Tree Limbs, and Unknown as main causes for the Lock-Outs and Unknown, Defective U/G Primary, High Winds/Tree and Wildlife for the Auto-Reclosures.

1e. 4.16kV Feeders

The 4.16kV feeders performed fairly well, in 2021, Appendix D contains the 4.16kV Feeder Outage Reports for all 4.16kV feeders experiencing 5 or more Auto-Reclosures or 2 or more Lock-Outs, during 2021. The following is a commentary on each of these feeders.

M.S. Feeder	**No. of 2021 Auto-Reclosures (2020)**	**No. of 2021 Lock-Outs (2020)**	**Comments/Cause**	
			Auto-Reclosures	**Lock-Outs**
Brant F2	0 (0)	2 (1)		T-Storm (2)
Fairleigh F2	3 (1)	2 (0)	Tree/Limb (1) Defective Insulator (1) High Winds/Tree (1)	Broken Pole (1) Defective Insulator (1)

Port Nelson F2	7 (7)	2 (3)	Defective U/G Primary (3) Cold Load (1) High Winds/Tree (1) Tree/Limb (1) Unknown (1)	T-Storm (1) Tree/Limb (1)
Spruce F3	2 (1)	2 (1)	Burned Tap Off (1) Tree/Limb (1)	Tree/Limb (2)

Table 7- 4.16 kV Feeders experiencing 5 or more Auto-Reclosures or, 2 or more Lockout

The 4.16kV feeders had decreased number of Lock-Outs, and slight increase in Auto-Reclosures in 2021. A review of the above comments identifies typical causes from Defective U/G Primary, High Winds, T-Storm and Tree Limbs for both Lock-Outs and Auto-Reclosures.

The need for feeder protection coordination and phase balance improvements has previously been identified as a need for improvement, on a number of 4.16kV feeders. This should receive increased attention to improve the operational efficiency of the system. Ref. Section 6c for recommendations.

2 Underground Distribution

A very large percentage of BHI's residential distribution system has been constructed underground, particularly in the newer neighborhoods, north of the QEW. This has been standard utility practice for over 30 years. These systems contain direct buried high voltage cables that have a finite length of life depending on the below-grade environment, the rate of deterioration of the cable insulation and the failure rate of underground splices. BHI closely monitors the failure of these cables on an individual feeder and geographic basis. Appendix E is a high-level annual record of primary cable failures within the distribution system.

The planned replacement of primary cables is a very significant element within any utility's Asset Management Plan and represents the liability for very large, on-going, capital expenditures. The timing of complete cable replacements within specific neighborhoods requires a careful balance considering the condition of the cable insulation and the historical reliability performance. Specific recommendations for future cable replacements are indicated in Section 7b. Commentary on the current maintenance and future recommendations for pad-mounted transformers and switching cubicles is included in Sections 4 and 6 respectively.

3 System demand and critical loading issues

3a. *Overall Demand/Load Growth*

The following table shows BHI's **coincident** peak demand and percentage growth for the last 14 years.

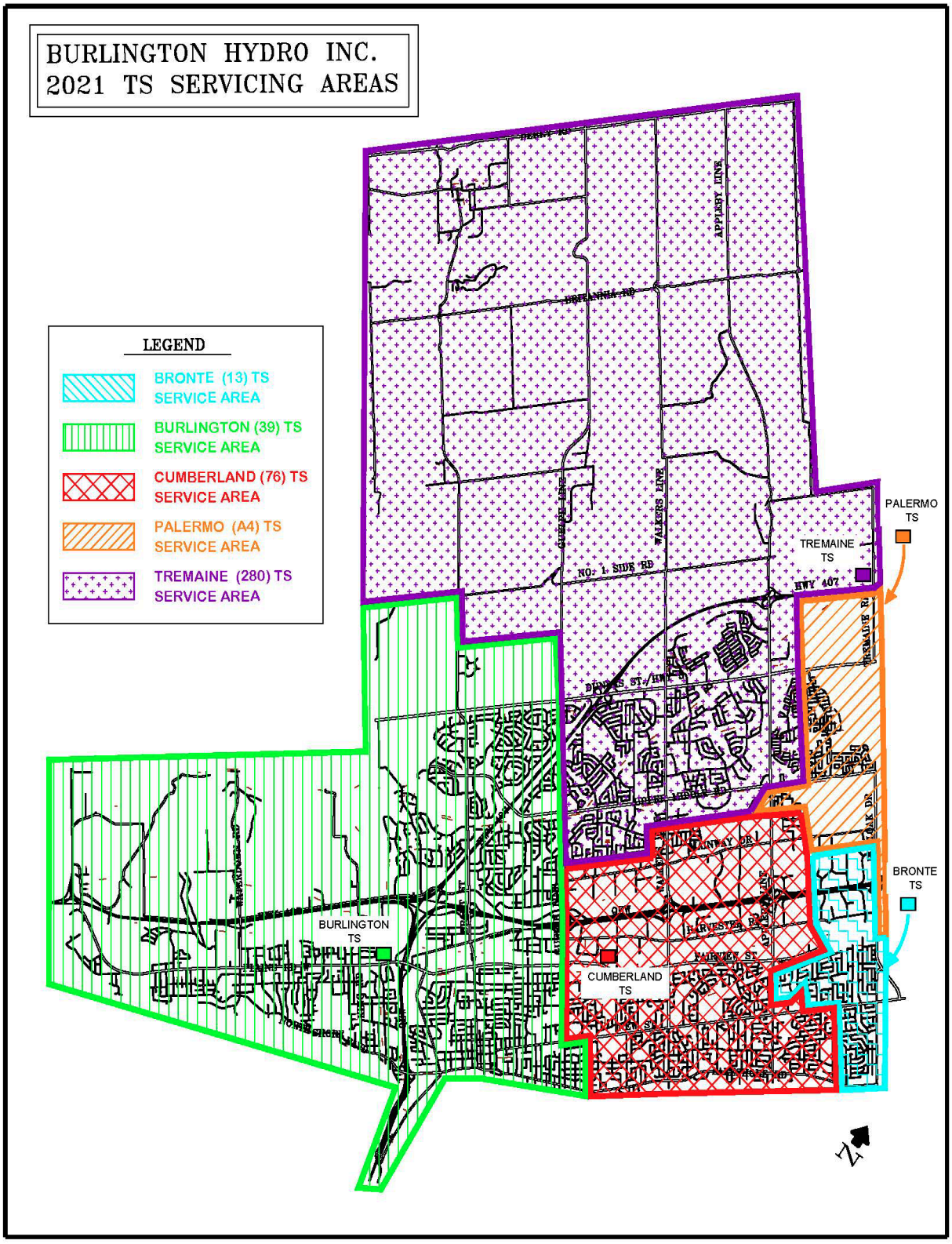
Year	Measured Peak Demand (MW)	Month	% Increase/decrease
2008	346.36	June	5.7
2009	350.43	August	1.18
2010	367.59	July	4.90
2011	379.69	July	3.29
2012	373.21	July	-1.71
2013	376.30	July	0.83
2014	325.55	August	-13.49
2015	340.35	July	4.55
2016	360.23	September	5.84
2017	321.21	September	-10.83
2018	351.44	July	9.41
2019	323.41	July	-7.97
2020	350.36	July	8.33
2021	344.66	August	-1.63

Table 8- Coincident peak demand and percentage growth

The 2021 coincident peak demand was slightly lower than 2020 but almost at the same level compared to the 10 years average. Each year there are many variables that contribute to this single number, such as customer growth, the local economy, summer heat, the impact of conservation initiatives and in the last couple of years the COVID-19 pandemic.

3b. *27.6 Feeder Loads and Transformer Station Capacity*

The issue of overall Transformer Stations capacity was alleviated somewhat by the commissioning of the new Tremaine TS in January 2013. Load was initially transferred from Palermo TS to the new Tremaine TS and later also from Burlington TS. In the spring of 2017 Lowville MS was transferred to Tremaine TS which has further offloaded Burlington TS. To keep the assigned capacity at Palermo TS in the fall of 2018 Towerline MS was transferred to Palermo TS and in 2020 Palmer MS was transferred from Cumberland TS to Tremaine TS. The map below indicates the five (5) TS's servicing boundaries from where it can be seen the need of continuation with the Tremaine TS feeders' egress to optimize the use of the TS's allocated capacity and create optimal loading on 27.6 KV feeders at each TS. Current Tremaine TS feeders egress situation introduces limitations to further load transfer between the TS's which could create inefficiency into the BHI distribution system operation and may expose customers to less-than-optimum reliability.


BURLINGTON HYDRO INC.
2021 TS SERVICING AREAS
LEGEND
BRONTE (13) TS SERVICE AREA
BURLINGTON (39) TS SERVICE AREA
CUMBERLAND (76) TS SERVICE AREA
PALERMO (A4) TS SERVICE AREA
TREMAINE (280) TS SERVICE AREA
PALERMO TS
TREMAINE TS
BRONTE TS
BURLINGTON TS
CUMBERLAND TS
APPLEBY LINE
WALKERS LINE
NO. 1 SIDE RD
DUNDAS ST./HWY
HWY 407
FAIRVIEW ST
N

BHI's 27.6kV feeder interconnections are well integrated and back-up arrangements have been further enhanced by the addition of remotely operated switches, however further system optimization analysis needs to be performed and more remotely operated switches to be installed at the existing and proposed egress feeders. The following table shows the 27.6kV feeder peaks during the **coincident** TS's Peak Load for 2021.

Feeder	Peak Load Amps - 2021
13M25	113
13M26	250
13M27	144
13M28	170
280M3	232
280M4	299
280M5	46
280M6	486
280M7	0
280M8	148
39M1	347
39M2	138
39M3	111
39M31	260
39M32	296
39M33	132
39M34	182
39M35	279
39M36	207
39M4	184
39M5	283
39M6	127
76M21	223
76M22	282
76M23	28
76M24	87
76M25	242
76M26	382
76M27	158
76M28	320
76M29	95
76M30	299
A4M5	365
A4M6	513

Table 9- 2021 Peak load Amps for 27.6 kV Feeders

Most of the 27.6 KV feeders have reasonable loading, up to approximately 300A, which is the preferred optimal feeder loading, with some exceptions due to Tremaine MS Feeder egress challenges, load growth in certain areas and the COVID-19 Pandemic and the increase in residential load and decrease in industrial/commercial load. The feeders loading is monitored daily and if required a load transfer will be performed to less loaded feeders. To improve the loading situation BHI has come up with a short and long-term plan to modify the feeder's configuration, interconnection, and load balancing.

However, the permanent solution will ultimately depend on the continuation of the Tremaine TS feeders egress projects that are part of the BHI short- and long-term capital budget. This will be an opportunity for load to be transferred easily among the feeders and stations, improve system flexibility, reliability and reduce system losses. In addition to this, the fact that BHI has purchased two more breakers at Tremaine TS is making it a priority system planning consideration.

Other areas that need immediate attention are the downtown Burlington and the West part of the City were the loading capacity of the feeders supplying these parts of the system have reached their optimal loading. The load has grown considerably in recent years and the long-term vision for downtown Burlington and west part of the city is expected to accelerate this growth. With the potential for reducing (transferring the load to less loaded feeders) the load on Cumberland TS feeders supplying the downtown and an updated system planning study should consider the opportunity to supply and/or back up the downtown load from Cumberland TS. One of the previous initiatives was completed in 2017 when BHI had proceeded with an upgrade of the 27.6KV supply at Port Nelson MS where a two supply sources were introduced via a new remotely controlled underground Vista switchgear installation. With this upgrade the substation reliability has been improved significantly and the entire substation load can be remotely transferred between Cumberland TS feeders 76M25 and 76M26. In addition, further system automation enhancements were introduced which involved an upgrade and expansion of the existing Intelliteam system that was completed in 2021. Additional load transfer and feeder's reconfiguration is required to offload Burlington TS downtown feeders and allocate capacity for future developments. Ref. to 6a for recommendations.

4 System maintenance activities and priorities

BHI aims to meet or exceed the system maintenance and inspection requirements of Section 4.4 of the Ontario Energy Board's Distribution System Code (DSC). The following routine maintenance programs are consistent with good utility practices and are applied annually within the BHI distribution system.

- **Wood pole testing and replacement**

In addition to the inspection requirements of the DSC, BHI has taken a proactive approach to the annual testing and replacement of wood poles. The testing is performed by an engineering company using specialized test equipment. Defective poles are identified for replacement with critical poles replaced immediately and a high priority placed on those equipped with transformers or underground dips. The following is a summary of the wood pole testing and replacement program for 2020 and 2021.

	2020	2021
Total number of poles in the system (Excluding Bell poles)	~15,241	~15,340
Number tested	3106	4071
Number replaced	18	81
Number treated to extend life	0	0
Number of rotten poles remaining in the system	347	630

The figures above indicate that BHI is maintaining its commitment to its pole testing program. The pole replacements include those due to vehicle accidents and storm damage. In 2021, 376 poles were identified for replacement, no poles were treated, and 81 poles were replaced of those that were identified to be replaced in the previous years. The remaining accumulated number of poles from the last few years identified for replacement is 630.

As a result of the annual Pole inspection, 4071 poles were inspected in 2021 and only 1 has grounding issue was identified and repaired, 4 down guy/ anchor issues and 23 riser pole ducts issues were identified and only few of them repaired. Also, 376 rotten poles and 30 rotten cross-arms were identified. Ref. Section 6d, for recommendations.

- **Insulator Washing**

Insulator washing is an important preventative measure to minimize flashovers and pole fires. Particular attention is given to the 27.6kV system including any areas where there are underbuilt circuits and areas with potential for high salt contamination i.e., adjacent to highways. In the course of this work in 2021, no defect was identified.

- **Infrared Thermography of the Overhead system and Municipal Substations**

Annual inspection and scanning of the overhead system and Stations are an important and worthwhile part of a good preventative maintenance program. This work was completed in 2021. Of the total 21 hot spot identified, only 10 were repaired.

- **Cleaning of Switching Cubicles**

BHI has approximately 201 pad mounted switching cubicles within its distribution system. 81 units were inspected and 58 of these required cleaning and testing, but only 21 out of 58 were cleaned in 2021. A specialized maintenance technique, using “dry ice”, is employed, to clean the selected number of the switching cubicles. This work can be safely completed with the equipment energized, therefore reducing the time and cost for switching activities.

- **Tree Trimming**

Tree trimming was carried in 2021, in accordance with BHI’s established 3-year cycle; this is a normal utility practice. Zones 1, 2, 3, 4, 5, 6 were fully completed. Maps of these zones are shown in Appendix F.

- **Submersible Transformers**

Submersible transformers are inspected as part of the annual transformer visual inspection process. no transformer was inspected in 2021. There were 10 reactive replacements of submersible transformers in 2021. There was a previous recommendation to introduce a formal program for the washing of underground vaults; this program has not been initiated yet. Ref. Section 6e, for recommendations.

- **Pad-Mounted/Pole-Mounted Transformers**

Patrol Inspections are scheduled every 3 years in accordance with the minimum inspection requirements of the Distribution System Code. There were 22 reactive replacements for pole-mounted and pad-mounted transformers and 14 proactive replacements in 2021. Because of the 2021 inspection 65 locations whit vegetation were identified and only 1 location have been completed, only 1 location where graffiti was removed out of 36. Also, 35 transformers were identified with an oil leak, and none was fixed, 1 transformer was fixed from 18 identified due to a rust issue. Ref. Section 6f, for recommendations on routine maintenance activities.

- **Substation Inspection and Preventive Maintenance**

Visual inspection of the station’s equipment is performed monthly, and any issues found are reported, priorities and rectified as necessary. In addition to the Visual inspection a preventive maintenance is performed on each station every 5 years. In 2021 the following stations were completed: Hampton MS, Partridge MS, Bridgeview MS, Fairwood MS and Mont Forest MS.

5 Reliability statistics and observations

In accordance with the Electricity Distribution System Reliability Measures and Expectations Report EB-2014-0189 completed by the Ontario Energy Board's (OEB's), BHI records and reports annually the following Service Reliability Indices:

$$\text{SAIDI} = \text{System Average Interruption Duration Index} = \frac{\text{Total Customer-Hours of Interruptions}}{\text{Total Customers Served}}$$

$$\text{SAIFI} = \text{System Average Interruption Frequency Index} = \frac{\text{Total Customer Interruptions}}{\text{Total Customers Served}}$$

$$\text{CAIDI} = \text{Customer Average Interruption Duration Index} = \frac{\text{Total Customer-Hours of Interruptions}}{\text{Total Customer Interruptions}}$$

In addition, BHI also records:

$$\text{SAARI} = \text{System Average Automatic Reclosure Index} = \frac{\text{Total Customer Automatic Reclosures}}{\text{Total Customers Served}}$$

These indexes provide BHI with an annual measure of its service performance for internal benchmarking and for comparisons with other distribution companies as part of the OEB's Performance Based Regulations. The following graphs demonstrate the individual performance measures over the last 8 years (excluding Lost of Supply and Major Events).

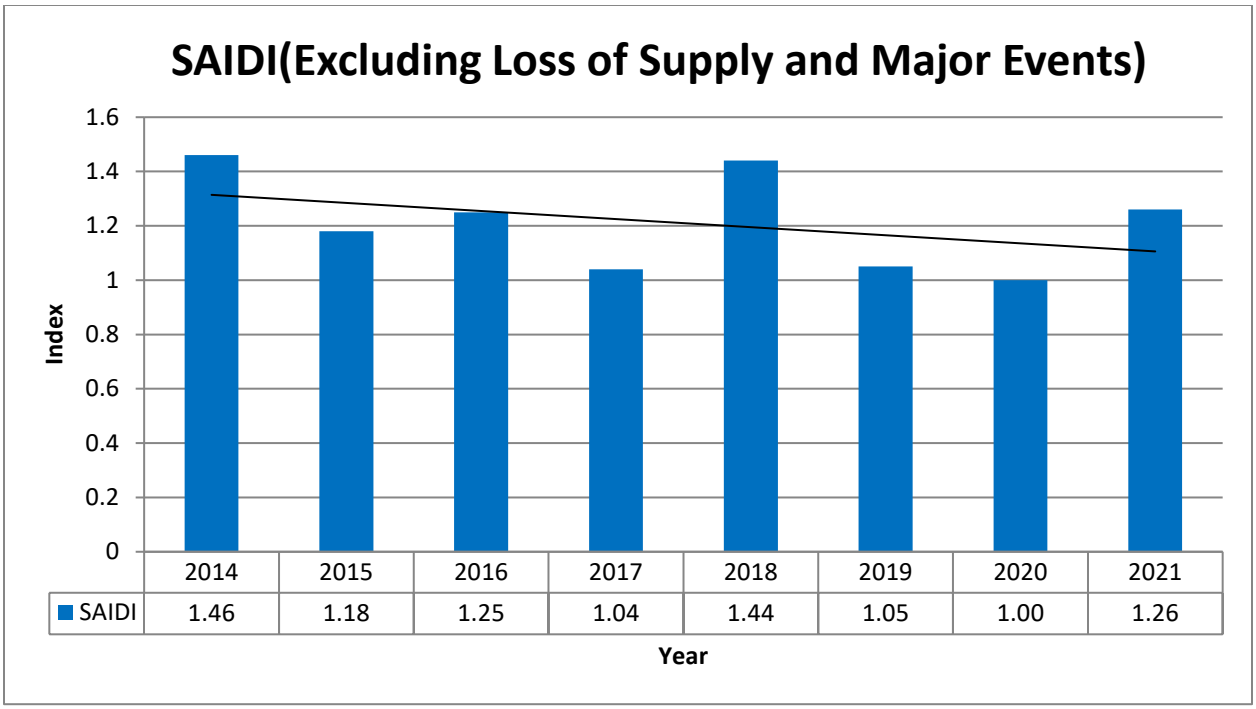


Figure 1- SAIDI from 2014 to 2021

8 Years Average – 1.21

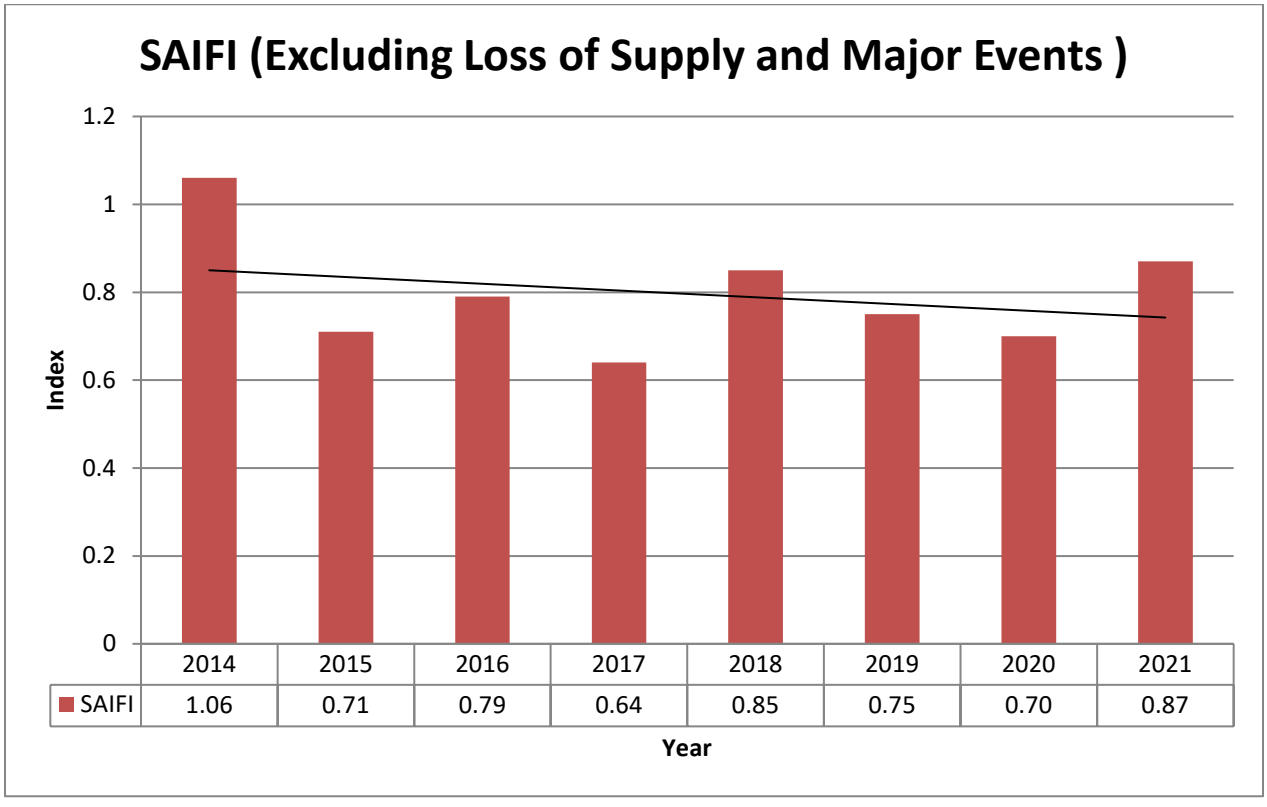


Figure 2- SAIFI from 2014 to 2021

8Years Average – 0.79

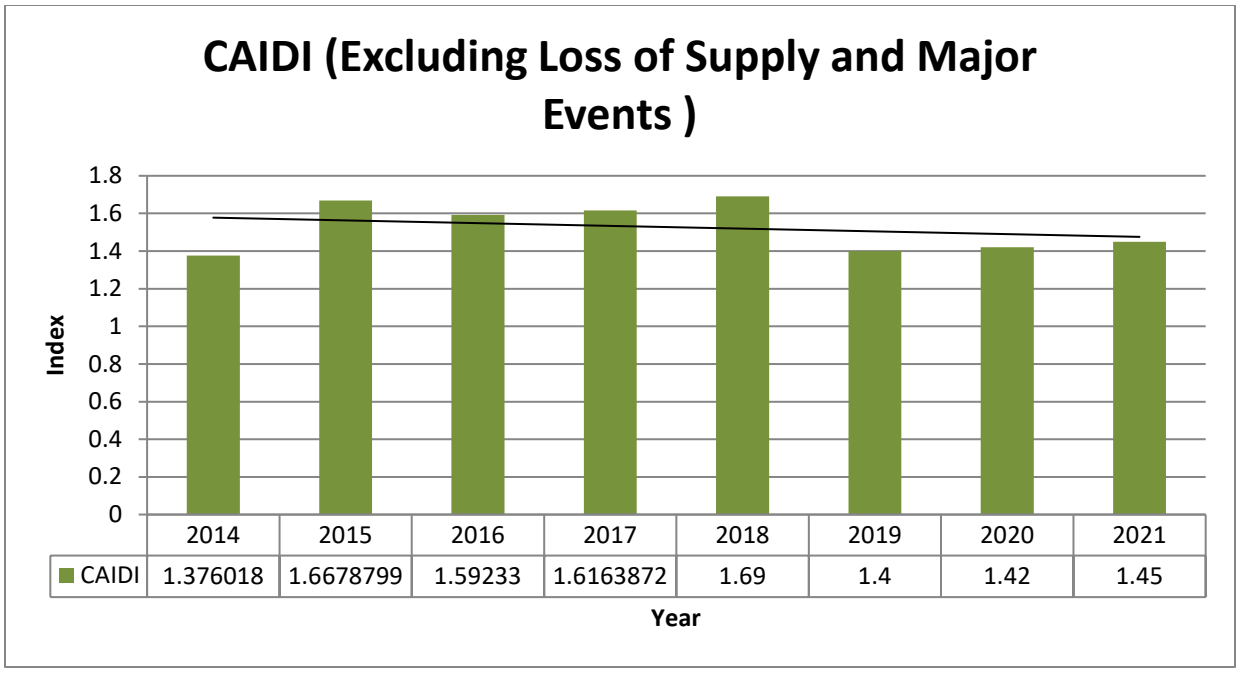


Figure 3- CAIDI from 2014 to 2021

8 Years Average – 1.52

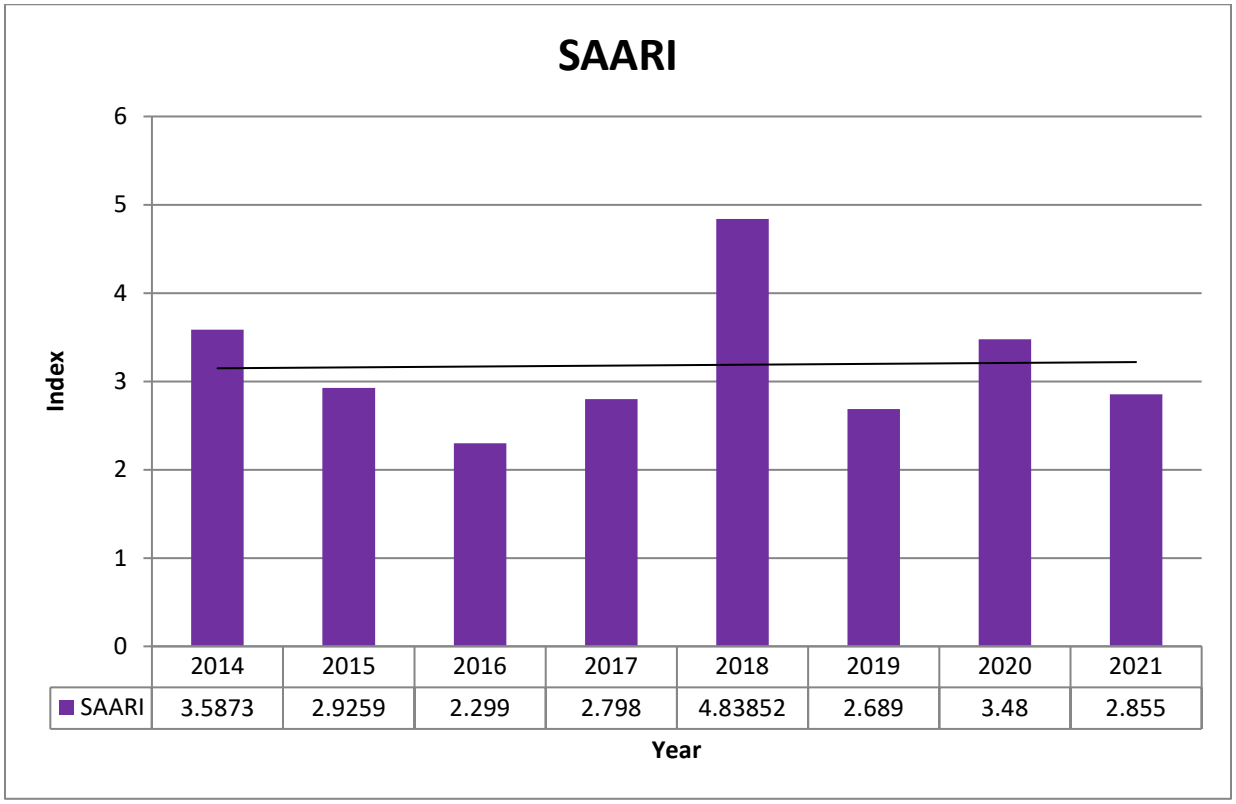


Figure 4- SAARI from 2014 to 2021

8 Year Average – 3.183

The graphs depict a slightly increasing but consistent level of performance compared with the previous years.

6 Future maintenance & operations recommendations

6a. *27.6kV Feeders*

With continuation of the already started Tremaine TS feeder egress projects more load from Burlington TS, Bronte TS and Cumberland TS can be transferred to Tremaine TS, and Palermo TS can be permanently loaded to the necessary allocated capacity.

In addition, feeders open point optimization should be performed on a regular annual basis which will be an opportunity to distribute loads more evenly and relieve some of the capacity limitations. Regular 27.6kV feeders load review is scheduled and should include an examination of the potential for supplying some existing and future downtown loads from Cumberland TS. To satisfy the load growth to the west part of the city some of the existing Burlington TS feeders, servicing the central part of the city, must be reconfigured and expanded. Also, BHI is working on a plan how to efficiently utilize the two new breaker positions at Tremaine TS that were installed in 2020.

Due to the increased number of SCADA-Mate switches failure in the past couple of years it is recommended a regular preventive maintenance to be introduced.

6b. *13.8kV Feeders*

Continued attention to the specific problems on the under-performing 13.8 kV feeders should be maintained. Monthly feeders' performance report should be generated which can show any under-performing feeders. In addition to the geographic 3-year cycle of tree trimming on-going inspection and attention should be given to the tree clearances and condition of these feeders. Upgrade of the existing Station air circuit breakers with vacuum circuit breakers and electromechanical relays with intelligent electronic relays will continue in the following years. Feeders open point and reclosers location optimization, as well as protection settings and functionality assessment of the new automation technologies and smart grid initiatives should be continued in 2022. The results of these applications should be monitored closely to identify the reliability improvements.

6c. *4.16kV Feeders*

Opportunities, in the field, for improved overcurrent protection coordination and phase load balancing on 4.16kV feeders should continue to be investigated and carried out. In addition, an upgrade of the existing Station air circuit breakers with vacuum circuit breakers and electromechanical relays with intelligent electronic relays should be continued in 2022.

6d. *Wood Pole Replacements*

A continued commitment to testing should be followed in 2022. The pole replacement program should be accelerated to catch up on the 630 poles requiring immediate replacement at the end of 2021, in advance of the 2022 testing and inspection program.

6e. *Vault Washing*

No vault washing was completed in 2021. A review of the inspection reports for the submersible transformers should be made and depending on the reported conditions, consideration should be given to a more structured vault washing program.

6f. *Pad-Mounted Transformers & Switching Cubicles*

The exterior condition and appearance of these units require some planned maintenance including attention to landscape plantings that may interfere with the safe operation of these units. A program for the removal of obstructions, rust removal, painting and replacement of safety signage and nomenclature has been introduced in the previous years and completed in 2021 and recommended for continuance.

7 Future Capital Budget recommendations

7a. *Substation Equipment*

With approximately twenty-five (25) of its substation power transformers over 40 years old and due to the high number of transformers, twelve (12), having elevated dissolved gases these units require close monitoring and testing. The program to acquire one or two new units per year for replacement or back up is endorsed and recommended for continuance. Additional programs for the primary switchgear, feeder circuit breakers and relay upgrades have been introduced and recommended for continuance.

7b. *27.6 KV Feeders*

The following are the proposed capital projects as a part of the Tremaine TS 27.6KV feeder's egress and Burlington TS feeders' expansion to the west that have been recommended to be constructed in the next few years to satisfy the above noted needs.

Add a second circuit 27.6 kV O/H line between Appleby Ln and Walkers Ln along Dundas Rd
Add a second circuit 27.6 kV O/H line between Walkers Ln and Guelph Ln along Dundas Rd
Add a second circuit 27.6 kV O/H line between Dundas Rd and Reservoir MS along Guelph Ln
Add three circuits 27.6 kV O/H line from Dundas Rd to Upper Middle Road along Bronte Creek
Add a second circuit 27.6 kV O/H line between Skyview Dr and south of Watertown Rd along NSR

7c. *13.8 KV and 4.16 KV Feeders*

The following feeders with primary cable failures have been identified and should be reviewed as part of the Asset Management plan and prioritized for capital budget consideration.

- Palmer MS F4, F3
- Towerline MS F1, F2, F3
- Tayandaga MS F2
- Reservoir MS F1
- Orchard MS F2
- Interchange MS F1
- Port Nelson F2

In addition to the cable replacement program BHI has started a formal program for MS feeder egress cables replacement, considering the cables that have already past the useful life and are showing signs of insulation deterioration during the regular preventive maintenance inspection and testing.

In the past BHI has installed new reclosing automation technologies, three phase recloser (IntelliRupter) and single phase reclosers (Tripsaver) on several 13.8 kV feeders. BHI should continue to install these or similar automation technology and integrate into the operation of the control room, to improve the reliability

of the customers supplied by these feeders. In addition to the Overhead Switches BHI is planning to upgrade the existing pad mounted switching cubicles at some crucial locations with remotely controlled switching devices. Based on this experience BHI expects to expand these applications throughout its system as part of future capital budget considerations, to improve the system performance of the under-performing feeders. Appendix C shows the underground primary cables faults and cables rebuild areas from 2002 to 2021.

7d. *System Planning*

BHI has been providing increased attention to long term system planning and has identified several proposals for major capital expenditures to enhance the performance of the distribution system. These were carefully prioritized and justified in advance of the required update to the Distribution System Plan to satisfy the Ontario Energy Board's requirements.

Appendix A1

Feeder Auto-Reclosures Summary (Sorted by Total)

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
LOWVILLE F3	13.8	25	28	3	2	4	1	6	11	2	5	29	116
TYANDAGA F2	13.8	7	11	17	10	5	4	13	12	10	10	9	108
LOWVILLE F1	13.8	7	7	16	6	8	11	4	12	9	5	17	102
RESERVOIR F1	13.8	4	23	7	6	10	10	15	10	7	2	4	98
TOWERLINE F4	13.8	6	2	7	13	8	4	10	14	7	6	9	86
PALMER F3	13.8	11	7	9	5	1	5	9	12	1	8	10	78
TYANDAGA F3	13.8	6	10	5	7	9	8	6	3	7	6	9	76
PALMER F1	13.8	3	8	5	4	8	7	5	9	4	7	10	70
TOWERLINE F1	13.8	11	2	13	19	1	2	5	1	3	7	1	65
FAIRVIEW F3	13.8	5	2	5	1	10	11	10	10	1	6	3	64
TOWERLINE F2	13.8	3	7	7	5	10	5	4	8	5	4	5	63
TYANDAGA F4	13.8	10	8	9	4	4	7	5	3	3	5	2	60
INTERCHANGE F1	13.8	0	0	2	5	1	10	7	9	5	8	12	59
PALMER F4	13.8	3	6	3	5	7	3	1	10	5	9	1	53
TYANDAGA F1	13.8	6	6	6	5	4	3	5	3	2	4	6	50
ORCHARD F2	13.8	3	8	6	5	4	9	1	6	1	3	1	47
13M27	27.6	1	5	3	8	4	3	1	6	6	4	4	45
76M21	27.6	4	1	0	13	3	7	0	1	6	4	4	43
PT NELSON F2	4.1	2	3	1	5	2	5	1	5	2	7	7	40
FAIRVIEW F2	13.8	1	7	2	3	4	2	2	2	4	8	2	37
PALMER F2	13.8	4	3	6	5	0	2	3	8	3	1	2	37
INTERCHANGE F2	13.8	6	3	1	4	0	3	3	5	1	2	6	34
76M30	27.6	5	0	3	2	2	1	1	6	3	6	3	32
ORCHARD F1	13.8	1	3	0	2	1	10	4	2	1	0	7	31
76M23	27.6	3	3	5	4	4	2	2	3	1	2	1	30
A4M6	27.6	0	1	2	8	4	3	2	6	1	3	0	30
76M28	27.6	0	4	4	2	1	2	4	0	5	4	1	27
LOWVILLE F2	13.8	1	1	3	1	2	1	3	5	1	3	6	27
76M24	27.6	2	2	2	0	0	3	3	10	1	1	2	26
FAIRWOOD F6	4.1	0	2	0	0	1	2	2	6	7	4	2	26
39M2	27.6	2	3	3	8	2	2	0	2	1	1	0	24
WALKERS F1	4.1	5	1	0	0	4	0	5	7	0	0	2	24
39M35	27.6	1	0	2	1	1	4	2	4	0	6	2	23
EASTERBROOK F3	4.1	1	4	3	1	1	4	2	1	0	2	4	23
39M1	27.6	2	2	3	0	4	3	0	2	3	1	2	22

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
39M32	27.6	1	4	1	2	2	0	3	0	4	4	1	22
39M36	27.6	1	0	0	2	3	1	1	4	4	0	6	22
39M5	27.6	1	2	3	0	0	2	5	3	0	4	1	21
76M26	27.6	0	0	2	0	1	2	5	6	2	3	0	21
76M27	27.6	3	1	2	0	2	0	3	1	2	3	3	20
PINEDALE F1	4.1	2	0	1	1	0	1	2	3	6	2	2	20
76M22	27.6	5	1	1	1	0	4	1	2	1	1	2	19
RESERVOIR F2	13.8	7	3	3	1	0	2	2	1	0	0	0	19
PINECOVE F1	4.1	2	2	3	0	0	0	0	7	2	2	1	19
SPRUCE F1	4.1	1	9	1	2	1	0	0	4	1	0	0	19
WALKERS F4	4.1	3	2	0	0	2	1	1	6	0	2	2	19
13M28	27.6	1	2	3	3	1	1	2	1	1	0	3	18
280M6	27.6	0	0	3	1	3	2	0	2	3	2	2	18
TOWERLINE F3	13.8	1	1	0	0	0	2	0	2	5	2	5	18
APPLEBY F1	4.1	1	6	0	0	1	0	4	2	0	3	1	18
MARLEY F3	4.1	1	0	1	1	3	1	1	3	2	4	1	18
SPRUCE F2	4.1	0	2	1	4	0	4	4	1	1	1	0	18
280M3	27.6	0	0	0	0	0	4	5	1	3	1	3	17
76M25	27.6	0	0	1	0	2	0	3	6	2	2	1	17
LOWVILLE F4	13.8	1	1	5	1	1	0	4	1	0	1	2	17
39M31	27.6	0	1	1	5	0	2	2	1	1	1	2	16
39M4	27.6	1	2	4	5	1	0	0	1	0	1	1	16
PINECOVE F3	4.1	0	0	0	2	2	2	1	8	1	0	0	16
ELGIN F1	4.1	2	4	2	1	0	0	1	2	1	2	0	15
FAIRWOOD F4	4.1	1	1	2	0	1	2	3	3	0	1	1	15
FAIRLEIGH F2	4.1	2	1	0	1	1	0	3	2	0	1	3	14
HAMPTON F1	4.1	1	0	0	3	0	0	3	5	2	0	0	14
HOWARD F3	4.1	1	0	2	3	1	3	0	0	2	1	1	14
MARTHA F1	4.1	2	0	1	1	0	1	1	5	0	3	0	14
BRIDGEVIEW F2	4.1	1	0	6	0	2	0	0	2	0	0	2	13
GRAHAMS F4	4.1	0	0	7	0	4	1	0	0	0	0	1	13
SPRUCE F3	4.1	0	0	2	1	2	0	2	2	1	1	2	13
WOODWARD F2	4.1	2	0	1	3	1	2	0	2	0	0	2	13
76M29	27.6	0	0	1	1	1	1	0	2	0	5	1	12
RESERVOIR F3	13.8	1	2	0	3	0	3	0	1	1	0	1	12
EASTERBROOK F2	4.1	0	3	2	0	0	0	2	1	2	2	0	12
MAPLE F8	4.1	2	0	2	1	2	3	0	1	0	0	1	12
PT NELSON F1	4.1	1	0	0	1	0	1	1	0	2	6	0	12

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
WALKERS F2	4.1	1	1	1	0	0	2	3	1	1	1	1	12
13M25	27.6	5	0	1	2	1	0	0	0	0	1	1	11
RESERVOIR F4	13.8	1	2	0	4	1	0	0	1	1	0	1	11
ELIZ GARDENS F3	4.1	0	0	2	2	0	1	4	1	1	0	0	11
MAPLE F6	4.1	0	1	0	0	0	0	0	3	6	1	0	11
PARTRIDGE F1	4.1	1	3	1	2	1	0	0	0	0	2	1	11
WOODWARD F5	4.1	0	0	0	5	0	2	0	3	0	0	1	11
BRANT F2	4.1	0	0	3	3	2	0	0	1	1	0	0	10
MARTHA F6	4.1	2	0	0	4	0	1	0	0	0	1	2	10
PINEDALE F2	4.1	0	0	1	0	1	5	1	1	0	0	1	10
A4M5	27.6	0	0	2	0	0	0	0	0	3	2	2	9
DRURY F1	4.1	0	1	1	5	0	0	0	2	0	0	0	9
ELGIN F2	4.1	2	2	1	1	0	0	0	1	0	2	0	9
FAIRWOOD F2	4.1	0	0	0	0	3	0	0	3	3	0	0	9
MARTHA F7	4.1	0	0	0	1	2	1	1	0	0	1	3	9
280M4	27.6	0	0	0	0	2	0	3	2	1	0	0	8
APPLEBY F4	4.1	0	0	3	0	0	0	1	2	1	0	1	8
BRIDGEVIEW F1	4.1	0	0	2	2	0	0	2	0	1	0	1	8
EASTERBROOK F1	4.1	1	0	4	1	0	1	0	0	0	0	1	8
ELIZ GARDENS F2	4.1	1	1	2	0	0	2	0	0	0	0	2	8
HARVESTER F1	4.1	1	0	1	0	0	1	1	3	0	0	1	8
HOWARD F2	4.1	1	0	4	0	0	0	0	1	0	0	2	8
PARTRIDGE F2	4.1	2	0	2	1	1	2	0	0	0	0	0	8
13M26	27.6	0	1	0	1	0	0	0	3	0	1	1	7
39M34	27.6	0	0	0	3	0	0	0	0	1	1	2	7
39M6	27.6	2	0	1	0	2	0	1	1	0	0	0	7
APPLEBY F6	4.1	3	0	0	2	0	1	0	0	1	0	0	7
ELIZ GARDENS F1	4.1	0	1	0	0	0	0	4	2	0	0	0	7
HAMPTON F6	4.1	1	0	1	1	0	0	3	0	0	0	1	7
MAPLE F2	4.1	1	1	2	0	1	1	0	0	0	0	1	7
MT FOREST F1	4.1	1	0	1	0	1	1	0	1	1	0	1	7
PT NELSON F3	4.1	0	1	0	0	0	1	0	1	1	2	1	7
WOODWARD F6	4.1	0	0	1	0	1	0	0	3	1	0	1	7
280M5	27.6	0	0	0	0	0	0	0	2	2	0	2	6
280M8	27.6	0	0	0	0	0	0	0	1	0	1	4	6
39M33	27.6	0	1	0	1	2	0	0	1	0	0	1	6
FAIRWOOD F5	4.1	0	1	1	2	0	0	0	1	0	0	1	6
HARVESTER F3	4.1	3	0	0	1	0	0	0	1	0	0	1	6

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
MAPLE F1	4.1	0	1	0	0	0	0	1	2	0	1	1	6
MT FOREST F2	4.1	0	0	0	0	0	2	0	0	1	1	2	6
PINECOVE F2	4.1	0	0	0	0	0	1	2	2	1	0	0	6
FAIRVIEW F1	13.8	0	0	0	0	1	0	1	3	0	0	0	5
APPLEBY F5	4.1	0	2	1	0	1	1	0	0	0	0	0	5
ELGIN F4	4.1	0	1	0	0	0	2	1	0	0	1	0	5
FAIRLEIGH F1	4.1	1	0	0	0	0	1	1	1	0	0	1	5
GRAHAMS F2	4.1	0	1	1	1	1	0	0	0	0	0	1	5
HAMPTON F2	4.1	0	0	2	0	0	1	0	1	0	0	1	5
MAPLE F5	4.1	1	0	0	0	1	1	1	1	0	0	0	5
MARLEY F1	4.1	0	0	1	0	0	0	1	1	0	1	1	5
MARTHA F2	4.1	1	0	1	0	0	1	0	2	0	0	0	5
MARTHA F3	4.1	1	2	1	0	0	0	1	0	0	0	0	5
PARTRIDGE F3	4.1	0	0	2	0	1	0	1	0	0	0	1	5
DRURY F4	4.1	0	0	0	0	0	1	0	1	1	1	0	4
MARLEY F2	4.1	0	0	0	2	0	0	0	1	0	0	1	4
FAIRVIEW F4	13.8	0	0	0	0	0	0	0	3	0	0	0	3
APPLEBY F2	4.1	0	0	0	0	1	0	1	0	1	0	0	3
BRANT F1	4.1	1	1	1	0	0	0	0	0	0	0	0	3
BRANT F3	4.1	0	0	0	0	0	0	0	1	2	0	0	3
FAIRWOOD F1	4.1	0	0	2	0	0	0	0	0	0	1	0	3
HARVESTER F2	4.1	1	0	0	0	0	0	1	0	1	0	0	3
MARTHA F8	4.1	0	0	0	2	0	0	1	0	0	0	0	3
SPRUCE F4	4.1	0	0	1	1	0	0	1	0	0	0	0	3
WOODWARD F4	4.1	1	0	0	0	0	0	2	0	0	0	0	3
280M7	27.6	0	0	0	0	0	0	0	0	0	2	0	2
39M3	27.6	0	0	0	0	0	0	1	0	0	1	0	2
DRURY F3	4.1	2	0	0	0	0	0	0	0	0	0	0	2
ELGIN F3	4.1	0	1	0	0	1	0	0	0	0	0	0	2
FAIRLEIGH F3	4.1	0	1	0	0	0	0	0	1	0	0	0	2
HOWARD F1	4.1	0	0	1	0	0	0	1	0	0	0	0	2
MAPLE F3	4.1	1	0	0	0	0	0	0	1	0	0	0	2
MAPLE F4	4.1	2	0	0	0	0	0	0	0	0	0	0	2
MARTHA F5	4.1	1	0	0	0	0	0	0	0	0	1	0	2
MT FOREST F3	4.1	0	0	1	0	0	0	0	0	1	0	0	2
WOODWARD F3	4.1	0	0	0	1	0	0	0	0	0	1	0	2
FAIRWOOD F3	4.1	0	0	0	0	1	0	0	0	0	0	0	1
GRAHAMS F1	4.1	0	1	0	0	0	0	0	0	0	0	0	1

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
HAMPTON F4	4.1	0	0	0	0	0	1	0	0	0	0	0	1
HAMPTON F5	4.1	0	0	0	1	0	0	0	0	0	0	0	1
MARTHA F4	4.1	0	0	1	0	0	0	0	0	0	0	0	1
PT NELSON F4	4.1	0	0	1	0	0	0	0	0	0	0	0	1
WALKERS F3	4.1	0	0	1	0	0	0	0	0	0	0	0	1
WOODWARD F1	4.1	0	0	0	0	0	0	0	1	0	0	0	1
APPLEBY F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
DRURY F2	4.1	0	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
HAMPTON F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MAPLE F7	4.1	0	0	0	0	0	0	0	0	0	0	0	0
PINEDALE F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0

Table 10- Feeder Auto-Reclosures Summary (Sorted by Total)

Appendix A2

Feeder Auto-Reclosures Summary (Sorted by 2021)

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
LOWVILLE F3	13.8	25	28	3	2	4	1	6	11	2	5	29	116
LOWVILLE F1	13.8	7	7	16	6	8	11	4	12	9	5	17	102
INTERCHANGE F1	13.8	0	0	2	5	1	10	7	9	5	8	12	59
PALMER F3	13.8	11	7	9	5	1	5	9	12	1	8	10	78
PALMER F1	13.8	3	8	5	4	8	7	5	9	4	7	10	70
TYANDAGA F2	13.8	7	11	17	10	5	4	13	12	10	10	9	108
TOWERLINE F4	13.8	6	2	7	13	8	4	10	14	7	6	9	86
TYANDAGA F3	13.8	6	10	5	7	9	8	6	3	7	6	9	76
PT NELSON F2	4.1	2	3	1	5	2	5	1	5	2	7	7	40
ORCHARD F1	13.8	1	3	0	2	1	10	4	2	1	0	7	31
TYANDAGA F1	13.8	6	6	6	5	4	3	5	3	2	4	6	50
INTERCHANGE F2	13.8	6	3	1	4	0	3	3	5	1	2	6	34
LOWVILLE F2	13.8	1	1	3	1	2	1	3	5	1	3	6	27
39M36	27.6	1	0	0	2	3	1	1	4	4	0	6	22
TOWERLINE F2	13.8	3	7	7	5	10	5	4	8	5	4	5	63
TOWERLINE F3	13.8	1	1	0	0	0	2	0	2	5	2	5	18
RESERVOIR F1	13.8	4	23	7	6	10	10	15	10	7	2	4	98
13M27	27.6	1	5	3	8	4	3	1	6	6	4	4	45
76M21	27.6	4	1	0	13	3	7	0	1	6	4	4	43
EASTERBROOK F3	4.1	1	4	3	1	1	4	2	1	0	2	4	23
280M8	27.6	0	0	0	0	0	0	0	1	0	1	4	6
FAIRVIEW F3	13.8	5	2	5	1	10	11	10	10	1	6	3	64
76M30	27.6	5	0	3	2	2	1	1	6	3	6	3	32
76M27	27.6	3	1	2	0	2	0	3	1	2	3	3	20
13M28	27.6	1	2	3	3	1	1	2	1	1	0	3	18
280M3	27.6	0	0	0	0	0	4	5	1	3	1	3	17
FAIRLEIGH F2	4.1	2	1	0	1	1	0	3	2	0	1	3	14
MARTHA F7	4.1	0	0	0	1	2	1	1	0	0	1	3	9
TYANDAGA F4	13.8	10	8	9	4	4	7	5	3	3	5	2	60
FAIRVIEW F2	13.8	1	7	2	3	4	2	2	2	4	8	2	37
PALMER F2	13.8	4	3	6	5	0	2	3	8	3	1	2	37
76M24	27.6	2	2	2	0	0	3	3	10	1	1	2	26
FAIRWOOD F6	4.1	0	2	0	0	1	2	2	6	7	4	2	26
WALKERS F1	4.1	5	1	0	0	4	0	5	7	0	0	2	24
39M35	27.6	1	0	2	1	1	4	2	4	0	6	2	23
39M1	27.6	2	2	3	0	4	3	0	2	3	1	2	22

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
PINEDALE F1	4.1	2	0	1	1	0	1	2	3	6	2	2	20
76M22	27.6	5	1	1	1	0	4	1	2	1	1	2	19
WALKERS F4	4.1	3	2	0	0	2	1	1	6	0	2	2	19
280M6	27.6	0	0	3	1	3	2	0	2	3	2	2	18
LOWVILLE F4	13.8	1	1	5	1	1	0	4	1	0	1	2	17
39M31	27.6	0	1	1	5	0	2	2	1	1	1	2	16
BRIDGEVIEW F2	4.1	1	0	6	0	2	0	0	2	0	0	2	13
SPRUCE F3	4.1	0	0	2	1	2	0	2	2	1	1	2	13
WOODWARD F2	4.1	2	0	1	3	1	2	0	2	0	0	2	13
MARTHA F6	4.1	2	0	0	4	0	1	0	0	0	1	2	10
A4M5	27.6	0	0	2	0	0	0	0	0	3	2	2	9
ELIZ GARDENS F2	4.1	1	1	2	0	0	2	0	0	0	0	2	8
HOWARD F2	4.1	1	0	4	0	0	0	0	1	0	0	2	8
39M34	27.6	0	0	0	3	0	0	0	0	1	1	2	7
280M5	27.6	0	0	0	0	0	0	0	2	2	0	2	6
MT FOREST F2	4.1	0	0	0	0	0	2	0	0	1	1	2	6
TOWERLINE F1	13.8	11	2	13	19	1	2	5	1	3	7	1	65
PALMER F4	13.8	3	6	3	5	7	3	1	10	5	9	1	53
ORCHARD F2	13.8	3	8	6	5	4	9	1	6	1	3	1	47
76M23	27.6	3	3	5	4	4	2	2	3	1	2	1	30
76M28	27.6	0	4	4	2	1	2	4	0	5	4	1	27
39M32	27.6	1	4	1	2	2	0	3	0	4	4	1	22
39M5	27.6	1	2	3	0	0	2	5	3	0	4	1	21
PINECOVE F1	4.1	2	2	3	0	0	0	0	7	2	2	1	19
APPLEBY F1	4.1	1	6	0	0	1	0	4	2	0	3	1	18
MARLEY F3	4.1	1	0	1	1	3	1	1	3	2	4	1	18
76M25	27.6	0	0	1	0	2	0	3	6	2	2	1	17
39M4	27.6	1	2	4	5	1	0	0	1	0	1	1	16
FAIRWOOD F4	4.1	1	1	2	0	1	2	3	3	0	1	1	15
HOWARD F3	4.1	1	0	2	3	1	3	0	0	2	1	1	14
GRAHAMS F4	4.1	0	0	7	0	4	1	0	0	0	0	1	13
76M29	27.6	0	0	1	1	1	1	0	2	0	5	1	12
RESERVOIR F3	13.8	1	2	0	3	0	3	0	1	1	0	1	12
MAPLE F8	4.1	2	0	2	1	2	3	0	1	0	0	1	12
WALKERS F2	4.1	1	1	1	0	0	2	3	1	1	1	1	12
13M25	27.6	5	0	1	2	1	0	0	0	0	1	1	11
RESERVOIR F4	13.8	1	2	0	4	1	0	0	1	1	0	1	11
PARTRIDGE F1	4.1	1	3	1	2	1	0	0	0	0	2	1	11

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
WOODWARD F5	4.1	0	0	0	5	0	2	0	3	0	0	1	11
PINEDALE F2	4.1	0	0	1	0	1	5	1	1	0	0	1	10
APPLEBY F4	4.1	0	0	3	0	0	0	1	2	1	0	1	8
BRIDGEVIEW F1	4.1	0	0	2	2	0	0	2	0	1	0	1	8
EASTERBROOK F1	4.1	1	0	4	1	0	1	0	0	0	0	1	8
HARVESTER F1	4.1	1	0	1	0	0	1	1	3	0	0	1	8
13M26	27.6	0	1	0	1	0	0	0	3	0	1	1	7
HAMPTON F6	4.1	1	0	1	1	0	0	3	0	0	0	1	7
MAPLE F2	4.1	1	1	2	0	1	1	0	0	0	0	1	7
MT FOREST F1	4.1	1	0	1	0	1	1	0	1	1	0	1	7
PT NELSON F3	4.1	0	1	0	0	0	1	0	1	1	2	1	7
WOODWARD F6	4.1	0	0	1	0	1	0	0	3	1	0	1	7
39M33	27.6	0	1	0	1	2	0	0	1	0	0	1	6
FAIRWOOD F5	4.1	0	1	1	2	0	0	0	1	0	0	1	6
HARVESTER F3	4.1	3	0	0	1	0	0	0	1	0	0	1	6
MAPLE F1	4.1	0	1	0	0	0	0	1	2	0	1	1	6
FAIRLEIGH F1	4.1	1	0	0	0	0	1	1	1	0	0	1	5
GRAHAMS F2	4.1	0	1	1	1	1	0	0	0	0	0	1	5
HAMPTON F2	4.1	0	0	2	0	0	1	0	1	0	0	1	5
MARLEY F1	4.1	0	0	1	0	0	0	1	1	0	1	1	5
PARTRIDGE F3	4.1	0	0	2	0	1	0	1	0	0	0	1	5
MARLEY F2	4.1	0	0	0	2	0	0	0	1	0	0	1	4
A4M6	27.6	0	1	2	8	4	3	2	6	1	3	0	30
39M2	27.6	2	3	3	8	2	2	0	2	1	1	0	24
76M26	27.6	0	0	2	0	1	2	5	6	2	3	0	21
RESERVOIR F2	13.8	7	3	3	1	0	2	2	1	0	0	0	19
SPRUCE F1	4.1	1	9	1	2	1	0	0	4	1	0	0	19
SPRUCE F2	4.1	0	2	1	4	0	4	4	1	1	1	0	18
PINECOVE F3	4.1	0	0	0	2	2	2	1	8	1	0	0	16
ELGIN F1	4.1	2	4	2	1	0	0	1	2	1	2	0	15
HAMPTON F1	4.1	1	0	0	3	0	0	3	5	2	0	0	14
MARTHA F1	4.1	2	0	1	1	0	1	1	5	0	3	0	14
EASTERBROOK F2	4.1	0	3	2	0	0	0	2	1	2	2	0	12
PT NELSON F1	4.1	1	0	0	1	0	1	1	0	2	6	0	12
ELIZ GARDENS F3	4.1	0	0	2	2	0	1	4	1	1	0	0	11
MAPLE F6	4.1	0	1	0	0	0	0	0	3	6	1	0	11
BRANT F2	4.1	0	0	3	3	2	0	0	1	1	0	0	10
DRURY F1	4.1	0	1	1	5	0	0	0	2	0	0	0	9

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
ELGIN F2	4.1	2	2	1	1	0	0	0	1	0	2	0	9
FAIRWOOD F2	4.1	0	0	0	0	3	0	0	3	3	0	0	9
280M4	27.6	0	0	0	0	2	0	3	2	1	0	0	8
PARTRIDGE F2	4.1	2	0	2	1	1	2	0	0	0	0	0	8
39M6	27.6	2	0	1	0	2	0	1	1	0	0	0	7
APPLEBY F6	4.1	3	0	0	2	0	1	0	0	1	0	0	7
ELIZ GARDENS F1	4.1	0	1	0	0	0	0	4	2	0	0	0	7
PINECOVE F2	4.1	0	0	0	0	0	1	2	2	1	0	0	6
FAIRVIEW F1	13.8	0	0	0	0	1	0	1	3	0	0	0	5
APPLEBY F5	4.1	0	2	1	0	1	1	0	0	0	0	0	5
ELGIN F4	4.1	0	1	0	0	0	2	1	0	0	1	0	5
MAPLE F5	4.1	1	0	0	0	1	1	1	1	0	0	0	5
MARTHA F2	4.1	1	0	1	0	0	1	0	2	0	0	0	5
MARTHA F3	4.1	1	2	1	0	0	0	1	0	0	0	0	5
DRURY F4	4.1	0	0	0	0	0	1	0	1	1	1	0	4
FAIRVIEW F4	13.8	0	0	0	0	0	0	0	3	0	0	0	3
APPLEBY F2	4.1	0	0	0	0	1	0	1	0	1	0	0	3
BRANT F1	4.1	1	1	1	0	0	0	0	0	0	0	0	3
BRANT F3	4.1	0	0	0	0	0	0	0	1	2	0	0	3
FAIRWOOD F1	4.1	0	0	2	0	0	0	0	0	0	1	0	3
HARVESTER F2	4.1	1	0	0	0	0	0	1	0	1	0	0	3
MARTHA F8	4.1	0	0	0	2	0	0	1	0	0	0	0	3
SPRUCE F4	4.1	0	0	1	1	0	0	1	0	0	0	0	3
WOODWARD F4	4.1	1	0	0	0	0	0	2	0	0	0	0	3
280M7	27.6	0	0	0	0	0	0	0	0	0	2	0	2
39M3	27.6	0	0	0	0	0	0	1	0	0	1	0	2
DRURY F3	4.1	2	0	0	0	0	0	0	0	0	0	0	2
ELGIN F3	4.1	0	1	0	0	1	0	0	0	0	0	0	2
FAIRLEIGH F3	4.1	0	1	0	0	0	0	0	1	0	0	0	2
HOWARD F1	4.1	0	0	1	0	0	0	1	0	0	0	0	2
MAPLE F3	4.1	1	0	0	0	0	0	0	1	0	0	0	2
MAPLE F4	4.1	2	0	0	0	0	0	0	0	0	0	0	2
MARTHA F5	4.1	1	0	0	0	0	0	0	0	0	1	0	2
MT FOREST F3	4.1	0	0	1	0	0	0	0	0	1	0	0	2
WOODWARD F3	4.1	0	0	0	1	0	0	0	0	0	1	0	2
FAIRWOOD F3	4.1	0	0	0	0	1	0	0	0	0	0	0	1
GRAHAMS F1	4.1	0	1	0	0	0	0	0	0	0	0	0	1
HAMPTON F4	4.1	0	0	0	0	0	1	0	0	0	0	0	1

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
HAMPTON F5	4.1	0	0	0	1	0	0	0	0	0	0	0	1
MARTHA F4	4.1	0	0	1	0	0	0	0	0	0	0	0	1
PT NELSON F4	4.1	0	0	1	0	0	0	0	0	0	0	0	1
WALKERS F3	4.1	0	0	1	0	0	0	0	0	0	0	0	1
WOODWARD F1	4.1	0	0	0	0	0	0	0	1	0	0	0	1
APPLEBY F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
DRURY F2	4.1	0	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
HAMPTON F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MAPLE F7	4.1	0	0	0	0	0	0	0	0	0	0	0	0
PINEDALE F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0

Table 11- Feeder Auto-Reclosures Summary (Sorted by 2021)

Appendix A3

Feeder Lock-Outs Summary (Sorted by Total)

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
LOWVILLE F4	13.8	2	5	7	8	4	10	1	6	2	0	1	46
LOWVILLE F3	13.8	1	4	1	4	3	3	3	8	2	0	2	31
PT NELSON F2	4.1	1	2	2	1	1	0	2	2	0	3	2	16
39M2	27.6	1	3	3	3	4	0	0	1	1	1	2	19
TOWERLINE F2	13.8	0	2	5	2	1	0	8	1	1	0	3	23
39M31	27.6	2	1	3	0	8	0	2	0	0	1	1	18
A4M6	27.6	1	1	1	0	3	0	1	6	2	0	0	15
ORCHARD F2	13.8	3	0	4	1	0	1	4	1	0	0	1	15
76M26	27.6	2	0	2	1	0	1	2	2	3	2	1	16
39M1	27.6	1	1	2	0	5	3	0	1	0	0	0	13
FAIRLEIGH F2	4.1	0	4	2	0	0	1	4	1	0	0	2	14
PINEDALE F2	4.1	0	1	4	1	0	2	2	2	0	0	1	13
SPRUCE F1	4.1	0	0	1	0	7	3	1	0	0	1	0	13
SPRUCE F3	4.1	2	1	2	0	4	1	1	1	1	1	2	16
39M5	27.6	1	1	1	0	2	2	1	2	2	1	0	13
76M21	27.6	0	1	1	3	1	0	0	2	1	1	1	11
ORCHARD F1	13.8	1	1	1	0	1	1	0	2	1	2	0	10
PALMER F1	13.8	0	1		1	2	1	7	0	1	0	0	13
280M6	27.6	0	0	7	0	1	1	0	0	0	3	1	13
FAIRVIEW F2	13.8	1	0	1	1	3	0	4	0	1	0	0	11
39M3	27.6	1	3	0	0	2	3	0	0	1	0	0	10
RESERVOIR F1	13.8	2	3	3	0	0	1	2	0	0	0	0	11
HARVESTER F1	4.1	0	1	1	3	0	1	1	0	0	1	0	8
13M27	27.6	0	0	6	1	0	0	1	0	0	1	0	9
INTERCHANGE F1	13.8	1	2	1	1	1	0	0	1	0	0	3	10
PALMER F2	13.8	0	2	1	0	0	0	2	3	1	1	0	10
DRURY F4	4.1	0	0	2	1	2	1	3	0	1	0	0	10
13M25	27.6	0	0	0	0	0	4	0	0	0	0	0	4
39M4	27.6	0	1	1	0	0	0	0	2	1	1	0	6
76M23	27.6	0	0	0	2	1	2	0	0	1	1	1	8
LOWVILLE F1	13.8	0	1	3	0	0	1	1	0	2	1	0	9
DRURY F1	4.1	0	0	1	5	0	1	0	0	1	0	0	8
FAIRWOOD F6	4.1	0	3	1	0	1	0	0	0	4	0	0	9
MARLEY F3	4.1	1	2	1	1	2	0	0	1	1	0	0	9
FAIRVIEW F3	13.8	3	0	0	1	0	0	0	2	1	1	0	8
LOWVILLE F2	13.8	1	0	0	0	2	0	0	2	2	1	3	11

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
TYANDAGA F3	13.8	0	1	1	0	2	0	0	1	1	2	2	10
PINECOVE F1	4.1	3	1	2	0	0	0	0	1	0	0	0	7
PALMER F3	13.8	1	2	0	0	0	0	1	0	0	0	0	4
TOWERLINE F1	13.8	4	0	3	0	0	0	0	0	0	0	0	7
TOWERLINE F4	13.8	1	1	3	1	0	0	0	0	1	0	0	7
HOWARD F2	4.1	6	0	0	0	0	0	0	0	0	0	0	6
MAPLE F6	4.1	3	0	0	0	2	0	1	0	0	1	1	8
MT FOREST F1	4.1	0	0	0	0	0	0	0	0	4	3	0	7
PARTRIDGE F2	4.1	0	2	0	1	0	1	0	1	0	0	0	5
PINEDALE F1	4.1	0	0	0	3	0	0	1	0	1	0	1	6
WALKERS F1	4.1	0	0	0	1	2	1	1	1	0	0	0	6
13M26	27.6	0	0	0	1	0	1	0	0	0	0	0	2
39M35	27.6	0	1	0	1	0	0	2	1	1	0	1	7
39M36	27.6	0	1	0	1	1	0	0	0	2	1	0	6
TYANDAGA F1	13.8	1	0	0	0	0	0	0	2	1	1	0	5
GRAHAMS F4	4.1	0	1	3	0	2	0	0	0	0	0	0	6
HAMPTON F6	4.1	0	1	1	1	0	1	2	0	0	0	0	6
MARLEY F2	4.1	0	0	1	5	0	0	0	0	0	0	0	6
PARTRIDGE F1	4.1	1	0	1	2	0	2	0	0	0	0	0	6
PINECOVE F3	4.1	0	1	0	0	0	0	1	2	1	0	0	5
280M4	27.6	0	0	0	1	0	0	2	0	0	2	0	5
39M6	27.6	0	0	0	1	1	0	0	0	0	0	0	2
76M24	27.6	0	0	0	2	1	0	2	0	0	0	0	5
INTERCHANGE F2	13.8	2	0	0	0	0	0	1	1	1	0	0	5
RESERVOIR F3	13.8	0	1	0	0	0	3	0	0	1	0	0	5
BRIDGEVIEW F2	4.1	0	0	5	0	0	0	0	0	0	0	0	5
EASTERBROOK F3	4.1	0	3	1	1	0	0	0	0	0	0	1	6
HOWARD F3	4.1	0	0	0	3	0	0	0	0	2	0	0	5
MAPLE F8	4.1	1	1	1	0	0	0	0	0	0	2	0	5
PARTRIDGE F3	4.1	1	0	0	1	2	0	0	0	1	0	0	5
PINECOVE F2	4.1	1	0	1	2	0	0	1	0	0	0	0	5
280M3	27.6	0	0	0	0	0	2	0	1	0	1	0	4
39M32	27.6	1	0	0	0	1	0	0	0	2	0	0	4
39M33	27.6	2	1	0	1	0	0	0	0	0	0	0	4
76M25	27.6	0	0	0	0	0	3	0	0	1	0	0	4
A4M5	27.6	0	0	1	0	1	0	1	0	0	0	0	3
RESERVOIR F2	13.8	0	0	1	0	0	1	0	0	0	2	0	4
TYANDAGA F2	13.8	0	0	3	0	0	0	0	0	0	0	0	3

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
TYANDAGA F4	13.8	0	1	2	0	0	0	1	0	0	0	0	4
APPLEBY F1	4.1	0	0	0	0	1	0	1	0	0	0	0	2
BRANT F2	4.1	0	1	2	0	0	0	0	0	0	1	2	6
BRIDGEVIEW F1	4.1	0	1	3	0	0	0	0	0	0	0	0	4
EASTERBROOK F1	4.1	0	0	1	1	0	0	0	0	0	1	0	3
ELGIN F1	4.1	0	1	0	1	0	0	0	2	0	0	0	4
FAIRLEIGH F1	4.1	0	0	0	0	0	0	1	2	0	0	0	3
FAIRWOOD F4	4.1	0	0	1	0	0	2	0	1	0	0	0	4
HARVESTER F2	4.1	1	1	1	0	0	0	1	0	0	0	0	4
PT NELSON F1	4.1	2	0	1	0	0	1	0	0	0	0	0	4
PT NELSON F3	4.1	1	0	2	0	0	1	0	0	0	0	0	4
39M34	27.6	0	0	0	1	1	0	0	0	1	0	0	3
76M27	27.6	0	0	2	0	0	0	0	0	0	1	1	4
ELGIN F2	4.1	2	0	0	0	0	1	0	0	0	0	0	3
GRAHAMS F1	4.1	1	1	0	1	0	0	0	0	0	0	0	3
HARVESTER F3	4.1	0	0	0	0	0	0	0	1	2	0	0	3
MAPLE F2	4.1	0	0	0	0	0	0	0	0	0	1	0	1
MAPLE F5	4.1	1	1	1	0	0	0	0	0	0	0	0	3
PT NELSON F4	4.1	1	0	1	0	0	0	1	0	0	0	1	4
SPRUCE F2	4.1	0	0	0	1	0	1	1	0	0	0	1	4
SPRUCE F4	4.1	0	0	0	0	0	1	1	0	0	1	0	3
WALKERS F3	4.1	0	0	0	0	1	1	0	1	0	0	0	3
WOODWARD F5	4.1	0	0	0	1	0	0	0	1	0	0	1	3
280M5	27.6	0	0	0	0	0	1	0	0	0	1	0	2
280M8	27.6	0	0	0	0	0	0	0	0	0	2	1	3
76M22	27.6	1	0	0	1	0	0	0	0	0	0	0	2
76M29	27.6	0	0	0	0	0	0	0	1	0	1	0	2
TOWERLINE F3	13.8	1	0	0	1	0	0	0	0	0	0	0	2
APPLEBY F4	4.1	0	0	0	0	0	1	0	0	0	1	0	2
BRANT F1	4.1	0	0	1	0	0	0	0	0	1	0	0	2
ELIZ GARDENS F2	4.1	0	1	0	0	0	0	0	0	1	0	0	2
ELIZ GARDENS F3	4.1	0	0	2	0	0	0	0	0	0	0	0	2
HAMPTON F1	4.1	0	0	0	2	0	0	0	0	0	0	0	2
HAMPTON F2	4.1	0	0	0	0	0	0	0	2	0	0	0	2
MAPLE F1	4.1	0	0	0	0	0	0	0	0	0	1	0	1
MAPLE F3	4.1	0	0	1	0	0	0	0	0	0	0	0	1
WOODWARD F2	4.1	0	0	0	1	0	0	0	0	0	0	0	1
WOODWARD F3	4.1	0	1	0	0	0	0	1	0	0	0	0	2

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
WOODWARD F4	4.1	0	0	0	0	0	1	0	0	0	0	0	1
13M28	27.6	0	0	0	0	0	0	0	0	0	0	0	0
280M7	27.6	0	0	0	0	0	0	0	0	0	1	0	1
76M28	27.6	0	0	0	0	0	0	0	0	0	0	0	0
76M30	27.6	0	0	0	0	0	0	0	1	0	0	0	1
FAIRVIEW F4	13.8	0	0	0	0	0	0	1	0	0	0	0	1
PALMER F4	13.8	0	0	0	0	0	0	0	1	0	0	0	1
DRURY F2	4.1	0	0	1	0	0	0	0	0	0	0	0	1
DRURY F3	4.1	0	0	1	0	0	0	0	0	0	0	0	1
ELGIN F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
ELIZ GARDENS F1	4.1	0	0	0	0	1	0	0	0	0	0	0	1
FAIRLEIGH F3	4.1	0	0	0	0	0	0	0	1	0	0	0	1
FAIRWOOD F1	4.1	0	0	1	0	0	0	0	0	0	0	0	1
GRAHAMS F2	4.1	0	0	1	0	0	0	0	0	0	0	0	1
GRAHAMS F3	4.1	0	0	0	0	0	0	0	0	1	0	0	1
HAMPTON F5	4.1	1	0	0	0	0	0	0	0	0	0	0	1
HOWARD F1	4.1	0	0	0	0	0	0	0	1	0	0	0	1
MARTHA F1	4.1	0	0	0	0	0	0	0	0	1	0	0	1
MARTHA F2	4.1	0	0	0	0	0	0	0	1	0	0	0	1
MARTHA F3	4.1	0	1	0	0	0	0	0	0	0	0	0	1
MARTHA F5	4.1	0	0	1	0	0	0	0	0	0	0	0	1
MARTHA F7	4.1	0	0	0	0	0	1	0	0	0	0	0	1
MT FOREST F3	4.1	0	1	0	0	0	0	0	0	0	0	0	1
PINEDALE F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
WALKERS F2	4.1	0	0	0	0	1	0	0	0	0	0	0	1
WALKERS F4	4.1	1	0	0	0	0	0	0	0	0	0	0	1
WOODWARD F1	4.1	0	0	0	0	0	0	0	0	0	0	0	0
WOODWARD F6	4.1	0	0	0	0	0	0	0	0	0	0	0	0
FAIRVIEW F1	13.8	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR F4	13.8	0	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F2	4.1	0	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F5	4.1	0	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F6	4.1	0	0	0	0	0	0	0	0	0	0	0	0
BRANT F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
EASTERBROOK F2	4.1	0	0	0	0	0	0	0	0	0	0	0	0
ELGIN F4	4.1	0	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F2	4.1	0	0	0	0	0	0	0	0	0	0	0	0

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
FAIRWOOD F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F5	4.1	0	0	0	0	0	0	0	0	0	0	1	1
HAMPTON F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
HAMPTON F4	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MAPLE F4	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MAPLE F7	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MARLEY F1	4.1	0	0	0	0	0	0	0	0	0	0	1	1
MARTHA F4	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MARTHA F6	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MARTHA F8	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MT FOREST F2	4.1	0	0	0	0	0	0	0	0	0	0	0	0

Table 12- Feeder Lock-Outs Summary (Sorted by Total)

Appendix A4

Feeder Lock-Outs Summary (Sorted by 2021)

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
TOWERLINE F2	13.8	0	2	5	2	1	0	8	1	1	0	3	23
INTERCHANGE F1	13.8	1	2	1	1	1	0	0	1	0	0	3	10
LOWVILLE F2	13.8	1	0	0	0	2	0	0	2	2	1	3	11
LOWVILLE F3	13.8	1	4	1	4	3	3	3	8	2	0	2	31
PT NELSON F2	4.1	1	2	2	1	1	0	2	2	0	3	2	16
39M2	27.6	1	3	3	3	4	0	0	1	1	1	2	19
FAIRLEIGH F2	4.1	0	4	2	0	0	1	4	1	0	0	2	14
SPRUCE F3	4.1	2	1	2	0	4	1	1	1	1	1	2	16
TYANDAGA F3	13.8	0	1	1	0	2	0	0	1	1	2	2	10
BRANT F2	4.1	0	1	2	0	0	0	0	0	0	1	2	6
LOWVILLE F4	13.8	2	5	7	8	4	10	1	6	2	0	1	46
39M31	27.6	2	1	3	0	8	0	2	0	0	1	1	18
ORCHARD F2	13.8	3	0	4	1	0	1	4	1	0	0	1	15
76M26	27.6	2	0	2	1	0	1	2	2	3	2	1	16
PINEDALE F2	4.1	0	1	4	1	0	2	2	2	0	0	1	13
76M21	27.6	0	1	1	3	1	0	0	2	1	1	1	11
280M6	27.6	0	0	7	0	1	1	0	0	0	3	1	13
76M23	27.6	0	0	0	2	1	2	0	0	1	1	1	8
MAPLE F6	4.1	3	0	0	0	2	0	1	0	0	1	1	8
PINEDALE F1	4.1	0	0	0	3	0	0	1	0	1	0	1	6
39M35	27.6	0	1	0	1	0	0	2	1	1	0	1	7
EASTERBROOK F3	4.1	0	3	1	1	0	0	0	0	0	0	1	6
76M27	27.6	0	0	2	0	0	0	0	0	0	1	1	4
PT NELSON F4	4.1	1	0	1	0	0	0	1	0	0	0	1	4
SPRUCE F2	4.1	0	0	0	1	0	1	1	0	0	0	1	4
WOODWARD F5	4.1	0	0	0	1	0	0	0	1	0	0	1	3
280M8	27.6	0	0	0	0	0	0	0	0	0	2	1	3
FAIRWOOD F5	4.1	0	0	0	0	0	0	0	0	0	0	1	1
MARLEY F1	4.1	0	0	0	0	0	0	0	0	0	0	1	1
A4M6	27.6	1	1	1	0	3	0	1	6	2	0	0	15
39M1	27.6	1	1	2	0	5	3	0	1	0	0	0	13
SPRUCE F1	4.1	0	0	1	0	7	3	1	0	0	1	0	13
39M5	27.6	1	1	1	0	2	2	1	2	2	1	0	13
ORCHARD F1	13.8	1	1	1	0	1	1	0	2	1	2	0	10
PALMER F1	13.8	0	1	0	1	2	1	7	0	1	0	0	13
FAIRVIEW F2	13.8	1	0	1	1	3	0	4	0	1	0	0	11

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
39M3	27.6	1	3	0	0	2	3	0	0	1	0	0	10
RESERVOIR F1	13.8	2	3	3	0	0	1	2	0	0	0	0	11
HARVESTER F1	4.1	0	1	1	3	0	1	1	0	0	1	0	8
13M27	27.6	0	0	6	1	0	0	1	0	0	1	0	9
PALMER F2	13.8	0	2	1	0	0	0	2	3	1	1	0	10
DRURY F4	4.1	0	0	2	1	2	1	3	0	1	0	0	10
13M25	27.6	0	0	0	0	0	4	0	0	0	0	0	4
39M4	27.6	0	1	1	0	0	0	0	2	1	1	0	6
LOWVILLE F1	13.8	0	1	3	0	0	1	1	0	2	1	0	9
DRURY F1	4.1	0	0	1	5	0	1	0	0	1	0	0	8
FAIRWOOD F6	4.1	0	3	1	0	1	0	0	0	4	0	0	9
MARLEY F3	4.1	1	2	1	1	2	0	0	1	1	0	0	9
FAIRVIEW F3	13.8	3	0	0	1	0	0	0	2	1	1	0	8
PINECOVE F1	4.1	3	1	2	0	0	0	0	1	0	0	0	7
PALMER F3	13.8	1	2	0	0	0	0	1	0	0	0	0	4
TOWERLINE F1	13.8	4	0	3	0	0	0	0	0	0	0	0	7
TOWERLINE F4	13.8	1	1	3	1	0	0	0	0	1	0	0	7
HOWARD F2	4.1	6	0	0	0	0	0	0	0	0	0	0	6
MT FOREST F1	4.1	0	0	0	0	0	0	0	0	4	3	0	7
PARTRIDGE F2	4.1	0	2	0	1	0	1	0	1	0	0	0	5
WALKERS F1	4.1	0	0	0	1	2	1	1	1	0	0	0	6
13M26	27.6	0	0	0	1	0	1	0	0	0	0	0	2
39M36	27.6	0	1	0	1	1	0	0	0	2	1	0	6
TYANDAGA F1	13.8	1	0	0	0	0	0	0	2	1	1	0	5
GRAHAMS F4	4.1	0	1	3	0	2	0	0	0	0	0	0	6
HAMPTON F6	4.1	0	1	1	1	0	1	2	0	0	0	0	6
MARLEY F2	4.1	0	0	1	5	0	0	0	0	0	0	0	6
PARTRIDGE F1	4.1	1	0	1	2	0	2	0	0	0	0	0	6
PINECOVE F3	4.1	0	1	0	0	0	0	1	2	1	0	0	5
280M4	27.6	0	0	0	1	0	0	2	0	0	2	0	5
39M6	27.6	0	0	0	1	1	0	0	0	0	0	0	2
76M24	27.6	0	0	0	2	1	0	2	0	0	0	0	5
INTERCHANGE F2	13.8	2	0	0	0	0	0	1	1	1	0	0	5
RESERVOIR F3	13.8	0	1	0	0	0	3	0	0	1	0	0	5
BRIDGEVIEW F2	4.1	0	0	5	0	0	0	0	0	0	0	0	5
HOWARD F3	4.1	0	0	0	3	0	0	0	0	2	0	0	5
MAPLE F8	4.1	1	1	1	0	0	0	0	0	0	2	0	5
PARTRIDGE F3	4.1	1	0	0	1	2	0	0	0	1	0	0	5

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
PINECOVE F2	4.1	1	0	1	2	0	0	1	0	0	0	0	5
280M3	27.6	0	0	0	0	0	2	0	1	0	1	0	4
39M32	27.6	1	0	0	0	1	0	0	0	2	0	0	4
39M33	27.6	2	1	0	1	0	0	0	0	0	0	0	4
76M25	27.6	0	0	0	0	0	3	0	0	1	0	0	4
A4M5	27.6	0	0	1	0	1	0	1	0	0	0	0	3
RESERVOIR F2	13.8	0	0	1	0	0	1	0	0	0	2	0	4
TYANDAGA F2	13.8	0	0	3	0	0	0	0	0	0	0	0	3
TYANDAGA F4	13.8	0	1	2	0	0	0	1	0	0	0	0	4
APPLEBY F1	4.1	0	0	0	0	1	0	1	0	0	0	0	2
BRIDGEVIEW F1	4.1	0	1	3	0	0	0	0	0	0	0	0	4
EASTERBROOK F1	4.1	0	0	1	1	0	0	0	0	0	1	0	3
ELGIN F1	4.1	0	1	0	1	0	0	0	2	0	0	0	4
FAIRLEIGH F1	4.1	0	0	0	0	0	0	1	2	0	0	0	3
FAIRWOOD F4	4.1	0	0	1	0	0	2	0	1	0	0	0	4
HARVESTER F2	4.1	1	1	1	0	0	0	1	0	0	0	0	4
PT NELSON F1	4.1	2	0	1	0	0	1	0	0	0	0	0	4
PT NELSON F3	4.1	1	0	2	0	0	1	0	0	0	0	0	4
39M34	27.6	0	0	0	1	1	0	0	0	1	0	0	3
ELGIN F2	4.1	2	0	0	0	0	1	0	0	0	0	0	3
GRAHAMS F1	4.1	1	1	0	1	0	0	0	0	0	0	0	3
HARVESTER F3	4.1	0	0	0	0	0	0	0	1	2	0	0	3
MAPLE F2	4.1	0	0	0	0	0	0	0	0	0	1	0	1
MAPLE F5	4.1	1	1	1	0	0	0	0	0	0	0	0	3
SPRUCE F4	4.1	0	0	0	0	0	1	1	0	0	1	0	3
WALKERS F3	4.1	0	0	0	0	1	1	0	1	0	0	0	3
280M5	27.6	0	0	0	0	0	1	0	0	0	1	0	2
76M22	27.6	1	0	0	1	0	0	0	0	0	0	0	2
76M29	27.6	0	0	0	0	0	0	0	1	0	1	0	2
TOWERLINE F3	13.8	1	0	0	1	0	0	0	0	0	0	0	2
APPLEBY F4	4.1	0	0	0	0	0	1	0	0	0	1	0	2
BRANT F1	4.1	0	0	1	0	0	0	0	0	1	0	0	2
ELIZ GARDENS F2	4.1	0	1	0	0	0	0	0	0	1	0	0	2
ELIZ GARDENS F3	4.1	0	0	2	0	0	0	0	0	0	0	0	2
HAMPTON F1	4.1	0	0	0	2	0	0	0	0	0	0	0	2
HAMPTON F2	4.1	0	0	0	0	0	0	0	2	0	0	0	2
MAPLE F1	4.1	0	0	0	0	0	0	0	0	0	1	0	1
MAPLE F3	4.1	0	0	1	0	0	0	0	0	0	0	0	1

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
WOODWARD F2	4.1	0	0	0	1	0	0	0	0	0	0	0	1
WOODWARD F3	4.1	0	1	0	0	0	0	1	0	0	0	0	2
WOODWARD F4	4.1	0	0	0	0	0	1	0	0	0	0	0	1
13M28	27.6	0	0	0	0	0	0	0	0	0	0	0	0
280M7	27.6	0	0	0	0	0	0	0	0	0	1	0	1
76M28	27.6	0	0	0	0	0	0	0	0	0	0	0	0
76M30	27.6	0	0	0	0	0	0	0	1	0	0	0	1
FAIRVIEW F4	13.8	0	0	0	0	0	0	1	0	0	0	0	1
PALMER F4	13.8	0	0	0	0	0	0	0	1	0	0	0	1
DRURY F2	4.1	0	0	1	0	0	0	0	0	0	0	0	1
DRURY F3	4.1	0	0	1	0	0	0	0	0	0	0	0	1
ELGIN F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
ELIZ GARDENS F1	4.1	0	0	0	0	1	0	0	0	0	0	0	1
FAIRLEIGH F3	4.1	0	0	0	0	0	0	0	1	0	0	0	1
FAIRWOOD F1	4.1	0	0	1	0	0	0	0	0	0	0	0	1
GRAHAMS F2	4.1	0	0	1	0	0	0	0	0	0	0	0	1
GRAHAMS F3	4.1	0	0	0	0	0	0	0	0	1	0	0	1
HAMPTON F5	4.1	1	0	0	0	0	0	0	0	0	0	0	1
HOWARD F1	4.1	0	0	0	0	0	0	0	1	0	0	0	1
MARTHA F1	4.1	0	0	0	0	0	0	0	0	1	0	0	1
MARTHA F2	4.1	0	0	0	0	0	0	0	1	0	0	0	1
MARTHA F3	4.1	0	1	0	0	0	0	0	0	0	0	0	1
MARTHA F5	4.1	0	0	1	0	0	0	0	0	0	0	0	1
MARTHA F7	4.1	0	0	0	0	0	1	0	0	0	0	0	1
MT FOREST F3	4.1	0	1	0	0	0	0	0	0	0	0	0	1
PINEDALE F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
WALKERS F2	4.1	0	0	0	0	1	0	0	0	0	0	0	1
WALKERS F4	4.1	1	0	0	0	0	0	0	0	0	0	0	1
WOODWARD F1	4.1	0	0	0	0	0	0	0	0	0	0	0	0
WOODWARD F6	4.1	0	0	0	0	0	0	0	0	0	0	0	0
FAIRVIEW F1	13.8	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR F4	13.8	0	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F2	4.1	0	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F5	4.1	0	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F6	4.1	0	0	0	0	0	0	0	0	0	0	0	0
BRANT F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
EASTERBROOK F2	4.1	0	0	0	0	0	0	0	0	0	0	0	0

FEEDER	VOLTAGE (kV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTALS (2011-2021)
ELGIN F4	4.1	0	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F2	4.1	0	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
HAMPTON F3	4.1	0	0	0	0	0	0	0	0	0	0	0	0
HAMPTON F4	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MAPLE F4	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MAPLE F7	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MARTHA F4	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MARTHA F6	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MARTHA F8	4.1	0	0	0	0	0	0	0	0	0	0	0	0
MT FOREST F2	4.1	0	0	0	0	0	0	0	0	0	0	0	0

Table 13- Feeder Lock-Outs Summary (Sorted by 2021)

Appendix B

Feeder Outage Report 27.6 kV Feeders

Feeder Outage Report 39M36

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
5/28/2021	11:19	5/28/2021	11:19	AUTO-RECLOSURE	UNKNOWN		39M36	1		768	NO
7/3/2021	07:07	7/3/2021	07:07	AUTO-RECLOSURE	UNKNOWN		39M36	1		768	NO
7/6/2021	06:23	7/6/2021	06:23	AUTO-RECLOSURE	UNKNOWN	NO CAUSE REPORTED	39M36	1		768	NO
8/6/2021	22:27	8/6/2021	22:27	AUTO-RECLOSURE	UNKNOWN		39M36	1		768	NO
9/11/2021	08:18	9/11/2021	08:18	AUTO-RECLOSURE	SQUIRREL	1125 LAKESHORE RD, SKYWAY SEWAGE PLANT. WASTE WATER PLANT REPORTING IT IS AT HALF POWER BLOWN FUSE. AUTO 39M36 08:18. LI ALL WORK COMPLETED, PC10C TERMINATED AND CUSTOMER RESTORED.	39M36	1		768	NO
11/29/2021	10:16	11/29/2021	10:16	AUTO-RECLOSURE	DEFECTIVE CUSTOMER EQUIPMENT	CCIW INTERNAL ISSUE AT 867 LAKESHORE	39M36	1		768	NO

Feeder Outage Report 27.6 kV Feeders

Feeder Outage Report 39M2

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
4/11/2021	11:27	4/11/2021	11:29	Lockout	UNKNOWN	SUSPECT TREE ACTIVITY IN ROW RUNNING WITH 39M4 WHICH ALSO AUTOED	39M2	1		2076	NO
12/13/2021	12:03	12/13/2021	14:37	Lockout	HIGH WINDS/TREE	See Operator Details	39M2	1		8514	NO

Appendix C

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report LOWVILLE F3

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
4/11/2021	9:51	4/11/2021	9:54	Lockout	UNKNOWN	POSSIBLE BAD INSULATOR AT 5265 APPLEBY RD, CREW CHANGED INSULATOR. DURING CHANGING THE LOWVILLE F3 LOCKED OUT. SUSPECT NOT RELATED TO WORK. CREWS PATROLLING	LOWV_F3	1		176	NO
11/26/2021	13:46	11/26/2021	13:54	Lockout	UNKNOWN	No power.	LOWV_F3	1		328	NO
1/27/2021	15:30	1/27/2021	15:30	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F3	1		417	NO
2/3/2021	01:13	2/3/2021	01:13	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F3	1		417	NO
2/9/2021	11:12	2/9/2021	11:12	AUTO-RECLOSURE	UNKNOWN	NO CAUSE REPORTED INTELLI - S4253 ALSO AUTO RECLOSED.	LOWVILLE F3	1		417	NO
2/27/2021	01:30	2/27/2021	01:30	AUTO-RECLOSURE	UNKNOWN	S4238 INTELLIRUPTER AUTO-BLUE PHASE OVERCURRENT	LOWVILLE F3	1		417	NO
3/1/2021	07:42	3/1/2021	07:42	AUTO-RECLOSURE	UNKNOWN	S4238 INTELLIRUPTER AUTO-BLUE PHASE OVERCURRENT	LOWVILLE F3	1		417	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
3/4/2021	22:51	3/4/2021	22:51	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F3	1		417	NO
3/7/2021	21:39	3/7/2021	21:39	AUTO-RECLOSURE	UNKNOWN	S4238 INTELLIRUPTER AUTO-BLUE PHASE OVERCURRENT	LOWVILLE F3	1		417	NO
3/9/2021	06:04	3/9/2021	06:04	AUTO-RECLOSURE	UNKNOWN	S4238 INTELLIRUPTER AUTO-BLUE PHASE OVERCURRENT	LOWVILLE F3	1		417	NO
3/11/2021	07:12	3/11/2021	07:12	AUTO-RECLOSURE	BROKEN POLE	BROKEN POLE AT 5300 APPLEBY LINE	LOWVILLE F3	1		417	NO
3/11/2021	10:26	3/11/2021	10:26	AUTO-RECLOSURE	BROKEN POLE	BROKEN POLE AT 5300 APPLEBY LINE	LOWVILLE F3	1		417	NO
3/13/2021	01:18	3/13/2021	01:18	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F3	1		417	NO
3/15/2021	03:50	3/15/2021	03:50	AUTO-RECLOSURE	UNKNOWN	S4238 AUTO'D AS WELL. B PHASE FAULT	LOWVILLE F3	1		417	NO
3/16/2021	21:21	3/16/2021	21:21	AUTO-RECLOSURE	UNKNOWN	FAULT INDICATOR AT 5550 APPLEBY LINE SOUTH OF NO 4 SIDE RD. SHOWED FAULT ON FIELD SIDE PHASE. NO OTHER FAULT INDICATORS SHOWED FAULT.	LOWVILLE F3	1		417	NO
3/18/2021	22:46	3/18/2021	22:46	AUTO-RECLOSURE	UNKNOWN	ALL FAULT INDICATORS INSTALLED SHOWED FAULT.	LOWVILLE F3	1		417	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
3/21/2021	01:28	3/21/2021	01:28	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F3	1		417	NO
3/22/2021	00:31	3/22/2021	00:31	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F3	1		417	NO
3/29/2021	09:00	3/29/2021	09:00	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F3	1		417	NO
4/11/2021	05:59	4/11/2021	05:59	AUTO-RECLOSURE	UNKNOWN	POSSIBLE BAD INSULATOR AT 5265 APPLEBY RD, CREW CHANGED INSULATOR. DURING CHANGING THE LOWVILLE F3 LOCKED OUT. SUSPECT NOT RELATED TO WORK.	LOWVILLE F3	1		417	NO
4/11/2021	10:52	4/11/2021	10:52	AUTO-RECLOSURE	UNKNOWN	WHITE PHASE FLAGGED AT S4238 WHICH ALSO AUTO RECLOSED	LOWVILLE F3	1		417	NO
4/12/2021	01:51	4/12/2021	01:51	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F3	1		417	NO
4/18/2021	14:06	4/18/2021	14:06	AUTO-RECLOSURE	SQUIRREL	LINE CREW FOUND TX AQ6 FUSE BLOWN. SQUIRREL	LOWVILLE F3	1		417	NO
4/18/2021	15:24	4/18/2021	15:24	AUTO-RECLOSURE	UNKNOWN	S4238 ALSO AUTO-RECLOSE. NO CAUSE FOUND.	LOWVILLE F3	1		417	NO
4/19/2021	21:42	4/19/2021	21:42	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F3	1		417	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
5/4/2021	00:59	5/4/2021	00:59	AUTO-RECLOSURE	TREE/LIMB	TREE LIMB ON FIRE IN FRONT OF 6409 APPLBE LINE. INTELLI S4238 AUTO AT SAME TIME, WHITE AND RED PHASE FAULT	LOWVILLE F3	1		417	NO
5/4/2021	01:32	5/4/2021	01:32	AUTO-RECLOSURE	TREE/LIMB	TREE LIMB ON FIRE IN FRONT OF 6409 APPLBE LINE. INTELLI S4238 AUTO AT SAME TIME, WHITE AND RED PHASE FAULT	LOWVILLE F3	1		417	NO
6/25/2021	18:37	6/25/2021	18:37	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F3	1		417	NO
7/8/2021	08:18	7/8/2021	08:18	AUTO-RECLOSURE	UNKNOWN	S4238 ALSO AUTO - RECLOSED RWB - NO CAUSE (RAINING DURING THIS TIME)	LOWVILLE F3	1		417	NO
7/11/2021	07:57	7/11/2021	07:57	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F3	1		417	NO
11/7/2021	07:58	11/7/2021	07:58	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F3	1		417	NO

