Exhibit 2:

RATE BASE

Exhibit 2: Rate Base

Tab 1 (of 4): Overview

RATE BASE

Appendix 2-BA has been completed and is based on capital in-service additions. Any variance analysis is based on capital additions in service in any year.

Kingston Hydro's opening and closing balances of gross fixed assets and accumulated depreciation for each year are outlined in Appendix 2-BA. Appendix 2-BA includes 2016-2021 actuals, an estimate of the bridge year 2022 as well as the 2023 test year.

The rate base has been calculated in accordance with the Ontario Energy Board's *Filing Requirements For Electricity Distribution Rate Applications - 2022 Edition for 2023 Rate Applications – Chapter 2 Cost of Service.*

Kingston Hydro's rate base has increased from the 2020 Board Approved of $61.1 million to the 2023 Test Year of $65.9 million. This three year increase is $4.8 million or averaging 2.6% per year from 2020 to 2023.

The increase is primarily because Kingston Hydro has and will continue to upgrade and replace ageing infrastructure and these capital additions are generally more than annual depreciation expense which is based on historic costs.

Table 1 illustrates the calculation of rate base for 2016 and 2020 Board Approved Years, and the 2023 Test Year as per Section 2.2.1 of the filing requirements.

1 **Table 1 – Rate Base**

Line No.	Rate Base Particulars	OEB Approved 2016	OEB Approved 2020	Test Year 2023
1	Gross Fixed Assets (average)	$73,879,610	$89,857,745	$79,352,818
2	Accumulated Depreciation (average)	($27,854,707)	($36,120,255)	($19,501,678)
3	Net Fixed Assets (average)	$46,024,903	$53,737,490	$59,851,140
4	Allowance for Working Capital	$7,418,704	$7,324,995	$6,098,321
5	**Total Rate Base**	$53,443,607	$61,062,485	$65,949,461

2

Exhibit 2: Rate Base

Tab 2 (of 4): Net Fixed Assets

FIXED ASSET CONTINUITY SCHEDULE

Appendix 2-BA contains the fixed asset continuity schedule.

The Fixed Asset Continuity Summary is included in Exhibit 2, Tab 2, Schedule 1, Attachment 1.

Kingston Hydro's capital additions in each year do not include any capitalized interest nor do they include any capitalized overhead.

For a detailed breakdown of material projects refer to Appendix 2-AA and DSP Section 5.4 of Exhibit 2, Tab 4, Schedule 1, Attachment 1.

NET CAPITAL ASSET VARIANCE ANALYSIS

2016 OEB Approved vs. 2023 Test Year

Kingston Hydro's requested Net Capital Assets for the 2023 test year is $60.2 million, which represents an increase of $12.4 million or 26 percent from the Net Capital Assets amount of $47.8 million approved by the OEB in 2016. This equates to an average of 3.7% per year.

2020 OEB Approved vs. 2023 Test Year

Kingston Hydro's requested Net Capital Assets for the 2023 test year is $60.2 million, which represents an increase of $5.6 million or 10 percent from the Net

Capital Assets amount of $54.6 million approved by the OEB in 2020. This equates to an average of 3.4 % per year.

2016 OEB Approved vs. 2016 Actuals

Kingston Hydro's actual Net Capital Assets including contributions was $0.4 million less than the 2016 approved Net Capital Assets.

See Section 5.4.1 Capital Expenditure Summary of the Distribution System plan for details of the gross capital asset additions for 2016.

Table 1 - Fixed Asset Continuity Schedule:

Description	2016 OEB - Approved MIFRS	2016 Historical MIFRS
Gross Assets	79,416,208	55,980,235
Accumulated Depreciation	(29,250,926)	(5,430,491)
Capital Contributions + Deferred Revenue	(2,848,475)	(3,242,246)
Accumulated Amortization of Capital Contributions	486,861	143,277
NBV - Fixed Assets	**47,803,668**	**47,450,775**

2016 Actual vs. 2017 Actual

Kingston Hydro's Net Capital Assets increased by $1.3 million from 2016 to 2017.

See Section 5.4.1 Capital Expenditure Summary of the Distribution System plan for details of the gross capital asset additions for 2017.

Table 2 - Fixed Asset Continuity Schedule:

Description	2016 Historical MIFRS	2017 Historical MIFRS
Gross Assets	55,980,235	63,943,533
Accumulated Depreciation	(5,430,491)	(7,567,500)
Capital Contributions + Deferred Revenue	(3,242,246)	(7,984,762)
Accumulated Amortization of Capital Contributions	143,277	389,918
NBV - Fixed Assets	**47,450,775**	**48,781,189**

Table 3 – Historical Fixed Assets in Rate Base:

Description	2017 Historical MIFRS
Gross Assets	59,961,884
Accumulated Depreciation	(6,498,996)
Capital Contributions + Deferred Revenue	(5,613,504)
Accumulated Amortization of Capital Contributions	266,598
NBV - Rate Base (average)	**48,115,982**

2017 Actual vs. 2018 Actual

Kingston Hydro's Net Capital Assets increased by $3.0 million from 2017 to 2018.

See Section 5.4.1 Capital Expenditure Summary of the Distribution System plan for details of the gross capital asset additions for 2018.

Table 4 - Fixed Asset Continuity Schedule:

Description	2017 Historical MIFRS	2018 Historical MIFRS
Gross Assets	63,943,533	69,232,592
Accumulated Depreciation	(7,567,500)	(9,821,353)
Capital Contributions + Deferred Revenue	(7,984,762)	(8,236,531)
Accumulated Amortization of Capital Contributions	389,918	577,659
NBV - Fixed Assets	**48,781,189**	**51,752,367**

Table 5 – Historical Fixed Assets in Rate Base:

Description	2018 Historical MIFRS
Gross Assets	66,588,063
Accumulated Depreciation	(8,694,427)
Capital Contributions + Deferred Revenue	(8,110,647)
Accumulated Amortization of Capital Contributions	483,789
NBV - Rate Base (average)	**50,266,778**

2018 Actual vs. 2019 Actual

Kingston Hydro's Net Capital Assets increased by $2.4 million from 2018 to 2019.

See Section 5.4.1 Capital Expenditure Summary of the Distribution System plan for details of the gross capital asset additions for 2019.

Table 6 - Fixed Asset Continuity Schedule:

Description	2018 Historical MIFRS	2019 Historical MIFRS
Gross Assets	69,232,592	73,976,913
Accumulated Depreciation	(9,821,353)	(12,136,628)
Capital Contributions + Deferred Revenue	(8,236,531)	(8,453,741)
Accumulated Amortization of Capital Contributions	577,659	771,341
NBV - Fixed Assets	**51,752,367**	**54,157,885**

Table 7 – Historical Fixed Assets in Rate Base:

Description	2019 Historical MIFRS
Gross Assets	71,604,753
Accumulated Depreciation	(10,978,991)
Capital Contributions + Deferred Revenue	(8,345,136)
Accumulated Amortization of Capital Contributions	674,500
NBV - Rate Base (average)	**52,955,126**

2019 Actual vs. 2020 Actual

Kingston Hydro's Net Capital Assets increased by $1.7 million from 2019 to 2020.

See Section 5.4.1 Capital Expenditure Summary of the Distribution System plan for details of the gross capital asset additions for 2020.

Table 8 - Fixed Asset Continuity Schedule:

Description	2019 Historical MIFRS	2020 Historical MIFRS
Gross Assets	73,976,913	78,144,464
Accumulated Depreciation	(12,136,628)	(14,553,524)
Capital Contributions + Deferred Revenue	(8,453,741)	(8,700,508)
Accumulated Amortization of Capital Contributions	771,341	971,309
NBV - Fixed Assets	**54,157,885**	**55,861,741**

Table 9 – Historical Fixed Assets in Rate Base:

Description	2020 Historical MIFRS
Gross Assets	76,060,689
Accumulated Depreciation	(13,345,076)
Capital Contributions + Deferred Revenue	(8,577,125)
Accumulated Amortization of Capital Contributions	871,325
NBV - Rate Base (average)	**55,009,813**

2020 Actual vs. 2021 Actual

Kingston Hydro's Net Capital Assets increased by $2.2 million from 2020 to 2021.

See Section 5.4.1 Capital Expenditure Summary of the Distribution System plan for details of the gross capital asset additions for 2021.

Table 10 - Fixed Asset Continuity Schedule:

Description	2020 Historical MIFRS	2021 Historical MIFRS
Gross Assets	78,144,464	82,758,579
Accumulated Depreciation	(14,553,524)	(17,033,196)
Capital Contributions + Deferred Revenue	(8,700,508)	(8,817,138)
Accumulated Amortization of Capital Contributions	971,309	1,175,820
NBV - Fixed Assets	**55,861,741**	**58,084,065**

Table 11 – Historical Fixed Assets in Rate Base:

Description	2021 Historical MIFRS
Gross Assets	80,451,522
Accumulated Depreciation	(15,793,360)
Capital Contributions + Deferred Revenue	(8,758,823)
Accumulated Amortization of Capital Contributions	1,073,565
NBV - Rate Base (average)	**56,972,903**

2021 Actual vs. 2022 Bridge Year

Kingston Hydro's Net Capital Assets is forecasted to increase by $1.4 million from 2021 to 2022.

See Section 5.4.1 Capital Expenditure Summary of the Distribution System plan for details of the planned gross capital asset additions for 2022.

Table 12 - Fixed Asset Continuity Schedule:

Description	2021 Historical MIFRS	2022 Bridge MIFRS
Gross Assets	82,758,579	86,755,206
Accumulated Depreciation	(17,033,196)	(19,653,148)
Capital Contributions + Deferred Revenue	(8,817,138)	(9,017,138)
Accumulated Amortization of Capital Contributions	1,175,820	1,386,192
NBV - Fixed Assets	**58,084,065**	**59,471,112**

Table 13 – Bridge Year Fixed Assets in Rate Base:

Description	2022 Bridge MIFRS
Gross Assets	84,756,893
Accumulated Depreciation	(18,343,172)
Capital Contributions + Deferred Revenue	(8,917,138)
Accumulated Amortization of Capital Contributions	1,281,006
NBV - Rate Base (average)	**58,777,589**

2022 Bridge Year vs. 2023 Test Year

Kingston Hydro's Net Capital Assets is forecasted to increase by $0.8 million from 2022 to 2023.

See Section 5.4.1 Capital Expenditure Summary of the Distribution System plan for details of the gross capital asset additions for 2023.

Table 14 - Fixed Asset Continuity Schedule:

Description	2022 Bridge MIFRS	2023 Test MIFRS
Gross Assets	86,755,206	90,184,706
Accumulated Depreciation	(19,653,148)	(22,340,029)
Capital Contributions + Deferred Revenue	(9,017,138)	(9,217,138)
Accumulated Amortization of Capital Contributions	1,386,192	1,603,631
NBV - Fixed Assets	**59,471,112**	**60,231,170**

Table 15 – Test Year Fixed Assets in Rate Base:

Description	2023 Test MIFRS
Gross Assets	88,469,956
Accumulated Depreciation	(20,996,589)
Capital Contributions + Deferred Revenue	(9,117,138)
Accumulated Amortization of Capital Contributions	1,494,912
NBV - Rate Base (average)	**59,851,141**

Attachment 1 (of 1):

Fixed Asset Continuity Summary

Fixed Asset Continuity Summary

Description	2016 OEB - Approved MIFRS	2016 Historical MIFRS	2017 Historical MIFRS	2018 Historical MIFRS	2019 Historical MIFRS	2020 OEB - Approved MIFRS	2020 Historical MIFRS	2021 Historical MIFRS	2022 Bridge MIFRS	2023 Test MIFRS
Gross Assets	79,416,208	55,980,235	63,943,533	69,232,592	73,976,913	94,657,529	78,144,464	82,758,579	86,755,206	90,184,706
Accumulated Depreciation	(29,250,926)	(5,430,491)	(7,567,500)	(9,821,353)	(12,136,628)	(37,977,925)	(14,553,524)	(17,033,196)	(19,653,148)	(22,340,029)
Capital Contributions + Deferred Revenue	(2,848,475)	(3,242,246)	(7,984,762)	(8,236,531)	(8,453,741)	(2,848,475)	(8,700,508)	(8,817,138)	(9,017,138)	(9,217,138)
Accumulated Amortization of Capital Contributions	486,861	143,277	389,918	577,659	771,341	743,383	971,309	1,175,820	1,386,192	1,603,631
NBV - Fixed Assets	**47,803,668**	**47,450,775**	**48,781,189**	**51,752,367**	**54,157,885**	**54,574,513**	**55,861,741**	**58,084,065**	**59,471,112**	**60,231,170**

GROSS ASSETS (PP&E)

Gross Assets- by Function

Kingston Hydro's gross assets are divided into three categories: general plant, distribution plant and intangible plant.

Kingston Hydro does not have any transmission plant assets.

Capital Contributions have been listed separately.

Exhibit 2, Tab 2, Schedule 2, Attachment 1 details the Gross Assets by Function as per the filing requirements.

Gross Assets- Detailed by Major Plant

Kingston Hydro has included a breakdown of each major plant account according to the Board's Uniform System of Accounts.

This information is detailed in Exhibit 2, Tab 2, Schedule 2, Attachment 2. This attachment covers historical years, the bridge year and test year in compliance with the filing requirements.

Accumulated Depreciation- by Function

Kingston Hydro's accumulated depreciation are divided into three categories: general plant, distribution plant and intangible plant.

Kingston Hydro does not have any transmission plant assets.

Capital Contributions have been listed separately.

Exhibit 2, Tab 2, Schedule 2, Attachment 3 details the Accumulated Depreciation by Function as per the filing requirements.

Accumulated Depreciation - Detailed by Major Plant

The accumulated depreciation detailed by Major Plant is in Exhibit 2, Tab 2, Schedule 2, Attachment 4. This attachment covers historical years, the bridge year and test year in compliance with the filing requirements.

Accumulated Depreciation – Disposals

Kingston Hydro's continuity statements Appendix 2-BA contains accumulated depreciation by Uniform System of Account. Additionally, any disposals are clearly marked within Appendix 2-BA for all historical, bridge and test years.

2023 Test Year

Kingston Hydro has included a description of each major plant item for the Test year. This information can be found in Exhibit 2, Tab 2, Schedule 2, Attachment 5.

In addition, a breakdown of the 2023 capital additions by OEB Uniform System of Account is provided at Exhibit 2, Tab 2, Schedule 2, Attachment 6.

Detailed analysis of material 2023 capital additions can be found in DSP Section 5.4 of Exhibit 2, Tab 4, Schedule 1, Attachment 1.

Attachment 1 (of 6):

Gross Assets Grouped by Function

Gross Assets by Function

Description		2016 Historical MIFRS	2017 Historical MIFRS	2018 Historical MIFRS	2019 Historical MIFRS	2020 Historical MIFRS	2021 Historical MIFRS	2022 Bridge MIFRS	2023 Test MIFRS
Distribution Plant	DP	52,155,996	59,627,684	64,338,715	68,422,778	72,369,609	76,651,289	80,335,915	82,968,415
General Plant	GP	3,615,511	4,315,853	4,893,876	5,554,134	5,774,855	6,107,291	6,419,291	7,216,291
Intangible Plant	IP	208,725	-	-	-	-	-	-	-
Capital Contributed	CC	(3,242,246)	(7,984,761)	(8,236,531)	(8,453,741)	(8,700,508)	(8,817,138)	(9,017,138)	(9,217,138)
Gross Assets less Capital Contributions		**52,737,986**	**55,958,776**	**60,996,060**	**65,523,171**	**69,443,956**	**73,941,442**	**77,738,068**	**80,967,568**

Attachment 2 (of 6):

Gross Assets Component by Major Plant

Gross Assets - Detailed by Major Plant

	Description	OEB	2016 Historical MIFRS	2017 Historical MIFRS	2018 Historical MIFRS	2019 Historical MIFRS	2020 Historical MIFRS	2021 Historical MIFRS	2022 Bridge MIFRS	2023 Test MIFRS
	Distribution Plant									
DP	Land	1805	197,343	197,343	197,343	197,343	197,343	197,343	197,343	197,343
DP	Buildings and Fixtures	1808	836,082	898,438	898,438	1,047,933	1,322,909	1,478,098	1,968,098	1,968,098
DP	Substation equipment	1820	7,812,078	8,135,564	8,623,025	10,157,888	11,786,900	12,973,917	13,706,417	13,706,417
DP	Poles, Towers & Fixtures	1830	11,781,749	16,343,436	17,441,690	18,296,568	19,073,793	20,255,561	21,121,061	21,821,061
DP	OH Conductors & Devices	1835	3,734,152	4,622,776	5,031,452	5,209,824	5,426,127	5,665,879	5,865,879	6,015,879
DP	UG Conduit	1840	11,232,047	11,549,088	12,846,507	12,931,710	13,033,400	13,317,683	13,602,683	14,142,683
DP	UG Conductors & Devices	1845	7,257,615	7,524,683	7,991,008	8,256,936	8,446,709	9,064,496	9,254,496	9,614,496
DP	Line Transformers	1850	3,223,597	3,571,770	4,092,782	4,512,263	4,783,033	5,074,913	5,472,413	5,869,913
DP	Services	1855	1,104,877	1,497,545	1,706,368	1,994,400	2,120,341	2,283,938	2,343,938	2,403,938
DP	Meters	1860	4,976,456	5,287,041	5,510,102	5,817,913	6,179,054	6,339,461	6,803,587	7,228,587
	Sub Total		**52,155,996**	**59,627,684**	**64,338,715**	**68,422,778**	**72,369,609**	**76,651,289**	**80,335,915**	**82,968,415**
	General Plant									
GP	Leasehold Improvements	1910	108,995	108,995	108,995	108,995	108,995	117,845	117,845	117,845
GP	Office Furniture & Equipment	1915	21,481	21,481	21,481	21,481	21,481	21,481	51,481	56,481
GP	Computer Equipment- Hardware	1920	178,233	389,720	389,720	587,308	588,436	615,512	615,512	615,512
GP	Computer Software	1925	61,915	64,768	346,279	496,681	667,005	849,178	1,081,178	1,348,178
GP	Transportation Equipment	1930	1,597,587	2,038,582	2,206,930	2,443,554	2,443,554	2,525,081	2,525,081	2,975,081
GP	Stores Equipment	1935	76,776	76,776	85,776	85,776	85,776	85,776	85,776	85,776
GP	Tools, Shop & Garage Equipment	1940	458,722	460,660	494,800	505,992	515,164	536,515	566,515	621,515
GP	Measurement & Testing Equipment	1945	71,356	71,356	81,965	81,965	81,965	81,965	81,965	81,965
GP	Equipment- Power Operated	1950			39,565	43,865	43,865	43,865	43,865	43,865
GP	Communications Equipment	1955	201,530	222,102	222,102	255,603	259,793	269,753	274,753	279,753
GP	System Supervisory Equipment	1980	838,916	861,413	896,263	922,914	958,821	960,320	975,320	990,320
	Sub Total		**3,615,511**	**4,315,853**	**4,893,876**	**5,554,134**	**5,774,855**	**6,107,291**	**6,419,291**	**7,216,291**
	Intangible Plant									
IP	Misc Intangible Plant	1610	208,725	-	-	-	-	-	-	-
	Sub Total		**208,725**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	Capital Contributed									
CC	Contributions	1995	(2,418,367)	(2,418,367)	(2,418,367)	(2,418,367)	(2,418,367)	(2,418,367)	(2,418,367)	(2,418,367)
CC	Deferred Rev	2440	(823,879)	(5,566,394)	(5,818,164)	(6,035,374)	(6,282,141)	(6,398,771)	(6,598,771)	(6,798,771)
	Sub Total		**(3,242,246)**	**(7,984,761)**	**(8,236,531)**	**(8,453,741)**	**(8,700,508)**	**(8,817,138)**	**(9,017,138)**	**(9,217,138)**
	Total		**52,737,986**	**55,958,776**	**60,996,060**	**65,523,171**	**69,443,956**	**73,941,442**	**77,738,068**	**80,967,568**

Attachment 3 (of 6):

Accumulated Depreciation Grouped by Function

Accumulated Depreciation by Function

Description		2016 Test MIFRS	2017 Test MIFRS	2018 Test MIFRS	2019 Test MIFRS	2020 Test MIFRS	2021 Test MIFRS	2022 Test MIFRS	2023 Test MIFRS
Distribution Plant	DP	4,152,670	5,866,099	7,611,601	9,379,951	11,243,834	13,205,966	15,267,134	17,415,847
General Plant	GP	1,259,637	1,701,402	2,209,751	2,756,677	3,309,690	3,827,229	4,386,015	4,924,182
Intangible Plant	IP	18,183	-	-	-	-	-	-	-
Capital Contributed	CC	(143,277)	(389,919)	(577,658)	(771,341)	(971,308)	(1,175,822)	(1,386,191)	(1,603,631)
Accumulated Depreciation		**5,287,213**	**7,177,582**	**9,243,694**	**11,365,287**	**13,582,216**	**15,857,373**	**18,266,958**	**20,736,398**

Attachment 4 (of 6):

Accumulated Depreciation Component by Major Plant

Accumulated Depreciation - Detailed by Major Plant

	Description	OEB	2016 Historical MIFRS	2017 Historical MIFRS	2018 Historical MIFRS	2019 Historical MIFRS	2020 Historical MIFRS	2021 Historical MIFRS	2022 Bridge MIFRS	2023 Test MIFRS
	Distribution Plant									
DP	Land	1805	-	-	-	-	-	-	-	-
DP	Buildings and Fixtures	1808	51,272	74,378	98,004	124,122	157,034	195,543	243,468	299,560
DP	Substation equipment	1820	680,620	916,893	1,169,557	1,451,344	1,760,154	2,098,029	2,455,400	2,820,095
DP	Poles, Towers & Fixtures	1830	783,699	1,234,048	1,655,962	2,099,578	2,561,327	3,044,844	3,551,108	4,074,766
DP	OH Conductors & Devices	1835	231,519	340,457	439,331	543,922	652,257	764,781	881,351	1,001,394
DP	UG Conduit	1840	566,267	782,269	1,012,071	1,253,444	1,496,212	1,742,094	1,992,682	2,249,987
DP	UG Conductors & Devices	1845	462,870	625,944	796,352	974,082	1,156,369	1,346,732	1,545,173	1,749,114
DP	Line Transformers	1850	259,872	362,505	476,003	601,256	735,138	876,053	1,025,585	1,185,056
DP	Services	1855	53,265	77,179	106,105	139,171	175,688	214,617	255,410	297,202
DP	Meters	1860	1,063,286	1,452,426	1,858,216	2,193,032	2,549,655	2,923,273	3,316,957	3,738,673
	Sub Total		**4,152,670**	**5,866,099**	**7,611,601**	**9,379,951**	**11,243,834**	**13,205,966**	**15,267,134**	**17,415,847**
	General Plant									
GP	Leasehold Improvements	1910	24,342	32,456	40,570	48,684	56,798	65,133	73,689	82,245
GP	Office Furniture & Equipment	1915	8,187	10,916	13,645	16,185	18,545	20,605	22,986	26,236
GP	Computer Equipment- Hardware	1920	124,595	173,881	235,785	303,557	385,663	470,412	536,720	581,879
GP	Computer Software	1925	59,964	62,202	90,923	162,835	266,819	406,053	586,420	788,251
GP	Transportation Equipment	1930	580,669	786,598	1,015,538	1,246,155	1,451,001	1,594,993	1,782,180	1,949,833
GP	Stores Equipment	1935	20,580	31,190	42,250	48,140	54,030	59,675	65,075	70,475
GP	Tools, Shop & Garage Equipment	1940	158,194	211,635	263,713	314,487	352,877	391,670	429,781	467,568
GP	Measurement & Testing Equipment	1945	24,126	33,951	44,306	51,529	57,275	62,505	67,218	71,849
GP	Equipment- Power Operated	1950	-	-	1,978	6,149	10,535	14,921	19,307	23,693
GP	Communications Equipment	1955	75,090	111,445	149,243	183,724	215,920	239,050	251,137	262,167
GP	System Supervisory Equipment	1980	183,890	247,128	311,800	375,232	440,227	502,212	551,502	599,986
	Sub Total		**1,259,637**	**1,701,402**	**2,209,751**	**2,756,677**	**3,309,690**	**3,827,229**	**4,386,015**	**4,924,182**
	Intangible Plant									
IP	Misc Intangible Plant	1610	18,183	-	-	-	-	-	-	-
	Sub Total		**18,183**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	Capital Contributed									
CC	Contributions	1995	(120,624)	(180,525)	(240,375)	(300,181)	(359,987)	(419,587)	(479,186)	(538,774)
CC	Deferred Rev	2440	(22,653)	(209,394)	(337,283)	(471,160)	(611,321)	(756,235)	(907,005)	(1,064,857)
	Sub Total		**(143,277)**	**(389,919)**	**(577,658)**	**(771,341)**	**(971,308)**	**(1,175,822)**	**(1,386,191)**	**(1,603,631)**
	Total		**5,287,213**	**7,177,582**	**9,243,694**	**11,365,287**	**13,582,216**	**15,857,373**	**18,266,958**	**20,736,398**

Attachment 5 (of 6):

Major Plant Account Description

Account	OEB	Description
Misc Intangible Plant	1610	Includes the cost of patent rights, licenses, privileges, capitalizable load profile development costs and other intangible property necessary or valuable in the conduct of utility operations and not specifically chargeable to any other account.
Land	1805	Includes the cost of land used in connection with power distribution.
Buildings and Fixtures	1808	Includes the cost in place of buildings and fixtures used in connection with distribution operations.
Substation equipment	1820	Includes the installed cost of transforming and switching equipment used for the purpose of stepping down to distribution voltages.
Poles, Towers & Fixtures	1830	Includes the costs of installed poles, towers, and appurtenant fixtures used for supporting overhead distribution conductors and service wires.
OH Conductors & Devices	1835	Includes the costs of installed overhead conductors and devices used for distribution purposes.
UG Conduit	1840	Includes the costs of installed underground conduit and tunnels used for housing distribution cables or wires.
UG Conductors & Devices	1845	Includes the costs of installed underground conductors and devices used for distribution purposes.
Line Transformers	1850	Includes the costs of installed overhead and underground distribution line transformers and poletype and underground voltage regulators owned by the utility, for use in transforming electricity to the voltage at which it is to be used by the customer, whether actually in service or held in reserve.
Services	1855	Includes the costs of installed overhead and underground conductors leading from a point where wires leave the last pole of the overhead system or the transformers or manhole, or the top of the pole of the distribution line, to the point of connection with the customer's electrical panel. Conduit used for underground service conductors shall be included herein.
Meters	1860	Includes the costs of installed meters or devices and appurtenances thereto, for use in measuring the electricity delivered to its users, whether actually in service or held in reserve.
Leasehold Improvements	1910	Includes the cost of additions, improvements or alterations made to premises the utility leases from others. The cost of the leasehold improvements shall be amortized over the term of the lease or the service life of the improvement, whichever is shorter. Renewal provisions in the lease agreement shall be disregarded in amortizing leasehold improvements.
Office Furniture & Equipment	1915	Includes the cost of the general office furniture and equipment.
Computer Equipment- Hardware	1920	Includes the costs of acquiring computer hardware. Hardware includes all physical equipment associated with input, processing, storage and output functions, also word processing equipment.
Computer Software	1925	Includes the cost of developed or purchased computer operating and application software that is material in amount.
Transportation Equipment	1930	Includes the cost of automobiles, small trucks, truck chassis, special truck bodies, aerial ladders, trailers and other mobile equipment.
Stores Equipment	1935	Includes the cost of equipment used for the receiving, shipping, handling, and storage of materials and supplies.
Tools, Shop & Garage Equipment	1940	Includes the cost of tools, implements, and equipment used in construction, repair work, general shops and garages and not specifically provided for or included in other accounts.
Measurement & Testing Equipment	1945	Includes the costs of installed laboratory equipment used for general laboratory purposes and not specifically provided for or included in other departmental or functional plant accounts.
Equipment- Power Operated	1950	Includes the cost of power operated equipment used in construction, repair and service work exclusive of equipment included in other accounts. Includes, also, the tools and accessories acquired for use with such equipment and the vehicle on which such equipment is mounted.
Communications Equipment	1955	Includes the costs of installed telephone and wireless equipment for general use in connection with utility operations.
System Supervisory Equipment	1980	Includes the costs of all control equipment used for the purposes of remote operation and control of utility transformer stations and distribution equipment.
Contributions	1995	Before IFRS adoption this account includes amounts relating to contributions or grants in cash, services or property from governments or government agencies, corporations, individuals and others received in aid of construction or for acquisition of fixed assets.
Deferred Rev	2440	After IFRS adption this account includes amounts relating to contributions or grants in cash, services or property from governments or government agencies, corporations, individuals and others received in aid of construction or for acquisition of fixed assets.

Attachment 6 (of 6):

Additions by Major Plant

2023 Additions			
	Description	OEB	2023 Test MIFRS
	Distribution Plant		
DP	Land	1805	-
DP	Buildings and Fixtures	1808	-
DP	Substation equipment	1820	-
DP	Poles, Towers & Fixtures	1830	700,000
DP	OH Conductors & Devices	1835	150,000
DP	UG Conduit	1840	540,000
DP	UG Conductors & Devices	1845	360,000
DP	Line Transformers	1850	397,500
DP	Services	1855	60,000
DP	Meters	1860	425,000
	Sub Total		**2,632,500**
	General Plant		
GP	Leasehold Improvements	1910	-
GP	Office Furniture & Equipment	1915	5,000
GP	Computer Equipment- Hardware	1920	-
GP	Computer Software	1925	267,000
GP	Transportation Equipment	1930	450,000
GP	Stores Equipment	1935	-
GP	Tools, Shop & Garage Equipment	1940	55,000
GP	Measurement & Testing Equipment	1945	-
GP	Equipment- Power Operated	1950	-
GP	Communications Equipment	1955	5,000
GP	System Supervisory Equipment	1980	15,000
	Sub Total		**797,000**
	Intangible Plant		
IP	Misc Intangible Plant	1610	-
	Sub Total		**-**
	Capital Contributed		
CC	Contributions	1995	-
CC	Deferred Rev	2440	(200,000)
	Sub Total		**(200,000)**
	Total		**3,229,500**

ACCUMULATED DEPRECIATION

Kingston Hydro Corporation amortized its capital assets in accordance with the Canadian Institute of Chartered Accountants (CICA) Handbook and the Ontario Energy Board's Accounting Procedures Handbook up to and including 2012. Assets were amortized on a straight-line basis over their useful lifes. Effective January 1, 2010, one-half of a year's worth of amortization is recorded during the year of purchase and this practice continues for all historical, bridge and test years.

Effective January 1, 2013, the Company reviewed the useful lives of all capital assets subject to amortization. This review was perfomed in accordance with IFRS IAS 16 and the requirement of the OEB to revise useful lives to coincide with IFRS. The estimates of useful lives of certain items of property, plant and equipment were revised which resulted in a change in amortization rates and years of amortization. Kingston Hydro confirms that the useful lives for its asset group's fall within the range allowed in the Board sponsored Kinectrics study. In support of the depreciation expense policy changes Kingston Hydro has filed a completed Appendix 2-BB.

Appendix 2-C Depreciation and Amortization Expense reconciles to the depreciation amounts shown in Appendix 2-BA Fixed Asset Continuity Schedule. These two files reconcile for all historical periods 2016-2021, bridge year 2022 and test year 2023.

Details for Depreciation, Amortization and Depletion by asset group for the Historical, Bridge and Test Years, including asset amounts and rates of depreciation or amortization can be found in the OEB Appendices. For these details, please refer to Appendix 2-BB and Appendix 2-BA.

Capital assets are amortized individually or on the group basis where the combined cost of a group of assets is amortized on the estimated average useful life of the assets in the group.

The depreciation practices followed and used in preparing the application are as follows:

Kingston Hydro Corporation calculates amortization on a straight-line basis over the estimated useful lives of the respective assets. The treatment of capital assets and the subsequent calculation of amortization are based IFRS IAS 16 and *Report of the Board, Transition to International Financial Reporting Standards,* EB-2008-0408, the Kinectrics Report, and the Revised 2012 *Accounting Procedures Handbook for Electricity Distributors* ("APH"). Similar assets are grouped by their nature for amortization purposes. The amortization method allocates the combined cost of the assets over their estimated useful life on a rational and systematic basis. The useful life is the estimated average life of the assets in the group.

For purposes of calculating the Test Year forecasts of amortization expense, the half year rule was applied. The proposed levels of depreciation/amortization expense are appropriately reflective of the useful lives of the assets and the Board`s accounting policies.

Kingston Hydro Corporation has not identified any Asset Retirement Obligations.

Kingston Hydro Corporation has not made any changes to our depreciation policy or asset service lives since our last rebasing, with the exception of some selected smart meters noted below.

Change in Depreciation Rate for Specific – Smart Meters

In 2019 Kingston Hydro revised the depreciation rate for 1860 Smart Meters that were purchased in 2009-2010 to have a useful life of 18 years. Useful life for wholesale meters per the Kinetrics Report is 5-15 years. Kingston Hydro has been using a useful life of 15 years to be consistent with expected useful life of Smart Meters.
Smart Meters originally have a 10-year seal, which can be extended based on sampling and testing of meters in use. In 2019 Kingston Hydro Smart meters passed this testing and their seals were extended to 18 total years.

The change in depreciation that occurred in 2019 was to extend the estimated useful life of smart meters that were purchased in 2009-2010 to 18 years vs 15 years. Future additions of Smart Meters will still start with the estimated useful life of 15 years, because they begin with a 10-year seal, which can only be extended through the same process of sampling and testing.

Appendix 2-BB Service Life for new smart meters will remain at 15 years until more data is collected to accurately predict their estimated useful life. Not all smart meters have moved to an EUL of 18 years and Kingston Hydro will continue evaluate their life cycle throughout this IRM.

POLICY OPTIONS FOR THE FUNDING OF CAPITAL

Kingston Hydro is not proposing any of the approaches in this application based on the new policy options for the funding of capital investments.

ADDITION OF ICM ASSETS TO RATE BASE

Kingston Hydro does not have any additions of previously approved ACM or ICM project assets to rate base.

CAPITALIZATION POLICY

Kingston Hydro has outlined its capitalization and amortization policy below. There are no changes to the policy since its last rebasing application (EB-2015-0083) filed with the Board.

Kingston Hydro adopted IFRS for financial reporting purposes with a transition date of January 1, 2015. The changes to accounting amortization mandated by the Board were implemented effective January 1, 2013.

Capital assets are recorded at cost and include contracted services, material, labour, engineering costs and an allowance for the cost of funds used during construction, when applied. Certain assets may be acquired or constructed with financial assistance in the form of contributions from developers or customers. When identifiable assets, such as buildings, substation equipment, system supervisory equipment, meters, tools and vehicles are retired or otherwise disposed of, and their original cost and accumulated amortization are identifiable, they are removed from the accounts and the related gain or loss is included in the operating results for the related fiscal period.

Self-Constructed Assets

Kingston Hydro has self-constructed assets. Appendix 2-D shows very few overhead costs associated with self-constructed assets, including the burden rates associated with self-constructed assets. In addition, the appropriate amount of post-employment benefits charges is applied to capitalized self-constructed assets

Capitalization and Amortization Policies

Kingston Hydro Corporation

1. Introduction

Kingston Hydro Corporation ("KHC" or the "Company") has established a capitalization policy regarding the methodology that it employs to identify, recognize and measure those expenditures that meet the criteria for categorization of property and equipment on its balance sheet. KHC has reviewed its capitalization policy resulting from the conversion to IFRS effective January 1, 2015 and determined that no changes were required.

2. Reference Documents

This policy was established in consultation with the following standards:

a. OEB Accounting Procedures Handbook for Electric Distribution Utilities, Article 410 – Property, Plant and Equipment
b. Canadian Institute of Chartered Accountants ("CICA") Handbook, section 3061 – *Property, Plant and Equipment*
c. CICA Handbook, section 3063 – *Impairment of Long-Lived Assets*
d. CICA Handbook, section 3064 – *Goodwill and Intangible Assets*
e. *Report of the Board, Transition to International Financial Reporting Standards,* EB-2008-0408, the Kinectrics Report, and the Revised 2012 *Accounting Procedures Handbook for Electricity Distributors* ("APH")
f. IFRS IAS 16- Property, Plant and Equipment
g. Regulatory accounting policy direction regarding changes to depreciation expense and capitalization policies in 2012 and 2013

3. Definitions

a. Asset

Assets are economic resources controlled by an entity as a result of past transactions or events and from which future economic benefits may be obtained.[1]

Assets have three essential characteristics:[2]

i. they embody a future benefit that involves a capacity, singly or in combination with other assets, in the case of profit-oriented enterprises, to contribute directly or indirectly to future net cash flows, and, in the case of not-for-profit organizations, to provide services;
ii. the entity can control access to the benefit; and
iii. the transaction or event giving rise to the entity's right to, or control of, the benefit has already occurred.

b. Betterment

The cost incurred to enhance the service potential of an item of property, plant and equipment is a betterment. Service potential may be enhanced when there is an increase in the previously assessed physical output or service capacity, associated operating costs are lowered, the life or useful life is extended, or the quality of output is improved. [3]

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[1] From CICA Handbook, section 3061 – *Property, Plant and Equipment*

[2] Ibid

[3] Ibid

c. Cost

Cost is the amount of consideration given up to acquire, construct, develop, or better an item of property, plant and equipment and includes all costs directly attributable to the acquisition, construction, development or betterment of the asset including installing it at the location and in the condition necessary for its intended use.[4]

d. Intangible Asset

An intangible asset is an identifiable non-monetary asset without physical substance.[5] It would include such assets as patents, trademarks, copyrights, land rights and software.

e. Maintenance Expenses

Also referred to as a repair expense. The cost incurred in the maintenance of the service potential of an item of property, plant and equipment is a repair or maintenance expense, not a betterment. If a cost has the attributes of both a repair and a betterment, the portion considered to be a betterment is included in the cost of the asset.

f. Property, Plant and Equipment

Property, plant and equipment are identifiable tangible assets that meet all of the following criteria:

i. are held for use in the production or supply of goods and services, for rental to others, for administrative purposes or

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[4] Ibid

[5] CICA Handbook, section 3064 – *Goodwill and Intangible Assets*

for the development, construction, maintenance or repair of other property, plant and equipment;

ii. have been acquired, constructed or developed with the intention of being used on a continuing basis; and

iii. are not intended for sale in the ordinary course of business.[6]

g. Distribution Asset

Per the OEB Act, 1998, a distribution asset is used to distribute electricity; includes any system, structure, equipment or other things used for that purpose.

h. Service Potential

Service potential is used to describe the output or service capacity of an item of property, plant and equipment and is normally determined by reference to attributes such as physical output capacity, associated operating costs, useful life and quality of output.[7]

i. Useful Life

Useful life is the period over which an asset, singly or in combination with other assets, is expected to contribute directly or indirectly to the future cash flows of an enterprise.[8]

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[6] Ibid

[7] Ibid

[8] Ibid

4. Policies

Kingston Hydro has adopted the following policies regarding the recognition and measurement of its property and equipment.

a. Allowance for Funds Used During Construction ("AFUDC")
   The Accounting Policy Handbook promulgated by the OEB requires local distribution companies to apply an AFUDC to all capital projects exceeding twelve months in duration. The AFUDC is calculated using the costs incurred on a project and a quarterly rate established by the OEB.

b. Amortization Expense
   The Company has established an accounting policy detailing the amortization method and useful life for each class of capital assets.

c. Asset Pools
   Similar assets are grouped by their nature for amortization purposes. The amortization method allocates the combined cost of the assets over their estimated useful life on a rational and systematic basis. The useful life of the asset pool is the estimated average life of the individual assets in the pool.

d. Capitalization Threshold
   In its determination of which expenditures get classified as capital additions and which get classified as repairs and maintenance expenses, Kingston Hydro Corporation considers the criteria in sections 3(a) and 3(b) of this policy in addition to the dollar amount of the expenditure. Expenditures less than $1,000 are classified as repairs and maintenance expenses regardless of whether they

meet the definition of assets. This threshold stems from the recognition that the administrative costs involved in capitalizing, tracking and depreciating capital assets may outweigh the benefits inherent in the accuracy of the Company's financial information. The Company notes that the use of a capitalization threshold is common in both the utility sector and industry in general, and the Company has considered the materiality thresholds established by organizations of like size.

e. Costs

For greater clarity, the Company shall include the following in the cost of construction of its property and equipment, where applicable:

i. the cost of direct labour incurred on the project ;
ii. materials and supplies used on the project;
iii. installation costs including design and engineering fees, legal fees, survey costs, site preparation costs, freight charges, insurance costs, testing and preparation charges;
iv. amounts paid to external contractors in respect of the project;
v. construction or building permits;
vi. allowance for funds used during construction;
vii. and internal equipment charges;

The labour costs include the estimated benefits attributed to the hours that the individuals work on the project.

Internal equipment usage costs are calculated for each vehicle or piece of equipment in the fleet, and include the direct costs associated with usage (maintenance, insurance, fuel and depreciation).

The Company does not allocate the costs of indirect overhead or general administrative overhead to its property and equipment other than other post-employment benefits.

f. Major Spare Equipment

Spare transformers and meters are accounted for as property, plant and equipment. Spares are held and dedicated for the specific purpose of backing up plant in service. It is expected that these items are not intended for resale, have a longer period of future benefit compared to inventory items, are an integral part of the distribution plant, and are expected to be placed in service. Transformers and meters held in reserve or as spares are to receive the same treatment as the related assets in service.

CAPITALIZATION OF OVERHEAD

Kingston Hydro does not capitalize overhead, only expenditures directly related to each capital project are capitalized with the exception of an appropriate allocation of other post-employment benefits.

COST OF ELIGIBLE INVESTMENTS FOR DISTRIBUTORS

Kingston Hydro has not incurred any cost or investment related to the connection of qualifying generations facilities.

SERVICE QUALITY AND RELIABILITY PERFORMANCE

Per the OEB's updated Chapter 2 and Chapter 5 Filing Requirements issued April 18, 2022, Service Quality and Reliability Performance is now addressed in Chapter 5 Filing Requirements, Section 5.2.3 Performance Measurement for Continuous Improvement.

Kingston Hydro's Distribution System Plan Filing includes this element. OEB Appendix 2-G tab has been completed in the Chapter 2 Appendices Excel file submission.

Exhibit 2: Rate Base

Tab 3 (of 4): Allowance for Working Capital

ALLOWANCE FOR WORKING CAPITAL

Kingston Hydro elects to take the 7.5% of the sum of Cost of Power and OM&A allowance approach for the calculation of its allowance for working capital.

Kingston Hydro is applying for an allowance for Working Capital for the 2023 Test Year in the amount of $6,098,321.

The following Table shows this calculation:

Table 1 – Allowance for Working Capital

Allowance for Working Capital - Derivation	
Controllable Expenses	$8,313,253
Cost of Power	$72,997,690
Working Capital Base	$81,310,943
Working Capital Rate %	7.50%
Working Capital Allowance	$6,098,321

Kingston Hydro's Power Supply Expenses for 2023 are projected to be $72,997,690. The commodity price estimated is based on the appropriate split between RPP and non-RPP Class A and Class B customers based on actual data and using the most current RPP prices as well as all other appropriate charges required for the calculation.

Please refer to Appendix 2-Z for more details.

Exhibit 2: Rate Base

Tab 4 (of 4): Distribution System Plan

DISTRIBUTION SYSTEM PLAN

Kingston Hydro is filing its consolidated Distribution System Plan (DSP) as a standalone document which includes all elements of the DSP as Exhibit 2 Tab 4 Schedule 1 Attachment 1 in accordance with the Chapter 2A Filing Requirements for Small Utilities. Kingston has organized its information using the headings indicated in the Chapter 5A Requirements for Small Utilities.

Attachment 1 (of 1):

Distribution System Plan

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5.2. Distribution Plan Introduction

The local utility structure provides the City of Kingston with a unique advantage over other municipalities. Throughout the city, the municipality owns the water and wastewater assets. In the core area of the city, the municipality owns gas assets and Kingston Hydro, which in turn owns the electric assets. As the affiliate service provider to Kingston Hydro, Utilities Kingston manages, operates, and maintains the electrical distribution assets in the core area of the City of Kingston. The corporate ownership and asset management responsibility are outlined in Figure 5.2-1.

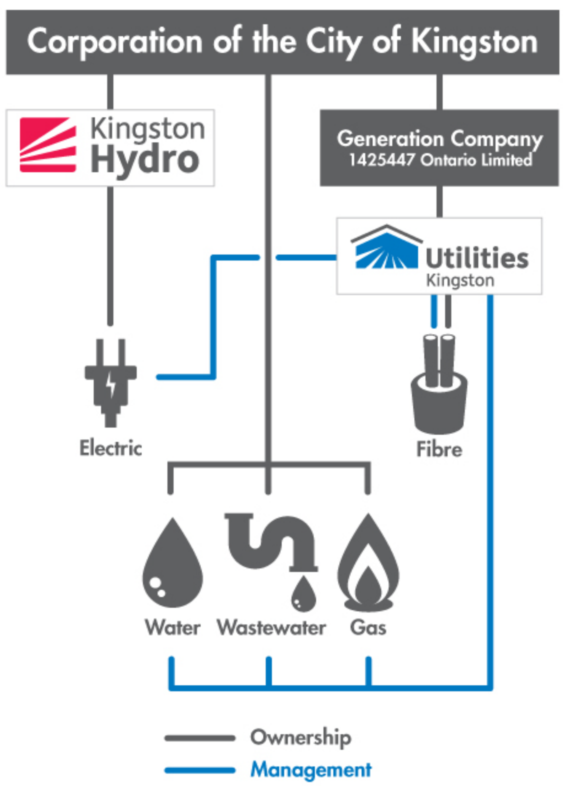


Figure 5.2-1 – Corporate Ownership and Asset Management

The Consolidated Distribution System Plan (Chapter 5) filing requirements issued by the Ontario Energy Board (OEB) for Electricity Distribution Applications establishes a standard format for filing Kingston Hydro's asset management and capital expenditure information in support of its Cost of Service (COS) rate application. Most importantly, the Distribution System Plan (DSP) identifies the level of investment required to sustain its infrastructure assets, the allocation of that investment by category, the capital investment required for the forecast period and the specific project details and explanations.

The timeframes covered by the previous and current COS application and DSP are summarized in Table 5.2-1.

Kingston Hydro Rate Applications	2016 CUSTOM IR	2021 IRM	2022 IRM	2023 COS
OEB File Reference	EB-2015-0083	EB-2020-0034	EB-2021-0037	EB-2022-0044
Test Year(s) (# of Years)	2016-2020 (5 Years)	2021 (1 Year)	2022 (1 Year)	2023 (1 Year)
Bridge Year	2015	N/A	N/A	2022
Effective Date for Rates	Jan 1, 2016	Jan 1, 2021	Jan 1, 2022	Jan 1, 2023
Filing Date	June 1, 2015	Aug 1, 2020	Aug 1, 2021	June, 2022
DSP Historic Timeframe (# of Years)	2011-2015 (5 Years)	N/A	N/A	2016-2022 **(7 Years)***
DSP Forecast Timeframe (# of Years)	2016-2020 (5 Years)	N/A	N/A	2023-2027

***NOTE:** DSP includes 7 Historic years (5 Historic years plus 2 Deferral Years) for 2023 COS

Table 5.2-1 – Timeframes Covered by COS and DSP

Kingston Hydro filed its first DSP in April 2015 with its 2016 COS application. Normally, the OEB expects distributors to update their DSP every 5 years, but Kingston Hydro requested and received authorization from the OEB to defer the submission of its current DSP from April 2020 to June 2022 due to the COVID-19 pandemic.
The current DSP is part of the Kingston Hydro 2023 COS application filed in June 2022 which covers the 2016-2022 historic timeframe and the 2023-2027 forecast timeframe.

Kingston Hydro’s DSP includes the following key elements:

- Provides information relating to our capacity for renewable energy, third party and regional planning considerations;
- Considers and addresses customer preferences by optimizing investments that support public policy objectives, deliver value for the investment required and address the need for investments in the distribution system assets;
- Provides the necessary performance measures to evaluate our progress towards implementing the plan,

- Provides a useful and understandable tool that communicates to our rate payers Kingston Hydro's future investments activities.

The DSP's organization provides the information and rationale on the investments proposed by Kingston Hydro during the forecast timeframe of 2023-2027. Within the framework of the Chapter 5 filing requirements Kingston Hydro will provide information on:

- asset related performance objectives and the approach to evaluating performance relative to those objectives
- our approach to lifecycle asset management planning and the management of asset related operational risk and financial risk;
- analysis of the 2023 capital expenditure forecast (the Test Year)

Overview

The DSP reflects an integrated and holistic approach to planning, prioritizing, and managing Kingston Hydro's assets. The OEB has directed distributors to present their investments into four categories:

- System Access,
- System Renewal,
- System Service, and
- General Plant

Kingston Hydro has followed these categories

System Access:

Investments that are modifications (including asset relocation) to a distributor's distribution system that a distributor is obliged to perform to provide a customer (including a generator customer) or group of customers with access to electricity services.

System Renewal:

Investments involve replacing and/or refurbishing system assets to extend the original service life of the assets and thereby maintain the ability of the distribution system to provide customers with electricity services.

System Service:

Investments that are modifications to a distributor's distribution system to ensure it continues to meet the distributor's operational objectives while addressing anticipated future customer electricity service requirements.

General Plant:

Investments that are modifications, replacements or additions to a distributor's assets that are not part of its distribution system, including land and buildings; tools and equipment, rolling stock and electronic devices and software used to support day to day business and operational activities.

The summary totals of proposed spending by category as described in Kingston Hydro's DSP are illustrated in Table 5.2-2 - Annual Expenditures by Category and Table 5.2-3 - Annual Percentage Expenditure by Category.

CATEGORY	Forecast Period (planned)					5 yr Avg
	2023	2024	2025	2026	2027	2023-2027
	$ '000					
System Access	1,083	1,288	1,253	1,100	1,125	**1,170**
System Renewal	1,490	1,310	1,540	1,325	1,685	**1,470**
System Service	75	200	75	357	80	**157**
General Plant	782	717	435	456	434	**565**
TOTAL EXPENDITURE	**3,430**	**3,515**	**3,302**	**3,238**	**3,324**	**3,362**
Capital Contributions	200	200	200	200	200	200
Net Capital Expenditures	**3,230**	**3,315**	**3,102**	**3,038**	**3,124**	**3,162**

Table 5.2-2 – Annual Expenditures by Category

CATEGORY	Forecast Period (planned)					5 yr Avg
	2023	2024	2025	2026	2027	2023-2027
	$ '000					
System Access	31.6%	36.6%	37.9%	34.0%	33.8%	**34.8%**
System Renewal	43.4%	37.3%	46.6%	40.9%	50.7%	**43.8%**
System Service	2.2%	5.7%	2.3%	11.0%	2.4%	**4.7%**
General Plant	22.8%	20.4%	13.2%	14.1%	13.1%	**16.7%**
TOTAL EXPENDITURE	100.0%	100.0%	100.0%	100.0%	100.0%	**100.0%**

Table 5.2-3 – Annual Percentage Expenditure by Category

The DSP has been arranged into two parts:

1. The Asset Management Process, and
2. The Capital Expenditure Plan.

The main sections within the Asset Management Process are:

5.2 Distribution Plan Introduction

5.2.1 Distribution System Plan Overview

- Key elements of the plan, sources of expected cost savings, review of historical and forecast period investments, contingent activities that are dependent on future events.

5.2.2 Coordinated Planning with Third Parties

- Demonstrating coordinated infrastructure planning with customers including generators, the transmitter, other distributors or third parties and appropriate agencies.

5.2.3 Performance Measurement for Continuous Improvement

- The identification of qualitative assessments and quantitative metrics utilized by Kingston Hydro to monitor the quality of the planning process, the efficiency of the implementation and the extent to which the planning objectives are met.

5.3. Asset Management Process

5.3.1 Planning Process

- Provides an overview of the planning process including key elements that have informed the preparation of the 5 year Capital Expenditure Plan. It also includes a summary of any important changes to the asset management process since the last DSP filing.
- Provides the processes used to identify, select, prioritize, and pace the execution of investments over the term of the DSP. It also demonstrates how customer feedback and potential risks were considered during the planning process.
- Provides a summary of the data used in the processes above to identify, select, prioritize, and pace the execution of investments over the term of the DSP.

5.3.2 Overview of Asset Managed

- The service territory, system configuration, asset utilization and assets managed by Kingston Hydro.

5.3.3 Asset Lifecycle Optimization Policies and Practices

- Details Kingston Hydro's asset refurbishment and replacement policies/practices, how the system renewal program spending is optimized and prioritized, the impact of system renewal spending has on routine OM&A and a description of maintenance practices. It also includes a summary of any important changes to the asset life optimization policies and processes since the last DSP filing.

5.3.4 System Capability Assessment for Renewable Energy Generation

- Summary of the capacity or constraints of Kingston Hydro distribution system to accommodate Renewable Energy Generation (REG). This information is especially required if a distributor has costs to accommodate and connect renewable generation facilities.

5.3.5 CDM Activities to Address System Needs

- Summary of any application for distribution rate funded CDM activities that may be a preferred approach to meeting a system need, thus avoiding or deferring spending on traditional infrastructure.

The main sections within the Capital Expenditure Plan are:

5.4 Capital Expenditure Plan

- The capital expenditure plan sets out and comprehensively justifies Kingston Hydro's proposed expenditures on its distribution system and general plant over the five-year planning period.

5.4.1 Capital Expenditure Summary

- Describes proposed capital investments by category, significant capital projects and drivers; outputs of the plan, customer engagement activities; regional planning; and five year system development.

5.4.2 Justifying Capital Expenditures

- Assessment of costs of material projects/programs as well as how the overall DSP budget is allocated to each of the four investment categories.

5.4.2.1 Material Investments

- Description of Kingston Hydro's capital expenditures by category for the historic and forecast period of the DSP with explanations of variances between actual and forecast amounts for the historic period.

5.2.1. Distribution Plan Overview

5.2.1.(a.) Key Investment Elements of the DSP

The DSP presents a capital investment strategy that is reflective of the key considerations, drivers, outcomes, and justifications that are important to Kingston Hydro in the management of its assets.

Kingston Hydro's capital investment plan is designed to renew the system infrastructure; mitigate risk around constraints in the system or critical infrastructure; manage mandatory investments that support customer connections or regulatory requirements (i.e. metering) and meet system planning requirements (forecasted demands on infrastructure).

In 2018, the following themes were identified for Kingston Hydro's 2019-2024 Strategic Plan:

1. Leveraging the Multi-Utility Model
2. The Power of Local Hydro
3. Reliable Infrastructure Management
4. Customer Service Excellence

At the start of 2020, the Utilities Kingston (UK) Board of Directors decided to carry out a Strategic Planning exercise. The onset of the global pandemic in March of 2020 delayed the exercise and after careful consideration, the UK Board decided to proceed later in the year. Staff undertook a planning process and information gathering exercise that involved the Utilities Kingston Senior Leadership Team, including Utilities Kingston Managers. Subsequently, a two-day facilitated session was held with the UK Board in late November of 2020.

There were two distinctively different things impacting this strategic planning exercise from past exercises. One was the global pandemic that has impacted almost everything since March of 2020 and will continue to have impacts in the immediate term and longer term. The other is the retirement of the Chief Executive Officer and the associated recruitment exercise in 2021. Both formed parts of the 2021 Work Plan and the UK Board's discussion. The following relevant items were also discussed and supported by the Utilities Kingston Board for the 2021 Work Plan:

- Cyber Security Program Expansion
- Wellness
- Health and Safety Hazard Identification
- Climate Action
- Process Improvements/Smart Utility

The following tables summarize capital expenditures for the 2023-2027 period.

CATEGORY	5 yr Avg 2023-2027	
	$ '000	%
System Access	1,170	34.8%
System Renewal	1,470	43.7%
System Service	157	4.7%
General Plant	565	16.8%
TOTAL EXPENDITURE	3,362	100.0%

Table 5.2-4 – 2023 to 2027 Average Annual Expenditures by Investment Category

CATEGORY	Main Budget Category	2023-2027 Total ($,000)	% Category	% of Total
System Access	13.8kV voltage conversion	375	6.4%	2.2%
	5Kv OH Line Upgrades	750	12.8%	4.5%
	Meters	2,695	46.1%	16.0%
	New Development	1,365	23.3%	8.1%
	Substations	400	6.8%	2.4%
	Transformer PCB	263	4.5%	1.6%
	Sub-Total	**5,848**	100.0%	34.8%
System Renewal	44 Kv UG Cable Upgrades	155	2%	0.9%
	44kv OH Line Upgrades	995	14%	5.9%
	5Kv OH Line Upgrades	2,010	27%	12.0%
	5Kv UG Cable Upgrades	2,970	40%	17.7%
	Buildings & Fixtures	310	4%	1.8%
	Services	60	1%	0.4%
	Substations	850	12%	5.1%
	Sub-Total	**7,350**	100%	43.7%
System Service	SCADA	85	10.8%	0.5%
	Services	300	38.1%	1.8%
	Substations	402	51.1%	2.4%
	Miscellaneous	0	0.0%	0.0%
	Sub-Total	**787**	100.0%	4.7%
General Plant	Computer Misc.	1,568	55.5%	9.3%
	Office Equipment/Furniture	25	0.9%	0.1%
	Radios	25	0.9%	0.1%
	Substations	20	0.7%	0.1%
	Tools/Equipment	270	9.6%	1.6%
	Vehicles	915	32.4%	5.4%
	Sub-Total	**2,823**	100.0%	16.8%
	Total	**16,808**		100.0%

Table 5.2-5 – 2023 to 2027 Key Investments

System Renewal which involves the replacement or refurbishment of system assets is 43.7% of the 2023-2027 total budget and System Access which involves modifications and/or expansions to the distribution system that a distributor is obliged to perform is 34.8% of the 2023-2027 total budget. System Renewal and System Access represent the majority of Kingston Hydro's capital expenditures for the forecast timeframe. When it comes to System Renewal it is important to have clarity and understanding behind the use of certain terms utilized in the DSP when referring to assets, such as “beyond useful life”; “end of life” and how Kingston Hydro uses that term. Kingston Hydro does not ascribe to the theory that the age of an asset is the only determinant criteria driving the replacement of an asset.

Age based data is one factor for consideration and is helpful in focusing further asset data collection activity and in understanding, in a holistic sense, the scope of general asset requirements. Age based data alone is not enough, in our opinion, to base a decision on whether action is required on an asset or not. Old assets do not always equal a need to replace.

Understanding how similar assets (i.e. transformers) behave over time, their degradation curves, health indexes and hence their “predictability” of failure is also a factor for consideration. The asset condition assessment (ACA) work completed by Kinectrics on behalf of Kingston Hydro (see Appendix B) is based on a snapshot of the GIS asset registry and inspection data and enriches our understanding of our asset base by providing information about the potential scope of asset renewal required to sustain assets over the long term. However, Kingston Hydro acknowledges that even assets that are similar can fail unpredictably. Operating and environmental conditions as an example can cause some assets to fail earlier than predicted and some to last longer than predicted.

Kingston Hydro therefore adds a third layer of information that is sourced from a real-time GIS dashboard (see Section 5.3.1 of the DSP) in addition to the age and ACA information described above. This real-time information is updated as annual inspection work is completed and comes directly from operational staff that observe, use, inspect, maintain, and operate our assets.

The integration of all of the data above assists in validating or adjusting the need to take action on an asset. The specific material capital project write-ups for the 2023 Test Year found in Appendix F illustrate the relationship. In general, there is often a correlation between age, condition assessment and our real-time GIS dashboard information.

As described in Section 5.3 Asset Management there are other factors such as risk, obsolescence etc. associated with an asset that can influence decisions, but the use of terms such as "beyond"; at "the end of" in the context of "useful life" is utilized in Kingston Hydro's submission in the context of a number of factors indicating that the time to take action on that asset is now rather than later.

5.2.1.(b.) Overview of how projects/initiatives address customer preferences

The backbone of our customer engagement strategy was direct communication with multiple customer groups in order to inform them about the rate application process and the investments needed to ensure the continued safety and reliability of the electricity system. We met face to face with customers, created an online survey and held meetings with many of the various groups that make up our customer base. In addition, we looked to the data collected as part of the 2019 and 2021 customer satisfaction survey required by the Ontario Energy Board.

During a public meeting on May 29, 2019, senior company leaders offered details on proposed plans to upgrade equipment and ensure the continued reliability of electricity services, consulting with customers on various factors.

In October and November of 2019 our focus was on segmenting customers so that feedback could be targeted. Along with the prior engagement outlined above, these targeted customers meetings allowed us to hear directly from these specific groups.

We used these opportunities to ask customers to share their feedback on the services we provide. Their feedback identified support for the following:

- Capital improvements that improve reliability
- Pacing the investment for rate stability
- The commitment to keep operating costs below the actual inflation rate
- Maintaining levels of customer service, including the one bill for all utilities
- More frequent meetings to discuss utility issues
- Continued focus on collaboration of projects

After our initial customer meetings, further meetings were held with large customers to better understand their plans and ensure alignment with Kingston Hydro planning. These meetings took place over the course of 2020 and 2021.

Based on the results of our customer engagement activities, Kingston Hydro's Distribution System Plan was influenced in the following ways as reflected in our application:

- Maintain distribution rates in the bottom half of Ontario's distributors
- Provide a reasonable balance between rates and reliability

Originally planned for April 2020, and then delayed due to the pandemic, in February 2022 we held follow-up meetings with our targeted customer segments. At these meetings, we provided an update to customers on how their comments and feedback helped shape our distribution system plan and provided an opportunity for comments and questions.

The IESO prepared the Integrated Regional Resource Plan (IRRP) report for the Peterborough to Kingston Region between May 2020 and November 2021. During this timeframe the IESO conducted several public webinars and collected public feedback forms as part of the community engagement process for the IRRP. Several large institutions in the Kingston area participated in the public webinars and the City of Kingston gave written feedback in response to two of the public webinars.

Additional details regarding Kingston Hydro's customer engagement activities can be found in Exhibit 2 of Kingston Hydro's 2023 Cost of Service rate application

5.2.1.(c.) Sources of Cost Savings

The following sources of cost savings have been factored into the 2023-2027 budget:

- Maximizing the useful life of poles to pace the renewal of deteriorated overhead infrastructure.
- Maximizing the useful life of substation power transformers to pace substation renewal costs. This includes pacing upgrades at Substation No. 5 and Substation No. 8.

- Reduced underground asset renewal costs through coordination and timing with other utility or city road works (i.e. restoration costs avoided through joint reconstruction of Princess Street).
- Minimizing the cost of materials through standardization and group purchasing as member of GridSmartCity

5.2.1.(d.) Currency of Information

The following table summarizes the most current information used in preparing the various DSP sections.

Section	Reference Document	Document Issue Date	Source Data Year
5.2.2	2nd Cycle Needs Assessment - Peterborough to Kingston Region (Group 2)	Feb 2020	2019
5.2.2	Scoping Assessment	May 2020	2019
5.2.2	Integrated Regional Resource Plan (IRRP) - Peterborough to Kingston Region (Group 2)	Nov 2021	2020/2021
5.2.2	Regional Infrastructure Plan (RIP) - Peterborough to Kingston Region (Group 2)	Expected May 2022	2020/2021
5.2.3	Reliability Measurements	N/A	2021
5.3.2	OEB RRR Data for OEB Yearbook	April 2022	As of Dec 2021
5.3.2	44kV Planning Updates	2019	2018
5.3.2	5kV/15kV Planning Updates	2020	2018
5.3.2	Asset Condition Assessment	2020	2018
5.4	2023-2027 Budget	N/A	Dec 2021

Table 5.2-6 – Current Information Used to Prepare DSP

5.2.1.(e.) Changes to Asset Management Process

This is the second DSP filed by Kingston Hydro Corporation. Since filing its first DSP, Kingston Hydro has focused on improving its asset registry and inspections. Kingston Hydro has also started the transition from a “top down” planning process where capital projects had to “fit” within the available dollars for a given year to a more formal asset lifecycle optimization approach.

5.2.1.(f.) Future Influences on DSP

Several ongoing activities or future events that may impact the current DSP are described in this section below.

Timing of Load Growth and Regional Plan Recommended Actions

The timing of load growth relative to the timing of the recommended actions in the IRRP/RIP reports of the current Regional Planning cycle for the Peterborough to Kingston region may have a potential impact on the current DSP forecast period and future DSP forecast period.

Please refer to Section 5.2.2 for a summary of the deliverables and recommendations from the current cycle of the Peterborough to Kingston regional planning.

New Development Intensification

In 2011, City Planning initiated intensification studies for the Williamsville and North Block districts downtown. Subsequently, the City received large development proposals for the Williamsville district and downtown that were not in keeping with the City Official Plan (e.g. high rise developments greater than 6 stories) and which resulted in Ontario Municipal Board (OMB) hearings. Since 2011 and the filing of our 2016 COS, City Planning has initiated additional intensification studies for the North King's Town (NKT) district and the Central Kingston Growth Strategy. These City development efforts are starting to be realized through the following City and development actions:

- July 2020 – UK received a letter from the City of Kingston planning department (refer to Appendix 6) confirming that it will continue to provide incentives for multi-unit residential development in Williamsville in addition to current pending/approved high-rise applications in the Williamsville district. Up to an additional 3400 residential units are anticipated in Williamsville over the next 10 years.
- Fall 2020 - Kingston Hydro received a draft submission for a subdivision agreement for a 1500 unit multi-rise development on a brownfield site, formerly known as the Davis Tannery.

- August 2021 – City of Kingston Report to Planning Committee (refer to Appendix 6) recommending approval of proposed intensification in three areas of central Kingston:
    - Johnson Street and Brock Street Corridor,
    - Portsmouth Avenue and Johnson Street Corridor, and
    - Sir John A. Macdonald Boulevard and Bath Road area

Since July 2020, Kingston Hydro has started to develop a plan to introduce 13.8kV distribution for the Williamsville district and Davis Tannery and effective January 1, 2021, Kingston Hydro's now offers 13.8kV primary services up to 1500kVA in size in targeted areas.

New and evolving development applications may force Kingston Hydro to review and potentially revise its current capital plan over the DSP forecast period to accommodate new development.

Electrification of Heating and Transportation

Kingston Hydro's energy consumption and system demand are heavily influenced by federal institutions, municipal facilities, universities, schools, and hospitals (I-MUSH Sector). The Kingston I-MUSH sector recently established net-zero energy targets for the 2040 to 2050 timeframe to help mitigate global climate change. During the recent reginal planning process, our I-MUSH sector customers indicated that they were starting to develop plans to electrify their transportation fleet (e.g. light duty electric vehicles) and heating systems (e.g. install heat pumps and electric boilers) within the next 5-10 years to meet interim targets on their path to net-zero. Electrification may become a significant planning issue for Kingston Hydro within the timeframe of the current DSP.

New Energy Efficiency Requirements for Distribution Transformers

More stringent energy efficiency standards for distribution transformers prescribed in O.Reg. 509/18 Energy and Water Efficiency – Appliance and Products are scheduled to come into effect January 1, 2023. USF and its members (including Kingston Hydro) will be attending a meeting with the Ministry of Energy on June 24, 2022, to raise concerns about the timing of when this regulation comes into effect given the current supply chain issues. This new regulation has the potential to impact the cost and availability of distribution transformers during the forecast period of this DSP.

Supply Chain Issues due to COVID-19 Pandemic

On May 16, 2022, the USF group organized a group meeting with members to discuss purchasing challenges that distributors are facing. At this meeting, some members expressed concerns that supply chain issues are potentially reaching crisis mode and may require capital plan reprioritization. Here are some examples that distributors highlighted:

- Distribution transformer quotes with delivery times up to 142 weeks
- Delivery and/or shortage issues with Western Red Cedar poles
- Meter delivery and shortage issues
- Some fleet vehicle suppliers are taking orders for delivery in 2024/2025 and in one instance as far out as 2026. Suppliers are also asking for more dollars up front to secure the order due to cost increases including freight costs.

Some members expressed concerns that if these trends keep up then it could trigger panic buying in bulk which could further exasperate these supply chain issues. The meeting concluded with distributors agreeing that there was still not enough information to develop a plan of action and members agreed to continue monitoring the situation over the next few months. Supply chain issues are expected to impact the forecast period of this DSP, but it is not clear at this time what that impact will be.

Smart Meter Regulatory Seal Expiry

A significant number of smart meter seals are scheduled to expire within the next 5-7 years which will result in lumpy rather than levelized/paced capital expenditures. Supply chain issues mentioned above may further exasperate this issue.

Continuous Improvements to the AMP process

Kingston Hydro plans to continue reviewing and updating its asset registry with an emphasis on the following assets during the 2023-2027 budget period:

- Testing and condition assessment of cables
- Underground structure condition assessment
- Testing and condition assessment of key substation assets such as breakers and switches

This information will be key to prioritizing future cable replacement and substation upgrades.

5.2.1.(g.) Identification of Grid Modernization Projects

Kingston Hydro's grid modernization efforts over the forecast period of this DSP are focused on upgrading the remaining legacy electromechanical protection relays and SCADA equipment at substations with new intelligent electronic devices that can be connected to the Kingston Hydro SCADA fibre network. The multitude of solutions and driving forces behind grid modernization make it necessary to pace efforts and resources. Kingston Hydro's grid modernization projects over the past 10 years have included 44kV motor-operated switches which can reduce power restoration times thus improving system reliability. However, as an early adopter of 44kv motor-operated switches, Kingston Hydro experienced technical challenges and has decided to pace future investments in 44kV motor-operated switches accordingly. Over the 2023-2027 period, Kingston Hydro also plans to develop a more detailed long-term voltage conversion plan and monitor evolving technology trends; especially trends related to DERs and electrification (e.g. heating and transportation).

5.2.2. Coordinated Planning With Third Parties

5.2.2.(a.) Summary of Consultations

Table 5.2-7 provides a summary of consultations with various organizations that influence the planning and operation of the Kingston Hydro distribution system.

Description of Consultation	Purpose of the Consultation	Who/What prompted	Other Participants	Deliverable Dates	DSP Impact
Regional Planning Process Cycle for Peterborough to Kingston Region	To review regional planning needs for the local area a minimum of every 5 years as per OEB requirements	OEB Planning Requirement	IESO Hydro One(Transmitter) Hydro One(Distributor) Elexicon Cornwall Electric Lakeshore Utility Services	Refer to Section 5.2.2.(b.) for details of all related deliverables	-The IRRP Identifies near, medium and long term electricity needs for Peterborough to Kingston region and provides recommendations for the near to medium term needs. -The IRRP recommendations prompted Kingston Hydro to allocate funds in 2024-2025 for preliminary planning of a new Municipal Transformer Station (MTS)
Joint Reconstruction Planning	To coordinate joint reconstruction projects in an effort to minimize disruptions to customers and identify potential savings through shared costs (e.g. shared restoration costs)	Collaborative Initiative	City of Kingston (Roads) Utilities Kingston (Sewer, Water, Gas)	Typically reviewed on an Annual basis (Fall)	Influences timing of some Capital Expenditures for 2023-2027 related to System Renewal and/or System Access

Table 5.2-7 – Summary of Coordination with Third Parties (continued on next page)

1

Description of Consultation	Purpose of the Consultation	Who/What prompted	Other Participants	Deliverable Dates	DSP Impact
Utilities Standards Forum (non-profit) Annual Membership	A forum where engineering, IT and regulatory departments collaborate on meeting regulatory requirements and general business needs	Collaborative Initiative	Ontario Distributors of various sizes (Approx. 49)	Quarterly meetings and ongoing standards development	Will help ensure continuous and cost-effective updating/improvement of standards to meet evolving engineering practices over the period of this DSP. Will help inform staff in a timely manner of changes to industry standards and regulations over the period of the DSP.
GridSmartCity	To achieve cost efficiencies and cost savings through group purchases	Collaborative Initiative	Ontario Distributors of various sizes (Approx. 14)	Quarterly meetings and annual group purchasing contracts	Refer to group purchase savings performance measure in Section 5.2.3
Consultations with Telecom Entities	To comply with O.Reg. 842/21	O.Reg. 842/21 OEB Act Electricity Infrastructure	UK Fibre Bell Cogeco P2P Fibre Rogers	Annual construction projects	Discussed in Section 5.2.2
ESA Audit, Declaration of Compliance and DDIs	To verify compliance with ESA Distribution Safety Regulation (O.Reg. 22/04)	O. Reg. 22/04 Electrical Safety Authority (ESA) Leads Regulation Enforcement	ESA Third Party Auditor	Annual Audits and Reports	Refer to ESA performance measures in Section 5.2.3

2 **Table 5.2-8 – Summary of Coordination with Third Parties (continued on next page)**

Description of Consultation	Purpose of the Consultation	Who/What prompted	Other Participants	Deliverable Dates	DSP Impact
Hydro One LDC Generation Working Group	To share, clarify and potentially improve/standardize the connection process and Technical Interconnection Requirements for DERs	Hydro One (Local Distributor /Transmitter) Lead for consultation process	Ontario Distributors of various sizes (Approx. 17)	Quarterly Working Group Meetings	Member Since 2010. Helps staff stay informed of evolving good utility practices related to grid modernization, distributed energy resources and addressing the Long-Term Energy plan
USF consultation with Ministry of Energy	To raise concerns about current supply chain issues and the timing of when new distribution transformer efficiency requirements prescribed in O.Reg. 509/18 come into effect .	O. Reg. 509/18 new prescribed efficiency standards for distribution transformers that are currently scheduled to come into effect on Jan 1, 2023	Ontario Distributors of various sizes (Approx. 49) Electro-Federation Canada (EFC) EDA	Meeting scheduled for June 24, 2022	The timing of when this regulation comes into effect combined with supply chain issues could impact the 2023-2027 capital plan of this DSP

Table 5.2-9 – Summary of Coordination with Third Parties

5.2.2.(b.) Regional Plan Process Deliverables

The Regional Planning process is part of Kingston Hydro's planning process which is discussed in Section 5.3.1 of the DSP. The following figure outlines the Regional Planning process:

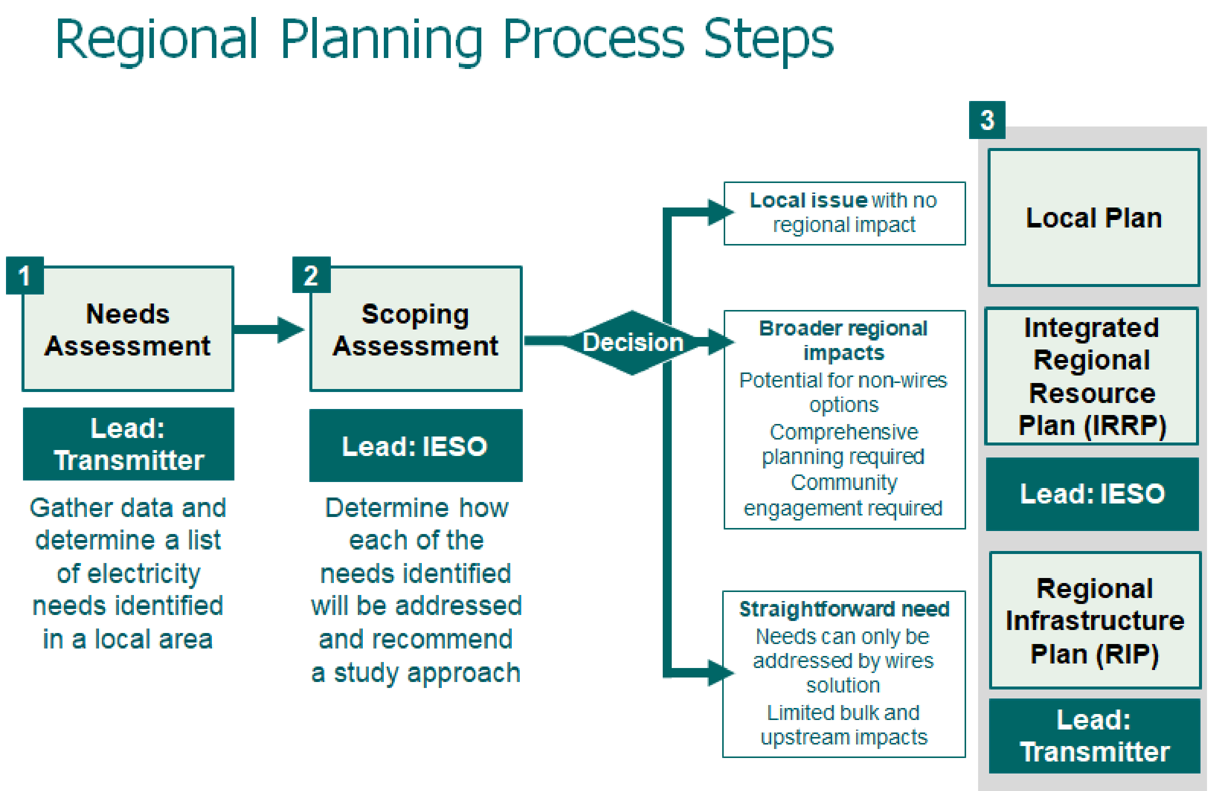


Figure 5.2-2 – Regional Planning Process

Kingston Hydro submitted three load forecast scenarios to IESO and Hydro One as a member of the regional planning process working group for Peterborough to Kingston region to facilitate an impact assessment on the existing supply from Hydro One Frontenac TS and Gardiner TS due to potential impact of electrification and intensification. The base reference load forecast uses a status quo approach based on historic electricity energy usage patterns whereas the medium and high growth scenarios examine potential worst case scenarios based on non-conventional energy usage predictions due to electrification and intensification. Refer to the IRRP report in Appendix C for further details.

Table 5.2-8 summarizes the regional plan deliverables established for the current planning cycle of the Peterborough to Kingston (PtoK) region (Group 2).

Deliverable	Lead	Role of Kingston Hydro	Status of Consultation	Date issued or expected
Transmission Load Forecast PtoK Region (Group 2)	Hydro One (Transmitter)	Submit Kingston Hydro Load Forecast	Completed	Nov 14, 2019
Needs Assessment Report PtoK Region (Group 2)	Hydro One (Transmitter)	Study Team Participant	Completed	Feb 10, 2020
Scoping Assessment Report PtoK Region (Group 2)	IESO	Study Team Participant	Completed	May 21, 2020
IRRP PtoK Region (Group 2)	IESO	Study Team Participant	Completed	Nov 4, 2021
RIP PtoK Region (Group 2)	Hydro One (Transmitter)	Study Team Participant	Kick-off Dec 2021	May 2020

Table 5.2-10 – Regional Plan Deliverables – Peterborough to Kingston Region

At the time of issuing this DSP in Spring 2022, the Hydro One RIP report was being finalized for the Peterborough to Kingston region with consideration of the recommendations of the recent IESO IRRP report issued in November 2021.

The Hydro One RIP for the Peterborough to Kingston region is expected to include the recommended actions from the IESO IRRP report however, Hydro One may not be able to commit to the recommended implementation timelines.

Key recommended actions from the IRRP that impact Kingston Hydro are:

1. Hydro One Distribution load transfer – Gardiner TS DESN #1 to Gardiner TS DESN #2. IRRP need date is today (2022)
2. Hydro One Transmission to advance end-of-life replacement of transformers at Gardiner TS DESN #1. IRRP need date is as soon as possible (2024-2025)
3. Monitor load growth on Frontenac TS and initiate development and siting work to build a new 230kV DESN transformer station in Kingston when needed. Estimated IRRP need date is between 2025 and 2029.
4. Address implementation and cost allocation barriers to cost-effectively deploying non-wires alternatives to defer needs.

The first two items above depend on action by Hydro One and could affect available transmission supply for new growth in the Kingston Area in the near term.

For the third item, Kingston Hydro plans to initiate the pre-design of a new Municipal Transformer Station (MTS) in 2024-2025 in addition to monitoring load growth over the DSP forecast period. The results of the pre-design work will help to inform Kingston Hydro's future DSP. Kingston Hydro is preparing to act on its customers evolving needs.

The fourth item is dependent upon policies, regulations, market rules and incentive programs that are yet to be developed and/or established by the IESO and/or OEB. It is not clear at this time what impact, if any this item may have on Kingston Hydro's current DSP forecast period or future DSPs.

In summary, the timing of load growth relative to the timing of the recommended actions in the IRRP/RIP reports of the current Regional Planning cycle for the Peterborough to Kingston region may have a potential impact on the current DSP forecast period and future DSP forecast period.

5.2.2.(c.) Consultations with Telecommunications Entities

On January 11, 2022, the OEB issued guidance on Regulation: O. Reg. 842/21 (Electricity Infrastructure (Part VI.1 of the Act))[1], that came into force on January 1, 2022, confirming that licensed distributors must comply with the following requirements: (i) consult with any telecommunications entity[2] that operates within its service area when preparing a capital plan for submission to the OEB, for the purpose of facilitating the provision of telecommunications services, and

[1] Wireless attachments are expressly excluded from the ambit of this Regulation.
[2] A "telecommunications entity" is a telecommunications service provider or other person or entity that needs the use of or access to a distributor's infrastructure in order to attach wires, cables, or any other telecommunications facility, not including a wireless attachment, for the purpose of providing or facilitating the provision of telecommunications services.

(ii) include the following information in its capital plan:
The number of consultations that were conducted and a summary of the manner in which the distributor determined with whom to consult.

I. A summary of the results of the consultations.
II. A statement as to whether the results of the consultations are reflected in the capital plan and, if so, a summary as to how.

The following summary of consultations with telecommunication entities demonstrates Kingston Hydro's compliance with regulation O.Reg. 842/21 and the associated OEB guidance:

I. Kingston Hydro conducted a total of seven (7) consultations with the following telecommunication entities who were either known entities operating in Kingston Hydro territory due to a previously executed Third Party Attachment agreement for telecommunication assets on Kingston Hydro poles or have previously expressed interest in doing so:
   - Bell Canada
   - Cogeco
   - Ockman Communications
   - Rogers
   - Telus
   - Utilities Kingston Fibre
   - Videotron/Fibrenoire
II. A letter dated March 3, 2022, was sent to each of the telecommunication entities mentioned above (a sample letter is included in Appendix G of this DSP). Table 5.2-11 summarizes the results of the consultations.

Telecom Entity	Letter dated March 3, 2022 Issued by UK to Telecom entity?	Response to UK letter received? (Yes/No)	Date of Response	Feedback /Comments
Bell Canada	Yes	No	-	None
Cogeco	Yes	No	-	None
Ockman Communications	Yes	No	-	None
Rogers	Yes	No	-	None
Telus	Yes	No	-	None
Utilities Kingston	Yes	Yes	March 9, 2022	None
Videotron/Fibrenoire	Yes	No	-	None

Table 5.2-11 – Summary of Results of Consultations

III. The consultations noted in the summary above resulted in one response (refer to Appendix G for response letter from Utilities Kingston Fibre) however, Kingston Hydro received no feedback and therefore these consultations had no impact on Kingston Hydro's 2023-2027 capital plan.

5.2.2.(d.) Renewable Energy Generation (REG)

In February 2020, Kingston Hydro forwarded an updated REG plan (Section 5.3.4 of this DSP) to the IESO for review and comment. The IESO acknowledged receipt of the Kingston Hydro REG plan and indicated there was no need for IESO to provide a formal comment letter as there are no material REG investments proposed for the forecast period of the current Distribution System Plan (DSP). Refer to Appendix H for the IESO response to Kingston Hydro's REG Plan submission.

5.2.3. Performance Measurement for Continuous Improvement

This section summarizes the performance methodologies, measures (metrics/targets) and historic trends that will be used to continuously improve Kingston Hydro's asset management and capital expenditure planning processes.

An Asset Management Plan is instrumental for best-practices management of an electric distribution system. Well-defined performance outcomes help evaluate the success of an Asset Management Plan and facilitate further improvements.

Performance outcomes or Levels of Service are typically identified through Regulatory Framework principles or Corporate Strategic Plans and are general in nature.

Performance measures or Key Performance Indicators (KPI) identify information to be monitored for selected programs to assess whether the dollars spent achieve the intended result (effectiveness) and/or are prudent (efficiency). Specific programs and performance measures are typically identified and monitored based on their materiality and visibility. Some performance measures are essential for regulatory reporting purposes (e.g. the OEB Scorecard) while others are useful for internal corporate reporting to staff and management.

When developing performance measures it's important to distinguish between effectiveness and efficiency. For example, it is possible to "effectively" mitigate the risk of a hazard due to a deteriorated pole line by replacing the entire pole line but this may not be the most "efficient" solution. A more "efficient" solution for this example may involve replacing only a select number of poles in the worst condition. Performance measures are specific and quantifiable.

On February 25, 2022, the OEB announced changes to the Activity and Program-based Benchmarking (APB) framework in line with its commitment to drive utility performance and support efficiencies in the regulatory process. Subsequently, on May 4, 2022, the OEB published a new APB report with unit cost results updated by OEB staff and econometric results updated by the project consultant, Pacific Economics Group Research LLC (PEG). A review and discussion of the most current results and performance for each of the ten APB metrics can be found in Exhibit 1 of Kingston Hydro's 2023 Cost of Service application. Due to timing, this DSP does not take APB metrics into consideration however, Kingston Hydro may consider APB metrics in future DSP submissions.

The performance measures used to inform Kingston Hydro when developing this DSP are summarized in the following sub-sections.

5.2.3.1 Distribution System Plan

(i) OEB Scorecard Performance Measure Objectives

The performance measures found in the OEB annual Scorecard were developed with consideration of performance outcomes identified in an OEB Report entitled **"Renewed Regulatory Framework for Electricity Distributors: A Performance-Based Approach"** dated Oct 18, 2012. One of the principal goals of Kingston Hydro's DSP that is indicative of good planning is the pacing and prioritizing of capital investments with consideration of the available resources, the need to control costs, the related rate impacts of proposed investments and customer feedback. The DSP and Annual OEB Scorecard are expected to shift the focus from "utility cost" to "value for customers". The OEB Scorecard facilitates monitoring of the year-over-year change and/or benchmarking analysis relative to a target for regulatory purposes. The Kingston Hydro OEB Scorecard is expected to evolve over time as part of a continuous improvement process.

OEB Scorecard Analysis Results

A snapshot of the Kingston Hydro OEB Scorecard results for 2016 through 2020 are summarized in Figure 5.2-18. Appendix 3 contains the complete Kingston Hydro OEB Scorecard. The historic trends were generally acceptable with the exception of one System Reliability performance measure that did not meet the acceptable OEB target levels. The average number of hours that power to a customer is interrupted exceeds the target over the 2016-2020 timeframe due to increased scheduled outages for 2016 through 2020, a pole line failure in 2016, higher than average outages due to motor vehicle accidents and an internal bus failure at Substation MS3. These contributing factors are discussed in detail in Section 5.2.3(c.) (i).

1

Appendix A

9/28/2021

Scorecard - Kingston Hydro Corporation

Performance Outcomes	Performance Categories	Measures		2016	2017	2018	2019	2020	Trend	Target: Industry	Target: Distributor
Customer Focus Services are provided in a manner that responds to identified customer preferences.	Service Quality	New Residential/Small Business Services Connected on Time		100.00%	100.00%	100.00%	100.00%	100.00%	flat (target met)	90.00%	
		Scheduled Appointments Met On Time		97.90%	100.00%	98.68%	99.73%	99.52%	up (target met)	90.00%	
		Telephone Calls Answered On Time		66.00%	68.76%	60.78%	64.63%	64.65%	down (target not met)	65.00%	
	Customer Satisfaction	First Contact Resolution		98.86%	98.84%	98.96%	99.18%	99.06%			
		Billing Accuracy		99.75%	97.09%	99.71%	92.04%	99.57%	down (target met)	98.00%	
		Customer Satisfaction Survey Results		'A'	'A'	'A'	'A'	'A'			
Operational Effectiveness Continuous improvement in productivity and cost performance is achieved; and distributors deliver on system reliability and quality objectives.	Safety	Level of Public Awareness		80.00%	79.00%	80.00%	79.00%	82.00%			
		Level of Compliance with Ontario Regulation 22/04 [1]		C	C	C	C	C	flat (target met)		C
		Serious Electrical Incident Index	Number of General Public Incidents	0	1	0	0	0	flat (target met)		0
			Rate per 10, 100, 1000 km of line	0.000	0.000	0.000	0.000	0.000	flat (target met)		0.042
	System Reliability	Average Number of Hours that Power to a Customer is Interrupted [2]		1.32	1.40	1.50	0.88	1.57	down (target not met)		1.03
		Average Number of Times that Power to a Customer is Interrupted [2]		0.59	1.07	1.00	0.73	0.87	up (target met)		0.95
	Asset Management	Distribution System Plan Implementation Progress		On track	on track	On track	Trending Up	On track			
	Cost Control	Efficiency Assessment		3	3	3	3	3			
		Total Cost per Customer [3]		$531	$538	$583	$574	$562			
		Total Cost per Km of Line [3]		$43,562	$44,400	$48,238	$47,559	$46,486			
Public Policy Responsiveness Distributors deliver on obligations mandated by government (e.g., in legislation and in regulatory requirements imposed further to Ministerial directives to the Board).	Connection of Renewable Generation	Renewable Generation Connection Impact Assessments Completed On Time									
		New Micro-embedded Generation Facilities Connected On Time		100.00%	100.00%	100.00%	100.00%	100.00%	flat (target met)	90.00%	
Financial Performance Financial viability is maintained; and savings from operational effectiveness are sustainable.	Financial Ratios	Liquidity: Current Ratio (Current Assets/Current Liabilities)		1.10	1.84	1.57	1.47	1.69			
		Leverage: Total Debt (includes short-term and long-term debt) to Equity Ratio		1.36	1.41	1.10	1.11	1.12			
		Profitability: Regulatory Return on Equity	Deemed (included in rates)	9.19%	9.19%	9.19%	9.19%	9.19%			
			Achieved	6.43%	7.82%	7.48%	9.50%	7.25%			

1. Compliance with Ontario Regulation 22/04 assessed: Compliant (C); Needs Improvement (NI); or Non-Compliant (NC).
2. An upward arrow indicates decreasing reliability while downward indicates improving reliability.
3. A benchmarking analysis determines the total cost figures from the distributor's reported information.
4. The CDM measure is based on the now discontinued 2015-2020 Conservation First Framework. 2019 results include savings reported to the IESO up until the end of February 2020.

Legend: 5-year trend: up, down, flat. Current year: target met, target not met.

2 **Figure 5.2-3 – Kingston Hydro 2016 to 2020 Scorecard – Performance Monitoring**

The OEB Scorecard indicates that the 2016-2020 Total Actual Capital Expenditures were generally "On Track" with respect to the Total Forecast Capital Expenditures with the exception of 2019 where the Total Actual Capital Expenditures were noted to be "Trending Up". The main reason for 2019 actuals "Trending Up" was due to fast tracking the remaining work at Substation MS1. This is discussed further in Section 5.4.

OEB Scorecard Impact on DSP

Generally speaking, the 2020 OEB Scorecard has not identified any significant needs for improvement to the current asset management and capital expenditure planning process. Analysis of System Reliability targets which were not met for 2016-2020 revealed that the causes were due to exceptional circumstances. Kingston Hydro will continue to monitor system reliability trends but does not anticipate the need for any special action as a result of the 2016-2020 system reliability performance.

The combined use of the new Scorecard and Cause of Outage analysis form an enhanced suite of performance monitoring tools that can flag the potential need for performance improvements.

(ii) ESA Public Safety Scorecard and Annual Audit Objectives

Kingston Hydro monitors trends in the number of incidents reported in the annual ESA Public Safety scorecard as well as trends in the number of Non-Conformance (NC) and Opportunity For Improvement (OFI) findings reported in Annual ESA Audits.

ESA Public Safety Scorecard and Annual Audit Results

A summary of the 2016-2021 ESA Public Safety Scorecard results is provided in Figure 5.2-4.

Component B: Level of Compliance with Ontario Regulation 22/04

Year	Compliance:
2021	Compliant
2020	Compliant
2019	Compliant
2018	Compliant
2017	Compliant
2016	Compliant

Component C: Serious Electrical Incident Index

Rate Category 100

	Results			Target	
Year	No. of Incidents	km Line	Rate per 10, 100, 1000 km of line (/Rate Category)	No. of Incidents	Rate per 10, 100, 1000 km of line (/Rate Category)
2021	0	335	0.000 / 100 km line	0	0.042 / 100 km line
2020	0	335	0.000 / 100 km line		/ 100 km line
2019	0	334	0.000 / 100 km line		/ 100 km line
2018	0	334	0.000 / 100 km line		/ 100 km line
2017	1	336	0.298 / 100 km line		/ 100 km line
2016	0	356	0.000 / 100 km line		/ 100 km line

Figure 5.2-4 - 2021 ESA Public Safety Scorecard

The incident recorded in year 2017 of Component C is in reference to a pole line failure incident that occurred in 2016. A third party review determined that the pole line failure was an isolated incident, driven by a number of unrelated factors that Kingston Hydro is confident won’t occur again.

A summary of the Annual ESA Audit findings is provided in Figure 5.2-5.

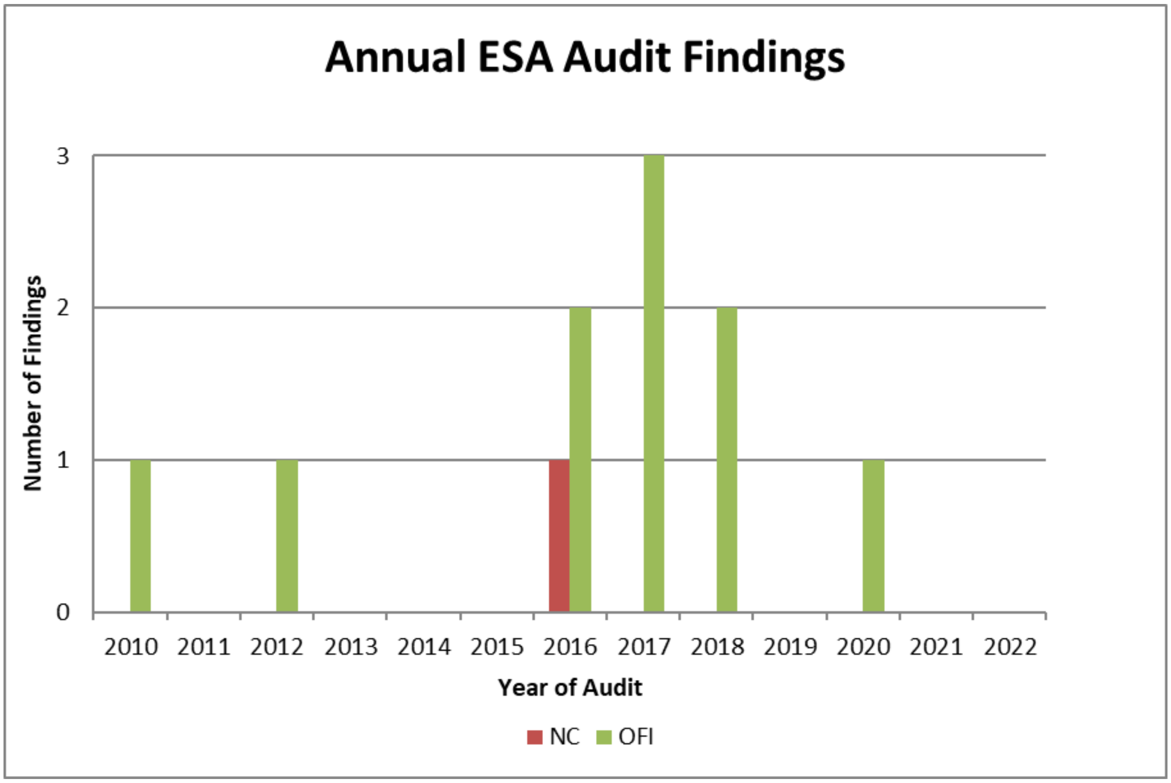


Figure 5.2-5 Annual ESA Audit Findings 2011 to 2021

The one non-conformance in 2016 was due to the extremely long time that it took Bell to provide a record of inspection and certificate for communication attachments on Kingston Hydro poles related to the Bell Fibre-to-the-Home project. In some cases, more than 12 months had elapsed since the Bell work was completed and Kingston Hydro still had not received the required inspection documentation for its files.

ESA Public Safety Scorecard and Audit Impact on DSP

The non-conformance in 2016 prompted Utilities Kingston staff to modify its third party attachment process to ensure that Bell third party attachments are inspected within 12 months of Bell completing their work.

Auditors may also recommend "opportunities for improvement" (OFIs) for the distributor to implement before the next audit as part of the continuous improvement philosophy of the annual audit process. The auditor has the discretion to escalate the OFI to a non-conformance in the next audit if the distributor does not act on the recommended OFI. This encourages continuous improvement of design, material and construction inspection processes.

(iii) Corporate Performance Measures

In 2017, Kingston Hydro retained METSCO to develop meaningful metrics/targets and to define outcome reporting in accordance with commitments made in the final settlement of OEB 2016 Cost of Service application #EB-2015-0083.

METSCO identified three categories of measures; Customer-Oriented Performance (COP), Planning and Execution Efficiency and Effectiveness (PEEE) and Equipment-Specific Performance (ESP). Kingston Hydro implemented the following performance measures identified by METSCO and expects to conduct a follow-up assessment in the future to determine which performance measures (if any) should be internally reported on an annual basis going forward.

A. Customer-Oriented Performance

A1. Average Customer Hours of Interruption (CHI) During Severe Weather Days

Definition: Three-year rolling average of combined CHI for Tree Contacts, Defective Equipment and Adverse Weather cause code outages, occurring on days that meet the threshold definition of Severe Weather (Days with Maximum Wind Gust of 50km/h or higher lasting more than 2 hours), less any CHI recorded on Major Event Days (MED) as per the IEEE 1366 methodology.

Analysis Results:

This metric tracks both the performance of Kingston Hydro's equipment and outage restoration operating functions.

Figure 5.2-22 shows the three-year rolling average customer hours of interruption per day during the severe weather days from 2010 to 2021.

The average CHI per day during severe weather days over the 2016-2021 timeframe is lower than the 2010-2015 timeframe. Kingston Hydro believes that its focus on System Renewal over the past 12 years has especially helped to make its overhead infrastructure more resilient.

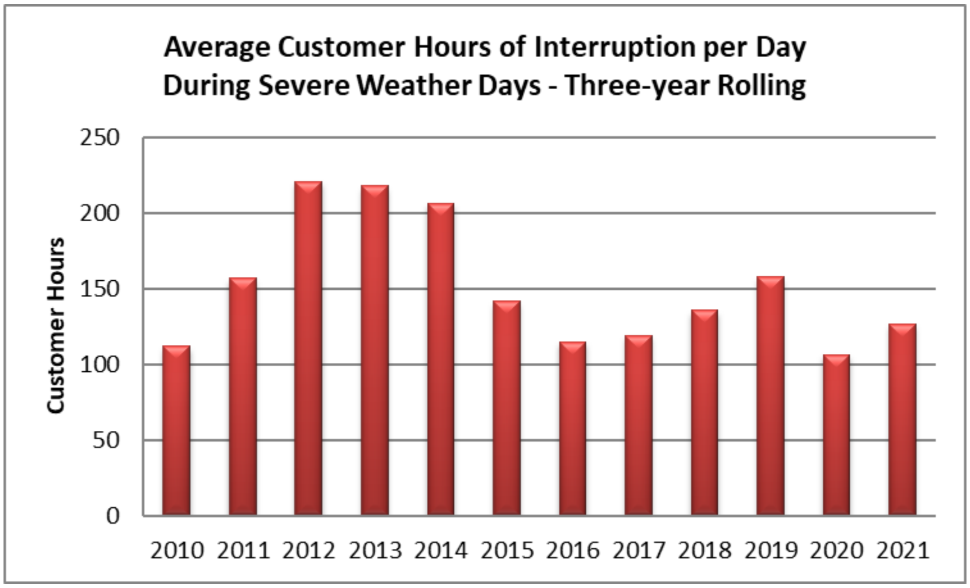


Figure 5.2-6 – 2010 to 2021 CHI per Day During Severe Weather Days

A2. Customer Average Interruption Duration (CAIDI) of Top 10 Days

Definition: A three-year rolling average of the output of a ratio of the total customer-hours of interruptions over the total customer interruptions, less the impact of Loss of Supply and MED events for the top 10 days contributing to CAIDI in each year. The operation-focused metric explores the operational effectiveness of the utility's field restoration crews and control room operators during the most operationally challenging days, which often coincide with poor weather.

Analysis Results:

Figure 5.2-7 shows the CAIDI for the top 10 days. Figure 5.2-8 shows the 3-year rolling average of CAIDI for top 10 days of each year for 2010 to 2021.

The high customer average interruption duration in 2017 was mainly due to two events.

- A motor vehicle collision broke two poles with 44kV and 5kV circuits. Kingston Hydro had to install two new poles that took a long time to restore the power.
- A large tree fell down on transformer kiosk TK300 and crushed the kiosk.

The high customer average interruption duration in 2014 was mainly due to a primary cable fault to a customer that took longer to replace compared to other faulted cables.