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report LOWVILLE F1

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
5/3/2021	12:39	5/3/2021	12:39	AUTO-RECLOSURE	SQUIRREL	3077 GUELPH LINE. JOHN FLEMING AT 3077 GUELPH LINE, TRANSFORMER ON THE PROPERTY, NO POWER, DEAD SQ REFUSED AT 10K, BLOWN FUSE WAS ALSO A 10K, CLOSED AND HOLDING.	LOWVILLE F1	1		200	NO
5/31/2021	08:50	5/31/2021	08:50	AUTO-RECLOSURE	SQUIRREL	4237 WALKERS LINE. #21 REPORTS FUSE F2165 BLOWN. #21 SK PATROLLED LINE NOTHING FOUND. REFUSED (10), CLOSED AND HOLDING. POWER RESTORED.	LOWVILLE F1	1		200	NO
6/29/2021	17:15	6/29/2021	17:15	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F1	1		200	NO
7/4/2021	07:46	7/4/2021	07:46	AUTO-RECLOSURE	SQUIRREL		LOWVILLE F1	1		200	NO
7/7/2021	20:29	7/7/2021	20:29	AUTO-RECLOSURE	BROKEN POLE	4408 CEDAR SPRINGS RD. LOST POWER ABOUT 10 TO 15 MINS AGO. BROKEN POLE AT TX AC32, CREW CUT DOWN PRIMA TX AC32, OVERHEAD PRIMARY	LOWVILLE F1	1		200	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
						AND SWITCH ALL REMOVED.					
7/7/2021	22:30	7/7/2021	22:30	AUTO-RECLOSURE	BROKEN POLE	4408 CEDAR SPRINGS RD. LOST POWER ABOUT 10 TO 15 MINS AGO. BROKEN POLE AT TX AC32, CREW CUT DOWN PRIMA TX AC32, OVERHEAD PRIMARY AND SWITCH ALL REMOVED.	LOWVILLE F1	1		200	NO
7/13/2021	13:51	7/13/2021	13:51	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F1	1		200	NO
7/15/2021	13:13	7/15/2021	13:13	AUTO-RECLOSURE	UNKNOWN	TX AG7 @1305 NO 2 SIDERD FUSE FOUND BLOWN. NO OBVIOUS CAUSE FOUND. REFUSED CLOSED AND HOLDING	LOWVILLE F1	1		200	NO
7/27/2021	08:17	7/27/2021	08:17	AUTO-RECLOSURE	UNKNOWN	SQUIRREL FOUND HANGING OFF INSULATOR ON TX AK7 @5190 WALKERS	LOWVILLE F1	1		200	NO
8/4/2021	06:08	8/4/2021	06:08	AUTO-RECLOSURE	SQUIRREL	DEAD SQUIRREL FOUND AT 5216 WALKERS LINE - TX AL2 REFUSED CLOSED AND HOLDING	LOWVILLE F1	1		200	NO
8/25/2021	08:35	8/25/2021	08:35	AUTO-RECLOSURE	BIRD	TX AK87 1 PHASE BLOWN AT 21523 MOUNT NEMO CRES.	LOWVILLE F1	1		200	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
10/4/2021	10:32	10/4/2021	10:32	AUTO-RECLOSURE	SQUIRREL	SQUIRREL AT FUSE FY3 ON GUELPH LINE	LOWVILLE F1	1		200	NO
11/12/2021	09:33	11/12/2021	09:33	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F1	1		200	NO
11/27/2021	08:44	11/27/2021	08:44	AUTO-RECLOSURE	SQUIRREL	SQUIRREL FOUND AT FAD19 ON SIDE RD 1	LOWVILLE F1	1		200	NO
12/11/2021	14:09	12/11/2021	14:09	AUTO-RECLOSURE	HIGH WINDS/TREE		LOWVILLE F1	1		200	NO
12/11/2021	17:36	12/11/2021	17:36	AUTO-RECLOSURE	HIGH WINDS/TREE		LOWVILLE F1	1		200	NO
12/11/2021	23:12	12/11/2021	23:12	AUTO-RECLOSURE	HIGH WINDS/TREE		LOWVILLE F1	1		200	NO

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report INTERCHANGE F1

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
5/22/2021	13:24	5/22/2021	13:26	Lockout	UNKNOWN	Loud bang and lots of sparks. Customer thinks transformer exploded.	INTR_F1	1		632	NO
5/28/2021	20:16	5/28/2021	20:18	Lockout	DEFECTIVE TRANSFORMER	No power.	INTR_F1	1		632	NO
10/25/2021	8:49	10/25/2021	12:07	Lockout	POLE FIRE	See Operator Details	INTR_F1	1		622	NO
20-Jun-20	07:06	20-Jun-20	07:06	AUTO-RECLOSURE	TREE/LIMB	BLOWN USEAT F3461 RED PH FOUND ON THIS FEEDER. POSSIBLY DUE TO TREES OR ANIMAL.	INTERCHANGE F1	1		402	NO
5/17/2021	20:42	5/17/2021	20:42	AUTO-RECLOSURE	DEFECTIVE TRANSFORMER	1306 SYCAMORE DR. INTERCHANGE F1 AND TYANDAGA F3 BOTH AUTO AT SAME TIME 2042. THEN INTERCHANGE F1 #24 RT STARTED TESTING CABLES AND FOUND DEFECTIVE TX N3. REQUIRED REPLACEMENT.	INTERCHANGE F1	1		402	NO
5/18/2021	01:41	5/18/2021	01:41	AUTO-RECLOSURE	DEFECTIVE TRANSFORMER	1306 SYCAMORE DR. INTERCHANGE F1 AND TYANDAGA F3 BOTH AUTO AT SAME TIME	INTERCHANGE F1	1		402	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
						2042. THEN INTERCHANGE F1 #24 RT STARTED TESTING CABLES AND FOUND DEFECTIVE TX N3. REQUIRED REPLACEMENT.					
6/4/2021	06:32	6/4/2021	06:32	AUTO-RECLOSURE	UNKNOWN		INTERCHANGE F1	1		402	NO
6/17/2021	20:28	6/17/2021	20:28	AUTO-RECLOSURE	UNKNOWN		INTERCHANGE F1	1		402	NO
7/25/2021	08:45	7/25/2021	08:45	AUTO-RECLOSURE	SQUIRREL	SQUIRREL BLEW FUSE AT TX N278. 1140 BLAIR RD	INTERCHANGE F1	1		402	NO
8/25/2021	06:51	8/25/2021	06:51	AUTO-RECLOSURE	UNKNOWN		INTERCHANGE F1	1		402	NO
9/7/2021	07:46	9/7/2021	07:46	AUTO-RECLOSURE	UNKNOWN		INTERCHANGE F1	1		402	NO
9/18/2021	04:20	9/18/2021	04:20	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	TX N32 X N33 CABLE FAULTED	INTERCHANGE F1	1		402	NO
9/28/2021	07:45	9/28/2021	07:45	AUTO-RECLOSURE	UNKNOWN	DEFECTIVE 8KV U/G CABLE TX N30 TO TX N31 @ 1417 ALLANGROVE	INTERCHANGE F1	1		402	NO
12/11/2021	14:26	12/11/2021	14:26	AUTO-RECLOSURE	HIGH WINDS/TREE		INTERCHANGE F1	1		402	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
12/11/2021	15:14	12/11/2021	15:14	AUTO-RECLOSURE	HIGH WINDS/TREE		INTERCHANGE F1	1		402	NO
12/11/2021	16:10	12/11/2021	16:10	AUTO-RECLOSURE	HIGH WINDS/TREE		INTERCHANGE F1	1		402	NO

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report PALMER F1

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
2/14/2021	06:05	2/14/2021	06:05	AUTO-RECLOSURE	UNKNOWN		PALMER F1	1		220	NO
6/17/2021	19:04	6/17/2021	19:04	AUTO-RECLOSURE	UNKNOWN		PALMER F1	1		220	NO
6/27/2021	06:51	6/27/2021	06:51	AUTO-RECLOSURE	UNKNOWN	NO CAUSE REPORTED	PALMER F1	1		220	NO
8/31/2021	08:27	8/31/2021	08:27	AUTO-RECLOSURE	UNKNOWN		PALMER F1	1		220	NO
9/6/2021	17:47	9/6/2021	17:47	AUTO-RECLOSURE	UNKNOWN		PALMER F1	1		220	NO
9/12/2021	12:35	9/12/2021	12:35	AUTO-RECLOSURE	UNKNOWN		PALMER F1	1		220	NO
9/17/2021	10:20	9/17/2021	10:20	AUTO-RECLOSURE	UNKNOWN		PALMER F1	1		220	NO
10/2/2021	08:10	10/2/2021	08:10	AUTO-RECLOSURE	UNKNOWN		PALMER F1	1		220	NO
10/6/2021	08:02	10/6/2021	08:02	AUTO-RECLOSURE	SQUIRREL	PART POWER @ 1051 HERITAGE - F74 PHASE BLOWN. NO SQUIRREL FOUND BUT OVERGROWN AND MAY HAVE BEEN	PALMER F1	1		220	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
						MISSED. REFUSED CLOSED AND HOLDING					
11/5/2021	17:58	11/5/2021	17:58	AUTO-RECLOSURE	UNKNOWN		PALMER F1	1		220	NO

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report PALMER F3

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
4/7/2021	07:31	4/7/2021	07:31	AUTO-RECLOSURE	SQUIRREL	TX Q77 @ UPPER MIDDLE RD AND COUNTRY CLUB RD FOUND FUSE BLOWN DUE TO SQUIRREL CONTACT	PALMER F3	1		2053	NO
5/29/2021	08:05	5/29/2021	08:05	AUTO-RECLOSURE	UNKNOWN		PALMER F3	1		2053	NO
8/15/2021	13:13	8/15/2021	13:13	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	CABLE FAULT WHISPERING PINES BET U 126 AND U 128 BLUE PH	PALMER F3	1		2053	NO
11/23/2021	02:43	11/23/2021	02:43	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY		PALMER F3	1		2053	NO
11/23/2021	09:46	11/23/2021	09:46	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	F741 @ WALKERS LINE AND JORDAN AVE FOUND BLOWN. LINE CREW TO INVESTIGATE FURTHER	PALMER F3	1		2053	NO
11/23/2021	09:50	11/23/2021	09:50	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	F741 @ WALKERS LINE AND JORDAN AVE FOUND BLOWN. LINE CREW TO INVESTIGATE FURTHER	PALMER F3	1		2053	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
11/29/2021	08:31	11/29/2021	08:31	AUTO-RECLOSURE	UNKNOWN		PALMER F3	1		2053	NO
11/29/2021	08:44	11/29/2021	08:44	AUTO-RECLOSURE	UNKNOWN		PALMER F3	1		2053	NO
11/30/2021	09:41	11/30/2021	09:41	AUTO-RECLOSURE	UNKNOWN		PALMER F3	1		2053	NO
12/3/2021	05:45	12/3/2021	05:45	AUTO-RECLOSURE	UNKNOWN		PALMER F3	1		2053	NO

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report TOWERLINE F4

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
4/5/2021	14:39	4/5/2021	14:39	AUTO-RECLOSURE	DEFECTIVE CONNECTION	4450 PALETTA CRT, UNION GAS. AUTO ON TOWELINE F4 @ 14:39. CREW ARRIVED AND FOUND BLOWN FUSE @ FF108. FURTHER ALL REPAIRS HAVE BEEN MADE, PERMIT TERMINATED. FF108 REFUSED @ 30 STD (CENTER PH	TOWERLINE F4	1		190	NO
5/16/2021	07:18	5/16/2021	07:18	AUTO-RECLOSURE	UNKNOWN		TOWERLINE F4	1		190	NO
7/19/2021	00:02	7/19/2021	00:02	AUTO-RECLOSURE	BIRD	5300 HARVESTER RD, DANA-LONG MFG. TOWNLINE F4 AUTO SATURDAY. #23 REPORTS NO SIGNS OF ANIMAL CONTACT. ONE PHASE BLO CABLE AND TX TESTED GOOD. #23 RT REFUSED FG42, CLOSED AND HOLDING. 30K FUSE.	TOWERLINE F4	1		190	NO
9/1/2021	21:45	9/1/2021	21:45	AUTO-RECLOSURE	UNKNOWN		TOWERLINE F4	1		190	NO
9/6/2021	14:21	9/6/2021	14:21	AUTO-RECLOSURE	UNKNOWN		TOWERLINE F4	1		190	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
9/11/2021	19:10	9/11/2021	19:10	AUTO-RECLOSURE	UNKNOWN		TOWERLINE F4	1		190	NO
10/23/2021	11:36	10/23/2021	11:36	AUTO-RECLOSURE	UNKNOWN		TOWERLINE F4	1		190	NO
11/8/2021	09:47	11/8/2021	09:47	AUTO-RECLOSURE	UNKNOWN		TOWERLINE F4	1		190	NO
11/21/2021	10:18	11/21/2021	10:18	AUTO-RECLOSURE	UNKNOWN		TOWERLINE F4	1		190	NO

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report TYANDAGA F3

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
6/29/2021	18:01	6/29/2021	18:40	Lockout	T-STORM	No power.	TYAN_F3	1		606	NO
6/29/2021	21:07	6/30/2021	0:12	Lockout	T-STORM/TREE	No power.	TYAN_F3	1		606	NO
3/26/2021	06:34	3/26/2021	06:34	AUTO-RECLOSURE	HIGH WINDS		TYANDAGA F3	1		669	NO
5/16/2021	09:38	5/16/2021	09:38	AUTO-RECLOSURE	UNKNOWN		TYANDAGA F3	1		669	NO
5/17/2021	20:42	5/17/2021	20:42	AUTO-RECLOSURE	DEFECTIVE TRANSFORMER	1306 SYCAMORE DR. INTERCHANGE F1 AND TYANDAGA F3 BOTH AUTO AT SAME TIME 2042. THEN INTERCHANGE F1 #24 RT STARTED TESTING CABLES AND FOUND DEFECTIVE TX N3. REQUIRED REPLACEMENT.	TYANDAGA F3	1		669	NO
5/18/2021	00:20	5/18/2021	00:20	AUTO-RECLOSURE	DEFECTIVE TRANSFORMER	1306 SYCAMORE DR. INTERCHANGE F1 AND TYANDAGA F3 BOTH AUTO AT SAME TIME 2042. THEN INTERCHANGE F1 #24 RT STARTED TESTING CABLES AND FOUND DEFECTIVE TX N3.	TYANDAGA F3	1		669	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
						REQUIRED REPLACEMENT.					
5/18/2021	00:41	5/18/2021	00:41	AUTO-RECLOSURE	DEFECTIVE TRANSFORMER	1306 SYCAMORE DR. INTERCHANGE F1 AND TYANDAGA F3 BOTH AUTO AT SAME TIME 2042. THEN INTERCHANGE F1 #24 RT STARTED TESTING CABLES AND FOUND DEFECTIVE TX N3. REQUIRED REPLACEMENT.	TYANDAGA F3	1		669	NO
6/16/2021	08:01	6/16/2021	08:01	AUTO-RECLOSURE	SQUIRREL	SQUIRREL FOUND AT REAR OF MAJESTIC DRIVE	TYANDAGA F3	1		669	NO
6/24/2021	09:47	6/24/2021	09:47	AUTO-RECLOSURE	UNKNOWN	CABLE FAULT N3 X N8	TYANDAGA F3	1		669	NO
8/2/2021	04:18	8/2/2021	04:18	AUTO-RECLOSURE	SQUIRREL		TYANDAGA F3	1		669	NO
8/6/2021	23:10	8/6/2021	23:10	AUTO-RECLOSURE	UNKNOWN		TYANDAGA F3	1		669	NO

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report TYANDAGA F2

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
4/7/2021	08:10	4/7/2021	08:10	AUTO-RECLOSURE	SQUIRREL	4100 GUELPH LINE. TYANDAGA F2 AUTO @ 08:10. F1359 FOUND BLOWN. QUICK PATROL OF LINE FOUND NOTHING. REFUSED F1359 @ 100K - CLOSED AND HOLDING. (POSSIBLE ANIMAL CONTACT)	TYANDAGA F2	1		942	NO
5/23/2021	05:32	5/23/2021	05:32	AUTO-RECLOSURE	UNKNOWN		TYANDAGA F2	1		942	NO
6/23/2021	22:11	6/23/2021	22:11	AUTO-RECLOSURE	UNKNOWN		TYANDAGA F2	1		942	NO
6/23/2021	22:27	6/23/2021	22:27	AUTO-RECLOSURE	UNKNOWN		TYANDAGA F2	1		942	NO
6/24/2021	10:52	6/24/2021	10:52	AUTO-RECLOSURE	UNKNOWN		TYANDAGA F2	1		942	NO
7/5/2021	06:58	7/5/2021	06:58	AUTO-RECLOSURE	SQUIRREL	TX R17 FUSE BLOWN FROM SQUIRREL.	TYANDAGA F2	1		942	NO
7/12/2021	06:31	7/12/2021	06:31	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	U/G CABLE FAULT TX T88 TO T89 @ 2187 LEOMINSTER DR - RE-TESTED CABLE T88 TO T89 TESTS GOOD - ACTUAL CABLE FAULT	TYANDAGA F2	1		942	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
						FOUND TX T198 TO TX T88 @ 2324 FLEET PATH					
7/12/2021	10:34	7/12/2021	10:34	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	AUTO RECLOSED ATTEMPTING TO PICK UP TX T87 @ 2325 DUNCASTER - BAD CABLE TX T198 TO TX T88	TYANDAGA F2	1		942	NO
7/18/2021	14:14	7/18/2021	14:14	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	T78 TO T77 FAULT ON CAVENDISH	TYANDAGA F2	1		942	NO

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report ORCHARD F1

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
3/19/2021	00:10	3/19/2021	00:10	AUTO-RECLOSURE	UNKNOWN		ORCHARD F1	1		854	NO
6/18/2021	10:17	6/18/2021	10:17	AUTO-RECLOSURE	SQUIRREL	FUSE F1118 BLOWN IN S/C # 57, CHIPMUNK ARCED OVER AND BLEW FUSE	ORCHARD F1	1		854	NO
9/22/2021	15:35	9/22/2021	15:35	AUTO-RECLOSURE	UNKNOWN	S4259 AUTO. SUSPECT BAD INSULATOR RED PHASE.	ORCHARD F1	1		854	NO
9/22/2021	20:56	9/22/2021	20:56	AUTO-RECLOSURE	UNKNOWN	S4259 AUTO. SUSPECT BAD INSULATOR RED PHASE.	ORCHARD F1	1		854	NO
9/22/2021	22:31	9/22/2021	22:31	AUTO-RECLOSURE	UNKNOWN	S4259 AUTO. SUSPECT BAD INSULATOR RED PHASE.	ORCHARD F1	1		854	NO
10/15/2021	09:50	10/15/2021	09:50	AUTO-RECLOSURE	UNKNOWN	S4259 AUTO RECLOSE (ORCHARD F1 DID NOT) - FR14 FOUND BLOWN, LINE PATROL FOUND NO OBVIOUS CAUSE - REFUSED CLOSED AND HOLDING @ 1107 DUNDAS ST E	ORCHARD F1	1		854	NO
12/25/2021	10:51	12/25/2021	10:51	AUTO-RECLOSURE	UNKNOWN		ORCHARD F1	1		854	NO

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report INTERCHANGE F2

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
6/4/2021	05:53	6/4/2021	05:53	AUTO-RECLOSURE	UNKNOWN	UNKNOWN	INTERCHANGE F2	1		250	NO
7/8/2021	12:34	7/8/2021	12:34	AUTO-RECLOSURE	UNKNOWN	HEAVY RAIN DURING THIS TIME	INTERCHANGE F2	1		250	NO
8/18/2021	17:12	8/18/2021	17:12	AUTO-RECLOSURE	DEFECTIVE TRANSFORMER	4200 MORISSON.	INTERCHANGE F2	1		250	NO
10/3/2021	07:36	10/3/2021	07:36	AUTO-RECLOSURE	UNKNOWN		INTERCHANGE F2	1		250	NO
10/25/2021	08:49	10/25/2021	08:49	AUTO-RECLOSURE	BROKEN POLE	BROKEN POLE/ ARCING ON POLE AT 3063 SOUTH SERVICE RD. ISOLATED UNDER OTO 21-718 TO REPLACE POLE	INTERCHANGE F2	1		250	NO
11/21/2021	10:52	11/21/2021	10:52	AUTO-RECLOSURE	UNKNOWN		INTERCHANGE F2	1		250	NO

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report LOWVILLE F2

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
5/3/2021	15:35	5/3/2021	17:00	Lockout	TREE/LIMB	See Operator Details	LOWV_F2	1		422	NO
7/13/2021	1:05	7/13/2021	1:07	Lockout	UNKNOWN	See Operator Details	LOWV_F2	1		420	NO
7/13/2021	8:09	7/13/2021	8:11	Lockout	UNKNOWN	See Operator Details	LOWV_F2	1		420	NO
6/2/2021	06:54	6/2/2021	06:54	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F2	1		391	NO
6/19/2021	18:29	6/19/2021	18:29	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F2	1		391	NO
7/11/2021	01:09	7/11/2021	01:09	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F2	1		391	NO
8/29/2021	08:35	8/29/2021	08:35	AUTO-RECLOSURE	BIRD	AUTO RECLOSE OF S4238 BLOWN FUSE @ FAM42	LOWVILLE F2	1		391	NO
11/6/2021	16:39	11/6/2021	16:39	AUTO-RECLOSURE	UNKNOWN		LOWVILLE F2	1		391	NO
12/6/2021	16:01	12/6/2021	16:01	AUTO-RECLOSURE	TREE/LIMB		LOWVILLE F2	1		391	NO

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report TYANDAGA F1

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
4/15/2021	08:45	4/15/2021	08:45	AUTO-RECLOSURE	DIG-IN	2416 SINCLAIR CIRCLE. TYANDAGA F1 AUTO @ 08:45. CREW ARRIVED ON-SITE AND FOUND A CONSTRUCTION CREW HAD SECTION ISOLATED FOR FUTURE REPAIR. ALL CUSTOMERS HAVE BEEN RESTORED IN AREA,	TYANDAGA F1	1		1144	NO
6/14/2021	19:49	6/14/2021	19:49	AUTO-RECLOSURE	UNKNOWN		TYANDAGA F1	1		1144	NO
8/12/2021	08:32	8/12/2021	08:32	AUTO-RECLOSURE	UNKNOWN		TYANDAGA F1	1		1144	NO
8/26/2021	18:32	8/26/2021	18:32	AUTO-RECLOSURE	T-STORM		TYANDAGA F1	1		1144	NO
11/1/2021	08:15	11/1/2021	08:15	AUTO-RECLOSURE	UNKNOWN		TYANDAGA F1	1		1144	NO
12/25/2021	10:51	12/25/2021	10:51	AUTO-RECLOSURE	UNKNOWN		TYANDAGA F1	1		1144	NO

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report TOWERLINE F2

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
1/9/2021	6:48	1/9/2021	9:05	Lockout	DEFECTIVE U/G PRIMARY	No power.	TOWL_F2	1		192	NO
5/1/2021	14:34	5/1/2021	14:40	Lockout	BURNED OFF TAP	F556 @5035 NORTH SERVICE RD BLOWN DUE TO SQUIRREL. AFTER CLOSE, HOT LINE CLAMP CAME LOOSE AND CONTACTED PRIMARY. CAUSING LOCKOUT. REPAIRS MADE	TOWL_F2	1		164	NO
5/1/2021	14:54	5/1/2021	16:34	Lockout	BURNED OFF TAP	See Operator Details	TOWL_F2	1		164	NO
5/1/2021	08:34	5/1/2021	08:34	AUTO-RECLOSURE	SQUIRREL	FUSE F556 AT 5035 NORTH SERVICE RD BLOWN DUE TO SQUIRREL CONTACT.	TOWERLINE F2	1		192	NO
8/5/2021	06:46	8/5/2021	06:46	AUTO-RECLOSURE	UNKNOWN		TOWERLINE F2	1		192	NO
8/15/2021	08:35	8/15/2021	08:35	AUTO-RECLOSURE	BIRD	BLOWN FUSE AT FG881	TOWERLINE F2	1		192	NO
10/18/2021	09:38	10/18/2021	09:38	AUTO-RECLOSURE	UNKNOWN		TOWERLINE F2	1		192	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
11/8/2021	15:41	11/8/2021	15:41	AUTO-RECLOSURE	UNKNOWN		TOWERLINE F2	1		192	NO

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report TOWERLINE F3

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
1/9/2021	08:22	1/9/2021	08:22	AUTO-RECLOSURE	COLD LOAD	COLD LOAD PICK UP FROM TOWERLINE F2 FEEDER.	TOWERLINE F3	1		1293	NO
1/16/2021	10:27	1/16/2021	10:27	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	2071 PARKLANE CRES. TOWERLINE F3 AUTO @ 10:27. FUSE FOUND BLOWN @ F651 B IN SC125. WHILE OPENING ELB PIN ON ELBOW HAS BEEN REPLACED UNDER PERMIT. DEFECTIVE CABLE IS OPEN PARKED AND	TOWERLINE F3	1		1293	NO
6/22/2021	09:22	6/22/2021	09:22	AUTO-RECLOSURE	UNKNOWN	NO POWER @ 2025 O'CONNELL BLVD - TESTING TX V92 TO FIND CAUSE	TOWERLINE F3	1		1293	NO
9/7/2021	00:55	9/7/2021	00:55	AUTO-RECLOSURE	UNKNOWN		TOWERLINE F3	1		1293	NO
10/8/2021	07:22	10/8/2021	07:22	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	DEFECTIVE U/G PRIMARY F2807 TO TX V400. OPENED AND CAUTION TAGGED.	TOWERLINE F3	1		1293	NO

Appendix D

Feeder Outage Report 4.16 kV Feeders

Feeder Outage Report BRANT F2

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
6/29/2021	18:39	6/29/2021	18:55	Lockout	T-STORM	No power.	BRAN_F2	1		650	NO
8/26/2021	20:58	8/27/2021	0:30	Lockout	T-STORM/TREE	No power. As per Robert Bottoni at 416-728-2413.	BRAN_F2	1		650	NO

Feeder Outage Report 4.16 kV Feeders

Feeder Outage Report FAIRLEIGH F2

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
3/26/2021	3:36	3/26/2021	23:30	Lockout	BROKEN POLE	See Operator Details	FAIR_F2	1		167	NO
5/17/2021	14:17	5/17/2021	17:08	Lockout	DEFECTIVE INSULATOR	No power.	FAIR_F2	1		471	NO
5/31/2021	16:22	5/31/2021	16:22	AUTO-RECLOSURE	TREE/LIMB	348 PEPPER DR. FAIRLEIGH F2 AUTO AT 1622 #21 FOUND TX D114 FUSE BLOWN. CLEARED VINES. REFUSED, CLOSED AND HOLDING TX D114	FAIRLEIGH F2	1		458	NO
7/27/2021	11:00	7/27/2021	11:00	AUTO-RECLOSURE	DEFECTIVE INSULATOR	1 PHASE DOWN @ 3108 LAKESHORE DUE TO BROKEN INSULATOR	FAIRLEIGH F2	1		458	NO
12/11/2021	16:16	12/11/2021	16:16	AUTO-RECLOSURE	HIGH WINDS/TREE		FAIRLEIGH F2	1		458	NO

Feeder Outage Report 4.16 kV Feeders

Feeder Outage Report PORT NELSON F2

Dates: January 01, 2021 through December 31, 2021

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
5/23/2021	15:19	5/23/2021	18:10	Lockout	TREE/LIMB-LINE DOWN	Customer heard loud explosions just before loss of power.	PTNL_F2	1		398	NO
9/8/2021	8:06	9/8/2021	8:43	Lockout	T-STORM/TREE	See Operator Details	PTNL_F2	1		399	NO
4/23/2021	07:46	4/23/2021	07:46	AUTO-RECLOSURE	DEFECTIVE SPLICE U/G PRIMARY	3133 SOUTH DR. PT NELSON F2 AUTO AT 0746. #40 JJ REPORTS FUSE F2465 BLOWN. CABLE FAULT AT TX E24 X E25.	PT NELSON F2	1		394	NO
4/23/2021	10:43	4/23/2021	10:43	AUTO-RECLOSURE	DEFECTIVE SPLICE U/G PRIMARY	3133 SOUTH DR. PT NELSON F2 AUTO AT 0746. #40 JJ REPORTS FUSE F2465 BLOWN. CABLE FAULT AT TX E24 X E25.	PT NELSON F2	1		394	NO
4/23/2021	10:54	4/23/2021	10:54	AUTO-RECLOSURE	DEFECTIVE SPLICE U/G PRIMARY	3133 SOUTH DR. PT NELSON F2 AUTO AT 0746. #40 JJ REPORTS FUSE F2465 BLOWN. CABLE FAULT AT TX E24 X E25.	PT NELSON F2	1		394	NO
7/27/2021	22:25	7/27/2021	22:25	AUTO-RECLOSURE	COLD LOAD	RESTORING CUSTOMERS ON ROSSMORE BLVD.	PT NELSON F2	1		394	NO

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
9/3/2021	11:04	9/3/2021	11:04	AUTO-RECLOSURE	UNKNOWN		PT NELSON F2	1		394	NO
12/11/2021	17:11	12/11/2021	17:11	AUTO-RECLOSURE	HIGH WINDS/TREE		PT NELSON F2	1		394	NO
6/27/2021	17:44	6/27/2021	17:44	AUTO-RECLOSURE	TREE/LIMB	427 ROSSMORE BLVD. PT. NELSON F2 AUTO @ 17:44. TREE TOOK TOP OF POLE OFF AT TX E86/ TREE ARCING IN LIMB REMOVED, PERMIT TERMINATED. RESTORED AREA AND FEEDER CLOSED. ALL CLEAR.	PT. NELSON F2	1		392	NO

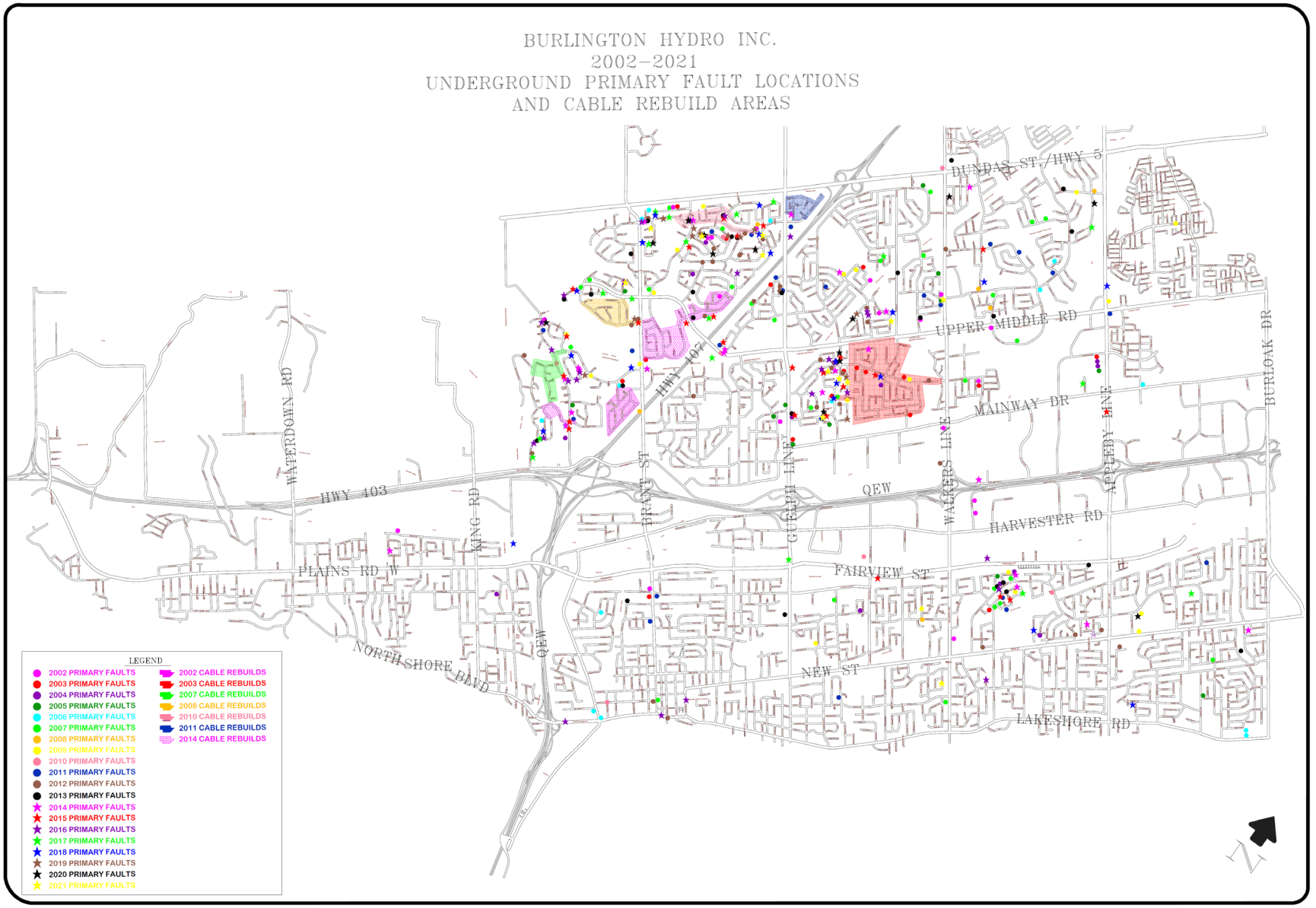
Feeder Outage Report 4.16 kV Feeders

Feeder Outage Report SPRUCE F3

Dates: January 01, 2021 through December 31, 2021

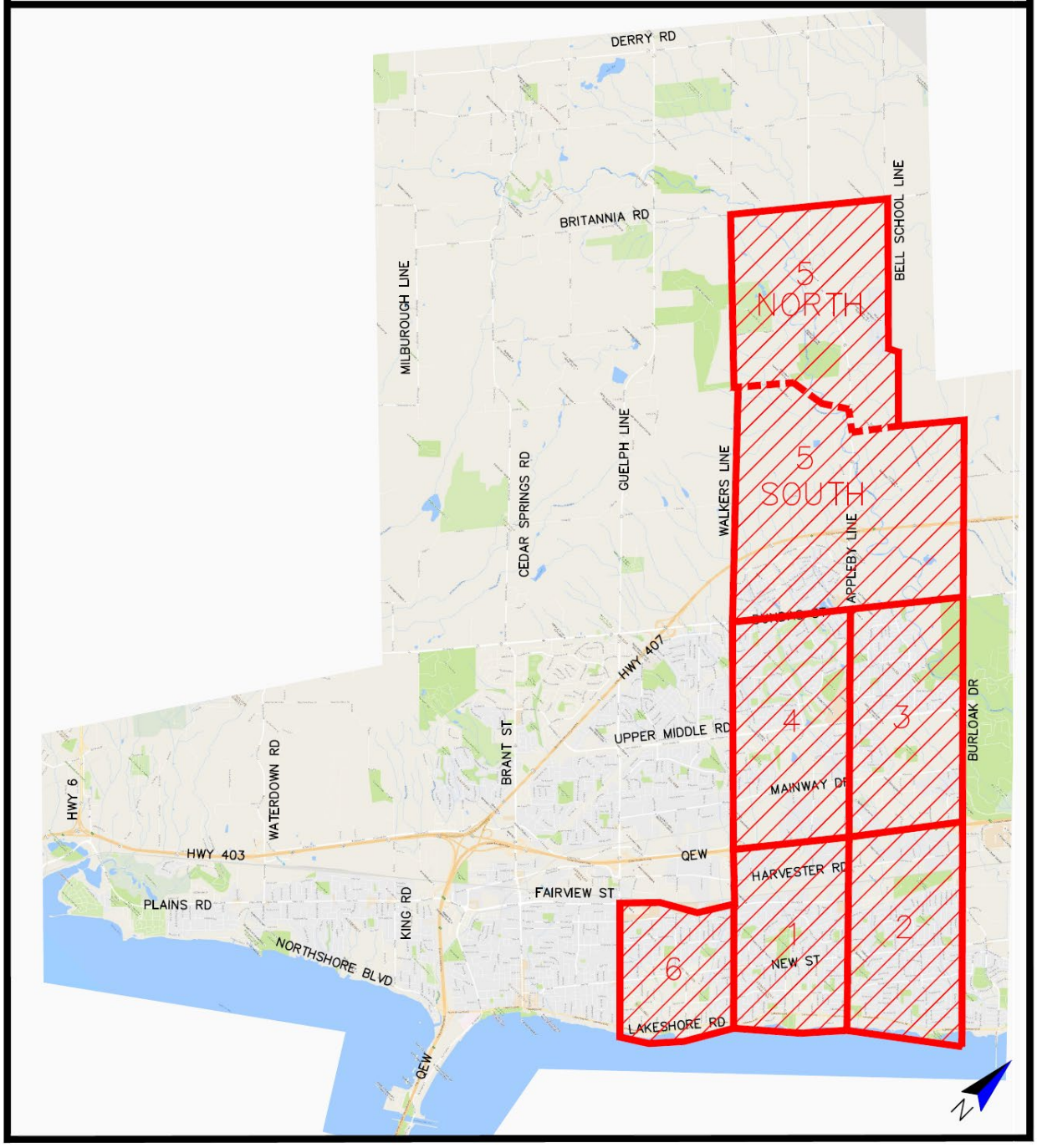
DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	FEEDER	COUNT	ABS #	NO# OF CUSTOMERS	PLANNED?
3/11/2021	16:05	3/11/2021	19:09	Lockout	TREE/LIMB	See Operator Details	SPRU_F3	1		237	NO
8/27/2021	8:42	8/27/2021	9:11	Lockout	TREE/LIMB	TREE LIMB AT LAKESHORE AND GOODRAM FOUND ON LINE	SPRU_F3	1		223	NO
8/7/2021	11:49	8/7/2021	11:49	AUTO-RECLOSURE	BURNED OFF TAP	137 AVONDALE CRT. SPRUCE F3 AUTO AT 1149. #23 JT REPORTS FUSE F866 BLOWN. PC10A E005070 IN EFFECT TO MAKE REPAIRS. WORK COMPLETED. POWER RESTORED.	SPRUCE F3	1		225	NO
10/28/2021	09:45	10/28/2021	09:45	AUTO-RECLOSURE	TREE/LIMB	4250 LAKESHORE RD. SPRUCE F3 AUTO @ 09:45 TREE LIMB HAS MADE CONTACT WITH LINE BLOWING FUSE @ FF684 CREW HAS REMOVED LIMB AND REFUSED @ 65A. CLOSED AND HOLDING FULL POWER RESTORED	SPRUCE F3	1		225	NO

Appendix E


BURLINGTON HYDRO INC.
2002–2021
UNDERGROUND PRIMARY FAULT LOCATIONS
AND CABLE REBUILD AREAS
DUNDAS ST./HWY 5
UPPER MIDDLE RD
MAINWAY DR
BURLOAK DR
APPLEBY LINE
WALKERS LINE
GUELPH LINE
BRANT ST
HWY 407
QEW
HWY 403
WATERDOWN RD
KING RD
PLAINS RD W
NORTH SHORE BLVD
HARVESTER RD
FAIRVIEW ST
NEW ST
LAKESHORE RD
LEGEND
2002 PRIMARY FAULTS
2003 PRIMARY FAULTS
2004 PRIMARY FAULTS
2005 PRIMARY FAULTS
2006 PRIMARY FAULTS
2007 PRIMARY FAULTS
2008 PRIMARY FAULTS
2009 PRIMARY FAULTS
2010 PRIMARY FAULTS
2011 PRIMARY FAULTS
2012 PRIMARY FAULTS
2013 PRIMARY FAULTS
2014 PRIMARY FAULTS
2015 PRIMARY FAULTS
2016 PRIMARY FAULTS
2017 PRIMARY FAULTS
2018 PRIMARY FAULTS
2019 PRIMARY FAULTS
2020 PRIMARY FAULTS
2021 PRIMARY FAULTS
2002 CABLE REBUILDS
2003 CABLE REBUILDS
2007 CABLE REBUILDS
2008 CABLE REBUILDS
2010 CABLE REBUILDS
2011 CABLE REBUILDS
2014 CABLE REBUILDS

Appendix F

Tree Trimming 2021 Zones 1-6



2022

System Performance

Report

Table of Contents

Table of Contents **2**

List of Appendices **3**

Introduction **4**

1 SUBSTATION AND FEEDER PERFORMANCE **5**

1.1 GENERAL 5

1.2 Substations 6

1.3 27.6kV Feeders 8

1.4 13.8kV Feeders 9

1.5 4.16kV Feeders 11

2 UNDERGROUND DISTRIBUTION **12**

3 SYSTEM DEMAND AND CRITICAL LOADING ISSUES **13**

3.2 Overall Demand/Load Growth 13

3.3 27.6 Feeder Loads and Transformer Station Capacity 14

4 SYSTEM MAINTENANCE ACTIVITIES AND PRIORITIES **19**

5 RELIABILITY STATISTICS AND OBSERVATIONS **20**

6 FUTURE CAPITAL BUDGET RECOMMENDATIONS **23**

6.1 Substation Equipment 23

6.2 27.6 KV Feeders 23

6.3 13.8 KV and 4.16 KV Feeders 23

6.4 System Planning 24

List of Appendices

APPENDIX A1 Feeder Auto-Reclosures Summary (Sorted by Total)

APPENDIX A2 Feeder Auto-Reclosures Summary (Sorted by 2022)

APPENDIX A3 Feeder Lock-Outs Summary (Sorted by Total)

APPENDIX A4 Feeder Lock-Outs Summary (Sorted by 2022)

APPENDIX B1 Feeder Outage Report 27.6 kV Feeders

APPENDIX B2 Feeder Outage Report 13.8 kV Feeders

APPENDIX B3 Feeder Outage Report 4.16 kV Feeders

APPENDIX C Underground Primary Fault Location and Cable Rebuild Area

APPENDIX D System Maintenance Activities and Priorities

Introduction

The 2022 System Performance Report is intended to provide a comprehensive overview of the performance of the Burlington Hydro distribution system during 2022. It is based on the format established for previous reports and contributes to BHI's Asset Management Strategy by identifying future maintenance and capital budget priorities to enhance the reliability and performance of the distribution system. The following specific attributes are reviewed and addressed:

1) Substation and Feeder performance at 4.16, 13.8 and 27.6 kV primary voltage levels
2) Underground Distribution
3) System demand and critical loading issues
4) System maintenance activities and priorities
5) Reliability statistics and observations
6) Future Capital Budget recommendations

Information contained in the report was supplied by the Burlington Hydro Control Room, Asset Management and BHI senior management; it summarizes statistics and incidents that occurred in 2022. Data from previous years was used for comparison purposes and to identify any recurring issues. Recommendations were based on consultations with BHI engineering and operations staff.

1 SUBSTATION AND FEEDER PERFORMANCE

1.1 GENERAL

In 2022, BHI had no major performance issues at any of its 32 substation locations. More specific observations and commentary, on substations, are included in section 1b below.

The following table summarizes the number of feeders at each voltage level.

Primary Voltage	Number of Feeders	Percentage of Total
27.6kV	34	21.11
13.8kV	28	17.39
4.16kV	99	61.49
Total	161	100.00

Table 1- Number of Feeders at each voltage level

The analysis of feeder performance is based on the recording of feeder Auto-Reclosures, of feeder Lock-Outs and a review of causes of interruptions. Appendix A summarizes the performance of each feeder since 2013, as follows:

1. Appendix A1: Auto-Recloses (sorted by total operations, since 2013)
2. Appendix A2: Auto-Recloses (sorted by no. of operations in 2022)
3. Appendix A3: Lock-Outs (sorted by total operations, since 2013)
4. Appendix A4: Lock-Outs (sorted by no. of operations in 2022)

These Appendices also identify the voltages of each feeder, and they are color coded the same as the typical BHI GIS voltage level colors; Blue - 4.16 KV, Red – 13.8 KV and Brown – 27.6 KV.

A review of the actual numbers of Auto-Recloses and Lock-Outs for 2022 and 2021 when compared to the average number since 2013 is also worthy of note.

Auto-Reclosures	2021	2022	Previous 10-year Average (2013-2022)
27.6kV	58	67	60.3
13.8kV	160	96	124.7
4.16kV	68	76	74.4
Total	286	239	259.4

Table 2- Auto-Recloses comparison between 2021, 2022 and the previous 10-year average (2013-2022)

Lock-Outs	2021	2022	Previous 10-year Average (2013-2022)
27.6kV	10	19	21
13.8kV	16	17	23.2
4.16kV	17	16	27.7
Total	43	52	71.9

Table 3- Lock-Outs comparison between 2021, 2022 and the previous 10-year average (2013-2022)

Conclusions:

It is important to appreciate the difference in loading capacity at each voltage level. A typical 4.16 kV feeder may supply only 500 customers, whereas a 13.8 kV feeder may supply around 1500 and 27.6 kV 4000 customers. Therefore, the exposure of feeder length has a proportional relationship to the number of customers served. Also, it is acknowledged that both the 4.16 and 13.8kV customers experience momentary interruptions and outages when incidents occur on their 27.6kV supply feeder. Therefore Auto-Reclosures and Lock-Outs, at each voltage level, are not at all equal with respect to their impact on customers. With that background the following conclusions can be drawn from the above:

1. The total number of Auto-Reclosures decreased in 2022 and is lower than 10-year average, primarily due to the lower number of Auto-Reclosures at 13.8kV voltage level compared to the previous year.
2. The total number of Lock-Outs increased in 2022 but is below 10-year average, primarily due to the increased number of Lock-Outs at 27.6 KV voltage level compared to the previous year.

More specific observations and commentary on these items are included in sections 1c, 1d and 1e below.

1.2 SUBSTATIONS

There are no significant changes to the station and feeder loadings, in 2022. BHI Control Room Operators are aware of the system capabilities for station and feeder back-ups. At most times of the year these are not an issue, however there are the following potential vulnerabilities some of which have been previously noted:

1. Brant M.S. and Mount Forest MS should provide back-up to each other, but this was not possible under heavy load conditions. To improve the situation BHI did upgrade the 4.16 KV feeder egress cables at Brant MS in 2019 and the Station Transformer at Mount Forest M.S in 2021. However, the upgrade of the 4.16 KV feeder egress cables at Mount Forest MS was deferred to a future date. With this upgrade and additional potential system improvements in the area, the back-up capacity between Mount Forest MS and Brant MS will significantly improve.

2. Lowville MS is only the rural station in BHI distribution system and its feeders are longer than typical urban feeders which can cause power quality issues such as voltage fluctuation. The station has two power transformers (T1 and T2) from which only one (T2) was equipped with an on-load tap changer (OLTC) that can automatically regulate the secondary voltage. Also, transformers are required to work in a DESN configuration at Lowville MS to maintain reliability and load transfer capability. Due to some signs of degradation on T2 and near end-of-life of T1, BHI has decided to proactively replace transformer T1 with a new upgraded transformer equipped with an OLTC in 2022. This project has mitigated potential asset failures, power quality issues and negative reliability, as well as the safety and environmental impacts they can cause.

BHI expects to operate most of its substations indefinitely, as conversion to a higher voltage can be cost prohibitive. The transformers, switchgears, breakers, relays, and buildings are well maintained, but many of them are over 30 years old and generally supply power to the older neighborhoods. Currently ten (10) Power Transformers are closely monitored due to the results of the Dissolved Gus Analysis (DGA) and quarterly oil test is performed throughout the year. Most of the substations, twenty (20) are equipped with a single power transformer and twelve (12) have double transformation. Approximately twenty-five (25) of the transformers are over 40 years old and therefore present the highest risk, particularly when the current insurance coverage applies to a depreciated value only and falls to zero for units over 40 years old. In 2011 an annual replacement program was initiated and since then twelve (12) Station Transformers have been replaced with new transformers, including the one in 2022.

1.3 27.6KV FEEDERS

Appendix B contains the 27.6kV Feeder Outage Reports for all 27.6kV feeders experiencing 5 or more Auto-Reclosures or 2 or more Lock-Outs, during 2022. The following is a commentary on each of these feeders.

Feeder (TS)	No. of 2022 Auto-Reclosures (2021)	No. of 2022 Lock-Outs (2021)	Comments/Cause	
			Auto-Reclosures	Lock-Outs
13M27 (Bronte)	2 (4)	2 (0)	Bird (2)	Bird (1) Defective Connection (1)
280M3 (Tremaine)	1 (3)	2 (0)	Unknown (1)	Defective Connection (1) Inadvertent Operation-Incorrect Nomenclature (1)
280M6 (Tremaine)	6 (2)	1 (1)	Unknown (3) High Winds/T-Storm (2) Defective Transformer Equipment (1)	High Winds/T-Storm (1)
39M31 (Burlington)	5 (2)	0 (1)	Unknown (3) High Winds/T-Storm (2)	None.
39M1 (Burlington)	1 (2)	2 (0)	Unknown (1)	Hydro One Problem (1) Blown Arrestor (1)
39M5 (Burlington)	1 (3)	2 (0)	Unknown (1)	Hydro One Problem (1) T-Storm/Tree-Line Down (1)
76M24 (Cumberland)	5 (1)	0 (1)	Unknown (5)	None.
76M26 (Cumberland)	1 (0)	4 (1)	Unknown (1)	Defective Termination (1) High Winds/Tree (1) Accidental Contact (NON-BHI) (2)
76M30 (Cumberland)	5 (3)	0 (1)	Unknown (5)	None.

Table 4- 27.6 kV Feeders experiencing 5 or more Auto-Reclosures or, 2 or more Lockout.

In total the BHI 27.6kV feeders experienced 19 Lock-Outs and 70 Auto-Reclosures, during 2022 and mainly they were caused by High Winds/T-Storm for the Lock-Outs, and Unknown cause, High Winds/T-Storm, and Wildlife for the Auto-Reclosures. The following table compares the preceding 10 years of Lock-Outs.

YEAR	Number of 27.6 kV Lockouts
2013	30
2014	20
2015	33
2016	23
2017	14
2018	20
2019	19
2020	22
2021	10
2022	19

Table 5- Number of 27.6 kV Lockouts per year

1.4 13.8KV FEEDERS

The performance of certain 13.8kV feeders continues to be monitored closely. Appendix C contains the 13.8kV Feeder Outage Reports for all 13.8kV feeders experiencing 5 or more Auto-Reclosures or 2 or more Lock-Outs, during 2022. The following is a commentary on each of these feeders.

M.S. Feeder	No. of 2022 Auto-Reclosures (2021)	No. of 2022 Lock-Outs (2021)	Comments/Cause	
			Auto-Reclosures	Lock-Outs
Interchange F1	17 (12)	3 (3)	Blown Arrester (5) Defective Insulator (2) Unknown (8) Raccoon (1) Defective U/G Primary (2)	Defective Connection (1) Defective Insulator (2)
Lowville F1	7 (17)	3 (0)	High Winds/Tree (2) Squirrel (1) Unknown (3) T-Storm (1)	Tree/Limb (3)
Lowville F3	0 (29)	3 (2)	None.	Unknown (1) T-Storm (1) High Winds/Tree (1)
Palmer F1	9 (10)	0 (0)	High Wind (3) Unknown (6)	None.
Palmer F3	6 (10)	0 (0)	Defective U/G Primary (1) Unknown (5)	None.
Palmer F4	8 (1)	0 (0)	Defective U/G Primary (3) Unknown (5)	None.
Towerline F4	13 (9)	1 (0)	Squirrel (1) Unknown (9) Defective U/G Primary (3)	Defective U/G Primary (1)
Tyandaga F3	9 (9)	0 (2)	Defective Transformer (1) Defective U/G Primary (2) Squirrel (2) High Winds (1) Unknown (3)	None.

Table 6- 13.8 kV Feeders experiencing 5 or more Auto-Reclosures or, 2 or more Lockout

The 13.8kV feeders had about the same number of Lock-Outs and decrease in number of Auto-Reclosures in 2022. A review of the above comments identifies Defective Equipment/Cable, Tree Limbs, and Unknown as main causes for the Lock-Outs; and Unknown, Defective U/G Primary, High Winds/Tree and Wildlife for the Auto-Reclosures.

1.5 4.16KV FEEDERS

The 4.16kV feeders performed fairly well, in 2022, Appendix D contains the 4.16kV Feeder Outage Reports for all 4.16kV feeders experiencing 5 or more Auto-Reclosures or 2 or more Lock-Outs, during 2022. The following is a commentary on each of these feeders.

M.S. Feeder	No. of 2022 Auto-Reclosures (2021)	No. of 2022 Lock-Outs (2021)	Comments/Cause	
			Auto-Reclosures	Lock-Outs
EasterBrook F2	8 (4)	0 (0)	Unknown (6) High Winds (2)	None.
Fairwood F4	6 (1)	0 (0)	Squirrel (1) Unknown (5)	None.
Maple F5	6 (0)	0 (0)	Defective U/G Primary (5) Unknown (1)	None.
Mt Forest F2	5 (2)	0 (0)	Defective Customer Equipment (2) T-Storm (2) Unknown (1)	None.
Harvester F1	2 (1)	2 (0)	T-Storm (1) Dig-In (1)	Defective Insulator (1) TREE/LIMB (1)
Spruce F2	2 (0)	2 (1)	T-Storm (1) Unknown (1)	Tree/Limb (1) High Winds (1)

Table 7- 4.16 kV Feeders experiencing 5 or more Auto-Reclosures or, 2 or more Lock-Outs.

The 4.16kV feeders had decreased number of Lock-Outs and increase in Auto-Reclosures in 2022. A review of the above comments identifies typical causes from Defective U/G Primary, High Winds, T-Storm and Tree Limbs for both Lock-Outs and Auto-Reclosures.

The need for feeder protection coordination and phase balance improvements has previously been identified as a need for improvement, on several 4.16kV feeders. This should receive increased attention to improve the operational efficiency of the system. Ref. Section 6c for recommendations.

2 UNDERGROUND DISTRIBUTION

A very large percentage of BHI's residential distribution system has been constructed underground, particularly in the newer neighborhoods, north of the QEW. This has been standard utility practice for over 30 years. These systems contain direct buried high voltage cables that have a finite length of life depending on the below-grade environment, the rate of deterioration of the cable insulation and the failure rate of underground splices. BHI closely monitors the failure of these cables on an individual feeder and geographic basis. Appendix **C** is a high-level annual record of primary cable failures within the distribution system.

The planned replacement of primary cables is a very significant element within any utility's Asset Management Plan and represents the liability for very large, on-going, capital expenditures. The timing of complete cable replacements within specific neighborhoods requires a careful balance considering the condition of the cable insulation and the historical reliability performance.

Specific recommendations for future cable replacements, current maintenance and future recommendations for pad-mounted transformers and switching cubicles is included in Appendix **D**.

3 SYSTEM DEMAND AND CRITICAL LOADING ISSUES

3.2 OVERALL DEMAND/LOAD GROWTH

The following table shows BHI's System **coincident** measured peak demand and percentage growth for the last 15 years.

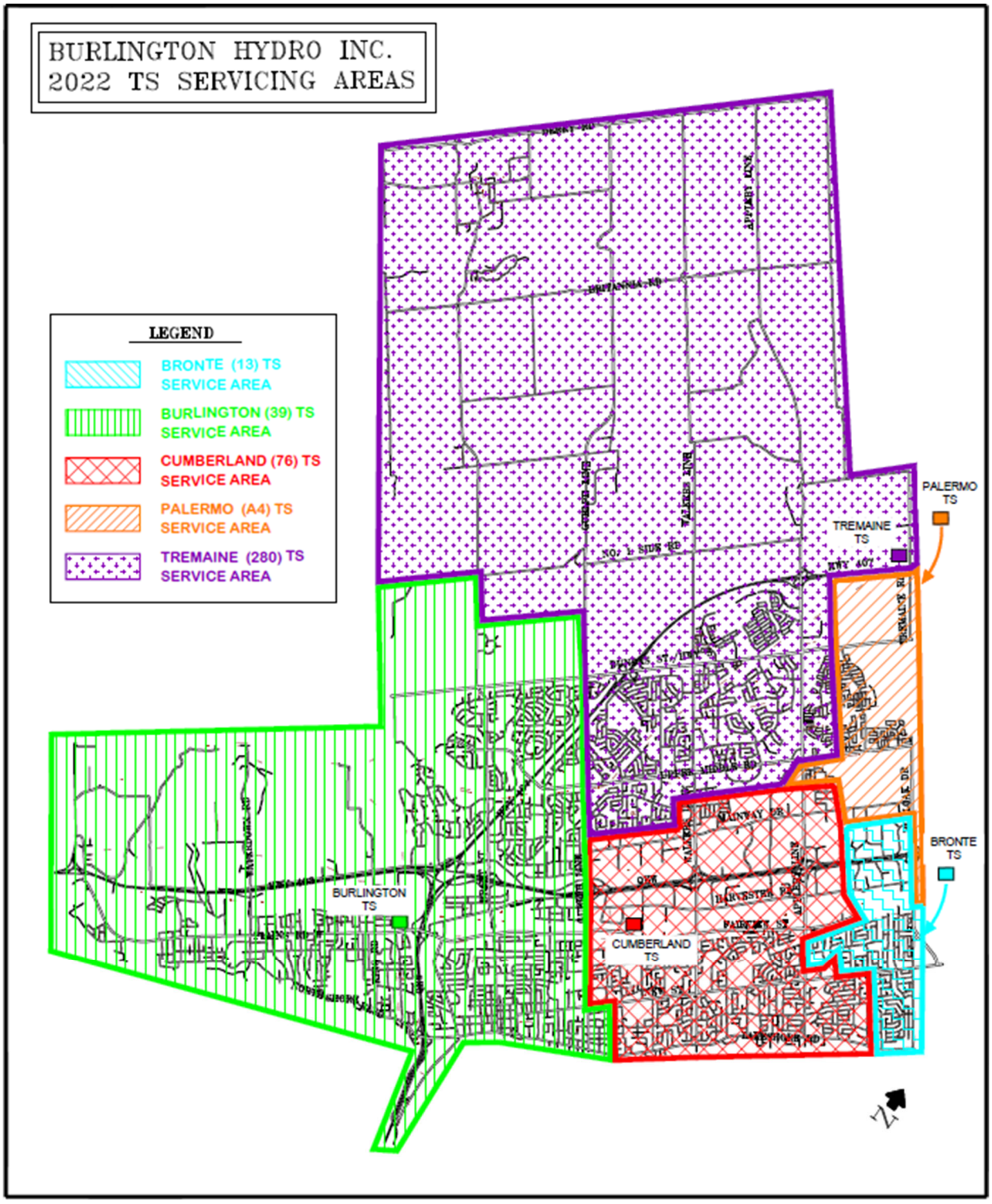
Year	Measured Peak Demand (MW)	Month	% Increase/decrease
2008	346.36	June	5.7
2009	350.43	August	1.18
2010	367.59	July	4.90
2011	379.69	July	3.29
2012	373.21	July	-1.71
2013	376.30	July	0.83
2014	325.55	August	-13.49
2015	340.35	July	4.55
2016	360.23	September	5.84
2017	321.21	September	-10.83
2018	351.44	July	9.41
2019	323.41	July	-7.97
2020	350.36	July	8.33
2021	344.66	August	-1.63
2022	344.05	June	-0.18

Table 8- Coincident peak demand and percentage growth

The 2022 coincident peak demand was slightly lower than 2021 but almost at the same level compared to the 10 years average. Each year there are many variables that contribute to this single number, such as customer growth, the local economy, summer heat, the impact of conservation initiatives and in the last couple of years the COVID-19 pandemic.

3.3 27.6 FEEDER LOADS AND TRANSFORMER STATION CAPACITY

The issue of overall Transformer Stations capacity was alleviated somewhat by the commissioning of the new Tremaine TS in January 2013. Load was initially transferred from Palermo TS to the new Tremaine TS and later also from Burlington TS. In the spring of 2017 Lowville MS was transferred to Tremaine TS which has further offloaded Burlington TS. To keep the assigned capacity at Palermo TS in the fall of 2018 Towerline MS was transferred to Palermo TS and in 2020 Palmer MS was transferred from Cumberland TS to Tremaine TS. The map below indicates the five (5) TS's servicing boundaries from where it can be seen the need of continuation with the Tremaine TS feeders' egress to optimize the use of the TS's allocated capacity and create optimal loading on 27.6 KV feeders at each TS. The current Tremaine TS feeders egress situation introduces limitations to further load transfer between the TS's which could create inefficiency into the BHI distribution system operation and may expose customers to less-than-optimum reliability.


BURLINGTON HYDRO INC.
2022 TS SERVICING AREAS
LEGEND
BRONTE (13) TS SERVICE AREA
BURLINGTON (39) TS SERVICE AREA
CUMBERLAND (76) TS SERVICE AREA
PALERMO (A4) TS SERVICE AREA
TREMAINE (280) TS SERVICE AREA
PALERMO TS
TREMAINE TS
BRONTE TS
BURLINGTON TS
CUMBERLAND TS

BHI's 27.6kV feeder interconnections are well integrated and back-up arrangements have been further enhanced by the addition of remotely operated switches, however further system optimization analysis needs to be performed and more remotely operated switches to be installed at the existing and proposed feeders. The following table shows the 27.6kV feeders load at the system **Coincident** Peak Load for 2022.

Feeder	Peak Load Amps (2022)	Peak Load Amp (2021)
13M25	113	113
13M26	230	250
13M27	229	144
13M28	180	170
280M3	263	232
280M4	230	299
280M5	47	46
280M6	371	486
280M7	0	0
280M8	406	148
39M1	257	347
39M2	312	138
39M3	115	111
39M31	257	260
39M32	318	296
39M33	231	132
39M34	187	182
39M35	275	279
39M36	218	207
39M4	130	184
39M5	281	283
39M6	134	127
76M21	234	223

76M22	254	282
76M23	29	28
76M2 4	108	87
76M25	239	242
76M26	379	382
76M27	170	158
76M28	303	320
76M29	101	95
76M30	293	299
A4M5	204	365
A4M6	381	513

Table 9- 2022 Peak load Amps for 27.6 kV Feeders

Most of the 27.6 KV feeders have reasonable loading, up to approximately 300A, which is the preferred optimal feeder loading, with some exceptions due to Tremaine TS Feeder egress challenges, load growth in certain areas, and the increase in residential load and decrease in industrial/commercial load. The feeders loading is monitored daily and if required a load transfer will be performed to less loaded feeders. To improve the loading situation BHI has come up with a short and long-term plan to modify the feeder's configuration, interconnection, and load balancing.

However, the permanent solution will ultimately depend on the continuation of the Tremaine TS feeders egress projects that are part of the BHI short- and long-term capital budget. This will be an opportunity for loads to be easily transferred among the feeders and Transformer Stations, improve system flexibility and reliability, and reduce system losses. In addition to this, the fact that BHI has purchased two more breakers at Tremaine TS is making it a priority system planning consideration.

Other areas that need immediate attention are around City of Burlington Mobility Hubs which includes the downtown and the three GO Stations where the loading capacity of the feeders supplying these parts of the City have reached their optimal loading. The load has grown

considerably in recent years and the City of Burlington long-term vision for downtown Burlington, GO Corridor and Major Transit Stations Areas is expected to accelerate this growth. BHI is constantly monitoring the System and feeders' capacity and performing regular system planning studies which results are used to optimize the existing feeders loading, propose feeder's reconfiguration and construction of new feeders to proactively mitigate any feeder's capacity constraints.

One of the previous initiatives was completed in 2017 when BHI had proceeded with an upgrade of the 27.6KV supply at Port Nelson MS where two supply sources were introduced via a new remotely controlled underground Vista switchgear installation. With this upgrade the substation reliability has been improved significantly and the entire substation load can be remotely transferred between Cumberland TS feeders 76M25 and 76M26. In addition, further system automation enhancements were introduced which involved an upgrade and expansion of the existing Intelliteam system that now includes 28 Intelligent switches and 5 feeders. This intelligent self-healing system will take less than a minute to isolate the faulted section and restore the power to the rest of the system. This project was completed in 2021. Additional load transfers and feeder's reconfiguration is required at both Burlington TS and Cumberland TS feeders to create capacity for future developments.

4 SYSTEM MAINTENANCE ACTIVITIES AND PRIORITIES

BHI aims to meet or exceed the system maintenance and inspection requirements of Section 4.4 of the Ontario Energy Board's Distribution System Code (DSC). Routine maintenance programs are consistent with good utility practices and are applied annually within the BHI distribution system. A detailed maintenance report including future maintenance and operations recommendations can be found in Appendix **D**.

5 RELIABILITY STATISTICS AND OBSERVATIONS

In accordance with the Electricity Distribution System Reliability Measures and Expectations Report EB-2014-0189 completed by the Ontario Energy Board's (OEB's), BHI records and reports annually the following Service Reliability Indices:

SAIDI = System Average Interruption Duration Index

$$= \frac{\text{Total Customer-Hours of Interruptions}}{\text{Total Customers Served}}$$

SAIFI = System Average Interruption Frequency Index

$$= \frac{\text{Total Customer Interruptions}}{\text{Total Customers Served}}$$

CAIDI = Customer Average Interruption Duration Index

$$= \frac{\text{Total Customer-Hours of Interruptions}}{\text{Total Customer Interruptions}}$$

In addition, BHI also records:

SAARI = System Average Automatic Reclosure Index

$$= \frac{\text{Total Customer Automatic Reclosures}}{\text{Total Customers Served}}$$

These indexes provide BHI with an annual measure of its service performance for internal benchmarking and for comparisons with other distribution companies as part of the OEB's Performance Based Regulations. The following graphs demonstrate the individual performance measures over the last 8 years (excluding Lost of Supply and Major Events). The graphs depict a slightly increasing but consistent level of performance compared with the previous years.

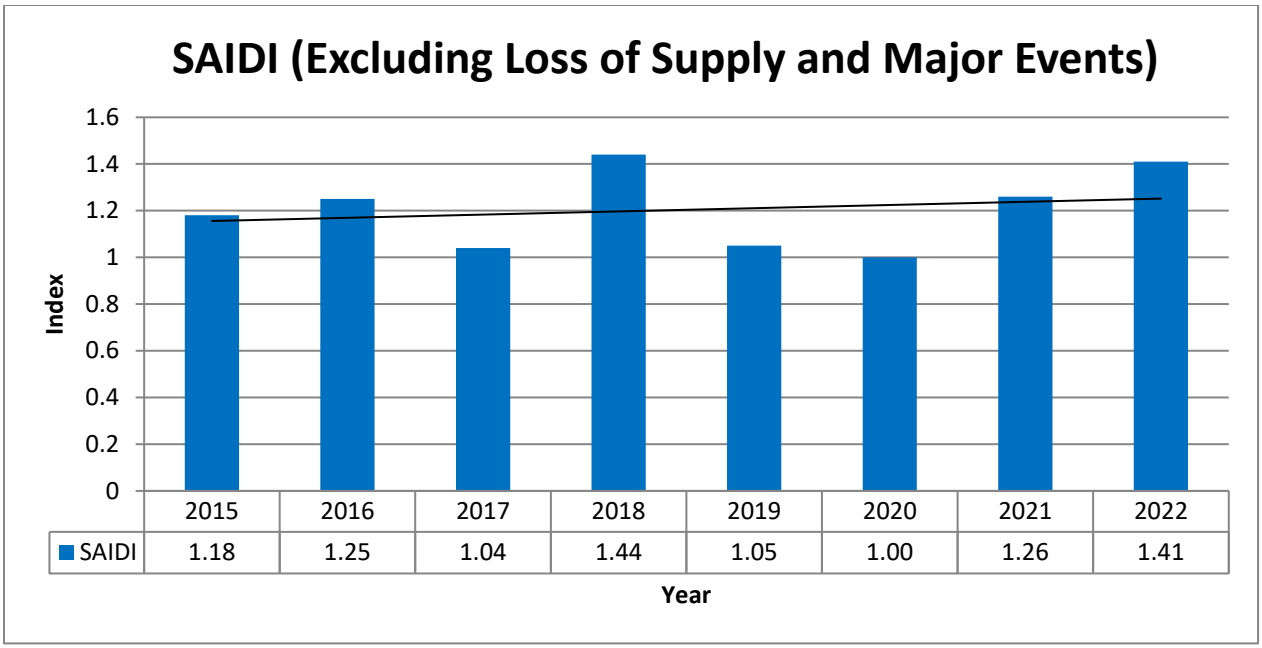


Figure 1- SAIDI from 2015 to 2022

8 Years Average – 1.23

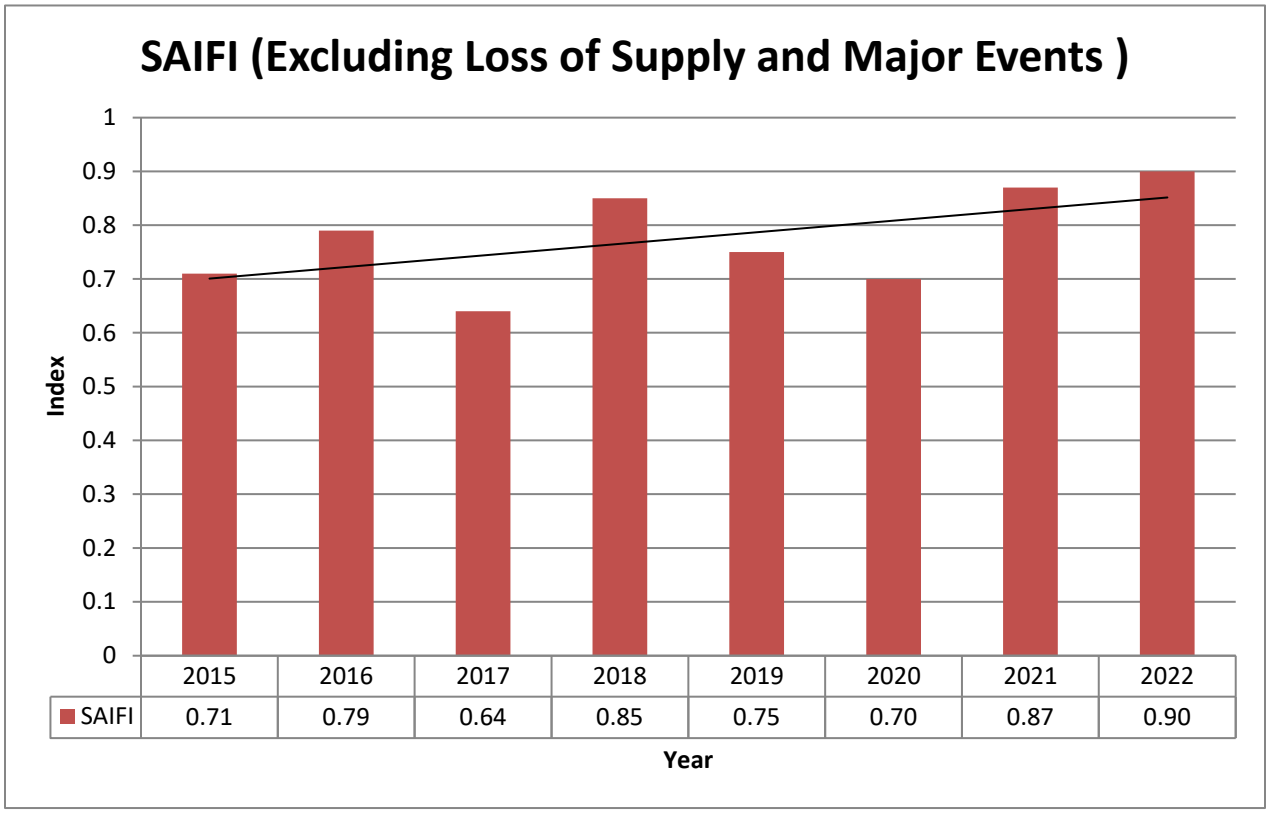


Figure 2- SAIFI from 2015 to 2022

8 Years Average – 0.81

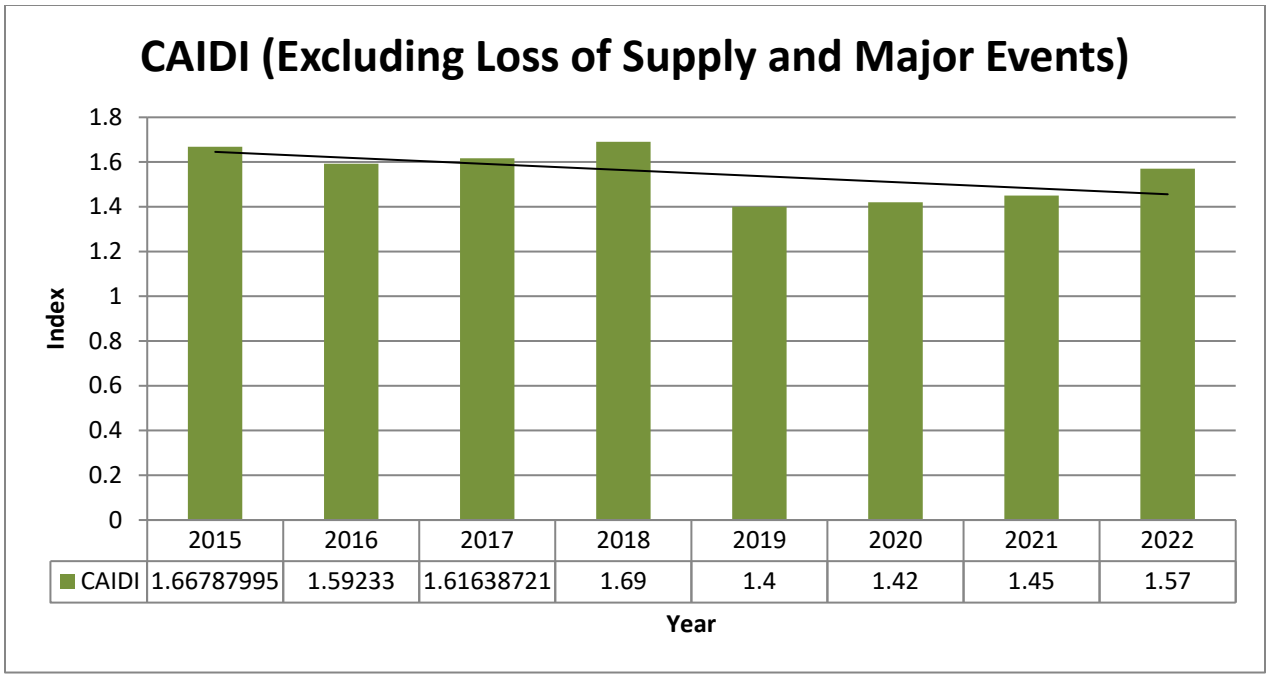


Figure 3- CAIDI from 2015 to 2022

8 Years Average – 1.53

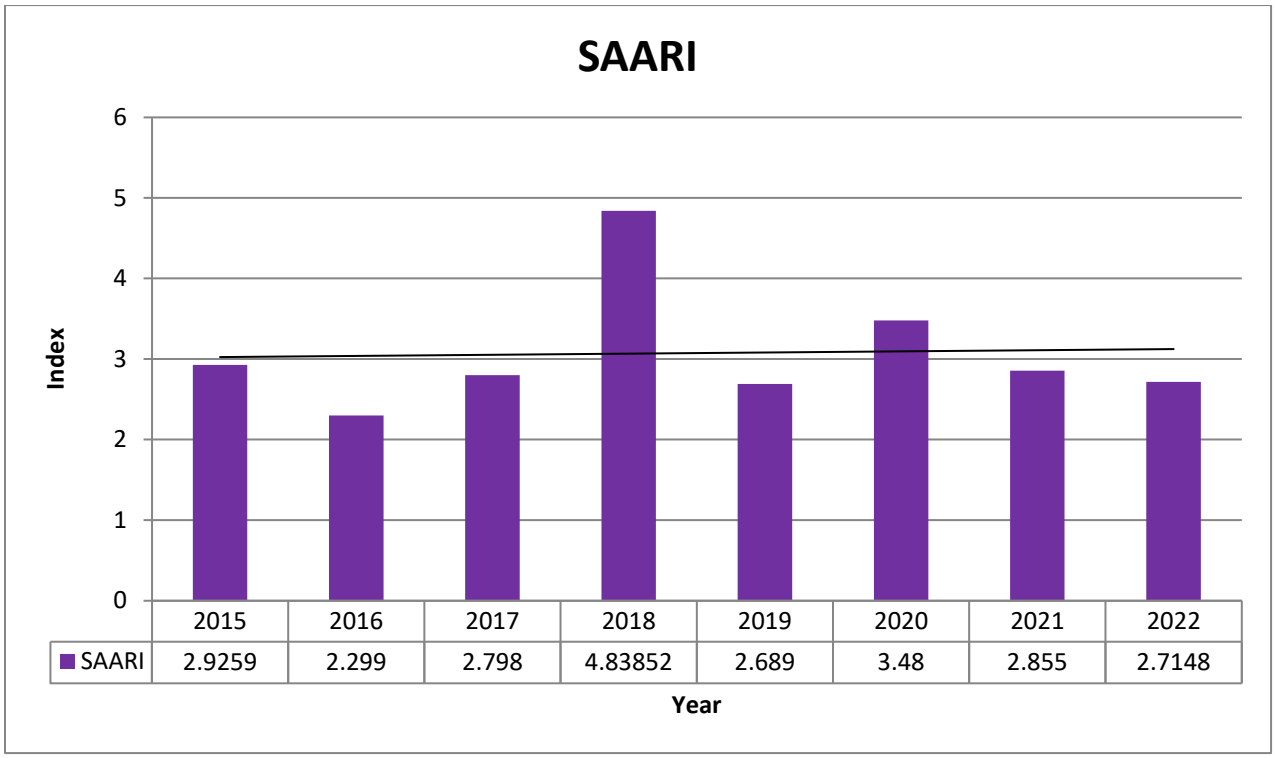


Figure 4- SAARI from 2015 to 2022

8 Year Average – 3.132

6 FUTURE CAPITAL BUDGET RECOMMENDATIONS

6.1 SUBSTATION EQUIPMENT

With approximately twenty-five (25) of its substation power transformers over 40 years old and due to the high number of transformers, twelve (12), having elevated dissolved gases, these units require close monitoring and testing. BHI will aim to replace 1 unit every year or every other year and is looking into alternatives to mitigate risks (critical spares, potential station conversion, refurb, etc.). Additional programs for the station primary switchgears, feeder circuit breakers and relay upgrades have been introduced and recommended for continuance.

6.2 27.6 KV FEEDERS

The following are the proposed capital projects as a part of the Tremaine TS 27.6KV feeder's egress and Burlington TS feeders' expansion to the west that have been recommended to be constructed in the next few years as new developments materialize.

Add a second circuit 27.6 kV O/H line between Appleby Ln and Walkers Ln along Dundas Rd

Add a second circuit 27.6 kV O/H line between Walkers Ln and Guelph Ln along Dundas Rd

Add a second circuit 27.6 kV O/H line between Dundas Rd and Reservoir MS along Guelph Ln

Add three circuits 27.6 kV O/H line from Dundas Rd to Upper Middle Road along Bronte Creek

Add a second circuit 27.6 kV O/H line between Skyview Dr and south of Watertown Rd along NSR.

6.3 13.8 KV AND 4.16 KV FEEDERS

The following feeders with primary cable failures have been identified and should be reviewed as part of the Asset Management plan and prioritized for capital budget consideration.

- Palmer MS F4, F3
- Towerline MS F1, F2, F3
- Tyandaga MS F2

- Reservoir MS F1
- Orchard MS F2
- Interchange MS F1
- Port Nelson F2

In addition to the cable replacement program BHI has started a formal program for MS feeder egress cables replacement, considering the cables that have already past the useful life and are showing signs of insulation deterioration during the regular preventive maintenance inspection and testing.

In the past BHI has installed new reclosing automation technologies, three phase recloser (IntelliRupter) and single phase reclosers (Tripsaver) on several 13.8 kV feeders. BHI should continue to install these or similar automation technologies and integrate them into the operation of the control room, to improve the reliability of the customers supplied by these feeders. In addition to the Overhead Switches BHI is planning to upgrade the existing pad mounted switching cubicles at some crucial locations with remotely controlled switching devices. Based on this experience BHI expects to expand these applications throughout its system as part of future capital budget considerations, to improve the system performance of the under-performing feeders. Appendix **C** shows the underground primary cables faults and cables rebuild areas from 2002 to 2022.

6.4 SYSTEM PLANNING

BHI has been providing increased attention to long-term system planning and has identified several proposals for major capital expenditures to enhance the performance of the distribution system. These were carefully prioritized and justified in advance of the required update to the Distribution System Plan to satisfy the Ontario Energy Board's requirements.

APPENDIX A1

Feeder Auto-Reclosures Summary

(Sorted by Total)

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
LOWVILLE F1	13.8	16	6	8	11	4	12	9	5	17	7	95
TOWERLINE F4	13.8	7	13	8	4	10	14	7	6	9	13	91
TYANDAGA F2	13.8	17	10	5	4	13	12	10	10	9	1	91
RESERVOIR F1	13.8	7	6	10	10	15	10	7	2	4	4	75
INTERCHANGE F1	13.8	2	5	1	10	7	9	5	8	12	15	74
TYANDAGA F3	13.8	5	7	9	8	6	3	7	6	9	9	69
PALMER F3	13.8	9	5	1	5	9	12	1	8	10	6	66
PALMER F1	13.8	5	4	8	7	5	9	4	7	10	6	65
LOWVILLE F3	13.8	3	2	4	1	6	11	2	5	29	0	63
FAIRVIEW F3	13.8	5	1	10	11	10	10	1	6	3	1	58
TOWERLINE F2	13.8	7	5	10	5	4	8	5	4	5	3	56
PALMER F4	13.8	3	5	7	3	1	10	5	9	1	8	52
TOWERLINE F1	13.8	13	19	1	2	5	1	3	7	1	0	52
TYANDAGA F4	13.8	9	4	4	7	5	3	3	5	2	1	43
13M27	27.6	3	8	4	3	1	6	6	4	4	2	41
76M21	27.6	0	13	3	7	0	1	6	4	4	2	40
TYANDAGA F1	13.8	6	5	4	3	5	3	2	4	6	2	40
ORCHARD F2	13.8	6	5	4	9	1	6	1	3	1	2	38
PT NELSON F2	4.1	1	5	2	5	1	5	2	7	7	0	35
FAIRVIEW F2	13.8	2	3	4	2	2	2	4	8	2	4	33
76M30	27.6	3	2	2	1	1	6	3	6	3	5	32
A4M6	27.6	2	8	4	3	2	6	1	3	0	2	31
ORCHARD F1	13.8	0	2	1	10	4	2	1	0	7	3	30
PALMER F2	13.8	6	5	0	2	3	8	3	1	2	0	30
LOWVILLE F2	13.8	3	1	2	1	3	5	1	3	6	4	29
76M23	27.6	5	4	4	2	2	3	1	2	1	4	28
INTERCHANGE F2	13.8	1	4	0	3	3	5	1	2	6	3	28
76M24	27.6	2	0	0	3	3	10	1	1	2	5	27
EASTERBROOK F3	4.1	3	1	1	4	2	1	0	2	4	8	26
39M36	27.6	0	2	3	1	1	4	4	0	6	4	25
FAIRWOOD F6	4.1	0	0	1	2	2	6	7	4	2	1	25
280M6	27.6	3	1	3	2	0	2	3	2	2	5	23
39M35	27.6	2	1	1	4	2	4	0	6	2	1	23
76M28	27.6	4	2	1	2	4	0	5	4	1	0	23
76M26	27.6	2	0	1	2	5	6	2	3	0	1	22
39M31	27.6	1	5	0	2	2	1	1	1	2	5	20
39M32	27.6	1	2	2	0	3	0	4	4	1	3	20

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
39M1	27.6	3	0	4	3	0	2	3	1	2	1	19
39M2	27.6	3	8	2	2	0	2	1	1	0	0	19
39M5	27.6	3	0	0	2	5	3	0	4	1	1	19
76M25	27.6	1	0	2	0	3	6	2	2	1	2	19
76M27	27.6	2	0	2	0	3	1	2	3	3	3	19
FAIRWOOD F4	4.1	2	0	1	2	3	3	0	1	1	6	19
MARLEY F3	4.1	1	1	3	1	1	3	2	4	1	2	19
WALKERS F1	4.1	0	0	4	0	5	7	0	0	2	1	19
280M3	27.6	0	0	0	4	5	1	3	1	3	1	18
TOWERLINE F3	13.8	0	0	0	2	0	2	5	2	5	2	18
PINEDALE F1	4.1	1	1	0	1	2	3	6	2	2	0	18
SPRUCE F2	4.1	1	4	0	4	4	1	1	1	0	2	18
13M28	27.6	3	3	1	1	2	1	1	0	3	2	17
76M22	27.6	1	1	0	4	1	2	1	1	2	4	17
WALKERS F4	4.1	0	0	2	1	1	6	0	2	2	3	17
76M29	27.6	1	1	1	1	0	2	0	5	1	4	16
PINECOVE F1	4.1	3	0	0	0	0	7	2	2	1	1	16
PINECOVE F3	4.1	0	2	2	2	1	8	1	0	0	0	16
39M4	27.6	4	5	1	0	0	1	0	1	1	2	15
LOWVILLE F4	13.8	5	1	1	0	4	1	0	1	2	0	15
BRIDGEVIEW F2	4.1	6	0	2	0	0	2	0	0	2	3	15
SPRUCE F3	4.1	2	1	2	0	2	2	1	1	2	1	14
GRAHAMS F4	4.1	7	0	4	1	0	0	0	0	1	0	13
HAMPTON F1	4.1	0	3	0	0	3	5	2	0	0	0	13
HOWARD F3	4.1	2	3	1	3	0	0	2	1	1	0	13
MAPLE F6	4.1	0	0	0	0	0	3	6	1	0	3	13
FAIRLEIGH F2	4.1	0	1	1	0	3	2	0	1	3	1	12
MAPLE F8	4.1	2	1	2	3	0	1	0	0	1	2	12
MARTHA F1	4.1	1	1	0	1	1	5	0	3	0	0	12
PINEDALE F2	4.1	1	0	1	5	1	1	0	0	1	2	12
PT NELSON F1	4.1	0	1	0	1	1	0	2	6	0	1	12
APPLEBY F1	4.1	0	0	1	0	4	2	0	3	1	0	11
ELIZ GARDENS F3	4.1	2	2	0	1	4	1	1	0	0	0	11
MT FOREST F2	4.1	0	0	0	2	0	0	1	1	2	5	11
WOODWARD F2	**4.1**	**1**	**3**	**1**	**2**	**0**	**2**	**0**	**0**	**2**	**0**	**11**
WOODWARD F5	**4.1**	**0**	**5**	**0**	**2**	**0**	**3**	**0**	**0**	**1**	**0**	**11**
A4M5	**27.6**	**2**	**0**	**0**	**0**	**0**	**0**	**3**	**2**	**2**	**1**	**10**
RESERVOIR F3	**13.8**	**0**	**3**	**0**	**3**	**0**	**1**	**1**	**0**	**1**	**1**	**10**

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
BRANT F2	4.1	3	3	2	0	0	1	1	0	0	0	10
FAIRWOOD F2	4.1	0	0	3	0	0	3	3	0	0	1	10
MAPLE F5	4.1	0	0	1	1	1	1	0	0	0	6	10
WALKERS F2	4.1	1	0	0	2	3	1	1	1	1	0	10
280M4	27.6	0	0	2	0	3	2	1	0	0	1	9
RESERVOIR F2	13.8	3	1	0	2	2	1	0	0	0	0	9
RESERVOIR F4	13.8	0	4	1	0	0	1	1	0	1	1	9
APPLEBY F4	4.1	3	0	0	0	1	2	1	0	1	1	9
BRIDGEVIEW F1	4.1	2	2	0	0	2	0	1	0	1	1	9
EASTERBROOK F2	4.1	2	0	0	0	2	1	2	2	0	0	9
ELGIN F1	4.1	2	1	0	0	1	2	1	2	0	0	9
HARVESTER F1	4.1	1	0	0	1	1	3	0	0	1	2	9
MARTHA F7	4.1	0	1	2	1	1	0	0	1	3	0	9
SPRUCE F1	4.1	1	2	1	0	0	4	1	0	0	0	9
13M26	27.6	0	1	0	0	0	3	0	1	1	2	8
DRURY F1	4.1	1	5	0	0	0	2	0	0	0	0	8
EASTERBROOK F1	4.1	4	1	0	1	0	0	0	0	1	1	8
MARTHA F6	4.1	0	4	0	1	0	0	0	1	2	0	8
PARTRIDGE F1	4.1	1	2	1	0	0	0	0	2	1	1	8
WOODWARD F6	4.1	1	0	1	0	0	3	1	0	1	1	8
280M8	27.6	0	0	0	0	0	1	0	1	4	1	7
39M34	27.6	0	3	0	0	0	0	1	1	2	0	7
HOWARD F2	4.1	4	0	0	0	0	1	0	0	2	0	7
PARTRIDGE F3	4.1	2	0	1	0	1	0	0	0	1	2	7
PINECOVE F2	4.1	0	0	0	1	2	2	1	0	0	1	7
13M25	27.6	1	2	1	0	0	0	0	1	1	0	6
280M5	27.6	0	0	0	0	0	2	2	0	2	0	6
39M33	27.6	0	1	2	0	0	1	0	0	1	1	6
39M6	27.6	1	0	2	0	1	1	0	0	0	1	6
ELIZ GARDENS F1	4.1	0	0	0	0	4	2	0	0	0	0	6
ELIZ GARDENS F2	4.1	2	0	0	2	0	0	0	0	2	0	6
GRAHAMS F2	4.1	1	1	1	0	0	0	0	0	1	2	6
HAMPTON F6	4.1	1	1	0	0	3	0	0	0	1	0	6
MARTHA F2	4.1	1	0	0	1	0	2	0	0	0	2	6
MT FOREST F1	4.1	1	0	1	1	0	1	1	0	1	0	6
PARTRIDGE F2	4.1	2	1	1	2	0	0	0	0	0	0	6

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
PT NELSON F3	4.1	0	0	0	1	0	1	1	2	1	0	6
FAIRVIEW F1	13.8	0	0	1	0	1	3	0	0	0	0	5
APPLEBY F6	4.1	0	2	0	1	0	0	1	0	0	1	5
ELGIN F2	4.1	1	1	0	0	0	1	0	2	0	0	5
FAIRLEIGH F1	4.1	0	0	0	1	1	1	0	0	1	1	5
FAIRWOOD F5	4.1	1	2	0	0	0	1	0	0	1	0	5
HAMPTON F2	4.1	2	0	0	1	0	1	0	0	1	0	5
MAPLE F1	4.1	0	0	0	0	1	2	0	1	1	0	5
MAPLE F2	4.1	2	0	1	1	0	0	0	0	1	0	5
MARLEY F1	4.1	1	0	0	0	1	1	0	1	1	0	5
MARLEY F2	4.1	0	2	0	0	0	1	0	0	1	1	5
WOODWARD F3	4.1	0	1	0	0	0	0	0	1	0	3	5
APPLEBY F2	4.1	0	0	1	0	1	0	1	0	0	1	4
APPLEBY F5	4.1	1	0	1	1	0	0	0	0	0	1	4
DRURY F4	4.1	0	0	0	1	0	1	1	1	0	0	4
ELGIN F4	4.1	0	0	0	2	1	0	0	1	0	0	4
HARVESTER F3	4.1	0	1	0	0	0	1	0	0	1	1	4
SPRUCE F4	4.1	1	1	0	0	1	0	0	0	0	1	4
280M7	27.6	0	0	0	0	0	0	0	2	0	1	3
FAIRVIEW F4	13.8	0	0	0	0	0	3	0	0	0	0	3
BRANT F3	4.1	0	0	0	0	0	1	2	0	0	0	3
FAIRWOOD F1	4.1	2	0	0	0	0	0	0	1	0	0	3
MARTHA F8	4.1	0	2	0	0	1	0	0	0	0	0	3
39M3	27.6	0	0	0	0	1	0	0	1	0	0	2
ELGIN F3	4.1	0	0	1	0	0	0	0	0	0	1	2
HAMPTON F3	4.1	0	0	0	0	0	0	0	0	0	2	2
HARVESTER F2	4.1	0	0	0	0	1	0	1	0	0	0	2
HOWARD F1	4.1	1	0	0	0	1	0	0	0	0	0	2
MARTHA F3	4.1	1	0	0	0	1	0	0	0	0	0	2
MT FOREST F3	4.1	1	0	0	0	0	0	1	0	0	0	2
WOODWARD F4	4.1	0	0	0	0	2	0	0	0	0	0	2
BRANT F1	4.1	1	0	0	0	0	0	0	0	0	0	1
FAIRLEIGH F3	4.1	0	0	0	0	0	1	0	0	0	0	1
FAIRWOOD F3	4.1	0	0	1	0	0	0	0	0	0	0	1
HAMPTON F4	4.1	0	0	0	1	0	0	0	0	0	0	1
HAMPTON F5	4.1	0	1	0	0	0	0	0	0	0	0	1
MAPLE F3	4.1	0	0	0	0	0	1	0	0	0	0	1
MARTHA F4	4.1	1	0	0	0	0	0	0	0	0	0	1

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
MARTHA F5	4.1	0	0	0	0	0	0	0	1	0	0	1
PT NELSON F4	4.1	1	0	0	0	0	0	0	0	0	0	1
WALKERS F3	4.1	1	0	0	0	0	0	0	0	0	0	1
WOODWARD F1	4.1	0	0	0	0	0	1	0	0	0	0	1
APPLEBY F3	4.1	0	0	0	0	0	0	0	0	0	0	0
DRURY F2	4.1	0	0	0	0	0	0	0	0	0	0	0
DRURY F3	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F1	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F3	4.1	0	0	0	0	0	0	0	0	0	0	0
MAPLE F4	4.1	0	0	0	0	0	0	0	0	0	0	0
MAPLE F7	4.1	0	0	0	0	0	0	0	0	0	0	0
PINEDALE F3	4.1	0	0	0	0	0	0	0	0	0	0	0

APPENDIX A2

Feeder Auto-Reclosures Summary

(Sorted by 2022)

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
INTERCHANGE F1	13.8	2	5	1	10	7	9	5	8	12	15	74
TOWERLINE F4	13.8	7	13	8	4	10	14	7	6	9	13	91
TYANDAGA F3	13.8	5	7	9	8	6	3	7	6	9	9	69
PALMER F4	13.8	3	5	7	3	1	10	5	9	1	8	52
EASTERBROOK F3	4.1	3	1	1	4	2	1	0	2	4	8	26
LOWVILLE F1	13.8	16	6	8	11	4	12	9	5	17	7	95
PALMER F1	13.8	5	4	8	7	5	9	4	7	10	6	65
PALMER F3	13.8	9	5	1	5	9	12	1	8	10	6	66
FAIRWOOD F4	4.1	2	0	1	2	3	3	0	1	1	6	19
MAPLE F5	4.1	0	0	1	1	1	1	0	0	0	6	10
280M6	27.6	3	1	3	2	0	2	3	2	2	5	23
39M31	27.6	1	5	0	2	2	1	1	1	2	5	20
76M24	27.6	2	0	0	3	3	10	1	1	2	5	27
76M30	27.6	3	2	2	1	1	6	3	6	3	5	32
MT FOREST F2	4.1	0	0	0	2	0	0	1	1	2	5	11
39M36	27.6	0	2	3	1	1	4	4	0	6	4	25
76M22	27.6	1	1	0	4	1	2	1	1	2	4	17
76M23	27.6	5	4	4	2	2	3	1	2	1	4	28
76M29	27.6	1	1	1	1	0	2	0	5	1	4	16
FAIRVIEW F2	13.8	2	3	4	2	2	2	4	8	2	4	33
LOWVILLE F2	13.8	3	1	2	1	3	5	1	3	6	4	29
RESERVOIR F1	13.8	7	6	10	10	15	10	7	2	4	4	75
39M32	27.6	1	2	2	0	3	0	4	4	1	3	20
76M27	27.6	2	0	2	0	3	1	2	3	3	3	19
INTERCHANGE F2	13.8	1	4	0	3	3	5	1	2	6	3	28
ORCHARD F1	13.8	0	2	1	10	4	2	1	0	7	3	30
TOWERLINE F2	13.8	7	5	10	5	4	8	5	4	5	3	56
BRIDGEVIEW F2	4.1	6	0	2	0	0	2	0	0	2	3	15
MAPLE F6	4.1	0	0	0	0	0	3	6	1	0	3	13
WALKERS F4	4.1	0	0	2	1	1	6	0	2	2	3	17
WOODWARD F3	4.1	0	1	0	0	0	0	0	1	0	3	5
13M26	27.6	0	1	0	0	0	3	0	1	1	2	8
13M27	27.6	3	8	4	3	1	6	6	4	4	2	41
13M28	27.6	3	3	1	1	2	1	1	0	3	2	17
39M4	27.6	4	5	1	0	0	1	0	1	1	2	15
76M21	27.6	0	13	3	7	0	1	6	4	4	2	40
76M25	27.6	1	0	2	0	3	6	2	2	1	2	19
A4M6	27.6	2	8	4	3	2	6	1	3	0	2	31

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
ORCHARD F2	13.8	6	5	4	9	1	6	1	3	1	2	38
TOWERLINE F3	13.8	0	0	0	2	0	2	5	2	5	2	18
TYANDAGA F1	13.8	6	5	4	3	5	3	2	4	6	2	40
GRAHAMS F2	4.1	1	1	1	0	0	0	0	0	1	2	6
HAMPTON F3	4.1	0	0	0	0	0	0	0	0	0	2	2
HARVESTER F1	4.1	1	0	0	1	1	3	0	0	1	2	9
MAPLE F8	4.1	2	1	2	3	0	1	0	0	1	2	12
MARLEY F3	4.1	1	1	3	1	1	3	2	4	1	2	19
MARTHA F2	4.1	1	0	0	1	0	2	0	0	0	2	6
PARTRIDGE F3	4.1	2	0	1	0	1	0	0	0	1	2	7
PINEDALE F2	4.1	1	0	1	5	1	1	0	0	1	2	12
SPRUCE F2	4.1	1	4	0	4	4	1	1	1	0	2	18
280M3	27.6	0	0	0	4	5	1	3	1	3	1	18
280M4	27.6	0	0	2	0	3	2	1	0	0	1	9
280M7	27.6	0	0	0	0	0	0	0	2	0	1	3
280M8	27.6	0	0	0	0	0	1	0	1	4	1	7
39M1	27.6	3	0	4	3	0	2	3	1	2	1	19
39M33	27.6	0	1	2	0	0	1	0	0	1	1	6
39M35	27.6	2	1	1	4	2	4	0	6	2	1	23
39M5	27.6	3	0	0	2	5	3	0	4	1	1	19
39M6	27.6	1	0	2	0	1	1	0	0	0	1	6
76M26	27.6	2	0	1	2	5	6	2	3	0	1	22
A4M5	27.6	2	0	0	0	0	0	3	2	2	1	10
FAIRVIEW F3	13.8	5	1	10	11	10	10	1	6	3	1	58
RESERVOIR F3	13.8	0	3	0	3	0	1	1	0	1	1	10
RESERVOIR F4	13.8	0	4	1	0	0	1	1	0	1	1	9
TYANDAGA F2	13.8	17	10	5	4	13	12	10	10	9	1	91
TYANDAGA F4	13.8	9	4	4	7	5	3	3	5	2	1	43
APPLEBY F2	4.1	0	0	1	0	1	0	1	0	0	1	4
APPLEBY F4	4.1	3	0	0	0	1	2	1	0	1	1	9
APPLEBY F5	4.1	1	0	1	1	0	0	0	0	0	1	4
APPLEBY F6	4.1	0	2	0	1	0	0	1	0	0	1	5
BRIDGEVIEW F1	4.1	2	2	0	0	2	0	1	0	1	1	9
EASTERBROOK F1	4.1	4	1	0	1	0	0	0	0	1	1	8
ELGIN F3	4.1	0	0	1	0	0	0	0	0	0	1	2
FAIRLEIGH F1	4.1	0	0	0	1	1	1	0	0	1	1	5
FAIRLEIGH F2	4.1	0	1	1	0	3	2	0	1	3	1	12
FAIRWOOD F2	4.1	0	0	3	0	0	3	3	0	0	1	10

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
FAIRWOOD F6	4.1	0	0	1	2	2	6	7	4	2	1	25
HARVESTER F3	4.1	0	1	0	0	0	1	0	0	1	1	4
MARLEY F2	4.1	0	2	0	0	0	1	0	0	1	1	5
PARTRIDGE F1	4.1	1	2	1	0	0	0	0	2	1	1	8
PINECOVE F1	4.1	3	0	0	0	0	7	2	2	1	1	16
PINECOVE F2	4.1	0	0	0	1	2	2	1	0	0	1	7
PT NELSON F1	4.1	0	1	0	1	1	0	2	6	0	1	12
SPRUCE F3	4.1	2	1	2	0	2	2	1	1	2	1	14
SPRUCE F4	4.1	1	1	0	0	1	0	0	0	0	1	4
WALKERS F1	4.1	0	0	4	0	5	7	0	0	2	1	19
WOODWARD F6	4.1	1	0	1	0	0	3	1	0	1	1	8
13M25	27.6	1	2	1	0	0	0	0	1	1	0	6
280M5	27.6	0	0	0	0	0	2	2	0	2	0	6
39M2	27.6	3	8	2	2	0	2	1	1	0	0	19
39M3	27.6	0	0	0	0	1	0	0	1	0	0	2
39M34	27.6	0	3	0	0	0	0	1	1	2	0	7
76M28	27.6	4	2	1	2	4	0	5	4	1	0	23
FAIRVIEW F1	13.8	0	0	1	0	1	3	0	0	0	0	5
FAIRVIEW F4	13.8	0	0	0	0	0	3	0	0	0	0	3
LOWVILLE F3	13.8	3	2	4	1	6	11	2	5	29	0	63
LOWVILLE F4	13.8	5	1	1	0	4	1	0	1	2	0	15
PALMER F2	13.8	6	5	0	2	3	8	3	1	2	0	30
RESERVOIR F2	13.8	3	1	0	2	2	1	0	0	0	0	9
TOWERLINE F1	13.8	13	19	1	2	5	1	3	7	1	0	52
APPLEBY F1	4.1	0	0	1	0	4	2	0	3	1	0	11
APPLEBY F3	4.1	0	0	0	0	0	0	0	0	0	0	0
BRANT F1	4.1	1	0	0	0	0	0	0	0	0	0	1
BRANT F2	4.1	3	3	2	0	0	1	1	0	0	0	10
BRANT F3	4.1	0	0	0	0	0	1	2	0	0	0	3
DRURY F1	4.1	1	5	0	0	0	2	0	0	0	0	8
DRURY F2	4.1	0	0	0	0	0	0	0	0	0	0	0
DRURY F3	4.1	0	0	0	0	0	0	0	0	0	0	0
DRURY F4	4.1	0	0	0	1	0	1	1	1	0	0	4
EASTERBROOK F2	4.1	2	0	0	0	2	1	2	2	0	0	9
ELGIN F1	4.1	2	1	0	0	1	2	1	2	0	0	9
ELGIN F2	4.1	1	1	0	0	0	1	0	2	0	0	5
ELGIN F4	4.1	0	0	0	2	1	0	0	1	0	0	4
ELIZ GARDENS F1	4.1	0	0	0	0	4	2	0	0	0	0	6

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
ELIZ GARDENS F2	4.1	2	0	0	2	0	0	0	0	2	0	6
ELIZ GARDENS F3	4.1	2	2	0	1	4	1	1	0	0	0	11
FAIRLEIGH F3	4.1	0	0	0	0	0	1	0	0	0	0	1
FAIRWOOD F1	4.1	2	0	0	0	0	0	0	1	0	0	3
FAIRWOOD F3	4.1	0	0	1	0	0	0	0	0	0	0	1
FAIRWOOD F5	4.1	1	2	0	0	0	1	0	0	1	0	5
GRAHAMS F1	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F3	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F4	4.1	7	0	4	1	0	0	0	0	1	0	13
HAMPTON F1	4.1	0	3	0	0	3	5	2	0	0	0	13
HAMPTON F2	4.1	2	0	0	1	0	1	0	0	1	0	5
HAMPTON F4	4.1	0	0	0	1	0	0	0	0	0	0	1
HAMPTON F5	4.1	0	1	0	0	0	0	0	0	0	0	1
HAMPTON F6	4.1	1	1	0	0	3	0	0	0	1	0	6
HARVESTER F2	4.1	0	0	0	0	1	0	1	0	0	0	2
HOWARD F1	4.1	1	0	0	0	1	0	0	0	0	0	2
HOWARD F2	4.1	4	0	0	0	0	1	0	0	2	0	7
HOWARD F3	4.1	2	3	1	3	0	0	2	1	1	0	13
MAPLE F1	4.1	0	0	0	0	1	2	0	1	1	0	5
MAPLE F2	4.1	2	0	1	1	0	0	0	0	1	0	5
MAPLE F3	4.1	0	0	0	0	0	1	0	0	0	0	1
MAPLE F4	4.1	0	0	0	0	0	0	0	0	0	0	0
MAPLE F7	4.1	0	0	0	0	0	0	0	0	0	0	0
MARLEY F1	4.1	1	0	0	0	1	1	0	1	1	0	5
MARTHA F1	4.1	1	1	0	1	1	5	0	3	0	0	12
MARTHA F3	4.1	1	0	0	0	1	0	0	0	0	0	2
MARTHA F4	4.1	1	0	0	0	0	0	0	0	0	0	1
MARTHA F5	4.1	0	0	0	0	0	0	0	1	0	0	1
MARTHA F6	4.1	0	4	0	1	0	0	0	1	2	0	8
MARTHA F7	4.1	0	1	2	1	1	0	0	1	3	0	9
MARTHA F8	4.1	0	2	0	0	1	0	0	0	0	0	3
MT FOREST F1	4.1	1	0	1	1	0	1	1	0	1	0	6
MT FOREST F3	4.1	1	0	0	0	0	0	1	0	0	0	2
PARTRIDGE F2	4.1	2	1	1	2	0	0	0	0	0	0	6
PINECOVE F3	4.1	0	2	2	2	1	8	1	0	0	0	16
PINEDALE F1	4.1	1	1	0	1	2	3	6	2	2	0	18
PINEDALE F3	4.1	0	0	0	0	0	0	0	0	0	0	0
PT NELSON F2	4.1	1	5	2	5	1	5	2	7	7	0	35

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
PT NELSON F3	4.1	0	0	0	1	0	1	1	2	1	0	6
PT NELSON F4	4.1	1	0	0	0	0	0	0	0	0	0	1
SPRUCE F1	4.1	1	2	1	0	0	4	1	0	0	0	9
WALKERS F2	4.1	1	0	0	2	3	1	1	1	1	0	10
WALKERS F3	4.1	1	0	0	0	0	0	0	0	0	0	1
WOODWARD F1	4.1	0	0	0	0	0	1	0	0	0	0	1
WOODWARD F2	4.1	1	3	1	2	0	2	0	0	2	0	11
WOODWARD F4	4.1	0	0	0	0	2	0	0	0	0	0	2
WOODWARD F5	4.1	0	5	0	2	0	3	0	0	1	0	11

APPENDIX A3

Feeder Lock-Outs Summary

(Sorted by Total)

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
LOWVILLE F4	13.8	7	8	4	10	1	6	2	0	1	1	40
LOWVILLE F3	13.8	1	4	3	3	3	8	2	0	2	3	29
TOWERLINE F2	13.8	5	2	1	0	8	1	1	0	3	0	21
76M26	27.6	2	1	0	1	2	2	3	2	1	4	18
39M2	27.6	3	3	4	0	0	1	1	1	2	1	16
39M31	27.6	3	0	8	0	2	0	0	1	1	0	15
280M6	27.6	7	0	1	1	0	0	0	3	1	1	14
PT NELSON F2	4.1	2	1	1	0	2	2	0	3	2	1	14
SPRUCE F3	4.1	2	0	4	1	1	1	1	1	2	1	14
39M1	27.6	2	0	5	3	0	1	0	0	0	2	13
39M5	27.6	1	0	2	2	1	2	2	1	0	2	13
A4M6	27.6	1	0	3	0	1	6	2	0	0	0	13
ORCHARD F2	13.8	4	1	0	1	4	1	0	0	1	1	13
PALMER F1	13.8	0	1	2	1	7	0	1	0	0	1	13
PINEDALE F2	4.1	4	1	0	2	2	2	0	0	1	1	13
SPRUCE F1	4.1	1	0	7	3	1	0	0	1	0	0	13
13M27	27.6	6	1	0	0	1	0	0	1	0	2	11
LOWVILLE F1	13.8	3	0	0	1	1	0	2	1	0	3	11
76M21	27.6	1	3	1	0	0	2	1	1	1	0	10
FAIRVIEW F2	13.8	1	1	3	0	4	0	1	0	0	0	10
INTERCHANGE F1	13.8	1	1	1	0	0	1	0	0	3	3	10
LOWVILLE F2	13.8	0	0	2	0	0	2	2	1	3	0	10
DRURY F4	4.1	2	1	2	1	3	0	1	0	0	0	10
FAIRLEIGH F2	4.1	2	0	0	1	4	1	0	0	2	0	10
ORCHARD F1	13.8	1	0	1	1	0	2	1	2	0	1	9
PALMER F2	13.8	1	0	0	0	2	3	1	1	0	1	9
TYANDAGA F3	13.8	1	0	2	0	0	1	1	2	2	0	9
HARVESTER F1	4.1	1	3	0	1	1	0	0	1	0	2	9
76M23	27.6	0	2	1	2	0	0	1	1	1	0	8
DRURY F1	4.1	1	5	0	1	0	0	1	0	0	0	8
39M3	27.6	0	0	2	3	0	0	1	0	0	1	7
TOWERLINE F4	13.8	3	1	0	0	0	0	1	0	1	1	7
MT FOREST F1	4.1	0	0	0	0	0	0	4	3	0	0	7
280M3	27.6	0	0	0	2	0	1	0	1	0	2	6
39M35	27.6	0	1	0	0	2	1	1	0	1	0	6
RESERVOIR F1	13.8	3	0	0	1	2	0	0	0	0	0	6
FAIRWOOD F6	4.1	1	0	1	0	0	0	4	0	0	0	6
MARLEY F2	4.1	1	5	0	0	0	0	0	0	0	0	6

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
MARLEY F3	4.1	1	1	2	0	0	1	1	0	0	0	6
PINEDALE F1	4.1	0	3	0	0	1	0	1	0	1	0	6
SPRUCE F2	4.1	0	1	0	1	1	0	0	0	1	2	6
WALKERS F1	4.1	0	1	2	1	1	1	0	0	0	0	6
280M4	27.6	0	1	0	0	2	0	0	2	0	0	5
39M36	27.6	0	1	1	0	0	0	2	1	0	0	5
39M4	27.6	1	0	0	0	0	2	1	1	0	0	5
76M24	27.6	0	2	1	0	2	0	0	0	0	0	5
76M27	27.6	2	0	0	0	0	0	0	1	1	1	5
FAIRVIEW F3	13.8	0	1	0	0	0	2	1	1	0	0	5
BRANT F2	4.1	2	0	0	0	0	0	0	1	2	0	5
BRIDGEVIEW F2	4.1	5	0	0	0	0	0	0	0	0	0	5
GRAHAMS F4	4.1	3	0	2	0	0	0	0	0	0	0	5
HAMPTON F6	4.1	1	1	0	1	2	0	0	0	0	0	5
HOWARD F3	4.1	0	3	0	0	0	0	2	0	0	0	5
MAPLE F6	4.1	0	0	2	0	1	0	0	1	1	0	5
PARTRIDGE F1	4.1	1	2	0	2	0	0	0	0	0	0	5
PINECOVE F2	4.1	1	2	0	0	1	0	0	0	0	1	5
13M25	27.6	0	0	0	4	0	0	0	0	0	0	4
76M25	27.6	0	0	0	3	0	0	1	0	0	0	4
INTERCHANGE F2	13.8	0	0	0	0	1	1	1	0	0	1	4
RESERVOIR F2	13.8	1	0	0	1	0	0	0	2	0	0	4
RESERVOIR F3	13.8	0	0	0	3	0	0	1	0	0	0	4
TYANDAGA F1	13.8	0	0	0	0	0	2	1	1	0	0	4
TYANDAGA F2	13.8	3	0	0	0	0	0	0	0	0	1	4
BRIDGEVIEW F1	4.1	3	0	0	0	0	0	0	0	0	1	4
FAIRWOOD F4	4.1	1	0	0	2	0	1	0	0	0	0	4
PARTRIDGE F3	4.1	0	1	2	0	0	0	1	0	0	0	4
PINECOVE F3	4.1	0	0	0	0	1	2	1	0	0	0	4
280M8	27.6	0	0	0	0	0	0	0	2	1	0	3
39M32	27.6	0	0	1	0	0	0	2	0	0	0	3
39M34	27.6	0	1	1	0	0	0	1	0	0	0	3
39M6	27.6	0	1	1	0	0	0	0	0	0	1	3
A4M5	27.6	1	0	1	0	1	0	0	0	0	0	3
TOWERLINE F1	13.8	3	0	0	0	0	0	0	0	0	0	3
TYANDAGA F4	13.8	2	0	0	0	1	0	0	0	0	0	3
EASTERBROOK F1	4.1	1	1	0	0	0	0	0	1	0	0	3
EASTERBROOK F3	4.1	1	1	0	0	0	0	0	0	1	0	3

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
ELGIN F1	4.1	0	1	0	0	0	2	0	0	0	0	3
FAIRLEIGH F1	4.1	0	0	0	0	1	2	0	0	0	0	3
HAMPTON F1	4.1	0	2	0	0	0	0	0	0	0	1	3
HARVESTER F3	4.1	0	0	0	0	0	1	2	0	0	0	3
MAPLE F8	4.1	1	0	0	0	0	0	0	2	0	0	3
PARTRIDGE F2	4.1	0	1	0	1	0	1	0	0	0	0	3
PINECOVE F1	4.1	2	0	0	0	0	1	0	0	0	0	3
PT NELSON F3	4.1	2	0	0	1	0	0	0	0	0	0	3
PT NELSON F4	4.1	1	0	0	0	1	0	0	0	1	0	3
SPRUCE F4	4.1	0	0	0	1	1	0	0	1	0	0	3
WALKERS F3	4.1	0	0	1	1	0	1	0	0	0	0	3
WOODWARD F5	4.1	0	1	0	0	0	1	0	0	1	0	3
13M26	27.6	0	1	0	1	0	0	0	0	0	0	2
280M5	27.6	0	0	0	1	0	0	0	1	0	0	2
76M29	27.6	0	0	0	0	0	1	0	1	0	0	2
76M30	27.6	0	0	0	0	0	1	0	0	0	1	2
APPLEBY F1	4.1	0	0	1	0	1	0	0	0	0	0	2
APPLEBY F4	4.1	0	0	0	1	0	0	0	1	0	0	2
BRANT F1	4.1	1	0	0	0	0	0	1	0	0	0	2
ELIZ GARDENS F2	4.1	0	0	0	0	0	0	1	0	0	1	2
ELIZ GARDENS F3	4.1	2	0	0	0	0	0	0	0	0	0	2
FAIRWOOD F5	4.1	0	0	0	0	0	0	0	0	1	1	2
HAMPTON F2	4.1	0	0	0	0	0	2	0	0	0	0	2
HARVESTER F2	4.1	1	0	0	0	1	0	0	0	0	0	2
MAPLE F1	4.1	0	0	0	0	0	0	0	1	0	1	2
MARTHA F5	4.1	1	0	0	0	0	0	0	0	0	1	2
PT NELSON F1	4.1	1	0	0	1	0	0	0	0	0	0	2
WALKERS F2	4.1	0	0	1	0	0	0	0	0	0	1	2
13M28	27.6	0	0	0	0	0	0	0	0	0	1	1
280M7	27.6	0	0	0	0	0	0	0	1	0	0	1
39M33	27.6	0	1	0	0	0	0	0	0	0	0	1
76M22	27.6	0	1	0	0	0	0	0	0	0	0	1
FAIRVIEW F4	13.8	0	0	0	0	1	0	0	0	0	0	1
PALMER F3	13.8	0	0	0	0	1	0	0	0	0	0	1
PALMER F4	13.8	0	0	0	0	0	1	0	0	0	0	1
TOWERLINE F3	13.8	0	1	0	0	0	0	0	0	0	0	1
DRURY F2	4.1	1	0	0	0	0	0	0	0	0	0	1
DRURY F3	4.1	1	0	0	0	0	0	0	0	0	0	1

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
ELGIN F2	4.1	0	0	0	1	0	0	0	0	0	0	1
ELIZ GARDENS F1	4.1	0	0	1	0	0	0	0	0	0	0	1
FAIRLEIGH F3	4.1	0	0	0	0	0	1	0	0	0	0	1
FAIRWOOD F1	4.1	1	0	0	0	0	0	0	0	0	0	1
GRAHAMS F1	4.1	0	1	0	0	0	0	0	0	0	0	1
GRAHAMS F2	4.1	1	0	0	0	0	0	0	0	0	0	1
GRAHAMS F3	4.1	0	0	0	0	0	0	1	0	0	0	1
HOWARD F1	4.1	0	0	0	0	0	1	0	0	0	0	1
MAPLE F2	4.1	0	0	0	0	0	0	0	1	0	0	1
MAPLE F3	4.1	1	0	0	0	0	0	0	0	0	0	1
MAPLE F5	4.1	1	0	0	0	0	0	0	0	0	0	1
MARLEY F1	4.1	0	0	0	0	0	0	0	0	1	0	1
MARTHA F1	4.1	0	0	0	0	0	0	1	0	0	0	1
MARTHA F2	4.1	0	0	0	0	0	1	0	0	0	0	1
MARTHA F7	4.1	0	0	0	1	0	0	0	0	0	0	1
MT FOREST F3	4.1	0	0	0	0	0	0	0	0	0	1	1
WOODWARD F2	4.1	0	1	0	0	0	0	0	0	0	0	1
WOODWARD F3	4.1	0	0	0	0	1	0	0	0	0	0	1
WOODWARD F4	4.1	0	0	0	1	0	0	0	0	0	0	1
76M28	27.6	0	0	0	0	0	0	0	0	0	0	0
FAIRVIEW F1	13.8	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR F4	13.8	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F2	4.1	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F3	4.1	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F5	4.1	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F6	4.1	0	0	0	0	0	0	0	0	0	0	0
BRANT F3	4.1	0	0	0	0	0	0	0	0	0	0	0
EASTERBROOK F2	4.1	0	0	0	0	0	0	0	0	0	0	0
ELGIN F3	4.1	0	0	0	0	0	0	0	0	0	0	0
ELGIN F4	4.1	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F2	4.1	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F3	4.1	0	0	0	0	0	0	0	0	0	0	0
HAMPTON F3	4.1	0	0	0	0	0	0	0	0	0	0	0
HAMPTON F4	4.1	0	0	0	0	0	0	0	0	0	0	0
HAMPTON F5	4.1	0	0	0	0	0	0	0	0	0	0	0
HOWARD F2	4.1	0	0	0	0	0	0	0	0	0	0	0
MAPLE F4	4.1	0	0	0	0	0	0	0	0	0	0	0
MAPLE F7	4.1	0	0	0	0	0	0	0	0	0	0	0

FEEDER	VOLTAGE	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
MARTHA F3	4.1	0	0	0	0	0	0	0	0	0	0	0
MARTHA F4	4.1	0	0	0	0	0	0	0	0	0	0	0
MARTHA F6	4.1	0	0	0	0	0	0	0	0	0	0	0
MARTHA F8	4.1	0	0	0	0	0	0	0	0	0	0	0
MT FOREST F2	4.1	0	0	0	0	0	0	0	0	0	0	0
PINEDALE F3	4.1	0	0	0	0	0	0	0	0	0	0	0
WALKERS F4	4.1	0	0	0	0	0	0	0	0	0	0	0
WOODWARD F1	4.1	0	0	0	0	0	0	0	0	0	0	0
WOODWARD F6	4.1	0	0	0	0	0	0	0	0	0	0	0

APPENDIX A4

Feeder Lock-Outs Summary

(Sorted by 2022)

FEEDER	KV	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
76M26	27.6	2	1	0	1	2	2	3	2	1	4	18
LOWVILLE F3	13.8	1	4	3	3	3	8	2	0	2	3	29
LOWVILLE F1	13.8	3	0	0	1	1	0	2	1	0	3	11
INTERCHANGE F1	13.8	1	1	1	0	0	1	0	0	3	3	10
39M1	27.6	2	0	5	3	0	1	0	0	0	2	13
39M5	27.6	1	0	2	2	1	2	2	1	0	2	13
13M27	27.6	6	1	0	0	1	0	0	1	0	2	11
HARVESTER F1	4.1	1	3	0	1	1	0	0	1	0	2	9
280M3	27.6	0	0	0	2	0	1	0	1	0	2	6
SPRUCE F2	4.1	0	1	0	1	1	0	0	0	1	2	6
LOWVILLE F4	13.8	7	8	4	10	1	6	2	0	1	1	40
39M2	27.6	3	3	4	0	0	1	1	1	2	1	16
280M6	27.6	7	0	1	1	0	0	0	3	1	1	14
PT NELSON F2	4.1	2	1	1	0	2	2	0	3	2	1	14
SPRUCE F3	4.1	2	0	4	1	1	1	1	1	2	1	14
ORCHARD F2	13.8	4	1	0	1	4	1	0	0	1	1	13
PALMER F1	13.8	0	1	2	1	7	0	1	0	0	1	13
PINEDALE F2	4.1	4	1	0	2	2	2	0	0	1	1	13
ORCHARD F1	13.8	1	0	1	1	0	2	1	2	0	1	9
PALMER F2	13.8	1	0	0	0	2	3	1	1	0	1	9
39M3	27.6	0	0	2	3	0	0	1	0	0	1	7
TOWERLINE F4	13.8	3	1	0	0	0	0	1	0	1	1	7
76M27	27.6	2	0	0	0	0	0	0	1	1	1	5
PINECOVE F2	4.1	1	2	0	0	1	0	0	0	0	1	5
INTERCHANGE F2	13.8	0	0	0	0	1	1	1	0	0	1	4
TYANDAGA F2	13.8	3	0	0	0	0	0	0	0	0	1	4
BRIDGEVIEW F1	4.1	3	0	0	0	0	0	0	0	0	1	4
39M6	27.6	0	1	1	0	0	0	0	0	0	1	3
HAMPTON F1	4.1	0	2	0	0	0	0	0	0	0	1	3
76M30	27.6	0	0	0	0	0	1	0	0	0	1	2
ELIZ GARDENS F2	4.1	0	0	0	0	0	0	1	0	0	1	2
FAIRWOOD F5	4.1	0	0	0	0	0	0	0	0	1	1	2
MAPLE F1	4.1	0	0	0	0	0	0	0	1	0	1	2
MARTHA F5	4.1	1	0	0	0	0	0	0	0	0	1	2
WALKERS F2	4.1	0	0	1	0	0	0	0	0	0	1	2

FEEDER	KV	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
13M28	27.6	0	0	0	0	0	0	0	0	0	1	1
MT FOREST F3	4.1	0	0	0	0	0	0	0	0	0	1	1
TOWERLINE F2	13.8	5	2	1	0	8	1	1	0	3	0	21
39M31	27.6	3	0	8	0	2	0	0	1	1	0	15
A4M6	27.6	1	0	3	0	1	6	2	0	0	0	13
SPRUCE F1	4.1	1	0	7	3	1	0	0	1	0	0	13
76M21	27.6	1	3	1	0	0	2	1	1	1	0	10
FAIRVIEW F2	13.8	1	1	3	0	4	0	1	0	0	0	10
LOWVILLE F2	13.8	0	0	2	0	0	2	2	1	3	0	10
DRURY F4	4.1	2	1	2	1	3	0	1	0	0	0	10
FAIRLEIGH F2	4.1	2	0	0	1	4	1	0	0	2	0	10
TYANDAGA F3	13.8	1	0	2	0	0	1	1	2	2	0	9
76M23	27.6	0	2	1	2	0	0	1	1	1	0	8
DRURY F1	4.1	1	5	0	1	0	0	1	0	0	0	8
MT FOREST F1	4.1	0	0	0	0	0	0	4	3	0	0	7
39M35	27.6	0	1	0	0	2	1	1	0	1	0	6
RESERVOIR F1	13.8	3	0	0	1	2	0	0	0	0	0	6
FAIRWOOD F6	4.1	1	0	1	0	0	0	4	0	0	0	6
MARLEY F2	4.1	1	5	0	0	0	0	0	0	0	0	6
MARLEY F3	4.1	1	1	2	0	0	1	1	0	0	0	6
PINEDALE F1	4.1	0	3	0	0	1	0	1	0	1	0	6
WALKERS F1	4.1	0	1	2	1	1	1	0	0	0	0	6
280M4	27.6	0	1	0	0	2	0	0	2	0	0	5
39M36	27.6	0	1	1	0	0	0	2	1	0	0	5
39M4	27.6	1	0	0	0	0	2	1	1	0	0	5
76M24	27.6	0	2	1	0	2	0	0	0	0	0	5
FAIRVIEW F3	13.8	0	1	0	0	0	2	1	1	0	0	5
BRANT F2	4.1	2	0	0	0	0	0	0	1	2	0	5
BRIDGEVIEW F2	4.1	5	0	0	0	0	0	0	0	0	0	5
GRAHAMS F4	4.1	3	0	2	0	0	0	0	0	0	0	5
HAMPTON F6	4.1	1	1	0	1	2	0	0	0	0	0	5
HOWARD F3	4.1	0	3	0	0	0	0	2	0	0	0	5
MAPLE F6	4.1	0	0	2	0	1	0	0	1	1	0	5
PARTRIDGE F1	4.1	1	2	0	2	0	0	0	0	0	0	5
13M25	27.6	0	0	0	4	0	0	0	0	0	0	4
76M25	27.6	0	0	0	3	0	0	1	0	0	0	4
RESERVOIR F2	13.8	1	0	0	1	0	0	0	2	0	0	4
RESERVOIR F3	13.8	0	0	0	3	0	0	1	0	0	0	4
TYANDAGA F1	13.8	0	0	0	0	0	2	1	1	0	0	4

FEEDER	KV	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
FAIRWOOD F4	4.1	1	0	0	2	0	1	0	0	0	0	4
PARTRIDGE F3	4.1	0	1	2	0	0	0	1	0	0	0	4
PINECOVE F3	4.1	0	0	0	0	1	2	1	0	0	0	4
280M8	27.6	0	0	0	0	0	0	0	2	1	0	3
39M32	27.6	0	0	1	0	0	0	2	0	0	0	3
39M34	27.6	0	1	1	0	0	0	1	0	0	0	3
A4M5	27.6	1	0	1	0	1	0	0	0	0	0	3
TOWERLINE F1	13.8	3	0	0	0	0	0	0	0	0	0	3
TYANDAGA F4	13.8	2	0	0	0	1	0	0	0	0	0	3
EASTERBROOK F1	4.1	1	1	0	0	0	0	0	1	0	0	3
EASTERBROOK F3	4.1	1	1	0	0	0	0	0	0	1	0	3
ELGIN F1	4.1	0	1	0	0	0	2	0	0	0	0	3
FAIRLEIGH F1	4.1	0	0	0	0	1	2	0	0	0	0	3
HARVESTER F3	4.1	0	0	0	0	0	1	2	0	0	0	3
MAPLE F8	4.1	1	0	0	0	0	0	0	2	0	0	3
PARTRIDGE F2	4.1	0	1	0	1	0	1	0	0	0	0	3
PINECOVE F1	4.1	2	0	0	0	0	1	0	0	0	0	3
PT NELSON F3	4.1	2	0	0	1	0	0	0	0	0	0	3
PT NELSON F4	4.1	1	0	0	0	1	0	0	0	1	0	3
SPRUCE F4	4.1	0	0	0	1	1	0	0	1	0	0	3
WALKERS F3	4.1	0	0	1	1	0	1	0	0	0	0	3
WOODWARD F5	4.1	0	1	0	0	0	1	0	0	1	0	3
13M26	27.6	0	1	0	1	0	0	0	0	0	0	2
280M5	27.6	0	0	0	1	0	0	0	1	0	0	2
76M29	27.6	0	0	0	0	0	1	0	1	0	0	2
APPLEBY F1	4.1	0	0	1	0	1	0	0	0	0	0	2
APPLEBY F4	4.1	0	0	0	1	0	0	0	1	0	0	2
BRANT F1	4.1	1	0	0	0	0	0	1	0	0	0	2
ELIZ GARDENS F3	4.1	2	0	0	0	0	0	0	0	0	0	2
HAMPTON F2	4.1	0	0	0	0	0	2	0	0	0	0	2
HARVESTER F2	4.1	1	0	0	0	1	0	0	0	0	0	2
PT NELSON F1	4.1	1	0	0	1	0	0	0	0	0	0	2
280M7	27.6	0	0	0	0	0	0	0	1	0	0	1
39M33	27.6	0	1	0	0	0	0	0	0	0	0	1
76M22	27.6	0	1	0	0	0	0	0	0	0	0	1
FAIRVIEW F4	13.8	0	0	0	0	1	0	0	0	0	0	1
PALMER F3	13.8	0	0	0	0	1	0	0	0	0	0	1
PALMER F4	13.8	0	0	0	0	0	1	0	0	0	0	1
TOWERLINE F3	13.8	0	1	0	0	0	0	0	0	0	0	1

FEEDER	KV	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
DRURY F2	4.1	1	0	0	0	0	0	0	0	0	0	1
DRURY F3	4.1	1	0	0	0	0	0	0	0	0	0	1
ELGIN F2	4.1	0	0	0	1	0	0	0	0	0	0	1
ELIZ GARDENS F1	4.1	0	0	1	0	0	0	0	0	0	0	1
FAIRLEIGH F3	4.1	0	0	0	0	0	1	0	0	0	0	1
FAIRWOOD F1	4.1	1	0	0	0	0	0	0	0	0	0	1
GRAHAMS F1	4.1	0	1	0	0	0	0	0	0	0	0	1
GRAHAMS F2	4.1	1	0	0	0	0	0	0	0	0	0	1
GRAHAMS F3	4.1	0	0	0	0	0	0	1	0	0	0	1
HOWARD F1	4.1	0	0	0	0	0	1	0	0	0	0	1
MAPLE F2	4.1	0	0	0	0	0	0	0	1	0	0	1
MAPLE F3	4.1	1	0	0	0	0	0	0	0	0	0	1
MAPLE F5	4.1	1	0	0	0	0	0	0	0	0	0	1
MARLEY F1	4.1	0	0	0	0	0	0	0	0	1	0	1
MARTHA F1	4.1	0	0	0	0	0	0	1	0	0	0	1
MARTHA F2	4.1	0	0	0	0	0	1	0	0	0	0	1
MARTHA F7	4.1	0	0	0	1	0	0	0	0	0	0	1
WOODWARD F2	4.1	0	1	0	0	0	0	0	0	0	0	1
WOODWARD F3	4.1	0	0	0	0	1	0	0	0	0	0	1
WOODWARD F4	4.1	0	0	0	1	0	0	0	0	0	0	1
76M28	27.6	0	0	0	0	0	0	0	0	0	0	0
FAIRVIEW F1	13.8	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR F4	13.8	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F2	4.1	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F3	4.1	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F5	4.1	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F6	4.1	0	0	0	0	0	0	0	0	0	0	0
BRANT F3	4.1	0	0	0	0	0	0	0	0	0	0	0
EASTERBROOK F2	4.1	0	0	0	0	0	0	0	0	0	0	0
ELGIN F3	4.1	0	0	0	0	0	0	0	0	0	0	0
ELGIN F4	4.1	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F2	4.1	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F3	4.1	0	0	0	0	0	0	0	0	0	0	0
HAMPTON F3	4.1	0	0	0	0	0	0	0	0	0	0	0
HAMPTON F4	4.1	0	0	0	0	0	0	0	0	0	0	0
HAMPTON F5	4.1	0	0	0	0	0	0	0	0	0	0	0
HOWARD F2	4.1	0	0	0	0	0	0	0	0	0	0	0
MAPLE F4	4.1	0	0	0	0	0	0	0	0	0	0	0
MAPLE F7	4.1	0	0	0	0	0	0	0	0	0	0	0

FEEDER	KV	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTALS (2013-2022)
MARTHA F3	4.1	0	0	0	0	0	0	0	0	0	0	0
MARTHA F4	4.1	0	0	0	0	0	0	0	0	0	0	0
MARTHA F6	4.1	0	0	0	0	0	0	0	0	0	0	0
MARTHA F8	4.1	0	0	0	0	0	0	0	0	0	0	0
MT FOREST F2	4.1	0	0	0	0	0	0	0	0	0	0	0
PINEDALE F3	4.1	0	0	0	0	0	0	0	0	0	0	0
WALKERS F4	4.1	0	0	0	0	0	0	0	0	0	0	0
WOODWARD F1	4.1	0	0	0	0	0	0	0	0	0	0	0
WOODWARD F6	4.1	0	0	0	0	0	0	0	0	0	0	0

Table 10- Feeder Lock-Outs Summary (Sorted by 2022)

APPENDIX B1

Feeder Outage Report 27.6 kV Feeders

Feeder Outage Report 13M27

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-07-05	18:42	2022-07-05	18:44	Lockout	BIRD		180	1
2022-08-18	0:37	2022-08-18	12:49	Lockout	DEFECTIVE CONNECTION		1489	1
2022-06-25	14:17	2022-06-25	14:17	AUTO-RECLOSURE	BIRD	BIRD NEST CAUSED ARESTOR TO BLOW	186	1
2022-07-05	12:00	2022-07-05	12:00	AUTO-RECLOSURE	BIRD		186	1

Feeder Outage Report 280M3

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-03-06	20:50	2022-03-07	0:00	Lockout	DEFECTIVE CONNECTION		229	1
2022-08-22	11:10	2022-08-22	11:17	Lockout	INADVERTENT OPERATION-INCORRECT NOMENCLATURE		68	1
2022-11-18	09:11	2022-11-18	09:11	AUTO-RECLOSURE	UNKNOWN		1968	1

Feeder Outage Report 280M6

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-03-02	07:12	2022-03-02	07:12	AUTO-RECLOSURE	UNKNOWN		5716	1
2022-05-24	02:58	2022-05-24	02:58	AUTO-RECLOSURE	UNKNOWN		5716	1
2022-06-26	13:29	2022-06-26	13:29	AUTO-RECLOSURE	DEFECTIVE TRANSFORMER	3450 DUNDAS EITHER BAD TX U518 OR BAD CABLES FROM FUSE TO U518	5716	1
2022-10-12	23:15	2022-10-12	23:17	LOCK-OUT	HIGH WINDS/T-STORM		5716	1
2022-12-16	16:05	2022-12-16	16:05	AUTO-RECLOSURE	UNKNOWN		5716	1
2022-12-23	15:35	2022-12-23	15:35	AUTO-RECLOSURE	HIGH WINDS		5716	1

Feeder Outage Report 39M31

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-06-05	20:10	2022-06-05	20:10	AUTO-RECLOSURE	UNKNOWN		1798	1
2022-11-06	08:23	2022-11-06	08:23	AUTO-RECLOSURE	UNKNOWN		1798	1
2022-11-30	14:18	2022-11-30	14:18	AUTO-RECLOSURE	UNKNOWN		1798	1
2022-12-23	10:25	2022-12-23	10:25	AUTO-RECLOSURE	HIGH WINDS		1798	1
2022-12-23	10:25	2022-12-23	10:25	AUTO-RECLOSURE	HIGH WINDS		1798	1

Feeder Outage Report 39M1

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-10-24	15:11	2022-10-24	15:11	AUTO-RECLOSURE	UNKNOWN		1995	1
2022-06-18	15:53	2022-06-18	17:05	Lockout	HYDRO ONE PROBLEM	Baldwin St, Brant St from Baldwin Ave to Grahams lane, Brant St from Grahams Lane to Plains Rd, Brant St to Drury Lane between Fairview and Ghent Ave, Brant St to Hager Ave between Baldwin Ave and Grahams Lane, Edinburgh Drive, Fairview St between Brant St and Drury Lane	3031	1
2022-12-13	12:44	2022-12-13	13:26	Lockout	BLOWN ARRESTER		4939	1

Feeder Outage Report 76M24

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-07-29	01:04	2022-07-29	01:04	AUTO-RECLOSURE	UNKNOWN		3412	1
2022-09-06	11:31	2022-09-06	11:31	AUTO-RECLOSURE	UNKNOWN		3412	1
2022-10-01	08:44	2022-10-01	08:44	AUTO-RECLOSURE	UNKNOWN		3412	1
2022-10-13	14:19	2022-10-13	14:19	AUTO-RECLOSURE	UNKNOWN		3412	1
2022-11-28	10:18	2022-11-28	10:18	AUTO-RECLOSURE	UNKNOWN	S145 GND/OC FAULT	3412	1

Feeder Outage Report 76M24

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-07-29	01:04	2022-07-29	01:04	AUTO-RECLOSURE	UNKNOWN		3412	1
2022-09-06	11:31	2022-09-06	11:31	AUTO-RECLOSURE	UNKNOWN		3412	1
2022-10-01	08:44	2022-10-01	08:44	AUTO-RECLOSURE	UNKNOWN		3412	1
2022-10-13	14:19	2022-10-13	14:19	AUTO-RECLOSURE	UNKNOWN		3412	1
2022-11-28	10:18	2022-11-28	10:18	AUTO-RECLOSURE	UNKNOWN	S145 GND/OC FAULT	3412	1

Feeder Outage Report 76M30

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-07-10	05:29	2022-07-10	05:29	AUTO-RECLOSURE	UNKNOWN		563	1
2022-07-11	02:17	2022-07-11	02:17	AUTO-RECLOSURE	UNKNOWN		563	1
2022-07-27	13:15	2022-07-27	13:15	AUTO-RECLOSURE	UNKNOWN		563	1
2022-09-24	07:08	2022-09-24	07:08	AUTO-RECLOSURE	UNKNOWN		563	1
2022-12-28	23:02	2022-12-28	23:02	AUTO-RECLOSURE	UNKNOWN		563	1

Feeder Outage Report 76M26

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-02-09	11:00	2022-02-09	14:30	Lockout	DEFECTIVE TERMINATION	Billings Court, Both Service Rds from Guelph Line to Walkers Line, Burlington Mall, Cumberland Ave, Cumberland Ave to Walkers Line between New St and Rexway, Guelph Line to Walkers Line between Woodward Ave and Lakeshore Rd, New St from Rossmore Boulevard to Pine Cove Rd	2280	1
2022-06-18	15:49	2022-06-18	17:49	Lockout	HIGH WINDS/TREE-LINE DOWN	Billings Court, Both Service Rds from Guelph Line to Walkers Line, Burlington Mall, Cumberland Ave, Cumberland Ave to Walkers Line between New St and Rexway, Guelph Line to Walkers Line between Woodward Ave and Lakeshore Rd, New St from Rossmore Boulevard to Pine Cove Rd	4393	1
2022-12-19	12:07	2022-12-19	12:10	Lockout	ACCIDENTAL CONTACT (NON-BHI)	Billings Court, Both Service Rds from Guelph Line to Walkers Line, Burlington Mall, Cumberland Ave, Cumberland Ave to Walkers Line between New St and Rexway, Guelph Line to Walkers Line between Woodward Ave and Lakeshore Rd, New St from Rossmore Boulevard to Pine Cove Rd	2244	1
2022-12-19	12:16	2022-12-19	19:25	Lockout	ACCIDENTAL CONTACT (NON-BHI)	Billings Court, Both Service Rds from Guelph Line to Walkers Line, Burlington Mall, Cumberland Ave, Cumberland Ave to Walkers Line between New St and Rexway, Guelph Line to Walkers Line between Woodward Ave and Lakeshore Rd, New St from Rossmore Boulevard to Pine Cove Rd	2244	1
2022-02-09	11:00	2022-02-09	14:30	Lockout	DEFECTIVE TERMINATION	Billings Court, Both Service Rds from Guelph Line to Walkers Line, Burlington Mall, Cumberland Ave, Cumberland Ave to Walkers Line between New St and Rexway, Guelph Line to Walkers Line between Woodward Ave and Lakeshore Rd, New St from Rossmore Boulevard to Pine Cove Rd	2280	1
2022-02-09	10:54	2022-02-09	10:54	AUTO-RECLOSURE	UNKNOWN		1436	1

APPENDIX **B2**

Feeder Outage Report 13.8 kV Feeders

Feeder Outage Report Interchange F1

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-03-15	16:41	2022-03-15	16:41	AUTO-RECLOSURE	BLOWN ARRESTER		402	1
2022-03-16	16:41	2022-03-16	16:41	AUTO-RECLOSURE	BLOWN ARRESTER	1153-8 PIONEER RD. CUSTMRE REPORTS PARTIAL POWER. TREE AUTO ON INTERCHANGE F1 (1641 2250 2310). ONE #22 JD REPLACED ARRESTER. POWER RESTORED.	402	1
2022-03-16	22:50	2022-03-16	22:50	AUTO-RECLOSURE	BLOWN ARRESTER		402	1
2022-03-17	07:19	2022-03-17	07:19	AUTO-RECLOSURE	BLOWN ARRESTER	1153-8 PIONEER RD. CUSTMRE REPORTS PARTIAL POWER. TREE AUTO ON INTERCHANGE F1 (1641 2250 2310). ONE #22 JD REPLACED ARRESTER. POWER RESTORED.	402	1
2022-02-15	11:59	2022-02-15	12:39	LOCK-OUT	DEFECTIVE INSULATOR	BROKEN INSULATOR F751 @ REAR OF 1242 CONSORT CRES	402	1
DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-03-17	08:07	2022-03-17	08:07	AUTO-RECLOSURE	BLOWN ARRESTER	1153-8 PIONEER RD. CUSTMRE REPORTS PARTIAL POWER. TREE AUTO ON INTERCHANGE F1 (1641 2250 2310). ONE #22 JD REPLACED ARRESTER. POWER RESTORED.	402	1

2022-09-26	05:43	2022-09-26	05:43	AUTO-RECLOSURE	DEFECTIVE SPLICE U/G PRIMARY		402	1
2022-06-17	10:53	2022-06-17	10:53	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY		402	1
2022-08-27	12:23	2022-08-27	12:23	AUTO-RECLOSURE	RACCOON	RACOON FOUND AT TX N274 @ 1171 PIONEER RD	402	1
2022-02-11	07:18	2022-02-11	07:18	AUTO-RECLOSURE	UNKNOWN		402	1
2022-04-03	17:28	2022-04-03	17:28	AUTO-RECLOSURE	UNKNOWN		402	1
2022-06-20	06:09	2022-06-20	06:09	AUTO-RECLOSURE	UNKNOWN		402	1
2022-07-04	06:55	2022-07-04	06:55	AUTO-RECLOSURE	UNKNOWN		402	1
2022-07-17	22:59	2022-07-17	22:59	AUTO-RECLOSURE	UNKNOWN		402	1
2022-08-13	07:10	2022-08-13	07:12	LOCK-OUT	UNKNOWN		402	1
2022-08-26	20:40	2022-08-26	20:40	AUTO-RECLOSURE	UNKNOWN		402	1
2022-09-16	20:11	2022-09-16	20:11	AUTO-RECLOSURE	UNKNOWN	TX N33 TO TX N32 CABLE FAULT	402	1

Feeder Outage Report Lowville F1

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-12-23	15:35	2022-12-23	15:35	AUTO-RECLOSURE	HIGH WINDS		200	1
2022-03-26	09:23	2022-03-26	09:23	AUTO-RECLOSURE	SQUIRREL		200	1
2022-07-18	06:40	2022-07-18	06:40	AUTO-RECLOSURE	TREE/LIMB	4490 WALKERS LINE. JENN BAKER AT 905-510-6750 AT 4490 WALKERS LINE HAS NO POWER. TREE BRANCH INTO BRANCH REMOVED, F1371 REFUSED AT 80K, CLOSED AND HOLDING, BLOWN FUSE WAS ALSO AT	200	1
2022-05-21	12:41	2022-05-21	12:41	AUTO-RECLOSURE	T-STORM		200	1
2022-05-14	19:52	2022-05-14	19:52	AUTO-RECLOSURE	UNKNOWN		200	1
2022-06-05	20:38	2022-06-05	20:38	AUTO-RECLOSURE	UNKNOWN	TX Y13 AT 3420 1 SIDERD FOUND BLOWN. CAUSE UNKNOWN. REFUSED CLOSED AND HOLDING	200	1
2022-08-13	08:17	2022-08-13	08:17	AUTO-RECLOSURE	UNKNOWN		200	1

Feeder Outage Report Lowville F3

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-03-31	10:51	2022-03-31	10:55	Lockout	UNKNOWN		328	1
2022-08-22	17:19	2022-08-22	19:38	Lockout	T-STORM		1	1
2022-11-05	15:14	2022-11-05	17:04	Lockout	HIGH WINDS/TREE		219	1

Feeder Outage Report Palmer F1

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-06-09	20:27	2022-06-09	20:27	AUTO-RECLOSURE	UNKNOWN		220	1
2022-06-19	16:41	2022-06-19	16:41	AUTO-RECLOSURE	UNKNOWN		220	1
2022-07-03	08:00	2022-07-03	08:00	AUTO-RECLOSURE	UNKNOWN		220	1
2022-07-09	06:42	2022-07-09	06:42	AUTO-RECLOSURE	UNKNOWN		220	1
2022-07-13	06:22	2022-07-13	06:22	AUTO-RECLOSURE	UNKNOWN		220	1
2022-07-14	16:05	2022-07-14	16:05	AUTO-RECLOSURE	UNKNOWN		220	1
2022-11-30	14:29	2022-11-30	14:31	LOCK-OUT	UNKNOWN	WINDY WEATHER	220	1

Feeder Outage Report Palmer F3

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-02-23	19:45	2022-02-23	19:45	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	RED PH FAULT ON DONALD DR BET TX U288 AND U289	2053	1
2022-06-05	06:40	2022-06-05	06:40	AUTO-RECLOSURE	UNKNOWN		2053	1
2022-07-01	07:24	2022-07-01	07:24	AUTO-RECLOSURE	UNKNOWN		2053	1
2022-07-02	06:03	2022-07-02	06:03	AUTO-RECLOSURE	UNKNOWN		2053	1
2022-09-06	19:17	2022-09-06	19:17	AUTO-RECLOSURE	UNKNOWN		2053	1
2022-09-07	21:17	2022-09-07	21:17	AUTO-RECLOSURE	UNKNOWN		2053	1

Feeder Outage Report Palmer F4

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-05-11	19:17	2022-05-11	19:17	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY		906	1
2022-05-11	19:21	2022-05-11	19:21	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY		906	1
2022-07-21	06:04	2022-07-21	06:04	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY		906	1
2022-05-16	06:18	2022-05-16	06:18	AUTO-RECLOSURE	UNKNOWN		906	1
2022-06-09	20:21	2022-06-09	20:21	AUTO-RECLOSURE	UNKNOWN		906	1
2022-06-19	17:50	2022-06-19	17:50	AUTO-RECLOSURE	UNKNOWN		906	1
2022-07-13	06:10	2022-07-13	06:10	AUTO-RECLOSURE	UNKNOWN		906	1
2022-07-22	23:21	2022-07-22	23:21	AUTO-RECLOSURE	UNKNOWN		906	1

Feeder Outage Report Towerline F4

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-02-11	15:41	2022-02-11	15:41	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	5300 HARVESTER RD, DANA-LONG MFG.. TOWERLINE F4 AUTO AT 1541 AND 1650. INTELLIRUPTER S4235 LOCKED OUT AT 1650. CREW PC10A E005036 IN EFFECT #21 RO REPLACED CABLE AND TERMINATIONS. WORK COMPLETED.	190	1
2022-02-11	16:50	2022-02-11	16:50	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	5300 HARVESTER RD, DANA-LONG MFG.. TOWERLINE F4 AUTO AT 1541 AND 1650. INTELLIRUPTER S4235 LOCKED OUT AT 1650. CREW PC10A E005036 IN EFFECT #21 RO REPLACED CABLE AND TERMINATIONS. WORK COMPLETED.	190	1
2022-02-11	16:52	2022-02-11	16:52	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY		190	1
2022-09-28	09:30	2022-09-28	09:30	AUTO-RECLOSURE	SQUIRREL	930 SHELDON CRT. CUSTOMER REPORTING NO POWER. FUSE FG546 FOUND BLOWN AND SQUIRRLE ON GROUND. REFUSED WITH A 20. CLOSED AND HOLDING	190	1

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-01-01	08:24	2022-01-01	08:24	AUTO-RECLOSURE	UNKNOWN		190	1
2022-06-30	07:43	2022-06-30	07:43	AUTO-RECLOSURE	UNKNOWN		190	1
2022-07-10	07:19	2022-07-10	07:19	AUTO-RECLOSURE	UNKNOWN		190	1
2022-07-19	18:57	2022-07-19	18:57	AUTO-RECLOSURE	UNKNOWN		190	1
2022-07-24	22:41	2022-07-24	22:41	AUTO-RECLOSURE	UNKNOWN		190	1
2022-10-02	16:52	2022-10-02	16:52	AUTO-RECLOSURE	UNKNOWN		190	1
2022-10-05	10:54	2022-10-05	10:54	AUTO-RECLOSURE	UNKNOWN		190	1
2022-10-07	21:15	2022-10-07	21:15	AUTO-RECLOSURE	UNKNOWN		190	1

Feeder Outage Report Tyandaga F3

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-05-11	17:05	2022-05-11	17:05	AUTO-RECLOSURE	DEFECTIVE TRANSFORMER	TX N343 DEFECTIVE AT REAR OF 1333 MAJESTIC	669	1
2022-03-31	15:09	2022-03-31	15:09	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	FAULT ON ALDRIDGEBET TX N15 AND TX N14	669	1
2022-08-17	17:58	2022-08-17	17:58	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY		669	1
2022-12-23	10:38	2022-12-23	10:38	AUTO-RECLOSURE	HIGH WINDS		669	1
2022-04-24	08:50	2022-04-24	08:50	AUTO-RECLOSURE	SQUIRREL		669	1
2022-08-25	14:14	2022-08-25	14:14	AUTO-RECLOSURE	SQUIRREL	SQUIRREL CONTACT AT NORTHVIEW CRES FUSE F1602.	669	1
2022-01-27	09:43	2022-01-27	09:43	AUTO-RECLOSURE	UNKNOWN		669	1
2022-05-11	15:09	2022-05-11	15:09	AUTO-RECLOSURE	UNKNOWN		669	1
2022-12-24	09:40	2022-12-24	09:40	AUTO-RECLOSURE	UNKNOWN		669	1

APPENDIX B3

Feeder Outage Report 4.16 kV Feeders

Feeder Outage Report EasterBrook F3

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-06-02	17:16	2022-06-02	17:16	AUTO-RECLOSURE	UNKNOWN		286	1
2022-06-05	20:10	2022-06-05	20:10	AUTO-RECLOSURE	UNKNOWN		286	1
2022-10-31	01:59	2022-10-31	01:59	AUTO-RECLOSURE	UNKNOWN		286	1
2022-11-01	05:24	2022-11-01	05:24	AUTO-RECLOSURE	UNKNOWN		286	1
2022-11-06	08:23	2022-11-06	08:23	AUTO-RECLOSURE	UNKNOWN		286	1
2022-11-30	14:18	2022-11-30	14:18	AUTO-RECLOSURE	UNKNOWN		286	1
2022-12-23	10:25	2022-12-23	10:25	AUTO-RECLOSURE	HIGH WINDS		286	1
2022-12-23	10:25	2022-12-23	10:25	AUTO-RECLOSURE	HIGH WINDS		286	1

Feeder Outage Report Fairwood F4

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-04-19	02:53	2022-04-19	02:53	AUTO-RECLOSURE	UNKNOWN		402	1
2022-04-19	08:43	2022-04-19	08:43	AUTO-RECLOSURE	UNKNOWN		402	1
2022-04-25	16:58	2022-04-25	16:58	AUTO-RECLOSURE	UNKNOWN		402	1
2022-05-01	17:45	2022-05-01	17:45	AUTO-RECLOSURE	UNKNOWN		402	1
2022-05-30	13:55	2022-05-30	13:55	AUTO-RECLOSURE	SQUIRREL		402	1
2022-08-29	14:26	2022-08-29	14:26	AUTO-RECLOSURE	UNKNOWN		402	1

Feeder Outage Report Maple F5

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-05-31	22:00	2022-05-31	22:00	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY		434	1
2022-05-31	22:03	2022-05-31	22:03	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY		434	1
2022-05-31	22:04	2022-05-31	22:04	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY		434	1
2022-05-31	22:18	2022-05-31	22:18	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY		434	1
2022-05-31	22:22	2022-05-31	22:22	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY		434	1
2022-06-01	02:50	2022-06-01	02:50	AUTO-RECLOSURE	UNKNOWN		434	1

Feeder Outage Report Mt Forest F2

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-03-07	03:12	2022-03-07	03:12	AUTO-RECLOSURE	UNKNOWN		390	1
2022-03-07	09:11	2022-03-07	09:11	AUTO-RECLOSURE	DEFECTIVE CUSTOMER EQUIPMENT	2054 MOUNTAINSIDE DR DEFECTIVE SECONDARY	390	1
2022-03-07	09:13	2022-03-07	09:13	AUTO-RECLOSURE	DEFECTIVE CUSTOMER EQUIPMENT	2054 MOUNTAINSIDE DR DEFECTIVE SECONDARY	390	1
2022-05-21	12:39	2022-05-21	12:39	AUTO-RECLOSURE	T-STORM		390	1
2022-05-21	12:39	2022-05-21	12:39	AUTO-RECLOSURE	T-STORM		390	1

Feeder Outage Report Harvester F1

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-02-19	05:33	2022-02-19	05:34	LOCK-OUT	DEFECTIVE INSULATOR	BROKEN INSULATOR AT GLENWOOD SCHOOL DR	481	1
2022-05-21	12:39	2022-05-21	12:39	AUTO-RECLOSURE	T-STORM		481	1
2022-09-28	14:25	2022-09-28	14:25	AUTO-RECLOSURE	DIG-IN		481	1
2022-10-13	01:55	2022-10-13	03:06	LOCK-OUT	TREE/LIMB	2357 GLENWOOD SCHOOL DRIVE BRANCH ON LINE	481	1

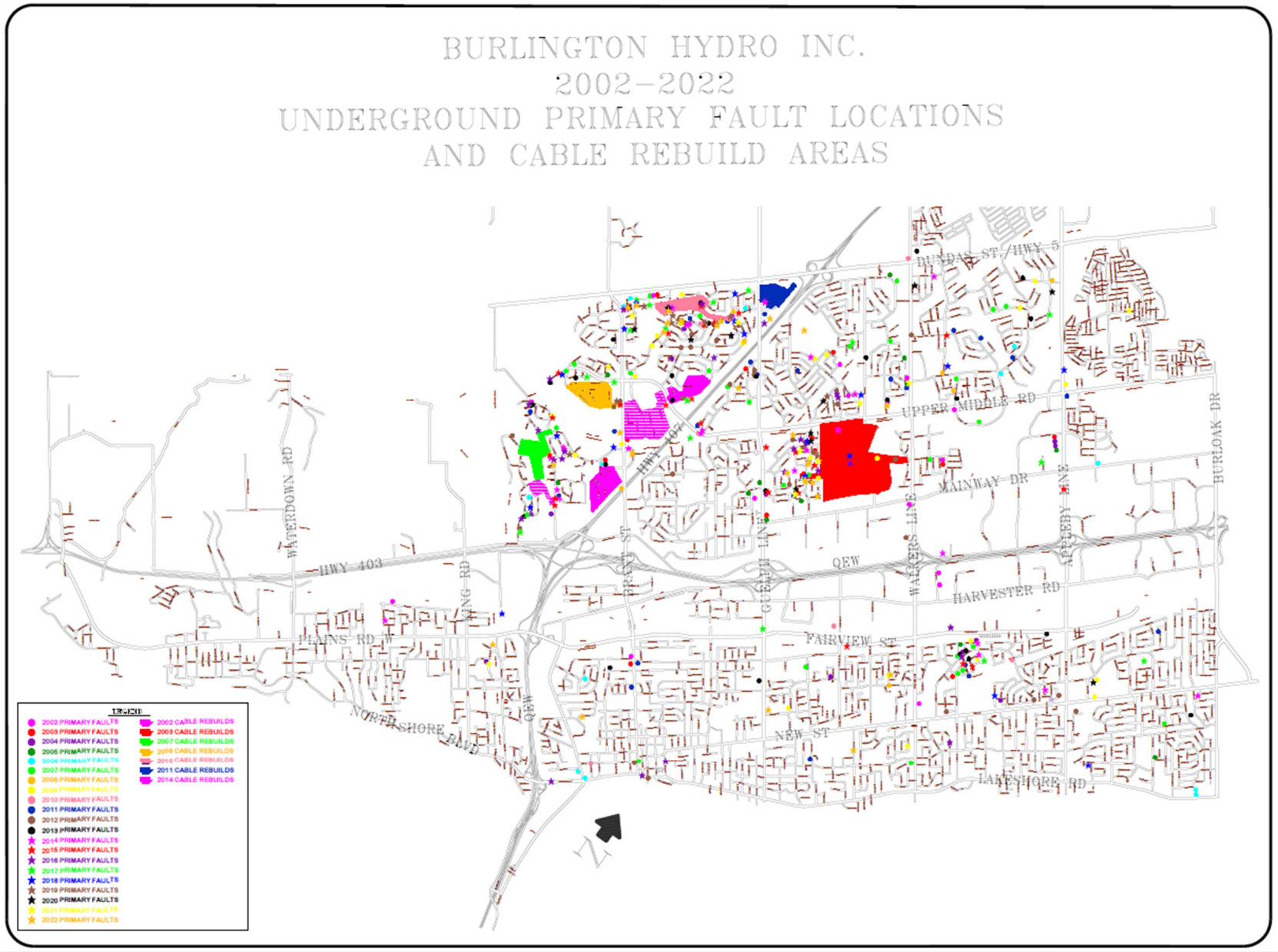
Feeder Outage Report Spruce F2

Dates: January 01, 2022 through December 31, 2022

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
2022-10-13	4:52	2022-10-13	4:55	Lockout	HIGH WINDS	SUSPECT F4409 AT SPRUCE AND BELVENIA RD BLOWN.	405	1
2022-10-13	16:02	2022-10-13	17:45	Lockout	TREE/LIMB		405	1
2022-05-22	11:39	2022-05-22	11:39	AUTO-RECLOSURE	T-STORM		403	1
2022-05-22	11:39	2022-05-22	11:39	AUTO-RECLOSURE	UNKNOWN		403	1

APPENDIX C

Underground Primary Fault Location and Cable Rebuild Area


BURLINGTON HYDRO INC.
2002–2022
UNDERGROUND PRIMARY FAULT LOCATIONS
AND CABLE REBUILD AREAS
DUNDAS ST / HWY 5
UPPER MIDDLE RD
MAINWAY DR
HARVESTER RD
FAIRVIEW ST
NEW ST
LAKESHORE RD
HWY 403
QEW
HWY 407
WATERDOWN RD
BRANT ST
GUELPH LINE
WALKERS LINE
APPLEBY LINE
BURLOAK DR
PLAINS RD W
NORTH SHORE BLVD
TRENCH
2002 PRIMARY FAULTS
2003 PRIMARY FAULTS
2004 PRIMARY FAULTS
2005 PRIMARY FAULTS
2006 PRIMARY FAULTS
2007 PRIMARY FAULTS
2008 PRIMARY FAULTS
2009 PRIMARY FAULTS
2010 PRIMARY FAULTS
2011 PRIMARY FAULTS
2012 PRIMARY FAULTS
2013 PRIMARY FAULTS
2014 PRIMARY FAULTS
2015 PRIMARY FAULTS
2016 PRIMARY FAULTS
2017 PRIMARY FAULTS
2018 PRIMARY FAULTS
2019 PRIMARY FAULTS
2020 PRIMARY FAULTS
2021 PRIMARY FAULTS
2022 PRIMARY FAULTS
2002 CABLE REBUILDS
2003 CABLE REBUILDS
2007 CABLE REBUILDS
2008 CABLE REBUILDS
2010 CABLE REBUILDS
2011 CABLE REBUILDS
2014 CABLE REBUILDS

APPENDIX D

System Maintenance Activities & Priorities

4.0 - SYSTEM MAINTENANCE ACTIVITIES & PRIORITIES

Asset Management

ABSTRACT

BHI aims to meet or exceed the system maintenance and inspection requirements of Section 4.4 and Appendix C of the Ontario Energy Board Distribution System Code (DSC) – latest revision. The following routine maintenance programs are consistent with good utility practices and are applied annually over a 3-year patrolled inspection period within the BHI distribution system territory.

Marko Bursac, P. Eng.

Manager, Asset Management

June 21, 2023

TABLE OF CONTENTS

4.1.0 System Maintenance Activities – Overhead System 1

4.1.1 Wood Pole Inspection and Replacement 1

4.1.2 Concrete Pole Inspection & Replacement 4

4.1.3 Insulator Washing – Porcelain Insulators 5

4.1.4 Tree Trimming & Vegetation Control 6

4.1.5 Infrared Thermography – Overhead System & Stations 7

4.1.6 Air Break Switch Maintenance 8

4.1.7 Pole Mounted Transformers 9

4.2.0 System Maintenance Activities – Underground System 11

4.2.1 Pad-Mounted Transformers 11

4.2.2 Submersible Transformers 13

4.2.3 Cleaning of Switching Cubicles 13

4.2.4 Substation Inspection and Preventive Maintenance 13

4.2.5 Cable Faults 14

4.2.6 Cable Testing – Brant Hills Subdivision 15

4.3.0 Future Maintenance & Operation Recommendations 17

4.3.1 Wood Pole Replacements 17

4.3.2 Vault Cleaning/Washing 17

4.3.3 Leaking Transformer Replacements 17

4.3.4 Transformer Load Utilization Replacements 18

4.3.5 Submersible to Pad-Mounted Transformer Conversion 19

4.3.6 Cable Testing – Palmer Subdivision 19

4.3.7 Cable Rejuvenation Program 20

Appendix i

Appendix A – Inspection Cycle 2020-2022 i

Appendix B – Insulator Washing Cycle 2022 ii

Appendix C – Tree Trimming Zones 2020-2022 iii

Appendix D – Infrared Thermography Maps – 27.6kV Map And 13.8kV & 4.16kV Map iv

Appendix E – Switching Cubicle Inspection Locations vi

Appendix F – Brant Hills Cable Testing Results vii

TABLE OF FIGURES

Figure 1: Table 1 – Wood Pole Testing & Replacement 2

Figure 2: Chart 1 – Wood Pole Testing & Replacement 2021 vs 2022 2

Figure 3: Table 2 - Overhead System Inspections – Hydro Poles 2022 3

Figure 4: BHI Concrete Pole with s Minor Reported Cracking Issue 4

Figure 5: Burlington Hydro's Contractor Performing Insulator Washing 5

Figure 6: Example of Tree Trimming Performed by Burlington Hydro's Contractor 6

Figure 7: Reported Overgrown Vegetation on a Burlington Hydro Wooded Hydro Pole 6

Figure 8: Infrared Photos Provided by Burlington Hydro's Contractor's Report 7

Figure 9: Table 3 – IR Measurements & Severity Rating 7

Figure 10: Stolen Grounding from a Burlington Hydro Air Break Switch Location 8

Figure 11: Table 4 – Pole Mounted Transformers 10

Figure 12: Chart 2 – Pole Mounted Transformers 2021 vs 2022 10

Figure 13: Table 5 – Pad-Mounted Transformers 12

Figure 14: Chart 3 – Pad-Mounted Transformers 2021 vs 2022 12

Figure 15: Table 6 – Underground System Inspections 2022 12

Figure 16: Chart 4 – Reliability Statistics for Yearly SAIDI & SAIFI Metrics 14

Figure 17: Table 7 - Reliability Statistics for SAIDI & SAIFI Metrics (Excluding Loss of Supply & Major Events) 14

Figure 18: Table 8 – Underground Primary Cable SAIDI & SAIFI Metrics for 2021 vs 2022 14

Figure 19: Chart 5 - Brant Hills Intervention Recommendation Summary 15

Figure 20: IR Photo from Brant Hills Elbow Hot Spot 16

Figure 21: Primary Cable Junction Collapse Due to Thermal Issues Brant Hills 16

Figure 22: Chart 6 – Annual Transformer Utilization by Transformer Type – 2022 18

Figure 23: Burlington Hydro's Contractor Performing Cable Testing at a Submersible Transformer 19

4.1.0 SYSTEM MAINTENANCE ACTIVITIES – OVERHEAD SYSTEM

4.1.1 WOOD POLE INSPECTION AND REPLACEMENT

The OEB – Distribution System Code requires BHI inspect each asset within a 3-year cycle. BHI has gone above and beyond that requirement by taking a proactive approach to the annual inspection, testing, and replacement of hydro poles.

The inspection and tests are performed by a contracted pole testing company (Under Pressure Inc.) using a few outlined methods and considerations:

- **Asset Age**
    - Assets within the BHI system have a typical useful life; based on the 'Asset Depreciation Study for the OEB', wood poles have a TUL of 45 years with a maximum of 75. Wood poles determined to be installed within 20-years are typically in good condition, poles >21-years to end-of-life are predominantly of focus and flagged for testing beyond visual inspection and hammer testing.
- **Visual Inspection**
    - The visual inspection asses the condition of the pole; if there are defects found such as integrity issues (woodpecker holes, pest infestation, cracks, leaning etc.), rotten pole tops, loose hardware/attachments, rotten crossarms, porcelain insulators, and attached equipment issues.
- **Hammer Test**
    - Pole integrity is verified by sound when the pole is tapped by a hammer or mallet in various locations starting from the base of the pole to determine if the pole is producing a clear and sharp rebound when struck.
- **Resistograph Test Drill – Wood Poles**
    - Predominant on poles >21-years of installation, a measurement is taken using a thin precisely calibrated drill for remaining pole base strength. The drill measures pole rot and decay at the base to a remaining strength level of which >70% is a pass, and <70% but >60% is a marginal pass; anything less is considered a failure, consistent with clause 8.3.1.3 of CSA 22.3 No-1.

Poles are categorized for remediation dependent on inspection results. Areas of focus are then grouped in clusters of the worst degradation criteria poles for potential capital rebuild. A high priority is placed on 3-phase poles with primary feeder circuits, equipment such as transformers, switching devices, underground dips, and line dead-end or major line angles over 15° which pose a higher risk due to the impact of failure. The following is a summary comparison of the pole testing and replacement program from 2021 to 2022:

Maintenance Activities: Wood Hydro Poles	2021	2022	Trend
Total Number of Poles in The System (Excluding Bell Pole Ownership)	15340	15362	
Number Inspected	7321	7127	
Number Installed	81	87	
Number Treated to Extend Life	0	0	
Number of Poles With Reported Issues	221	776	
Number of Rotten Poles Remaining in The System	630	994	

Figure 1: Table 1 – Wood Pole Testing & Replacement

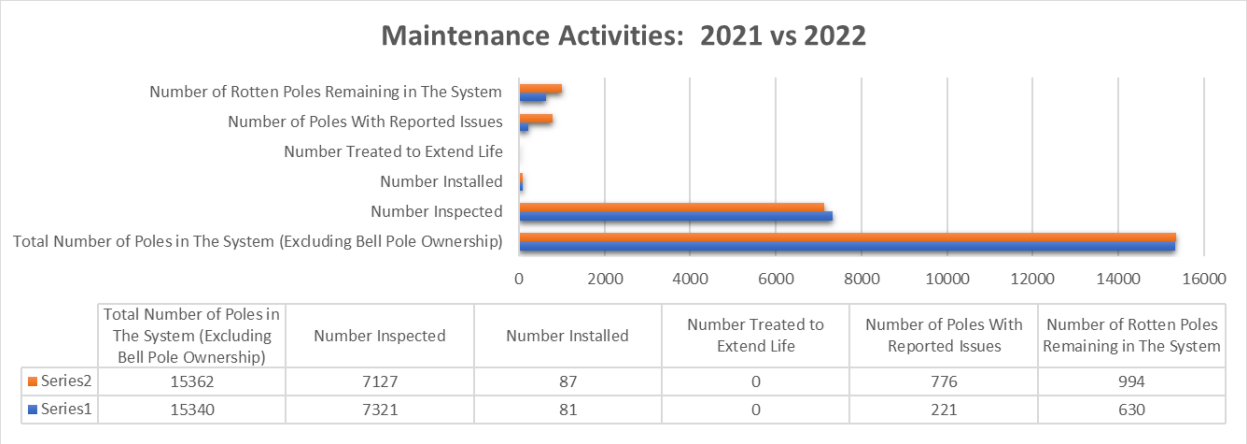


Figure 2: Chart 1 – Wood Pole Testing & Replacement 2021 vs 2022

The figures above indicate that BHI is maintaining its commitment to improving its 'System Renewal' program through the inspection cycle periods, maintenance, and remediation replacements. The pole installations for 2022 include replacements due to end-of-life conditions, vehicle accidents, and storm damage.

Throughout the fiscal year, 7127 poles were inspected, completing the 3-year overhead inspectional cycle for BHI from 2020 to 2021. Comparing 2022 to 2021, 364 additional poles were identified as rotten, again no poles were treated, and 87 poles were replaced with an additional 6 replacements comparative to year-over-year. Additionally, 555 poles were reported to have some issue compared to the year before stemming from the visual inspection criteria mentioned previously. The increase in rotten poles is attributable to the changes in pole inspector and inspection process, resulting in a higher number of failed poles during this initial cycle under the new regime. However, it is not expected that rotten pole count will continue to increase at this pace in the second cycle.

Overhead Inspections	
Pole Issue Type	# of Issues
Rotten Pole	994
Loose Hardware	111
Vegetation	85
Anchor issue	80
Riser issue	17
Leaking Transformers	82
R/crossarm	51
R/pole top	44
Sweating	264
Infrared	41
Total	1770

Figure 3: Table 2 - Overhead System Inspections – Hydro Poles 2022

Part of ongoing process review and improvements, review of data gaps have been added to the inspection requirements. Pole leaning severity, lightning arrester connection verification, and porcelain insulator identification have been added with ongoing efforts for pole remaining strength percent to be an ease of access for BHI personnel. Pole issues are remediated throughout the year as needed dependent on priority and condition category. With the 2022 fiscal year end, the BHI 3-year inspection cycle has ended and 2023 will begin a new cycle; see 'Appendix A' for the inspection cycle map.

4.1.2 CONCRETE POLE INSPECTION & REPLACEMENT

Figure 4: BHI Concrete Pole with s Minor Reported Cracking Issue

Concrete poles undergo a visual inspection, completed by the same contractor as wood poles. Based on the same OEB study, concrete poles have a typical useful life of 60 years with a maximum of 80. In 2022, 57 concrete poles were visually inspected for any mechanical defects and/or leaning issues. Throughout the cycle year, 4 poles were identified with minor issues of rebar exposure/concrete cracks. BHI continues to monitor these assets through inspections to ensure current issues are not expanding and creating integral strength issues. Through these continued efforts, process reviews with our inspection contractor, Under Pressure, are essential in ensuring all required data is collected. Lightning arrester connections, pole rust/corrosion conditions, visual leaning concerns, and porcelain insulator identification were all added to the patrolled inspection data collection. See 'Appendix A' for the inspection cycle map.

4.1.3 INSULATOR WASHING – PORCELAIN INSULATORS

Insulator washing is an important preventative measure to minimize flashovers and pole fires. The insulator washing program is primarily carried out after the Winter months to ensure all salt exposure is removed from the insulators by a certified dedicated crew (K-Line), contracted by BHI. Frequency of the washing is dependent on the amount of de-icing salt mixture used throughout that year. BHI's focus is main arterial roads and high traffic areas throughout the service area. Particular attention is given to the 27.6kV system including any areas where there are underbuilt circuits and areas with potential for high salt contamination such as areas adjacent to highways. In the course of this work in 2022, one 3-phase in-line switch was identified for replacement and remediated. Additionally, primary feeder lines from Tremaine T.S. and the single-phase primary line near the rail crossing North of Canada Brick should be patrolled for evidence of contamination and evaluated for washing needs as necessary. Note, polymer insulators are not washed as the skirt surface area is not of a concern for flashover, for this reason, only porcelain insulators are targeted. See 'Appendix B' for the completed insulator washing map, 2022.

Figure 5: Burlington Hydro's Contractor Performing Insulator Washing

4.1.4 TREE TRIMMING & VEGETATION CONTROL

Tree trimming tackles a few safety and reliability aspects by mitigating safety issues, asset damage, maintenance, and service interruption (minimizing BHI's SAIDI, SAIFI scores). During storms, fallen branches and limbs can cause downed power lines, damaging equipment such as switches & transformers and potential pole fires that are an endangerment to the public. Additionally, as the tree branches and limbs grow throughout the year, with wind as a factor, the continuous rubbing can damage power line conductors causing other safety and reliability concerns. Tree trimming was successfully carried out in 2022, by 2 certified contractors (Davey Tree and Kodiak Tree Services – formerly by OLC) throughout the 'Tree Trimming Zones' identified for the year. In accordance with BHI's established 3-year inspection cycle; this is a normal utility practice. 'Tree Trimming Zones' 1, 5, 7, 15, 10, 11 & 17 were fully completed. In August, a significant amount of time was required to complete the R.O.W. trimming from Seneca Ave to Guelph Line within zone 7. Zones 2, 6, & 9 were partially completed which will leave zones 2, 3, 6, 8, 9, & 12 for completion in 2023. The Waterfront Trail running from Martha M.S. to Port Nelson M.S. on New St. should be patrolled and trimmed due to lockouts caused by fallings limbs and trees impacting the downtown core. See 'Appendix C' for tree trimming zone maps.

Figure 6: Example of Tree Trimming Performed by Burlington Hydro's Contractor

Vegetation surrounding BHI assets are of concern primarily due to emergency access that can create delays in emergency repairs and replacements. These vegetation related issues are remediated throughout the year, see 'Appendix A' for inspection zones through the patrolled 3-year inspection cycle.

Figure 7: Reported Overgrown Vegetation on a Burlington Hydro Wooded Hydro Pole

4.1.5 INFRARED THERMOGRAPHY – OVERHEAD SYSTEM & STATIONS

Annual inspection and scanning of the overhead system and municipal stations are an important and worthwhile part of a good preventative maintenance program. This approach ensures areas with high risk for failure do not result in safety concerns for the public and interruption losses for BHI customers. The infrared inspections were completed in 2022 by an engineering contractor (DDP). A total of 14 hot spots were identified in 2022 resulting in only 2 receiving a rating of serious and both were remediated. Due to an increasing number of SCADAmate switch failures, BHI has scanned three of the oldest units which had shown all three units demonstrated hot spots. A system wide scan is recommended and discussions with S&C, the manufacturer, are ongoing to determine the root cause of these failures. BHI began a maintenance program for SCADAmate switches in 2023. See 'Appendix D' for the infrared main circuit maps, 27.6kV, and 13.8kV & 4.16kV.

Figure 8: Infrared Photos Provided by Burlington Hydro's Contractor's Report

Measurements	°C
Spot 1	54.8
Spot 2	27.5
Spot 3	62.3
Spot 4	28.7
Spot 5	47.4
Spot 6	27.6
Spot 3-Spot 4	33.6
Spot 5-Spot 6	19.8
Spot 1-Spot 6	27.3
Rating	Intermediate

Figure 9: Table 3 – IR Measurements & Severity Rating

4.1.6 AIR BREAK SWITCH MAINTENANCE

Maintenance programs are crucial during yearly inspection cycles in ensuring the overhead system safety and reliability is maintained to the highest degree. Air break switches (ABS) are an essential part of the overhead system as they provide a live operating break on the circuit for safe work practices while BHI crews perform switching and isolating operations. The ABS is typically a manually operated switch by a mechanical open, operated by a handle secured to the hydro pole close to ground level. Crews are required to be electrically bonded by being elevated on a grounding mat as to ensure an equipotential work zone for the operator. Through the maintenance program, BHI crews inspect correct operation of equipment, ensuring the mechanical handle is operating as intended without defect, the switches open as intended, grounding connections are correctly connected, no arc flash burns are present, as well as ensuring contacts are cleaned and lubricated. Through the patrolled inspections, the 2022 inspection area had 10 ABS inspected. Out of all inspected and serviced ABS, only 1 defect was found with a stolen down ground wire and grounding cable to the operating handle at the pole location; remediation was completed along routine maintenance and lubrication on all ABS. No additional maintenance program recommendations required at this time. See 'Appendix A' inspection cycle map for areas of focus for each year.

Figure 10: Stolen Grounding from a Burlington Hydro Air Break Switch Location

4.1.7 POLE MOUNTED TRANSFORMERS

Along with the hydro pole inspection, attached equipment throughout the patrolled inspection cycle year is inspected as well at the same time. Inspection criteria is verified to ensure that there are no minor or catastrophic failures resulting in service interruptions to customers in the future.

The following are criteria typically reviewed for pole mounted transformers:

- **Asset Age**
    - BHI assets have a general useful as well as a financial book value. The 'Asset Depreciation Study for the Ontario Energy Board' lists overhead transformers as having a typical useful life of 40 years with a maximum of 60 years. Book value is based over 40 years before the asset is considered a fully depreciated asset.
- **Visual Damage**
    - Any visual defects that can be seen are noted dependent on the determined severity of damage, determines repair or replacement recommendations.
- **Oil Leakage**
    - Due to insufficient seals, metallic rust, and/or overheating, an overhead pole mounted transformer can experience oil leaking. This can typically be noticed by visual inspection of oil leaking on the outside of the transformer and/or ground contamination. Soil clean-up and restoration is completed as needed. Oil PCBs were remediated to below 50ppm since 2011 throughout BHI's service territory.
- **Animal Nesting**
    - Small animals are known to create nests on overhead assets. This can result in temporary faults causing service interruptions and impact BHI SAIDI & SAIFI scores. These issues are remediated as necessary.
- **Load Reporting**
    - A useful tool used in transformer replacement metrics is load reporting recently introduced in 2022 through our GIS. BHI can determine if the transformer is under or overutilized based on coincidental and non-coincidental peak loads.

Pole mounted transformers are remediated as required. Current economic situations have resulted in greater than normal logistical delays for manufacturers as well as a combined labour shortage. This has resulted in replacement inventory delays and in-depth review of asset conditions and replacement criteria.

Maintenance Activities: Pole Mounted Transformers	2021	2022	Trend
Total Number of Overhead Transformer in The System	3185	3176	
Number of Single Phase Installations	38	30	
Number of Three Phase Bank Installations	5	3	

Figure 11: Table 4 – Pole Mounted Transformers

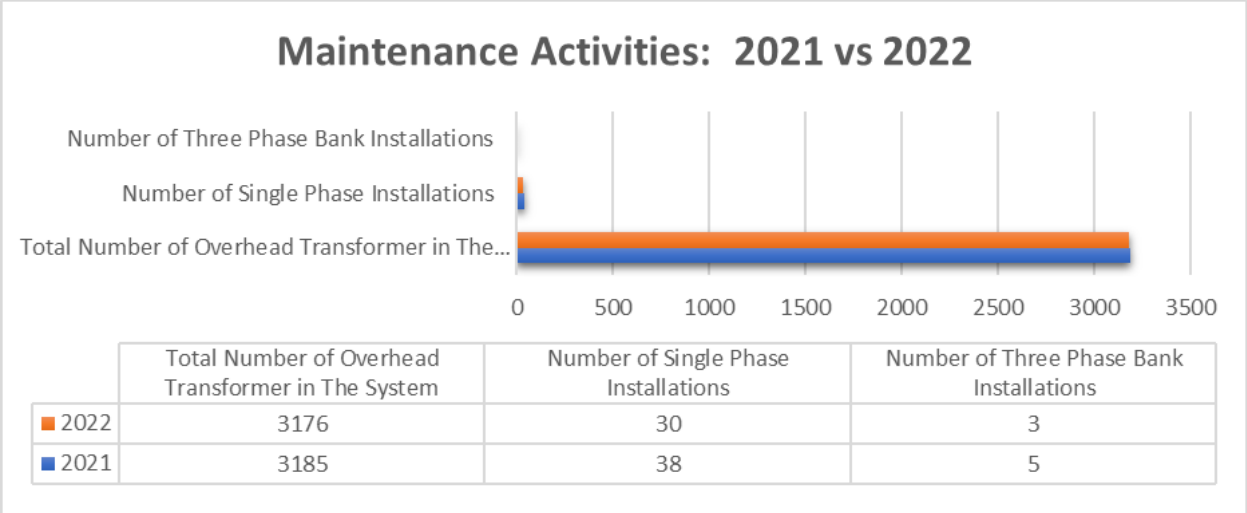


Figure 12: Chart 2 – Pole Mounted Transformers 2021 vs 2022

As the trend lines show, there was a decrease in overhead transformer activity from 2021 to 2022. As mentioned, this can be related to current economic situations and inventory delays as well as attributed activity to system efficiency efforts such as ensuring optimized loading on available transformers to minimize system losses as well as BHI underground system expansions. See 'Appendix A' for inspection cycle year area.

4.2.0 SYSTEM MAINTENANCE ACTIVITIES – UNDERGROUND SYSTEM

4.2.1 PAD-MOUNTED TRANSFORMERS

Through the BHI 3-year inspection cycle, the same areas are targeted for pad-mounted transformers in accordance with the minimum inspection requirements of the Distribution System Code. The following are typical criteria of inspection patrols:

- **Asset Age**
    - BHI assets have a general useful as well as a financial book value. The 'Asset Depreciation Study for the Ontario Energy Board' lists underground pad-mounted transformers as having a typical useful life of 40 years with a maximum of 45 years. Book value is based over 40 years before the asset is considered a fully depreciated asset.
- **Visual Defects – Damage, Rust, Graffiti, & Discolouration**
    - Any visual defects that can be seen are noted dependent on the determined severity of damage such as internal equipment, external rust, snowplows, pedestrians, and vehicle accidents, determines the replacement or repair recommendation. As per city by-law 49-2022 – Section 6.12 graffiti is remediated as reported including discolouration from UV and environmental exposure such as street de-icing.
- **Oil Leakage**
    - Due to insufficient seals, metallic rust, and/or overheating, an underground pad-mounted transformer can experience oil leakage. This can typically be noticed by visual inspection of oil leaking on the outside of the transformer, dark discolouration saturation on the concrete pad, and/or ground contamination. Soil clean-up and restoration is completed as needed.
- **Load Reporting**
    - A useful tool used in transformer replacement metrics is load reporting recently introduced in 2022 through our GIS. BHI can determine if the transformer is under or overutilized based on coincidental and non-coincidental peak loads.

Maintenance Activities: Pad-Mounted Transformers	2021	2022	Trend
Total Number of Three Phase Pad Mounted Transformers	972	974	
Total Number of Single Phase Pad Mounted Transformers	3140	3146	
Number of Three Phase Installations	11	12	
Number of Single Phase Installations	13	15	

Figure 13: Table 5 – Pad-Mounted Transformers

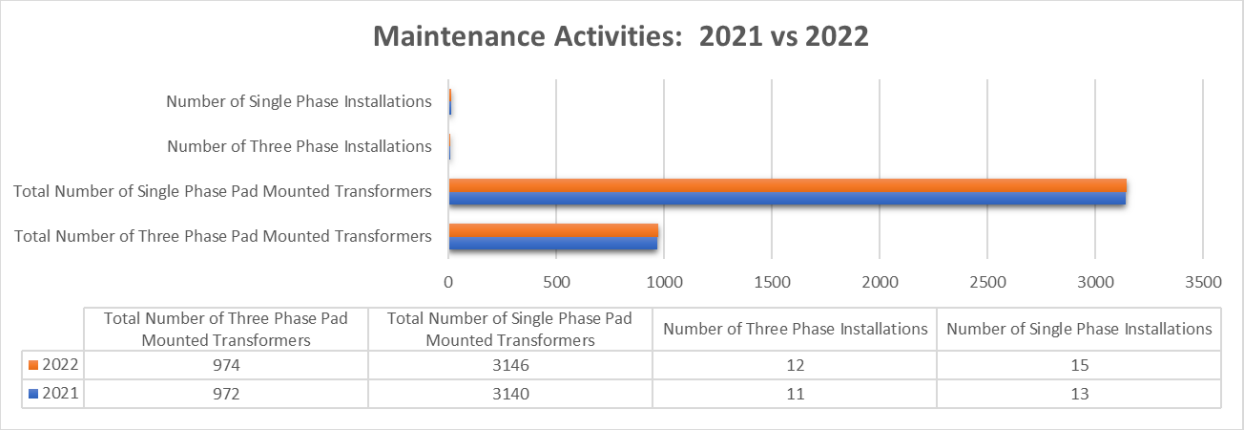


Figure 14: Chart 3 – Pad-Mounted Transformers 2021 vs 2022

Throughout the year there were 2 elbow related issues remediated, a total 26 rust reported issues for pad-mounted transformers with 1 repaired due to asset condition, 4 leaking transformers were replaced out of a list of 12 reported. An ongoing list of leaking transformers is being kept up to date and transformers are ordered and replaced as permitted by current stock levels. We have seen a positive trend in pad-mount transformer installations at 27 for the 2022 cycle year but BHI continues to mitigate procurement delays by ensuring top priority assets are replaced as required. See 'Appendix A' for inspection cycle year area.

Underground Inspections	
Issue Type	# of Issues
Damaged	3
Leaking	90
Sweating	79
Graffitti	10
Rusted	46
Grading	68
Lock	27
Paint	0
Vegetation	261
Shifted	12
Total	**1104**

Figure 15: Table 6 – Underground System Inspections 2022

4.2.2 SUBMERSIBLE TRANSFORMERS

Submersible transformers are inspected as part of the annual transformer visual inspection process by ensuring no damage is present on the outer lid with potential for a tripping hazard or worse for the public. There were 6 reactive replacements of submersible transformers in 2022. There was a previous recommendation to introduce a formal program for the washing of underground vaults; this program has not been initiated yet. See 'Appendix A' for inspection cycle year as well as 4.3.2 for future recommendations.

4.2.3 CLEANING OF SWITCHING CUBICLES

BHI has 236 pad mounted switching cubicles within its distribution system which is an increase of 3 units from the previous year: 1 PMH unit and 2 Vista units. There were 132 switching cubicles inspected through the cycle year (both by DDP for internal inspection and Under Pressure Inc for exterior inspection – this is to be combined into a single DDP inspection moving forward), 24 of these units were cleaned with 1 unit having ultrasound testing performed and remediating any signs of electrical corona. A specialized maintenance technique, using "dry ice", is employed, to clean the selected number of the switching cubicles, 24 units for 2022. This work can be safely completed with the equipment energized, therefore reducing the time and cost for switching activities. Through the cleaning cycle, 4 units had shown signs of hot spots through IR scanning as well as 2 having ultrasound detection. No remediation was completed in 2022, all required maintenance will be pushed through 2023, as required. See 'Appendix E' for inspection cycle year area.

4.2.4 SUBSTATION INSPECTION AND PREVENTIVE MAINTENANCE

Visual patrolled inspections of the stations and the equipment is performed monthly. Any issues found are reported, prioritized, and rectified as necessary. In addition to the visual inspection, preventive maintenance is performed on each station every 5 years. In 2022 the following stations were completed: Appleby, Elgin, Lowville & Marley

In 2023, the following stations are targeted for inspection and preventative maintenance: Elizabeth Gardens, Pt. Nelson, Walkers & Tyandaga

4.2.5 CABLE FAULTS

A total of 23 primary cable faults were remediated throughout the 2022 year. Primary cable faults result in significant service interruption times and require reactive emergency repairs if service cannot be restored promptly. This affects BHI SAIDI & SAIFI metrics with increases in both metrics. SAIDI had increased from 0.17 in 2021 to 0.22 in 2022 while SAIFI had increased from 0.04 in 2021 to 0.08 in 2022.

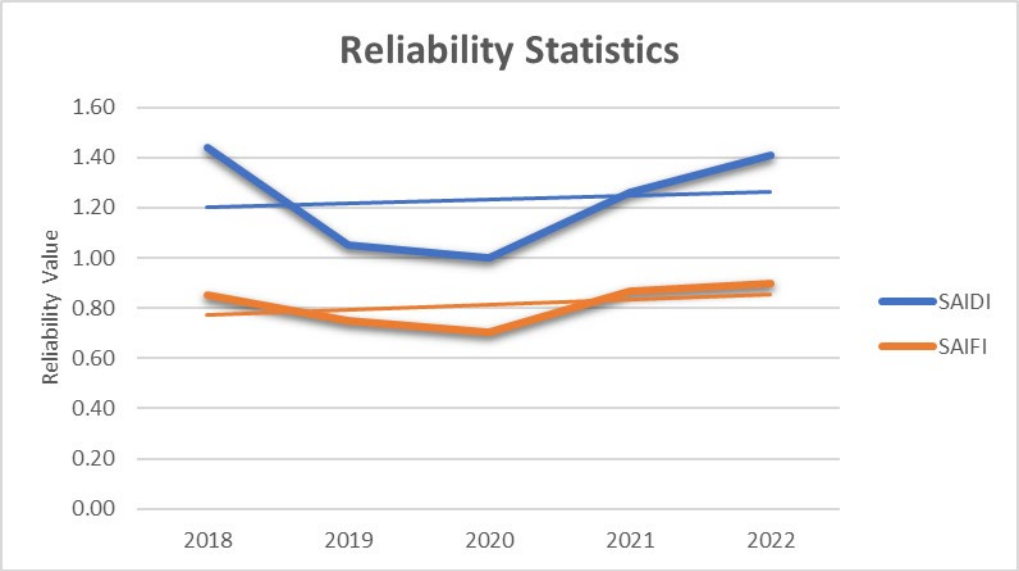


Figure 16: Chart 4 – Reliability Statistics for Yearly SAIDI & SAIFI Metrics

	2015	2016	2017	2018	2019	2020	2021	2022	Target
SAIDI	1.18	1.25	1.04	1.44	1.05	1.00	1.26	1.41	1.19
SAIFI	0.71	0.79	0.64	0.85	0.75	0.70	0.87	0.90	0.75

Figure 17: Table 7 - Reliability Statistics for SAIDI & SAIFI Metrics (Excluding Loss of Supply & Major Events)

Metrics	Year	1	2	3	4	5	6	7	8	9	10	11	12	YTD
Number of Customers	2021	68,584	68,610	68,629	68,640	68,659	68,649	68,627	68,685	68,728	68,708	68,761	68,783	68,672
	2022	68,793	68,830	68,832	68,807	68,808	68,860	68,844	68,856	68,895	68,871	68,896	68,912	68,850
Customer Hours of Interruption - U/G Primary Cable	2021	470	-	7	2,507	79	3,028	568	1,497	519	644	2,074	171	11,564
	2022	103	308	2,265	-	2,790	2,152	2,510	554	863	1,317	1,264	848	14,973
SAIDI - U/G Primary Cable	2021	0.01	-	0.00	0.04	0.00	0.04	0.01	0.02	0.01	0.01	0.03	0.00	**0.17**
	2022	0.00	0.00	0.03	-	0.04	0.03	0.04	0.01	0.01	0.02	0.02	0.01	**0.22**
Number of Customer Interruptions - U/G Primary Cable	2021	231	-	5	401	95	548	174	338	171	373	161	62	2,559
	2022	23	220	950	-	1,072	808	480	221	343	284	617	173	5,191
SAIFI - U/G Primary Cable	2021	0.00	-	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	**0.04**
	2022	0.00	0.00	0.01	-	0.02	0.01	0.01	0.00	0.00	0.00	0.01	0.00	**0.08**

Figure 18: Table 8 – Underground Primary Cable SAIDI & SAIFI Metrics for 2021 vs 2022

4.2.6 CABLE TESTING – BRANT HILLS SUBDIVISION

In 2022 cable testing was introduced to the maintenance activities due to an increase of primary faults throughout older subdivisions in Burlington Hydro's service territory. A focused approach was implemented targeting the Brant Hills subdivision as the first area for testing. After reviewing all 332 cable segments for the subdivision, 7 primary loops were chosen based on attached asset service age and area within the subdivision. A variety of primary cables were chosen to ensure no specific type of cable or generalized area was targeted for a well-rounded dataset. A total of 71 segments were tested by Metsco using the following methods:

- **Very Low Frequency Tan-Delta**
  - Used to estimate the amount of loss in a cable system based on the measurement of Tan-Delta and assessed overall aging of the cable insulation.
- **Partial Discharge**
  - Used to detect voids that may be present within the cable insulation, this test assessed the condition of the cable insulation and cable splices and terminations.
- **Time Domain Reflectometry**
  - Used to locate changes in the cable impedance due to issues such as corroded neutrals, shorts, or water ingress.
- **Infrared Thermography**
  - While completing cable testing, IR scans were conducted to identify and remediate potential issues with elbows and primary cable junction bars.

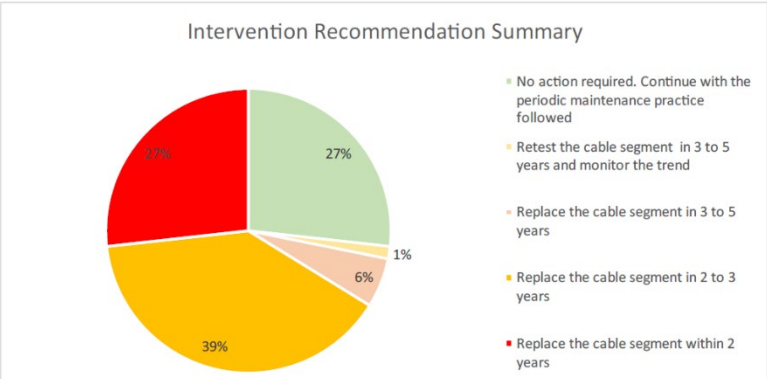


Figure 19: Chart 5 - Brant Hills Intervention Recommendation Summary

A large focus will need to be made towards cable replacements, 66% of the tested cables are suggested to be remediated within the next 3 years as recommended by the test results.

Contracted K-Line crews had ensured ESA 22/04 was met at all tested locations. Work permits were well organized with the BHI Control Room to ensure rolling cable isolations minimized any potential for customer service interruptions. IR scans indicated hot spots that were remediated throughout the rolling isolations. Arresters were added to loop open points for additional protection and fault indicators were introduced to over 40 segments to mitigate future cable fault interruption times. while the crews supported testing efforts. Overall, the pilot program was successful by all parties involved and future recommendations for continued efforts will be made. See 'Appendix F' for Brant Hills test result map, as well as 4.3.6 for future recommendations.

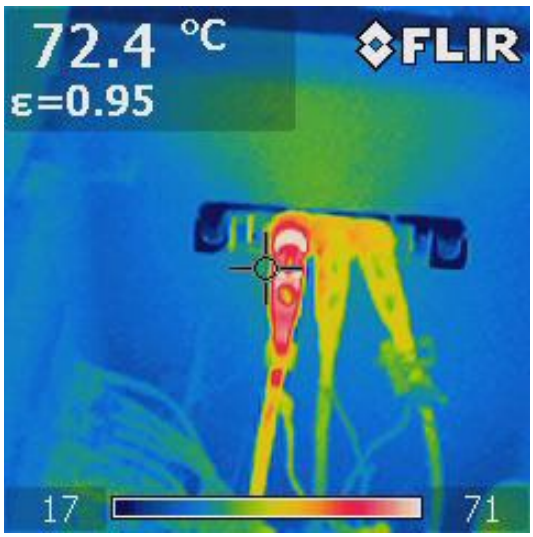


Figure 20: IR Photo from Brant Hills Elbow Hot Spot

Figure 21: Primary Cable Junction Collapse Due to Thermal Issues Brant Hills

4.3.0 FUTURE MAINTENANCE & OPERATION RECOMMENDATIONS

4.3.1 WOOD POLE REPLACEMENTS

With the conclusion of the 2020 to 2022 3-year patrolled inspection cycle, a great amount of detailed data is available for the next BHI Asset Condition Assessment Report. Due to current Cost of Service budget allocations and a continued increase in equipment costs and delays due to ever changing economic situations, a continued effort will be put towards pole replacements and any changes required to replacement frequency due to the influx of rotten poles will be evaluated in advance of the next cost of service application. The current pole replacement program may require acceleration with currently 994 identified rotten poles requiring replacement due to failed integral strength conditions. With current pole replacement costs, a general goal of 110 rotten pole replacements is targeted while only 60-80 are able to be met due to increased inventory & labour costs as well as budget mitigation updates for 2024 & 2025.

4.3.2 VAULT CLEANING/WASHING

Currently, there is not a submersible vault washing program for the BHI underground system. A review of the patrolled inspection reports for all underground system vaulted equipment should be considered for future budgets and dependent on reported conditions, consideration should be given to a more concentrated vault cleaning/washing program for equipment that does not currently have one. Dirt buildup could result in electrical tracking under certain conditions.