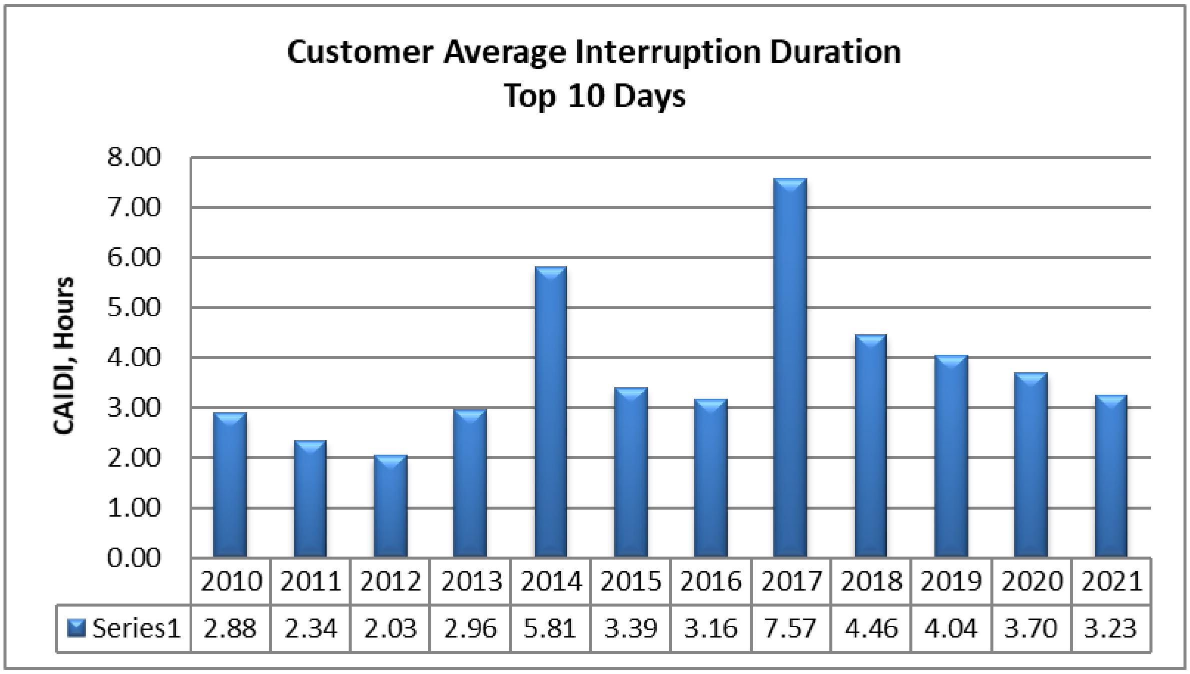


Figure 5.2-7 – 2010 to 2021 CAIDI for Top 10 Days

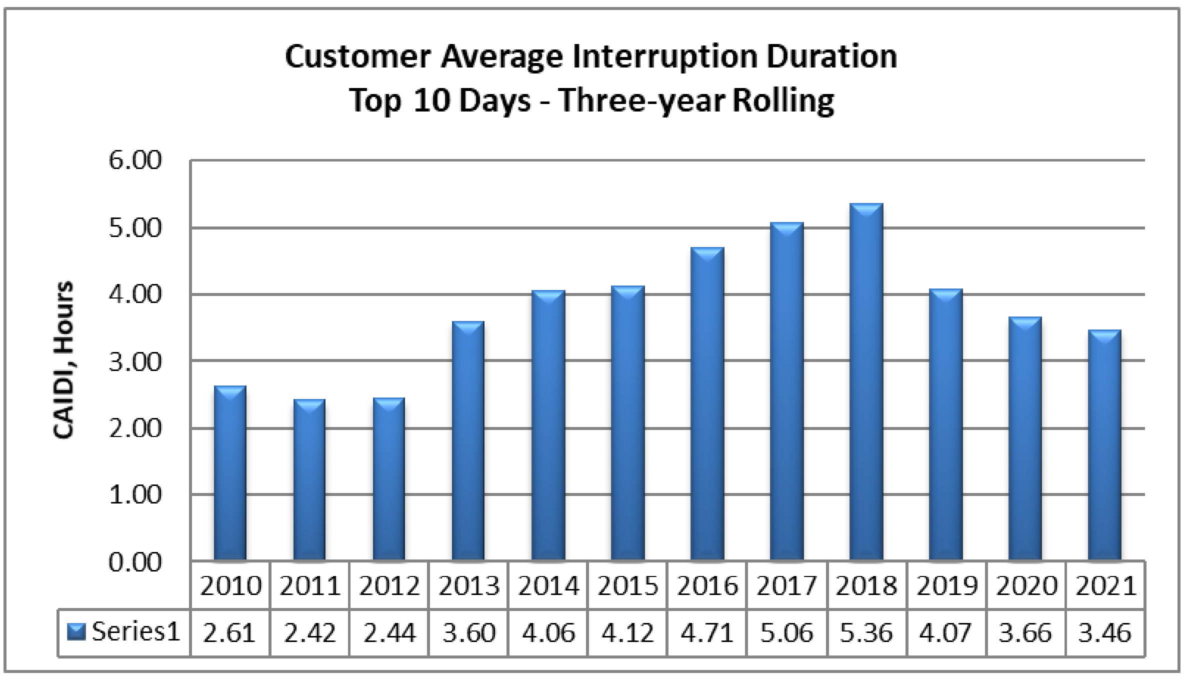


Figure 5.2-8 - 2010 to 2021 CAIDI for Top 10 Days - 3 Year Rolling Average

A3. Automated Outage Capability Detection Implementation Progress

Definition: Percentage completion of the contemplated project to enable automatic identification of outages using smart meter last gasp technology. The percentage can be expressed as a ratio of predetermined milestones over total milestones, completion count of phases, or progress of enablement as a percentage of total number of meters, among other possible expressions.

Analysis Results:

100% Complete

B. Planning and Execution Efficiency and Effectiveness Measures

B1. Warehouse Inventory Turnover (Days in Inventory).

Definition: The length of time (in days) that materials and equipment spend in the utility's inventory in a given year. A lower number of days implies that the utility is managing its inventory effectively and is not keeping unnecessarily high amounts of materials on hand (which would imply incurring additional working capital costs). The metric, as proposed here, is calculated in the following three steps:

Step 1: Determine Average Annual Inventory Amount – the average value of supplies and materials on hand throughout the year ($):

$$\frac{\$\text{ Opening Inventory} + \$\text{ Closing Inventory}}{2}$$

Step 2: Calculate the Inventory Turns – the number of times that the inventory is "turned over" (replenished) in a given year:

$$\frac{\$\text{ Materials Used in a Year}}{\$\text{ Average Annual Inventory}}$$

Step 3: Calculate Days in Inventory:

$$\frac{365}{\text{Inventory Turns}}$$

Analysis Results:

	2018	**2019**	**2020**	**2021**
Average Annual Inventory ($)	$1,989,032	$1,836,912	$1,803,727	$1,741,931
Inventory Turns	0.5324	0.4505	0.3820	0.628
Days in Inventory	685	810	955	581

Table 5.2-12 - Warehouse Inventory Turnover - Analysis Results

B2. Group Procurement Materials Cost Savings (%)

Definition: Equipment and materials savings enabled by way of group procurements through the GridSmartCity(GSC) group, relative to the baseline cost of the same basket of goods procured in recent past:

$$1 - \left(\frac{\$\text{ Basket of Goods Procured through GridSmart}}{\$\text{ Historical Baseline Basket of Goods}}\right)$$

Analysis Results:*

	2017	2018
GSC % Cost Savings – Group	-3.4%	-6.2%

Table 5.2-13 – Group Procurement Materials Cost Savings – Analysis Results

***Data supplied by GridSmartCity**

The baseline for GSC cost savings was 2016. After 2018 it became impractical to calculate year over year savings due to constant price increases caused by the pandemic and skyrocketing inflations.

There continues to be value from group purchases, however, and we appreciate better pricing and delivery times by purchasing in the group dynamic.

We plan to continue to purchase within this dynamic for these reasons.

B3. Progress of OMS / GIS / CIS Integration Activities.

Definition: Percentage completion of the contemplated project to enable the integration between the utility's Outage Management, GIS Asset Registry and Customer Information System (CIS) capabilities. The percentage can be expressed as a ratio of predetermined milestones over total milestones, or completion count of phases.

Analysis Results:

100% (Completed 2019)

C. Equipment-Specific Performance Measures

C1. Gas Insulated Switches Planned Outage CHI Avoided

Definition: Total number of hours of avoided planned outages enabled by installation of Gas-Insulated Switches that do not require equipment outages to conduct live-switching and maintenance work:

Number of Hours for live-switching and maintenance in a Year on Assets with new gas-insulated switches × Average Customers connected to these Assets

Analysis Results:

The following tables summarize total number of outages and average customer-hour interruptions (CHI) avoided for various gas switch IDs by date and switching order (PC17 #).

2018 Gas Switch Operations (Installed Before 2015)				
Date	PC17 #	Switch ID	Total Outages	CHI AVOIDED
2018-03-08	17-9396	GS11	4	446
2018-04-24	17-9493	GS11		
2018-06-19	17-9670	GS11		
2018-08-03	17-9778	GS11		
2018-04-27	17-9496	GS12	7	780.5
2018-04-27	17-9496	GS12		
2018-04-27	17-9496	GS12		
2018-04-27	17-9496	GS12		
2018-10-11	17-9935	GS12		
2018-10-11	17-9935	GS12		
2018-10-11	17-9935	GS12		
2018-04-24	17-9493	GS13	4	446
2018-08-29	17-9828	GS13		
2018-10-11	17-9947	GS13		
2018-10-15	17-9951	GS13		
2018-08-03	17-9778	GS15	1	111.5
2018-04-24	17-9493	GS2	2	223
2018-04-24	17-9493	GS2		
2018-08-16	17-9789	GS28	1	111.5
2018-06-26	17-9679	GS39	1	111.5
2018-04-19	17-9490	GS6	4	446
2018-04-24	17-9493	GS6		
2018-10-11	17-9935	GS6		
2018-10-11	17-9935	GS6		
		TOTAL CHI AVOIDED =		2676

Table 5.2-14 – 2018 Gas Switch Operations Installed Before 2015

2019 Gas Switch Operations (Installed Before 2015)				
Date	PC17 #	Switch ID	Total Outages	CHI AVOIDED
2019-04-17	17-10466	GS2	12	1338
2019-04-17	17-10466	GS2		
2019-04-17	17-10466	GS2		
2019-05-07	17-10508	GS2		
2019-05-07	17-10508	GS2		
2019-05-30	17-10604	GS2		
2019-05-30	17-10604	GS2		
2019-05-30	17-10604	GS2		
2019-05-30	17-10604	GS2		
2019-07-29	17-10813	GS2		
2019-09-27	17-10916	GS2		
2019-11-28	17-11106	GS2		
2019-05-08	17-10505	GS6	3	334.5
2019-09-26	17-10919	GS6		
2019-12-03	17-11141	GS6		
2019-03-20	17-10357	GS7	4	446
2019-03-20	17-10357	GS7		
2019-03-20	17-10359	GS7		
2019-09-26	17-10919	GS7		
2019-03-19	17-10345	GS11	11	1226.5
2019-03-20	17-10346	GS11		
2019-03-20	17-10363	GS11		
2019-03-20	17-10363	GS11		
2019-04-23	17-10482	GS11		
2019-05-06	17-10542	GS11		
2019-05-31	17-10605	GS11		
2019-07-29	17-10813	GS11		
2019-09-26	17-10919	GS11		
2019-11-28	17-11106	GS11		
2019-12-02	17-11109	GS11		
2019-05-07	17-10508	GS12	2	223
2019-05-15	17-10565	GS12		
2019-03-19	17-10345	GS13	11	1226.5
2019-03-20	17-10363	GS13		
2019-04-17	17-10466	GS13		
2019-04-17	17-10477	GS13		
2019-04-23	17-10487	GS13		
2019-04-24	17-10495	GS13		
2019-05-06	17-10542	GS13		
2019-05-07	17-10543	GS13		
2019-05-30	17-10604	GS13		
2019-07-29	17-10813	GS13		
2019-12-03	17-11138	GS13		
2019-04-30	17-10509	GS15	1	111.5
2019-05-08	17-10505	GS28	1	111.5
2019-06-28	17-10735	GS39	1	111.5
2019-05-08	17-10505	GS82	1	111.5
2019-05-08	17-10505	GS100	6	669
2019-06-03	17-10624	GS100		
2019-09-26	17-10919	GS100		
2019-12-01	17-11133	GS100		
2019-12-01	17-11131	GS100		
2019-12-03	17-11138	GS100		
	TOTAL CHI AVOIDED =		5909.5	

Table 5.2-15 – 2019 Gas Switch Operations Installed Before 2015

2020 Gas Switch Operations (Installed Before 2015)				
Date	PC17 #	Switch ID	Total Outages	CHI AVOIDED
2020-07-24	17-11543	GS2	1	111.5
2020-08-12	17-11544	GS6	3	334.5
2020-08-24	17-11598	GS6		
2020-11-18	17-11674	GS6		
2020-08-26	17-11618	GS12	1	111.5
2020-04-15	17-11352	GS13	6	669
2020-06-24	17-11473	GS13		
2020-07-09	17-11507	GS13		
2020-11-18	17-11674	GS13		
2020-12-08	17-11853	GS13		
2020-12-08	17-11853	GS13		
2020-03-10	17-11323	GS15	5	557.5
2020-03-22	17-11300	GS15		
2020-03-13	17-11306	GS15		
2020-08-26	17-11602	GS15		
2020-08-26	17-11618	GS15		
2020-04-15	17-11352	GS28	10	1115
2020-07-09	17-11508	GS28		
2020-09-20	17-11649	GS28		
2020-09-20	17-11652	GS28		
2020-09-25	17-11661	GS28		
2020-09-25	17-11661	GS28		
2020-09-25	17-11661	GS28		
2020-10-17	17-11714	GS28		
2020-10-17	17-11716	GS28		
2020-11-18	17-11674	GS28		
2020-01-16	17-11215	GS39	4	446
2020-01-31	17-11218	GS39		
2020-11-12	17-11766	GS39		
2020-12-22	17-11878	GS39		
2020-11-05	17-11763	GS41	2	223
2020-11-24	17-11796	GS41		
2020-01-10	17-11204	GS82	6	669
2020-01-11	17-11207	GS82		
2020-10-01	17-11668	GS82		
2020-10-01	17-11673	GS82		
2020-12-03	17-11841	GS82		
2020-12-08	17-11850	GS82		
2020-04-15	17-11352	GS100	4	446
2020-06-24	17-11473	GS100		
2020-11-18	17-11674	GS100		
2020-12-08	17-11850	GS100		
	TOTAL CHI AVOIDED =		4683	

Table 5.2-16 - 2020 Gas Switch Operations Installed Before 2015

2021 Gas Switch Operations (Installed Before 2015)				
Date	PC17 #	Switch ID	Total Outages	CHI AVOIDED
2021-06-17	17-12213	GS2	5	557.5
2021-12-08	17-12527	GS2		
2021-12-08	17-12527	GS2		
2021-12-23	17-12612	GS2		
2021-12-23	17-12612	GS2		
2021-01-05	17-11881	GS11	3	334.5
2021-01-05	17-11883	GS11		
2021-02-03	17-11965	GS11		
2021-04-18	17-12090	GS12	2	223
2021-04-25	17-12136	GS12		
2021-01-05	17-1181	GS13	10	1115
2021-01-05	17-11883	GS13		
2021-01-05	17-11883	GS13		
2021-01-09	17-11892	GS13		
2021-07-23	17-12281	GS13		
2021-07-23	17-12281	GS13		
2021-12-08	17-12527	GS13		
2021-12-08	17-12549	GS13		
2021-12-14	17-12551	GS13		
2021-12-23	17-12612	GS13		
2021-12-08	17-12527	GS28	2	223
2021-12-23	17-12612	GS28		
2021-12-08	17-12527	GS100	2	223
2021-12-23	17-12612	GS100		
	TOTAL CHI AVOIDED =		2676	

Table 5.2-17 – 2021 Gas Switch Operations Installed Before 2015

*Average Customers Connected to a Gas Switch = 223
*Average Outage Length to Switch an Oil Switch is 30 minutes
* 0.5 (hr) X 8 (operations) X 223 (average customers connected) = **CHI Avoided**

2018 Gas Switch Operations (Installed after 2015)				
Date	PC17 #	Switch ID	Total Operations	CHI AVOIDED
2018-04-19	17-9490	GS8	2	223
2018-08-29	17-9828	GS8		
2018-09-26	17-9910	GS85	2	223
2018-09-26	17-9914	GS85		
2018-06-01	17-9617	GS9	4	446
2018-08-29	17-9828	GS9		
2018-04-04	17-9446	GS9		
2018-04-04	17-9446	GS9		
		TOTAL CHI AVOIDED =		892

Table 5.2-18 – 2018 Gas Switch Operations Installed After 2015

2019 Gas Switch Operations (Installed After 2015)				
Date	PC17 #	Switch ID	Total Operations	CHI AVOIDED
2019-05-08	17-10505	GS8	5	557.5
2019-07-05	17-10758	GS8		
2019-09-26	17-10919	GS8		
2019-10-08	17-10932	GS8		
2019-11-28	17-11106	GS8		
2019-07-05	17-10758	GS9	2	223
2019-11-28	17-11106	GS9		
2019-01-21	17-10218	GS29	1	111.5
		TOTAL CHI AVOIDED =		892

Table 5.2-19 – 2019 Gas Switch Operations Installed After 2015

2020 Gas Switch Operations (Installed After 2015)				
Date	PC17 #	Switch ID	Total Operations	CHI AVOIDED
2020-07-09	17-11507	GS9	4	446
2020-09-20	17-11649	GS9		
2020-09-25	17-11661	GS9		
2020-11-18	17-11674	GS9		
2020-10-29	17-11735	GS85	1	111.5
2020-11-12	17-11766	GS29	5	557.5
2020-11-12	17-11766	GS29		
2020-11-18	17-11768	GS29		
2020-11-18	17-11768	GS29		
2020-12-22	17-11878	GS29		
		TOTAL CHI AVOIDED =		1115

Table 5.2-20 – 2020 Gas Switch Operations Installed After 2015

2021 Gas Switch Operations (Installed After 2015)				
Date	PC17 #	Switch ID	Total Operations	CHI AVOIDED
2021-06-17	17-12213	GS3	2	223
2021-06-17	17-12213	GS3		
2021-02-08	17-11696	GS29	4	446
2021-11-23	17-12505	GS29		
2021-11-23	17-12505	GS29		
2021-11-23	17-12505	GS29		
2021-07-21	17-12283	GS85	2	223
2021-07-21	17-12285	GS85		
			TOTAL CHI AVOIDED =	892

Table 5.2-21 – 2021 Gas Switch Operations Installed After 2015

C3. Average CHI for Defective Equipment Outages.

Definition: Annual average CHI for all Defective Equipment Outages Experienced, less any MED attributed outages.

Analysis Results:

It measures the extent of impact on Kingston Hydro's customers by outages caused by defective equipment, as an indication of the state of repair of Kingston Hydro assets. Over time, this metric's results could be used to inform the planning decisions as to which assets to replace.

Figure 5.2-9 shows the Total Customer-hours of Interruptions Caused by Defective Equipment. The high customer-hour caused by Defective Equipment in 2020 was mainly due to a failed bushing of the 44kV oil circuit breaker 2M22 at the substation MS2 that alone contributed 10593 customer-hours.

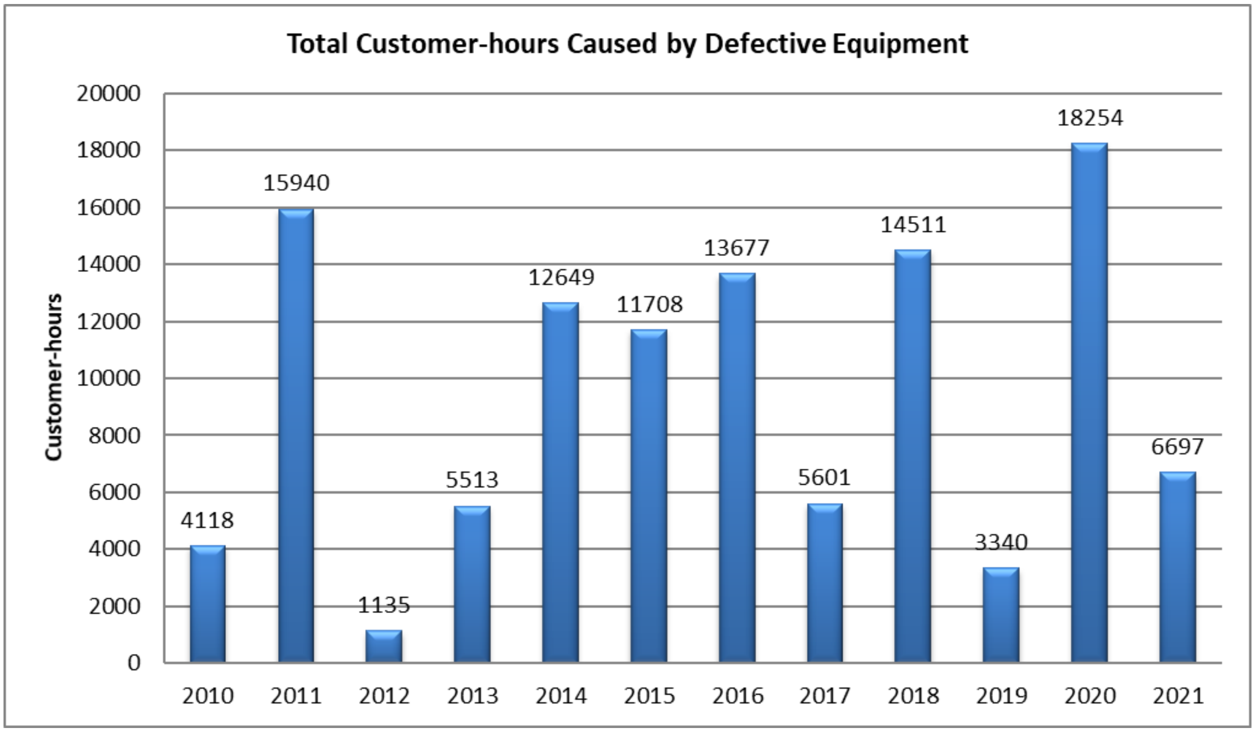


Figure 5.2-9 – Total Customer-Hours of Interruptions Caused by Defective Equipment

C4. System Average Interruption Frequency Index – Defective Equipment by Major Asset Class: Poles, Underground Cables, Transformers.

Definition: Contribution to SAIFI of defective equipment outages attributed to specific asset classes, deemed to be in a particularly poor condition, or otherwise prioritized by the utility or considered for future prioritization.

Analysis Results:

This measurement provides Kingston with indication of the relative impact magnitude of each major equipment type's failure on the system as a whole. Observation of changes in multi-year trends across different asset classes presents Kingston Hydro with another way to plan and prioritize its future replacement work across a number of potential capital allocation options.

Figures 5.2-10 through 5.2-12 show the System Average Interruption Frequency caused by defective cable, distribution transformer and pole respectively. The analysis shows the defective cables have a significant impact on customer service reliability. The high number of customer interruptions caused by Defective Cable in 2021 was mainly due to a faulted 44kV PILC cable.

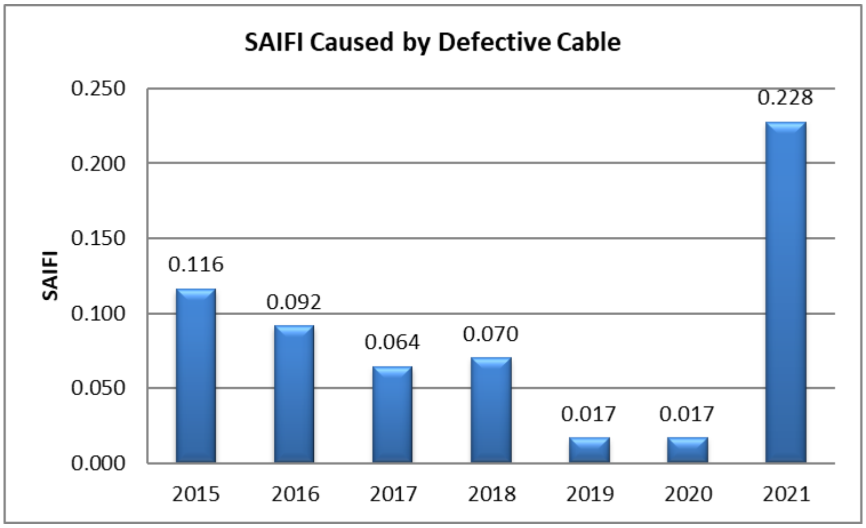


Figure 5.2-10 - The System Average Interruption Frequency Caused by Defective Major Equipment - Caused by Defective Cable

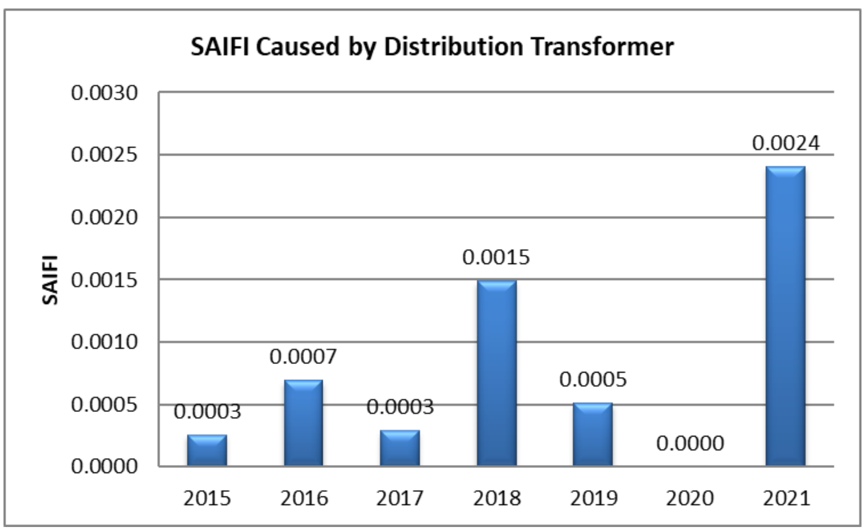


Figure 5.2-11 – The System Average Interruption Frequency Caused by Defective Major Equipment - Caused by Distribution Transformer

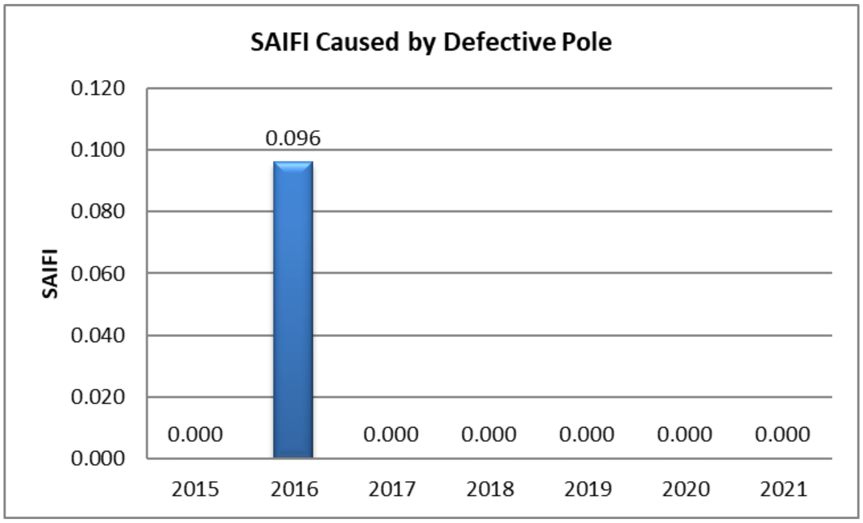


Figure 5.2-12 – The System Average Interruption Frequency Caused by Defective Major Equipment - Caused by Defective Pole

Corporate Performance Measures Impact on DSP

Kingston Hydro has only recently started to track some of the Corporate performance measure recommended by Metsco. Kingston Hydro will continue to monitor and act on Corporate Performance Outcomes and Performance Measures.

(iv) Other Measures

Monitoring of Risk Management

Analyzing the historic outage trends due to tree contact, underground cable failures and 5kV oil switches have been an effective form of risk management for Kingston Hydro and these trends are described in further detail below.

a) Tree Trimming Program Risk Management - Results

The cause of outage summaries in Figure 5.2-22 indicates that tree contact represented 14.73% of the total 2015-2021 TCHI when loss of supply and major events were excluded.

Tree Trimming Program Risk Management - Impact on DSP

Approximately 5 years ago, staff analyzed the historic impact of tree contacts on Total Customer Hour Interruptions (TCHI) and adjusted the Tree Trimming program. Kingston Hydro will continue to monitor expenses against this program over the 2023-2027 timeframe.

b) 44kV and 5kV 500MCM PILC Cable Risk Management - Results

As one of the oldest LDCs, Kingston Hydro has large amounts of 44kV and 5kV PILC cables in service. 44kV and 5kV main PILC cable faults occurred two times per year on average in the past ten years. Figure 5.2-13 shows the number of 5kV main 500MCM PILC cable faults and TCHI caused by cable faults by year from 2010 to 2021, (branch PILC cables and service PILC cables are not included).

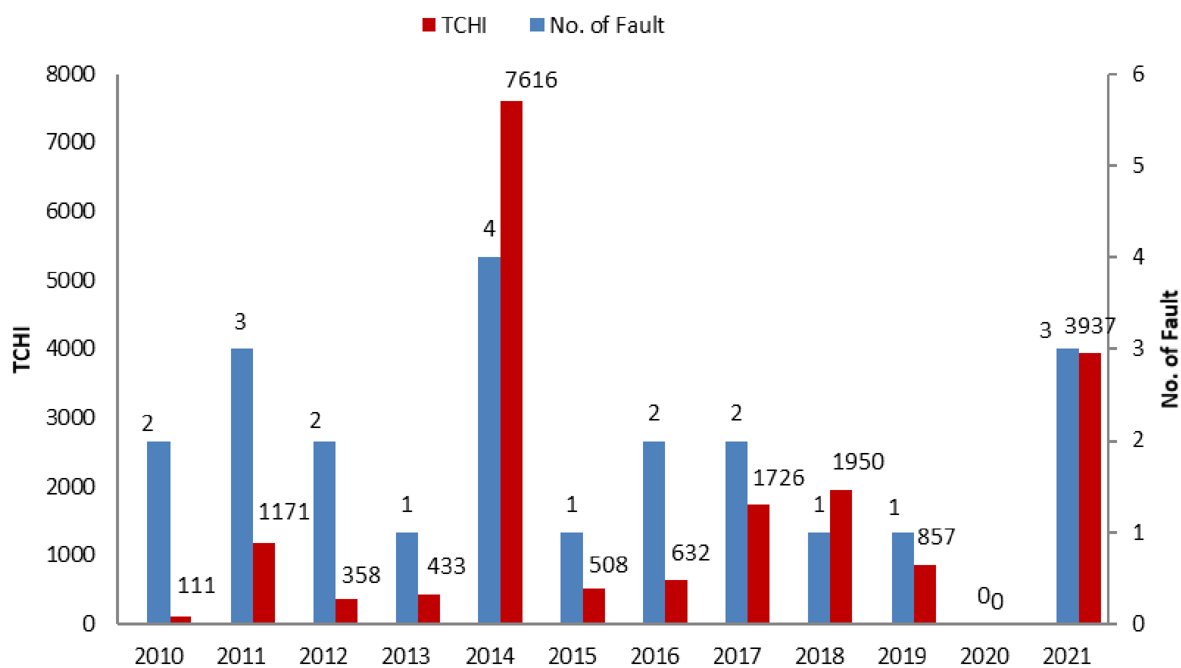


Figure 5.2-13 – 2010 to 2021 Outages Caused by Fault of 5kV 500MCM PILC Cables

44kV and 5kV 500MCM PILC Cable Risk Management – Impact on DSP

To address these high frequency asset failure issues, Kingston Hydro has established a systematic plan to replace PILC cable risers at substations. There is also provision in the 2022-2027 capital plan to replace faulted and/or obsolete 5kV 500MCM PILC Main Cables through reactive cable replacement, substation upgrade, transformer vault upgrade projects and road reconstruction projects.

Kingston Hydro recently undertook collaborative testing of underground cable with IREQ (Tan-Delta) and Cable-Q (high frequency depolarization) in order to better understand the condition of existing 5kV XLPE cables, but the findings were inconclusive.

Kingston Hydro will continue to pace the replacement of obsolete and legacy PILC cable. In cases where both 44kV supplies to a Kingston Hydro substation are dependent on PILC cables, Kingston Hydro has prioritized replacement of at least one of those supplies.

(c) Monitoring of Growth and Planning

Master Plan studies completed every 5 years are considered to be the most effective performance measure for monitoring growth and planning.

Kingston Hydro also believes CDM targets are another effective performance measure for ensuring its distribution system meets both current and future needs.

(d) 5kV Oil Switches in Transformer Vaults - Objectives

Kingston Hydro will continue to pace the replacement of obsolete and legacy 5kV oil switches in transformer vaults with the goal of eventually eliminating these legacy assets to improve system operability and worker safety.

5kV Oil Switches in Transformer Vaults - Results

The Kingston Hydro underground distribution system features legacy oil switches which are unsafe to operate while energized due to slow-moving deteriorated mechanical contacts. Therefore, planned outages classified as a Code 1 cause of interruption are further sub-classified internally as 1A and 1B outages. 1A is identical to planned outage Code 1 as defined in the OEB RRR Filing Requirements, while 1B denotes planned outages performed to accommodate work, or switching, that requires these old oil switches to be de-energized before operating to ensure a safe work environment. These supporting outages significantly increase the number of planned outages, negatively impacting reliability performance and our customers. Figure 5.2-14 shows the numbers of planned outages scheduled to operate the oil switches and Figure 5.2-15 shows total customers affected and total customer-hours of interruption caused by having to de-energize the oil switches by year from 2005 to 2021. Kingston Hydro has replaced three 5kV oil switches (twelve ways) in the previous planning horizon (2015-2020), we can see the decline of planned outages related to the need to operate oil switches. Kingston Hydro also monitors the outages avoided through replacing oil switches with new gas switches. Table 5.2-22 shows the numbers of avoided plan outage and avoided total customer-hours of interruption by these three gas switches from 2018 to 2021. Kingston Hydro will continue this oil switch replacement program over the 2022-2027 timeframe.

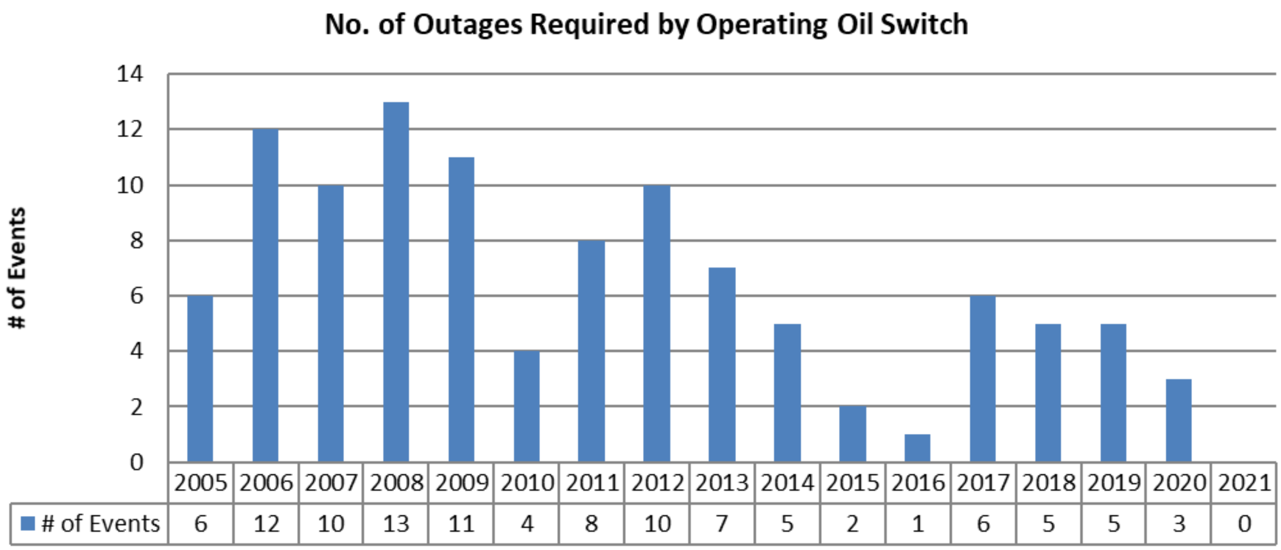


Figure 5.2-14 - 2005 to 2021 Number of Planned Outages Required for Operating Oil Switch

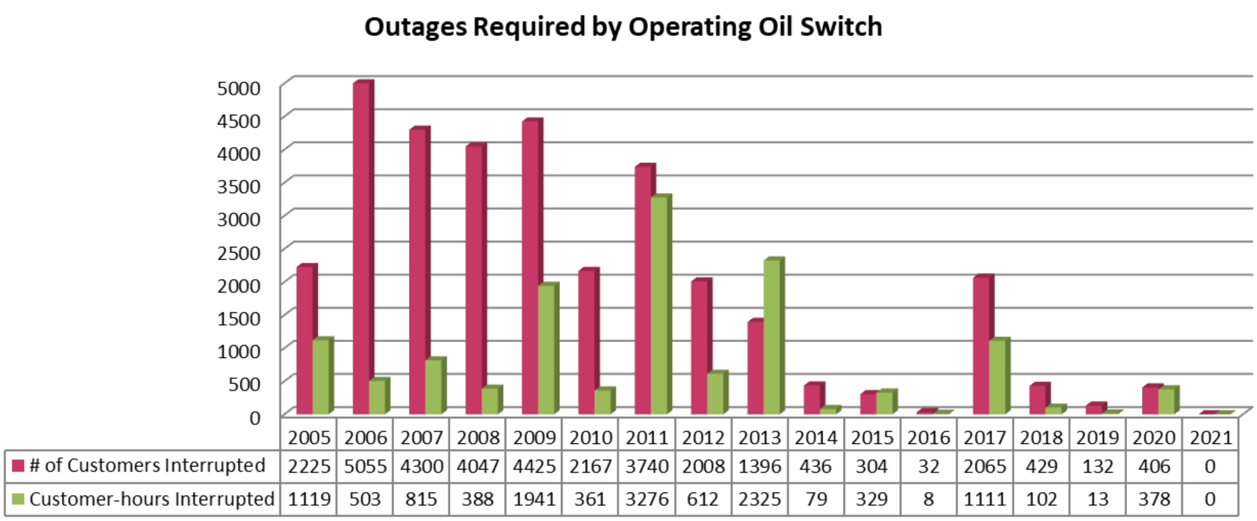


Figure 5.2-15 – 2005 to 2021 Outages Required for Operating Oil Switch

Year	# of Events	Customer-hours Interrupted
2018	20	3122
2019	33	5798
2020	25	3568
2021	18	3122

Table 5.2-22 – Avoided Planned Outages Required for Operating Oil Switch

(e) Engineering Support Services Performance Measure - Objective

Kingston Hydro benefits from the multi-utility model of its affiliate service provider, Utilities Kingston and has evaluated the annual savings of this service model.

Kingston Hydro is committed to ensuring that it receives best value for the work it contracts through continuous review of pricing received for contract work.

Kingston Hydro ensures cost-effective design solutions through monitoring of engineering costs as a percentage of total project cost.

Engineering Support Services Performance Measure - Results

Kingston Hydro benefits from the multi-utility model of its affiliate service provider, Utilities Kingston. A previous audit confirmed that the multi-utility model saves more than $60 per Kingston Hydro customer annually. More information related to the benefits of the multi-utility model was filed under Exhibit 1 Tab 2 of the Kingston Hydro 2016 rate filing (EB-2015-0083).

Kingston Hydro is committed to ensuring that it receives best value for contracted work through continuous review of pricing and when necessary, makes adjustments to its processes or the scope of contracts accordingly. One such example, from 2007 to 2012, Kingston Hydro awarded one large General Services contract annually for civil works. However, since 2012, Kingston Hydro has switched to issuing smaller, multiple contracts rather than one large contract. This change in approach to contracting allows Kingston Hydro to tailor contracts to specific project needs thus optimizing pricing and minimizing financial risk.

Kingston Hydro undertook a review of design costs associated with its capital work. This activity includes all engineering design work and construction management services provide throughout a project. Due to recent Financial Management System Upgrades (FMS) upgrades, this review was limited to 2017-2021.

The design costs were analyzed, and the results are summarized in Table 5.2-23 and Table 5.2-24.

	Project Expenditure		% Design of Project		2017-2021 Total Expenditures		
Project Type	Min.	Max.	Min.	Max.	Project	Design	%Design
Overhead	$20,856	$2,775,578	1.5%	13.2%	$6,990,247	$380,523	5.4%
Underground	$25,759	$1,276,143	1.1%	7.1%	$2,795,478	$108,484	3.9%
Substation	$60,339	$5,033,356	6.1%	17.2%	$6,735,367	$736,137	10.9%

Table 5.2-23 – Analysis of Project Design Costs

	2017	2018	2019	2020	2021	Total
Annual CAPEX	$4,183,433	$5,074,622	$4,825,859	$4,061,528	$4,659,846	$22,805,288
Design CAPEX	$ 214,401	$ 294,840	$ 317,686	$ 397,320	$ 265,840	$ 1,490,086
% Design	5.1%	5.8%	6.6%	9.8%	5.7%	6.5%

Table 5.2-24 – Total Design Costs by Year

As per Table 5.2-23, individual project design costs ranged from 1.1% to 17.2%. Overhead and underground projects typically involve the assembly of standard designs whereas substation work involves more custom or site specific design, coordination, and commissioning. The % design costs for underground projects are generally lower than overhead projects because the material costs are typically a higher percentage of underground projects compared to overhead projects.

The total annual design expenditures expressed as a percentage of total annual capital expenditures in Table 5.2-24 range from 5.1% to 9.8%. The highest 9.8% figure for 2020 is due to the upfront design costs of multi-year projects such as the Substation MS1 rebuild.

Relative to performance, Kingston Hydro expenditures compare favorably with industry norms. The current version of the Ontario Society of Profession Engineers (OSPE) Fee Guideline (2015) provides suggested fees as a percentage of construction cost for construction contracts. For projects $500,000 to $1,000,000 in value, the fees for “engineering design services only” range from 6.2% to 9.3% of construction costs and the fees for “complete design and construction management” range from 23% to 34.5%. Kingston Hydro costs for the same activities compare favorably and trend to the lower end of the industry range. For the forecast period of 2022 to 2027 Kingston Hydro will continue to monitor its engineering design and construction management expenses against total project costs. Kingston Hydro while recognizing that varying project scope triggers different levels of activities expects its average annual design and inspection costs will remain between 5.1% and 9.8% of annual capital expenditures.

Engineering Support Services Performance – Impact on DSP

Kingston Hydro's does not anticipate any significant changes to its engineering support services at this time.

5.2.3.2 Service Quality and Reliability

Reliability Performance Using Industry Standards - Objectives

In accordance with Industry Standards and the Ontario Energy Board's (OEB's) Electricity Distribution Rate Handbook and Electricity Reporting and Record Keeping Requirements (RRR), Kingston Hydro records and files the System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) to the OEB annually. The industry standard formula for calculating SAIDI and SAIFI is as follows:

$$\text{SAIDI} = \frac{\text{Total customer hours of interruptions}}{\text{Average number of customers served}}$$

$$\text{SAIFI} = \frac{\text{Total customer interruptions}}{\text{Average number of customers served}}$$

At present, Kingston Hydro does not monitor momentary interruptions under a minute and therefore cannot calculate the Momentary Average Interruption Frequency Index (MAIFI) which is a relatively new industry standard that has not been adopted by all distributors to date. Furthermore, momentary outages are not currently a source of customer concerns or complaint.

Kingston Hydro developed the Kingston Hydro Outage Management Database (OMD), which captures Time-off and Time-on of the Services, Numbers of Customers Affected, Cause of Interruption (OEB Outage Code), Weather Condition and other outage information for reliability analysis and operational management, in 2000. Kingston Hydro adopted secondary causes developed by CEA Service Continuity Committee in 2017, in addition to the primary causes, to provide greater detail in cause analysis of outages. A new Outage Management System (OMS) was implemented in March 2019. The new OMS will improve the accuracy of the outage data and provide more powerful tools to analyze the Kingston Hydro system reliability performance. Kingston Hydro calculates the annual reliability indexes, analyzes reliability trends by Cause of Interruption and reports these reliability performance measures to the OEB and Kingston Hydro's Board of Directors.

Kingston Hydro performs reliability statistics and analysis in three ways:

- including Loss of Supply and Major Event Days;
- excluding Loss of Supply; and
- excluding Loss of Supply and Major Event Days.

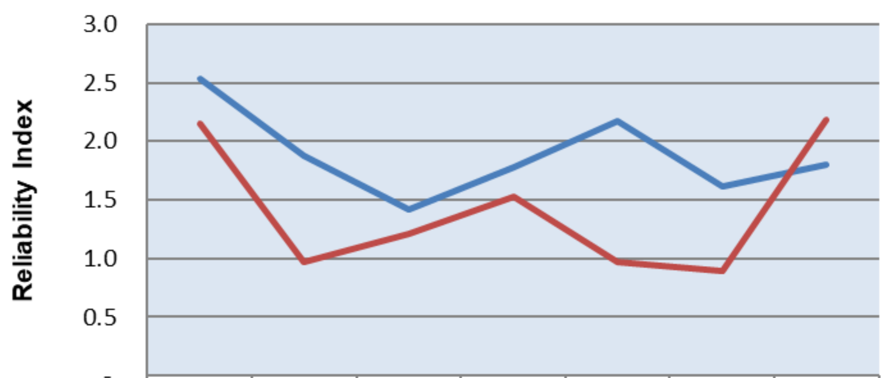
Kingston Hydro files the reliability indexes SAIDI and SAIFI, SAIDI and SAIFI excluding Loss of Supply, SAIDI and SAIFI excluding Loss of Supply and Major Event Days, to the OEB as specified in the RRR requirements. Kingston Hydro calculates and analyzes the two reliability indexes excluding Loss of Supply and Major Event Days for the following reasons:

- Events of **Loss of Supply** have a significant impact on the service reliability of the Kingston Hydro Distribution System but are out of Kingston Hydro's control so excluded from the system reliability analysis in order to focus on performance within the control of the utility.
- Major Event Days are defined as the days on which the energy delivery system experienced stresses beyond that normally expected, such as severe weather, in accordance with the IEEE 1366 standard. These major events shall are studied separately from daily operation to better reveal trends in daily operation that would be hidden by the large statistical effect of major events.

Reliability Performance Results Using Industry Standards - Results

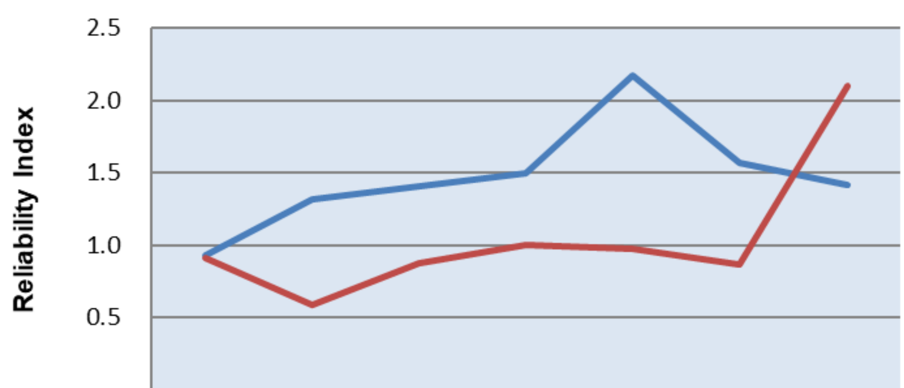
Reliability Trends

Figure 5.2-16 shows the unadjusted system reliability indices SAIDI and SAIFI for the years of 2015-2021 including loss of supply and major event days. Figure 5.2-17 shows system reliability indices SAIDI and SAIFI for the years of 2015-2021 excluding loss of supply. Figure 5.2-18 shows system reliability indices SAIDI and SAIFI for the years of 2015-2021 excluding loss of supply and major event days. There was a major event day in 2019.



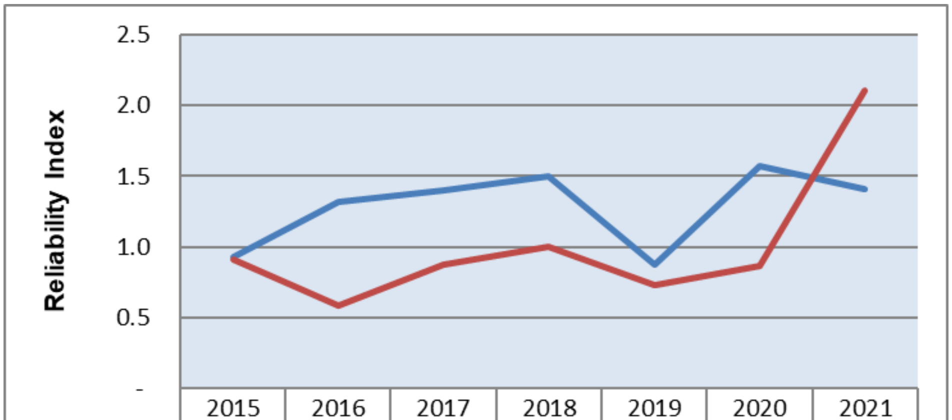
	2015	2016	2017	2018	2019	2020	2021
SAIDI	2.54	1.88	1.42	1.78	2.17	1.61	1.80
SAIFI	2.16	0.97	1.21	1.53	0.97	0.89	2.18

Figure 5.2-16 – 2015 to 2021 System Reliability Indices Including Loss of Supply and Major Event Days



	2015	2016	2017	2018	2019	2020	2021
SAIDI	0.93	1.32	1.40	1.50	2.17	1.57	1.41
SAIFI	0.91	0.59	0.87	1.00	0.97	0.87	2.10

Figure 5.2-17 – 2015 to 2021 System Reliability Indices Excluding Loss of Supply



	2015	2016	2017	2018	2019	2020	2021
SAIDI	0.93	1.32	1.40	1.50	0.88	1.57	1.41
SAIFI	0.91	0.59	0.87	1.00	0.73	0.87	2.10

Figure 5.2-18 – 2015 to 2021 System Reliability Indices Excluding Loss of Supply and Major Event Days

Major Event Day

A severe windstorm hit Ontario on November 1, 2019. Sixteen 5kV feeders and one 44kV feeder tripped, leaving 7,069 out of 27,600 or 25.6% of customers without power in the Kingston Hydro service territory. This Major Event accounted for 35,770 total customer hours of interruption or 60% of yearly TCHI in 2019.

Reliability Target

Kingston Hydro has defined the SAIDI and SAIFI remaining within the range of its historical performance in the past five years (2010-2014) as the reliability performance targets for the planning horizon (2015-2020) in previous rate application. The targets are:

SAIDI = 1.78 hours

SAIFI = 1.42

These reliability performance targets include major event days. The adjusted targets excluding major event days are

SAIDI = 1.45 hours

SAIFI = 1.40

The OEB report EB-2014-0189 **Electricity Distribution System Reliability Measures and Expectations** sets the average reliability index in the past five historical years as the reliability performance benchmarks for the distributor in its scorecard measurement. These targets for Kingston Hydro are

SAIDI = 1.03 hours

SAIFI = 0.95

Figures 5.2-19 and 5.2-20 shows the reliability performance targets in the previous rate application, the OEB scorecard targets and the actual SAIDI and SAIFI excluding loss of supply and major event days from 2015 to 2021.

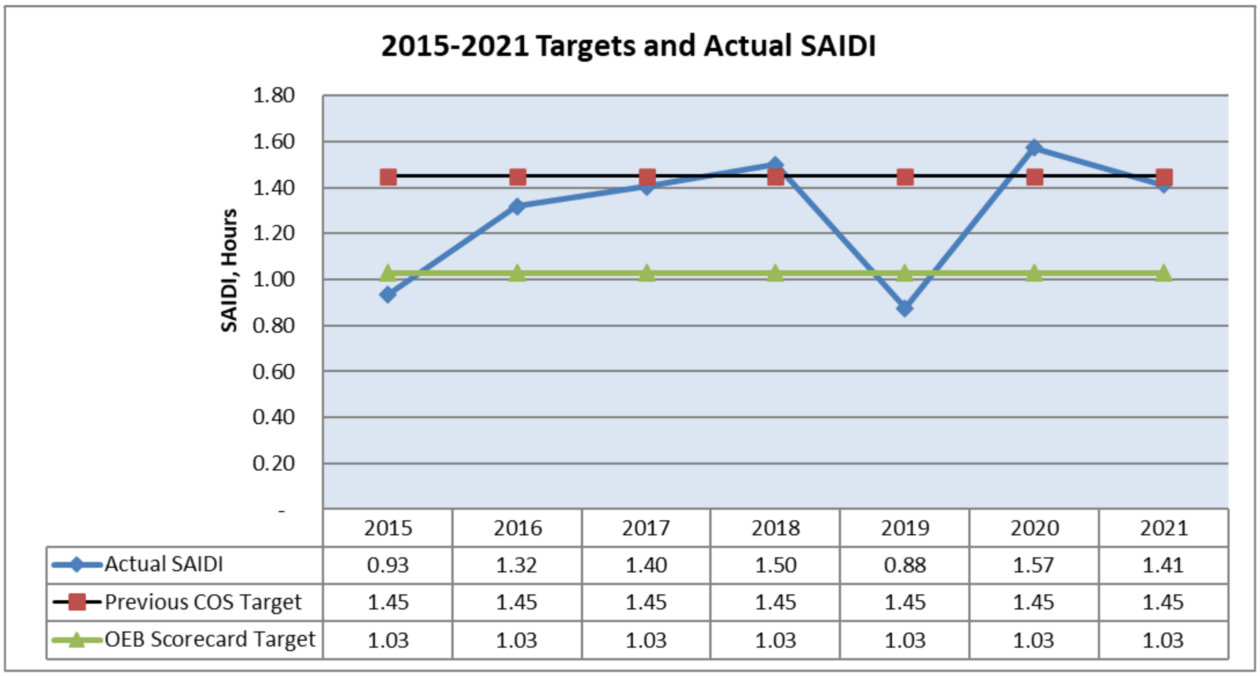
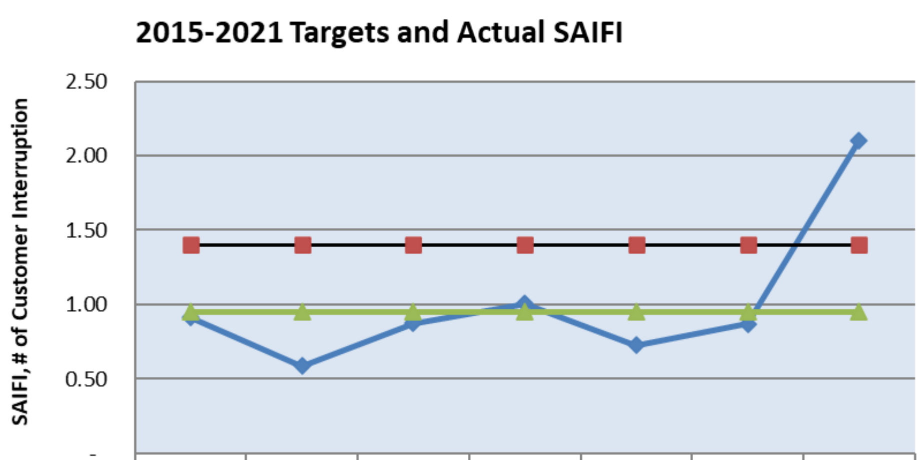


Figure 5.2-19 – 2015 to 2021 Targets and Actual SAIDI



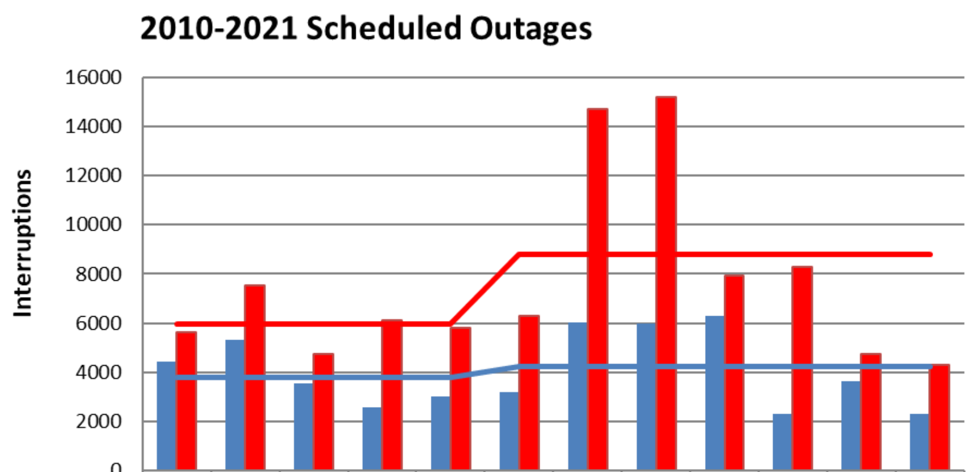
	2015	2016	2017	2018	2019	2020	2021
Actual SAIFI	0.91	0.59	0.87	1.00	0.73	0.87	2.10
Previous COS Target	1.40	1.40	1.40	1.40	1.40	1.40	1.40
OEB Scorecard Target	0.95	0.95	0.95	0.95	0.95	0.95	0.95

Figure 5.2-20 – 2015 to 2021 Targets and Actual SAIFI

In general, the Kingston Hydro's SAIFI performance between 2015 and 2021 meets both reliability targets set up by Kingston Hydro and the OEB scorecard except in 2021. The SAIDI meets Kingston Hydro targets except in 2018 and 2020 but doesn't meet the targets set up by the OEB scorecard from 2015 to 2021.

This under-performance was due to the following events:

- **Increased Scheduled Outages for Asset Upgrades (2016 to 2019)**
  Kingston Hydro increased investments to upgrade aging assets in previous planning horizon (2015-2020). Consequently, the required scheduled outages for asset upgrades increased, especially to overhead asset upgrades. Figure 5.2-21 shows the total customer hours of interruptions and total customer interruptions caused by Scheduled Outages from 2010 to 2021. The average SAIDI caused by Scheduled Outages from 2015 to 2020 increases 0.126 relative to that from 2010 to 2014. With the investment level back to normal in the next planning horizon (2022-2027), Kingston Hydro expect the SAIDI and SAIFI due to Scheduled Outage for asset upgrades will decrease.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
No. of Customer Interruptions	4424	5334	3559	2579	3023	3187	6016	5972	6310	2291	3652	2293
Customer-hours of Interruptions	5617	7535	4729	6096	5796	6310	14716	15164	7924	8292	4740.9	4278
5 Yr Average	3784	3784	3784	3784	3784	4246	4246	4246	4246	4246	4246	4246
5 Yr Average	5955	5955	5955	5955	5955	8775	8775	8775	8775	8775	8775	8775

Figure 5.2-21 – 2010 to 2021 Interruptions by Scheduled Outages

- **A Pole Line Failure on John Counter Boulevard in 2016**

  A 5kV pole line on John Counter Boulevard failed on June 17, 2016. A total of 2,630 customers were impacted. The forced outage caused a total of 8,283 customer-hours of interruptions and increased the SAIDI by 0.3 hours and SAIFI by 0.1.

  A third party investigation of the pole line failure determined that several factors contributed to the pole line failure. At the time of the failure, the pole line had been identified by the utility to be replaced due to its condition and age, and in fact, the lines were being transferred to the new poles the following business day. The pole line failure was an isolated incident, driven by a number of unrelated factors that Kingston Hydro is confident won't occur again.

- **Substantial Customer-hours of Interruptions by Vehicle Accidents in 2017**

  Four vehicle accidents occurred in 2017, involving a 44kV circuit and five 5kV circuits and causing a total of 6,072 customer-hours of interruptions, or 0.22 in SAIDI and 0.11 in SAIFI. Normally, the outages caused by vehicle accidents have minimal impacts to the system reliability. However, the substantially high customer interruptions by vehicle accidents in 2017 are exceptional. It was outside of Kingston Hydro's control.

- **MS3 5kV Bus Trip Due to a Defective Fibre Insulation Board in 2018**
  The Arc-flash Protection tripped both of the transformer main breakers at the substation MS3 on January 11, 2018, due to a defective fibre insulation board in the bus-tie cell. The single forced outage was responsible for 0.34 hours in SAIDI and 0.08 in SAIFI. In response to this incident, all equipment at substations was checked to verify that this was a particularly isolated case.

- **MS2 44kV Oil Circuit Breaker Bushing Failure in 2020**
  A 44kV bushing of a 44kV oil circuit breaker at the substation MS2 failed, causing 3,041 customers without power and a total of 10,593 customer-hours of interruptions, or 0.38 in SAIDI. This single event contributed 24.3% of the annual SAIDI in 2020. This was the second 44kV bushing failure in the last few years. There are seven end-of-life 44kV oil circuit breakers in the Kingston Hydro. Kingston Hydro has planned to replace five 44kV oil circuit breakers by 2025.

- **44kV Customer-owned Equipment Failure in 2021**
  A 44kV cable termination was failed at a customer owned substation on March 5, 2021. The foreign interference caused a total of 10,716 customers of interruptions and 13,873 customer-hours of interruptions, or 0.38 in SAIFI and 0.50 in SAIDI. This single event contributed 35.5% of the annual SAIDI and 18.1% of the annual SAIFI in 2021.

- **Unknown Trips of Multiple 44kV Feeders During A Thunderstorm in 2021**
  Two 44kV feeders that also were back-feeding other 44kV feeders tripped during a thunderstorm on July 1, 2021. A total of four 44kV feeders involved in this outage. The single unknown forced outage was responsible for 0.65 in SAIFI in 2021.

Kingston Hydro has defined the SAIDI and SAIFI remaining within the range of the average of the past five years (2017-2021) of historical data as the reliability performance targets for the next planning horizon (2022-2027). The SAIDI and SAIFI targets are:

- SAIDI = 1.35 hours
- SAIFI = 1.11

A summary of service reliability index and the 5 year average in the last five historical years (Appendix 2-G) is listed in Table 5.2-25 and Table 5.2-26.

Service Reliability

Index	Excluding Loss of Supply and Major Event Days					Including Major Event Days, Excluding Loss of Supply				
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
SAIDI	1.40	1.50	0.88	1.57	1.41	1.40	1.50	2.17	1.57	1.41
SAIFI	0.87	1.00	0.73	0.87	2.10	1.07	1.00	0.97	0.87	2.10

5 Year Historical Average

SAIDI		1.352		1.610
SAIFI		1.114		1.202

SAIDI = System Average Interruption Duration Index

SAIFI = System Average Interruption Frequency Index

Table 5.2-25 – Summary of Service Reliability Excluding Loss of Supply – 2017 to 2021 (From App.2-G SQI)

Note: The SAIFI published in the Scorecard for the 2017 measure is incorrect, as it includes momentary outages that are not to be included in this measure.

Service Reliability

Index	Including Loss of Supply, Excluding Major Event Days					Including Loss of Supply and Major Event Days				
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
SAIDI	1.42	1.78	0.88	1.61	1.80	1.42	1.78	2.17	1.61	1.80
SAIFI	1.21	1.53	0.73	0.89	2.18	1.21	1.53	0.97	0.89	2.18

5 Year Historical Average

SAIDI		1.498		1.756
SAIFI		1.308		1.356

SAIDI = System Average Interruption Duration Index

SAIFI = System Average Interruption Frequency Index

Table 5.2-26 – Summary of Service Reliability Including Loss of Supply – 2017 to 2021 (From App.2-G SQI)

Note: The SAIFI published in the Scorecard for the 2017 measure is incorrect, as it includes momentary outages that are not to be included in this measure.

Analysis by Cause of Interruption

Overview

Kingston Hydro tracks all outages by cause of interruption as specified in the OEB's RRR Requirements. Figure 5.2-22 and Figure 5.2-23 present a breakdown of all outages including and excluding loss of supply and major events from 2015 to 2021 by the total customer hours of interruption ("TCHI") and outage codes. The majority of all outages from 2015 to 2021 were due to loss of supply (Code 2 at 24.17%) followed by defective equipment (Code 5 at 22.49%) and scheduled outage (Code 1 at 19.46%).

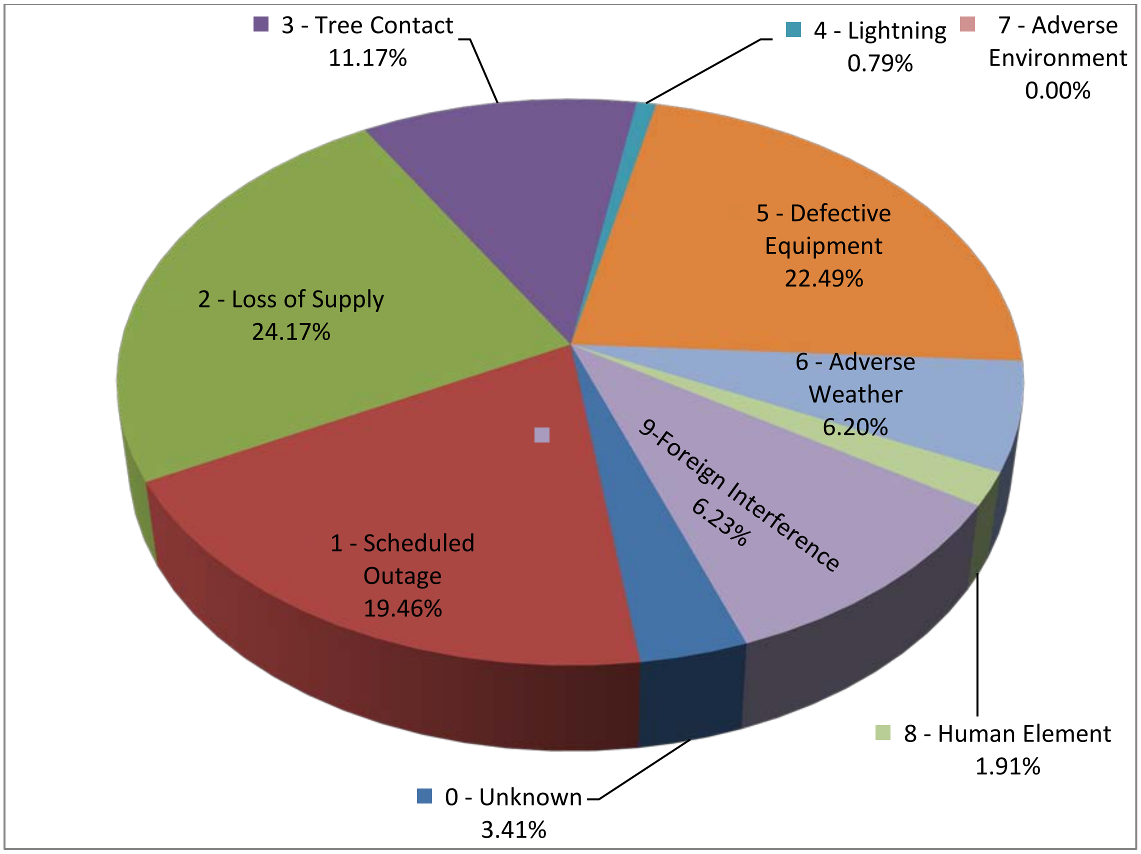


Figure 5.2-22 – 2015 to 2021 TCHI for All Outages by Cause of Interruption Including Loss of Supply and Major Event Days

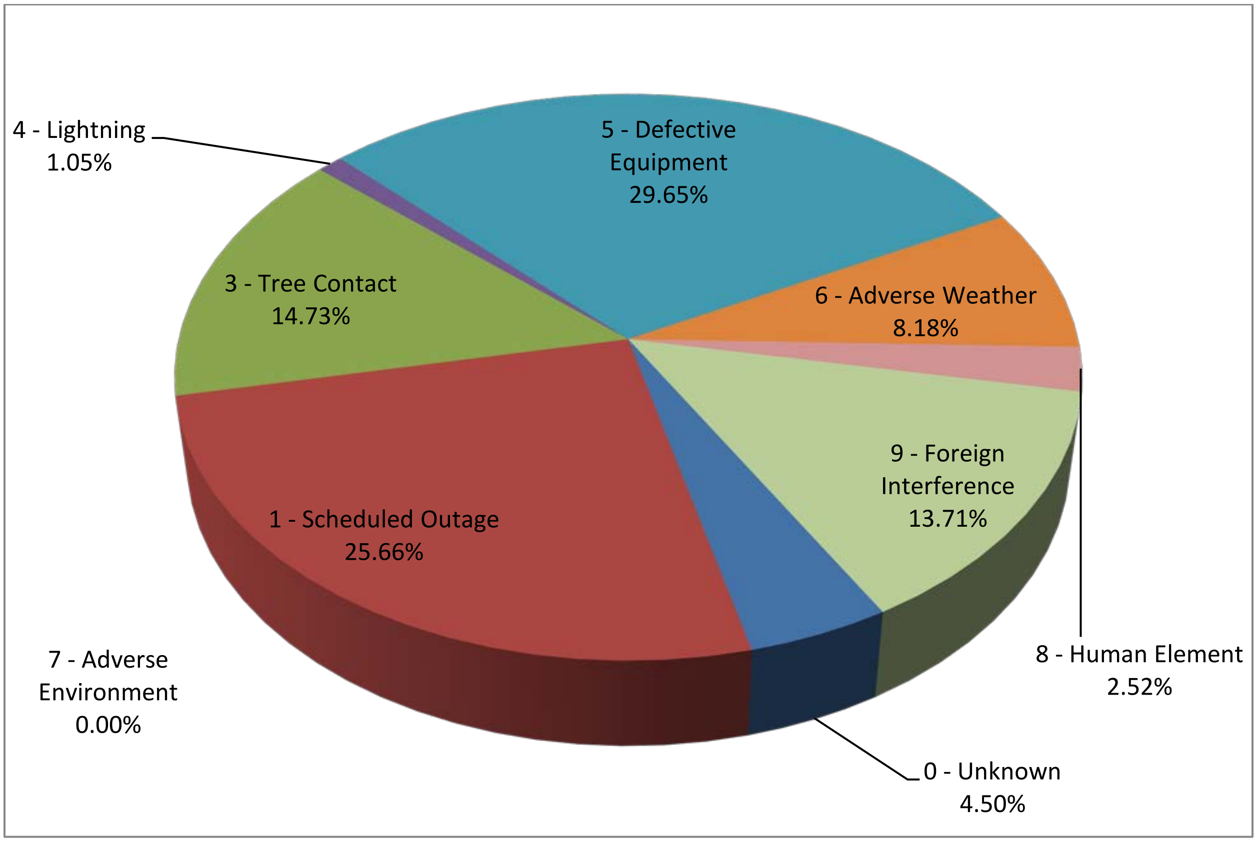
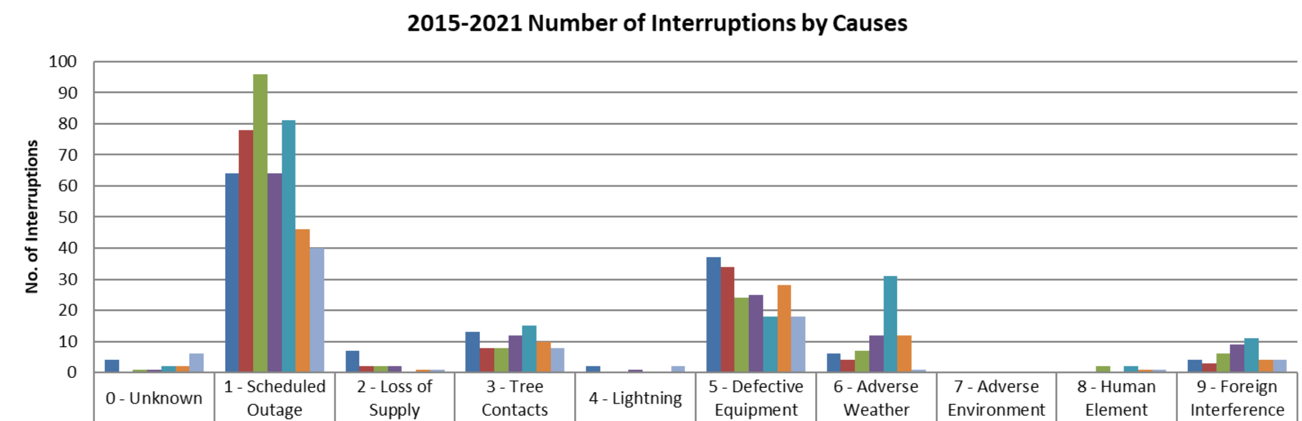


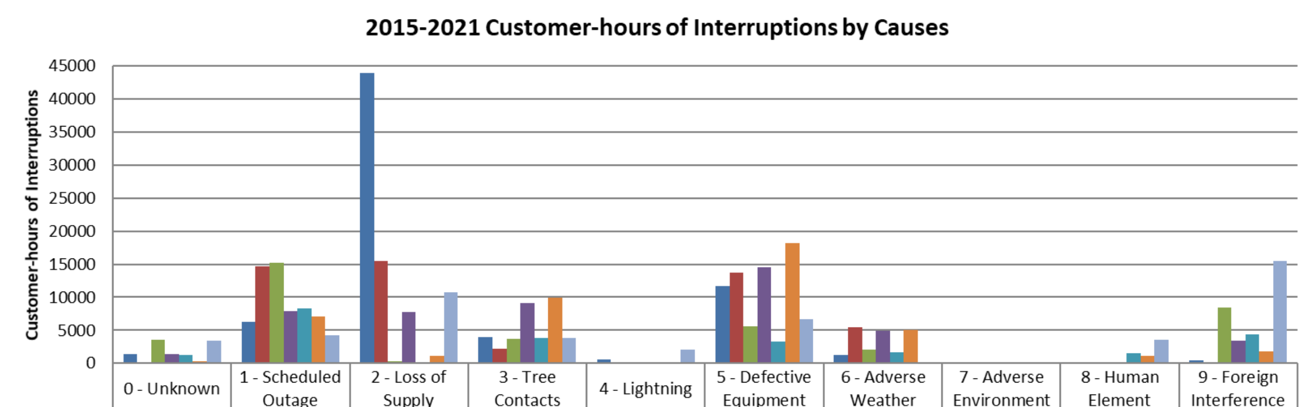
Figure 5.2-23 – 2015 to 2021 TCHI for All Outages by Cause of Interruption Excluding Loss of Supply and Major Events

Figure 5.2-24 through 5.2-26 shows detailed Number of Interruptions, SAIDI and SAIFI cause code breakdown excluding major event days from 2015 through 2021.



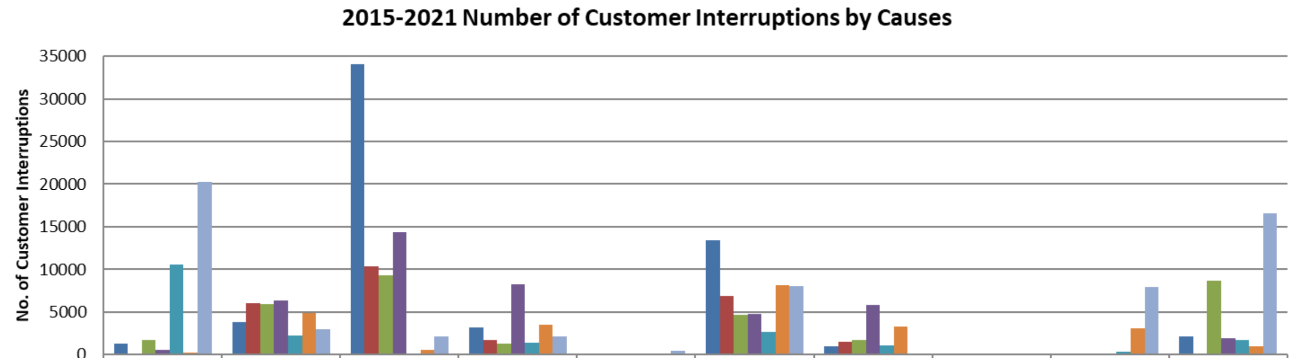
	0 - Unknown	1 - Scheduled Outage	2 - Loss of Supply	3 - Tree Contacts	4 - Lightning	5 - Defective Equipment	6 - Adverse Weather	7 - Adverse Environment	8 - Human Element	9 - Foreign Interference
2015	4	64	7	13	2	37	6	0	0	4
2016	0	78	2	8	0	34	4	0	0	3
2017	1	96	2	8	0	24	7	0	2	6
2018	1	64	2	12	1	25	12	0	0	9
2019	2	81	0	15	0	18	31	0	2	11
2020	2	46	1	10	0	28	12	0	1	4
2021	6	40	1	8	2	18	1	0	1	4

Figure 5.2-24 – 2015 to 2021 Number of Interruptions by Cause Code Breakdown Excluding Major Events



	0 - Unknown	1 - Scheduled Outage	2 - Loss of Supply	3 - Tree Contacts	4 - Lightning	5 - Defective Equipment	6 - Adverse Weather	7 - Adverse Environment	8 - Human Element	9 - Foreign Interference
2015	1357	6338	43918	3932	552	11708	1219	0	0	424
2016	0	14716	15433	2241	0	13677	5511	0	0	21
2017	3513	15164	355	3753	0	5601	2047	0	44	8496
2018	1419	7924	7810	9071	17	14511	4946	0	0	3484
2019	1244	8292	0	3824	0	3340	1621	0	1548	4332
2020	294	7146	1065	9948	0	18254	5002	0	1085	1864
2021	3360	4278	10726	3878	2032	6697	8	0	3587	15502

Figure 5.2-25 – 2015 to 2021 SAIDI Cause Code Breakdown Excluding Major Events

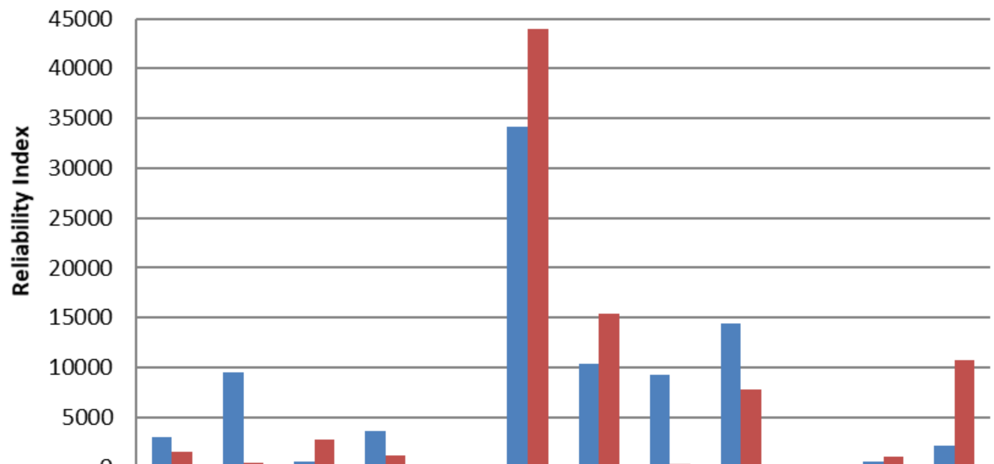


	0 - Unknown	1 - Scheduled Outage	2 - Loss of Supply	3 - Tree Contacts	4 - Lightning	5 - Defective Equipment	6 - Adverse Weather	7 - Adverse Environment	8 - Human Element	9 - Foreign Interference
2015	1264	3792	34088	3176	137	13415	993	0	0	2129
2016	0	6016	10388	1692	0	6829	1484	0	0	45
2017	1700	5972	9288	1294	0	4693	1672	0	25	8694
2018	560	6310	14400	8238	11	4819	5784	0	0	1961
2019	10520	2291	0	1449	0	2677	1063	0	355	1702
2020	190	4877	597	3553	0	8100	3277	0	3101	981
2021	20314	2993	2110	2139	459	8060	14	0	7970	16618

Figure 5.2-26 – 2015 to 2021 SAIFI Cause Code Breakdown Excluding Major Events

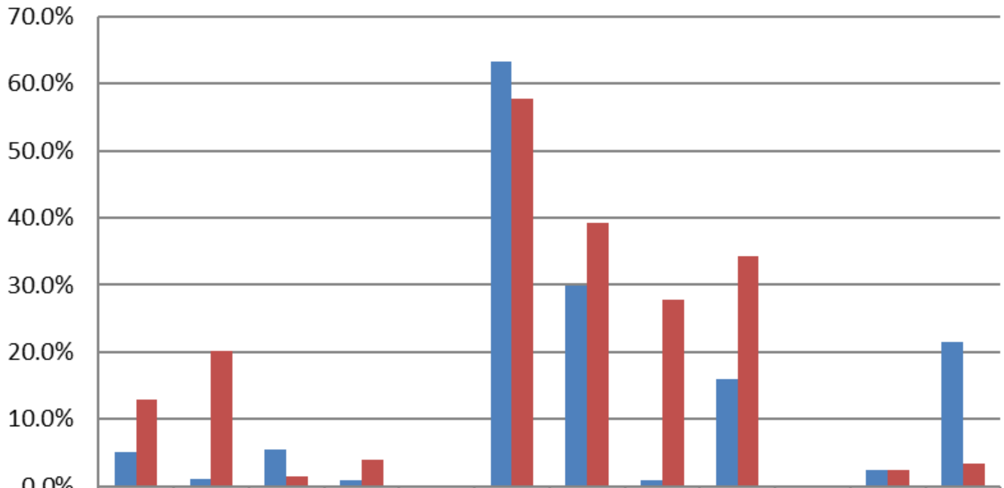
Loss of Supply

Figure 5.2-27 shows the total customer hours of interruptions and total number of customer interruptions caused by loss of supply between 2010 and 2021. Figure 5.2-28 shows the loss of supply contributed to the annual SAIDI and SAIFI from 2010 to 2021.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Customer-hour of Interruptions	3010	9500	500	3570	0	34088	10388	9288	14400	0	597	2110
# of Customer Interruptions	1558	400	2808	1107	0	43918	15433	355	7810	0	1065	10726

Figure 5.2-27 – Customer Interruptions Caused by Loss of Supply



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
SAIDI	5.1%	1.0%	5.6%	0.8%	0.0%	63.2%	29.9%	0.9%	15.9%	0.0%	2.4%	21.4%
SAIFI	12.9%	20.1%	1.6%	4.0%	0.0%	57.8%	39.3%	27.9%	34.2%	0.0%	2.4%	3.5%

Figure 5.2-28 – Loss of Supply Contribution to Annual Reliability Index

Loss of supply had a significant impact on Kingston Hydro's system reliability over the 2015 to 2021 period. In 2015 alone, more than 50% of customer interruptions were caused by loss of supply. Prior to 2015, the data indicates that loss of supply had a minor impact on Kingston Hydro's reliability over the 2010 to 2014 period. Loss of Supply is out of Kingston Hydro's control, so Kingston Hydro has raised this issue with Hydro One who is the upstream Distributor and Transmitter for Kingston Hydro. Refurbishments to the Frontenac TS protections completed by Hydro One in 2021 are expected to contribute to improved reliability in the future. Other future upgrades that are not currently planned by Hydro One but would improve reliability and power restoration include upgrading legacy electromechanical protection relays at Gardiner DESN1 to modern microprocessor protection relays with fault locating capability and installing wireless fault indicators at the Hydro One demarcation point with Kingston Hydro to quickly determine if an outage was caused by an upstream fault in the Hydro One distribution system or a downstream fault in the Kingston Hydro distribution system. In the meantime, Kingston Hydro notes that one of the biggest challenges to escalating this loss of supply issue is the difference in reporting of the number of customers impacted by an outage. For example, Hydro One reports a loss of supply to

Kingston Hydro as an impact to one customer whereas Kingston Hydro reports a loss of supply as an impact to many (typically 1000's) of customers.

The Table 5.2-27 summarizes data from Hydro One's annual reliability reports and illustrates this point further:

Delivery	Station	Delivery Point	Voltage (kV)	Outlier Baseline of Delivery Point Interruptions	Delivery Point Interruptions (Zero Voltage)					
					2015	2016	2017	2018	2019	2020
Transmission	Frontenac TS	Bus B – M2, M5	115/44	1.8	1	0	1	1	0	0
		Bus Y – M4		1.5	1	0	0	0	0	0
Distribution	Frontenac TS	M3	44		1	0	0	0	0	2
	Gardiner TS	M7	44		3	1	0	0	0	0
	Gardiner TS	M9	44		1	0	0	0	0	0
	Gardiner TS	M12	44		2	1	0	0	0	0
	Gardiner TS	M13	44		1	0	0	0	0	0
				Total	**10**	**2**	**1**	**1**	**0**	**2**

Table 5.2-27 – Loss of Supply from Hydro One Customer Reliability Reports

Kingston Hydro believes it would be more insightful if Hydro One also reported the number of MW interrupted for each delivery point interruption.

The Table 5.2-28 summarizes the total number of annual Kingston Hydro interruptions due to Loss of supply:

Year	2015	2016	2017	2018	2019	2020	2021
Delivery Point Interruptions	7	2	2	2	0	1	1
# of Customers Interrupted	34088	10388	9288	14400	0	597	2110
# of Customer-Hours	43918	15433	355	7810	0	1065	10726

Table 5.2-28 – Loss of Supply from Kingston Hydro Reliability reports

The total Loss of Supply interruptions recorded by Kingston Hydro vs Hydro One in the tables above are slightly different for the following reasons:

2015: Kingston Hydro counted multiple feeder trips caused by the same bus fault as one event, while Hydro One counted it by tripped feeder.

2017: The Gardiner M9 breaker tripped when transferring load between Gardiner TS and Frontenac TS. The power was lost for 38seconds which is classified as a momentary interruption therefore it is not counted in the Hydro One report.

2018: The Gardiner M7 line was hit by a truck in Hydro One territory but this event was not counted in the Hydro One report since it was due to a motor vehicle accident.

2020: Kingston Hydro only reported one event in 2020 since one was a momentary outage that was not reported.

Defective Equipment

Defective equipment is still one of the top causes of customer interruptions and had a large contribution to SAIDI and SAIFI in the period of 2015-2021. The historical outage data between 2015 and 2021 were analyzed, and defective equipment was broken down by assets in Table 5.2-29. The analysis indicates cable faults and overhead equipment were the major assets among the Defective Equipment.

Equipment	Total Customer-hours of Interruptions	Total Customer Interruptions	Number of Events
Cable	19657	15404	34
OH Wires and Lead	2194	1500	25
Hot Spot	233	728	23
Distribution Switch	5905	8209	24
Fuse	787	382	14
Distribution Transformer	466	144	12
Elbow	1617	1080	3
Lightning Arrester	352	2163	3
Spaced Aerial	142	386	1
Pole	8283	2630	1
5kV Switchgear	9488	2065	1
Others	14807	7535	17

Table 5.2-29 – Defective Equipment Cause Breakdown from 2015 to 2021

Reliability Trends – Impact on DSP

Kingston Hydro analyzes reliability trends by Cause of Interruption and develops improvement plans in three areas; capital investment, operational and preventive maintenance.

1) Capital Investment

In general, outages caused by Defective Equipment have a direct connection with asset condition. Historical reliability data are a key input in Kingston Hydro's Asset Management process and the development of capital investment programs and capital projects.

2) Operational

Kingston Hydro regularly reviews system wide protection coordination and protective device settings. With new digital relays and SCADA, Kingston Hydro is able to analyze event reports to optimize protection settings, reducing outage duration and frequency. Kingston Hydro uses a three-year pruning cycle and follows clearances as established in the Electrical and Utilities Safety Association Line Clearing Operations Safe Practice Guide 2008. Kingston Hydro keeps monitoring the trend of interruptions caused by Tree Contact and makes the necessary adjustments to the annual Tree Trimming Program.

3) Preventive Maintenance

Kingston Hydro has an annual maintenance program that is consistent with good utility practices and exceeds the minimum maintenance and inspection requirements of the Ontario Energy Board's Distribution System Code. Kingston Hydro adjusts the maintenance program regularly based on the annual reliability analysis, e.g. maintenance period, to improve asset condition and service reliability.

SAIDI and SAIFI are generally lagging indicators of reliability and are not the only indicators used to identify when and which assets should be replaced or repaired to maintain reliability. Kingston Hydro therefore uses historical reliability data as a key input in its Asset Management Process then develops capital investment programs and capital projects based on Asset Condition Assessment and Asset Management Policy.

The following capital investment programs and projects are identified using reliability performance information:

- 5kV vault oil switch replacement projects
- 44kV riser PILC cable replacement at substations
- Reactive 5kV PILC cable replacement

5.2.3.3 Distributor Specific Reliability Targets

Kingston Hydro currently uses the SAIDI and SAIFI performance measures and performance targets set out in the annual OEB Scorecard to establish reliability expectations.

5.3. Management Process

Kingston Hydro utilizes an asset management process to plan, prioritize, reprioritize and optimize it's capital expenditure plan. This section will enable an understanding of the Kingston Hydro asset management process and the links between the process and expenditure decisions that comprise our capital investments.

Kingston Hydro's asset management process is revised through a continuous improvement strategy. Kingston Hydro recognizes that as asset registry (enterprise data collection) information and, asset condition assessment (health index calculation) systems improve so too will practices, procedures and decision making.
Kingston Hydro's asset management process utilizes a mix of both Top Down and Bottom Up analysis. Each analysis method has its unique advantages and disadvantages as shown in Figure 5.3-1 (NAMS, IIMM 2011).

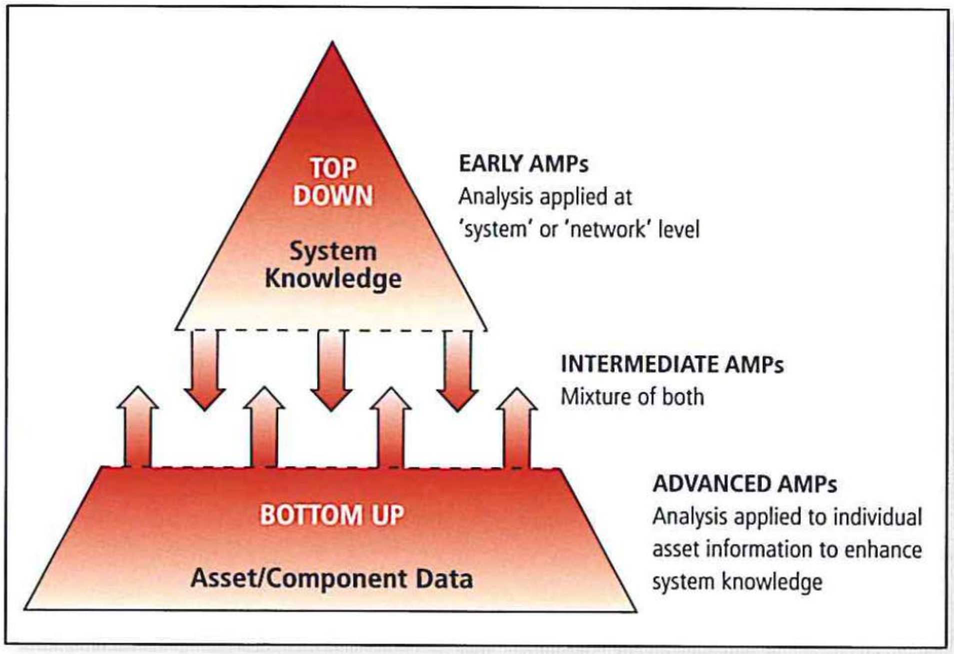


Figure 5.3-1 – Top Down vs. Bottom Up Development of Asset Management Plan (NAMS, IIMM 2011)

The top down approach is qualitative and less resource intensive but does not support much in the way a lot of detailed analysis due to the limited data available. The bottom up approach is data driven making it more resource intensive but is potentially more useful for performing detailed analysis (quantitative) and making investment decisions with a higher degree of confidence.

Kingston Hydro has undergone a gradual transition to a more formal asset management process, with the following results and benefits:

- improved transparency and stronger accountability associated with capital programs;
- more sustainable decisions;
- enhanced customer service;
- effective risk management; and
- improved financial efficiency.

Lastly Kingston Hydro recognizes the importance of following good utility practices for system planning to ensure reliability and the quality of electrical services being provided to our customers that is reflected in our Distribution System Plan.

Project selection and prioritization is an important element of the Kingston Hydro asset management program that balances the subjective and objective elements of the asset against the resources available to implement.

5.3.1 Planning Process

The asset management process can be seen in Figure 5.3-2. The activities identified cover all aspects of Kingston Hydro's asset management planning from determining long term capacity requirements to determining the needs to renew aging infrastructure. The activity areas described are inputs derived from various data sets developed by Kingston Hydro which then create inputs to the next steps identified by arrows in the process flow.

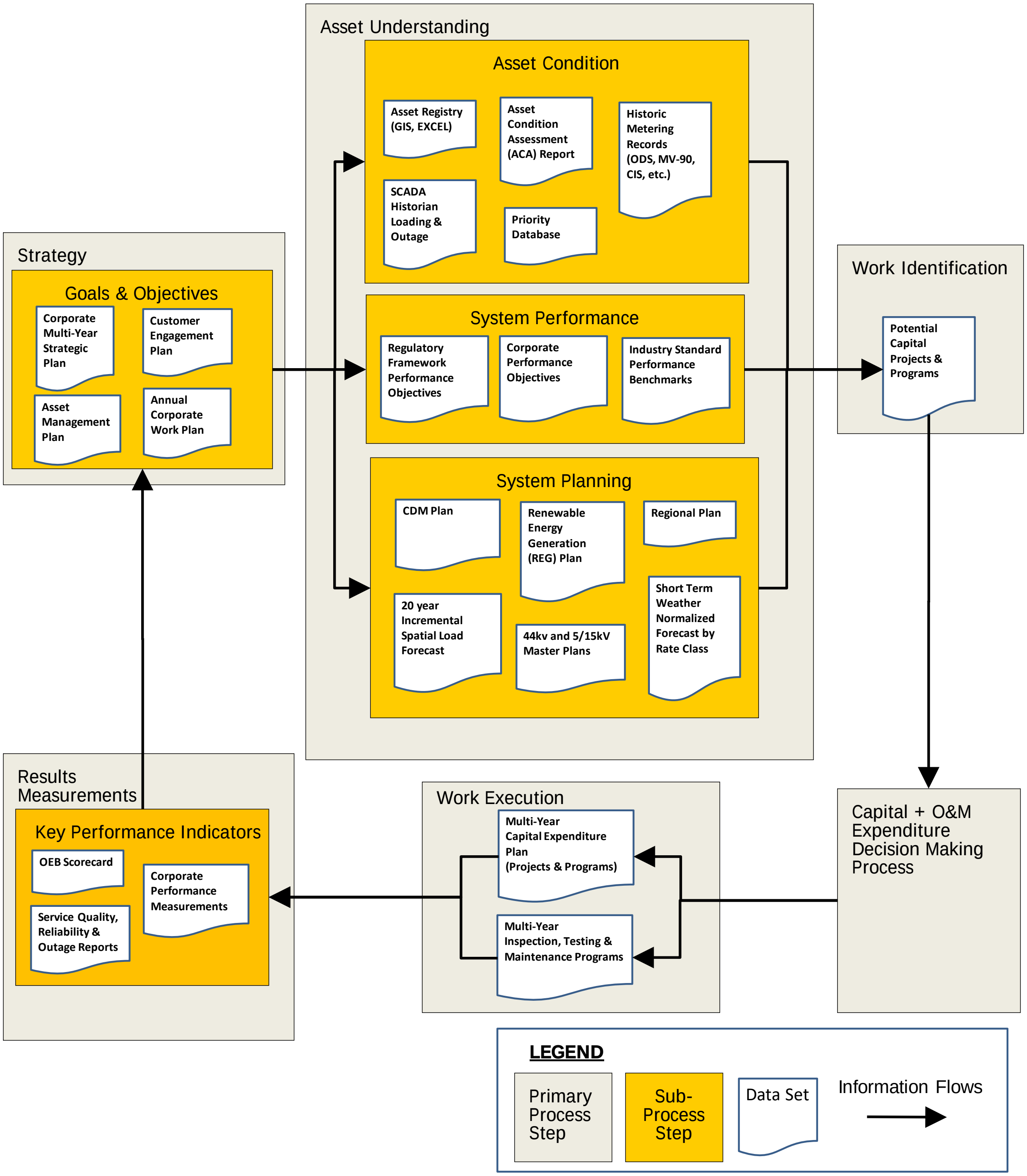


Figure 5.3-2 – Kingston Hydro Asset Management Process

The following describes each of the major sub processes:

Strategy

Kingston Hydro’s goals and objectives, guide the management of our assets (long term and short term requirements) and the decision making process to ensure that investment decisions are made that maximize the value of the asset(s) and deliver value to the customer.

The Kingston Hydro 2019-2024 Strategic Plan has identified the following themes and goals as the corporate focus:

	Themes		Goals
1	Leveraging the multi-utility model	**1**	Leverage cross-functional expertise and efficiencies
		2	Leverage external shared services
2	The power of local hydro	**1**	Respond to community priorities
		2	Maintain fair and reasonable rates
		3	Promote Shareholder awareness of the asset they hold in Kingston Hydro
3	Reliable infrastructure management	**1**	Ensure sustainability of infrastructure
		2	Maximize efficiency of electricity operations
		3	Prepare for the Future Grid
4	Customer service excellence	**1**	Maintain excellence in customer service

Table 5.3-1 – Themes and Goals of the Kingston Hydro 2019-2024 Strategic Plan

Kingston Hydro's asset management goals and objectives have been created to align with our corporate objectives and good asset management practices that reflect the systematic and coordinated practices and activities by which Kingston Hydro manages its assets, their performance, risks, and the expenditures over their life cycle. Effective management of our assets enables Kingston Hydro to maximize the value of the investment made in the asset and to deliver on our corporate goals and objectives effectively. These are identified within the following categories, the assets, the customer, and the financial considerations.

Assets:

- Ensure the continuous improvement of Kingston Hydro’s asset management system from asset condition data to critical processes of system planning and decision making.
- Continuous improvement of services delivered, productivity and ultimately in cost performance.
- Achieve over the long term, the optimum investment level needed to sustain the assets (distribution and general plant) over their life cycle in an effective and efficient manner.
- Seek new and innovative solutions to operate, manage and renew Kingston Hydro’s assets.

Customer:

- Deliver safe and reliable electricity to our customers.
- Continue to satisfy customer expectations by delivering value for the rates charged.
- Continue to engage in dialogue with our customers to ensure meaningful and appropriate distribution system improvements and operational effectiveness.
- Ensure predictable smooth rates

Financial Considerations:

- Management of the assets to minimize their total life cycle costs.
- Optimize operational and capital investments through innovation and best practices for replacement, refurbishment, and maintenance.
- Ensure a predictable and smooth investment program that prioritizes expenditures while minimizing risk and that is at a pace that recognizes customer impacts and is reflective of Kingston Hydro’s resources.

Asset Understanding Process

This area represents the practices and processes for collecting, storing, and maintaining attribute and asset information on the distribution system and general plant. The major components of this are i) Asset Condition, ii) System Performance and iii) System Planning.

i. Asset Condition Sub-Process

Asset management planning typically begins with gathering and storing data about the assets with a view to understanding what you have and their condition. Decisions on the renewal of assets need to be based on accurate and predictive assessments of their life cycle. Kingston Hydro employs several methodologies in this regard.

Asset Registry

Asset registers store the primary source of information for various types of assets. There are several types of systems deployed by Kingston Hydro to collect, store maintain this data.

Most distribution assets (with the exception of Substation assets) are documented in the existing Enterprise Geospatial Information System (GIS) as a linear or point feature type. This data holds both locational and attribute data (age, size/length, installation date, electrical connectivity, etc.). This data can then be queried and extracted for various purposes. Kingston Hydro's Cyme Modeling Software relies on this asset data source for various analytical purposes such as determining the impacts of new development on the distribution system.

Kingston Hydro's engineering department, through its GIS group, maintains these records and has instituted processes and procedures to collect, maintain and ensure the accuracy (quality assurance and quality control programs) of the distribution asset data.

Related inspection data from operations staff is recorded through a mix of reports, worksheets, and database entries. Some of the inspection data is standalone and some is linked to GIS data. Substation Asset inventory information is currently documented on Single Line Diagrams stored in AutoCAD format and the associated substation inspection data is recorded in standalone worksheets/databases.

The Supervisory Control and Data Acquisition (SCADA) system provides real time data on certain assets such as substations, switches, and specific meters. Monitoring of the assets through SCADA enables operators to configure the system to achieve optimal performance on an ongoing basis. Typical data collected by the SCADA Historian includes feeder loading, outages and equipment status which enables detailed engineering analysis of system performance thus facilitating system improvements.

Outage management is another significant aspect of operations that relies on SCADA, asset information and now CIS information. As noted in Section 5.2.4 Realized Efficiencies Due to Smart Meters, Kingston Hydro recently implemented an Outage Management System (OMS) reporting tool for customers by leveraging its investment in smart meters and GIS. This solution allows information to be shared with customers on our website regarding both planned and unplanned system outages and represents the ongoing commitment of Kingston Hydro to continuous improvement. Currently, all outages are tracked internally through the SCADA system and a standalone data base for reliability reporting and analysis of trends that could impact asset condition.

Asset Condition Assessment

The condition assessment activity is the process of analyzing the data from the asset registry and inspection, testing and maintenance program and determining the assets health and the potential for action.

In 2019, Utilities Kingston retained the services of Kinectrics to perform a detailed Asset Condition Assessment (ACA) of major assets using readily available historical age and condition data. The final report, attached as Appendix 4 of the DSP, was issued March 2020. Kinectrics had previously performed a detailed ACA of Kingston Hydro's major assets in 2012. The following provides a summary of the Kinectrics methodology.

The Kinectrics methodology involves the process of determining the Health Index for a class of assets and the development of a condition-based "flag for action plan" for each asset category. This data is then used Kingston Hydro to develop an action plan for assets in very poor or poor condition while taking into account the criticality and/or risk of the major assets (i.e. station transformers).

The Health Index quantifies the condition of the asset, based on numerous condition parameters that are related to long-term degradation factors that lead to end of life for that class of asset. The Health Index is an indicator of the overall health of the assets and is typically expressed in percentages (100% representing new). Results are aggregated into five categories.