4.3.3 LEAKING TRANSFORMER REPLACEMENTS

With continued procurement issues, all reported leaking transformers are inspected on condition and equipment is ordered unless emergency repairs are required. Additional stock is recommended to be ordered to ensure replacements can be performed in a timely manner in the event that the leaking transformer fails or immediate replacement is triggered through ESA/customer complaint. An ongoing leaking transformer list is kept between Asset Management & Lines with transformers ordered accordingly. Additional repair methods are being investigated such as leak sealer from Polywater and ONTech Coatings services.

4.3.4 TRANSFORMER LOAD UTILIZATION REPLACEMENTS

As mentioned previously, load reports are now available through the Burlington Hydro GIS. Coincidental peaks should be assessed on transformers that are above 100% and below 25%-50% utilization. There is a large amount of pad mounted transformers, A focused effort in replacements should be targeted with an appropriate budget to reduce system strain and losses. An 'Annual Transformer Utilization by Transformer Type' report was created for 2022 and will be utilized in these efforts.

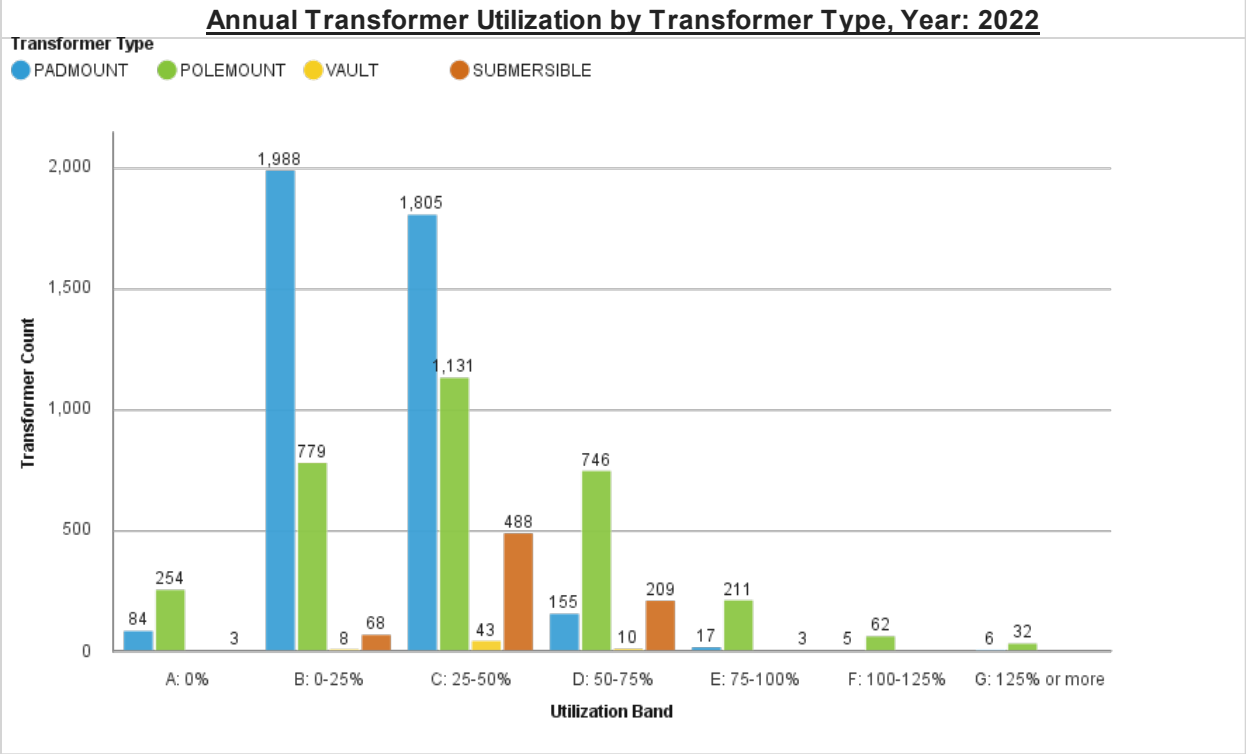


Figure 22: Chart 6 – Annual Transformer Utilization by Transformer Type – 2022

4.3.5 SUBMERSIBLE TO PAD-MOUNTED TRANSFORMER CONVERSION

With climate change and climate change related risks becoming a larger topic of consideration, CSA has made changes to their existing CSA 22.3 No. 7 – Underground Systems standards. Where practicable, pad-mounted installations above ground should be selected over submersible installations in subsurface chambers. Burlington Hydro has a commitment to the Burlington 'Climate Action Plan' and a recommended pilot has been introduced to convert end-of-life submersible transformers to pad-mounted transformers. The initial conversion is planned for 2023 at unit T186, lessons learned will be integrated into a future program which will be finalized after the unit has been replaced with an anticipated 2024 program start.

4.3.6 CABLE TESTING – PALMER SUBDIVISION

As previous successes with the Brant Hills cable testing program, a continued effort needs to be maintained to gather more data on subdivisions susceptible to continued cable faults. Palmer subdivision has already been targeted as the next best candidate for testing. The same approach will need to be taken with cable testing, equipment maintenance where required. Palmer cable testing is going to be completed in conjunction with Tyandaga cable testing in 2024. Cable testing has been delayed due to ongoing inventory procurement delays from manufacturers and vendors. With the implementation of test point mounted fault indicators, certain older style elbows cannot make proper contact resulting in some FCI not working as intended. As cables reach end of life, the FCI will be transferred to the new elbows at each location.

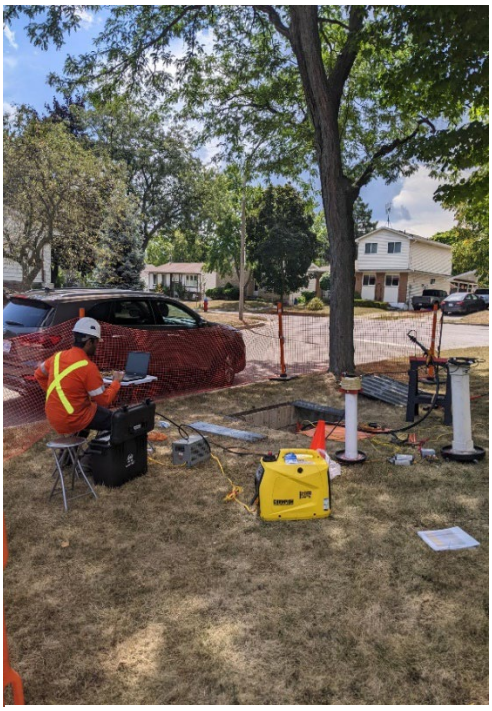


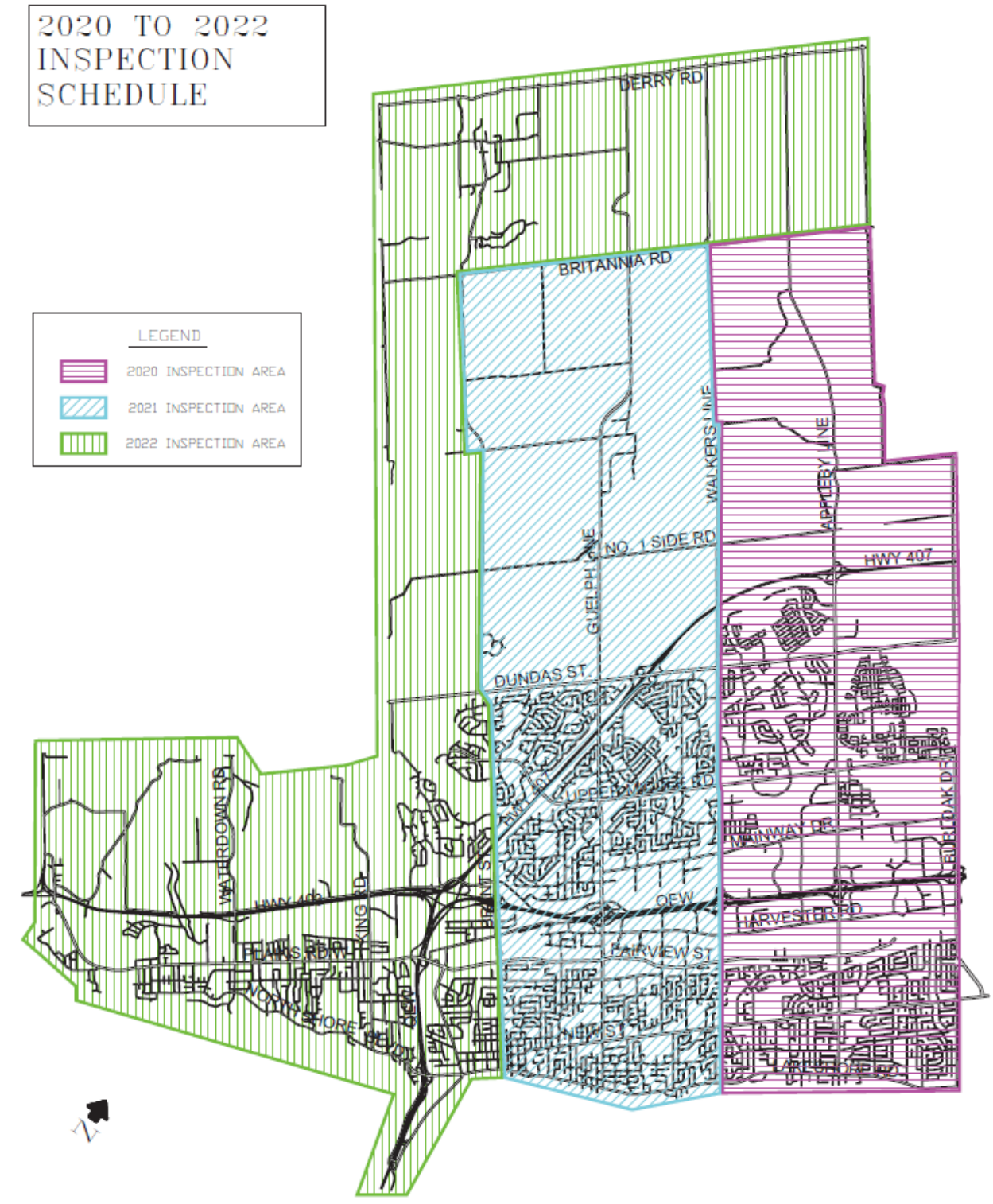
Figure 23: Burlington Hydro's Contractor Performing Cable Testing at a Submersible Transformer

4.3.7 CABLE REJUVENATION PROGRAM

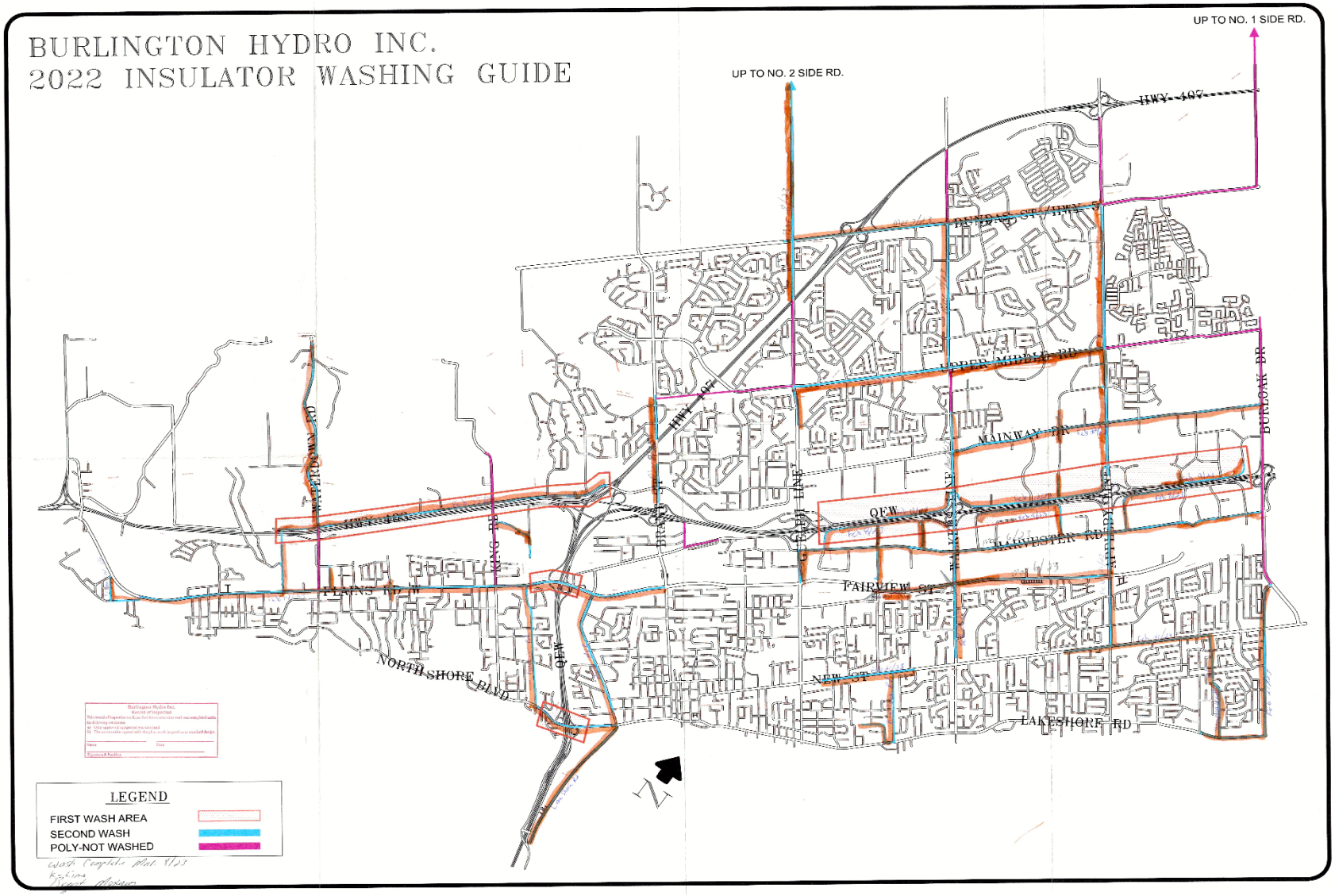
Continued efforts with cable testing have shown suboptimal results for cable conditions in Brant Hills. Novinium is a Southwire company that is currently the only cable rejuvenation provider in North America. As test result data is compiled, areas need to be assessed for potential use of cable injection. Cable injection primarily focuses on voids, defects, and water trees within cable insulation to fill the gaps and reduce the chance of cable faults while extending the asset life of cables. This is a much cheaper alternative to cable replacement and can be capitalized as it extends and improves asset life. A coordinated cable rejuvenation effort may be required to ensure not only cable injection but attached cable accessories are replaced as well to mitigate the risks of potential failures or issues from aged equipment. Meetings with Novinium, Kinectrics and other industry partners have been held in 2023 to start determining how cable rejuvenation might play a part in BHI's asset management strategy.

APPENDIX

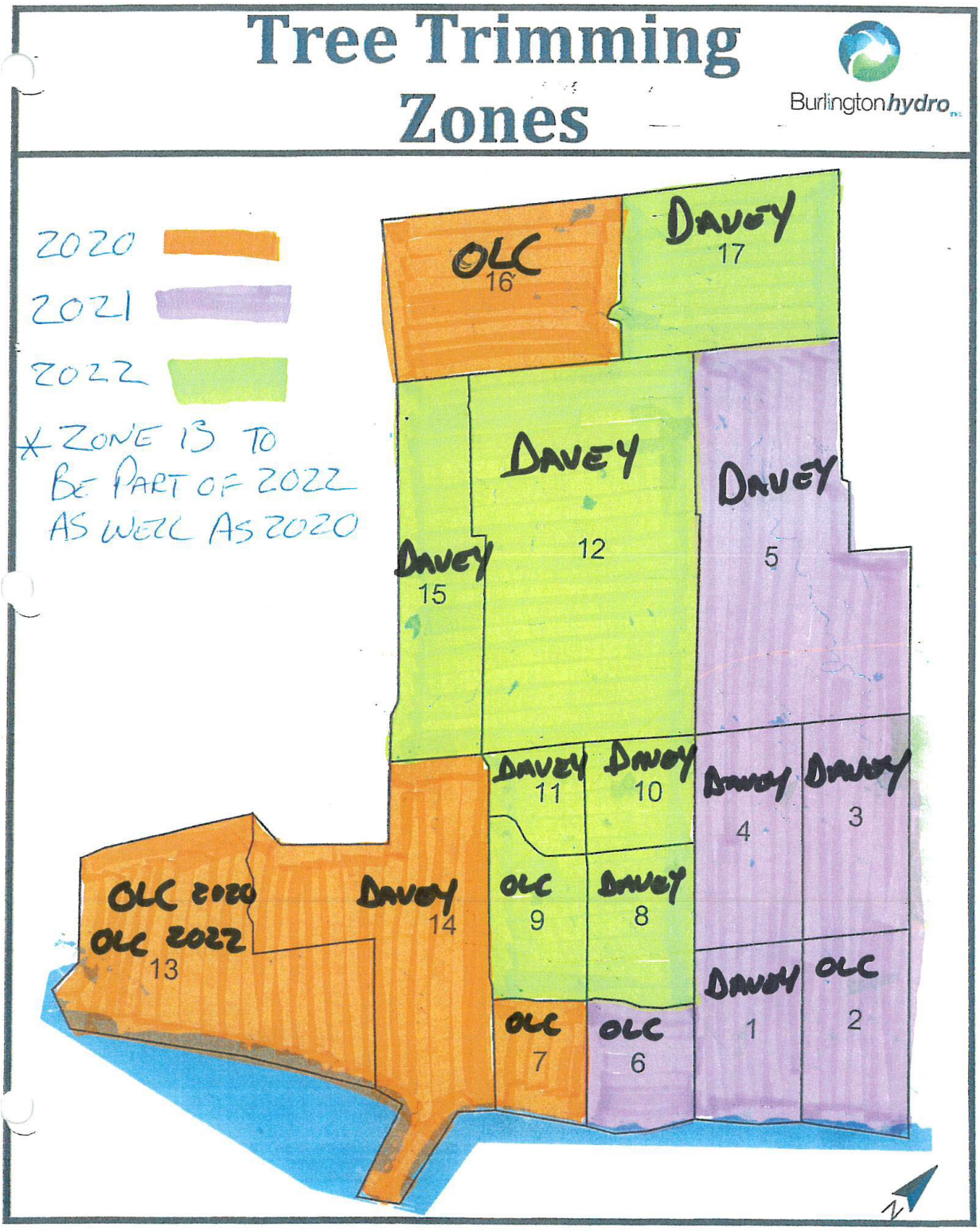
APPENDIX A – INSPECTION CYCLE 2020-2022



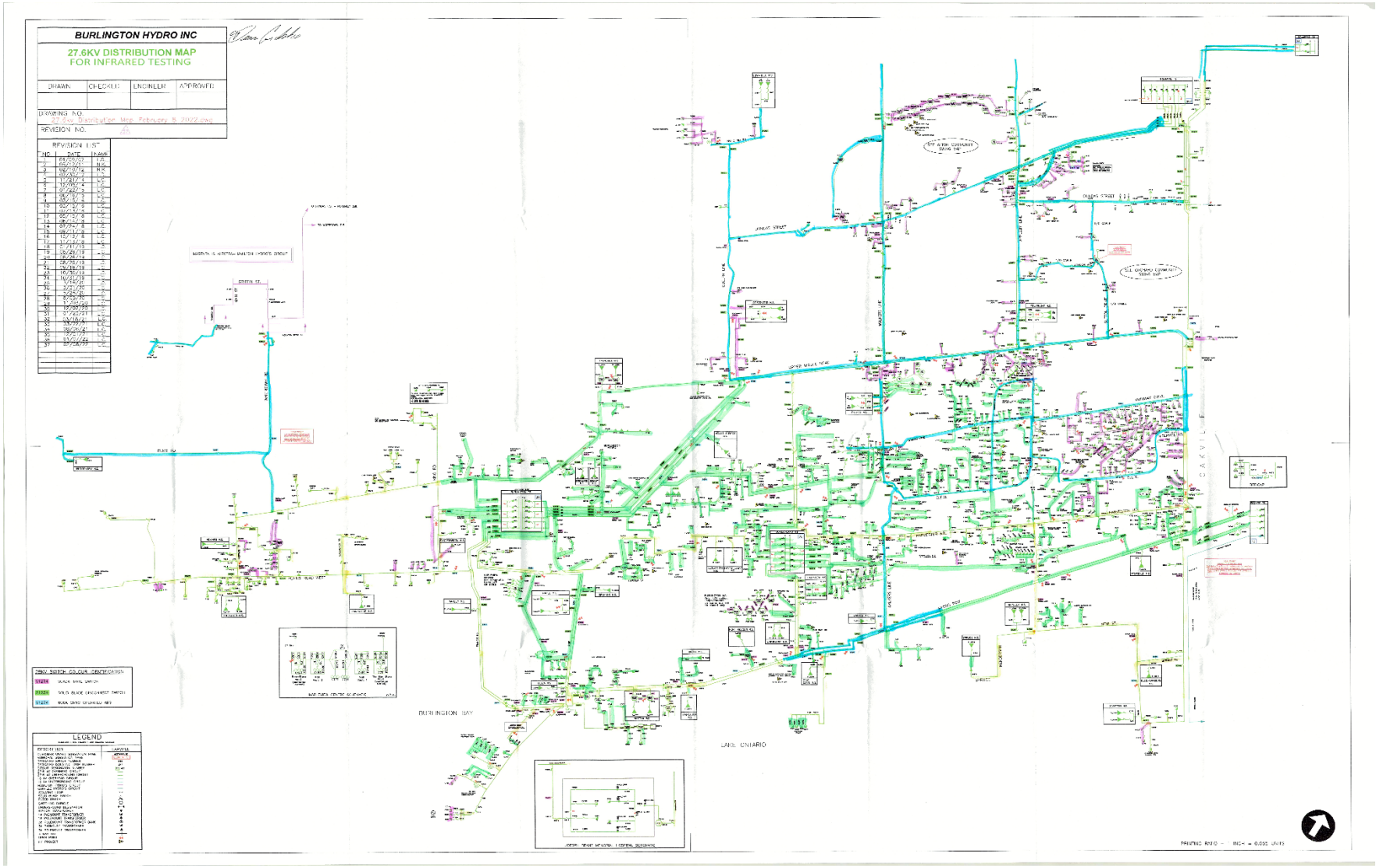
APPENDIX B – INSULATOR WASHING CYCLE 2022

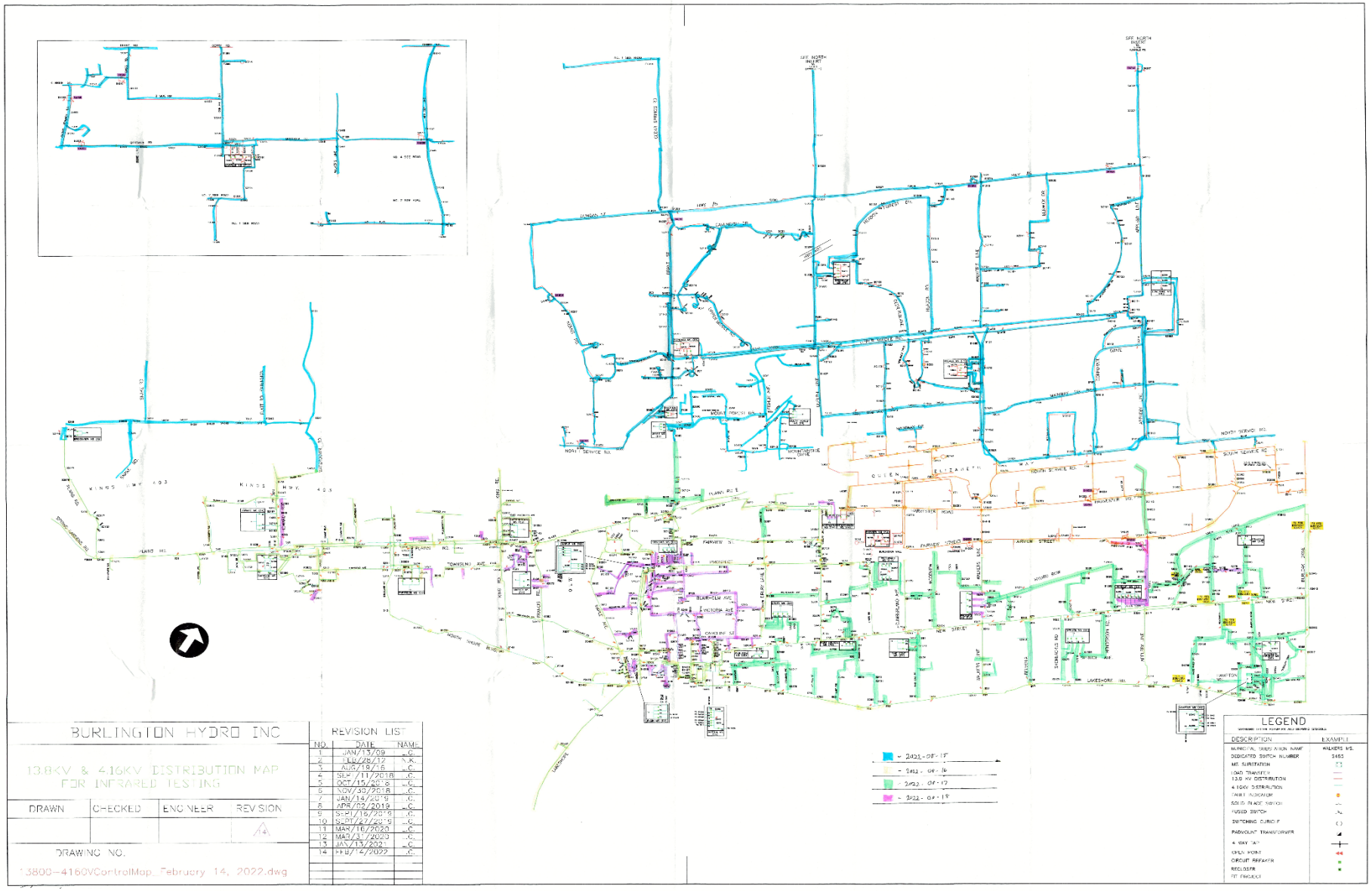


APPENDIX C – TREE TRIMMING ZONES 2020-2022

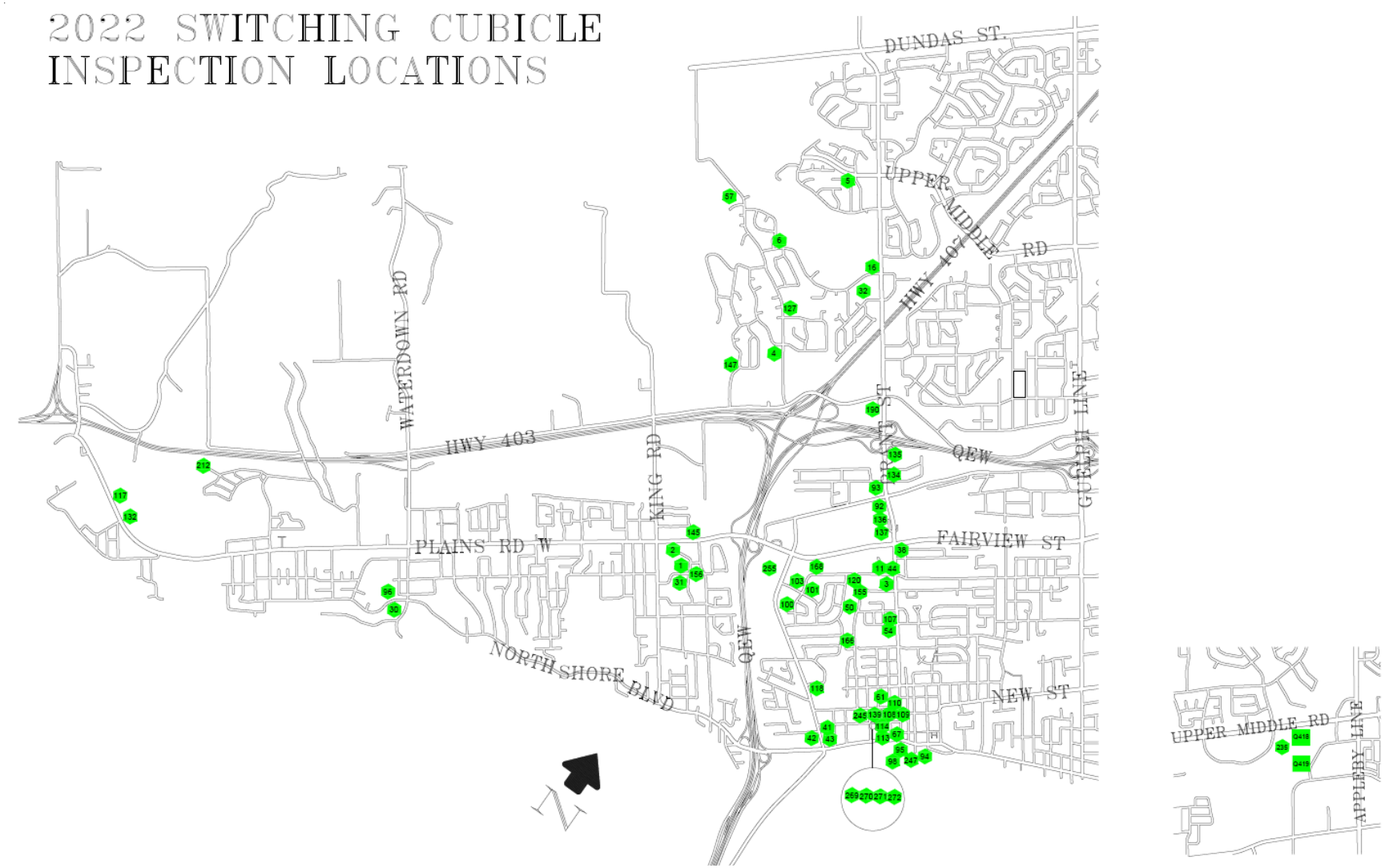


APPENDIX D – INFRARED THERMOGRAPHY MAPS – 27.6KV MAP AND 13.8KV & 4.16KV MAP

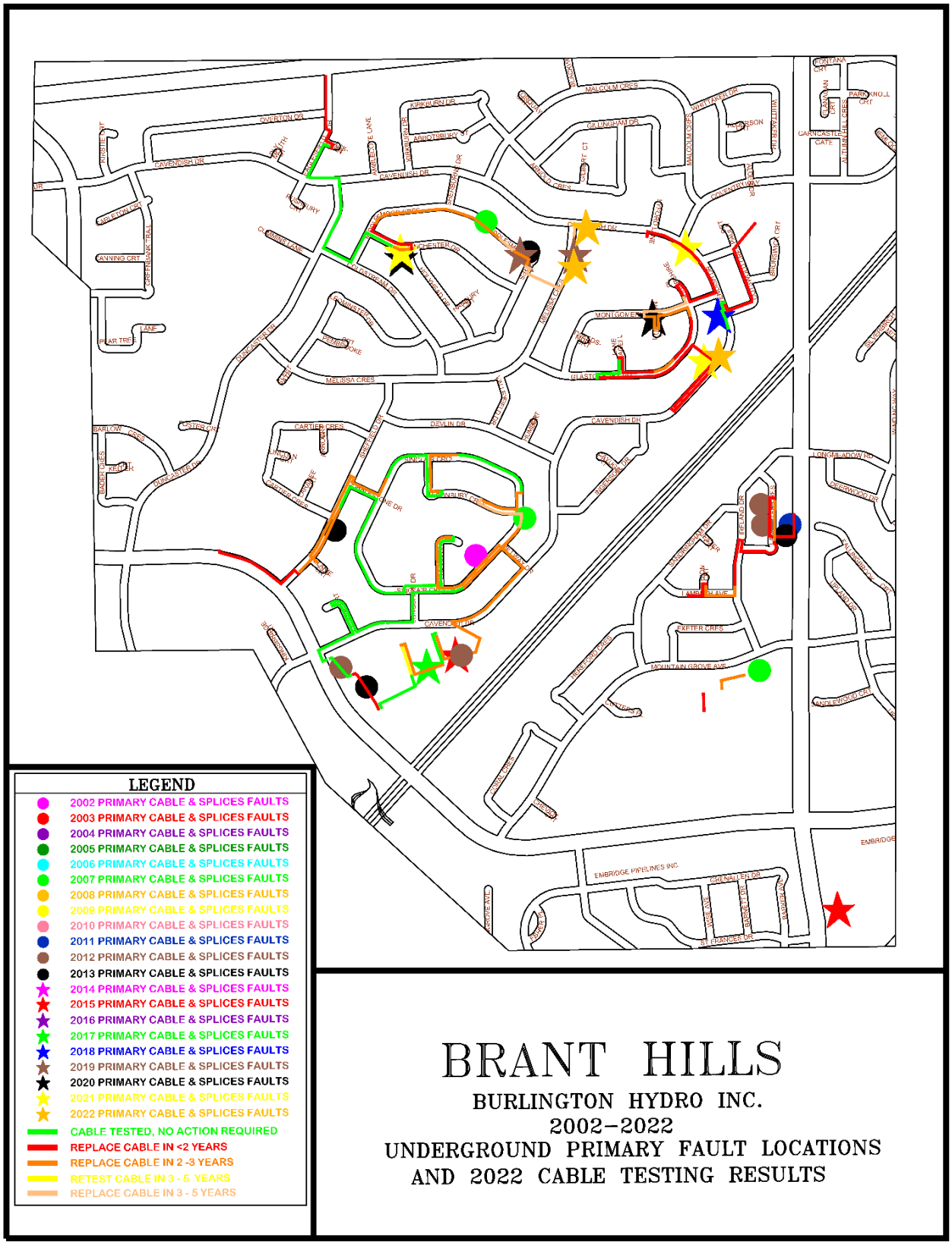



BURLINGTON HYDRO INC
13.8KV & 4.16KV DISTRIBUTION MAP
FOR INFRARED TESTING
DRAWN
CHECKED
ENGINEER
REVISION
DRAWING NO.
13800-4160VControlMap_Februcry 14, 2022.dwg
REVISION LIST
NO
DATE
NAME
1 JAN/15/09 .C.
2 FEB/26/12 M.K.
3 AUG/19/16 .C.
4 SEP /11/2018 .C.
5 OCT/15/2018 .C.
6 NOV/30/2018 .C.
7 JAN/14/2019 .C.
8 APR/02/2019 .C.
9 SEPT/16/2019 .C.
10 SEPT/27/2019 .C.
11 MAR/16/2020 .C.
12 MAR/31/2020 .C.
13 JAN/13/2021 .C.
14 FEB/14/2022 .C.
LEGEND
DESCRIPTION
EXAMPLE
MUNICIPAL SUBSTATION NAME
WALKERS MS.
DEDICATED SWITCH NUMBER
3453
ME SUBSTATION
LOAD TRANSFER
13.8 KV DISTRIBUTION
4.16KV DISTRIBUTION
JOINT ADDENDUM
SOLID BLADE SWITCH
FUSED SWITCH
SWITCHING CUBICLE
PADMOUNT TRANSFORMER
4 WAY TAP
OPEN POINT
CIRCUIT BREAKER
RECLOSER
TP PROJECT

APPENDIX E – SWITCHING CUBICLE INSPECTION LOCATIONS



APPENDIX F – BRANT HILLS CABLE TESTING RESULTS



2024

System Performance

Report

Table of Contents

Table of Contents **2**

List of Appendices **3**

Introduction **4**

1 SUBSTATION AND FEEDER PERFORMANCE **5**

1.1 GENERAL 5

1.2 Substations 7

1.3 27.6kV Feeders 8

1.4 13.8kV Feeders 9

1.5 4.16kV Feeders 11

2 UNDERGROUND DISTRIBUTION **13**

3 SYSTEM DEMAND AND CRITICAL LOADING ISSUES **14**

3.2 Overall Demand/Load Growth 14

3.3 27.6 Feeder Loads and Transformer Station Capacity 15

4 SYSTEM MAINTENANCE ACTIVITIES AND PRIORITIES **19**

5 RELIABILITY STATISTICS AND OBSERVATIONS **20**

6 FUTURE CAPITAL BUDGET RECOMMENDATIONS **25**

6.1 Substation Equipment 25

6.2 27.6 KV Feeders 25

6.3 13.8 KV and 4.16 KV Feeders 26

6.4 System Planning 26

List of Appendices

APPENDIX A1 Feeder Auto-Reclosures Summary (Sorted by Total)

APPENDIX A2 Feeder Auto-Reclosures Summary (Sorted by 2024)

APPENDIX A3 Feeder Lock-Outs Summary (Sorted by Total)

APPENDIX A4 Feeder Lock-Outs Summary (Sorted by 2024)

APPENDIX B1 Feeder Outage Report 27.6 kV Feeders

APPENDIX B2 Feeder Outage Report 13.8 kV Feeders

APPENDIX B3 Feeder Outage Report 4.16 kV Feeders

APPENDIX C Underground Primary Fault Location and Cable Rebuild Area

APPENDIX D System Maintenance Activities and Priorities

Introduction

The 2024 System Performance Report is intended to provide a comprehensive overview of the performance of the Burlington Hydro Inc. (BHI) distribution system during 2024. It is based on the format established for previous reports and contributes to BHI's Asset Management Strategy by identifying future maintenance and capital budget priorities to enhance the reliability and performance of the distribution system. The following specific attributes are reviewed and addressed:

1) Substation and Feeder performance at 4.16, 13.8 and 27.6 kV primary voltage levels
2) Underground Distribution
3) System demand and critical loading issues
4) System maintenance activities and priorities
5) Reliability statistics and observations
6) Future Capital Budget recommendations

The information contained in the report was supplied by the Burlington Hydro Control Room, System Planning, Asset Management and BHI senior management; it summarizes statistics and incidents that occurred in 2024. Data from previous years was used for comparison purposes and to identify any recurring issues. Recommendations were based on consultations with BHI engineering and operations staff.

1 SUBSTATION AND FEEDER PERFORMANCE

1.1 GENERAL

In 2024, BHI had no major performance issues at any of its 32 substation locations. More specific observations and commentary, on substations, are included in section 1b below.

The following table summarizes the number of feeders at each voltage level.

Primary Voltage	Number of Feeders	Percentage of Total
27.6kV	34	21.51
13.8kV	26	16.45
4.16kV	98	62.02
Total	158	100.00

Table 1- Number of Feeders at each voltage level

The analysis of feeder performance is based on the recording of feeder Auto-Reclosures, of feeder Lock-Outs and a review of causes of interruptions. Appendix A summarizes the performance of each feeder since 2015, as follows:

1. Appendix A1: Auto-Recloses (sorted by total operations, since 2015)
2. Appendix A2: Auto-Recloses (sorted by no. of operations in 2024)
3. Appendix A3: Lock-Outs (sorted by total operations, since 2015)
4. Appendix A4: Lock-Outs (sorted by no. of operations in 2024)

These Appendices also identify the voltages of each feeder, and they are color coded the same as the typical BHI Geographic Information System (GIS) voltage level colors; Blue - 4.16 KV, Red – 13.8 KV and Brown – 27.6 KV.

A review of the actual numbers of Auto-Recloses and Lock-Outs for 2023 and 2024 when compared to the average number since 2015 is provided below.

Auto-Reclosures	2023	2024	Previous 10-year Average (2015-2024)
27.6kV	59	73	60.9
13.8kV	124	102	120.7
4.16kV	67	74	72.3
Total	250	248	253.9

Table 2- Auto-Recloses comparison between 2023, 2024 and the previous 10-year average (2015-2024)

Lock-Outs	2023	2024	Previous 10-year Average (2015-2024)
27.6kV	15	16	19.1
13.8kV	8	13	19.2
4.16kV	11	14	20.7
Total	34	43	59

Table 3- Lock-Outs comparison between 2023, 2024 and the previous 10-year average (2015-2024)

Conclusions:

It is important to appreciate the difference in loading capacity at each voltage level. A typical 4.16 kV feeder may supply only 500 customers, whereas a 13.8 kV feeder may supply around 1500 and a 27.6 kV feeder may supply 4000 customers. Therefore, the exposure of feeders to possible incidents due to the length has a proportional relationship to the number of customers served. Also, it is acknowledged that both the 4.16 and 13.8kV customers experience momentary interruptions and outages when incidents occur on their 27.6kV supply feeder. Therefore Auto-Reclosures and Lock-Outs, at each voltage level, are not at all equal with respect to their impact on customers. With that background the following conclusions can be drawn from the above:

1. The total number of Auto-Reclosures in 2024 is slightly lower compared to the previous year and it is still slightly lower than 10-year average.
2. The total number of Lock-Outs increased in 2024 but is still below the previous 10-year average.

More specific observations and commentary on these items are included in sections 1c, 1d and 1e below.

1.2 SUBSTATIONS

There are no significant changes to the station and feeder loadings in 2024. BHI Control Room Operators are aware of the system capabilities for station and feeder back-ups.

BHI has successfully completed the first phase of the long-term decommissioning plan for the Fairview MS. As part of this phase, two 13.8 kV overhead feeders (F2 and F3) have been fully converted to the 27.6 kV distribution system. This conversion initiative was driven by the requirements of a major Metrolinx infrastructure project, which necessitated significant modifications to BHI's distribution system, including the relocation of several distribution lines. BHI leveraged this opportunity to begin transitioning the 13.8 kV feeders to the 27.6 kV system, aligning with long-term system planning objectives. The remaining two 13.8 kV feeders are scheduled for conversion over the next few years. These timelines are influenced by ongoing legal and real estate considerations involving existing customers connected to those feeders. Ultimately, this staged conversion will enable the full decommissioning of the Fairview MS.

BHI expects to operate most of its substations indefinitely, as conversion to a higher voltage can be cost prohibitive. The transformers, switchgears, breakers, relays, and buildings are well maintained, but many of them are over 30 years old and generally supply power to the existing and developed neighborhoods. All transformers with elevated dissolved gases are closely monitored based on the results of the Dissolved Gas Analysis (DGA) and quarterly oil testing are performed throughout the year. Of the substations, twenty (20) are equipped with a single power transformer and twelve (12) have dual redundant transformation. Twenty-five (25) of the transformers are over 40 years old and therefore present the highest risk of failure. In 2011 an annual replacement program was initiated and since then thirteen (13) Power Station Transformers have been replaced with new transformers.

1.3 27.6KV FEEDERS

Appendix B contains the 27.6kV Feeder Outage Reports for all 27.6kV feeders experiencing 5 or more Auto-Reclosures or 2 or more Lock-Outs, during 2024. The following is a commentary on each of these feeders.

Feeder (TS)	No. of 2024Auto-Reclosures (2023)	No. of 2024 Lock-Outs (2023)	Comments/Cause	
			Auto-Reclosures	Lock-Outs
280M8	6 (10)	1 (2)	Unknown (4) Defective Customer Equipment (2)	Defective Switching Cubicle (1)
280M6	3 (5)	2 (2)	Thunderstorm/Lightning (1) Unknown (2)	High Winds (2)
76M28	6 (1)	0 (0)	Defective Switching Cubicle (1) Defective Switch (1) Tree/Limb (2) Unknown (2)	None
76M29	11 (1)	1 (0)	Vehicle Accident (2) Defective U/G Primary (3) Defective Transformer (1) Unknown (5)	Unknown (1)
39M1	2 (0)	3 (0)	Animal (1) Defective Customer Equipment (1)	Defective U/G Primary (1) Burned Off Phase-Lines Down (1) Unknown (1)
39M31	3 (2)	2 (1)	Defective Customer Equipment (2) Unknown (1)	Tree Contacts Broken Branch or Overgrowth (1) Broken Pole (1)
39M36	2 (3)	2 (0)	Animal (2)	Animal (1) Tree Contacts – Broken Branch or Overgrowth (1)

Table 4- 27.6 kV Feeders experiencing 5 or more Auto-Reclosures or 2 or more Lockout.

In total the BHI 27.6kV feeders experienced 16 Lock-Outs and 73 Auto-Reclosures, during 2024. The main causes of the lockouts were due to tree contacts followed closely by animal contact

and high winds, while the main causes of reclosures were due to animal contact, defective equipment and customer equipment failures. The following table compares the preceding 10 years of Lock-Outs.

YEAR	Number of 27.6 kV Lockouts
2015	33
2016	23
2017	14
2018	20
2019	19
2020	22
2021	10
2022	19
2023	15
2024	16

Table 5- Number of 27.6 kV Lockouts per year

1.4 13.8KV FEEDERS

The performance of certain 13.8kV feeders continues to be monitored closely. Appendix C contains the 13.8kV Feeder Outage Reports for all 13.8kV feeders experiencing 5 or more Auto-Reclosures or 2 or more Lock-Outs, during 2024. The following is a commentary on each of these feeders.

M.S. Feeder	No. of 2024 Auto-Reclosures (2023)	No. of 2024 Lock-Outs (2023)	Comments/Cause	
			Auto-Reclosures	Lock-Outs
PALMER F1	12 (10)	1 (0)	Unknown (10) Defective Switch (1) Animal (1)	Unknown (1)
PALMER F3	12 (11)	1 (0)	Unknown (8) Defective Connection (1) Cold Load (3)	Defective Switching Cubicle (1)
LOWVILLE F1	9 (14)	0 (0)	Unknown (5) Tree/Limb (2) Pole Fire (1) Blown Arrestor (1)	None

PALMER F2	8 (9)	1 (1)	Unknown (6) Defective U/G Primary (1) Tree/Limb (1)	Defective Insulator (1)
TOWERLINE F2	8 (2)	2 (0)	Unknown (7) Defective U/G Primary (1)	Defective Connection (1) Unknown (1)
PALMER F4	6 (6)	1 (0)	Unknown (1) Animal (1) Defective U/G Primary (2) Defective Transformer (1) Defective Slice U/G Primary (1)	Defective U/G Primary (1)
ORCHARD F1	5 (5)	0 (0)	Unknown (2) Defective U/G Primary (3)	None
TOWERLINE F3	5 (0)	0 (0)	Unknown (5)	None
TYANDAGA F3	5 (3)	0 (2)	Unknown (2) Tree/Limb (1) Defective U/G Primary (1)	High Winds (1)
LOWVILLE F3	2 (4)	2 (0)	Unknown (1) Blown Arrester (1)	High Winds (1) Tree Contacts – Fallen Tree on Public R.O.W. (1)

Table 6- 13.8 kV Feeders experiencing 5 or more Auto-Reclosures or, 2 or more Lockout

The 13.8kV feeders had decreased number of Auto-Reclosures and an increased number of Lockouts in 2024. The main causes of lockouts on the 13.8kV system are due to tree contacts and defective equipment, while the main causes of reclosures are due to defective U/G primary faults and tree contacts. The following table compares the preceding 10 years of Lock-Outs.

YEAR	Number of 13.8 kV Lockouts
2015	19
2016	22
2017	36
2018	31
2019	19
2020	11
2021	16
2022	17

2023	8
2024	13

Table 7- Number of 13.8 kV Lockouts per year

1.5 4.16KV FEEDERS

Appendix D contains the 4.16kV Feeder Outage Reports for all 4.16kV feeders experiencing 5 or more Auto-Reclosures or 2 or more Lock-Outs, during 2024. The following is a commentary on each of these feeders.

M.S. Feeder	No. of 2024 Auto-Reclosures (2023)	No. of 2024 Lock-Outs (2023)	Comments/Cause	
			Auto-Reclosures	Lock-Outs
GRAHAMS F4	0 (0)	2 (1)	None	Tree Contacts – Fallen Tree on Public R.O.W. (2)
PARTRIDGE F2	0 (1)	2 (0)	None	High Winds (2)
PINEDALE F2	1 (2)	2 (1)	Blown Arrester (1)	Tree Contact – Broken Branch (1) Unknown (1)
PORT NELSON F2	3 (1)	2 (0)	Defective Switch (1) Overload (1) Tree/Limb (1)	Tree Contact – Broken Branch (1) Unknown (1)
SPRUCE F2	5 (6)	0 (1)	Blown Arrester (1) Blown Elbow (1) Cold Load (1) Defective Switch (1) Tree/Limb-Line Down (1)	None
APPLEBY F1	5 (1)	0 (0)	Tree/Limb (2) Defective Switch (1) Defective Switching Cubicle (1) Cold Load (1)	None

Table 8- 4.16 kV Feeders experiencing 5 or more Auto-Reclosures or, 2 or more Lock-Outs.

The 4.16kV feeders had an increased number of Lock-Outs and Auto-Reclosures in 2024. A review of all lockouts identifies the leading causes from tree contacts and high winds. The leading cause of auto-reclosures is due to defective equipment and tree contacts.

The need for feeder protection coordination and load balancing has previously been identified as a need for improvement, on several 4.16kV feeders. This should continue to receive increased attention to improving the operational efficiency of the system. Ref. Section 6c for recommendations.

YEAR	Number of 4.16 kV Lockouts
2015	29
2016	26
2017	28
2018	25
2019	23
2020	18
2021	17
2022	16
2023	11
2024	14

Table 9 – Number of 4.16kV Lockouts per year

2 UNDERGROUND DISTRIBUTION

A very large percentage of BHI's residential distribution system has been constructed underground, particularly in the newer neighborhoods, north of the QEW. Underground construction has been standard utility practice for over 30 years. These systems contain direct buried high voltage cables that are in contact with the ground and as such exposed to changes in that environment resulting in a higher rate of deterioration of the cable insulation as well as a higher failure rate of underground splices. BHI tracks the incidents of failure at these cables on an individual feeder and geographic location basis and uses this information to inform our capital investment program and capital budgets, for timely replacements and/or repairs. Appendix **C** is a high-level annual record of primary cable failures within the distribution system.

The planned replacement of primary cables is a very significant element within BHI's Asset Management Plan and represents a significant portion of the capital budget. The timing of cable replacements within specific neighborhoods requires a careful balance considering the condition of the cable insulation and the historical reliability performance.

Specific recommendations for future cable replacements, current maintenance and future recommendations for pad-mounted transformers and switching cubicles are included in Appendix D - "System Maintenance Activities & Priorities"

3 SYSTEM DEMAND AND CRITICAL LOADING ISSUES

3.2 OVERALL DEMAND/LOAD GROWTH

The following table shows BHI's System **coincident** measured peak demand and percentage growth for the last 15 years.

Year	Measured Peak Demand (MW)	Month	% Increase/decrease
2009	350.43	August	1.18
2010	367.59	July	4.90
2011	379.69	July	3.29
2012	373.21	July	-1.71
2013	376.30	July	0.83
2014	325.55	August	-13.49
2015	340.35	July	4.55
2016	360.23	September	5.84
2017	321.21	September	-10.83
2018	351.44	July	9.41
2019	323.41	July	-7.97
2020	350.36	July	8.33
2021	344.66	August	-1.63
2022	344.05	June	-0.18
2023	337.02	September	-2.04
2024	340.32	June	0.98

Table 10- Coincident peak demand and percentage growth

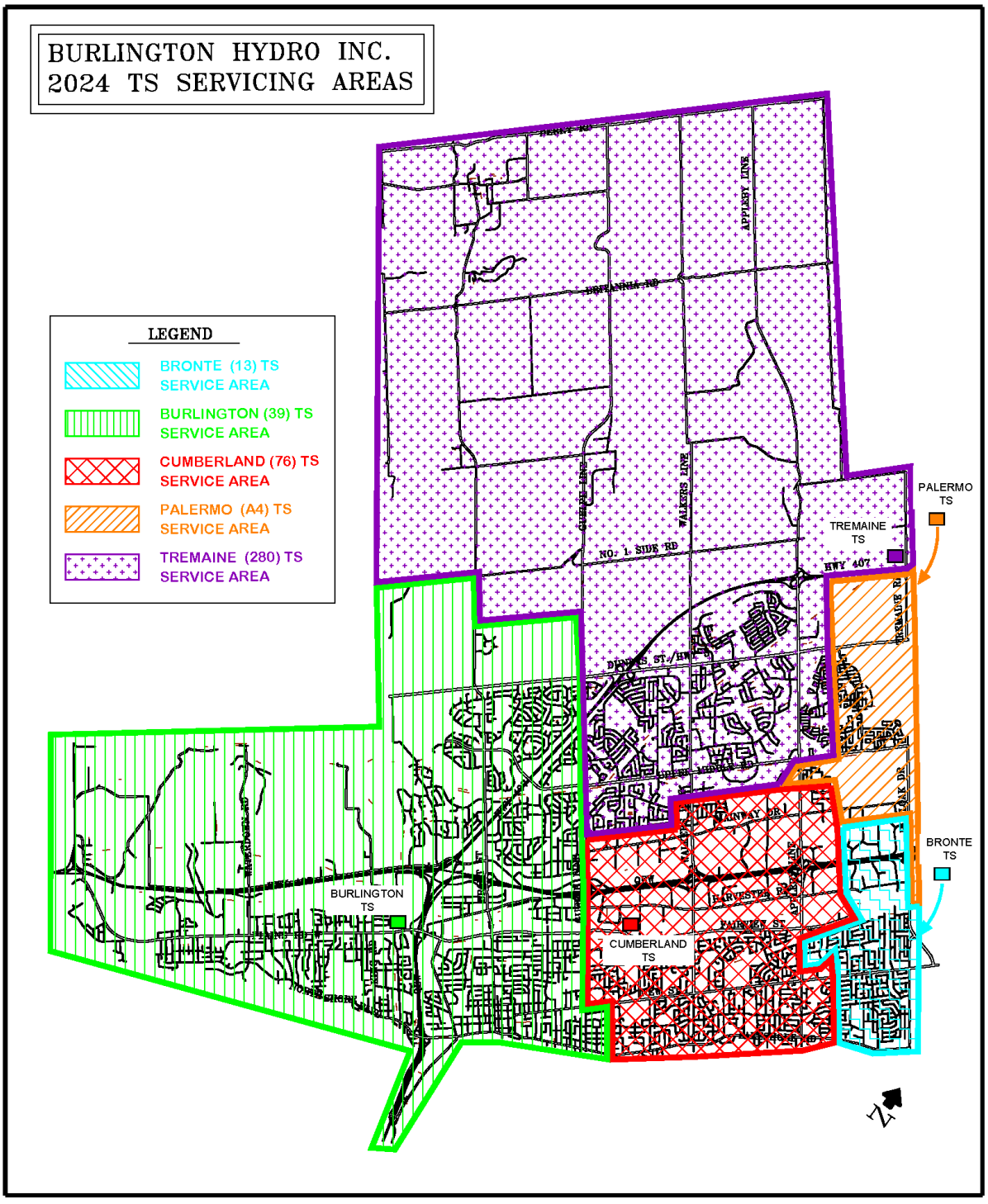
The 2024 coincident peak demand was slightly higher than 2023 and very close to the 10 years average of 341.3 MW. Each year there are many variables that contribute to this number, such as customer growth, the local economy, summer heat and the impact of conservation initiatives.

3.3 27.6 FEEDER LOADS AND TRANSFORMER STATION CAPACITY

The map below indicates the five (5) Transformer Stations' (TS) servicing boundaries, where feeders from each station are servicing the customers in the respective service areas. Feeders are interconnected and configured so the loading is optimized based on available Station capacity and customer demand in these service areas. However, further system enhancements as well as continuation with the Tremaine TS feeders' egress/expansions are required to optimize the use of the TS's allocated capacity and create optimal loading on 27.6 KV feeders at each TS. In the absence of these additional feeders from Tremaine TS, there are limitations to load transfer capability with other TS's which could potentially create inefficiency into the BHI distribution system operation and may expose customers to less-than-optimum reliability.

Critical areas that need immediate attention regarding the feeder loading and available capacity are around the City of Burlington Mobility Hubs, which include the downtown and the three GO Stations, where the loading capacity of the feeders supplying these parts of the City have reached their optimal limit. The City of Burlington's long-term vision for downtown Burlington, GO Corridor and Major Transit Stations Areas (MTSA) is expected to accelerate the growth.

Since the City of Burlington has established the boundaries of the MTSA's (Main Transit Station Areas) we have seen an increased number of development applications for new mid/high rise buildings in these areas that represent large, concentrated demand, which will require expansion of existing feeders as well as bringing in new feeders to meet the needs of the new developments. BHI is constantly monitoring the System and feeders' capacity and performing regular system planning studies to balance load and allow efficient system operation and reliability for our customers. This may entail reconfiguration of existing open points (switching) and construction of new feeders to proactively mitigate any capacity constraints (at the feeder level)


BURLINGTON HYDRO INC.
2024 TS SERVICING AREAS
LEGEND
BRONTE (13) TS SERVICE AREA
BURLINGTON (39) TS SERVICE AREA
CUMBERLAND (76) TS SERVICE AREA
PALERMO (A4) TS SERVICE AREA
TREMAINE (280) TS SERVICE AREA
PALERMO TS
TREMAINE TS
BRONTE TS
BURLINGTON TS
CUMBERLAND TS
APPLEBY LINE
WALKERS LINE
NO. 1 SIDE RD
HWY 407
DUNDAS ST / HWY 5
FAIRVIEW ST
HARVESTER RD
FAIRWAY DR
LAKE DR
N

BHI's 27.6kV feeder interconnections are well integrated and back-up arrangements have been further enhanced by the addition of remotely operated switches, however further system optimization analysis needs to be performed and more remotely operated switches to be installed at the intersection of existing and proposed feeders as well as for facilitating load transfers.

Most of the 27.6 KV feeders have reasonable loading. This is optimized at the planning capacity of approximately 300A, as is the preferred feeder loading to allow for emergency load transfers and back-up capability. There are some exceptions in maintaining this standard across the board, mainly due to Tremaine TS Feeder egress challenges, load growth in certain areas, and the increase in residential load and decrease in industrial/commercial load. The feeders loading is monitored regularly and if required a load transfer is performed where needed to off-load some of the heavy-loaded feeders. To improve this situation BHI has come up with a short and long-term plan to modify the feeder's configuration, interconnection, and load balancing. However, the permanent solution will ultimately depend on the continuation of the Tremaine TS feeder's expansion projects that are part of the BHI short-term and long-term capital investment strategy. Once implemented, this will provide an opportunity for loads to be easily transferred among the feeders and Transformer Stations, improve system flexibility and reliability, and reduce system losses.

In 2024, the planned reconfiguration of the Cumberland Transformer Station (TS) feeders was successfully completed. This upgrade enabled the offloading of several Burlington TS feeders that previously serviced the downtown Burlington area, thereby creating additional capacity for new load connections.

As a result of this system enhancement, the performance of the existing intelligent self-healing system in the downtown core will be significantly improved. The system is designed to isolate faulted sections and restore power to unaffected areas in under one minute, greatly enhancing reliability and minimizing service disruptions.

Additional load transfers and feeder reconfiguration are required at both Burlington TS and Cumberland TS feeders to create capacity for future developments.

4 SYSTEM MAINTENANCE ACTIVITIES AND PRIORITIES

BHI aims to meet or exceed the system maintenance and inspection requirements of Section 4.4 of the Ontario Energy Board's Distribution System Code (DSC). Routine maintenance programs are consistent with good utility practices and are applied annually across all major assets within the BHI distribution system. A detailed maintenance report including future maintenance and operations recommendations can be found in Appendix **D** - "System Maintenance Activities & Priorities".

5 RELIABILITY STATISTICS AND OBSERVATIONS

In accordance with the Electricity Distribution System Reliability Measures and Expectations Report EB-2014-0189 completed by the Ontario Energy Board's (OEB's), BHI records and reports annually the following Service Reliability Indices:

SAIDI = System Average Interruption Duration Index

$$= \frac{\text{Total Customer-Hours of Interruptions}}{\text{Total Customers Served}}$$

SAIFI = System Average Interruption Frequency Index

$$= \frac{\text{Total Customer Interruptions}}{\text{Total Customers Served}}$$

CAIDI = Customer Average Interruption Duration Index

$$= \frac{\text{Total Customer-Hours of Interruptions}}{\text{Total Customer Interruptions}}$$

In addition, BHI also records:

SAARI = System Average Automatic Reclosure Index

$$= \frac{\text{Total Customer Automatic Reclosures}}{\text{Total Customers Served}}$$

These indices provide BHI with an annual measure of its service performance for internal benchmarking and for comparisons with other distribution companies as part of OEB's Performance Based Regulations. The following graphs demonstrate the individual performance measures over the last 8 years (excluding Loss of Supply and Major Events). The graphs below show an increasing but consistent level of performance compared with previous years.

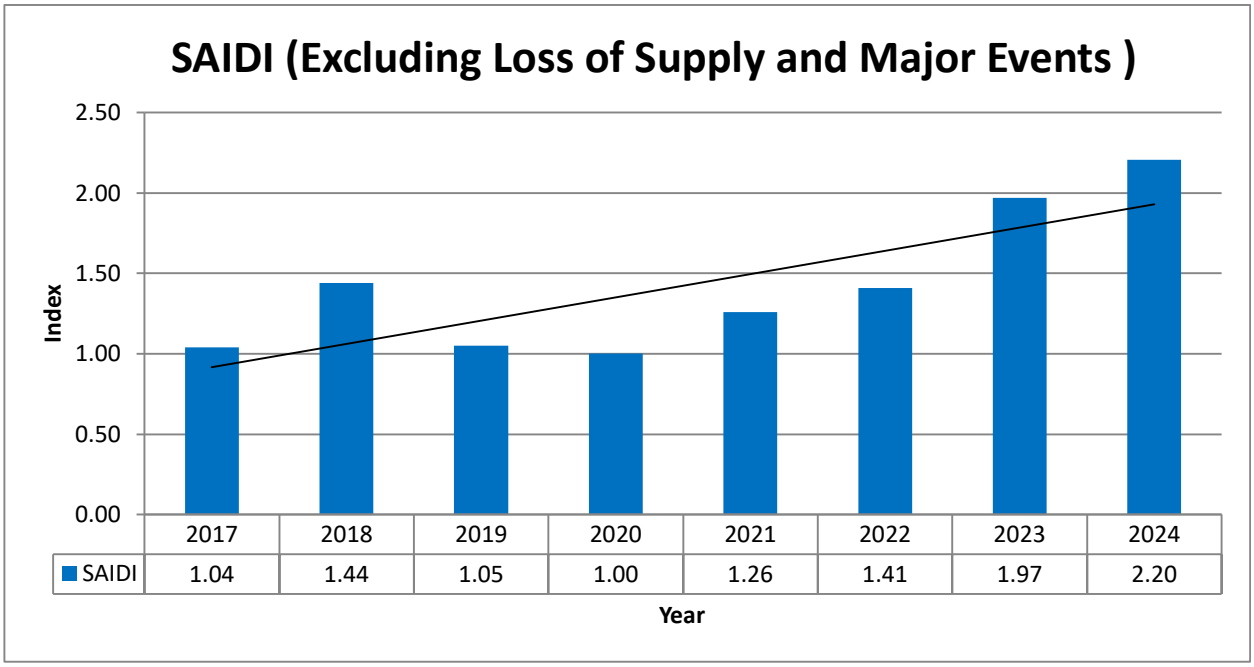


Figure 1- SAIDI from 2017 to 2024

8 Years Average – 1.422

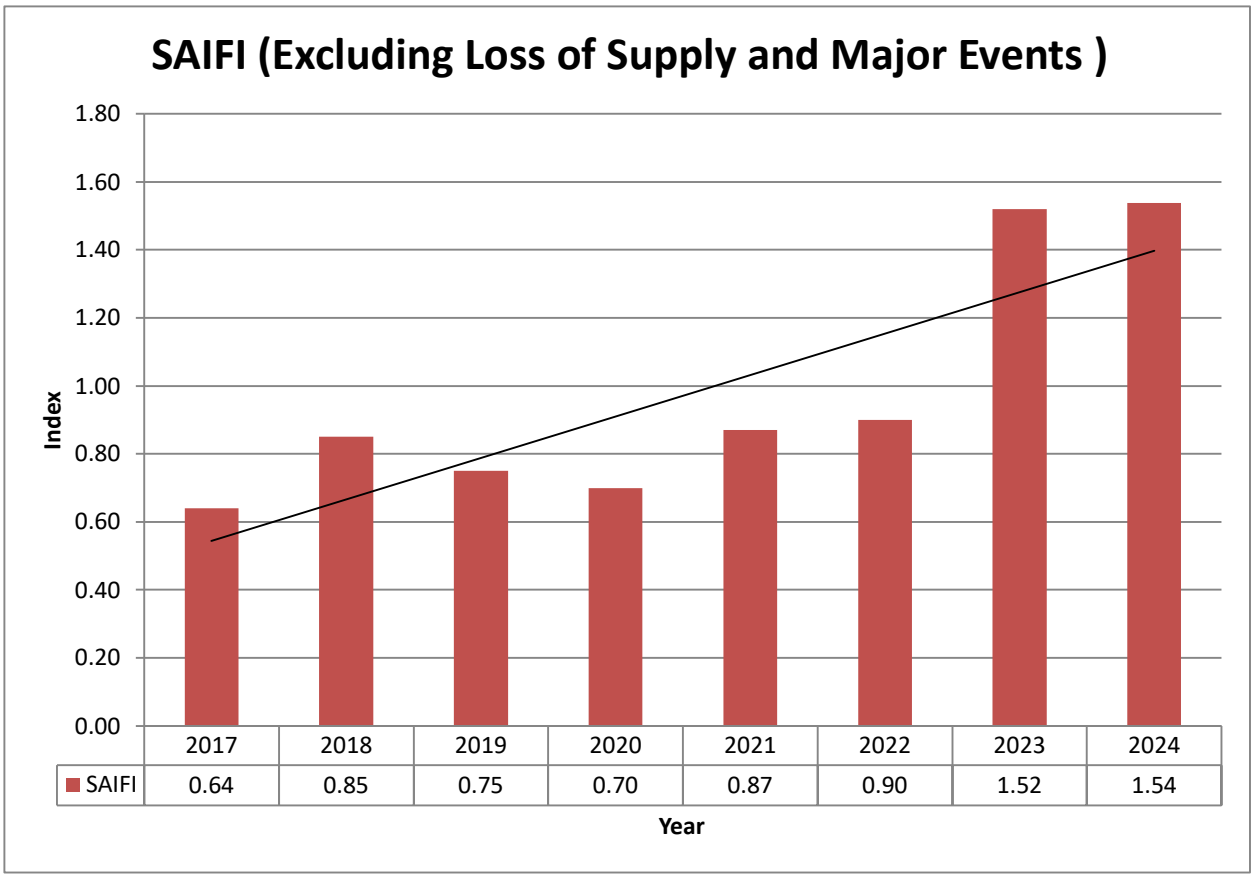


Figure 2- SAIFI from 2017 to 2024

8 Years Average – 0.971

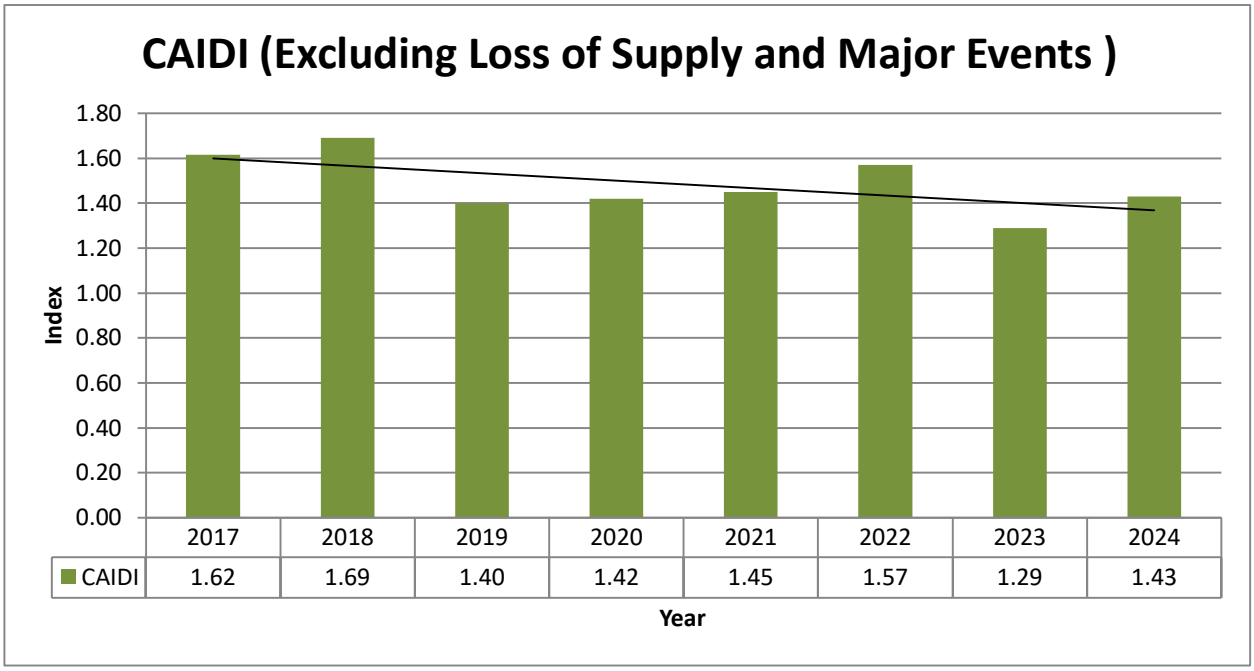


Figure 3- CAIDI from 2017 to 2024

8 Years Average – 1.483

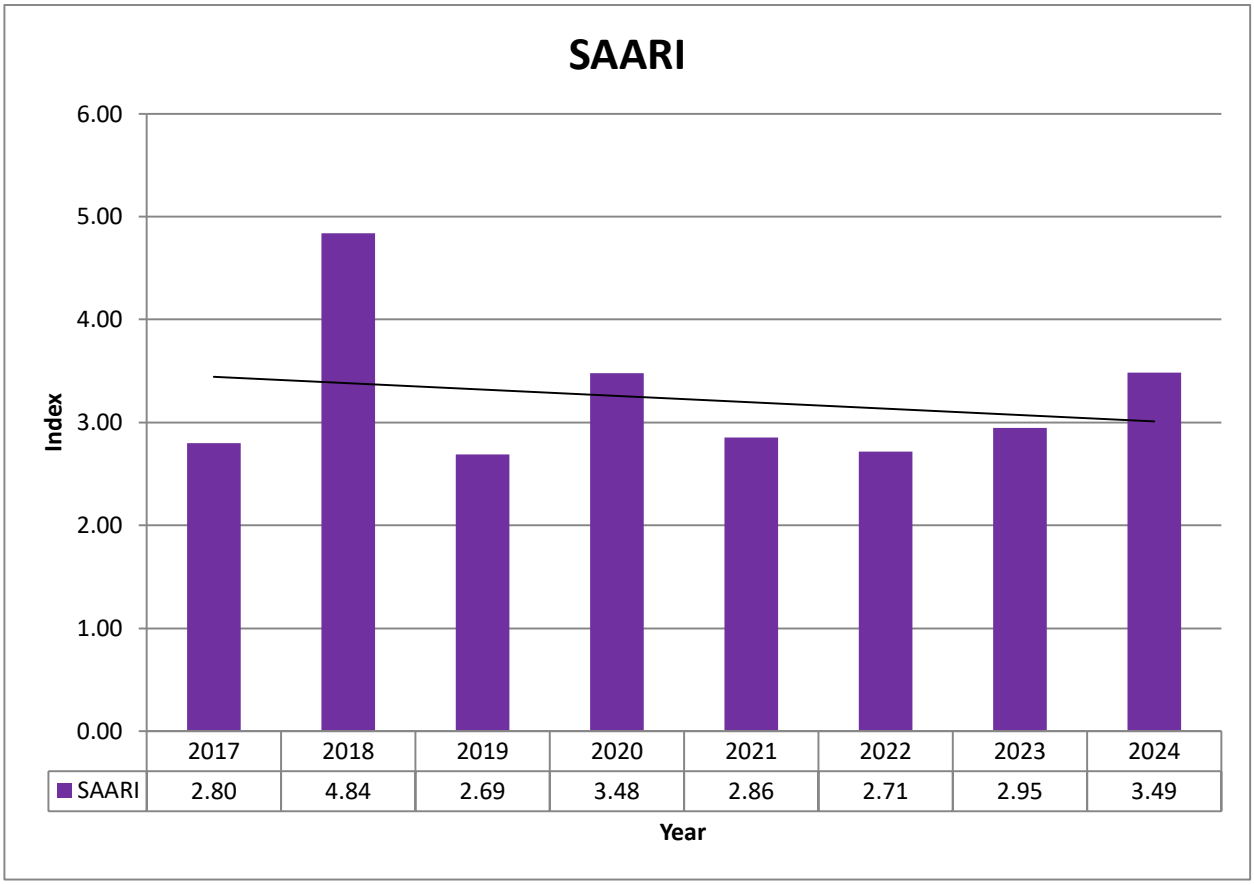


Figure 4- SAARI from 2017 to 2024

8 Year Average – 3.226

6 FUTURE CAPITAL BUDGET RECOMMENDATIONS

6.1 SUBSTATION EQUIPMENT

With approximately twenty-five (25) of its substation power transformers over 40 years old and four (4), having significantly elevated dissolved gases, these units require close monitoring and testing. BHI will aim to replace 1 unit every year or every other year and is looking into alternatives to mitigate risks (critical spares, potential station conversion, refurbishments, etc.). Additional programs for the station primary switchgears, feeder circuit breakers and relay upgrades, at least one station per year, have been introduced and recommended for continuance.

6.2 27.6 KV FEEDERS

The following are the proposed major capital projects as a part of the Tremaine TS 27.6KV feeder's and Burlington TS feeders' expansion, required to be constructed in the next few years as new developments materialize.

Expansion of the existing circuit 27.6 kV O/H line between Appleby Ln and Guelph Ln along Dundas Rd

Expansion of the existing circuit 27.6 kV O/H line between Dundas Rd and Reservoir MS along Guelph Ln

Expansion of two existing circuits 27.6 kV O/H line between Tremaine TS and Dundas Rd along Tremaine Rd

Expansion of three circuits 27.6 kV O/H line from Dundas Rd to UMR along Bronte Creek

Expansion of the existing circuit 27.6 kV O/H line between Skyview Dr and south of Watertown Rd along NSR

Expansion of the existing 27.6 KV U/G line between Burlington GO Station and Guelph Ln along Fairview St

Expansion of the existing 27.6 KV U/G line between Grahams Ln and Pine St along Brant St

6.3 13.8 KV AND 4.16 KV FEEDERS

The following feeders with primary cable failures have been identified and should be reviewed as part of the Asset Management plan and prioritized for capital budget consideration.

- Palmer MS F1, F2, F3 and F4
- Towerline MS F2
- Tyandaga MS F3
- Orchard MS F1

In addition to the cable replacement program BHI has started a formal program for proactive MS feeder egress cables replacement, targeting cables that are already past their useful life and are showing signs of insulation deterioration during the regular preventive maintenance inspection and testing.

In the past BHI installed new reclosing automation technologies, three phase recloser (IntelliRupter) and single phase reclosers (Tripsaver) on several 13.8 kV feeders. BHI should continue to install these or similar automation technologies and integrate them into the operation of the control room, to improve the reliability for the customers supplied by these feeders. In addition to the Overhead Switches, BHI is planning to upgrade the existing pad mounted switching cubicles at some key locations with remotely controlled switching devices. BHI has plans to expand these applications throughout its system as part of future energy transition and grid modernization requirements, to improve the system performance. Appendix **C** shows the underground primary cables faults and cables rebuild areas from 2002 to 2024.

6.4 SYSTEM PLANNING

BHI has focused on long-term system planning and has identified several projects for investments in its distribution system to meet the needs of anticipated demand at the city established mobility Hub's (Downtown, MTSA's) as well as enhance the performance of the distribution system for its customers. These are prioritized in advance of the required update to the Distribution System Plan.

APPENDIX A1

Feeder Auto-Reclosures Summary

(Sorted by Total)

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
LOWVILLE F1	13.8	8	11	4	12	9	5	17	7	14	9	96
TOWERLINE F4	13.8	8	4	10	14	7	6	9	13	13	2	86
PALMER F1	13.8	8	7	5	9	4	7	10	6	10	12	78
PALMER F3	13.8	1	5	9	12	1	8	10	6	11	12	75
INTERCHANGE F1	13.8	1	10	7	9	5	8	12	15	4	2	73
RESERVOIR F1	13.8	10	10	15	10	7	2	4	4	6	1	69
TYANDAGA F3	13.8	9	8	6	3	7	6	9	9	3	5	65
TYANDAGA F2	13.8	5	4	13	12	10	10	9	1	0	0	64
LOWVILLE F3	13.8	4	1	6	11	2	5	29	0	4	2	64
PALMER F4	13.8	7	3	1	10	5	9	1	8	6	6	56
FAIRVIEW F3	13.8	10	11	10	10	1	6	3	1	3	0	55
TOWERLINE F2	13.8	10	5	4	8	5	4	5	3	2	8	54
TYANDAGA F4	13.8	4	7	5	3	3	5	2	1	8	4	42
TYANDAGA F1	13.8	4	3	5	3	2	4	6	2	5	4	38
ORCHARD F1	13.8	1	10	4	2	1	0	7	3	5	5	38
ORCHARD F2	13.8	4	9	1	6	1	3	1	2	7	3	37
PALMER F2	13.8	0	2	3	8	3	1	2	0	9	8	36
76M21	27.6	3	7	0	1	6	4	4	2	5	2	34
PT NELSON F2	4.1	2	5	1	5	2	7	7	0	1	3	33
13M27	27.6	4	3	1	6	6	4	4	2	1	1	32
76M30	27.6	2	1	1	6	3	6	3	5	1	4	32
INTERCHANGE F2	13.8	0	3	3	5	1	2	6	3	4	4	31
LOWVILLE F2	13.8	2	1	3	5	1	3	6	4	3	3	31
76M24	27.6	0	3	3	10	1	1	2	5	3	3	31
FAIRVIEW F2	13.8	4	2	2	2	4	8	2	4	2	0	30
280M3	27.6	0	4	5	1	3	1	3	1	8	4	30
39M36	27.6	3	1	1	4	4	0	6	4	3	2	28
TOWERLINE F1	13.8	1	2	5	1	3	7	1	0	4	2	26
FAIRWOOD F6	4.1	1	2	2	6	7	4	2	1	1	0	26
76M29	27.6	1	1	0	2	0	5	1	4	1	11	26
EASTERBROOK F3	4.1	1	4	2	1	0	2	4	8	1	2	25
76M27	27.6	2	0	3	1	2	3	3	3	4	4	25
SPRUCE F2	4.1	0	4	4	1	1	1	0	2	6	5	24
76M28	27.6	1	2	4	0	5	4	1	0	1	6	24
39M32	27.6	2	0	3	0	4	4	1	3	2	4	23
280M6	27.6	3	2	0	2	3	2	2	5	1	3	23
76M26	27.6	1	2	5	6	2	3	0	1	0	3	23

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
TOWERLINE F3	13.8	0	2	0	2	5	2	5	2	0	5	23
280M8	27.6	0	0	0	1	0	1	4	1	10	6	23
A4M6	27.6	4	3	2	6	1	3	0	2	0	1	22
76M23	27.6	4	2	2	3	1	2	1	4	2	1	22
39M35	27.6	1	4	2	4	0	6	2	1	0	2	22
WALKERS F1	4.1	4	0	5	7	0	0	2	1	0	2	21
WALKERS F4	4.1	2	1	1	6	0	2	2	3	1	3	21
76M25	27.6	2	0	3	6	2	2	1	2	2	0	20
39M31	27.6	0	2	2	1	1	1	2	5	2	3	19
13M28	27.6	1	1	2	1	1	0	3	2	6	2	19
MARLEY F3	4.1	3	1	1	3	2	4	1	2	1	1	19
PINEDALE F1	4.1	0	1	2	3	6	2	2	0	1	2	19
39M5	27.6	0	2	5	3	0	4	1	1	1	1	18
FAIRWOOD F4	4.1	1	2	3	3	0	1	1	6	0	1	18
39M1	27.6	4	3	0	2	3	1	2	1	0	2	18
76M22	27.6	0	4	1	2	1	1	2	4	1	0	16
BRIDGEVIEW F2	4.1	2	0	0	2	0	0	2	3	6	1	16
APPLEBY F1	4.1	1	0	4	2	0	3	1	0	0	5	16
PINECOVE F3	4.1	2	2	1	8	1	0	0	0	0	0	14
PINEDALE F2	4.1	1	5	1	1	0	0	1	2	2	1	14
FAIRLEIGH F2	4.1	1	0	3	2	0	1	3	1	1	2	14
SPRUCE F3	4.1	2	0	2	2	1	1	2	1	1	2	14
PINECOVE F1	4.1	0	0	0	7	2	2	1	1	0	1	14
WALKERS F2	4.1	0	2	3	1	1	1	1	0	3	2	14
FAIRWOOD F2	4.1	3	0	0	3	3	0	0	1	3	0	13
MAPLE F6	4.1	0	0	0	3	6	1	0	3	0	0	13
MARTHA F1	4.1	0	1	1	5	0	3	0	0	1	2	13
HAMPTON F1	4.1	0	0	3	5	2	0	0	0	1	0	11
PT NELSON F1	4.1	0	1	1	0	2	6	0	1	0	0	11
MT FOREST F2	4.1	0	2	0	0	1	1	2	5	0	0	11
13M26	27.6	0	0	0	3	0	1	1	2	2	2	11
LOWVILLE F4	13.8	1	0	4	1	0	1	2	0	0	2	11
SPRUCE F1	4.1	1	0	0	4	1	0	0	0	1	4	11
HOWARD F3	4.1	1	3	0	0	2	1	1	0	2	0	10
MAPLE F5	4.1	1	1	1	1	0	0	0	6	0	0	10
ELGIN F1	4.1	0	0	1	2	1	2	0	0	2	2	10
MAPLE F8	4.1	2	3	0	1	0	0	1	2	0	0	9

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
280M4	27.6	2	0	3	2	1	0	0	1	0	0	9
APPLEBY F4	4.1	0	0	1	2	1	0	1	1	2	1	9
A4M5	27.6	0	0	0	0	3	2	2	1	0	1	9
EASTERBROOK F1	4.1	0	1	0	0	0	0	1	1	3	3	9
39M2	27.6	2	2	0	2	1	1	0	0	0	0	8
39M4	27.6	1	0	0	1	0	1	1	2	1	1	8
WOODWARD F2	4.1	1	2	0	2	0	0	2	0	0	1	8
RESERVOIR F4	13.8	1	0	0	1	1	0	1	1	0	3	8
ELIZ GARDENS F3	4.1	0	1	4	1	1	0	0	0	0	1	8
MARTHA F7	4.1	2	1	1	0	0	1	3	0	0	0	8
PARTRIDGE F3	4.1	1	0	1	0	0	0	1	2	3	0	8
PARTRIDGE F1	4.1	1	0	0	0	0	2	1	1	1	2	8
PINECOVE F2	4.1	0	1	2	2	1	0	0	1	1	0	8
HARVESTER F1	4.1	0	1	1	3	0	0	1	2	0	0	8
MARLEY F1	4.1	0	0	1	1	0	1	1	0	3	1	8
EASTERBROOK F2	4.1	0	0	2	1	2	2	0	0	0	1	8
APPLEBY F2	4.1	1	0	1	0	1	0	0	1	2	2	8
MT FOREST F1	4.1	1	1	0	1	1	0	1	0	1	2	8
ELIZ GARDENS F1	4.1	0	0	4	2	0	0	0	0	0	2	8
WOODWARD F5	4.1	0	2	0	3	0	0	1	0	1	0	7
RESERVOIR F3	13.8	0	3	0	1	1	0	1	1	0	0	7
ELGIN F4	4.1	0	2	1	0	0	1	0	0	3	0	7
WOODWARD F6	4.1	1	0	0	3	1	0	1	1	0	0	7
39M6	27.6	2	0	1	1	0	0	0	1	1	1	7
APPLEBY F6	4.1	0	1	0	0	1	0	0	1	1	3	7
APPLEBY F5	4.1	1	1	0	0	0	0	0	1	1	3	7
MARTHA F6	4.1	0	1	0	0	0	1	2	0	1	1	6
RESERVOIR F2	13.8	0	2	2	1	0	0	0	0	1	0	6
13M25	27.6	1	0	0	0	0	1	1	0	1	2	6
MARTHA F2	4.1	0	1	0	2	0	0	0	2	1	0	6
280M5	27.6	0	0	0	2	2	0	2	0	0	0	6
GRAHAMS F4	4.1	4	1	0	0	0	0	1	0	0	0	6
PT NELSON F3	4.1	0	1	0	1	1	2	1	0	0	0	6
WOODWARD F3	4.1	0	0	0	0	0	1	0	3	0	2	6
MARLEY F2	4.1	0	0	0	1	0	0	1	1	2	0	5
39M34	27.6	0	0	0	0	1	1	2	0	0	1	5
BRIDGEVIEW F1	4.1	0	0	2	0	1	0	1	1	0	0	5

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
HARVESTER F3	4.1	0	0	0	1	0	0	1	1	2	0	5
39M33	27.6	2	0	0	1	0	0	1	1	0	0	5
FAIRVIEW F1	13.8	1	0	1	3	0	0	0	0	0	0	5
FAIRLEIGH F1	4.1	0	1	1	1	0	0	1	1	0	0	5
MAPLE F1	4.1	0	0	1	2	0	1	1	0	0	0	5
ELIZ GARDENS F2	4.1	0	2	0	0	0	0	2	0	0	1	5
BRANT F2	4.1	2	0	0	1	1	0	0	0	0	0	4
PARTRIDGE F2	4.1	1	2	0	0	0	0	0	0	1	0	4
GRAHAMS F2	4.1	1	0	0	0	0	0	1	2	0	0	4
HAMPTON F6	4.1	0	0	3	0	0	0	1	0	0	0	4
BRANT F3	4.1	0	0	0	1	2	0	0	0	1	0	4
DRURY F4	4.1	0	1	0	1	1	1	0	0	0	0	4
ELGIN F2	4.1	0	0	0	1	0	2	0	0	0	0	3
FAIRWOOD F5	4.1	0	0	0	1	0	0	1	0	0	1	3
WOODWARD F4	4.1	0	0	2	0	0	0	0	0	1	0	3
280M7	27.6	0	0	0	0	0	2	0	1	0	0	3
FAIRVIEW F4	13.8	0	0	0	3	0	0	0	0	0	0	3
HAMPTON F2	4.1	0	1	0	1	0	0	1	0	0	0	3
HOWARD F2	4.1	0	0	0	1	0	0	2	0	0	0	3
MAPLE F2	4.1	1	1	0	0	0	0	1	0	0	0	3
HAMPTON F3	4.1	0	0	0	0	0	0	0	2	0	1	3
HARVESTER F2	4.1	0	0	1	0	1	0	0	0	0	1	3
DRURY F1	4.1	0	0	0	2	0	0	0	0	0	0	2
SPRUCE F4	4.1	0	0	1	0	0	0	0	1	0	0	2
MARTHA F3	4.1	0	0	1	0	0	0	0	0	1	0	2
39M3	27.6	0	0	1	0	0	1	0	0	0	0	2
ELGIN F3	4.1	1	0	0	0	0	0	0	1	0	0	2
MT FOREST F3	4.1	0	0	0	0	1	0	0	0	0	1	2
PINEDALE F3	4.1	0	0	0	0	0	0	0	0	0	2	2
MARTHA F8	4.1	0	0	1	0	0	0	0	0	0	0	1
FAIRLEIGH F3	4.1	0	0	0	1	0	0	0	0	0	0	1
FAIRWOOD F1	4.1	0	0	0	0	0	1	0	0	0	0	1
FAIRWOOD F3	4.1	1	0	0	0	0	0	0	0	0	0	1
HAMPTON F4	4.1	0	1	0	0	0	0	0	0	0	0	1
HOWARD F1	4.1	0	0	1	0	0	0	0	0	0	0	1
MAPLE F3	4.1	0	0	0	1	0	0	0	0	0	0	1
MARTHA F5	4.1	0	0	0	0	0	1	0	0	0	0	1

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
WOODWARD F1	4.1	0	0	0	1	0	0	0	0	0	0	1
HAMPTON F5	4.1	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F3	4.1	0	0	0	0	0	0	0	0	0	0	0
BRANT F1	4.1	0	0	0	0	0	0	0	0	0	0	0
DRURY F2	4.1	0	0	0	0	0	0	0	0	0	0	0
DRURY F3	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F1	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F3	4.1	0	0	0	0	0	0	0	0	0	0	0
MAPLE F4	4.1	0	0	0	0	0	0	0	0	0	0	0
MAPLE F7	4.1	0	0	0	0	0	0	0	0	0	0	0
MARTHA F4	4.1	0	0	0	0	0	0	0	0	0	0	0
PT NELSON F4	4.1	0	0	0	0	0	0	0	0	0	0	0
WALKERS F3	4.1	0	0	0	0	0	0	0	0	0	0	0

APPENDIX A2

Feeder Auto-Reclosures Summary

(Sorted by 2024)

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
PALMER F1	13.8	8	7	5	9	4	7	10	6	10	12	78
PALMER F3	13.8	1	5	9	12	1	8	10	6	11	12	75
76M29	27.6	1	1	0	2	0	5	1	4	1	11	26
LOWVILLE F1	13.8	8	11	4	12	9	5	17	7	14	9	96
TOWERLINE F2	13.8	10	5	4	8	5	4	5	3	2	8	54
PALMER F2	13.8	0	2	3	8	3	1	2	0	9	8	36
PALMER F4	13.8	7	3	1	10	5	9	1	8	6	6	56
76M28	27.6	1	2	4	0	5	4	1	0	1	6	24
280M8	27.6	0	0	0	1	0	1	4	1	10	6	23
TYANDAGA F3	13.8	9	8	6	3	7	6	9	9	3	5	65
ORCHARD F1	13.8	1	10	4	2	1	0	7	3	5	5	38
SPRUCE F2	4.1	0	4	4	1	1	1	0	2	6	5	24
TOWERLINE F3	13.8	0	2	0	2	5	2	5	2	0	5	23
APPLEBY F1	4.1	1	0	4	2	0	3	1	0	0	5	16
TYANDAGA F4	13.8	4	7	5	3	3	5	2	1	8	4	42
TYANDAGA F1	13.8	4	3	5	3	2	4	6	2	5	4	38
76M30	27.6	2	1	1	6	3	6	3	5	1	4	32
INTERCHANGE F2	13.8	0	3	3	5	1	2	6	3	4	4	31
280M3	27.6	0	4	5	1	3	1	3	1	8	4	30
76M27	27.6	2	0	3	1	2	3	3	3	4	4	25
39M32	27.6	2	0	3	0	4	4	1	3	2	4	23
SPRUCE F1	4.1	1	0	0	4	1	0	0	0	1	4	11
ORCHARD F2	13.8	4	9	1	6	1	3	1	2	7	3	37
PT NELSON F2	4.1	2	5	1	5	2	7	7	0	1	3	33
LOWVILLE F2	13.8	2	1	3	5	1	3	6	4	3	3	31
76M24	27.6	0	3	3	10	1	1	2	5	3	3	31
280M6	27.6	3	2	0	2	3	2	2	5	1	3	23
76M26	27.6	1	2	5	6	2	3	0	1	0	3	23
WALKERS F4	4.1	2	1	1	6	0	2	2	3	1	3	21
39M31	27.6	0	2	2	1	1	1	2	5	2	3	19
EASTERBROOK F1	4.1	0	1	0	0	0	0	1	1	3	3	9
RESERVOIR F4	13.8	1	0	0	1	1	0	1	1	0	3	8
APPLEBY F6	4.1	0	1	0	0	1	0	0	1	1	3	7
APPLEBY F5	4.1	1	1	0	0	0	0	0	1	1	3	7
TOWERLINE F4	13.8	8	4	10	14	7	6	9	13	13	2	86
INTERCHANGE F1	13.8	1	10	7	9	5	8	12	15	4	2	73
LOWVILLE F3	13.8	4	1	6	11	2	5	29	0	4	2	64

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
76M21	27.6	3	7	0	1	6	4	4	2	5	2	34
39M36	27.6	3	1	1	4	4	0	6	4	3	2	28
TOWERLINE F1	13.8	1	2	5	1	3	7	1	0	4	2	26
EASTERBROOK F3	4.1	1	4	2	1	0	2	4	8	1	2	25
39M35	27.6	1	4	2	4	0	6	2	1	0	2	22
WALKERS F1	4.1	4	0	5	7	0	0	2	1	0	2	21
13M28	27.6	1	1	2	1	1	0	3	2	6	2	19
PINEDALE F1	4.1	0	1	2	3	6	2	2	0	1	2	19
39M1	27.6	4	3	0	2	3	1	2	1	0	2	18
FAIRLEIGH F2	4.1	1	0	3	2	0	1	3	1	1	2	14
SPRUCE F3	4.1	2	0	2	2	1	1	2	1	1	2	14
WALKERS F2	4.1	0	2	3	1	1	1	1	0	3	2	14
MARTHA F1	4.1	0	1	1	5	0	3	0	0	1	2	13
13M26	27.6	0	0	0	3	0	1	1	2	2	2	11
LOWVILLE F4	13.8	1	0	4	1	0	1	2	0	0	2	11
ELGIN F1	4.1	0	0	1	2	1	2	0	0	2	2	10
PARTRIDGE F1	4.1	1	0	0	0	0	2	1	1	1	2	8
APPLEBY F2	4.1	1	0	1	0	1	0	0	1	2	2	8
MT FOREST F1	4.1	1	1	0	1	1	0	1	0	1	2	8
ELIZ GARDENS F1	4.1	0	0	4	2	0	0	0	0	0	2	8
13M25	27.6	1	0	0	0	0	1	1	0	1	2	6
WOODWARD F3	4.1	0	0	0	0	0	1	0	3	0	2	6
PINEDALE F3	4.1	0	0	0	0	0	0	0	0	0	2	2
RESERVOIR F1	13.8	10	10	15	10	7	2	4	4	6	1	69
13M27	27.6	4	3	1	6	6	4	4	2	1	1	32
A4M6	27.6	4	3	2	6	1	3	0	2	0	1	22
76M23	27.6	4	2	2	3	1	2	1	4	2	1	22
MARLEY F3	4.1	3	1	1	3	2	4	1	2	1	1	19
39M5	27.6	0	2	5	3	0	4	1	1	1	1	18
FAIRWOOD F4	4.1	1	2	3	3	0	1	1	6	0	1	18
BRIDGEVIEW F2	4.1	2	0	0	2	0	0	2	3	6	1	16
PINEDALE F2	4.1	1	5	1	1	0	0	1	2	2	1	14
PINECOVE F1	4.1	0	0	0	7	2	2	1	1	0	1	14
APPLEBY F4	4.1	0	0	1	2	1	0	1	1	2	1	9
A4M5	27.6	0	0	0	0	3	2	2	1	0	1	9
39M4	27.6	1	0	0	1	0	1	1	2	1	1	8
WOODWARD F2	4.1	1	2	0	2	0	0	2	0	0	1	8

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
ELIZ GARDENS F3	4.1	0	1	4	1	1	0	0	0	0	1	8
MARLEY F1	4.1	0	0	1	1	0	1	1	0	3	1	8
EASTERBROOK F2	4.1	0	0	2	1	2	2	0	0	0	1	8
39M6	27.6	2	0	1	1	0	0	0	1	1	1	7
MARTHA F6	4.1	0	1	0	0	0	1	2	0	1	1	6
39M34	27.6	0	0	0	0	1	1	2	0	0	1	5
ELIZ GARDENS F2	4.1	0	2	0	0	0	0	2	0	0	1	5
FAIRWOOD F5	4.1	0	0	0	1	0	0	1	0	0	1	3
HAMPTON F3	4.1	0	0	0	0	0	0	0	2	0	1	3
HARVESTER F2	4.1	0	0	1	0	1	0	0	0	0	1	3
MT FOREST F3	4.1	0	0	0	0	1	0	0	0	0	1	2
TYANDAGA F2	13.8	5	4	13	12	10	10	9	1	0	0	64
FAIRVIEW F3	13.8	10	11	10	10	1	6	3	1	3	0	55
FAIRVIEW F2	13.8	4	2	2	2	4	8	2	4	2	0	30
FAIRWOOD F6	4.1	1	2	2	6	7	4	2	1	1	0	26
76M25	27.6	2	0	3	6	2	2	1	2	2	0	20
76M22	27.6	0	4	1	2	1	1	2	4	1	0	16
PINECOVE F3	4.1	2	2	1	8	1	0	0	0	0	0	14
FAIRWOOD F2	4.1	3	0	0	3	3	0	0	1	3	0	13
MAPLE F6	4.1	0	0	0	3	6	1	0	3	0	0	13
HAMPTON F1	4.1	0	0	3	5	2	0	0	0	1	0	11
PT NELSON F1	4.1	0	1	1	0	2	6	0	1	0	0	11
MT FOREST F2	4.1	0	2	0	0	1	1	2	5	0	0	11
HOWARD F3	4.1	1	3	0	0	2	1	1	0	2	0	10
MAPLE F5	4.1	1	1	1	1	0	0	0	6	0	0	10
MAPLE F8	4.1	2	3	0	1	0	0	1	2	0	0	9
280M4	27.6	2	0	3	2	1	0	0	1	0	0	9
39M2	27.6	2	2	0	2	1	1	0	0	0	0	8
MARTHA F7	4.1	2	1	1	0	0	1	3	0	0	0	8
PARTRIDGE F3	4.1	1	0	1	0	0	0	1	2	3	0	8
PINECOVE F2	4.1	0	1	2	2	1	0	0	1	1	0	8
HARVESTER F1	4.1	0	1	1	3	0	0	1	2	0	0	8
WOODWARD F5	4.1	0	2	0	3	0	0	1	0	1	0	7
RESERVOIR F3	13.8	0	3	0	1	1	0	1	1	0	0	7
ELGIN F4	4.1	0	2	1	0	0	1	0	0	3	0	7
WOODWARD F6	4.1	1	0	0	3	1	0	1	1	0	0	7
RESERVOIR F2	13.8	0	2	2	1	0	0	0	0	1	0	6