Very Poor	Health Index <25%
Poor	25< =Health Index <50%
Fair	50< = Health Index <70%
Good	70< = Health Index < 85%
Excellent	Health Index >=85%

Although many asset classes are aggregated, the individual health index for station transformers is provided.

The condition based flag for action plan identifies the number of units that are recommended for replacement over the next twenty years. The Kinectrics model provides two methods for determining the recommended replacement: 1) reactive; and 2) proactive.

Assets that represent little risk due to the small consequences of failure are "generally" replaced reactively upon failure. This approach is based on the expected failure rate of the asset group and incorporates the possibility that an asset may fail prematurely and prior to their end of life.

Substation transformers and substation circuit breakers utilize a proactive approach so that the assets are replaced prior to failure. For these critical asset classes, a risk assessment study is completed to determine the units eligible for replacement. This approach establishes a relationship between the Health Index and the corresponding probability of failure for each asset within the asset group. The determination of the criticality of the asset is also considered through the assignment of weights and scores to factors that determine risk and replacement priorities for the asset in question. The combination of criticality and probability of failure determines risk and replacement strategies for that asset. Finally, the health Index distribution is determined, and a condition based “flag-for-action” plan developed for substation transformers and substation circuit breakers.

Kingston Hydro acknowledges that continuous improvement of asset condition information is required (i.e. underground plant) and has elected to utilize its own in-house staff to perform regular asset inspections in the field and utilize an expert third party such as Kinectrics to prepare an ACA report containing the calculated asset Health Indices and Flag-For-Action (FFA) quantities.

With respect to assets categorized as General Plant Kingston Hydro requires assets such as fleet or computer information systems to be reasonably current and in good working order. Although useful life indices are reasonable guidelines for assets in this category Kingston Hydro also considers other factors such as reliability, redundancy, maintenance, support services such as updates and fixes and impact of failure in its planning for asset renewal/replacement and as such remain critical factors in asset management renewal considerations.

Similarly fleet assets are required to remain in good working condition. Depending on the class of vehicle (i.e. line truck vs. service van) replacement is recommended when the vehicle reaches a prescribed odometer reading, hours of service, or age combined with an upward trend of unscheduled maintenance costs over the last 2-3 years.

As Kingston Hydro does not own its administrative building and leases this space, no formal asset management activities are undertaken with respect to office administration buildings.

ii. System Performance Sub-Process

The second major aspect of asset understanding is System Performance data which considers the effect and impact of system reliability indices and equipment failure data to assess the operational performance of the distribution system. This typically includes reliability data (SAIDI), service quality, customer inputs and the asset dashboard. The asset dashboard is a new tool that replaces the former priority database and provides a geo-spatial representation of the inspection data.

Service Quality and Reliability Reports

The System Average Interruption Duration Index (SAIDI) is used to measure the average annual hours of interruption experienced by all customers. Reliability reports provide a certain level of detail into system performance by classifying outages by cause, voltage, area, and impact (numbers, duration) and assist in identifying assets potentially requiring investment. Kingston Hydro recognizes that reliability indices do not always present a complete picture of the assets and as such further detailed investigation is undertaken as to the causal factors behind the outage to determine the appropriate action, which is not always capital reinvestment.

Additionally, outages caused by equipment failure are investigated to determine the cause of that failure. This information is applied to improve failure predictability factors relating to similar assets that may then be flagged for further action or consideration in the capital programing.

Service and power quality reports are also collected and monitored for inputs into the performance of the system to determine if action is required. As noted earlier, Kingston Hydro’s dashboard allows staff to visually relate inspection and maintenance data activities to system performance using geo-spatial mapping. Lastly customer input (complaints, concerns, etc.) are collected and monitored for trends and potential actions to address issues.

iii. System Planning Sub-Process

The third major aspect of asset understanding is System Planning, which must ensure adequate system capacity to accommodate new load while ensuring the reliability of services to existing customers as well as future customers. In addition, system planning considers the ability to continue operating when a major asset fails, in other words the ability to provide an alternate source of power to the customer.

To facilitate system planning Kingston Hydro undertakes a number of studies and consultations to ensure that influences on system planning are properly considered in our planning. Kingston Hydro recently issued a memo in 2019 to document updates to its 44kV master plan study which was previously updated in 2013. Kingston Hydro also issued a memo in 2020 to document updates to its 5Kv/15Kv master plan which was previously updated in 2014. Kingston Hydro aims to update these studies approximately every five years and include an assessment of feeder, transformer, and overall system capacity. The main outcome of these master plans is to determine if the existing Kingston Hydro distribution system has sufficient capacity to accommodate the 20-year incremental load forecast.

Master Plans

The 44kV and 5/15kV Master Plans contain long term forecasts that are important to system planning. Kingston Hydro, given its geographic service area is able to identify specific parcels of land where incremental load growth is expected to occur over the next 20 years. A long term "spatial" forecast was developed through a survey of existing development applications and vacant land in the Kingston Hydro territory. This work is undertaken in cooperation with the City of Kingston's Planning and Development Department. In 2012, the City Planning department completed an intensification study for Williamsville district and the North Block area served by Kingston Hydro. In 2017, the City Planning department commissioned studies of potential of intensification in the North King's Town district and Central Kingston area served by Kingston Hydro.

Regional Plan

Regional planning refers to the various obligations, requirements and guidelines associated with the OEB regional planning process that Kingston Hydro must comply with as a licensed distributor. Regional plans must be updated at least every 5 years (maximum planning cycle interval) and follow the process outlined in Figure 5.3-3:

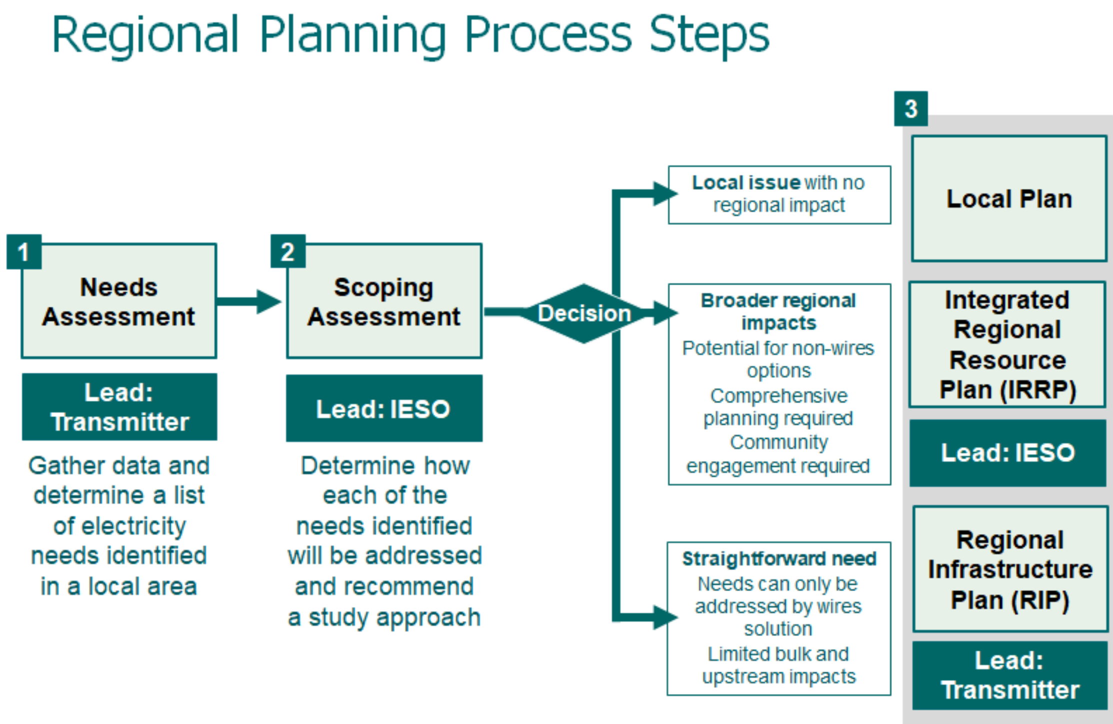


Figure 5.3-3 – Regional Planning Process

The Needs Assessment is a mandatory first step of the OEB regional planning process. For the Peterborough to Kingston (PtoK) region, Hydro One Transmission (HONI TX), is responsible for leading the assessment and compiling a high level 20-year load forecast and report with the help of working group members at least once every 5 years.

The Needs Assessment may trigger a Scoping Assessment (second step) by the IESO and one or more of the following studies as part of the third step: a Local Plan, an Integrated Regional Resource Plan (IRRP), a Regional Infrastructure Plan (RIP).

Refer to Section 5.2.2 for a summary of the Regional Plan process deliverables for the current planning cycle of the Peterborough to Kingston region.

Renewable Energy Plan

The Renewable Energy Plan (REG) plan refers to the various obligations, requirements and guidelines associated with enabling the connection of Renewable Energy Generation that Kingston Hydro must comply with as a licensed distributor. As such Kingston Hydro assesses each application received for its impact on feeders and stations to ensure that cumulative impacts on the assets are considered and managed appropriately. Forecasted REG projects are also considered, as noted above and for this application Kingston Hydro notes that there no REG related proposed capital works based on projected demand.

CDM Plan

Kingston Hydro also considers the impact of its conservation programs on the system and in particular its impact to mitigate load growth and consequent distribution system improvements.

Work Identification Process

Ultimately the Work Identification process identifies assets requiring capital investment based on the outputs of the Asset Understanding process.

Potential Capital Projects and Programs

Candidate capital projects, identified through asset understanding, system planning and operational performance activities are then generated. These projects undergo a scoping exercise to assess the following issues:

- Sequencing or order of projects
- Linkages of a project(s) to other potential projects for cost efficiencies
- Determination of the scope of work involved

- High level expenditure estimates
- Consistency with the ACA work recommendations on the number of units expected to be replaced in the next twenty years

During this phase no projects are eliminated from the potential capital program, rather additional information is gathered to assist in the decision-making phase.

Capital Expenditure Decision Making Process

The list of potential capital projects now enters a process of prioritizing projects/programs for the next 5 years. This process involves a number of criteria, such as risk, criticality, customer input utilized to evaluate the merits of each program.

During this phase the capital budget threshold is identified (top down approach) to provide a context within which to consider the magnitude of the capital projects/program year over year.

Potential Capital Projects are considered and evaluated against how they satisfy the identified Asset Management Objectives such as:

- Achieve over the long term, the optimum investment level needed to sustain the assets (distribution and general plant) over their life cycle in an effective and efficient manner
- Deliver safe and reliable electricity to our customers
- Ensure a predictable and smooth investment program that prioritizes expenditures while minimizing risk and that is at a pace that recognizes customer impacts and is reflective of Kingston Hydro’s resources.

Projects are also considered within the context of the pace or rate of investments being considered. This aspect considers ability to complete the work contemplated, resource availability, construction sequencing, potential conflicts with other service providers (other City or Utility work) being planned over the next five years and impacts on customers.

Furthermore, projects and programs are considered and evaluated against the following factors: safety – worker and public, risk of asset failure, customer impact, regulatory requirements, and environmental impacts. Included in this review is an assessment as to whether the capital project can be reasonably deferred (i.e., such as run to failure) through additional operational activity associated with inspections or maintenance.

Kingston Hydro, during this process, continues the practice of utilizing both qualitative and objective criteria to its decision making. “Risk of Deferral” and “Project Value” are qualitatively assessed by experienced line and station staff providing important insight into prioritization of capital projects. Meetings which bring together representative staff along with objective data (i.e. ACA data) to assess projects yields a capital reinvestment program that provides for the effective management of assets, enabling Kingston Hydro to maximize the value of the investment made in its assets while delivering on its corporate goals and objectives.

Work Execution Process

The outputs of the Capital Expenditure Decision Making Process are specific capital program(s), specific capital project(s) and in some instances operational activities.

Capital Expenditure Plan

Capital programs refer to annual repetitive work such as overhead pole remediation/replacement that are ongoing, with similar work activity but in differing locations. Capital projects are typically site specific and involve a specific type of work required to address the identified need.

Capital projects involve project design, material acquisition, construction and financial closure. This process involves a number of departments within Kingston Hydro that adds complexity due to integration requirements. In 2017, Kingston Hydro transitioned to a new financial management system (FMS) that will enable easier financial reporting, tracking, and planning of projects moving forward.

Inspection, Testing and Maintenance Programs

Kingston Hydro undertakes regular, planned inspection and maintenance programs in accordance with regulatory requirements and good practices. Inspection and maintenance comprise the physical gathering of attribute data on assets and making immediate or planned actions as required.

Electrical inspection and maintenance programs are summarized in the table below.

Program	Frequency
Pole Inspection	1/3 of system annually
Underground Visual Inspection (structures and equipment)	1/3 of system annually
44kV Overhead IR Scan	annually
5kV Overhead IR Scan	1/3 of system annually
Substation Visual Inspection	monthly
Substation Transformer Oil Analysis	annually
Substation Maintenance (Breakers, Switchgear, Transformers)	Condition Based

Table 5.3-2 – Kingston Hydro Electrical Inspection and Maintenance Programs

Deficiencies or concerns identified during routine inspection programs are flagged by field staff and added to the dashboard and/or noted in reports. The dashboard and inspection reports are reviewed regularly by a team of staff (engineering and operations) who perform a qualitative risk assessment and review priorities of both unplanned (reactive) work flagged by the priority database and planned capital work identified in an annual capital expenditure plan.

Results Measurements Process

The objective of continuous improvement in Kingston Hydro's asset management cycle requires the measurement of the effectiveness of the program. Completion of capital projects requires assessment in terms of performance in areas such as cost effectiveness/efficiency, asset and system performance, and customer satisfaction/value. As elaborated further in Section 5.2.3, this effort enables Kingston Hydro to measure successes or failures, adjust as required and importantly assess whether the goals and objectives of the program need to evolve and change.

Non-Distribution Alternatives

OMS System

Utilities Kingston Outage Management System is using smart meter messaging to inform Operations Groups and Customers of power outages. This solution allows for information to be shared with customers through an online portal regarding both planned and unplanned system outages. Operations crews are also using OMS to troubleshoot and ensure customers are restored to service.

Customer TOU Web Presentment and Powerful Insights

Utilities Kingston's "MyUtilities" web portal service allows customers access to their consumption data online at any time, and provides weather correlation data, green button access through a user-friendly graphic interface. "Powerful Insights" uses analysis of smart meter data to generate value for the customer. The program provides customers with mailed, customized reports for their own home showing a breakdown of electricity consumption by use, benchmarking to homes of similar size and heating type, and specific energy savings tips.

Customers

Smart meters have been deployed to enable Time-Of-Use billing and to provide customers with better visibility of their electricity consumption data. We have an Operational Data Store (ODS) established to provide access and basic analysis for smart meter data. Having access to historical data has been useful in addressing data requests for planning purposes by generating various consumption reports to suit the needs of our customers.

Meter Alarms

Utilities Kingston group is utilizing meter alarms to address tampering and improper generation installations. We have investigated and reported several unsafe solar panel installations to ESA due to the reverse power alarm. The meter tampering alarm has also been useful to confirm suspected meter tampering.

Remote Access using RNI (Regional Network Interface)
Utilities Kingston is able to access meter info and troubleshoot metering issues. We can restore communication, upgrade firmware, and review meter alarms remotely to address issues in a timely manner. A good example of this is meters that stop communicating. The alarms identify meters not communicating which we can then access, adjust the settings through the RNI and restore communications.

We have also purchased meters that we can remotely disconnect/connect through the RNI. From 2016 to 2018 we have disconnected 1280 customers and reconnected 1114 customers. We are expecting significant savings by having the ability manage arrears customers remotely.

Data Collection

The data used in the processes identified above can be found in the Sections 5.2.1; 5.2.2 and 5.3.2.

5.3.2. Overview of Assets Managed

This section highlights characteristics and data on the assets covered by the asset management process.

5.3.2.(a.) Features of Distribution Service Area

A map of Kingston Hydro’s distribution service territory is provided in Figure 5.3-4.

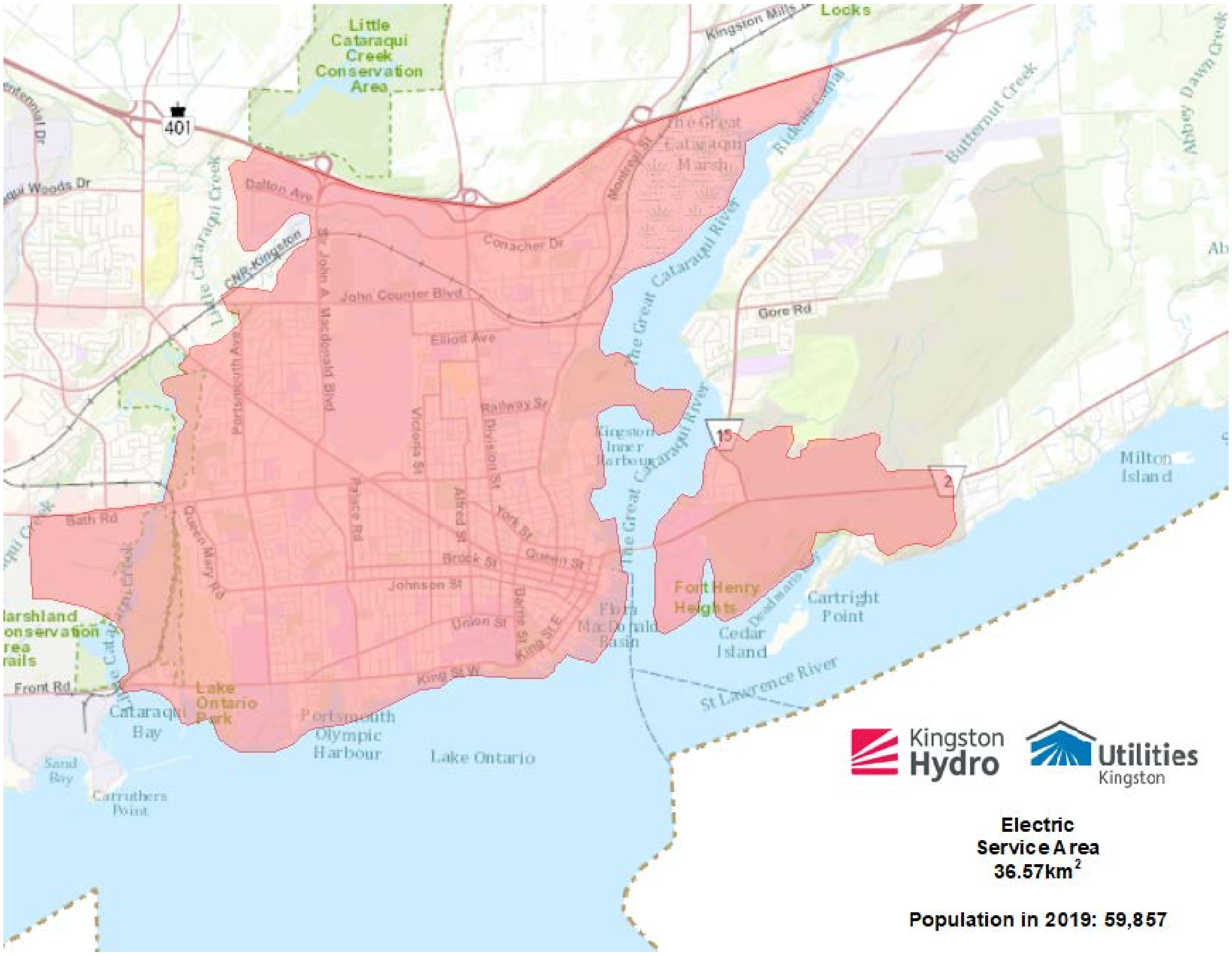


Figure 5.3-4 – Kingston Hydro Distribution Service Territory

Overview

Kingston Hydro delivers electricity to an urban service territory 36 square kilometers in size. Underground distribution is generally found in the downtown area and newer subdivisions while a mix of Underground and Overhead distribution is found throughout the rest of the distribution area. Kingston Hydro has traditionally experienced low customer growth rate (less than 1%) for several decades. Over the past decade, Kingston Hydro's total annual energy consumption flat-lined and its annual peak system demand declined slightly despite a growing customer count.

Community Served by Kingston Hydro Distribution System:

- The City of Kingston as it existed prior to amalgamation on December 31, 1997

- Collins Bay Penitentiary which is now included in the amalgamated City of Kingston
- The Village of Barriefield
- Canadian Forces Base Kingston including McNaughton and Vimy Barracks and the residences for military personnel which are managed by the Canadian Forces Housing Authority.
- Royal Military College
- Fort Henry

Climate

Kingston's climate is generally cooler in the summer and warmer in the winter than most of Southern Ontario due to its proximity to both Lake Ontario and the St. Lawrence River. The mild to strong breezes that come off Lake Ontario can also on occasion increase precipitation, including heavy snowfall events. Extreme weather has been a concern over the past 24 years with ice storms (Jan 1998, Dec 2013), flash floods (July 2011) and windstorms (Nov 2019). By 2050, the following changes in climate (relative to base year 2010) are predicted for the City of Kingston:

- Average summer temperatures will increase by 3.2°C and average winter ones by 4.1°C.
- Number of days/year when the temperature is greater than 30°C will increase from 4 to 30.
- The number of Cooling Degree Days (CDD) will increase from 280 to 611. CDD measures the need for air conditioning.
- The number of Heating Degree Days (HDD) will reduce from 3984 to 3096. HDD measures the need for heating.
- The average spring rainfall will increase by 128 mm (about 50%).
- A 50% increase in the number of freezing rain events lasting 6 hours or longer.
- A 15% to 20% increase in the number of days with wind gusts greater than 90 kph.

Source of climate change data: City of Kingston Climate Action webpage

These changes in climate will impact the personal lives and workplaces of Kingston Hydro's customers. An increase in annual CDD combined with an increase in annual freezing rain and extreme wind events could have the greatest long term impact on the Kingston Hydro distribution system. For now, Kingston Hydro is monitoring the situation and will determine appropriate long term action in a future COS application.

Heritage

The City of Kingston is situated on the traditional homeland of the Anishinaabe, Haudenosaunee and the Huron-Wendat people. Archaeological evidence suggests people lived in the Kingston region as early as the Archaic Period (about 9,000–3,000 years ago). Evidence of Late Woodland Period (about 1000–500 AD) occupation also exists. The first more permanent encampments by Indigenous people in the Kingston area began about 500 AD.

The former City of Kingston (prior to amalgamation) is one of the oldest cities in Canada and was incorporated in 1846. Kingston also has three designated historic districts, which are located within Kingston Hydro's distribution territory. These historic districts are: Barriefield Village, Market Square and Sydenham Ward. Barriefield Village dates back to 1814 when there was increased activity by the British in the area in response to the War of 1812 and the construction of Fort Henry in the 1830's. Market Square is the site of a historic marketplace dating from 1801 and Kingston's City Hall (built originally in 1843-1844). Sydenham Ward consists of about 550 historic properties. Finally, there are over 20 National Historic sites located within Kingston Hydro's distribution territory, one of which is the site of Fort Frontenac built by the French in 1673.

With all this rich history, it is not uncommon for Kingston Hydro to retain the services of an archeologist to document historic finds during excavation work on underground infrastructure projects. Archeological sites are typically assessed with consideration of three historic occupation periods: First Nations (pre-European contact), French and British. Work in and around heritage districts and heritage sites therefore requires additional approvals. These approvals can range from something as basic as selecting a meter location to the placement and aesthetics of proposed overhead and underground plant.

Seasonal Electrical Demand

UK's energy consumption and system demand has historically been winter-peaking and heavily influenced by federal institutions, municipal facilities, universities, schools and hospitals (I-MUSH Sector). The unique climate and older heritage buildings have contributed to the historic winter peaking electrical demand trend of the local region.

Over the historic period of 2016 to 2021, the residential customer count increased at an average rate of 0.4% per year while the "gross" average annual peak electricity demand declined by approximately 0.5 MW/year. This demand trend is attributed to several factors including the closure of Kingston Penitentiary in 2013, UK's success in achieving and in some instances exceeding provincial CDM targets over the 2015-2018 timeframe, provincial Time of Use (TOU) rates and the Global Adjustment program which came into effect around 2015. The "net" average annual peak electricity demand was 6 to 12 MW lower than the gross demand over the same historic period due to embedded generation. This net demand reduction is attributed mainly to a 15 MW cogeneration facility which is operated jointly by Queen's University and Kingston General Hospital to reduce Global Adjustment charges.

Moving forward, UK is anticipating a significant growth in both summer and winter electricity demand over the next few decades due to local climate change (warmer summers), increased development intensification encouraged by City planning policies and global climate change mitigation efforts which include electrification of transportation (e.g. electric vehicles) and heating (e.g. heat pumps, etc.). The I-MUSH sector in Kingston is expected to lead the way with the goal of achieving net-zero energy targets as early as 2040 but no later than 2050.

Geography

Kingston is often called the "Limestone City" because limestone bedrock is commonly encountered 30cm to 1m below the surface and because many of the older homes and landmarks around the City (including City Hall) are constructed from limestone quarried from the local area. The shallow depth and unpredictable hardness of the local limestone bedrock can make underground infrastructure upgrades challenging and costly for Kingston Hydro. Many of the existing electrical underground structures were constructed more than 50 years ago before practical excavation techniques had been developed to remove the limestone bedrock. As a result, it was quite common for legacy concrete encased electrical ducts to be installed just inches below the asphalt roadway surface on top of the limestone bedrock. City Standards now require new electrical ducts to be installed to a minimum depth of 60cm to allow for increased granular road base and better drainage. Replacing/adding ducts in the City Right-of-Way and/or installing new poles can increase installation costs when rock removal is required.

Economy

Kingston's economy relies heavily on public sector institutions and establishments. The most important sectors are related to health care, education (Queen's University, the Royal Military College of Canada, and St. Lawrence College), government (including the military and correctional services), tourism and culture. Manufacturing, and research and development now play a smaller role than they did in the past. Some of Kingston's major industrial employers of the 20th century have closed; the Canadian Locomotive Company in 1969 and Canada Steamship Lines shipyard in 1968. The current operations of Novelis (formerly Alcan) and Invista (formerly DuPont) employ far fewer people than in the past. However, the trucking and logistics warehousing industry has developed in the Greater Kingston area in recent years due to the city's central location between Toronto, Ottawa, Montreal and Syracuse, NY. Also, a food and beverage industry is beginning to develop in the Greater Kingston area with the recent construction of large processing facilities.

The Prison for Women and Kingston Penitentiary (KP), two of Kingston Hydro’s long standing institutional customers ceased operations in 2000 and 2013 respectively. In the short term, Kingston Hydro has seen some reduction in system demand (less than 1%)

as these facilities are not currently occupied. There is talk of redevelopment of these sites however, it may take many more years to re-develop these sites and it's not clear how this redevelopment will impact Kingston Hydro and the local economy. The closure of KP had a minimal impact on the greater Kingston community and economy since many of the inmates and staff were transferred to the nearby Millhaven/Bath, Collins Bay/Frontenac, and Joyceville/Pittsburgh federal correctional institutions.

On a positive note, the new Providence Care hospital opened in 2017 and replaced the former Kingston Psychiatric and St. Mary's of the Lake Hospital. In the near term, the combined effect of consolidating two small hospitals into one large new hospital has had a net zero impact on electrical demand. The former Kingston Psychiatric hospital was demolished after Providence Care hospital was built but St Mary's Of The Lake facility has been temporarily repurposed as an alternate health facility in the event of hospital capacity challenges due to COVID-19.

Load Growth

In the previous DSP (EB-2015-0083), the Kingston Hydro load forecast predicted energy consumption would increase approximately 1.1% per year. A recent review of historic patterns shows that actual energy consumption actually declined by 0.6% per year on average from 2016 to 2019 and declined by 4.3% in 2020 due to the COVID-19 pandemic. Energy consumption rebounded a bit in 2021. Over this same period the average annual peak demand declined slightly. For example, the 6 year average Winter demand for 2009-2014 was 131MW (2009-2014) while the 6 year average Winter demand for 2015-2021 was 120.7MW. Similarly, the 6 year average Summer demand for 2009-2014 was 118.5MW while the 6 year average Summer demand for 2015-2021 was 116.2MW.

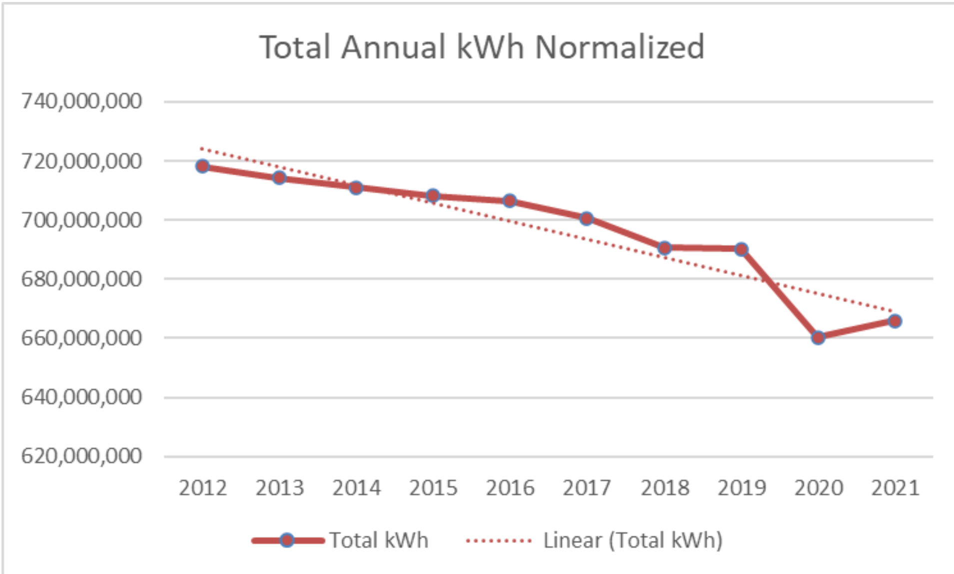


Figure 5.3-5 – 2012 to 2021 Total Retail Energy

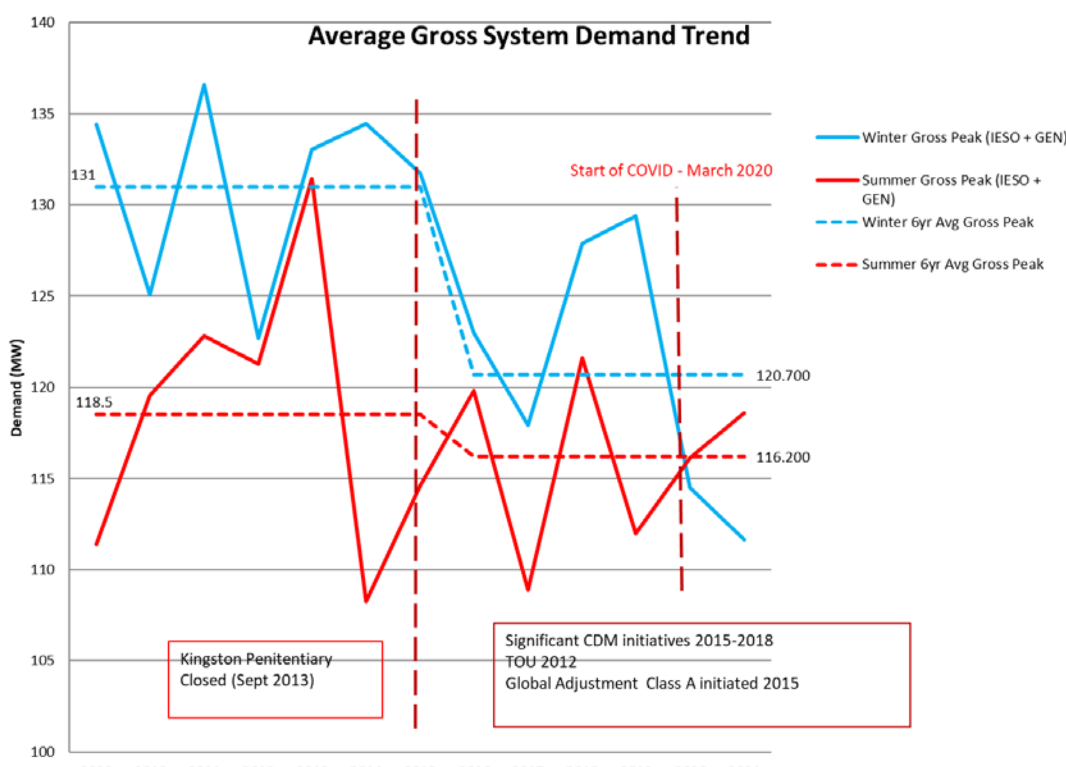


Figure 5.3-6 – 2009 to 2021 Annual Gross Peak system Demand Trend

The reductions in system demand are due to several factors including the introduction of TOU in 2012, closure of Kingston Penitentiary in 2013, significant CDM initiatives in 2015-2018, Global Adjustment program in 2015 and the start of the COVID19 pandemic in March 2020. In summary, Kingston Hydro believes that Economic factors, CDM, appliance fuel switching (from electricity to natural gas) and general improvements in energy efficiency have all contributed to lower than predicted load growth over the 2016-2020 timeframe. Moving forward, the likelihood of further demand reductions in the gross system demand is unlikely but “net demand” reductions may be possible with the help of NWA projects.

At the time of filing the previous DSP(EB-2015-0083), City planning had completed studies for the rejuvenation and intensification of the Williamsville District (Princess Street from Division St. to Concession St.) and the North Block (Area bounded by Queen, Barrack, Wellington, and Ontario Streets) and was undertaking another planning study for the rejuvenation and intensification of the Princess Street Corridor from Concession St. to Centennial Drive. At the time of filing the current DSP, Kingston Hydro has seen an increase in the number and size of development applications for Williamsville. In 2017, the City commissioned additional intensification studies for the North King’s Town district (inner harbour area) and the Central Kingston Growth Strategy (neighbourhoods in the vicinity of Queen’s University and St. Lawrence College).

For the 2023 to 2027 timeframe, Kingston Hydro sees the potential for higher than normal load growth due to the combined effect of development intensification (multi-rise residential buildings plus new campus facilities) and the I-MUSH sector adoption of net-zero carbon policies that are targeting significant Green House Gas reductions over the next 20 to 30 years through electrification of transportation and heating. This is concerning because preliminary estimates suggest that electrical demand could double or triple within the next 20 years and the existing electrical transmission lines and facilities serving the Peterborough to Kingston region have limited capacity to meet this demand need. Kingston Hydro is also concerned about rapid load growth within the next 20 years since it typically takes 10 to 15 years to plan and build new transmission assets. The recent Regional Planning initiative lead by the IESO identified an immediate need at Gardiner TS which is supplied from the 230kV transmission system and a near-to-mid-term need at Frontenac TS which is supplied from the 115kV transmission system. The recommendation for addressing the need at Frontenac TS is to construct a new 230kV station in close proximity to the existing 230kV double circuit transmission line that supplies Gardiner TS then extend 44kV distribution feeders into Kingston Hydro territory. Kingston Hydro continues to monitor load growth closely so that it can take timely and appropriate action. It is very difficult to predict the timing of this load growth since much of it depends on Federal, Provincial and Municipal policies and funding.

Kingston Hydro also services three major hospital sites; Hotel Dieu Hospital (HDH), Kingston General Hospital (KGH) and Providence Care. The Providence Care facility was built in 2017 and replaced the former Kingston Psychiatric and St. Mary's of the Lake hospitals. HDH is currently undergoing some minor renovations and the KGH site is scheduled to undergo a multi-year renovation beginning in 2024.

As a final note, Kingston Hydro expects the demolition of older, less efficient buildings and facilities will have only a modest reduction in the overall load growth due to magnitude of the forecast of new intensification and electrification projects in the area.

5.3.2.(b.) Summary Description of System Configuration

Table 5.3-7 contains a summary of key features of the Kingston Hydro distribution territory as of December 2021.

Feature	Characteristics
Service Area Population	59,857 (2019 Estimate from Density Analysis)
Greater Kingston Population	123,800 (2016 Census) 145,638 (2019 Forecast :120,463 Permanent Pop. + 25,175 Student Pop.)
Predominantly Rural or Urban?	Urban
Service Territory Size	36.57 sq. km
Primary Operating Voltages	44kV (46kV Class) 13.8kV (15kV Class) 4.16kV (5kV Class)
Mostly Overhead or Underground?	Combination Overhead and Underground with above average Undergrounding (PEG report to OEB dated May 2013)
Contiguous Service Area ?	Yes
Asset Location	Lines Generally located in Road Allowances Kingston Hydro owns Substation properties
Climate	Temperate climate moderated by proximity to Lake Ontario
Extreme Weather Events	Ice Storms: Jan 1998, Dec 2013 Flash Floods: July 2011 Rain and Windstorm: Oct/Nov 2019
Heritage	Significant archeology due to three historic occupation periods: • First Nations (pre-European contact). • French (established 1673) • British (established 1758) Historic sites: • Fort Frontenac – circa 1673 • Market Square – circa 1801 • Barriefield Village – circa 1814 • Sydenham Ward – circa 1800's • City Hall – circa 1846
Seasonal Electrical Demand	Historic Winter Peaking Future Forecast trends: Increasing Summer peak due to local climate change (hotter summers) Increasing Winter peaks due to electrification of heating and transportation
Geography	Limestone Bedrock with minimal topsoil cover
Ground Conditions	Difficult due to limestone, archeology and congested urban underground infrastructure
Submarine Cable?	None owned by Kingston Hydro, but a portion of territory is served from a Hydro One owned 44kV submarine cable that crosses the Cataraqui River
Economy	Mix of Institutional, Municipal, University, Schools and Hospitals (I-MUSH Sector) and Residential customers. Seasonal influxes due to post-secondary schools, military staff, tourism and culture.
2023 Incremental Load Forecast	3.3MW (2.7% of Average Summer Peak of 120.7MW)
Major Developments	Downtown Intensification Electrification initiatives by I-MUSH sector
Neighbouring Utilities	Hydro One Networks Distribution
Host or Embedded Utility Status	Partially embedded distributor – 3 of 7 delivery points are Transmission connected
IESO registered meter participant	Kingston Hydro is the registered IESO meter participant for all 7 delivery points

Figure 5.3-7 – Summary of Key Features of Kingston Hydro Territory

Kingston Hydro does not own any transmission or high voltage assets (>50kV) that were deemed previously by the OEB as distribution assets and there are no such assets that Kingston Hydro is asking the OEB to deem as distribution assets in the present Cost of Service application.

Kingston Hydro is deemed to be a Partially Embedded distributor due to its mix of transmission and distribution connected delivery points with Hydro One however, monthly energy charges for all seven of its delivery points are received from the Independent Electricity System Operator (IESO) since Kingston Hydro is the registered meter participant for all delivery points. The percentage of Kingston Hydro load supplied from the upstream Host Transmitter and Distributor is summarized in Table 5.3-3.

Kingston Hydro is not a Host Distributor.

Delivery Point	Upstream Host	Connection Type	Supply Facility	# of Feeders	Feeder Type	Feeder IDs	% Annual Load
1	Hydro One Transmission	Transmission	Frontenac TS	3	Dedicated	M2, M4, M5	44%
2	Hydro One Distribution	Distribution	Gardiner TS	3	Dedicated	M7, M9, M12	49%
3	Hydro One Distribution	Distribution	Frontenac TS	1	Shared	M3	7%
			Total	**7**		**Total**	**100%**

Table 5.3-3 – Percentage Load Supplied from Host Transmitter and Distributor

Table 5.3-4 summarizes the overhead and underground circuit km by voltage class.

Type	Overhead (Circuit km)	Underground (Circuit km)	Totals (Circuit km)
44KV Conductor	47.457	7.231	54.687
5KV Conductor	179.914	99.413	279.327
13.8KV Conductor	0.023	0.072	0.095
Secondary Conductor	148.016	19.946	167.962
Primary Service	0.000	0.261	0.261
Secondary Service	182.221	7.718	189.939
Total Circuit km (including Secondary & Services)	**510.174**	**127.410**	**637.584**
Total Primary Circuit km (excluding Secondary & Services)	**179.937**	**99.485**	**279.422**

Table 5.3-4 – Overhead and Underground Circuit km by Voltage Class

Table 5.3-5 contains an overview of Kingston Hydro’s distribution system features.

Quantity	Feature / Characteristics
6	Dedicated 44kV Feeders from Hydro One
1	Shared 44kV Feeder from Hydro One
107	5kV (4.16kV) and 15kV(13.8kV) Feeders
15	Municipal Substations (MS) that stepdown voltage from 44kV to 4.16kV
1	Municipal Substation (MS) that stepdown voltage from 44kV to 13.8kV
34	Municipal Substation (MS) Transformers (all facilities)
129.4 111.7	MW - 2019 Winter Gross System Peak (Pre-COVID) MW – 2021 Winter Gross System Peak (COVID)
122.3 118.6	MW - 2018 Summer Gross System Peak (Pre-COVID) MW – 2021 Summer Gross System Peak (COVID)

Table 5.3-5 – Overview of Kingston Hydro's Distribution System Characteristics

Table 5.3-6 contains an overview of Kingston Hydro’s 44kV supply from Hydro One.

Characteristics	
3	Transmission Connected, Dedicated 44kV Feeders from Hydro One Frontenac TS
3	Distribution Connected, Dedicated 44kV feeders from Hydro One Gardiner TS
1	Distribution Connected, Shared (Embedded) 44kV Feeder from Hydro One Frontenac TS
21.5	MW - Normal rating of each 44kV feeder
43.0	MW - Emergency rating of each 44kV feeder

Table 5.3-6 – Overview of Kingston Hydro's Supply from Hydro One

The capacity and loading of power transformers at Kingston Hydro’s sixteen (16) Municipal Substations are summarized in Section 5.3.2.(d).

5.3.2.(c.) Summary of Asset Age and Condition

Kingston Hydro uses two types of asset registries to track electrical distribution assets. Most Distribution Assets (with the exception of Substation assets) are documented in the existing Enterprise Geographic Information System (GIS) as a Linear or Point feature type and any related inspection data is generally recorded in a standalone worksheet(s)/database(s) that is linked to the GIS data. Substation Asset inventory is currently documented on a Single Line Diagram in AutoCAD format and the associated substation inspection data is recorded in standalone worksheets/databases. A summary of Distribution Assets and Substation Assets based on the Kingston Hydro

2018 asset registry data is provided in Table 5.3-7 and Table 5.3-8 respectively. These tables include the Typical Useful Life (TUL) used for financial depreciation purposes.

Asset Class	Asset Subclass	TUL	Qty	unit	Tracked In GIS?
Poles	Wood	45	6213	each	YES
	Concrete	45	150	each	YES
Overhead Conductors	Conductors	60	563	km	YES
	Switches 44kV 3ph ganged	45	31	each	YES
Distribution Line Transformers	Pole Top Transformer (1ph + 3ph)	40	1095	each	YES
	1 ph Pad-Mounted Transformer	40	359	each	YES
	3ph Pad-Mounted Transformer	40	237	each	YES
	Indoor Vault Transformer (1ph + 3ph)	40	64	each	YES
	Outdoor Sub. Vault Transformer (3ph)	40	17	each	YES
Underground Civil Structures	Cable Chambers (maintenance holes)	60	318	each	YES
	Cable Chambers (hand holes)	60	197	each	YES
	UG Foundations (pads)	40	618	each	YES*
	Underground Vault (w/ Underground Switch)	60	25	each	YES*
	Underground Vault Roof	25	7	each	YES*
	Concrete encased duct banks	50	334	CCT km	YES*
Underground Cable	Pad Switches - various	45	22	each	YES
	UG Switches - various	45	26	each	YES
	Primary Cables in Duct	40	334	CCT km	YES *
Services	Overhead Conductor	60	TBD	m	YES *
	Underground Cable	50	TBD	m	YES *

* - Denotes Estimated Quantity

Table 5.3-7 – Summary of Kingston Hydro's Distribution Assets

Asset Class	Asset Subclass		TUL	Qty	unit	Tracked In GIS?
Substation Equipment	MS Power Transformer		50	35	each	
	Station Service Transformer		50	17	each	YES
	Station Grounding System	Ground Grid	50	17	each	
		Arresters	20	183	set	
	Station DC System		20	17	each	
	Station Metal Clad Switchgear - Rackout Breakers and Structure mount reclosers		50	140	brkr	
	Concrete encased duct banks station egress		60	9000	CCT m	
	Outdoor Submersible Transformer - Vault Structure		60	0	each	
	Primary TR XLPE Cables in Duct		50	9000	CCT m	YES *
	Current and Potential Transformers (CT and PT)		50	164	brkr	
	Station Independent Breakers - 44kV		50	7	brkr	
	Station Switch - 44kV ganged 3ph		50	53	each	
	Station Switch - 5kV ganged 3ph		50	29	each	
	Digital and Numeric Relays		20	147	brkr	
	Rigid Busbars		50	1260	m	
Substation Buildings	Station Buildings		60	11	each	YES
	Station Walk-in 5kV Metal Clad Enclosure		60	3	each	
	Indoor/Outdoor Steel Structure		60	7	each	
	Roof		30	11	per station	
	Parking		30	0		
	Fence		30	15	per station	
	Other Fixtures (e.g. control hut)		30	3	each	
Monitoring and Control Systems	Smart meters		15			
	Wholesale		15			
	Current and Potential Transformers (CT and PT)		50			
Fleet	Vehicles		22			
	Trailer equipment		7			

* - Denotes Estimated Quantity

1 **Table 5.3-8 – Summary of Kingston Hydro's Substation Assets**

Assets with Detailed Condition Assessment

In early 2019, UK selected and engaged Kinectrics Inc. (Kinectrics) to perform an Asset Condition Assessment (ACA) of key electric distribution assets. Kinectrics had completed a previous ACA report for Kingston Hydro in 2013.

The assets were divided into the following 12 categories for the Kinectrics ACA:

- Station Transformers
- Station Breakers
- Station Ganged Switches (MV, 44 kV)
- Pole Mounted Transformers (1-Phase, 3-Phase)
- Pad Mounted Transformers (1-Phase, 3-Phase)
- Poles (Wood, Concrete)
- Pad Mounted Switchgear
- Vault Transformers
- Vault Switchgear
- Transformer Vaults
- UG Primary Cables - PILC (44 kV, Non 44 kV 1-Ph, Non 44 kV 3-Ph)
- UG Primary Cables - XLPE (44 kV, Non 44 kV 1-Ph, Non 44 kV 3-Ph)

Health Index

Kinectrics developed a Health Index (HI) as part of its ACA Methodology. Health Indexing quantifies equipment condition based on numerous condition parameters related to the long-term degradation factors that cumulatively lead to an asset’s end of life. The Health Index is an indicator of the asset’s overall health, relative to a brand new asset, and is given in terms of percentage, with 100% HI representing an asset in brand new condition and 50% HI or less representing an asset with a 50% or greater likelihood of being removed from service (e.g. asset effective age is equal to or greater than the typical useful life).

The condition data used in the Kinectrics study were obtained from UK and included the following:

- Test Results (e.g. Oil Quality, DGA)
- Inspection Records
- Loading
- Make, Model, and Type
- Age

A Health Index was calculated for each asset with sufficient condition data. As well, in order to provide an effective overview of the condition of each asset group, the Health Index Distribution for each asset category was determined. The Health Index Summary is presented in both a tabulated and graphic format in Table 5.3-9 and Figure 5.3-8.

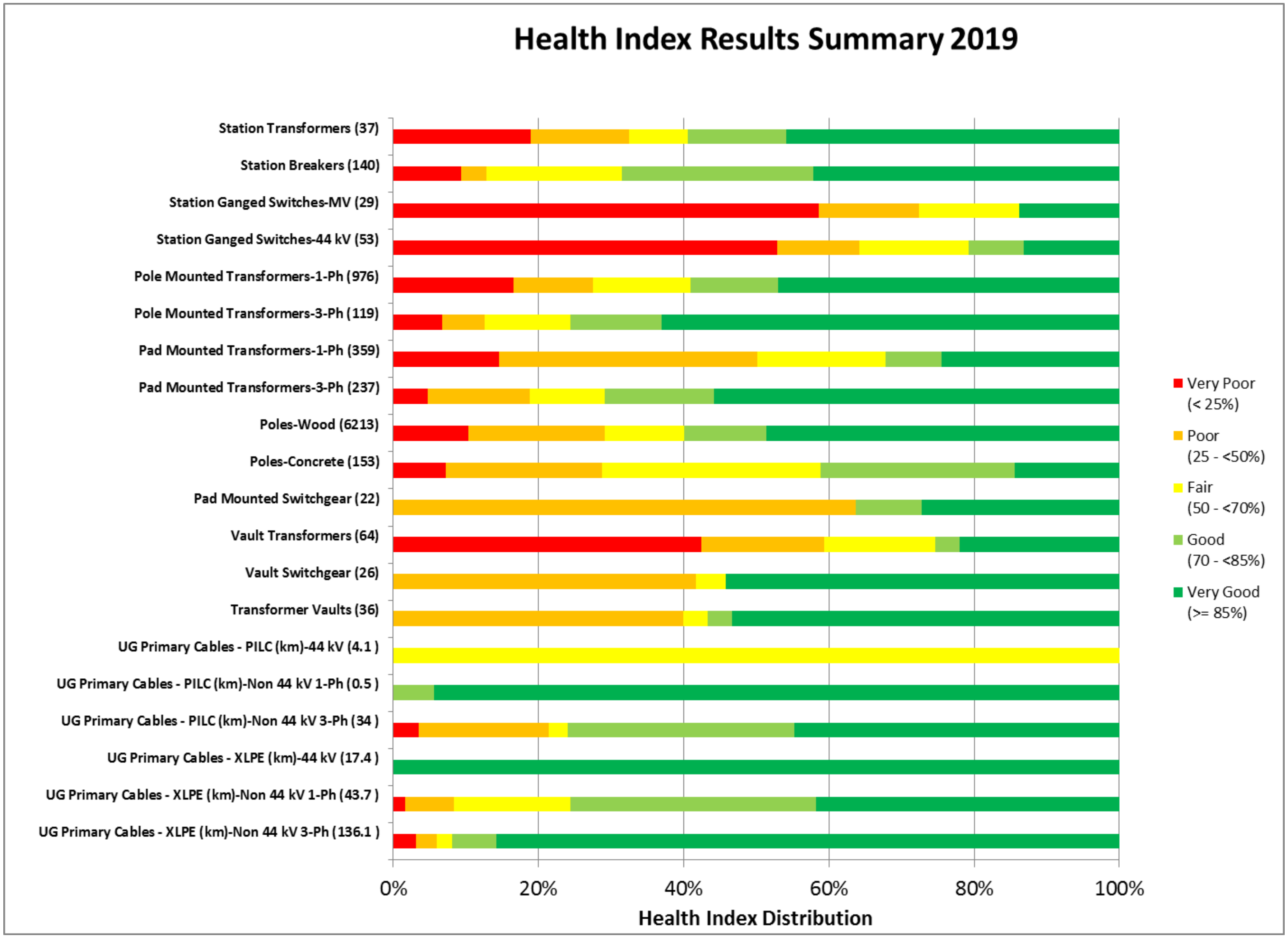
The base year (Age=0) used to calculate Age for ACA purposes is 2019.

Asset Category		Population	Sample Size	Average Health Index	Health Index Distribution: Very Poor (< 25%)	Poor (25 - <50%)	Fair (50 - <70%)	Good (70 - <85%)	Very Good (>= 85%)	Average Age	Average DAI	Age Availability
Station Transformers		37	37	63%	7	5	3	5	17	43	76%	100%
Station Breakers		140	140	74%	13	5	26	37	59	34	39%	100%
Station Ganged Switches	MV	29	29	29%	17	4	4	0	4	57	3%	100%
	44 kV	53	53	36%	28	6	8	4	7	54	15%	100%
Pole Mounted Transformers	1-Ph	976	971	70%	161	106	130	118	456	25	92%	99%
	3-Ph	119	119	80%	8	7	14	15	75	18	87%	100%
Pad Mounted Transformers	1-Ph	359	323	54%	47	115	57	25	79	34	10%	90%
	3-Ph	237	213	77%	10	30	22	32	119	21	17%	90%
Poles	Wood	6213	6186	71%	641	1163	678	699	3005	30	85%	100%
	Concrete	153	153	62%	11	33	46	41	22	40	87%	100%
Pad Mounted Switchgear		22	22	59%	0	14	0	2	6	30	64%	100%
Vault Transformers		64	59	46%	25	10	9	2	13	38	17%	92%
Vault Switchgear		26	24	68%	0	10	1	0	13	25	4%	92%
Transformer Vaults		36	30	73%	0	12	1	1	16	27	43%	83%
UG Primary Cables - PILC (km)	44 kV	4.1	0.1	69%	0.0	0.0	0.1	0.0	0.0	2	Age Only	3%
	Non 44 kV 1-Ph	0.5	0.5	99%	0.0	0.0	0.0	0.0	0.5	25	Age Only	99%
	Non 44 kV 3-Ph	34.0	6.1	76%	0.2	1.1	0.2	1.9	2.7	8	Age Only	18%
UG Primary Cables - XLPE (km)	44 kV	17.4	9.2	100%	0.0	0.0	0.0	0.0	9.2	5	Age Only	53%
	Non 44 kV 1-Ph	43.7	16.1	80%	0.3	1.1	2.6	5.5	6.8	11	Age Only	37%
	Non 44 kV 3-Ph	136.1	51.8	93%	1.6	1.5	1.1	3.1	44.4	5	Age Only	38%

0% – 100%

Age Only: No information other than age

Table 5.3-9 – Health Index Distribution Summary

1 

2 **Figure 5.3-8 – Overview of Asset Group Health Index Summary**

The age distribution for Substation Power Transformers is shown in the figure below. Age was available for 100% of the population. The average age was found to be 43 years.

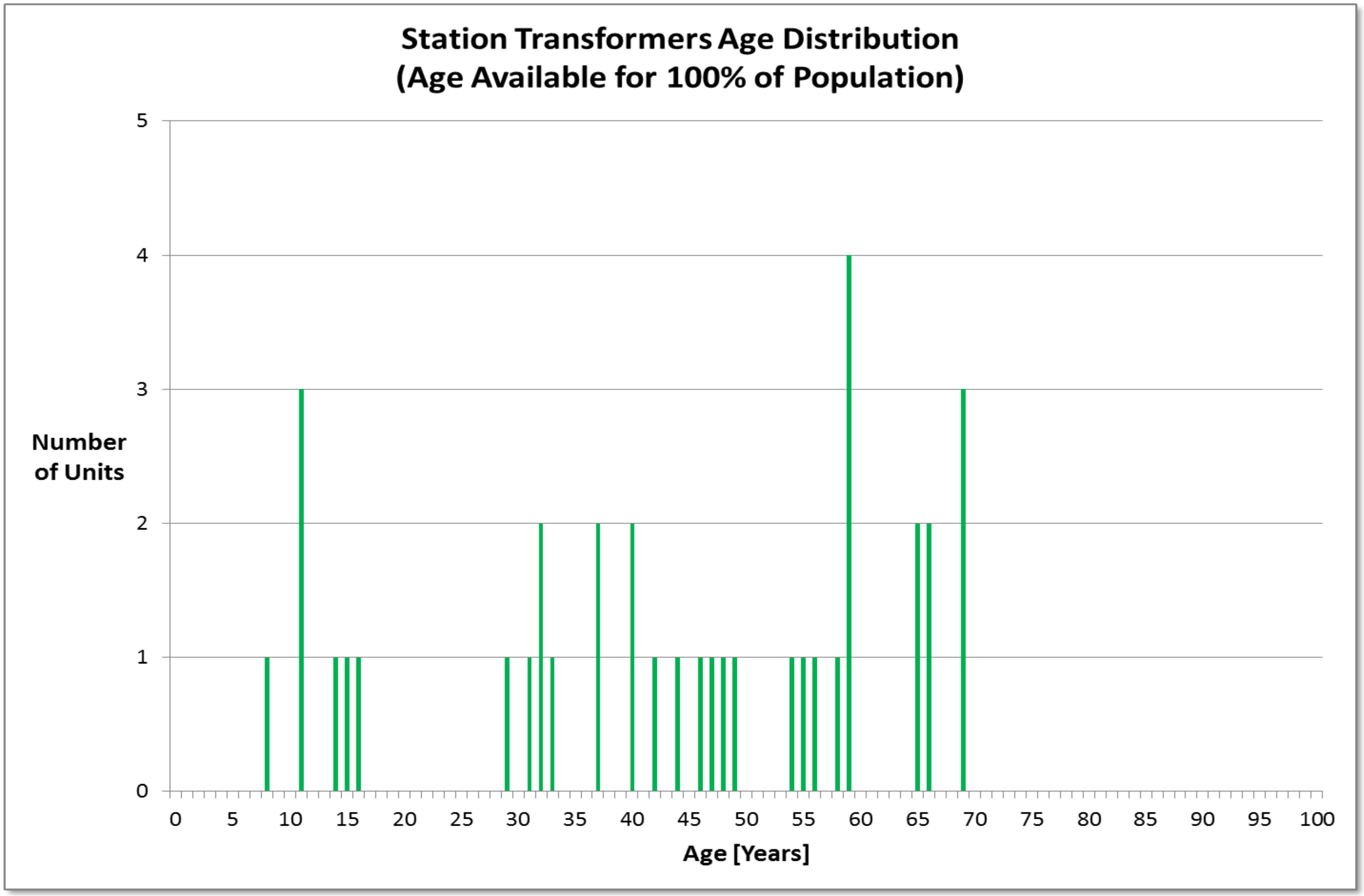
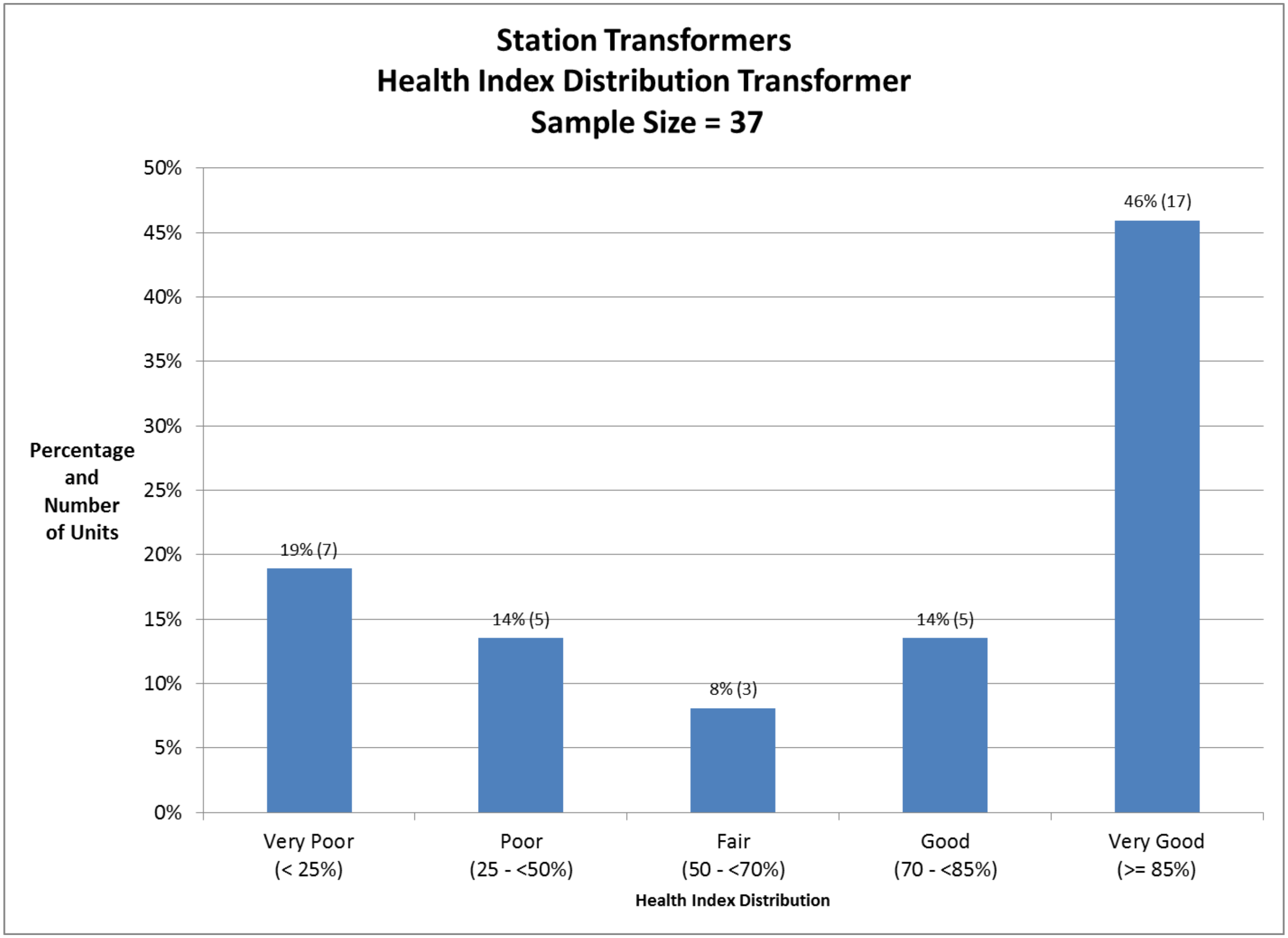


Figure 5.3-9 – Substation Power Transformer Age Distribution



1
2 **Figure 5.3-10 – Substation Power Transformer Health Index Distribution**

3

The age distribution for station breakers is shown in Figure 5.3-11. Age was available for 100% of the population. The average age was found to be 34 years.

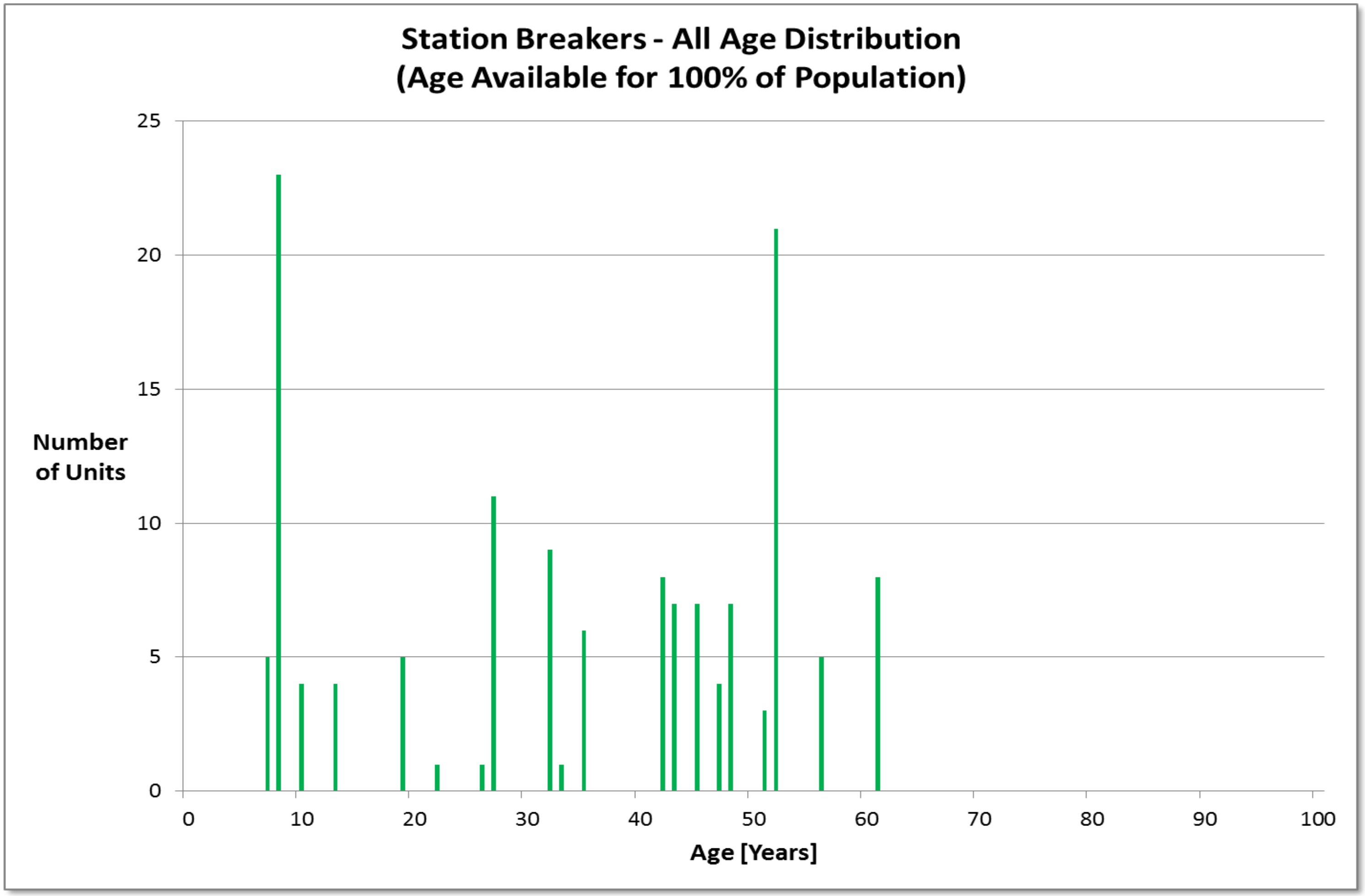


Figure 5.3-11 – Station Breaker Age Distribution

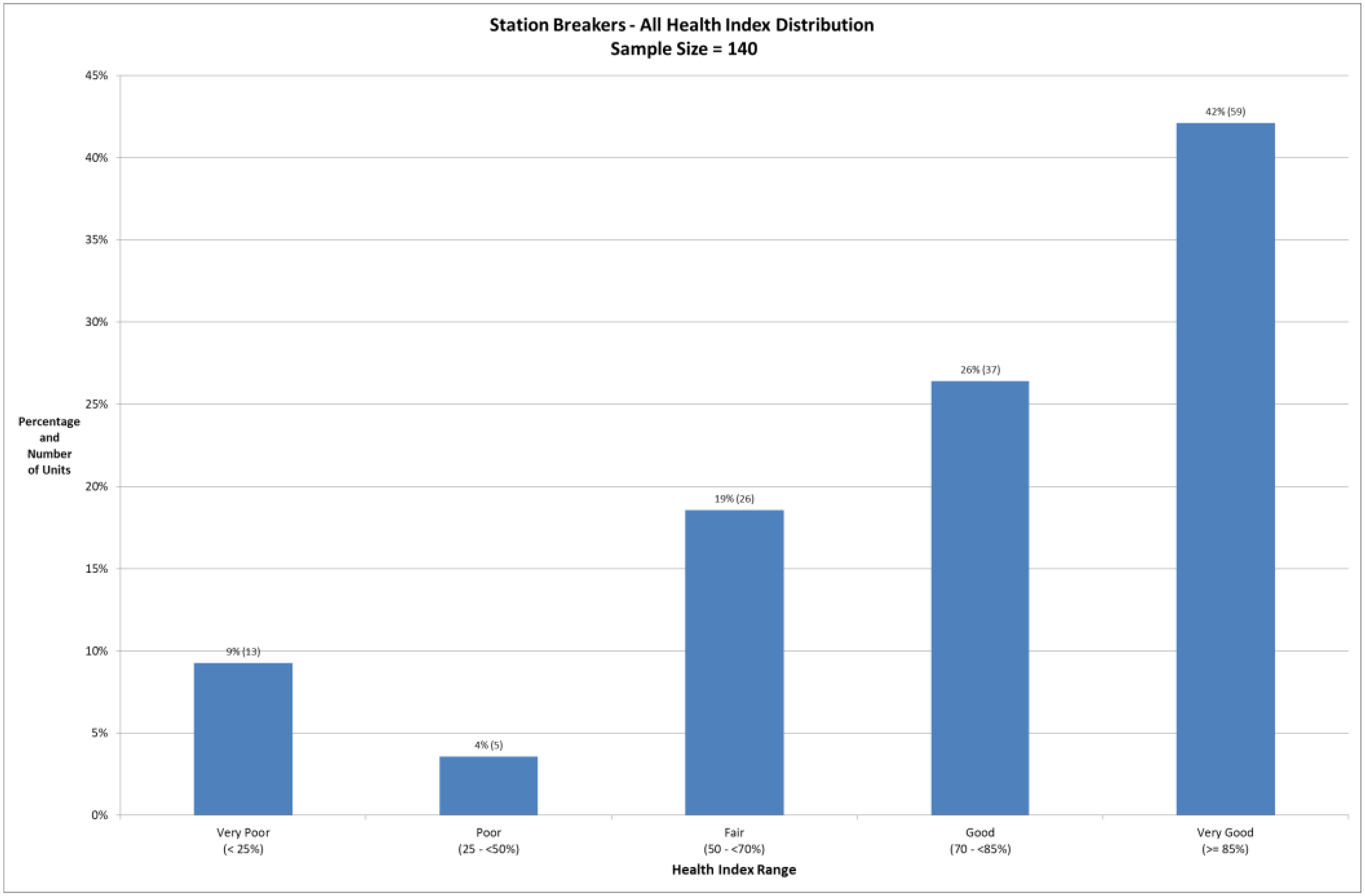


Figure 5.3-12 – Station Breaker Health Index Distribution

The age distribution for MV and 44kV station ganged switches is shown in Figure 5.3-13. Age was available for 100% of the population. The average age was found to be 57 and 54 years respectively.

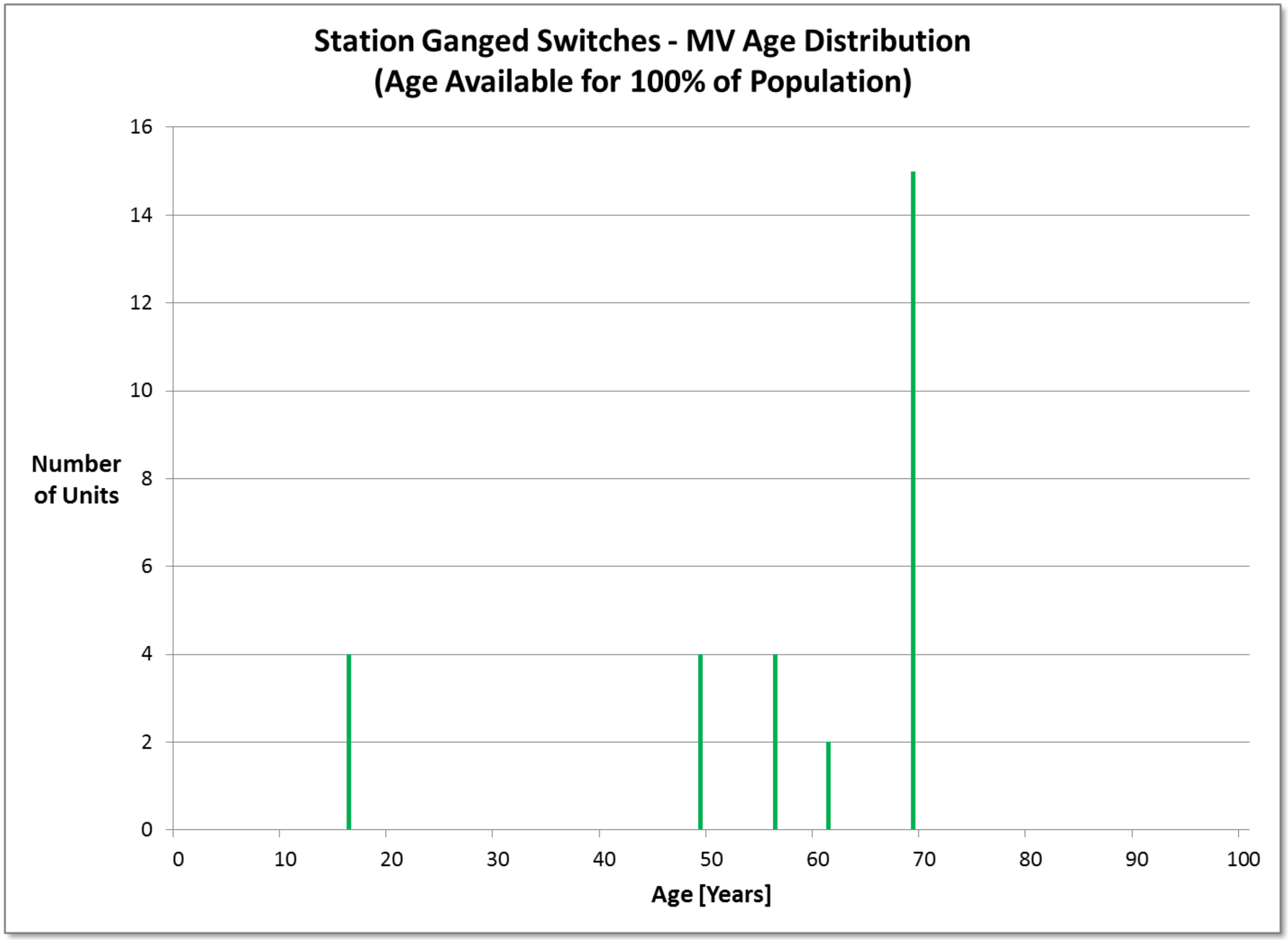
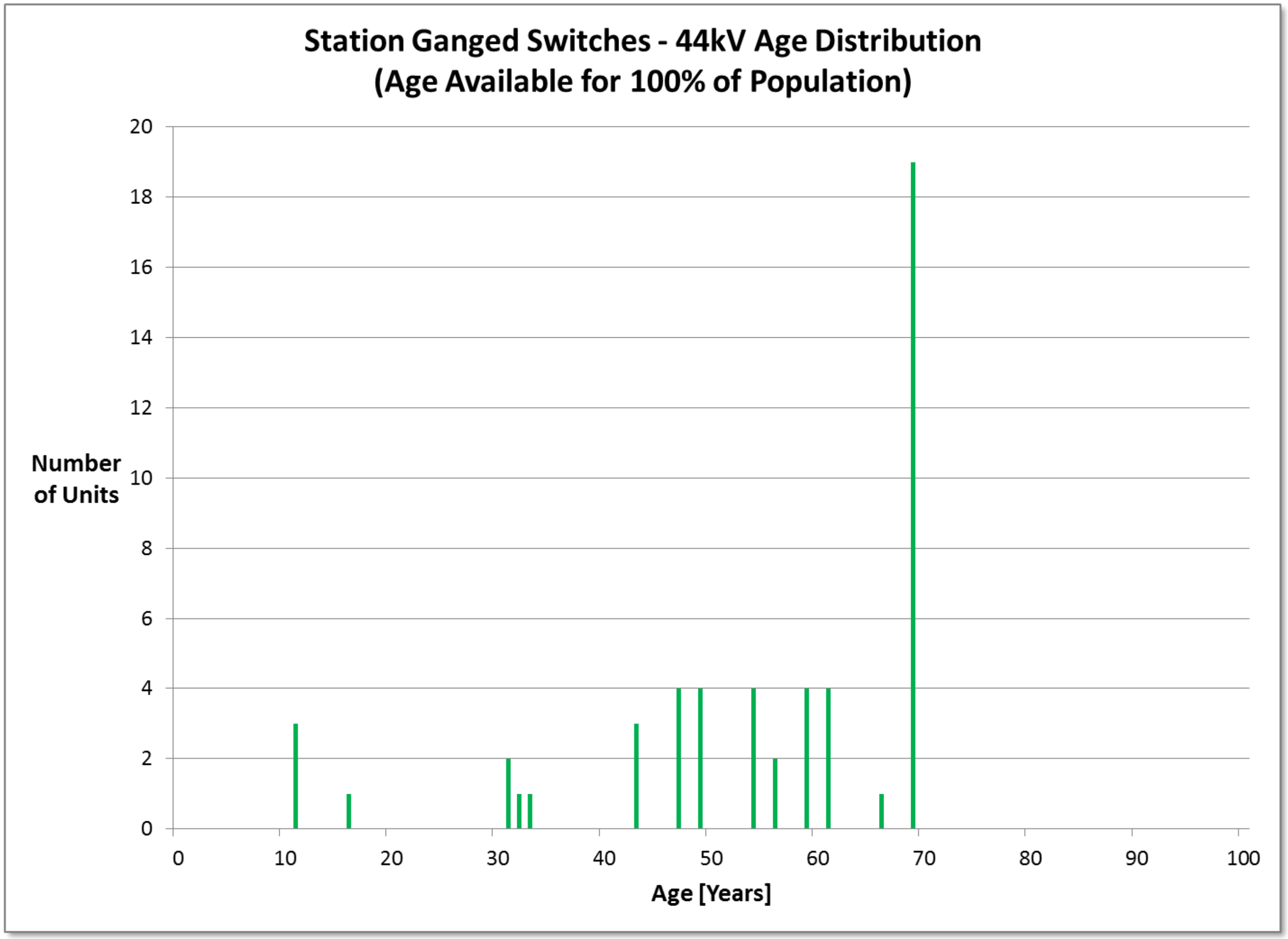
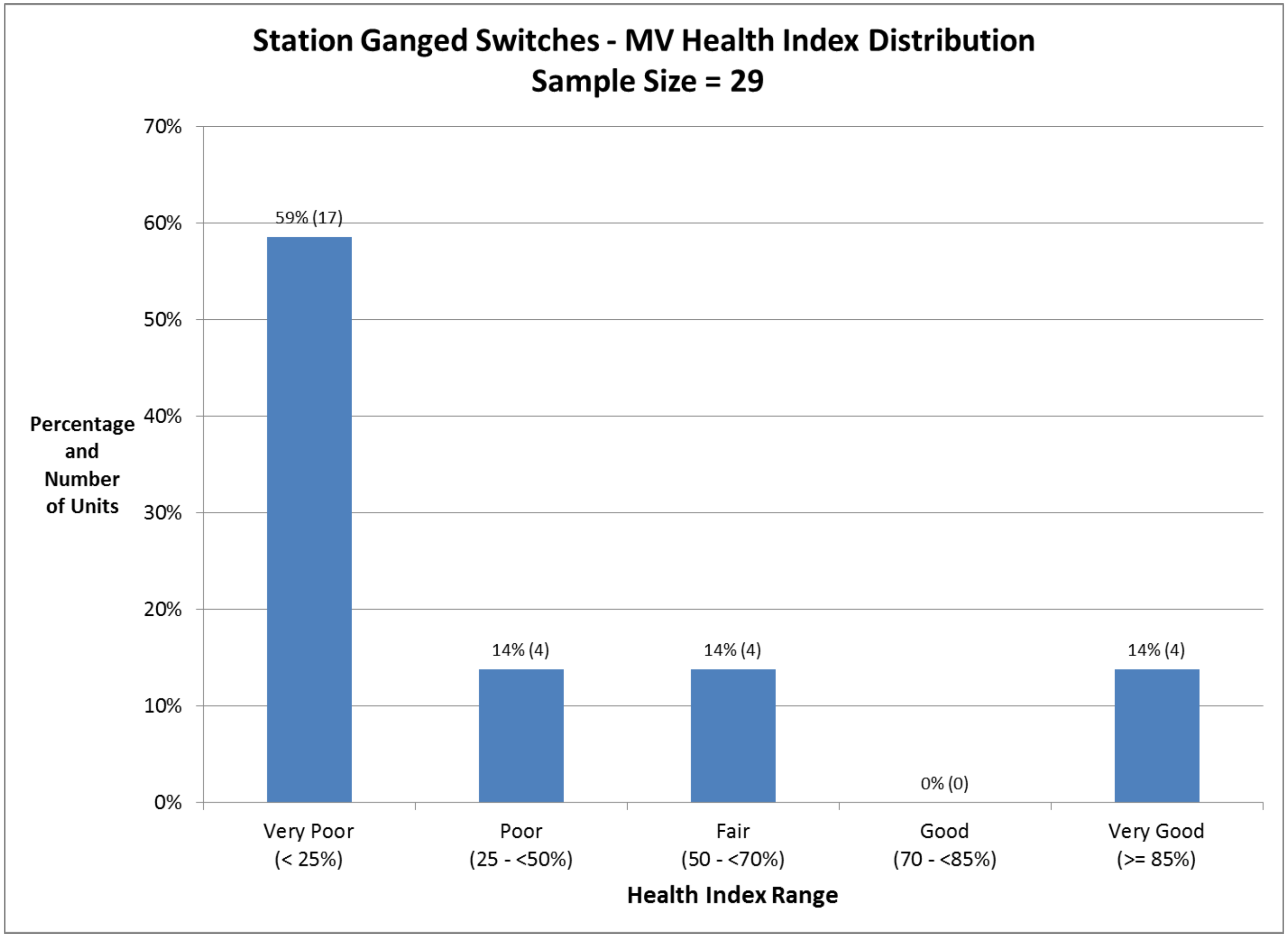


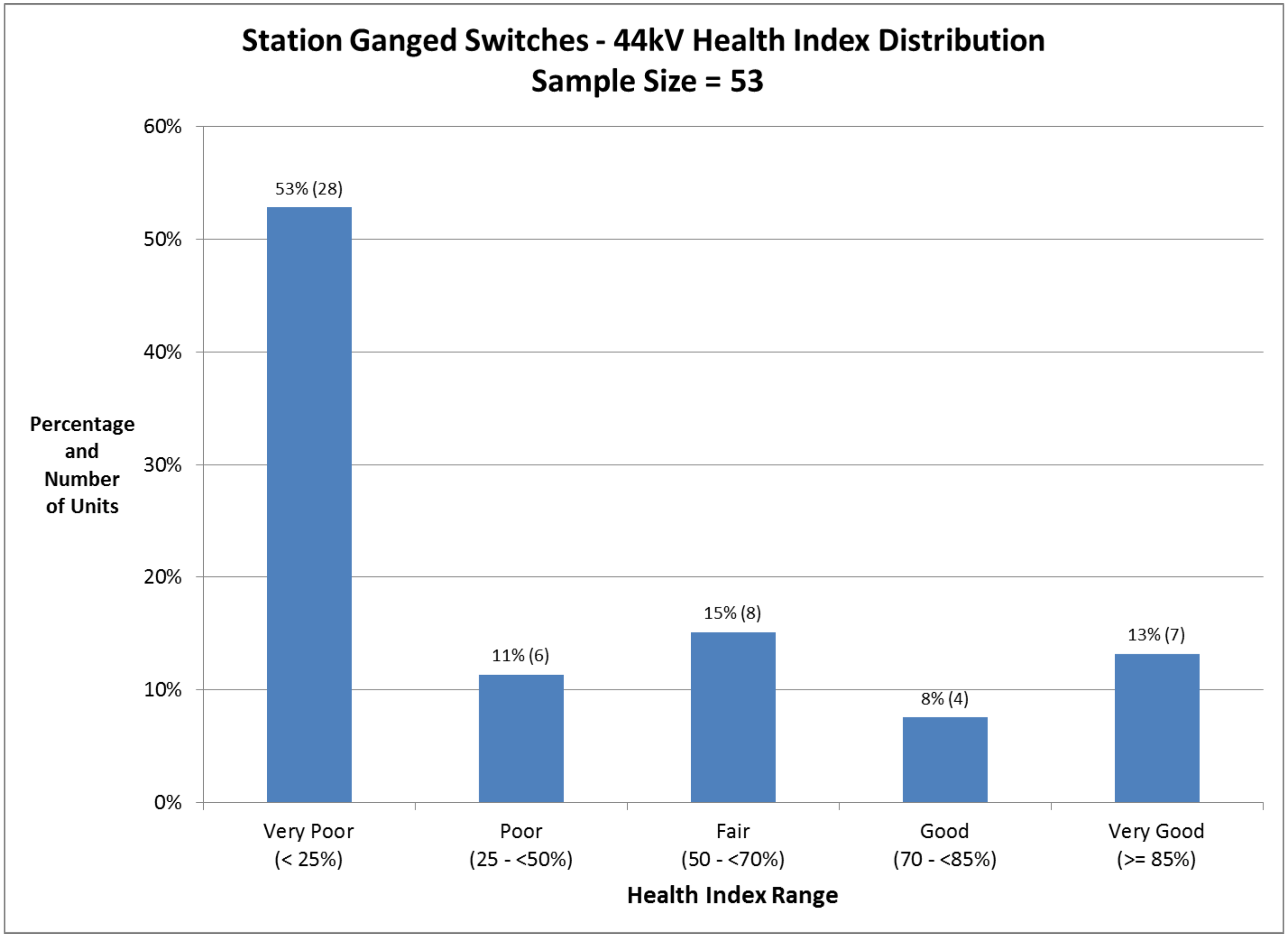
Figure 5.3-13 – MV Station Ganged Switch Age Distribution



1
2 **Figure 5.3-14 – 44kV Station Ganged Switch Age Distribution**

1 

2 **Figure 5.3-15 – MV Station Ganged Switch Health Index Distribution**

1


2 **Figure 5.3-16 – 44kV Station Ganged Switch Health Index Distribution**

The age distribution for 1-Phase and 3-Phase pole transformers is shown in Figures 5.3-17 and 5.3-18. Age was available for 99% of the population. The average age was found to be 25 and 18 years respectively.

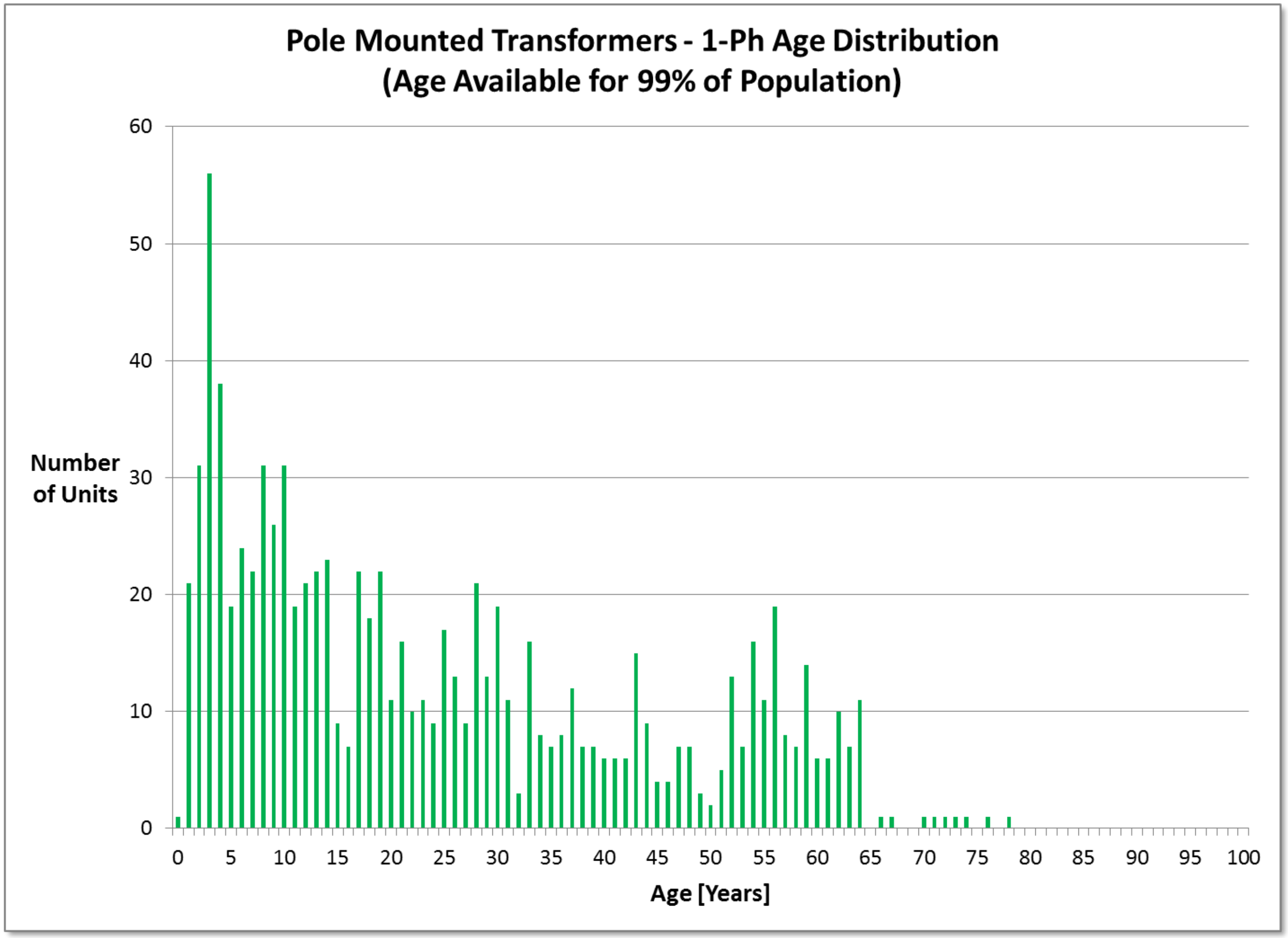


Figure 5.3-17 – 1-ph Pole Transformer Age Distribution

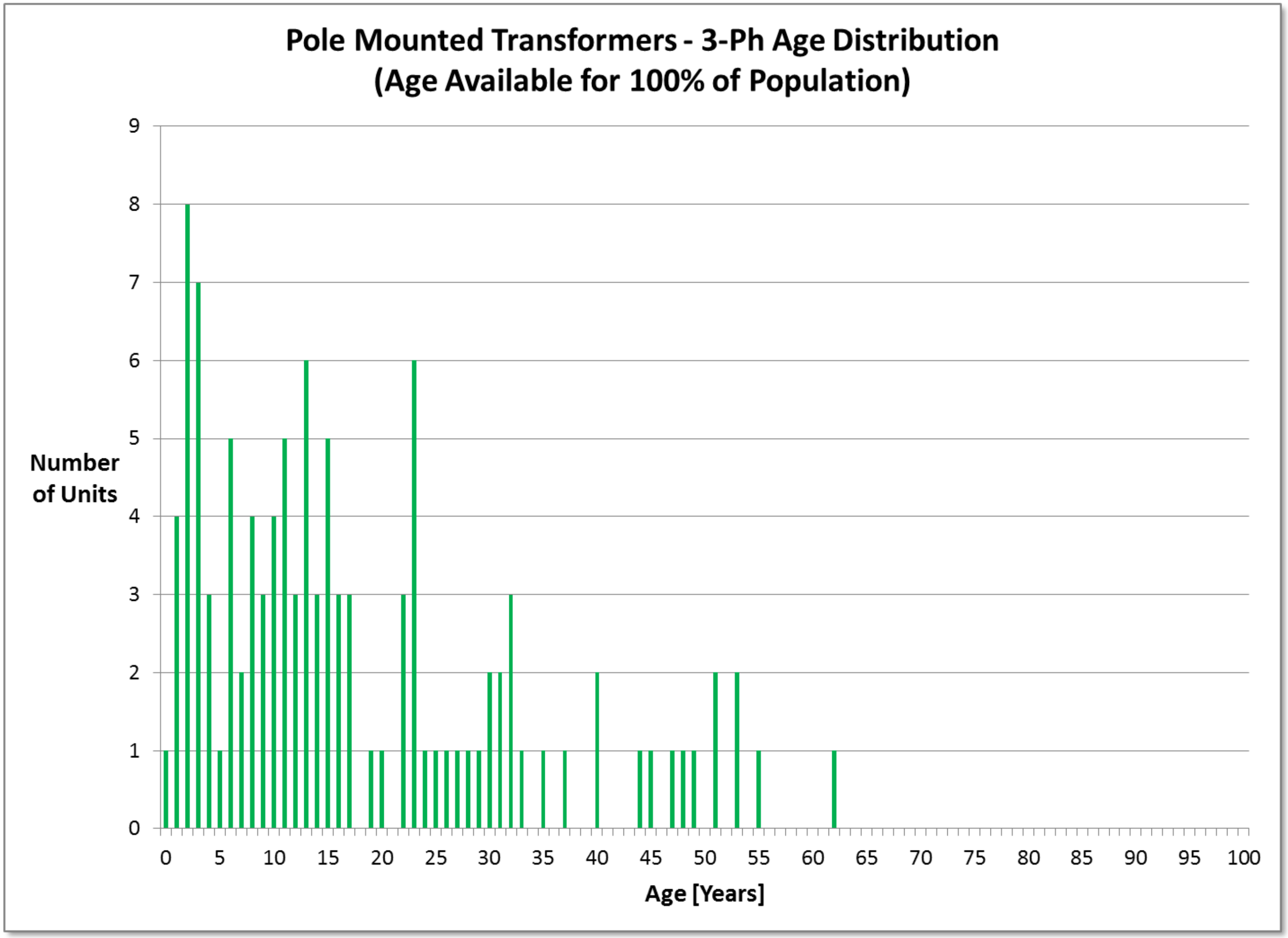
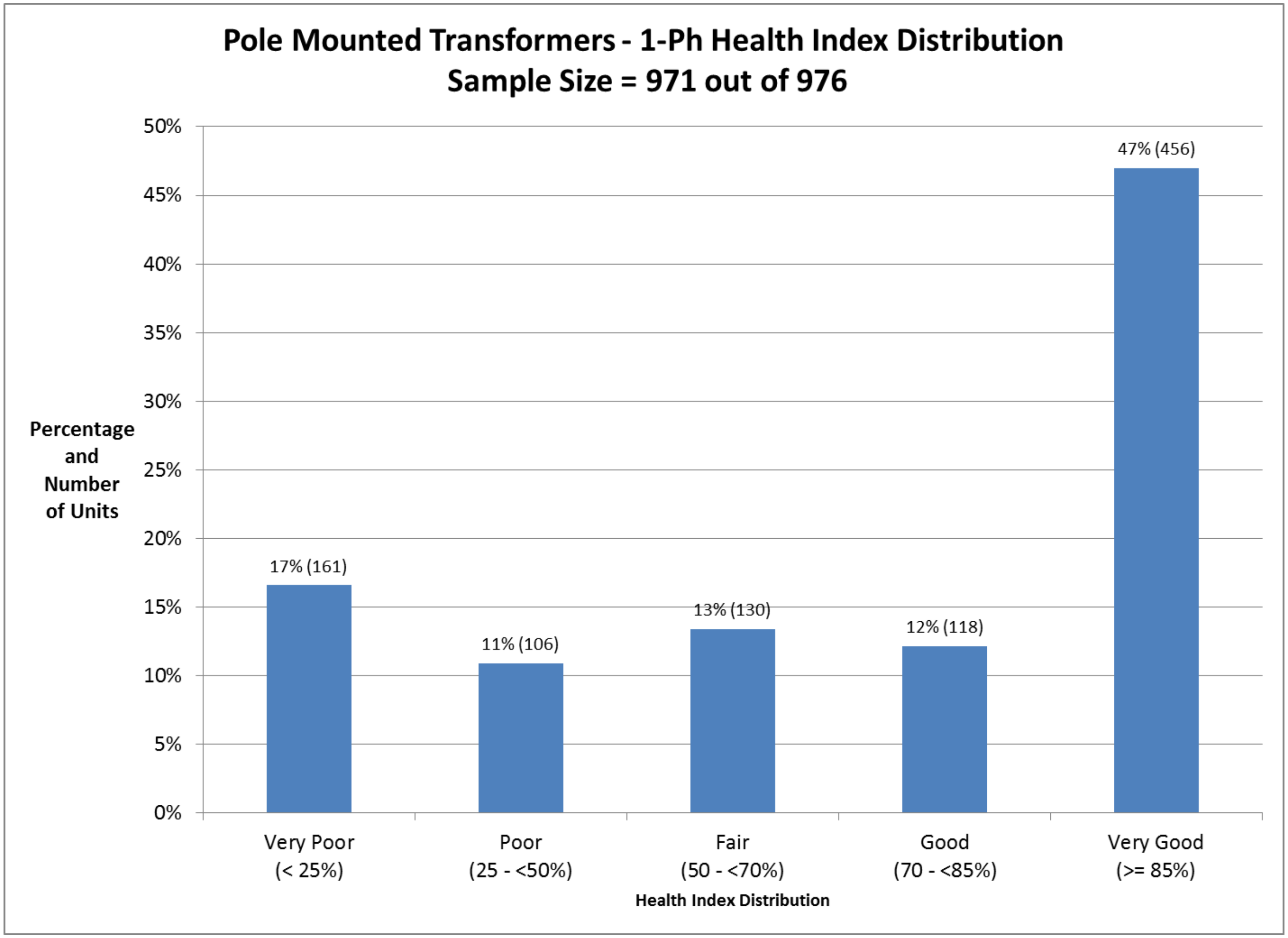


Figure 5.3-18 – 3-ph Pole Transformer Age Distribution

1 

2 **Figure 5.3-19 – 1-ph Pole Transformer Health Index Distribution**

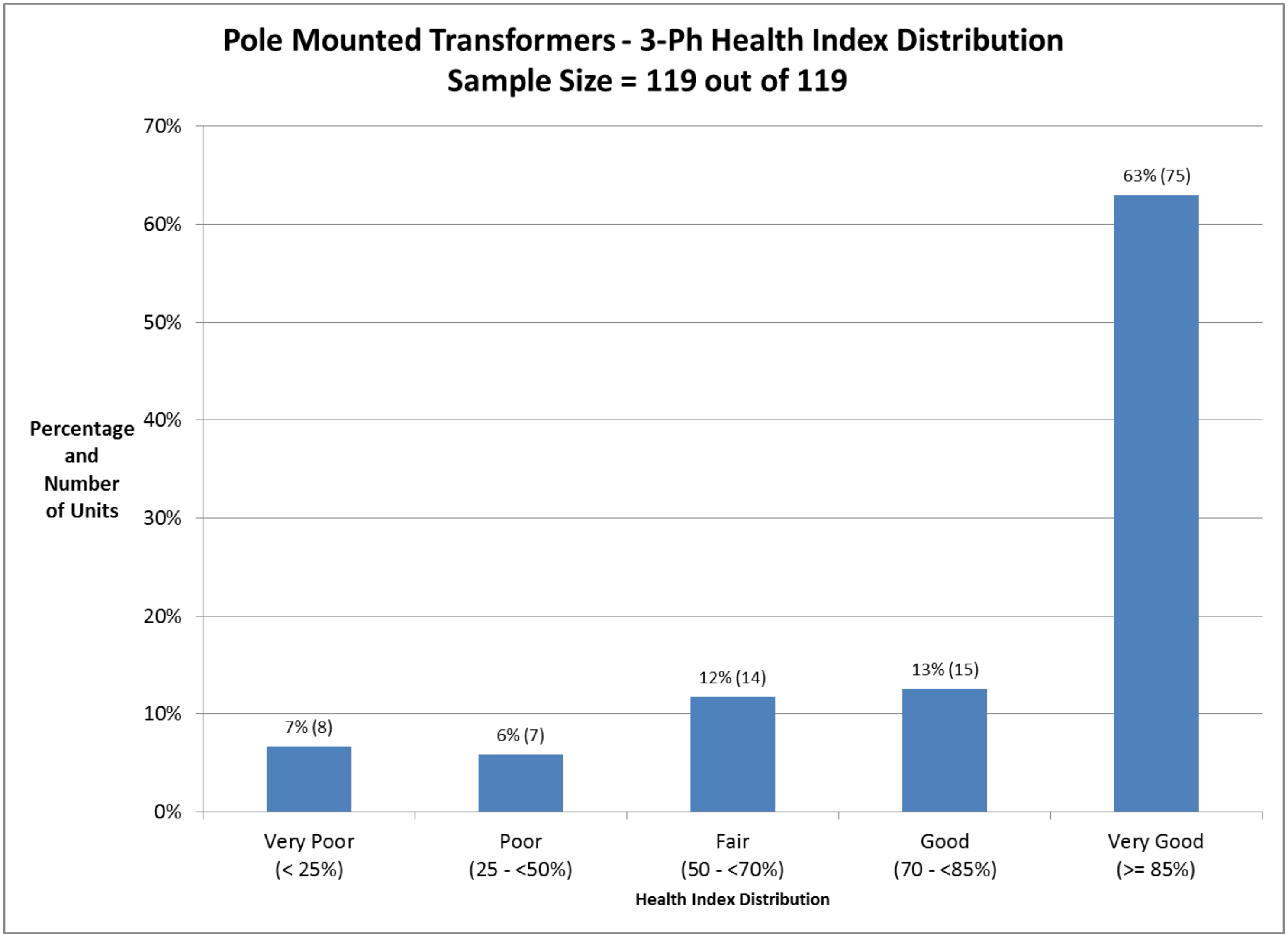


Figure 5.3-20 – 3-ph Pole Transformer Health Index Distribution

The age distribution for single phase pad transformers is shown in Figure 5.3-21. Age was available for 90% of the population. The average age was found to be 34 years.

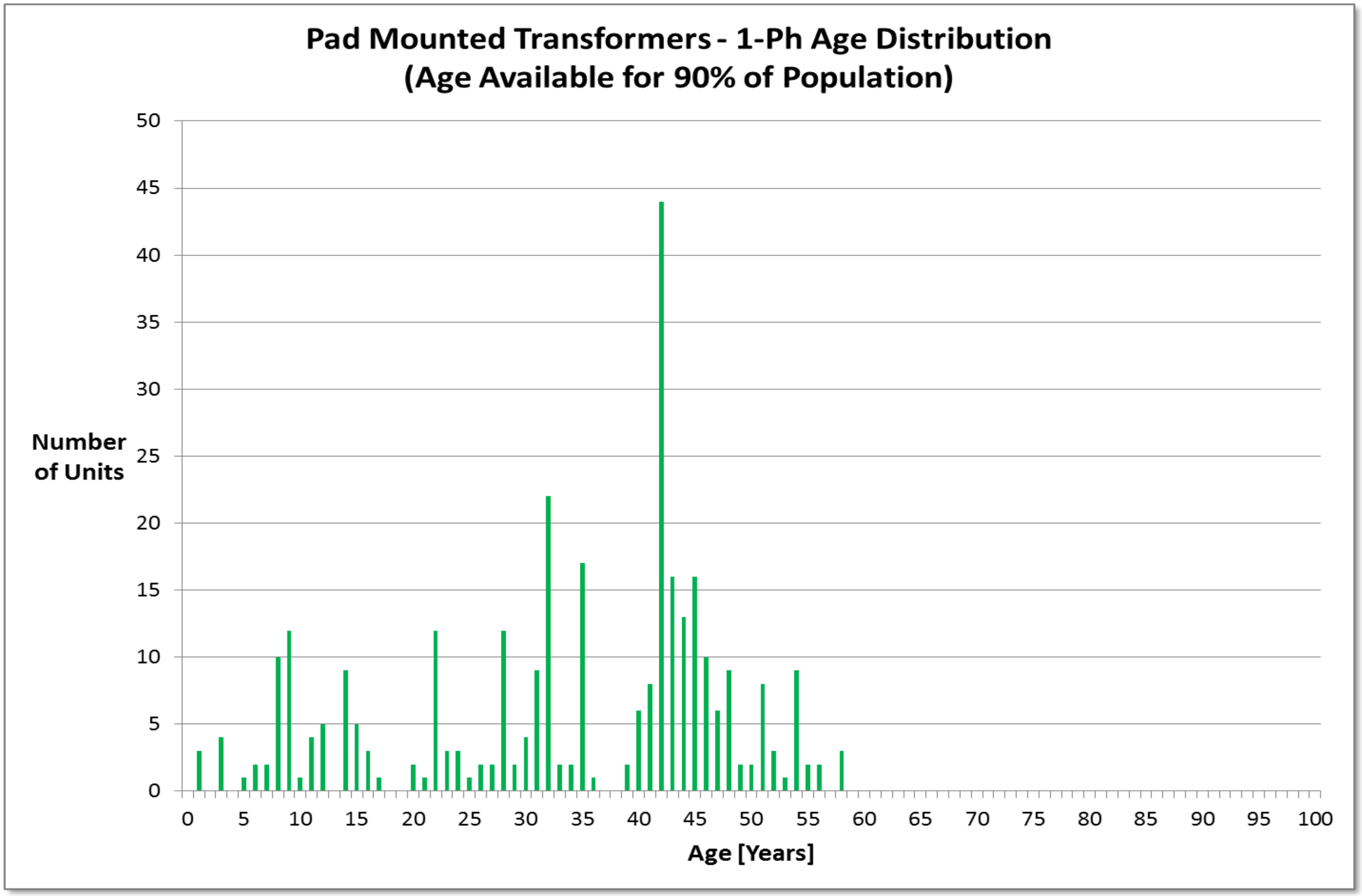
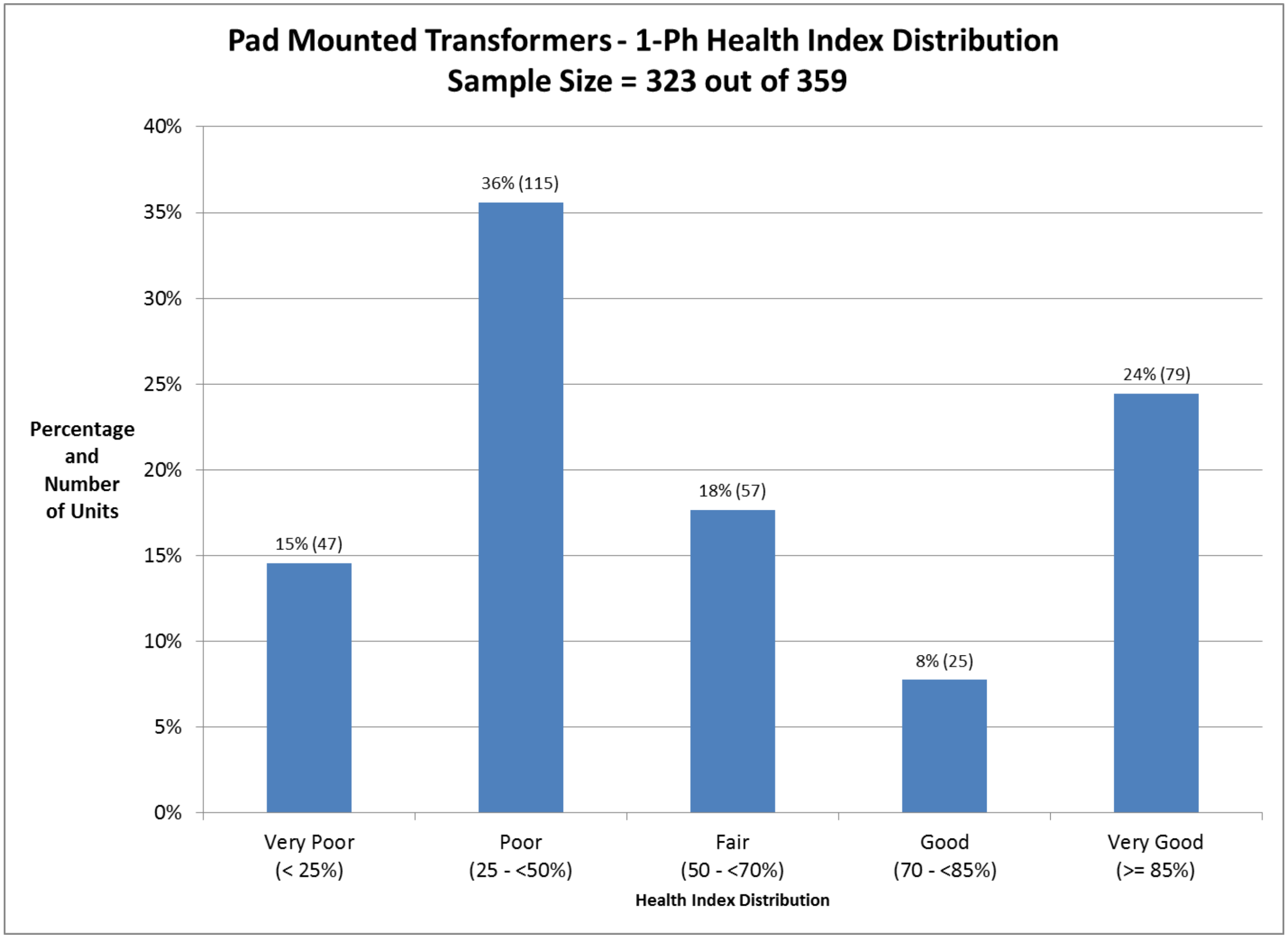


Figure 5.3-21 – 1-ph Pad Mounted Transformer Age Distribution

1 

2 **Figure 5.3-22 – 1-ph Pad Mounted Transformer Health Index Distribution**

3

The age distribution for three phase pad transformers is shown in Figure 5.3-23. Age was available for 90% of the population. The average age was found to be 21 years.

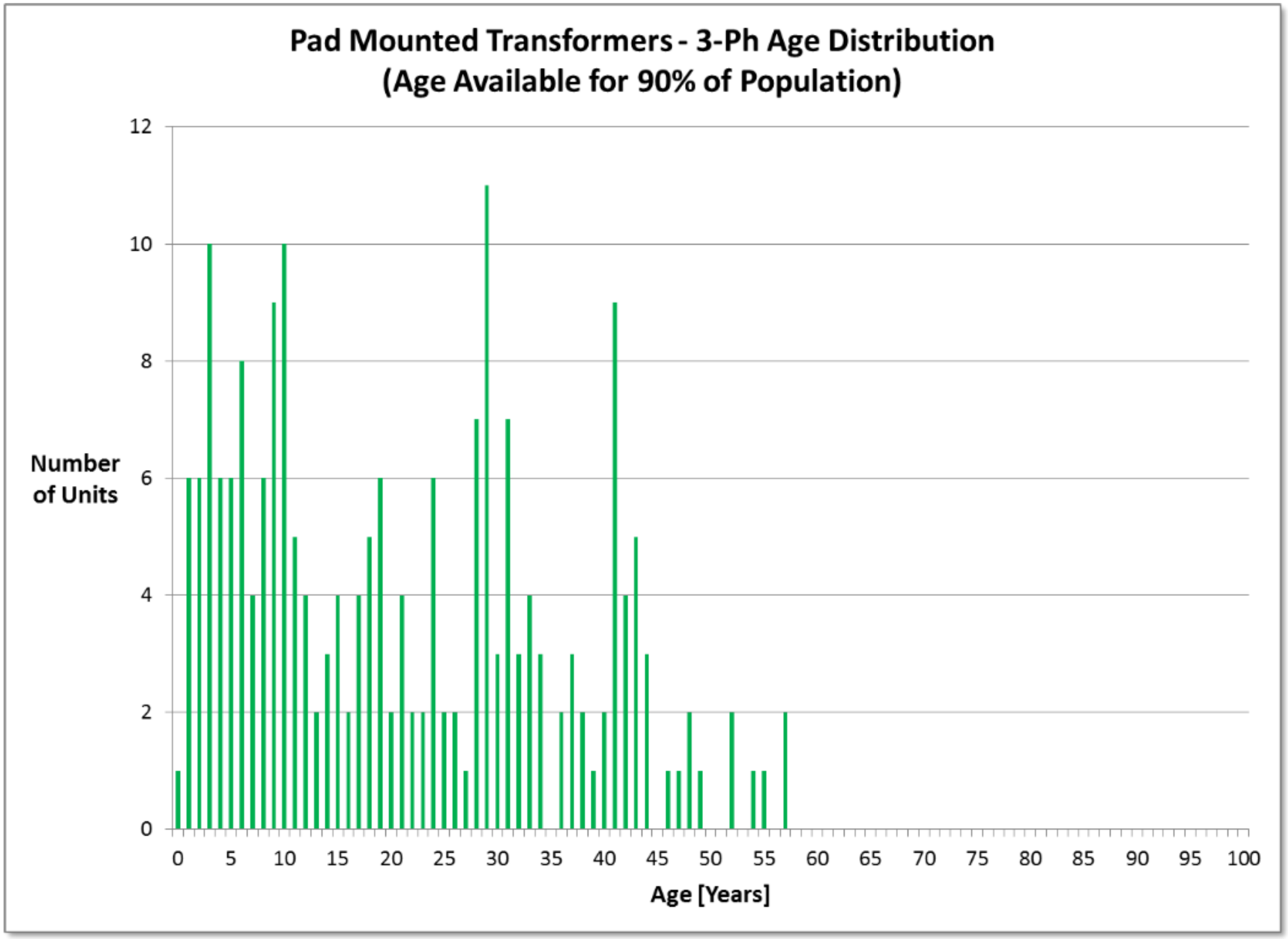


Figure 5.3-23 – 3 Phase Pad Mounted Transformer Age Distribution

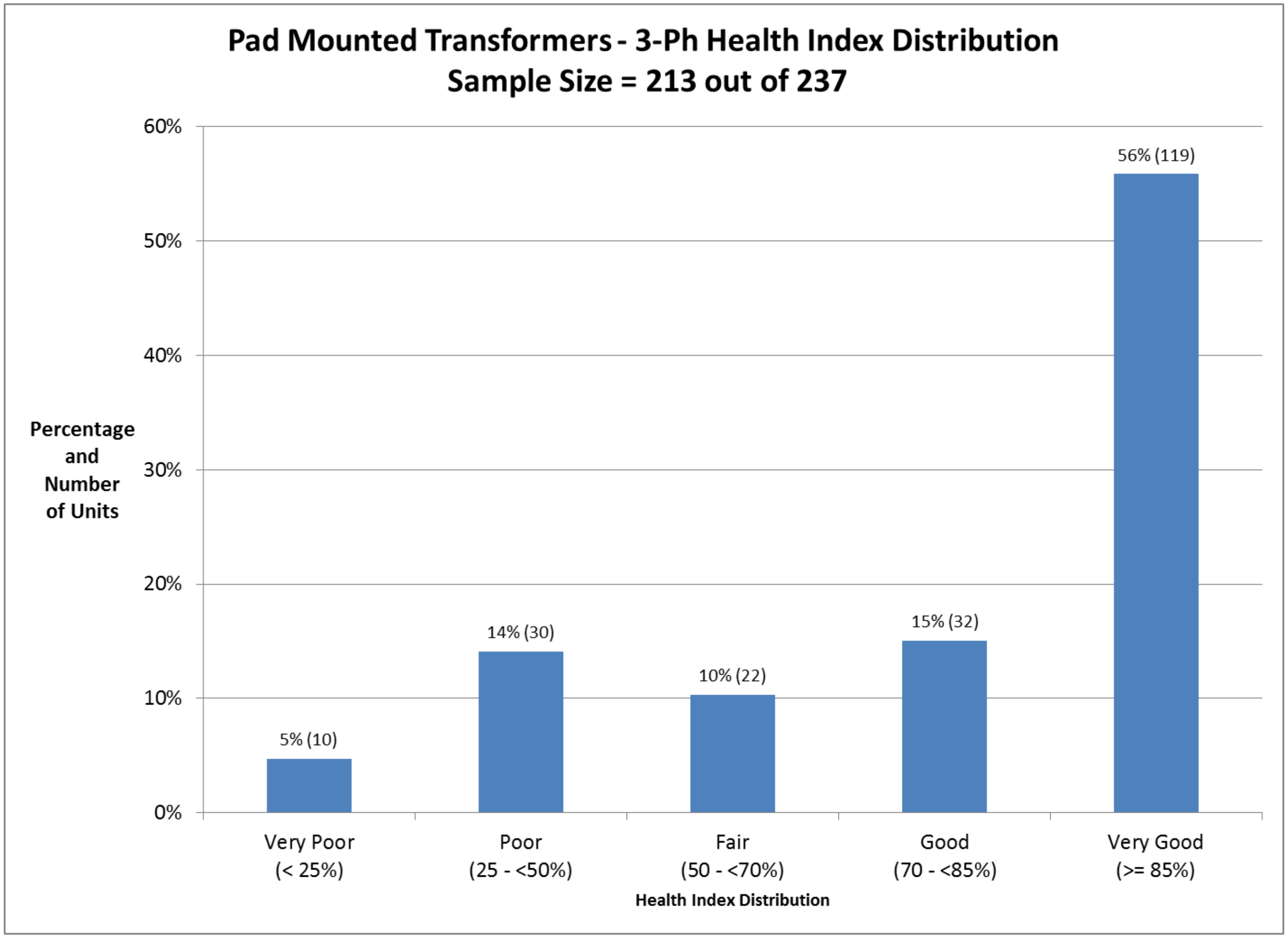
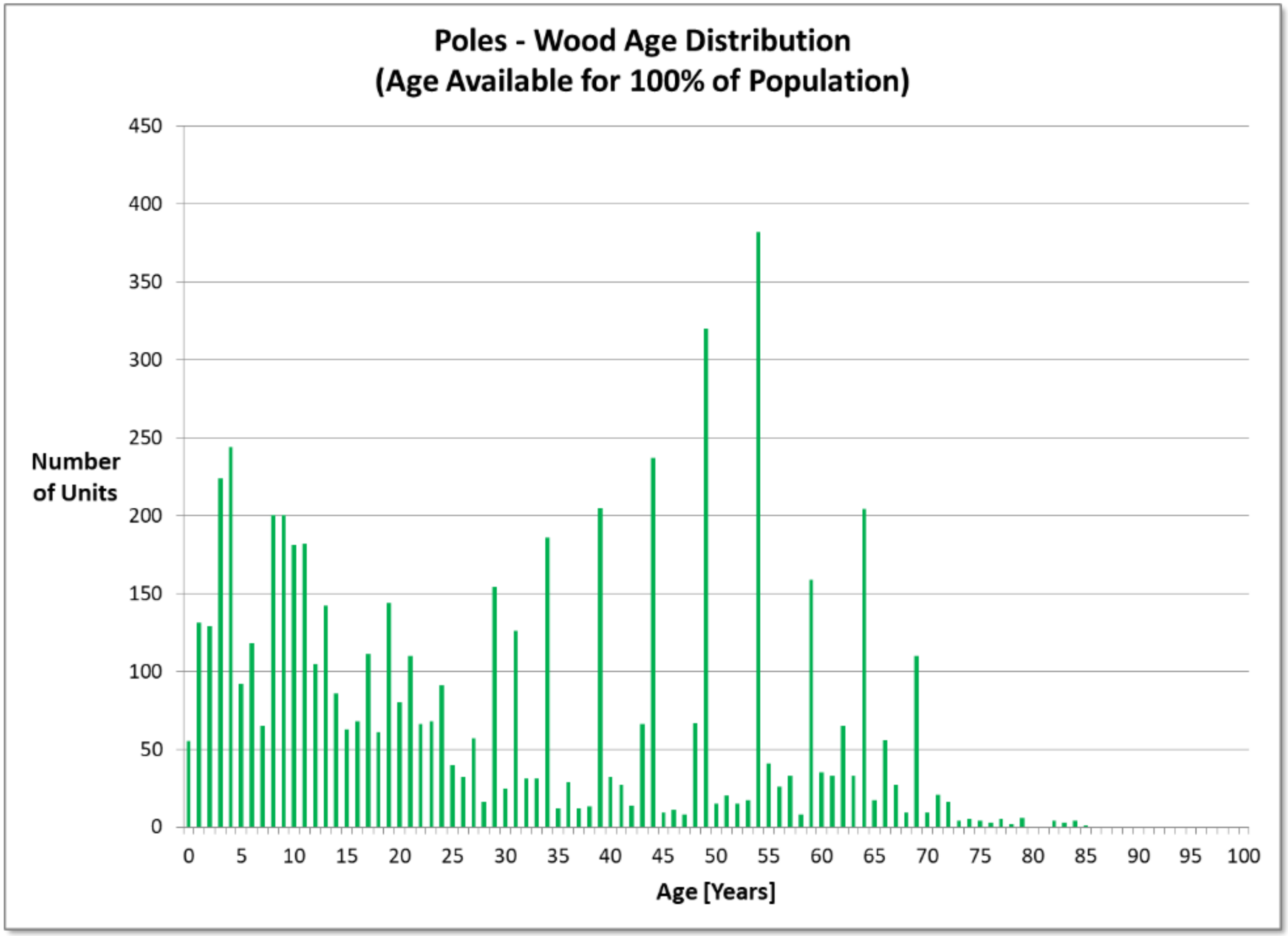


Figure 5.3-24 – 3 Phase Pad Mounted Transformer Health Index Distribution

1 The age distribution for wood poles is shown in Figure 5.3-25. Age was available for 100% of the population. The average
2 age was found to be 27 years.



3

4 **Figure 5.3-25 – Wood Pole Age Distribution**

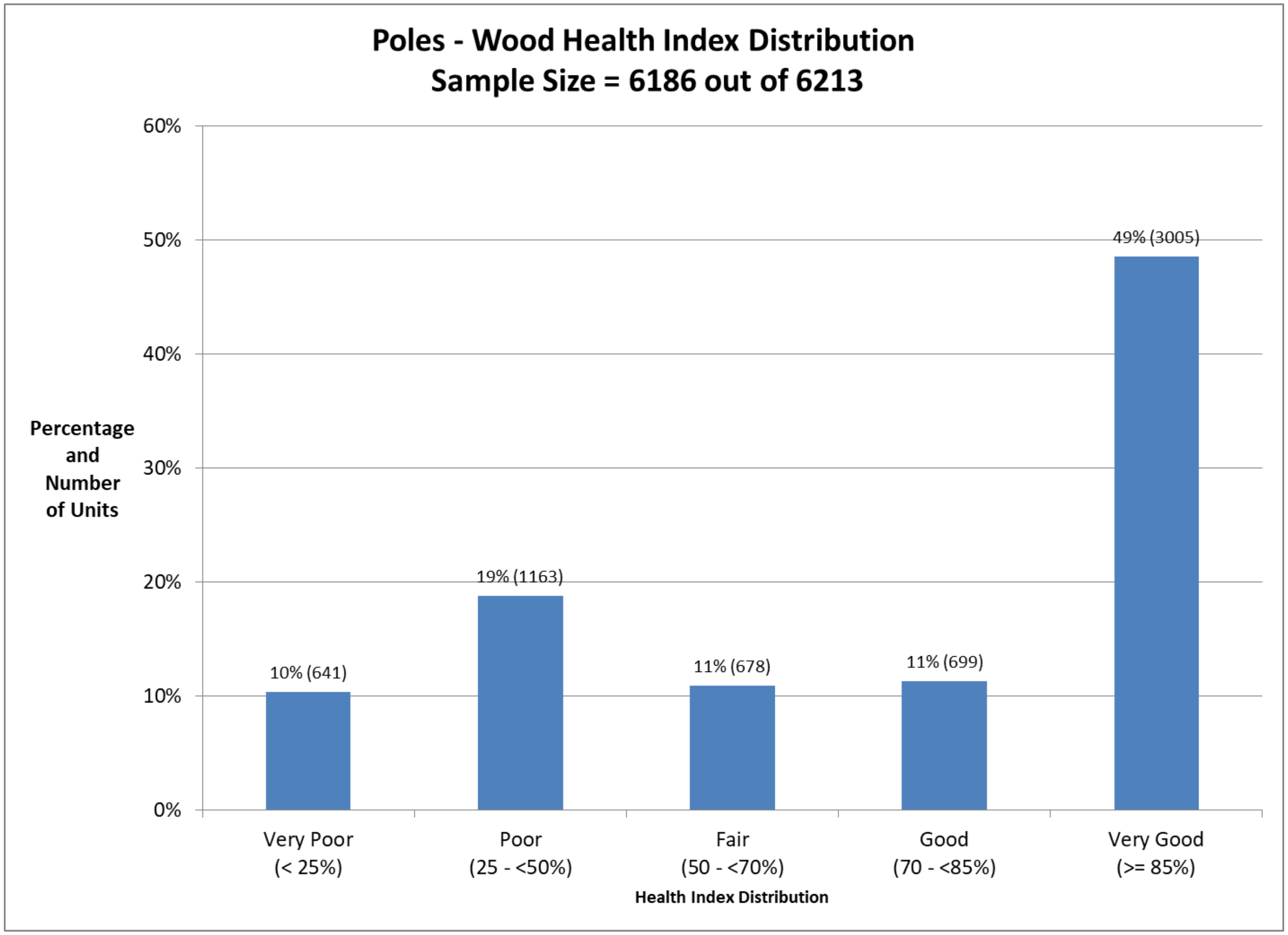


Figure 5.3-26 – Wood Pole Health Index Distribution

The age distribution for concrete poles is shown in Figure 5.3-27. Age was available for 100% of the population. The average age was found to be 42 years.

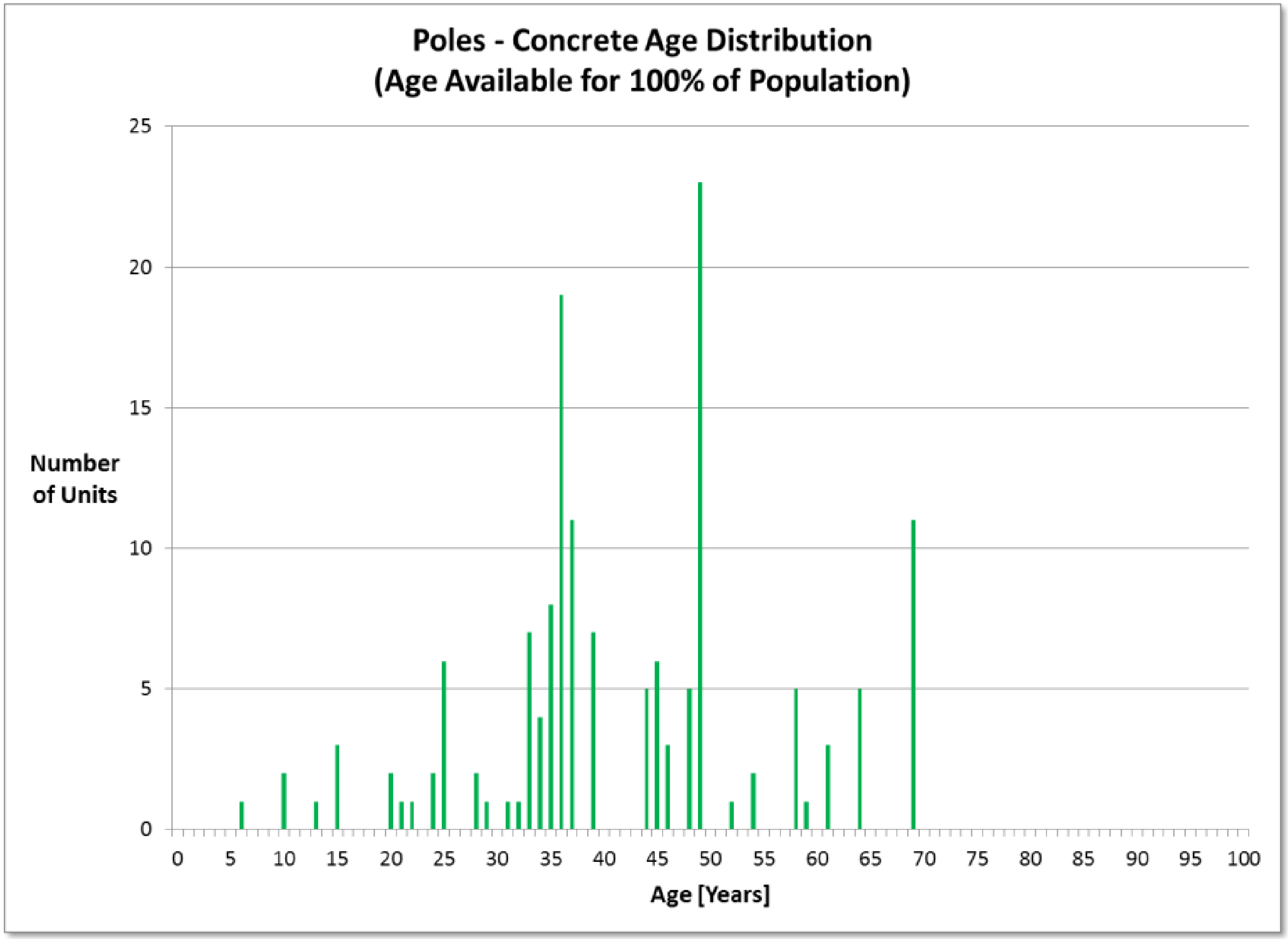
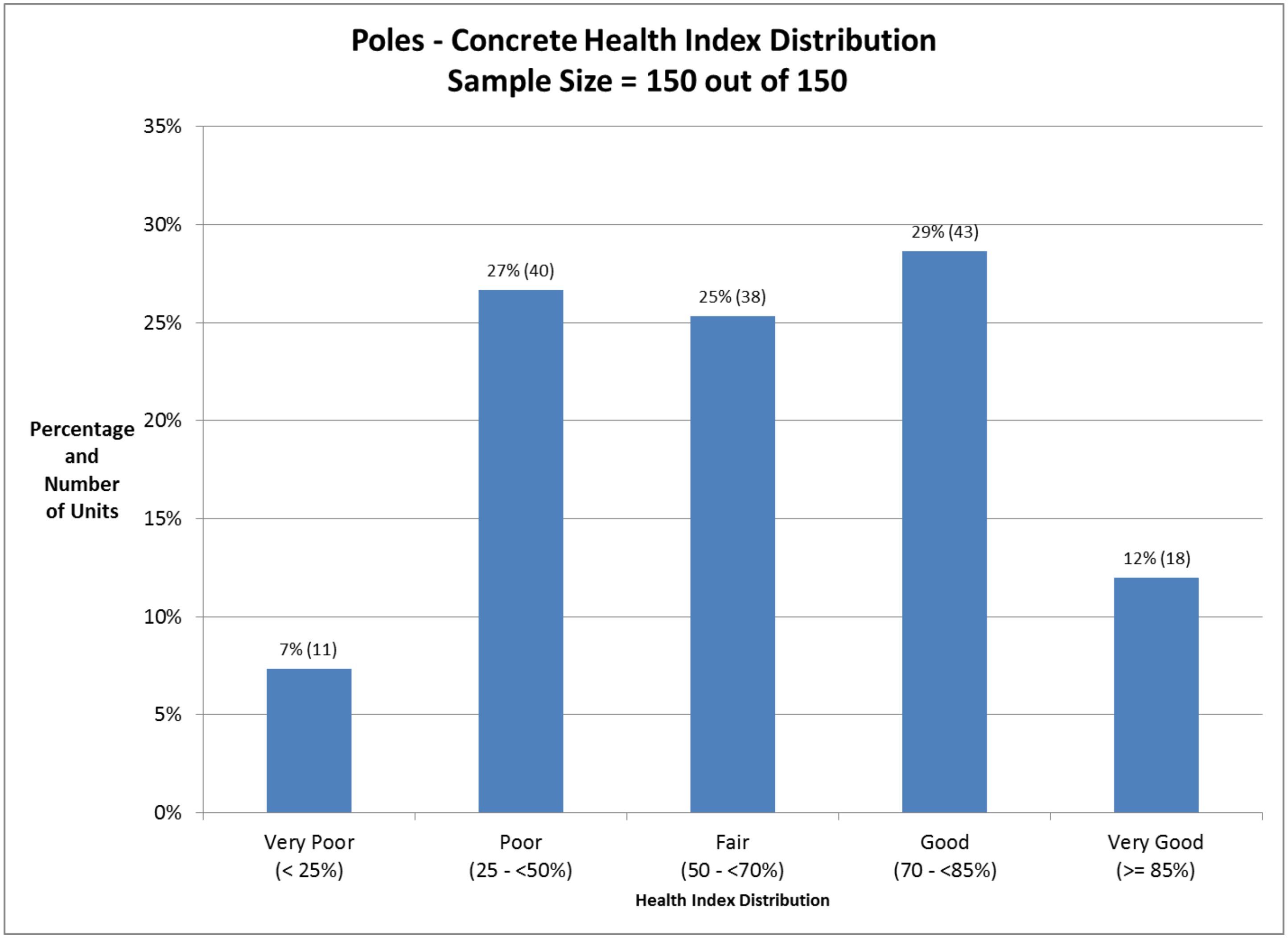


Figure 5.3-27 – Concrete Pole Age Distribution

1


2 **Figure 5.3-28 – Concrete Pole Health Index Distribution**

The age distribution for pad mount switchgear is shown in Figure 5.3-29. Age was available for 100% of the population. The average age was found to be 30 years.

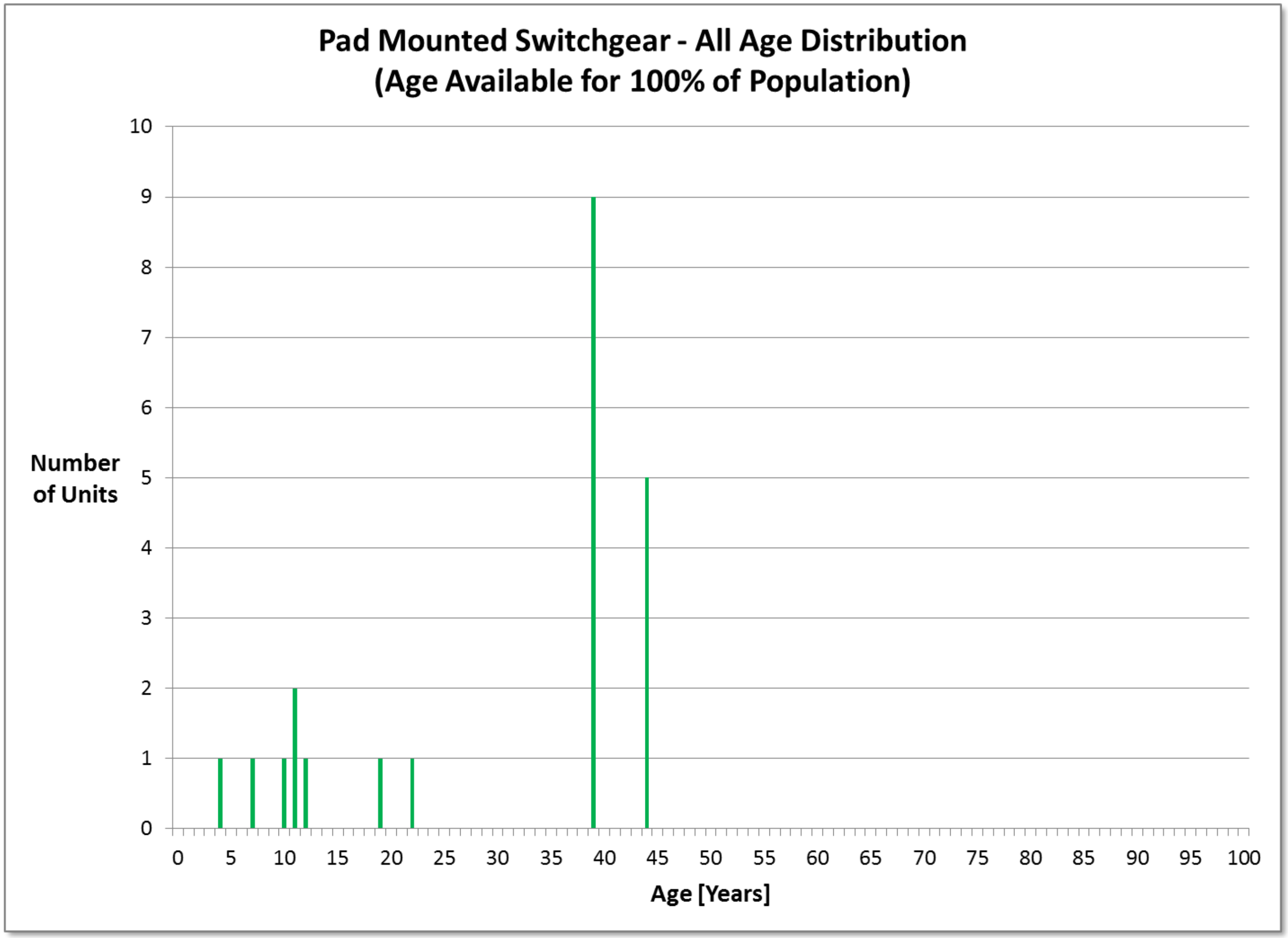


Figure 5.3-29 – Pad Mounted Switchgear Age Distribution

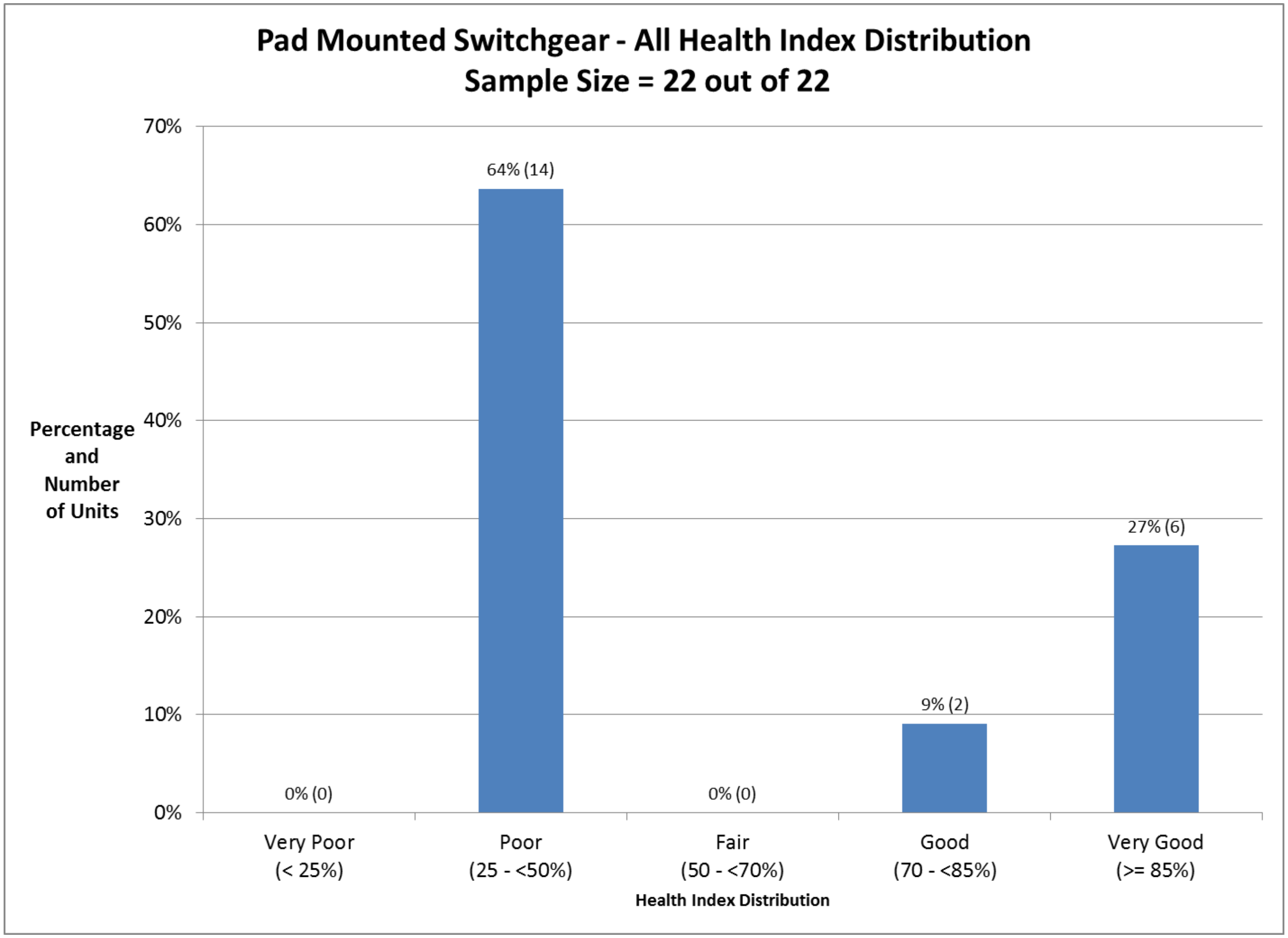


Figure 5.3-30 – Pad Mounted Switchgear Health Index Distribution

The age distribution for vault transformers is shown in Figure 5.3-31. Age was available for 92% of the population. The average age was found to be 38 years.

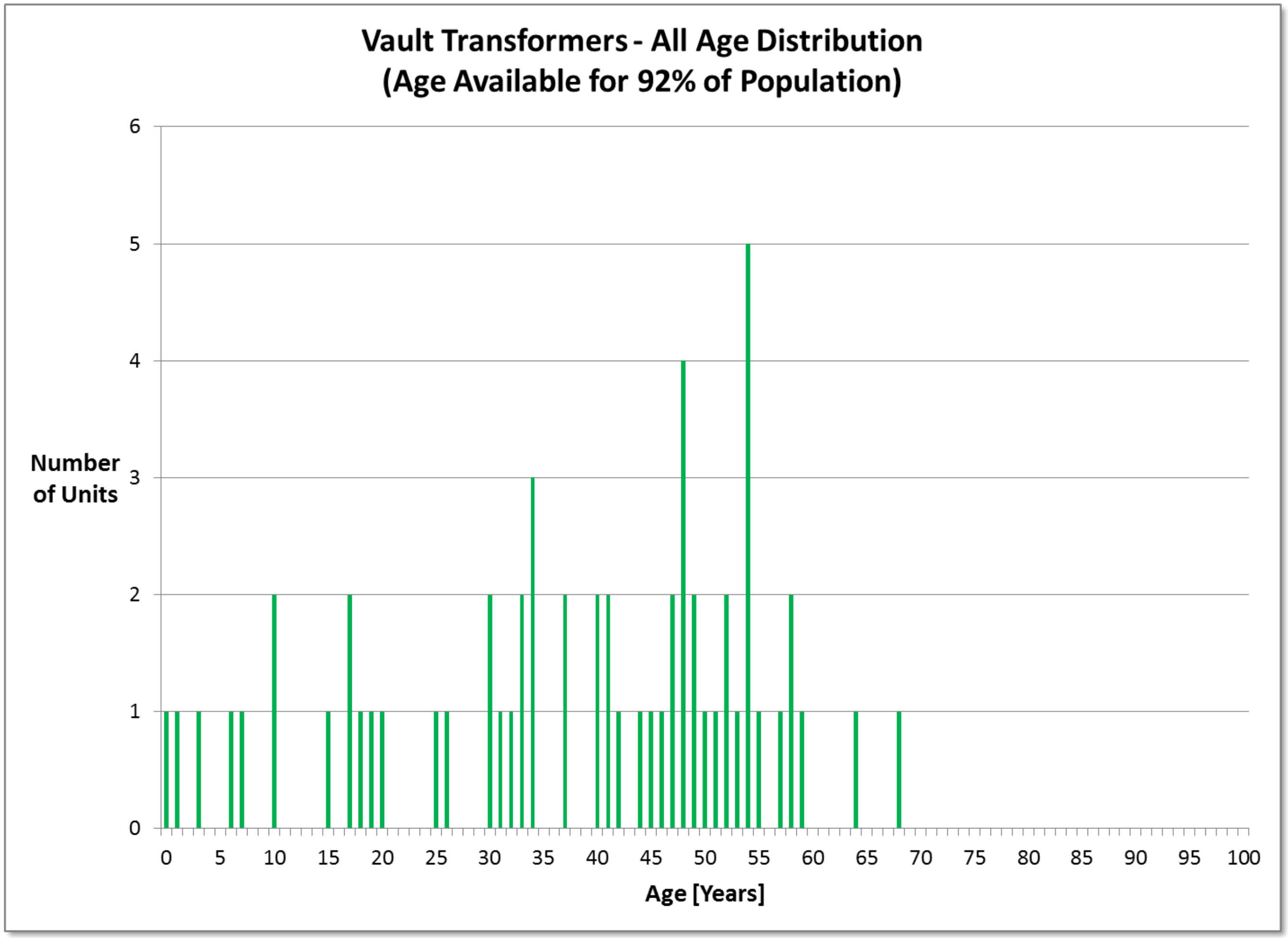


Figure 5.3-31 – Vault Transformer Age Distribution

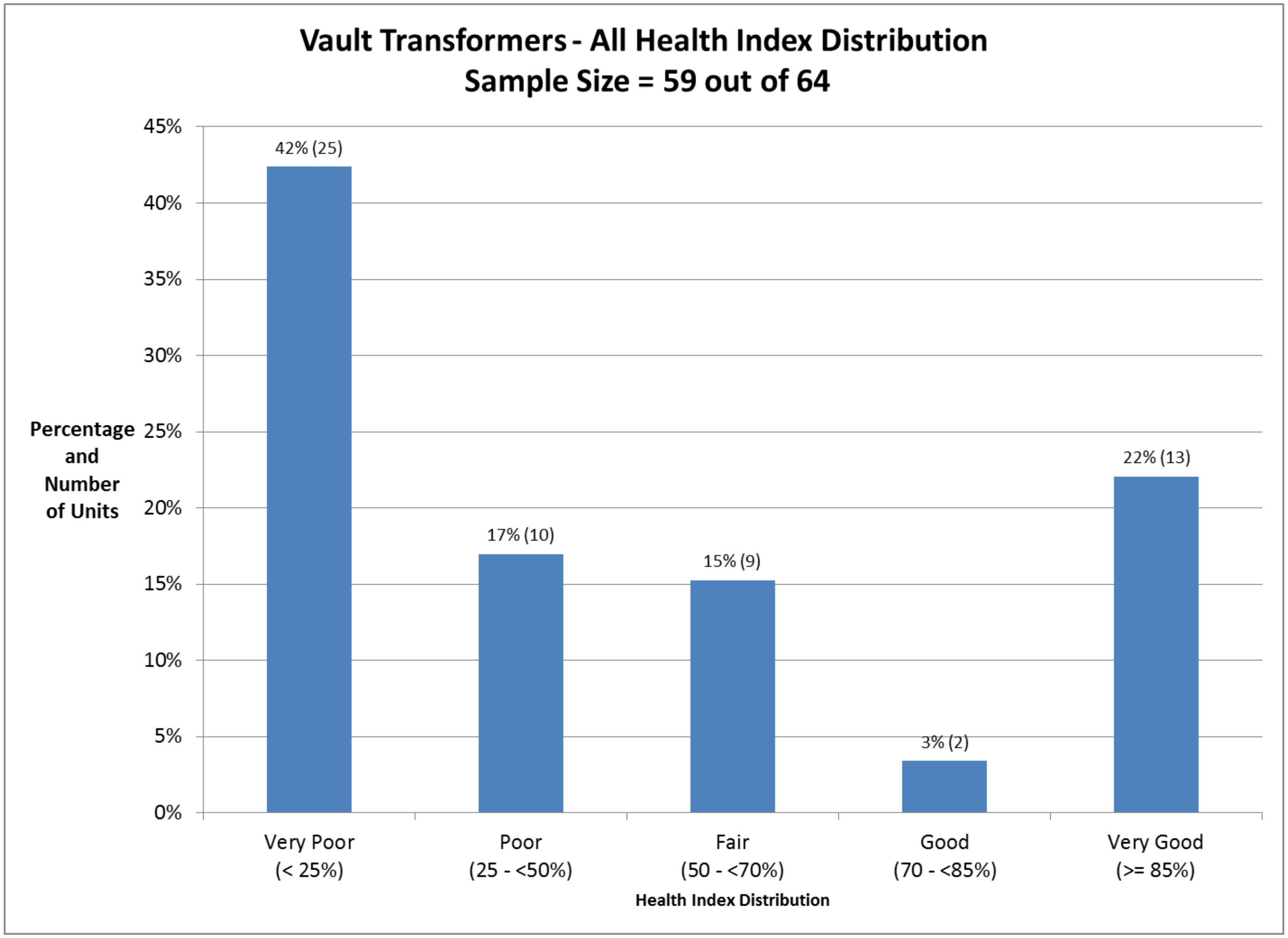
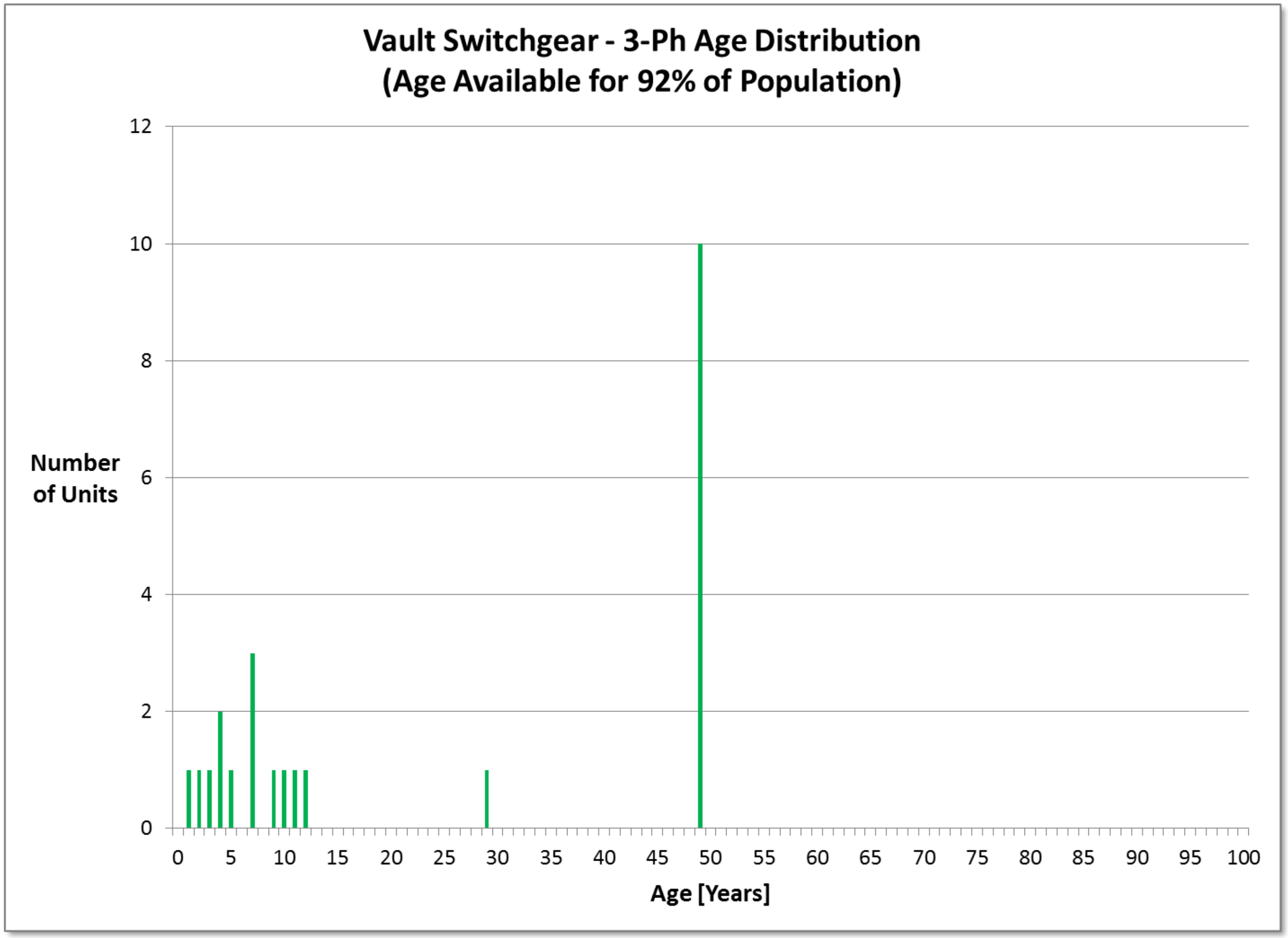


Figure 5.3-32 – Vault Transformer Health Index Distribution

1 The age distribution for 3-phase vault switchgear is shown in Figure 5.3-33. Age was available for 92% of the population.
2 The average age was found to be 25 years.

3 

4 **Figure 5.3-33 – Vault Switchgear Age Distribution**

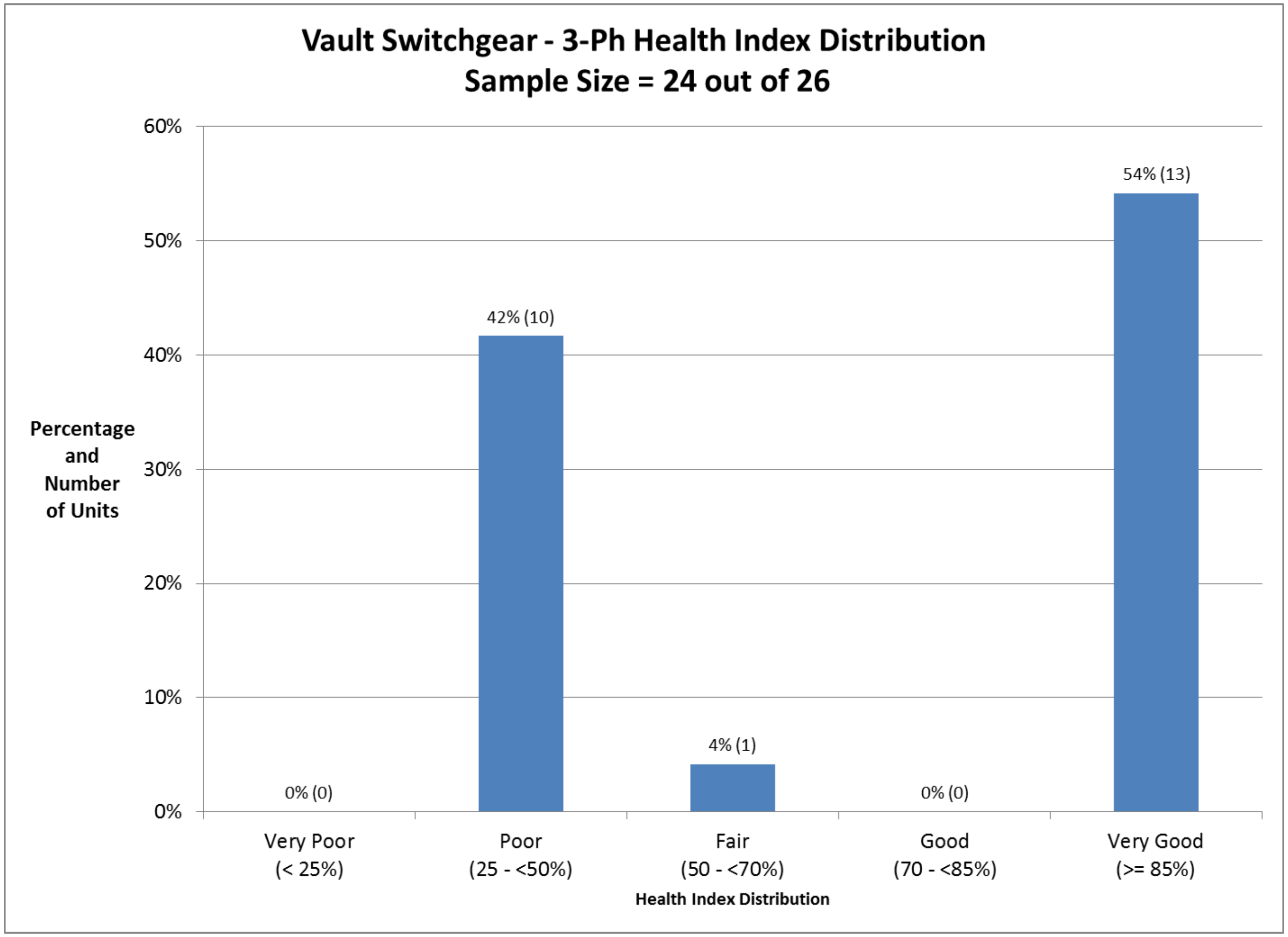
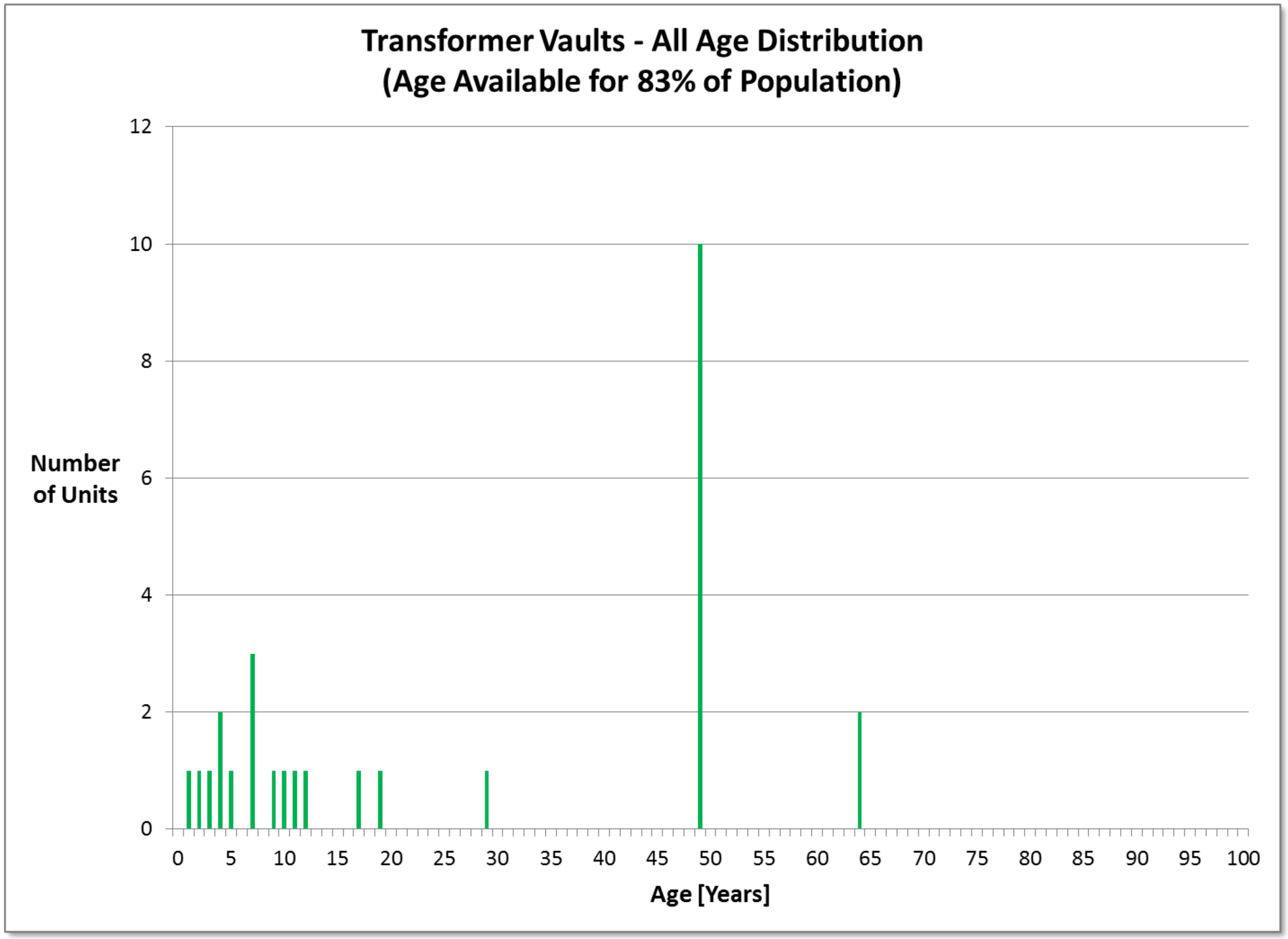


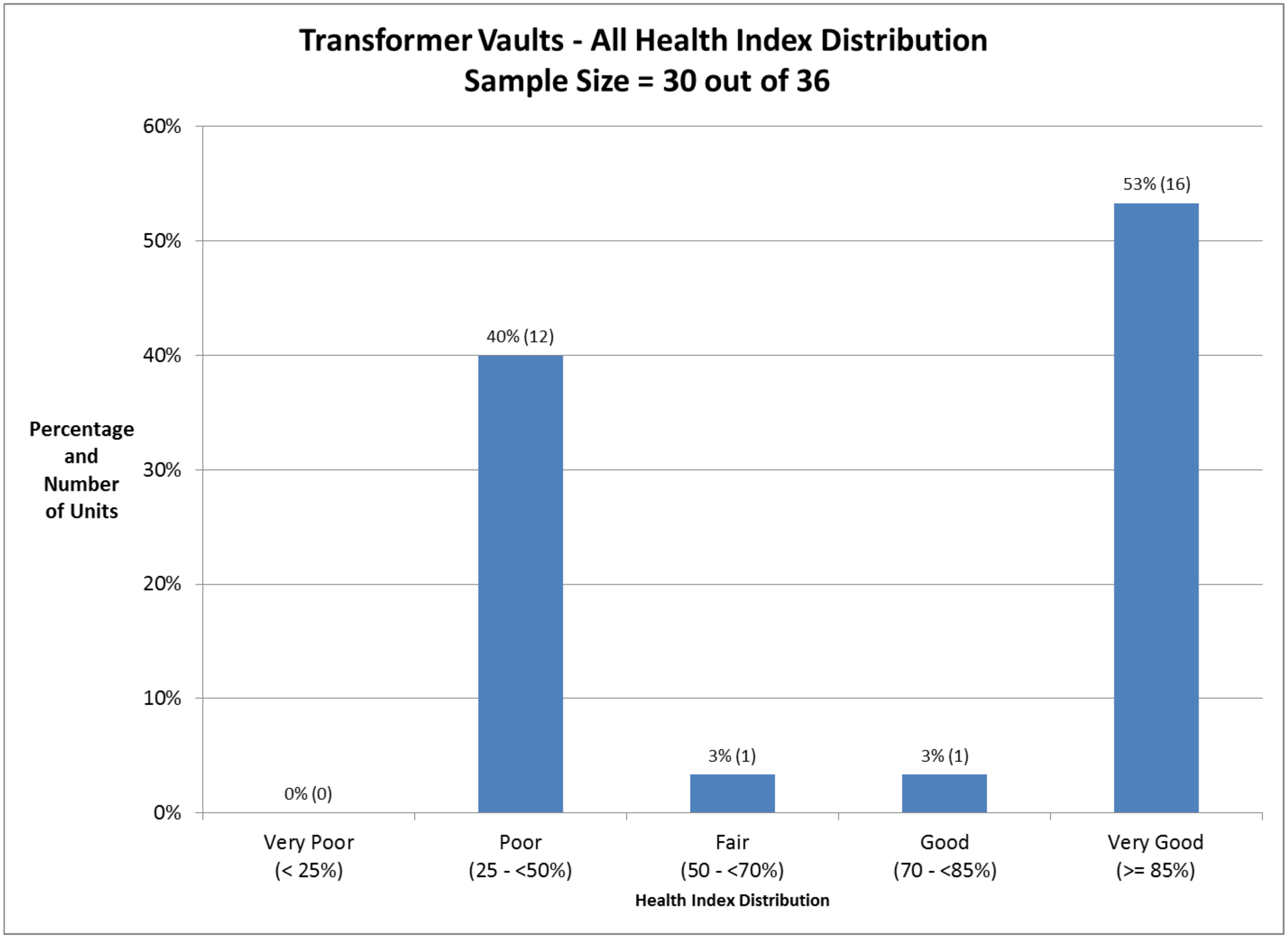
Figure 5.3-34 – Vault Switchgear Health Index Distribution

1 The age distribution for underground vault structures is shown in Figure 5.3-35. Age was available for 83% of the
2 population. The average age was found to be 27 years.



3

4 **Figure 5.3-35 – Underground Vault Structure Age Distribution**

1 

2 **Figure 5.3-36 – Underground Vault Structure Health Index Distribution**

The age distribution for legacy PILC cables is shown in Figure 5.3-37. There was limited age available for most of the population. The age of legacy PILC cable is estimated to range between 66 and 26 years of age.

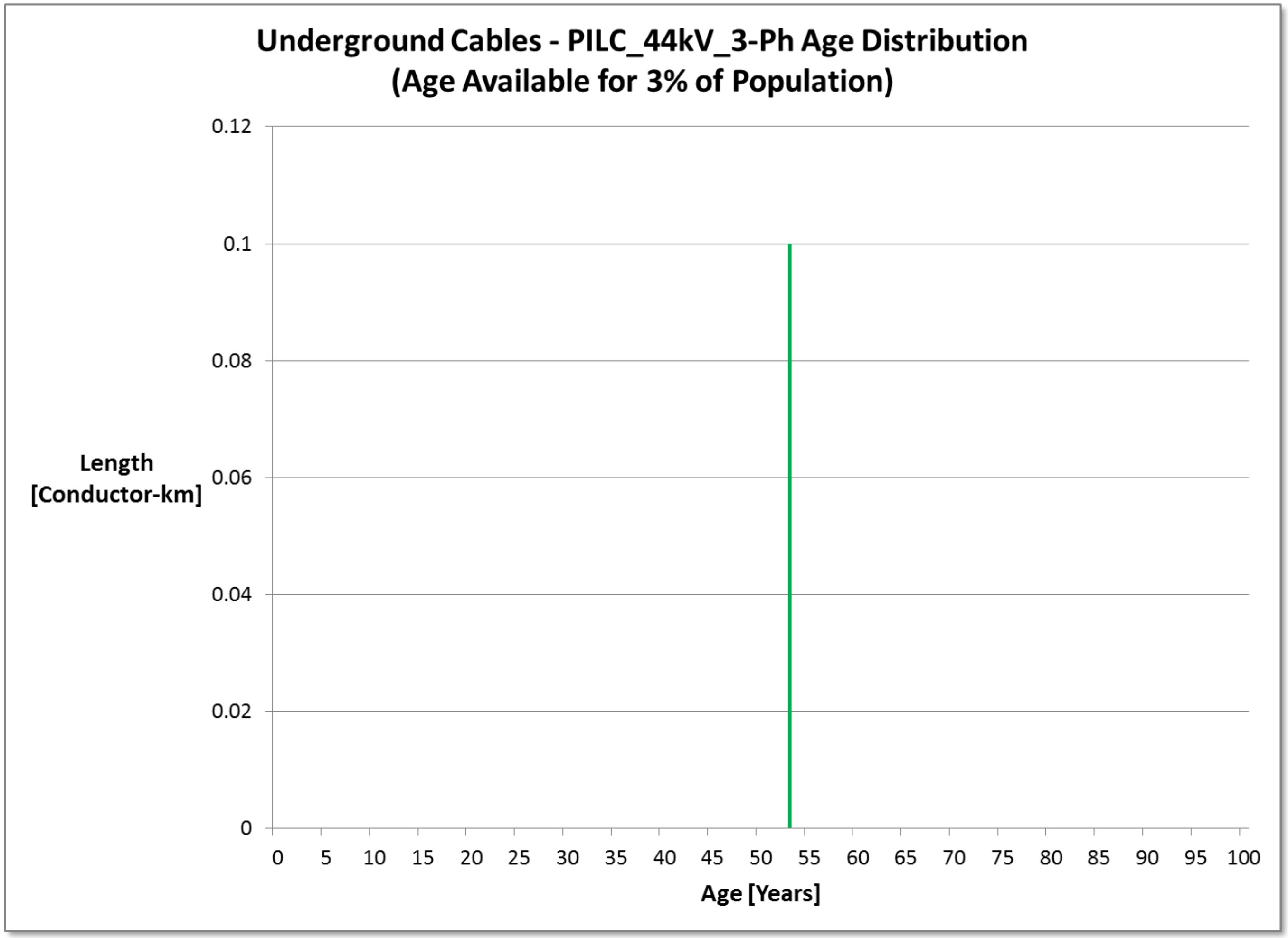


Figure 5.3-37 – 44kV PILC Cable Age Distribution

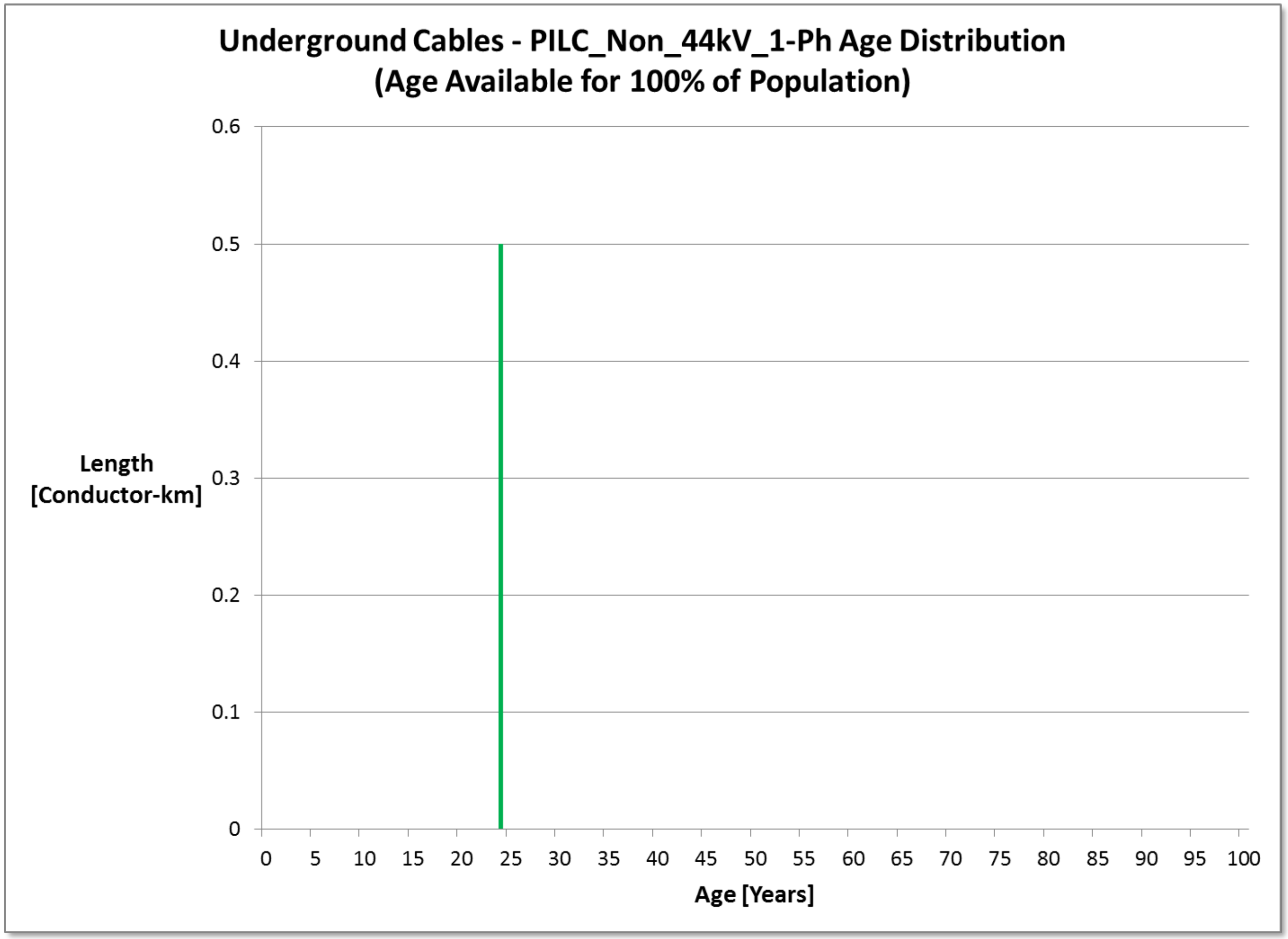


Figure 5.3-38 – 5kV 1ph PILC Cable Age Distribution

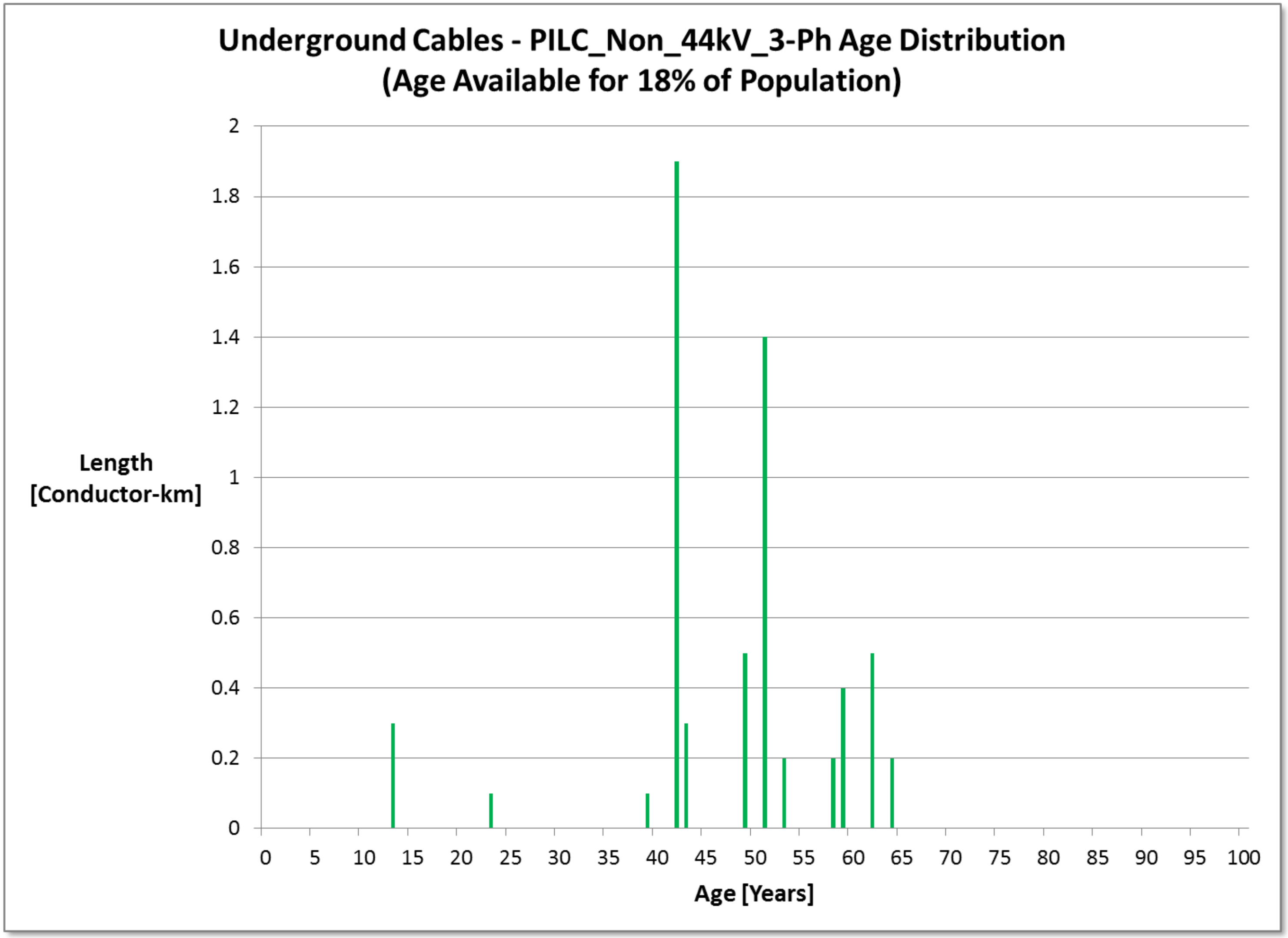
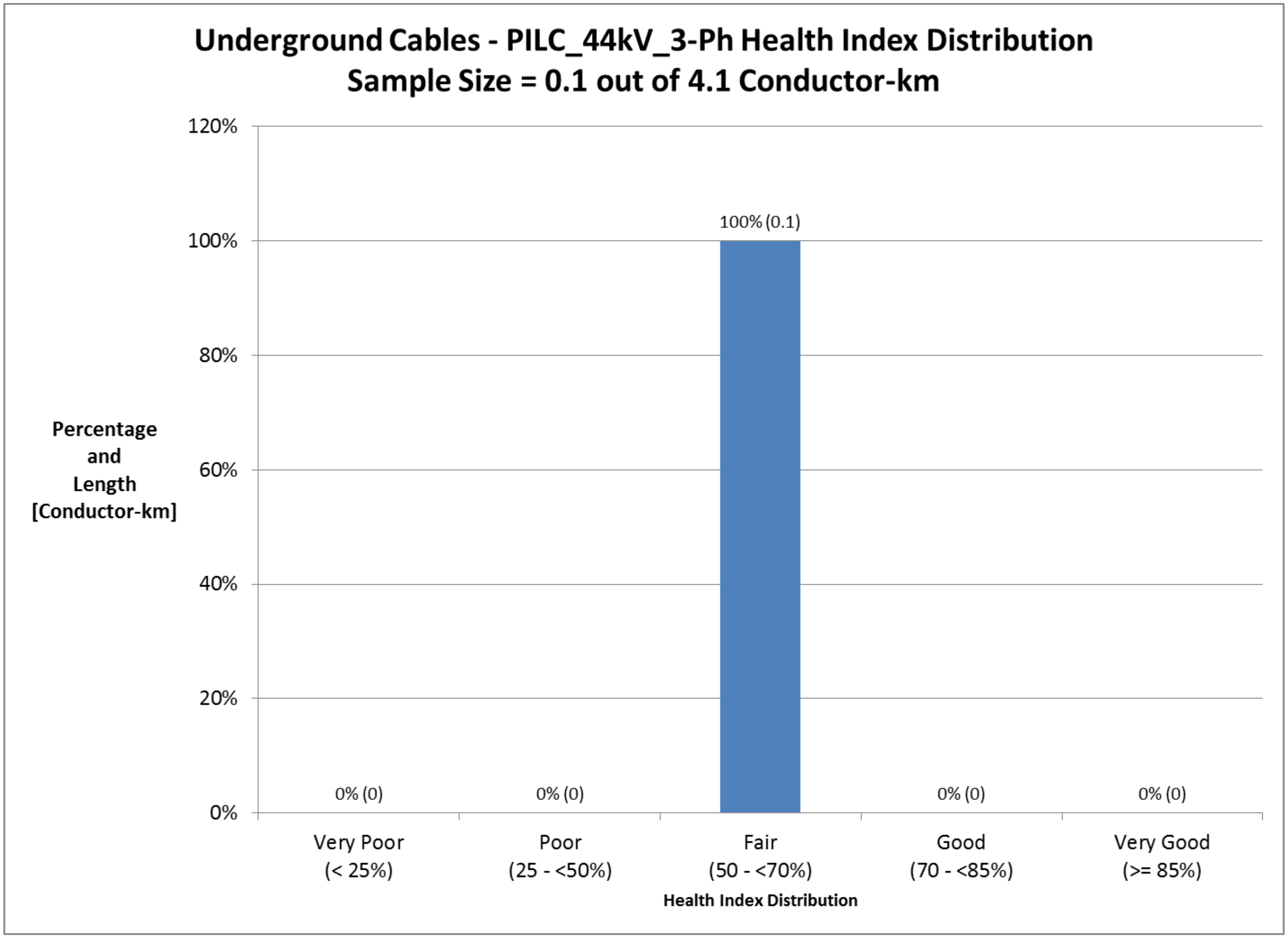
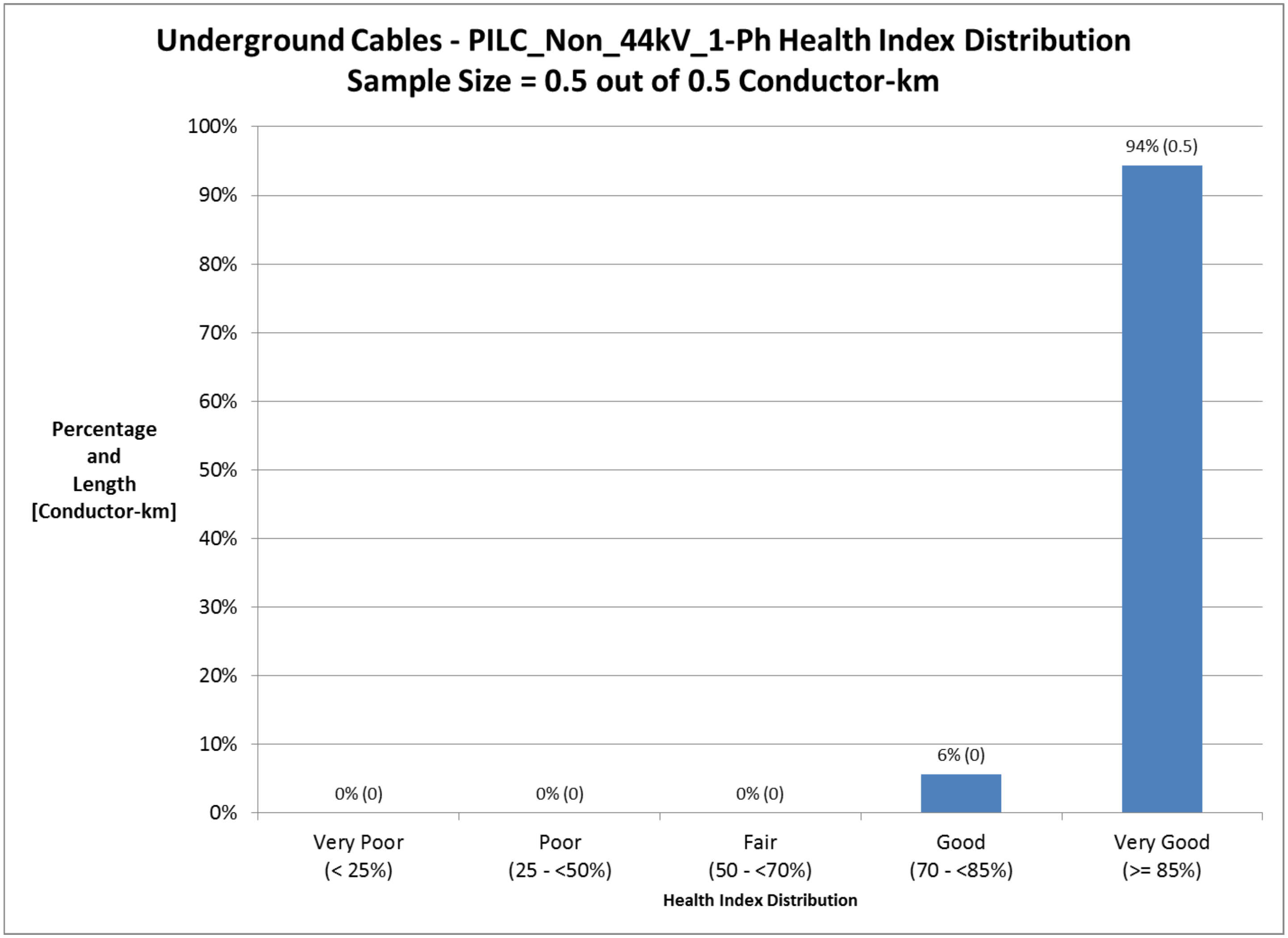


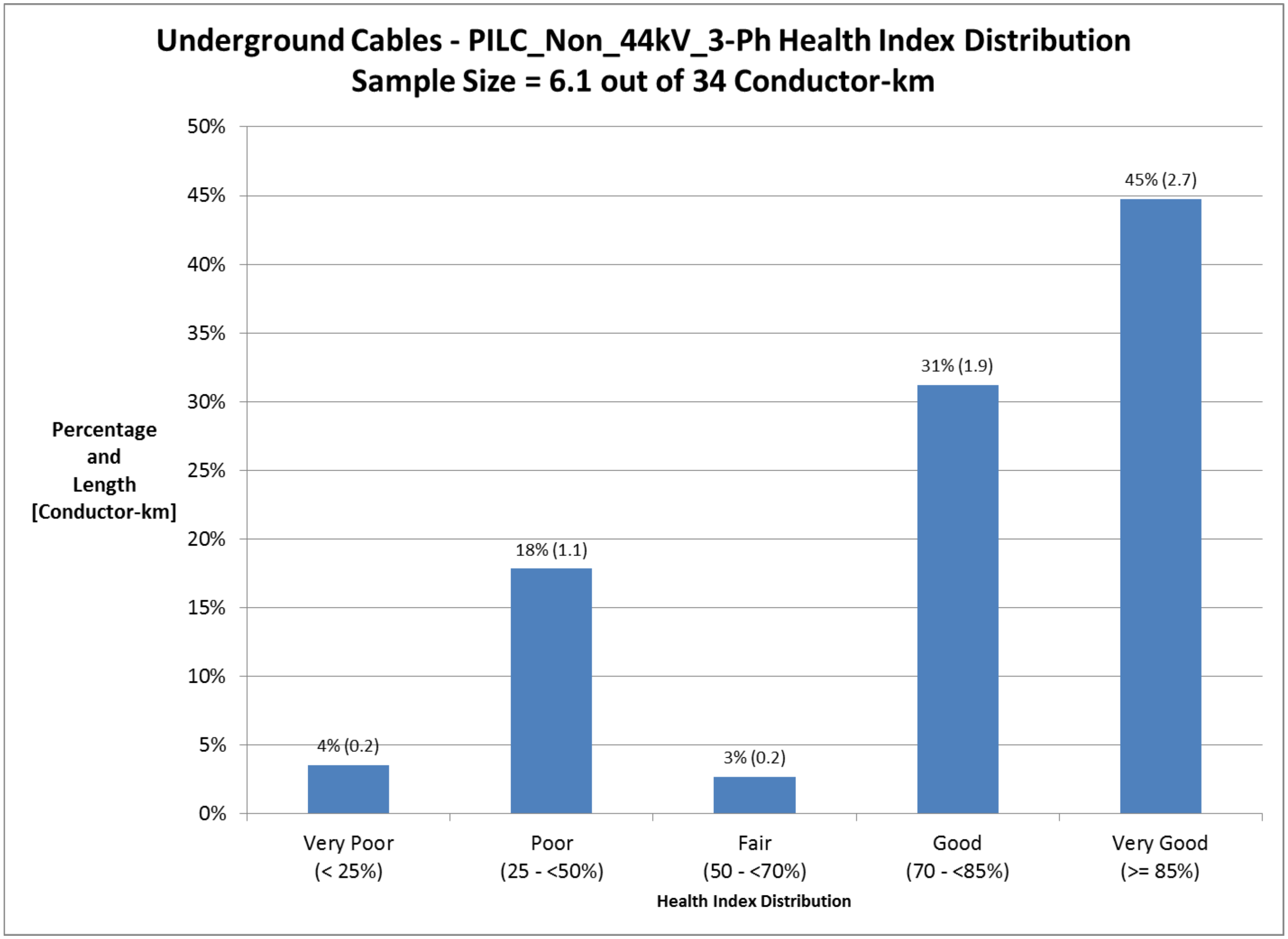
Figure 5.3-39 – 5kV 3ph PILC Cable Age Distribution

1 

2 **Figure 5.3-40 – 44kV PILC Cable Health Index Distribution**

1 

2 **Figure 5.3-41 – 5kV 1ph PILC Cable Health Index Distribution**

1 

2 **Figure 5.3-42 – 5kV 3ph PILC Cable Health Index Distribution**

The age distribution for XLPE cables is shown in Figure 5.3-43. Age was available for less than 50% of the population. Some XLPE cable is estimated to be as old as 45 years in age.

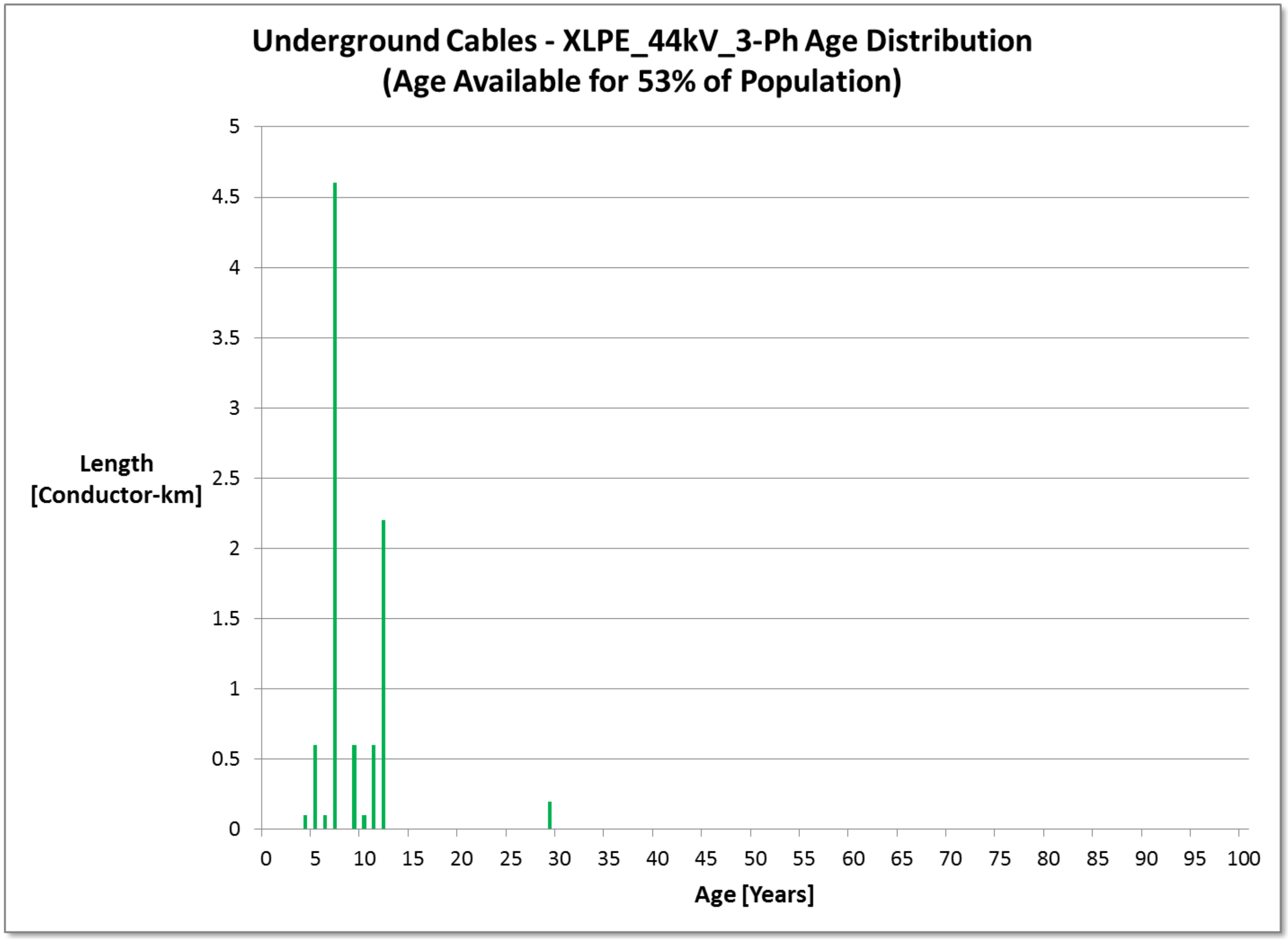
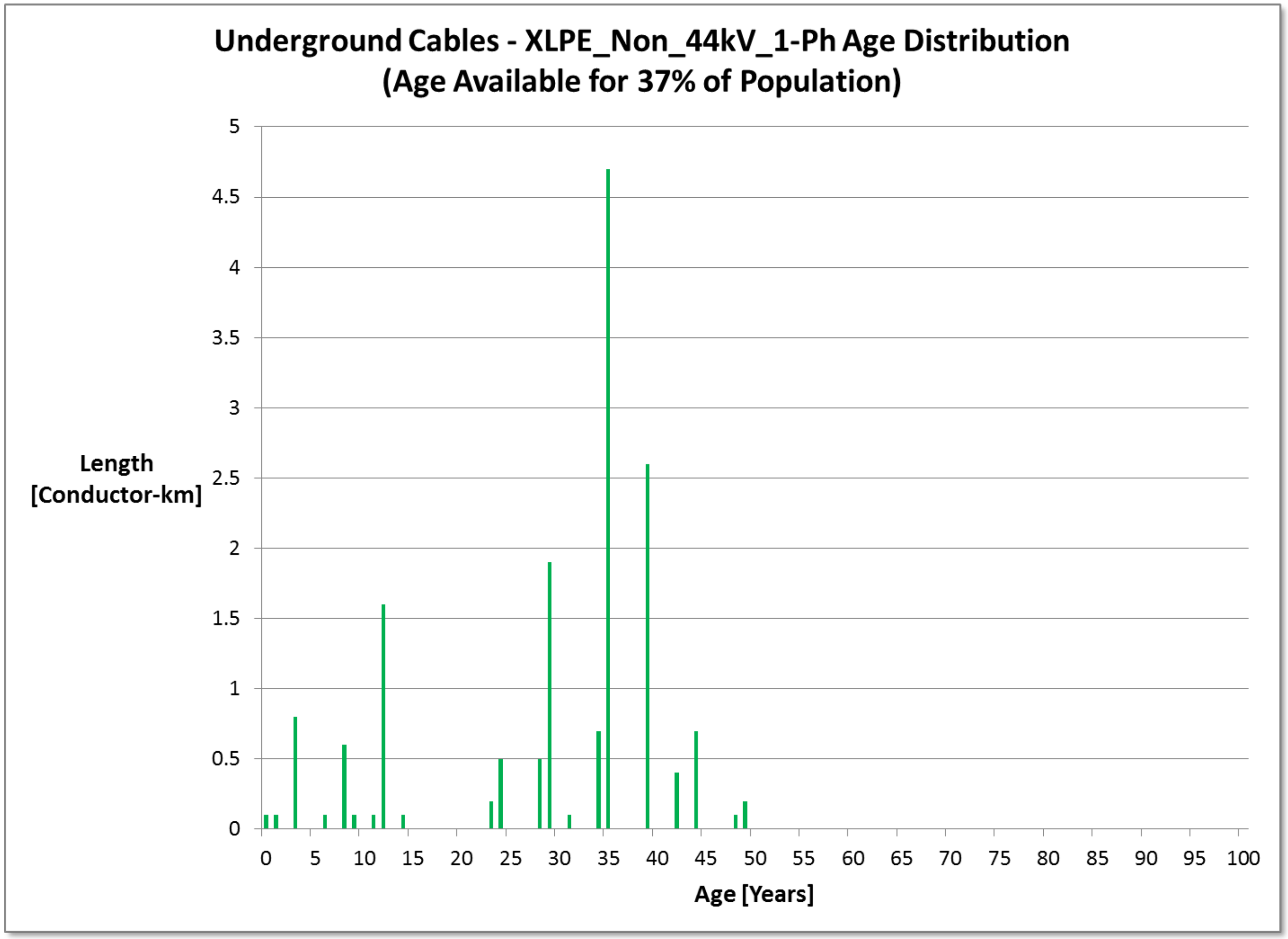


Figure 5.3-43 – 44kV XLPE Cable Age Distribution

1 

2 **Figure 5.3-44 – 5kV 1ph XLPE Cable Age Distribution**

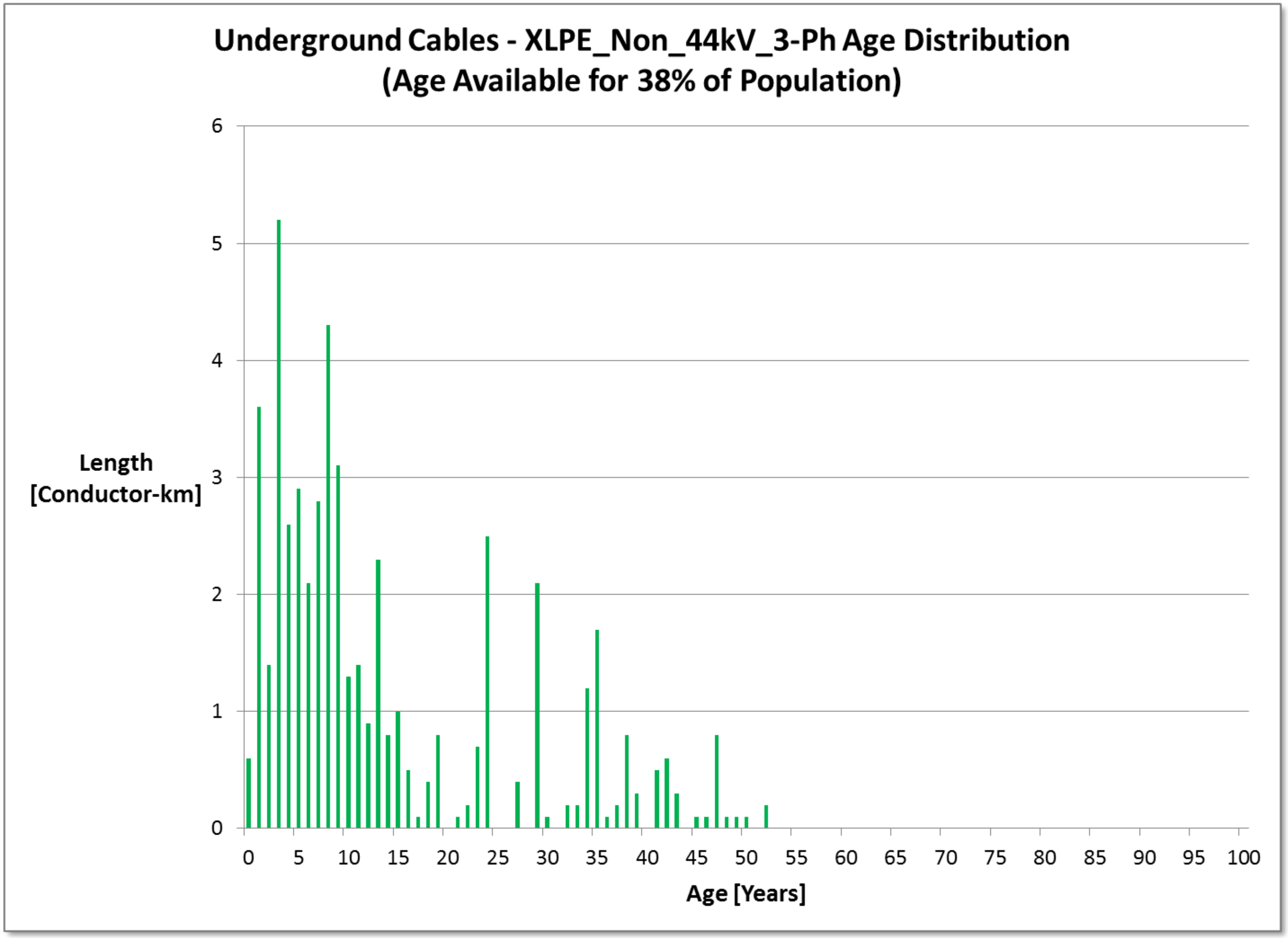
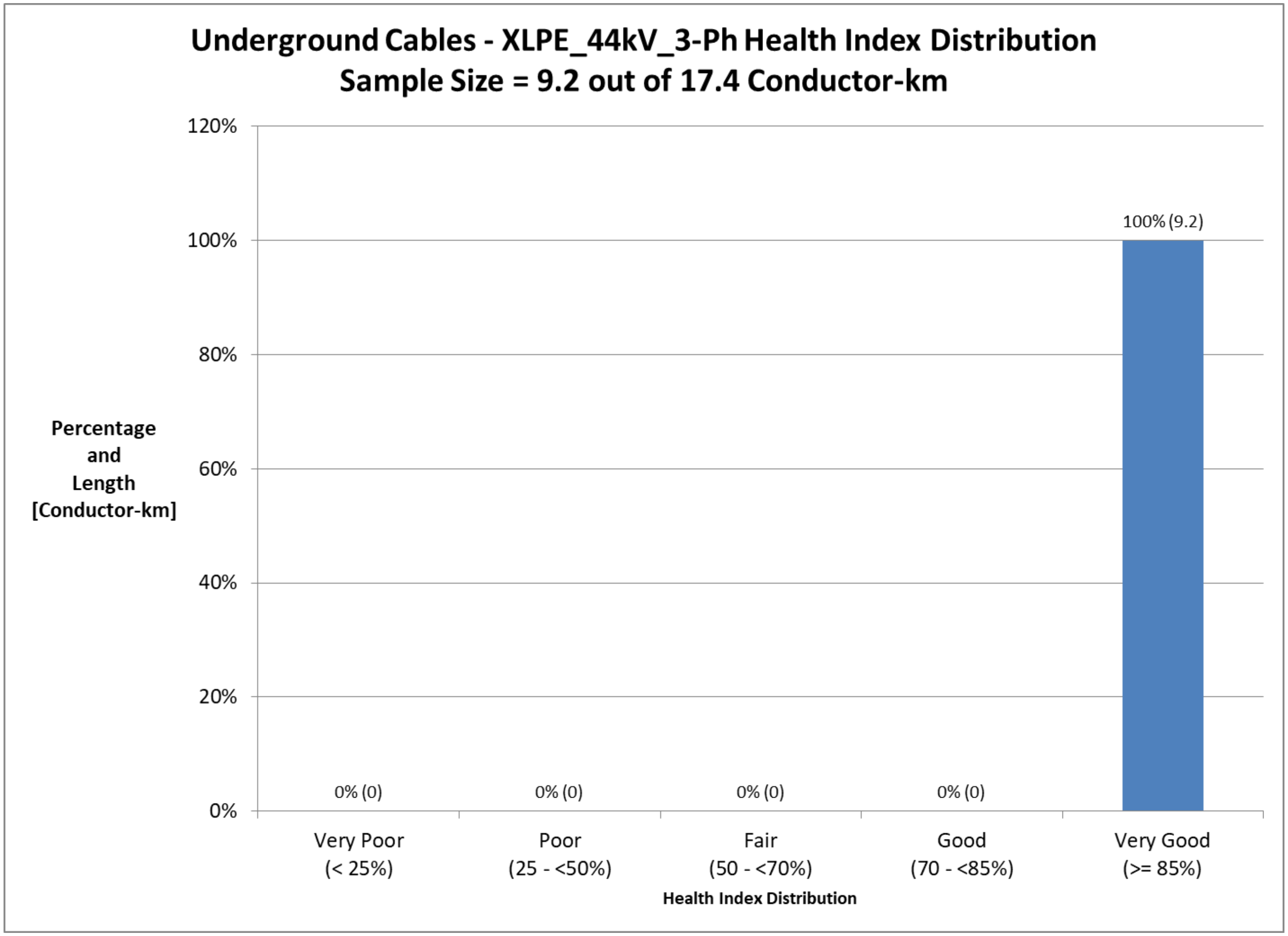
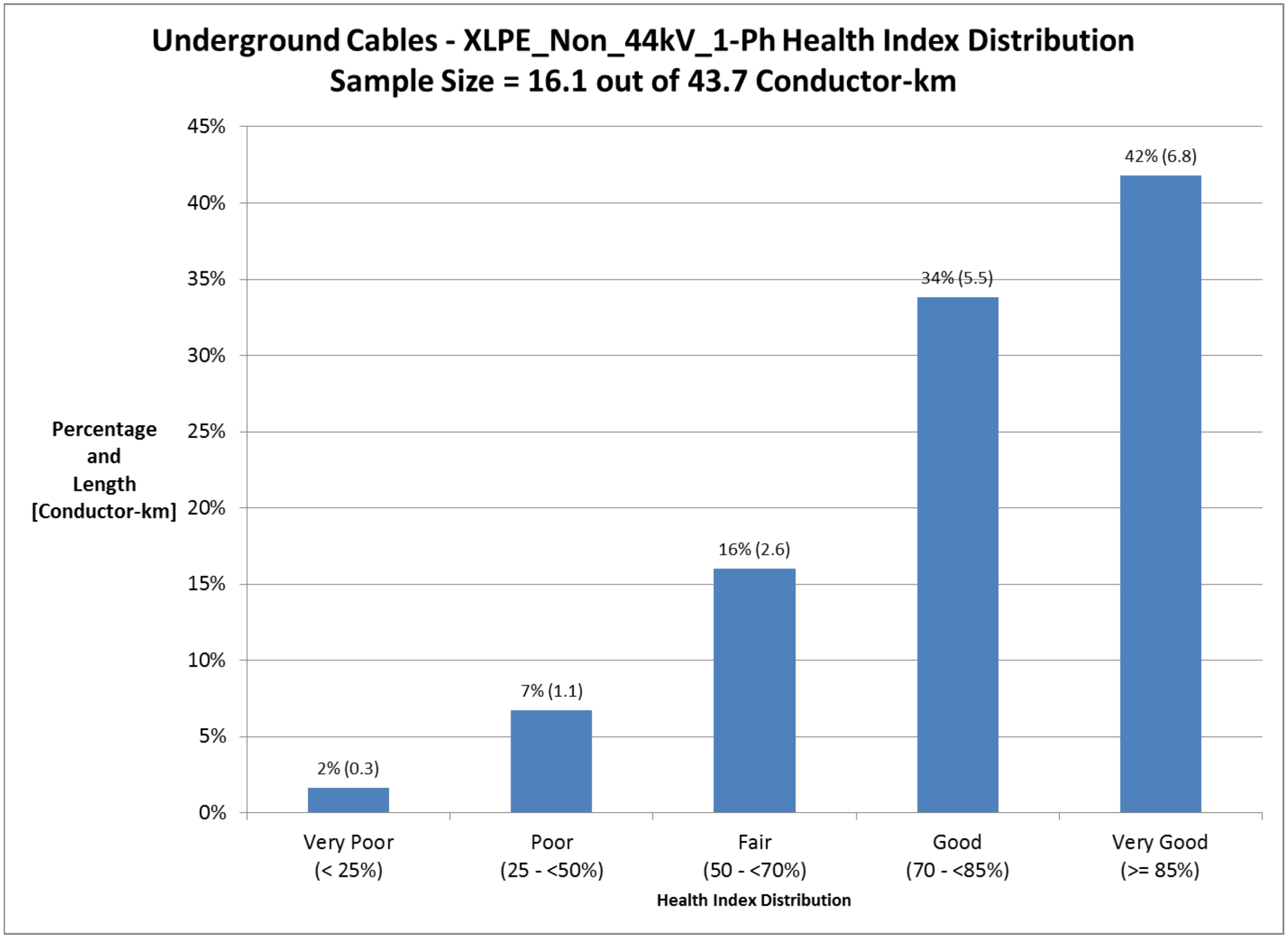


Figure 5.3-45 – 5kV 3ph XLPE Cable Age Distribution

1 

2 **Figure 5.3-46 – 44kV XLPE Cable Health Index Distribution**

1 

2 **Figure 5.3-47 – 5kV 1ph XLPE Cable Health Index Distribution**

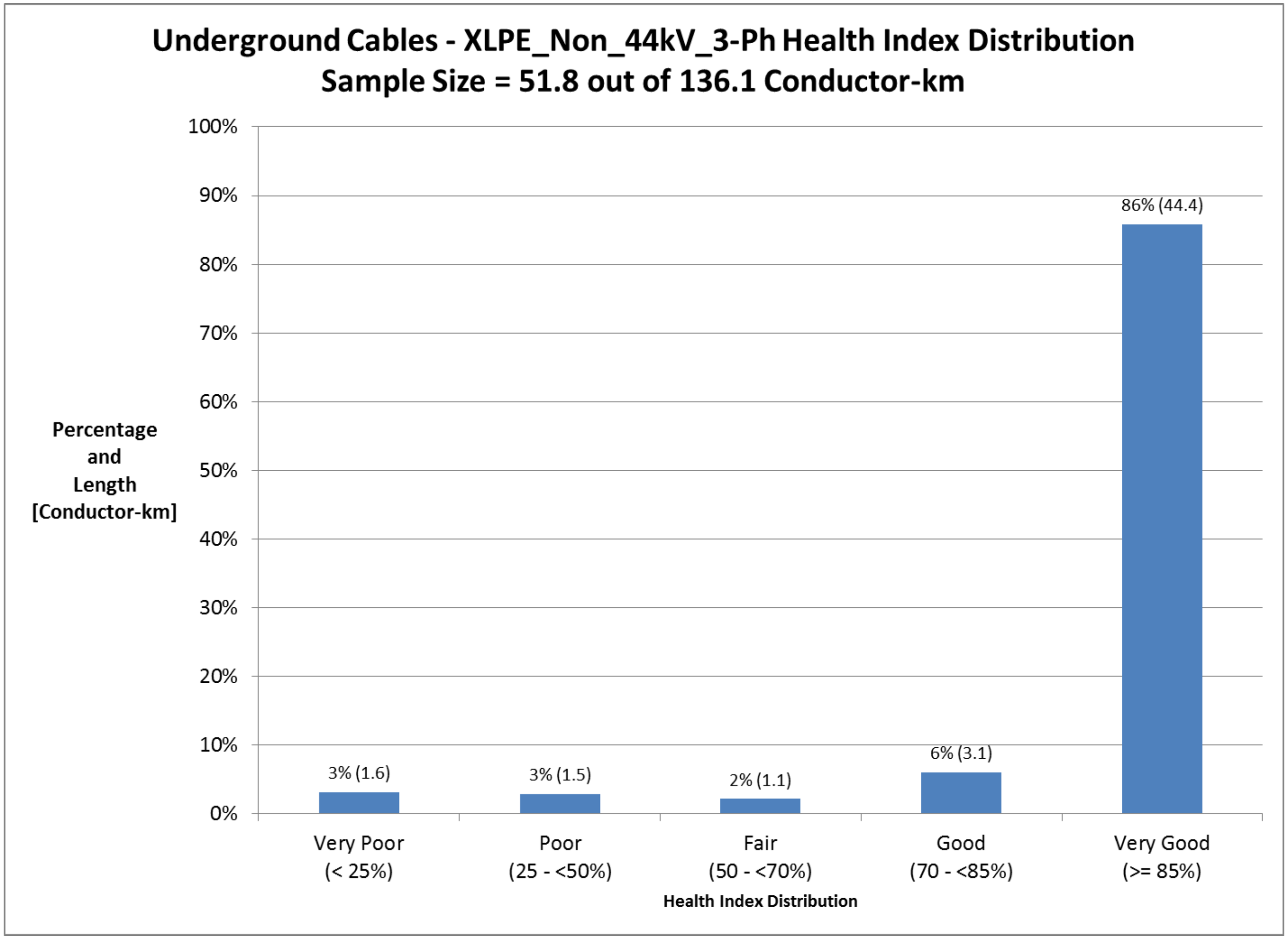


Figure 5.3-48 – 5kV 3ph XLPE Cable Health Index Distribution

Age of Fleet

The age of Fleet Vehicles and Fleet Trailer equipment based on 2021 asset inventory is summarized in the following tables.