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
MARTHA F2	4.1	0	1	0	2	0	0	0	2	1	0	6
280M5	27.6	0	0	0	2	2	0	2	0	0	0	6
GRAHAMS F4	4.1	4	1	0	0	0	0	1	0	0	0	6
PT NELSON F3	4.1	0	1	0	1	1	2	1	0	0	0	6
MARLEY F2	4.1	0	0	0	1	0	0	1	1	2	0	5
BRIDGEVIEW F1	4.1	0	0	2	0	1	0	1	1	0	0	5
HARVESTER F3	4.1	0	0	0	1	0	0	1	1	2	0	5
39M33	27.6	2	0	0	1	0	0	1	1	0	0	5
FAIRVIEW F1	13.8	1	0	1	3	0	0	0	0	0	0	5
FAIRLEIGH F1	4.1	0	1	1	1	0	0	1	1	0	0	5
MAPLE F1	4.1	0	0	1	2	0	1	1	0	0	0	5
BRANT F2	4.1	2	0	0	1	1	0	0	0	0	0	4
PARTRIDGE F2	4.1	1	2	0	0	0	0	0	0	1	0	4
GRAHAMS F2	4.1	1	0	0	0	0	0	1	2	0	0	4
HAMPTON F6	4.1	0	0	3	0	0	0	1	0	0	0	4
BRANT F3	4.1	0	0	0	1	2	0	0	0	1	0	4
DRURY F4	4.1	0	1	0	1	1	1	0	0	0	0	4
ELGIN F2	4.1	0	0	0	1	0	2	0	0	0	0	3
WOODWARD F4	4.1	0	0	2	0	0	0	0	0	1	0	3
280M7	27.6	0	0	0	0	0	2	0	1	0	0	3
FAIRVIEW F4	13.8	0	0	0	3	0	0	0	0	0	0	3
HAMPTON F2	4.1	0	1	0	1	0	0	1	0	0	0	3
HOWARD F2	4.1	0	0	0	1	0	0	2	0	0	0	3
MAPLE F2	4.1	1	1	0	0	0	0	1	0	0	0	3
DRURY F1	4.1	0	0	0	2	0	0	0	0	0	0	2
SPRUCE F4	4.1	0	0	1	0	0	0	0	1	0	0	2
MARTHA F3	4.1	0	0	1	0	0	0	0	0	1	0	2
39M3	27.6	0	0	1	0	0	1	0	0	0	0	2
ELGIN F3	4.1	1	0	0	0	0	0	0	1	0	0	2
MARTHA F8	4.1	0	0	1	0	0	0	0	0	0	0	1
FAIRLEIGH F3	4.1	0	0	0	1	0	0	0	0	0	0	1
FAIRWOOD F1	4.1	0	0	0	0	0	1	0	0	0	0	1
FAIRWOOD F3	4.1	1	0	0	0	0	0	0	0	0	0	1
HAMPTON F4	4.1	0	1	0	0	0	0	0	0	0	0	1
HOWARD F1	4.1	0	0	1	0	0	0	0	0	0	0	1
MAPLE F3	4.1	0	0	0	1	0	0	0	0	0	0	1
MARTHA F5	4.1	0	0	0	0	0	1	0	0	0	0	1

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
WOODWARD F1	4.1	0	0	0	1	0	0	0	0	0	0	1
HAMPTON F5	4.1	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F3	4.1	0	0	0	0	0	0	0	0	0	0	0
BRANT F1	4.1	0	0	0	0	0	0	0	0	0	0	0
DRURY F2	4.1	0	0	0	0	0	0	0	0	0	0	0
DRURY F3	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F1	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F3	4.1	0	0	0	0	0	0	0	0	0	0	0
MAPLE F4	4.1	0	0	0	0	0	0	0	0	0	0	0
MAPLE F7	4.1	0	0	0	0	0	0	0	0	0	0	0
MARTHA F4	4.1	0	0	0	0	0	0	0	0	0	0	0
PT NELSON F4	4.1	0	0	0	0	0	0	0	0	0	0	0
WALKERS F3	4.1	0	0	0	0	0	0	0	0	0	0	0

APPENDIX A3

Feeder Lock-Outs Summary

(Sorted by Total)

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
BRIDGEVIEW F1	4.1	4	10	1	6	2	0	1	1	3	1	29
BRANT F3	4.1	3	3	3	8	2	0	2	3	0	2	26
76M26	27.6	0	1	2	2	3	2	1	4	1	0	16
ELGIN F4	4.1	1	0	8	1	1	0	3	0	0	2	16
39M31	27.6	8	0	2	0	0	1	1	0	1	2	15
39M1	27.6	5	3	0	1	0	0	0	2	0	3	14
DRURY F2	4.1	2	1	7	0	1	0	0	1	0	1	13
TOWERLINE F2	13.8	1	0	2	2	0	3	2	1	0	2	13
39M5	27.6	2	2	1	2	2	1	0	2	0	0	12
A4M6	27.6	3	0	1	6	2	0	0	0	0	0	12
TYANDAGA F1	13.8	7	3	1	0	0	1	0	0	0	0	12
TYANDAGA F3	13.8	4	1	1	1	1	1	2	1	0	0	12
280M6	27.6	1	1	0	0	0	3	1	1	2	2	11
39M2	27.6	4	0	0	1	1	1	2	1	1	0	11
BRANT F2	4.1	2	0	0	2	2	1	3	0	0	1	11
SPRUCE F3	4.1	0	2	2	2	0	0	1	1	1	2	11
DRURY F1	4.1	0	1	4	1	0	0	1	1	1	1	10
DRURY F3	4.1	0	0	2	3	1	1	0	1	1	1	10
FAIRLEIGH F2	4.1	2	0	0	1	1	2	2	0	2	0	10
INTERCHANGE F1	13.8	0	1	4	1	0	0	2	0	0	1	9
APPLEBY F2	4.1	3	0	4	0	1	0	0	0	0	0	8
APPLEBY F5	4.1	1	0	0	1	0	0	3	3	0	0	8
BRANT F1	4.1	0	1	1	0	2	1	0	3	0	0	8
BRIDGEVIEW F2	4.1	1	1	0	2	1	2	0	1	0	0	8
HAMPTON F1	4.1	2	1	3	0	1	0	0	0	0	1	8
39M3	27.6	2	3	0	0	1	0	0	1	0	0	7
76M23	27.6	1	2	0	0	1	1	1	0	1	0	7
PT NELSON F1	4.1	0	0	0	0	4	3	0	0	0	0	7
280M3	27.6	0	2	0	1	0	1	0	2	0	0	6
280M8	27.6	0	0	0	0	0	2	1	0	2	1	6
39M35	27.6	0	0	2	1	1	0	1	0	1	0	6
39M36	27.6	1	0	0	0	2	1	0	0	0	2	6
76M21	27.6	1	0	0	2	1	1	1	0	0	0	6
76M25	27.6	0	3	0	0	1	0	0	0	2	0	6
MARTHA F2	4.1	0	1	1	0	0	1	0	2	0	1	6
ORCHARD F2	13.8	2	0	1	0	0	1	1	0	0	1	6
TYANDAGA F2	13.8	0	1	1	0	0	0	1	2	1	0	6

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
WALKERS F1	4.1	2	1	1	1	0	0	0	0	1	0	6
13M25	27.6	0	4	0	0	0	0	0	0	0	1	5
13M27	27.6	0	0	1	0	0	1	0	2	0	1	5
280M4	27.6	0	0	2	0	0	2	0	0	1	0	5
39M4	27.6	0	0	0	2	1	1	0	0	0	1	5
76M27	27.6	0	0	0	0	0	1	1	1	1	1	5
MAPLE F2	4.1	1	0	0	0	4	0	0	0	0	0	5
MAPLE F6	4.1	2	0	0	0	0	0	0	0	1	2	5
RESERVOIR F2	13.8	2	0	0	0	1	0	0	0	2	0	5
SPRUCE F1	4.1	0	0	1	2	1	0	0	0	1	0	5
76M24	27.6	1	0	2	0	0	0	0	0	1	0	4
APPLEBY F3	4.1	0	0	0	2	1	1	0	0	0	0	4
APPLEBY F6	4.1	0	0	1	1	1	0	0	1	0	0	4
EASTERBROOK F2	4.1	0	1	2	0	0	0	0	0	1	0	4
ELGIN F1	4.1	0	3	0	0	1	0	0	0	0	0	4
ELIZ GARDENS F2	4.1	0	0	0	0	1	0	1	1	0	1	4
ELIZ GARDENS F3	4.1	0	0	0	2	1	1	0	0	0	0	4
PARTRIDGE F1	4.1	2	0	0	1	1	0	0	0	0	0	4
RESERVOIR F1	13.8	0	1	0	1	0	0	0	0	0	2	4
39M32	27.6	1	0	0	0	2	0	0	0	0	0	3
76M29	27.6	0	0	0	1	0	1	0	0	0	1	3
76M30	27.6	0	0	0	1	0	0	0	1	1	0	3
EASTERBROOK F3	4.1	0	1	0	0	0	2	0	0	0	0	3
FAIRVIEW F4	13.8	0	1	0	0	0	1	0	0	1	0	3
FAIRWOOD F4	4.1	0	0	0	0	0	1	2	0	0	0	3
GRAHAMS F2	4.1	0	1	0	0	1	0	0	0	0	1	3
HOWARD F1	4.1	0	0	0	0	1	0	0	1	0	1	3
HOWARD F3	4.1	0	0	1	2	0	0	0	0	0	0	3
LOWVILLE F4	13.8	0	2	0	1	0	0	0	0	0	0	3
MARTHA F1	4.1	0	1	2	0	0	0	0	0	0	0	3
MARTHA F4	4.1	0	0	0	1	2	0	0	0	0	0	3
MARTHA F7	4.1	0	0	0	0	2	0	0	0	1	0	3
SPRUCE F2	4.1	0	0	1	0	1	0	1	0	0	0	3
TYANDAGA F4	13.8	0	1	1	0	0	1	0	0	0	0	3
WALKERS F3	4.1	1	1	0	1	0	0	0	0	0	0	3
13M26	27.6	0	1	0	0	0	0	0	0	0	1	2
280M5	27.6	0	1	0	0	0	1	0	0	0	0	2

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
39M34	27.6	1	0	0	0	1	0	0	0	0	0	2
39M6	27.6	1	0	0	0	0	0	0	1	0	0	2
A4M5	27.6	1	0	1	0	0	0	0	0	0	0	2
DRURY F4	4.1	0	0	1	0	0	0	0	0	0	1	2
EASTERBROOK F1	4.1	0	0	0	1	0	0	0	0	0	1	2
FAIRLEIGH F3	4.1	0	0	1	0	0	0	0	0	0	1	2
FAIRVIEW F1	13.8	1	0	1	0	0	0	0	0	0	0	2
HAMPTON F5	4.1	0	0	0	2	0	0	0	0	0	0	2
MAPLE F1	4.1	0	0	0	0	0	0	1	1	0	0	2
MAPLE F8	4.1	0	0	0	2	0	0	0	0	0	0	2
MARTHA F8	4.1	0	0	0	0	0	1	0	1	0	0	2
PALMER F2	13.8	0	0	0	0	0	2	0	0	0	0	2
PT NELSON F4	4.1	0	2	0	0	0	0	0	0	0	0	2
RESERVOIR F4	13.8	0	0	1	0	0	0	0	1	0	0	2
TOWERLINE F4	13.8	0	0	1	0	0	0	1	0	0	0	2
WALKERS F2	4.1	1	0	0	0	0	0	0	1	0	0	2
WOODWARD F5	4.1	0	0	0	1	0	0	1	0	0	0	2
13M28	27.6	0	0	0	0	0	0	0	1	0	0	1
280M7	27.6	0	0	0	0	0	1	0	0	0	0	1
APPLEBY F4	4.1	0	0	1	0	0	0	0	0	0	0	1
FAIRLEIGH F1	4.1	0	0	0	0	0	0	0	1	0	0	1
FAIRWOOD F3	4.1	0	0	0	0	1	0	0	0	0	0	1
FAIRWOOD F6	4.1	0	0	0	0	0	0	0	1	0	0	1
HAMPTON F2	4.1	0	0	0	0	0	1	0	0	0	0	1
HAMPTON F3	4.1	0	0	0	0	0	0	0	0	1	0	1
HAMPTON F4	4.1	0	0	0	0	0	0	1	0	0	0	1
HAMPTON F6	4.1	0	1	0	0	0	0	0	0	0	0	1
HARVESTER F3	4.1	1	0	0	0	0	0	0	0	0	0	1
INTERCHANGE F2	13.8	0	0	0	1	0	0	0	0	0	0	1
MAPLE F5	4.1	0	0	0	0	1	0	0	0	0	0	1
MAPLE F7	4.1	0	0	0	0	0	0	0	1	0	0	1
MARLEY F2	4.1	0	0	0	0	0	0	0	0	1	0	1
MARTHA F3	4.1	0	0	1	0	0	0	0	0	0	0	1
MARTHA F5	4.1	0	0	0	1	0	0	0	0	0	0	1
MT FOREST F1	4.1	0	0	0	0	0	1	0	0	0	0	1
PALMER F3	13.8	0	0	0	0	0	0	1	0	0	0	1
PARTRIDGE F2	4.1	0	0	0	0	1	0	0	0	0	0	1

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
PARTRIDGE F3	4.1	0	0	0	1	0	0	0	0	0	0	1
PINECOVE F3	4.1	0	0	0	0	0	0	0	1	0	0	1
PINEDALE F2	4.1	0	1	0	0	0	0	0	0	0	0	1
PT NELSON F3	4.1	0	0	0	0	0	0	0	1	0	0	1
RESERVOIR F3	13.8	0	0	0	1	0	0	0	0	0	0	1
TOWERLINE F1	13.8	0	1	0	0	0	0	0	0	0	0	1
TOWERLINE F3	13.8	0	1	0	0	0	0	0	0	0	0	1
WOODWARD F3	4.1	0	0	1	0	0	0	0	0	0	0	1
WOODWARD F4	4.1	0	1	0	0	0	0	0	0	0	0	1
39M33	27.6	0	0	0	0	0	0	0	0	0	0	0
76M22	27.6	0	0	0	0	0	0	0	0	0	0	0
76M28	27.6	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F1	4.1	0	0	0	0	0	0	0	0	0	0	0
ELGIN F2	4.1	0	0	0	0	0	0	0	0	0	0	0
ELGIN F3	4.1	0	0	0	0	0	0	0	0	0	0	0
ELIZ GARDENS F1	4.1	0	0	0	0	0	0	0	0	0	0	0
FAIRVIEW F2	13.8	0	0	0	0	0	0	0	0	0	0	0
FAIRVIEW F3	13.8	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F1	4.1	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F2	4.1	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F5	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F1	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F3	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F4	4.1	0	0	0	0	0	0	0	0	0	0	0
HARVESTER F1	4.1	0	0	0	0	0	0	0	0	0	0	0
HARVESTER F2	4.1	0	0	0	0	0	0	0	0	0	0	0
HOWARD F2	4.1	0	0	0	0	0	0	0	0	0	0	0
LOWVILLE F1	13.8	0	0	0	0	0	0	0	0	0	0	0
LOWVILLE F2	13.8	0	0	0	0	0	0	0	0	0	0	0
LOWVILLE F3	13.8	0	0	0	0	0	0	0	0	0	0	0
MAPLE F3	4.1	0	0	0	0	0	0	0	0	0	0	0
MAPLE F4	4.1	0	0	0	0	0	0	0	0	0	0	0
MARLEY F1	4.1	0	0	0	0	0	0	0	0	0	0	0
MARLEY F3	4.1	0	0	0	0	0	0	0	0	0	0	0
MARTHA F6	4.1	0	0	0	0	0	0	0	0	0	0	0
MT FOREST F2	4.1	0	0	0	0	0	0	0	0	0	0	0
MT FOREST F3	4.1	0	0	0	0	0	0	0	0	0	0	0

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
ORCHARD F1	13.8	0	0	0	0	0	0	0	0	0	0	0
PALMER F1	13.8	0	0	0	0	0	0	0	0	0	0	0
PALMER F4	13.8	0	0	0	0	0	0	0	0	0	0	0
PINECOVE F1	4.1	0	0	0	0	0	0	0	0	0	0	0
PINECOVE F2	4.1	0	0	0	0	0	0	0	0	0	0	0
PINEDALE F1	4.1	0	0	0	0	0	0	0	0	0	0	0
PINEDALE F3	4.1	0	0	0	0	0	0	0	0	0	0	0
PT NELSON F2	4.1	0	0	0	0	0	0	0	0	0	0	0
SPRUCE F4	4.1	0	0	0	0	0	0	0	0	0	0	0
WALKERS F4	4.1	0	0	0	0	0	0	0	0	0	0	0
WOODWARD F1	4.1	0	0	0	0	0	0	0	0	0	0	0
WOODWARD F2	4.1	0	0	0	0	0	0	0	0	0	0	0
WOODWARD F6	4.1	0	0	0	0	0	0	0	0	0	0	0

APPENDIX A4

Feeder Lock-Out Summary

(Sorted by 2024)

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
39M1	27.6	5	3	0	1	0	0	0	2	0	3	14
BRANT F3	4.1	3	3	3	8	2	0	2	3	0	2	26
ELGIN F4	4.1	1	0	8	1	1	0	3	0	0	2	16
39M31	27.6	8	0	2	0	0	1	1	0	1	2	15
TOWERLINE F2	13.8	1	0	2	2	0	3	2	1	0	2	13
280M6	27.6	1	1	0	0	0	3	1	1	2	2	11
SPRUCE F3	4.1	0	2	2	2	0	0	1	1	1	2	11
39M36	27.6	1	0	0	0	2	1	0	0	0	2	6
MAPLE F6	4.1	2	0	0	0	0	0	0	0	1	2	5
RESERVOIR F1	13.8	0	1	0	1	0	0	0	0	0	2	4
BRIDGEVIEW F1	4.1	4	10	1	6	2	0	1	1	3	1	29
DRURY F2	4.1	2	1	7	0	1	0	0	1	0	1	13
BRANT F2	4.1	2	0	0	2	2	1	3	0	0	1	11
DRURY F1	4.1	0	1	4	1	0	0	1	1	1	1	10
DRURY F3	4.1	0	0	2	3	1	1	0	1	1	1	10
INTERCHANGE F1	13.8	0	1	4	1	0	0	2	0	0	1	9
HAMPTON F1	4.1	2	1	3	0	1	0	0	0	0	1	8
280M8	27.6	0	0	0	0	0	2	1	0	2	1	6
MARTHA F2	4.1	0	1	1	0	0	1	0	2	0	1	6
ORCHARD F2	13.8	2	0	1	0	0	1	1	0	0	1	6
13M25	27.6	0	4	0	0	0	0	0	0	0	1	5
13M27	27.6	0	0	1	0	0	1	0	2	0	1	5
39M4	27.6	0	0	0	2	1	1	0	0	0	1	5
76M27	27.6	0	0	0	0	0	1	1	1	1	1	5
ELIZ GARDENS F2	4.1	0	0	0	0	1	0	1	1	0	1	4
76M29	27.6	0	0	0	1	0	1	0	0	0	1	3
GRAHAMS F2	4.1	0	1	0	0	1	0	0	0	0	1	3
HOWARD F1	4.1	0	0	0	0	1	0	0	1	0	1	3
13M26	27.6	0	1	0	0	0	0	0	0	0	1	2
DRURY F4	4.1	0	0	1	0	0	0	0	0	0	1	2
EASTERBROOK F1	4.1	0	0	0	1	0	0	0	0	0	1	2
FAIRLEIGH F3	4.1	0	0	1	0	0	0	0	0	0	1	2
76M26	27.6	0	1	2	2	3	2	1	4	1	0	16
39M5	27.6	2	2	1	2	2	1	0	2	0	0	12
A4M6	27.6	3	0	1	6	2	0	0	0	0	0	12
TYANDAGA F1	13.8	7	3	1	0	0	1	0	0	0	0	12
TYANDAGA F3	13.8	4	1	1	1	1	1	2	1	0	0	12

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
39M2	27.6	4	0	0	1	1	1	2	1	1	0	11
FAIRLEIGH F2	4.1	2	0	0	1	1	2	2	0	2	0	10
APPLEBY F2	4.1	3	0	4	0	1	0	0	0	0	0	8
APPLEBY F5	4.1	1	0	0	1	0	0	3	3	0	0	8
BRANT F1	4.1	0	1	1	0	2	1	0	3	0	0	8
BRIDGEVIEW F2	4.1	1	1	0	2	1	2	0	1	0	0	8
39M3	27.6	2	3	0	0	1	0	0	1	0	0	7
76M23	27.6	1	2	0	0	1	1	1	0	1	0	7
PT NELSON F1	4.1	0	0	0	0	4	3	0	0	0	0	7
280M3	27.6	0	2	0	1	0	1	0	2	0	0	6
39M35	27.6	0	0	2	1	1	0	1	0	1	0	6
76M21	27.6	1	0	0	2	1	1	1	0	0	0	6
76M25	27.6	0	3	0	0	1	0	0	0	2	0	6
TYANDAGA F2	13.8	0	1	1	0	0	0	1	2	1	0	6
WALKERS F1	4.1	2	1	1	1	0	0	0	0	1	0	6
280M4	27.6	0	0	2	0	0	2	0	0	1	0	5
MAPLE F2	4.1	1	0	0	0	4	0	0	0	0	0	5
RESERVOIR F2	13.8	2	0	0	0	1	0	0	0	2	0	5
SPRUCE F1	4.1	0	0	1	2	1	0	0	0	1	0	5
76M24	27.6	1	0	2	0	0	0	0	0	1	0	4
APPLEBY F3	4.1	0	0	0	2	1	1	0	0	0	0	4
APPLEBY F6	4.1	0	0	1	1	1	0	0	1	0	0	4
EASTERBROOK F2	4.1	0	1	2	0	0	0	0	0	1	0	4
ELGIN F1	4.1	0	3	0	0	1	0	0	0	0	0	4
ELIZ GARDENS F3	4.1	0	0	0	2	1	1	0	0	0	0	4
PARTRIDGE F1	4.1	2	0	0	1	1	0	0	0	0	0	4
39M32	27.6	1	0	0	0	2	0	0	0	0	0	3
76M30	27.6	0	0	0	1	0	0	0	1	1	0	3
EASTERBROOK F3	4.1	0	1	0	0	0	2	0	0	0	0	3
FAIRVIEW F4	13.8	0	1	0	0	0	1	0	0	1	0	3
FAIRWOOD F4	4.1	0	0	0	0	0	1	2	0	0	0	3
HOWARD F3	4.1	0	0	1	2	0	0	0	0	0	0	3
LOWVILLE F4	13.8	0	2	0	1	0	0	0	0	0	0	3
MARTHA F1	4.1	0	1	2	0	0	0	0	0	0	0	3
MARTHA F4	4.1	0	0	0	1	2	0	0	0	0	0	3
MARTHA F7	4.1	0	0	0	0	2	0	0	0	1	0	3
SPRUCE F2	4.1	0	0	1	0	1	0	1	0	0	0	3

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
TYANDAGA F4	13.8	0	1	1	0	0	1	0	0	0	0	3
WALKERS F3	4.1	1	1	0	1	0	0	0	0	0	0	3
280M5	27.6	0	1	0	0	0	1	0	0	0	0	2
39M34	27.6	1	0	0	0	1	0	0	0	0	0	2
39M6	27.6	1	0	0	0	0	0	0	1	0	0	2
A4M5	27.6	1	0	1	0	0	0	0	0	0	0	2
FAIRVIEW F1	13.8	1	0	1	0	0	0	0	0	0	0	2
HAMPTON F5	4.1	0	0	0	2	0	0	0	0	0	0	2
MAPLE F1	4.1	0	0	0	0	0	0	1	1	0	0	2
MAPLE F8	4.1	0	0	0	2	0	0	0	0	0	0	2
MARTHA F8	4.1	0	0	0	0	0	1	0	1	0	0	2
PALMER F2	13.8	0	0	0	0	0	2	0	0	0	0	2
PT NELSON F4	4.1	0	2	0	0	0	0	0	0	0	0	2
RESERVOIR F4	13.8	0	0	1	0	0	0	0	1	0	0	2
TOWERLINE F4	13.8	0	0	1	0	0	0	1	0	0	0	2
WALKERS F2	4.1	1	0	0	0	0	0	0	1	0	0	2
WOODWARD F5	4.1	0	0	0	1	0	0	1	0	0	0	2
13M28	27.6	0	0	0	0	0	0	0	1	0	0	1
280M7	27.6	0	0	0	0	0	1	0	0	0	0	1
APPLEBY F4	4.1	0	0	1	0	0	0	0	0	0	0	1
FAIRLEIGH F1	4.1	0	0	0	0	0	0	0	1	0	0	1
FAIRWOOD F3	4.1	0	0	0	0	1	0	0	0	0	0	1
FAIRWOOD F6	4.1	0	0	0	0	0	0	0	1	0	0	1
HAMPTON F2	4.1	0	0	0	0	0	1	0	0	0	0	1
HAMPTON F3	4.1	0	0	0	0	0	0	0	0	1	0	1
HAMPTON F4	4.1	0	0	0	0	0	0	1	0	0	0	1
HAMPTON F6	4.1	0	1	0	0	0	0	0	0	0	0	1
HARVESTER F3	4.1	1	0	0	0	0	0	0	0	0	0	1
INTERCHANGE F2	13.8	0	0	0	1	0	0	0	0	0	0	1
MAPLE F5	4.1	0	0	0	0	1	0	0	0	0	0	1
MAPLE F7	4.1	0	0	0	0	0	0	0	1	0	0	1
MARLEY F2	4.1	0	0	0	0	0	0	0	0	1	0	1
MARTHA F3	4.1	0	0	1	0	0	0	0	0	0	0	1
MARTHA F5	4.1	0	0	0	1	0	0	0	0	0	0	1
MT FOREST F1	4.1	0	0	0	0	0	1	0	0	0	0	1
PALMER F3	13.8	0	0	0	0	0	0	1	0	0	0	1
PARTRIDGE F2	4.1	0	0	0	0	1	0	0	0	0	0	1

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
PARTRIDGE F3	4.1	0	0	0	1	0	0	0	0	0	0	1
PINECOVE F3	4.1	0	0	0	0	0	0	0	1	0	0	1
PINEDALE F2	4.1	0	1	0	0	0	0	0	0	0	0	1
PT NELSON F3	4.1	0	0	0	0	0	0	0	1	0	0	1
RESERVOIR F3	13.8	0	0	0	1	0	0	0	0	0	0	1
TOWERLINE F1	13.8	0	1	0	0	0	0	0	0	0	0	1
TOWERLINE F3	13.8	0	1	0	0	0	0	0	0	0	0	1
WOODWARD F3	4.1	0	0	1	0	0	0	0	0	0	0	1
WOODWARD F4	4.1	0	1	0	0	0	0	0	0	0	0	1
39M33	27.6	0	0	0	0	0	0	0	0	0	0	0
76M22	27.6	0	0	0	0	0	0	0	0	0	0	0
76M28	27.6	0	0	0	0	0	0	0	0	0	0	0
APPLEBY F1	4.1	0	0	0	0	0	0	0	0	0	0	0
ELGIN F2	4.1	0	0	0	0	0	0	0	0	0	0	0
ELGIN F3	4.1	0	0	0	0	0	0	0	0	0	0	0
ELIZ GARDENS F1	4.1	0	0	0	0	0	0	0	0	0	0	0
FAIRVIEW F2	13.8	0	0	0	0	0	0	0	0	0	0	0
FAIRVIEW F3	13.8	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F1	4.1	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F2	4.1	0	0	0	0	0	0	0	0	0	0	0
FAIRWOOD F5	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F1	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F3	4.1	0	0	0	0	0	0	0	0	0	0	0
GRAHAMS F4	4.1	0	0	0	0	0	0	0	0	0	0	0
HARVESTER F1	4.1	0	0	0	0	0	0	0	0	0	0	0
HARVESTER F2	4.1	0	0	0	0	0	0	0	0	0	0	0
HOWARD F2	4.1	0	0	0	0	0	0	0	0	0	0	0
LOWVILLE F1	13.8	0	0	0	0	0	0	0	0	0	0	0
LOWVILLE F2	13.8	0	0	0	0	0	0	0	0	0	0	0
LOWVILLE F3	13.8	0	0	0	0	0	0	0	0	0	0	0
MAPLE F3	4.1	0	0	0	0	0	0	0	0	0	0	0
MAPLE F4	4.1	0	0	0	0	0	0	0	0	0	0	0
MARLEY F1	4.1	0	0	0	0	0	0	0	0	0	0	0
MARLEY F3	4.1	0	0	0	0	0	0	0	0	0	0	0
MARTHA F6	4.1	0	0	0	0	0	0	0	0	0	0	0
MT FOREST F2	4.1	0	0	0	0	0	0	0	0	0	0	0
MT FOREST F3	4.1	0	0	0	0	0	0	0	0	0	0	0

FEEDER	VOLTAGE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTALS (2015-2024)
ORCHARD F1	13.8	0	0	0	0	0	0	0	0	0	0	0
PALMER F1	13.8	0	0	0	0	0	0	0	0	0	0	0
PALMER F4	13.8	0	0	0	0	0	0	0	0	0	0	0
PINECOVE F1	4.1	0	0	0	0	0	0	0	0	0	0	0
PINECOVE F2	4.1	0	0	0	0	0	0	0	0	0	0	0
PINEDALE F1	4.1	0	0	0	0	0	0	0	0	0	0	0
PINEDALE F3	4.1	0	0	0	0	0	0	0	0	0	0	0
PT NELSON F2	4.1	0	0	0	0	0	0	0	0	0	0	0
SPRUCE F4	4.1	0	0	0	0	0	0	0	0	0	0	0
WALKERS F4	4.1	0	0	0	0	0	0	0	0	0	0	0
WOODWARD F1	4.1	0	0	0	0	0	0	0	0	0	0	0
WOODWARD F2	4.1	0	0	0	0	0	0	0	0	0	0	0
WOODWARD F6	4.1	0	0	0	0	0	0	0	0	0	0	0

APPENDIX B1

Feeder Outage Report

(27.6 kV Feeders)

Feeder Outage Report 280M6

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
01-Jun-24	19:20	01-Jun-24	19:20	AUTO-RECLOSURE	UNKNOWN		5716	1
12-Jul-24	18:27	12-Jul-24	18:27	AUTO-RECLOSURE	T-STORM	HEAVY RAIN IN AREA	5716	1
10-Aug-24	08:04	10-Aug-24	08:04	AUTO-RECLOSURE	UNKNOWN		5716	1
13-Jan-24	10:48	13-Jan-24	10:51	LOCKOUT	HIGH WINDS		5841	1
13-Jan-24	10:57	13-Jan-24	13:53	LOCKOUT	HIGH WINDS		7875	1

Feeder Outage Report 280M8

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
06-Jan-24	08:26	06-Jan-24	08:26	AUTO-RECLOSURE	DEFECTIVE CUSTOMER EQUIPMENT	TX Q460 DEFECTIVE AT 1250 APPLEBY LINE	673	1
11-Jun-24	13:44	11-Jun-24	13:44	AUTO-RECLOSURE	DEFECTIVE CUSTOMER EQUIPMENT	CUSTOMER ISSUE AT 1250 APPLEBY LINE	673	1
24-Jun-24	20:39	24-Jun-24	20:39	AUTO-RECLOSURE	UNKNOWN		673	1
26-Aug-24	02:05	26-Aug-24	02:05	AUTO-RECLOSURE	UNKNOWN		673	1
20-Sep-24	08:17	20-Sep-24	08:17	AUTO-RECLOSURE	UNKNOWN	S35 BLUE PHASE OVERCURRENT	673	1
29-Dec-24	03:00	29-Dec-24	03:00	AUTO-RECLOSURE	UNKNOWN		673	1
24-Jan-24	9:40	24-Jan-24	9:45	LOCKOUT	DEFECTIVE SWITCHING CUBICLE	280M8 LOCKOUT UNDER HOLD OFF AT 0940.	5216	1

Feeder Outage Report 39M1

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
06-Jul-24	16:16	06-Jul-24	16:16	AUTO-RECLOSURE	SQUIRREL	FC483 FUSE BLOWN, DEAD SQUIRREL FOUND ACROSS FUSE BARREL.	1995	1
06-Aug-24	01:07	06-Aug-24	01:07	AUTO-RECLOSURE	DEFECTIVE CUSTOMER EQUIPMENT	S247 AT 1055 TRUMAN ST FOUND DEFECTIVE.	1995	1
06-Jun-24	16:13	06-Jun-24	16:15	LOCKOUT	DEFECTIVE U/G PRIMARY		2555	1
30-Jul-24	11:00	30-Jul-24	15:33	LOCKOUT	BURNED OFF PHASE-LINE DOWN	39M1 LOCKOUT. CITY OF BURLINGTON REPORTING WIRES DOWN AT 1255 FAIRVIEW.	5169	1
17-Dec-24	16:02	17-Dec-24	16:04	LOCKOUT	UNKNOWN		2572	1

Feeder Outage Report 39M31

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
27-Jul-24	04:17	27-Jul-24	04:17	AUTO-RECLOSURE	DEFECTIVE CUSTOMER EQUIPMENT	FUSES AT 1217 KING RD	1798	1
30-Jul-24	02:14	30-Jul-24	02:14	AUTO-RECLOSURE	DEFECTIVE CUSTOMER EQUIPMENT	FUSE AT 1032 HOWARD	1798	1
20-Nov-24	07:29	20-Nov-24	07:29	AUTO-RECLOSURE	UNKNOWN		1798	1
13-Jan-24	23:55	14-Jan-24	3:18	LOCKOUT	TREE CONTACTS – BROKEN BRANCH OR OVERGROWTH	39M31 LOCKOUT. HALTON POLICE REPORTING SPARKING SEEN AT NORTH SERVICE AND WATERDOWN RD. TREE ON THE LINE AT 151 NORTH SERVICE.	1829	1
05-Dec-24	10:07	05-Dec-24	13:00	LOCKOUT	BROKEN POLE		1806	1

Feeder Outage Report 39M36

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
28-May-24	06:38	28-May-24	06:38	AUTO-RECLOSURE	RACCOON	RACCOON GOT INTO FUSES FC 756 CUSTOMER OWNED BLOWING TWO AND AUTOING FEEDER	768	1
02-Jun-24	07:21	02-Jun-24	07:21	AUTO-RECLOSURE	SQUIRREL	1125 LAKESHORE RD DEAD SQUIRREL	768	1
10-Sep-24	19:16	10-Sep-24	23:45	LOCKOUT	RACCOON	39M36 LOCKOUT, INTELLITEAM SECTIONALIZED FAULTED AREA AND BREAKER CLOSED RESTORING ALL BUT LAKESHORE RD BEACH STRIP	747	1
15-Oct-24	12:08	15-Oct-24	12:35	LOCKOUT	TREE CONTACTS – BROKEN BRANCH OR OVERGROWTH	39M36 LOCKOUT AT 12:08. INTELLI TEAM OPERATION. S4546 OPEN. S2945 OPENED AND S3974 CLOSE. CLOSE ATTEMPT NO GOOD.	734	1

Feeder Outage Report 76M28

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
30-Mar-24	23:59	30-Mar-24	23:59	AUTO-RECLOSURE	UNKNOWN		3802	1
28-May-24	06:12	28-May-24	06:12	AUTO-RECLOSURE	UNKNOWN		3802	1
04-Jul-24	08:00	04-Jul-24	08:00	AUTO-RECLOSURE	DEFECTIVE SWITCHING CUBICLE	SC129 FOUND DEFECTIVE	3802	1
07-Aug-24	15:35	07-Aug-24	15:35	AUTO-RECLOSURE	DEFECTIVE SWITCH	S91 SCADAMATE DEFECTIVE. SQUIRREL GOT ACROSS B PHASE JAW	3802	1
11-Nov-24	18:02	11-Nov-24	18:02	AUTO-RECLOSURE	TREE/LIMB	TREE LIMB AT PINE COVE MS	3802	1
11-Nov-24	18:02	11-Nov-24	18:02	AUTO-RECLOSURE	TREE/LIMB	LIMB S/OF S3817.	3802	1

Feeder Outage Report 76M29

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
29-Jan-24	10:07	29-Jan-24	10:07	AUTO-RECLOSURE	VEHICLE ACCIDENT	CAR HIT TX F627 ON TAYLOR	772	1
12-Feb-24	07:56	12-Feb-24	07:56	AUTO-RECLOSURE	UNKNOWN		772	1
24-May-24	19:51	24-May-24	19:51	AUTO-RECLOSURE	UNKNOWN		772	1
25-May-24	07:22	25-May-24	07:22	AUTO-RECLOSURE	UNKNOWN		772	1
21-Jun-24	15:28	21-Jun-24	15:28	AUTO-RECLOSURE	DEFECTIVE TRANSFORMER	DEFECTIVE TX F829, BLOWN ELBOW AT F830 AND DEFECTIVE CABLE TX F826 X F827 AT 4155 PALERMO COMMON	772	1
22-Jun-24	00:09	22-Jun-24	00:09	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	DEFECTIVE TX F829, BLOWN ELBOW AT F830 AND DEFECTIVE CABLE TX F826 X F827 AT 4155 PALERMO COMMON	772	1
22-Jun-24	00:20	22-Jun-24	00:20	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	DEFECTIVE TX F829, BLOWN ELBOW AT F830 AND DEFECTIVE CABLE TX F826 X F827 AT 4155 PALERMO COMMON	772	1
22-Jun-24	04:05	22-Jun-24	04:05	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	DEFECTIVE TX F829, BLOWN ELBOW AT F830 AND DEFECTIVE CABLE TX F826 X F827 AT 4155 PALERMO COMMON	772	1
03-Oct-24	18:59	03-Oct-24	18:59	AUTO-RECLOSURE	VEHICLE ACCIDENT-POLE HIT	TRANSPORT TRUCK HIT POLE AT HARVESTER AND APPLEBY	772	1

06-Nov-24	15:44	06-Nov-24	15:44	AUTO-RECLOSURE	UNKNOWN		772	1
16-Nov-24	08:11	16-Nov-24	08:11	AUTO-RECLOSURE	UNKNOWN		772	1
27-Nov-24	8:19	27-Nov-24	8:22	LOCKOUT	UNKNOWN		1409	1

APPENDIX **B2**

Feeder Outage Report

(13.8 kV Feeders)

Feeder Outage Report Lowville F1

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
12-Jan-24	14:30	12-Jan-24	14:30	AUTO-RECLOSURE	TREE/LIMB	4372 CEDAR SPRINGS RD. LOWVILLE F1 AUTO AT 1430. #21 AR REPORTS FUSE F1346 BLOWN. PATROLLED LINE NOTHING FOUND. REFUSE F1346 (80K	200	1
09-Feb-24	11:14	09-Feb-24	11:14	AUTO-RECLOSURE	UNKNOWN		200	1
21-Feb-24	14:44	21-Feb-24	14:44	AUTO-RECLOSURE	BLOWN ARRESTER	BLOWN ARRESTER AT TX AB16 AT 4444 CEDAR SPRINGS RD	200	1
11-Apr-24	00:59	11-Apr-24	00:59	AUTO-RECLOSURE	UNKNOWN		200	1
11-Apr-24	17:20	11-Apr-24	17:20	AUTO-RECLOSURE	UNKNOWN		200	1
28-Apr-24	19:53	28-Apr-24	19:53	AUTO-RECLOSURE	POLE FIRE	POLE FIRE AT MT NEMO CRES	200	1
02-Jun-24	17:52	02-Jun-24	17:52	AUTO-RECLOSURE	UNKNOWN		200	1
08-Jul-24	06:09	08-Jul-24	06:09	AUTO-RECLOSURE	UNKNOWN		200	1
13-Jul-24	07:17	13-Jul-24	07:17	AUTO-RECLOSURE	TREE/LIMB		200	1

Feeder Outage Report Lowville F3

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
12-Jul-24	13:48	12-Jul-24	13:48	AUTO-RECLOSURE	UNKNOWN		417	1
13-Jul-24	17:17	13-Jul-24	17:17	AUTO-RECLOSURE	BLOWN ARRESTER	BLOWN ARRESTER AT TX AL70 AT 4108 BRITANNIA RD.	417	1
12-Jan-24	21:48	12-Jan-24	22:17	LOCKOUT	TREE CONTACTS – FALLEN TREE ON PUBLIC R.O.W.		325	1
23-Jun-24	15:20	23-Jun-24	17:17	LOCKOUT	HIGH WINDS/TREE	LOWVILLE F3 LOCKOUT @ 15:18	317	1

Feeder Outage Report Lowville F4

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
08-Jan-24	08:29	08-Jan-24	08:29	AUTO-RECLOSURE	SQUIRREL		300	1
04-Aug-24	07:21	04-Aug-24	07:21	AUTO-RECLOSURE	UNKNOWN		300	1
10-Jan-24	12:24	10-Jan-24	12:43	LOCKOUT	TREE CONTACTS – BROKEN BRANCH OR OVERGROWTH	LOWVILLE F4 LOCKOUT @ 12:24 WHILE UNDER HOLDOFF BY TT.	545	1

Feeder Outage Report Orchard F1

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
17-Feb-24	12:56	17-Feb-24	12:56	AUTO-RECLOSURE	UNKNOWN		854	1
07-Aug-24	22:42	07-Aug-24	22:42	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	1191 TYANDAGA PARK DR. NO POWER ON OUR STREET AT ALL, I HEARD A LOUD NOISE FROM THE TRANSFORMER. ORCHA UNDERGROUND CABLE FAULT BETWEEN TX L122 AND TX L534, BOTH ENDS OPENED AND TAGGED	854	1
07-Sep-24	06:35	07-Sep-24	06:35	AUTO-RECLOSURE	UNKNOWN		854	1
10-Nov-24	23:04	10-Nov-24	23:04	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY		854	1
20-Nov-24	21:45	20-Nov-24	21:45	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	TX L581 X L131.	854	1

Feeder Outage Report Palmer F1

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
20-Apr-24	07:13	20-Apr-24	07:13	AUTO-RECLOSURE	SQUIRREL		220	1
10-May-24	23:56	10-May-24	23:56	AUTO-RECLOSURE	UNKNOWN		220	1
19-May-24	07:16	19-May-24	07:16	AUTO-RECLOSURE	UNKNOWN		220	1
21-May-24	17:34	21-May-24	17:34	AUTO-RECLOSURE	UNKNOWN		220	1
22-Jun-24	08:09	22-Jun-24	08:09	AUTO-RECLOSURE	DEFECTIVE SWITCH	BROKEN FUSE AT ARTISAN AND MAINWAY	220	1
06-Jul-24	19:26	06-Jul-24	19:26	AUTO-RECLOSURE	UNKNOWN		220	1
01-Aug-24	20:21	01-Aug-24	20:21	AUTO-RECLOSURE	UNKNOWN		220	1
06-Sep-24	03:55	06-Sep-24	03:55	AUTO-RECLOSURE	UNKNOWN	RACCON AT 1110 HERITAGE RD	220	1
07-Sep-24	08:12	07-Sep-24	08:12	AUTO-RECLOSURE	UNKNOWN		220	1
05-Oct-24	07:25	05-Oct-24	07:25	AUTO-RECLOSURE	UNKNOWN		220	1
08-Oct-24	13:18	08-Oct-24	13:18	AUTO-RECLOSURE	UNKNOWN		220	1
30-Dec-24	03:18	30-Dec-24	03:18	AUTO-RECLOSURE	UNKNOWN		220	1
31-Dec-24	11:07	31-Dec-24	11:08	LOCKOUT	UNKNOWN		247	1

Feeder Outage Report Palmer F2

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
12-Apr-24	21:44	12-Apr-24	21:44	AUTO-RECLOSURE	UNKNOWN		945	1
17-Jun-24	18:59	17-Jun-24	18:59	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	FAULT BETWEEN TX N112 AND N113 ON CONSORT CRES.	945	1
25-Jun-24	20:57	25-Jun-24	20:57	AUTO-RECLOSURE	UNKNOWN		945	1
14-Jul-24	22:46	14-Jul-24	22:46	AUTO-RECLOSURE	TREE/LIMB	LIMB FELL AT 3419 MAINWAY BLOWING N321 FUSE	945	1
10-Nov-24	23:10	10-Nov-24	23:10	AUTO-RECLOSURE	UNKNOWN		945	1
16-Dec-24	22:15	16-Dec-24	22:15	AUTO-RECLOSURE	UNKNOWN	RED AND WHITE PHASE FAULTS REPORTED BY MULTIPLE 27.6 SCADA DEVICES	945	1
28-Dec-24	01:18	28-Dec-24	01:18	AUTO-RECLOSURE	UNKNOWN		945	1
29-Dec-24	10:14	29-Dec-24	10:14	AUTO-RECLOSURE	UNKNOWN		945	1
14-Jul-24	13:46	14-Jul-24	19:25	LOCKOUT	DEFECTIVE INSULATOR		945	1

Feeder Outage Report Palmer F3

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
16-Mar-24	14:11	16-Mar-24	14:11	AUTO-RECLOSURE	UNKNOWN		2053	1
19-May-24	08:01	19-May-24	08:01	AUTO-RECLOSURE	UNKNOWN		2053	1
09-Jun-24	07:51	09-Jun-24	07:51	AUTO-RECLOSURE	UNKNOWN		2053	1
12-Jun-24	19:37	12-Jun-24	19:37	AUTO-RECLOSURE	DEFECTIVE CONNECTION	CONNECTION AT SW F732 BURNT UP AT UPPER MIDDLE AND CLEAVER AVE	2053	1
25-Jun-24	05:30	25-Jun-24	05:30	AUTO-RECLOSURE	UNKNOWN		2053	1
30-Jun-24	21:36	30-Jun-24	21:36	AUTO-RECLOSURE	COLD LOAD		2053	1
30-Jun-24	21:37	30-Jun-24	21:37	AUTO-RECLOSURE	COLD LOAD		2053	1
30-Jun-24	22:00	30-Jun-24	22:00	AUTO-RECLOSURE	COLD LOAD		2053	1
24-Aug-24	07:46	24-Aug-24	07:46	AUTO-RECLOSURE	UNKNOWN		2053	1
11-Nov-24	22:44	11-Nov-24	22:44	AUTO-RECLOSURE	UNKNOWN		2053	1
14-Nov-24	11:47	14-Nov-24	11:47	AUTO-RECLOSURE	UNKNOWN		2053	1
30-Nov-24	23:29	30-Nov-24	23:29	AUTO-RECLOSURE	UNKNOWN		2053	1
30-Jun-24	18:55	30-Jun-24	23:19	LOCKOUT	DEFECTIVE SWITCHING CUBICLE		1561	1

Feeder Outage Report Palmer F4

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
13-Jun-24	06:58	13-Jun-24	06:58	AUTO-RECLOSURE	DEFECTIVE SPLICE U/G PRIMARY	TX N29-N30 @ ALLANGROVE	906	1
13-Jul-24	21:24	13-Jul-24	21:24	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	U/G PRIMARY FAULT BET TX N57 AND TX N58	906	1
15-Jul-24	13:08	15-Jul-24	13:08	AUTO-RECLOSURE	DEFECTIVE TRANSFORMER		906	1
14-Aug-24	04:21	14-Aug-24	04:21	AUTO-RECLOSURE	UNKNOWN		906	1
26-Sep-24	15:04	26-Sep-24	15:04	AUTO-RECLOSURE	SQUIRREL		906	1
05-Oct-24	07:24	05-Oct-24	07:24	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	1322 SYCAMORE DR. THERE IS NO POWER IN THE HOME. NOTE: PALMER F4 AUTO RECLOSED AT 07:24. F2296 CABLE FAULT ON CENTENNIAL DR BETWEEN TX N9 AND TX N8, BOTH ENDS OPENED AND TAGGE	906	1
13-Jul-24	21:24	14-Jul-24	5:59	LOCKOUT	DEFECTIVE U/G PRIMARY	CABLE FAULT BETWEEN TX N57 AND TX N58 ON DEWBOURNE CRES.	1319	1

Feeder Outage Report Towerline F2

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
30-Jun-24	08:27	30-Jun-24	08:27	AUTO-RECLOSURE	UNKNOWN		192	1
05-Jul-24	20:27	05-Jul-24	20:27	AUTO-RECLOSURE	UNKNOWN		192	1
18-Aug-24	19:00	18-Aug-24	19:00	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	BAD CABLE FOUND AT 5439 HARVESTER AND POSSIBLY BAD TX.	192	1
24-Aug-24	08:28	24-Aug-24	08:28	AUTO-RECLOSURE	UNKNOWN		192	1
09-Sep-24	16:31	09-Sep-24	16:31	AUTO-RECLOSURE	UNKNOWN		192	1
11-Sep-24	07:12	11-Sep-24	07:12	AUTO-RECLOSURE	UNKNOWN		192	1
11-Sep-24	12:12	11-Sep-24	12:12	AUTO-RECLOSURE	UNKNOWN		192	1
20-Sep-24	07:46	20-Sep-24	07:46	AUTO-RECLOSURE	UNKNOWN		192	1
29-Jan-24	10:47	29-Jan-24	10:52	LOCKOUT	DEFECTIVE CONNECTION		144	1
26-Sep-24	11:07	26-Sep-24	11:10	LOCKOUT	UNKNOWN		255	1

Feeder Outage Report Towerline F3

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
26-May-24	22:19	26-May-24	22:19	AUTO-RECLOSURE	UNKNOWN		1293	1
06-Oct-24	08:00	06-Oct-24	08:00	AUTO-RECLOSURE	UNKNOWN		1293	1
19-Oct-24	08:43	19-Oct-24	08:43	AUTO-RECLOSURE	UNKNOWN		1293	1
24-Oct-24	08:33	24-Oct-24	08:33	AUTO-RECLOSURE	UNKNOWN		1293	1
03-Nov-24	16:22	03-Nov-24	16:22	AUTO-RECLOSURE	UNKNOWN		1293	1

Feeder Outage Report Tyandaga F3

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
19-Jan-24	08:24	19-Jan-24	08:24	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	CABLE FAULT	669	1
22-May-24	13:35	22-May-24	13:35	AUTO-RECLOSURE	TREE/LIMB	TREE CAME IN CONTACT WITH CONDUCTOR BLOWING WHITE PHASE ON FUSE FN491	669	1
10-Jul-24	17:13	10-Jul-24	17:13	AUTO-RECLOSURE	UNKNOWN		669	1
07-Aug-24	16:05	07-Aug-24	16:05	AUTO-RECLOSURE	UNKNOWN		669	1
11-Oct-24	12:26	11-Oct-24	12:26	AUTO-RECLOSURE	DEFECTIVE U/G PRIMARY	CABLE FAULT N13 BY N14 ALDRIDGE	669	1

APPENDIX B3

Feeder Outage Report
(4.16 kV Feeders)

Feeder Outage Report Appleby F1

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
19-May-24	23:46	19-May-24	23:46	AUTO-RECLOSURE	COLD LOAD		442	1
04-Jul-24	08:00	04-Jul-24	08:00	AUTO-RECLOSURE	DEFECTIVE SWITCHING CUBICLE	SC129 FOUND DEFECTIVE	442	1
09-Sep-24	14:58	09-Sep-24	14:58	AUTO-RECLOSURE	TREE/LIMB	VINE GROWN INTO TX F502 304 SILVANA CRES	442	1
11-Nov-24	18:02	11-Nov-24	18:02	AUTO-RECLOSURE	TREE/LIMB	APPLEBY F2, F4, F5. F6 AUTO LIMB S/OF S3817. COLD LOAD PICK UP	442	1
29-Nov-24	00:32	29-Nov-24	00:32	AUTO-RECLOSURE	DEFECTIVE SWITCH	BALLOON IN SECONDARY AT 421 APPLEBY LINE	442	1

Feeder Outage Report Grahams F4

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
12-Dec-24	11:21	12-Dec-24	11:23	LOCKOUT	TREE CONTACTS – FALLEN TREE ON PUBLIC R.O.W.	LOCKOUT WITH 1 AUTO RECLOSE.	63	1
12-Dec-24	12:40	12-Dec-24	12:41	LOCKOUT	TREE CONTACTS – FALLEN TREE ON PUBLIC R.O.W.	SECOND LOCKOUT TODAY AN HOUR AND 20 MINUTES APART. STATIONS SENT TO GRAHAMS AND LINES TO PATROL	63	1

Feeder Outage Report Partridge F2

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
20-Jun-24	4:10	20-Jun-24	5:45	LOCKOUT	HIGH WINDS		226	1
20-Jun-24	5:57	20-Jun-24	7:31	LOCKOUT	HIGH WINDS		226	1

Feeder Outage Report Port Nelson F2

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
11-May-24	10:46	11-May-24	10:46	AUTO-RECLOSURE	DEFECTIVE SWITCH	BURNING SWITCH AT 1ST AND HART	394	1
21-Jun-24	09:40	21-Jun-24	09:40	AUTO-RECLOSURE	TREE/LIMB	272 POMONA AVE. PT NELSON F2 AUTO @ 09:40. CREW FOUND TX E178 FUSE BLOWN. APPEARS TO BE VINES GR REMOVED VINES, REFUSED AT 30A AND CLOSED FUSED - HOLDING.-	394	1
29-Jul-24	18:25	29-Jul-24	18:25	AUTO-RECLOSURE	OVERLOAD	PT NELSON F2 LOADING HIGH DUE TO HOT WEATHER AND FAIRLEIGH F1 AND F2 BEING OFFLOADED BECAUSE OF BIKE PATH TREE TRIMMING. BREAKER LOAD NOW BALANCED BETTER	394	1
04-Dec-24	12:50	04-Dec-24	12:54	LOCKOUT	UNKNOWN		247	1
09-Dec-24	10:18	09-Dec-24	10:46	LOCKOUT	TREE CONTACTS – BROKEN BRANCH OR OVERGROWTH		281	1

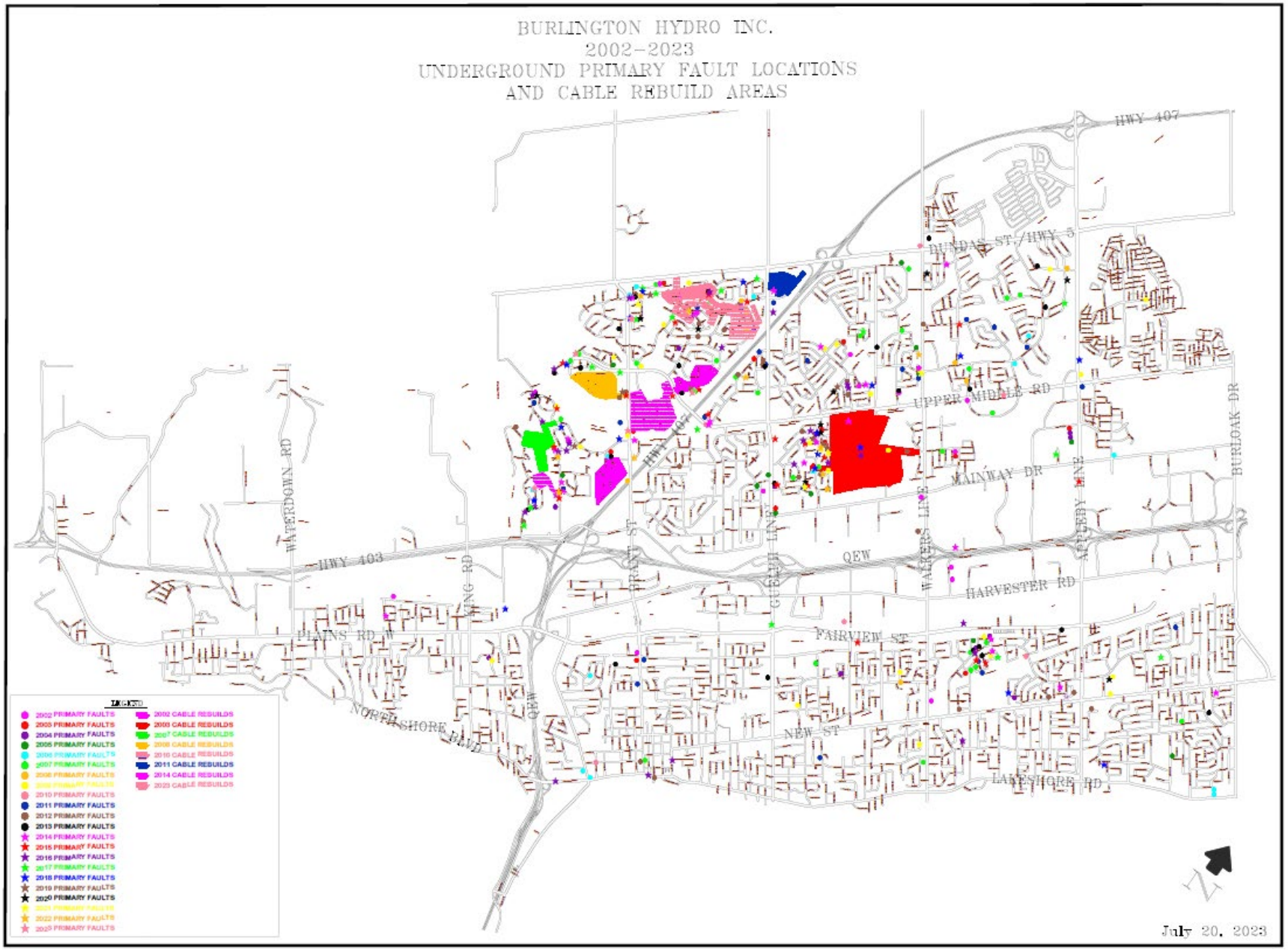
Feeder Outage Report Spruce F2

Dates: January 1, 2024 through December 31, 2024

DATE OUT	TIME OUT	DATE IN	TIME IN	OPERATION	CAUSE	LOCATION/REMARKS	NO. OF CUSTOMERS	COUNT
20-Jun-24	19:45	20-Jun-24	19:45	AUTO-RECLOSURE	DEFECTIVE SWITCH	SPRUCE F2 AUTO'D WHEN CREW WAS OPENING FUSE F132. WAS RAINING WHEN CREW OPERATED SWITCH AND DREW A SMALL ARC	403	1
30-Jun-24	08:48	30-Jun-24	08:48	AUTO-RECLOSURE	TREE/LIMB-LINE DOWN	4062 SPRUCE AVE. CUSTOMER REPORTS NO POWER. SPRUCE F2 AUTO AT 0848. #21 RT REPORTS TREE BRANCH CA PC10A E005680 IN EFFECT TO REPAIR. WORK COMPLETED, REPAIRS MADE. PERMIT TERMINAT	403	1
01-Oct-24	18:12	01-Oct-24	18:12	AUTO-RECLOSURE	BLOWN ELBOW	TX F93 SMOKING BAD ELBOW AND TERMINATION AT CAMELOT	403	1
11-Dec-24	11:51	11-Dec-24	11:51	AUTO-RECLOSURE	COLD LOAD	CREW CLOING S3818 TO RESTORE 129 CUSTOMERS	403	1
24-Dec-24	03:45	24-Dec-24	03:45	AUTO-RECLOSURE	BLOWN ARRESTER	ARRESTOR BLOWN AT F244	403	1

APPENDIX C

Underground Primary Fault Locations and Cable Rebuild Area


BURLINGTON HYDRO INC.
2002-2023
UNDERGROUND PRIMARY FAULT LOCATIONS
AND CABLE REBUILD AREAS
HWY 407
DUNDAS ST / HWY 5
UPPER MIDDLE RD
MAINWAY DR
BURLOAK DR
WATERDOWN RD
HWY 403
PLAINS RD W
NORTH SHORE BLVD
BRANT ST
GUELPH LINE
WALKERS LINE
APPLEBY LINE
QEW
HARVESTER RD
FAIRVIEW ST
NEW ST
LAKESHORE RD
July 20, 2023

APPENDIX D

System Maintenance Activities & Priorities

4.0 - SYSTEM MAINTENANCE ACTIVITIES & PRIORITIES

Asset Management

ABSTRACT

BHI aims to meet or exceed the system maintenance and inspection requirements of Section 4.4 and Appendix C of the Ontario Energy Board Distribution System Code (DSC) – latest revision. The following routine maintenance programs are consistent with good utility practices and are applied annually over a 3-year patrolled inspection period within the BHI distribution system territory.

TABLE OF CONTENTS

4.1.0 System Maintenance Activities – Overhead System 1

4.1.1 Wood Pole Inspection and Replacement 1

4.1.2 Concrete Pole Inspection & Replacement 4

4.1.3 Insulator Washing – Porcelain Insulators 5

4.1.4 Tree Trimming & Vegetation Control 6

4.1.5 Infrared Thermography – Overhead System & Stations 7

4.1.6 Air Break Switch Maintenance 8

4.1.7 Pole Mounted Transformers 9

4.2.0 System Maintenance Activities – Underground System 11

4.2.1 Pad-Mounted Transformers 11

4.2.2 Submersible Transformers 13

4.2.3 Cleaning of Switching Cubicles 13

4.2.4 Substation Inspection and Preventive Maintenance 13

4.2.5 Cable Faults 14

4.2.6 ScadaMate Inspection and Maintenance 15

4.2.7 Submersible to Pad-Mounted Transformer Conversion 17

4.3.0 Future Maintenance & Operation Recommendations 18

4.3.1 Wood Pole Replacements & Reinforcement 18

4.3.2 Vault Cleaning/Washing 18

4.3.3 Rust & Corrosion Repair 18

4.3.4 Transformer Load Utilization Replacements 18

4.3.6 Cable Testing – Palmer and North Tyandaga Subdivisions 20

4.3.7 Cable Rejuvenation Program 21

Appendix i

Appendix A – Inspection Cycle 2023-2025 i

Appendix B – Insulator Washing Cycle 2024 ii

Appendix C – Tree Trimming Zones 2023-2024 iii

Appendix D – Infrared Thermography Maps – 27.6kV Map And 13.8kV & 4.16kV Map iv

Appendix E – Switching Cubicle Inspection Locations vi

Appendix F – ScadaMate Maintenance Locations vii

TABLE OF FIGURES

Figure 1: Table 1 – Wood Pole Testing & Replacement 2

Figure 2: Chart 1 – Wood Pole Testing & Replacement 2024 vs 2023 2

Figure 3: Table 2 - Overhead System Inspections – Hydro Poles 2024 0

Figure 4: BHI Concrete Pole 0

Figure 5: Burlington Hydro's Contractor Performing Insulator Washing 0

Figure 6: Example of Tree Trimming Performed by Burlington Hydro's Contractor 0

Figure 7: Reported Overgrown Vegetation on a Burlington Hydro Wooded Hydro Pole 0

Figure 8: Infrared Photos Provided by Burlington Hydro's Contractor's Report 0

Figure 9: Table 3 – IR Measurements & Recommendation 7

Figure 10: Broken Operating Handle from a Burlington Hydro Air Break Switch Location 0

Figure 11: Table 4 – Pole Mounted Transformers 10

Figure 12: Chart 2 – Pole Mounted Transformers 2024 vs 2023 10

Figure 13: Table 5 – Pad-Mounted Transformers 12

Figure 14: Chart 3 – Pad-Mounted Transformers 2024 vs 2023 12

Figure 15: Table 6 – Underground System Inspections 2024 0

Figure 16: Chart 4 – Reliability Statistics for Yearly SAIDI & SAIFI Metrics 14

Figure 17: Table 7 - Reliability Statistics for SAIDI & SAIFI Metrics (Excluding Loss of Supply & Major Events) 14

Figure 18: Table 8 – Underground Primary Cable SAIDI & SAIFI Metrics for 2024 vs 2023 15

Figure 19: Existing ScadaMate Installation 0

Figure 20: Transformer T186 Pilot Conversion 0

Figure 21: Submersible Transformer Locations by Ward boundaries 0

Figure 22: Chart 6 – Annual Transformer Utilization by Transformer Type – 2024 19

Figure 23: Burlington Hydro's Contractor Performing Cable Testing at a Submersible Transformer 0

4.1.0 SYSTEM MAINTENANCE ACTIVITIES – OVERHEAD SYSTEM

4.1.1 WOOD POLE INSPECTION AND REPLACEMENT

The OEB – Distribution System Code requires BHI inspect each asset within a 3-year cycle. BHI has gone above and beyond that requirement by taking a proactive approach to the annual inspection, testing, and replacement of hydro poles.

The inspection and tests are performed by a contracted pole testing company (Under Pressure Inc.) using a few outlined methods and considerations:

- **Asset Age**
    - Assets within the BHI system have a typical useful life; based on the 'Asset Depreciation Study for the OEB', wood poles have a TUL of 45 years with a maximum of 75. Wood poles determined to be installed within 10-years are typically in good condition, poles >21-years to end-of-life are predominantly of focus and flagged for testing beyond visual inspection and hammer testing.
- **Visual Inspection**
    - The visual inspection asses the visible surface condition of the pole; if there are defects found such as integrity issues (woodpecker holes, pest infestation, cracks, leaning etc.), rotten pole tops, loose hardware/attachments, rotten crossarms, porcelain insulators, and attached equipment issues.
- **Hammer Test**
    - Pole integrity is verified by sound when the pole is tapped by a hammer or mallet in various locations starting from the base of the pole to determine if the pole is producing a clear and sharp rebound when struck.
- **Resistograph Test Drill – Wood Poles**
    - Predominant on poles >21-years of installation, a measurement is taken using a thin precisely calibrated drill for remaining pole fiber strength. The drill measures pole rot and decay just below the base to a remaining strength level of which >70% is a pass, and <70% but >60% is a marginal pass; anything less is considered a failure, consistent with clause 8.3.1.3 of CSA 22.3 No-1 latest version.

Poles are categorized for remediation dependent on inspection results. Areas of focus are then grouped in clusters of the worst degradation criteria poles for potential capital rebuild. A high priority is placed on 3-phase poles with primary feeder circuits, equipment such as transformers, switching devices, underground dips, and line dead-end or major line angles over 15° which pose a higher risk due to the impact of failure. The following is a summary comparison of the pole testing and replacement program from 2023 to 2024:

Maintenance Activities: Wood Hydro Poles	2023	2024	Trend
Total Number of Poles in The System (Excluding Bell Pole Ownership)	15294	15200	↓
Number Inspected	6930	5121	↓
Number Installed	99	189	↑
Number Treated to Extend Life	0	0	→
Number of Poles with Reported Visible Issues	1880	3810	↑
Number of Rotten Poles Remaining in The System	1164	1324	↑

Figure 14: Table 1 – Wood Pole Testing & Replacement

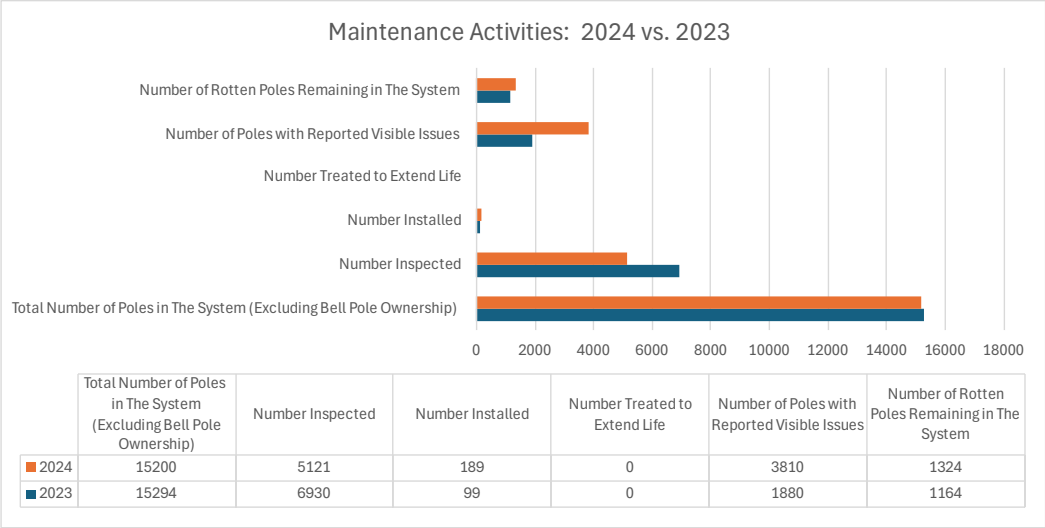


Figure 15: Chart 1 – Wood Pole Testing & Replacement 2024 vs 2023

The figures above indicate that BHI is maintaining its commitment to improving its 'System Renewal' program through the inspection cycle periods, maintenance, and remediation

replacements. The pole installations for 2024 include replacements due to end-of-life conditions, vehicle accidents, and storm damage.

Throughout the fiscal year, 5,121 poles were inspected, within Area 2 of the second 3-year overhead inspectional cycle being completed by the same contractor for BHI for 2024. Comparing 2024 to 2023, 160 additional poles were identified as rotten, again no poles were treated, and 189 poles were replaced with an additional 90 replacements comparative to year-over-year. Additionally, 1,930 poles were reported to have some issue compared to the year before stemming from the visual inspection criteria mentioned previously. The increase in rotten poles is attributable to the changes in the inspection process, resulting in a higher number of failed poles during this initial cycle due to updated drill test criteria. Due to the 3-year overhead inspection cycle under a new inspection contractor, it is expected that rotten pole count will continue to increase at this pace throughout this inspector's second cycle due to age, environmental, and location degradation factors.

Overhead Inspections		
Pole Issue	Type	Amount
Concrete Condition	Cracking	8
	Minor Rust	1
Mechanical Damage	Minor	1
Splitting	Major	79
	Minor	1888
Burn Damage	Major	1
	Minor	3
Rotten Pole Top	Major	386
	Minor	1567
Rotten Crossarm	Major	20
	Minor	319
Loose Hardware	Major	4
	Minor	39
Wood Pecker Holes	Major	58
	Minor	581
Surface Cracks	Major	207
	Minor	3171
Vegetation	Major	72
	Minor	142
Anchor Issue	Major	7
	Minor	23
Insect Infestation	Major	5
	Minor	27
Pole Test	Fail	166
Grounding	Broken Arrestor Tail	106
	-50 OHMS	662
Total		**9543**

Figure 16: Table 2 - Overhead System Inspections – Hydro Poles 2024

Part of the ongoing process review and improvements, review of data gaps have been added to the inspection requirements. A new inspection process within BHI's use of ESRI – Field Maps has been established to collect deficiency severity for multiple issues on any asset. Pole remaining strength percent has also been introduced for ease of access for BHI personnel. Pole issues are remediated throughout the year as needed dependent on priority and condition category. With the 2024 fiscal year end, the beginning of a second BHI 3-year inspection cycle has successfully begun; see 'Appendix A' for the inspection cycle map.

4.1.2 CONCRETE POLE INSPECTION & REPLACEMENT

Concrete poles undergo a visual inspection, completed by the same contractor as wood poles. Based on the same OEB study, concrete poles have a typical useful life of 60 years with a maximum of 80. In 2024, 145 concrete poles were visually inspected for any mechanical defects and/or leaning issues. Throughout the cycle year, 16 poles were identified with visible condition issues. BHI continues to monitor these assets through inspections to ensure current issues are not expanding and creating integral strength issues. Through these continued efforts, process reviews with our inspection contractor, Under Pressure, are essential in ensuring all required data is collected. Pole rust/corrosion conditions, visual leaning concerns, lightning arrester connections, vegetation issues, anchor issues, loose hardware, and porcelain insulator identification were all inspected throughout the cycle year. See 'Appendix A' for the inspection cycle map.

Figure 17: BHI Concrete Pole

4.1.3 INSULATOR WASHING – PORCELAIN INSULATORS

Insulator washing is an important preventative measure to minimize flashovers and pole fires. The insulator washing program is primarily carried out after the Winter months to ensure all salt exposure is removed from the insulators by a certified dedicated crew (K-Line), contracted by BHI. Frequency of the washing depends on the amount of de-icing salt mixture used throughout that year. BHI's focus is main arterial roads and high traffic areas throughout the service area. Particular attention is given to the 27.6kV system including any areas where there are underbuilt circuits and areas with potential for high salt contamination such as areas adjacent to highways. In the course of this work in 2024, 8 equipment deficiencies were identified for replacement and remediated. Note, specific areas with polymer insulators are not washed as the skirt surface area is not of concern for flashover, for this reason, only porcelain insulators are targeted within those areas. Additionally, ScadaMate switches are identified for no pressure washing due to potential for contact failure. See 'Appendix B' for the completed insulator washing map, 2023.

Figure 18: Burlington Hydro's Contractor Performing Insulator Washing

4.1.4 TREE TRIMMING & VEGETATION CONTROL

Tree trimming tackles a few safety and reliability aspects by mitigating safety issues, asset damage, maintenance, and service interruption (minimizing BHI's SAIDI, SAIFI scores). Significant effort is maintained to reduce impact temporary and potential long-duration outage impacts for customers. During storms, fallen branches and limbs can cause downed power lines, damaging equipment such as switches & transformers and potential pole fires that are an endangerment to the public. Additionally, as the tree branches and limbs grow throughout the year, with wind as a factor, the continuous rubbing can damage power line conductors causing other safety and reliability concerns. Tree trimming was successfully carried out in 2024, by 2 certified contractors (Davey Tree and Kodiak Tree Services – formerly by OLC) throughout the 'Tree Trimming Zones' identified for the year. In accordance with BHI's established 3-year inspection cycle; this is a normal utility practice. 'Tree Trimming Zones' 3, 4, 5, 7 & 16 were completed as well as the addition of Zones 10 & 11 were all fully completed as part of the 2024 schedule. See 'Appendix C' for tree trimming zone maps.

Figure 19: Example of Tree Trimming Performed by Burlington Hydro's Contractor

Vegetation surrounding BHI assets are of concern primarily due to emergency access that can create delays in emergency repairs and replacements. These vegetation related issues are remediated throughout the year, see 'Appendix A' for inspection zones through the patrolled 3-year inspection cycle.

Figure 20: Reported Overgrown Vegetation on a Burlington Hydro Wooded Hydro Pole

4.1.5 INFRARED THERMOGRAPHY – OVERHEAD SYSTEM & STATIONS

Annual inspection and scanning of the overhead system and municipal stations are an important and worthwhile part of a good preventative maintenance program. This approach ensures areas with high risk of failure do not result in safety concerns for the public and interruption losses for BHI customers. The infrared inspections were completed in 2024 by an engineering contractor (DDP). A total of 32 hot spots were identified resulting in 8 intermediate rated issues and 2 receiving a serious rating. All locations rated serious were remediated with no areas of concern regarding types of equipment, locations or patterns of serious concern requiring targeted focus. See 'Appendix D' for the infrared main circuit maps, 27.6kV, and 13.8kV & 4.16kV.

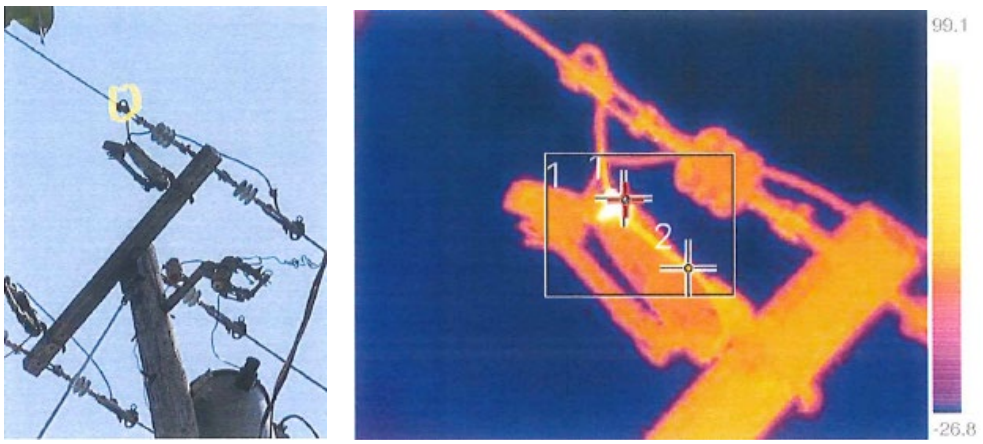


Figure 21: Example of Infrared Photos Provided by Burlington Hydro's Contractor's Report

Measurements	°C
Spot 1	150>
Spot 2	48
Area 1 Max.	150>
Rating	Serious
Recmmendation	Replace or Tighten

Figure 22: Table 3 – Example of IR Measurements & Recommendation

4.1.6 AIR BREAK SWITCH MAINTENANCE

Maintenance programs are crucial during yearly inspection cycles in ensuring the overhead system safety and reliability is maintained to the highest degree. Air break switches (ABS) are an essential part of the overhead system as they provide a live operating break on the circuit for safe work practices while BHI crews perform switching and isolating operations. The ABS is typically a manually operated switch by a mechanical open, operated by a handle secured to the hydro pole close to ground level. Crews are required to be electrically bonded by being elevated on a grounding mat to ensure an equipotential work zone for the operator. Through the maintenance program, BHI crews inspect correct operation of equipment, ensuring the mechanical handle is operating as intended without defect, the switches open as intended, grounding connections are correctly connected, no arc flash burns are present, as well as ensuring contacts are cleaned and lubricated. Through the patrolled inspections, the 2024 inspection area had 2 defects that were found with a broken ground located at the operating handle which were remediated along with routine maintenance and lubrication on all ABS. No additional maintenance program recommendations required at this time. See 'Appendix A' inspection cycle map for areas of focus for each year.

Figure 23: Broken Operating Handle from a Burlington Hydro Air Break Switch Location

4.1.7 POLE MOUNTED TRANSFORMERS

Along with the hydro pole inspection, attached equipment throughout the patrolled inspection cycle year is inspected as well at the same time. Inspection criteria is verified to ensure that there are no minor or catastrophic failures resulting in service interruptions to customers in the future.

The following are criteria typically reviewed for pole mounted transformers:

- **Asset Age**
    - BHI assets have a general useful as well as a financial book value. The 'Asset Depreciation Study for the Ontario Energy Board' lists overhead transformers as having a typical useful life of 40 years with a maximum of 60 years. Book value is based over 40 years before the asset is considered a fully depreciated asset.
- **Visual Damage**
    - Any visual defects that can be seen are noted dependent on the determined severity of damage, determines repair or replacement recommendations.
- **Oil Leakage**
    - Due to insufficient seals, metallic rust, and/or overheating, an overhead pole mounted transformer can experience oil leakage. This can typically be noticed by oil stains on the outside of the transformer and/or ground contamination. Soil clean-up and remediation is completed as needed. Oil PCBs were remediated to meet Canadian Environmental Protection Act – PCB Regulations since 2011 throughout BHI's service territory.
- **Animal Nesting**
    - Small animals are known to create nests on overhead assets. This can result in faults causing service interruptions and impact BHI SAIDI & SAIFI scores. These issues are remediated as necessary.
- **Load Reporting**
    - A useful tool used in transformer replacement metrics is load reporting recently introduced in 2022 through our GIS. BHI can determine if the transformer is under or overutilized based on coincidental and non-coincidental peak loads.

Pole mounted transformers are remediated as required. Current economic situations have resulted in greater than normal logistical delays for manufacturers as well as a combined labour shortage. This has resulted in replacement inventory delays and in-depth review of asset conditions and replacement criteria.

Maintenance Activities: Pole Mounted Transformers	2023	2024	Trend
Total Number of Overhead Transformers in The System	3178	3212	↑
Number of Polemount Transformer Installations	32	60	↑
Number of Three Phase Bank Installations	5	11	↑

Figure 24: Table 4 – Pole Mounted Transformers

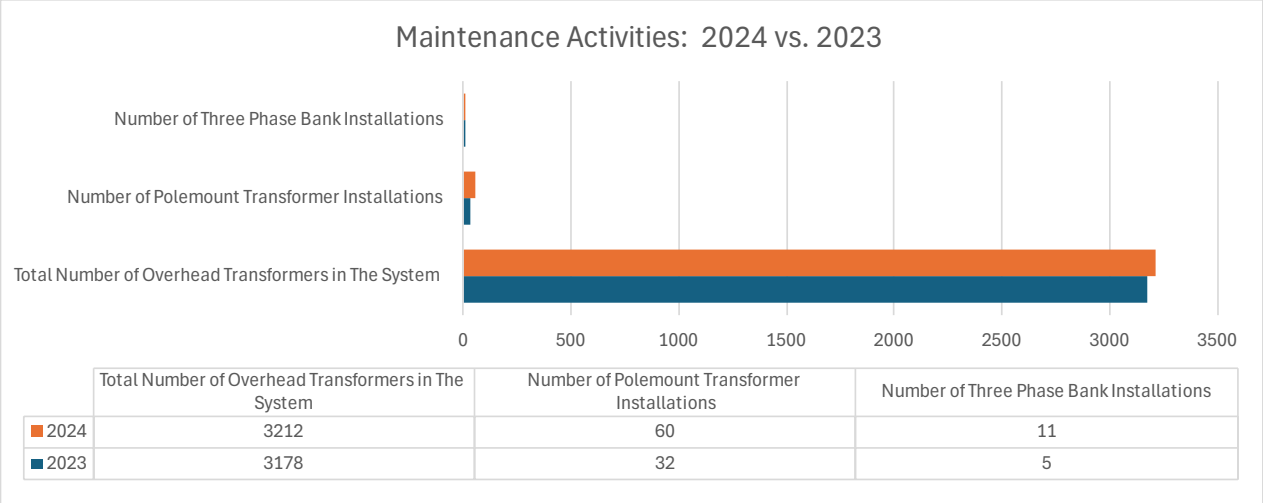


Figure 25: Chart 2 – Pole Mounted Transformers 2024 vs 2023

As the trend lines show, there was an increase in overhead transformer activity from 2023 to 2024. This trend is a minimal increase but ensures optimized loading on available transformers to minimize system losses as well as BHI underground system expansions through replacement efforts as well as new installations. See 'Appendix A' for inspection cycle year area.

4.2.0 SYSTEM MAINTENANCE ACTIVITIES – UNDERGROUND SYSTEM

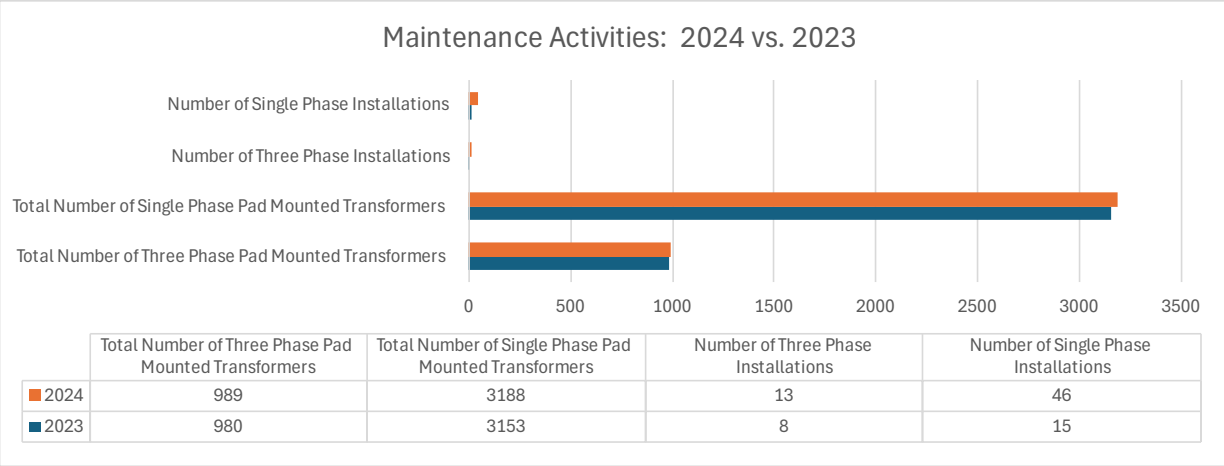
4.2.1 PAD-MOUNTED TRANSFORMERS

Through the BHI 3-year inspection cycle, the same areas are targeted for pad-mounted transformers in accordance with the minimum inspection requirements of the Distribution System Code. The following are typical criteria of inspection patrols:

- **Asset Age**
    - BHI assets have a general useful as well as a financial book value. The 'Asset Depreciation Study for the Ontario Energy Board' lists underground pad-mounted transformers as having a typical useful life of 40 years with a maximum of 45 years. Book value is based over 40 years before the asset is considered a fully depreciated asset.
- **Visual Defects – Damage, Rust, Graffiti, & Discolouration**
    - Any visual defects that can be seen are noted dependent on the determined severity of damage such as internal equipment, external rust, snowplows, pedestrians, and vehicle accidents, determines the replacement or repair recommendation. As per city by-law 49-2022 – Section 6.12 graffiti is remediated as reported including discolouration from UV and environmental exposure such as street de-icing.
- **Oil Leakage**
    - Due to insufficient seals, metallic rust, and/or overheating, an underground pad-mounted transformer can experience oil leakage. This can typically be noticed by visual inspection of oil leaking on the outside of the transformer, dark discolouration saturation on the concrete pad, and/or ground contamination. Soil clean-up and restoration is completed as needed.
- **Load Reporting**
    - A useful tool used in transformer replacement metrics is load reporting recently introduced in 2022 through our GIS. BHI can determine if the transformer is under or overutilized based on coincidental and non-coincidental peak loads.

Maintenance Activities: Pad-Mounted Transformers	2023	2024	Trend
Total Number of Three Phase Pad Mounted Transformers	980	989	↑
Total Number of Single Phase Pad Mounted Transformers	3153	3188	↑
Number of Three Phase Installations	8	13	↑
Number of Single Phase Installations	15	46	↑

Figure 26: Table 5 – Pad-Mounted Transformers



	Total Number of Three Phase Pad Mounted Transformers	Total Number of Single Phase Pad Mounted Transformers	Number of Three Phase Installations	Number of Single Phase Installations
2024	989	3188	13	46
2023	980	3153	8	15

Figure 27: Chart 3 – Pad-Mounted Transformers 2024 vs 2023

Throughout the year there were a total of 16 leaking transformers replaced. An ongoing list of leaking transformers is being kept up to date and transformers are ordered and replaced as permitted by current stock levels. We have seen an upward trend in pad-mount transformer installations at 36 for the 2024 cycle year as BHI continues to mitigate procurement delays by ensuring top priority assets are replaced as required. See 'Appendix A' for inspection cycle year area.

Underground Inspections		
Issue	Type	Amount
Leaking		54
Lock Installed		1
Pentabolt Installed		77
Clearance Issue		35
Safety Labels Required		283
Bollards Required		3
Bollard Damage	Major	0
	Minor	2
Insulation Levels		0
Corrosion/Rust	Major	35
	Minor	313
Paint required		389
Damage	Major	2
	Minor	5
Equipment Shifted on Pad		2
Concrete Pad Damage	Major	1
	Minor	1
Grading Concerns	Major	5
	Minor	13
Vegetation	Major	2
	Minor	200
Rodent Infestation		0
Water Infiltration		0
Total		**1423**

Figure 28: Table 6 – Underground System Inspections 2024

4.2.2 SUBMERSIBLE TRANSFORMERS

Submersible transformers are inspected as part of the annual transformer visual inspection process by ensuring no damage is present on the outer lid with potential for a tripping hazard or worse for the public. There were 9 replacements of submersible transformers in 2024. There was a previous recommendation to introduce a formal program for the washing of underground vaults; this program has not been initiated yet. See 'Appendix A' for inspection cycle year as well as 4.3.2 for future recommendations.

4.2.3 CLEANING OF SWITCHING CUBICLES

BHI has 241 pad mounted switching cubicles within its distribution system which is an increase of 1 unit from the previous year: 1 Vista unit. There were 57 switching cubicles inspected through the cycle year by DDP for internal inspection and Under Pressure Inc for exterior inspection. Through the inspection cycle, 13 units had shown signs of hot spots through IR scanning as well as 10 having ultrasound detection. A specialized maintenance technique, using "dry ice", is employed, to clean the selected number of the switching cubicles. This work can be safely completed with the equipment energized, therefore reducing the time and cost for switching activities. Remediation was completed in 2024, by completing all 2023 required maintenance items due to budget constraints of the previous year. See 'Appendix E' for inspection cycle year area.

4.2.4 MUNISIPAL STATION (MS) INSPECTION AND PREVENTIVE MAINTENANCE

Visual patrolled inspection of the stations and the equipment is performed monthly. Any issues found are reported, prioritized, and rectified as necessary. In addition to the visual inspection, preventive maintenance is performed at each station every 5 years. In 2024 the following stations were maintained:

- Fairleigh MS, Howard MS, Pinecove MS, Spruce MS , Towerline MS, & InterchageMS

For 2025, the following stations are targeted for maintenance:

- Pinedale, Easterbrook, Orchard, Reservoir, Palmer, Woodward, & Garhams

4.2.5 CABLE FAULTS

A total of 10 primary cable faults were remediated throughout the year 2024. Primary cable faults result in significant service interruption times and require reactive emergency repairs if service cannot be restored promptly. This affects BHI SAIDI & SAIFI metrics with increases in both metrics. SAIDI had increased from 1.97 in 2023 to 2.20 in 2024 while SAIFI had increased from 1.52 in 2023 to 1.54 in 2024. Overall, 2024 reliability metrics are above the OEB target for BHI.

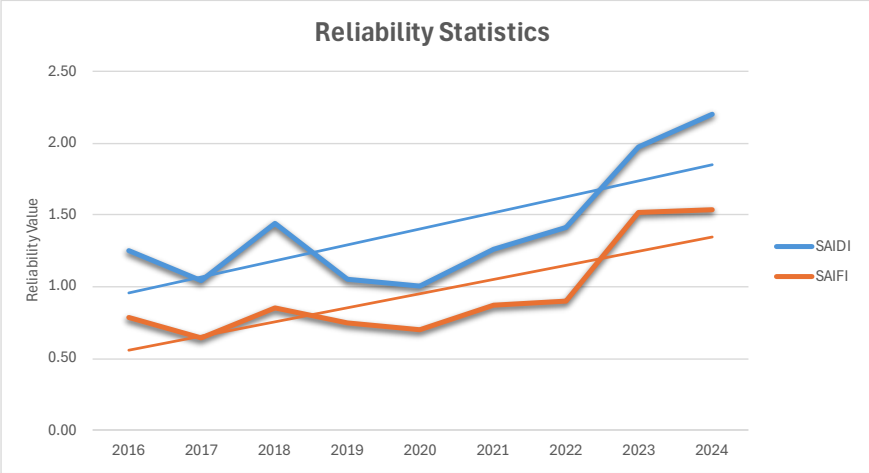


Figure 29: Chart 4 – Reliability Statistics for Yearly SAIDI & SAIFI Metrics

	2016	2017	2018	2019	2020	2021	2022	2023	2024	Target
SAIDI	1.25	1.04	1.44	1.05	1.00	1.26	1.41	1.97	2.20	1.19
SAIFI	0.79	0.64	0.85	0.75	0.70	0.87	0.90	1.52	1.54	0.75

Figure 30: Table 7 - Reliability Statistics for SAIDI & SAIFI Metrics (Excluding Loss of Supply & Major Events)

Metrics	Year	YTD	Trend
Number of Customers	2023	69,057	
	2024	69,443	↑
Customer Hours of Interruption - Defective U/G Primary	2023	14,115	
	2024	5,388	↓
SAIDI - Defective U/G Primary	2023	0.20	
	2024	0.08	↓
Number of Customer Interruptions - Defective U/G Primary	2023	6,517	
	2024	5,130	↓
SAIFI - Defective U/G Primary	2023	0.09	
	2024	0.07	↓

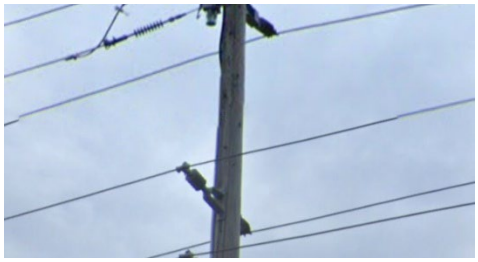
Figure 31: Table 8 – Underground Primary Cable SAIDI & SAIFI Metrics for 2024 vs 2023

4.2.6 SCADA-MATE SWITCHES INSPECTION AND MAINTENANCE

S&C Scada-Mate switches are intelligent circuit-breaking switching devices used in distribution automation systems to enhance grid reliability and performance. Proper maintenance ensures their optimal operation, reduces unplanned outages, and extends the switch's lifespan. There is a total of 71 Scada-Mate installed within the Burlington Hydro service territory.

Due to multiple switch failures, a maintenance program was established for 2023 and continued into 2024. Inspection of components such as the insulation and sensors, disconnection of live parts, control cabinet and control cable, as well as verifying the condition of lightening arresters with proper grounding connections. Cleaning and lubrication are performed on the insulators to remove dirt and contaminants and the current carrying contacts are wiped down to remove grease and dirt buildup as to allow for the application of a light coating of non-sulfur containing contact lubricant. IR scans were performed on all 71 Scada-Mate units throughout 2024. Due to critical customer load that could not be isolated during the 2023 maintenance cycle, 2 units completed maintenance in 2024. In total 6 units were identified through DDP IR scans and additional assessment, and cleaning was performed with 2 units requiring contact replacement to ensure customer interruptions were not a result of failed units. See 'Appendix F' for the Scada-Mate location map.

Figure 32: Existing ScadaMate Installation



4.2.7 SUBMERSIBLE TO PAD-MOUNTED TRANSFORMER CONVERSION

With climate change and climate change related risks becoming a larger topic of consideration, CSA has made changes to their existing CSA 22.3 No. 7 – Underground Systems standards. Where practicable, pad-mounted installations above ground should be selected over submersible installations in subsurface chambers. Burlington Hydro has a commitment to the Burlington 'Climate Action Plan' and a recommended pilot has been introduced to convert end-of-life submersible transformers to pad-mounted transformers. The lifecycle cost of pad mounted units is less than submersible units, allowing Burlington Hydro to achieve more with replacement budgets and provide overall better service to the community. The initial pilot conversion was completed in 2023 on transformer T186 with a custom concrete lid designed to be used with existing submersible transformer foundations in the conversion to pad-mounted units. In 2024 the program continues where applicable all submersible replacements are aimed for conversion.

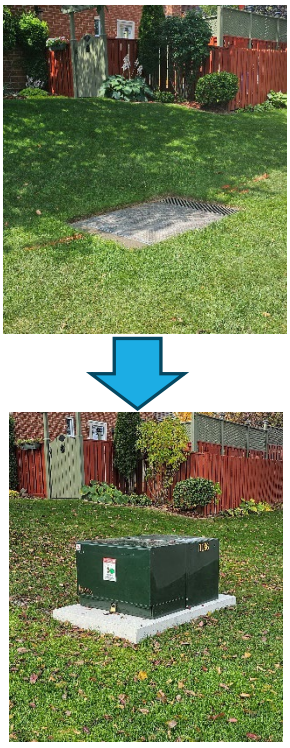


Figure 33: Transformer T186 Pilot Conversion

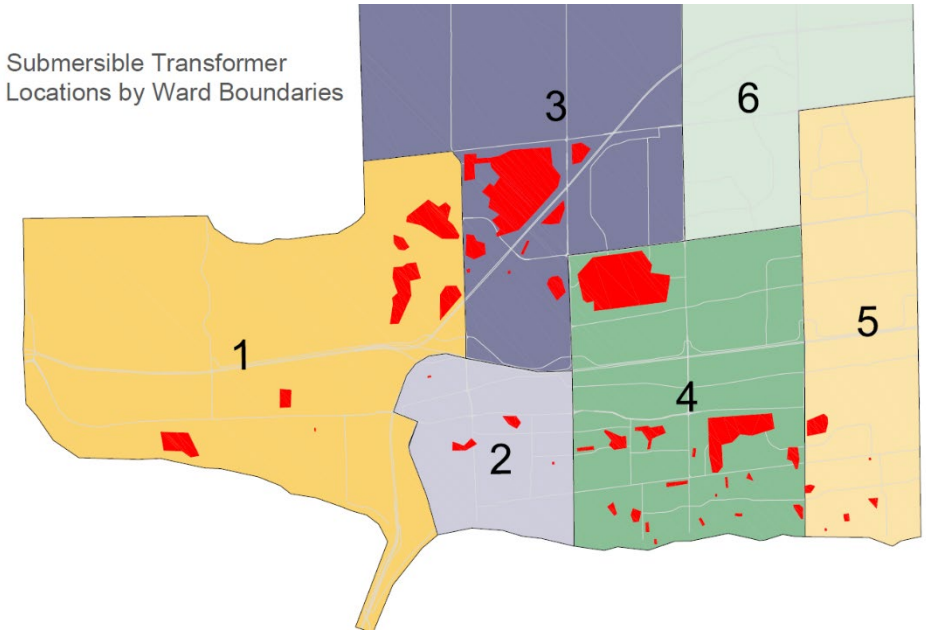


Figure 341: Submersible Transformer Locations by Ward boundaries

4.3.0 FUTURE MAINTENANCE & OPERATION RECOMMENDATIONS

4.3.1 WOOD POLE REPLACEMENTS & REINFORCEMENT

With the conclusion of the 3-year patrolled inspection cycle in 2023, a great amount of detailed data was utilized for the 2024 BHI Asset Condition Assessment Report. Recommendations were presented for BHI's Cost of Service rate filing in 2025 with a focused increase in budget allocation for replacement and pole reinforcement aimed at decreasing the 1,324 rotten poles currently identified throughout the service territory. The general goal is aimed at 100 replacements with 50 reinforcements.