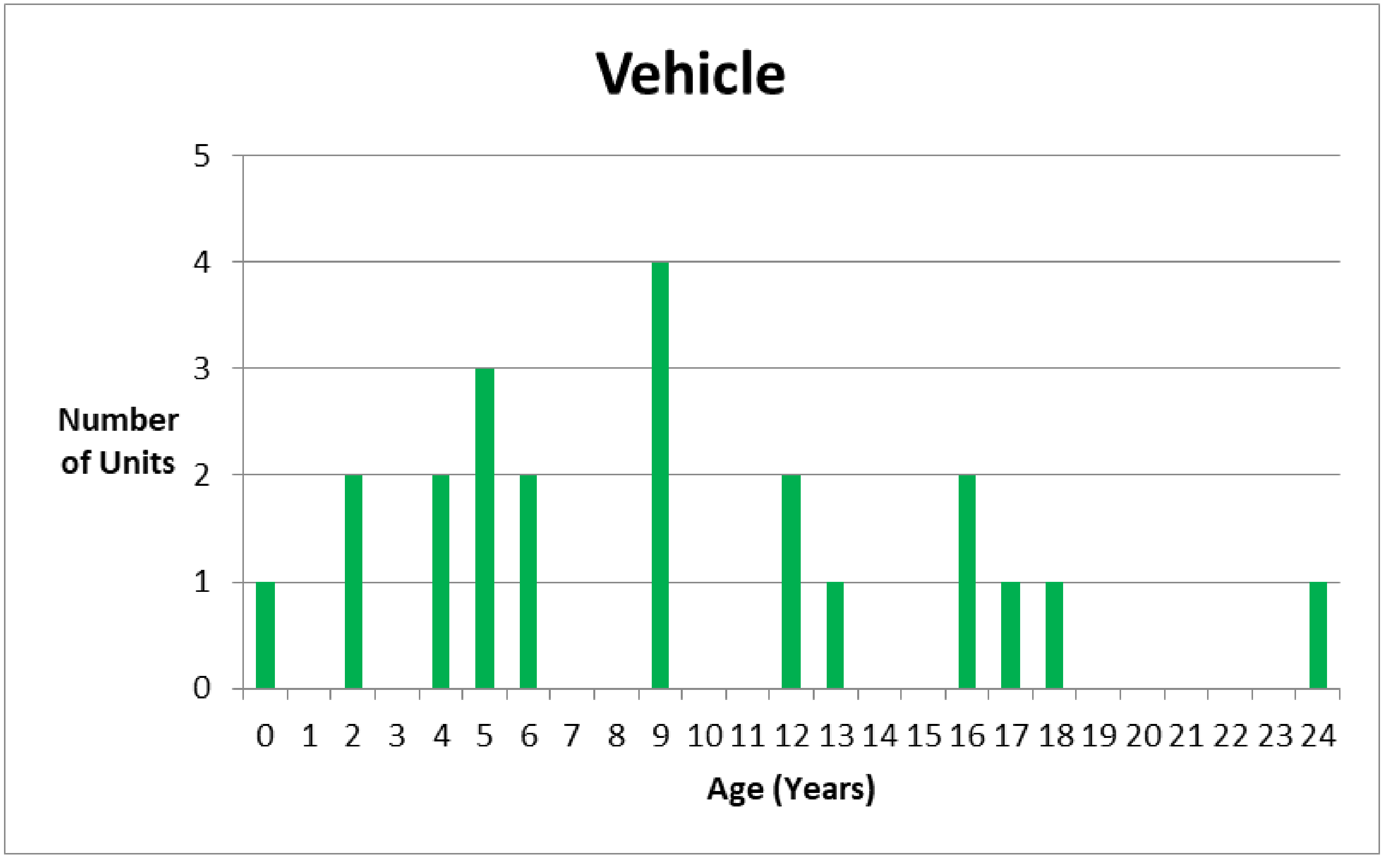
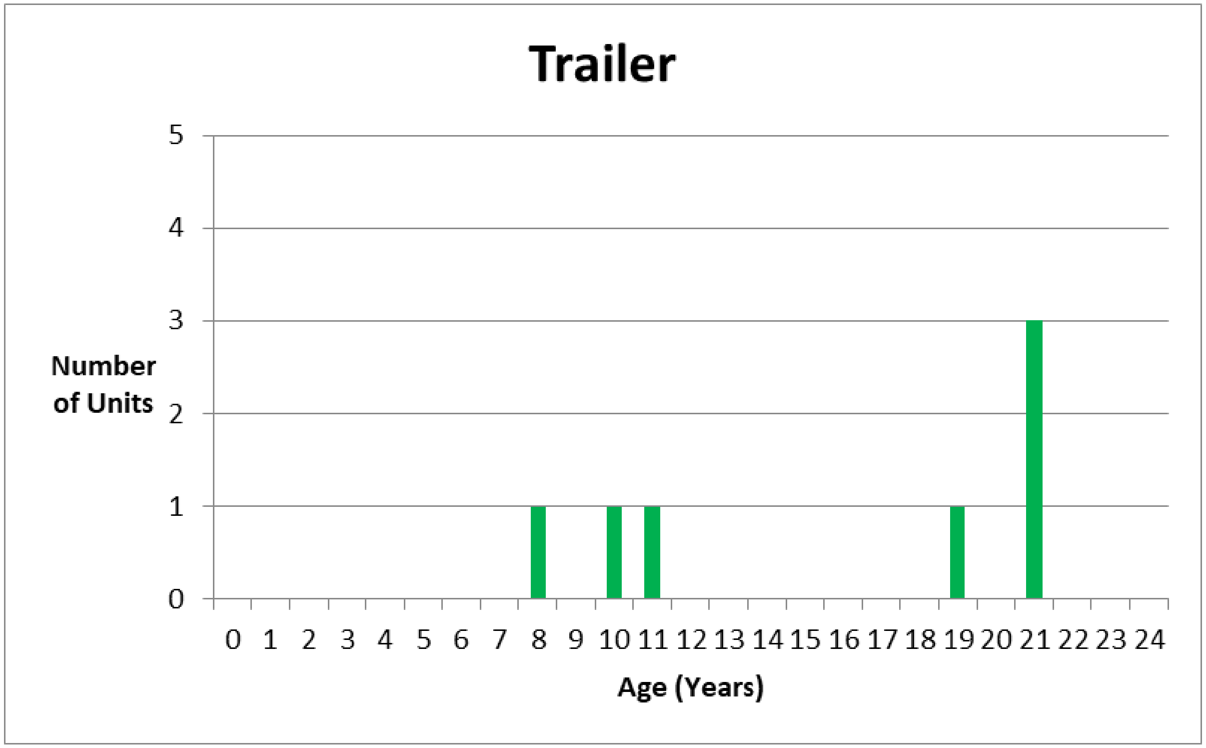


Figure 5.3-49 – Fleet Vehicle Age Distribution

1


2
3 **Figure 5.3-50 – Fleet Trailer Age Distribution**

Assets Requiring Detailed Condition Assessment

The next step towards continuous improvement of Kingston Hydro's asset management plan is to collect more detailed inventory and condition information for key assets such as maintenance holes and underground cables.

Maintenance Holes

In the previous DSP (EB-2015-0083), Kingston Hydro indicated that it was contemplating a combination of photo and laser scanning of its existing maintenance holes for asset condition assessment purposes. During the 2015-2020 historic period, Kingston Hydro revaluated this option and decided to focus instead on converting as-built scans of maintenance hole sketches to AutoCAD as a first step. For the 2022-2027 forecast period, Kingston Hydro will reevaluate the benefits and costs of hiring a third party to do photo and laser scanning versus internal staff taking 360 degree photos.

Primary Cable

The length and location of Primary cable assets are well documented in the GIS system, but the cable size, type and age is not. With that being said, Kingston Hydro has many as-built scans of maintenance hole sketches that indicate the cable size, type, and installation date. Over the past five years, Kingston Hydro has focused on converting these sketches to AutoCAD.

In addition to updating its cable asset registry, Kingston Hydro purchased a 15kV VLF Tan-Delta cable testing unit 2014 and undertook some joint testing of 5kV underground cables with IREQ (Research division of Quebec Hydro) and Cable Q(spin-off of NRCAN and Hydro Ottawa research) from 2015 to 2017. The purpose of the joint cable testing was to compare VLF Tan Delta test results with Partial Discharge using VLF (IREQ) and DC Polarization/Depolarization (Cable Q).

Kingston Hydro came to the following conclusions as a result of this joint testing:

	VLF Tan Delta	Partial Discharge using VLF	DC Polarization/ Depolarization
Cable Types	PILC, XLPE, EPR	PILC, XLPE, EPR	XLPE
Approx. Test Time per cable	10min.	More than 10min.	1min.
Risks	Potential risk of cable failure when applying test voltage up to 1.5 x cable rating	Potential risk of cable failure when applying test voltage up to 1.5 x cable rating	Non-destructive (Max 3kV)
Test Equipment	least expensive and fairly simple to operate	expensive and requires more training to operate	proprietary NRCAN technology must be contracted or leased
Test Results	Provides an overall (global) indication of insulation condition. Results can be influenced by terminations and cable length. May recommend additional investigation depending on results.	Results can often pinpoint the location of a major insulation problem. Partial Discharge location may constantly shift in PILC cables due to the migration of the oil insulation medium inside the cable	Health Index quantifies the progression of water trees

Table 5.3-10 – Comparison of Cable Test Methods

Kingston Hydro faces some additional challenges when it comes to cable condition assessment because it has many instances of cable transition splices; a splice between two different cable types such as PILC and XLPE. Most cable tests can only evaluate condition when the cable section under test is of the same construction (e.g. PILC or XLPE) and not mixed construction (e.g. PILC with transition to XLPE); providing further evidence that there is little value in testing Kingston Hydro's obsolete 5kV PILC cables.

Kingston Hydro plans to focus efforts on VLF Tan Delta testing of some 5kV cables using in-house resources for the 2022-2027 forecast period.

Substation Facilities

Kingston Hydro has an extensive asset registry of major substation components such as Power Transformers and Circuit Breakers and is in the process of updating its asset registry to include other electrical and structural components to obtain a more complete understanding of substation facility condition. Kingston Hydro will continue to search for cost effective asset registry tools for storing and managing substation facility asset data as the current GIS system is not a suitable application for facility asset data.

5.3.2.(d.) Assessment of Existing Assets Relative to Planning Criteria

System Planning

The 44kV and 5kV master plans contain incremental spatial load forecasts that were developed from a review of pending development applications, vacant lands and customer surveys using existing City development and zoning by-laws. The main purpose of these master plans is to determine if the 44kV and 5kV distribution systems have sufficient capacity to accommodate future load growth for the next 20 years. A secondary outcome is to identify opportunities to optimize the existing distribution system.

The first 44kV and 5kV master plans were issued in 2013 and 2014 respectively. Subsequently, in 2018-2019, city planning initiated intensification studies of the North King's Town (NKT) District and Central Kingston Growth Strategy with the goal of identifying new zoning and development hubs. Kingston Hydro completed a high level incremental capacity assessment for the "ultimate" infill scenario of the NKT study with consideration of several degrees of EV charging uptake.

44kV Load Forecast

A detailed load forecast was included with the Kingston Hydro 44kV Master Plan issued in 2013 and filed with the previous DSP (EB-2015-0083). The 44kV Master plan determined that the 44kV distribution system had sufficient capacity for the near term (2014-2020) and identified some opportunities to optimize/upgrade the 44kV distribution system (refer to Appendix E of this DSP for excerpts from the 44kV Master Plan).

Kingston Hydro's 44kV load forecast has been updated more recently and shared with the working group of the current Peterborough to Kingston Regional Planning Cycle with a Needs Assessment study kick-off in 2019 followed by an IRRP study kick-off in 2020.

As part of the recent IRRP study, the IESO asked distributors to submit an electrification forecast scenario in addition to the reference forecast. As a result, Kingston Hydro developed three load forecasts with the help of several customers from Kingston Hydro's Institutional Municipal University Schools and Hospital (I-MUSH) sector who shared preliminary plans and targets for electrification of heating and transportation fleets. The three load forecast scenarios are as follows:

- Reference Forecast (assumes status quo gas/electric energy usage patterns)
- Scenario 1 Electrification Forecast (assumes partial electrification of heating using heat pumps) and
- Scenario 2 Electrification Forecast (assumes full electrification of heating with resistive heating back-up).

The following tables summarize the 2019-2027 incremental 44kV load forecasts for Kingston Hydro's delivery points.

	MW										MW/Year
Delivery Point	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**Total**	**Average**
Frontenac DX (M3)	0.08	0.08	0.08	0.08	0.08	0.24	0.24	0.24	0.24	**1.36**	0.15
Frontenac TX (M2, M4, M5)	0.33	0.33	0.33	1.33	0.78	0.78	0.78	0.78	0.78	**6.18**	0.69
Gardiner DX (M7, M9, M12)	0.31	1.69	2.59	2.49	2.49	2.49	1.11	1.11	1.11	**15.36**	1.71
Total	0.72	2.10	3.00	3.90	3.35	3.50	2.12	2.12	2.12	**22.90**	**2.54**

Table 5.3-11 – Reference Forecast - Winter

	MW										MW/Year
Delivery Point	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**Total**	**Average**
Frontenac DX (M3)	0.08	0.08	0.41	0.41	0.41	0.41	0.41	0.41	0.41	**3.03**	0.34
Frontenac TX (M2, M4, M5)	0.33	0.33	0.73	2.18	1.22	1.54	2.21	3.06	4.26	**15.86**	1.76
Gardiner DX (M7, M9, M12)	0.31	1.69	2.69	3.04	3.02	3.02	1.64	1.64	1.64	**18.69**	2.08
Total	0.72	2.10	3.83	5.64	4.65	4.97	4.26	5.11	6.31	**37.57**	**4.17**

Table 5.3-12 – Scenario 1 (Medium) Electrification Forecast – Winter

	MW										MW/Year
Delivery Point	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**Total**	**Average**
Frontenac DX (M3)	0.08	0.08	1.21	1.21	1.21	1.21	1.21	1.21	1.21	**8.60**	0.96
Frontenac TX (M2, M4, M5)	0.33	0.33	1.62	3.97	2.20	3.15	5.16	7.71	8.91	**33.36**	3.71
Gardiner DX (M7, M9, M12)	0.31	1.69	3.87	4.22	4.14	4.14	2.76	2.76	2.76	**26.65**	2.96
Total	0.72	2.10	6.69	9.40	7.54	8.50	9.12	11.68	12.88	**68.62**	**7.62**

Table 5.3-13 – Scenario 2 (High) Electrification Forecast – Winter

Hydro One Transformer Station Capacity

Kingston Hydro is currently supplied by three dedicated 44kV feeders and one shared 44kV feeder from Frontenac TS (115kV – 44kV) and three dedicated 44kV feeders from Gardiner DESN 1 (230kV – 44kV). The local Hydro One station capacity and % of feeder assigned to Kingston Hydro is summarized in the following table.

Facility	10 Day Summer LTR (MW)	10 Day Winter LTR (MW)	Total # of 44kV Station Feeders Serving Kingston Region	# of 44kV Station Feeders Serving Kingston Hydro*	% of 44kV Station Feeders Serving Kingston Hydro
Frontenac (T3/T4)	111	122	6	2.5	42%
Gardiner DESN1 (T1/T2)	125	143	9	3	33%
Gardiner DESN2 (T3/T4)	84	84	4	0	0%

Table 5.3-14 – Hydro One Transformer Station Capacity and Feeder Allocation

***NOTE:** Kingston Hydro is an embedded distributor on the Frontenac M3 Feeder and shares this feeder with Hydro One Distribution.

The actual station capacity allocated to Kingston Hydro is more complicated than simply applying the feeder allocation at each transformer station; it is based on historical facility loading.

The following summary is an estimate of the total remaining capacity of the Frontenac and Gardiner DESN1 stations based on data supplied in the IESO IRRP report for the Peterborough to Kingston region released Nov 2021 for the three load forecast scenarios:

Frontenac TS - Summer

- Summer LTR = 111MW
- Summer Peak (2019) = 100MW
- Remaining Summer Capacity = 11MW
- Need Date based on Reference Summer Forecast: 2029

- Need Date based on Growth Scenario 1 Summer Forecast: 2024
- Need Date based on Growth Scenario 2 Summer Forecast: 2022

Frontenac TS - Winter

- Winter LTR = 121MW
- Winter Peak (2019) = 110MW
- Remaining Winter Capacity = 11MW
- Need Date based on Reference Winter Forecast: 2029
- Need Date based on Growth Scenario 1 Winter Forecast: 2024
- Need Date based on Growth Scenario 2 Winter Forecast: 2022

Gardiner DESN1 – Summer

- Summer LTR = 125MW
- Summer Peak (2019) = 144MW
- Remaining Summer Capacity = Exceeds LTR (Load Transfer required)
- Need Date based on Reference Summer Forecast: Need today
- Need Date based on Growth Scenario 1 Summer Forecast: Need today
- Need Date based on Growth Scenario 2 Summer Forecast: Need today

Gardiner DESN 1 – Winter

- Winter LTR = 143MW
- Winter Peak (2019) = 129MW
- Remaining Winter Capacity = 14MW
- Need Date based on Reference Winter Forecast: 2028
- Need Date based on Growth Scenario 1 Winter Forecast: 2026
- Need Date based on Growth Scenario 2 Winter Forecast: 2026

Refer to Section 5.2.2(b) of the DSP for further details of the Regional Plan Process Deliverables.

44kV Feeder Capacity

The typical 44kV feeder capacity is summarized in Table 5.3-13.

Feeder	Operating Scenario	Rating		
		Amps	MVA	MW
Typical 44kV Feeder Rating	Emergency Rating	680	54.2	48.8
	Economic Rating	426	33.9	30.5
	Normal	340	27.1	24.4

Table 5.3-15 – Typical 44kV Feeder Capacity

As mentioned previously, Kingston Hydro is supplied by a total of seven 44kV feeders; six dedicated and one shared. At least 50% of the shared feeder is assumed to be allocated to Kingston Hydro which results in a total combined normal 44kV feeder capacity of approximately 162.5MW (25MW/feeder x 6.5 feeders).

5kV/15kV Substation Capacity

Kingston Hydro has 16 substations and a total of 34 substation transformers that step the Hydro One 44kV sub-transmission voltage down to a medium voltage of either 4.16/2.4kV (5kV Class) or 13.8/8kV (15kV Class) to facilitate distribution of electricity to residential and small commercial customers. Transformer nameplate capacity ranges from 3MVA to 10MVA. The combined nameplate capacity of all substation transformers is 218 MVA.

5kV/15kV Feeder Capacity

Kingston Hydro has a total of 107 feeders operating at the 5kV/15kV voltage class. The typical feeder capacity for these voltages is summarized in Table 5.3-14.

Voltage Class	Operating Scenario	Rating		
		Amps	MVA	MW
Typical 5kV Feeder (4.16kV nominal)	Emergency Rating	400	2.9	2.6
	Economic Rating	282	2.0	1.8
	Normal	200	1.4	1.3
Typical 15kV Feeder (13.8kV nominal)	Emergency Rating	400	9.6	8.6
	Economic Rating	282	6.7	6.1
	Normal	200	4.8	4.3

Table 5.3-16 – 5/15kV Feeder Capacity Ratings

5kV Master Plan

A 5kV master plan was issued in 2014 and included with the previous DSP (Refer to EB-2015-0083). Below is a summary and status of proposed system upgrades identified in the 5kV master plan.

1.0 Substation Upgrades

1.1 Add Fans to MS3 – T1

- Completed in 2014

1.2 Add Fans to MS3 – T2

- Completed in 2014

1.3 Add Fans to MS13 – T1

- Still pending installation.

1.4 Address capacity concerns at MS5 due to failed T1 transformer

- MS5 is scheduled to be upgraded in 2022. In the meantime, an existing transformer that was removed from Substation MS4 in 2018 was moved to Substation MS5 as an emergency spare.

1.5 Replace MS4-T1 and MS4-T2 transformers with one new transformer

- This work was completed in 2018.
- The old MS4-T2 transformer was moved to Substation MS5 as an emergency spare

1.6 Upgrade capacity of MS17 from 3MVA to 5MVA by reusing old MS4-T2

- In 2019, staff determined it would be better to add a feeder to substation MS16 to reinforce the existing 5kV distribution area served by MS17 and decommission MS17. This work was completed in 2020.

1.7 Replace MS8 – T2 with larger transformer:

- This work is planned for 2024

1.8 Upgrade East Transformer bank at MS1 from 9MVA to 12MVA

- This work was completed in 2021.

1.9 Upgrade West Transformer bank at MS1 from 9MVA to 12MVA

- This work was completed in 2020

2.0 Expansion work – North of John Counter and West of Division

- In the near term, the reinforcement of the1402 feeder is being paced. Some near term load relief involving the reconfiguration of Feeder 1401 (back up for Feeder 1402) was completed in 2019 in preparation for the decommissioning of substation MS17. The replacement of existing 5kV cable with new 15kV cable is planned for feeders 1401 and 1402 along Dalton Avenue in 2025 to facilitate a future voltage conversion for the Clyde industrial park (Dalton Avenue, Binnington Court, Grant Timmins Drive). Also, existing overhead poles insulated for 5kV that have reached end of life are being replaced with new overhead poles insulated for 15kV
- In the long term a voltage conversion from 5kV to 15kV is recommended for the area of the Kingston Hydro distribution system supplied by MS14 and MS16. A 15kV supply exists at the recently built Substation MS16 however, the cost to upgrade the existing 5kV distribution in the area to 15kV is estimated at $7.2million. Kingston Hydro plans to revisit and update the voltage conversion plan over the 2022-2027 forecast period.

3.0 Expansion work – North of Queen and East of Bagot

- A tie between the 108 and 809 feeders was completed in 2017. This tie was required to facilitate isolation of Substation MS1 for extended periods of time in preparation for the Substation MS1 rebuild project.
- Planning for development of the North Block and City Pier at the foot of Queen Street is currently on hold. Another proposed developments in the area is currently under review and Kingston Hydro requires further details regarding the proposed electric servicing before it can develop a cost-effective servicing plan. Electric planning solutions will depend on whether this future development is serviced from the 44kV distribution or the 5kV distribution system.

4.0 Expansion work – Williamsville

4.1 Shift load from Feeder 1302 and 201 to 1301

- Completed during 2015-2019 historic period.

4.2 Shift load from Feeder 104 to 201 after completing 4.1 above

- Completed during 2015-2019 historic period.

4.3 Shift Load from Feeder 207 to 208 then Extend Feeder 207 to Supply New Development

- Completed during 2015-2019 historic period.

4.4 Extend Feeder 204 from Brock St. to Princess St. Via Albert St.

- Completed during 2015-2019 historic period.

4.5 Add 44kV – 13.8kV transformers at substation MS2 and MS13 and extend 15kV feeders to Princess

- The estimated cost of this 15kV expansion is $4.5million. Kingston Hydro will revisit this plan during 2022-2027 forecast period but has no plans to undertake this work at this time.

5.0 Expansion work – Redevelopment of ORC Lands fronting on King St.

- The redevelopment of ORC lands is currently on hold. In the long term, Kingston Hydro anticipates the need to extend a feeder from MS7 to service the ultimate load forecast for the proposed commercial/residential development.

Drivers of Material Investment

In recent years, 5kV planning **has focused on reassessment of the Williamsville forecast as well as new intensification studies initiated by City Planning for** North King's Town (NKT) and Central Kingston Growth Strategy (CKGS). The results of these studies were then used to develop Kingston Hydro's most recent load forecast for the 2019-2027 timeframe of this DSP and the load forecasts for the recent Peterborough to Kingston Needs Assessment and Integrated Regional Resource Plan (IRRP).

The assessments described in the preceding paragraph were used to identify and prioritize capital projects for the 2023-2027 capital expenditure plan. In recent years, Kingston Hydro has seen a gradual increase in System Access investments and System Service investments. Also, many of the System Renewal investments planned for 2023-2027 complement future System Access and System Service investments. For example, some end-of-life cable replacement and end-of-life pole replacement aligns with future voltage conversion plans for the area served by MS16, MS14 and MS13.

5.3.3. Asset Lifecycle Optimization Policies and Practices

This section provides an overview of Kingston Hydro's asset lifecycle optimization policies and practices.

Kingston Hydro's historic approach to decision making on asset replacement and refurbishment is explained as well as its current and evolving Asset Condition Assessment (ACA) methodology.

The routine inspection and maintenance programs that facilitate the sustainment of existing assets are also discussed.

5.3.3.1 Asset Lifecycle Optimization

Kingston Hydro manages its assets using the following approaches:

1. Maintenance
2. Refurbishment
3. Replacement

Maintenance

Maintenance activities can be divided into four categories:

1. Reactive – Corrective Maintenance following Run-to-Failure
2. Preventive – Time-Based Maintenance
3. Predictive – Condition Based Maintenance
4. Proactive – Identification of Root Cause Before Failure

Reactive maintenance is always a fall back option. However, when time and resources permit, Kingston Hydro undertakes Preventive, Predictive and Proactive maintenance activities as described in the following examples below.

Preventive

- Cleaning switches, vaults, maintenance holes
- Switch maintenance
- Vegetation management
- Insulator washing
- Substation equipment maintenance (transformers, breakers, and relays)

Predictive

- Wood pole testing
- Thermographic/Infrared (IR)
- Visual inspections
- Substation tests (Transformer oil analysis, Battery testing, Electrical resistance, and insulation tests)

Proactive

- Breaker Bearing Replacement (bearings were determined to be the root cause of slow breaker operating time)
- Power Transformer maintenance (oil filtering or replacement, gasket seal repairs, etc.)

Refer to Table 5.3-2 for details regarding the frequency of Kingston Hydro's key electrical inspection and maintenance programs.

Refurbishment

Refurbishment applies primarily to substation and underground vault facilities. For example, Kingston Hydro retrofitted the walk-in metal enclosures at Substation MS3 and MS15 in 2011-2012 with new rack-out breakers because the enclosure was in good condition and the breaker cubicle dimensions could accommodate a retrofit kit. Also, for underground vaults it is quite common to reuse the main vault structure and only replace the top slabs and/or beams.

Replacement

Replacement activities are divided into two categories:

1. Proactive
2. Reactive

For assets with a relatively small consequence of failure, units are generally replaced **reactively** or on failure. The ACA flag-for-action plan for such an approach is based on the asset group's failure rate. This approach incorporates the possibility that assets may fail prematurely, prior to their expected typical end of lives.

In the **proactive** approach, units are considered for replacement prior to failure. For asset groups that fall under this approach, a Risk Assessment study is conducted to determine each unit's eligibility for replacement. This process establishes a relationship between an asset's Health Index and the corresponding probability of failure. Also, for some asset categories, quantification of asset criticality is done through the assignment of weights and scores to factors that impact the decision for replacement. The combination of criticality and probability of failure determines risk and replacement priority.

The following table shows the Primary and Secondary Replacement Strategy for assets. The primary replacement strategy is the preferred replacement strategy. However, sometimes an alternate (secondary) replacement strategy must be considered for investment decision reasons.

For example, the primary strategy for substation transformers is proactive replacement, however, capital budget constraints may require staff to consider reactive replacement as a secondary strategy if this capital expenditure needs to be deferred due to limited capital funds. Risk of failure and contingency plans in the event of failure are carefully considered in this instance.

Conversely, the primary strategy for underground cables is reactive replacement, however there are cases where it makes sense to coordinate replacement of underground cables and duct structure with joint reconstruction projects to save future restoration costs. Therefore, proactive replacement of some underground cables is necessary to bring an entire block up to standards.

Asset	Primary Replacement Strategy	Secondary Replacement Strategy
Wood Poles	Reactive	Proactive
Overhead Conductors	Reactive	Proactive
Distribution Line Transformers	Reactive	Proactive
Underground Civil Structures	Reactive	Proactive
Pad Mounted Switchgear	Reactive	Proactive
Underground Vault Switchgear	Reactive	Proactive
Underground Cables	Reactive	Proactive
Substation Transformers	Proactive	Reactive
Substation Circuit Breakers	Proactive	Reactive
Substation Switchgear	Reactive	Proactive

Table 5.3-17 – Summary of Asset Replacement Strategies

5.3.3.2 Asset Lifecycle Risk Management

Kingston Hydro used its existing Asset Management process to screen and select projects for the 2023-2027 investment period.

Criteria considered includes the following:

- System Loading
- Asset Health (estimates from the formal ACA review)
- Flag for Action Replacement Quantities (estimates from the formal ACA review)
- Annual Inspection data available through a real-time GIS dashboard
- Meetings with operations staff who are Subject Matter Experts with working knowledge of assets and operating risks
- Available capital funds

As an older LDC in Ontario, Kingston Hydro acknowledges that various amounts of its asset base have approached or exceeded their estimated useful life. While maximizing the usefulness and value of its assets operationally, it is also recognized that the emphasis on system renewal investments is the result of having to deal with assets that are in service beyond their estimated useful life and where their condition is indicating that action is warranted.

1 **5.3.3.3 Outcomes of Asset Lifecycle Optimization and Risk Management**

2 The following table summarizes the 10 year annual levelized Flagged for Action (FFA) plan suggested in the Kinectrics
3 ACA report for Year 0 (2019) to Year 10 (2028).

4

Asset Category		Flagged for Action Plan by Year										
		0	1	2	3	4	5	6	7	8	9	10
Station Transformers		7	0	0	0	0	4	0	1	0	0	0
Station Breakers		13	0	5	0	0	0	0	0	0	0	0
Station Ganged Switches	MV	17	0	4	0	0	0	0	0	0	0	0
	44 kV	28	0	2	0	0	0	0	4	0	0	0
Pole Mounted Transformers	1-Ph	60	53	46	40	34	31	27	25	23	21	20
	3-Ph	5	5	5	5	4	4	3	3	2	2	3
Pad Mounted Transformers	1-Ph	22	22	20	19	18	17	16	15	14	14	13
	3-Ph	8	8	8	7	7	7	7	6	6	7	7
Poles	Wood	145	144	144	143	142	141	140	139	138	137	135
	Concrete	8	8	7	7	6	6	5	5	4	4	4
Pad Mounted Switchgear		1	1	1	1	1	1	1	1	1	1	0
Vault Transformers		6	4	4	4	3	3	2	2	2	2	2
Vault Switchgear		1	1	1	1	1	1	1	1	1	1	1
Transformer Vaults		1	1	1	1	1	1	1	1	1	1	0
UG Primary Cables - PILC (km)	44 kV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non 44 kV 1-Ph	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non 44 kV 3-Ph	1.1	1.7	0.5	1.7	1.1	0.6	1.1	1.1	2.2	1.7	1.7
UG Primary Cables - XLPE (km)	44 kV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non 44 kV 1-Ph	1.9	2.2	1.9	1.9	2.7	2.7	2.1	2.2	1.9	2.2	1.6
	Non 44 kV 3-Ph	2.4	2.1	2.3	1.9	2.3	1.1	1.0	1.6	1.6	1.6	1.0

5 **Table 5.3-18 – 10 Year Annual Levelized Flagged for Action Plan from Kinectrics ACA Report**

6 * Year 0 = 2019, year 1 = 2020, year 2 = 2021, etc.

7 It's important to note that the FFA quantities give the estimated number of assets per year that need to be addressed
8 however, the year that a specific unit needs to be addressed is not calculated. Actual/planned quantities may be lower or

higher than the FFA suggested quantities for each asset type due to Kingston Hydro's risk management and optimization strategies. The following table summarizes, the asset population, health distribution (poor and very poor), FFA and total plan quantities for the 2019-2023 timeframe of this DSP.

Asset Group	Asset Category	Population	Health Index Distribution		2019-2023			
					5 Year Flag For Action		5 Year Plan Total	
			Very Poor (< 25%)	Poor (25 - <50%)	Total FFA Qty	% FFA of Pop.	Total Plan Qty	% Plan of Pop.
Stations	Station Transformers	37	7	5	7	18.9%	11	29.7%
	Station Breakers	140	13	5	18	12.9%	15	10.7%
	Station Ganged Switches MV	29	17	4	21	72.4%	1	3.4%
	Station Ganged Switches 44 kV	53	28	6	30	56.6%	4	7.5%
Distribution Transformers	Pole Mounted Transformers 1-Ph	976	161	106	233	23.9%	96	9.8%
	Pole Mounted Transformers 3-Ph	119	8	7	24	20.2%	11	9.2%
	Pad Mounted Transformers 1-Ph	359	47	115	101	28.1%	15	4.2%
	Pad Mounted Transformers 3-Ph	237	10	30	38	16.0%	24	10.1%
Poles	Poles (Wood & Concrete)	6213	652	1196	718	11.6%	341	5.5%
Underground Distribution	Pad Mounted Switchgear	22	0	14	5	22.7%	2	9.1%
	Vault Transformers	64	25	10	21	32.8%	2	3.1%
	Vault Switchgear	26	0	10	5	19.2%	3	11.5%
	Transformer Vault Structures	36	0	12	5	13.9%	0	0.0%
UG Primary Cables (km)	44kV	21.53	0.30	0.00	0.00	0.00%	0.12	0.001%
	5kV/15kV	214.34	2.10	3.70	27.70	0.01%	12.08	0.01%

Table 5.3-19 – Summary of Asset Population, Poor Health Distribution, FFA and Total Plan Quantities for 2019-2023

The following sub-sections discuss the outcomes of the asset lifecycle optimization and risk management for this DSP.

5.3.3.3.1 Station Equipment

The following chart summarizes the total suggested FFA quantity and the total plan quantity of major station equipment for the 2019-2023 timeframe.

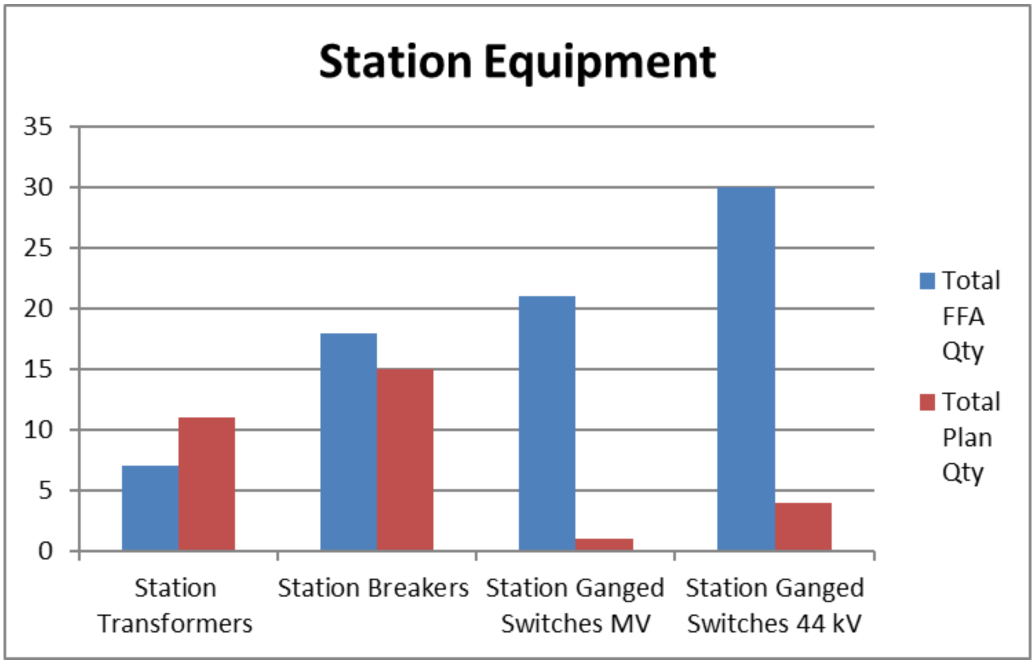


Figure 5.3-51 – 2019 to 2023 Station Equipment Quantities

Substation Equipment - Substation Transformers

The risk based prioritization list of the worst Substation Transformers is shown in Table 5.3-20.

ID	Substation	Position	MVA	Age	DAI	HI by condition	HI	Risk Index 100% = Most Risk 0% = Least Risk	FFA Year
MS1-T4	1	4	3	69	76%	88%	0%	86.0%	0
MS1-T1	1	1	3	66	48%	100%	3%	86.0%	0
MS5-T3	5	3	3	69	76%	94%	0%	85.7%	0
MS17-T1	17	1	3	66	75%	77%	3%	85.7%	0
MS5-T2	5	2	3	65	71%	84%	5%	85.7%	0
MS5-T1	5	1	3	65	95%	63%	5%	85.7%	0
MS8-T2	8	2	5	69	76%	90%	0%	85.3%	0
MS1-T6	1	6	3	59	71%	94%	32%	85.0%	5
MS1-T3	1	3	3	59	48%	95%	32%	83.8%	5
MS1-T2	1	2	3	59	52%	86%	32%	83.8%	5
MS6-T2	6	2	5	59	95%	90%	32%	83.5%	5
MS1-T5	1	5	3	58	71%	99%	38%	79.6%	7
MS9-T2	9	2	7.5	56	71%	55%	50%	52.1%	13

Table 5.3-20 – Transformer Health Index

Kingston Hydro had a total of 37 station transformers in service when the ACA report was issued with 12 in Poor or Very Poor condition and a suggested FFA quantity of 7 for the 2019-2023 timeframe. Since the ACA report was issued, Kingston Hydro has taken proactive action to address these critical assets.

Eight of the substation transformers from the flag-for-action list were addressed over the 2018-2021 historic timeframe as follows:

- Decommissioned MS17-T1 (NOTE: transferred load to MS16)
- Decommissioned MS5-T1 (NOTE: MS5-T1 load temporarily transferred to MS5-T2 and MS5-T3)
- Replaced 6 transformers at MS1 with 6 new transformers as part of the MS1 project
- Developed plan to reuse 1 transformer recently removed from MS4 to replace/upgrade MS5-T2 in 2022

Another 2 substation transformers from the flag-for-action list (MS5-T3 and MS8-T2) will be replaced over the 2022-2027 timeframe plan.

These proactive actions address 11 of the 12 worst station transformers that the ACA identified to be in Poor or Very Poor condition.

It's important to note that although Kingston Hydro's primary replacement strategy for substation transformers is "proactive", Kingston Hydro also has a secondary "reactive" replacement" strategy for pacing these major capital expenditures that involves asset life extension (e.g. oil maintenance) and temporary load transfers should a transformer asset fail before the planned replacement time of the capital expenditure forecast.

Substation Equipment - Substation Breakers

The risk based prioritization list of the worst Substation breakers is shown in Table 5.3-19 below. Twelve medium voltage substation breakers were identified as being in "Very Poor" condition (Health Index of 50% or less) in the Kinectrics "Asset Condition Assessment" (ACA) report.

Busbar	Location	Voltage (kV)	Curent	Interruption Medium	Age	DAI	HI (Condition)	HI (Final)	HI Category
BUS TIE	196 Hillendale Ave.	4	1958	Oil	61	0.0%		14.8	Very Poor
407	196 Hillendale Ave.	4	1958	Oil	61	0.0%		14.8	Very Poor
408	196 Hillendale Ave.	4	1958	Oil	61	0.0%		14.8	Very Poor
409	196 Hillendale Ave.	4	1958	Oil	61	0.0%		14.8	Very Poor
F1	3 Festubert St.	5	1958	Air	61	0.0%		14.8	Very Poor
F2	3 Festubert St.	5	1958	Air	61	0.0%		14.8	Very Poor
F3	3 Festubert St.	5	1958	Air	61	0.0%		14.8	Very Poor
F4	3 Festubert St.	5	1958	Air	61	0.0%		14.8	Very Poor
501RECLOSER	3 Festubert St.	5	2000	Vacuum	19	0.0%		25.0	Very Poor
503RECLOSER	3 Festubert St.	5	2000	Vacuum	19	0.0%		25.0	Very Poor
504RECLOSER	3 Festubert St.	5	2000	Vacuum	19	0.0%		25.0	Very Poor
505RECLOSER	3 Festubert St.	5	2000	Vacuum	19	0.0%		25.0	Very Poor
902	40 Division St.	9	1963	Air	56	69.6%	73.2	35.1	Poor
908	40 Division St.	9	1963	Air	56	87.5%	100.0	35.1	Poor
905	40 Division St.	9	1963	Air	56	100.0%	82.1	35.1	Poor
906	40 Division St.	9	1963	Air	56	100.0%	82.1	35.1	Poor
907	40 Division St.	9	1963	Air	56	100.0%	83.9	35.1	Poor

Table 5.3-21 – Station Medium Voltage Breaker Health Index

Four of these legacy oil circuit breakers were located at MS4 and replaced in 2019 as part of the previous plan. The remaining eight breakers will be addressed by Kingston Hydro's 2022-2027 plan as follows:

- Four legacy structure mounted reclosers located at the MS5 North Side facility will be replaced with new reclosers (501, 503, 504, 505)
- Four legacy circuit breakers located at the MS5 South Side facility will be decommissioned in 2023 (F1, F2, F3, F4) and replaced with one new recloser located at the MS5 North Side facility.

5.3.3.3.2 Distribution Transformers

The following chart summarizes the total suggested FFA quantity and the total plan quantity of distribution transformer assets for the 2019-2023 timeframe.

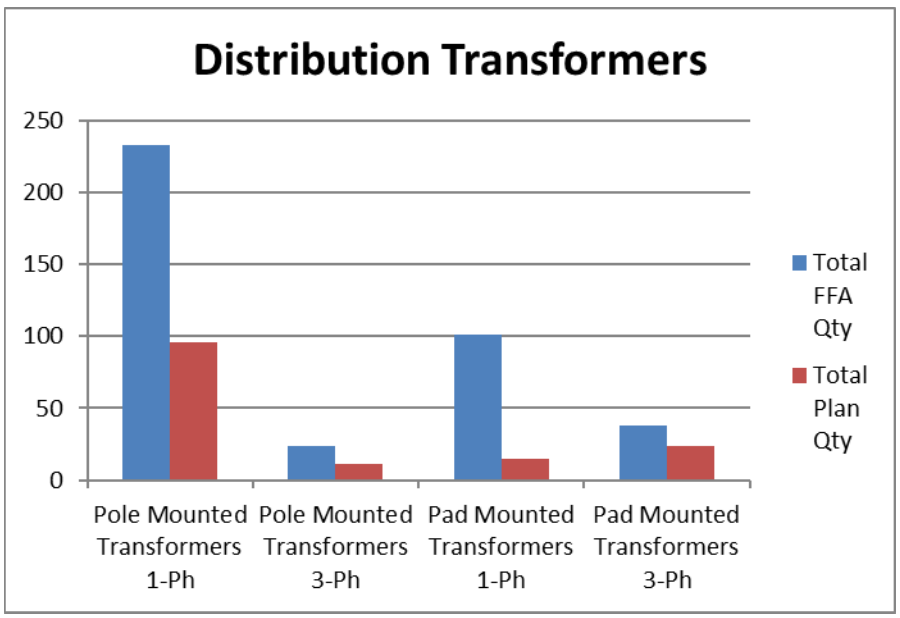


Figure 5.3-52 – 2019 to 2023 Distribution Transformer Quantities

Pole Mounted Transformers

Kingston Hydro has a total of 1095 pole transformers (1ph + 3ph) in its distribution system with 282 or 26% of the pole mounted transformers in Poor or Very Poor condition and a suggested FFA quantity of 257 transformers for the 2019-2023 timeframe. Kingston will replace approximately 107 pole mounted transformers over this timeframe.

Kingston Hydro is proposing to pace deteriorated pole replacement and pole transformer replacement so that a greater portion of available capital funds can be allocated to renewal of other assets. The average annual FFA quantity for wood poles and pole mounted transformers has not changed significantly from the previous DSP.

Pad Mounted Transformers

If necessary, the capital funds for pad mounted transformers will be pooled with the capital funds for underground distribution equipment to fund reactive replacement of these assets in the event of a disproportionate number of asset failures in these asset categories. Kingston Hydro's proposed plan has a greater focus on 3-phase pad mounted transformers since the reliability impact and financial risk due to failure is much greater than that of single phase pad mounted transformers.

5.3.3.3.3 Poles

The following chart summarizes the total suggested FFA quantity and the total plan quantity of poles for the 2019-2023 timeframe.

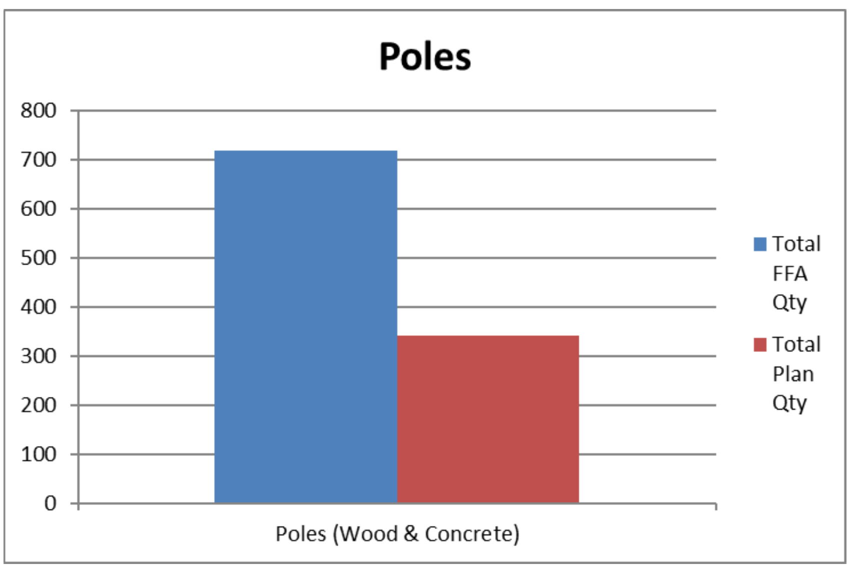


Figure 5.3-53 – 2019 to 2023 Pole Quantities

Kingston Hydro has a total of 6,213 wood poles in its distribution system with 1804 poles or 29% of the pole assets in Poor or Very Poor condition and a suggested FFA quantity of 718 poles for the 2019-2023 timeframe. Kingston Hydro will replace approximately 341 poles over this timeframe in paced manner so that a greater portion of available capital funds can be allocated to renewal of other assets. The average annual FFA quantity for wood poles has not changed significantly from the previous DSP. The reliability and financial risk of a pole failure is also partially mitigated through the annual pole inspection program and continuous prioritization of pole work. For example, replacement of deteriorated poles with a 44kV circuit and/or multiple 5kV circuits would typically be prioritized over a pole with a single phase primary circuit or secondary circuit due to the higher reliability and financial risk involved.

5.3.3.3.4 Underground Distribution Equipment

The following chart summarizes the total suggested FFA quantity and the total plan quantity of underground distribution assets for the 2019-2023 timeframe.

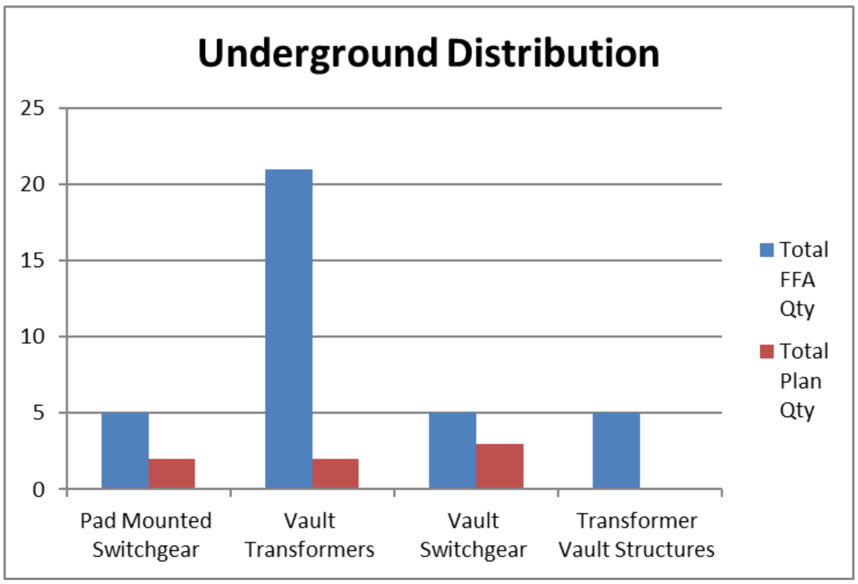


Figure 5.3-54 – 2019 to 2023 Underground Distribution Quantities

As mentioned above, the capital funds for pad mounted transformers will be pooled with the capital funds for underground distribution equipment, if necessary, to fund reactive replacement of these assets in the event of a disproportionate number of asset failures in these asset categories.

Vault Transformers

Kingston Hydro's vault transformers may be located in a customer-owned vault (fire-rated room) within a customer's premises or in an underground concrete structure in the city right-of-way that is owned by Kingston Hydro. Vault transformers in customer vaults typically consist of a bank of three single phase transformers. Vault transformers in underground vaults consists of a self-contained three phase submersible transformer. Kingston Hydro's proposed plan has a greater focus on 3-phase submersible transformers since the reliability impact and financial risk due to failure is much greater than that of single phase vault transformers.

Vault Switchgear

The replacement of obsolete vault switchgear assemblies can be paced. However, the risk of not replacing obsolete switchgear assemblies is that Kingston Hydro would need to continue with planned outages to do switching which can be an inconvenience to customers and would continue to impact service quality and reliability performance numbers. There were a total of 5 vault switchgear assemblies that were flagged for action in the ACA. Kingston Hydro replaced TV38 switchgear in 2019 and plans to replace TV18 and TV4 switchgear in 2022.

5.3.3.3.5 Primary Cables

The following chart summarizes the total suggested FFA quantity, and the total plan quantity of primary cable identified for replacement over the 2019-2023 timeframe.

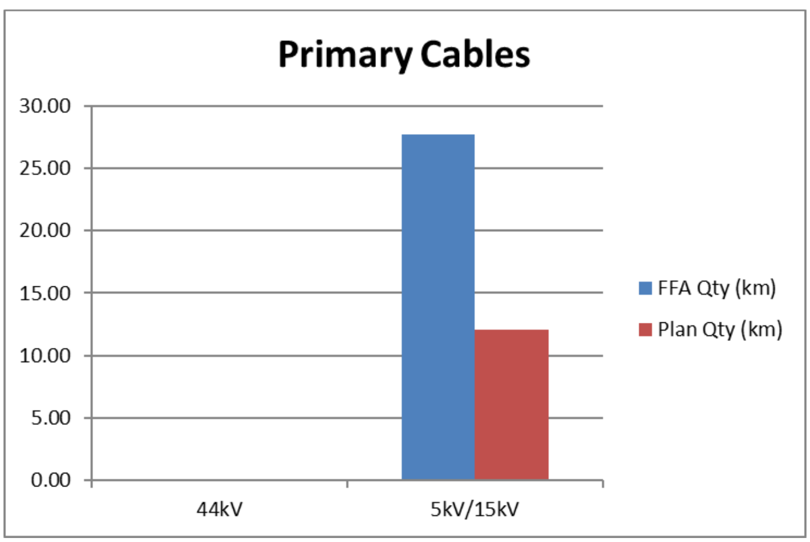


Figure 5.3-55 – 2019 to 2023 Primary Cable Quantities

Kingston Hydro has a total of 235.87 km of primary cable in its distribution system with 38.6 km or 16% being obsolete PILC cable. The suggested FFA quantity for the 2019-2023 timeframe is 27.70km. Kingston Hydro will replace approximately 12.2 km of primary cable over this timeframe through a mix of pro-active and reactive cable replacement programs.

5.3.3.3.6 Miscellaneous Assets

The following assets are not included in the Kinectrics ACA report but were factored into Kingston Hydro's asset replacement plans.

44kV Overhead Ganged Switches

There are currently 31 ganged type overhead switches that are used to sectionalize and reconfigure the 44kV overhead distribution system. Kingston Hydro does not have asset condition assessment information for 44kV overhead ganged switches however, seven of these switches are legacy air-break (A/B) switches that are obsolete and only suitable for isolation whereas the majority are standard load break (L/B) switches that are suitable for making and breaking parallel between different 44kV circuits. There is limited age and asset condition information available for these assets, so Kingston Hydro had operations staff identify the type of switch and rank the worst switches from 1(highest priority) through 6 (lowest priority). The following table summarizes the replacement priority for 44kV overhead ganged switches.

Switch #	Type	Motor	Priority	Replacement Recommendations
M12-121	A/B		1	Motor Operator - Isolation point from Hydro One (Pole Line Rebuild)
M3-RMC	A/B		2	
M5-54	A/B		2	
M5-55	A/B		2	
M5-126	L/B		3	Motor Operator - Common Switch for making and breaking parallels
M5-51	L/B		3	Motor Operator - Common Switch for making and breaking parallels
M7-74	L/B		4	Motor Operator - Common Switch for making and breaking parallels
M9-92	L/B		5	Motor Operator - Isolation point from Hydro One
M2-22	L/B		6	Motor Operator - Common Switch for making and breaking parallels

Table 5.3-22 – 44kV Overhead Ganged Switch Replacement Priority

Fleet

Capital Expenditures related to new and replacement fleet vehicles are summarized in the 2023-2027 Forecast Capital Project Descriptions found in Appendix F of the DSP. It is vital that Fleet vehicles remain in good working order if staff are to execute planned and unplanned work under any and all weather conditions. The main investment category for these expenditures is General Plant.

Business Systems

Over the 2023-2027 forecast period, Kingston Hydro plans miscellaneous upgrades to business systems including its Financial Management System (FMS), Customer Information System (CIS) and HR Management System (HRMS). The main investment category for these expenditures is General Plant.

5.3.4. System Capability Assessment for Renewable Energy Generation (REG) and Other Distributed Generation (DG)

Appendix A contains a system capability assessment for connecting Renewable Energy Generation (REG) to the Kingston Hydro distribution system.

The capital plan for this DSP does not include any costs to accommodate and connect renewable generation facilities that will be the responsibility of Kingston Hydro under the DSC and are eligible for recovery through the provincial cost recovery mechanism set out in section 79.1 of the Ontario Energy Board Act, 1998.

5.3.5 CDM Activities to Address System Needs

CDM activity under the provincial 2021-2024 CDM Framework is centralized under the IESO. The 2021 CDM Guidelines indicate that any efforts by distributors to support these IESO programs should be limited in nature and non-duplicative of the IESO’s activities, and that distributors should not request funding through distribution rates for dedicated CDM staff to support IESO programs.

Kingston Hydro confirms that no costs for dedicated CDM staff to support IESO programs funded under the 2021-2024 CDM Framework are included in this application and that Kingston Hydro will continue to rely on the IESO CDM programs for our area.

Kingston Hydro can confirm that it continues to work with its customers in encouraging or supporting energy efficiency, energy generation or storage in their development projects. Kingston Hydro continues to support private sector initiatives in this regard by facilitating connections.

Kingston Hydro also considers the impact of conservation programs on the system and in particular its impact to mitigate load growth and consequent distribution system improvements. Conservation programs have historically had a positive impact in mitigate distribution improvements attributed to load growth. At this time, Kingston Hydro has no plans to seek a partnership with the IESO's LIP, nor any rate-based CDM activities to address system needs.

5.4. Capital Expenditure Plan

The capital expenditure plan sets out and comprehensively justifies Kingston Hydro's proposed expenditures on its distribution system and general plant over a five-year planning period. Kingston Hydro's system investment decisions were developed from its planning process. As noted in section 5.2 above, this DSP includes information on the 2016-2022 historical period (from the first Test year of Kingston Hydro's last cost of service application to the Bridge year of the current cost of service application) and the 2023-2027 forecast period (five forecast years beginning with the Test year of the current cost of service application). Typically, the historic and forecast period of a DSP spans a 10 year timeframe (5 historic and 5 forecast years) however, this DSP spans a 12 year timeframe (7 historic and 5 forecast years) because Kingston Hydro received approval from the OEB to defer the filing of its cost of service application in 2020 and 2021 due to the COVID-19 Pandemic.

5.4.1. Capital Expenditure Summary

This section provides a snapshot of capital expenditures for the historic and forecast period of this DSP.

Kingston Hydro's materiality threshold for projects/programs is $70,000 (0.5% of $14million distribution revenue requirement) as set out in the Chapter 2 Filing Requirements for Electricity Distribution Rate Applications – 2022 Edition for 2023 Rate

Applications. For material projects/programs, estimates and costs have been allocated to the relevant investment categories to justify the investment and assist readers in understanding the relationship between the costs and benefits attributable to each driver underlying the investment. In any event, the categorization of an individual project or program for the purposes of these filing requirements did not in any way affect the proper apportionment of project costs as per the DSC.

Kingston Hydro follows the capitalization practices described in the OEB Accounting Procedures Handbook for Electricity Distributors. For projects that have a life cycle greater than one year, some or all of the capital expenditures may be treated as Construction Work In Progress (CWIP) and carried forward to subsequent year(s) until the electric asset(s) are put into service (e.g. energized). The OEB Accounting Procedures Handbook makes some exceptions to the accounting treatment of major spare parts and standby equipment such as distribution transformers and metering assets.

A summary of capital expenditures by investment category and by material projects can be found in sections 5.4.1.1 and 5.4.1.2 respectively.

5.4.1.1 Summary by Investment Category

Despite the multi-purpose character that a project or program may have, for summary purposes Kingston Hydro allocated the entire cost of individual projects or program to one of the four investment categories (System Access, System Renewal, System Service, General Plant) on the basis of the primary (i.e., initial or trigger) driver of the investment.

5.4.1.1.1 Analysis of Historic Capital Expenditures by Investment Category

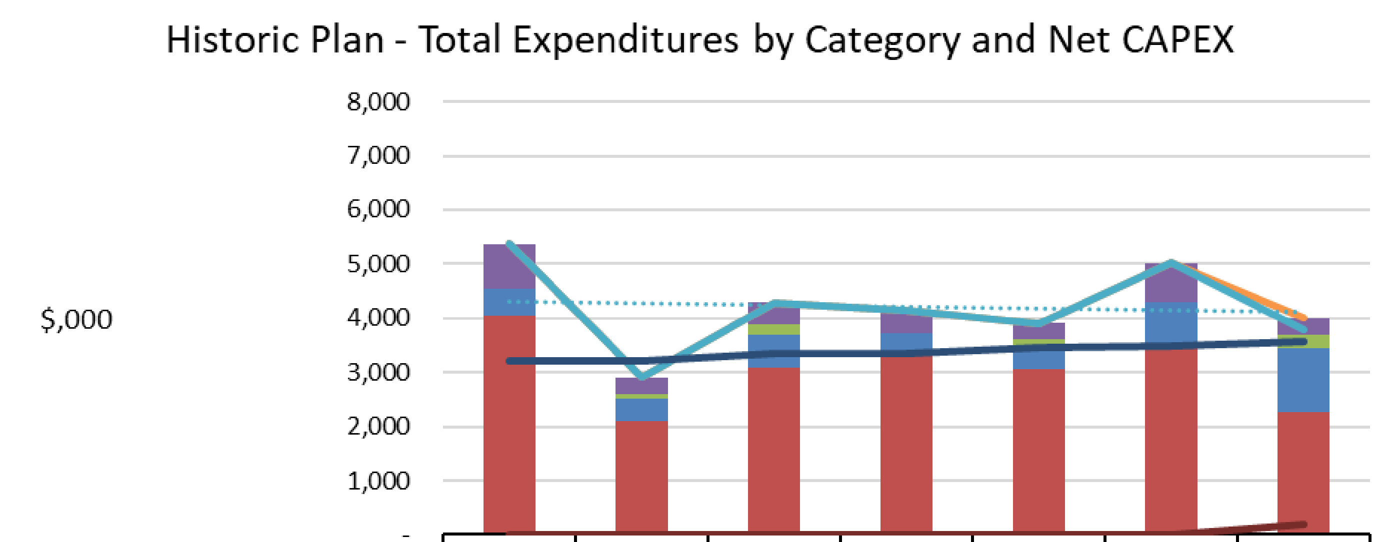
A snapshot of the OEB Appendix 2-AB EXCEL template summarizing capital expenditures by investment category for the 2016-2022 historic period is provided in Table 5.4-1, Figure 5.4-1, and Figure 5.4-2.

CATEGORY	Historical Period (previous plan[1] & actual)						Historical Period (previous plan[1] & actual)														
	2016			2017			2018			2019			2020			2021			2022		
	Plan	Actual	Var	Plan	Actual	Var	Plan	Actual	Var	Plan	Actual	Var	Plan	Actual	Var	Plan	Actual	Var	Plan	Actual[2]	Var
	$ '000		%	$ '000		%	$ '000		%	$ '000		%	$ '000		%	$ '000		%	$ '000		%
System Access	495	750	51.6%	415	576	39.0%	583	287	-50.7%	395	590	49.2%	364	751	106.3%	833	700	-16.0%	1,195	114	-90.4%
System Renewal	4,041	4,738	17.2%	2,103	6,726	219.9%	3,098	3,931	26.9%	3,312	3,438	3.8%	3,054	3,223	5.5%	3,457	3,192	-7.7%	2,258	312	-86.2%
System Service	19	16	-16.7%	76	69	-9.2%	201	462	130.0%	20	113	471.2%	186	25	-86.5%	15	380	2433.0%	248	37	-85.0%
General Plant	821	331	-59.7%	306	800	161.3%	408	494	21.1%	422	604	43.2%	298	168	-43.5%	707	467	-34.0%	297	3	-98.9%
TOTAL EXPENDITURE	5,376	5,835	8.5%	2,900	8,172	181.8%	4,290	5,175	20.6%	4,149	4,744	14.3%	3,903	4,168	6.8%	5,012	4,739	-5.5%	3,997	466	-88.3%
Capital Contributions	-	593	--	-	4,743	--	-	252	--	-	217	--	-	247	--	-	117	--	200	117	-41.4%
Net Capital Expenditures	5,376	5,242	-2.5%	2,900	3,430	18.3%	4,290	4,923	14.8%	4,149	4,527	9.1%	3,903	3,921	0.5%	5,012	4,623	-7.8%	3,797	349	-90.8%
System O&M	3,215	3,615	12.4%	3,212	3,365	4.8%	3,357	3,912	16.5%	3,353	3,469	3.5%	3,449	3,508	1.7%	3,484	3,467	-0.5%	3,580	1,201	-66.5%

Notes to the Table:

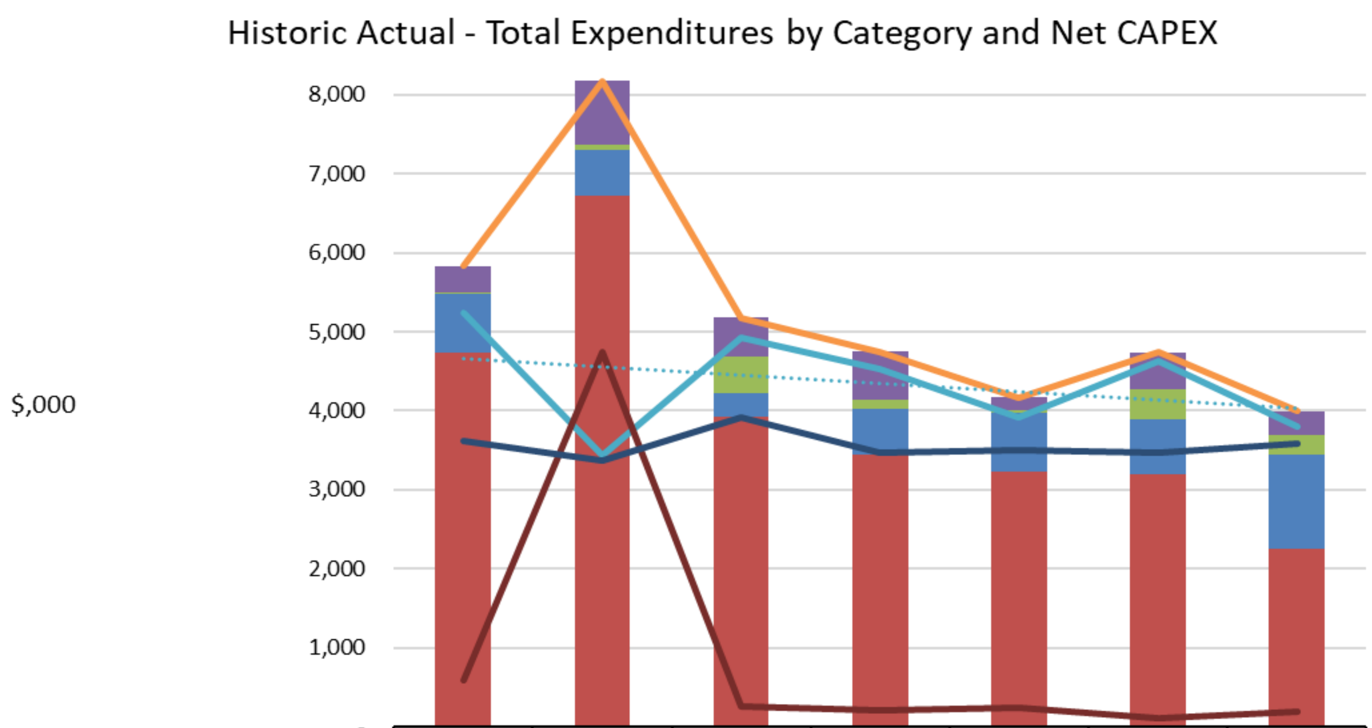
1. Historical period is up to the Bridge year (2022).
2. Actual data for the Bridge year (2022) is for the first 4 months (January to April) available at time of filing

Table 5.4-1 – 2016 to 2022 Historic Capex Summary (From Appendix 2-AB)



	2016	2017	2018	2019	2020	2021	2022
General Plant - Plan	821	306	408	422	298	707	297
System Service - Plan	19	76	201	20	186	15	248
System Access - Plan	495	415	583	395	364	833	1,195
System Renewal - Plan	4,041	2,103	3,098	3,312	3,054	3,457	2,258
TOTAL EXPENDITURE - Plan	5,376	2,900	4,290	4,149	3,903	5,012	3,997
Net CAPEX - Plan	5,376	2,900	4,290	4,149	3,903	5,012	3,797
Capital Contributions - Plan	-	-	-	-	-	-	200
System O&M - Plan	3,215	3,212	3,357	3,353	3,449	3,484	3,580

Figure 5.4-1 – Historic Plan – Total Expenditures by Category and Net Capex – Appendix 2-AB Data



	2016	2017	2018	2019	2020	2021	2022
General Plant - Actual	331	800	494	604	168	467	297
System Service - Actual	16	69	462	113	25	380	248
System Access - Actual	750	576	287	590	751	700	1,195
System Renewal - Actual	4,738	6,726	3,931	3,438	3,223	3,192	2,258
TOTAL EXPENDITURE - Actual	5,835	8,172	5,175	4,744	4,168	4,739	3,997
Net CAPEX - Actual	5,242	3,430	4,923	4,527	3,921	4,623	3,797
Capital Contributions - Actual	593	4,743	252	217	247	117	200
System O&M - Actual	3,615	3,365	3,912	3,469	3,508	3,467	3,580

Figure 5.4-2 – Historic Actual - Total Expenditures by Category and Net CAPEX – Appendix 2-AB Data

The investment category variances in the preceding Table 5.4-2 was calculated in accordance with the OEB Appendix 2-AB filing requirements. Kingston Hydro understands that the OEB prefers levelized (not lumpy) year-to-year spending in each investment category however, this was challenging for Kingston Hydro to achieve over the 2016-2022 historic period for several reasons that include:

- The approved plan for 2016-2020 was already lumpy due to the nature of the planned work.
- The timing of capital contributions such as the Bell Fibre-to-the-Home (FTTH) project had a significant impact on the Actual System Renewal and Actual Total Expenditures for 2017. This also impacted the variance analysis due to the fact that the Plan Total Expenditures for 2017 were the lowest of the 2016-2020 approved plan.
- The majority of Kingston Hydro's total expenditures over the 2016-2022 historic period were allocated to System Renewal which made the Appendix 2-AB variance analysis the System Access, System Service and General Plant categories more sensitive to fluctuations in actual spending.
- Annual expenditures for investment categories are often skewed due to the timing of actual expenditures that are beyond the control of the distributor. For example, a delay in the delivery of a new vehicle can impact annual General Plant expenditures or the timing of new development and/or new services can impact System Access and/or System Service expenditures
- In some instances the investment category classification for the actual expenditures was different than the original plan due to a change in the scope of work and/or the primary driver of the project.
- Actual capital contributions skew some of the variance analysis because Kingston Hydro's approved plan for 2016-2020 did not include a forecast of capital contributions.

Given these challenges, Kingston Hydro presents a modified annual variance analysis for the 2016 to 2022 historic timeframe of this DSP in Table 5.4-2 to demonstrate its cost management. The results of the modified annual variance analysis include the following modifications:

- capital contributions reported in 2017 and 2018 for the Bell FTTH project in the amounts of $3,686,486 and $146,765 respectively were removed from the actual 2017 and 2018 expenditures thus removing this anomaly and reducing the total capital contributions, System Renewal additions and Total Expenditures for these years. **Note:** Even after adjustment for the Bell FTTH project, capital contributions reported for 2017 in the modified analysis are $1,056K which is still quite high compared to the capital contributions reported for other years.
- the percentage variance for each investment category has been calculated with respect to the total planned expenditure instead of the investment category.

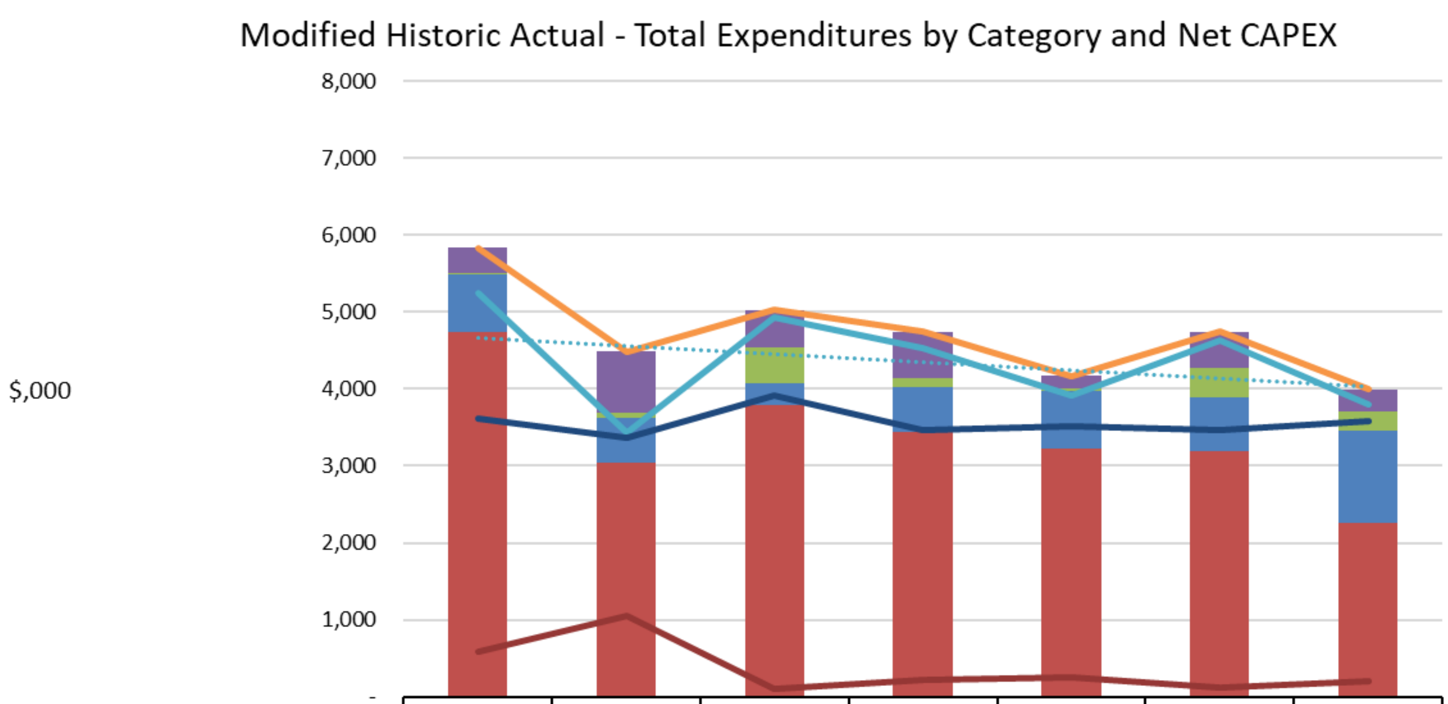
Table 5.4-2 summarizes the 5 year modified historic variance analysis for the 2016-2022 historic timeframe and is based on the data from Table 5.4-4.

CATEGORY	Modified Annual Historic Expenditures																										
	2016				2017				2018				2019				2020				2021				2022		
	Plan	Actual	Var	Var wrt Plan Total	Plan	Actual[1]	Var	Var wrt Plan Total	Plan	Actual[1]	Var	Var wrt Plan Total	Plan	Actual	Var	Var wrt Plan Total	Plan	Actual	Var	Var wrt Plan Total	Plan	Actual	Var	Var wrt Plan Total	Plan	Actual[2]	Var
	$ '000			%	$ '000			%	$ '000			%	$ '000			%	$ '000			%	$ '000			%	$ '000		%
System Access	495	750	255	4.7%	415	576	162	5.6%	583	287	-296	-6.9%	395	590	195	4.7%	364	751	387	9.9%	833	700	-133	-2.7%	1,195	1,195	0.0%
System Renewal	4,041	4,738	697	13.0%	2,103	**3,040**	937	32.3%	3,098	**3,784**	686	16.0%	3,312	3,438	126	3.0%	3,054	3,223	168	4.3%	3,457	3,192	-265	-5.3%	2,258	2,258	0.0%
System Service	19	16	- 3	-0.1%	76	69	- 7	-0.2%	201	462	261	6.1%	20	113	93	2.2%	186	25	-161	-4.1%	15	380	365	7.3%	248	248	0.0%
General Plant	821	331	-491	-9.1%	306	800	494	17.0%	408	494	86	2.0%	422	604	182	4.4%	298	168	-130	-3.3%	707	467	-240	-4.8%	297	297	0.0%
TOTAL EXPENDITURE	5,376	5,835	458	8.5%	2,900	**4,486**	1,586	54.7%	4,290	**5,028**	738	17.2%	4,149	4,744	595	14.3%	3,903	4,168	265	6.8%	5,012	4,739	-273	-5.5%	3,997	3,997	0.0%
Capital Contributions	-	593		--	-	**1,056**		--	-	**105**		--	-	217		--	-	247		--	-	117		--	200	200	0.0%
Net Capital Expenditures	5,376	5,242		-2.5%	2,900	**3,430**		18.3%	4,290	**4,923**		14.8%	4,149	4,527		9.1%	3,903	3,921		0.5%	5,012	4,623		-7.8%	3,797	3,797	0.0%
System O&M	3,215	3,615		12.4%	3,212	3,365		4.8%	3,357	3,912		16.5%	3,353	3,469		3.5%	3,449	3,508		1.7%	3,484	3,467		-0.5%	3,580	3,580	0.0%

Notes to the Table:

1. Actual System Renewal Expenditures and Actual Total Expenditure for 2017 and 2018 less Capital Contributions from Bell FTTH
2. Actual Expenditures for 2022 are assumed to equal current Plan Expenditures

Table 5.4-2 – 2016 to 2022 Modified Annual Historic Variance with Respect to Total Planned Expenditure



	2016	2017	2018	2019	2020	2021	2022
General Plant - Modified	331	800	494	604	168	467	297
System Service - Modified	16	69	462	113	25	380	248
System Access - Modified	750	576	287	590	751	700	1,195
System Renewal - Modified	4,738	3,040	3,784	3,438	3,223	3,192	2,258
TOTAL EXPENDITURE - Modified	5,835	4,486	5,028	4,744	4,168	4,739	3,997
Capital Contributions - Modified	593	1,056	105	217	247	117	200
Net CAPEX - Modified	5,242	3,430	4,923	4,527	3,921	4,623	3,797
System O&M - Actual	3,615	3,365	3,912	3,469	3,508	3,467	3,580

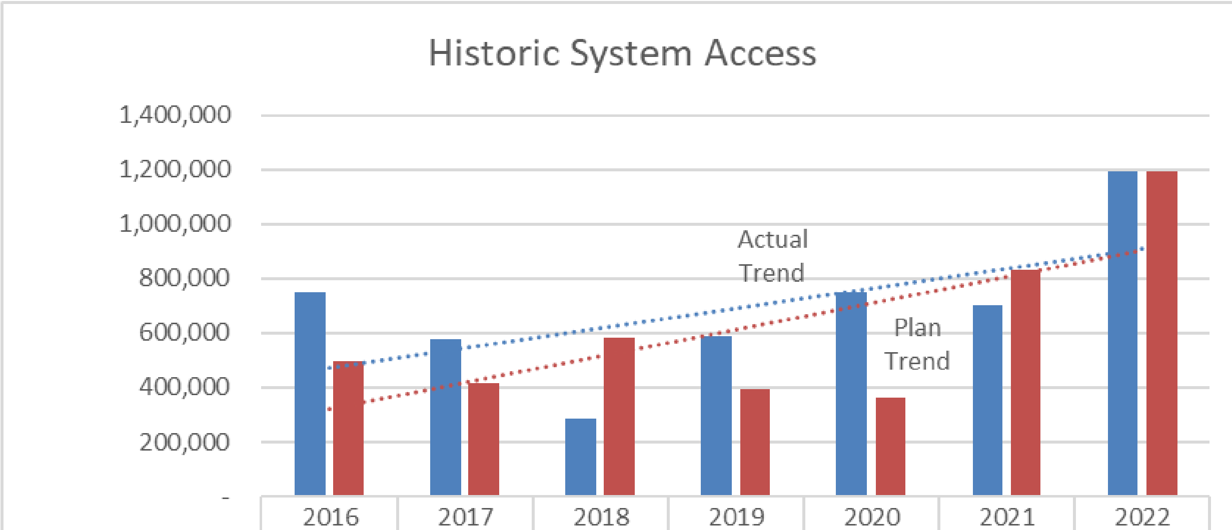
Figure 5.4-3 – Modified Historic Actual – Total Expenditures by Category and Net Capex

CATEGORY	5 year Historic Analysis											
	2016-2020				2016-2021 excluding 2017				2018-2022			
	Plan	Actual	Var	Var wrt Plan Total	Plan	Actual	Var	Var wrt Plan Total	Plan	Actual	Var	Var wrt Plan Total
	$ '000			%	$ '000			%	$ '000			%
System Access	2,252	2,955	703	3.4%	2,670	3,079	408	1.8%	3,370	3,523	153	0.7%
System Renewal	15,609	18,223	2,614	12.7%	16,963	18,375	1,412	6.2%	15,179	15,895	715	3.4%
System Service	502	685	183	0.9%	441	996	555	2.4%	669	1,228	558	2.6%
General Plant	2,255	2,397	142	0.7%	2,656	2,064	- 593	-2.6%	2,132	2,030	- 102	-0.5%
TOTAL EXPENDITURE	20,618	24,260	3,642	17.7%	22,730	24,514	1,783	7.8%	21,351	22,676	1,325	6.2%

Table 5.4-3 – 5 Year Modified Historic Variance with Respect to Total Planned Expenditure

The 5 year modified historic variance analysis in Table 5.4-3 above demonstrates that 2017 was an exceptional year and that the 5 year modified variance with respect to total expenditures is 7.8% or less when 2017 is excluded from the variance analysis.

System Access

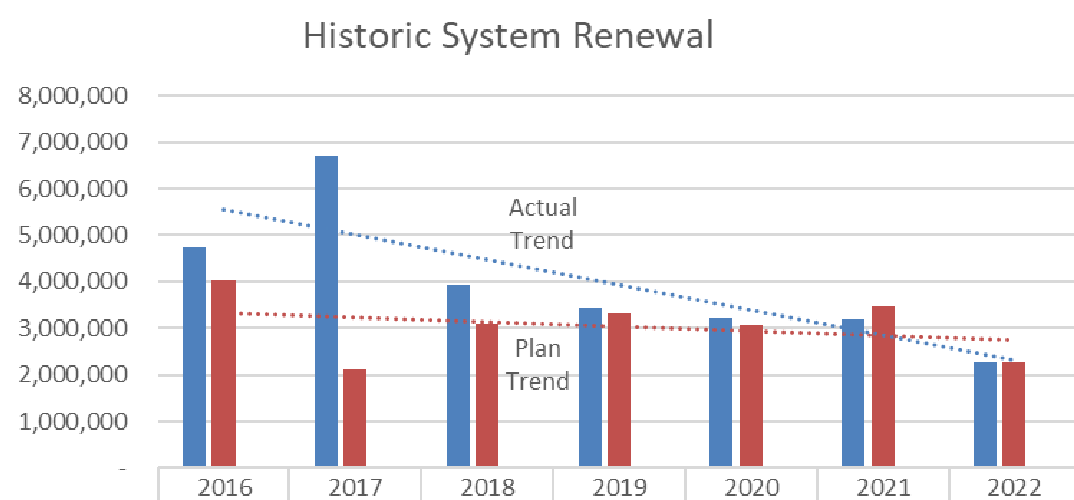


	2016	2017	2018	2019	2020	2021	2022
Actual	750,002	576,338	287,150	589,733	751,492	700,261	1,194,626
Plan	494,799	414,661	582,853	395,143	364,238	833,388	1,194,626
Variance -- -- --	255,203	161,677	-295,703	194,590	387,254	-133,127	-

Figure 5.4-4 – Historic System Access Expenditures

The annual variances for System Access over the 2016 to 2021 timeframe are material and attributed to new development. Expenditures in this category are for investments that a distributor is obligated to perform to provide a customer or a group of customers with access to electricity services via the distribution system and are therefore not within Kingston Hydro's control. Construction schedules for new developments are difficult to predict. Some projects encounter delays and other projects progress more quickly than anticipated.

System Renewal



	2016	2017	2018	2019	2020	2021	2022
Actual	4,738,159	6,726,263	3,931,259	3,437,927	3,222,596	3,192,085	2,257,500
Plan	4,041,174	2,102,786	3,098,166	3,312,285	3,054,210	3,457,000	2,257,500
Variance -- -- --	696,986	4,623,477	833,093	125,642	168,387	-264,915	-

Figure 5.4-5 – Historic System Renewal Expenditures

The annual variances for System Renewal over the 2016 to 2021 historic period are material however, it’s difficult to identify a single cause for the annual variances in the System Renewal category due to the number of projects/programs in this category. With that being said, the Substation MS1 rebuild, and the Annual Deteriorated Pole Replacement programs are the most significant multi-year programs spanning the historic period and account for 61% or approximately $11.7million of the $19.1million total System Renewal plan over the 2016 to 2021 timeframe.

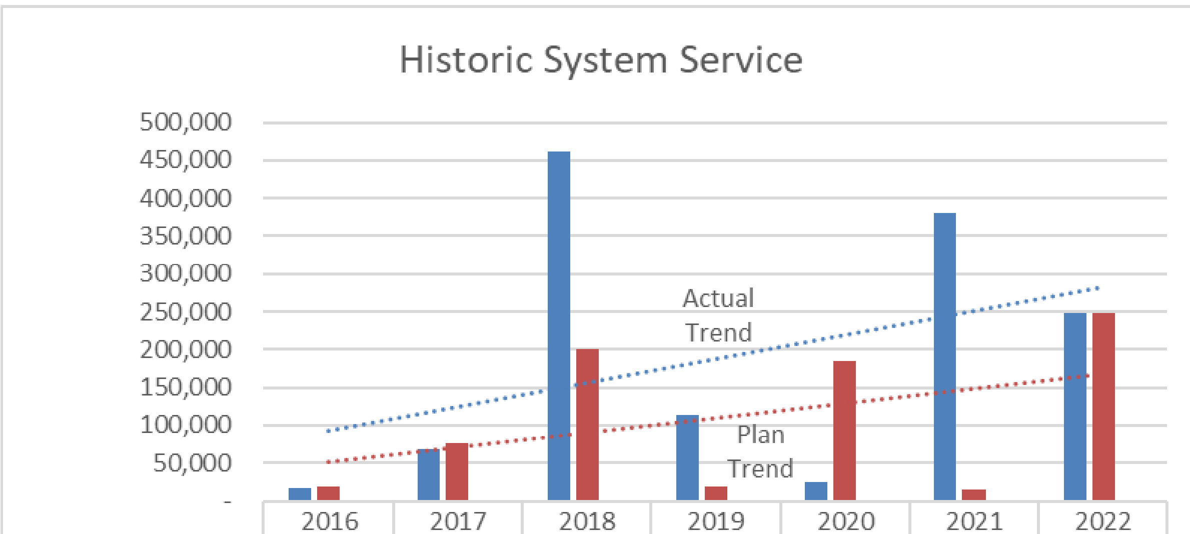
The material increases in 2016 and 2017 are mainly attributed to capital contributions received from third party attachments and the Bell FTTH project.

The material increase in 2018 is mainly attributed to rescheduling of the next phase of the Princess Street reconstruction project with the City of Kingston. The approved 2016-2020 plan originally anticipated this joint reconstruction work would commence in 2016 but the City decided to defer this work to 2018 at the request of local downtown businesses due to concerns about the disruptiveness and economic impact of scheduling the next phase of major reconstruction work so soon after the previous phase of major reconstruction.

The material increase in 2019 and 2020 is partially attributed to the Substation MS1 rebuild program. In 2019 Kingston Hydro decided to fast-track the transformer replacements at Substation MS1 which increased actual expenditures for this program.

The material decrease in 2021 is partially attributed to the Substation MS1 rebuild program. This project was completed in 2021 and actual expenditures were materially less than the planned expenditures for the year.

System Service



	2016	2017	2018	2019	2020	2021	2022
Actual	15,851	69,076	462,186	112,851	25,040	379,947	247,500
Plan	19,031	76,085	200,984	19,757	185,836	15,000	247,500
Variance -- -- --	-3,180	-7,009	261,202	93,094	-160,796	364,947	-

Figure 5.4-6 – Historic System Service

Some of the annual variances for System Service over the 2016 to 2021 historic period are material.

The material increase in 2018 is attributed to a change in the investment category of the Substation MS4 transformer upgrade. The approved 2016-2020 plan classified the Substation MS4 transformer upgrade as System Renewal however Kingston Hydro determined that the actual costs for this project should be assigned to the System

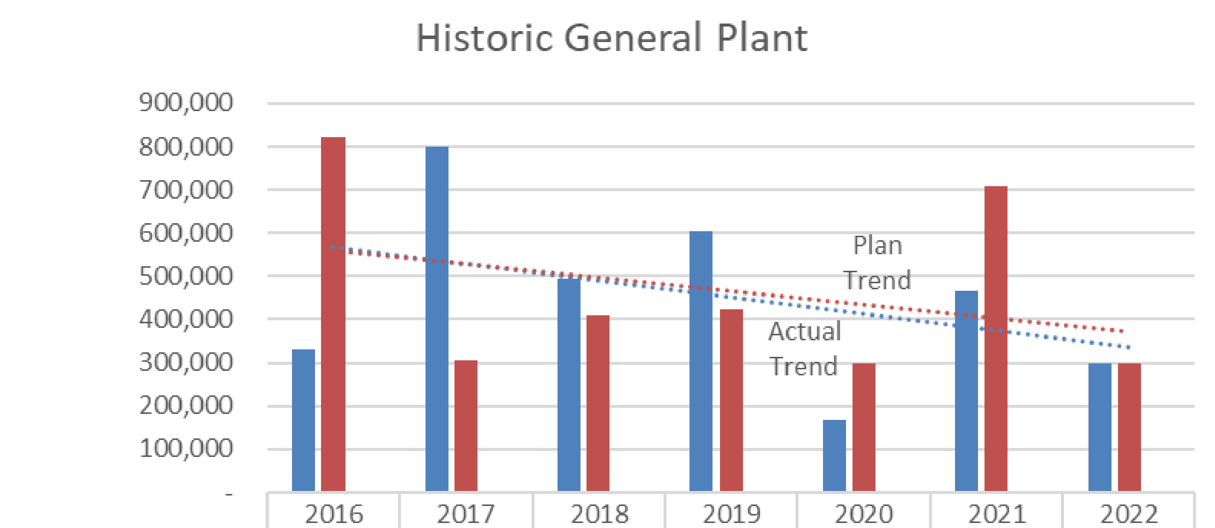
Service category since the primary driver was to increase the transformer capacity serving the existing 5kV bus.

The material increase in 2019 is attributed to fast tracking an additional new 5kV feeder position at Substation MS16 so that the legacy Substation MS17 located nearby could be decommissioned. This work was fast tracked because the Kinectrics Asset Condition Assessment and other subsequent transformer oil analysis results indicated the MS17 transformer had reached end of life and there was an increased risk of failure.

The material decrease in 2020 is attributed to the cancellation of the installation of two new 44kV motorized switches. Kingston Hydro decided to install new manually operated 44kV switches instead which are approximately a third of the cost of 44kV motorized switches and are classified as a System Renewal rather than a System Service expenditure.

The material increase in 2021 is attributed to fast tracking the voltage conversion of a feeder from a 4.16kV operating voltage (5kV voltage class) to a 13.8kV operating voltage (15kV voltage class) to accommodate new development intensification in Williamsville. Substation MS16 is Kingston Hydro’s newest substation and has two 15kV feeders with spare capacity. An existing 5kV overhead circuit was rebuilt in 2021 as part of the voltage conversion plan to establish a new 15kV overhead circuit from MS16 to Williamsville. The scope involved a mix of System Renewal and System Service work, but the main driver was System Service.

General Plant



	2016	2017	2018	2019	2020	2021	2022
Actual	330,531	800,352	494,017	603,848	168,423	466,918	297,000
Plan	821,176	306,240	407,997	421,815	298,266	707,000	297,000
Variance -- -- --	-490,644	494,112	86,020	182,033	-129,844	-240,082	-

Figure 5.4-7 – Historic General Plant Expenditures

The annual variances for General Plant over the 2016 to 2021 historic period are material and attributed to several factors.

The material decrease in 2016 is attributed to delays in vehicle purchases and computer system upgrades.

The material increase in 2017 is mainly attributed to the arrival of a new vehicle in 2017 instead of 2016.

The material increase in 2018 and 2019 is mainly attributed to computer system upgrades.

The material decrease in 2020 and 2021 is mainly attributed to a change in prioritization of vehicle replacement strategy.

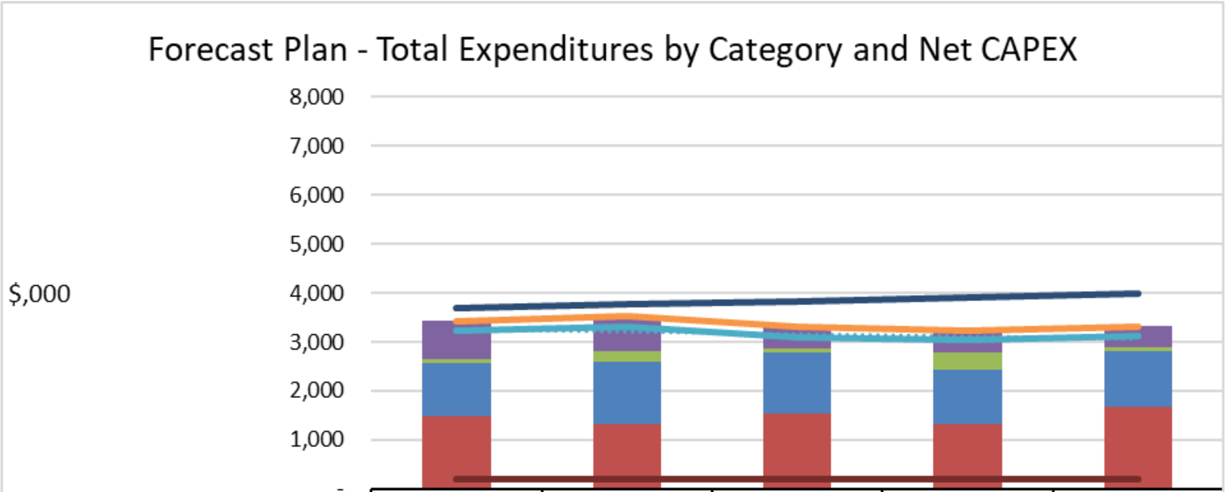
5.4.1.1.2 Analysis of Forecast Capital Expenditures by Investment Category

A snapshot of the OEB Appendix 2-AB EXCEL template summarizing capital expenditures by investment category for the 2023-2027 forecast period is provided in Table 5.4-6.

CATEGORY	Forecast Period (planned)				
	2023	2024	2025	2026	2027
	Test Year	Forecast	Forecast	Forecast	Forecast
	$ '000				
System Access	1,083	1,288	1,253	1,100	1,125
System Renewal	1,490	1,310	1,540	1,325	1,685
System Service	75	200	75	357	80
General Plant	782	717	435	456	434
TOTAL EXPENDITURE	3,430	3,515	3,302	3,238	3,324
Capital Contributions	200	200	200	200	200
Net Capital Expenditures	3,230	3,315	3,102	3,038	3,124
System O&M	3,689	3,762	3,838	3,914	3,993

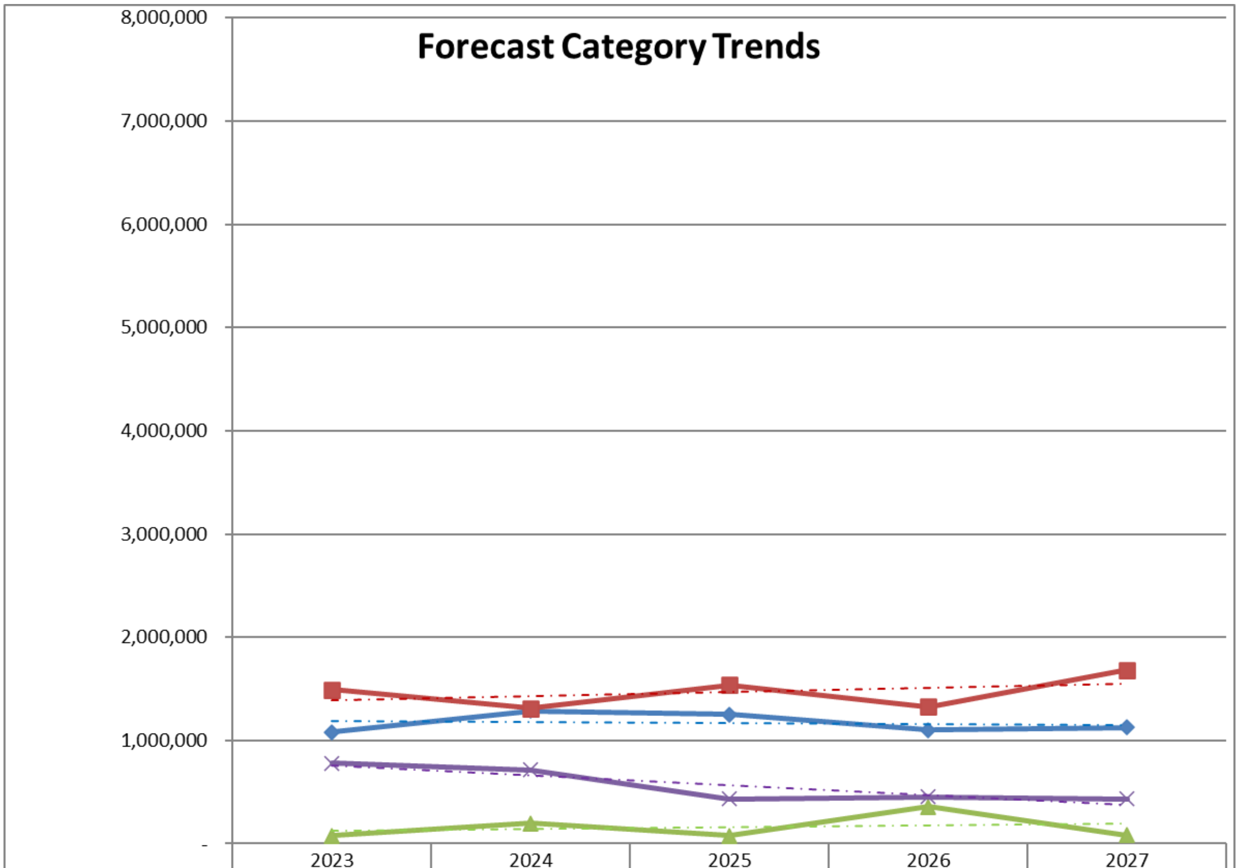
Table 5.4-4 – 2023 to 2027 Forecast Capex Summary (From Appendix 2-AB)

The following charts help to visualize the forecast expenditures.



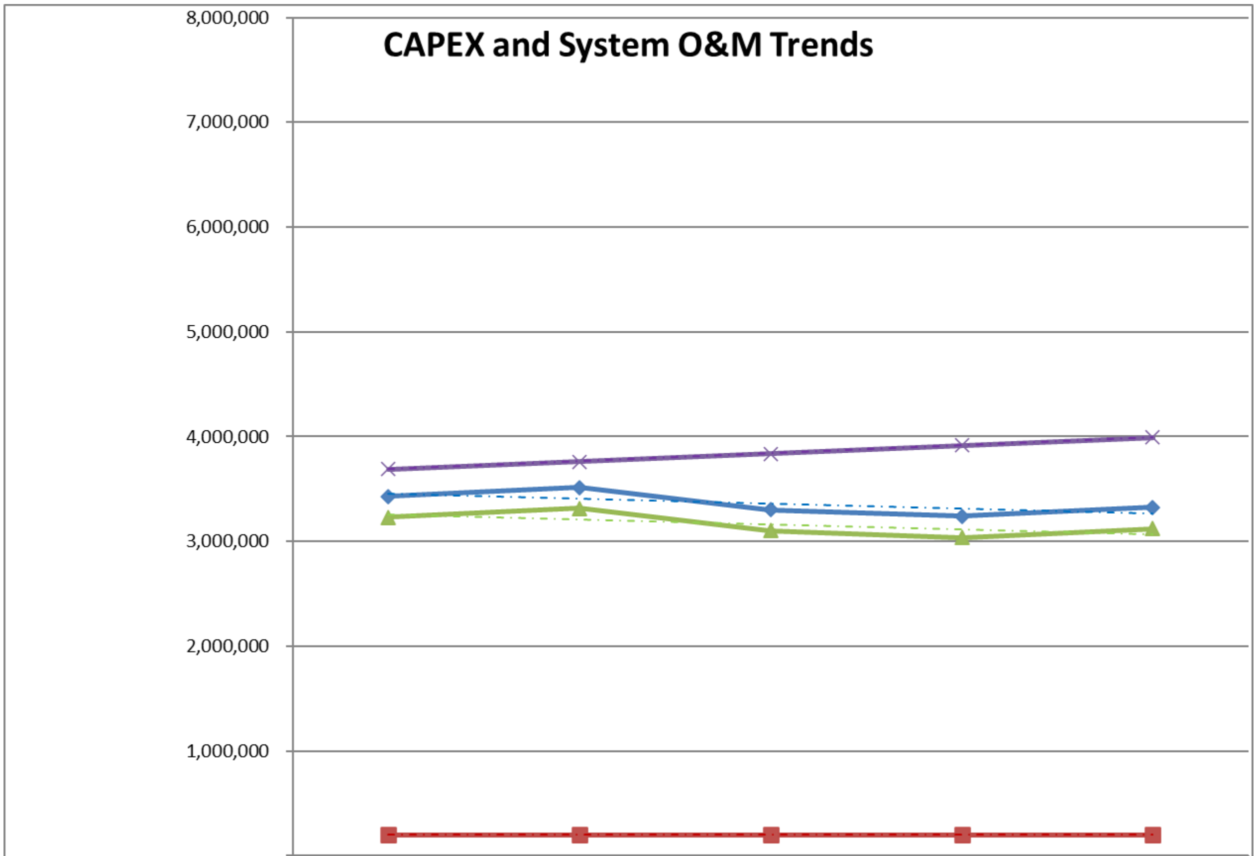
	2023	2024	2025	2026	2027
General Plant - Plan	782	717	435	456	434
System Service - Plan	75	200	75	357	80
System Access - Plan	1,083	1,288	1,253	1,100	1,125
System Renewal - Plan	1,490	1,310	1,540	1,325	1,685
TOTAL EXPENDITURE - Plan	3,430	3,515	3,302	3,238	3,324
Capital Contributions - Plan	200	200	200	200	200
Net CAPEX - Plan	3,230	3,315	3,102	3,038	3,124
System O&M - Plan	3,689	3,762	3,838	3,914	3,993

Figure 5.4-8 – 2023 to 2027 Forecast Capex Summary (from Appendix 2-AB)



	2023	2024	2025	2026	2027
System Access	1,082,500	1,287,500	1,252,500	1,100,000	1,125,000
System Renewal	1,490,000	1,310,000	1,540,000	1,325,000	1,685,000
System Service	75,000	200,000	75,000	357,000	80,000
General Plant	782,000	717,000	434,500	456,000	433,750

Figure 5.4-9 – 2023 to 2027 Forecast Category Trends



	2023	2024	2025	2026	2027
TOTAL EXPENDITURE	3,429,500	3,514,500	3,302,000	3,238,000	3,323,750
Capital Contributions	200,000	200,000	200,000	200,000	200,000
Net Capital Expenditures	3,229,500	3,314,500	3,102,000	3,038,000	3,123,750
System O&M	$3,688,628	$3,762,400	$3,837,648	$3,914,401	$3,992,689

Figure 5.4-10 – 2023 to 2027 CAPEX and System O&M Trends

System Access

System Access expenditures for the 2023-2027 forecast period will be higher than the 2016-2022 historic period due to City of Kingston policies that promote intensification of new development. Kingston Hydro does employ a Capital Cost Recovery (CCR) financial process (economic evaluation) to new development to ensure the appropriate allocation of costs in accordance with the Ontario Energy Board (OEB) Distribution System Code (DSC).

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Other programs that will contribute to the higher System Access expenditures for the 2023-2027 forecast period compared to the 2016-2022 period include regulatory meter replacements/seal updates and regulatory removal of transformers containing PCB's which must be completed by the end of 2025.

System Renewal

System Renewal expenditures for the 2023-2027 forecast period will be significantly lower compared to the 2016-2022 historic period because several of Kingston Hydro's major renewal programs are winding down including the Substation MS1 rebuild, deteriorated pole program and underground vault rebuilds.

System Service

Kingston Hydro has very limited investments planned for the System Service category over the 2023-2027 forecast period. There are annual programs for service upgrades and SCADA equipment and Kingston Hydro plans to upgrade the obsolete electro-mechanical relays and SCADA equipment at Substation MS7, MS9 and MS13 in 2024 and 2026.

General Plant

General Plant investments are forecast to increase in order to maintain secure and reliable customer service. Annual programs include Cybersecurity, Customer Information Systems (CIS) and Non-CIS Systems and vehicles.

5.4.1.1.3 Analysis of Forecast Period Compared to Historical Period

The average forecast expenditures are compared to several different historic references in the following tables.

	Historic Actual 2016-2020		Forecast 2023-2027		Variance Forecast - Historic	
CATEGORY	Average $	% Allocation of Total Expenditure	Average $	% Allocation of Total Expenditure	Variance $ (Forecast - Historic)	Change in % Allocation (Forecast - Historic)
System Access	590,943	10.5%	1,169,500	34.8%	578,557	24.3%
System Renewal	4,411,241	78.5%	1,470,000	43.7%	- 2,941,241	-34.8%
System Service	137,001	2.4%	157,400	4.7%	20,399	2.2%
General Plant	479,434	8.5%	564,650	16.8%	85,216	8.3%
TOTAL EXPENDITURE	5,618,619	100.0%	3,361,550	100.0%	- 2,257,069	0.0%
Capital Contributions	1,210,187	n/a	200,000	n/a	- 1,010,187	n/a
Net Capital Expenditures	4,408,432	n/a	3,161,550	n/a	- 1,246,882	n/a
System O&M	3,231,241	n/a	3,700,000	n/a	468,759	n/a

Table 5.4-5 – Forecast Expenditures Compared to 2016-2020 Historic Actual Expenditures

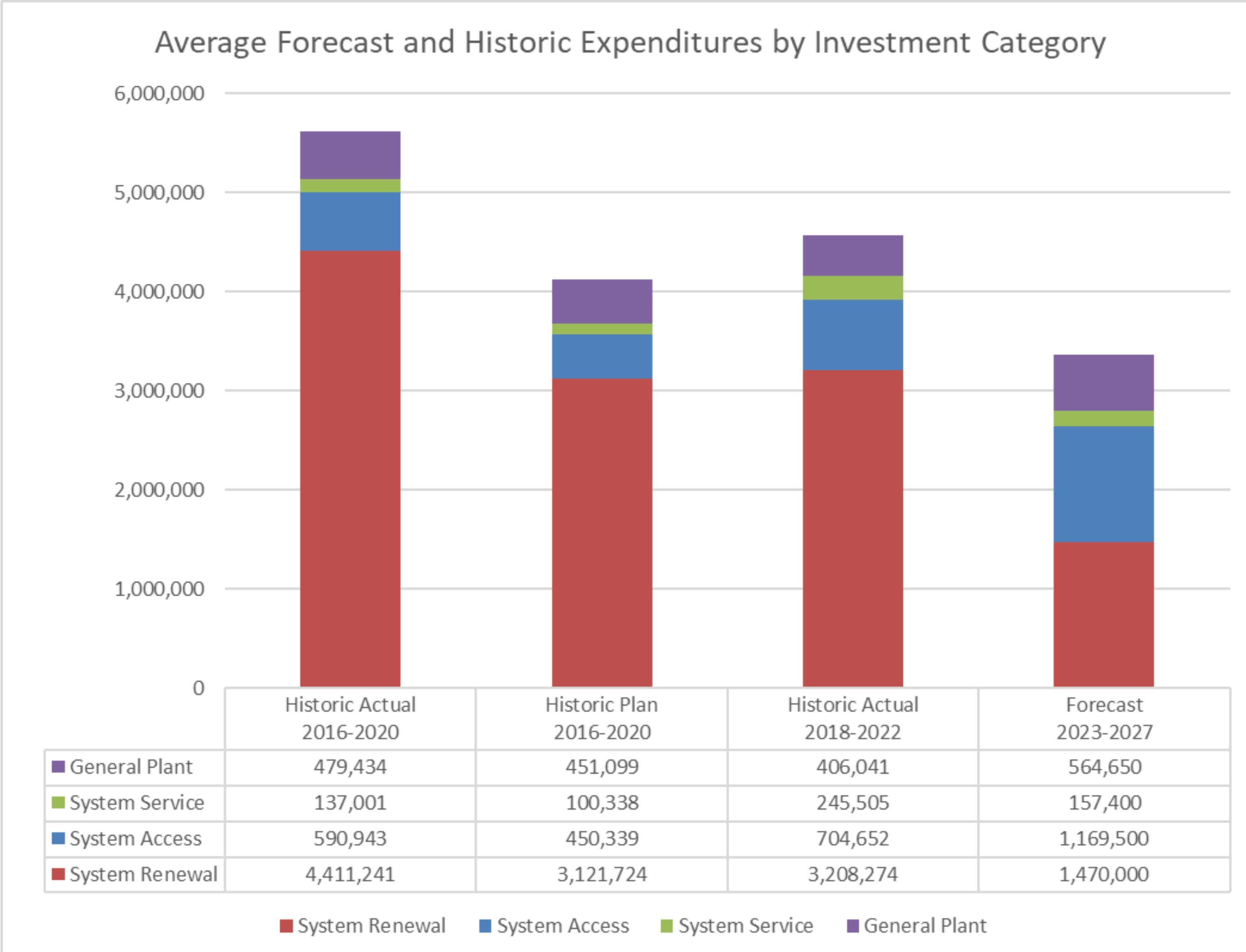
	Historic Actual 2018-2022		Forecast 2023-2027		Variance Forecast - Historic	
CATEGORY	**Average $**	**% Allocation of Total Expenditure**	**Average $**	**% Allocation of Total Expenditure**	**Variance $ (Forecast - Historic)**	**Change in % Allocation (Forecast - Historic)**
System Access	704,652	15.4%	1,169,500	34.8%	464,848	19.4%
System Renewal	3,208,274	70.3%	1,470,000	43.7%	- 1,738,274	-26.6%
System Service	245,505	5.4%	157,400	4.7%	- 88,105	-0.7%
General Plant	406,041	8.9%	564,650	16.8%	158,609	7.9%
TOTAL EXPENDITURE	4,564,472	100.0%	3,361,550	100.0%	- 1,202,922	0.0%
Capital Contributions	206,475	n/a	200,000	n/a	- 6,475	n/a
Net Capital Expenditures	4,357,996	n/a	3,161,550	n/a	- 1,196,446	n/a
System O&M	3,008,303	n/a	3,700,000	n/a	691,697	n/a

Table 5.4-6 – Forecast Expenditures Compared to 2018-2022 Historic Actual Expenditures

CATEGORY	Historic Plan 2016-2020 Average $	Historic Plan 2016-2020 % Allocation of Total Expenditure	Forecast 2023-2027 Average $	Forecast 2023-2027 % Allocation of Total Expenditure	Variance Forecast - Historic: Variance $ (Forecast - Historic)	Variance Forecast - Historic: Change in % Allocation (Forecast - Historic)
System Access	450,339	10.9%	1,169,500	34.8%	719,161	23.9%
System Renewal	3,121,724	75.7%	1,470,000	43.7%	- 1,651,724	-32.0%
System Service	100,338	2.4%	157,400	4.7%	57,062	2.2%
General Plant	451,099	10.9%	564,650	16.8%	113,551	5.9%
TOTAL EXPENDITURE	4,123,500	100.0%	3,361,550	100.0%	- 761,950	0.0%
Capital Contributions	-	n/a	200,000	n/a	200,000	n/a
Net Capital Expenditures	4,123,500	n/a	3,161,550	n/a	- 961,950	n/a
System O&M	3,027,814	n/a	3,700,000	n/a	672,186	n/a

Table 5.4-7 – Forecast Expenditures Compared to 2016-2020 Historic Plan Expenditures

The following charts summarize the average forecast and historic expenditures and allocations.



	Historic Actual 2016-2020	Historic Plan 2016-2020	Historic Actual 2018-2022	Forecast 2023-2027
General Plant	479,434	451,099	406,041	564,650
System Service	137,001	100,338	245,505	157,400
System Access	590,943	450,339	704,652	1,169,500
System Renewal	4,411,241	3,121,724	3,208,274	1,470,000

Figure 5.4-11 – Average Forecast and Historic Expenditures by Investment Category

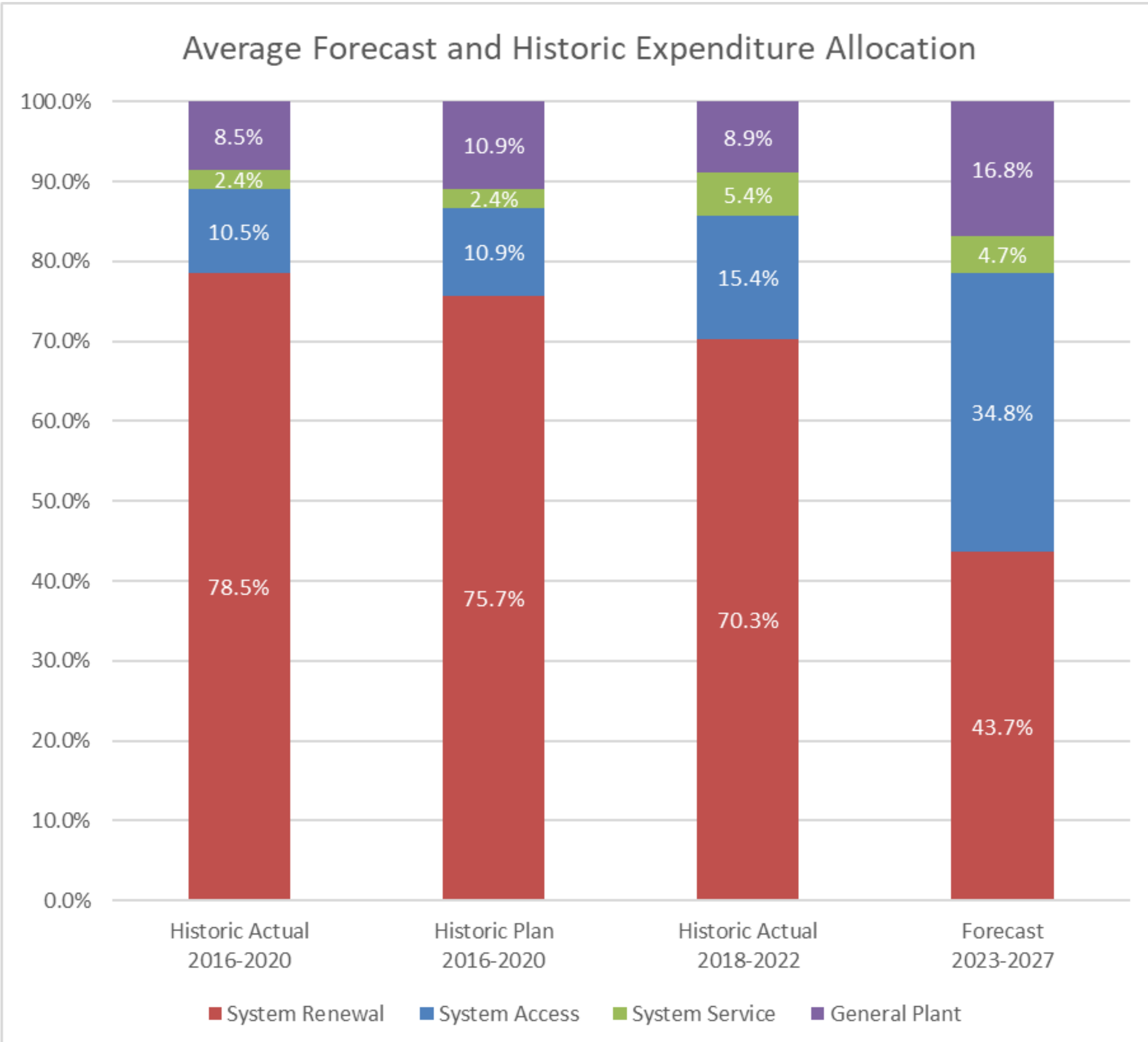


Figure 5.4-12 – Comparison of Forecast and Historic Expenditure Allocation

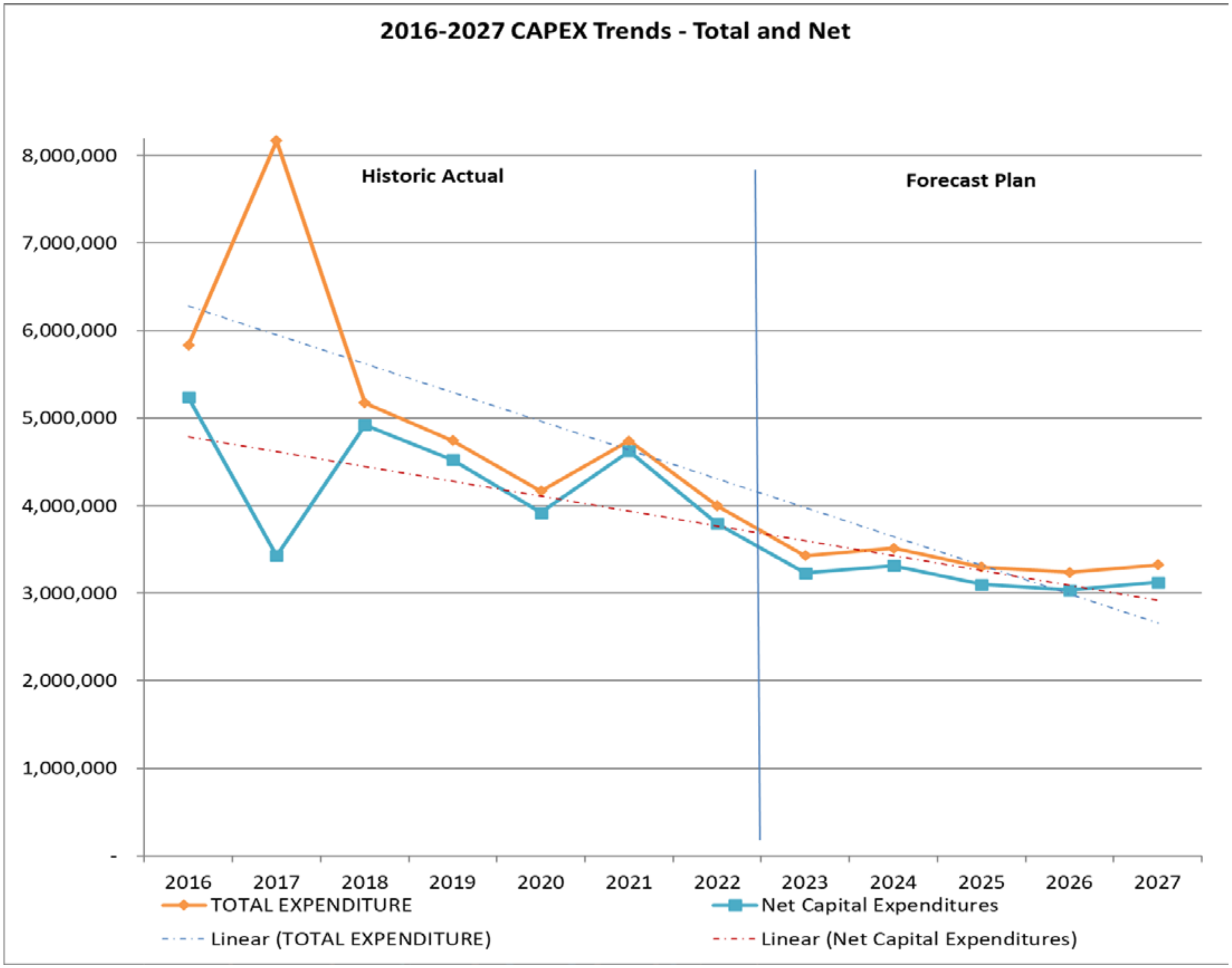
The following is a summary of the changes in the average annual expenditure allocation:

- System Renewal is forecast to decline from a historic high of 78.5% to 43.7%
- System Access is forecast to increase from a historic low of 10.5% to 34.8%.
- System Service is forecast to increase from a historic low of 2.4% to 4.7%
- General Plant is forecast to increase from 8.5% to 16.8%

It's important to note that the change in the average annual expenditure allocation will be tempered by the reduction in the average total expenditure for the forecast timeframe which ranges from $800K to $2.3million depending upon the historical expenditure reference used.

The shift in expenditure allocation from System Renewal to System Access and System Service is warranted because the City of Kingston planning policies are promoting intensification of development in the downtown core and Kingston Hydro has made significant System Renewal investments over the past 10-15 years.

The following charts show the overall trend in spending for the complete 2016-2027 timeframe of the DSP.



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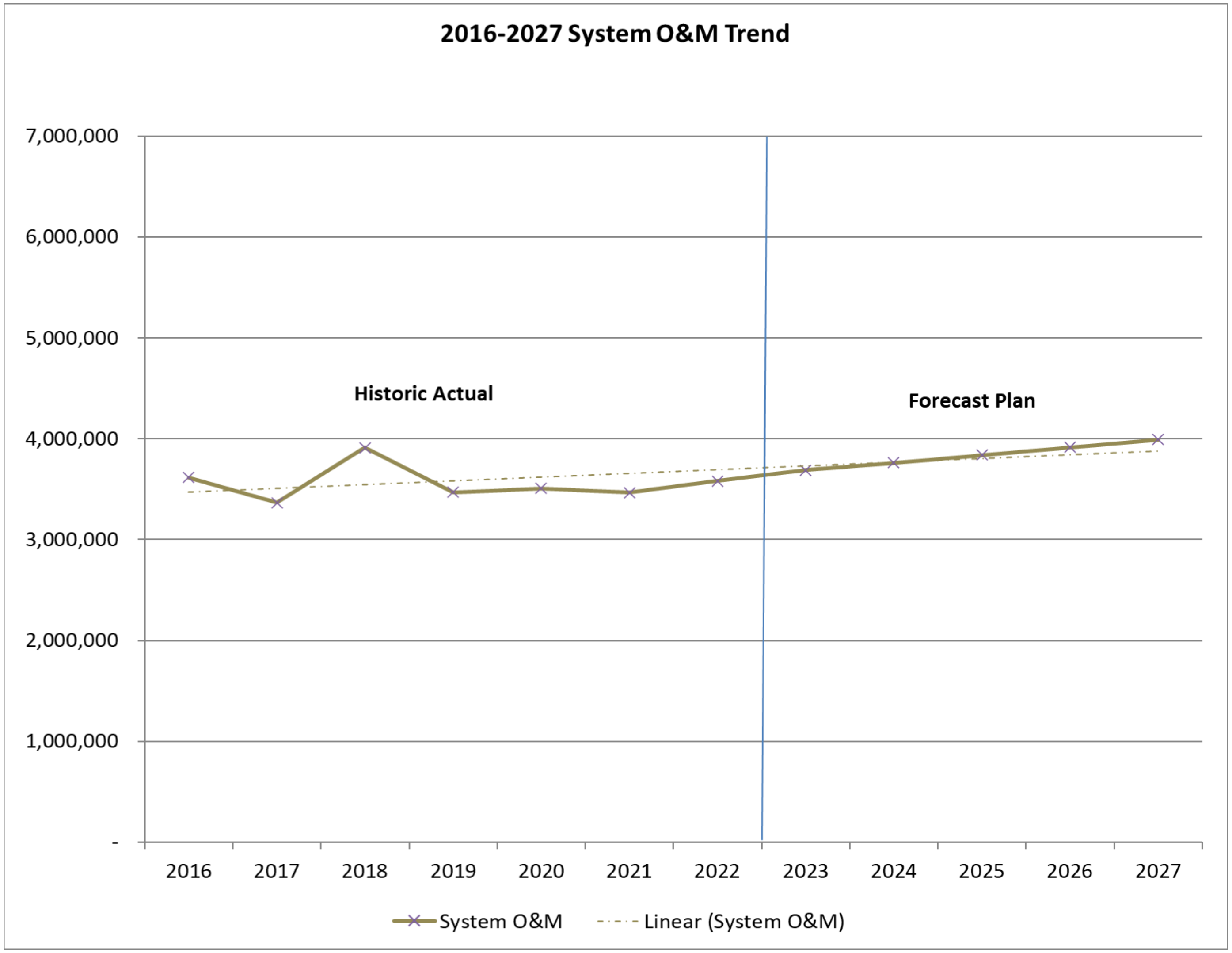
2 **Figure 5.4-13 – 2016 to 2027 CAPEX Trends – Total and Net**

1 

2 **Figure 5.4-14 – 2016 to 2027 System O&M Trend**

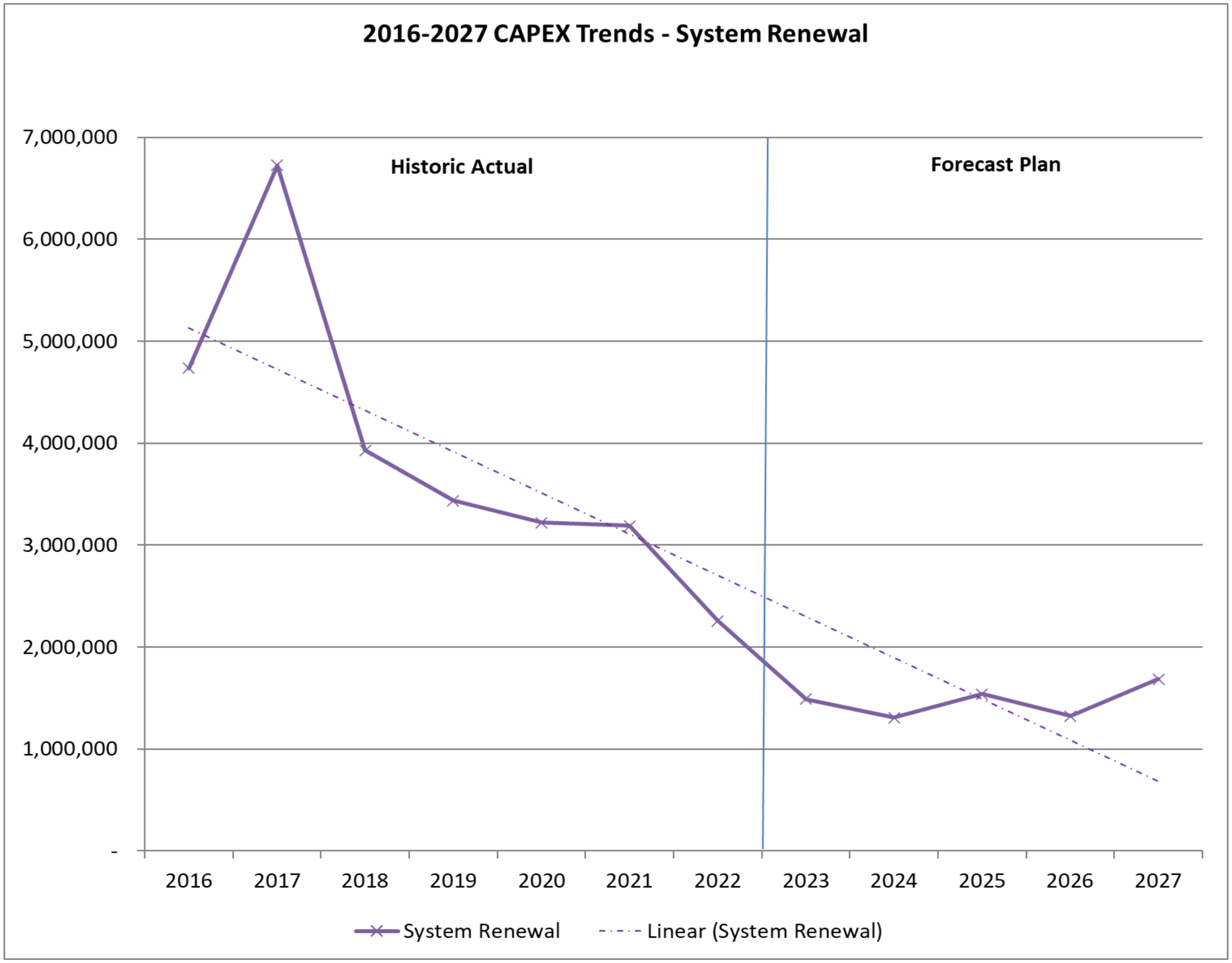
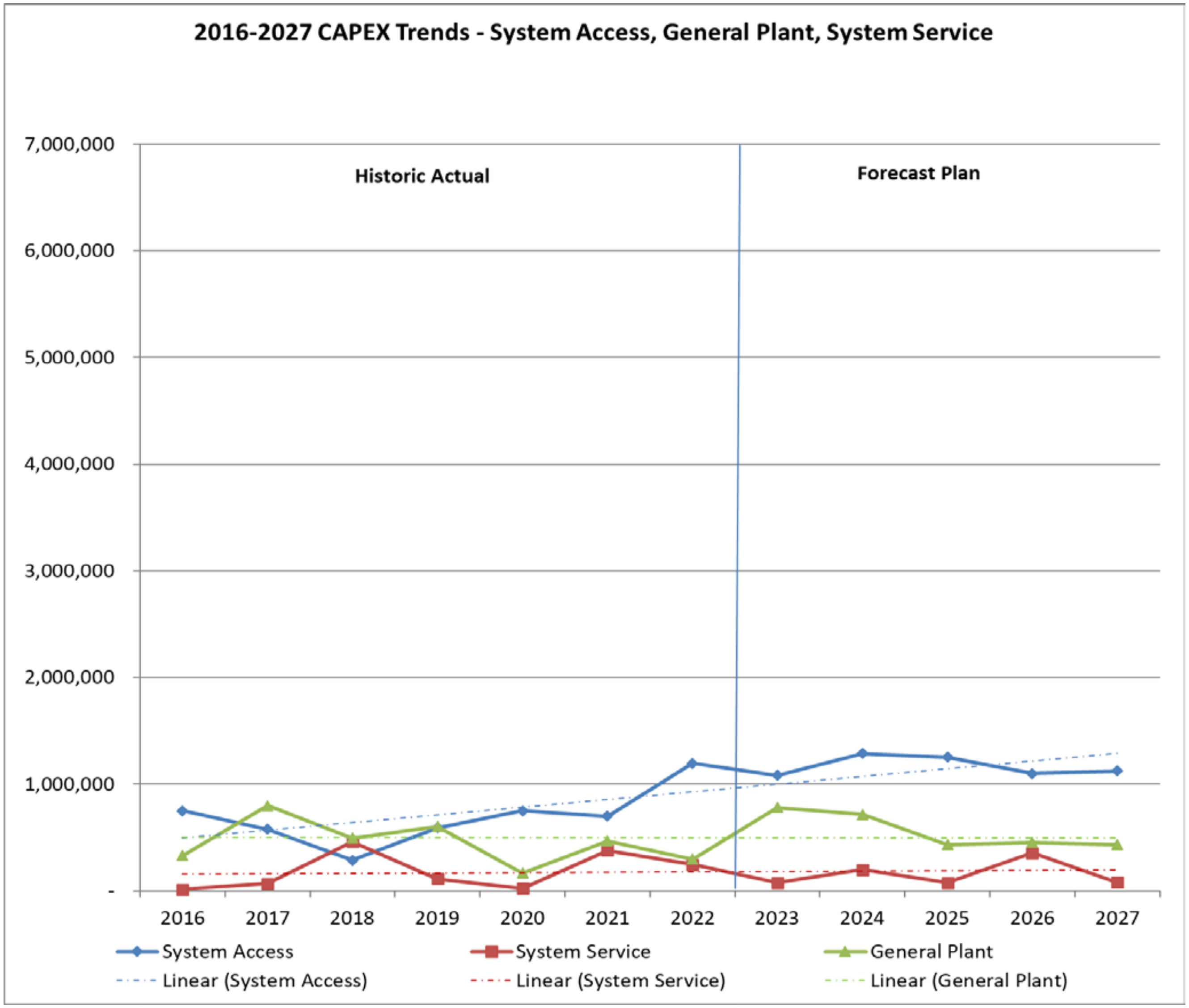


Figure 5.4-15 – 2016 to 2027 CAPEX Trends – System Renewal

1


2 **Figure 5.4-16 – 2016 to 2027 CAPEX Trends – System Access, General Plant, System Service**

5.4.1.2 Summary of Material Capital Projects

A snapshot of the OEB Appendix 2-AA Capital Projects Table for 2016-2022 historic period and the 2023 Test Year is provided in Figure 5.4-17 and Figure 5.4-18.

Projects	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022 Bridge Year**	**2023 Test Year**
Reporting Basis	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**
System Access								
Regulatory Meter Replacements/Seal Updates	240,850	327,265	223,061	307,811	361,140	162,042	414,126	375,000
New Development	-	-	-	-	-	-	300,000	300,000
New Transformers/Connections funded by Capital Contributions	-	-	-	-	-	-	150,000	150,000
13.8kV voltage conversion	-	-	-	-	-	-	-	120,000
Removal of Transformers containing PCBs	-	-	-	-	-	-	87,500	87,500
New 13.8kV Feeder From MS16 across CN on Rigney St to JCB	-	-	-	-	-	-	115,000	-
Williamsville new development 575 Princess St	-	-	-	-	-	-	78,000	-
UK-KHC-Binnington Crt-Cable Upgrade-SK4 to LBC106	-	-	-	-	-	86,276	-	-
UK-KHC-Victoria Street-OH to UG Reconfig	-	-	-	-	100,270	65,029	-	-
UK-KHC-Frontenac St-Pole Line Rebuild	-	-	-	-	142,358	56,842	-	-
Services-Overhead & Undergrnd	96,758	113,000	105,567	77,671	49,418	42,705	-	-
Elect Cap-40 Cliff Cres	74,809	-	-	-	87,205	15,356	-	-
UK-KHC-RNI Upgrades	-	-	-	196,355	-	-	-	-
ECap-Rigney St Pole Line	168,210	-	-	-	-	-	-	-
University Ave Rebuild	112,926	-	-	-	-	-	-	-
Sub-Total	693,553	440,265	328,628	581,837	740,391	428,250	1,144,626	1,032,500

Figure 5.4-17 – Appendix 2-AA Capital Projects Table for 2016-2023 – System Access

Projects	2016	2017	2018	2019	2020	2021	2022 Bridge Year	2023 Test Year
Reporting Basis	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**
System Service								
Frontenac TS-MS1 Pilot Wire Upgrades (1M43 & 1M56 Protection)	-	-	-	-	-	-	140,000	-
UK-KHC-Leroy Grant Dr. - Pole Line Rebuild-Design&Inspect	-	-	-	-	-	201,349	-	-
UK-KHC-Leroy Grant Dr. - JCB to MS13-Design&Inspect	-	-	-	-	-	147,524	-	-
UK-KHC-MS16-New Feeder-Substation Work	-	-	-	82,669	-	-	-	-
UK-KHC-MS4 Transformer Upgrade-Design Inspection	-	-	403,845	-	-	-	-	-
Sub-Total	0	0	403,845	82,669	0	348,873	140,000	0

Figure 5.4-18 – Appendix 2-AA Capital Projects Table for 2016-2023 – System Service

Projects	2016	2017	2018	2019	2020	2021	2022 Bridge Year	2023 Test Year
Reporting Basis	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**
General Plant								
UK-KHC-Vehicles & Vehicle Modifications	86,243	440,994	168,349	236,624	-	206,623	-	450,000
Non CIS systems (TTS, HRMS, etc.)	-	-	-	-	-	-	140,000	129,000
CIS/Work Management/Customer Engagement	-	-	-	-	-	-	46,000	92,000
UK-KHC-IS&T Expenditures from City	-	-	-	85,601	66,163	109,260	-	-
UK-KHC-CRM-Computer Software	-	38,993	86,543	21,801	56,732	36,044	-	-
Tools & Equipment	223,147	21,062	84,314	32,207	26,219	31,311	-	-
FMS	75,770	-49,922	18,163	17,048	801	13,134	-	-
Substation structures	-	-	18,889	143,834	8,649	-	-	-
UK-KHC-Outage Management System-Computer Software	-	-	75,332	14,935	-	-	-	-
Sub-Total	385,160	451,127	451,590	552,050	158,564	396,372	186,000	671,000

Figure 5.4-19 – Appendix 2-AA Capital Projects Table for 2016-2023 – General Plant

Projects	2016	2017	2018	2019	2020	2021	2022 Bridge Year	2023 Test Year
Reporting Basis	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**
System Renewal								
Queen St - King St to Wellington St - Replace 5kV Ducts&Cables	-	-	-	-	-	-	-	540,000
Princess st Reconstruction – Division to Alfred	-	-	-	-	-	-	-	350,000
Annual Deteriorated Pole Replacement - spot replacements	1,108,368	568,031	344,179	243,443	252,540	143,871	180,000	180,000
Bagot St - Upgrade 5kV distribution from MS8 to Russell St	-	-	-	-	-	-	-	150,000
44KV & 5KV pole replacement SJA from Union St towards Johnson	-	-	-	-	-	-	-	100,000
MS5 Rebuild - Install New Transformer, control hut	-	-	-	-	-	-	560,000	-
MS6 Structural Rehabilitation and Roof Membrane	-	-	-	-	-	-	350,000	-
TV18 - Transformer Vault Upgrade	-	-	-	-	-	-	275,000	-
TV4 - Transformer Vault Upgrade	-	-	-	-	-	-	215,000	-
MS9 900 CCT - Overhead Rebuild of Barrie St -from King St to north of Cou	-	-	-	-	-	-	130,000	-
UK-KHC-Pole Replacement-CFB Kingston Hwy2-Design & Recon	-	-	-	664	17,082	128,778	115,000	-
MS2 Roof Replacement	-	-	-	-	-	-	80,000	-
Ruskin St - 1303 CCT 3-ph backyard pole line reconstruction, Possibly rel	-	-	-	-	-	-	75,000	-
Substn MS1 Rebuild-Stage 3	171,973	266,911	331,911	958,515	1,627,801	1,263,386	-	-
UK-KHC-King St. W 608-609 Cable Replacement-Design&Recon	-	-	-	-	-	408,654	-	-
UK-KHC-TV3 Rebuild	-	-	-	-	609	231,065	-	-
UK-KHC-MS2-203 CCT-PILC Cable Replacement-Design&Recon	-	-	-	-	-	164,720	-	-
Transformer Installations	56,671	154,526	103,346	196,543	142,819	145,681	-	-
UK-KHC-EM36 Rebuild - King St W at Beverley St-Design&Inspec	-	-	-	-	-	140,520	-	-
UK-KHC-Pole Replacement-Railway St-Design&Inspect	-	-	-	-	-	133,209	-	-
UK-KHC-Weller Ave-Pole Replacement-Montreal to Baker-P&F	-	-	-	-	-	82,735	-	-
UK-KHC-Pole Line-MacDonnell-207 CCT	-	-	-	-	212,890	76,936	-	-
UK-KHC-Pole Replacement-Bath Rd Gren to Arm	-	-	-	-	147,340	71,929	-	-
UK-KHC-Johnson Backyard Poles-Design	-	-	-	1,151	88,378	20,783	-	-
UK-KHC-Pole Replacement MS16 & 17-Dalton Ave	-	-	-	-	190,064	1,843	-	-
UK-KHC-MS#4 5KV Switchgear Replacement Design-Design	-	-	12,457	859,780	106,349	-	-	-
UK-KHC-Pole Replacement-Patrick & Railway-Design & Recon	-	-	1,591	158,677	6,329	-	-	-

Figure 5.4-20 – Appendix 2-AA Capital Projects Table for 2016-2023 – System Renewal

Projects	2016	2017	2018	2019	2020	2021	2022 Bridge Year	2023 Test Year
Reporting Basis	MIFRS	MIFRS	MIFRS	MIFRS	MIFRS	MIFRS	MIFRS	MIFRS
System Renewal								
UK-KHC-Pole Replacement-Russel & Patrick-Design & Insp	-	-	35,040	130,078	1,873	-	-	-
UK-KHC-Pole Replacement-Victoria, Mack to Princess-Design	-	-	1,360	169,412	-	-	-	-
UK-KHC-Pole Replacement-Francis & Churchill	-	-	29,381	142,597	-	-	-	-
UK-KHC-TV85(TV38 Replacement)-Dsg/Insp/Adv	-	-	315,490	134,095	-	-	-	-
Princess St Recon Phase 3	1,902,032	-	-	37,296	-	-	-	-
UK-KHC-Barriefield,Regent & Drummond-Tx	-	225,913	19,289	22,327	-	-	-	-
UK-KHC-Princess St Reconstruction Phase 4-Design & Recon	-	68,077	1,208,066	-	-	-	-	-
UK-KHC-Bagot & Cataraqui Pole Line- OHD Line	-	14,273	337,760	-	-	-	-	-
UK-KHC-Pole Replacement - McMichael St	-	163	197,761	-	-	-	-	-
UK-KHC-Pole Replacement-Victoria-Johnson to Union-Design&Ins	-	-	111,858	-	-	-	-	-
UK-KHC-MS#12-Design Inspection	-	4,953	78,886	-	-	-	-	-
UK-KHC-TV29 Oil Switch & 2ndry Breaker	-	210,902	58,011	-	-	-	-	-
CAP-Division-Hamilton-Colborne	67,392	154,618	26,776	-	-	-	-	-
ECAP-Division-York-Chatham	42,404	270,938	19,700	-	-	-	-	-
ECAP-Division-Adelaide-Stanley	62,904	347,841	12,365	-	-	-	-	-
Duct Work Princess - Mac & Vic	426,827	202,038	1,113	-	-	-	-	-
UK-KHC-Durham St Pole Line- OHD Line	-	126,490	94	-	-	-	-	-
Pole line-Wellington, Barrack	67,331	117,505	-	-	-	-	-	-
Pole Line-Hickson Ave	132,269	108,520	-	-	-	-	-	-
Drayton Ave Pole Line Reconst	18,593	88,867	-	-	-	-	-	-
Grosvenor Court-Pole Replace	41,741	71,385	-	-	-	-	-	-
Assoro Cr and Sicily Drive	135,498	-	-	-	-	-	-	-
Portsmouth Ave-Howard to Valle	117,561	-	-	-	-	-	-	-
Roof Replacem SubStation MS#1	115,930	-	-	-	-	-	-	-
TV37-Princess at Drayton	100,837	-	-	-	-	-	-	-
Transformers - unallocated	160,397	-76,320	110,899	93,515	-16,576	-71,961	-	-
Robert Wallace Mackenzie Campb	73,290	-	-	-	-	-	-	-
Sub-Total	4,802,018	2,925,631	3,357,333	3,148,093	2,777,498	2,942,149	1,980,000	1,320,000

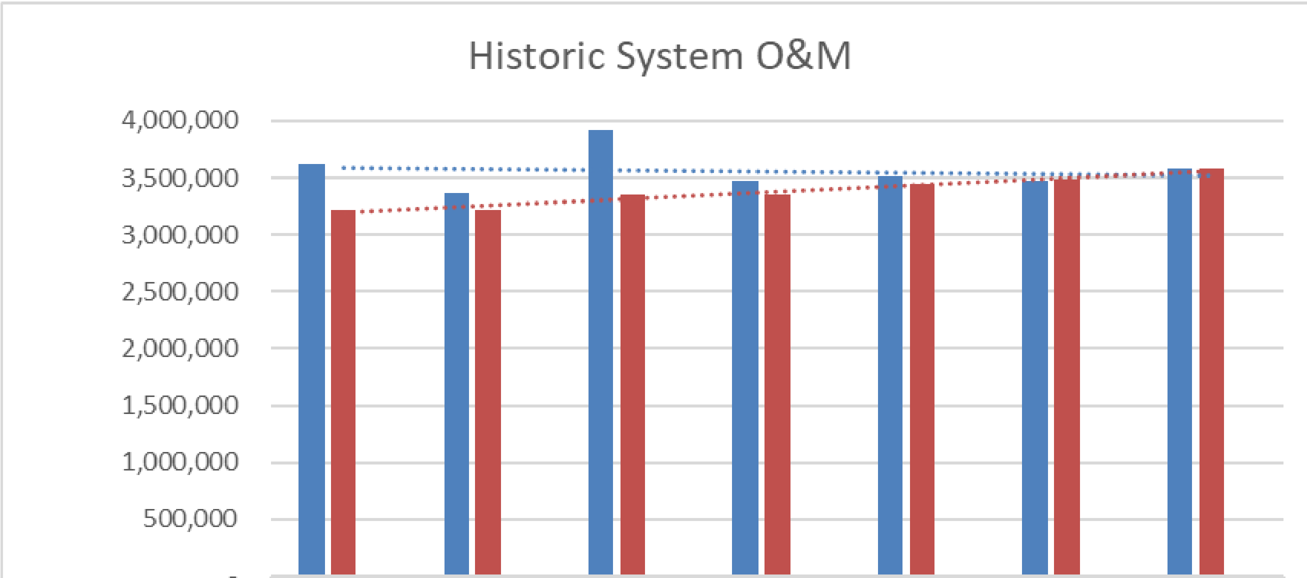
Figure 5.4-21 – Appendix 2-AA Capital Projects Table for 2016-2023 – System Renewal (continued)

Projects	2016	2017	2018	2019	2020	2021	2022 Bridge Year	2023 Test Year
Reporting Basis	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**	**MIFRS**
Miscellaneous	188,410	366,410	533,226	461,210	385,075	544,202	546,000	406,000
Total	**6,069,141**	**4,183,433**	**5,074,622**	**4,825,859**	**4,061,528**	**4,659,846**	**3,996,626**	**3,429,500**
Less Renewable Generation Facility Assets and Other Non-Rate-Regulated Utility Assets ***(input as negative)***	0	0	0	0	0	0	0	0
Total	**6,069,141**	**4,183,433**	**5,074,622**	**4,825,859**	**4,061,528**	**4,659,846**	**3,996,626**	**3,429,500**

Figure 5.4-22 – Appendix 2-AA Capital Projects Table for 2016-2023 – Miscellaneous and Total

5.4.1.3 System O&M

The System O&M expenditures for the 2016-2022 Historic period are summarized in Table 5.4-21 and the System O&M for the 2023-2027 Forecast period is summarized in tables and figures in Section 5.4.1.1.2.



	2016	2017	2018	2019	2020	2021	2022
Actual	3,614,993	3,364,657	3,912,288	3,468,930	3,508,108	3,466,607	3,580,015
Plan	3,215,361	3,212,047	3,357,255	3,352,706	3,448,986	3,483,929	3,580,015
Variance -- -- --	399,631	152,610	555,033	116,224	59,122	-17,322	-

Figure 5.4-23 – Historic System O&M

The Actual System O&M costs for the 2016-2022 historic period fluctuated from year to year but the overall average annual spending trend from 2016 to 2022 decreased at a rate of 0.2% per year.

The Plan System O&M costs for the forecast period are expected to increase at a rate of 2% per year primarily due to inflationary pressures.

Kingston Hydro will manage the overall O&M spending for the forecast period of this DSP. Year to year fluctuations up and down are to be expected due to many factors including inflationary increases in labour equipment and materials.

Kingston Hydro's capital investment plans in this DSP are not expected to have a substantial impact on O&M costs over the forecast period.

5.4.1.4 Non-Distribution Activities

There are no expenditures for non-distribution activities in Kingston Hydro's budget.

5.4.2. Justifying Capital Expenditures

The purpose of this section is to further demonstrate how Kingston Hydro's DSP delivers value to customers, including the control of costs in relation to its proposed investments through appropriate optimization, prioritization and pacing of capital-related expenditures while keeping pace with technological changes and integrating cost-effective innovative investments and traditional planning needs such as load growth, asset condition and reliability.

The following table summarizes the prioritization (rank) of material capital expenditure projects/programs proposed for the 2023 Test Year.

Rank	Parent Program	Program Name	Brief Project Description	OEB Driver	2023 Expenditure
1	**100449**	**Meters**	Regulatory Meter Replacements/Seal Updates	System Access	375,000
1	**100441**	**City Road Reconstruction**	Princess st Reconstruction – Division to Alfred	System Renewal	350,000
1	**100440**	**New Development**	New Development	System Access	300,000
			13.8kV voltage conversion	System Access	120,000
2	**100434**	**Transformers**	New Transformers/Connections funded by Capital Contributions	System Access	150,000
			Removal of Transformers containing PCBs	System Access	87,500
3	**100437**	**Cable Upgrades**	Queen St - King St to Wellington St - Replace 5kV Ducts&Cables	System Renewal	540,000
3	**100439**	**Annual Deteriorated Poles**	Annual Deteriorated Pole - spot replacements	System Renewal	180,000
			Bagot St - Upgrade 5kV distribution	System Renewal	150,000
			Pole replacement SJA from Union St to Johnson	System Renewal	100,000
5	**100450**	**Computer HW/SW**	Non CIS systems (TTS, HRMS, etc.)	General Plant	129,000
			CIS/Work Management/Customer Engagement	General Plant	92,000
7	**100454**	**Vehicles**	Vehicles	General Plant	450,000
					3,023,500

Table 5.4-8 Prioritization of 2023 Material Capital Projects/Programs

Table 5.4-9 and Table 5.4-10 shows the annual change in investment categories from the 2022 Bridge Year to the end of the 2023-2027 Forecast period.

CATEGORY	Annual Change in Forecast Expenditures					Net Change from Bridge Year	Net Avg Change/Year from Bridge Year
	2022 to 2023	2023 to 2024	2024 to 2025	2025 to 2026	2026 to 2027	2022 to 2027	2022 to 2027
	$ '000						
System Access	-112.13	205.00	-35.00	-152.50	25.00	**-69.63**	**-13.93**
System Renewal	-767.50	-180.00	230.00	-215.00	360.00	**-572.50**	**-114.50**
System Service	-172.50	125.00	-125.00	282.00	-277.00	**-167.50**	**-33.50**
General Plant	485.00	-65.00	-282.50	21.50	-22.25	**136.75**	**27.35**
OTAL EXPENDITURE	-567.13	85.00	-212.50	-64.00	85.75	**-672.88**	**-134.58**
Capital Contributions	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**
Net Capital Expenditures	-567.13	85.00	-212.50	-64.00	85.75	**-672.88**	**-134.58**
System O&M	108.61	73.77	75.25	76.75	78.29	**412.67**	**82.53**

Table 5.4-9 – Annual Change in Forecast Expenditures

CATEGORY	% Annual Change in Forecast Expenditures					Net Change from Bridge Year	Net Avg Change/Year from Bridge Year
	2022 to 2023	2023 to 2024	2024 to 2025	2025 to 2026	2026 to 2027	2022 to 2027	2022 to 2027
	%						
System Access	-9.4%	18.9%	-2.7%	-12.2%	2.3%	**-3.1%**	**-0.6%**
System Renewal	-34.0%	-12.1%	17.6%	-14.0%	27.2%	**-15.3%**	**-3.1%**
System Service	-69.7%	166.7%	-62.5%	376.0%	-77.6%	**332.9%**	**66.6%**
General Plant	163.3%	-8.3%	-39.4%	4.9%	-4.9%	**115.7%**	**23.1%**
TOTAL EXPENDITURE	-14.2%	2.5%	-6.0%	-1.9%	2.6%	**-17.0%**	**-3.4%**
Capital Contributions	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**	**0.0%**
Net Capital Expenditures	-14.9%	2.6%	-6.4%	-2.1%	2.8%	**-18.0%**	**-3.6%**
System O&M	3.0%	2.0%	2.0%	2.0%	2.0%	**11.0%**	**2.2%**

Table 5.4-10 – Percentage Annual Change in Forecast Expenditures

Over the 2016 to 2022 historic period, System Renewal expenditures were at an all-time high due to the high priority Substation MS1 rebuild program. Over the same time, non-discretionary System Access expenditures started to increase due to regulatory meter work and new development connections. Also over the same time, Kingston Hydro had some high priority grid modernization investments related to cyber security and SCADA systems.

Over the 2023 to 2027 forecast period, Kingston Hydro anticipates lumpy and material fluctuations in its System Access, System Service and General Plant expenditures and has proposed significant reductions to its System Renewal expenditures to minimize the overall impact on rates.

The following discussion describes how the trends and drivers in the DSP budget allocation to the four OEB investment categories over the 2023-2027 forecast period are expected to achieve customer value over the forecast period.

System Access

The main drivers for System Access category over the six historic years were Metering, Vehicles and Customer Service Requests.

Kingston Hydro anticipates lumpy and material annual System Access expenditures over the 2023-2027 forecast years due to non-discretionary drivers. The key drivers are:

- Mandated Service Obligations – Metering
  A total of $2.7million has been allocated to regulatory mandated meter replacements due to seals that are set to expire over the forecast period.
- New Development and 13.8kV Voltage Conversion
  A total of $1.7million has been allocated for new development as a result of changes to the Kingston Hydro Capital Cost Recovery (CCR) policy which came into effect Jan 1, 2021.
- Another $400,000 has been allocated for pre-design of a new Municipal Transformer Station (MTS). Kingston Hydro is forecasting increased demand due to intensification and electrification and the existing Hydro One transformer stations are reaching capacity.
- There are several projects that support the transition from 4.16kV to 13.8kV distribution voltage. One project involves a 13.8kV voltage conversion at a cost of $240,000. Another involves a new 13.8kV feeder from MS16 at a cost of $115,000 and another involves a pole line rebuild to enable a future 13.8kV supply the Davis Tannery development site at a cost of $135,000. These projects are needed to support new development and future electrification of heating/transportation.

System Renewal

Kingston Hydro's historic expenditures within the System Renewal investment category over the last five years were primarily focused on deteriorated overhead infrastructures, Substation No. 1, and the downtown underground network.

System Renewal investments over the 2023-2027 forecast period are significantly less than System Renewal investments over the 2016-2022 historic period due to the achievement the completion of the multi-year Substation MS1 rebuild project and the significant investments made in deteriorated overhead poles and underground vaults over the past 10 to 15 years.

Kingston Hydro plans to upgrade the following major assets over the 2023-2027 forecast period:

- Deteriorated Overhead Infrastructures

  In accordance with the Asset Condition Assessment report prepared by Kinectrics, Kingston Hydro must replace some overhead infrastructure over the forecast period, so that the overhead infrastructure can be sustained.
- Substation No.5 Rebuild

  Municipal Substation No. 5 (MS5) is located east of the Cataraqui river and supplies a mix of institutional, commercial, and residential customers. MS5 has served Kingston Hydro customers for approximately 50 years since it was acquired from the Department of National Defense in 1972. Today, Kingston Hydro considers Substation No.5 to be one of its highest priorities for capital renewal projects due to the criticality, reliability, condition, and maintainability of the transformers at this facility.

  Kingston Hydro plans to install one new transformer and reuse one transformer from MS4 to provide redundancy and additional capacity to the surrounding area served by MS5.
- Substation No.8 Transformer T2 Replacement

  Transformer T2 at Municipal Substation No. 8 (MS8) replacement was flagged for action in the Kinectrics Asset Condition Assessment.
- Queen Street Cable Replacement

  Portions of the underground infrastructure along Queen Street were rebuilt in the 1950's and 1960's and most of the original clay duct structure from 1910's and 1920's has been abandoned. The duct banks and maintenance holes in this area are deteriorated and have reached end of life. Kingston Hydro is proposing to install new civil duct structures from King to Wellington Street for 5 existing 5kV circuits that egress out of Substation MS1. In order to pace expenditures, Kingston Hydro will only replace cabling for 2 of the 5 existing 5kV circuits.

- Overhead and Underground Transformer Replacement

  Kingston Hydro has budgeted a total of $720,000 over the forecast period to support its “run-to-failure” asset management strategy for overhead and pad mount distribution transformers

- Princess Street Joint Reconstruction – Division to Alfred

  Kingston Hydro is installing new electric duct structure on Princess Street from Division Street to Alfred Street as part of a joint reconstruction project with the City to prepare for new development in the area and save on restoration costs. The installation of new underground distribution cables and equipment has been deferred to allow for pacing of future upgrade costs for this neighbourhood.

- Substation No. 6 – Structural Rehabilitation

  A recent condition assessment of substation structures identified the need to completely rehabilitate the building (roof membrane, steel building frame structure and exterior masonry walls) that house the 5kV switchgear for Substation No. 6 (MS6).

System Service

The major drivers for System Service over the last five years were system operational objectives, specifically, relay and SCADA upgrades. Kingston Hydro replaced obsolete SCADA equipment and electro-mechanical relays at substations with intelligent electronic SCADA and relay devices to improve system reliability and system efficiency.

Over the forecast period, Kingston Hydro will spend $487K to upgrade legacy feeder protection relays and SCADA equipment. This work includes upgrades to legacy 5kV feeder protection and SCADA equipment at three substations (MS7, MS9 and MS13). This work will nearly complete the grid modernization of relay and SCADA equipment at Kingston Hydro’s sixteen substations which has been paced over many years.

Kingston Hydro has budgeted $360K over the forecast period to support its "run-to-failure" asset management strategy for overhead and pad mount distribution transformers

General Plant

Key investments within the General Plant investment category were fleet vehicles over the historic period.

Kingston Hydro projects that fleet vehicle renewal will still be a main driver for the 2023-2027 forecast period as three heavy-duty service trucks which are vital to Kingston Hydro's day-to-day field work have surpassed their normal useful life and need to be replaced over the forecast period at a total cost of $915K.

Kingston Hydro also has planned upgrades to finance/administration/billing software totaling $1.1million, Cybersecurity activities totaling $414K and Tools/Equipment totaling $300K.

5.4.2.1 Material Investments

The purpose of this section is to provide detailed supporting evidence for historic and forecast projects/programs that meet the materiality threshold set out in Chapter 2 of the Filing Requirements for Electricity Distribution Rate Applications and/or are distinct (e.g. unique characteristics; marked divergence from previous trend, etc.) which is $70,000 for Kingston Hydro (0.5% of $14million distribution revenue requirement).

Material projects/programs for the 2023 Test Year are listed in the tables of Section 5.4.1.2 by their OEB investment category and the supporting descriptions for these material forecast projects/programs are located in Appendix F of the DSP.

Appendix A

Summary of System Capability Assessment for REG

Appendix A – System Capability Assessment for REG

A1.1 Historic Applications From Renewable Generators

Kingston Hydro has a total of 183 existing embedded generator connections with a total nameplate capacity of 17,245kW. Renewable Energy Generation (REG) represents 99.5% (182 of 183) of the total number of existing generator connections but only 13% (2,237kW) of the total generator nameplate capacity. The remaining 87% of the connected nameplate capacity is attributed to one large 15,000 kW natural gas (Non-REG) Combined Heat and Power (CHP) co-generation plant.

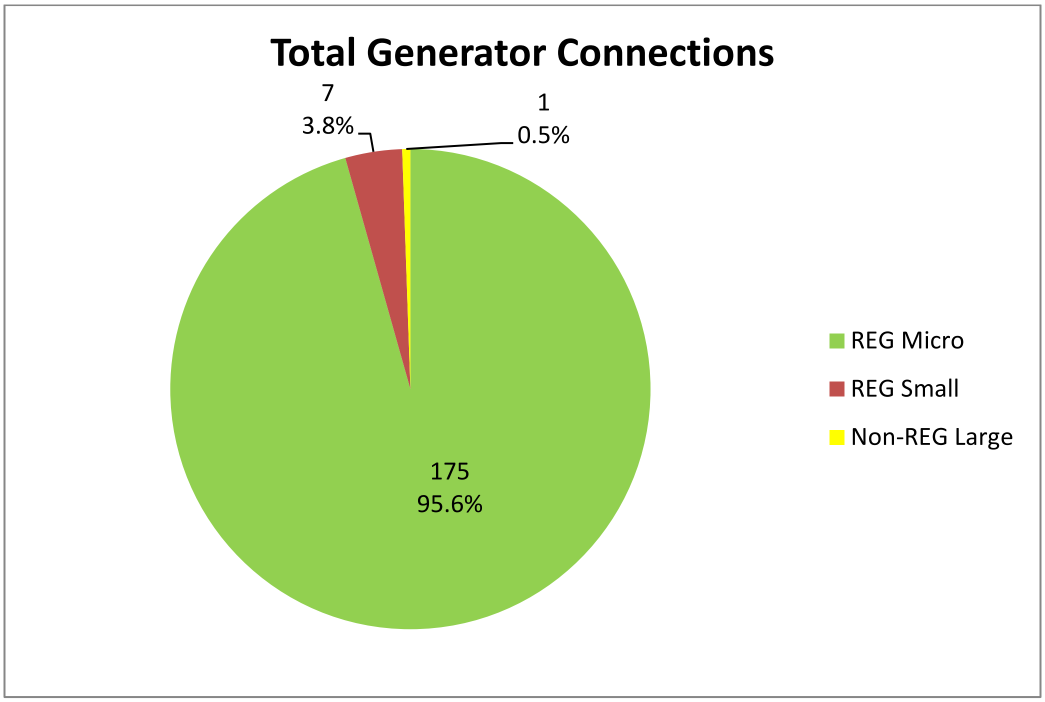
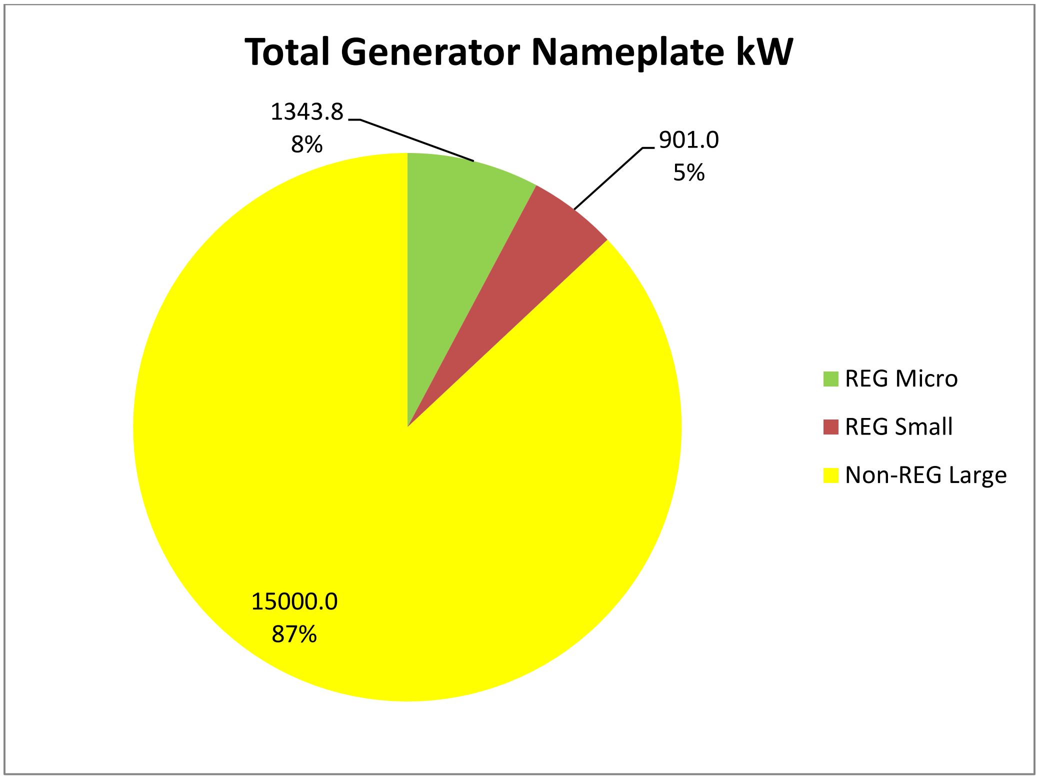


Figure A1.1-1 - Total Generator Connections



1

2 **Figure A1.1-2 - Total Generator Nameplate kW**

3 The various types of embedded generation settlement are summarized in Table A1.1-1.

Energy Type	Technology Example	Settlement Type	Export to Grid	Retail Load Displacement	Settlement Details
Renewable Energy Generation (REG)	Solar PV, Wind	Net-Meter	Yes	Yes	O.Reg. 541/05
		RESOP	Yes	No	IESO RESOP Program
		Micro FIT	Yes	No	IESO Micro FIT Program
		FIT	Yes	No	IESO FIT Program
REG, Waste Energy or non-REG	CHP, BESS	BtM	No	Yes	OEB Retail Settlement Code and IESO Real-time Energy Market
		Retail Merchant	Yes	No	OEB Retail Settlement Code and IESO Real-time Energy Market

Table A1.1-1 - Embedded Generator Settlement Types

The various sizes of embedded generation defined by the Ontario Energy Board (OEB) Distribution System Code (DSC) are summarized in the following table.

Size Class	Nameplate Rating	Facility Connection Voltage
Micro	10kW or less	any
Small	500kW or less	less than 15kV
	1MW or less	15kV or greater
Mid-Size	more than 500kW	less than 15kV
	more than 1MW	15kV or greater
Large	more than 10MW	any

Table A1.1-2 - Embedded Generator Size Classes

The cumulative Micro-REG connections and Small REG Connections for 2015 to 2021 are summarized in the following figures.

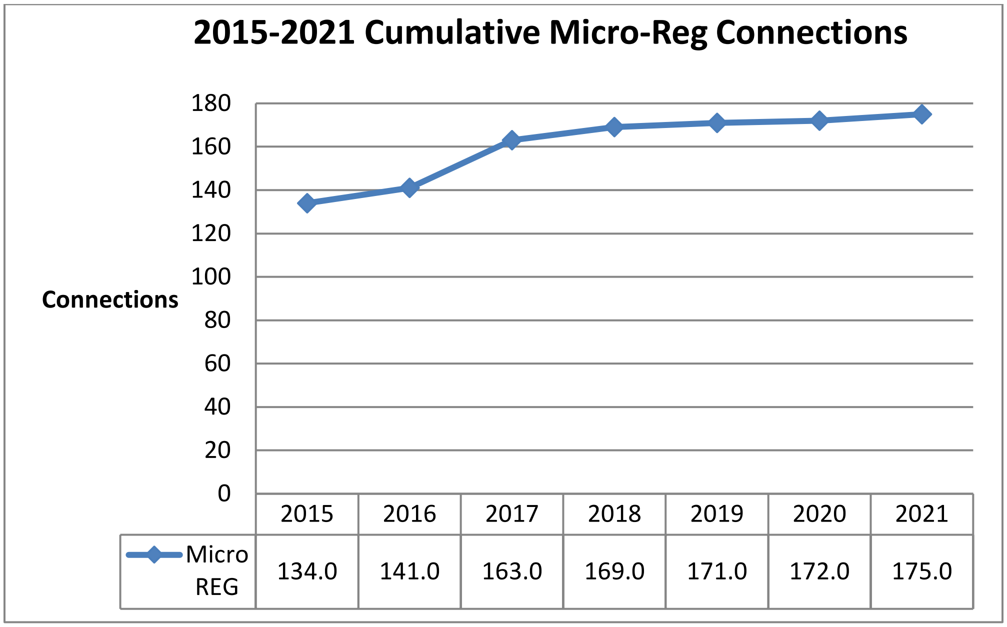


Figure A1.1-3 - Annual Cumulative Micro-REG Connections

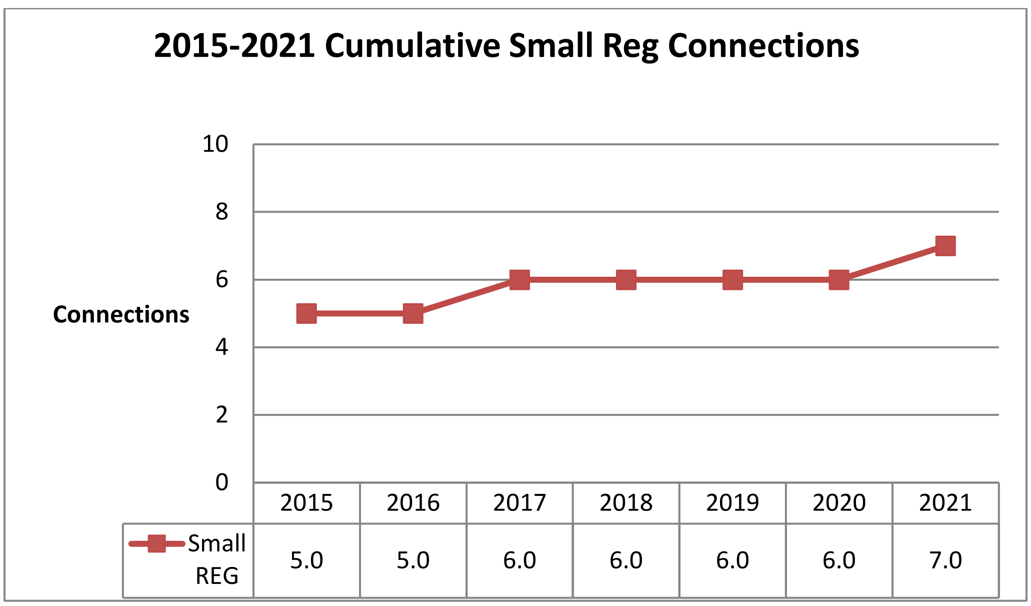


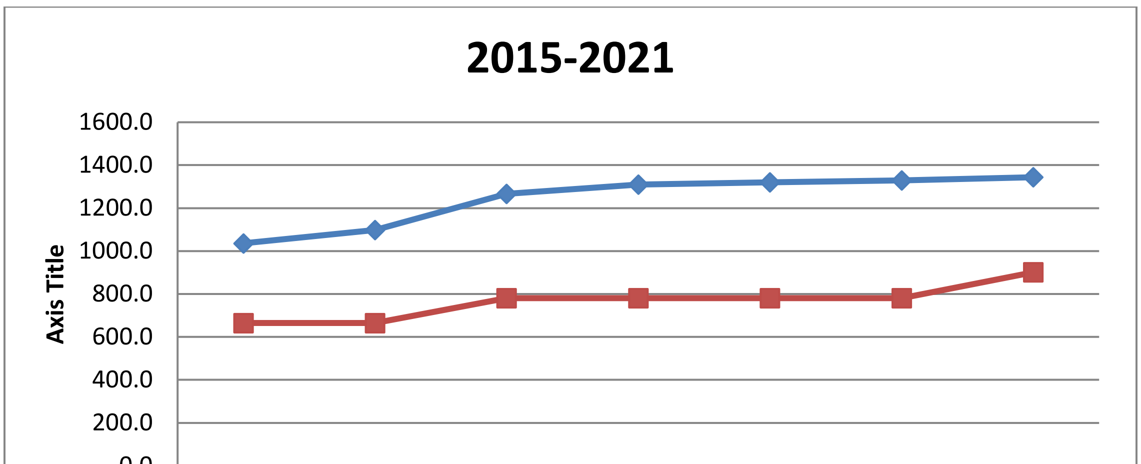
Figure A1.1-4 - Annual Cumulative Small REG Connections

The incremental REG connections from 2015 to 2021 are summarized by settlement type in the table below.

	Micro FIT (Micro)	Net-Meter (Micro)	Net-Meter (Small)	RESOP (Small)	FIT (Small)
2016	7	0	0	0	0
2017	22	0	1	0	0
2018	5	1	0	0	0
2019		2	0	0	0
2020		1	0	0	0
2021	-1	4	1	0	0

Table A1.1-3 - Annual Incremental REG Connections by Settlement Type

The cumulative REG nameplate kW for 2015 to 2021 are summarized by size below.



	2015	2016	2017	2018	2019	2020	2021
Micro REG	1036.2	1097.8	1266.0	1309.5	1320.5	1328.5	1343.8
Small REG	665.0	665.0	781.0	781.0	781.0	781.0	901.0

Figure A1.1-5 - Annual Cumulative REG Nameplate kW

The annual incremental REG nameplate kW for 2015 to 2021 are summarized by settlement type in the table below.

	Micro FIT (Micro)	Net-Meter (Micro)	Net-Meter (Small)	RESOP (Small)	FIT (Small)
2016	61.6	0.0	0.0	0.0	0.0
2017	168.3	0.0	116.0	0.0	0.0
2018	40.0	3.5	0.0	0.0	0.0
2019	0.0	11.0	0.0	0.0	0.0
2020	0.0	8.0	0.0	0.0	0.0
2021	-10.0	25.3	120.0	0.0	0.0

Table A1.1-4 - Annual Incremental REG Nameplate kW by Settlement Type

The following is a summary of the number of pre-consultations and total nameplate of pre-consultations of proposed generator projects greater than 10kW from 2016-2021.

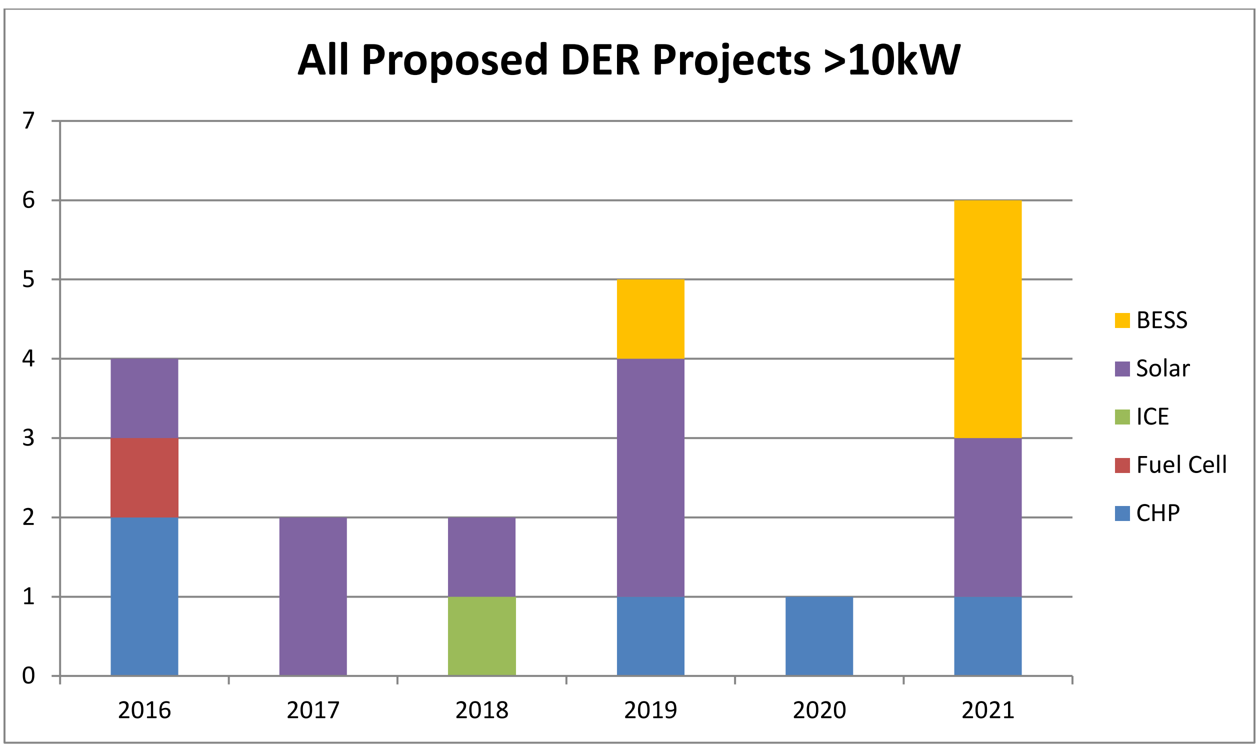


Figure A1.1-6 - 2016 to 2021 - Annual Number of Pre-Consultations

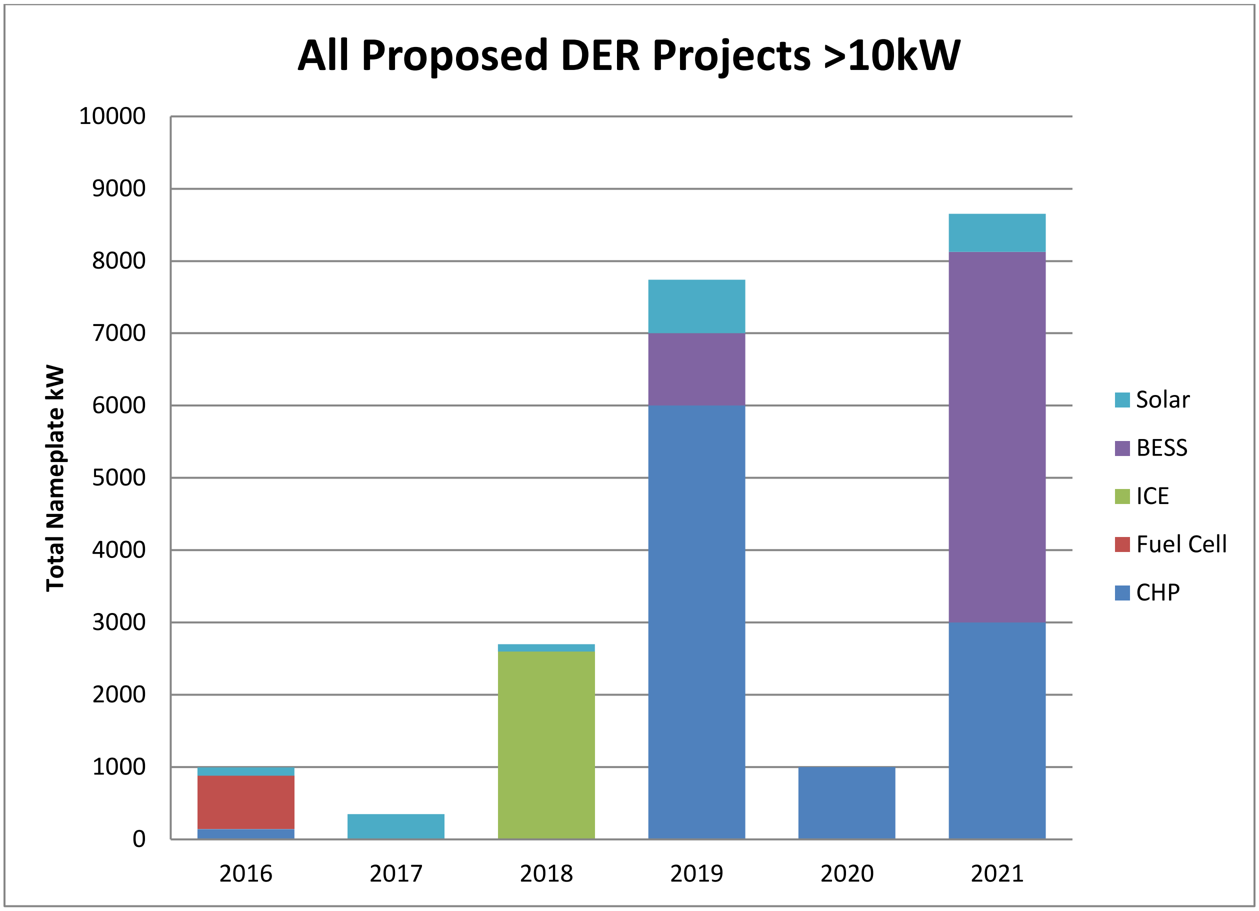


Figure A1.1-7 - 2016 to 2021 Annual Nameplate kW of Pre-Consultations

A1.2 Forecast Applications From Renewable Generators

The following tables summarize Kingston Hydro’s forecast of generator connections and nameplate kW for the 2022-2027 timeframe:

	2022	2023	2024	2025	2026	2027
Micro Net-Meter (REG)	2	4	4	6	6	8
Small Net-Meter (REG)	1	1*	1	1	1	1
Micro BtM BESS (Non-REG)	0	0	1	1	1	1
Mid-Size BtM BESS (Non-REG)	0	3*	0	1	0	1
CHP (Non-REG)	0	1*	0	0	0	0

Table A1.2-1 - Forecast Generation Connections

	2022	2023	2024	2025	2026	2027
Micro Net-Meter (REG)	12	24	24	36	36	48
Small Net-Meter (REG)	120	500*	120	120	120	120
Micro BtM BESS (Non-REG)	0	0	6	6	6	6
Mid-Size BtM BESS (Non-REG)	0	5120*	0	1500	0	1500
CHP (Non-REG)	0	3000*	0	0	0	0

Table A1.2-2 - Forecast Total Annual Incremental Nameplate Generation (kW)

***NOTE:** An exceptional volume of applications have been received and capacity has been allocated for the 2023 forecast. Here is a further breakdown of the 2023 connections and nameplate generation values flagged with an asterisk in the table above:

- 1500kW on-shore BESS for new electric ferry peak shaving
- 500kW solar photovoltaic and 2080kW BESS for campus facility peak shaving
- 1540kW BESS for campus facility peak shaving
- 3000kW CHP for campus facility peak shaving

The remaining figures in the 2022-2027 forecast tables above are considered more in-line with historic trends. During the customer consultation process, all local institutional customers at the federal, provincial, and municipal level indicated a desire to reduce their existing Green House Gas (GHG) emissions from facilities and fleets with an ultimate aspiration to be Carbon Neutral by no later than 2050. Renewable energy generation will likely factor prominently into the long term plans of these institutional customers but the quantity and size of new REG projects greater than 10kW for the 2022-2027 timeframe is difficult to predict due to the effects of the COVID-19 pandemic and associated supply chain impacts.

REG projects are generally favourable when one or more benefits can be combined. Some of these “stacked benefits” include:

1. REG enabling incentives in the form of grants, loans and/or energy purchase contracts (e.g. Feed-in Tariff program)
2. payback less than 10 years (reasonable project costs and favourable revenues)
3. back-up power capability for resiliency
4. optimized electrical supply capacity (non-wires solution)
5. GHG reduction target and/or carbon offset credit

The phase-out of the IESO sponsored programs (e.g., Micro-FIT and FIT) approximately 5 years ago eliminated a major source of REG enabling incentives. The current federal government program, NRCAN Greener Homes, offers homeowners a grant up to $5,000 for REG projects and a grant up to $1,000 for Battery Storage (resiliency measures).

Kingston Hydro estimates the current payback for a solar net-meter installation in Kingston is between 13 to 23 years. This simple payback estimate is based on the following assumptions:

- unit installation costs ranging from $3.20/kW for a 10kW system to $2.05/kW for a 250kW system
- annual solar energy generation potential of 1200kWh per nameplate kw installed
- average electricity energy rate between $0.1068/kWh to $0.1760/kWh

A1.3 Capacity of Distribution System to Connect REG and Other DG

The following diagram (Figure A1.3-1) is intended to provide an overview of the local transmission and distribution system serving Kingston Hydro and associated distribution voltages that affect the feeder capacity and available generation capacity.

Overview of Local Transmission and Distribution System Serving Kingston Hydro

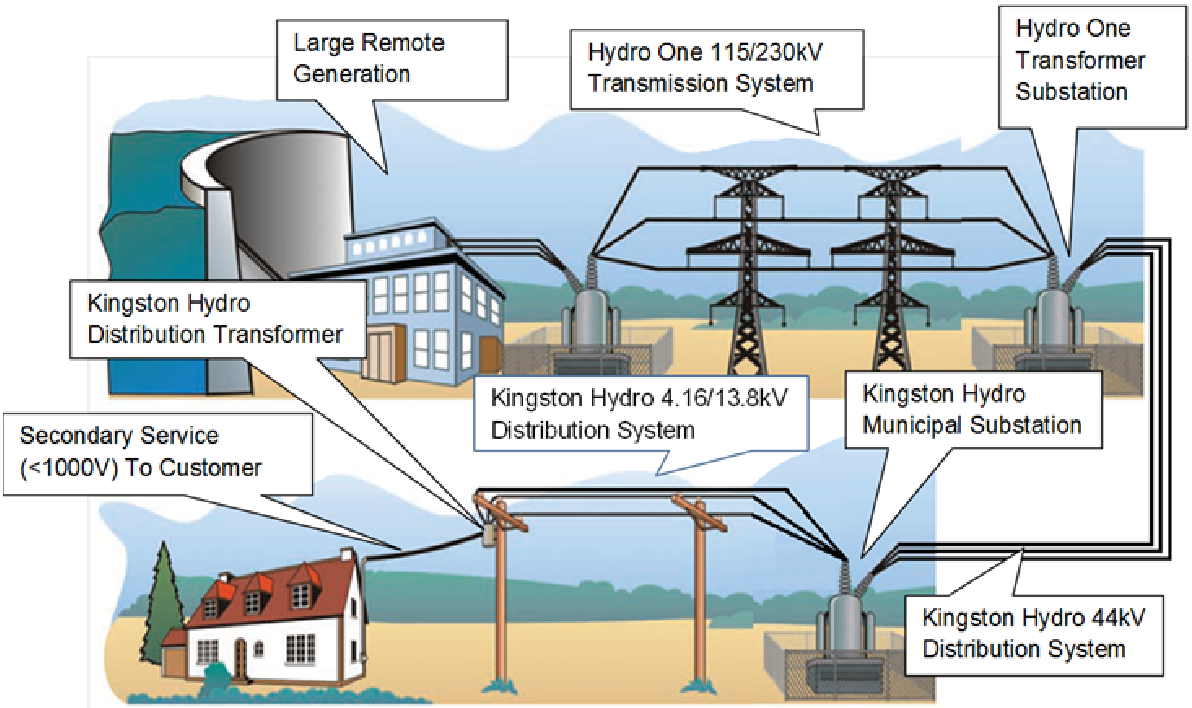


Figure A1.3-1 - Overview of Local Transmission and Distribution System

The Kingston Hydro generation forecast for 2022-2027 presented in Section A1.2 is not expected to have a significant impact on the existing thermal, short circuit and/or voltage limits of the Kingston Hydro distribution system or the upstream Hydro One transmission system at this time. Therefore, the Kingston Hydro distribution system has sufficient capacity to connect the forecast generation amount and no capital expenditures greater than the OEB materiality threshold are anticipated for the 2022-2027 forecast period to accommodate additional REG projects.

Hydro One Transformer Station Capacity

The two Hydro One Transformer Stations (TS), Frontenac TS and Gardiner TS, that supply the Kingston Hydro 44kV distribution system currently have sufficient capacity to connect the forecast REG generation shown in Table A1.2-2 44kV protection upgrades at the Hydro One TS facilities to accommodate new REG generation are not anticipated at this time however, Kingston Hydro will establish transfer trip over fibre to Frontenac TS by 2023 for a pending 3MW natural gas generator.

Kingston Hydro Feeder Thermal Capacity

The total acceptable three-phase generation capacity of Kingston Hydro feeders is:

- 24.4 MW for 44kV dedicated sub-transmission feeders
- 1.5 MW for 4.16kV distribution feeders

The above limits are established by the normal thermal limits of typical feeder conductors used for these distribution voltages.

Kingston Hydro 44kV Feeder – Available Capacity

The available capacity of Kingston Hydro's 44kV feeders is determined by minimum feeder load which is summarized in the following table:

HONI Supply	Max. Feeder Load (kW)	Min. Feeder Load (kW)	Existing Name-Plate Generation (kW)**	Remaining Feeder Capacity (kW)
Frontenac M2	9,800.0	2,058.0	221.5	1,836.5
Frontenac M3(shared)	9,240.0	1,940.4	-	1,940.4
Frontenac M4	24,800.0	5,208.0	209.2	4,998.8
Frontenac M5	25,200.0	5,292.0	481.3	4,810.7
Gardiner M12	18,150.0	3,811.5	381.8	3,429.7
Gardiner M7	27,000.0	5,670.0	144.8	5,525.2
Gardiner M9	18,400.0	3,864.0	636.9	3,227.1

Table A1.3-1 - Kingston Hydro 44kV Feeder - Available Capacity

NOTES:** Excludes Large Generators with Transfer Trip

1 **Municipal Substation Bus – Available Capacity**

2 The available capacity of Kingston Hydro's Municipal Substation Buses are limited by
3 the reverse thermal limit of the substation transformer or the short circuit rating of the
4 bus. These capacity limitations are summarized in the following table.

Municipal Substation	Total Nameplate Generation (kW)	Smallest Substation Transformer Size (kVA)	Transformer Reverse Thermal Limit for Generation* (kVA)	Estimated Generation Short Circuit Contribution @ 4.16kV (Amps)	Calculated LLL Bus Fault Level without Generation (Amps)	Total LLL Bus Fault Level with Generation (Amps)	Bus Fault Rating (Amps)
MS1	59	9000	5400	11	21160	21171	35000
MS2	134	7500	4500	26	14860	14886	33000
MS3	144	7500	4500	28	19580	19608	35000
MS4	103	7500	4500	20	17020	17040	35000
MS5	0	3000	1800	0	6600	6600	12500
MS6	31	5000	3000	6	11430	11436	35000
MS7	150	6000	3600	29	18110	18139	35000
MS8	166	5000	3000	32	15210	15242	35000
MS9	64	7500	4500	12	15940	15952	30300
MS10	272	7500	4500	53	18640	18693	30300
MS11	81	7500	4500	16	17610	17626	40000
MS12	90	7500	4500	17	15990	16007	37500
MS13	101	7500	4500	20	16580	16600	35000
MS14	220	7500	4500	42	16050	16092	25000
MS15	28	7500	4500	5	17720	17725	35000
MS16	0	6000	3600	0	13894	13894	16000

5 **Table A1.3-2 - Municipal Substation Bus - Available Capacity**

6 *NOTE: Reverse Thermal Limit for Substation Transformers is 60% Rated Nameplate

7 **Kingston Hydro Medium Voltage Distribution Feeder – Available Capacity**

8 The available capacity of Kingston Hydro's medium voltage (4.16/13.8kV) distribution
9 feeders is determined by the minimum feeder loads summarized in the following table.

Distribution Feeder ID	Voltage Class (kV)	Max Feeder Load (kW)	Min Feeder Load (kW)	Nameplate Generation (kW)	Remaining Feeder Capacity (kW)
102	4.16	1818	381.7	0.0	381.7
103	4.16	2125	446.3	10.0	436.3
104	4.16	2795	587.0	26.3	560.8
105	4.16	2791	586.1	9.9	576.3
106	4.16	2050	430.5	0.0	430.5
107	4.16	932	195.6	9.9	185.8
108	4.16	1331	279.4	0.0	279.4
109	4.16	2359	495.5	0.0	495.5
110	4.16	1861	390.8	2.9	387.9
111	4.16	536	112.5	0.0	112.5
112	4.16	2812	590.6	0.0	590.6
113	4.16	1572	330.1	0.0	330.1
201	4.16	2260	474.6	26.4	448.2
203	4.16	1819	381.9	3.7	378.2
204	4.16	1324	278.1	4.3	273.8
205	4.16	2468	518.3	6.7	511.7
206	4.16	2380	499.9	0.0	499.9
207	4.16	2300	483.1	11.3	471.8
208	4.16	2351	493.8	9.9	483.9
301	4.16	522	109.7	0.0	109.7
302	4.16	1897	398.4	0.0	398.4
303	4.16	1503	315.7	10.0	305.7
304	4.16	1873	393.4	10.0	383.4
305	4.16	985	206.8	30.0	176.8
306	4.16	2296	482.3	16.4	465.9
307	4.16	2204	462.8	0.0	462.8
308	4.16	2151	451.8	19.9	431.9
401	4.16	988	207.6	17.6	190.0
402	4.16	1813	380.8	9.0	371.8
404	4.16	1678	352.5	10.0	342.5
405	4.16	2471	518.9	0.0	518.9
406	4.16	652	136.9	9.9	127.0

1 **Table A1.3-3 - Kingston Hydro Distribution Feeder Capacity (continued)**

Distribution Feeder ID	Voltage Class (kV)	Max Feeder Load (kW)	Min Feeder Load (kW)	Nameplate Generation (kW)	Remaining Feeder Capacity (kW)
407	4.16	2150	451.5	0.0	451.5
408	4.16	1646	345.6	34.6	310.9
409	4.16	2247	472.0	0.0	472.0
501	4.16	2040	428.3	0.0	428.3
503	4.16	2480	520.9	0.0	520.9
504	4.16	1133	237.9	0.0	237.9
505	4.16	1422	298.6	0.0	298.6
604	4.16	2464	517.4	0.0	517.4
605	4.16	2684	563.6	9.2	554.4
606	4.16	2190	460.0	0.0	460.0
607	4.16	1540	323.4	11.8	311.5
608	4.16	625	131.2	0.0	131.2
609	4.16	2605	547.0	10.0	537.0
701	4.16	1175	246.8	5.8	241.0
702	4.16	2134	448.1	23.5	424.6
703	4.16	1509	317.0	10.7	306.3
704	4.16	776	162.9	16.9	146.0
705	4.16	2431	510.4	14.0	496.5
706	4.16	660	138.7	10.0	128.7
804	4.16	2786	585.0	18.1	566.9
805	4.16	469	98.6	0.0	98.6
806	4.16	2106	442.3	12.4	429.8
807	4.16	2679	562.6	27.9	534.8
808	4.16	2007	421.6	10.0	411.6
809	4.16	1868	392.2	8.6	383.6
900	4.16	2419	508.0	0.0	508.0
901	4.16	2882	605.3	9.5	595.8
902	4.16	2882	605.3	24.7	580.5
903	4.16	2373	498.4	0.0	498.4
904	4.16	2470	518.6	0.0	518.6
905	4.16	2082	437.3	0.0	437.3
906	4.16	1653	347.2	0.0	347.2
907	4.16	1921	403.3	0.0	403.3
908	4.16	2125	446.2	0.0	446.2
909	4.16	1549	325.3	30.0	295.3

Table A1.3-3 - Kingston Hydro Distribution Feeder Capacity (continued)

Distribution Feeder ID	Voltage Class (kV)	Max Feeder Load (kW)	Min Feeder Load (kW)	Nameplate Generation (kW)	Remaining Feeder Capacity (kW)
910	4.16	2132	447.7	0.0	447.7
1002	4.16	1239	260.1	10.0	250.1
1003	4.16	1935	406.3	0.0	406.3
1004	4.16	2392	502.3	165.0	337.3
1006	4.16	1201	252.2	20.0	232.2
1007	4.16	2843	597.0	0.0	597.0
1008	4.16	1531	321.5	0.0	321.5
1009	4.16	2398	503.5	0.0	503.5
1102	4.16	2610	548.1	14.6	533.5
1104	4.16	2462	517.0	0.0	517.0
1105	4.16	1902	399.5	20.6	378.9
1106	4.16	2793	586.6	9.8	576.8
1107	4.16	2188	459.5	27.6	431.9
1108	4.16	1989	417.6	0.0	417.6
1109	4.16	957	201.0	0.0	201.0
1201	4.16	2195	461.0	5.0	456.0
1202	4.16	2342	491.8	6.9	484.9
1203	4.16	1242	260.8	0.0	260.8
1204	4.16	853	179.1	14.5	164.6
1205	4.16	1864	391.4	10.0	381.4
1206	4.16	1821	382.3	15.3	367.0
1207	4.16	877	184.1	7.5	176.6
1208	4.16	1153	242.1	8.6	233.5
1301	4.16	1355	284.5	3.5	281.0
1302	4.16	1823	382.8	20.0	362.8
1303	4.16	1458	306.2	15.6	290.5
1304	4.16	2572	540.2	10.0	530.2
1401	4.16	1624	341.0	150.0	191.0
1402	4.16	2832	594.7	10.0	584.7
1403	4.16	1741	365.7	60.0	305.7

Table A1.3-3 - Kingston Hydro Distribution Feeder Capacity (continued)

Distribution Feeder ID	Voltage Class (kV)	Max Feeder Load (kW)	Min Feeder Load (kW)	Nameplate Generation (kW)	Remaining Feeder Capacity (kW)
1501	4.16	815	171.2	7.8	163.4
1502	4.16	1004	210.9	19.9	191.0
1602	13.8	1791	376.0	0.0	376.0
1603	13.8	1791	376.0	0.0	376.0

Table A1.3-3 - Kingston Hydro Distribution Feeder Capacity

A1.4 Constraints Related to Connection of REG

The generation forecast for 2022-2027 presented in Section 5.3.4(b) is not expected to have a significant impact on the existing thermal, short circuit and/or voltage limits of upstream distribution and transmission assets at this time. Therefore, the Kingston Hydro distribution system has sufficient capacity to connect the forecast generation amount and capital expenditures to accommodate additional REG are not expected to exceed the OEB materiality threshold for the 2022-2027 near term forecast period.

In the long term, protection issues could arise if the aggregate generation connected to a feeder or station exceeds the minimum load safety margin or the system fault levels exceed equipment ratings. If this occurs, then Kingston Hydro may need to upgrade existing feeder overcurrent protection with more costly and complicated distance protection. Distance protection is preferred to overcurrent protection because it is much less susceptible to changes in short-circuit-current magnitude, and, therefore much less affected by changes in connected generating capacity. Currently, 4.16kV feeders are more likely to require protection upgrades compared to 44kV feeders due to the relative amount of remaining feeder capacity. Kingston Hydro will monitor the situation and determine appropriate protection upgrades on a case-by-case basis if and when required.

A1.5 Constraints for Embedded Distributor

There are no embedded distributors within the Kingston Hydro service territory.

Appendix B

Asset Condition Assessment – Kinectrics

UTILITIES Kingston
2019 ASSET CONDITION ASSESSMENT

Kinectrics Report: K-814190-RA-0001-R01

April 22, 2020

Kinectrics Inc.
800 Kipling Avenue
Toronto, ON
M8Z 6C4 Canada
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UTILITIES KINGSTON
2019 ASSET CONDITION ASSESSMENT

Kinectrics Report: K-814190-RA-0001-R01

April 22, 2020

Prepared by:

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____

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Dated: 2020-04-22

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Revision History

Revision Number	Date	Comments	Approved
R00	2019-10-23	Draft	
R01	2020-04-22	Final	

EXECUTIVE SUMMARY

In 2019 Utilities Kingston (Kingston) determined a need to perform a condition assessment of its key distribution assets. Kingston selected and engaged Kinectrics Inc. (Kinectrics) to assist with this work. This report presents the results of 2019 Asset Condition Assessment (ACA) study, and is based on the available condition data as of the end of December 2018.

Asset Categories Considered

The asset groups included in the 2019 ACA are as follows, including 12 categories or 20 sub-categories:

- Station Transformers
- Station Breakers
- Station Ganged Switches (MV, 44 kV)
- Pole Mounted Transformers (1-Phase, 3-Phase)
- Pad Mounted Transformers (1-Phase, 3-Phase)
- Poles (Wood, Concrete)
- Pad Mounted Switchgear
- Vault Transformers
- Vault Switchgear
- Transformer Vaults
- UG Primary Cables - PILC (44 kV, Non 44 kV 1-Ph, Non 44 kV 3-Ph)
- UG Primary Cables - XLPE (44 kV, Non 44 kV 1-Ph, Non 44 kV 3-Ph)

For each asset category, available data was assessed, Health Index distribution was determined, and condition-based Flagged for Action plan was developed.

Some of these asset groups, such as station transformers and station breakers, require that an individual asset unit get replaced before its failure. A risk based prioritized list was developed for each of these groups, indicating the projected flagged for action year of each individual unit.

Overall Health Index Distribution

In general, over one third of the 20 sub-categories had over 70% of their units classified as "good" or "very good", and more than half of them had an average Health Index score of greater than 70%.

With respect to the asset categories of concern, Station Ganged Switches, Pad Mounted Transformers (1-Ph), Pad Mounted Switchgear and Vault Transformers had over half of units classified as "poor" or "very poor" in each case. in "poor" to "very poor" condition

Flagged for Action Plans

In general, the sub-categories within stations showed major backlog in terms of flagged for action numbers in the first year. Other sub-categories with substantial number of flagged for action units in the near future included Pole Mounted Transformers (1-Ph). The other sub-categories had their flagged for action plans showing smooth variation throughout the next 10 years.