4.3.2 VAULT CLEANING/WASHING

Currently, there is not a submersible vault washing program for the BHI underground system. A review of the patrolled inspection reports for all underground system vaulted equipment should be considered for future budgets and dependent on reported conditions, consideration should be given to a more concentrated vault cleaning/washing program for equipment that does not currently have one. Dirt buildup could result in electrical tracking under certain conditions.

4.3.3 RUST & CORROSION REPAIR

With continued procurement delays, and increasing numbers of leaking transformers numbers from inspections, alternative repair methods have been reviewed. A 2025 pilot is being reviewed for utilize ONTech Coatings services which utilize a proprietary cold-spray technology to remove rust and corrosion to extend the useful life of transformers.

4.3.4 TRANSFORMER LOAD UTILIZATION REPLACEMENTS

As mentioned previously, load reports are now available through the Burlington Hydro GIS. Coincidental peaks should be assessed on transformers that are above 100% and below 25%-50% utilization. There is a large quantity of pad mounted transformers within our service territory. A focused effort in replacements should be targeted with an appropriate budget to reduce system strain and losses. An 'Annual Transformer Utilization by Transformer Type' report was created for 2024 and will be utilized in these efforts.

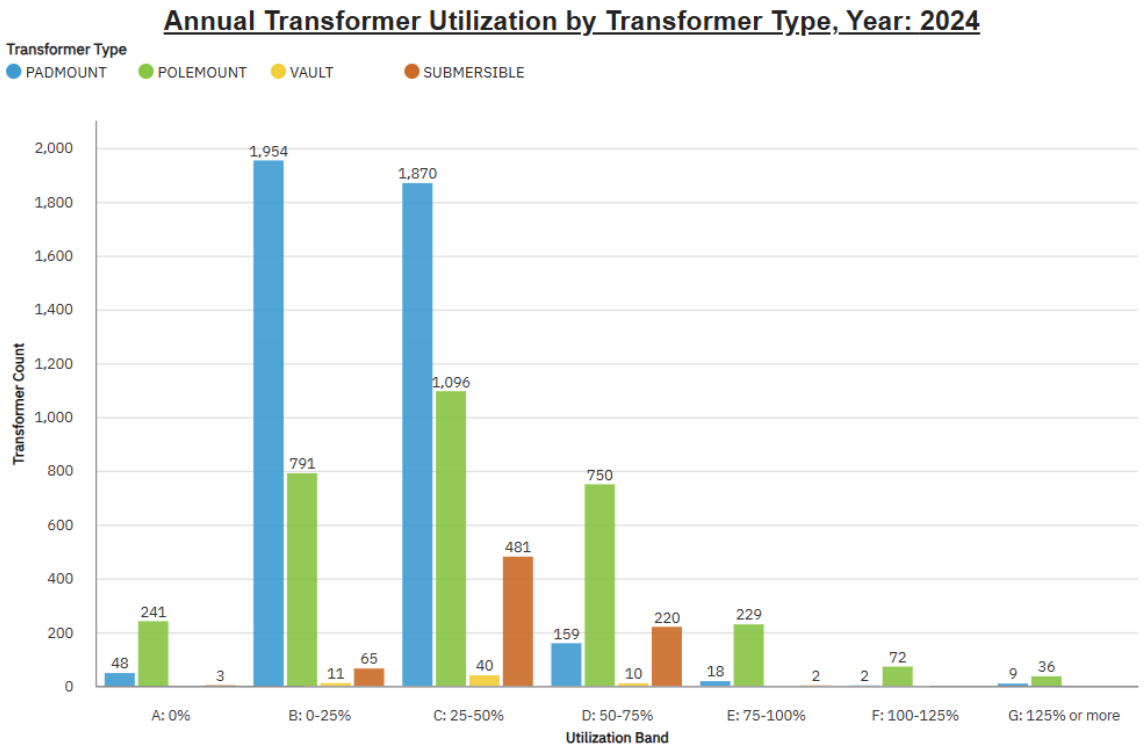


Figure 35: Chart 6 – Annual Transformer Utilization by Transformer Type – 2024

4.3.6 CABLE TESTING – PALMER AND NORTH TYANDAGA SUBDIVISIONS

As previous successes with the BHI cable testing program, a continued effort needs to be maintained to gather more data on subdivisions susceptible to continued cable faults. With the implementation of test point mounted fault indicators, certain older style elbows cannot make proper contact resulting in some FCI not working as intended. As cables reach end of life, the FCI will be transferred to the new elbows at each location.

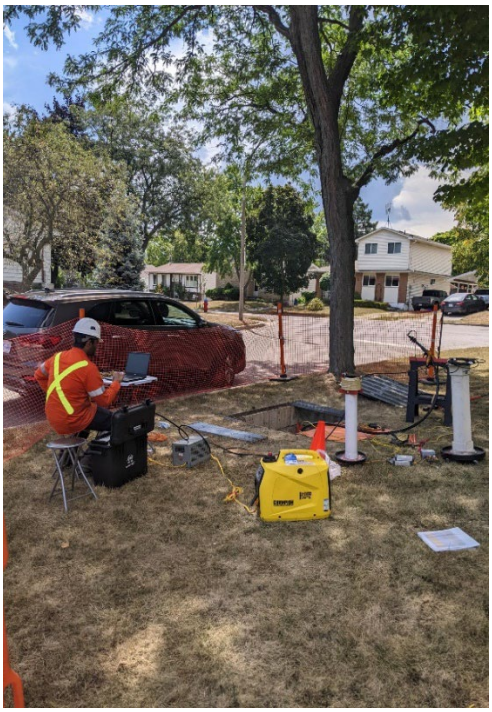


Figure 36: Burlington Hydro's Contractor Performing Cable Testing at a Submersible Transformer

Palmer & North Tyandaga subdivisions have been completed in 2024, and condition report data is being utilized for the 2025 cable replacement program. South Tyandaga has been targeted as the next best candidate for testing. The same approach will need to be taken with cable testing, equipment maintenance where required. In conjunction to South Tyandaga, Headon Forest is the next viable candidate as an aim to complete the cable testing of subdivisions North of Brant St by 2026. With the implementation of test point mounted fault indicators, certain older style elbows cannot make proper contact resulting in some FCI not working as intended. As cables reach the end of life, the FCI will be transferred to the new elbows at each location.

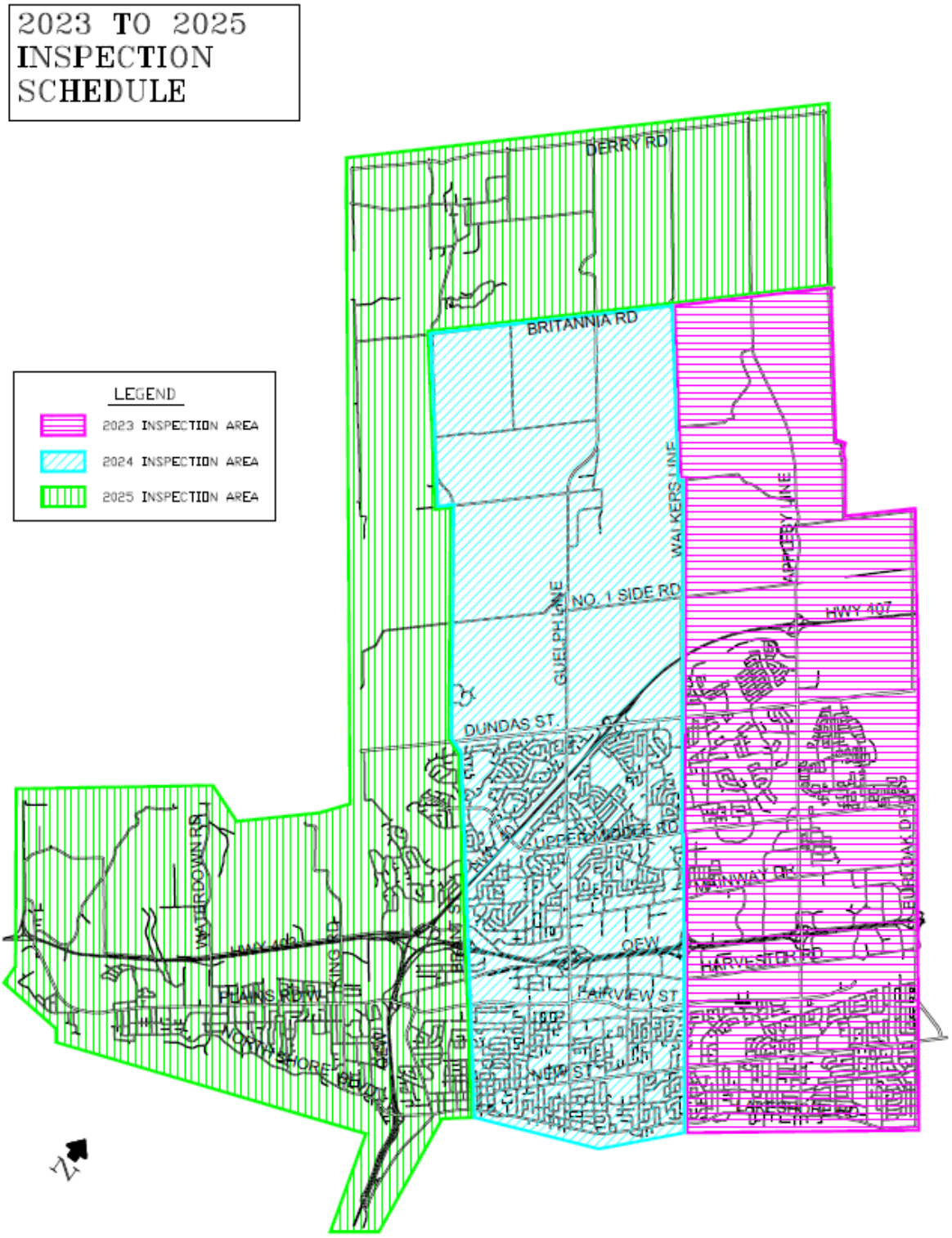
Figure 37: Burlington Hydro's Contractor Performing Cable Testing at a Submersible Transformer

4.3.7 CABLE REJUVENATION PROGRAM

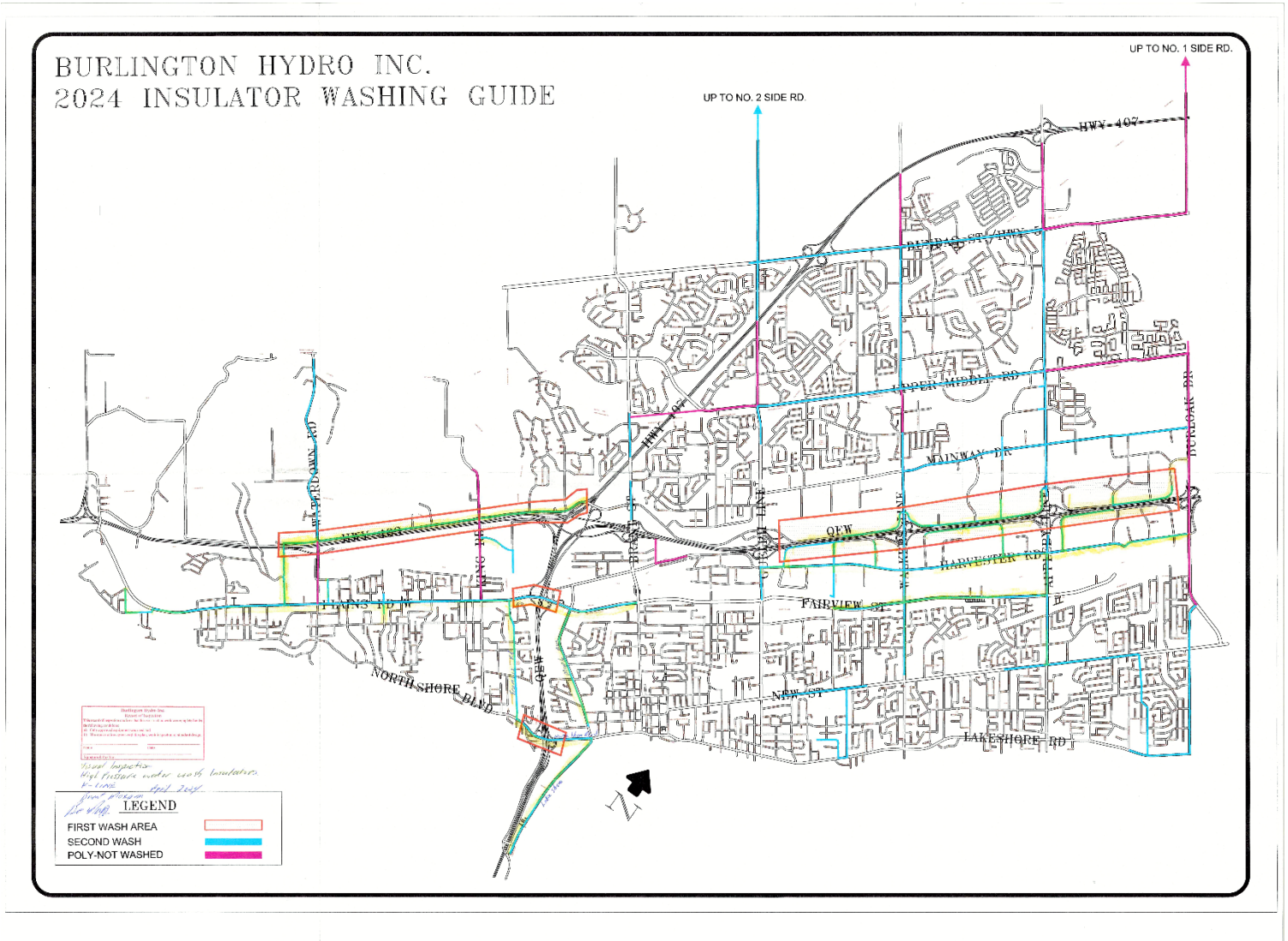
Continued efforts with cable testing have shown suboptimal results for cable conditions in Brant Hills. Novinium is a Southwire company that is currently the only cable rejuvenation provider in North America. As test result data is compiled, areas need to be assessed for potential use of cable injection. Cable injection primarily focuses on voids, defects, and water trees within cable insulation to fill the gaps and reduce the chance of cable faults while extending the asset life of cables. This is a much cheaper alternative to cable replacement and can be capitalized as it extends and improves asset life. A coordinated cable rejuvenation effort may be required to ensure not only cable injection but attached cable accessories are replaced as well to mitigate the risks of potential failures or issues from aged equipment. Meetings with Southwire, formerly Novinium, have been held in 2024 to develop the pilot program slated for a 2025 start date in late Spring.

APPENDIX

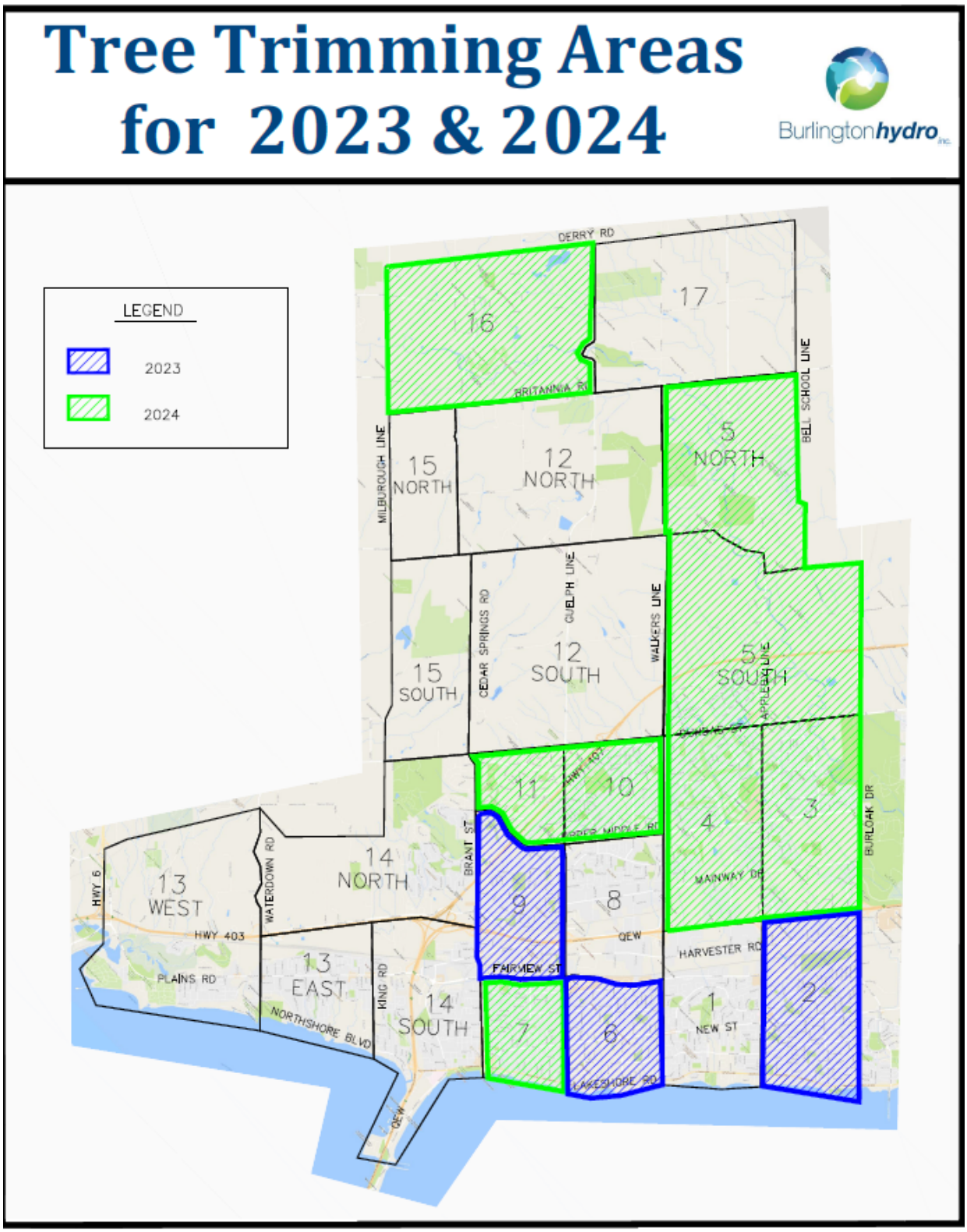
APPENDIX A – INSPECTION CYCLE 2023-2025



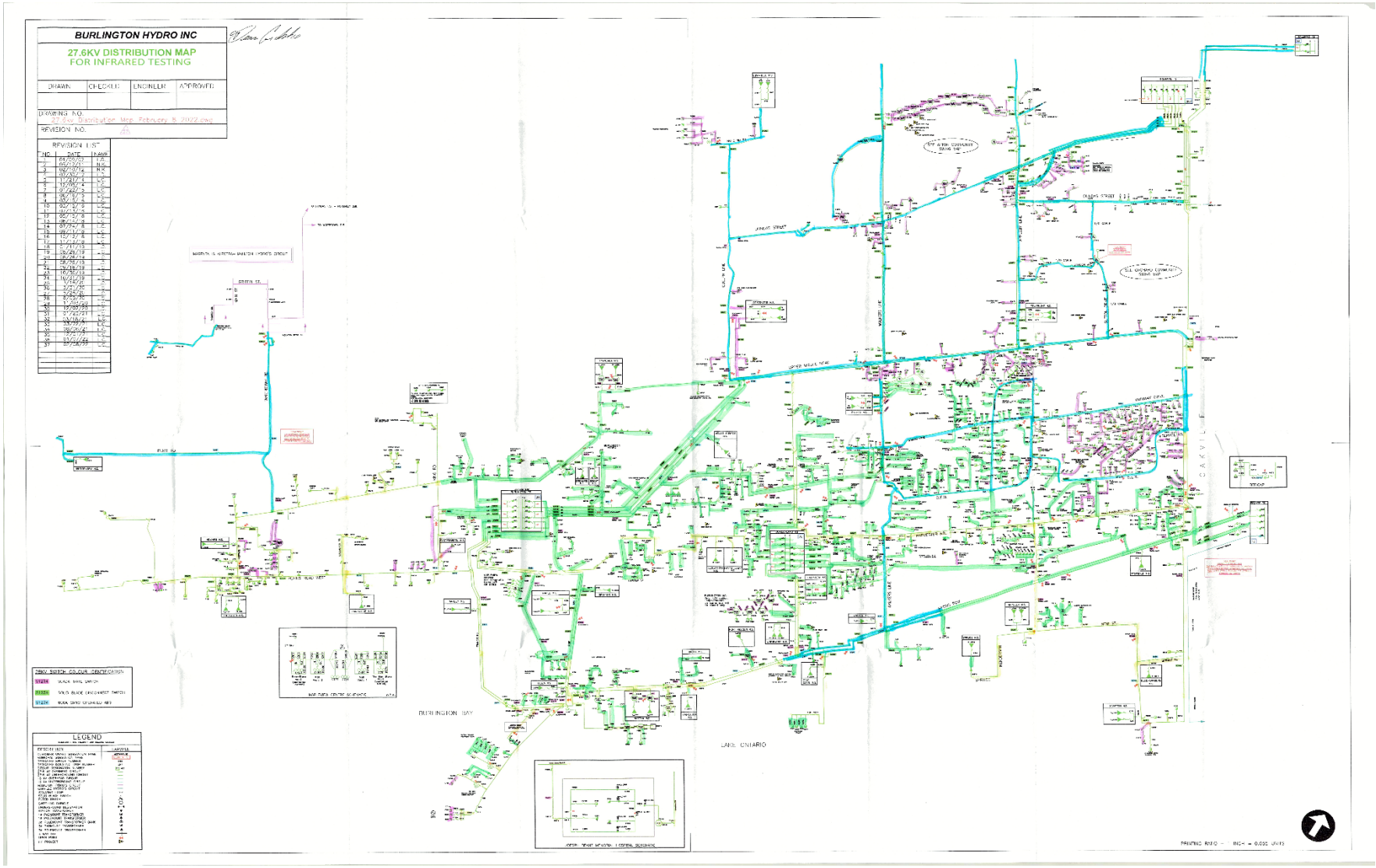
APPENDIX B – INSULATOR WASHING CYCLE 2024

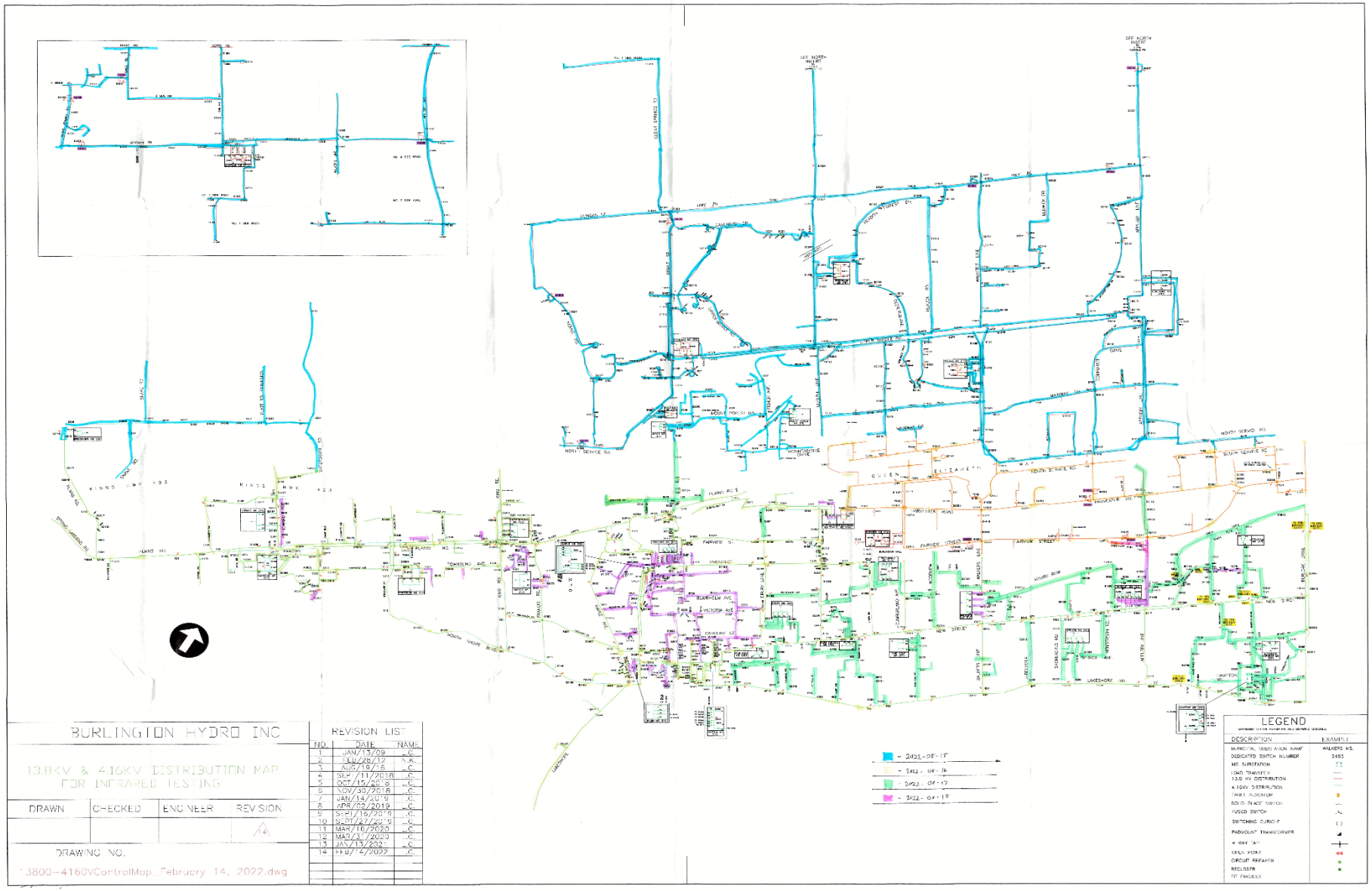


APPENDIX C – TREE TRIMMING ZONES 2023-2024



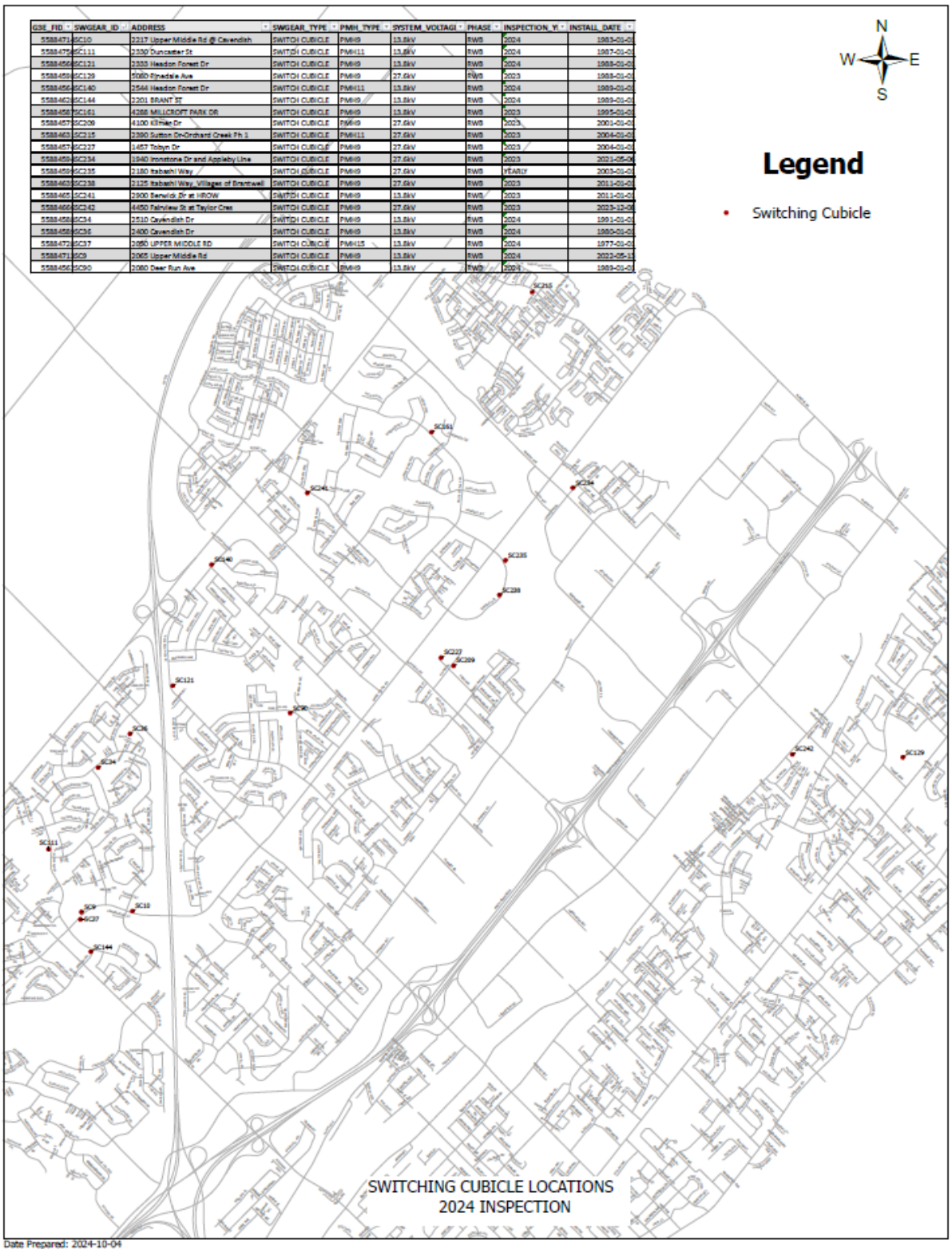
APPENDIX D – INFRARED THERMOGRAPHY MAPS – 27.6KV MAP AND 13.8KV & 4.16KV MAP




BURLINGTON HYDRO INC
13.8KV & 4.16KV DISTRIBUTION MAP
FOR INFRARED TESTING
DRAWN
CHECKED
ENGINEER
REVISION
DRAWING NO.
13800-4160VControlMap_Februcry 14, 2022.dwg
REVISION LIST
NO
DATE
NAME
1 JAN/15/09 .C.
2 FEB/26/12 M.K.
3 AUG/19/16 .C.
4 SEP /11/2018 .C.
5 OCT/15/2018 .C.
6 NOV/30/2018 .C.
7 JAN/14/2019 .C.
8 APR/02/2019 .C.
9 SEPT/16/2019 .C.
10 SEPT/27/2019 .C.
11 MAR/16/2020 .C.
12 MAR/31/2020 .C.
13 JAN/13/2021 .C.
14 FEB/14/2022 .C.
LEGEND
DESCRIPTION
EXAMPLE
MUNICIPAL SUBSTATION NAME
WALKERS MS.
DEDICATED SWITCH NUMBER
3453
ME SUBSTATION
LOAD TRANSFER
13.8 KV DISTRIBUTION
4.16KV DISTRIBUTION
JOINT ADDENDUM
SOLID BLADE SWITCH
FUSED SWITCH
SWITCHING CUBICLE
PADMOUNT TRANSFORMER
4 WAY TAP
OPEN POINT
CIRCUIT BREAKER
RECLOSER
TP PROJECT

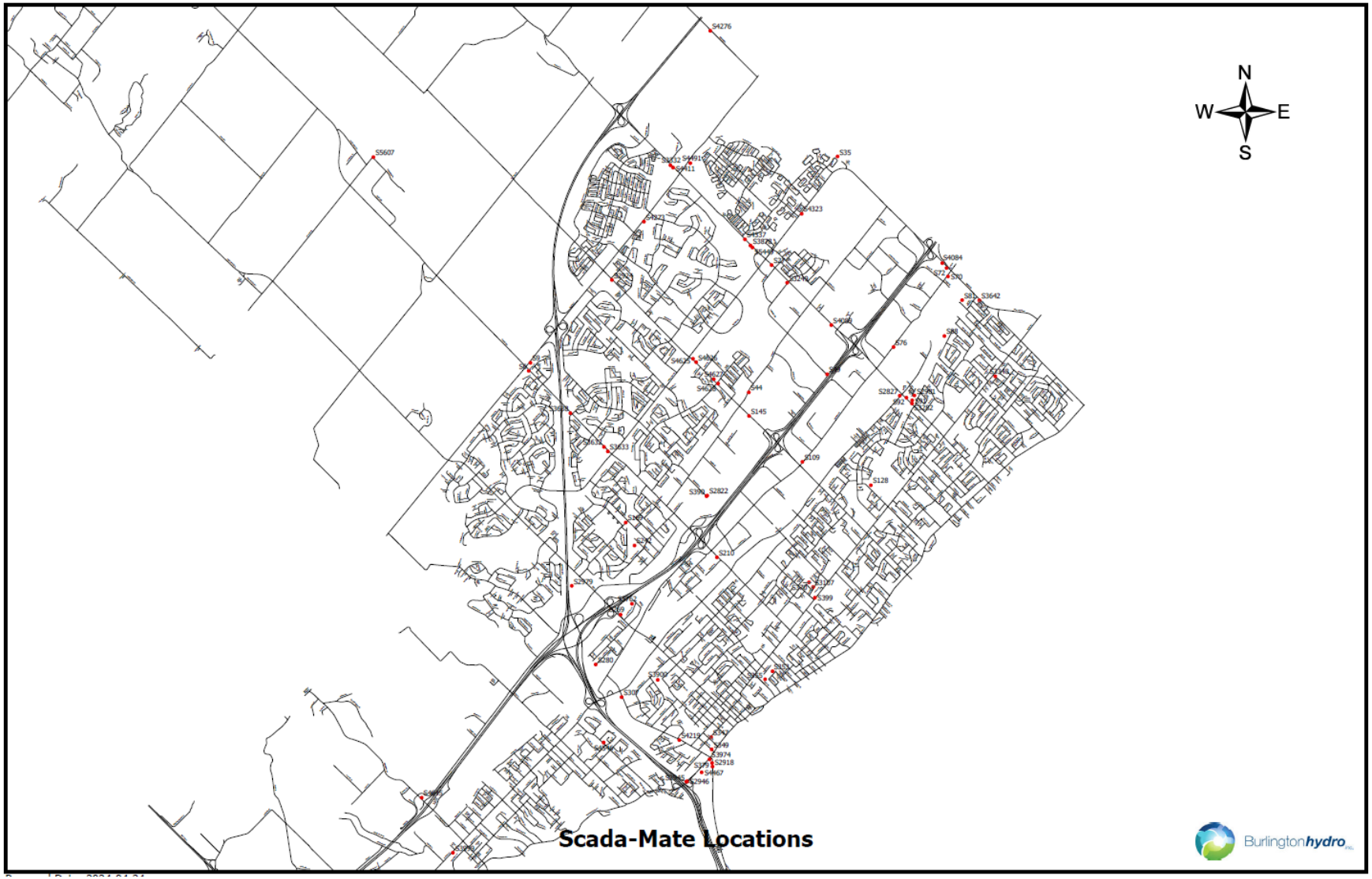
APPENDIX E – SWITCHING CUBICLE INSPECTION LOCATIONS

GSE_FID	SWGEAR_ID	ADDRESS	SWGEAR_TYPE	PMH_TYPE	SYSTEM_VOLTAGE	PHASE	INSPECTION_YE	INSTALL_DATE
5588471	SC10	2317 Upper Middle Rd @ Cavendish	SWITCH CUBICLE	PMH9	13.8kV	RWB	2024	1983-01-01
5588475	SC111	2330 Duncaster St	SWITCH CUBICLE	PMH11	13.8kV	RWB	2024	1987-01-01
5588456	SC121	2333 Headon Forest Dr	SWITCH CUBICLE	PMH9	13.8kV	RWB	2024	1988-01-01
5588459	SC129	5080 Pinedale Ave	SWITCH CUBICLE	PMH9	27.6kV	RWB	2023	1988-01-01
5588456	SC140	2566 Headon Forest Dr	SWITCH CUBICLE	PMH11	13.8kV	RWB	2024	1989-01-01
5588462	SC144	2201 BRANT ST	SWITCH CUBICLE	PMH9	13.8kV	RWB	2024	1989-01-01
5588458	SC161	4288 MILLCROFT PARK DR	SWITCH CUBICLE	PMH9	13.8kV	RWB	2023	1995-01-01
5588457	SC209	4100 Kilmile Dr	SWITCH CUBICLE	PMH9	27.6kV	RWB	2023	2001-01-01
5588463	SC215	2390 Sutton Dr-Orchard Creek Ph 1	SWITCH CUBICLE	PMH11	27.6kV	RWB	2023	2004-01-01
5588457	SC227	1457 Tobyn Dr	SWITCH CUBICLE	PMH9	27.6kV	RWB	2023	2004-01-01
5588459	SC234	1940 Ironstone Dr and Appleby Line	SWITCH CUBICLE	PMH9	27.6kV	RWB	2023	2021-05-01
5588459	SC235	2180 Itabashi Way	SWITCH CUBICLE	PMH9	27.6kV	RWB	YEARLY	2003-01-01
5588463	SC238	2125 Itabashi Way, Villages of Brantwell	SWITCH CUBICLE	PMH9	27.6kV	RWB	2023	2013-01-01
5588465	SC241	2900 Berwick Dr at HROW	SWITCH CUBICLE	PMH9	13.8kV	RWB	2023	2011-01-01
5588466	SC242	4450 Fairview St at Taylor Cres	SWITCH CUBICLE	PMH9	27.6kV	RWB	2023	2023-12-01
5588458	SC34	2510 Cavendish Dr	SWITCH CUBICLE	PMH9	13.8kV	RWB	2024	1991-01-01
5588458	SC36	2400 Cavendish Dr	SWITCH CUBICLE	PMH9	13.8kV	RWB	2024	1990-01-01
5588472	SC37	2050 UPPER MIDDLE RD	SWITCH CUBICLE	PMH15	13.8kV	RWB	2024	1977-01-01
5588471	SC9	2065 Upper Middle Rd	SWITCH CUBICLE	PMH9	13.8kV	RWB	2024	2022-05-11
5588456	SC90	2080 Deer Run Ave	SWITCH CUBICLE	PMH9	13.8kV	RWB	2024	1989-01-01



Date Prepared: 2024-10-04

APPENDIX F – SCADAMATE MAINTENANCE LOCATIONS



Appendix – 2-Intervenor-80a)

METSCO

MAKING IT POSSIBLE

<page left blank intentionally>

Burlington hydro inc.

ASSET CONDITION ASSESSMENT FINAL REPORT 2019

Prepared by

METSCO MAKING IT POSSIBLE

P-19-101

November 11, 2019

Disclaimer

This 2019 report has been prepared by METSCO Energy Solutions Inc. ("METSCO") for Burlington Hydro Inc. ("BHI"). Neither BHI, nor METSCO, nor any other person acting on their behalf makes any warranty, expressed or implied, or assumes any legal responsibility for the accuracy of any information or for the completeness or usefulness of any process disclosed or results presented, or accepts liability for the use, or damages resulting from the use, thereof. Any reference in this report to any specific process or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement or recommendation by BHI or METSCO.

Asset Condition Assessment Report 2019

Final Report

November 11, 2019

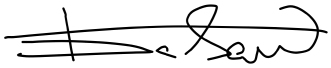
Experts:

Robert Otal, B.Eng., P.Eng.
Director, Asset Management & Analytics

Dawid Lizak, B.A.Sc., M.Eng
Associate, Asset Management & Strategy

Rashid Turjo, B.A.Sc.
Associate, Engineer in Training

Approved By:



Dmitry Balashov, MBA, MPA
Director, Utility Strategy and Economic Regulation

Executive Summary

Context of the Study

Burlington Hydro Inc. ("BHI") is an electricity distributor operating a system made up of 32 substations and almost 1,550 km of medium-voltage distribution lines delivering electricity to approximately 68,000 residential and commercial customers in the City of Burlington. BHI engaged METSCO Energy Solutions to prepare a comprehensive Asset Condition Assessment ("ACA") study for the assets comprising BHI's distribution system. The ACA is required as one of the key inputs for the preparation of BHI's five-year Distribution System Plan (DSP), developed in accordance with the filing requirements enacted by the Ontario Energy Board ("OEB").

Scope of the Study

METSCO's work included interviews with BHI subject matter experts to define the Health Indices appropriate for the asset types, review and consolidation of the client's data sets, analysis of BHI's asset records to calculate the Health Index values, and preparation of the final document. In total METSCO assessed and calculated Health Index values for the following asset classes:

- Distribution Wood Poles
- Distribution Concrete Poles
- Overhead Primary Conductors
- Underground Primary Cables
- Distribution Transformers
- Distribution Switchgear
- Overhead Switches
- Reclosers
- Station Power Transformers
- Station Circuit Breakers
- Station Feeder Egress Cables
- Station Battery Banks and Chargers
- Station Primary Switchgears
- Protection Relays
- Station Buildings

All asset condition data used in the study is maintained by BHI as part of its regular asset management practices and collected in compliance with the Distribution System Code requirements. METSCO received BHI's data in raw format between May and September of 2019.

Methodology and Findings

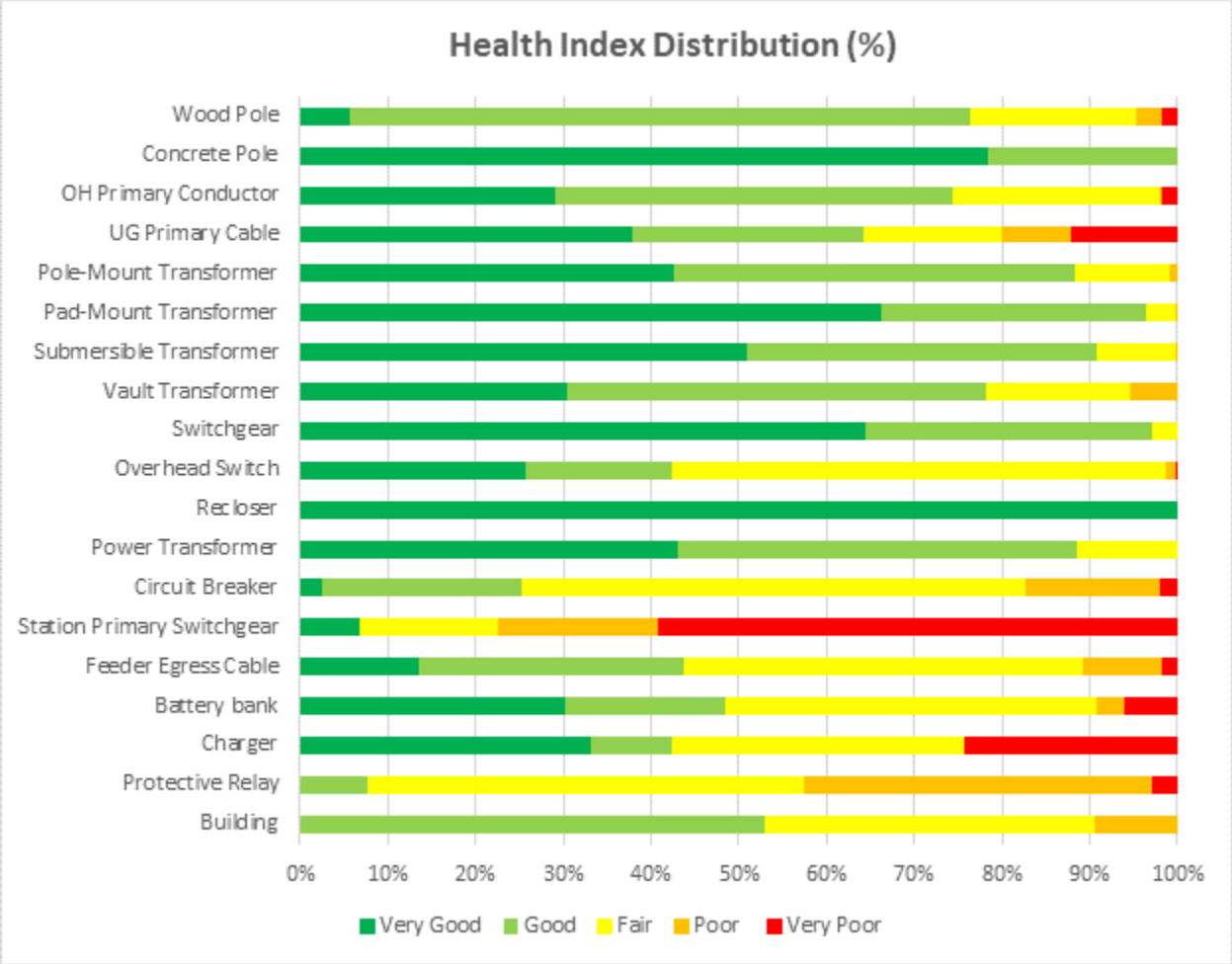
For all asset classes that underwent assessment, METSCO used a consistent scale of asset health from Very Good to Very Poor. The numerical Health Index ("HI") corresponding to each condition category serves as an indicator of an asset's remaining life, expressed as a percentage. Table 0-1 presents the HI ranges corresponding to each condition score, along with their corresponding implications as to the follow-up actions required by the asset manager at BHI.

Table 0-1: Health Index Ranges and Corresponding Implications for the Asset Condition

Health Index Score (%)	Condition	Description	Implications
[85-100]	Very Good	Some evidence of aging or minor deterioration of a limited number of components	Normal Maintenance
[70-85)	Good	Significant Deterioration of some components	Normal Maintenance
[50-70)	Fair	Widespread significant deterioration or serious deterioration of specific components	Increase diagnostic testing; possible remedial work or replacement needed depending on the unit's criticality
[30-50)	Poor	Widespread serious deterioration	Start the planning process to replace or rehabilitate, considering the risk and consequences of failure
[0-30)	Very Poor	Extensive serious deterioration	The asset has reached its end-of-life; immediately assess risk and replace or refurbish based on assessment

Using this scale, METSCO calculated Health Indices for every asset class in the scope of its assessment using a selected Health Index model. The HI for each asset class is made up of available and relevant "condition parameters" – individual characteristics of the state of an asset's components – each with its own sub-scale of assessment, and a weighting contribution that represents the percentage in the overall HI made up by the particular parameter. METSCO's findings for each asset class were developed using this methodology, as described in more detail in Section 3 and Section 4. The consolidated results of the Asset Condition Assessment are summarized in Figure 0-1.

Figure 0-1: Health Index Results



As the figure above indicates, the majority of BHI's distribution system is in Fair or better condition, with several asset classes containing units found to be in Poor and Very Poor condition – most notably switchgears and station protective relays. Table 0-2 on the following page presents the numerical Health Index summary for each asset class. The distribution of Health Indices is based on the total population count of a given asset class. For each asset class, the following details are listed: total population, average Health Index, average Data Availability Index ("DAI"), and the Health Index distribution. A DAI is a percentage of condition parameter data available for an asset or asset class, as measured against the condition parameters considered in the Health Index Formulation. A DAI of 100% for an asset indicates that data was available for all assets and all condition parameters in an asset class. DAI is also calculated for individual condition parameters used in the Health Index Formulation.

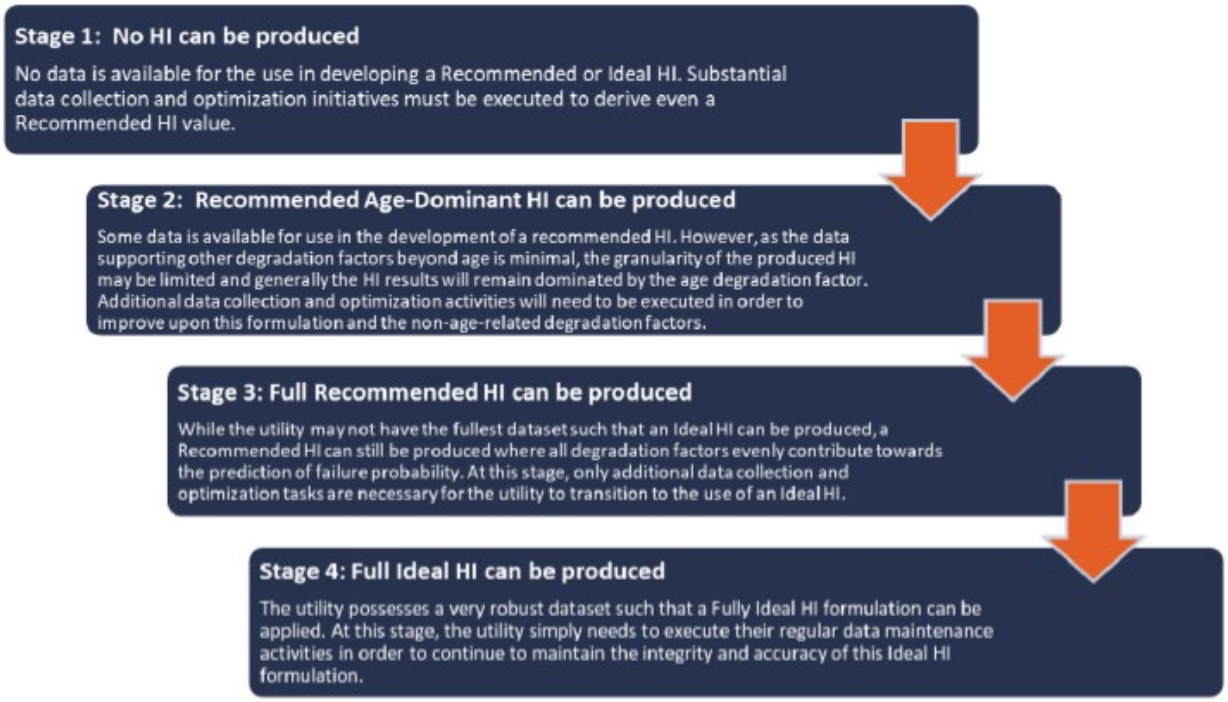
Table 0-2: Asset Condition Assessment Overall results

Asset Class	Population	Health Index Distribution (%)					Average Health Index	Average DAI
		Very Good	Good	Fair	Poor	Very Poor		
Wood Pole	14471	5.84%	70.73%	18.93%	2.84%	1.65%	74.13%	82.62%
Concrete Pole	165	78.62%	21.38%	0.00%	0.00%	0.00%	88.70%	89.15%
Overhead Primary Conductor (km)	827.0	29.25%	45.19%	23.73%	0.15%	1.68%	74.94%	99.52%
Underground Primary Cable (km)	661.8	37.96%	26.30%	15.74%	8.08%	11.92%	72.09%	99.64%
Pole-Mount Transformer	3189	42.64%	45.85%	10.78%	0.73%	0.00%	83.52%	96.48%
Pad-Mount Transformer	4007	66.46%	30.05%	3.46%	0.03%	0.00%	88.50%	96.15%
Submersible Transformer	772	51.01%	40.00%	8.86%	0.13%	0.00%	84.42%	99.29%
Vault Transformer	72	30.56%	47.76%	16.42%	5.97%	0.00%	77.93%	88.69%
Switchgear	201	64.52%	32.80%	2.69%	0.00%	0.00%	88.68%	97.25%
Overhead Switch	5174	25.86%	16.63%	56.19%	1.23%	0.10%	75.59%	93.48%
Recloser	14	100.00%	0.00%	0.00%	0.00%	0.00%	97.99%	96.43%
Power Transformer	44	43.18%	45.45%	11.36%	0.00%	0.00%	83.03%	97.27%
Circuit Breaker	132	2.73%	22.73%	57.27%	15.45%	1.82%	61.44%	85.24%
Station Primary Switchgear	44	6.82%	0.00%	15.91%	18.18%	59.09%	34.90%	100.00%
Feeder Egress Cable (km)	22.8	13.73%	30.22%	45.39%	9.05%	1.62%	69.54%	100.00%
Battery Bank	33	30.30%	18.18%	42.42%	3.03%	6.06%	70.45%	100.00%
Charger	33	33.33%	9.09%	33.33%	0.00%	24.24%	63.28%	100.00%
Protective Relay	127	0.00%	7.72%	49.80%	39.58%	2.90%	50.12%	90.94%
Building	32	0.00%	53.13%	37.50%	9.38%	0.00%	66.33%	100.00%

BHI's Current Health Index Maturity and Continuous Improvement

Overall, BHI's asset data collection practices are sufficiently robust to enable calculation of recommended Asset Condition Assessment that is consistent with industry best practices. Figure 0-2 illustrates the characteristics of the four major maturity levels associated with ACA and HI implementation across distribution system assets. Based on our assessment, BHI's overall asset data collection capabilities are aligned with the Stage 3 of ACA maturity. This is an advanced maturity level, which represents a state where full recommended Health Index calculations can generally be produced, with moderate enhancements only separating the utility from an "Ideal" state (Stage 4) of ACA / HI implementation maturity.

Figure 0-2: Maturity levels of ACA framework



In limited cases, such as station circuit breakers and reclosers, there are opportunities for BHI to introduce additional variables that can provide further insight into the degradation level of a given asset class. For example, there remain a few instances where select recommended parameter data is not collected or is not available across a large enough portion of the population, resulting in certain condition parameters being excluded from the formulation. However, such instances represent relative exceptions rather than the rule, enabling METSCO to classify BHI's HI formulation as being closely aligned with best practices, and being commensurate with the Stage 3 of ACA framework maturity.

While the existing framework provides BHI with a significant volume of data, certain procedural and technological enhancements could further the granularity of its asset condition data and facilitate calculation of a greater proportion of numerical degradation scores. To this end, Section 5 of this study includes a set of METSCO's recommendations for incremental data collection enhancements that BHI can consider going forward based on its assessment of their relative cost-benefit tradeoffs. METSCO prioritized the individual items according to the significance of the additional insights they would enable BHI to generate.

In providing these recommendations, METSCO is cognizant of the fact that regulated utilities are facing cost constraints across numerous facets of their operations, while contending with the effects of aging infrastructure, changing climate, evolving customer

needs, and many other priorities. As such, an adoption of any incremental enhancement to the existing asset data collection practices must be grounded in management's assessment of the incremental value of such enhancements, relative to the opportunity cost of advancements elsewhere in the utility's operations. METSCO makes this observation to highlight its position that the sole fact of a gap between a utility's current process state and the industry best practices need not necessarily indicate that an action to remedy that gap is required in short order.

Table of Contents

EXECUTIVE SUMMARY 6
TABLE OF CONTENTS 12
LIST OF FIGURES 14
LIST OF TABLES 15
1 INTRODUCTION 18
2 INDUSTRY STANDARD FOR ASSET CONDITION ASSESSMENTS WITHIN ASSET MANAGEMENT PLANNING 20
3 ASSET HEALTH INDEX CALCULATION METHODOLOGY 23
3.1 Asset Condition Assessment Methodologies 23
3.2 Overview of Selected Methodology 23
3.2.1 Condition Parameters 23
3.2.2 Final Health Index (HI) Formulation 25
3.2.3 Health Index Results 25
3.3 Data Availability Index 26
3.3.1 Condition Parameter Data Threshold 27
3.3.2 Data Sources 27
3.4 Use of Age as a Condition Parameter 28
3.4.1 METSCO's Project Execution 29
4 HEALTH INDICES 31
4.1 Distribution Assets 31
4.1.1 Wood Pole 31
4.1.2 Concrete Pole 34
4.1.3 Overhead Primary Conductor 37
4.1.4 Underground Primary Cable 39
4.1.5 Overhead Distribution (Pole-Mount) Transformer 42
4.1.6 Underground Distribution Transformer 44
4.1.7 Distribution Switchgear 49
4.1.8 Overhead Switch 52
4.1.9 Recloser 55
4.2 Station Assets 57
4.2.1 Power Transformer 57
4.2.2 Circuit Breaker 60
4.2.3 Station Primary Switchgear 63
4.2.4 Station Feeder Egress Cable 65
4.2.5 Battery Bank and Charger 68
4.2.6 Protection Relay 71
4.2.7 Station Building 74
5 RECOMMENDATIONS 76
5.1 Health Index Improvement 76
5.2 Data availability improvements 79

6 CONCLUSION 81

7 APPENDIX A – METSCO COMPANY PROFILE 83

8 APPENDIX B – CONDITION PARAMETERS GRADING TABLES 85

1. WOOD POLE 85
2. CONCRETE POLE 86
3. OVERHEAD PRIMARY CONDUCTOR 87
4. UNDERGROUND PRIMARY CABLE 87
5. OVERHEAD/POLE MOUNT TRANSFORMER 88
6. UNDERGROUND TRANSFORMER 88
7. SWITCHGEAR 89
8. OVERHEAD SWITCH 90
9. RECLOSERS 91
10. POWER TRANSFORMER 91
11. CIRCUIT BREAKER 93
12. STATION PRIMARY SWITCHGEAR 94
13. STATION FEEDER EGRESS CABLE 94
14. STATION BATTERY BANK AND CHARGER 95
15. PROTECTIVE RELAY 95
16. BUILDINGS 96

List of Figures

FIGURE 0-1: HEALTH INDEX RESULTS 8
FIGURE 0-2: MATURITY LEVELS OF ACA FRAMEWORK 10
FIGURE 2-1: RELATIONSHIP BETWEEN KEY ASSET MANAGEMENT TERMS[1] 21
FIGURE 3-1: HEALTH INDEX FORMULATION COMPONENTS 24
FIGURE 3-2: A SAMPLE ASSET AGE VS. CONDITION COMPARISON CHART 29
FIGURE 4-1: WOOD POLES AGE DEMOGRAPHIC 32
FIGURE 4-2: WOOD POLES HEALTH INDEX DEMOGRAPHIC 33
FIGURE 4-3: CONCRETE POLES AGE DEMOGRAPHIC 35
FIGURE 4-4: CONCRETE POLES HEALTH INDEX DEMOGRAPHIC 36
FIGURE 4-5 OVERALL OVERHEAD PRIMARY CONDUCTOR AGE DEMOGRAPHIC 37
FIGURE 4-6: OVERHEAD PRIMARY CONDUCTOR HEALTH INDEX DEMOGRAPHIC 38
FIGURE 4-7: OVERALL UNDERGROUND PRIMARY CABLE AGE DEMOGRAPHIC 40
FIGURE 4-8: UNDERGROUND PRIMARY CABLE HEALTH INDEX DEMOGRAPHIC 41
FIGURE 4-9: POLE-MOUNT TRANSFORMERS AGE DEMOGRAPHIC 43
FIGURE 4-10: POLE-MOUNT TRANSFORMERS HEALTH INDEX DEMOGRAPHIC 44
FIGURE 4-11: DISTRIBUTION TRANSFORMERS AGE DEMOGRAPHIC 46
FIGURE 4-12: PAD-MOUNT TRANSFORMERS HEALTH INDEX DEMOGRAPHIC 47
FIGURE 4-13: SUBMERSIBLE TRANSFORMERS HEALTH INDEX DEMOGRAPHIC 47
FIGURE 4-14: VAULT TRANSFORMERS HEALTH INDEX DEMOGRAPHIC 48
FIGURE 4-15: SWITCHGEARS AGE DEMOGRAPHIC 50
FIGURE 4-16: SWITCHGEARS HEALTH INDEX DEMOGRAPHIC 51
FIGURE 4-17: OVERHEAD SWITCHES AGE DEMOGRAPHIC 53
FIGURE 4-18: OVERHEAD SWITCHES HEALTH INDEX DEMOGRAPHIC 54
FIGURE 4-19: RECLOSERS AGE DEMOGRAPHIC 55
FIGURE 4-20: RECLOSERS HEALTH INDEX DEMOGRAPHIC 56
FIGURE 4-21: POWER TRANSFORMERS AGE DEMOGRAPHIC 58
FIGURE 4-22: POWER TRANSFORMERS HEALTH INDEX DEMOGRAPHIC 59
FIGURE 4-23: POWER TRANSFORMERS DGA ANALYSIS RESULTS 59
FIGURE 4-24: CIRCUIT BREAKERS AGE DEMOGRAPHIC 61
FIGURE 4-25: CIRCUIT BREAKERS HEALTH INDEX DEMOGRAPHIC 62
FIGURE 4-26: STATION PRIMARY SWITCHGEARS AGE DEMOGRAPHIC 63
FIGURE 4-27: STATION PRIMARY SWITCHGEARS HEALTH INDEX DEMOGRAPHIC 64
FIGURE 4-28: STATION FEEDER EGRESS CABLE AGE DEMOGRAPHIC 66
FIGURE 4-29: STATION FEEDER EGRESS CABLE HEALTH INDEX DEMOGRAPHIC BY LENGTH 66
FIGURE 4-30: STATION FEEDER EGRESS CABLE HEALTH INDEX DEMOGRAPHIC BY FEEDER 67
FIGURE 4-31: STATION BATTERY BANKS AGE DEMOGRAPHIC 69
FIGURE 4-32: STATION CHARGERS AGE DEMOGRAPHIC 69
FIGURE 4-33: STATION BATTERY BANKS HEALTH INDEX DEMOGRAPHIC 70
FIGURE 4-34: CHARGERS HEALTH INDEX DEMOGRAPHIC 71
FIGURE 4-35: PROTECTION RELAYS AGE DEMOGRAPHIC 72
FIGURE 4-36: PROTECTION RELAYS HEALTH INDEX DEMOGRAPHIC 73
FIGURE 4-37: STATION BUILDINGS AGE DEMOGRAPHIC 74
FIGURE 4-38: STATION BUILDING HEALTH INDEX DEMOGRAPHIC 75
FIGURE 6-1: HEALTH INDEX RESULTS 81
FIGURE 7-1: METSCO CLIENTS 83

List of Tables

Table 0-1: Health Index Ranges and Corresponding Implications for the Asset Condition 7
Table 0-2: Asset Condition Assessment Overall results 9
Table 3-1: Health Index Ranges and Corresponding Asset Condition 26
Table 4-1: Wood Pole Health Index Algorithm 31
Table 4-2: Wood Poles condition parameters data availability 33
Table 4-3: Concrete Pole Health Index Algorithm 34
Table 4-4: Concrete Poles condition parameters data availability 36
Table 4-5: Overhead Primary Conductor Health Index Algorithm 37
Table 4-6: Overhead Primary Conductor condition parameters data availability 38
Table 4-7: Underground Primary Cable Health Index Algorithm 39
Table 4-8: Underground Primary Cables condition parameters data availability 41
Table 4-9: Pole-Mount Transformer Health Index Algorithm 42
Table 4-10: Pole-Mount Transformers condition parameters data availability 44
Table 4-11: Underground Distribution Transformer Health Index Algorithm 45
Table 4-12: Underground Transformers condition parameters data availability 48
Table 4-13: Switchgear Health Index Algorithm 49
Table 4-14: Switchgears condition parameters data availability 51
Table 4-15: Overhead Switch Health Index Algorithm 52
Table 4-16: Overhead Switches condition parameters data availability 54
Table 4-17: Recloser Health Index Algorithm 55
Table 4-18: Reclosers condition parameters data availability 56
Table 4-19: Power Transformer Health Index Algorithm 57
Table 4-20: Power Transformers condition parameters data availability 60
Table 4-21: Circuit Breaker Health Index Algorithm 60
Table 4-22: Circuit Breakers condition parameters data availability 62
Table 4-23: Station Primary Switchgears Health Index Algorithm 63
Table 4-24: Primary Station Switchgears condition parameters data availability 64
Table 4-25: Station Feeder Egress Cable Health Index Algorithm 65
Table 4-26: Station Feeder Egress Cable condition parameters data availability 67
Table 4-27: Station Battery Bank Health Index Algorithm 68
Table 4-28: Station Batteries & Chargers condition parameters data availability 71
Table 4-29: Protection Relay Health Index Algorithm 71
Table 4-30: Protection relays condition parameters data availability 73
Table 4-31: Station Building Health Index Algorithm 74
Table 4-32: Station building condition parameters data availability 75
Table 5-1: Data Collection Recommendation for Underground Primary Cable 77
Table 5-2: Data Collection Recommendation for Underground Distribution Transformer 77
Table 5-3: Data Collection Recommendation for Switchgear 77
Table 5-4: Data Collection Recommendation for Overhead Switch 77
Table 5-5: Data Collection Recommendation for Oil Insulated Recloser 78
Table 5-6: Data Collection Recommendation for Vacuum Insulated Recloser 78
Table 5-7: Data Collection Recommendation for Power Transformer 78
Table 5-8: Data Collection Recommendation for Circuit Breaker 79
Table 5-9: Data Collection Recommendations for Protection Relay 79
Table 8-1: Criteria for Service Age 85

TABLE 8-2: CRITERIA FOR REMAINING STRENGTH 85
TABLE 8-3: CRITERIA FOR WOOD ROT 85
TABLE 8-4: CRITERIA FOR MECHANICAL DEFECTS 85
TABLE 8-5: CRITERIA FOR OUT OF PLUMB 85
TABLE 8-6: CRITERIA FOR SERVICE AGE 86
TABLE 8-7: CRITERIA FOR DEFECTS 86
TABLE 8-8: CRITERIA FOR OUT OF PLUMB 86
TABLE 8-9: CRITERIA FOR SERVICE AGE 87
TABLE 8-10: CRITERIA FOR SMALL RISK CONDUCTOR 87
TABLE 8-11: CRITERIA FOR SERVICE AGE (TRXLPE CABLES) 87
TABLE 8-12: CRITERIA FOR FIELD TESTING 87
TABLE 8-13: CRITERIA FOR HISTORIC FAILURE RATE 87
TABLE 8-14: CRITERIA FOR SERVICE AGE 88
TABLE 8-15: CRITERIA FOR PEAK LOADING 88
TABLE 8-16: CRITERIA FOR VISUAL INSPECTION 88
TABLE 8-17: IR SCAN RESULTS 88
TABLE 8-18: CRITERIA FOR SERVICE AGE 88
TABLE 8-19: CRITERIA FOR PEAK LOADING 89
TABLE 8-20: CRITERIA FOR VISUAL INSPECTION 89
TABLE 8-21: CRITERIA FOR CONDITION OF THE ENCLOSURE 89
TABLE 8-22: CRITERIA FOR SERVICE AGE 89
TABLE 8-23: CRITERIA FOR CONDITION OF ENCLOSURE 89
TABLE 8-24: CRITERIA FOR CONDITION OF THE PAD 90
TABLE 8-25: CRITERIA FOR IR SCAN RESULTS 90
TABLE 8-26: CRITERIA FOR SERVICE AGE 90
TABLE 8-27: CRITERIA FOR CONDITION OF BLADES 90
TABLE 8-28: CRITERIA FOR IR SCAN RESULTS 90
TABLE 8-29: CRITERIA FOR SERVICE AGE 91
TABLE 8-30: CRITERIA FOR CONDITION OF TERMINATION 91
TABLE 8-31: CRITERIA FOR COUNTER READINGS 91
TABLE 8-32: CRITERIA FOR DGA RESULTS 91
TABLE 8-33: CRITERIA FOR LOAD HISTORY 92
TABLE 8-34: CRITERIA FOR INSULATION POWER FACTOR 92
TABLE 8-35: CRITERIA FOR OIL QUALITY TESTS 92
TABLE 8-36: CRITERIA FOR SERVICE AGE 92
TABLE 8-37: CRITERIA FOR VISUAL INSPECTION FIELD 92
TABLE 8-38: CRITERIA FOR SERVICE AGE 93
TABLE 8-39: CRITERIA FOR CONTACT RESISTANCE TEST 93
TABLE 8-40: CRITERIA FOR OVERALL CONDITION 93
TABLE 8-41: CRITERIA FOR INSULATION RESISTANCE TEST 93
TABLE 8-42: CRITERIA FOR COUNTER READINGS 93
TABLE 8-43: CRITERIA FOR SERVICE AGE 94
TABLE 8-44: CRITERIA FOR VISUAL INSPECTION 94
TABLE 8-45: CRITERIA FOR SERVICE AGE (TRXLPE CABLES) 94
TABLE 8-46: CRITERIA FOR FIELD TESTING 94
TABLE 8-47: CRITERIA FOR HISTORIC FAILURE RATE 94
TABLE 8-48: CRITERIA FOR LOADING HISTORY 95

TABLE 8-49: CRITERIA FOR SERVICE AGE 95
TABLE 8-50: CRITERIA FOR TESTING 95
TABLE 8-51: CRITERIA FOR SERVICE AGE 95
TABLE 8-52: CRITERIA FOR TESTING 96
TABLE 8-53: CRITERIA FOR ROOF CONDITION 96
TABLE 8-54: CRITERIA FOR WALL CONDITION 96
TABLE 8-55: CRITERIA FOR DOORS/WINDOWS/LOUVRES 96
TABLE 8-56: CRITERIA FOR FLOORS/FOUNDATIONS 97
TABLE 8-57: CRITERIA FOR LIGHTING/POWER/HVAC 97
TABLE 8-58: CRITERIA FOR OVERALL BUILDING 97

1 Introduction

METSCO Energy Solutions has been leading the industry in Asset Condition Assessment ("ACA") and Asset Management practices for over 10 years. METSCO has completed a large volume of asset condition assessments, asset management plans, and asset management framework implementations for transmission and distribution utilities across North America. METSCO's collective record of experience in these areas is among the most extensive in the world, with our asset management frameworks gaining acceptance across multiple regulatory jurisdictions. A selection of METSCO's past projects is attached as Appendix A to this report.

Burlington Hydro Inc. ("BHI") is an electricity distributor operating in the City of Burlington. BHI engaged METSCO to prepare a comprehensive ACA study for the assets comprising BHI's distribution system. The ACA is required as one of the key inputs for the preparation of BHI's five-year Distribution System Plan, prepared in accordance with the filing requirements enacted by the Ontario Energy Board ("OEB"). The study's primary objective is to generate and report on the Health Indices grounded in the latest condition data of in-service assets – to enable future prioritization of asset renewal investments using objective decision inputs. Supplementary objectives included preparing the ACA results to be used for BHI's upcoming rate filing as well as to continuously improve BHI's asset management framework.

A unique ACA methodology is applied to each asset class deployed within BHI's distribution system. The adoption of the ACA methodology requires identifying end-of-life criteria for various components associated with each asset type, followed by periodic asset inspections and recording of asset condition to identify the assets most at risk at reaching the end-of-life criteria over the relevant planning horizon. Each criterion represents a factor that is influential, to a specific degree, in determining an asset's (or its component's) condition relative to its potential failure. These components and tests are weighted based on their importance in determining the assets' end-of-life.

The assets covered in the report include the following major asset classes:

- Distribution Wood Poles
- Distribution Concrete Poles
- Overhead Primary Conductors
- Underground Primary Cables
- Distribution Transformers
- Distribution Switchgear
- Overhead Switches
- Reclosers

- Station Power Transformers
- Station Circuit Breakers
- Station Feeder Egress Cables
- Station Battery Banks and Chargers
- Station Primary Switchgears
- Protection Relays
- Station Buildings

All the asset condition data is maintained by BHI as part of its regular asset management and collected in compliance with the Distribution System Code requirements. METSCO received BHI's data for the current condition assessment with date records between May and September 2019.

The report is organized into six sections including this introductory section:

- Section 2 summarizes the PAS-55 and ISO 55000/55001/55002 standards, discusses how the ACA fits into the overall asset management framework; and provides an overview of METSCO's ACA methodology;
- Section 3 summarizes the asset Health Index calculation methodology;
- Section 4 provides the Condition Assessment methodology framework and assessment for each of the identified asset classes;
- Section 5 summarizes METSCO's recommendations for BHI on data collection improvements for continuous improvement efforts for the ACA; and
- Section 6 summarizes METSCO's concluding remarks.

2 Industry Standard for Asset Condition Assessments within Asset Management Planning

An Asset Condition Assessment ("ACA") represents the first step in implementing the Asset Management ("AM") framework outlined by ISO 55000. By evaluating the current set of available data related to the condition of in-service assets comprising an organization's asset portfolio, condition scores for each asset are determined. Asset condition assessments consist of collecting, consolidating, and utilizing the results within an organizational AM framework for the purposes of objectively quantifying and managing the risks of its asset portfolio. The level of degradation of an asset, its configuration within the system, and its corresponding likelihood of failure feed directly into a risk-based assessment, which help utilities prioritize among potential replacement investment targets. An ACA is designed to provide insights into the current state of an organization's asset base, the risks associated with identified degradation, approaches to managing this degradation within the current AM framework, and how to best make use of these results to extract the optimal value from the asset portfolio going forward.

The following paragraphs serve as a brief introduction to the ISO standards and provide a brief overview of the applicability of AM standards within an entity.

The Industry Standard for AM Planning is outlined in ISO 5500X (which captures 55000, 55001 and 55002). Each business entity finds itself at one of the three main stages along the Asset Management journey:

1. Exploratory stage - entities looking to establish and set up an asset management system;
2. Advancement stage - entities looking to realize more value from an asset base; and
3. Continuous Improvement stage - those looking to assess and progressively enhance an asset management system already in place for avenues of improvement.

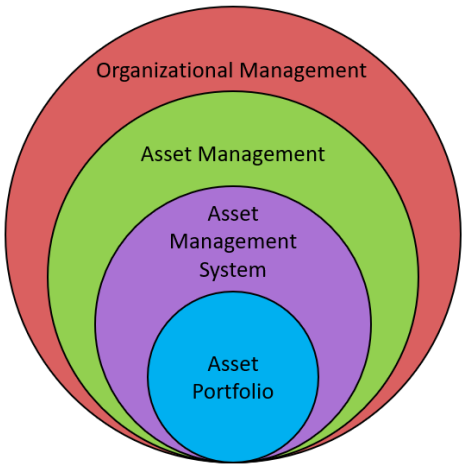
Given that asset management is a continuous journey, ISO 5500X remains continuously relevant within an organization; providing an objective, evidence-based framework against which the organizations can assess the managerial decisions relating to their purpose, operating context, and financial constraints over the different stages of their existence.[1]

An asset is any item or entity that has a value to the organization. This can be actual or potential value, in a monetary or otherwise intangible sense (i.e. public safety). The hierarchy of an AM framework is as follows: an asset portfolio, containing all known

[1] ISO 55000 – Asset management – Overview, principles and terminology

information regarding the assets, sits as the fundamental core of an organization. Around the asset portfolio, the AM system operates and represents a set of interacting elements that establish policy, objectives, and the processes to achieve those objectives. The AM system is encompassed by the AM practices – coordinated activities of the organization to realize maximum value from its assets. Finally, the organizational management organizes and executes the underlying hierarchy.[1]

Figure 2-1: Relationship between key Asset Management terms[1]



Asset management is fundamentally grounded in a risk-based evaluation of continued value. The overarching goal of an AM process it to quantify all assets risk by their probability and impact (where possible) and then look to minimize these risks through asset management operations and procedures. The application of rigorous AM processes can produce multiple types of benefits for an organization including, but not limited to: realized financial profits, better classified and managed risk among assets, better-informed investment decisions, demonstrated compliance among the asset base, increased public and worker safety, and corporate sustainability.[1]

Asset management processes are ideally integrated throughout an entire organization. This requires a well-documented AM framework that is shared between all relevant agents. In this way, the organization stands to benefit the most from its internal resources, whether it be via technical experts, those operating and maintaining the assets or those with an understanding of the financial operations and constraints on the organization as a whole. Usually, the AM implementing principles are documented within a Strategic Asset Management Plan (SAMP). The SAMP should be used as a guide for the organization to apply its asset management principles and practices for its specific use case. Distribution of the SAMP should be well-publicized within an organization and updated on a regular basis, in order to best quantify the most current and comprehensive asset management practices being implemented. Just as the asset base performance is subject to an in-depth

review, the asset management process and system should be reviewed with the same rigor.[1]

Well executed AM hinges on the ability of an organization to classify its assets via comprehensive and extensive data and data collection procedures. This includes but is not limited to: the collection and storage of technical specifications, historical asset performance, projected asset behaviour and degradation, the configuration of an asset or asset-group within the system, the operational relationship of one asset to another, etc. In this way, AM systems should be focused on the techniques and procedures in which data can be most efficiently extracted and stored from its asset base to allow for further analysis and insights to be made. With more asset data on hand, better and more informed decisions can be made to realize greater benefits and reduce the risk across the asset portfolio managed by an organization.[2]

AM practices can help quantify and drive strategic decisions. A better understanding of the asset portfolio and how it is performing within an organization will allow for optimal decision-making. This is largely due to AM being a fundamentally risk-based approach, which lends it to be a structured framework for creating financial plans driven by data. AM practices should also have goals in mind when framing asset investments, changes in asset configuration, or acquisition of new assets. This can include better technical compliance, increased safety, increased reliability, or increased financial performance of the asset base. ISO 5500X states explicitly that all asset portfolio improvements should be assessed via a risk-based approach prior to being implemented.[2]

Finally, asset management should be regarded as a fluid process. Adopting a framework and an idealized set of practices does not bind the organization or restrict its agency. With time, the goal of any asset management system is to continually improve and realize benefits within the organization through better management of its asset portfolio. Continually improved asset data and data collection procedures, updated SAMPs, and further integration into all aspects of an organization's activities as it grows and changes over time should be the goal of any AM framework.[2]

[2] ISO 55002 – Asset management – Management systems – Guidelines for the application of ISO 55001

3 Asset Health Index Calculation Methodology

3.1 Asset Condition Assessment Methodologies

Prior to completing an ACA, a methodology needs to be selected for the current entity. The four most common methodologies that can be employed to assess the condition of the system health include:

1. Additive models – asset degradation factors and scores are used to independently calculate a score for each individual asset, with the Health Index representing a weighted average of all individual scores from 0 to 100;
2. Gateway models – select parameters deemed to be most impactful on the asset's overall functionality act as "gates" to drive the overall condition of an asset, by effectively "deflating" the scores of other (less impactful) components;
3. Subtractive models – consider that a relatively Poor condition for any of several major assets within a broader system of assets could act as a sufficient justification to drive investments into the entire system; and
4. Multiplicative models – a Health Index that dynamically shifts the calculation towards specific degradation factors, if they are a leading indicator to show that an asset is failing.

The additive and gateway models are typically used for assessing individual assets, whereas the subtractive and multiplicative models are typically used for aggregate and composite system-level assessments. The latter models are still in an early stage and require extensive refinement and validation to confirm their applicability. The gateway model assigns gates to criteria or asset subcomponents which are difficult or expensive to replace and maintain, and/or are known to be a major cause of asset malfunctioning. This methodology is commonly used in conjunction with the additive model for major assets such as wood poles, where a "gate" score will act to reduce the Health Index due to a low recorded score for a given criterion. An example would be the "Remaining Strength" condition parameter for the wood pole asset class. If the remaining strength of a wood pole is less than 60%, the final Health Index for that asset is halved.

In general, most distribution sector utilities employ an additive model with select gateway model elements. METSCO selected this approach when conducting the ACA, which is in alignment with most of BHI's peer utilities.

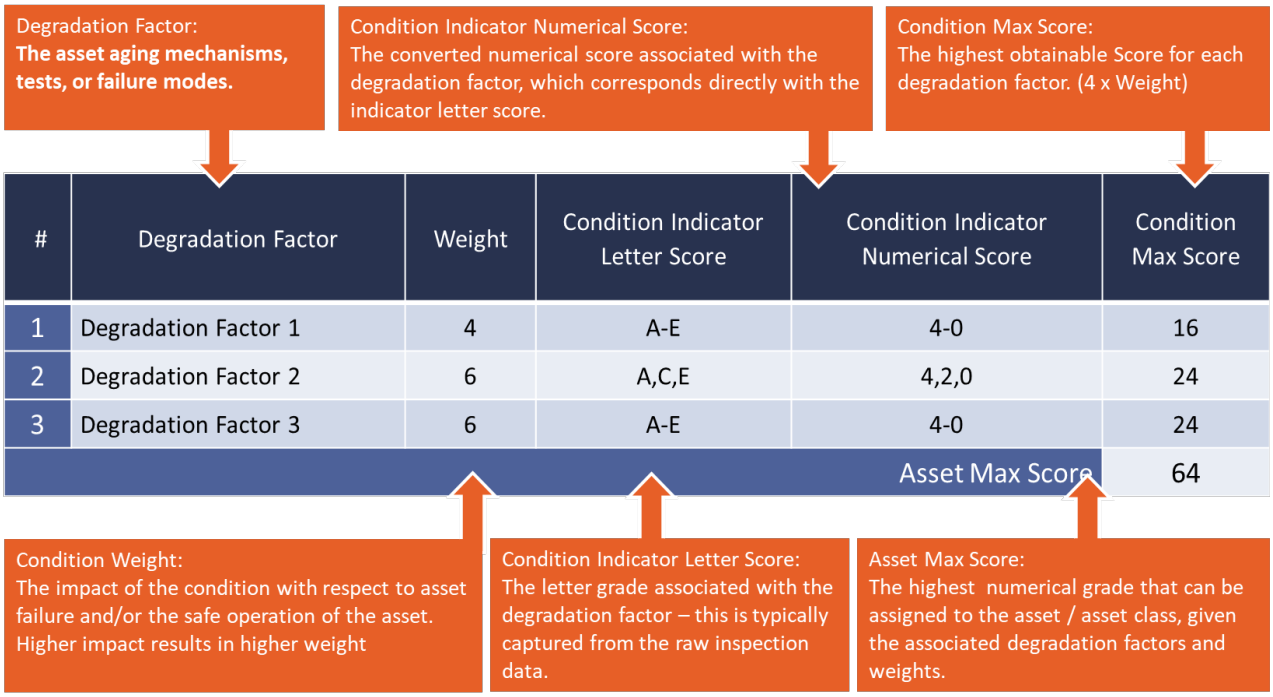
3.2 Overview of Selected Methodology

3.2.1 Condition Parameters

To determine the overall Health Index for an asset, formulations are developed based on condition parameters that can be expected to contribute to the degradation and eventual

failure of that asset. A weight is assigned to each condition parameter to indicate the amount of influence the condition has on the overall health of the asset. Figure 3-1 provides an example of a Health Index formulation table.

Figure 3-1: Health Index Formulation Components



Condition parameters of the asset are characteristic properties that are used to derive the overall Health Index. Condition parameters are specific and uniquely graded to each asset class. Additionally, some condition parameters can be comprised of sub-condition parameters. This is particularly true for power transformers and the associated condition parameter "Oil Quality". The "Oil Quality" condition parameter can include multiple sub-condition parameters like "Acid Number", "Interfacial Tension", "Dielectric Strength" and "Water Content". The "Oil Quality" condition parameter table is provided in Appendix B. In this case, the lowest sub-condition score is used as the score for the condition parameter.

The scale used to determine an asset's score for a condition parameter is called the Condition Indicator. Each condition parameter is ranked from A to E and each rank corresponds to a numerical grade. In the above example, a condition score of 4 represents the best grade, whereas a condition score of 0 represents the worst grade.

The conversion from alphabetic ranking to numerical grade and a brief characteristic description of the grade is provided below:

A – 4 Best Condition
B – 3 Normal Wear
C – 2 Requires Remediation
D – 1 Rapidly Deteriorating
E – 0 Beyond Repair

3.2.2 Final Health Index (HI) Formulation

The final Health index ("HI"), which is a function of the condition scores and weightings, is calculated based on the following formula:

$$HI = \left(\frac{\sum_{i=1} Weight_i * Numerical\ Grade_i}{Total\ Score}\right) x\ 100\%$$

Where *i* corresponds to the condition parameter number, and the Health Index is a percentage representing the remaining life of the asset.

A gating approach is used for condition parameters that have a significant influence on the health of an asset. If the condition parameter that has been flagged as a gating parameter is below a pre-defined threshold value, the overall Health Index is reduced by 50%. An example would be the "Remaining Strength" condition parameter for the wood pole asset class. If the remaining strength of a wood pole is less than 60%, the final Health Index for that asset would be divided by two. This approach enables utilities to efficiently flag severely degraded assets through identification of condition parameters acknowledged to be critical indicators of overall asset health.

3.2.3 Health Index Results

METSCO's assessment of asset condition uses a consistent five-point scale along the expected degradation path for every asset, ranging from Very Good to Very Poor. To assign each asset into one of the categories, METSCO constructs numerical Health Indices for each asset class that captures information on individual degradation factors contributing to that asset's declining condition over time. Condition scores assigned to each degradation factor are also expressed as numerical or letter grades along with pre-defined scales. The final Health Index – expressed as a value between 0% and 100% is a weighted sum of scores of individual degradation factors, with each of the five condition categories (Very Good, Good, Fair, Poor, Very Poor) corresponding to a numerical band that are roughly equivalent to the percentage of remaining useful life for the given asset. For example, the condition score of Very Good indicates assets with Health Indices between 100% and 85%, whereas assets found to be in a Very Poor condition score are those with calculated Health Indices between 0% and 30%. Generating a Health Index provides a succinct measure of the long-term health of an asset. Table 3-1 presents the Health Index ranges with the corresponding asset condition, its description as well as implications for maintaining, refurbishing or replacing the asset prior to failure.

Table 3-1: Health Index Ranges and Corresponding Asset Condition

Health Index Score (%)	Condition	Description	Implications
[85-100]	Very Good	Some evidence of aging or minor deterioration of a limited number of components	Normal Maintenance
[70-85)	Good	Significant Deterioration of some components	Normal Maintenance
[50-70)	Fair	Widespread significant deterioration or serious deterioration of specific components	Increase diagnostic testing; possible remedial work or replacement needed depending on the unit's criticality
[30-50)	Poor	Widespread serious deterioration	Start the planning process to replace or rehabilitate, considering the risk and consequences of failure
[0-30)	Very Poor	Extensive serious deterioration	The asset has reached its end-of-life; immediately assess risk and replace or refurbish based on assessment

To put the calculation of Health Indices into the context of available data, METSCO supplemented its Health Index findings with the calculation of a Data Availability Index, which indicates the percentage of total asset population for which the condition information is available.

3.3 Data Availability Index

The Data Availability Index ("DAI") is a measure of the availability of condition parameter data for a specific asset, as they pertain to the construction of the Health Index score. The Data Availability Index is determined by comparing the sum of the weights of the condition parameters available to the total weight of the condition parameters used to construct the Health Index for an asset class. The formula is given by:

$$DAI = \left(\frac{\sum_{i=1} Weight_i * \alpha_i}{\sum_{i=1} Weight_i} \right) x\ 100\%$$

Where i corresponds to the condition parameter number and α is the availability of coefficient (=1 when data available =0 when data unavailable)

An asset with all condition parameter data available will have a DAI value of 100%, independent of the asset's HI score. Assets with a high DAI will correlate to HI scores that describe the asset condition with a high degree of confidence. In the case where the DAI for an asset is less than 70%, a valid Health Index cannot be calculated. This asset is assigned an extrapolated Health Index value based on the valid Health Index calculations of the asset class.

3.3.1 Condition Parameter Data Threshold

The Health Index formulations calculated in this study are based only on available data provided by BHI. In almost all circumstances additional condition parameters or tests exists that can be performed on an asset to further ascertain its state of degradation. In certain cases, condition parameters may be available for a portion of the asset population, but unavailable for others in the same class. As an illustrative example, an asset population can have 100% visual inspections recorded but age can be known for only 50% of the population.

While many opinions exist as to what percentage of assets with information on particular condition parameter is sufficient to include it in the HI calculation, in most cases asset managers are best served by abandoning a condition parameter if it is available for less than approximately 60% of the population in that asset class. Continuing from the previous example, age as a condition parameter would not be included as part of the HI calculation. The DAI is then calculated based on the revised HI for each asset. The existing criteria for DAI to be equal to or greater than 70% still apply to determine a valid HI.

3.3.2 Data Sources

To assess the demographics and establish the unit population of BHI's distribution system assets, METSCO was provided with BHI's geospatial data from their current Geographic Information System (GIS). This data came from BHI's corporate asset registries containing information on asset vintage, model and year of commissioning. The database served as the primary asset library that contained asset nameplate information such as age and unique identifiers.

To assess the condition of BHI's system, METSCO was provided with BHI's asset inspection and maintenance data for all asset classes applicable. Historical records for the assets were dated to complete a full lifecycle of the asset population. This means that if an asset class has an inspection lifecycle of three years, BHI provided METSCO with three years of historical data in order to have a complete set of available data. This data set contained the last calculated degradation score for a particular asset as well as the most recent test results which were translated to a score and ultimately a HI. Most of this data came from primary sources such as equipment inspection forms completed by BHI staff or

contractors or results of specific technical tests such as Dissolved Gas Analysis (DGA) of transformer oil.

Additionally, METSCO was provided with historical operating data for assets that required operating information for the HI calculation. An example of operating data used includes historical loading information for transformers and counter readings for reclosers.

In instances where the information available from primary sources was insufficient to construct multi-factor Health Indices, METSCO relied on available secondary sources, such as assessments prepared by other external consultants that opined on, or empirically tested certain assets to determine their condition or continued usability. This report clearly denotes all instances where the findings of other external parties form a part of METSCO's Health Index calculations. Within this ACA study, the only report utilized in this manner was a CableQ test report for underground cables.

3.4 Use of Age as a Condition Parameter

Some industry participants question the appropriateness of including age as a potential condition parameter for calculating asset Health Indices. At the core of the argument against the use of age in calculating asset condition is the notion that age implies a linear degradation path for an asset that does not always match the actual experience in the field.

While some assets lose their structural integrity faster than would be expected with the passage of time, others, such as those with limited exposure to natural environmental factors, or those that benefitted from regular predictive and corrective maintenance, may retain their original condition for a longer period of time than age-based degradation would imply.

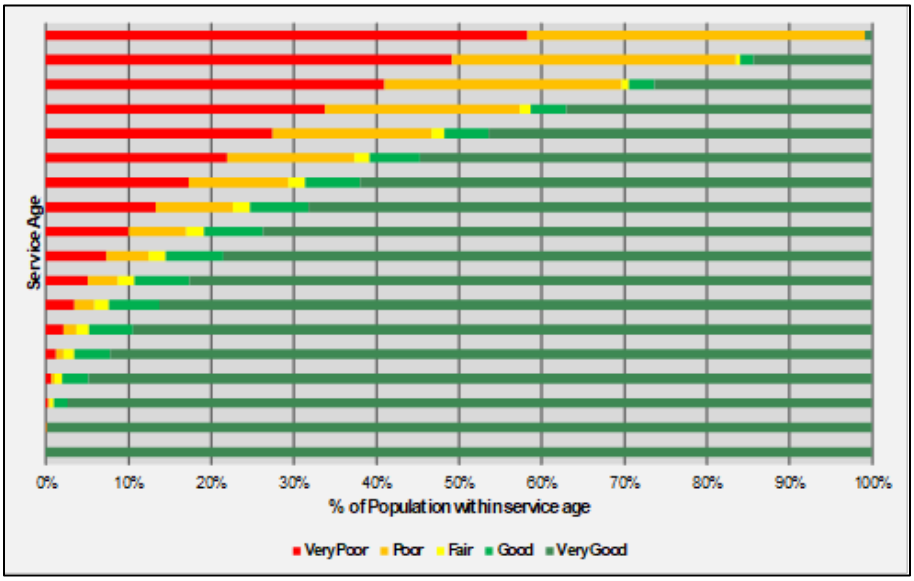
In recognition of the argument as to the limitations of age-based condition scoring, METSCO limits the instances where it relies on only age as a parameter explicitly incorporated into the calculation of asset Health Indices. However, in some cases, the limited number of condition parameters available for calculation of asset health makes age a useful proxy for the important factors that the analysis would not otherwise capture. In other cases, such as when assessing condition of complex equipment such as power transformers, which contain a number of internal mechanical components that degrade with continuous operation and the state of which cannot be assessed without destructive testing, age represents an important component of asset health calculation irrespective of the number of other factors that may be available for analysis.

In the context of the current study, the availability of data on condition parameters was positive and every asset class, except station chargers, included additional condition

parameters other than service age. In all asset classes, except station buildings, age as a parameter was included in the asset health calculation.

Irrespective of the fact that METSCO used age data in calculating the Health Index for a particular asset class, an analysis that compares calculated asset condition with the applicable service age of units comprising the asset population is generally expected to follow the trend depicted in Figure 3-2 below. The figure shows a trend contrasting the age data with the calculated condition results. The trend can indicate to an asset manager that as age increases the condition increasingly becomes worse. However, this is not indicative of any clear action needed to be taken and is ultimately up to the corporation to manage asset health.

Figure 3-2: A Sample Asset Age vs. Condition Comparison Chart



3.4.1 METSCO's Project Execution

METSCO's execution path in completing the ACA study can be separated into four phases described below:

Initial Information Gathering – including initial interviews with BHI staff to investigate system configuration and the prominence of certain asset classes, establish the range of available condition data sources at the beginning of the engagement, and confirm the key assumptions regarding these factors with BHI subject matter experts through a series of interviews.

Database Construction – activities to construct a single database of condition-related information for each BHI asset class using the provided data sources. This includes

consolidation of BHI's asset inspection records, databases containing results of technical tests performed by BHI contractors, and the entire database from the GIS.

HI and DAI Calculation – upon confirming the integrity of its condition dataset along with the accuracy of assumptions made in its preparation, METSCO calculated the Health Indices and DAI for all asset classes. Additional data sources were requested from BHI to improve the accuracy of the asset health calculation if applicable.

Results Reporting – the final phase of the project scope was the creation of the ACA report.

4 Health Indices

This section presents the current Health Index formulation for each asset class, the calculated scores for Health Indices, as well as the data available to perform the study.

4.1 Distribution Assets

4.1.1 Wood Pole

Table 4-1: Wood Pole Health Index Algorithm

Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Remaining Strength	8	A,B,C,D,E	4,3,2,1,0	32
Wood Rot	6	A,B,C,D,E	4,3,2,1,0	24
Mechanical Defects	4	A,B,C,D,E	4,3,2,1,0	16
Service Age	3	A,B,C,D,E	4,3,2,1,0	12
Out of Plumb	2	A,B,C,D,E	4,3,2,1,0	8
			Total Score	**92**

Wood poles are an integral part of any distribution system. They support the structure for overhead distribution lines often found with installed assets such as overhead transformers, switches, reclosers, and streetlights. The Health Index for wood poles is estimated by considering a combination of end-of-life criteria summarized in Table 4-1. Each condition parameter represents a factor critical in determining the asset's condition relative to a potential failure to occur. Appendix B-1 provides grading tables for each condition parameter.

Wood, being a natural material, has degradation processes that are different from other assets in distribution systems. The most critical degradation process for wood poles involves biological and environmental mechanisms such as fungal decay, wildlife damage and effects of weather which can impact the mechanical strength of the pole. Any loss in the strength of the pole can present additional safety and environmental risks to the public and to BHI. The remaining strength condition parameter is a quantitative measurement that provides adequate evidence of the deterioration of the operational health of the asset.

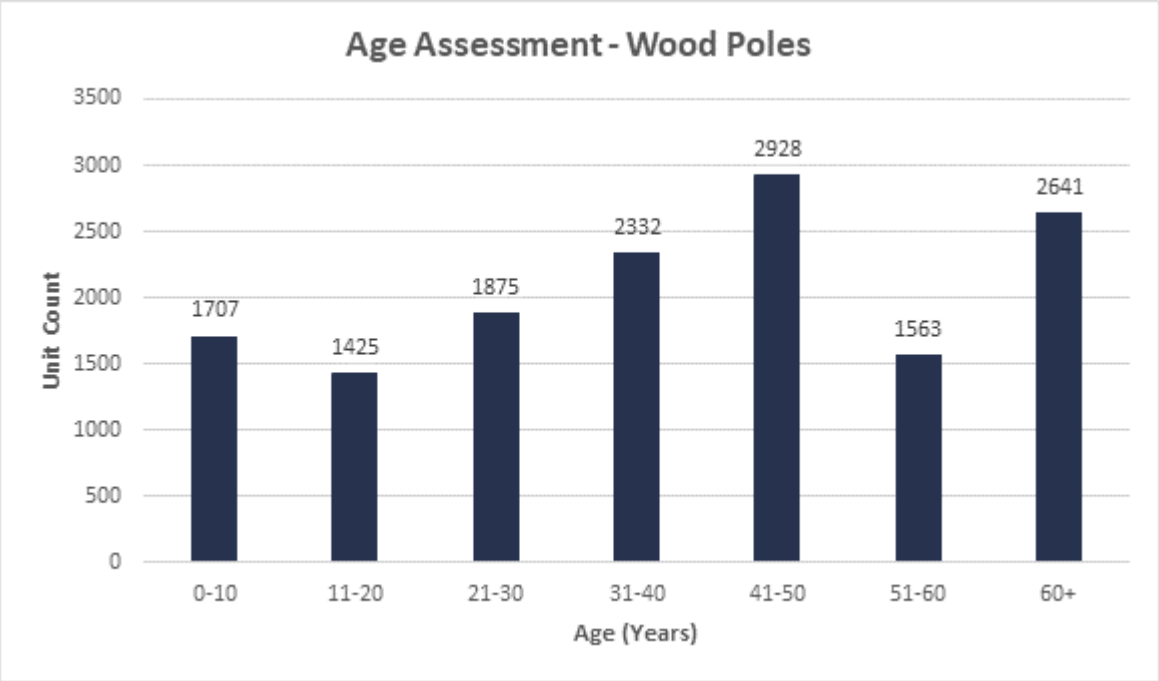
The Health Index formulation for wood poles is a combination between the additive and gateway model; with the gateway applied to the remaining strength parameter. When the remaining strength for a pole is below 60%, the final Health Index for that pole is reduced by half. Remaining strength below 60% indicates significant degradation of the pole which can present a risk to safety and the possibility of failure to meet its intended function of holding the overhead line.