In the short term, it was determined that Station Ganged Switches (both MV and 44 kV) had the highest percentages of units flagged for action in first year, exceeding 50% of population in both cases.

Furthermore, within the next 10 years, about half or more of the Station Ganged Switches (both MV and 44 kV), Pad Mounted Transformers (1-Ph), Vault Transformers and UG Primary Cables – XLPE (Non 44 kV 1-Ph) are expected to require some action to be taken to address their condition.

The actual replacement plans might be only a subset of the Flagged for Action plans after Kingston's review based on Kingston's maintenance and replacement strategy.

Data Availability

The asset groups of Station Transformers, Station Breakers and Station Ganged Switches had relatively complete data sets, with both test and detailed inspection data available in addition to age information.

UG primary Cables had age information only.

All the other asset groups had age information and inspection data at component level.

Distribution transformers (Pole Mounted, Pad Mounted, Vault) and Poles (Wood, Concrete) had historic removal data, allowing to develop Kingston specific degradation curves for these asset groups.

Recommendations

Compared to other local distribution utilities, Kingston had above average amount of data for 2019 ACA study, based on which informed decisions could be made. For the purpose of improving ACA study in the future, it is recommended that Kingston enhance data collection in the following areas:

- Acquisition of loading data for all the distribution transformers outside stations.

- Operation cycle counts, for both the normal operation and fault interruption for Station Breakers, as well as manufacturer specification limits on contact resistance and operation cycles, for the purpose of estimating breaker degradation due to usage.

- Adoption of a single file (instead of separate files) to contain the inspection and test data for all the individual units, for the asset groups inside stations (Station Transformers, Station Breakers, Station Ganged Switches).

- Historic records of asset removal for all the asset groups inside stations as well as for Pad Mounted Switchgear, Vault Switchgear, Transformer Vaults and UG Primary Cables, for the purpose of developing Kingston specific asset degradation curves in the future.

- Continous tracking of Underground Cables failures by location in the outage database. Such information has been collected by Kingston for many years. Once sufficient data are available in the future, they could be incorporated in ACA study.

The results presented in this study are based solely on asset condition as determined by available data. Note that there are numerous other considerations that may influence Kingston's planning process. Among these are obsolescence, system growth, corporate priorities, technological advancements, etc.

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DEFINITIONS

Terminology	Acronym	Definition
Age Limiter	AL	The final HI assigned to an individual asset may also be limited by the asset's age. The AL is generally equal to the cumulative survival probability at a given age of an asset group. If the calculated HI is less than or equal to the AL, the final HI assigned is the calculated HI. Otherwise, the final HI assigned is equal to the AL.
Asset Condition Assessment	ACA	Process of using asset information to determine the condition of assets. Condition data can include nameplate information, test results, asset inspection records, corrective maintenance records, operational experience, etc.
Condition Parameter Score	CPS	Score of an asset for a particular condition parameter. In this study, the scoring system used ranges from 0 through 4 (0 = worst; 4 = best).
Condition Parameters	CP	Asset characteristics or properties that are used to derive the HI.
Criticality		Metric used to quantify consequence of failure in this methodology.
Criticality Index	CI	Index used to determine asset Criticality. CI ranges from 0% to 100%, with 100% representing the unit with the highest possible consequence of failure.
Cumulative Distribution Function	CDF	Cumulative distribution function. Assumed in this methodology as the Weibull function representing the cumulative likelihood of removals.

Terminology	Acronym	Definition
Data Availability Indicator	DAI	A measure of the amount of condition parameter data that an asset has, as measured against the full data sets that are practically available and included in the HI formula. It is determined by the weighted ratio of the condition parameters availability of an individual unit, over the maximum condition parameters availability of an asset group.
Data Gap		A data gap is the case where none of the units in an asset group has data for a particular item as requested by "ideal" data sets. A data gap means the data is either unavailable or not in a useable format.
De-rating Multiplier	DR	Multipliers used to adjust a condition or sub-condition parameter score or calculated Health Index so as to reflect certain conditions.
Flagged for Action Plan	FFA Plan	Number of units that are expected to require attention annually.
Flagged for Action Year	FFA Year	The year that a particular unit is flagged for action.
Health Index	HI	Health Indexing quantifies equipment condition based on numerous condition parameters that are related to the factors that cumulatively lead to an asset's end of life. HI is given in terms of a percentage range of 0%-100%, with 100% representing as new condition.
Probability Density Function	PDF	Probability density function. Assumed in this methodology as the Weibull function representing the likelihood that an asset will be removed from service when its age is within a particular range.
Removal Rate		Weibull hazard function. Assumed in this methodology as the rate of removal (removals per year for given age, including failures, proactively replaced, removal for non-condition reasons).
Risk		Product of likelihood of removal and consequence of failure.
Sample Size		Subset of an asset population with enough data (i.e. age or condition data) to calculate the HI.

Terminology	Acronym	Definition
Sub-Condition Parameter Score	SCPS	Score of an asset for a particular sub condition parameter. In this study, the scoring system used ranges from 0 through 4 (0 = worst; 4 = best).
Sub-Condition Parameters	CP	Asset characteristics or properties that are used to derive the HI. Each condition parameter can be comprised of multiple sub-condition parameters.
Weibull Distribution		Continuous function used, in this methodology to model, the removal rates of assets.
Weight of Condition Parameter	WCP	In the HI formula, condition parameters are assigned a weight that is based on t he degree of contribution or relevance to asset degradation.
Weight of Sub-Condition Parameter	WSCP	In the HI formula, condition parameters are assigned a weight that is based on t he degree of contribution or relevance to asset degradation.

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I INTRODUCTION

Utilities Kingston (Kingston) engaged Kinectrics Inc (Kinectrics) in 2019 to perform an Asset Condition Assessment (ACA) on selected distribution assets. An assessment produces a quantifiable evaluation of asset condition and also aids in prioritizing and allocating sustainment investments. This undertaking, if done continuously over time, would allow Kingston to monitor trends in the condition of its assets and to continuously improve its assessment process and asset management practices. This assessment covered Kingston's asset population as of September 2019. This report presents results based on the available data. Year 0 shown in all figures is for 2019, year 1 for 2020, year 2 for 2021 etc.

I.1 Objective and Scope of Work

The categories and sub-categories of assets considered in this study are as follows:

Asset Category	
Station Transformers	-
Station Breakers	-
Station Ganged Switches	**MV**
	44 kV
Pole Mounted Transformers	**1-Ph**
	3-Ph
Pad Mounted Transformers	**1-Ph**
	3-Ph
Poles	**Wood**
	Concrete
Pad Mounted Switchgear	-
Vault Transformers	-
Vault Switchgear	-
Transformer Vaults	-
UG Primary Cables – PILC (km)	**44 kV**
	Non 44 kV 1-Ph
	Non 44 kV 3-Ph
UG Primary Cables – XLPE (km)	**44 kV**
	Non 44 kV 1-Ph
	Non 44 kV 3-Ph

I.2 Deliverables

The deliverable in this study is a Report that includes the following information:

- Description of the Asset Condition Assessment methodology
- For each asset category the following were included:
    - Health Index formulation
    - Age distribution
    - Health Index distribution
    - Condition-based Flagged For Action Plan
    - Prioritized risk based list of proactively replaced asset groups
    - Assessment of data availability and a Data Gap analysis

- Prioritized risk based lists were provided for the asset groups requiring replacement of individual asset units before failure

II ASSET CONDITION ASSESSMENT METHODOLOGY

The Asset Condition Assessment (ACA) Methodology involves the process of determining asset Health Index, as well as developing a condition-based Flagged for Action Plan for each asset group. The methods used are described in the subsequent sections.

II.1 Health Index

Health Indexing quantifies equipment condition based on numerous condition parameters that are related to the degradation factors that lead to an asset's end of service life. The Health Index is an indicator of the asset's overall health and is typically given in terms of percentage, with 100% representing an asset in brand new condition. Health Indexing provides a measure of long-term degradation and thus differs from defect management, whose objective is finding defects and deficiencies that need correction or remediation in order to keep an asset operating prior to reaching its end of life.

Condition parameters are the asset characteristics or properties that are used to derive the Health Index. A condition parameter may be comprised of several sub-condition parameters. For example, a parameter called "Oil Quality" may be a composite of parameters such as "Moisture", "Acid", "Interfacial Tension", "Dielectric Strength" and "Colour".

In formulating a Health Index, condition parameters are ranked, through the assignment of *weights*, based on their contribution to asset degradation. The *condition parameter score* for a particular parameter is a numeric evaluation of an asset with respect to that parameter.

Health Index (HI), which is a function of scores and weightings, is therefore given by:

$$HI = \frac{\sum_{m=1}^{\forall m} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{\forall m} \alpha_m (CPS_{m.\max} \times WCP_m)} \times DR$$

Equation 0-1

where

$$CPS = \frac{\sum_{n=1}^{\forall n} \beta_n (CPF_n \times WSCP_n)}{\sum_{n=1}^{\forall n} \beta_n (WSCP_n)}$$

Equation 0-2

CPS	Condition Parameter Score
WCP	Weight of Condition Parameter
α_m	Data availability coefficient (1 if available; 0 if not available)
CPF	Sub-Condition Parameter Score
WSCP	Weight of Sub-Condition Parameter
β_n	Data availability coefficient for sub-condition parameter (1 if available; 0 if not available)
DR	De-Rating Multiplier

The scale that is used to determine an asset's score for a particular parameter is called the *condition criteria*. For this project, a condition criteria scoring system of 0 through 4 is used. A score of 0 represents the worst score while 4 represents the best score. I.e. $CPF_{max} = 4$.
De-Rating multipliers are applied to the calculated HI. These may be used to represent the impact of non-condition issues such as design or operating environment.

II.1.1 Health Index Results

As stated previously, an asset's Health Index is given as a percentage, with 100% representing "as new" condition. The Health Index is calculated only if there is sufficient condition data. The subset of the population with sufficient data is called the *sample size*. Results are generally presented in terms of number of units and as a percentage of the sample size. If the sample size is sufficiently large and the units within the sample size are sufficiently random, the results may be extrapolated for the entire population.

The Health Index distribution given for each asset group illustrates the overall condition of the asset group. Further, the results are aggregated into five categories and the categorized distribution for each asset group is given. The Health Index categories are as follows:

Very Poor	Health Index < 25%
Poor	25 ≤ Health Index < 50%
Fair	50 ≤ Health Index <70%
Good	70 ≤ Health Index <85%
Very Good	Health Index ≥ 85%

Note that for critical asset groups, such as Power Transformers, the Health Index of each individual unit is given.

II.2 **Condition Based Flagged for Action Plan**

The condition based Flagged for Action Plan outlines the number of units that are expected to require attention in the next 10 years. The numbers of units are estimated using either a *proactive* or *reactive* approach. In the proactive approach, units are considered for action prior to failure, whereas the reactive approach is based on expected failures per year.

Both approaches consider asset removal rate and probability of failure. The removal rate is estimated using the method described in the subsequent section.

II.2.1 Removal Rate and Probability of Removal

Where removal rate data is not available, a frequency of removal that grows exponentially with age provides a good model.

Depending on its application, there have been various forms derived from the original equation. Based on Kinectrics' experience in removal rate studies of multiple power system asset groups, Kinectrics has selected the Weibull equation to model the removal curves. The Weibull function has no specific characteristic shape and, as such, can model the exponentially increasing removal rate using appropriate parameters.

The Weibull removal density function is defined as:

$$f(t) = \frac{\beta t^{\beta-1}}{\alpha^{\beta}} e^{-(\frac{t}{\alpha})^{\beta}}$$

Equation 0-3

f	= removal rate per unit time
t	= time
α, β	= constant that control the scale and shape of the curve

Depending on its application, there have been various forms derived from the original equation. Based on Kinectrics' experience in removal rate studies of multiple power system asset groups, the following variation of the removal rate formula has been adopted:

The corresponding cumulative removal distribution is therefore:

$$Q(t) = 1 - R(t) = 1 - e^{-(\frac{t}{\alpha})^{\beta}}$$

Equation 0-4

Q(t)	= cumulative failure distribution
R(t)	= survival function

Finally, the removal rate function (i.e. hazard function) is then:

$$\lambda(t) = \frac{f(t)}{1 - Q(t)} = \frac{\beta t^{\beta-1}}{\alpha^{\beta}}$$

Equation 0-5

λ(t)	= hazard function (removals per year)

Different asset groups experience different removal rates and therefore different removal distributions. The parameters α and β are determine the shapes of these curves. For each asset group, the values of these constant parameters were selected to reflect typical useful lives for these assets.

Consider, for example, an asset class where at the ages of 40 and 75 the asset has cumulative probabilities of removal of 20% and 95% respectively. It follows that when using Equation 5, α and β are calculated as 57.503 and 4.132 respectively. The removal rate and probability of removal graphs for these parameters are as follows:

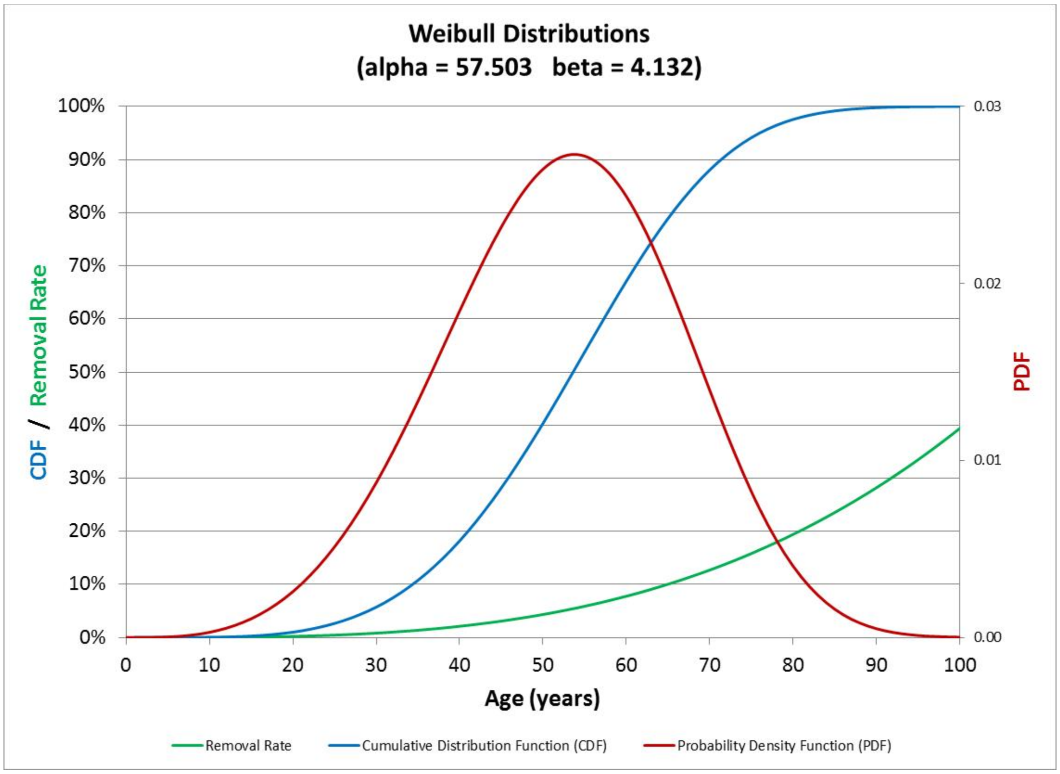

Figure 1 Removal rate vs. Age

II.2.2 Projected Flagged for Action Plan Using a Probabilistic Approach

For assets that have low consequences of failure or that are run to failure, a probabilistic approach is taken to estimate the number of units that are flagged for action in a given year.

For such asset types, the number of units expected to be replaced in a given year are determined based on the asset's removal rates. The number of failures per year is given by Equation 0-5.

An example of such a Flagged for Action Plan is as follows: Consider an asset distribution of 100 - 5 year old units, 20 – 10 year old units, and 50 - 20 year old units. Assume that the removal rates for 5, 10, and 20 year old units for this asset class are $\lambda_5 = 0.02$, $\lambda_{10} = 0.05$, $\lambda_{20} = 0.1$ failures / year respectively. In the current year, the total number of replacements is 100(.02) + 20(0.05) + 50(0.1) = 2 + 1 + 5 = 8.

In the following year, the expected asset distribution is, as a result, as follows: 8 – 1 year old units, 98 – 6 year old units, 19 – 11 year old units, and 45 - 21 year old units. The number of replacements in year 2 is therefore $8(\lambda_1) + 19(\lambda_6) + 45(\lambda_{11}) + 45(\lambda_{21})$.

Note that in this study the "age" used is in fact "effective age", or condition-based age if available, as opposed to the chronological age of the asset.

For the asset categories below, the probabilistic approach is used to estimate the FFA Plan. It is also important to note that the FFA gives the estimated number of assets per year that need to be addressed; the year that a specific unit needs to be addressed is not calculated.

- Voltage regulators
- Capacitors
- OH line switches
- OH line reclosers
- Distribution transformers (pole mounted, pad mounted, vault, submersible)
- Poles (wood, concrete, steel)
- Pad mounted switchgear
- Primary underground cables

II.2.3 Projected Flagged for Action Plan Using a Prioritized Risk Approach

For certain asset classes, costs of replacement and/or consequences of failure are more significant. As such planning for replacement requires more consideration. For these assets, a risk-based approach is taken when developing the FFA Plan. This risk-based methodology considers both the asset likelihood of removal (as related to HI) and its consequence of failure (criticality). The product of likelihood or removal and consequence of failure determines asset risk.

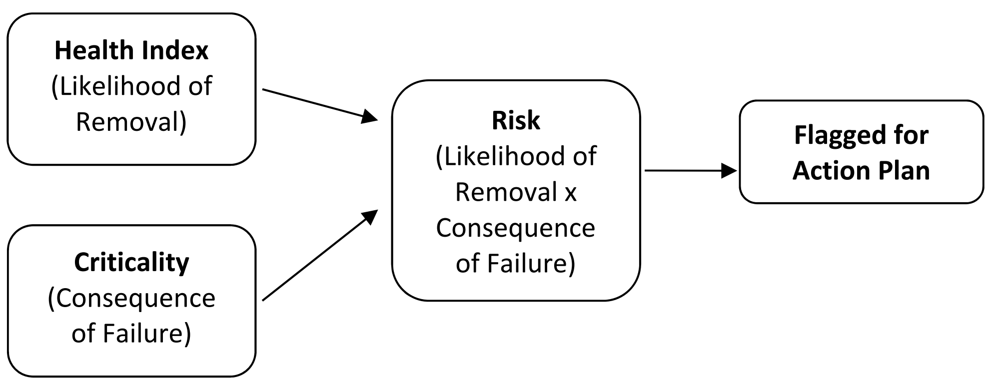

Figure 2 Risk Assessment Procedure

Relating Health Index and Probability of Removal

If there are no dominant sources, it can be assumed that the stress to which an asset is exposed is not constant and will have a somewhat normal frequency distribution. This is illustrated by the probability density curve of stress below. The vertical lines in the figure represent condition or strength (Health Index) of an asset.

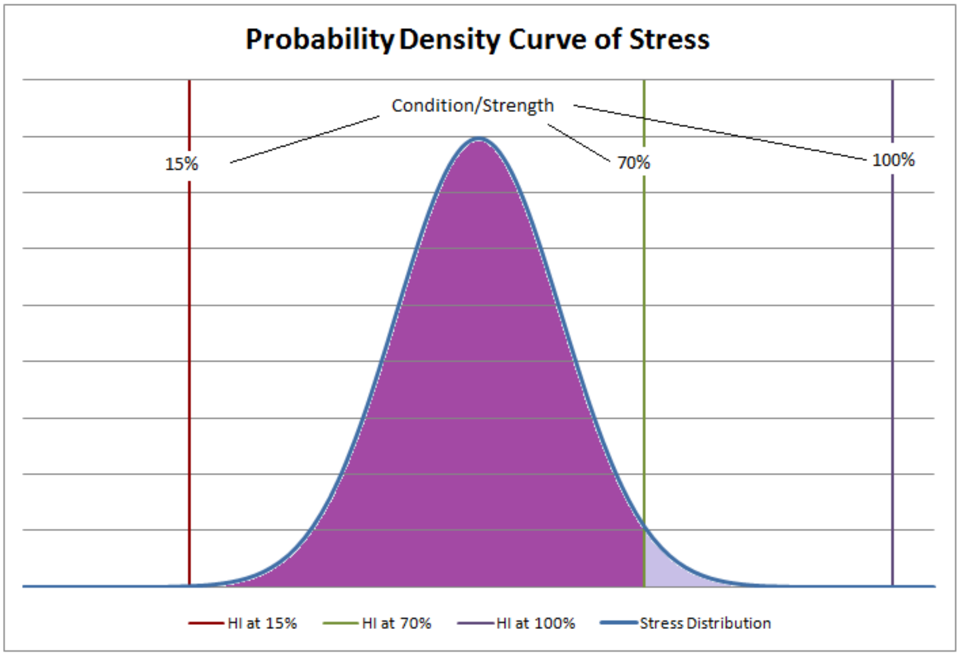

Figure 3 Stress Curve

An asset is in as-new condition (100% strength) should be able to withstand most levels of stress. As the condition of the asset deteriorates, it may be less able to withstand higher levels of stress. Consider, for example, the green vertical line that represents 70% condition/strength. The asset should be able to withstand magnitudes of stress to left of the green line. If, however, the stress is of a magnitude to the right of the green line, the asset will fail.

To create a relationship between the Health Index and likelihood of removal, assume two “points” on the stress curve that correspond to two different Health Index values. In this example, assume that an asset that has a condition/strength (Health Index) of 100% can withstand all magnitudes of stress to the left of the purple line. It then follows that probability that an asset in 100% condition will fail is the probability that the magnitude of stress is at levels to the right of the purple line. This corresponds to the area under the stress density curve to the right of the purple line. Similarly, if it assumed that an asset with a condition of 15% will fail if subjected to stress at magnitudes to the right of the red line, the probability of failure at 15% condition is the area under the stress density curve to the right of the red line.

The likelihood of removal at a particular Health Index is found from plotting the Health Index on X-axis and the area under the probability density curve to the right of the Health Index line on Y-axis, as shown on the graph of the figure below.

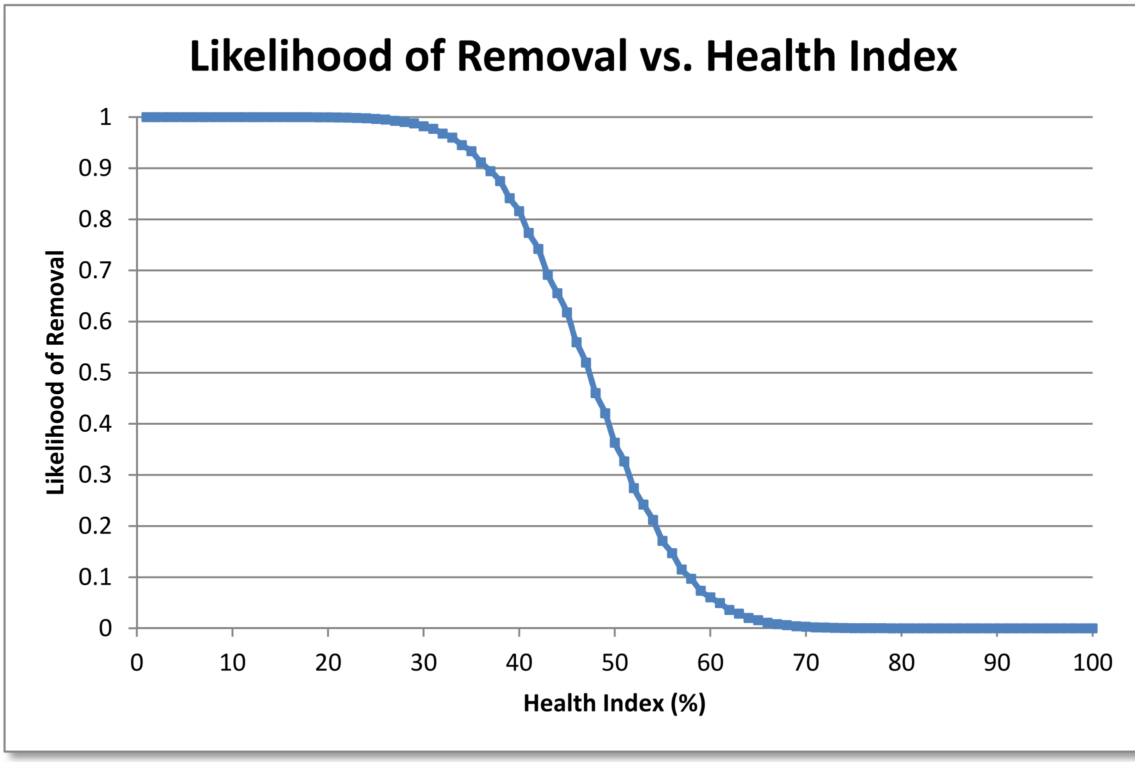

Figure 4 Likelihood of Removal vs. Health Index

Condition-Based Flagged for Action Plan

In this study, the metric used to measure consequence of failure is referred to as *Criticality*. Criticality may be determined in numerous ways, with monetary consequence or degree of risk to corporate business values being examples. The higher the criticality value assigned to a unit, the higher it's consequence of failure.

Due to the small population size for the asset groups applicable to prioritized risk based approach, in this study all the units in these asset groups were assigned of minimum criticality value.

To develop a Flagged for Action Plan, the risk of removal of each unit must be quantified. Risk is the product of a unit's likelihood of removal and its consequence of failure. An asset unit is flagged for action when the calculated risk value exceeds a pre-set threshold.

For the asset categories listed below, the risk-based approach is used to estimate the FFA Plan.

- Station transformers (main tank + LTC)
- Station circuit breakers

It is also important to note with this approach, in addition to the estimated number of assets per year that need to be addressed, the FFA Year (i.e. the years that a particular unit is flagged for action) is calculated for each asset unit.

II.3 Data Assessment

The condition data used in this study included the following:

- Test Results (e.g. Oil Quality, DGA)
- Inspection Records
- Loading
- Make, Model, and Type
- Age

There are two components that assess the availability and quality of data used in this study: data availability indicator (DAI) and data gap.

II.3.1 Data Availability Indicator (DAI)

The Data Availability Indicator (DAI) is a measure of the amount of condition parameter data that an asset has, as measured against the full data sets that are practically available and included in the HI formula. It is determined by the weighted ratio of the condition parameters availability of an individual unit, over the maximum condition parameters availability of an asset group. The formula is given by:

$$DAI = \frac{\sum_{m=1}^{\forall m} (DAI_{CPS\,m} \times WCP_m)}{\sum_{m=1}^{\forall m} (WCP_m)}$$

Equation 6

where

$$DAI_{CPSm} = \frac{\sum_{n=1}^{\forall n} \beta_n \times WCFn}{\sum_{n=1}^{\forall n} (WCPFn)}$$

Equation 7

DAI_{CPSm}	Data Availability Indicator for Condition Parameter m with n Condition Parameter Factors (CPF)
β_n	Data availability coefficient for sub-condition parameter (=1 when data available, =0 when data unavailable)
$WSCP_n$	Weight of Condition Parameter Factor n
DAI	Overall Data Availability Indicator for the m Condition Parameters
WCP_m	Weight of Condition Parameter m

For example, consider an asset with the following condition parameters and sub-condition parameters:

Condition Parameter		Condition Parameter Weight (WCP)	Sub-Condition Parameter		Sub-Condition Parameter Weight (WCF)	Data Available? (β = 1 if available; 0 if not)
m	Name		n	Name		
1	A	1	1	A_1	1	1
2	B	2	1	B_1	2	1
			2	B_2	4	1
			3	B_3	5	0
3	C	3	1	C_1	1	0

The Data Availability Indicator is calculated as follows:

$$DAI_{CP1} = (1*1) / (1) = 1$$
$$DAI_{CP2} = (1*2 + 1*4 + 0*5) / (2 + 4 + 5) = 0.545$$
$$DAI_{CP3} = (0*1) / (1) = 0$$

$$DAI = (DAI_{CP1}*WCP_1 + DAI_{CP2}*WCP_2 + DAI_{CP3}*WCP_3) / (WCP_1 + WCP_2 + WCP_3)$$
$$= (1*1 + 0.545*2 + 0*3) / (1 + 2 + 3)$$
$$= 35\%$$

An asset with all available condition parameter data represented will, by definition, have a DAI value of 100%. In this case, an asset will have a DAI of 100% regardless of its Health Index score. Bear in mind that a DAI of 100% does not mean there is no data gap (to be discussed in the following section). What it really indicates is that, at the time of study, an asset has information on all the condition parameters that a utility is able to provide information for.

Provided that the condition parameters used in the Health Index formula are of good quality and there are little data gaps, there will be a high degree of confidence that the Health Index score accurately reflects the asset's condition.

II.3.2 Data Gap

The Health Index formulations developed and used in this study are based only on Kingston's available data. There are additional parameters or tests that Kingston may not collect but that are important indicators of the deterioration and degradation of assets. While these will not be included in the HI formula, they are referred to as data gaps. I.e. A data gap is the case where none of the units in an asset group has data for a particular item as requested by "ideal" data sets. The situation where data is provided for only a sub-set of the population is not considered as a data gap.

As part of this study, the data gaps of each asset category are identified. In addition, the data items are ranked in terms of importance. There are three priority levels, the highest being most indicative of asset degradation.

Priority	Description	Symbol
High	Impactive data; most useful as an indicator of asset degradation	☆☆☆
Medium	Important data; can indicate the need for corrective maintenance or increased monitoring	☆☆
Low	Helpful data; least indicative of asset deterioration	☆

When filling up data gaps, it is generally recommended that data collection be initiated for the items marked with higher priority, because such information will result in higher quality Health Index formulas.

The more impactive and important data included in the Health Index formula of a certain asset group, and the higher the Data Availability Indicator of a particular unit in that group, the higher the confidence in the Health Index calculated for the particular unit.

If an asset group has significant data gaps and lacks good quality condition, there is less confidence that the Health Index score of a particular unit accurately reflects its condition, regardless of the value of its DAI.

To facilitate the incorporation of data gap items into improved Health Index formulas for future assessments, the data gaps items are presented in this report as sub-condition parameters. For each item, the parent condition parameter is identified. Also given are the object or component addressed by the parameter, a description of what to assess for each component or object, and the possible source of data.

The following is an example for "Tank Corrosion" on a Pad-Mounted Transformer:

Data Gap (Sub-Condition Parameter)	**Parent Condition Parameter**	**Priority**	**Object or Component Addressed**	**Description**	**Source of Data**
Tank Corrosion	Physical Condition	☆☆	Oil Tank	Tank surface rust or deterioration due to environmental factors	Visual Inspection

III RESULTS

This section summarizes the findings of this study.

III.1 Health Index Results

A summary of the Health Index evaluation results is shown in Table 1. For each asset category the population, sample size (number of assets with sufficient data for Health Indexing), average age, age availability and average DAI are given. The average Health Index and distribution are also shown. A summary of the Health Index distribution for all asset categories are also graphically shown in Figure 5. Note that the Health Index distribution percentages are based on the asset group's sample size.

It can be observed that out of the 20 sub-categories, 7 of them had over 70% of their units classified as "good" or "very good". Also 10 of them had an average Health Index score of greater than 70%.

The only asset group that had all the units in "very good" condition was UG Primary Cables – XLPE (44 kV).

It can be seen from the results that among all the asset categories, Station Ganged Switches, Pad Mounted Transformers (1-Ph), Pad Mounted Switchgear and Vault Transformers were relatively speaking the ones of major concern. More than 50% of the units in these asset groups were classified as "poor" or "very poor".

Other asset group of concern included Station Transformers, Vault Switchgear, and Transformer Vaults, having over 30% of units classified as "poor" or "very poor".

Table 1 Health Index Results Summary

Asset Category		Population	Sample Size	Average Health Index	Health Index Distribution					Average Age	Average DAI	Age Availability
					Very Poor (< 25%)	Poor (25 - <50%)	Fair (50 - <70%)	Good (70 - <85%)	Very Good (>= 85%)			
Station Transformers		37	37	63%	7	5	3	5	17	43	76%	100%
Station Breakers		140	140	74%	13	5	26	37	59	34	39%	100%
Station Ganged Switches	MV	29	29	29%	17	4	4	0	4	57	3%	100%
	44 kV	53	53	36%	28	6	8	4	7	54	15%	100%
Pole Mounted Transformers	1-Ph	976	971	70%	161	106	130	118	456	25	92%	99%
	3-Ph	119	119	80%	8	7	14	15	75	18	87%	100%
Pad Mounted Transformers	1-Ph	359	323	54%	47	115	57	25	79	34	10%	90%
	3-Ph	237	213	77%	10	30	22	32	119	21	17%	90%
Poles	Wood	6213	6186	71%	641	1163	678	699	3005	30	85%	100%
	Concrete	153	153	62%	11	33	46	41	22	40	87%	100%
Pad Mounted Switchgear		22	22	59%	0	14	0	2	6	30	64%	100%
Vault Transformers		64	59	46%	25	10	9	2	13	38	17%	92%
Vault Switchgear		26	24	68%	0	10	1	0	13	25	4%	92%
Transformer Vaults		36	30	73%	0	12	1	1	16	27	43%	83%
UG Primary Cables - PILC (km)	44 kV	4.1	0.1	69%	0.0	0.0	0.1	0.0	0.0	2	Age Only	3%
	Non 44 kV 1-Ph	0.5	0.5	99%	0.0	0.0	0.0	0.0	0.5	25	Age Only	99%
	Non 44 kV 3-Ph	34.0	6.1	76%	0.2	1.1	0.2	1.9	2.7	8	Age Only	18%
UG Primary Cables - XLPE (km)	44 kV	17.4	9.2	100%	0.0	0.0	0.0	0.0	9.2	5	Age Only	53%
	Non 44 kV 1-Ph	43.7	16.1	80%	0.3	1.1	2.6	5.5	6.8	11	Age Only	37%
	Non 44 kV 3-Ph	136.1	51.8	93%	1.6	1.5	1.1	3.1	44.4	5	Age Only	38%

0% – 100% (colour scale)   Age Only: No information other than age

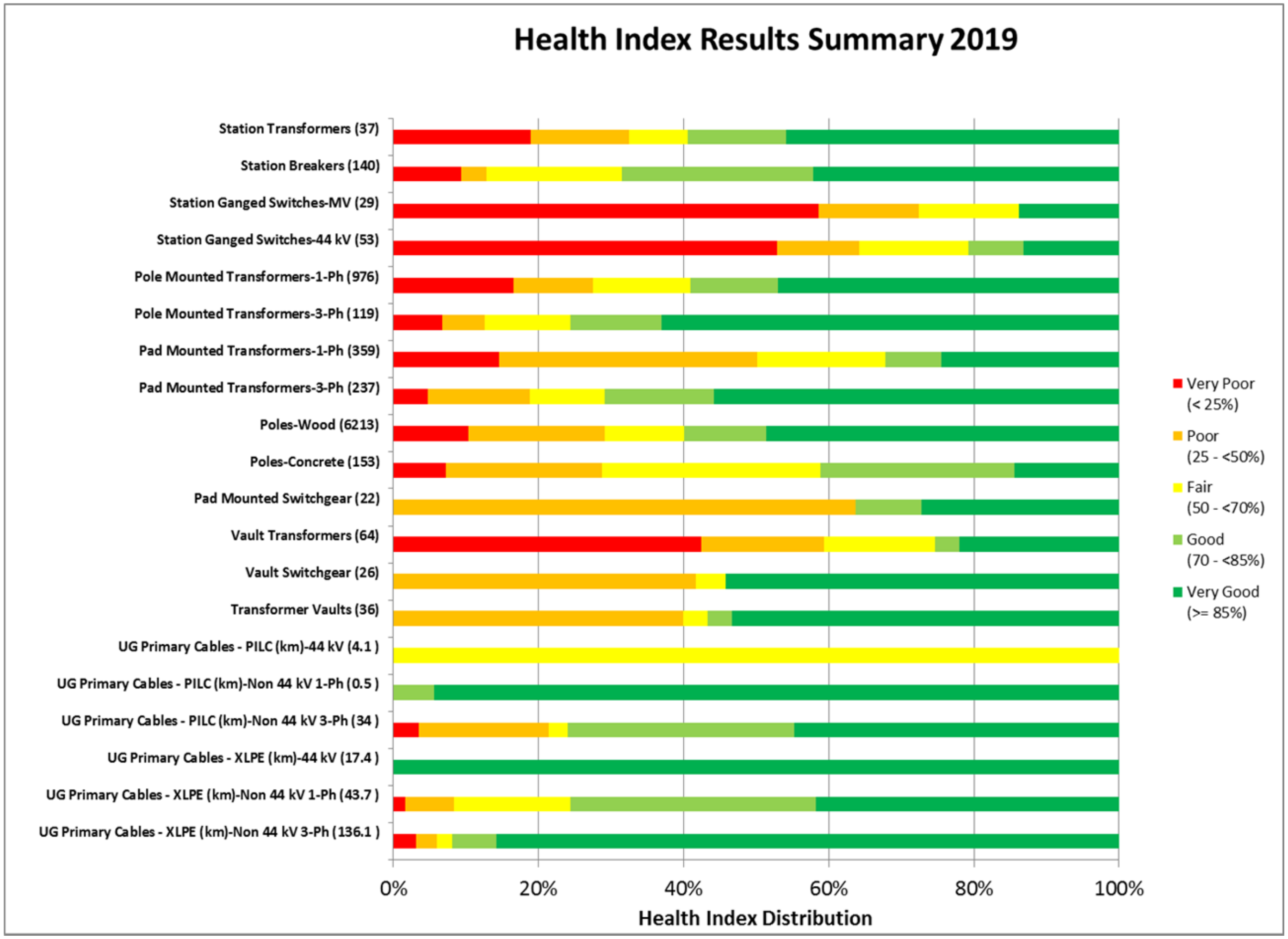

Figure 5 Health Index Results Summary

III.2 Condition-Based Flagged for Action Plan

The Flagged for Action Plan estimates the number of units expected to require attention in a given year.

Table 2 shows the Year 0 (year 2019) and 10 Year cumulative Flagged for Action Plan. Table 3 shows the 10 Year Flagged for Action Plan annually.

Table 2 Summary of Flagged for Action

Asset Category		1st Year Action		10 Year Action in Total		Replacement Strategy
		Quantity	Percentage	Quantity	Percentage	
Station Transformers		7	18.9%	12	32.4%	Proactive
Station Breakers		13	9.3%	18	12.9%	Proactive
Station Ganged Switches	MV	17	58.6%	21	72.4%	Proactive
	44 kV	28	52.8%	34	64.2%	Proactive
Pole Mounted Transformers	1-Ph	60	6.1%	360	36.9%	Reactive
	3-Ph	5	4.2%	38	31.9%	Reactive
Pad Mounted Transformers	1-Ph	22	6.1%	177	49.3%	Reactive
	3-Ph	8	3.4%	71	30.0%	Reactive
Poles	Wood	145	2.3%	1413	22.7%	Proactive/Reactive
	Concrete	8	5.2%	60	39.2%	Proactive/Reactive
Pad Mounted Switchgear		1	4.5%	10	45.5%	Reactive
Vault Transformers		6	9.4%	32	50.0%	Reactive
Vault Switchgear		1	3.8%	10	38.5%	Reactive
Transformer Vaults		1	2.8%	10	27.8%	Reactive
UG Primary Cables - PILC (km)	44 kV	0	0.0%	0	0.0%	Reactive
	Non 44 kV 1-Ph	0	0.0%	0	0.0%	Reactive
	Non 44 kV 3-Ph	1.1	3.2%	12.8	37.7%	Reactive
UG Primary Cables - XLPE (km)	44 kV	0	0.0%	0	0.0%	Reactive
	Non 44 kV 1-Ph	1.9	4.3%	21.7	49.6%	Reactive
	Non 44 kV 3-Ph	2.4	1.8%	17.9	13.1%	Reactive

100% 0%

Table 3 Ten Year Flagged for Action Plan

Asset Category		Flagged for Action Plan by Year										
		0	1	2	3	4	5	6	7	8	9	10
Station Transformers		7	0	0	0	0	4	0	1	0	0	0
Station Breakers		13	0	5	0	0	0	0	0	0	0	0
Station Ganged Switches	**MV**	17	0	4	0	0	0	0	0	0	0	0
	44 kV	28	0	2	0	0	0	0	4	0	0	0
Pole Mounted Transformers	**1-Ph**	60	53	46	40	34	31	27	25	23	21	20
	3-Ph	5	5	5	5	4	4	3	3	2	2	3
Pad Mounted Transformers	**1-Ph**	22	22	20	19	18	17	16	15	14	14	13
	3-Ph	8	8	8	7	7	7	7	6	6	7	7
Poles	**Wood**	145	144	144	143	142	141	140	139	138	137	135
	Concrete	8	8	7	7	6	6	5	5	4	4	4
Pad Mounted Switchgear		1	1	1	1	1	1	1	1	1	1	0
Vault Transformers		6	4	4	4	3	3	2	2	2	2	2
Vault Switchgear		1	1	1	1	1	1	1	1	1	1	1
Transformer Vaults		1	1	1	1	1	1	1	1	1	1	0
UG Primary Cables - PILC (km)	**44 kV**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non 44 kV 1-Ph	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non 44 kV 3-Ph	1.1	1.7	0.5	1.7	1.1	0.6	1.1	1.1	2.2	1.7	1.7
UG Primary Cables - XLPE (km)	**44 kV**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non 44 kV 1-Ph	1.9	2.2	1.9	1.9	2.7	2.7	2.1	2.2	1.9	2.2	1.6
	Non 44 kV 3-Ph	2.4	2.1	2.3	1.9	2.3	1.1	1.0	1.6	1.6	1.6	1.0

* Year 0 = 2019, year 1 = 2020, year 2 = 2021 … etc

It is evident from Table 3 that in general, the asset groups outside stations had relatively smooth flagged for action plans, indicating relatively small variation or gradual ascending/descending trend, in terms of yearly flagged for action numbers.

The asset categories inside stations showed a significant proportion of backlog at present.

It is important to note that the Flagged for Action plan suggested in this study is based solely on asset condition. It uses a probabilistic, non-deterministic, approach and as such can only show expected failures or probable number of units that are expected to be candidates for replacement or other action. While this condition-based Flagged for Action Plan can be used as a guide or input to Kingston's distribution system plan, it is not expected that it be followed directly or as the final deciding factor in making sustainment capital decisions. There are numerous other factors and considerations that will influence Kingston's Asset Management decisions, such as obsolescence, system expansion, regulatory requirements, municipal demand and customer preferences etc.

III.3 Data Assessment Results

Data assessment determines the data availability of each asset group, as well as identifying the data gaps for each asset group. Data availability is a measure of the amount of data that an individual unit has in comparison with the set of data currently available in for its respective asset category. Data gaps are items that are indicators of asset degradation, but are currently not collected or available for any asset in an asset category. The fewer the data gaps, the higher the quality of available condition data and Health Index formulas.

Data for Station Transformers (main tank) included age, loading, oil and insulation test results, and inspection records. Major data gaps were test and inspection records for bushings and cooling systems, as well as historic removal records.

Data for Station Breakers included age, contact resistance test results, and inspection records. Major data gaps were interruption medium status, timing test results, fault operating cycle count and manufacturer specification limits on contact resistance and operating cycle, as well as historic removal records.

Data for Station Ganged Switches included age, contact resistance test results, and inspection records. Major data gaps were insulation status, as well as historic removal records.

Data for Pole mounted Transformers, Pad Mounted Transformers and Vault Transformers included age and inspection results. Major data gaps were transformer loading.

Data for Wood Poles and Concrete Poles included age, inspection results and hammer test results. Major data gaps for Wood Poles were remaining strength test results. There were no major data gaps for Concrete Poles.

Data for Pad Mounted Switchgear and Vault Switchgear included age and inspection results. Major data gaps were inspection on insulation, as well as historic removal records.

Data for Transformer Vaults included age and inspection results. Major data gaps were historic demolition records.

UG Primary Cables had age only. Data gaps were inspection results at component level and fault statistics at segment level, as well as historic removal records.

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IV CONCLUSIONS

An Asset Condition Assessment was conducted for twelve of Kingston's distribution asset categories (twenty sub-categories). For each asset category, the Health Index distribution was determined and a condition-based Flagged for Action plan was developed.

Risk based prioritized lists were developed for Station Transformers, Station Breakers and Station Ganged Switches. These lists indicated the projected flagged for action year of each individual unit.

The following conclusions were drawn based on the ACA findings of this study.

1) In general, the asset units in over one third of Kingston's asset groups were in good condition, with 10 sub-categories having an average Health Index score of greater than 70%.

2) Among all the asset groups, UG Primary Cables – XLPE (44 kV) were in the best condition, having all the segments classified as "very good".

3) With respect to the asset groups that were of concern, Station Ganged Switches, Pad Mounted Transformers (1-Ph), Pad Mounted Swucthgear and Vault Transformers were found to be in the relatively speaking bad condition.

4) Other asset groups of concern included Station Transformers, Poles (Concrete), Vault Switchgear, and Transformer Vaults.

5) In terms of flagged-for-action plans, asset groups inside stations had high backlog of units to be addressed immediately.

6) For 10-year long term flagged-for-action plans, Station Ganged Switches (both MV and 44 kV), Pad Mounted Transformers (1-Ph), Vault Transformers and UG Primary Cables – XLPE (Non 44 kV 1-Ph) had the highest percentage of the population to be addressed.

7) It is important to note that the Flagged for Action plan presented in this study is based solely on asset condition and that there are numerous other considerations that may influence Kingston's Asset Management Plan, such as obsolescence, system growth, regulatory requirements, municipal initiatives, etc.

Kingston did better job than the majority of distribution utilities in the field of historic removal data collection, for distribution transformers (Pole Mounted, Pad Mounted, Vault) and poles (Wood, Concrete). This allowed Kinectrics to develop Kingston specific asset degradation curves for these asset groups.

With respect to data quality, Kingston had prepared multiple years of historic data on operation and maintenance of its asset groups at the start of the project. Such data were screened so as to filter out the stale information before being incorporated in ACA study. Kingston kept on data collection work throughout the entire process of ACA study, with ACA study results being used as feedback to calibrate and validate the data collection process. Through communication and interviews between Kingston and Kinectrics, Kingston was able to review and update the information in its inventory, test, operation and maintenance database while incorporating new data from other sources.

V RECOMMENDATIONS

The following recommendations were made based on the study results:

a) In the future, historic records of asset removal need to be collected for all the asset groups, so as to improve the accuracy of asset degaradtion curves.

b) Inspection records at component level need to be collected for UG Primary Cables, so as to improve the input granularity for better assessment of component condition status.

c) Manufacturer Specification limits for contact resistance and operation cycles need to be collected for Station Breakers and Station Ganged Switches, so as to set up the thresholds for assessing breaker and switch usage.

d) Operation cycle counts need to be collected for Station Breakers, for both the normal operation and fault interruption. This will help determine the degradation due to different usage.

e) Inspection and test data for the individual unts under the same asset group need to be merged under one data file for each asset group. This applies to the asset groups inside stations.

f) Underground Cables failures need to be tracked and recorded. Such information could indicate historic trend in cable degradation in the future when sufficient data have been collected. Efforts would be taken to sort such data by cable segments for statistical processing before being incorporated in ACA study.

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VI APPENDIX A: RESULTS FOR EACH ASSET CATEGORY

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1 STATION TRANSFORMERS

1.1 Health Index Formula

Assume a parameter scoring system of 0 through 4, where 0 and 4 represent the "worst" and "best" scores respectively. Thus, the maximum score for any condition or sub-condition parameter (maximum CPS and CPF) is "4".

1.1.1 Condition and Sub-Condition Parameters

Table 1-1 Condition Parameter and Weights – Station Transformers

m	Condition Parameter	WCP_m	Sub-Condition Parameters
1	Internals	5	Table 1-2
2	Insulation	4	Table 1-3
3	Windings	3	Table 1-4
4	Paper	4	Table 1-5
5	Service Record	5	Table 1-6
	Age Limiting	Overall Multiplier	Figure 1-1

Table 1-2 Internals Sub-Condition Parameters and Weights (m=1) – Station Transformers

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	H2	5	Table 1-7
2	CH4	3	Table 1-7
3	C2H6	3	Table 1-7
4	C2H4	3	Table 1-7
5	C2H2	5	Table 1-7

Table 1-3 Insulation Oil Sub-Condition Parameters and Weights (m=2) – Station Transformers

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	Dissipation Factor	2	Table 1-8
2	Moisture	4	Table 1-8
3	Dielectric Strength	5	Table 1-8
4	IFT	3	Table 1-8
5	Acid Number	2	Table 1-8

Table 1-4 Windings Sub-Condition Parameters and Weights (m=3) – Station Transformers

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	TTR	1	Equation 1-1
2	Excitation Current	1	Equation 1-2
3	Winding Resistance	1	Equation 1-3

Table 1-5 Paper Sub-Condition Parameters and Weights (m=4) – Station Transformers

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	Power Factor	5	Table 1-9
2	Insulation Resistance	1	Equation 1-4
3	DGA CO	2	Table 1-7
4	DGA CO2	1	Table 1-7
5	Degree of Polymerisation	3	Table 1-10

Table 1-6 Service Record Sub-Condition Parameters and Weights (m=5) – Station Transformers

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	Loading	1	Table 1-11

1.1.2 Condition Criteria

<u>Oil DGA – Transformer Oil</u>

Table 1-7 DGA Criteria - Transformers

	Dissolved Gas	**Scores**					
		4	**3.2**	**2.4**	**1.6**	**0.8**	**0**
2.5 MVA to 10 MVA	**H2 (Hydrogen)**	X ≤ 70	70 < X ≤ 100	100 < X ≤ 200	200 < X ≤ 400	400 < X ≤ 1000	X >1000
	CH4 (Methane)	X ≤ 70	70 < X ≤ 120	120 < X ≤ 200	200 < X ≤ 400	400 < X ≤ 600	X > 600
	C2H6 (Ethane)	X ≤ 75	75 < X ≤ 100	100 < X ≤ 150	150 < X ≤ 250	250 < X ≤ 500	X > 500
	C2H4 (Ethylene)	X ≤ 60	60 < X ≤ 100	100 < X ≤ 150	150 < X ≤ 250	250 < X ≤ 500	X > 500
	C2H2 (Acetylene)	X ≤ 3	3 < X ≤ 7	7 < X ≤ 35	35 < X ≤ 50	50 < X ≤ 100	X > 100
	CO (Carbon Monoxide)	X ≤ 750	750 < X ≤ 1000	1000 < X ≤ 1300	1300 < X ≤ 1500	1500 < X ≤ 1700	X > 1700
	CO2 (Carbon Dioxide)	X ≤ 7500	7500 < X ≤ 8500	8500 < X ≤ 9000	9000 < X ≤ 12000	12000 < X ≤ 15000	X > 15000
> 10 MVA	**H2 (Hydrogen)**	X ≤40	40 < X ≤ 100	100 < X ≤ 300	300 < X ≤ 500	500 < X ≤ 1000	X >1000
	CH4 (Methane)	X ≤ 80	80 < X ≤ 150	150 < X ≤ 200	200 < X ≤ 500	500 < X ≤ 700	X > 700
	C2H6 (Ethane)	X ≤ 70	70 < X ≤ 100	100 < X ≤ 150	150 < X ≤ 250	250 < X ≤ 500	X > 500
	C2H4 (Ethylene)	X ≤ 60	60 < X ≤ 100	100 < X ≤ 150	150 < X ≤ 250	250 < X ≤ 500	X > 500
	C2H2 (Acetylene)	X ≤ 3	3 < X ≤ 7	7 < X ≤ 35	35 < X ≤ 50	50 < X ≤ 80	X > 80
	CO (Carbon Monoxide)	X ≤ 350	350 < X ≤ 500	500 < X ≤ 600	600 < X ≤ 1000	1000 < X ≤ 1500	X > 1500
	CO2 (Carbon Dioxide)	X ≤ 3000	3000 < X ≤ 4500	4500 < X ≤ 5700	5700 < X ≤ 7500	7500 < X ≤ 10000	X > 10000

General Oil Quality

Table 1-8 Oil Quality Test Criteria

Oil Quality Test		Voltage Class [kV]	Score				
			4	3	2	1	0
Water Content (D1533) [ppm]	Main Tank	V ≤ 69	< 30	30-33.3	33.3-36.6	36.6-40	> 40
		69 < V < 230	< 20	20-25	25-30	30-35	> 35
		V ≥ 230	< 15	15-18.3	18.3-21.6	20-25	> 25
	Tap	V ≤ 69	< 30	30-33.3	33.3-36.6	36.6-40	> 40
		V > 69	< 20	20-25	25-30	30-35	> 35
Dielectric Strength (D1816 – 1mm gap) [kV]	Main Tank	V ≤ 69	> 20	20-17.5	12.5-17.5	10-12.5	< 10
		69 < V < 230	> 25	21-25	17-21	13-17	< 13
		V ≥ 230	> 27	23-27	20-23	17-20	< 17
	Tap	V ≤ 69	> 25	21.6-25	18.3-21.6	15-18.3	< 15
		V > 69	> 30	26-30	22-26	18-22	< 18
Dielectric Strength (D877) [kV]	Main Tank	All	> 40	33.3-40	22.6-33.3	20-22.6	< 20
	Tap	All	> 25	21.6-25	18.3-21.6	15-18.3	< 15
IFT (D971) [dynes/cm]	Main Tank	V ≤ 69	> 25	21.6-25	18.3-21.6	15-18.3	< 15
		69 < V < 230	> 30	26-30	22-26	18-22	< 18
		V ≥ 230	> 32	28-32	24-28	20-24	< 20
	Tap	All	> 25	21.6-25	18.3-21.6	15-18.3	< 15
Color	Main Tank	All	< 1.5	1.5-1.8	1.8-2.1	2.1-2.5	> 2.5
	Tap	All	< 2.0	2.0-2.3	2.3-2.6	2.6-3.0	> 3.0
Acid Number (D974) [mg KOH/g]	Main Tank	V ≤ 69	< 0.05	0.05-0.1	0.1-0.15	0.15-0.2	> 0.2
		69 < V < 230	< 0.04	0.04-0.077	0.077-0.113	0.113-0.15	> 0.15
		V ≥ 230	< 0.03	0.03-0.053	0.053-0.076	0.076-0.1	> 0.1
	Tap	All	< 0.05	0.05-0.1	0.1-0.15	0.15-0.2	> 0.2
Dissipation Factor (D924 - 25C)	Main Tank and Tap	All	< 0.5%	0.5%-1%	1-1.5%	1.5-2%	> 2%
Dissipation Factor (D924 - 100C)		All	< 5%	5%-10%	10%-15%	15%-20%	> 20%

Transformer Turns Ratio (TTR)

The "turns ratio" parameter compares the measured TTR to the expected (calculated) value.

If Maximum TTR varies from the calculated value by more than 0.5%
Then **Score** = 0

Else **Score** = 4

Equation 1-1

Excitation Current

There will be two high readings ($Reading_{High1}$ and $Reading_{High2}$) and one low reading ($Reading_{low}$). Evaluation is done by comparing the two similar high readings.

Score = Max($Score_i$, $Score_2$, …, $Score_t$)

Where

$Score_t$ are scores for different tap positions and

And

If $Reading_{High1}$ or $Reading_{High2}$ > 50 mA
If Variation between $Reading_{High1}$ and $Reading_{High2}$ > 10%
$\mathbf{Score_{tap}}$ = 0
Else $\mathbf{Score_{tap}}$ = 4

Else
If Variation between $Reading_{High1}$ and $Reading_{High2}$ > 5%
$\mathbf{Score_{tap}}$ = 0
Else $\mathbf{Score_{tap}}$ = 4
End if

Equation 1-2

Winding Resistance

The "winding resistance" parameter compares the winding resistance variation between phases in all tap positions.

If Maximum winding resistance variation between three phases across any tap position (LV or HV) is greater than 5% *Then* **Score** = 0

Else **Score** = 4

Equation 1-3

Insulation Resistancet

The "insulation resistance" parameter has 3 readings for insulation resistance from individual windings to ground and between individual windings.

If Minimum insulation resistance $< 1.5 \times \frac{Transformer\ Primary\ Line\ Voltage}{\sqrt{Transformer\ Capacity}}$, *Then* **Score** = 0

Else **Score** = 4

Equation 1-4

Power Factor Test

Table 1-9 Power Factor Test Criteria

Score	Description
4	PF < 0.05%
3	0.05% < PF < 0.5%
2	0.5% < PF < 1%
1	1% < PF < 2%
0	PF >2%

Degree of Polymerisation

Table 1-10 Degree of Polymerisation Criteria

Score	Description
4	DP > 1000
3	800 < DP < 1000
2	450 < DP < 800
1	250 < DP < 450
0	DF < 250

Loading History

Table 1-11 Loading History - Station Transformers

Data: S1, S2, S3, …, SN recorded data (average daily loading)
SB= rated MVA NA=Number of Si/SB which is lower than 0.6 NB= Number of Si/SB which is between 0.6 and 0.8 NC= Number of Si/SB which is between 0.8 and 1.0 ND= Number of Si/SB which is between 1 and 1.2 NE= Number of Si/SB which is greater than 1.2 Score = $\frac{NA \times 4 + NB \times 3 + NC \times 2 + ND \times 1}{N}$

Age Limiting Factor

In this project, age was used as a limiting factor to reflect the degradation of asset unit as time passed by.

The calculated overall HI result (after taking into account all the possible de-rating multipliers) is then compared with an age limiting factor.

$$Final\ overall\ HI = \begin{cases} HI_{calculated} & if\ HI_{calculated} <= Age\_Limiter \\ Age\_limiter & if\ HI_{calculated} > Age\_Limiter \end{cases}$$

The age derating is the Weibull survival function (1 – cumulative distribution function), assuming it could be modeled by the Weibull distribution.

$$Age\_Derating = S_f = e^{-(\frac{x}{\alpha})^{\beta}}$$

Equation 1-5

S_f = survivor function
x = age in years
α *= constant that controls scale of function*
β *= constant that controls shape of function*

In this project, the parameters of Station Transformers age limiting curve are shown in the following table, based on Kingston expert feedback.

Table 1-12 Age Limiting Curve Parameters - Station Transformers

Asset Type	α	β
Station Transformers	**58.1804**	**9.8989**

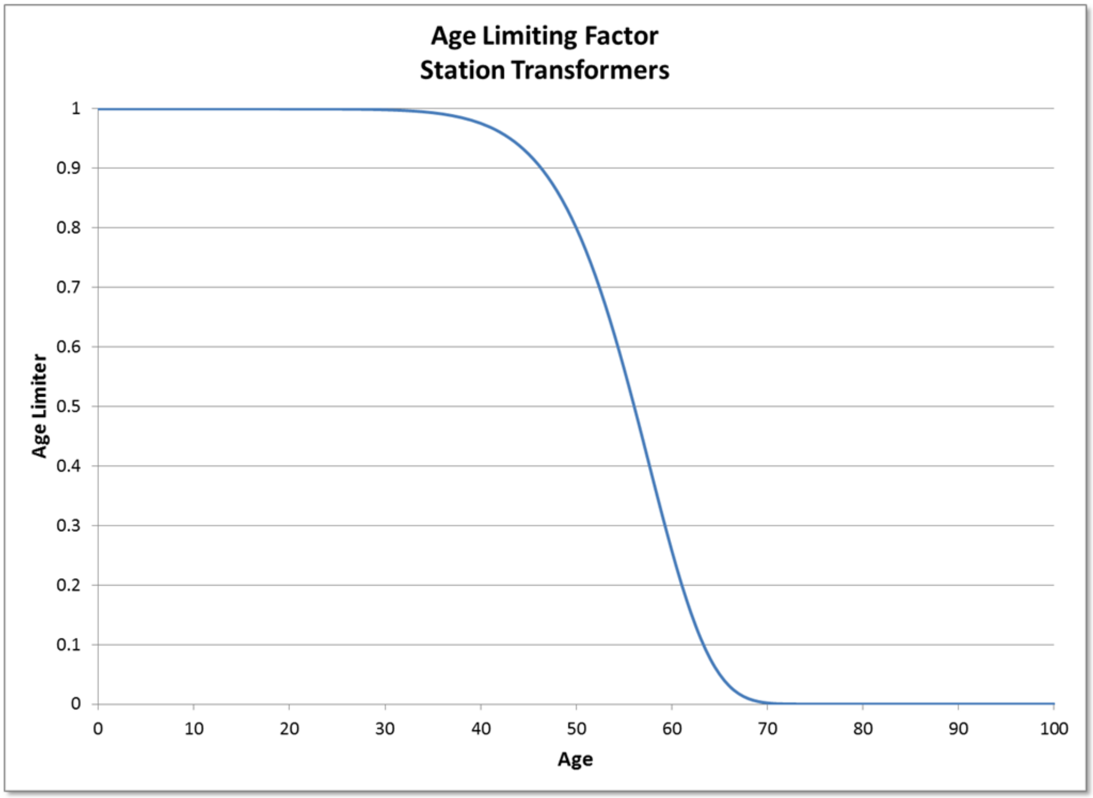

Figure 1-1 Age Limiting Factor Criteria - - Station Transformers

1.2 Age Distribution

The average age was 43 for Station Transformers. The age distribution was as follows.

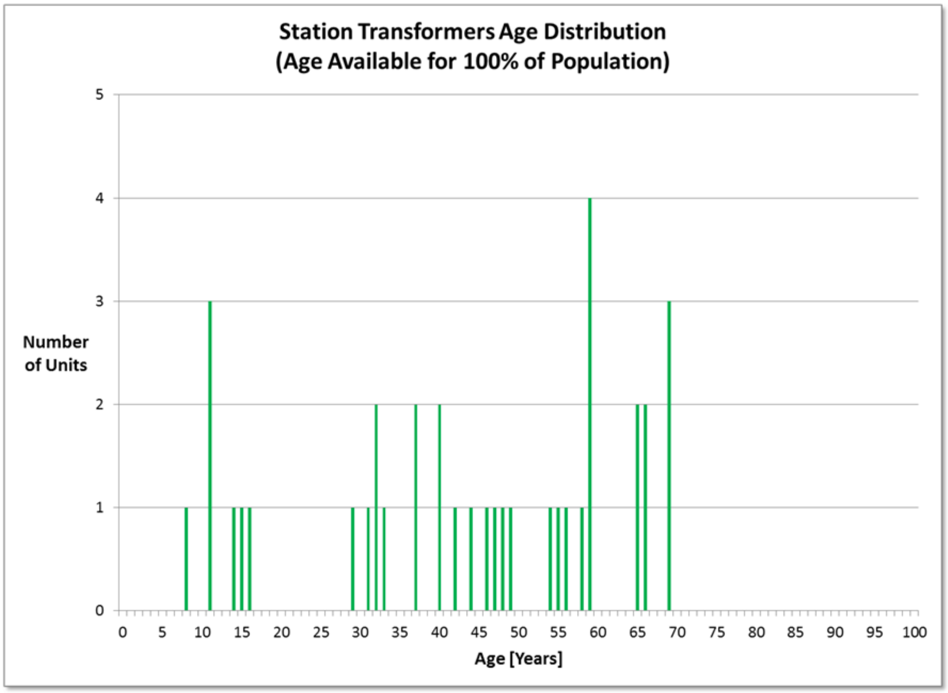

Figure 1-2 Age Distribution –Station Transformers

1.3 Health Index Results

There were 37 units of Station Transformers. All of them had sufficient data for a Health Indexing.

The average Health Index was 63%.

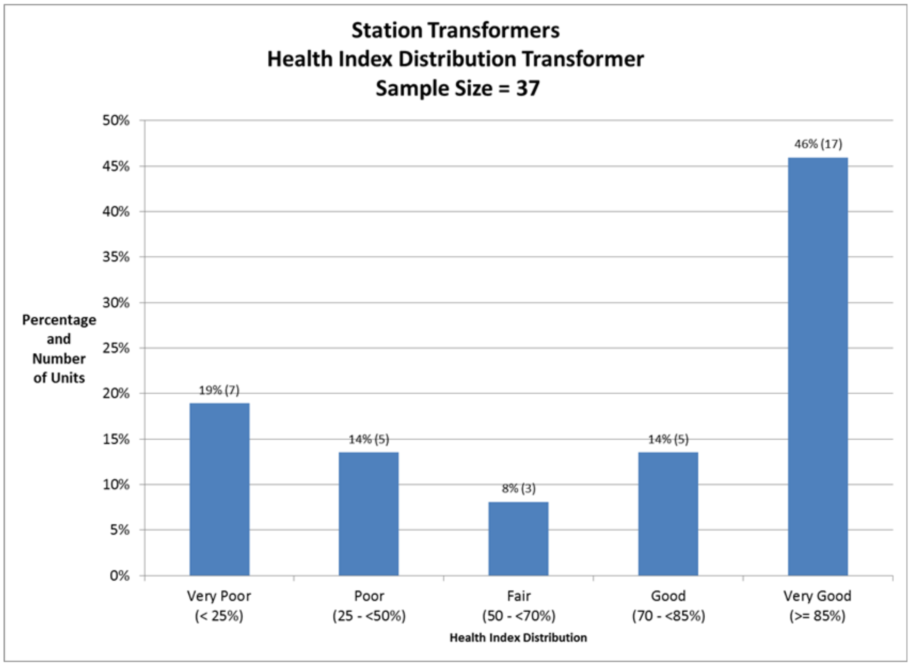

Figure 1-3 Health Index Distribution –Station Transformers

1.4 Flagged for Action Plan

As it is assumed that Station Transformers are proactively replaced, the risk assessment and flag-for-action plan procedure described in Section II.2.3 was applied for this asset class.

As noted in Section II, a unit becomes a candidate for replacement when its risk, product of its *probability of failure* and *criticality*, is greater than or equal to a pre-set minimum risk value. The probability of failure is as determined by the Health Index. Criticality is determined as shown in the following section. The minimum risk value in this study is defined as 1.25*95% = 1.1875.

The minimum criticality, $Criticality_{min}$, is 1.25. This value is selected such that a unit with a probability of failure of 80% becomes a candidate for replacement (i.e. 80% * 1.25 = 1). The maximum criticality, $Criticality_{max,}$ is twice the base criticality ($Criticality_{max,}$ = 1.25*2 = 2.5).

Each unit's criticality is defined as follows:

$$Criticality = (Criticality_{max} - Criticality_{min})*Criticality\_Multiple + Criticality_{min}$$

where the Criticality_Multiple (CM) is defined by criticality factors, weights, and scores:

$$CM = \frac{\sum_{CF=1}^{\forall CF}(CFS_{CF} \times WCF_{CF})}{\sum_{CF=1}^{\forall CF}(WCF_{CF})}$$

Where

CFS	Criticality Factor Score
WCF	Weight of Condition Factor

The factors, weights and the score system of each factor are as follows:

Table 1-13 Criticality Factors

Criticality Factor (CF)	Description	Weight (WCF)	Score (CFS)	
Load criticality	--- Number of customers --- Customer importance (e.g. hospitals, provincial buildings, restoration time sensitive customers)	30	Low	0
			High	1
Physical Protection	oil containment, blast wall, deluge system	15	Yes	0
			No	1
Location	public exposure, environmental impact	15	No	0
			Yes	1
Expected Outage Duration	Back-up unit unavailable, alternate feeds unavailable	20	No	0
			Yes	1
Operation & Maintenance	--- obsolescence of spare parts (e.g. manufacturers cease to produce old types of spare parts) --- known issues (e.g. not economical to have routine maintenance)	20	No	0
			Yes	1

The flagged for action plan was as follows:

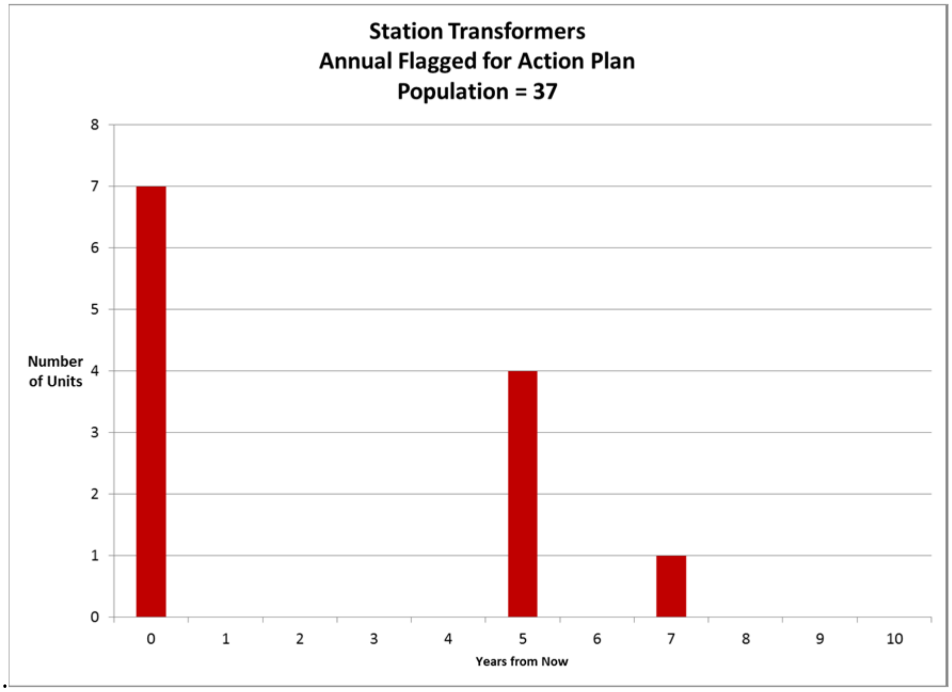

Figure 1-4 Flagged for Action Plan - Station Transformers

1.5 Risk Based Prioritized List

The following table shows the risk based prioritization lists.

Table 1-14 Risk Based Prioritization List - Station Transformers

Rank	0% = least critical 100% = most critical	ID	Substation	Position	MVA	Age	DAI	HI by condition	HI	Risk Index 100% = Most Risk 0% = Least Risk	FFA Year
1	17%	MS1-T4	1	4	3	69	76%	88%	0%	86.0%	0
2	17%	MS1-T1	1	1	3	66	48%	100%	3%	86.0%	0
3	15%	MS5-T3	5	3	3	69	76%	94%	0%	85.7%	0
4	15%	MS17-T1	17	1	3	66	75%	77%	3%	85.7%	0
5	15%	MS5-T2	5	2	3	65	71%	84%	5%	85.7%	0
6	15%	MS5-T1	5	1	3	65	95%	63%	5%	85.7%	0
7	12%	MS8-T2	8	2	5	69	76%	90%	0%	85.3%	0
8	25%	MS1-T6	1	6	3	59	71%	94%	32%	85.0%	5
9	17%	MS1-T3	1	3	3	59	48%	95%	32%	83.8%	5
10	17%	MS1-T2	1	2	3	59	52%	86%	32%	83.8%	5
11	15%	MS6-T2	6	2	5	59	95%	90%	32%	83.5%	5
12	25%	MS1-T5	1	5	3	58	71%	99%	38%	79.6%	7
13	17%	MS9-T2	9	2	7.5	56	71%	55%	50%	52.1%	13
14	15%	MS6-T3	6	3	5	55	71%	92%	56%	36.4%	16
15	20%	MS11-T2	11	2	7.5	54	95%	93%	62%	21.1%	19
16	20%	MS14-T1	14	1	7.5	16	71%	71%	71%	7.7%	>20
17	12%	MS8-T3	8	3	7.5	14	95%	81%	81%	1.1%	>20
18	40%	MS10-T2	10	2	7.5	49	71%	98%	83%	0.7%	>20
19	25%	MS16-T2	16	2	6	11	71%	84%	84%	0.7%	>20
20	17%	MS9-T1	9	1	7.5	48	95%	83%	83%	0.7%	>20
21	40%	MS2-T2	2	2	7.5	40	95%	85%	85%	0.5%	>20
22	40%	MS13-T1	13	1	7.5	32	71%	88%	88%	0.3%	>20
23	40%	MS12-T1	12	1	7.5	47	71%	97%	89%	0.2%	>20
24	40%	MS3-T1	3	1	7.5	31	94%	89%	89%	0.2%	>20
25	15%	MS4-T2	4	2	5	46	71%	92%	91%	0.1%	>20
26	40%	MS15-T1	15	1	7.5	33	71%	93%	93%	0.1%	>20
27	15%	MS3-T2	3	2	7.5	29	95%	93%	93%	0.1%	>20
28	25%	MS11-T1	11	1	7.5	44	94%	94%	94%	0.1%	>20
29	15%	MS4-T3	4	3	7.5	15	71%	94%	94%	0.0%	>20
30	40%	MS12-T2	12	2	7.5	32	71%	95%	95%	0.0%	>20
31	40%	MS16-T1	16	1	6	11	48%	95%	95%	0.0%	>20
32	25%	MS2-T1	2	1	7.5	40	71%	95%	95%	0.0%	>20
33	15%	MS7-T1	7	1	6.6	37	94%	95%	95%	0.0%	>20
34	15%	MS7-T2	7	2	9.2	37	94%	95%	95%	0.0%	>20
35	17%	MS10-T1	10	1	7.5	42	71%	99%	96%	0.0%	>20
36	15%	MS4-T1	4	1	7.5	8	71%	98%	98%	0.0%	>20
37	15%	MS16-T3	16	3	6	11	67%	100%	100%	0.0%	>20

Note: **MS5-T1 is to be replaced with MS4-T2 (relocated on MS5 site since 2018)**
MS4-T1 was scrapped in 2019
MS17-T1 is to be scrapped in 2020

1.6 Data Gaps

Data for Station Transformers included age, loading, oil and various transformer test results. The following table shows the data gaps.

Table 1-15 Data Gap for Station Transformers

Data Gap (Sub-Condition Parameter)	**Parent Condition Parameter**	**Priority**	**Description**	**Source of Data**
Bushing PF, Dielectric Loss, Capacitance	Bushings	☆☆	Insulation degradation or defects for bushings	Testing
Partial Discharge		☆☆		
Oil Level		☆	Low oil level	Maintenance and/or Inspection records
Radiators, Coolers Fans	Cooling System	☆☆	Defect due to installation	Maintenance and/or Inspection records
Conservator, Tank Breather	Oil Storage	☆	Defect due to installation	Maintenance and/or Inspection records
Historic Removal Record		☆☆☆	Age at removal	Inventory Database

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2 STATION BREAKERS

2.1 Health Index Formula

Assume a parameter scoring system of 0 through 4, where 0 and 4 represent the "worst" and "best" scores respectively. Thus, the maximum score for any condition or sub-condition parameter (maximum CPS and CPF) is "4".

2.1.1 Condition and Sub-Condition Parameters

Table 2-1 Condition Parameter and Weights – Station Breakers

m	Condition Parameter	WCP_m				Sub-Condition Parameters
		Oil	SF6	Air	Vac	
1	Operating Mechanism	14	11	14	11	Table 2-2
2	Contact Performance	7	7	7	7	Table 2-3
3	Arc Extinction	9	5	5	5	Table 2-4
4	Insulation	5	5	5	5	Table 2-5
	Age Limiting					Figure 2-1

Table 2-2 Operating Mechanism Sub-Condition Parameters and Weights (m=1) – Station Breakers

n	Sub-Condition Parameter	$WCPF_n$				Condition Criteria Table
		Oil	SF6	Air	Vac	
1	Lubrication	9	7	9	7	Table 2-6
2	Mechanism Linkage	5	4	5	4	Table 2-6
	Operating Mechanism Derating - Multiplier					Table 2-8

Table 2-3 Contact Performance Sub-Condition Parameters and Weights (m=2) – Station Breakers

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	Main Contact	1	Table 2-6
2	Trip Timing	2	Table 2-6
3	Contact Resistance	1	Table 2-7

Table 2-4 Arc Extinction Sub-Condition Parameters and Weights (m=3) – Station Breakers

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	Interrupter	1	Table 2-6

Table 2-5 Insulation Sub-Condition Parameters and Weights (m=4) – Station Breakers

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	Bushing Insulation	1	Table 2-6
2	Insulator	1	Table 2-6

2.1.2 Condition Criteria

Individual Inspection

The score based on individual inspection in the past years is calculated as:

$$Average\ Score = \frac{\sum W_i Score_i}{\sum W_i}$$

Equation 2-1

Where *i* represents the year of inspection

Table 2-6 Individual Inspection Criteria - Station Breakers

Score	Inspection Input
4	A (Acceptable)
2	C (Corrected)
1	N (Needs Repair)

And the weights for different inspection years are as follows

Year (i)	Weight (W_i)
2019	1
2018	0.9
2017	0.8
2016	0.7
2015	0.6
2014	0.5
2013	0.4
2012	0.3
2011	0.2
2010	0.1
2009	0

Contact Resistance

Contact resistance test results of breaker are checked against the maximum allowable specification limits.

Table 2-7 Contact Resistance Results Criteria - Station Breakers

Score (SCPS)	"Test Results" Description
4	Measurement Reading $\leq$ 80% Specification Limit
3	Measurement Reading $\in$(80%, 100%] Specification Limit
1	Measurement Reading $\in$ (100%, 120%] Specification Limit
0	Measurement Reading > 120% Specification Limit

Where the specification limits for different types of breakers at different voltage levels are as follows:

Voltage	Contact Resistance Specification Limits (uOhm)			
	Oil	**SF6**	**Air**	**Vacuum**
0 – 69 kV	300	150	150	250
115 kV	600			
>= 230 kV	900			

Operating Mechanism Derating

Table 2-8 Operating mechanism Derating Criteria - Station Breakers

Score	"CM Count" Value
Spring	1
Spring / Pneumatic	0.9
Pneumatic	0.8
Hydraulic	0.6
Store Energy	1

Age Limiting Factor

Age was used as a limiting factor to reflect the degradation of asset unit as time passed by. Refer to section 1.1.2 for principle.

In this project, the parameters of Station Breakers age limiting curve are shown in the following table, based on subject matter expert feedback from Kingston.

Table 2-9 Age Limiting Curve Parameters - Station Breakers

Asset Type	α	β
Station Breakers	**55.6475**	**7.0627**

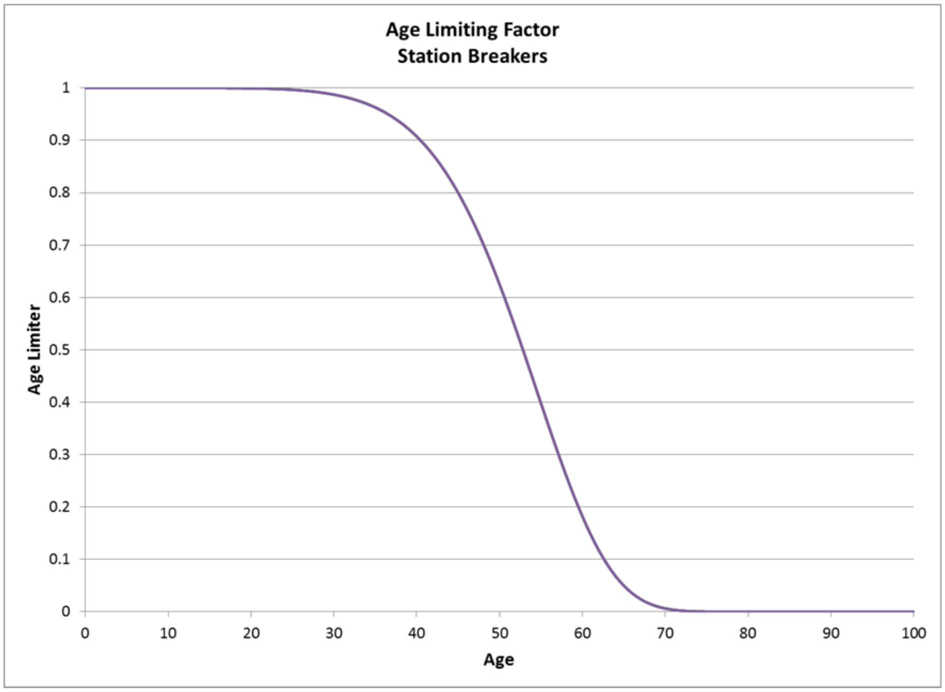

Figure 2-1 Age Limiting Factor Criteria - - Station Breakers

2.2 Age Distribution

The average age was 34. The age distribution was as follows.

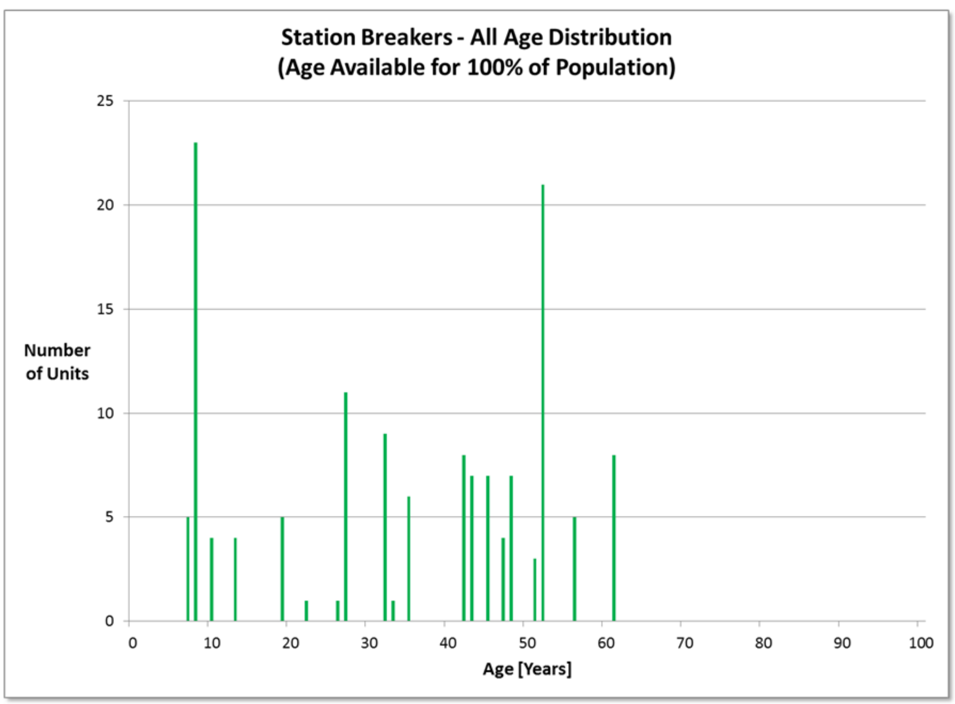

Figure 2-2 Age Distribution –Station Breakers

2.3 Health Index Results

There were 140 units of Station Breakers. All of them had sufficient data for a Health Indexing.

The average Health Index was 74%.

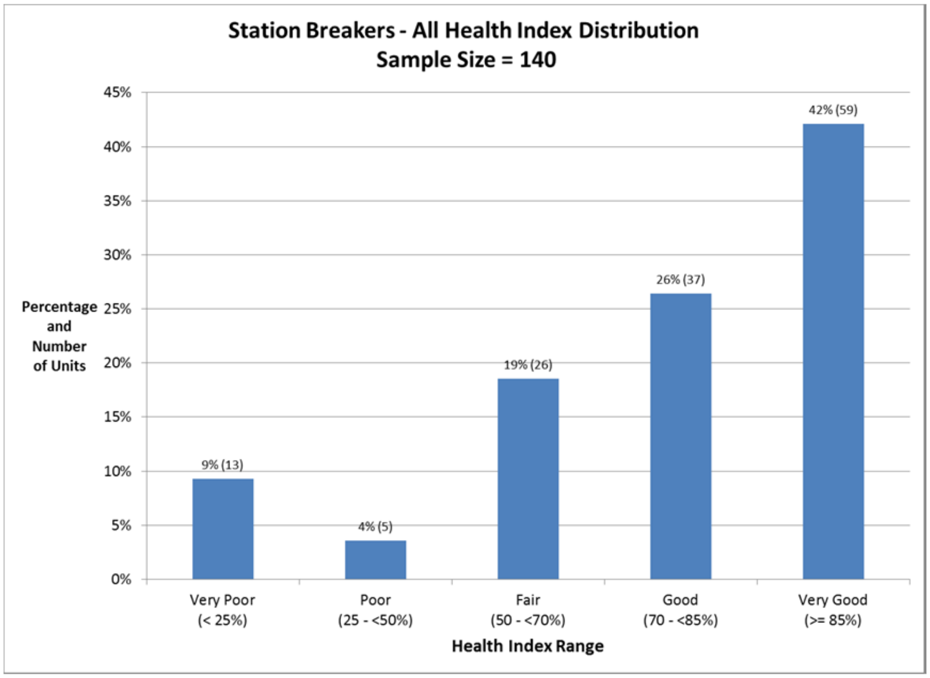

Figure 2-3 Health Index Distribution –Station Breakers

2.4 Flagged for Action Plan

As it is assumed that Station Breakers are proactively replaced, the risk assessment and flag-for-action plan procedure described in Section II.2.3 was applied for this asset class.

As the criticality information for Station Breakers is unavailable, a unit becomes a candidate for replacement when its cumulative probability of failure is greater than or equal to 80%. The probability of failure is as determined by the Health Index.

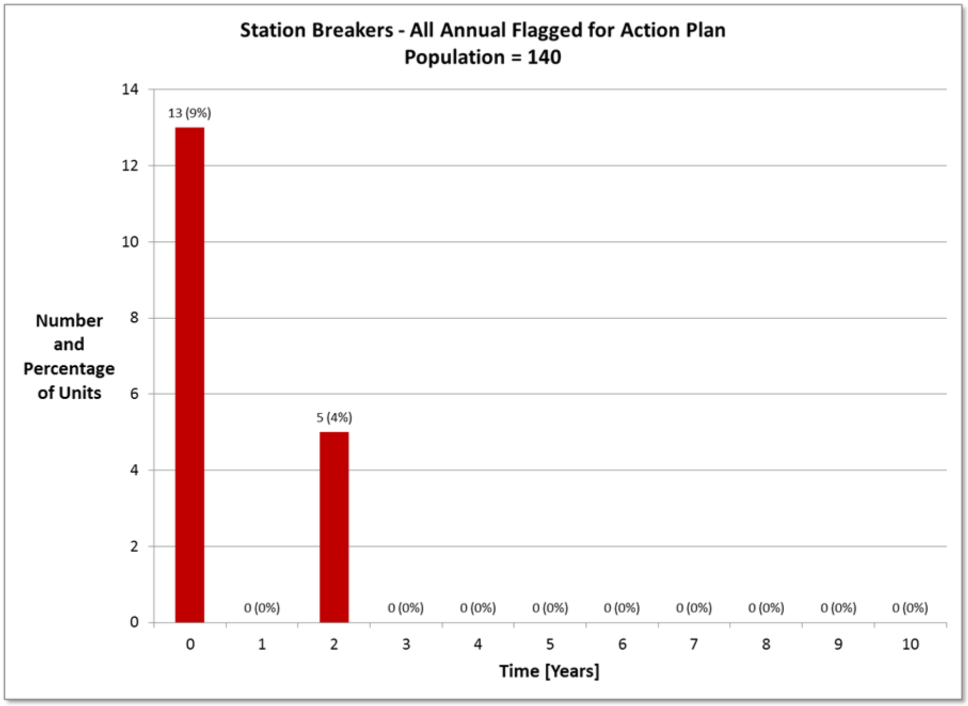

Figure 2-4 Flagged for Action Plan - Station Breakers

2.5 Risk Based Prioritized List

The following table shows the risk based prioritization lists.

Table 2-10 Risk Based Prioritization List - Station Breakers

Rank	Station ID	Location	Station Address	Interruption Medium	Age	DAI	HI (Final)	Risk Index 100%=Most Risk 0% = Least Risk	FFA Year
1	4BUS TIE	BUS TIE	196 Hillendale Ave.	Oil	61	0.0%	14.8	83.3%	0
2	4407	407	196 Hillendale Ave.	Oil	61	0.0%	14.8	83.3%	0
3	4408	408	196 Hillendale Ave.	Oil	61	0.0%	14.8	83.3%	0
4	4409	409	196 Hillendale Ave.	Oil	61	0.0%	14.8	83.3%	0
5	5F1	F1	3 Festubert St.	Air	61	0.0%	14.8	83.3%	0
6	5F2	F2	3 Festubert St.	Air	61	0.0%	14.8	83.3%	0
7	5F3	F3	3 Festubert St.	Air	61	0.0%	14.8	83.3%	0
8	5F4	F4	3 Festubert St.	Air	61	0.0%	14.8	83.3%	0
9	5501RECLOSER	501RECLOSER	3 Festubert St.	Vacuum	19	0.0%	25.0	83.3%	0
10	5503RECLOSER	503RECLOSER	3 Festubert St.	Vacuum	19	0.0%	25.0	83.3%	0
11	5504RECLOSER	504RECLOSER	3 Festubert St.	Vacuum	19	0.0%	25.0	83.3%	0
12	5505RECLOSER	505RECLOSER	3 Festubert St.	Vacuum	19	0.0%	25.0	83.3%	0
13	171701RECLOSER	1701RECLOSER	268 Dalton Ave.	Vacuum	19	0.0%	25.0	83.3%	0
14	9902	902	40 Division St.	Air	56	69.6%	35.1	78.0%	2
15	9908	908	40 Division St.	Air	56	87.5%	35.1	78.0%	2
16	9905	905	40 Division St.	Air	56	100.0%	35.1	78.0%	2
17	9906	906	40 Division St.	Air	56	100.0%	35.1	78.0%	2
18	9907	907	40 Division St.	Air	56	100.0%	35.1	78.0%	2
19	1T1-CB	T1-CB	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
20	1T2-CB	T2-CB	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
21	1T3-CB	T3-CB	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
22	1T4-CB	T4-CB	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
23	1T5-CB	T5-CB	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
24	1T6-CB	T6-CB	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
25	1BUS TIE	BUS TIE	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
26	1TRANSFER BUS1	TRANSFER BUS1	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
27	1TRANSFER BUS2	TRANSFER BUS2	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
28	1102	102	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
29	1103	103	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
30	1104	104	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
31	1105	105	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
32	1106	106	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
33	1107	107	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
34	1108	108	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
35	1109	109	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
36	1110	110	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
37	1111	111	29 Queen St.	Air	52	0.0%	53.8	42.1%	13

Rank	Station ID	Location	Station Address	Interruption Medium	Age	DAI	HI (Final)	Risk Index 100%=Most Risk 0% = Least Risk	FFA Year
38	1112	112	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
39	1113	113	29 Queen St.	Air	52	0.0%	53.8	42.1%	13
40	9901	901	40 Division St.	Air	51	69.6%	58.3	29.0%	16
41	9903	903	40 Division St.	Air	51	69.6%	58.3	29.0%	16
42	9904	904	40 Division St.	Air	51	87.5%	58.3	29.0%	16
43	8809	809	680 Bagot St.	Air	48	100.0%	65.0	14.4%	>20
44	6608	608	63 Centre St.	Air	45	87.5%	68.2	9.7%	>20
45	8BUS TIE	BUS TIE	680 Bagot St.	Air	48	0.0%	70.3	7.5%	>20
46	8804	804	680 Bagot St.	Air	48	0.0%	70.3	7.5%	>20
47	8807	807	680 Bagot St.	Air	48	0.0%	70.3	7.5%	>20
48	8808	808	680 Bagot St.	Air	48	0.0%	70.3	7.5%	>20
49	8805	805	680 Bagot St.	Air	48	100.0%	70.3	7.5%	>20
50	8806	806	680 Bagot St.	Air	48	100.0%	70.3	7.5%	>20
51	6606	606	63 Centre St.	Air	45	87.5%	70.4	7.5%	>20
52	7702	702	67 Mary St.	Air	43	100.0%	70.4	7.5%	>20
53	7704	704	67 Mary St.	Air	43	100.0%	70.4	7.5%	>20
54	7706	706	67 Mary St.	Air	43	100.0%	70.4	7.5%	>20
55	6607	607	63 Centre St.	Air	45	87.5%	70.7	7.5%	>20
56	6BUS TIE	BUS TIE	63 Centre St.	Air	45	100.0%	71.4	6.2%	>20
57	6605	605	63 Centre St.	Air	45	100.0%	71.4	6.2%	>20
58	7701	701	67 Mary St.	Air	43	100.0%	71.7	6.2%	>20
59	7705	705	67 Mary St.	Air	43	100.0%	71.7	6.2%	>20
60	121204	1204	876 Johnson St.	Air	47	6.3%	73.8	4.6%	>20
61	121201	1201	876 Johnson St.	Air	47	87.5%	73.8	4.6%	>20
62	121202	1202	876 Johnson St.	Air	47	87.5%	73.8	4.6%	>20
63	121203	1203	876 Johnson St.	Air	47	87.5%	73.8	4.6%	>20
64	7703	703	67 Mary St.	Air	43	100.0%	75.5	3.4%	>20
65	121205	1205	876 Johnson St.	Air	32	87.5%	77.7	2.4%	>20
66	121206	1206	876 Johnson St.	Air	32	87.5%	77.7	2.4%	>20
67	121207	1207	876 Johnson St.	Air	32	87.5%	77.7	2.4%	>20
68	121208	1208	876 Johnson St.	Air	32	87.5%	77.7	2.4%	>20
69	6609	609	63 Centre St.	Air	45	0.0%	80.0	1.3%	>20
70	6604	604	63 Centre St.	Air	45	100.0%	80.0	1.3%	>20
71	7BUS TIE	BUS TIE	67 Mary St.	Air	43	100.0%	80.0	1.3%	>20
72	9910	910	40 Division St.	Air	26	75.9%	80.4	1.3%	>20
73	2201	201	619 Brock St.	Vacuum	27	79.0%	80.6	1.3%	>20
74	111105	1105	60 Notch Hill Rd.	Vacuum	8	62.0%	80.6	1.3%	>20
75	111108	1108	60 Notch Hill Rd.	Vacuum	8	62.0%	80.6	1.3%	>20
76	101008	1008	260 Wilson St.	Air	42	100.0%	80.8	1.3%	>20
77	101003	1003	260 Wilson St.	Air	42	100.0%	81.9	1.0%	>20
78	101002	1002	260 Wilson St.	Air	42	100.0%	83.1	0.7%	>20
79	9909	909	40 Division St.	Air	33	100.0%	83.9	0.7%	>20
80	101005	1005	260 Wilson St.	Air	42	87.5%	84.1	0.5%	>20
81	101006	1006	260 Wilson St.	Air	42	87.5%	84.1	0.5%	>20
82	2203	203	619 Brock St.	Vacuum	27	86.0%	86.0	0.3%	>20

Rank	Station ID	Location	Station Address	Interruption Medium	Age	DAI	HI (Final)	Risk Index 100%=Most Risk 0% = Least Risk	FFA Year
83	2204	204	619 Brock St.	Vacuum	27	86.0%	86.0	0.3%	>20
84	2205	205	619 Brock St.	Vacuum	27	86.0%	86.0	0.3%	>20
85	2206	206	619 Brock St.	Vacuum	27	86.0%	86.0	0.3%	>20
86	2207	207	619 Brock St.	Vacuum	27	86.0%	86.0	0.3%	>20
87	2208	208	619 Brock St.	Vacuum	27	86.0%	86.0	0.3%	>20
88	2T2-CB	T2-CB	619 Brock St.	Vacuum	27	86.0%	86.0	0.3%	>20
89	2BUS TIE	BUS TIE	619 Brock St.	Vacuum	27	86.0%	86.0	0.3%	>20
90	101004	1004	260 Wilson St.	Air	42	87.5%	87.2	0.3%	>20
91	101007	1007	260 Wilson St.	Air	42	87.5%	87.2	0.3%	>20
92	101009	1009	260 Wilson St.	Air	42	87.5%	87.2	0.3%	>20
93	4401	401	196 Hillendale Ave.	Air	35	0.0%	96.3	0.0%	>20
94	4402	402	196 Hillendale Ave.	Air	35	0.0%	96.3	0.0%	>20
95	4403	403	196 Hillendale Ave.	Air	35	0.0%	96.3	0.0%	>20
96	4404	404	196 Hillendale Ave.	Air	35	0.0%	96.3	0.0%	>20
97	4405	405	196 Hillendale Ave.	Air	35	0.0%	96.3	0.0%	>20
98	4406	406	196 Hillendale Ave.	Air	35	0.0%	96.3	0.0%	>20
99	131301	1301	640 McDonnel St.	Air	32	0.0%	98.0	0.0%	>20
100	131302	1302	640 McDonnel St.	Air	32	0.0%	98.0	0.0%	>20
101	131303	1303	640 McDonnel St.	Air	32	0.0%	98.0	0.0%	>20
102	131304	1304	640 McDonnel St.	Air	32	0.0%	98.0	0.0%	>20
103	13T1-CB	T1-CB	640 McDonnel St.	Air	32	0.0%	98.0	0.0%	>20
104	2202	202	619 Brock St.	Vacuum	27	0.0%	99.4	0.0%	>20
105	2T1-CB	T1-CB	619 Brock St.	Vacuum	27	0.0%	99.4	0.0%	>20
106	9900	900	40 Division St.	Vacuum	22	86.0%	99.9	0.0%	>20
107	141400RECLOSER	1400RECLOSER	60 Lappans Lane	Vacuum	13	0.0%	100.0	0.0%	>20
108	141401RECLOSER	1401RECLOSER	60 Lappans Lane	Vacuum	13	0.0%	100.0	0.0%	>20
109	141402RECLOSER	1402RECLOSER	60 Lappans Lane	Vacuum	13	0.0%	100.0	0.0%	>20
110	141403RECLOSER	1403RECLOSER	60 Lappans Lane	Vacuum	13	0.0%	100.0	0.0%	>20
111	161601RECLOSER	1601RECLOSER	132 Dalton Ave.	Vacuum	10	0.0%	100.0	0.0%	>20
112	161602RECLOSER	1602RECLOSER	132 Dalton Ave.	Vacuum	10	0.0%	100.0	0.0%	>20
113	161603RECLOSER	1603RECLOSER	132 Dalton Ave.	Vacuum	10	0.0%	100.0	0.0%	>20
114	161604RECLOSER	1604RECLOSER	132 Dalton Ave.	Vacuum	10	0.0%	100.0	0.0%	>20
115	3304	304	135 Railway St.	Vacuum	8	0.0%	100.0	0.0%	>20
116	3306	306	135 Railway St.	Vacuum	8	0.0%	100.0	0.0%	>20
117	3307	307	135 Railway St.	Vacuum	8	0.0%	100.0	0.0%	>20
118	3308	308	135 Railway St.	Vacuum	8	0.0%	100.0	0.0%	>20
119	11T2-CB	T2-CB	60 Notch Hill Rd.	Vacuum	8	0.0%	100.0	0.0%	>20
120	111102	1102	60 Notch Hill Rd.	Vacuum	8	7.0%	100.0	0.0%	>20
121	111103	1103	60 Notch Hill Rd.	Vacuum	8	7.0%	100.0	0.0%	>20
122	111104	1104	60 Notch Hill Rd.	Vacuum	8	7.0%	100.0	0.0%	>20
123	111107	1107	60 Notch Hill Rd.	Vacuum	8	7.0%	100.0	0.0%	>20
124	111109	1109	60 Notch Hill Rd.	Vacuum	8	7.0%	100.0	0.0%	>20
125	11T1-CB	T1-CB	60 Notch Hill Rd.	Vacuum	8	7.0%	100.0	0.0%	>20

Rank	Station ID	Location	Station Address	Interruption Medium	Age	DAI	HI (Final)	Risk Index 100%=Most Risk 0% = Least Risk	FFA Year
126	11BUS TIE	BUS TIE	60 Notch Hill Rd.	Vacuum	8	7.0%	100.0	0.0%	>20
127	111106	1106	60 Notch Hill Rd.	Vacuum	8	62.0%	100.0	0.0%	>20
128	111101	1101	60 Notch Hill Rd.	Vacuum	8	69.0%	100.0	0.0%	>20
129	3301	301	135 Railway St.	Vacuum	8	76.0%	100.0	0.0%	>20
130	3302	302	135 Railway St.	Vacuum	8	76.0%	100.0	0.0%	>20
131	3303	303	135 Railway St.	Vacuum	8	76.0%	100.0	0.0%	>20
132	3305	305	135 Railway St.	Vacuum	8	76.0%	100.0	0.0%	>20
133	3T1-CB	T1-CB	135 Railway St.	Vacuum	8	76.0%	100.0	0.0%	>20
134	3T2-CB	T2-CB	135 Railway St.	Vacuum	8	76.0%	100.0	0.0%	>20
135	3BUS TIE	BUS TIE	135 Railway St.	Vacuum	8	76.0%	100.0	0.0%	>20
136	151501	1501	20 Esdon St.	Vacuum	7	0.0%	100.0	0.0%	>20
137	151502	1502	20 Esdon St.	Vacuum	7	0.0%	100.0	0.0%	>20
138	151503	1503	20 Esdon St.	Vacuum	7	0.0%	100.0	0.0%	>20
139	151504	1504	20 Esdon St.	Vacuum	7	0.0%	100.0	0.0%	>20
140	15T1-CB	T1-CB	20 Esdon St.	Vacuum	7	0.0%	100.0	0.0%	>20

Note **Units 407 to 409 and bus tie at station of 196 Hillendale Ave were replaced in 2019**

2.6 Data Gaps

Data for Station Breakers included age, contact resistance test results, visual inspection records. The following table shows the data gaps.