Additional condition parameters include service age, wood rot presence, mechanical defects, and the leaning of wood poles. A visual inspection record notes the degree of

wood rot/decay developed on the pole's external surface, internal cross-section and cross-arm sections. The presence of wood rot signifies there is a high moisture content surrounding the pole and impacts the pole's strength. Additionally, visual inspections note for the following mechanical defects found on wood poles:

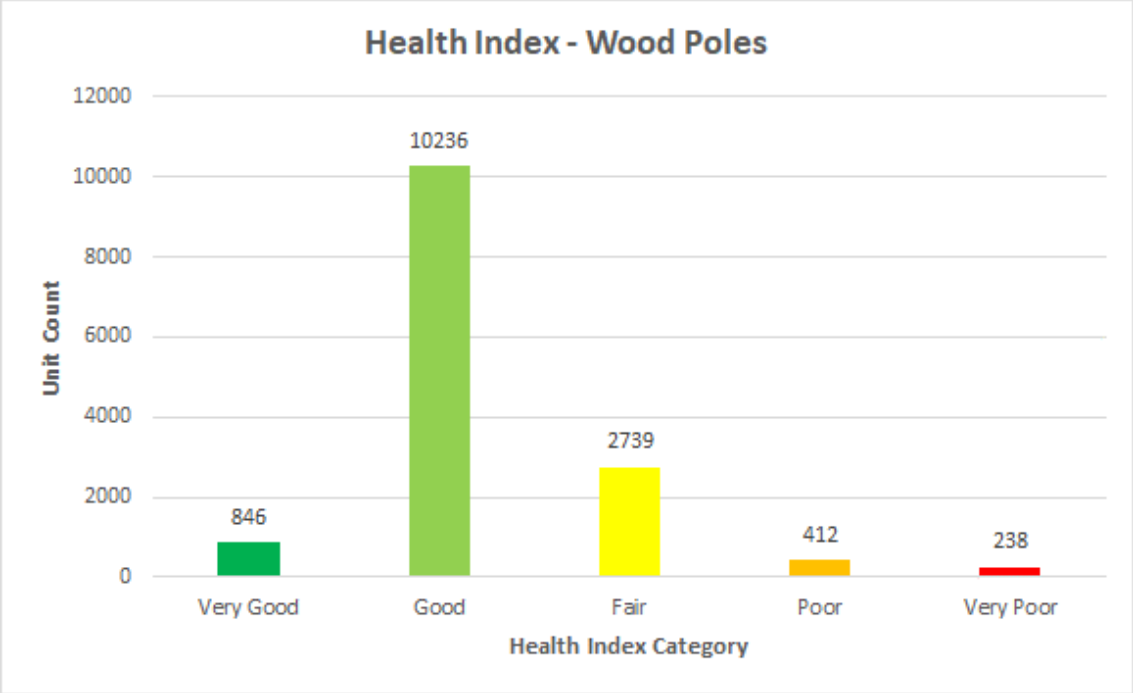
- Vegetation Interference
- Broken Strands
- Grounding
- Crossarms
- Cracking

Figure 4-1: Wood Poles Age Demographic



BHI owns 14471 wood poles within its service territory. Installation date is unknown for approximately 3% of the total in-service population. The assets with unknown installation dates were extrapolated by weight onto the asset population with a recorded installation date to show an approximate representation of the age distribution. Extrapolated age results were not used as part of the Health Index calculation. Figure 4-1 presents the age distribution for in-service wood poles.

Figure 4-2: Wood Poles Health Index Demographic



BHI's pole maintenance and nameplate data were used to calculate the Health Index based on the criteria provided in Table 4-1. Poles are inspected on a 7-year cycle and to date, BHI has maintained wood pole inspection records for the last 14 years. A valid Health Index was calculated for ~58% of the wood poles. To complete the full analysis, the Health Index for the remaining 42% has been extrapolated based on the Health Index distribution of the asset population with a valid Health Index score. The overall Health Index distribution for the wood poles is presented in Figure 4.2. Most of the poles are in Very Good or Good condition with ~5% of the total population being in Poor or Very Poor condition. The average Health Index for the wood pole population is 74%.

Table 4-2: Wood Poles condition parameters data availability

Condition Parameter	% of Assets with Data
Remaining Strength	59%
Wood Rot	98%
Mechanical Defects	92%
Service Age	97%
Out of Plumb	93%

The DAI for most condition parameters regarding wood poles is high (>90%). The exception is remaining strength, for which only 59% of the assets have data. However, METSCO still included remaining strength in the Health Index calculation due to the significant value the condition parameter offers for the HI framework for wood poles. The

average DAI across the wood pole asset class is 83%. Table 4-2 presents the DAI of individual condition parameters used for the wood pole HI framework.

4.1.2 Concrete Pole

Table 4-3: Concrete Pole Health Index Algorithm

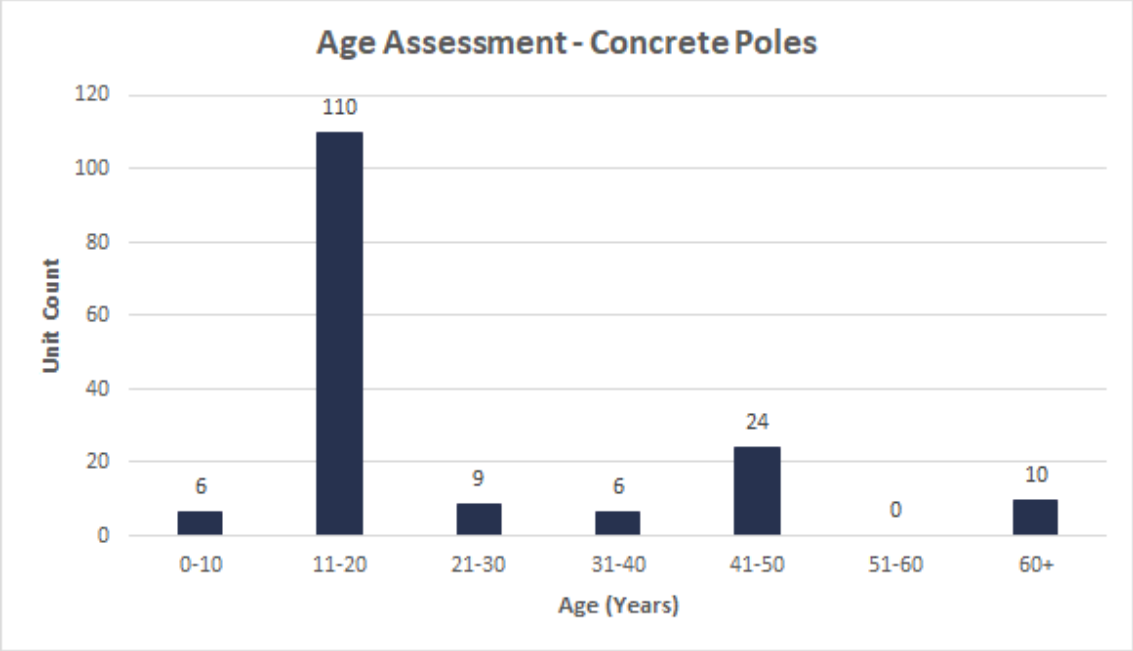
Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Defects	4	A,B,C,D,E	4,3,2,1,0	16
Service Age	3	A,B,C,D,E	4,3,2,1,0	12
Out of Plumb	3	A,B,C,D,E	4,3,2,1,0	12
			Total Score	**40**

Like wood poles, concrete poles support the overhead distribution system. Concrete poles have significantly greater strength than typical wood poles and have a longer service life. However, concrete poles are very heavy and are costlier to transport and install, hence fewer are in-service compared to wood poles. The Health Index for concrete poles is calculated by considering a combination of end-of-life criteria summarized in Table 4-3. Appendix B-2 provides grading tables for each condition parameter.

Each condition parameter represents a factor critical in determining the asset's condition relative to a potential failure to occur. Aside from service age, condition parameters include defects and evidence of leaning for concrete poles. The HI formulation for concrete poles does not contain a quantitative measure of remaining strength as found with the wood poles. Hence, it is more dependent on visual inspection of defects. All the condition parameters have similar weightings with defects having the highest weight. Visual inspections note for the following defects found on concrete poles:

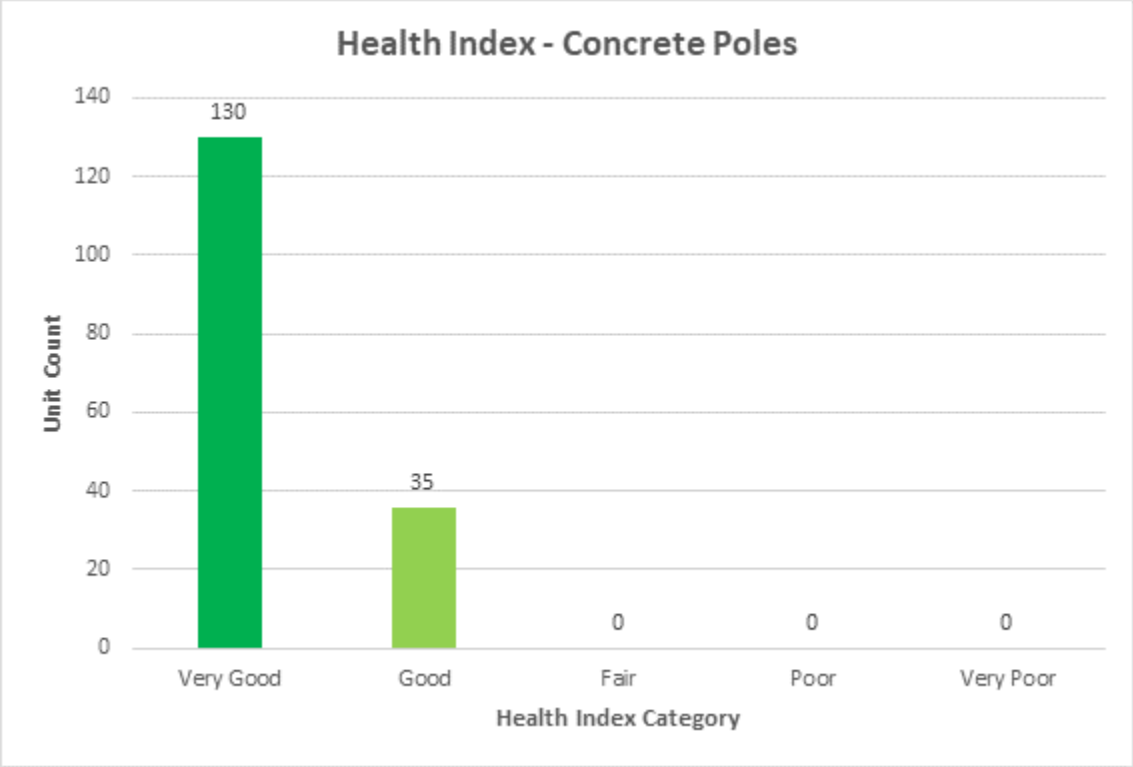
- Vegetation Interference
- Broken Strands
- Grounding
- Cracking

Figure 4-3: Concrete Poles Age Demographic



BHI owns 165 concrete poles within its service territory. Installation date is unknown for approximately 7% of the total in-service population. The assets with unknown installation dates were extrapolated by weight onto the asset population with a recorded installation date to show an approximate representation of the age distribution. Extrapolated age results were not used as part of the Health Index calculation. Figure 4-3 presents the age distribution for concrete poles.

Figure 4-4: Concrete Poles Health Index Demographic



BHI's maintenance and nameplate information was used to calculate the Health Index based on the criteria provided in Table 4-3. An estimated 12% of the population does not have a valid Health Index score. To complete the full analysis, the Health Index for the remaining 12% has been extrapolated based on the Health Index distribution of the asset population with a valid Health Index score. The overall Health Index distribution for the concrete poles is presented in Figure 4-4. All the poles are in either Very Good or Good condition. The average Health Index for the concrete pole population is 89%.

Table 4-4: Concrete Poles condition parameters data availability

Condition Parameter	% of Assets with Data
Rusting/ Corrosion/ Spalling	35%
Mechanical Defects	88%
Service Age	93%
Out of Plumb	87%

The DAI for most condition parameters regarding concrete poles is high (>85%). The exception is rusting/ spalling/ corrosion, for which only 35% of the assets have data. Since the condition parameter was well below 60%, it was not included in the HI framework for the asset class. The average DAI across the concrete pole asset class, after excluding rusting/corrosion/spalling, is 89%. Table 4-4 presents the DAI of individual condition parameters.

4.1.3 Overhead Primary Conductor

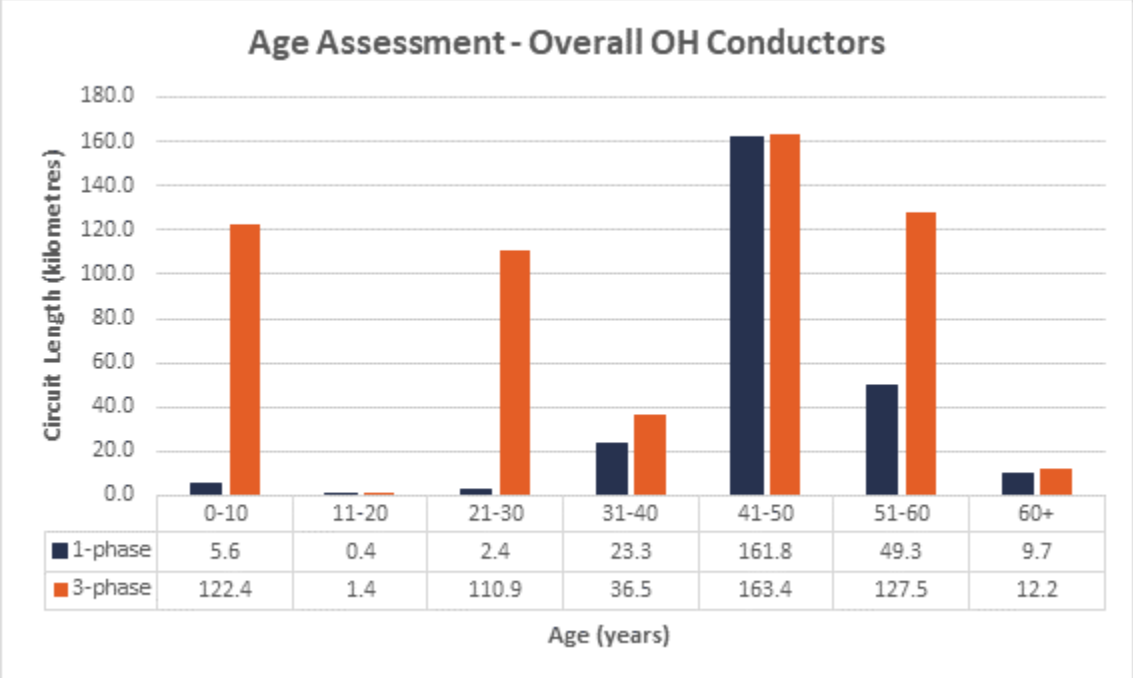
Table 4-5: Overhead Primary Conductor Health Index Algorithm

Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Service Age	5	A,B,C,D,E	4,3,2,1,0	20
Small Conductor Risk	5	A,E	4,0	20
			Total Score	**40**

Overhead conductors transmit electricity from substations to customer premises and are supported by service poles. The Health Index formulation for overhead primary conductors is summarized in Table 4-5. Appendix B-3 provides grading tables for each condition parameter.

Although laboratory tests are available to determine the tensile strength and assess the remaining useful life of conductors, distribution line conductors rarely require testing. An appropriate proxy for the tensile strength of the conductor and to determine the remaining life of the asset is the use of service age. In addition to age, an undersized conductor is the additional condition parameter used to evaluate the HI of overhead conductors. Undersized conductors carrying large loads can result in sub-optimal system operation due to high line losses and are susceptible to frequent breakdowns.

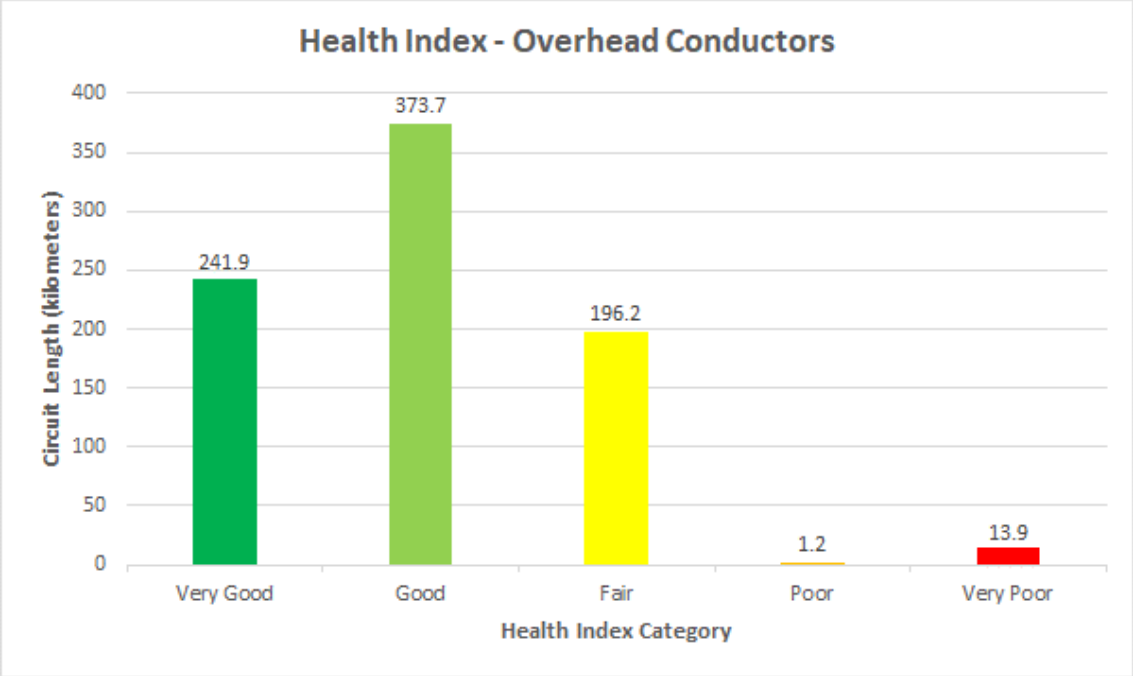
Figure 4-5 Overall Overhead Primary Conductor Age Demographic



BHI owns approximately 827km of overhead primary conductor within its service territory. Where installation date was unknown, the corresponding feeder installation date was used

as a proxy. However, age was still unknown for approximately 1% of both 1-phase and 3-phase conductors and was extrapolated by weight onto the asset population with a known age to show an approximate representation of the age distribution. The figure presents the total length of overhead primary conductors for each age band. Extrapolated age results were not used as part of the Health Index calculation. Figure 4-5 presents the overall overhead primary conductor age demographics.

Figure 4-6: Overhead Primary Conductor Health Index Demographic



The overall Health Index for overhead primary conductors is illustrated in Figure 4-6. A valid Health Index was calculated for 99% of the conductors. To complete the full analysis, the Health Index for the remaining 1% has been extrapolated based on the Health Index distribution of the asset population with a valid Health Index score. Most of the primary conductors are in Very Good and Good condition with 2% in Poor and Very Poor condition. The average Health Index for overhead primary conductors is 75%.

Table 4-6: Overhead Primary Conductor condition parameters data availability

Condition Parameter	% of Assets with Data
Service Age	99%
Small Conductor Risk	100%

The average DAI across the overhead primary conductor asset class is 99%. Table 4-6 presents the DAI of individual condition parameters used for the overhead primary conductors HI framework.

4.1.4 Underground Primary Cable

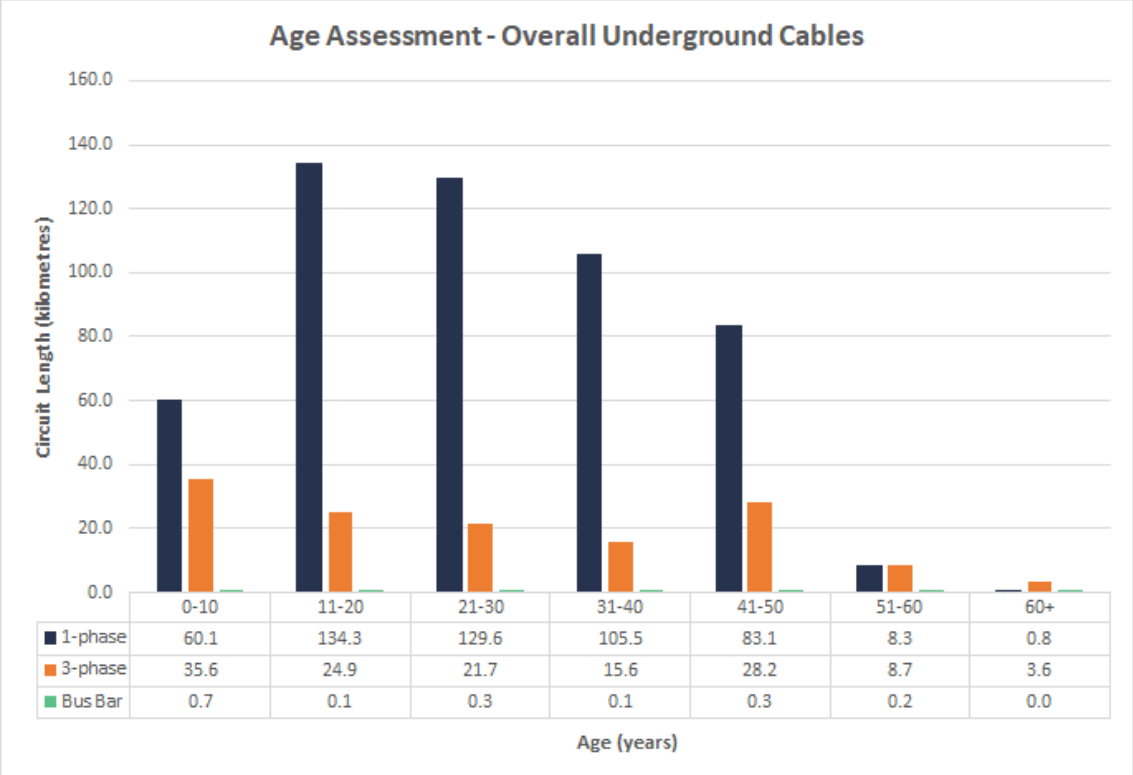
Table 4-7: Underground Primary Cable Health Index Algorithm

Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Service Age	10	A,B,C,D,E	4,3,2,1,0	40
Field Testing	10	A, C, D, E	4,2,1,0	40
Outage Records in last 5 years	8	A,B,C,D,E	4,3,2,1,0	32
			Total Score	**112**

Like overhead conductors, underground cables also transmit electricity along the electrical distribution system, however, they are located below ground. BHI's underground system typically consists of TR-XLPE type cables. Compared to overhead lines, they are much more reliable since they are not exposed to severe weather conditions, tree contacts or foreign interference. However, distribution underground cables are more expensive and are one of the more challenging assets in electricity systems from a condition assessment and asset management viewpoint. Several test techniques, such as partial discharge (PD) and water tree diagnostic testing have become available over recent years to identify the condition and performance of the asset class. Some tests can be destructive to the asset and hence are used less frequently. Accordingly, the preference is given to non-destructive testing such as Hi-Pot testing. In the absence of these tests, a sampling methodology can be executed to determine the general condition of the asset.

The Health Index for underground primary cable is calculated by considering the service age, historic failure instances, and field test data. Since the service age provides a reasonably good measure of the remaining life of the asset, it may be employed as an assessment parameter for identifying assets for replacement. Additionally, BHI conducts the Hi-Pot test that helps find crushed insulation, terminal spacing problems, stray wire strands or braided shielding, and conductive or corrosive contaminants around the cables. BHI also contracted CableQ to perform sample tests of its cables across the system to detect the effect that water trees have on the cables. It is assumed that the remaining sections of the feeders are in a similar condition to those assessed through these testing methods. Table 4-7 summarizes the methodology to combine these criteria into an overall Health Index. Appendix B-4 provides grading tables for each condition parameter.

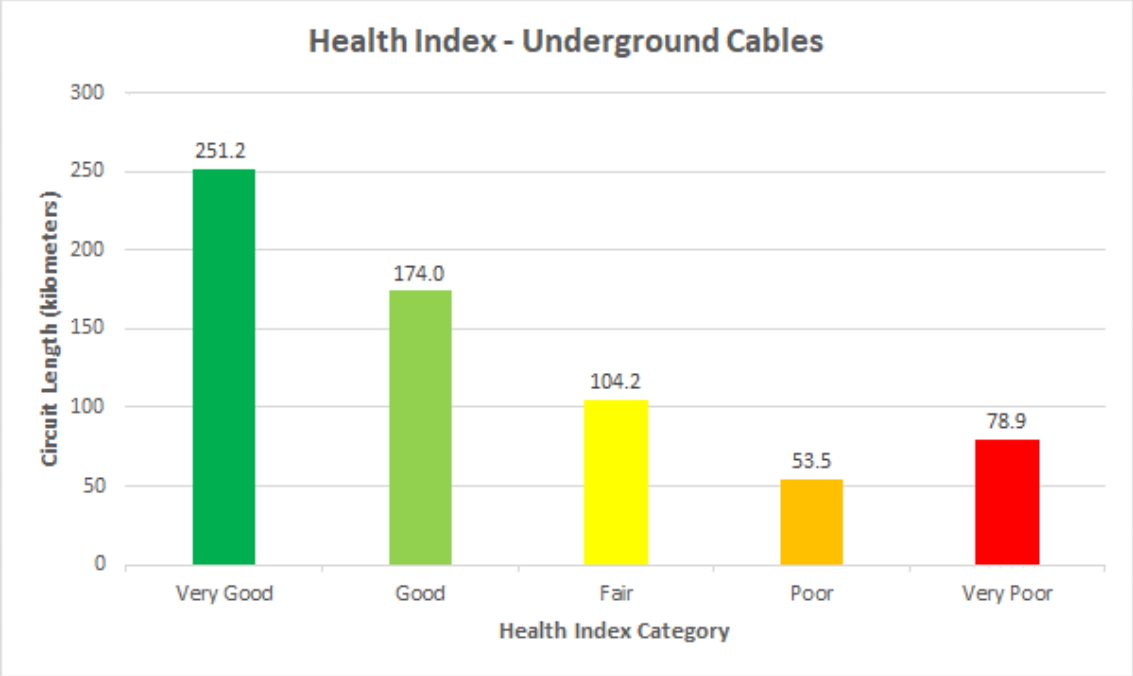
Figure 4-7: Overall Underground Primary Cable Age Demographic



	0-10	11-20	21-30	31-40	41-50	51-60	60+
1-phase	60.1	134.3	129.6	105.5	83.1	8.3	0.8
3-phase	35.6	24.9	21.7	15.6	28.2	8.7	3.6
Bus Bar	0.7	0.1	0.3	0.1	0.3	0.2	0.0

BHI owns approximately 662km of underground primary cable within its service territory. Where installation date was unknown, the corresponding feeder installation date was used as a proxy. However, age was still unknown for approximately 1% of both 1-phase and 3-phase cables, and was extrapolated by weight onto the asset population with a known age to show an approximate representation of the age distribution The figure presents the total length of underground primary cables for each age band. Extrapolated age results were not used as part of the Health Index calculation. Figure 4-7 presents the underground primary cable age demographic.

Figure 4-8: Underground Primary Cable Health Index Demographic



The overall Health Index for underground primary cable is illustrated in Figure 4-8. Most of the underground primary cables are in Very Good and Good condition with ~22% being in Very Poor and Poor condition. The average Health Index for underground primary cables is 72%.

Table 4-8: Underground Primary Cables condition parameters data availability

Condition Parameter	% of Assets with Data
Service Age	99%
Field Testing	100%
Outage Records in last 5 years	100%

The average DAI across the underground primary cable asset class is 99%. Table 4-8 presents the DAI of individual condition parameters used for the underground primary cable HI framework.

4.1.5 Overhead Distribution (Pole-Mount) Transformer

Table 4-9: Pole-Mount Transformer Health Index Algorithm

Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Visual Inspection	4	A,B,C,D,E	4,3,2,1,0	16
IR Scan Results	4	A,C,E	4,2,0	16
Service Age	3	A,B,C,D,E	4,3,2,1,0	12
Peak Loading	3	A,B,C,D,E	4,3,2,1,0	12
			Total Score	**56**

Overhead (pole-mount) transformers are installed on service poles above ground with the primary function to step down power from the medium voltage distribution system to the final voltage rating for customer use. The Health Index for pole-mount transformers is calculated by considering a combination of end-of-life criteria summarized in Table 4-9. Each condition parameter represents a factor critical in determining the asset's condition relative to a potential failure to occur. Appendix B-5 provides grading tables for each condition parameter.

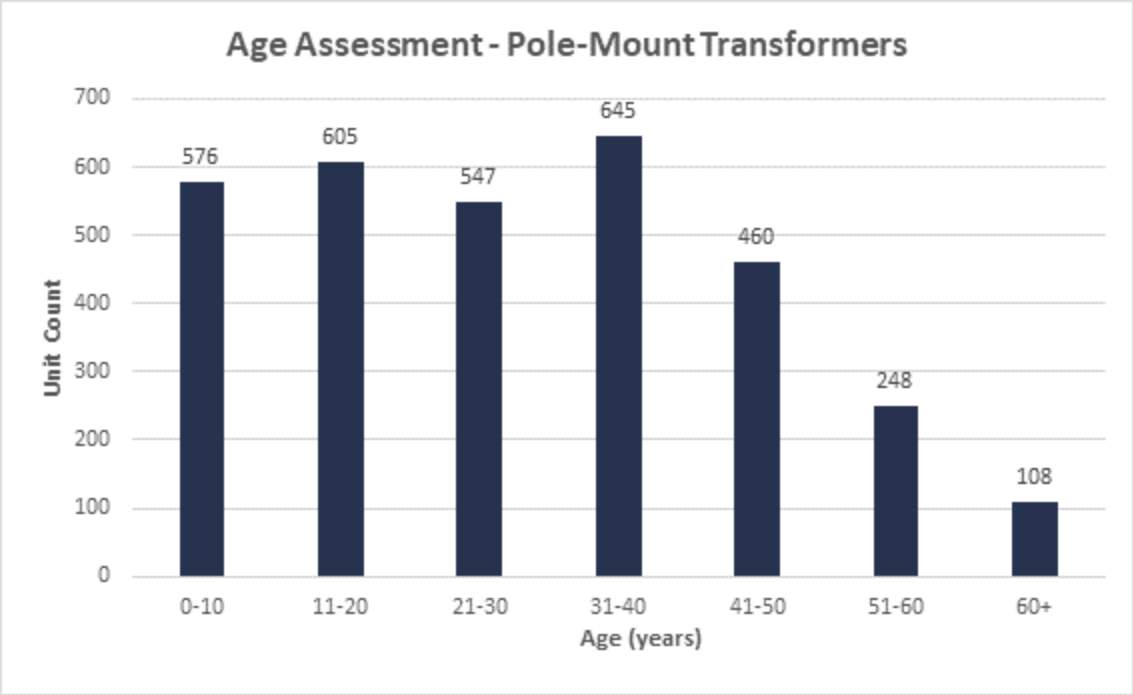
Infrared ("IR") scanning results are an important condition parameter for condition assessment of the overhead transformers since they identify hotspots (i.e. high temperatures) on the asset. Assets operating continuously at high temperatures can cause accelerated degradation of the insulation oil and may experience premature failure. It is assumed and confirmed by BHI that transformers that exhibited high temperatures have since been corrected. If the transformers remained in service, the IR scan condition parameter was graded to be a Fair condition.

An additional condition parameter is the peak loading experienced by the transformer. Load unbalances or peak loading reduces the useful life of a distribution transformer. In general, the useful life of a transformer is determined by its insulation condition which is largely affected by transformer loading, temperature, and presence of oxygen and moisture in the oil. BHI records its peak loading data in kilowatts. To convert to kVA a power factor of 90% was used to calculate the percentage of the transformer being overloaded in relation to its nameplate rating.

Additionally, visual inspections note for the following defects found on overhead transformers:

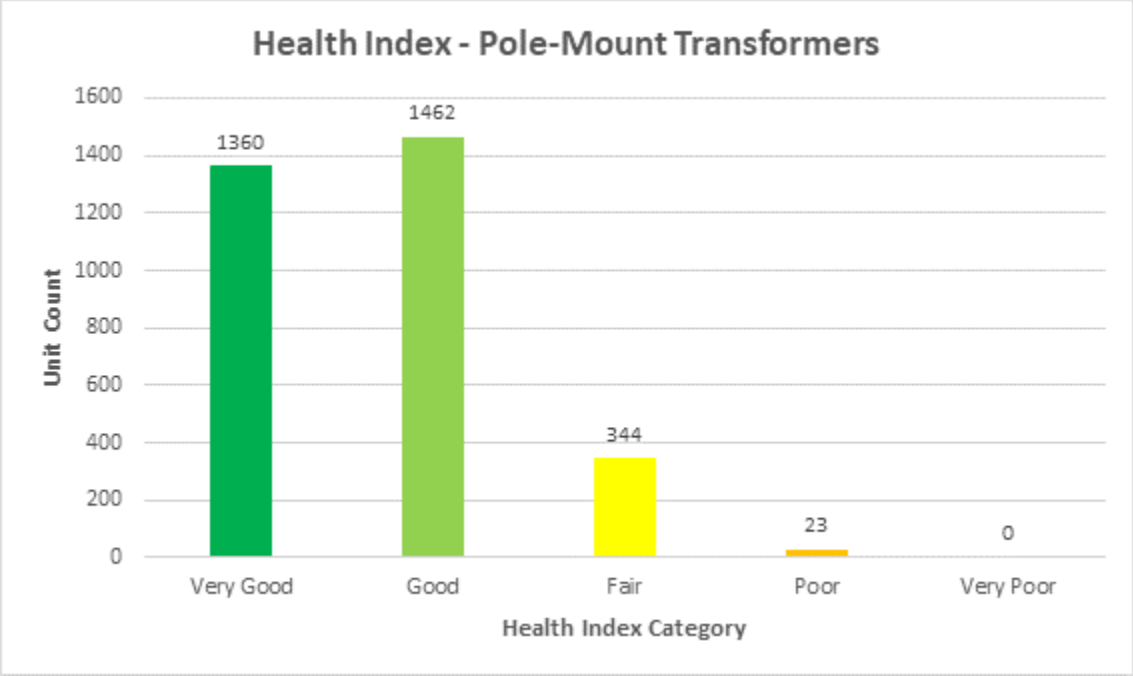
- Presence of oil leaks
- Vegetation Interference
- Presence of rust
- Bushing Condition

Figure 4-9: Pole-Mount Transformers Age Demographic



BHI owns 3,189 pole mount transformers within its service territory. Installation date is unknown for ~1% of the asset population. For unknown installation dates, the assumption made was to use the corresponding feeder age as the transformer age which resulted in 100% of assets having a known installation date. The applied assumption for service age of assets was used in the Health Index calculation and was confirmed with BHI. Figure 4-9 presents the age distribution for pole-mount transformers.

Figure 4-10: Pole-Mount Transformers Health Index Demographic



BHI's transformer maintenance records, nameplate information, and operating loading data were used to calculate the Health Index based on the criteria provided in Table 4-9. A valid Health Index was calculated for ~99% of the overhead transformers. To complete the full analysis, the Health Index for the remaining 1% has been extrapolated based on the Health Index distribution of the asset population with a valid Health Index score. The overall Health Index distribution is presented in Figure 4-10 for the overhead transformer. Most of the population are in Very Good or Good condition. The average Health Index of the overhead distribution transformers is 84%.

Table 4-10: Pole-Mount Transformers condition parameters data availability

Condition Parameter	% of Assets with Data
Visual Inspection	94%
IR Scan Results	100%
Service Age	100%
Peak Loading	91%

The DAI for the condition parameters for pole-mount transformers is 96%. Table 4-10 presents the DAI of individual condition parameters used for the overhead distribution transformer HI framework.

4.1.6 Underground Distribution Transformer

Underground distribution transformers are utilized for similar functionalities as pole-mount transformers. They step down power from the medium voltage distribution system

to the final utilization voltage for the customer, however, they are located below ground or on the ground level. Three types of underground distribution transformers are assessed within this report:

- Pad-Mount transformer
- Submersible transformer
- Vault transformer

Table 4-11: Underground Distribution Transformer Health Index Algorithm

Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Visual Inspection	4	A,B,C,D,E	4,3,2,1,0	16
Condition of the Enclosure	4	A,C,E	4,2,0	16
Service Age	3	A,B,C,D,E	4,3,2,1,0	12
Peak loading	3	A,B,C,D,E	4,3,2,1,0	12
			Total Score	**56**

The Health Index for underground distribution transformers is calculated by considering a combination of end-of-life criteria summarized in Table 4-11. Each condition parameter represents a factor critical in determining the asset's condition relative to a potential failure to occur. Appendix B-6 provides grading tables for each condition parameter.

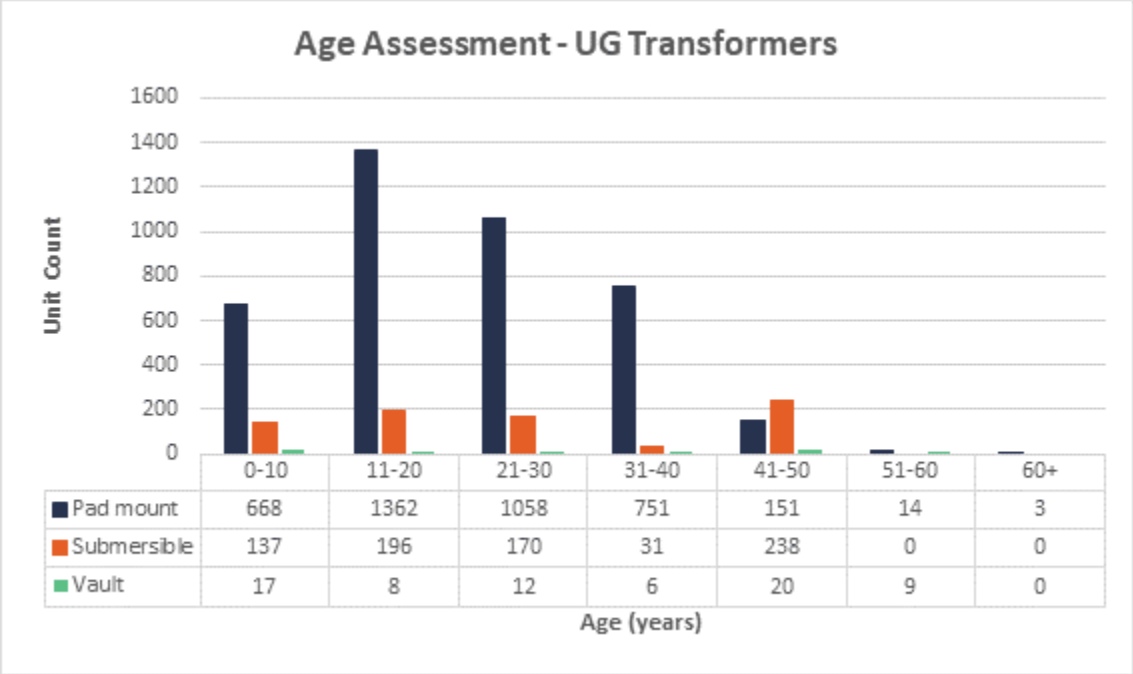
Visual inspections identify the following defects found on underground transformers:

- Presence of oil leaks
- Vegetation interference
- Presence of rust
- Evidence of animal intrusion

The condition of the encloser is a stand-alone condition parameter with its own weight since damage to the encloser can expose the transformer to severe weather conditions and present serious safety concerns to humans should they come into contact with the contents inside. Hence, an enclosure that is deteriorated should be replaced to maintain safety performance.

Additionally, the peak loading experienced by the transformer is a good condition parameter to use. Load unbalances or peak loading reduces the useful life of a distribution transformer. In general, the useful life of a transformer is determined by its insulation condition which is largely affected by transformer loading, temperature, and presence of oxygen and moisture in the oil. Currently, BHI records its peak loading data in kilowatts. A power factor of 90% was assumed to convert peak loading data into kVA to calculate the percent of overloading experienced on the asset in relation to the asset's rating.

Figure 4-11: Distribution Transformers Age Demographic



BHI owns 4,007 pad mount transformers, 772 submersible transformers and 72 vault transformers within its service territory. Unknown installation dates accounts for approximately 1% of both pad-mount and submersible transformers. For unknown installation dates, the assumption made was to use the average age of installed underground distribution transformers which resulted in 100% of assets having a known installation date. The applied assumption for service age of assets was used in the Health Index calculation and was confirmed with BHI. Figure 4-11 presents the age distribution by transformer types.

Figure 4-12: Pad-mount Transformers Health Index Demographic

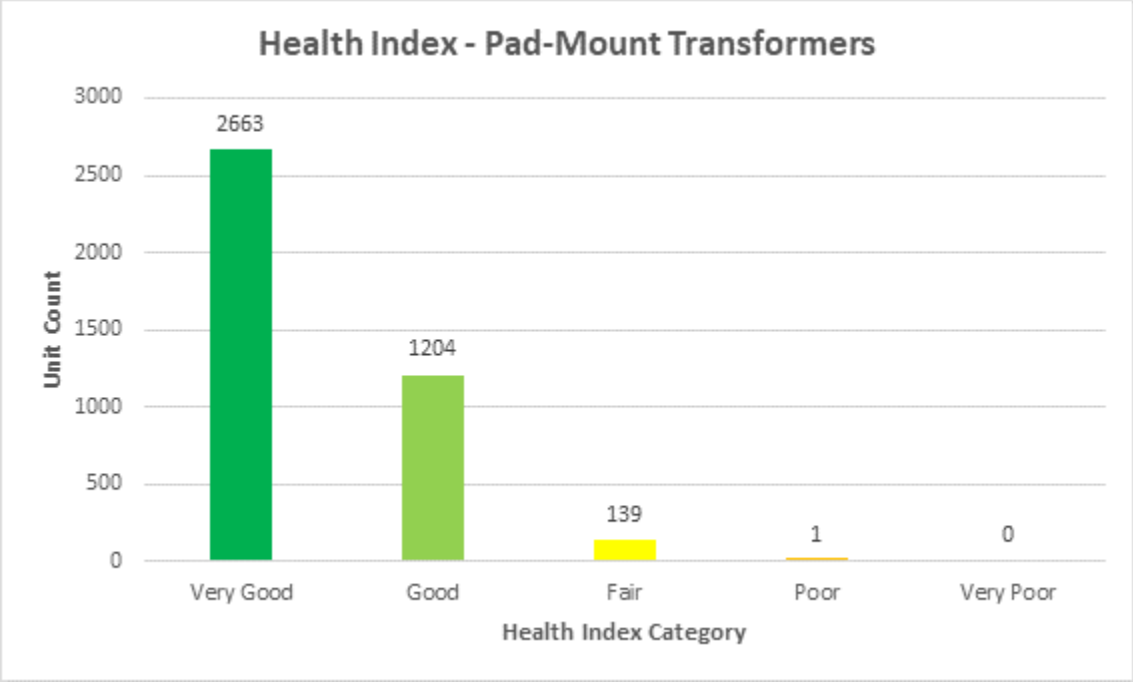


Figure 4-13: Submersible Transformers Health Index Demographic

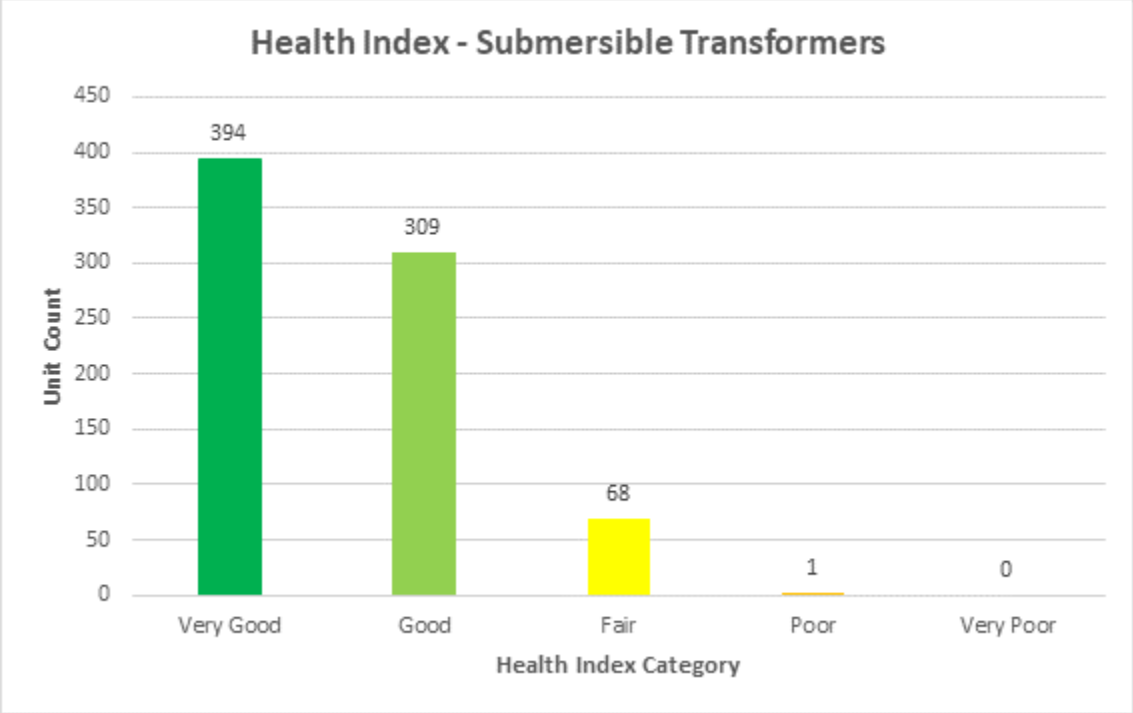
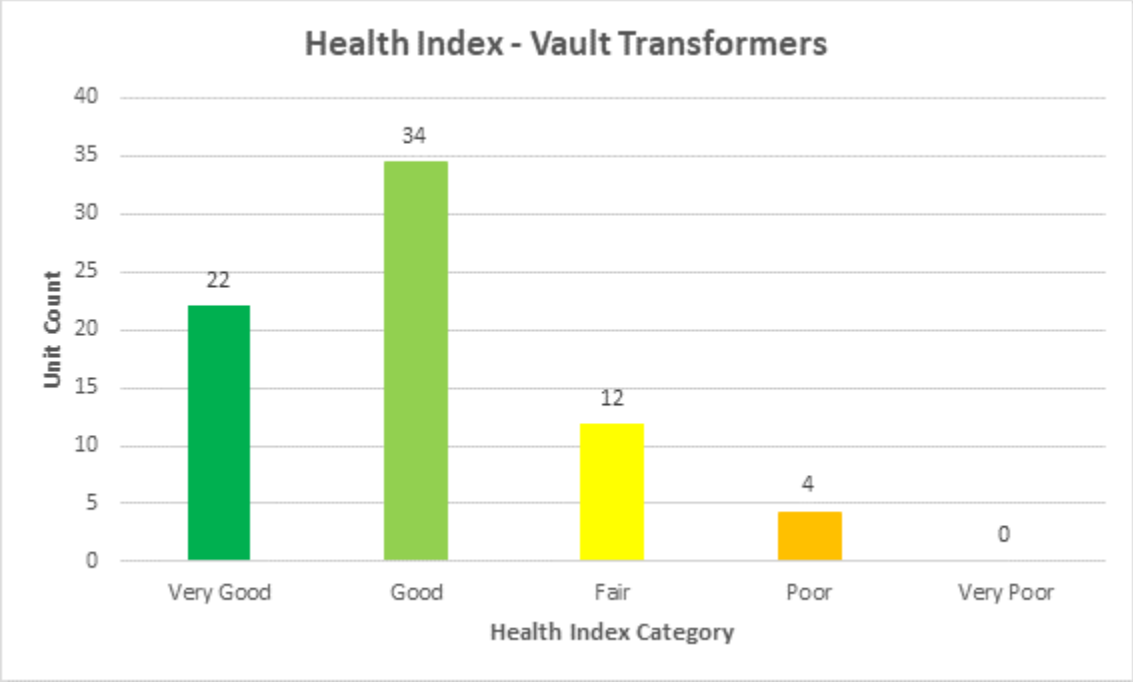


Figure 4-14: Vault Transformers Health Index Demographic



BHI's transformer maintenance records, nameplate information, and operating loading data were used to calculate the Health Index based on the criteria provided in Table 4-11. Approximately 3% of the underground distribution transformers within BHI's service territory have peak loading percentage greater than 100% which can pose operating restrictions and impact the condition of the assets. The overall Health Index distribution is presented in Figure 4-12 to Figure 4-14 for each transformer type. A valid Health Index was calculated for ~97%, ~99% and ~93% of pad-mount, submersible and vault transformers, respectively. To complete the full analysis, the Health Index for the remaining population has been extrapolated based on the Health Index distribution of the asset population with a valid Health Index score. Most of the population are in Very Good or Good condition. The average Health Index of the pad-mount, submersible and vault transformers are 89%, 84%, and 78% respectively.

Table 4-12: Underground Transformers condition parameters data availability

Condition Parameter	% of Assets with Data		
	Pad-Mount Tx	Submersible Tx	Vault Tx
Visual Inspection	95%	99%	89%
Condition of Encloser	98%	99%	86%
Service Age	100%	100%	100%
Peak Loading	90%	99%	81%

Most of the assets have the visual inspection, encloser condition, age, and peak loading information. The class-average DAI for pad-mount, submersible and vault transformer data are 96%, 99%, and 89% respectively. Table 4-12 presents the DAI of individual condition parameters used for the underground distribution transformers HI framework.

4.1.7 Distribution Switchgear

Table 4-13: Switchgear Health Index Algorithm

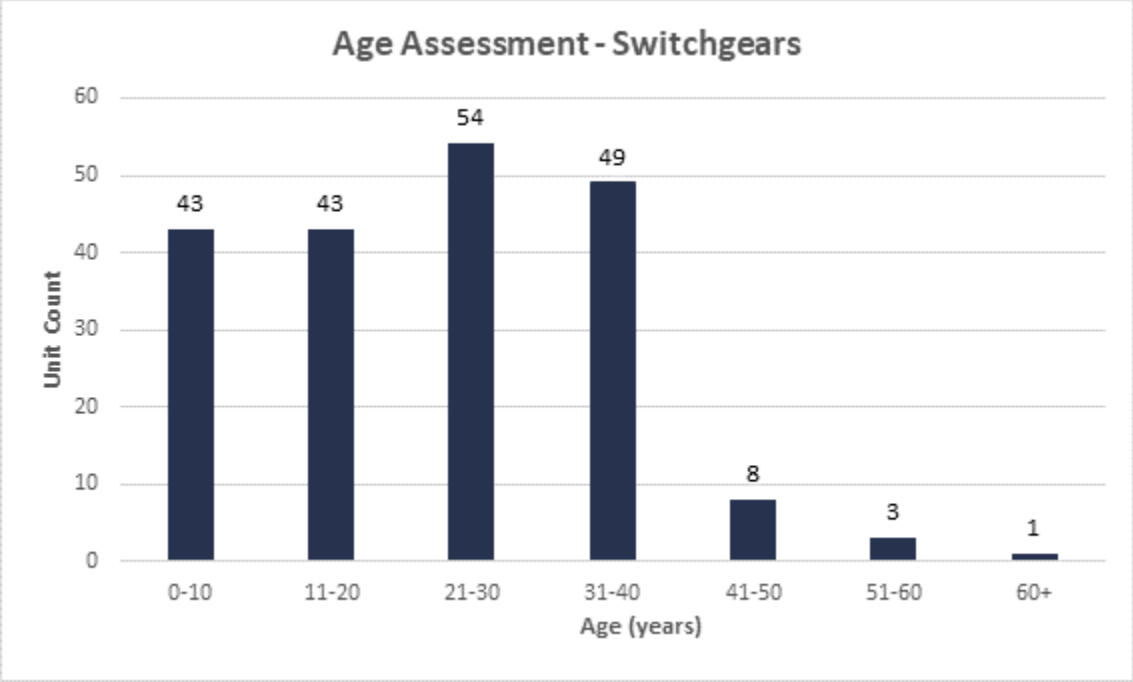
Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
IR Scan Results	8	A,C,E	4,2,0	32
Service Age	4	A,B,C,D,E	4,3,2,1,0	16
Condition of Pad	4	A,C,E	4,2,0	16
Condition of Enclosure	3	A,B,C,D,E	4,3,2,1,0	12
			Total Score	**76**

Distribution switchgears provide the required level of operating flexibility. They are employed for controlling, regulating and isolating the electrical circuit in the distribution system. During a fault, the switchgear isolates and clears the faults downstream. It also de-energizes equipment during maintenance and testing. They are used to manually or automatically transfer power in distribution circuits from a preferred source to an alternate source. The Health Index for distribution switchgears is calculated by considering a combination of end-of-life criteria summarized in Table 4-13. Each condition parameter represents a factor critical in determining the asset's condition relative to a potential failure to occur. Appendix B-7 provides grading tables for each condition parameter.

Infrared (IR) scanning results are an important condition parameter for condition assessment of distribution switchgears since they identify hotspots (i.e. high temperatures) on the asset. Assets operating continuously at high temperatures can cause accelerated degradation of the asset and may experience premature failure. It is assumed and confirmed by BHI that switchgears that exhibited high temperatures have since been corrected. If the distribution switchgear remained in service, the IR scan condition parameter was graded to be a Fair condition.

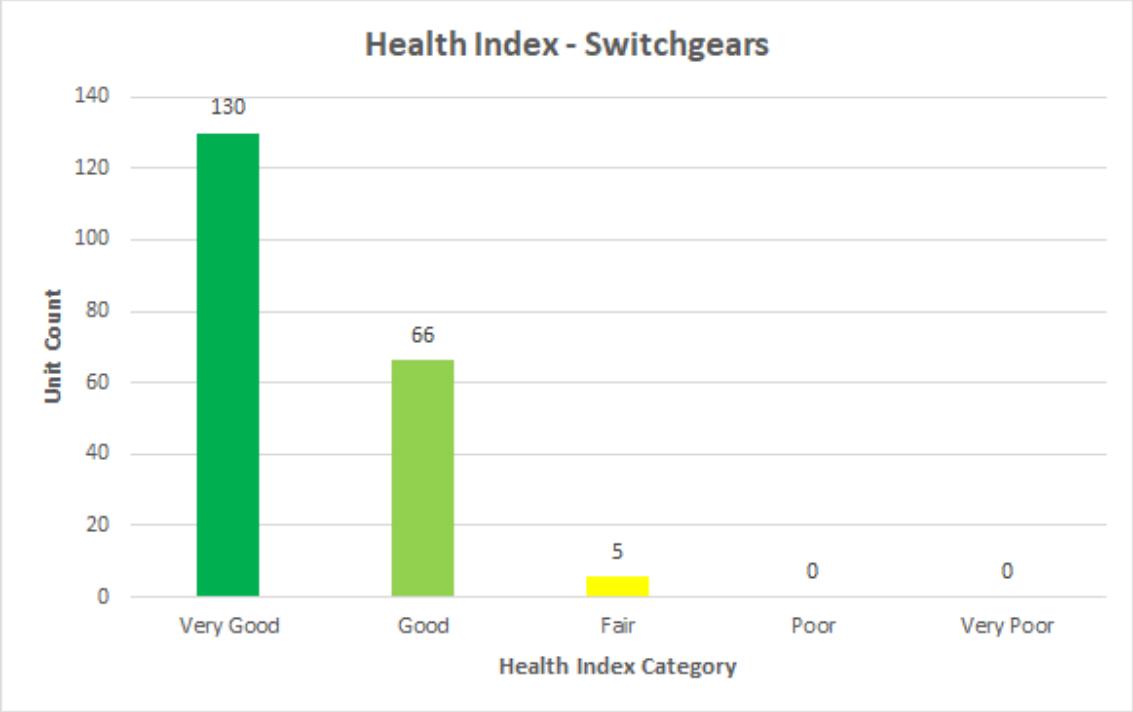
The condition of the pad and encloser, which indicate the presence of rust or damage and cracks on the encloser and the pad, are an important factor in the assessment of overall asset condition. The condition of the encloser is a stand-alone condition parameter with its own weight since damage to the encloser can expose the transformer to severe weather conditions and present serious safety concerns to humans should they come into contact with the contents inside. Hence, an enclosure that is deteriorated should be replaced to maintain safety performance. The condition of the pad is important to maintain the stability of the asset to prevent faults. Sometimes pads can be replaced without replacing the whole switchgear.

Figure 4-15: Switchgears Age Demographic



BHI owns 201 switchgears within its service territory. Age was known for the entire population of BHI's in-service switchgears. Figure 4-15 presents the age distribution for switchgears.

Figure 4-16: Switchgears Health Index Demographic



BHI's maintenance records and nameplate information was used to calculate the Health Index based on the criteria provided in Table 4-13. A valid Health Index was calculated for ~93% of the switchgears. To complete the full analysis, the Health Index for the remaining 7% has been extrapolated based on the Health Index distribution of the asset population with a valid Health Index score. The overall Health Index distribution for the switchgear is presented in Figure 4-16. Most of the population are in Very Good or Good condition. The average Health Index of the distribution switchgear is 89%.

Table 4-14: Switchgears condition parameters data availability

Condition Parameter	% of Assets with Data
IR Scan Results	100%
Service Age	100%
Condition of Pad	93%
Condition of Encloser	93%
Condition of Interphase Barriers	19%
Condition of Termination	19%
Condition of Blades	19%
Condition of Operating Mechanism	19%

Several condition parameters that are collected through BHI's visual inspection program are well below the 60% threshold. Therefore, these parameters are not included in the HI

framework for the asset class. However, the remaining condition parameters currently part of the HI framework provide a reasonable representation of the asset's health. For the condition parameters that are used, the average DAI for the switchgear population is 97%. Table 4-14 presents the DAI of individual condition parameters.

4.1.8 Overhead Switch

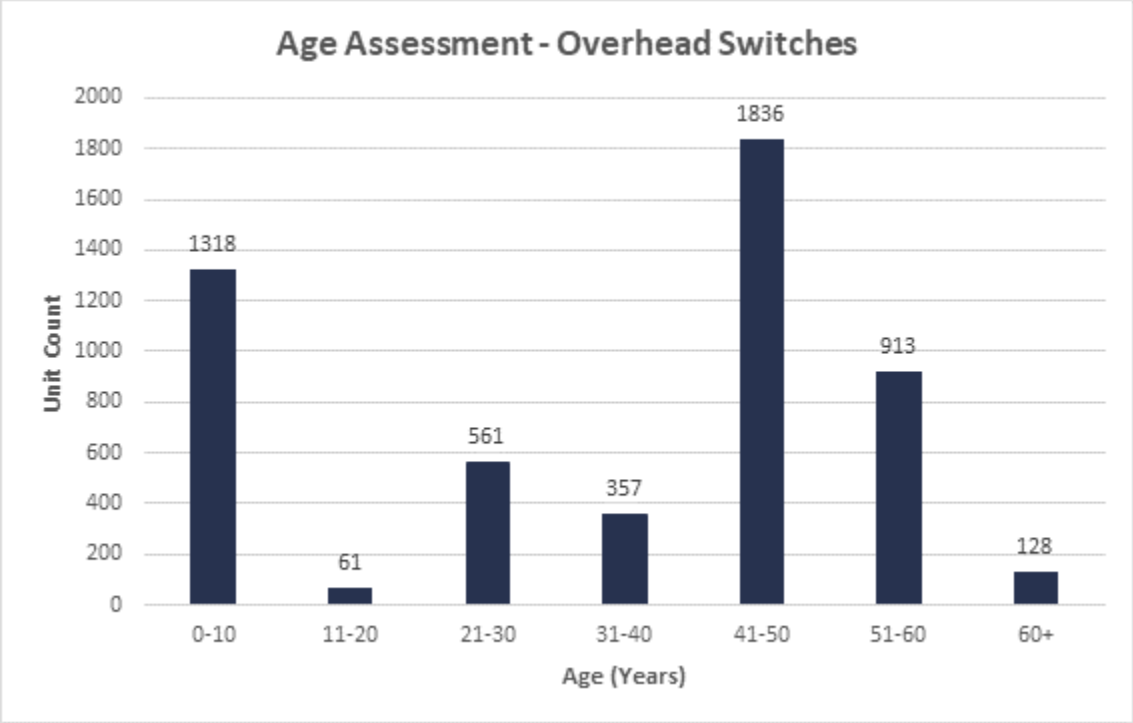
Table 4-15: Overhead Switch Health Index Algorithm

Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
IR Scan Results	4	A,B,C,D,E	4,3,2,1,0	16
Service Age	4	A,B,C,D,E	4,3,2,1,0	16
Condition of Blades	2	A,B,C,D,E	4,3,2,1,0	8
			Total Score	**40**

BHI's overhead switch types include fused cutout, load break, and air-break switches and are located on its service poles. Load break and air break switches are operated to sectionalize the circuit during a restoration procedure by breaking all three phases of load with a single operation. These switches are operated either manually or from BHI's control room. Fused cutout switches are a combination of a switch and a fuse and provide over-current protection during overload conditions or short circuits. The Health Index for switches is calculated by considering a combination of end-of-life criteria summarized in Table 4-15. Each condition parameter represents a factor critical in determining the asset's condition relative to a potential failure to occur. Appendix B-8 provides grading tables for each condition parameter.

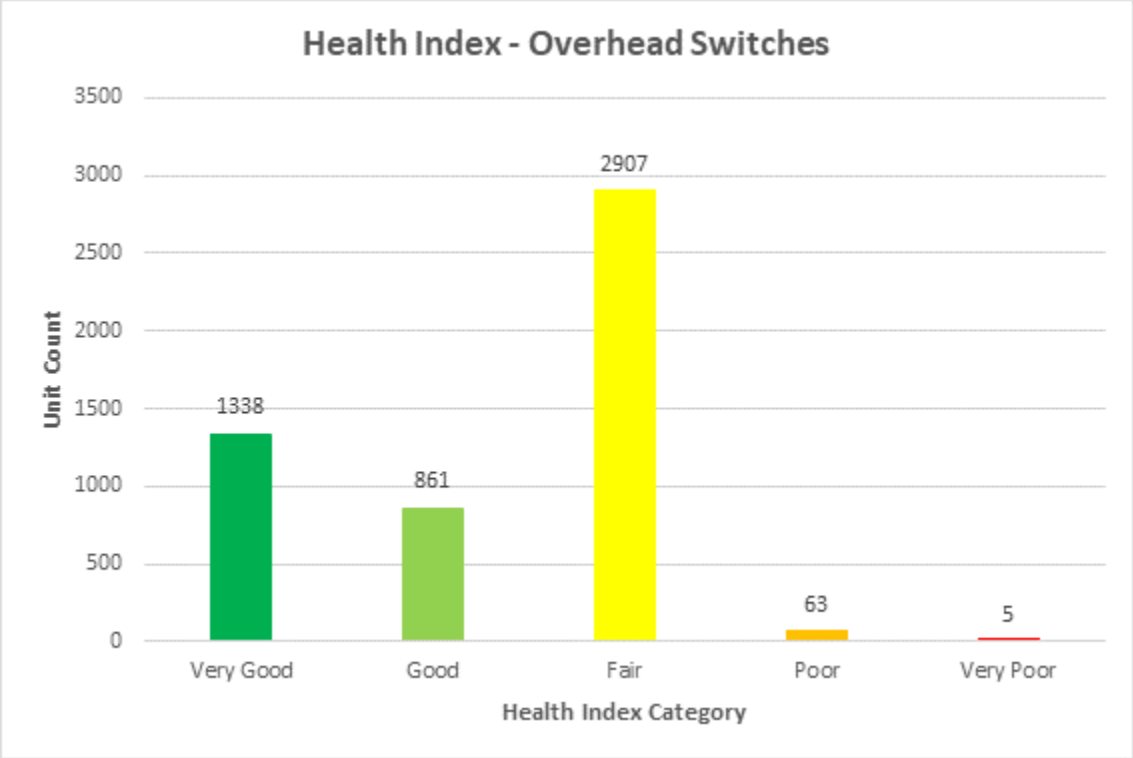
Infrared (IR) scanning results are an important condition parameter for condition assessment of overhead switches since they identify hotspots (i.e. high temperatures) on the asset. Assets operating continuously at high temperatures can cause accelerated degradation of the asset and may experience premature failure. METSCO assumed and confirmed by BHI that switches that exhibited high temperatures have since been corrected. If the switches remained in service, the IR scan condition parameter was graded to be a Fair condition.

Figure 4-17: Overhead Switches Age Demographic



BHI owns 5,174 overhead switches within its service territory. For assets with unknown installation dates, the assumption made was to use the corresponding feeder age as a proxy. This results in 99% of switches having a known installation date. The applied assumption for service age of assets was used in the Health Index calculation and was confirmed with BHI. The remaining 1% of the switch population does not have a known installation date. This is due to the fact the switches did not have a feeder tagged to the asset. The 1% of the asset class with an unknown age were extrapolated by weight onto the asset population with a known age. Figure 4-17 presents the age distribution for overhead switches to show an approximate representation of the age distribution. Extrapolated age results were not used as part of the Health Index calculation.

Figure 4-18: Overhead Switches Health Index Demographic



BHI's maintenance records and nameplate information was used to calculate the Health Index based on the criteria provided in Table 4-15. Approximately 1% of the population does not have a valid Health Index score and have been extrapolated to the known valid Health Index distribution. The overall Health Index distribution for the overhead switches is presented in Figure 4-18. More than 50% of the switches are in Fair condition and 43% of the switches are in Very Good or Good condition. The average Health Index of overhead switches is 76%.

Table 4-16: Overhead Switches condition parameters data availability

Condition Parameter	% of Assets with Data
IR Scan Results	100%
Service Age	99%
Condition of Blades	71%

The DAI for the condition parameters regarding overhead switches is over 99% except for the condition of blades which have a DAI of 71%. The average DAI for overhead switch data is 94%. Table 4-16 presents the DAI of individual condition parameters used for the overhead switch HI framework.

4.1.9 Recloser

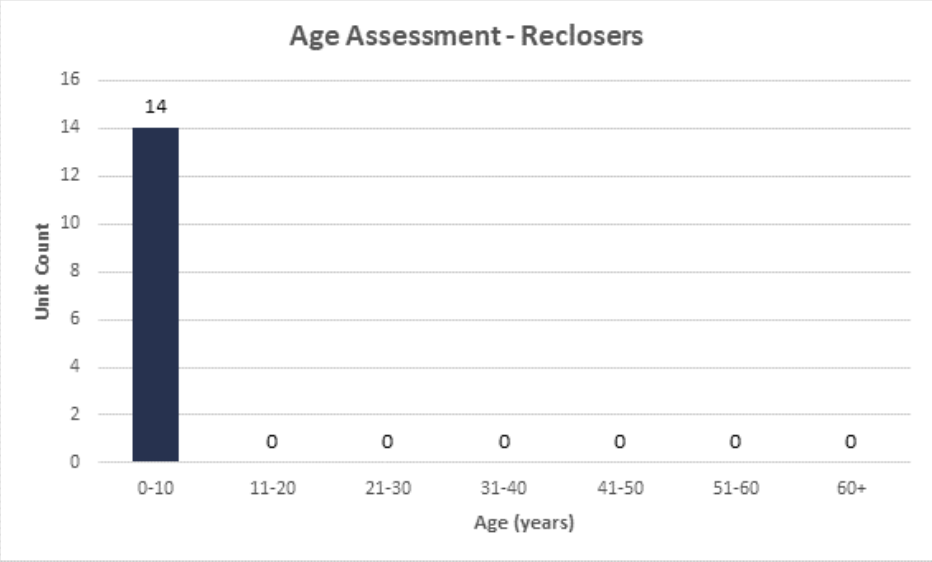
Table 4-17: Recloser Health Index Algorithm

Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Counter Readings	3	A,B,C,D,E	4,3,2,1,0	12
Service Age	3	A,B,C,D,E	4,3,2,1,0	12
Condition of Terminations	2	A,B,C,D,E	4,3,2,1,0	8
			Total Score	**32**

Reclosers are installed on the distribution system to interrupt the circuit during a fault and are designed to automatically reclose to restore the normal operating conditions. Since the majority of the faults on the overhead system are self-clearing/ transient, the presence of reclosers improves the reliability of the system significantly as the power is restored within seconds after a fault occurs. The Health Index for reclosers is calculated by considering a combination of end-of-life criteria summarized in Table 4-17. Each condition parameter represents a factor critical in determining the asset's condition relative to a potential failure to occur. Appendix B-9 provides grading tables for each condition parameter.

The counter reading criterion provides a reasonable assessment of the operating condition of the reclosers and is determined based on the number of operations of the recloser compared to the rated number of operations of an IntelliRupter specified by the manufacturer.[3] Service age provides a reasonably good measure of the remaining life of the asset and is utilized as a condition parameter.

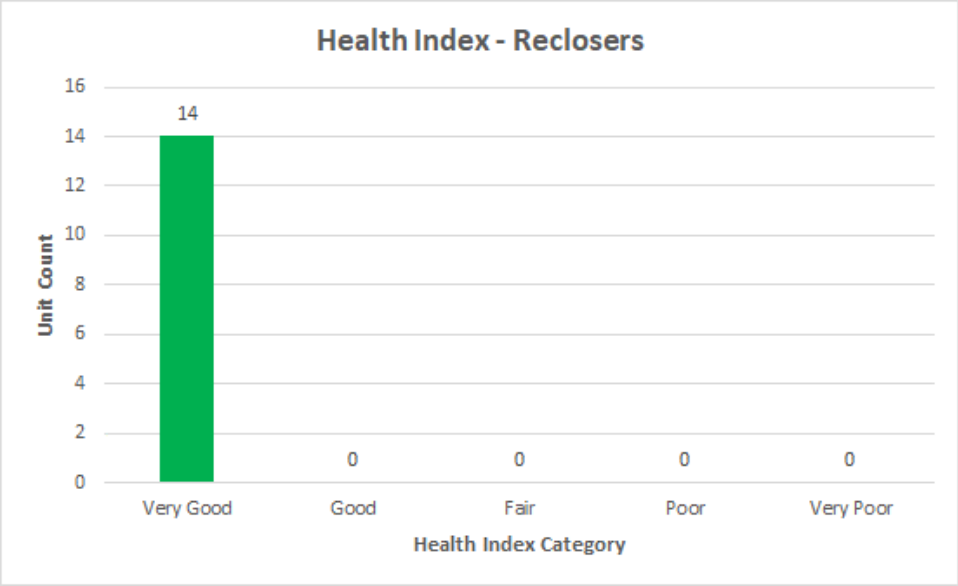
Figure 4-19: Reclosers Age Demographic



[3] S&C IntelliRupter® PulseCloser® Fault Interrupter – Specifications.

BHI owns 14 reclosers within its service territory. For assets with unknown installation dates, the applied assumption used the average age of the asset class as the service age. This results in 100% of assets having a known installation date. The applied assumption for service age of assets was used in the Health Index calculation and was confirmed with BHI. Figure 4-19 presents the age distribution for reclosers.

Figure 4-20: Reclosers Health Index Demographic



BHI's maintenance records, nameplate information, and operating parameters were used to calculate the Health Index based on the criteria provided in Table 4-17. The overall Health Index distribution for the reclosers is presented in Figure 4-20. All the reclosers are in Very Good condition. The average Health Index for reclosers is 98%.

Table 4-18: Reclosers condition parameters data availability

Condition Parameter	% of Assets with Data
Service Age	100%
Counter Readings	100%
Condition of Terminations	86%

The average DAI for the asset class is 97%. Table 4-18 presents the DAI of individual condition parameters used for the recloser HI framework.

4.2 Station Assets

4.2.1 Power Transformer

Table 4-19: Power Transformer Health Index Algorithm

Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Dissolved Gas Analysis	10	A,B,C,D,E	4,3,2,1,0	40
Load History	10	A,B,C,D,E	4,3,2,1,0	40
Insulation Power Factor	10	A,B,C,D,E	4,3,2,1,0	40
Oil Quality	8	A,C,E	4,2,0	32
Service Age	6	A,B,C,D,E	4,3,2,1,0	24
Overall Condition	6	A,B,C,D,E	4,3,2,1,0	24
			Total Score	**200**

Power transformers in the distribution system are housed within municipal stations. They are used to step down the voltage within the distribution system to supply end users. Computing the Health Index of a transformer requires developing end-of-life criteria for its various components. Table 4-19 summarizes the methodology to generate the Health Index for oil type power transformers. The Health Index score for a transformer is composed of six condition parameters. Three of the six parameters are determined by quantitative testing results, with each parameter carrying a weight of eight or ten. These measurements include dissolved gas analysis, insulation power factor, and oil quality. Each of these parameters represents an aspect of a power transformer with a direct impact on the operational health of the asset. BHI also owns dry type power transformers, for which loading history, service age and overall condition was used to calculate the Health Index Score.

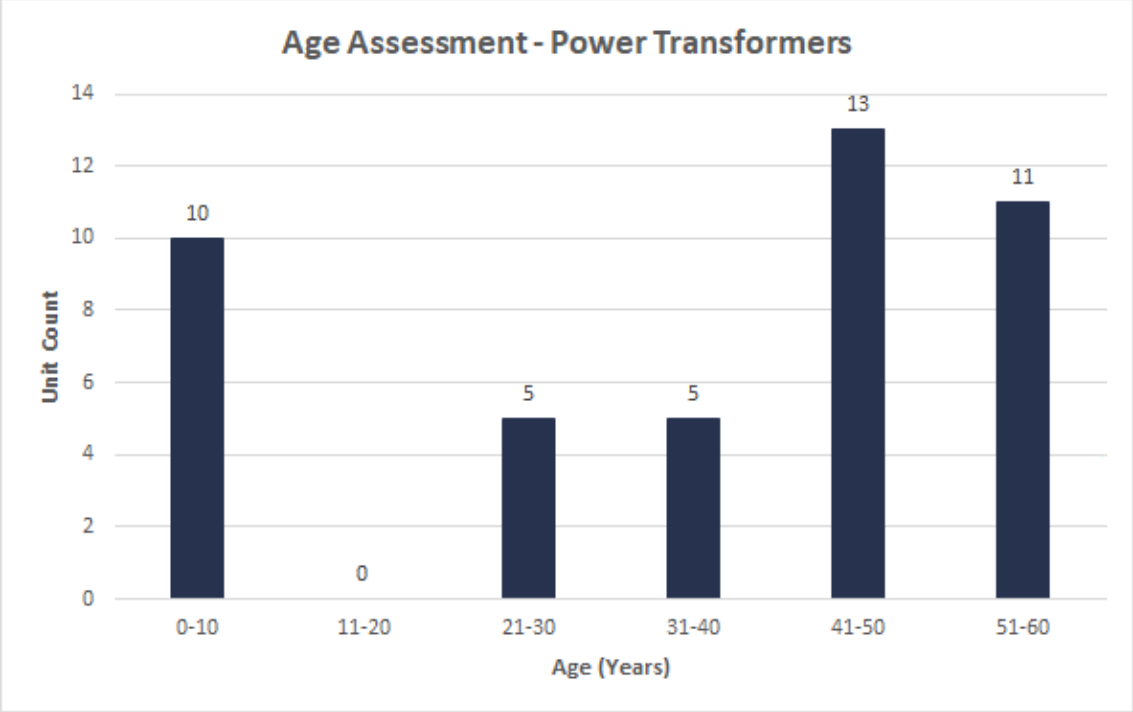
By performing the dissolved gas analysis ("DGA"), it is possible to identify the internal faults such as arcing, partial discharge, low-energy sparking, severe overloading, and overheating in the insulating medium. Insulation power factor measurements are an important source of data to monitor transformer and bushing conditions. Lower scores for one or a combination of these condition parameters strongly indicate progressed degradation of the asset, hence their larger weights.

Although load history is not a test, it holds value as an input for the Health Index algorithm. The peak loading information of 2018 and 2017 (January to October) was used for the analysis. The rate of insulation degradation is directly related to the operating temperature which is directly related to transformer loading levels. The peak loading level of the transformers is expressed in a percentage of the nameplate rating. BHI collects the substation load history monthly, recording the monthly peak for each month.

Oil leaks and overall condition of components are collected by visual inspection and serve as indicators of the total health of the asset. Additionally, service age provides a

reasonably good measure of the remaining life of the asset and is employed as a condition parameter.

Figure 4-21: Power Transformers Age Demographic



BHI owns 37 oil and 7 dry type power transformers within its service territory with one oil and two dry type transformers having a load tap changer (LTC). Figure 4-21 presents the age profile of power transformers in-service.

Figure 4-22: Power Transformers Health Index Demographic

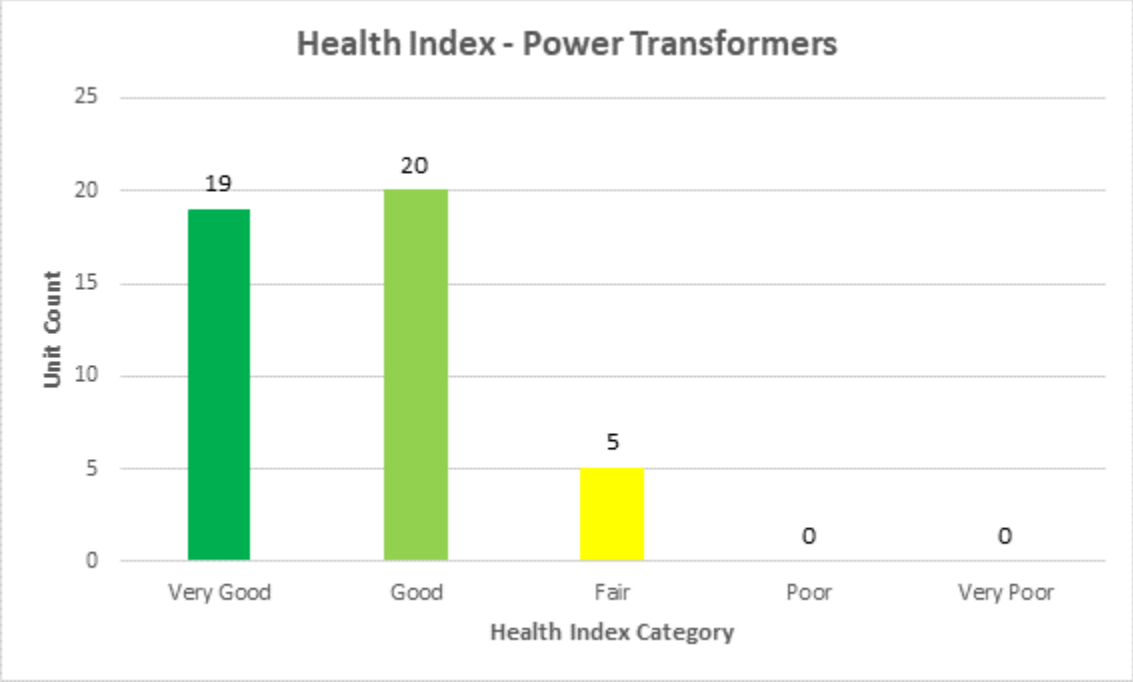
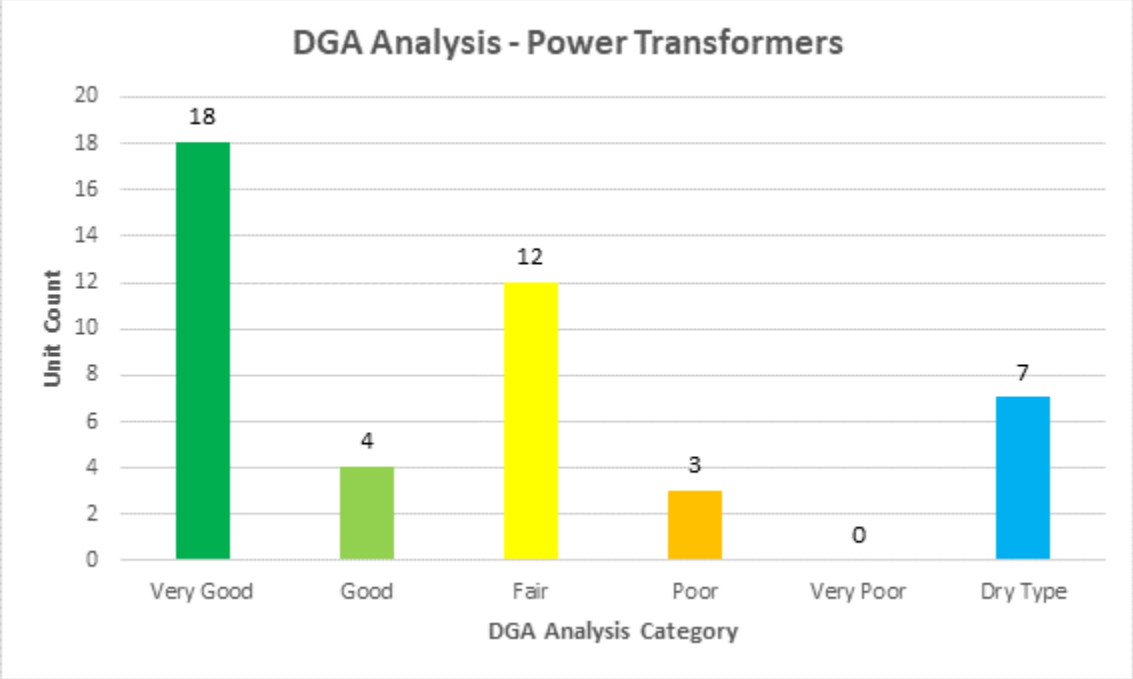


Figure 4-23: Power Transformers DGA Analysis Results



BHI's power transformer inspections, test results, loading history and age demographics were used to calculate the Health Index based on the criteria provided in Table 4-19. The Health Index distribution for in-service power transformers is presented in Figure 4-22.

Most of the power transformers are in Very Good or Good condition with five power transformers in Fair condition. The average Health Index for power transformer is 83%.

Figure 4-23 illustrates the DGA analysis results for the power transformers. DGA tests can be a leading indicator as to how the power transformer's internal condition is before experiencing unfavorable results. The figure is presented to show there are power transformers tested that may require intervention within a timely manner even though the overall Health Index is Fair.

Table 4-20: Power Transformers condition parameters data availability

Condition Parameter	% of Assets with Data	
	Oil Type Tx	Dry Type Tx
Dissolved Gas Analysis	100%	
Load History	100%	100%
Insulation Power Factor	84%	
Oil Quality	100%	
Service Age	100%	100%
Overall Condition	100%	100%

The average DAI for oil type and dry type power transformer data is 97% and 100% respectively. DGA, service age, load history, oil quality, and overall condition have 100% DAI. Insulation power factor data was missing for 16% of oil type transformers. For dry type transformers, loading history, service age, and overall condition all have 100% data available. Table 4-20 presents the DAI of individual condition parameters used for the power transformer HI framework.

4.2.2 Circuit Breaker

Table 4-21: Circuit Breaker Health Index Algorithm

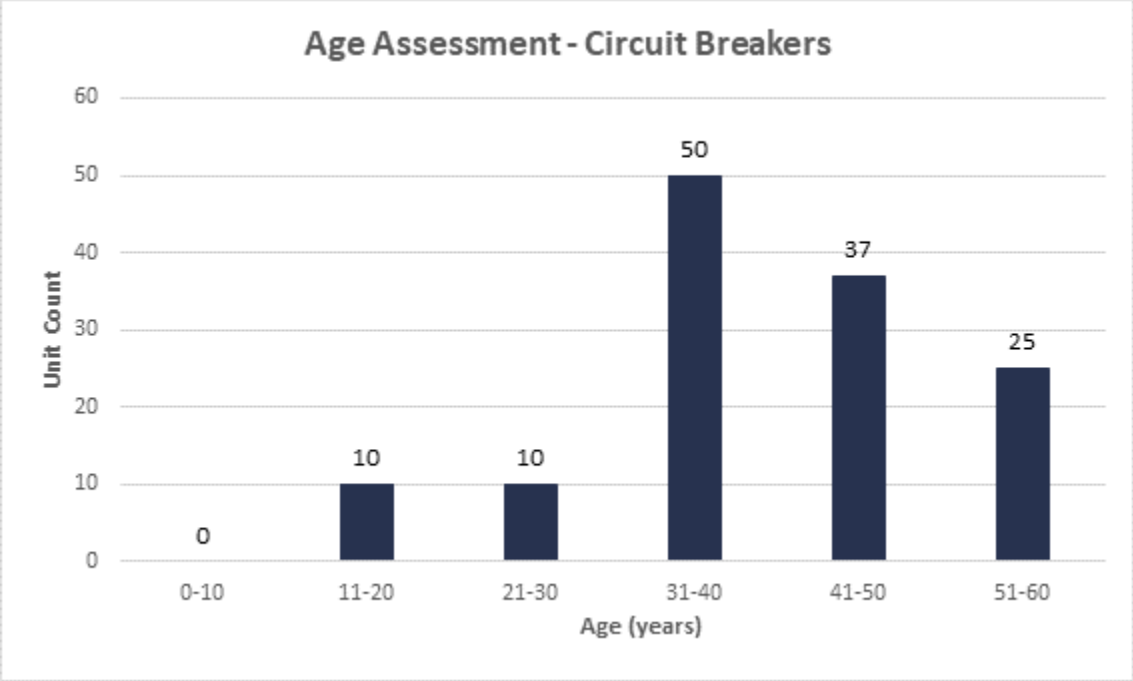
Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Contact Resistance Test	8	A,B,C,D,E	4,3,2,1,0	32
Insulation Resistance Test	8	A,E	4,0	32
Service Age	5	A,B,C,D,E	4,3,2,1,0	20
Counter Reading	5	A,B,C,D,E	4,3,2,1,0	20
Visual Inspection	3	A,B,C,D,E	4,3,2,1,0	12
			Total Score	**116**

Circuit breakers, located in station switchgears, are electrical switches that operate automatically during a fault. It is a protective device that protects the electrical system from overloading due to the short circuit current. It operates when a fault is detected and can be programmed to automatically restore the connection once the fault is cleared or can be reset manually based on the severity of the fault. Computing the Health Index of a circuit breaker considers end-of-life criteria for its various components. Each criterion

represents a factor critical in determining the component's condition relative to potential failure. The Health Index for substation circuit breakers is calculated by considering a combination of test results, number of operations and visual inspections as summarized in Table 4-21. Appendix B-11 provides grading tables for each condition parameter.

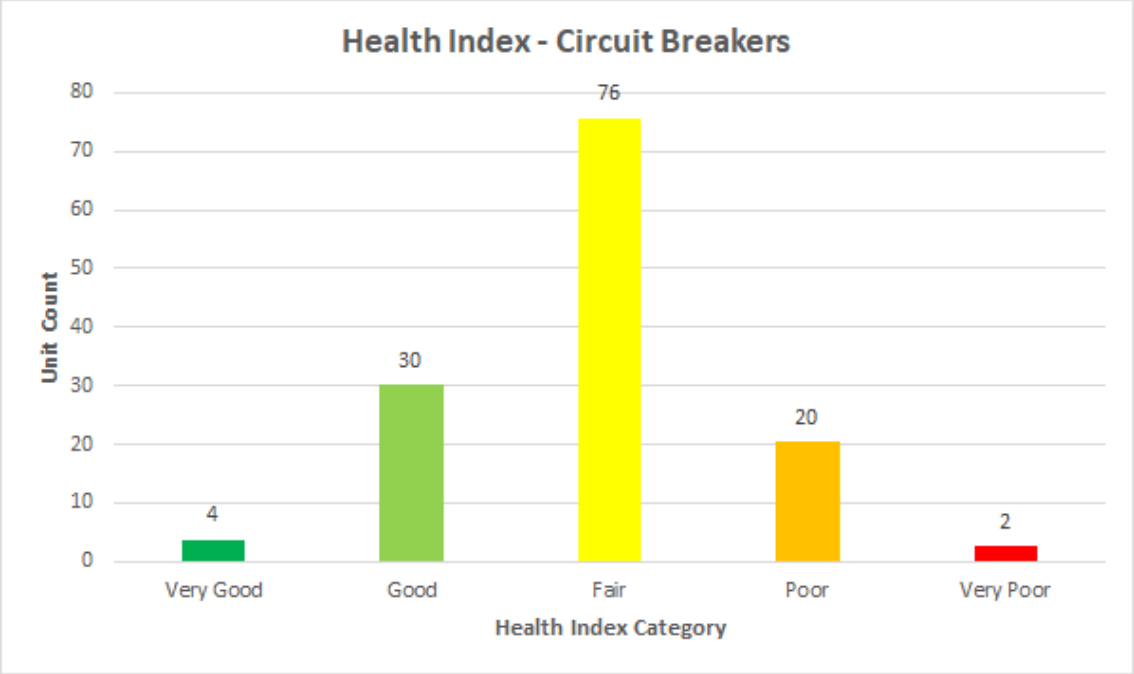
Maintenance tests, such as the contact resistance test and insulation resistance test, are weighted the highest because they are the best indicator of the asset's condition and performance.

Figure 4-24: Circuit Breakers Age Demographic



BHI owns 120 air magnetic and 12 vacuum circuit breakers within its service territory. The age of the circuit breakers is not known and assumed to be the same age as the station switchgears in which they house. The assumption is confirmed with BHI and is used for calculating the Health Index. Figure 4-24 presents the age distribution for circuit breakers.

Figure 4-25: Circuit Breakers Health Index Demographic



BHI's maintenance records, operation data, and nameplate information were used to calculate the Health Index based on the criteria provided in Table 4-21. A valid Health Index was calculated for ~83% of the circuit breakers. To complete the full analysis, the remaining 17% has been extrapolated to the overall Health Index. The overall Health Index distribution for station circuit breakers is presented in Figure 4-25. Approximately 60% of the circuit breakers are in Fair condition with 17% of the breakers to be in Very Poor or Poor condition. The average Health Index for the circuit breaker is 61%.

Table 4-22: Circuit Breakers condition parameters data availability

Condition Parameter	% of Assets with Data
Contact Resistance Test	67%
Insulation Resistance Test	83%
Service Age	100%
Counter Reading	80%
Visual Inspection	96%

The average DAI for circuit breaker data is 85%. Data availability for all condition parameters is above 60%. Table 4-22 presents the DAI of individual condition parameters used for the circuit breaker HI framework.

4.2.3 Station Primary Switchgear

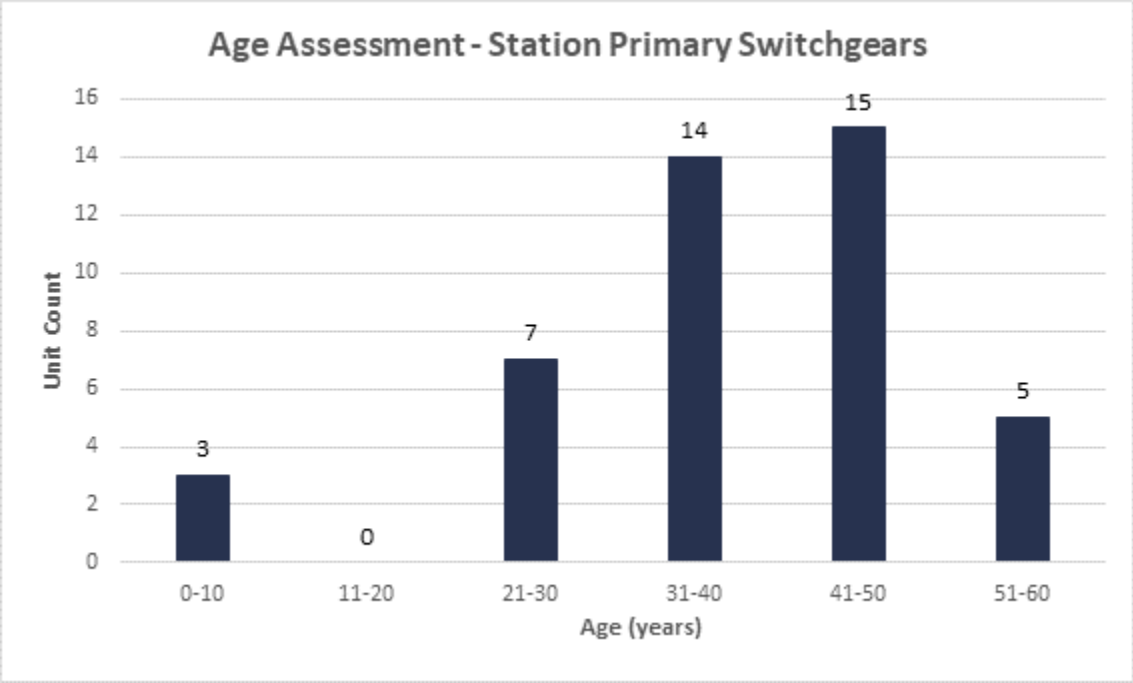
Table 4-23: Station Primary Switchgears Health Index Algorithm

Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Service Age	4	A,B,C,D,E	4,3,2,1,0	16
Visual Inspection	3	A,B,C,D,E	4,3,2,1,0	12
			Total Score	**28**

Station primary switchgears consist of breakers, fuses, and switches that control and regulate the current flowing through the distribution system. During a fault, the primary switchgear isolates and clears the faults downstream. It is also used to de-energize equipment during maintenance and testing. The Health Index for station primary switchgears is calculated by considering a combination of end-of-life criteria summarized in Table 4-23. Each condition parameter represents a factor critical in determining the asset's condition relative to a potential failure to occur. Appendix B-12 provides grading tables for each condition parameter.

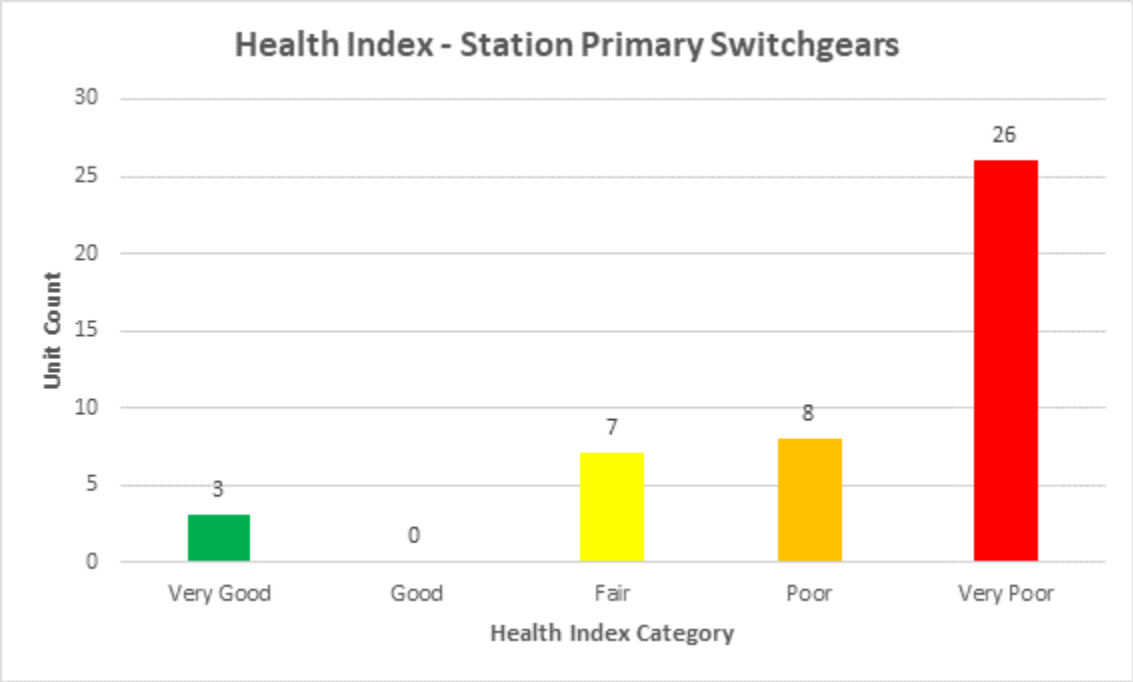
Service age provides a reasonably good measure of the remaining life of the asset and is utilized as a condition parameter. Visual inspection records of the switchgears is also used as a condition parameter.

Figure 4-26: Station Primary Switchgears Age Demographic



BHI owns 44 station primary switchgears within its service territory. Age was known for the total population of BHI's in-service station switchgears. Figure 4-26 presents the age profile of station primary switchgears.

Figure 4-27: Station Primary Switchgears Health Index Demographic



BHI's maintenance records and nameplate information were used to calculate the Health Index based on the criteria provided in Table 4-23. The overall Health Index distribution for the station primary switchgear is presented in Figure 4-27. Most of the asset class is in Fair condition or below, with 59% of the station primary switchgears in Very Poor condition. The average Health Index for station primary switchgear is 35%. The primary driver is the age, where most of the assets are well beyond the typical useful life, assumed based on the *Asset Depreciation Study for the Ontario Energy Board*[4], and are at higher risk of failing in comparison to newer assets installed.

Table 4-24: Primary Station Switchgears condition parameters data availability

Condition Parameter	% of Assets with Data
Service Age	100%
Visual Inspection	100%

The DAI for switchgear data is 100%. Table 4-24 presents the DAI of individual condition parameters used for the switchgear HI framework.

[4] Kinectrics – Asset Depreciation Study for the Ontario Energy Board

4.2.4 Station Feeder Egress Cable

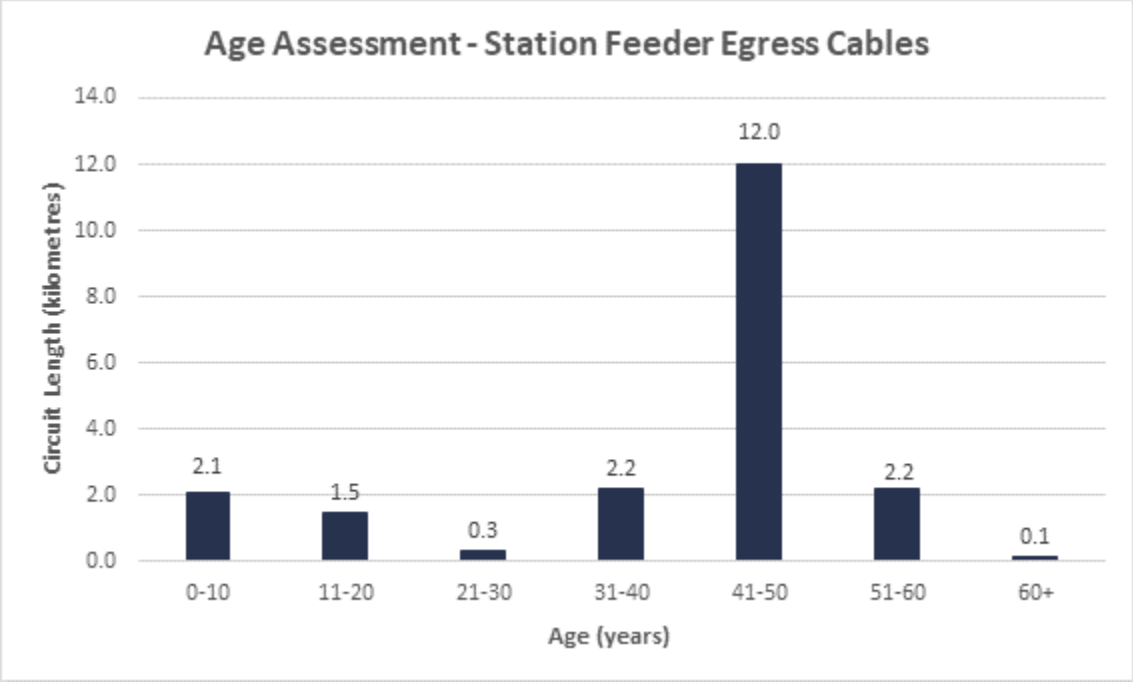
Table 4-25: Station Feeder Egress Cable Health Index Algorithm

Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Service Age	10	A,B,C,D,E	4,3,2,1,0	40
Field Testing	10	A, C, D, E	4,2,1,0	40
Outage Records in last 5 years	8	A,B,C,D,E	4,3,2,1,0	32
Loading History	5	A,B,C,D,E	4,3,2,1,0	20
			Total Score	**132**

Station feeder egress cables are the cable sections that connect the municipal station to the distribution feeders and transmit electricity to the electrical distribution system. These are the cables coming out of the circuit breakers at the station and experience the maximum fault current during a fault occurrence. Table 4-25 summarizes the methodology to combine these criteria into an overall Health Index. Appendix B-13 provides grading tables for each condition parameter.

Service age provides a reasonably good measure of the remaining life of the asset and hence is used as a condition parameter in the Health Index framework. Additionally, BHI conducts the Hi-Pot test that helps find crushed insulation, terminal spacing problems, stray wire strands or braided shielding, and conductive or corrosive contaminants around the cables. BHI also retained CableQ to perform sample tests of its cables across the system to detect the effect that water trees have on the cables. It is assumed that the remaining sections of the feeders are in a similar condition to those assessed through these testing methods. Additionally, the 2018 loading history of the cables was also used as a condition parameter since overloading these cables can significantly deteriorate the health of the cables.

Figure 4-28: Station Feeder Egress Cable Age Demographic



BHI owns approximately 23km of station feeder egress cables within its service territory. Age data was available for the entire population of station feeder egress cables. Figure 4-28 presents the station feeder egress cables age demographic.

Figure 4-29: Station Feeder Egress Cable Health Index Demographic by Length

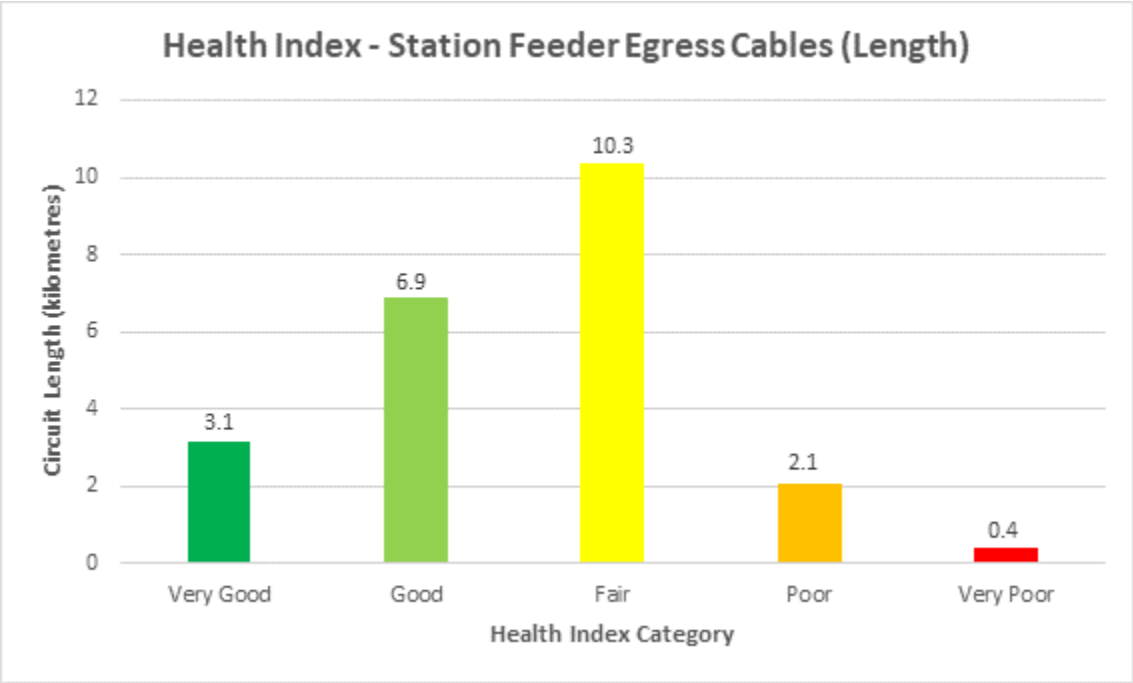
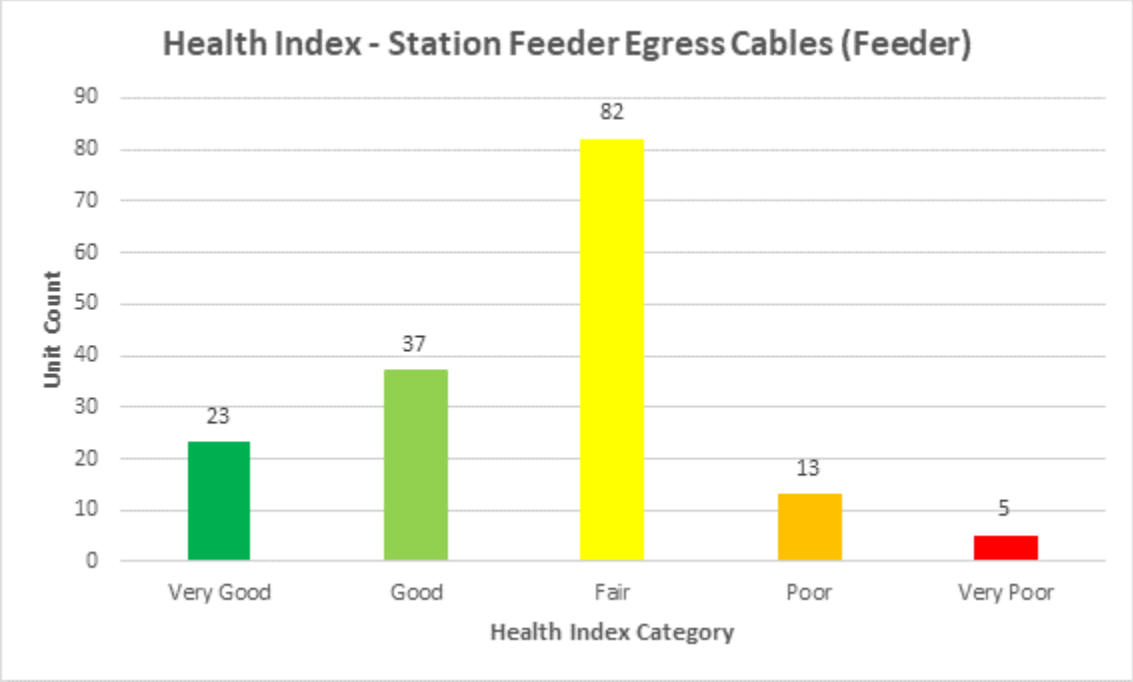


Figure 4-30: Station Feeder Egress Cable Health Index Demographic by Feeder



The Health Index for station feeder egress cable by circuit length and feeder are illustrated in Figure 4-29 and Figure 4-30 respectively. Approximately 50% of the cables by length are in Fair condition with 11% being in Very Poor and Poor condition. The average Health Index for station feeder egress cable is 70%. The Health Index demographic by feeder considers the cable segments by feeder and is presented as a count summation of feeders instead of length.

Table 4-26: Station Feeder Egress Cable condition parameters data availability

Condition Parameter	% of Assets with Data
Service Age	100%
Field Testing	100%
Outage Records in last 5 years	100%
Loading History	100%

The DAI across the station feeder egress cable asset class is 100%. Table 4-26 presents the DAI of individual condition parameters used for the station feeder egress cable HI framework.

4.2.5 Battery Bank and Charger

Table 4-27: Station Battery Bank Health Index Algorithm

Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Service Age (Battery & Charger)	4	A,B,C,D,E	4,3,2,1,0	16
Testing	4	A,C,E	4,2,0	16
			Total Score	**32**

The battery system provides backup power to essential station functionalities such as lighting, communication, and P&C equipment in the event of a loss of supply to the station. The main components of the battery system are the charger and the battery bank which is comprised of several battery cells in series.

The battery bank Health Index score is comprised of two condition parameters with equivalent weightings. The first condition parameter is age, which provides insight into the remaining useful life of the asset based on the typical useful lives of DC systems seen across the industry. Batteries also operate based on a determinate chemical process, which has a known lifetime and useful duration. Discharge testing (A/H testing) provides detail on individual cell charges, total voltage, and discharge rates as the battery supplies energy over time. Any atypical degradation of a battery bank's performance will be seen with this testing procedure. By building the Health Index score from these two parameters, static and dynamic effects on a battery bank's remaining life can be classified. Table 4-27 summarizes the methodology to generate the Health Index for station battery banks. Appendix B-14 provides grading tables for each condition parameter.

For chargers, only service age data is used to calculate the Health Index score, which is the common approach to assess the Health Index. Service age is based on the maximum useful life of station chargers seen across the industry[5]. This provides insight into the remaining useful life of the asset.

[5] Kinectrics – Asset Depreciation Study for the Ontario Energy Board

Figure 4-31: Station Battery Banks Age Demographic

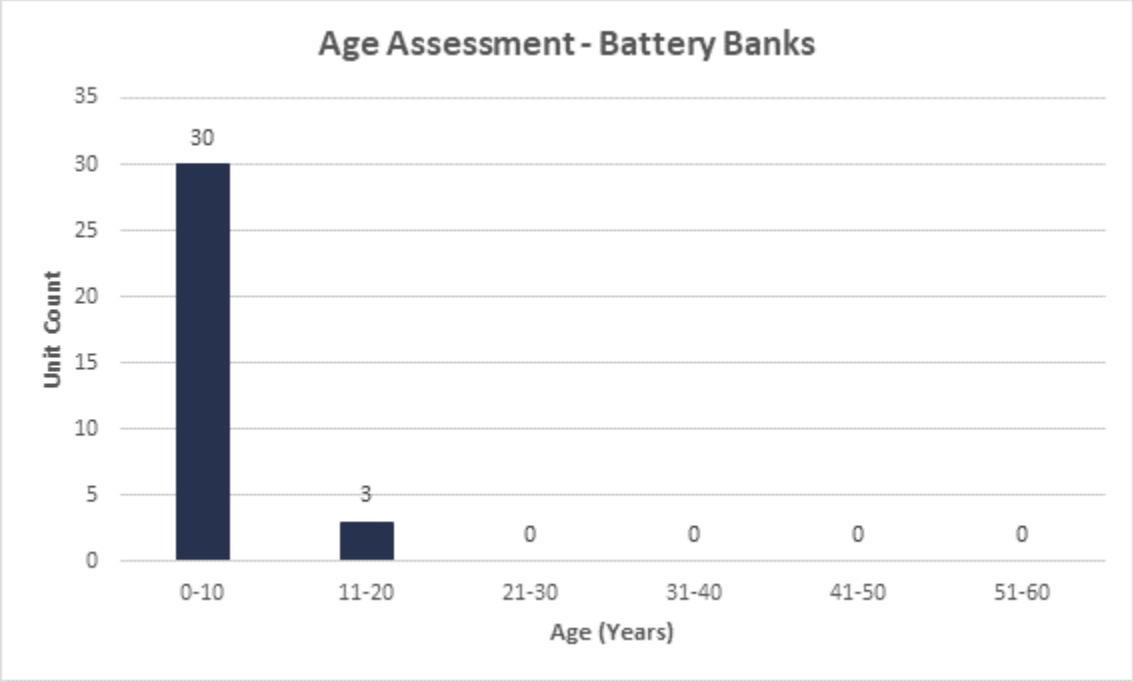
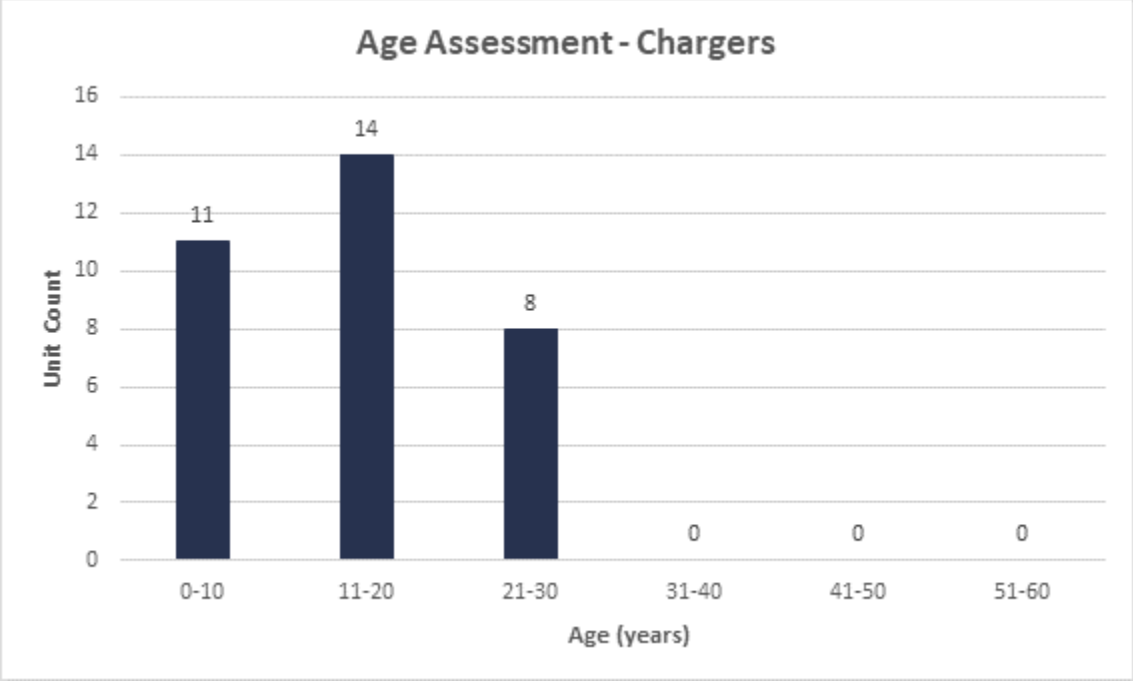


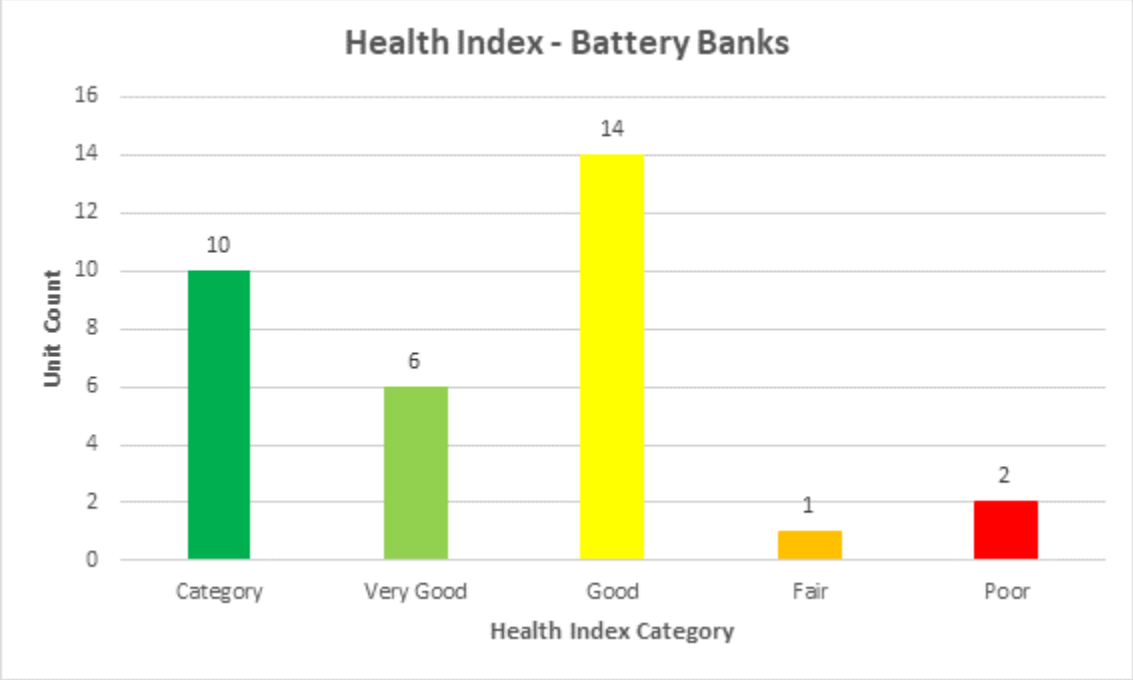
Figure 4-32: Station Chargers Age Demographic



BHI owns 33 batteries and 33 chargers. Age was known for all the assets except one charger. The average age of the known charger population was assigned to the unknown charger. The applied assumption was confirmed by BHI and used in the Health Index

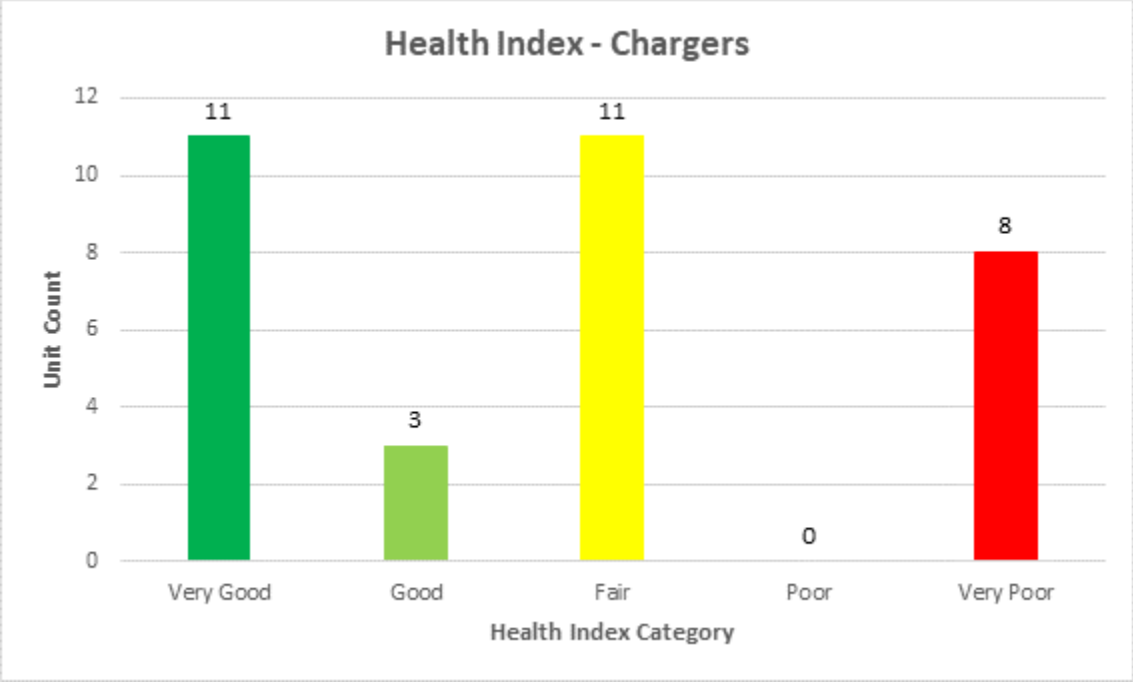
calculation. Figure 4-31 and Figure 4-32 presents the age distribution for station battery banks and chargers respectively.

Figure 4-33: Station Battery Banks Health Index Demographic



BHI's maintenance tests and nameplate information was used to calculate the Health Index based on the criteria provided in Table 4-27. The Health Index distribution for station batteries is presented in Figure 4-33. Almost 50% of the battery banks are in Fair condition with three battery banks being in Poor or Very Poor condition. The average Health Index for battery banks is 70%.

Figure 4-34: Chargers Health Index Demographic



Service age data of the chargers were used to calculate the overall Health Index. Health Index distribution for the station chargers is presented in Figure 4-34. Approximately 24% of the chargers are in Very Poor condition. The average Health Index for chargers is 63%.

Table 4-28: Station Batteries & Chargers condition parameters data availability

Condition Parameter	% of Assets with Data	
	Battery Bank	Charger
Service Age	100%	100%
Testing	100%	

The class-average DAI for both battery banks and chargers' data is 100%. Table 4-28 presents the DAI of individual condition parameters used for the batteries HI framework.

4.2.6 Protection Relay

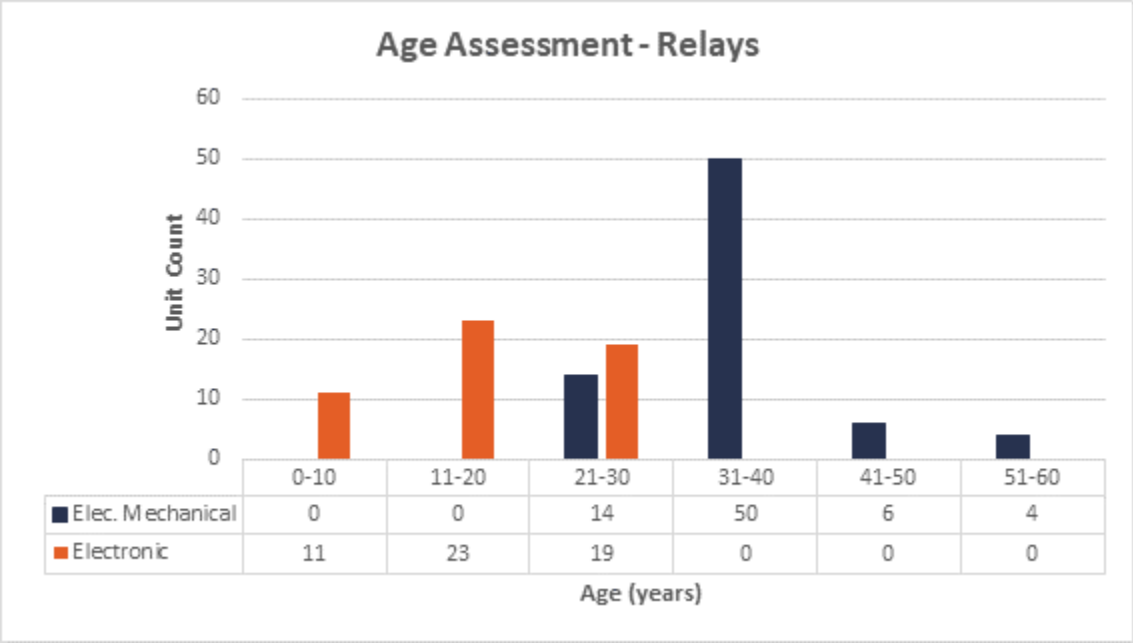
Table 4-29: Protection Relay Health Index Algorithm

Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Service Age	4	A,B,C,D,E	4,3,2,1,0	16
Testing	4	A,C,E	4,2,0	16
			Total Score	**32**

The function of protection relays in distribution systems is to detect and abnormal operating conditions and initiate a recloser trip to isolate faulty circuits from healthy circuits. Protection relays obtain their input from instrument transformers, process the

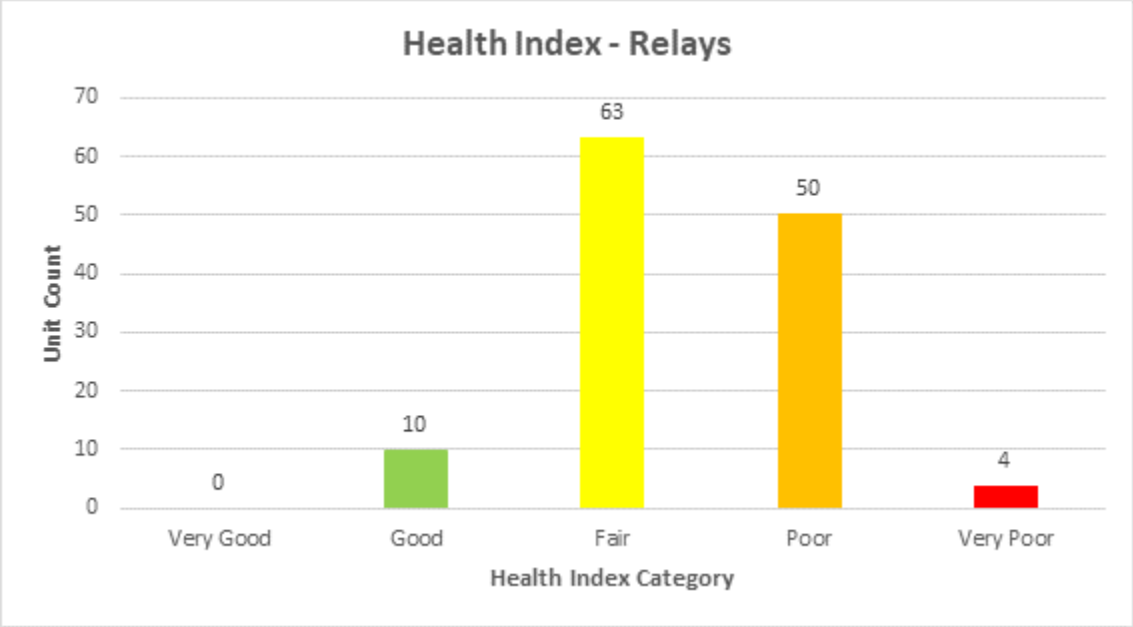
information and automatically take corrective action with adequate speed and selectivity. Table 4-29 summarizes the methodology to generate the Health Index for protection relays. The main inputs considered are service age and test results. Appendix B-15 provides grading tables for each condition parameter.

Figure 4-35: Protection Relays Age Demographic



BHI owns 127 protection relays with a mix of electronic and electronic mechanical types. Age was known for all the relays in the system. Figure 4-35 presents the age demographics of the protection relays.

Figure 4-36: Protection Relays Health Index Demographic



BHI's most recent testing results and useful life were used to calculate the Health Index based on the criteria provided in Table 4-29. A valid Health Index was calculated for ~82% of the relays. To complete the full analysis, the remaining 18% has been extrapolated to the overall Health Index. The Health Index distribution for relays is presented in Figure 4-36. Most of the population are in Fair condition or below with 43% of the relays in Very Poor or Poor condition. The average Health Index for protection relay is 50%.

Table 4-30: Protection relays condition parameters data availability

Condition Parameter	% of Assets with Data
Service Age	100%
Testing	82%

The average DAI for protection relays is 91%. Table 4-30 presents the DAI of individual condition parameters used for the relays HI framework.

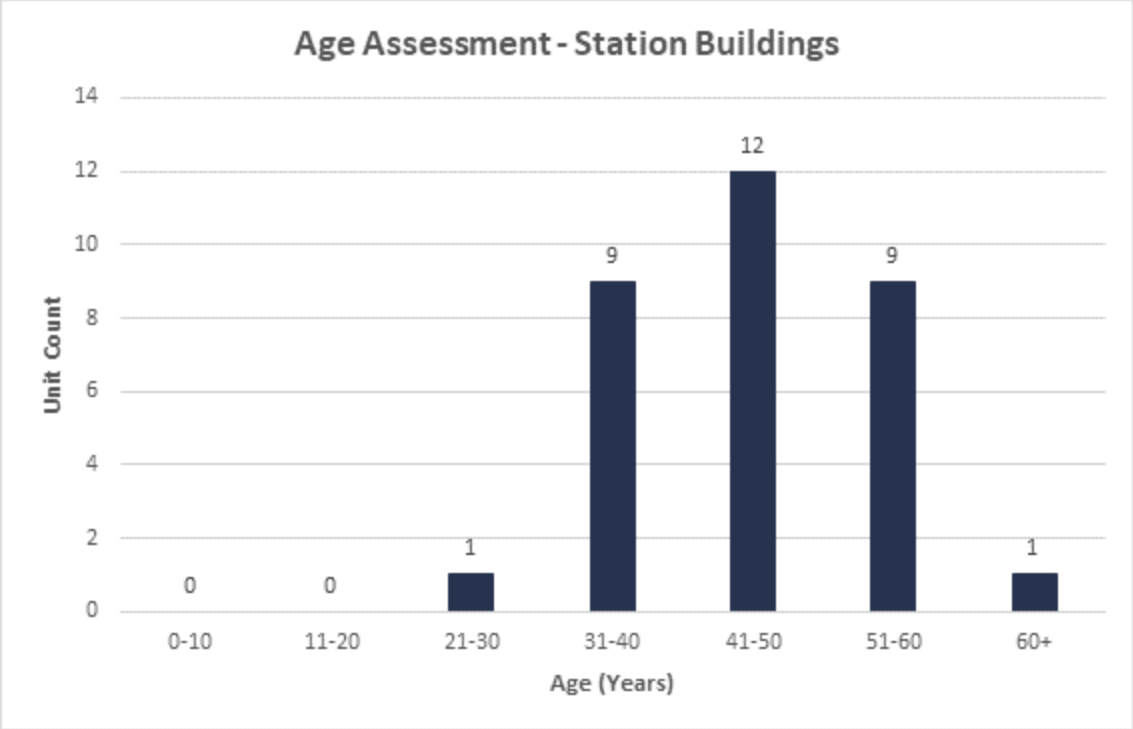
4.2.7 Station Building

Table 4-31: Station Building Health Index Algorithm

Condition Parameter	Weight	Ranking	Numerical Grade	Max Score
Roof Condition	4	A,B,C,D,E	4,3,2,1,0	16
Wall Condition	4	A,B,C,D,E	4,3,2,1,0	16
Floors/Foundations Condition	4	A,B,C,D,E	4,3,2,1,0	16
Overall Building Condition	4	A,B,C,D,E	4,3,2,1,0	16
Lighting/Power/HVAC Condition	2	A,B,C,D,E	4,3,2,1,0	8
Doors/Windows/Louvres Condition	2	A,B,C,D,E	4,3,2,1,0	8
			Total Score	**80**

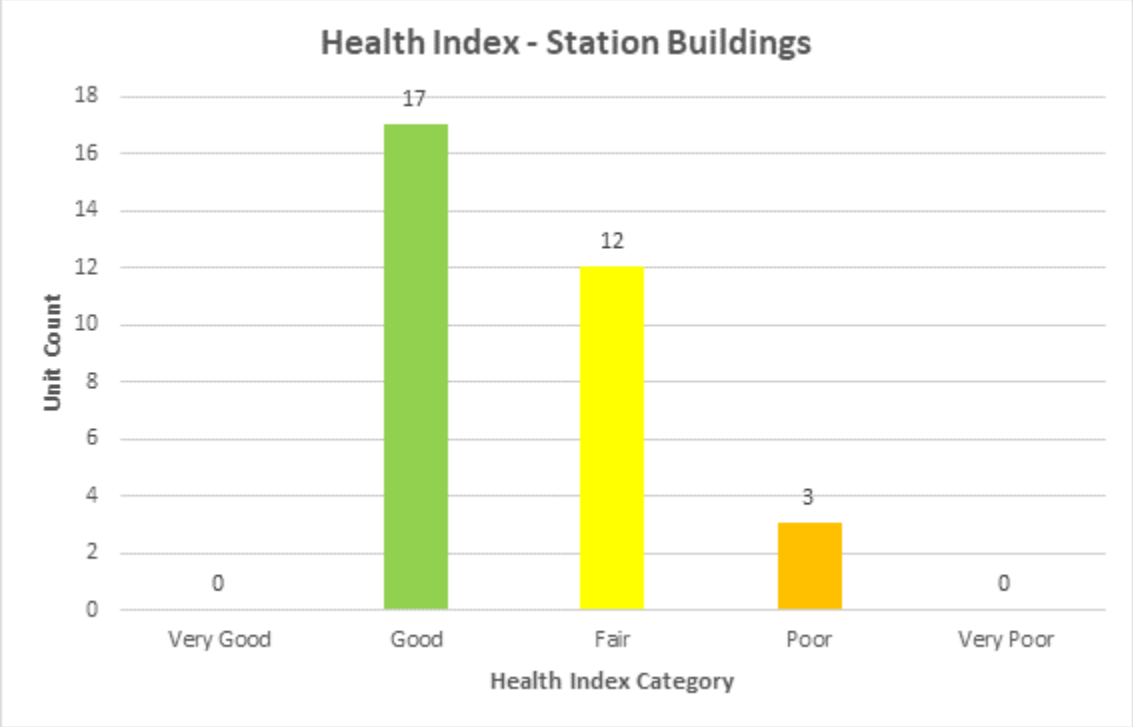
Each municipal station has a building where protection and control equipment, battery systems and indoor switchgears are located. The condition of the building is critical as they are the housing unit for storing and operating the in-service assets. Additionally, they serve a protective function for the assets from external weather patterns that may impact both the condition and performance of the housed assets. The Health Index for station buildings is calculated by considering visual inspections of several components of the buildings. Table 4-31 highlights the Health Index algorithm for buildings. Appendix B-16 provides grading tables for each condition parameter.

Figure 4-37: Station Buildings Age Demographic



BHI owns 32 buildings within its service territory. Age was known for all the station buildings. Figure 4-37 presents the age distribution for buildings.

Figure 4-38: Station Building Health Index Demographic



BHI's maintenance records were used to calculate the Health Index based on the criteria provided in Table 4-31. The Health Index distribution for station buildings is presented in Figure 4-38. 53% of the population is in Good condition and the rest of the population are in Fair and Poor condition. The average Health Index for station building is 66%.

Table 4-32: Station building condition parameters data availability

Condition Parameter	% of Assets with Data
Roof Condition	100%
Wall Condition	100%
Floors/Foundations Condition	100%
Overall Building Condition	100%
Lighting/Power/HVAC Condition	100%
Doors/Windows/Louvres Condition	100%

The average DAI for station buildings is 100%. Table 4-32 presents the DAI of individual condition parameters used for the station buildings HI framework.

5 Recommendations

A complete ACA framework for BHI represents an integral component of its broader asset management framework, enabling it to proactively manage its distribution assets and ensure that the right actions are taken for the right assets at the right time. This framework leveraged the information captured from maintenance programs and other utility records, creating an essential linkage between the ongoing maintenance activities and the capital investment decision-making process. Leveraging the HI insights allows for BHI's investment decision-making to be further enhanced with the current information regarding the state of the assets. There are also further opportunities to introduce new data collected, improve on data availability, and continuously improve the ACA framework.

This section breaks down METSCO's recommendations into the following categories:

- Health Index improvement
- Data availability improvements

5.1 Health Index Improvement

For select asset classes, a recommended Health Index formulation was used for BHI's ACA framework. The following set of recommendations target additional condition parameters that can be incorporated for specific asset classes to improve the Health Index formulation and provide BHI with additional data to refine its asset condition calculations. The recommendations are based on the "Ideal" ACA framework for assets and should not be interpreted as suggesting that immediate action is warranted. The following tables highlight the condition parameter name, a short description of the reasoning to include the condition parameter, and a priority of importance to include it into the specific asset's class HI framework. The priority is dependent on the condition parameter's weighting in comparison to the current HI framework condition parameter's weights.

1. Underground Cable

Table 5-1: Data Collection Recommendation for Underground Primary Cable

Criteria	Reasoning	Priority
Cable Failure	Identifying water tree samples throughout the service territory and varying age, the utility would be able to have an improved view on cable conditions within the system.	**High**
Condition of Concentric Neutral	Corrosion of concentric neutrals is another mode of degradation. Insulation degradation and cable failures can be accelerated if the cable jacket is damaged allowing moisture to enter into the insulation system. Concentric neutral corrosion is a major problem particularly on unjacketed cables or when the neutrals of the cable are exposed to excessive moisture over time. The corrosion can lead to premature cable failures and/or cause touch potential risks. Time Domain Reflectometry (TDR) tests are performed to determine the degree of corrosion on concentric neutral cables.	**Medium**
Loading History	Cable degradation can also occur due to overheating under overloading or short circuit conditions. Over stressing of insulation during voltage surges can also lead to cable failures.	**Low**

2. Underground Distribution Transformer

Table 5-2: Data Collection Recommendation for Underground Distribution Transformer

Criteria	Reasoning	Priority
IR Scan	To identify if the transformer is operating within normal temperature ranges – excess temperature would require further investigation.	**High**

3. Switchgear

Table 5-3: Data Collection Recommendation for Switchgear

Criteria	Reasoning	Priority
Visual Inspection – SF6 Leaks	SF6 leakage is an environmental hazard since SF6 has been designated a greenhouse gas by the EPA and can affect the organization financially. Identification of leaks over time provides degradation information of an asset.	**Medium**

4. Overhead Switch

Table 5-4: Data Collection Recommendation for Overhead Switch

Criteria	Reasoning	Priority
Visual Inspection – Condition of Insulators	The condition of the insulator helps assess the life expectancy of the switch which affects the operability of the switch. Identification of this condition parameter over time provides degradation information of an asset.	**Medium**

5. Recloser

Table 5-5: Data Collection Recommendation for Oil Insulated Recloser

Criteria	Reasoning	Priority
Visual Inspection – Condition of Oil	The criterion affects the performance of the recloser which is dependent on the oil's dielectric strength since it is the insulating medium. The identification of oil quality over time provides degradation information of an asset.	**High**
Visual Inspection - Condition of Tank	The damaged tank can cause oil leaks which is an environmental hazard and can and can affect the organization financially. Identification of this condition parameter over time provides degradation information of an asset.	**Medium**
Visual Inspection – Oil Leaks	Oil leaks are an environmental hazard and can and can affect the organization financially. Identification of this condition parameter over time provides degradation information of an asset.	**Medium**
Visual Inspection - Condition of Operating Mechanism	Defects in the operating mechanism affect the operability of recloser. Identification of this condition parameter over time provides degradation information of an asset.	**Low**

Table 5-6: Data Collection Recommendation for Vacuum Insulated Recloser

Criteria	Reasoning	Priority
Visual Inspection – Integrity of Vacuum Bottle	Damaged vacuum bottle would compromise the fundamental operability of the recloser Identification of this condition parameter over time provides degradation information of an asset.	**High**
Visual Inspection - Condition of Enclosure	Condition of enclosure affects the life expectancy of a recloser. The damaged enclosure can expose the recloser components to adverse weather conditions and animal intrusion. Identification of this condition parameter over time provides degradation information of an asset.	**Medium**
Visual Inspection - Condition of Operating Mechanism	Defects in the operating mechanism affect the operability of recloser. Identification of this condition parameter over time provides degradation information of an asset.	**Low**

6. Power Transformer

Table 5-7: Data Collection Recommendation for Power Transformer

Criteria	Reasoning	Priority
IR Scanning	To identify if the transformer is operating within normal temperature ranges – excess temperature would require further investigation.	**High**

7. Circuit Breaker

Table 5-8: Data Collection Recommendation for Circuit Breaker

Criteria	Reasoning	Priority
SF6 Gas Analysis	SF6 gas is the insulating medium for SF6 circuit breakers. SF6 gas analysis provides the information its dielectric strength which affects the operability of the device. The identification of gas quality provides degradation information of an asset.	**High**
Visual Inspection - Condition Bushing Insulators	The condition of the bushing helps assess the life expectancy of the circuit breaker since it affects the operability of the breaker. Identification of this condition parameter over time provides degradation information of an asset.	**Medium**
Visual Inspection - Condition of Operating Mechanism	Defects in the operating mechanism affect the operability of the circuit breaker. Identification of this condition parameter over time provides degradation information of an asset.	**Medium**
Timing/Travel tests	Timing/ Travel test provides information as to whether the breaker's operating mechanism is operating properly. Identification of operation use over time provides degradation information of an asset.	**Medium**
Visual Inspection – SF6 Leaks	SF6 leakage is an environmental hazard since SF6 has been designated a greenhouse gas by the EPA and can affect the organization financially. Identification of leaks over time provides degradation information of an asset.	**Medium**

8. Protection Relay

Table 5-9: Data Collection Recommendations for Protection Relay

Criteria	Reasoning	Priority
Visual Inspection	Criterion affects the life expectancy of a protection relay. The identification of a fuse condition provides degradation information of an asset.	**Medium**
Mean Time Between Failures	Objective asset tests with output results identify asset conditions over time.	**Medium**
Non-Discretionary / Discretionary Obsolescence	Criterion affects utility asset management related objectives.	**Medium**

5.2 Data availability improvements

Data availability is critical in being able to produce prudent, accurate and justified decision-making outputs. It represents the single most important element that can influence the degree to which the AM decision-making relies on objective factors. Companies understand that it is critical to execute continuous improvement procedures through an AM data lifecycle, such that data gaps and inaccuracies can be addressed and mitigated. In the case of this ACA study, each asset class included a breakdown of data available for each condition parameter collected. For condition parameters with data availability below 60%, METSCO recommends that BHI continue collecting the information related to these

data points to reach the 60% data availability threshold. An example of this is seen for concrete poles; the condition parameter "Rusting/Corrosion/Spalling" is collected but is only available for 35% of the asset population, thus being removed from the HI formulation.

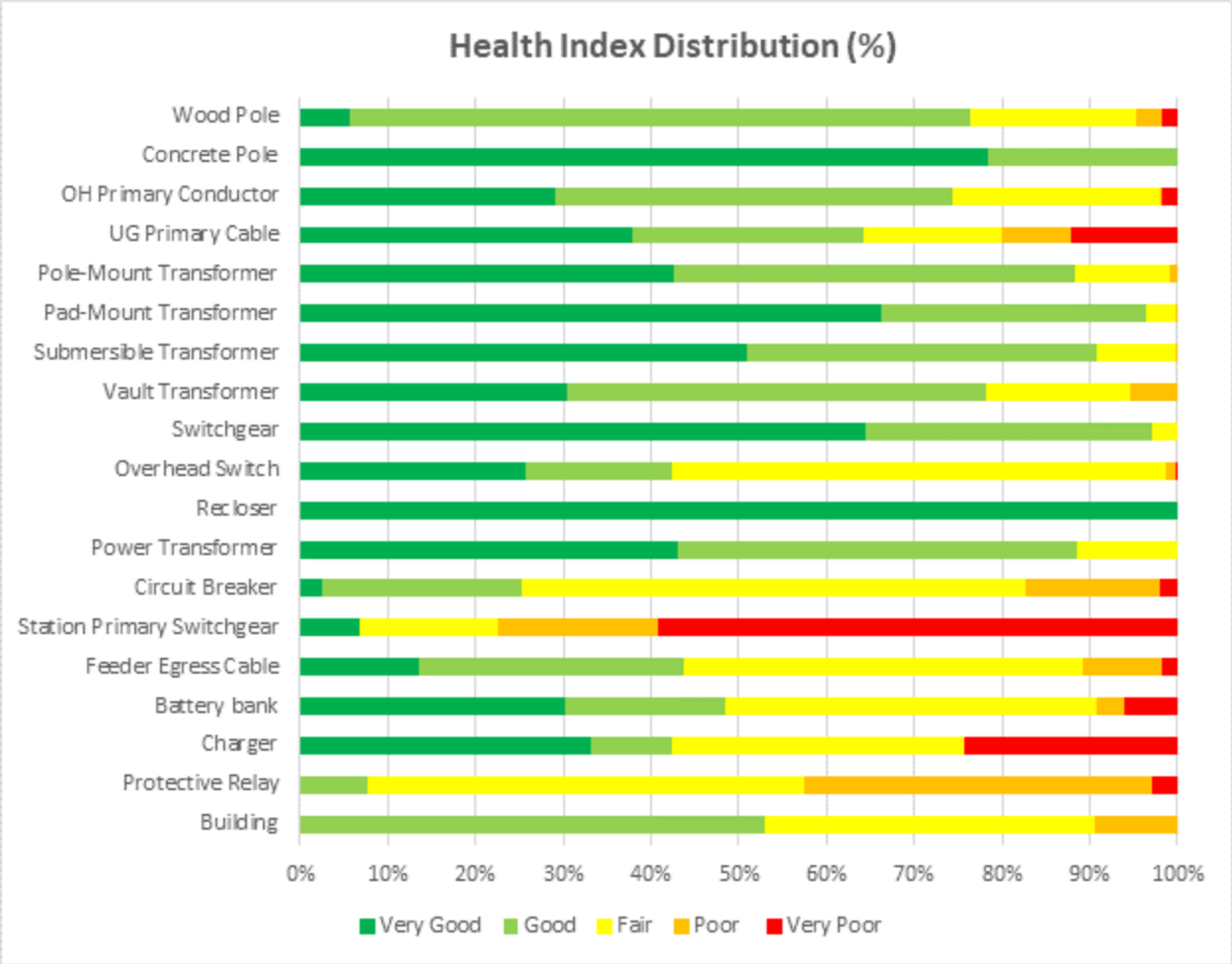
Additionally, for an asset to have a valid Health Index, it must meet a minimum 70% of available data across the condition parameters used in the HI formulation. As part of future improvement opportunities, it is recommended that BHI continue capturing asset data for condition parameters that are currently available for a small proportion of the asset population, such that valid Health Indices can be produced across the population. It is expected that with every passing year, the inspection record database will continue to grow, allowing for Health Indices to be calculated for the remaining population.

Lastly, METSCO noticed that some condition parameters recorded by BHI vary in the detail with respect to the grading scheme. Some parameters will have a three-tier grade (e.g. Good, Fair and Poor) and others may have five levels (e.g., from Very Good to Very Poor). METSCO recommends for BHI to evaluate options of changing some condition parameters recorded to a five-level grade, as doing so can provide more defined segregation between assets that need immediate attention and those that can still be in-service without intervention in the short-term.

6 Conclusion

As Figure 6-1 indicates, most assets across BHI's asset classes analyzed are in Fair condition or better, with a significant portion of asset populations in Good or Very Good condition. This can indicate BHI has taken steps in the past to manage their asset health and performance for the benefit of its customers. As with every system, however, there are areas that require BHI's attention in the coming years where asset populations contain material portions of equipment in or approaching Poor condition or worse.

Figure 6-1: Health Index Results



METSCO recommends that BHI continue to work on mitigating the existing data gaps, such that more degradation parameters can be assigned actual grades, thus expanding the sample size of valid HI and capturing all possible degradation of the evaluated assets. BHI's testing, inspection, and maintenance programs are well-positioned to continue to capture this information using processes and technologies in place at their facility.

This concludes METSCO's report on the condition assessment performed for BHI. We wish the utility's staff all the best as they continue their system planning work and preparation for their upcoming rate filing.

7 Appendix A – METSCO Company Profile

METSCO Energy Solutions Inc. is a Canadian corporation which started its operations on the market in 2006. METSCO is engaged in the business of providing consulting and project management services to electricity generating, transmission, and distribution companies, major industrial and commercial users of electricity, as well as municipalities and constructors on lighting services, asset management, and construction audits. Our head office is located in Toronto, ON and our western office is located in Calgary, AB. Through our network of associates, we provide consulting services to power sector clients around the world. A small subset of our major clients is shown in the figure below.

Figure 7-1: METSCO Clients

METSCO has been leading the industry in Asset Condition Assessment and Asset Management practices for over 10 years. Our founders are the pioneers of the first-ever Health Index methodology for power equipment in North America as well as the most robust high voltage risk-based analytics on the market today. METSCO has since completed hundreds of asset condition assessments, asset management plans, and asset management framework implementations. Our collective record of experience in these

areas is the largest in the world, with ours being the only practice with widespread acceptance across regulatory jurisdictions. METSCO has worked with over 100 different utilities through its tenure, and as such, has been exposed and introduced to practices and unique challenges from a variety of entities, environments, and geographies. When a client chooses METSCO to work on improving Asset Management practices, it is choosing the industry-leading standard, rigorously tested and refined on a continued basis. Our experts have developed, supported, managed, led and sat on stand defending their own DSPs as utility staff giving METSCO the qualified expertise to provide its service to BHI.

In addition to our work in the area of asset health assessments and lifecycle enhancement, our services span a broad common utility issue area, including planning and asset management, design, construction supervision, project management, commissioning, troubleshooting operating problems, investigating asset failures and providing training and technology transfer.

Our founders and leaders are pioneers in their respective fields. The fundamental electrical utility-grade engineering services we provide include:

- Power sector process engineering and improvement
- Fixed Asset Investment Planning – development of economic investment plans
- Regulatory Proceeding Support
- Power System Planning and Studies – identifying system constraints
- Smart Grid Development – from planning to implementation of leading technologies
- Asset Performance and Asset Management
- Distribution and Transmission System Design
- Mentoring, Training, and Technical Resource Development
- Health Index Validation and Development
- Business Case Development
- Owners Engineering Services
- Risk Modeling – Asset Lifecycle and Risk Assessment

8 Appendix B – Condition Parameters Grading Tables

1. Wood Pole

Table 8-1: Criteria for Service Age

Condition Rating	Corresponding Condition
A	0 to 10 years
B	11 to 30 years
C	31 to 40 years
D	41 to 55 years
E	Over 55 years

Table 8-2: Criteria for Remaining Strength

Condition Rating	Corresponding Condition
A	91% to 100%
B	81% to 90%
C	71% to 80%
D	61% to 70%
E	Less than 60%

Table 8-3: Criteria for Wood Rot

Condition Rating	Corresponding Condition
A	There is no wood rot or other damage to the pole and the pole is in like-new condition
B	Minor wood rot and/or minor damage to the pole, does not require corrective action. Minimal deterioration
C	There is significant wood rot and/or damage, requiring planned corrective action. Significant deterioration
D	There is major wood rot, and/or damage requiring immediate emergency repairs. Major deterioration
E	Wood rot or damage is beyond repair

Table 8-4: Criteria for Mechanical Defects

Condition Rating	Corresponding Condition
A	No signs of any defects on the wood pole due to cracking, insect infestation, vandalism, vehicular accidents, electrical burns, lightning, soil erosion.
B	Minor signs of defects on the wood pole due to cracking, insect infestation, vandalism, vehicular accidents, electrical burns, lightning, soil erosion
C	Significant signs of defects on the wood pole due to cracking, insect infestation, vandalism, vehicular accidents, electrical burns, lightning, soil erosion
D	Major signs of defects on the wood pole due to cracking, insect infestation, vandalism, vehicular accidents, electrical burns, lightning, soil erosion
E	Serious signs of defects on the wood pole due to cracking, insect infestation, vandalism, vehicular accidents, electrical burns, lightning, soil erosion

Table 8-5: Criteria for Out of Plumb

Condition Rating	Corresponding Condition
A	There is no displacement of footings from the original installed condition, and there is no disorientation, the pole is perfectly straight
B	There is minor pole disorientation, but is acceptable and does not require

	corrective action
C	There is significant displacement of footings and/or there is significant disorientation, requiring planned corrective action
D	Major displacement of footings and/or major disorientation of the pole in present requiring immediate emergency repairs
E	Serious displacement of footings and disorientation of the pole in present requiring immediate emergency repairs

2. Concrete Pole

Table 8-6: Criteria for Service Age

Condition Rating	Corresponding Condition
A	0 to 10 years
B	11 to 30 years
C	31 to 40 years
D	41 to 50 years
E	Over 50 years

Table 8-7: Criteria for Defects

Condition Rating	Component Condition
A	No signs of any defects on the concrete pole due to vandalism, vehicular accidents, electrical burns, or cracking
B	Signs of minor defects on the concrete pole due to vandalism, vehicular accidents, electrical burns, or cracking
C	Signs of significant defects on the concrete pole due to vandalism, vehicular accidents, electrical burns, or cracking
D	Signs of serious defects on the concrete pole due to vandalism, vehicular accidents, electrical burns, or cracking
E	Signs of very serious defects on the concrete pole due to vandalism, vehicular accidents, electrical burns, or cracking

Table 8-8: Criteria for Out of Plumb

Condition Rating	Component Condition
A	There is no displacement of footings from the original installed condition, and there is no disorientation, the pole is perfectly straight
B	There is minor pole disorientation, but is acceptable and does not require corrective action
C	There is significant displacement of footings and/or there is significant disorientation, requiring planned corrective action
D	Major displacement of footings and/or major disorientation of the pole in present requiring immediate emergency repairs
E	Serious displacement of footings and disorientation of the pole in present requiring immediate emergency repairs

3. Overhead Primary Conductor

Table 8-9: Criteria for Service Age

Condition Rating	Corresponding Condition
A	0 to 10 years
B	11 to 30 years
C	31 to 50 years
D	51 to 70 years
E	Over 70 years

Table 8-10: Criteria for Small Risk Conductor

Condition Rating	Corresponding Condition
A	Absence of small-sized conductors
E	Presence of small-sized conductors (#4 to #6 copper)

4. Underground Primary Cable

Table 8-11: Criteria for Service Age (TRXLPE Cables)

Condition Rating	Corresponding Condition
A	0 to 15 years
B	16 to 25 years
C	26 to 35 years
D	36 to 45 years
E	Over 45 years

Table 8-12: Criteria for Field Testing

Condition Rating	Corresponding Condition
A	No abnormalities detected; CableQ test: Good
C	Leakage Current; CableQ test: Fair
E	Failure of Hi-Pot test; CableQ test Poor

Table 8-13: Criteria for Historic Failure Rate

Condition Rating	Corresponding Condition
A	Less than 0.5 failure per 10 km in the last 5 years
B	0.5 to 1.0 failure per 10 km in the last 5 years
C	1.0 to 2.0 failures per 10 km in the last 5 years
D	2.0 to 4.0 failures per 10 km in the last 5 years
E	4.0 or more failures per 10 km in the last 5 years

5. Overhead/pole mount transformer

Table 8-14: Criteria for Service Age

Condition Rating	Corresponding Condition
A	0 to 10 years
B	11 to 20 years
C	21 to 30 years
D	31 to 40 years
E	Over 40 years

Table 8-15: Criteria for Peak Loading

Condition Rating	Component Condition
A	Peak load of less than 50% of its rating
B	Peak load of 50% to 75% of its rating
C	Peak load of 75% to 100% of its rating
D	Peak load of 100% to 125% of its rating
E	Peak load of greater than 125% of its rating

Table 8-16: Criteria for Visual Inspection

Condition Rating	Component Condition
A	No rust on tank/enclosure, no damage to bushings, no sign of oil leaks
B	Only one of the following defects: Minor rust, or minor cracks in bushings or minor oil leak
C	Two or more of the above-indicated defects present but do not impact the safe operation
D	Tank/radiator badly rusted or major damage to bushing or major oil leak
E	Two or more of the above-indicated defects

Table 8-17: IR Scan Results

Condition Rating	Component Condition
A	No hot spots detected
B	Noticeable hot spots detected, but they do not jeopardize the safe on-going operation.
C	Very Serious hot spots detected

6. Underground Transformer

Table 8-18: Criteria for Service Age

Condition Rating	Corresponding Condition
A	0 to 10 years
B	11 to 20 years
C	21 to 30 years
D	31 to 40 years
E	Over 40 years

Table 8-19: Criteria for Peak Loading

Condition Rating	Component Condition
A	Peak load of less than 50% of its rating
B	Peak load of 50% to 75% of its rating
C	Peak load of 75% to 100% of its rating
D	Peak load of 100% to 125% of its rating
E	Peak load of greater than 125% of its rating

Table 8-20: Criteria for Visual Inspection

Condition Rating	Component Condition
A	No rust on tank/enclosure, no damage to bushings, no sign of oil leaks, padlocks in good condition on pad-mounted transformers
B	Only one of the following defects: Minor rust, or minor cracks in bushings or minor oil leak
C	Two or more of the above-indicated defects present but do not impact the safe operation
D	Tank/radiator badly rusted or major damage to bushing or major oil leak
E	Two or more of the above-indicated defects

Table 8-21: Criteria for Condition of the Enclosure

Condition Rating	Component Condition
A	Good condition as new
B	Poor condition, remedial action required
C	Immediate replacement required

7. Switchgear

Table 8-22: Criteria for Service Age

Condition Rating	Corresponding Condition
A	0 to 10 years
B	11 to 20 years
C	21 to 30 years
D	31 to 40 years
E	Over 40 years

Table 8-23: Criteria for Condition of Enclosure

Condition Rating	Component Condition
A	No signs of rust on tank/enclosure, or damage on the enclosure due to corrosion, dirt/contamination, or vehicle accidents
B	Minor signs of rust on tank/enclosure, or damage on the enclosure due to corrosion, dirt/contamination, or vehicle accidents
C	Significant signs of rust on tank/enclosure, or damage on the enclosure due to corrosion, dirt/contamination, or vehicle accidents
D	Major signs of rust on tank/enclosure, or damage on the enclosure due to corrosion, dirt/contamination, or vehicle accidents
E	Serious signs of rust on tank/enclosure, or damage on the enclosure due to corrosion, dirt/contamination, or vehicle accidents

Table 8-24: Criteria for Condition of the Pad

Condition Rating	Component Condition
A	Good condition as new
C	Poor condition, remedial action required
E	Immediate replacement required

Table 8-25: Criteria for IR Scan Results

Condition Rating	Component Condition
A	No hot spots detected
C	Noticeable hot spots detected, but they do not jeopardize safe on-going operation.
E	Very Serious hot spots detected

8. Overhead Switch

Table 8-26: Criteria for Service Age

Condition Rating	Corresponding Condition
A	0 to 10 years
B	11 to 20 years
C	21 to 30 years
D	31 to 40 years
E	Over 40 years

Table 8-27: Criteria for Condition of Blades

Condition Rating	Component Condition
A	Blades are clean, free from corrosion, cracks, distortion, abrasion or obstruction. All fasteners are tight. No visible evidence of looseness, loss of adjustment, or excess bearing wear
B	Minor signs of wear with respect to the above-listed deficiencies
C	Significant signs of wear with respect to the above-listed deficiencies, but the deficiencies are not critical to the safe operation of the cutout
D	Blades are degraded requiring replacement during the next scheduled outage
E	Blades are damaged/degraded beyond repair, requiring immediate replacement

Table 8-28: Criteria for IR Scan Results

Condition Rating	Component Condition
A	No hot spots detected
C	Noticeable hot spots detected, but they do not jeopardize safe on-going operation.
E	Very Serious hot spots detected

9. Reclosers

Table 8-29: Criteria for Service Age

Condition Rating	Corresponding Condition
A	0 to 7 years
B	8 to 15 years
C	16 to 24 years
D	25 to 32 years
E	33 years or older

Table 8-30: Criteria for Condition of Termination

Condition Rating	Corresponding Condition
A	Terminations are tight, free from corrosion and show no sign of overheating.
B	Minor signs of wear with respect to the above characteristics
C	Significant signs of degradation with respect to the above characteristics, but they do not impact the safe operation of the switchgear
D	Major deficiencies with respect to the above-listed characteristics requiring repairs during the next scheduled outage
E	Major deficiencies with respect to the above-listed characteristics requiring immediate repairs or replacement

Table 8-31: Criteria for Counter Readings

Condition Rating	Corresponding Condition
A	Less than 10% of the maximum rated operation suggested by the manufacturer
B	More than 10% and up to 30% of the maximum rated operation suggested by the manufacturer
C	More than 30% and up to 50% of the maximum rated operation suggested by the manufacturer
D	More than 50% and up to 80% of the maximum rated operation suggested by the manufacturer
E	More than 80% of the maximum rated operation suggested by the manufacturer

10.Power Transformer

Table 8-32: Criteria for DGA Results

Gas Condition	Gas Generation Rate		
	Low	Low to High	High
Condition 1	A	A	B
Condition 2	B	B	C
Condition 3	C	C	D
Condition 4	D	D	E

Table 8-33: Criteria for Load History

Condition Rating	Corresponding Condition
A	LS ≥ 3.5
B	2.5 ≤ LS < 3.5
C	1.5 ≤ LS < 2.5
D	0.5 ≤ LS < 1.5
E	LS < 0.5

Table 8-34: Criteria for Insulation Power Factor

Condition Rating	Corresponding Condition
A	$PF_{MAX} < 0.5$
B	$0.5 \leq PF_{MAX} < 1$
C	$1 \leq PF_{MAX} < 1.5$
D	$1.5 \leq PF_{MAX} < 2$
E	$PF_{MAX} \geq 2$

Table 8-35: Criteria for Oil Quality Tests

Test	Station Transformer Voltage Class	Grade
	U ≤ 69 kV	
Acid Number	≤0.05	A
	0.05-0.20	C
	≥0.20	E
IFT [mN/m]	≥30	A
	25-30	C
	≤25	E
Dielectric Strength [kV]	>23 (1mm gap) >40 (2 mm gap)	A
	≤40	E
Water Content [ppm]	<35	A
	≥35	E

Table 8-36: Criteria for Service Age

Condition Rating	Corresponding Condition
A	Less than 20 years
B	20 to 40 years
C	40 to 60 years
D	More than 60 years
E	-

Table 8-37: Criteria for Visual Inspection field

Condition Rating	Corresponding Condition
A	Excellent condition / No defect / No leaks
B	Good condition with minor defect/ leaks
C	One of the above characteristics is unacceptable
D	Two or more of the characteristics are unacceptable
E	Unacceptable condition, requires immediate replacement

11. Circuit Breaker

Table 8-38: Criteria for Service Age

Condition Rating	Corresponding Condition
A	0-10 years
B	11-20 years
C	21-30 years
D	31-40 years
E	41+ years

Table 8-39: Criteria for Contact Resistance Test

Condition Rating	Corresponding Condition
A	The difference in contact resistance among phases is less than 1%
B	The difference in contact resistance among phases is between 1-3%
C	The difference in contact resistance among phases is between 3-5%
D	The difference in contact resistance among phases is between 5-10%
E	The difference in contact resistance among phases is more than 10%

Table 8-40: Criteria for Overall Condition

Condition Rating	Corresponding Condition
A	No rust on tank/radiator, no damage to bushings, no sign of oil leaks, forced air cooling fully functional
B	Only one of the following defects: Minor rust, or minor cracks in bushings or minor oil leaks
C	Two or more of the above-indicated defects present but do not impact the safe operation
D	Tank/radiator badly rusted or major damage to bushing or major oil leak
E	Two or more of the above-indicated defects of the cooling fans do not work

Table 8-41: Criteria for Insulation Resistance Test

Condition Rating	Corresponding Condition
A	Passed; Insulation Resistance is greater than 1,500 Megaohms
E	Failed; Insulation Resistance is less than 1,500 Megaohms

Table 8-42: Criteria for Counter readings

Condition Rating	Corresponding Condition
A	0-1000 operations
B	1000-3000 operations
C	3000-5000 operations
D	5000-10000 operations
E	10000+ operations

12. Station Primary Switchgear

Table 8-43: Criteria for Service Age

Condition Rating	Corresponding Condition
A	0 to 10 years
B	11 to 20 years
C	21 to 30 years
D	31 to 40 years
E	Over 40 years

Table 8-44: Criteria for Visual Inspection

Condition Rating	Component Condition
A	Conductor in excellent condition (As new)
B	Conductor in good condition
C	Minor defect visible on the switchgear
D	Major defect visible on the switchgear
E	Unacceptable condition, requires immediate replacement

13.Station Feeder Egress Cable

Table 8-45: Criteria for Service Age (TRXLPE Cables)

Condition Rating	Corresponding Condition
A	0 to 15 years
B	16 to 25 years
C	26 to 35 years
D	36 to 45 years
E	Over 45 years

Table 8-46: Criteria for Field Testing

Condition Rating	Corresponding Condition
A	No abnormalities detected; CableQ test: Good
C	Leakage Current; CableQ test: Fair
E	Failure of Hi-Pot test; CableQ test Poor

Table 8-47: Criteria for Historic Failure Rate

Condition Rating	Corresponding Condition
A	Less than 0.5 failure per 10 km in the last 5 years
B	0.5 to 1.0 failure per 10 km in the last 5 years
C	1.0 to 2.0 failures per 10 km in the last 5 years
D	2.0 to 4.0 failures per 10 km in the last 5 years
E	4.0 or more failures per 10 km in the last 5 years

Table 8-48: Criteria for Loading History

Condition Rating	Corresponding Condition
A	The cable has been consistently loaded below 50% of its continuous design rating. The cable has not been subjected to emergency loading
B	The cable has been consistently loaded to more than 50% and up to 70% of its continuous design rating. The cable has been subjected to emergency loading within recommended time-temperature limits
C	The cable has been consistently loaded to more than 70% and up to 90% of its continuous design rating. The cable has been subjected to emergency loading within recommended time-temperature limits
D	The cable has been consistently loaded to more than 90% and up to 100% of its continuous design rating or the cable has been subjected to emergency loading exceeding recommended time-temperature limits
E	The cable has been so consistently loaded above 100% of its continuous design rating or above recommended time-temperature limits that it has become damaged/degraded beyond repair

14.Station Battery Bank and Charger

Table 8-49: Criteria for Service Age

Condition Rating	Corresponding Condition
A	Less than 25% of the manufacturer recommended age
B	25 - 50% of the manufacturer recommended age
C	50 - 75% of the manufacturer recommended age
D	75 - 100% of the manufacturer recommended age
E	Age exceeds the manufacturer recommended age

Table 8-50: Criteria for Testing

Condition Rating	Corresponding Condition
A	Battery capable of storing full rated energy
C	Battery stores marginally less than full rated energy, but still adequate for required functions
E	Battery stores significantly less than the full rated energy, inadequate for required functions

15.Protective Relay

Table 8-51: Criteria for Service Age

Condition Rating	Corresponding Condition
A	In-service life to design life ratio of 0% to 20%
B	In-service life to design life ratio of 20% to 40%
C	In-service life to design life ratio of 40% to 80%
D	In-service life to design life ratio of 80% to 100%
E	In-service life to design life ratio of 100% or more

Table 8-52: Criteria for Testing

Condition Rating	Corresponding Condition
A	Calibrations have not been needed and functional test passed
B	Small adjustments in calibrations have been occasionally needed and functional test passed
C	Small adjustments in calibrations are regularly needed and functional test passed
D	Major calibration has been needed or a functional test failed
E	Equipment is so damaged or degraded that calibration is not possible.

16.Buildings

Table 8-53: Criteria for Roof Condition

Condition Rating	Corresponding Condition
A	Clean and free from signs of deterioration. Roof elements straight and level. Gutters and Spouts in good condition. No leaks are noticeable. Appears 'as new' or to have been well maintained.
B	Normal signs of wear with respect to the above characteristics.
C	One or two of the above characteristics are unacceptable. Minor maintenance suggested.
D	More than two of the above characteristics are unacceptable. Significant maintenance or repair is required.
E	More than two of the above characteristics are unacceptable and cannot be brought into an acceptable condition.

Table 8-54: Criteria for Wall Condition

Condition Rating	Corresponding Condition
A	Clean and free from signs of deterioration. Wall elements straight and level. Paint on surfaces clean and free from cracking, discoloration or flaking/peeling. Caulking, flashings and other seals in good condition. No wall cracks or other damage. Appears 'as new' or to have been well maintained.
B	Normal signs of wear with respect to the above characteristics.
C	One or two of the above characteristics are unacceptable. Minor maintenance suggested.
D	More than two of the above characteristics are unacceptable. Significant maintenance or repair is required.
E	More than two of the above characteristics are unacceptable and cannot be brought into an acceptable condition.

Table 8-55: Criteria for Doors/Windows/Louvres

Condition Rating	Corresponding Condition
A	Clean and free from signs of deterioration. No leaks are noticeable. Paint on surfaces clean and free from cracking, discoloration or flaking/peeling. Locks and mechanisms in good working condition. Appears 'as new' or to have been well maintained.
B	Normal signs of wear with respect to the above characteristics.
C	One or two of the above characteristics are unacceptable. Minor maintenance suggested.
D	More than two of the above characteristics are unacceptable. Significant maintenance or repair is required.
E	More than two of the above characteristics are unacceptable and cannot be brought into an acceptable condition.

Table 8-56: Criteria for Floors/Foundations

Condition Rating	Corresponding Condition
A	Clean and free from signs of deterioration. Floors are straight and level. Foundation is level and free from cracks and spalling. Caulking, flashings and other seals in good condition. No floor cracks or other damage. Appears 'as new' or to have been well maintained.
B	Normal signs of wear with respect to the above characteristics.
C	One or two of the above characteristics are unacceptable. Minor maintenance suggested.
D	More than two of the above characteristics are unacceptable. Significant maintenance or repair is required.
E	More than two of the above characteristics are unacceptable and cannot be brought into an acceptable condition.

Table 8-57: Criteria for Lighting/Power/HVAC

Condition Rating	Corresponding Condition
A	Clean and free from signs of deterioration. Lighting adequate and in good working condition. Electrical wiring and tables, AC and DC in good condition. HVAC in good working condition. Appears 'as new' or to have been well maintained.
B	Normal signs of wear with respect to the above characteristics.
C	One or two of the above characteristics are unacceptable. Minor maintenance suggested.
D	More than two of the above characteristics are unacceptable. Significant maintenance or repair is required.
E	More than two of the above characteristics are unacceptable and cannot be brought into an acceptable condition.

Table 8-58: Criteria for Overall Building

Condition Rating	Corresponding Condition
A	Clean and free from signs of deterioration. Structural elements are straight and level. Paint on surfaces clean and free from cracking, discoloration or flaking/peeling. Caulking, flashings and other seals in good condition. Appears 'as new' or to have been well maintained.
B	Normal signs of wear with respect to the above characteristics.
C	One or two of the above characteristics are unacceptable. Minor maintenance suggested.
D	More than two of the above characteristics are unacceptable. Significant maintenance or repair is required.
E	Buildings or structures damaged/degraded beyond repair.

Appendix – 4-Intervenor-93c)

Total Program Costs - 4.3 Summary **2025 FORECAST 4-Intervenor-93c)**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Accounting	$608,967	$590,452	$632,368	$661,220	$743,755	$772,794	$954,659	($18,515)	$293,440	$345,692	9.4%
Administration	$2,673,579	$2,843,300	$3,254,782	$3,072,430	$3,518,057	$3,654,714	$4,019,329	$169,721	$946,900	$1,345,750	8.5%
Billing	$1,006,045	$965,993	$1,102,876	$1,032,132	$990,968	$1,246,537	$1,300,134	($40,052)	$268,002	$294,089	5.3%
Communications	$366,481	$295,462	$299,039	$336,839	$376,639	$471,800	$487,426	($71,019)	$150,588	$120,945	5.9%
Control Room	$1,545,177	$1,566,262	$1,382,956	$1,164,429	$1,243,213	$1,461,639	$1,616,699	$21,084	$452,270	$71,522	0.9%
Customer Service	$1,392,341	$1,213,548	$1,269,623	$1,163,490	$1,365,178	$1,408,423	$1,461,991	($178,793)	$298,501	$69,650	1.0%
Distribution Maintenance and Operations	$3,878,894	$4,238,009	$4,145,072	$5,231,163	$5,140,114	$5,957,886	$6,174,882	$359,116	$943,719	$2,295,989	9.7%
Engineering	$1,998,406	$2,031,288	$2,296,522	$2,458,146	$2,237,625	$2,616,317	$3,352,738	$32,882	$894,592	$1,354,332	10.9%
Facilities	$463,385	$447,279	$431,790	$498,301	$523,538	$522,714	$596,324	($16,106)	$98,022	$132,939	5.2%
Fleet	$221,990	$242,583	$292,451	$206,498	$324,542	$201,311	$188,665	$20,593	($17,833)	($33,325)	-3.2%
Human Resources	$1,103,009	$1,092,865	$889,092	$1,079,348	$1,166,733	$1,322,131	$1,397,773	($10,143)	$318,426	$294,765	4.9%
Information Services	$1,456,883	$1,232,343	$1,495,353	$1,657,133	$1,814,501	$2,572,452	$3,087,916	($224,541)	$1,430,782	$1,631,032	16.2%
Metering	$1,097,647	$1,330,952	$1,116,890	$1,226,010	$1,096,931	$1,332,567	$1,287,051	$233,306	$61,041	$189,404	3.2%
Regulatory	$1,029,102	$907,947	$937,239	$952,660	$1,044,976	$1,133,412	$1,611,271	($121,155)	$658,611	$582,170	9.4%
Safety	$723,637	$607,355	$645,656	$716,013	$755,630	$812,334	$1,021,294	($116,282)	$305,281	$297,657	7.1%
Stations Maintenance and Operations	$1,486,628	$1,455,394	$1,363,737	$1,545,453	$1,421,304	$1,377,181	$1,505,154	($31,234)	($40,299)	$18,527	0.2%
Other - FTE Adj	($572,068)	$0	$0	$0	$0	$0	$0	$572,068	$0	$572,068	-100.0%
Miscellaneous	$77,673	$66,368	$70,738	$78,170	$70,950	$82,902	$94,007	($11,305)	$15,837	$16,334	3.9%
Total	**$20,557,775**	**$21,127,400**	**$21,626,185**	**$23,079,436**	**$23,834,655**	**$26,947,114**	**$30,157,314**	**$569,625**	**$7,077,878**	**$9,599,539**	**8.0%**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$560,352	$566,900	$591,743	$642,693	$646,732	$708,769	$871,005	$6,547	$228,312	$310,653	9.2%
Bad Debt Expense	$25,000	$3,449	$25,000	$6,343	$79,925	$50,000	$50,000	($21,551)	$43,657	$25,000	14.9%
Accounting - All Other	$23,615	$20,103	$15,624	$12,183	$17,098	$14,025	$33,654	($3,512)	$21,471	$10,039	7.3%
Total	**$608,967**	**$590,452**	**$632,368**	**$661,220**	**$743,755**	**$772,794**	**$954,659**	**($18,515)**	**$293,440**	**$345,692**	**9.4%**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$1,292,740	$1,466,043	$1,648,130	$1,379,258	$1,542,256	$1,652,754	$1,711,266	$173,303	$332,008	$418,526	5.8%
Incentive Pay	$765,444	$766,954	$961,620	$978,092	$1,238,129	$1,090,083	$1,256,983	$1,510	$278,892	$491,539	10.4%
Insurance	$170,000	$138,599	$169,439	$200,893	$197,698	$285,565	$326,050	($31,401)	$125,157	$156,050	13.9%
Director Remuneration	$129,756	$107,269	$120,857	$118,482	$145,910	$145,999	$148,563	($22,487)	$30,081	$18,807	2.7%
Memberships and Dues	$86,300	$85,589	$87,807	$90,443	$96,473	$97,658	$98,600	($711)	$8,157	$12,300	2.7%
Professional Fees	$116,300	$173,560	$122,648	$112,532	$103,970	$167,681	$270,029	$57,260	$157,498	$153,729	18.3%
Bank Fees	$48,000	$43,752	$45,685	$45,265	$50,025	$47,992	$48,472	($4,248)	$3,208	$472	0.2%
Administration - All Other	$65,039	$61,534	$98,598	$147,467	$143,595	$166,981	$159,366	($3,505)	$11,899	$94,327	19.6%
Total	**$2,673,579**	**$2,843,300**	**$3,254,782**	**$3,072,430**	**$3,518,057**	**$3,654,714**	**$4,019,329**	**$169,721**	**$946,900**	**$1,345,750**	8.5%

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$318,959	$419,409	$445,480	$475,377	$429,006	$446,896	$607,257	$100,450	$131,880	$288,298	13.7%
Postage	$503,364	$410,705	$489,445	$373,753	$396,691	$596,906	$509,060	($92,659)	$135,307	$5,696	0.2%
Mail Service Contract - Billing	$118,800	$87,074	$111,661	$106,114	$87,033	$122,170	$103,020	($31,726)	($3,094)	($15,780)	-2.8%
Stationery	$35,000	$35,000	$34,000	$47,287	$54,241	$54,000	$54,540	$0	$7,253	$19,540	9.3%
Billing - All Other	$29,922	$13,805	$22,291	$29,601	$23,997	$26,566	$26,257	($16,117)	($3,344)	($3,665)	-2.6%
Total	**$1,006,045**	**$965,993**	**$1,102,876**	**$1,032,132**	**$990,968**	**$1,246,537**	**$1,300,134**	**($40,052)**	**$268,002**	**$294,089**	**5.3%**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$193,220	$192,871	$195,959	$236,794	$249,960	$304,807	$300,248	($349)	$63,454	$107,028	9.2%
Customer Communications	$77,404	$42,581	$44,664	$48,891	$48,475	$49,325	$46,738	($34,823)	($2,153)	($30,666)	-9.6%
BHI Website	$32,004	$25,147	$37,915	$22,372	$31,346	$39,390	$39,784	($6,857)	$17,412	$7,780	4.4%
Communications - All Other	$63,853	$34,863	$20,501	$28,782	$46,859	$78,279	$100,656	($28,990)	$71,875	$36,803	9.5%
Total	**$366,481**	**$295,462**	**$299,039**	**$336,839**	**$376,639**	**$471,800**	**$487,426**	**($71,019)**	**$150,588**	**$120,945**	**5.9%**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$1,248,135	$1,224,111	$1,095,285	$950,893	$1,012,451	$1,224,909	$1,370,090	($24,024)	$419,198	$121,955	1.9%
Overtime	$197,135	$311,396	$270,885	$191,011	$207,610	$206,040	$208,100	$114,261	$17,089	$10,965	1.1%
Maintenance	$31,000	$3,923	$0	$307	$1,500	$4,949	$4,998	($27,077)	$4,691	($26,002)	-30.6%
Bell Canada Line Rental	$35,664	$8,820	$0	$0	$0	$0	$0	($26,844)	$0	($35,664)	-100.0%
Tower Rental	$12,046	$12,360	$5,501	$5,400	$5,400	$12,120	$12,241	$314	$6,841	$195	0.3%
Control Room - All Other	$21,197	$5,652	$11,284	$16,818	$16,252	$13,620	$21,269	($15,545)	$4,451	$72	0.1%
Total	**$1,545,177**	**$1,566,262**	**$1,382,956**	**$1,164,429**	**$1,243,213**	**$1,461,639**	**$1,616,699**	**$21,084**	**$452,270**	**$71,522**	**0.9%**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$658,413	$655,861	$679,979	$682,115	$701,109	$764,786	$798,591	($2,551)	$116,476	$140,178	3.9%
Bad Debt Expense	$200,000	$58,023	$182,595	$108,870	$200,451	$150,000	$150,000	($141,977)	$41,130	($50,000)	-5.6%
Collections	$280,836	$245,157	$225,708	$242,747	$250,476	$224,599	$229,900	($35,679)	($12,847)	($50,936)	-3.9%
Credit Checks/Insurance/Risk Monitoring	$76,272	$91,547	$18,723	$19,317	$20,778	$94,300	$94,800	$15,275	$75,483	$18,528	4.4%
Lockbox	$26,796	$23,414	$21,179	($886)	$0	$0	$0	($3,382)	$886	($26,796)	-100.0%
Interactive Voice Response	$44,820	$72,031	$80,589	$70,821	$89,399	$96,000	$102,000	$27,211	$31,179	$57,180	17.9%
Telephone Answering Service	$30,525	$33,991	$27,167	$23,382	$30,415	$28,800	$30,000	$3,466	$6,618	($525)	-0.3%
Customer Service - All Other	$74,679	$33,524	$33,683	$17,124	$72,551	$49,937	$56,700	($41,155)	$39,576	($17,979)	-5.4%
Total	**$1,392,341**	**$1,213,548**	**$1,269,623**	**$1,163,490**	**$1,365,178**	**$1,408,423**	**$1,461,991**	**($178,793)**	**$298,501**	**$69,650**	**1.0%**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$1,272,753	$1,890,638	$1,558,041	$2,114,768	$2,040,531	$2,497,651	$2,437,734	$617,885	$322,965	$1,164,981	13.9%
Overtime	$456,438	$573,028	$671,496	$638,416	$568,885	$606,000	$612,060	$116,590	($26,356)	$155,622	6.0%
Contracted Labour	$152,000	$279,188	$178,000	$260,768	$418,753	$415,635	$419,791	$127,188	$159,023	$267,791	22.5%
Equipment Maintenance/Repairs	$65,928	$56,040	$58,967	$78,767	$80,141	$103,700	$104,737	($9,888)	$25,970	$38,809	9.7%
Materials - Distribution Mtce and Ops	$394,489	$264,653	$322,546	$285,537	$309,493	$288,275	$324,042	($129,836)	$38,506	($70,447)	-3.9%
Locates	$387,000	$389,799	$409,406	$408,675	$464,437	$551,118	$567,210	$2,799	$158,535	$180,210	7.9%
Vegetation Management	$768,502	$445,140	$630,791	$1,049,846	$820,832	$1,195,007	$1,400,724	($323,362)	$350,877	$632,222	12.8%
Distribution Assets Inspection	$150,000	$187,247	$99,629	$132,459	($67)	$0	$0	$37,247	($132,459)	($150,000)	-100.0%
Insulator Washing	$45,600	$43,541	$44,559	$38,357	$49,722	$38,000	$38,380	($2,060)	$23	($7,220)	-3.4%
Switch Cubicle Cleaning	$32,564	$32,180	$22,946	$42,457	$23,840	$26,260	$26,523	($384)	($15,934)	($6,041)	-4.0%
Scada-Mate Switch Maintenance	$0	$0	$0	$0	$175,748	$72,210	$72,422	$0	$72,422	$72,422	n/a
Transformer Oil Cleanup/Disposal	$6,737	($63,486)	($12,876)	$13,909	$6,442	$7,613	$7,689	($70,223)	($6,219)	$952	2.7%
Feeder Rental	$24,403	$24,790	$24,000	$44,332	$27,771	$24,507	$24,752	$387	($19,580)	$349	0.3%
Easements	$28,800	$32,212	$60,282	$30,210	$38,341	$51,599	$52,115	$3,412	$21,905	$23,315	12.6%
Tools and Clothing	$51,555	$39,693	$39,383	$56,713	$42,202	$49,743	$50,240	($11,862)	($6,473)	($1,315)	-0.5%
Distribution Mtce and Ops - All Other	$42,124	$43,346	$37,903	$35,949	$73,042	$30,567	$36,464	$1,222	$515	($5,660)	-2.8%
Total	**$3,878,894**	**$4,238,009**	**$4,145,072**	**$5,231,163**	**$5,140,114**	**$5,957,886**	**$6,174,882**	**$359,116**	**$943,719**	**$2,295,989**	**9.7%**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$2,304,484	$2,238,740	$2,322,921	$2,670,017	$2,780,008	$2,535,590	$3,697,700	($65,744)	$1,027,684	$1,393,217	9.9%
Consultants	$115,000	$125,609	$144,222	$151,242	$182,034	$163,418	$165,052	$10,609	$13,810	$50,052	7.5%
Computer Software	$61,823	$18,238	$34,598	$48,465	$46,904	$76,593	$0	($43,585)	($48,465)	($61,823)	-100.0%
Design and Estimates	$24,830	$3,643	$1,008	$0	$0	$0	$0	($21,187)	$0	($24,830)	-100.0%
GIS/OMS Licensing and Support	$214,000	$239,044	$203,431	$263,728	$215,342	$220,975	$0	$25,044	($263,728)	($214,000)	-100.0%
Pole/Cable Testing	$134,000	$53,853	$156,688	$46,029	$180,478	$171,701	$173,417	($80,147)	$127,388	$39,417	5.3%
Distribution Assets Inspection	$0	$0	$0	$0	$179,744	$202,000	$204,020	$0	$204,020	$204,020	n/a
Memberships and Dues	$41,000	$47,446	$48,056	$60,818	$41,313	$44,837	$45,285	$6,446	($15,533)	$4,285	2.0%
Prints and Supplies	$25,437	$10,074	$13,852	$10,955	$8,382	$10,768	$10,768	($15,363)	($187)	($14,669)	-15.8%
Engineering - All Other	$92,985	$52,284	$76,299	$73,716	$38,924	$65,934	$78,735	($40,701)	$5,019	($14,250)	-3.3%
Allocated to Capital/Billable	($1,015,153)	($757,643)	($704,553)	($866,824)	($1,435,505)	($875,499)	($1,022,239)	$257,510	($155,416)	($7,087)	0.1%
Total	**$1,998,406**	**$2,031,288**	**$2,296,522**	**$2,458,146**	**$2,237,625**	**$2,616,317**	**$3,352,738**	**$32,882**	**$894,592**	**$1,354,332**	**10.9%**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Facilities - Office Building Maintenance	$300,886	$274,891	$279,108	$317,298	$344,744	$336,933	$387,662	($25,995)	$70,364	$86,776	5.2%
Facilities - Service Centre and Stores	$623,009	$590,951	$623,093	$626,359	$863,862	$717,492	$774,077	($32,058)	$147,718	$151,068	4.4%
Total before Allocation	**$923,895**	**$865,842**	**$902,201**	**$943,657**	**$1,208,606**	**$1,054,425**	**$1,161,739**	**($58,053)**	**$218,082**	**$237,844**	**4.7%**
Burden Allocated to Materials	($460,510)	($418,563)	($470,411)	($445,356)	($685,068)	($531,711)	($565,415)	$41,947	($120,059)	($104,905)	4.2%
Total	**$463,385**	**$447,279**	**$431,790**	**$498,301**	**$523,538**	**$522,714**	**$596,324**	**($16,106)**	**$98,022**	**$132,939**	**5.2%**

Fleet **2025 FORECAST 4-Intervenor-93c)**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$30,338	$0	$0	$4,066	$0	$25,283	$38,745	($30,338)	$34,679	$8,407	4.2%
Vehicle Operations and Maintenance	$482,058	$482,322	$568,638	$496,376	$660,430	$482,567	$482,567	$264	($13,809)	$509	0.0%
Vehicles - All Other	$11,947	$38,584	$22,036	$41,050	$21,633	$28,461	$28,460	$26,637	($12,590)	$16,513	15.6%
Total before Allocation to Capital/Billable	**$524,343**	**$520,906**	**$590,674**	**$541,493**	**$682,064**	**$536,311**	**$549,772**	($3,438)	$8,279	$25,429	0.8%
Allocated to Capital/Billable	($302,353)	($278,323)	($298,222)	($334,994)	($357,521)	($335,000)	($361,107)	$24,030	($26,113)	($58,754)	3.0%
Total	**$221,990**	**$242,583**	**$292,451**	**$206,498**	**$324,542**	**$201,311**	**$188,665**	**$20,593**	**($17,833)**	**($33,325)**	**-2.7%**

Human Resources **2025 FORECAST 4-Intervenor-93c)**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$497,821	$487,708	$484,097	$518,784	$592,496	$641,153	$785,814	($10,114)	$267,030	$287,993	9.6%
Union Expenses	$28,000	$31,730	$3,024	$4,609	$44,421	$5,000	$6,144	$3,730	$1,535	($21,856)	-26.2%
Retiree Benefits and Group Insurance	$345,505	$347,613	$151,372	$303,134	$292,946	$338,620	$326,801	$2,108	$23,667	($18,704)	-1.1%
Consultants	$70,000	$57,986	$71,604	$73,498	$52,647	$81,000	$71,700	($12,014)	($1,798)	$1,700	0.5%
Professional Fees	$31,200	$38,148	$36,104	$43,389	$92,681	$107,350	$57,540	$6,948	$14,152	$26,340	13.0%
Payroll Software	$27,978	$31,987	$32,121	$38,688	$27,513	$37,200	$37,572	$4,009	($1,116)	$9,594	6.1%
Advertising	$12,000	$20,733	$14,690	$15,243	$21,210	$15,500	$15,600	$8,733	$357	$3,600	5.4%
Health and Wellness	$15,000	$585	$300	$2,168	$854	$11,800	$11,796	($14,415)	$9,628	($3,204)	-4.7%
Human Resources - All Other	$75,504	$76,376	$95,779	$79,836	$41,964	$84,508	$84,806	$872	$4,970	$9,302	2.4%
Total	**$1,103,009**	**$1,092,865**	**$889,092**	**$1,079,348**	**$1,166,733**	**$1,322,131**	**$1,397,773**	**($10,143)**	**$318,426**	**$294,765**	**4.9%**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$700,794	$661,748	$688,948	$661,274	$910,712	$1,282,434	$1,277,814	($39,047)	$616,540	$577,020	12.8%
Software Licensing, Support and Maintenance	$261,764	$173,664	$216,350	$281,943	$303,657	$658,260	$901,494	($88,100)	$619,551	$639,730	28.1%
Hardware Maintenance and Support	$63,352	$26,574	$35,805	$41,866	$31,897	$37,250	$41,350	($36,778)	($516)	($22,003)	-8.2%
Technology Managed Services	$90,000	$92,430	$133,166	$156,273	$124,357	$145,000	$150,500	$2,430	($5,773)	$60,500	10.8%
Hosting Services	$130,000	$128,471	$141,134	$153,606	$144,044	($41,000)	$205,000	($1,529)	$51,394	$75,000	9.5%
Technology Consulting Services	$60,000	$68,072	$192,151	$253,742	$155,643	$225,439	$239,000	$8,072	($14,742)	$179,000	31.8%
Business Continuity & Disaster Recovery	$61,800	$5,596	$2,524	$29,546	$61,420	$67,000	$72,000	($56,204)	$42,454	$10,200	3.1%
Telecommunication Services	$44,473	$55,337	$46,314	$42,123	$39,672	$45,000	$45,450	$10,864	$3,327	$977	0.4%
Subscriptions	$0	($925)	$0	$5,385	$0	$93,000	$93,000	($925)	$87,615	$93,000	n/a
Information Services - All Other	$44,700	$21,376	$38,961	$31,376	$43,099	$60,068	$62,308	($23,324)	$30,932	$17,608	6.9%
Total	**$1,456,883**	**$1,232,343**	**$1,495,353**	**$1,657,133**	**$1,814,501**	**$2,572,452**	**$3,087,916**	**($224,541)**	**$1,430,782**	**$1,631,032**	**16.2%**

Metering **2025 FORECAST 4-Intervenor-93c)**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$407,818	$646,718	$521,915	$663,661	$518,872	$685,374	$644,764	$238,900	($18,897)	$236,946	9.6%
Contracted Labour	$26,100	$30,442	$10,969	$11,889	$15,574	$52,344	$60,347	$4,342	$48,458	$34,247	18.3%
AMI Operations	$283,672	$247,400	$247,915	$250,952	$252,487	$255,200	$257,752	($36,272)	$6,800	($25,920)	-1.9%
Computer Software - MV90/Maintenance	$135,132	$113,213	$96,647	$113,259	$133,760	$101,011	$79,716	($21,919)	($33,543)	($55,416)	-10.0%
Wholesale Settlement	$145,855	$123,450	$123,783	$123,216	$124,882	$172,830	$176,725	($22,405)	$53,509	$30,870	3.9%
Communications	$36,204	$23,996	$20,841	$9,777	$7,473	$11,126	$8,667	($12,208)	($1,110)	($27,537)	-24.9%
Web Presentment	$14,250	$11,175	$20,000	$14,997	$0	$0	$0	($3,075)	($14,997)	($14,250)	-100.0%
Metering - All Other	$48,616	$134,558	$74,821	$38,260	$43,884	$54,682	$59,080	$85,942	$20,820	$10,464	4.0%
Total	**$1,097,647**	**$1,330,952**	**$1,116,890**	**$1,226,010**	**$1,096,931**	**$1,332,567**	**$1,287,051**	**$233,306**	**$61,041**	**$189,404**	**3.2%**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$458,077	$443,522	$409,280	$401,142	$443,438	$492,901	$799,824	($14,555)	$398,683	$341,748	11.8%
OEB Regulatory Costs	$308,300	$262,091	$315,516	$344,839	$403,739	$431,838	$496,887	($46,209)	$152,048	$188,587	10.0%
Rate Rebasing Costs	$169,769	$134,040	$134,040	$134,040	$134,040	$134,040	$189,784	($35,729)	$55,744	$20,015	2.3%
IRM Filing Costs	$9,500	$0	$4,199	$11,706	$0	$1,869	$10,000	($9,500)	($1,706)	$500	1.0%
Leap Funding	$47,000	$47,000	$47,000	$47,000	$47,000	$47,000	$65,000	$0	$18,000	$18,000	6.7%
Regulatory - All Other	$36,456	$21,294	$27,204	$13,933	$16,760	$25,765	$49,776	($15,162)	$35,843	$13,320	6.4%
Total	**$1,029,102**	**$907,947**	**$937,239**	**$952,660**	**$1,044,976**	**$1,133,412**	**$1,611,271**	**($121,155)**	**$658,611**	**$582,170**	**9.4%**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$424,813	$408,506	$444,644	$478,138	$502,462	$523,265	$676,479	($16,307)	$198,341	$251,666	9.8%
Consultants	$35,000	$5,280	$11,276	$11,600	$8,858	$6,000	$6,060	($29,720)	($5,540)	($28,940)	-29.6%
Training - Safety/Apprenticeships/Other	$131,000	$104,289	$130,115	$162,343	$156,041	$197,499	$222,525	($26,711)	$60,182	$91,525	11.2%
Safety Incentives Program	$35,000	$22,608	$3,907	$18,064	$18,923	$11,000	$11,200	($12,392)	($6,864)	($23,800)	-20.4%
H&S Excellence (Paths to Zero)	$35,000	$16,650	$4,995	$10,561	$11,043	$12,000	$12,500	($18,350)	$1,939	($22,500)	-18.6%
HSEMS Technology Solution	$0	$0	$11,041	$10,743	$10,443	$12,000	$13,000	$0	$2,257	$13,000	n/a
Public Safety Campaign	$35,000	$14,800	$21,050	$14,392	$23,911	$21,000	$21,300	($20,200)	$6,908	($13,700)	-9.5%
Safety - All Other	$27,824	$35,222	$18,628	$10,173	$23,950	$29,570	$58,230	$7,398	$48,057	$30,406	15.9%
Total	**$723,637**	**$607,355**	**$645,656**	**$716,013**	**$755,630**	**$812,334**	**$1,021,294**	**($116,282)**	**$305,281**	**$297,657**	**7.1%**

Stations Maintenance and Operations **2025 FORECAST 4-Intervenor-93c)**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Salaries and Benefits	$902,187	$879,283	$821,087	$953,921	$838,505	$725,080	$833,700	($22,904)	($120,221)	($68,487)	-1.6%
Materials - Station Mtce/Ops	$73,260	$61,185	$71,712	$89,886	$53,080	$102,180	$115,238	($12,075)	$25,352	$41,978	9.5%
Building Operations and Maintenance	$125,510	$111,997	$97,059	$105,680	$119,960	$122,475	$123,427	($13,513)	$17,747	($2,083)	-0.3%
Insurance	$48,300	$71,964	$74,964	$81,974	$88,985	$83,695	$84,532	$23,664	$2,557	$36,232	11.8%
Telephone/Utilities	$98,440	$90,426	$89,378	$90,949	$96,656	$91,910	$92,784	($8,014)	$1,834	($5,656)	-1.2%
Leases/Rent	$29,077	$26,479	$28,458	$27,476	$35,408	$43,596	$43,863	($2,598)	$16,387	$14,786	8.6%
Oil Tests	$18,531	$33,985	$29,088	$35,222	$34,261	$36,360	$36,724	$15,454	$1,502	$18,192	14.7%
Software Maintenance	$161,050	$132,033	$125,064	$125,161	$127,095	$141,602	$143,018	($29,017)	$17,857	($18,032)	-2.3%
Station Mtce/Ops - All Other	$30,273	$48,042	$26,926	$35,184	$27,352	$30,282	$31,869	$17,769	($3,315)	$1,596	1.0%
Total	**$1,486,628**	**$1,455,394**	**$1,363,737**	**$1,545,453**	**$1,421,304**	**$1,377,181**	**$1,505,154**	**($31,234)**	**($40,299)**	**$18,527**	**0.2%**

Description	2021 CoS	2021 Actuals	2022 Actuals	2023 Actuals	2024 Actuals	2025 Bridge Year	2026 Test Year	2021 Actuals vs. 2021 CoS Incr/(Decr) $	2026 vs. 2023 Actuals Incr/(Decr) $	2026 vs. 2021 CoS Incr/(Decr) $	2026 vs. 2021 CoS CAGR
Miscellaneous	$77,673	$66,368	$70,738	$78,170	$70,950	$82,902	$94,007	($11,305)	$15,837	$16,334	3.9%
Total	**$77,673**	**$66,368**	**$70,738**	**$78,170**	**$70,950**	**$82,902**	**$94,007**	**($11,305)**	**$15,837**	**$16,334**	**3.9%**