Table 2-11 Data Gap for Station Breakers

Data Gap (Sub-Condition Parameter)	Parent Condition Parameter	Priority	Description	Source of Data
Cabinet	Operating Mechanism	★	Control cabinet issue	Inspection/ Maintenance Records
Arcing Contact	Contact performance	★★	Arc contact worn-out	Inspection/ Maintenance Records
Heater	Arc Extinction	★	Space heater issue	Inspection/ Maintenance Records
Interruption Medium		★★	Leak/moisture	Inspection/Test
Power Factor	Insulation	★★	Insulation degradation	Test
Operating Count	Service Record	★★	Moisture infiltration	Operation records
Historic Removal Record		★★★	Age at removal	Inventory Database

3 STATION GANGED SWITCHES

3.1 Health Index Formula

Assume a parameter scoring system of 0 through 4, where 0 and 4 represent the "worst" and "best" scores respectively. Thus, the maximum score for any condition or sub-condition parameter (maximum CPS and CPF) is "4".

3.1.1 Condition and Sub-Condition Parameters

Table 3-1 Condition Parameter and Weights – Station Ganged Switches

m	Condition Parameter	WCP_m	Sub-Condition Parameters
1	Operating Mechanism	14	Table 3-2
2	Contact Performance	7	Table 3-3
3	Arc Extinction	9	Table 3-4
4	Insulation	2	Table 3-5
	Age Limiting		Figure 3-1

Table 3-2 Operating Mechanism Sub-Condition Parameters and Weights (m=1) – Station Ganged Switches

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	Lubrication	9	Table 3-6
2	Mechanism Linkage	5	Table 3-6
3	Cabinet	2	Table 3-6

Table 3-3 Contact Performance Sub-Condition Parameters and Weights (m=2) – Station Ganged Switches

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	Main Contact	1	Table 3-6
2	Trip Timing	2	Table 3-6
3	Contact Resistance	1	Table 3-7

Table 3-4 Arc Extinction Sub-Condition Parameters and Weights (m=3) – Station Ganged Switches

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	Interrupter	1	Table 3-6

Table 3-5 Insulation Sub-Condition Parameters and Weights (m=4) – Station Ganged Switches

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	Bushing Insulation	1	Table 3-6
2	Insulator	1	Table 3-6

3.1.2 Condition Criteria

Individual Inspection

The score based on individual inspection in the past years is calculated as:

$$Average\ Score = \frac{\sum W_i Score_i}{\sum W_i}$$

Equation 3-1

Where *i* represents the year of inspection

Table 3-6 Individual Inspection Criteria - Station Ganged Switches

Score	Inspection Input
3	A (Acceptable)
2	C (Corrected)
1	N (Needs Repair)

And the weights for different inspection years are as follows

Year (i)	Weight (W_i)
2019	1
2018	0.9
2017	0.8
2016	0.7
2015	0.6
2014	0.5
2013	0.4
2012	0.3
2011	0.2
2010	0.1
2009	0

Contact Resistance

Contact resistance test results of breaker are checked against the maximum allowable specification limits.

Table 3-7 Contact Resistance Results Criteria - Station Ganged Switches

Score (SCPS)	"Test Results" Description
4	Measurement Reading $\leq$ 80% Specification Limit
3	Measurement Reading $\in$(80%, 100%] Specification Limit
1	Measurement Reading $\in$ (100%, 120%] Specification Limit
0	Measurement Reading > 120% Specification Limit

Where the specification limits for different types of breakers at different voltage levels are as follows:

Voltage	Contact Resistance Specification Limits (uOhm)			
	Oil	**SF6**	**Air**	**Vacuum**
0 – 69 kV	300	150	150	250
115 kV	600			
>= 230 kV	900			

Age Limiting Factor

Age was used as a limiting factor to reflect the degradation of asset unit as time passed by. Refer to section 1.1.2 for principle.

In this project, the parameters of Station Ganged Switches age limiting curve are shown in the following table, based on subject matter expert feedback from Kingston.

Table 3-8 Age Limiting Curve Parameters - Station Ganged Switches

Asset Type	α	β
Station Ganged Switches	**55.6475**	**7.0627**

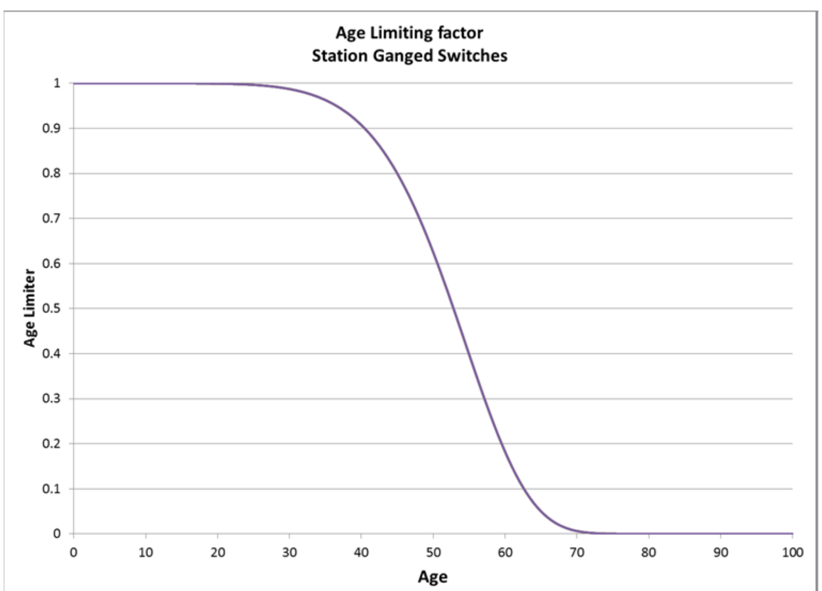

Figure 3-1 Age Limiting Factor Criteria - - Station Ganged Switches

3.2 Age Distribution

The average ages were 57 and 54, for MV and 44 kV Station Ganged Switches respectively. The age distribution was as follows.

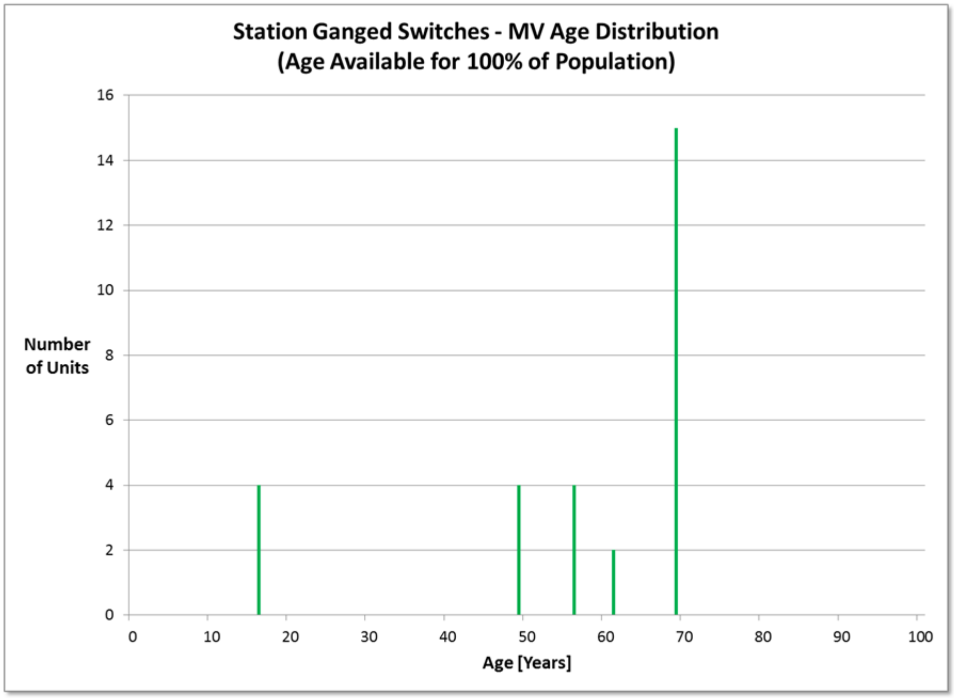

Figure 3-2 Age Distribution –Station Ganged Switches (MV)

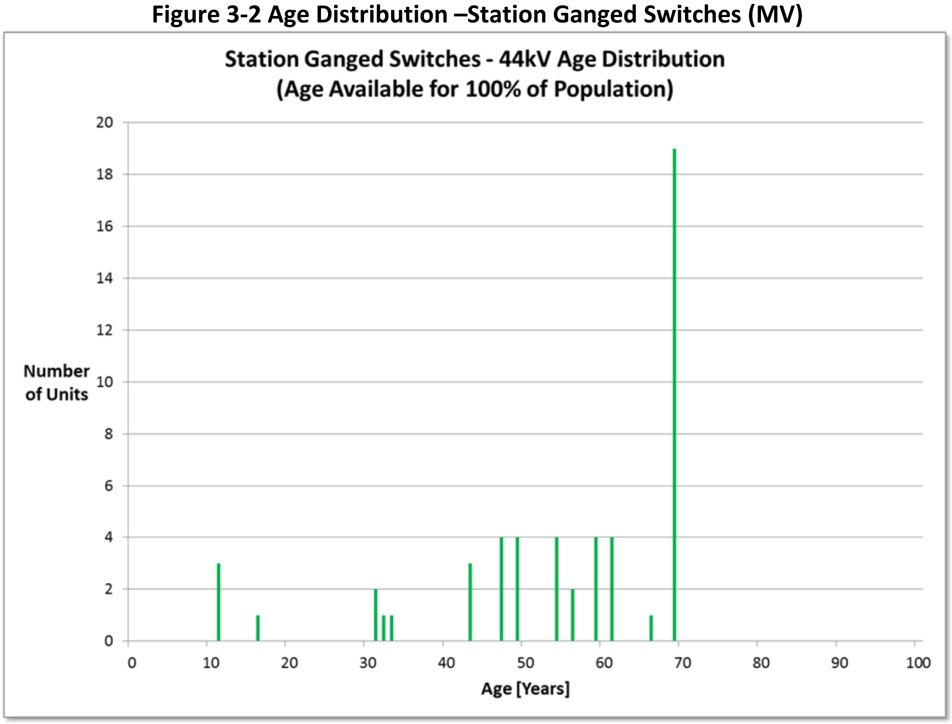

Figure 3-3 Age Distribution –Station Ganged Switches (44 kV)

3.3 Health Index Results

There were 29 units of Station Ganged Switches - MV and 53 units of Station Ganged Switches – 44 kV. All of them had sufficient data for a Health Indexing.

The average Health Index was 29% and 36%, for Station Ganged Switches – MV and Station Ganged Switches – 44 kV respectively.

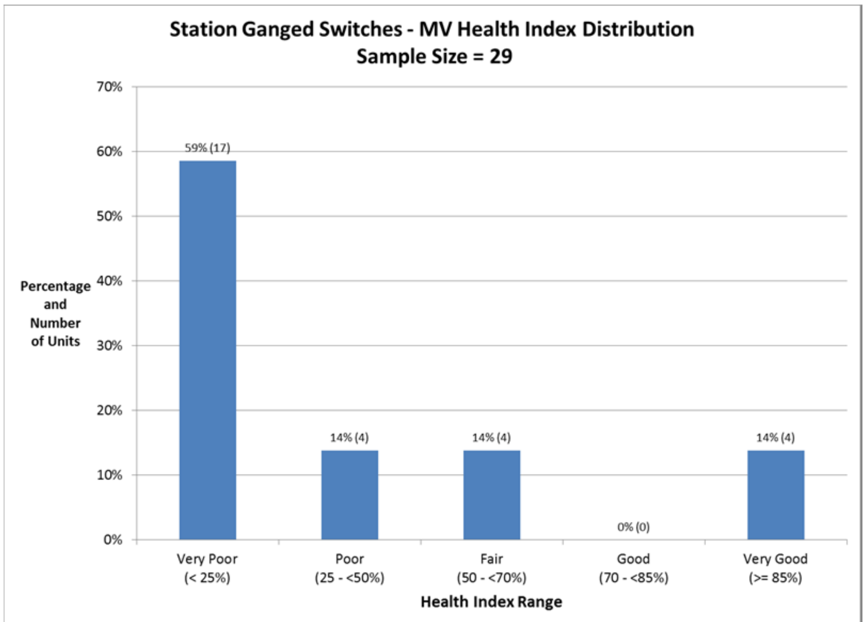

Figure 3-4 Health Index Distribution –Station Ganged Switches (MV)

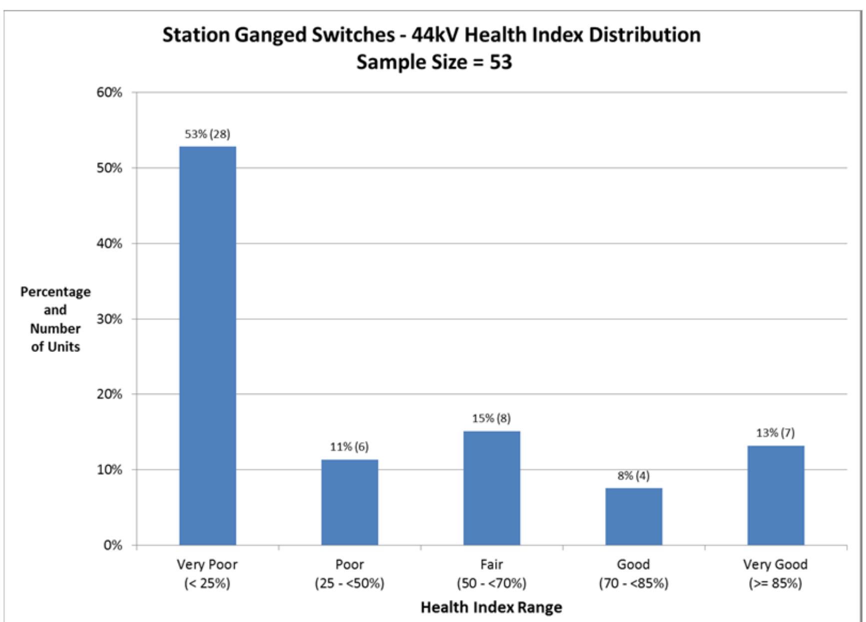

Figure 3-5 Health Index Distribution –Station Ganged Switches (44 kV)

3.4 Flagged for Action Plan

As it is assumed that Station Ganged Switches are proactively replaced, the risk assessment and flag-for-action plan procedure described in Section II.2.3 was applied for this asset class.

As the criticality information for Station Ganged Switches is unavailable, a unit becomes a candidate for replacement when its cumulative probability of failure is greater than or equal to 80%. The probability of failure is determined by the Health Index.

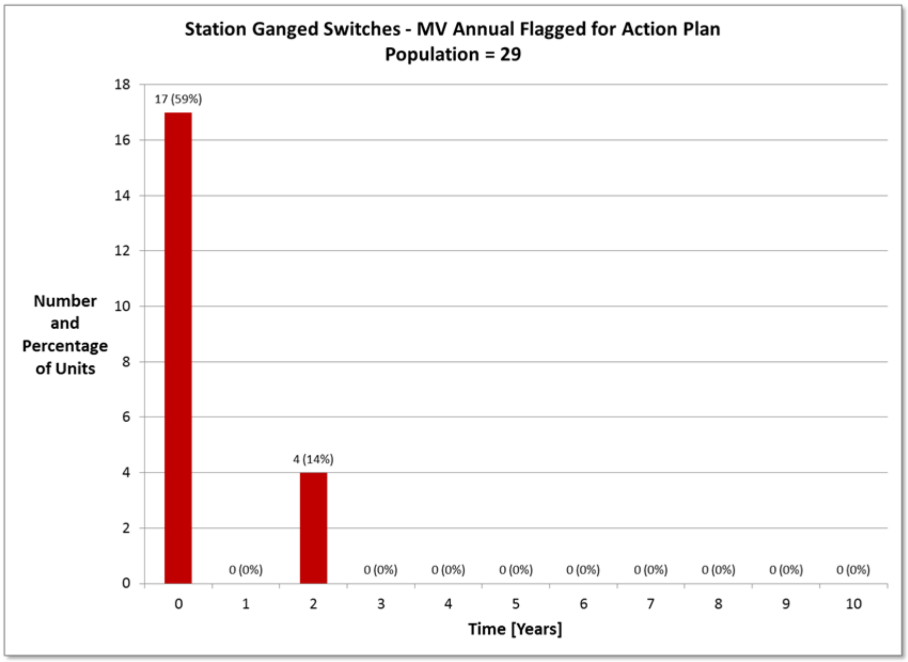

Figure 3-6 Flagged for Action Plan - Station Ganged Switches (MV)

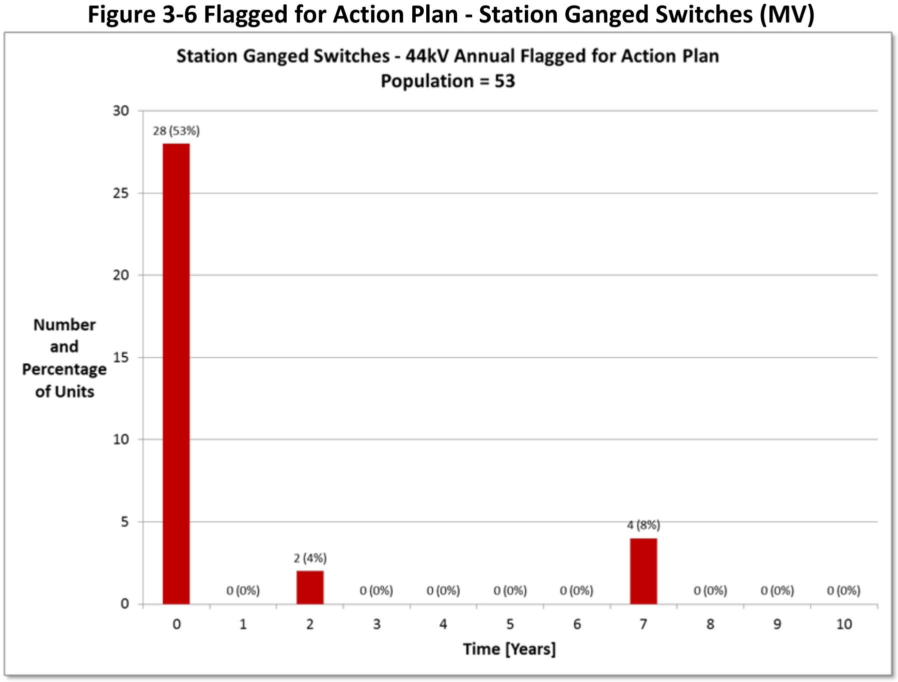

Figure 3-7 Flagged for Action Plan - Station Ganged Switches (44 kV)

3.5 Risk Based Prioritized List

The following tables show the risk based prioritization lists.

Table 3-9 Risk Based Prioritization List - Station Ganged Switches (MV)

Rank	ID	Location	Station	Age	DAI	HI (Final)	Risk Index 100%=Most Risk 0% = Least Risk	FFA Year
1	111TB	4KV TRANSFER BUS SWITCH	MS1	69	0.0%	1.0	83.3%	0
2	113TB	4KV TRANSFER BUS SWITCH	MS1	69	0.0%	1.0	83.3%	0
3	107TB	4KV TRANSFER BUS SWITCH	MS1	69	0.0%	1.0	83.3%	0
4	Y2-Y3	4KV BUS TIE SWITCH	MS5	69	0.0%	1.0	83.3%	0
5	108TB	4KV TRANSFER BUS SWITCH	MS1	69	0.0%	1.0	83.3%	0
6	104TB	4KV TRANSFER BUS SWITCH	MS1	69	0.0%	1.0	83.3%	0
7	112TB	4KV TRANSFER BUS SWITCH	MS1	69	0.0%	1.0	83.3%	0
8	102TB	4KV TRANSFER BUS SWITCH	MS1	69	0.0%	1.0	83.3%	0
9	103TB	4KV TRANSFER BUS SWITCH	MS1	69	0.0%	1.0	83.3%	0
10	105TB	4KV TRANSFER BUS SWITCH	MS1	69	0.0%	1.0	83.3%	0
11	109TB	4KV TRANSFER BUS SWITCH	MS1	69	0.0%	1.0	83.3%	0
12	T2-Y2	4KV TX ISOLATION SWITCH	MS8	69	0.0%	1.0	83.3%	0
13	106TB	4KV TRANSFER BUS SWITCH	MS1	69	0.0%	1.0	83.3%	0
14	110TB	4KV TRANSFER BUS SWITCH	MS1	69	0.0%	1.0	83.3%	0
15	Y1-Y2	4KV BUS TIE SWITCH	MS5	69	0.0%	1.0	83.3%	0
16	T3-Y3	4KV TX ISOLATION SWITCH	MS4	61	0.0%	14.8	83.3%	0
17	T1-Y1	4KV TX ISOLATION SWITCH	MS4	61	100.0%	14.8	83.3%	0
18	1Y-8Q	4KV FEEDER TIE SWITCH	MS9	56	0.0%	35.1	78.0%	2
19	2Y-7Q	4KV FEEDER TIE SWITCH	MS9	56	0.0%	35.1	78.0%	2
20	3Y-6Q	4KV FEEDER TIE SWITCH	MS9	56	0.0%	35.1	78.0%	2
21	4Y-5Q	4KV FEEDER TIE SWITCH	MS9	56	0.0%	35.1	78.0%	2
22	2Y-9Q	4KV FEEDER TIE SWITCH	MS10	49	0.0%	66.6	12.4%	>20
23	4Y-7Q	4KV FEEDER TIE SWITCH	MS10	49	0.0%	66.6	12.4%	>20
24	3Y-8Q	4KV FEEDER TIE SWITCH	MS10	49	0.0%	66.6	12.4%	>20
25	5Y-6Q	4KV FEEDER TIE SWITCH	MS10	49	0.0%	66.6	12.4%	>20
26	1400-A	5KV 600A LINE LINE SW.	MS14	16	0.0%	100.0	0.0%	>20
27	1401-A	5KV 600A LINE LINE SW.	MS14	16	0.0%	100.0	0.0%	>20
28	1402-A	5KV 600A LINE LINE SW.	MS14	16	0.0%	100.0	0.0%	>20
29	1403-A	5KV 600A LINE LINE SW.	MS14	16	0.0%	100.0	0.0%	>20

Table 3-10 Risk Based Prioritization List - Station Ganged Switches (44 kV)

Rank	ID	Location	Station	Age	DAI	HI (Final)	Risk Index 100%=Most Risk 0% = Least Risk	FFA Year
1	1M43-A	44KV BREAKER ISOLATION	MS1	69	0.0%	1.0	83.3%	0
2	1M43-L	44KV BREAKER ISOLATION	MS1	69	0.0%	1.0	83.3%	0
3	1M451A	44KV BREAKER ISOLATION	MS1	69	0.0%	1.0	83.3%	0

Rank	ID	Location	Station	Age	DAI	HI (Final)	Risk Index 100%=Most Risk 0% = Least Risk	FFA Year
4	1M451L	44KV BREAKER ISOLATION	MS1	69	0.0%	1.0	83.3%	0
5	1M56-A	44KV BREAKER ISOLATION	MS1	69	0.0%	1.0	83.3%	0
6	1M56-L	44KV BREAKER ISOLATION	MS1	69	0.0%	1.0	83.3%	0
7	1T1-A	44KV TX ISOLATION SWITCH	MS1	69	0.0%	1.0	83.3%	0
8	1T2-A	44KV TX ISOLATION SWITCH	MS1	69	0.0%	1.0	83.3%	0
9	1T3-A	44KV TX ISOLATION SWITCH	MS1	69	0.0%	1.0	83.3%	0
10	1T4-A	44KV TX ISOLATION SWITCH	MS1	69	0.0%	1.0	83.3%	0
11	1T5-A	44KV TX ISOLATION SWITCH	MS1	69	0.0%	1.0	83.3%	0
12	1T6-A	44KV TX ISOLATION SWITCH	MS1	69	0.0%	1.0	83.3%	0
13	5T1-A	44KV TX ISOLATION SWITCH	MS5	69	0.0%	1.0	83.3%	0
14	5T2-A	44KV TX ISOLATION SWITCH	MS5	69	0.0%	1.0	83.3%	0
15	5T3-A	44KV TX ISOLATION SWITCH	MS5	69	0.0%	1.0	83.3%	0
16	8A-41	44KV SWITCH	MS8	69	0.0%	1.0	83.3%	0
17	8A-54	44KV SWITCH	MS8	69	0.0%	1.0	83.3%	0
18	8T2-A	44KV TX ISOLATION SWITCH	MS8	69	0.0%	1.0	83.3%	0
19	8T3-A	44KV TX ISOLATION SWITCH	MS8	69	0.0%	1.0	83.3%	0
20	17A125	44KV SWITCH	MS17	66	0.0%	3.6	83.3%	0
21	4T1-A	44KV TX ISOLATION SWITCH	MS4	61	0.0%	14.8	83.3%	0
22	4T3-A	44KV TX ISOLATION SWITCH	MS4	61	0.0%	14.8	83.3%	0
23	4A-121	44KV SWITCH	MS4	61	100.0%	14.8	83.3%	0
24	4A-124	44KV SWITCH	MS4	61	100.0%	14.8	83.3%	0
25	6A-74	44KV SWITCH	MS6	59	0.0%	22.1	83.3%	0
26	6A-96	44KV SWITCH	MS6	59	0.0%	22.1	83.3%	0
27	6T2-A	44KV TX ISOLATION SWITCH	MS6	59	0.0%	22.1	83.3%	0
28	6T3-A	44KV TX ISOLATION SWITCH	MS6	59	0.0%	22.1	83.3%	0
29	9T1-A	44KV TX ISOLATION SWITCH	MS9	56	0.0%	35.1	78.0%	2
30	9T2-A	44KV TX ISOLATION SWITCH	MS9	56	0.0%	35.1	78.0%	2
31	11A-93	44KV SWITCH	MS11	54	0.0%	44.5	65.1%	7
32	11T2-A	44KV TX ISOLATION SWITCH	MS11	54	0.0%	44.5	65.1%	7
33	11A-7	44KV SWITCH	MS11	54	94.5%	44.5	65.1%	7
34	11T1-A	44KV TX ISOLATION SWITCH	MS11	54	100.0%	44.5	65.1%	7
35	7A-92	44KV SWITCH	MS7	43	100.0%	51.4	48.8%	11
36	7T2-A	44KV TX ISOLATION SWITCH	MS7	43	100.0%	52.7	45.5%	12
37	3A-41	44KV SWITCH	MS3	31	100.0%	64.7	16.6%	>20
38	10A-50	44KV SWITCH	MS10	49	0.0%	66.6	12.4%	>20
39	10A-51	44KV SWITCH	MS10	49	0.0%	66.6	12.4%	>20
40	10T1-A	44KV TX ISOLATION SWITCH	MS10	49	0.0%	66.6	12.4%	>20
41	10T2-A	44KV TX ISOLATION SWITCH	MS10	49	0.0%	66.6	12.4%	>20
42	3A-52	44KV SWITCH	MS3	31	100.0%	69.6	8.9%	>20
43	12A-73	44KV SWITCH	MS12	47	0.0%	73.8	4.6%	>20
44	12A-95	44KV SWITCH	MS12	47	0.0%	73.8	4.6%	>20
45	12T1-A	44KV TX ISOLATION SWITCH	MS12	47	0.0%	73.8	4.6%	>20
46	12T2-A	44KV TX ISOLATION SWITCH	MS12	47	0.0%	73.8	4.6%	>20
47	7T1-A	44KV TX ISOLATION SWITCH	MS7	43	0.0%	85.1	0.5%	>20
48	15A-50	44KV SWITCH	MS15	33	0.0%	97.5	0.0%	>20

Rank	ID	Location	Station	Age	DAI	HI (Final)	Risk Index 100%=Most Risk 0% = Least Risk	FFA Year
49	13A-21	44KV SWITCH	MS13	32	0.0%	98.0	0.0%	>20
50	14A-123	60 Lappan's Lane (MS 14) Pole 15387	MS14	16	0.0%	100.0	0.0%	>20
51	16T1-A	44KV TX ISOLATION SWITCH	MS16	11	0.0%	100.0	0.0%	>20
52	16T2-A	44KV TX ISOLATION SWITCH	MS16	11	0.0%	100.0	0.0%	>20
53	16T3-A	44KV TX ISOLATION SWITCH	MS16	11	0.0%	100.0	0.0%	>20

3.6 Data Gaps

Data for Station Ganged Switches included age, contact resistance test results, visual inspection records. The following table shows the data gaps.

Table 3-11 Data Gap for Station Ganged Switches

Data Gap (Sub-Condition Parameter)	Parent Condition Parameter	Priority	Description	Source of Data
Power Factor	Insulation	☆☆	Insulation degradation	Test
Historic Removal Record		☆☆☆	Age at removal	Inventory Database

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4 POLE MOUNTED TRANSFORMERS

4.1 Health Index Formula

Assume a parameter scoring system of 0 through 4, where 0 and 4 represent the "worst" and "best" scores respectively. Thus, the maximum score for any condition or sub-condition parameter (maximum CPS and CPF) is "4".

4.1.1 Condition and Sub-Condition Parameters

Table 4-1 Condition Parameter and Weights – Pole Mounted Transformers

m	Condition Parameter	WCP_m	Sub-Condition Parameters
1	Physical Condition	3	Table 4-2
2	Connection and Insulation	5	Table 4-3
	Age Limiting		Figure 4-1

Table 4-2 Physical Condition Sub-Condition Parameters and Weights (m=1) – Pole Mounted Transformers

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	Paint	1	Table 4-4

Table 4-3 Connection and Insulation Sub-Condition Parameters and Weights (m=2) – Pole Mounted Transformers

n	Sub-Condition Parameter	$WCPF_n$	Condition Criteria Table
1	Oil Leak	1	Table 4-4
2	Bushing	2	Table 4-4

4.1.2 Condition Criteria

<u>Defect</u>

Table 4-4 Defect Criteria - Pole Mounted Transformers

Score	Condition Description
0	Applicable
4	(No Input)

<u>Age Limiting Factor</u>

Age was used as a limiting factor to reflect the degradation of asset unit as time passed by. Refer to section 1.1.2 for principle.

In this project, the parameters of Pole Mounted Transformers age limiting curve are shown in the following table, based on Kingston's own historic removal records.

Table 4-5 Age Limiting Curve Parameters - Pole Mounted Transformers

Asset Type	α	β
Pole Mounted Transformers	**40.4805**	**2.0306**

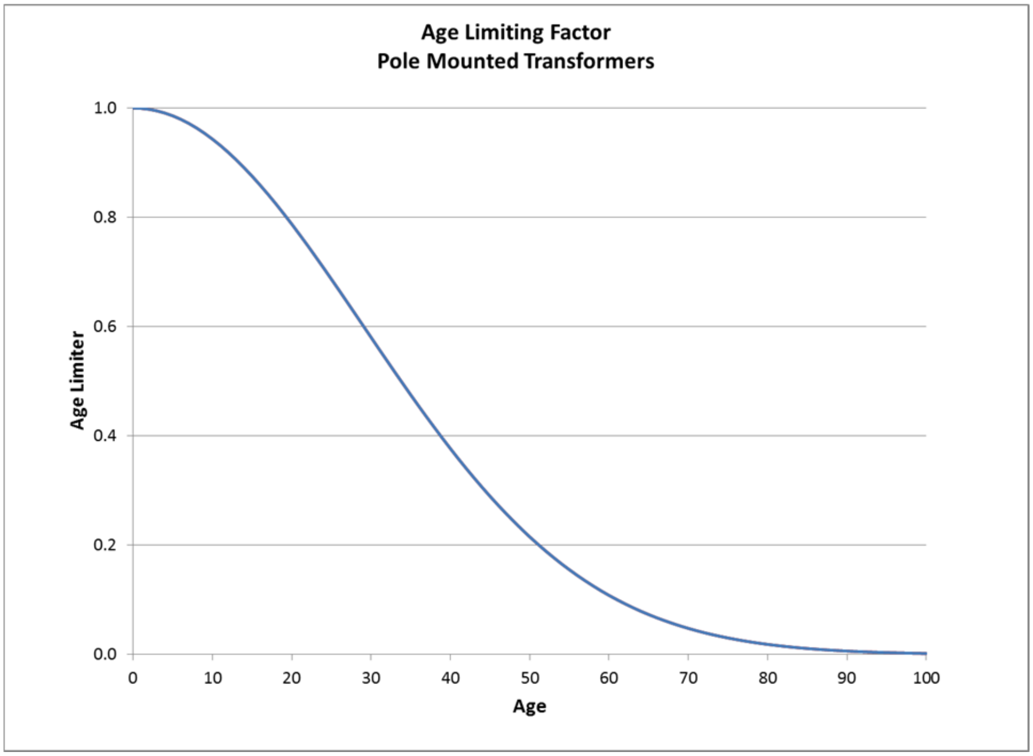

Figure 4-1 Age Limiting Factor Criteria - - Pole Mounted Transformers

4.2 Age Distribution

The average ages of all in service units were 25 and 18, for 1-Phase and 3-Phase Pole Mounted Transformers respectively. The age distributions were as follows.

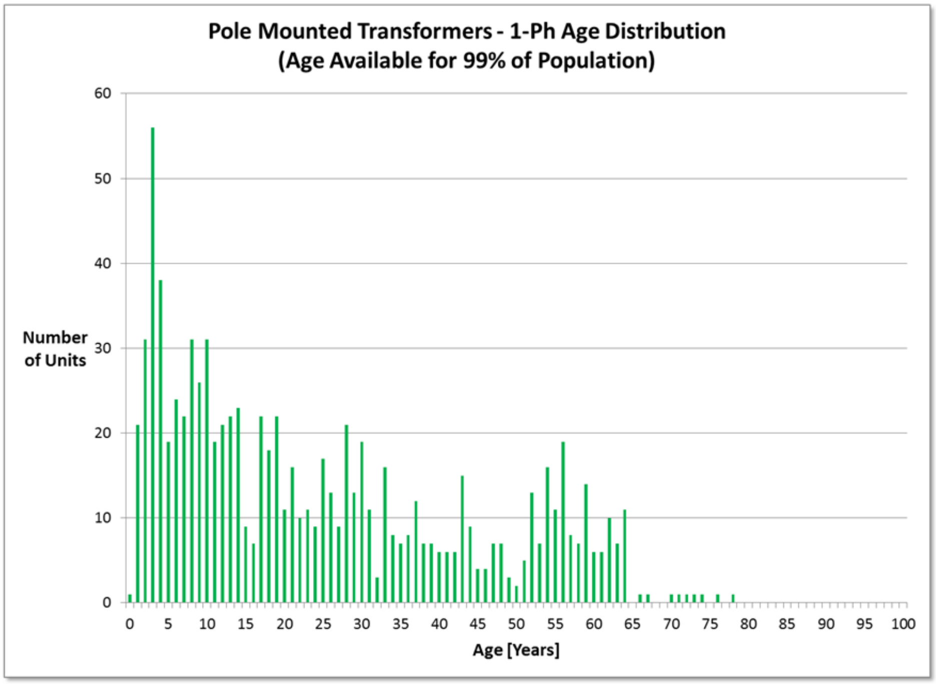

Figure 4-2 Age Distribution - Pole Mounted Transformers (1-Phase)

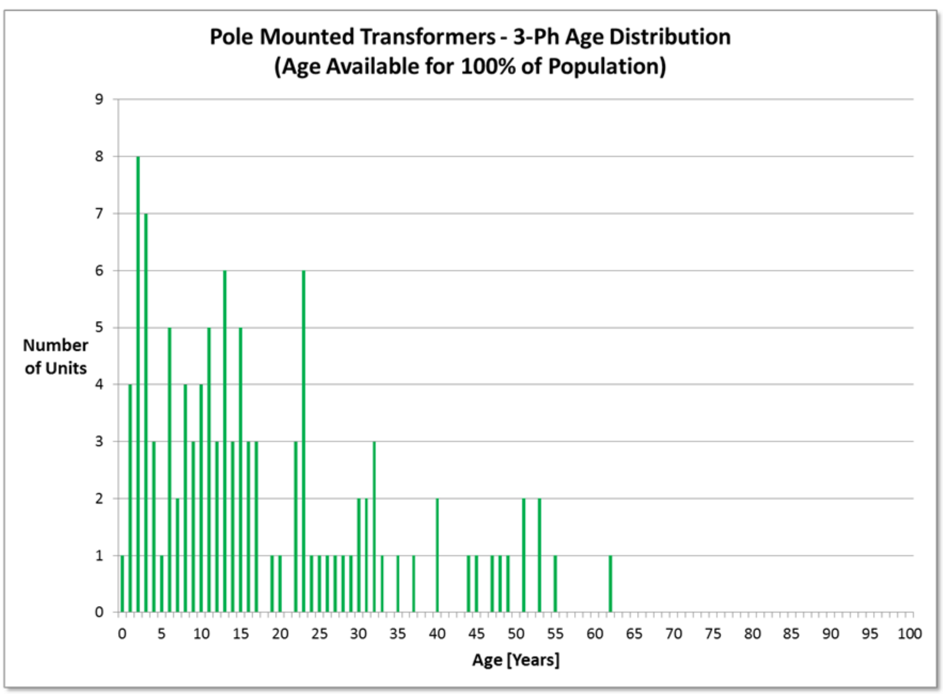

Figure 4-3 Age Distribution - Pole Mounted Transformers (3-Phase)

4.3 Health Index Results

There were 976 units of 1-Phase Pole Mounted Transformers. Among them, 971 units had sufficient data for a Health Indexing.

There were 119 units of 3-Phase Pole Mounted Transformers. All of them had sufficient data for a Health Indexing.

The average Health Index was 70% and 80%, for 1-Phase and 3-Phase Pole Mounted Transformers respectively.

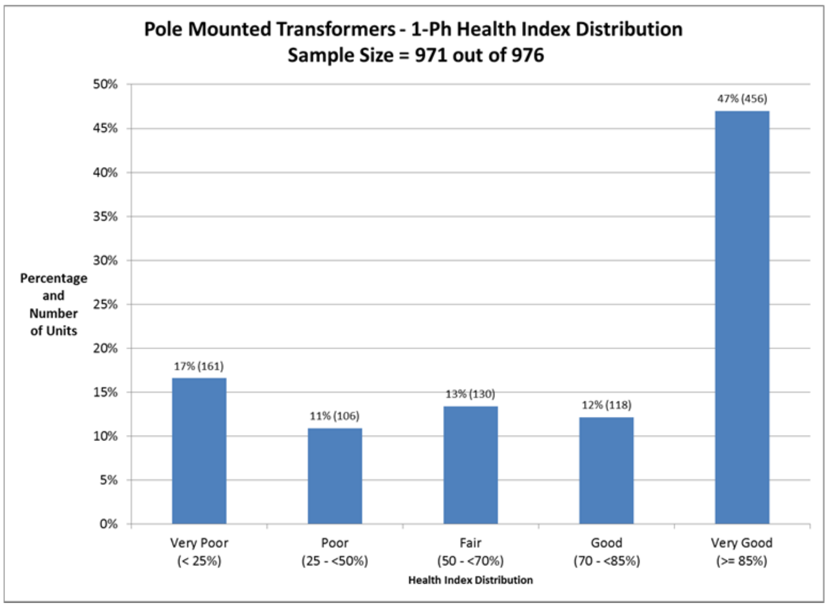

Figure 4-4 Health Index Distribution - Pole Mounted Transformers (1-Phase)

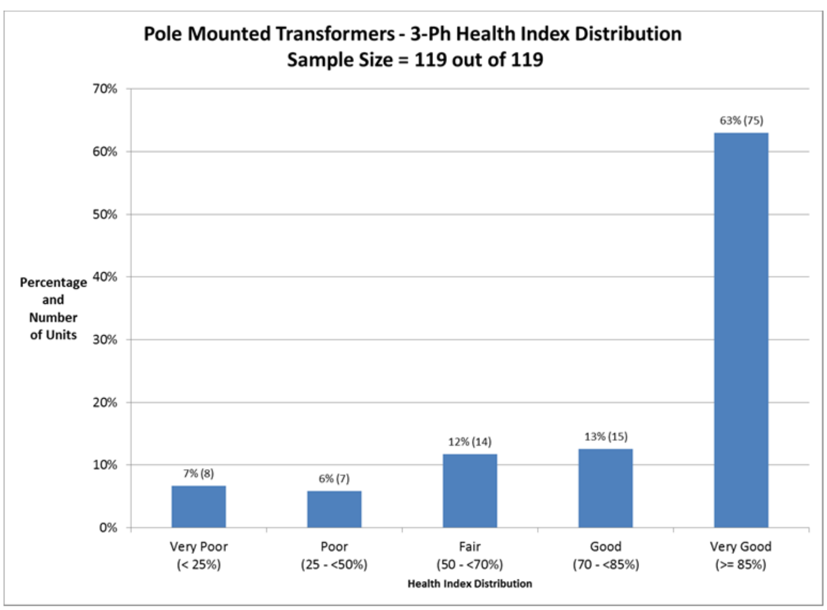

Figure 4-5 Health Index Distribution - Pole Mounted Transformers (3-Phase)

4.4 Flagged for Action Plan

The flagged for action plan for Pole Mounted Transformers were based on the data from sample size and extrapolated to the entire population.

The flagged for action plan for Pole Mounted Transformers was as follows:

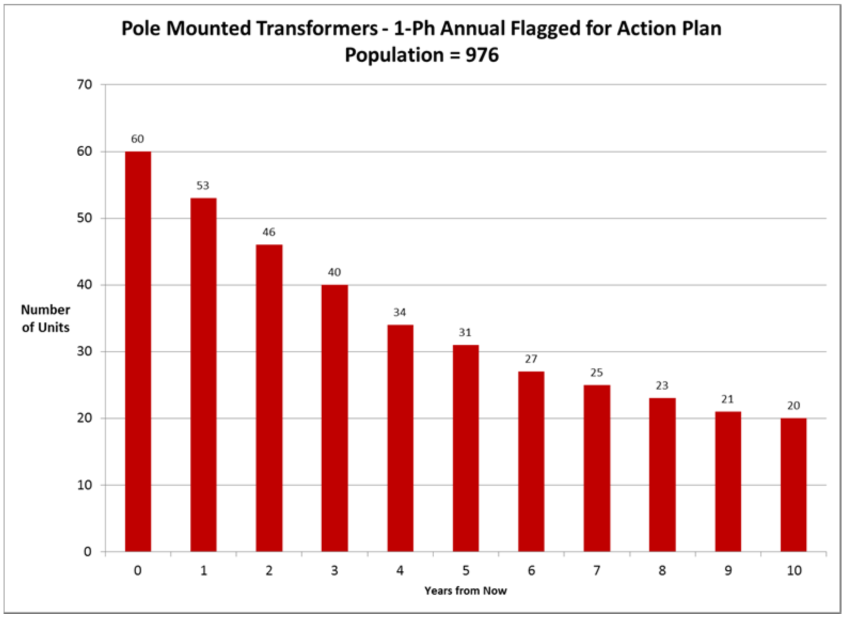

Figure 4-6 Flagged for Action Plan – Pole Mounted Transformers (1-Phase)

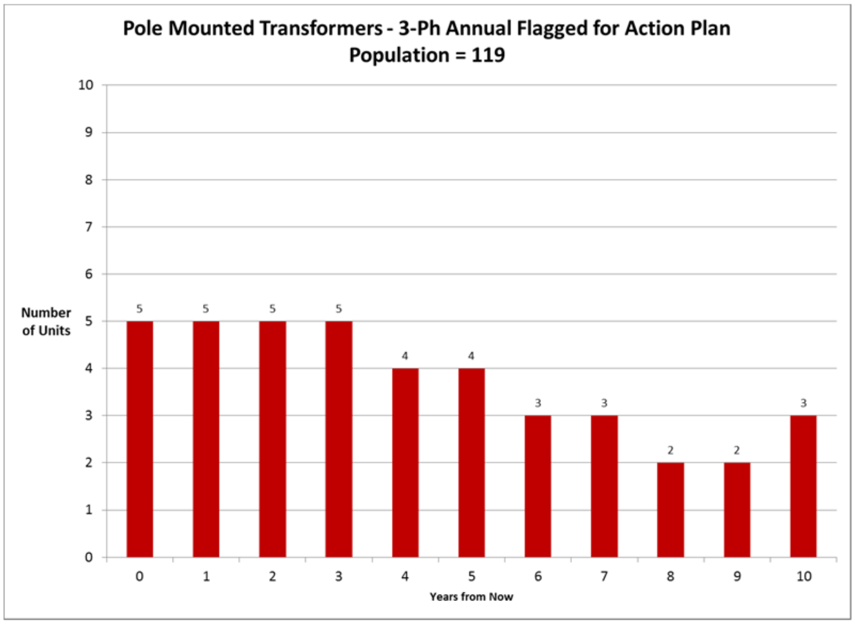

Figure 4-7 Flagged for Action Plan – Pole Mounted Transformers (3-Phase)

4.5 Data Gaps

The data for in service Pole Mounted Transformers included age and component inspection.

The data gaps for this asset category are as follows:

Table 4-6 Data Gap for Pole Mounted Transformers

Data Gap (Sub-Condition Parameter)	**Parent Condition Parameter**	**Priority**	**Object or Component Addressed**	**Description**	**Source of Data**
Loading	Service Record	✮✮	Transformer load	Monthly 15 min peak load throughout years	Operation Record

5 PAD MOUNTED TRANSFORMERS

5.1 Health Index Formula

Assume a parameter scoring system of 0 through 4, where 0 and 4 represent the "worst" and "best" scores respectively. Thus, the maximum score for any condition or sub-condition parameter (maximum CPS and CPF) is "4".

5.1.1 Condition and Sub-Condition Parameters

Table 5-1 Condition Parameter and Weights - Pad Mounted Transformers

m	Condition parameter	WCP_m	Sub-Condition Parameters
1	Physical Condition	3	Table 5-2
2	Connection and Insulation	5	Table 5-3
3	Service Record	5	Table 5-4
	Age Limiting Factor		Figure 5-1

Table 5-2 Physical Condition Sub-Condition Parameters and Weights (m=1) - Pad Mounted Transformers

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Tank Corrosion	3	Table 5-5
2	Access	1	Table 5-5
3	Base	2	Table 5-5

Table 5-3 Connection Sub-Condition Parameters and Weights (m=2) - Pad Mounted Transformers

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Oil Leak	2	Table 5-5
2	Elbow	4	Table 5-5
3	Grounding	1	Table 5-5
4	Insulation	4	Table 5-5

Table 5-4 Service Record Sub-Condition Parameters and Weights (m=3) - Pad Mounted Transformers

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Overall	2	Table 5-6

5.1.2 Condition Criteria

<u>Defect</u>

All the condition scores are based on Kingston's inspection grading results as follows.

Table 5-5 Defect Criteria - Pad Mounted Transformers

Score	Condition Description
0	Applicable
1	Major
2	Minor
4	(No Input)

Overall Status

Table 5-6 Overall Maintenance Count Criteria - Pad Mounted Transformers

Score	Condition Description
3	Satisfactory
1	Needs Attention

Age Limiting Factor

In this project, age was used as a limiting factor to reflect the degradation of asset unit as time passed by. Principle of applying the degradation survival curve is described in Equation 1-5 of Section 1.1.2.

In this project, the parameters of Pad Mounted Transformers age limiting curve are shown in the following table, based on Kingston's own historic removal records.

Table 5-7 Age Limiting Curve Parameters - Pad Mounted Transformers

Asset Type	α	β
Pad Mounted Transformers	**41.8388**	**2.9644**

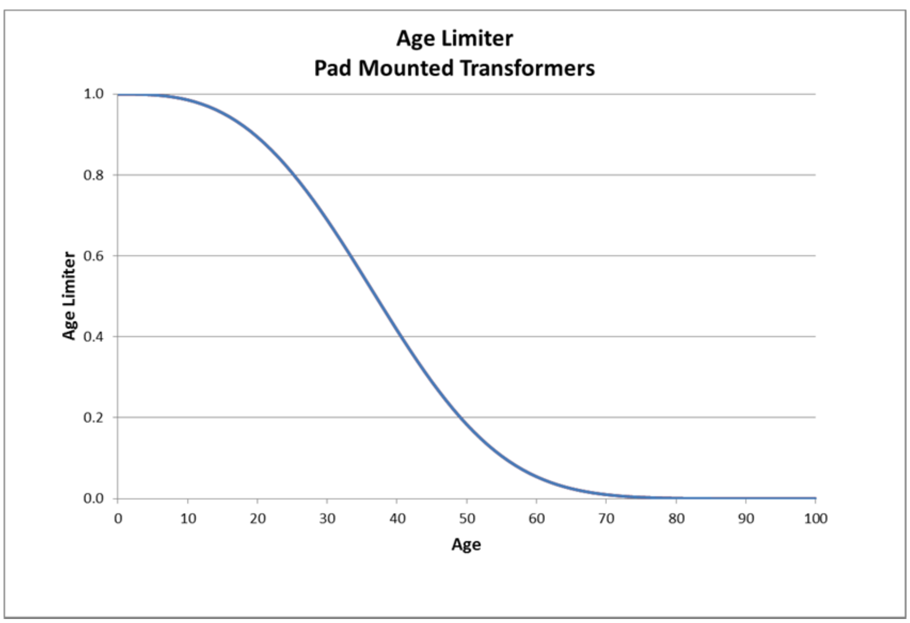

Figure 5-1 Age Limiting Factor Criteria - - Pad Mounted Transformers

5.2 Age Distribution

The average age of the units was 34 and 21 years, for single phase and three phase Pad Mounted Transformers respectively.

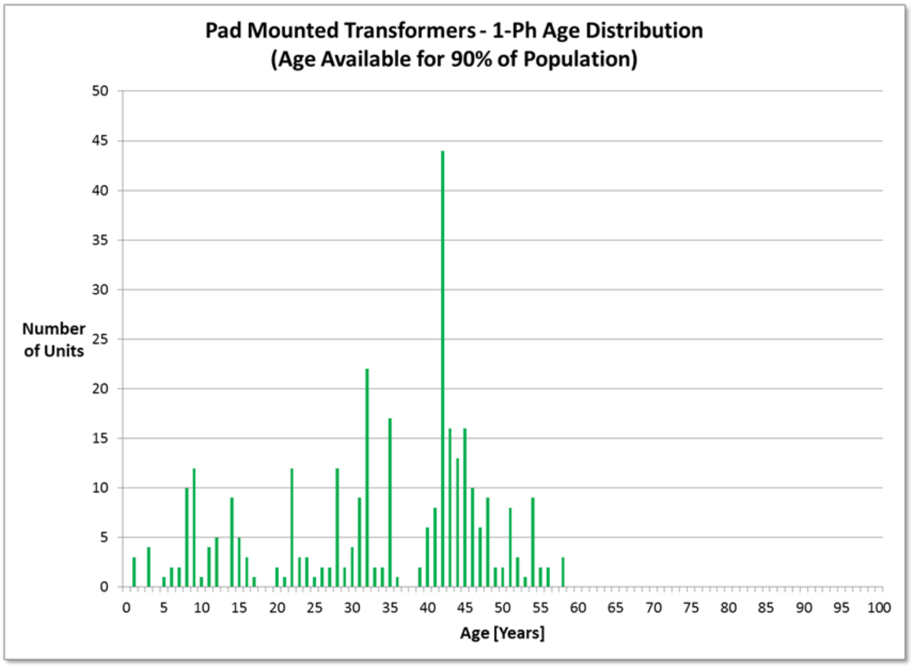

Figure 5-2 Age Distribution - Pad Mounted Transformers (Single Phase)

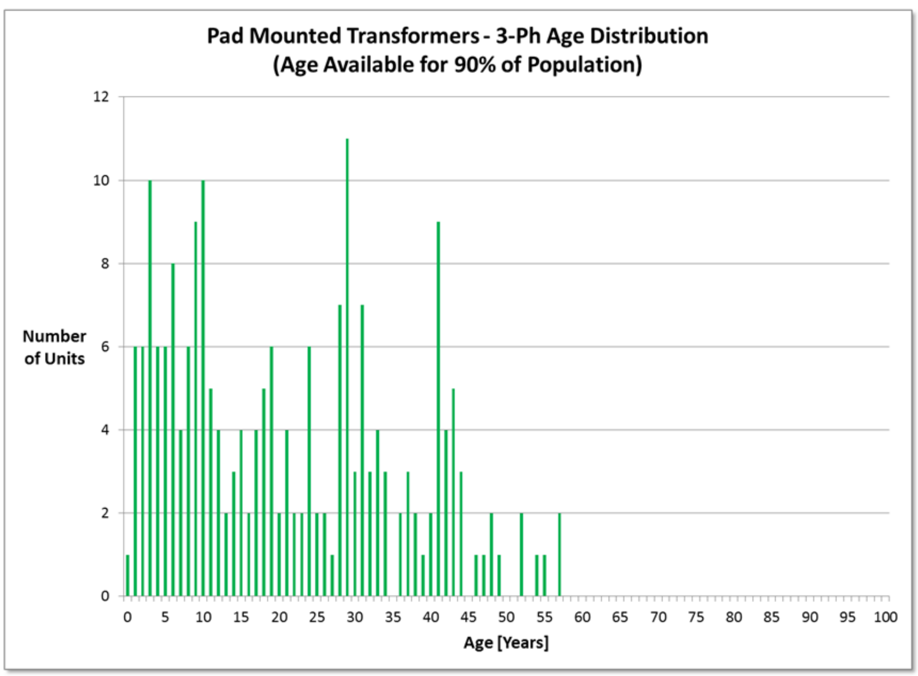

Figure 5-3 Age Distribution - Pad Mounted Transformers (Three Phase)

5.3 Health Index Results

There were a total of 359 units of single phase Pad Mounted Transformers. Among them, 323 units had sufficient data for a Health Indexing.

There were a total of 237 units of three phase Pad Mounted Transformers. Among them, 213 units had sufficient data for a Health Indexing.

The average Health Index score for this asset group was 54% and 77%, for single phase and three phase Pad Mounted Transformers respectively.

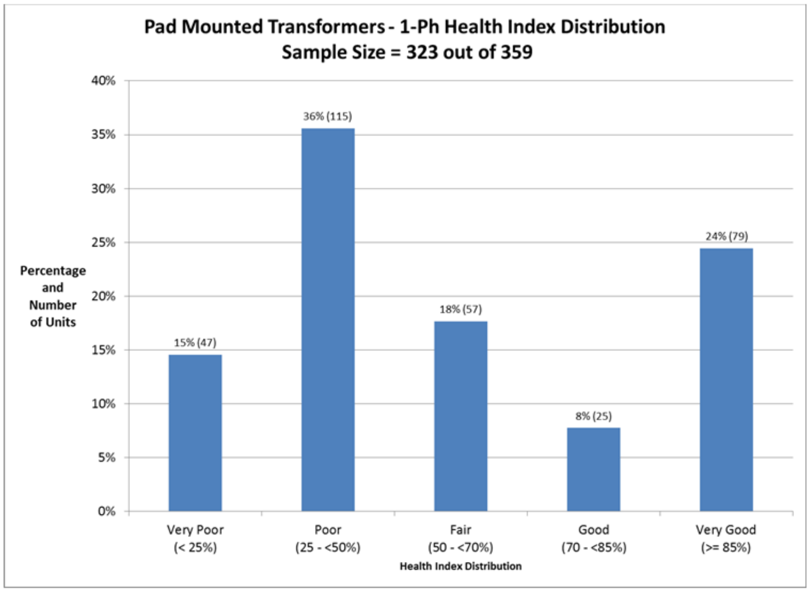

Figure 5-4 Health Index Distribution - Pad Mounted Transformers (Single Phase)

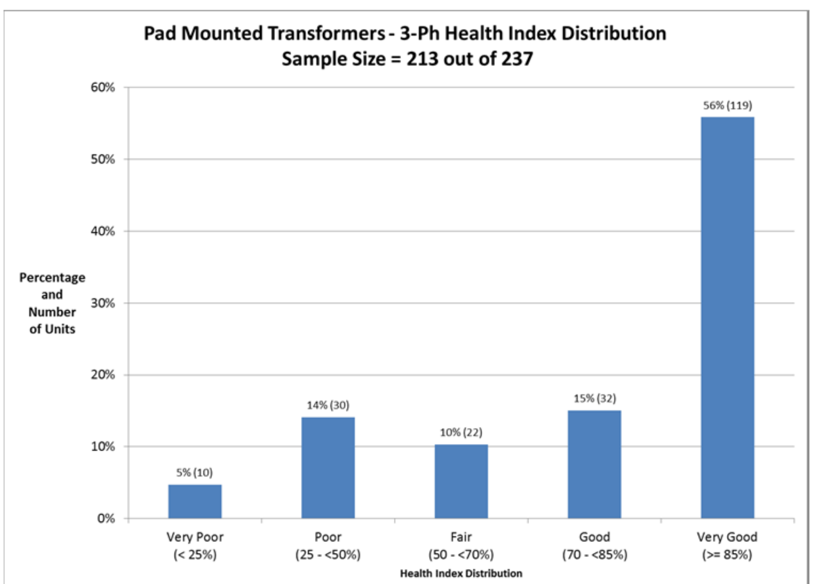

Figure 5-5 Health Index Distribution - Pad Mounted Transformers (Three Phase)

5.4 Flagged for Action Plan

The flagged for action plan of Pad Mounted Transformers was based on the asset removal rate.

The flagged for action plans for Pad Mounted Transformers were based on the data from sample size and extrapolated to the entire population. The following diagram shows the flagged for action plans:

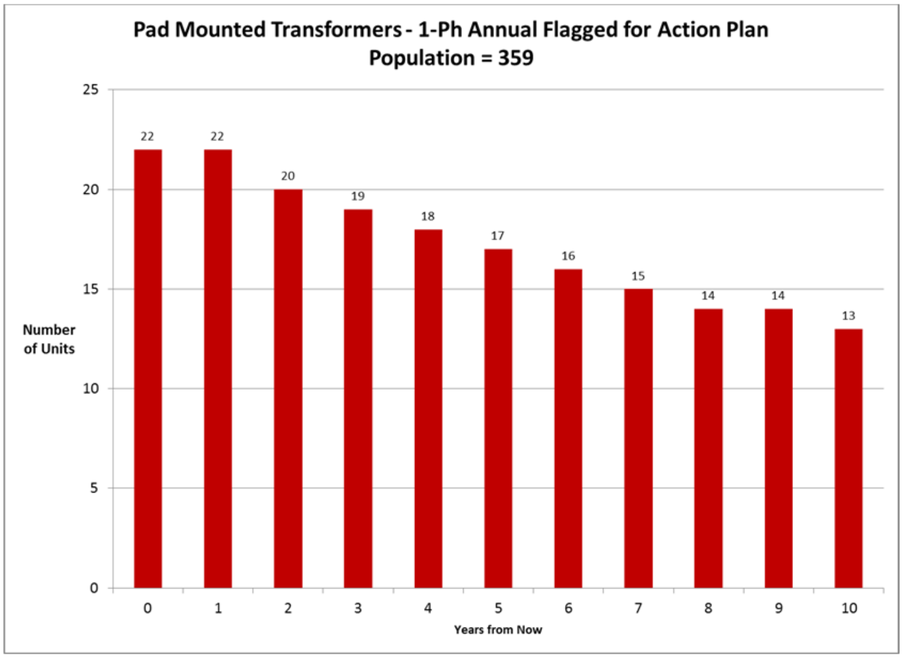

Figure 5-6 Flagged for Action Plan - Pad Mounted Transformers (Single Phase)

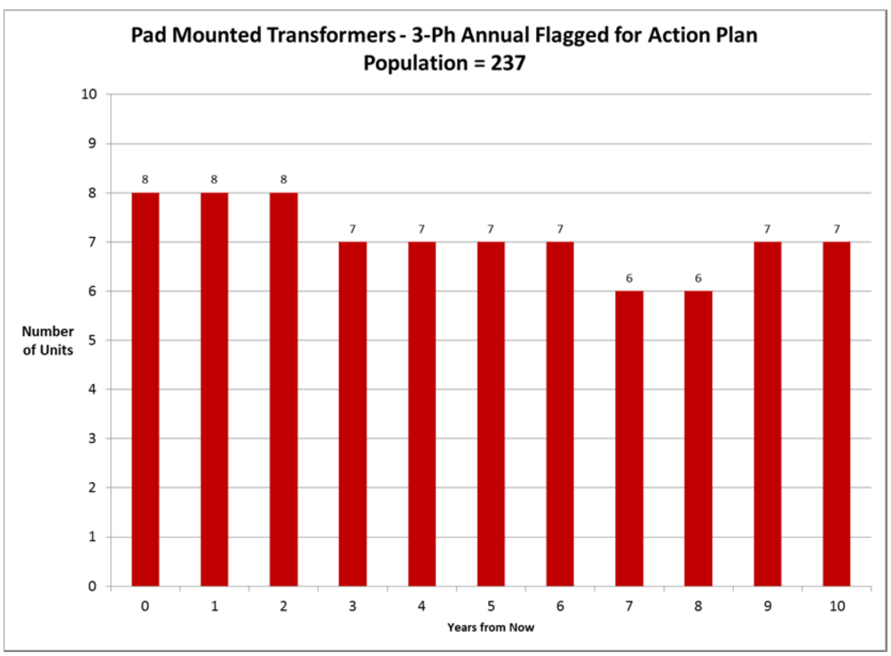

Figure 5-7 Flagged for Action Plan - Pad Mounted Transformers (Three Phase)

5.5 Data Gaps

The data used for single phase Pad Mounted Transformers assessment included age and inspection results for individual components.

The data gaps are as follows.

Table 5-8 Data Gap for Pad Mounted Transformers

Data Gap (Sub-Condition Parameter)	**Parent Condition Parameter**	**Priority**	**Object or Component Addressed**	**Description**	**Source of Data**
Loading	Service Record	☆	Transformer load	Monthly 15 min peak load throughout years	Operation Record

6 Poles

6.1 Health Index Formula

Assume a parameter scoring system of 0 through 4, where 0 and 4 represent the “worst” and “best” scores respectively. Thus, the maximum score for any condition or sub-condition parameter (maximum CPS and CPF) is “4”.

6.1.1 Condition and Sub-Condition Parameters

Table 6-1 Condition Parameter and Weights - Poles

m	Condition parameter	WCP_m	Sub-Condition Parameters
1	Pole Strength	7	Table 6-2
2	Pole Condition	5	Table 6-3
3	Pole Accessories	3	Table 6-4
	Age Limiting Factor		Figure 6-1

Table 6-2 Pole Strength Sub-Condition Parameters and Weights (m=1) - Poles

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Hammer Test	1	Table 6-5

Table 6-3 Pole Condition Sub-Condition Parameters and Weights (m=2) - Poles

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Broken	2	Table 6-5
2	Rot	2	Table 6-5
3	Decay	3	Table 6-5
4	Woodpeckers	2	Table 6-5
5	Damage	1	Table 6-5

Table 6-4 Pole Accessories Sub-Condition Parameters and Weights (m=3) - Poles

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Guy	2	Table 6-5
2	Crossarm	3	Table 6-5
3	Leaning	4	Table 6-5

6.1.2 Condition Criteria

<u>Defect</u>

Table 6-5 Defect Criteria - Poles

Score	Condition Description
0	Applicable
0	Critical
1	Major
2	Minor
0	Broken

<u>Age Limiting Factor</u>

In this project, age was used as a limiting factor to reflect the degradation of asset unit as time passed by. Principle of applying the degradation survival curve is described in Equation 1-5 of Section 1.1.2.

In this project, the parameters of Poles age limiting curve are shown in the following table, based on Kingston's own historic removal data.

Table 6-6 Age Limiting Curve Parameters - Poles

Asset Type	α	β
Wood Poles	**52.9706**	**2.4198**
Concrete Poles	**57.1481**	**2.2686**

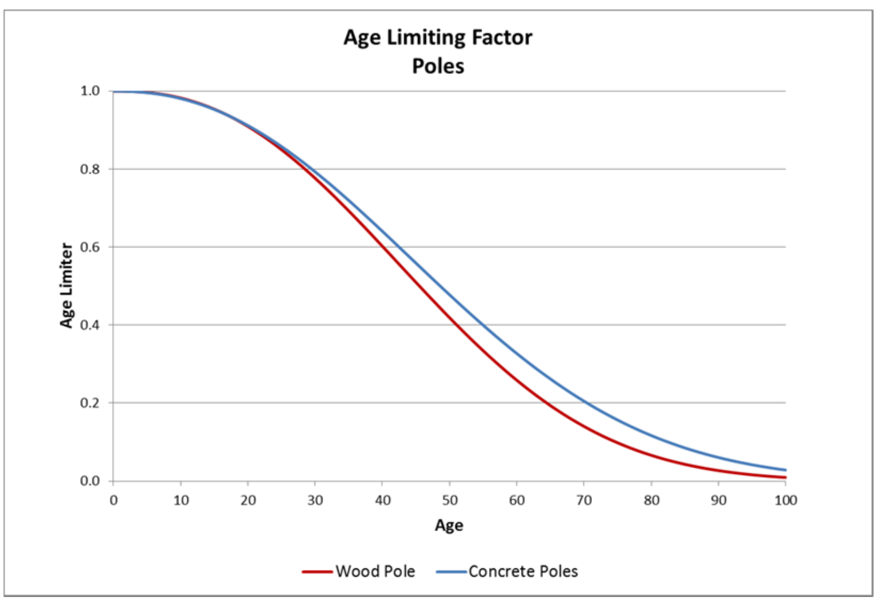

Figure 6-1 Age Limiting Factor Criteria - Poles

6.2 Age Distribution

The average ages of all units were 30 and 40 years, for Wood and Concrete Poles respectively.

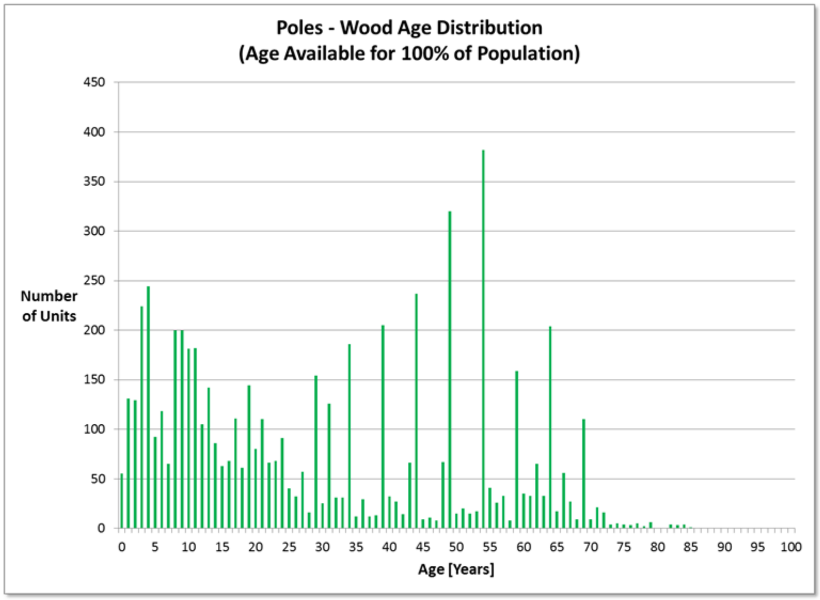

Figure 6-2 Age Distribution – Poles (Wood)

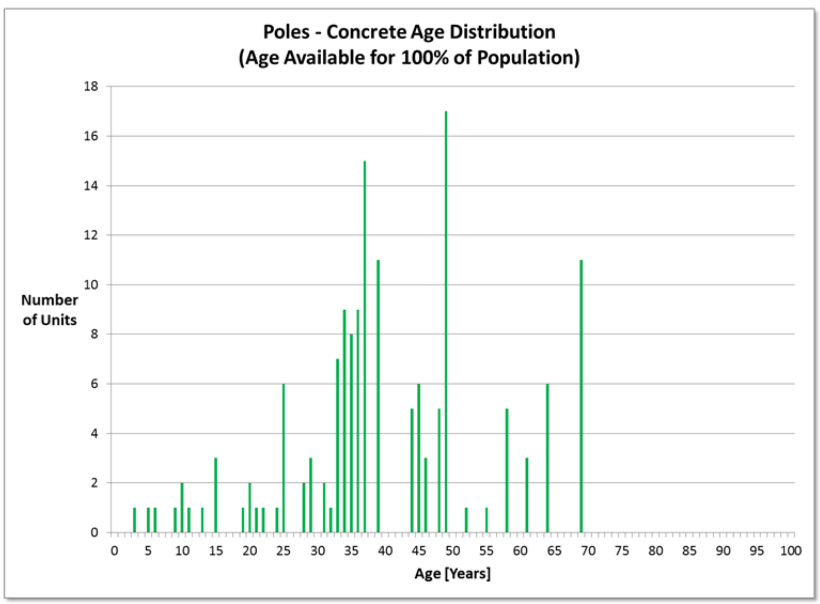

Figure 6-3 Age Distribution – Poles (Concrete)

6.3 Health Index Results

There were 6213 Wood Poles. Among them, 6186 units had sufficient data for a Health Indexing.

There were 153 Concrete Poles. All of them had sufficient data for a Health Indexing.

The average Health Index was 71% and 62%, for Wood and Concrete Poles respectively.

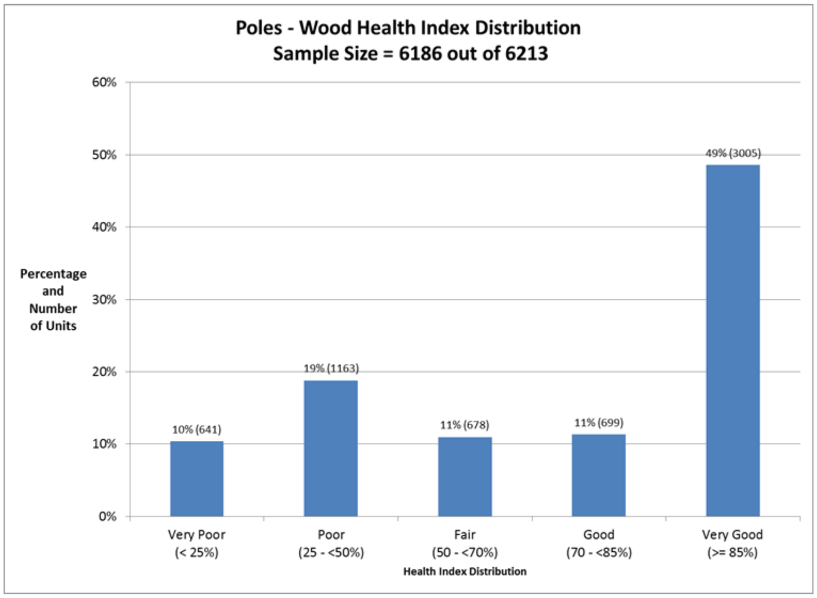

Figure 6-4 Health Index Distribution - Poles (Wood)

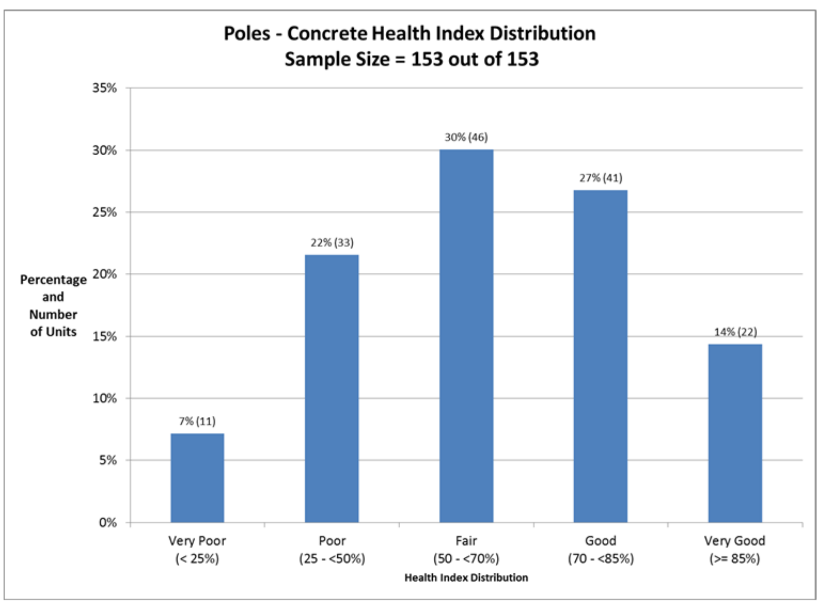

Figure 6-5 Health Index Distribution - Poles (Concrete)

6.4 Flagged for Action Plan

The flagged for action plan of Poles was based on the asset removal rate.

The flagged for action plans for Poles were based on the data from sample size and extrapolated to the entire population. The following diagrams show the flagged for action plans:

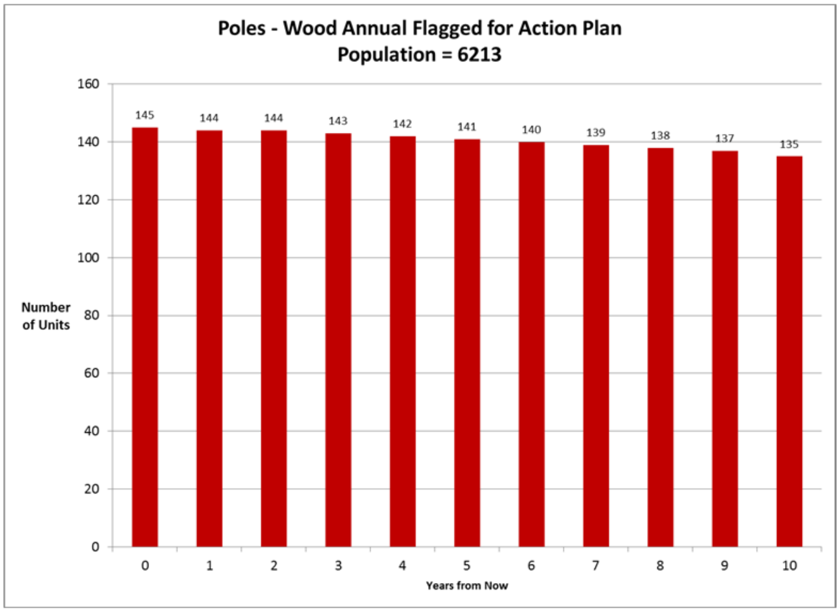

Figure 6-6 Flagged for Action Plan - Poles (Wood)

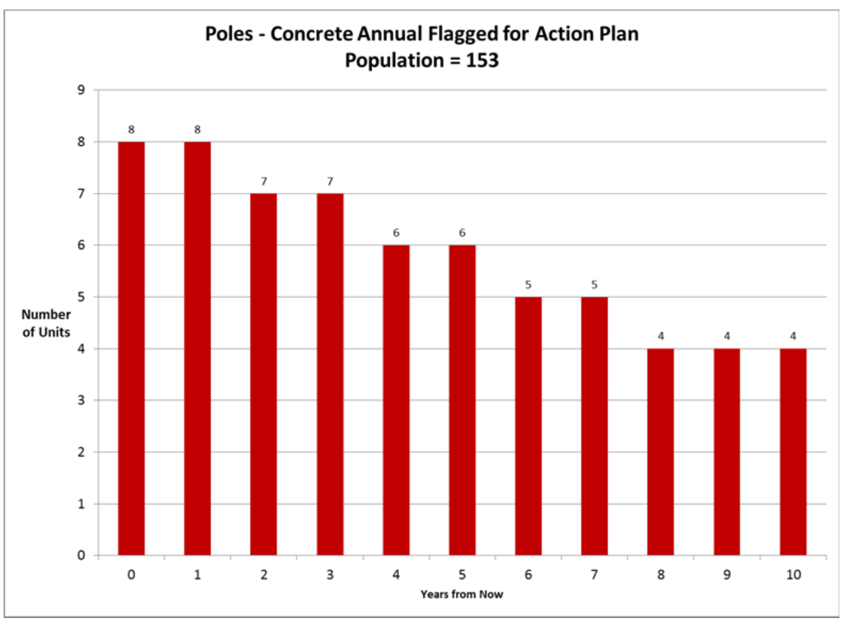

Figure 6-7 Flagged for Action Plan - Poles (Concrete)

6.5 Data Gaps

The data used for Poles assessment included age and pole inspection status condition.

The data gaps for this asset category are as follows:

Table 6-7 Data Gap for Poles

Data Gap (Sub-Condition Parameter)	**Parent Condition Parameter**	**Priority**	**Object or Component Addressed**	**Description**	**Source of Data**
Pole Strength*	Pole Physical	☆☆	Pole	Remaining strength	On-site test

* Wood poles only

7 PAD MOUNTED SWITCHGEAR

7.1 Health Index Formula

Assume a parameter scoring system of 0 through 4, where 0 and 4 represent the “worst” and “best” scores respectively. Thus, the maximum score for any condition or sub-condition parameter (maximum CPS and CPF) is “4”.

7.1.1 Condition and Sub-Condition Parameters

Table 7-1 Condition Parameter and Weights - Pad Mounted Switchgear

m	Condition parameter	WCP_m	Sub-Condition Parameters
1	Physical Condition	3	Table 7-2
2	Connection and Switch	4	Table 7-3
3	Insulation	4	Table 7-4
4	Service Record	3	Table 7-5
	Age Limiting Factor		Table 7-8

Table 7-2 Physical Condition Sub-Condition Parameters and Weights (m=1) - Pad Mounted Switchgear

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Corrosion	4	Table 7-6
2	Painting	1	Table 7-6
3	Pad	1	Table 7-6
4	Access	1	Table 7-6

Table 7-3 Connection and Switch Sub-Condition Parameters and Weights (m=2) - Pad Mounted Switchgear

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Cable	2	Table 7-6
2	Elbow	1	Table 7-6
3	Grounding	1	Table 7-6
4	Switch	3	Table 7-6

Table 7-4 Insulation Sub-Condition Parameters and Weights (m=3) - Pad Mounted Switchgear

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Barrier	1	Table 7-6

Table 7-5 Service Record Sub-Condition Parameters and Weights (m=4) - Pad Mounted Switchgear

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Overall	1	Table 7-7

7.1.2 Condition Criteria

Defect

All the condition scores are based on Kingston's inspection grading as follows:

Table 7-6 Inspection Result Criteria - Pad Mounted Switchgear

Score	Defect Condition Description
1	Major
2	Minor
0	Critical
4	(No Input)

Overall Assessment

Table 7-7 Overall Maintenance Count Criteria - Pad Mounted Switchgear

Score	Assessment Value
1	Needs Attention
3	Satisfactory

Age Limiting Factor

In this project, age was used as a limiting factor to reflect the degradation of asset unit as time passed by. Principle of applying the degradation survival curve is described in Equation 1-5 of Section 1.1.2.

In this project, the parameters of Pad Mounted Switchgear age limiting curve are shown in the following table, based on industry practice.

Table 7-8 Age Limiting Curve Parameters - Pad Mounted Switchgear

Asset Type	α	β
Pad Mounted Switchgear	**44.966**	**1.789**

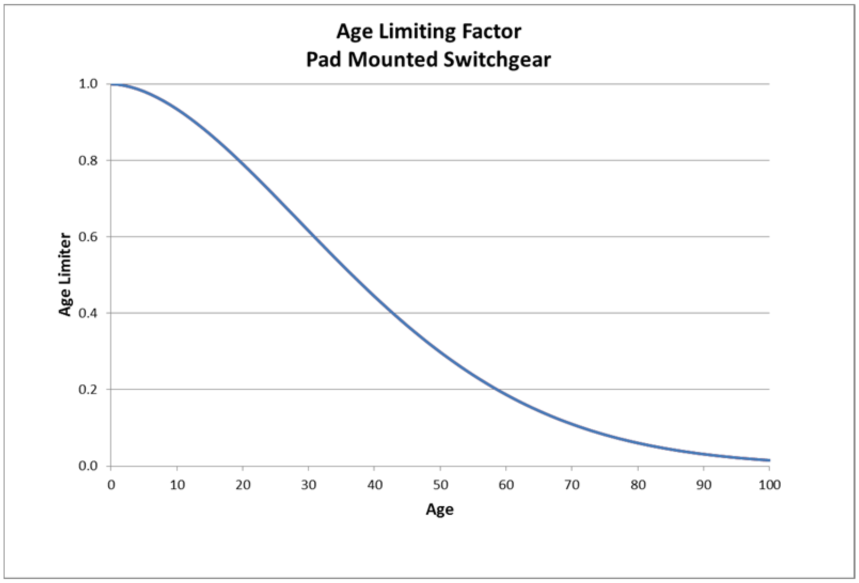

Figure 7-1 Age Limiting Factor Criteria - - Pad Mounted Switchgear

7.2 Age Distribution

The average age of the units was 30 years for Pad Mounted Switchgear.

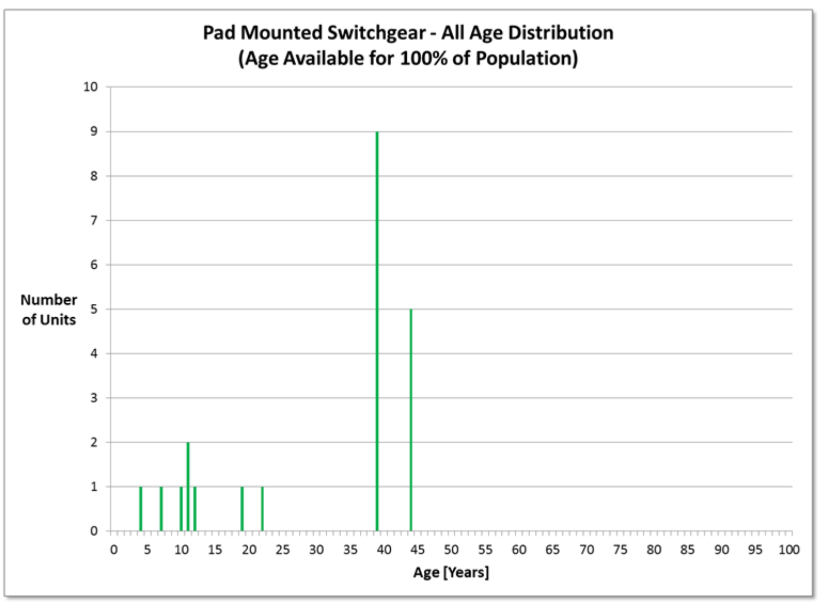

Figure 7-2 Age Distribution - Pad Mounted Switchgear

7.3 Health Index Results

There were a total of 22 units of Pad Mounted Switchgear. All of them units had sufficient data for a Health Indexing.

The average Health Index score for this asset group was 59%.

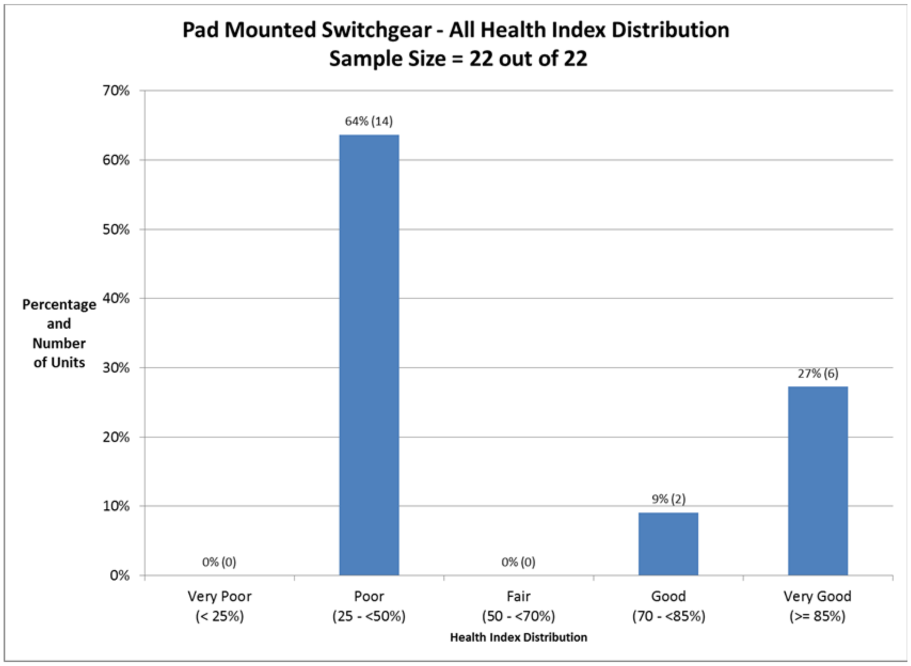

Figure 7-3 Health Index Distribution - Pad Mounted Switchgear

7.4 Flagged for Action Plan

The flagged for action plan of Pad Mounted Switchgear was based on the asset removal rate.

The flagged for action plans for Pad Mounted Switchgear were based on the data from sample size and extrapolated to the entire population. The following diagram shows the flagged for action plans:

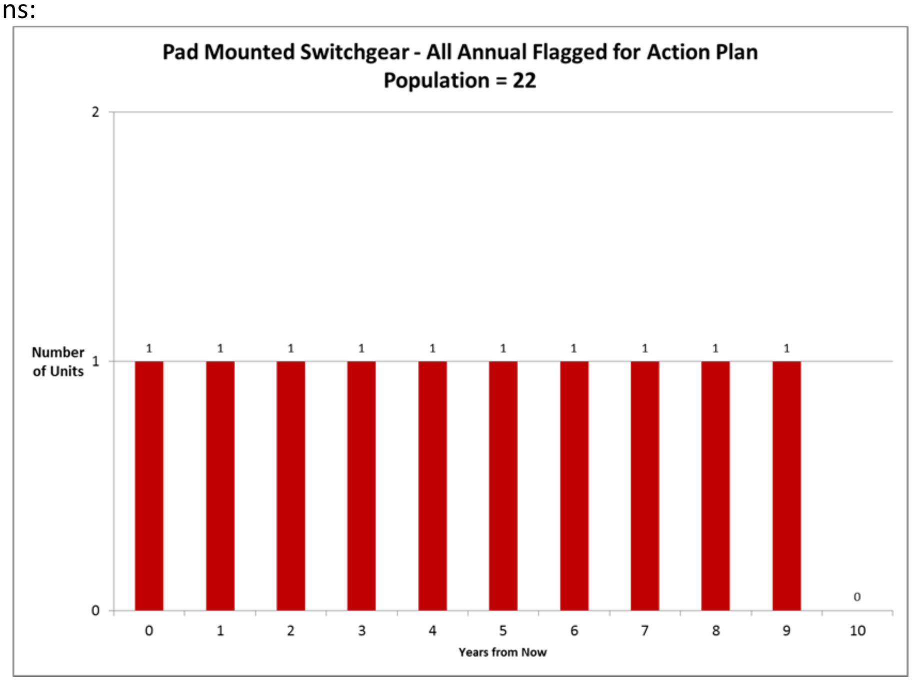

Figure 7-4 Flagged for Action Plan - Pad Mounted Switchgear

7.5 Data Gaps

The data used for Pad Mounted Switchgear assessment included age and inspection results.

The data gaps are as follows.

Data Gap (Sub-Condition Parameter)	**Parent Condition Parameter**	**Priority**	**Object or Component Addressed**	**Description**	**Source of Data**
Insulators	Insulation Condition	☆ ☆	Insulation	Insulation defect	On-site visual inspection
Historic Removal Record		☆ ☆ ☆	Switchgear Unit	Age at removal	Inventory Database

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8 VAULT TRANSFORMERS

8.1 Health Index Formula

Assume a parameter scoring system of 0 through 4, where 0 and 4 represent the "worst" and "best" scores respectively. Thus, the maximum score for any condition or sub-condition parameter (maximum CPS and CPF) is "4".

8.1.1 Condition and Sub-Condition Parameters

Table 8-1 Condition Parameter and Weights - Vault Transformers

m	Condition parameter	WCP_m	Sub-Condition Parameters
1	Physical Condition	3	Table 8-2
2	Connection and Insulation	5	Table 8-3
3	Service Record	5	Table 8-4
	Age Limiting Factor		Figure 8-1

Table 8-2 Physical Condition Sub-Condition Parameters and Weights (m=1) - Vault Transformers

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Tank Corrosion	3	Table 8-5
2	Access	1	Table 8-5
3	Base	2	Table 8-5

Table 8-3 Connection and Insulation Sub-Condition Parameters and Weights (m=2) - Vault Transformers

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Oil Leak	2	Table 8-5
2	Elbow	4	Table 8-5
3	Grounding	1	Table 8-5
4	Bushing	4	Table 8-5

Table 8-4 Service Record Sub-Condition Parameters and Weights (m=3) - Vault Transformers

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Overall	1	Table 8-6

8.1.2 Condition Criteria

Defect

All the condition scores are based on Kingston's inspection grading results as follows.

Table 8-5 Defect Criteria - Vault Transformers

Score	Condition Description
0	Applicable
1	Major
2	Minor
4	(No Input)

Overall Status

Table 8-6 Overall Maintenance Count Criteria - Vault Transformers

Score	Condition Description
3	Satisfactory
1	Needs Attention

Age Limiting Factor

In this project, age was used as a limiting factor to reflect the degradation of asset unit as time passed by. Principle of applying the degradation survival curve is described in Equation 1-5 of Section 1.1.2.

In this project, the parameters of Vault Transformers age limiting curve are shown in the following table, based on Kingston's own historic removal records.

Table 8-7 Age Limiting Curve Parameters - Vault Transformers

Asset Type	α	β
Vault Transformers	**41.8388**	**2.9644**

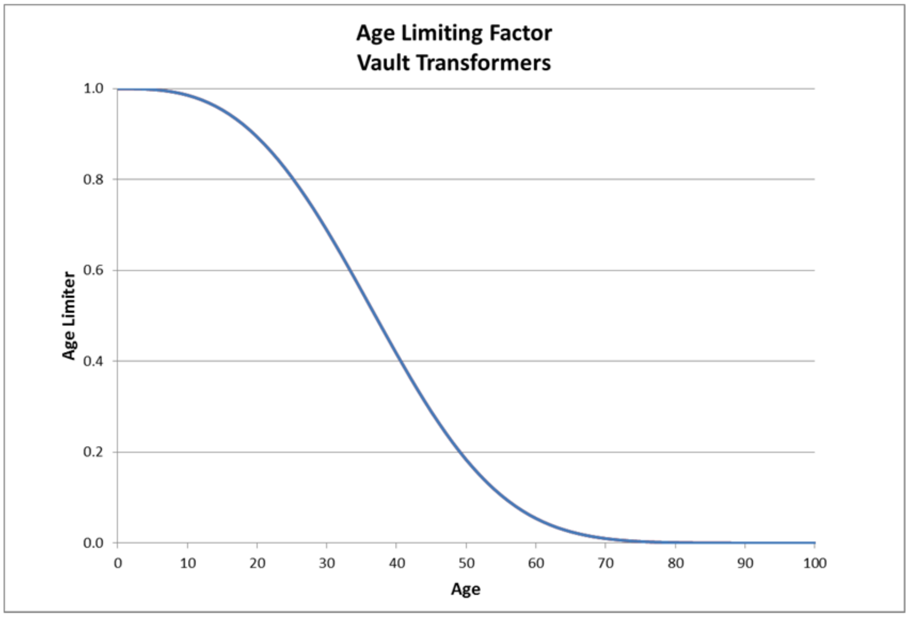

Figure 8-1 Age Limiting Factor Criteria - - Vault Transformers

8.2 Age Distribution

The average age of the units was 38 years.

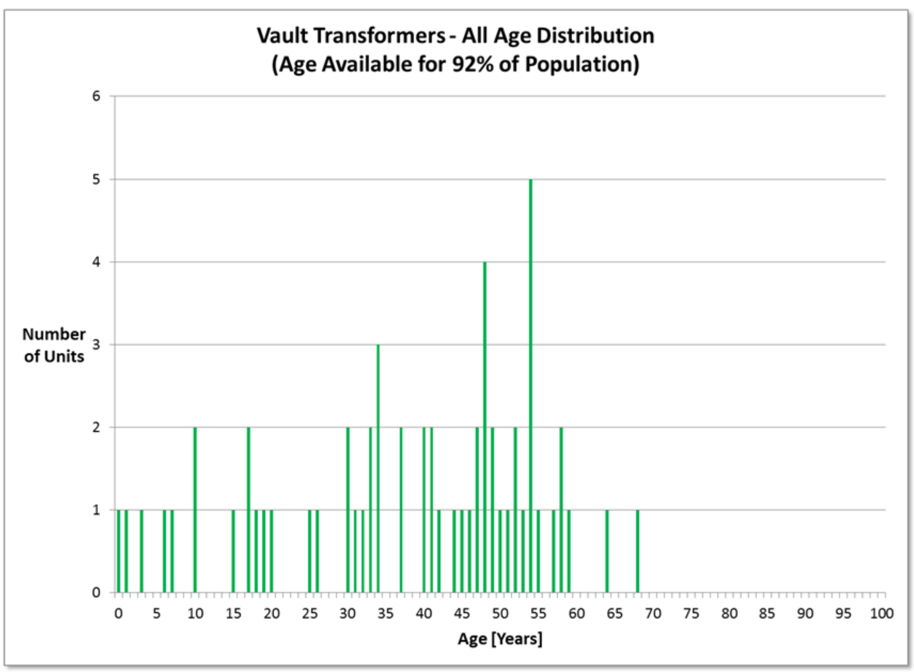

Figure 8-2 Age Distribution - Vault Transformers

8.3 Health Index Results

There were a total of 64 units of Vault Transformers. Among them, 59 units had sufficient data for a Health Indexing.

The average Health Index score for this asset group was 46%.

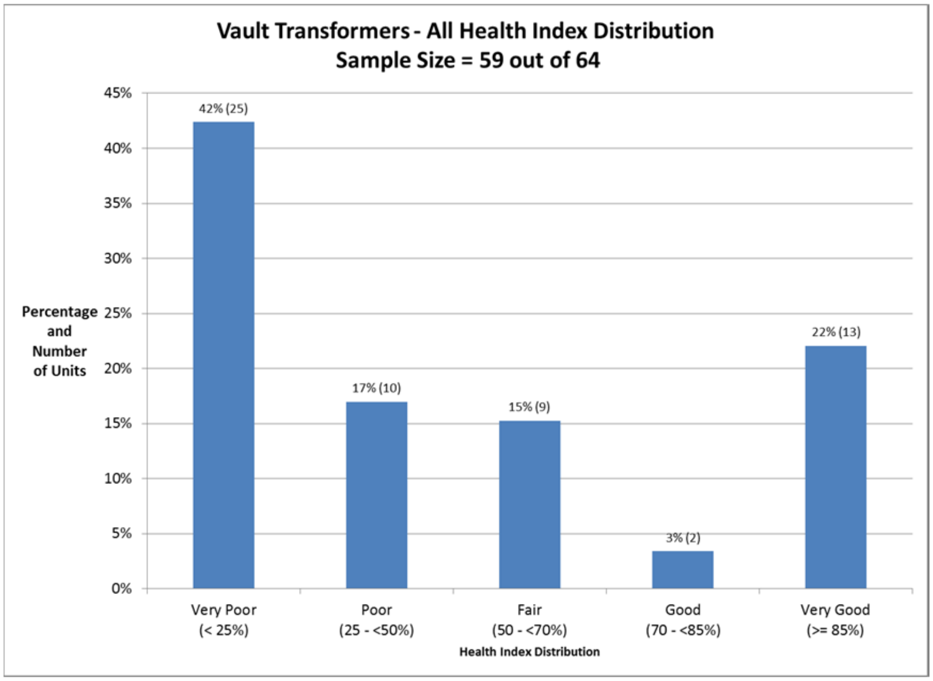

Figure 8-3 Health Index Distribution - Vault Transformers

8.4 Flagged for Action Plan

The flagged for action plan of Vault Transformers was based on the asset removal rate.

The flagged for action plans for Vault Transformers were based on the data from sample size and extrapolated to the entire population. The following diagram shows the flagged for action plans:

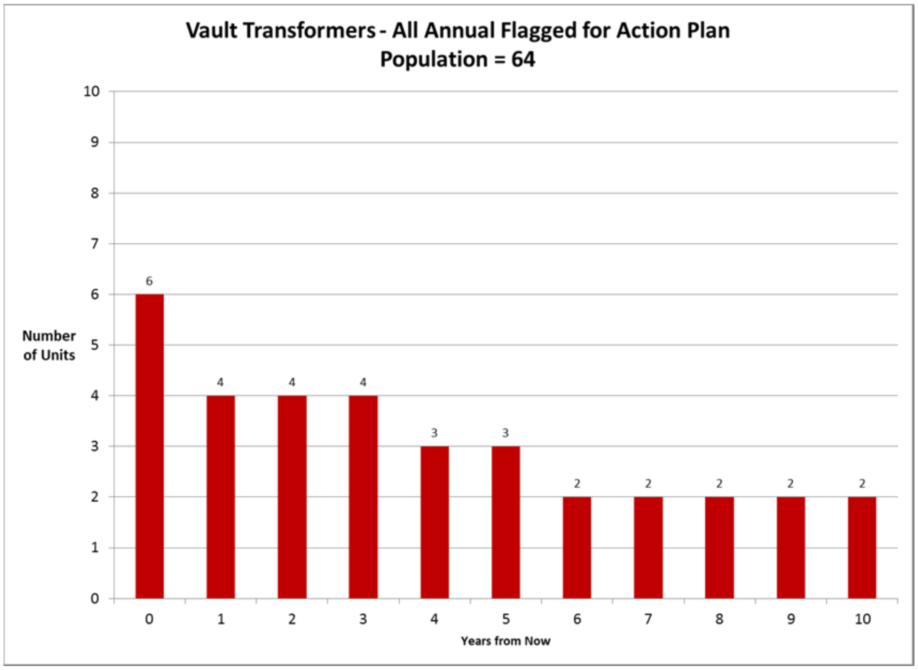

Figure 8-4 Flagged for Action Plan - Vault Transformers

8.5 Data Gaps

The data used for Vault Transformers assessment included age and inspection results for individual components.

The data gaps are as follows.

Table 8-8 Data Gap for Vault Transformers

Data Gap (Sub-Condition Parameter)	**Parent Condition Parameter**	**Priority**	**Object or Component Addressed**	**Description**	**Source of Data**
Loading	Service Record	☆	Transformer load	Monthly 15 min peak load throughout years	Operation Record

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9 VAULT SWITCHGEAR

9.1 Health Index Formula

Assume a parameter scoring system of 0 through 4, where 0 and 4 represent the “worst” and “best” scores respectively. Thus, the maximum score for any condition or sub-condition parameter (maximum CPS and CPF) is “4”.

9.1.1 Condition and Sub-Condition Parameters

Table 9-1 Condition Parameter and Weights - Vault Switchgear

m	Condition parameter	WCP_m	Sub-Condition Parameters
1	Physical Condition	3	Table 9-2
2	Connection and Switch	4	Table 9-3
3	Insulation	4	Table 9-4
4	Service Record	3	Table 9-5
	Age Limiting Factor		Figure 9-1

Table 9-2 Physical Condition Sub-Condition Parameters and Weights (m=1) - Vault Switchgear

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Corrosion	4	Table 9-6
2	Painting	1	Table 9-6
3	Pad	1	Table 9-6
4	Access	1	Table 9-6

Table 9-3 Connection and Switch Sub-Condition Parameters and Weights (m=2) - Vault Switchgear

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Cable	2	Table 9-6
2	Elbow	1	Table 9-6
3	Grounding	1	Table 9-6
4	Switch	3	Table 9-6

Table 9-4 Insulation Sub-Condition Parameters and Weights (m=3) - Vault Switchgear

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Barrier	1	Table 9-6

Table 9-5 Service Record Sub-Condition Parameters and Weights (m=4) - Vault Switchgear

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Overall	1	Table 9-7

9.1.2 Condition Criteria

Defect

All the condition scores are based on Kingston's inspection grading as follows:

Table 9-6 Inspection Result Criteria - Vault Switchgear

Score	Defect Condition Description
1	Major
2	Minor
0	Critical
4	(No Input)

Overall Assessment

Table 9-7 Overall Maintenance Count Criteria - Vault Switchgear

Score	Assessment Value
1	Needs Attention
3	Satisfactory

Age Limiting Factor

In this project, age was used as a limiting factor to reflect the degradation of asset unit as time passed by. Principle of applying the degradation survival curve is described in Equation 1-5 of Section 1.1.2.

In this project, the parameters of Vault Switchgear age limiting curve are shown in the following table, based on industry practice.

Table 9-8 Age Limiting Curve Parameters - Vault Switchgear

Asset Type	α	β
Vault Switchgear	**44.966**	**1.789**

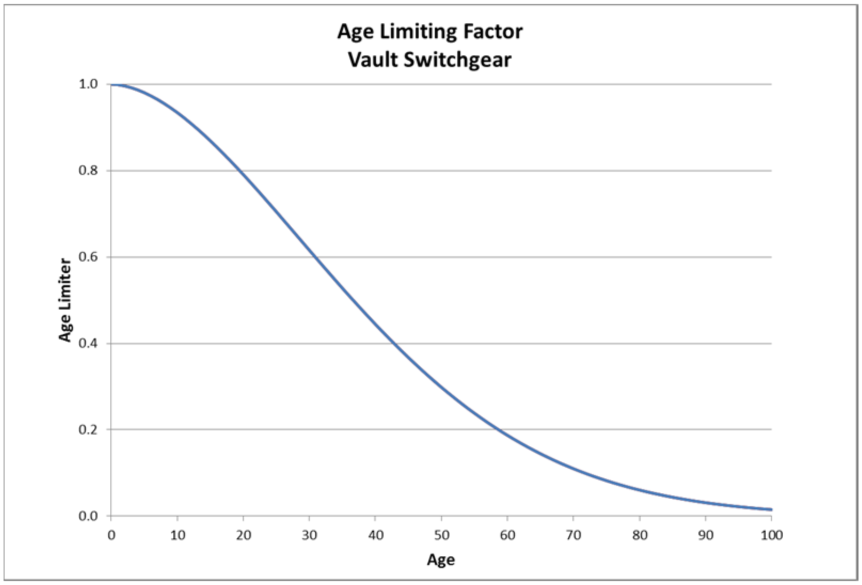

Figure 9-1 Age Limiting Factor Criteria - - Vault Switchgear

9.2 Age Distribution

The average age of the units was 25 years for Vault Switchgear.

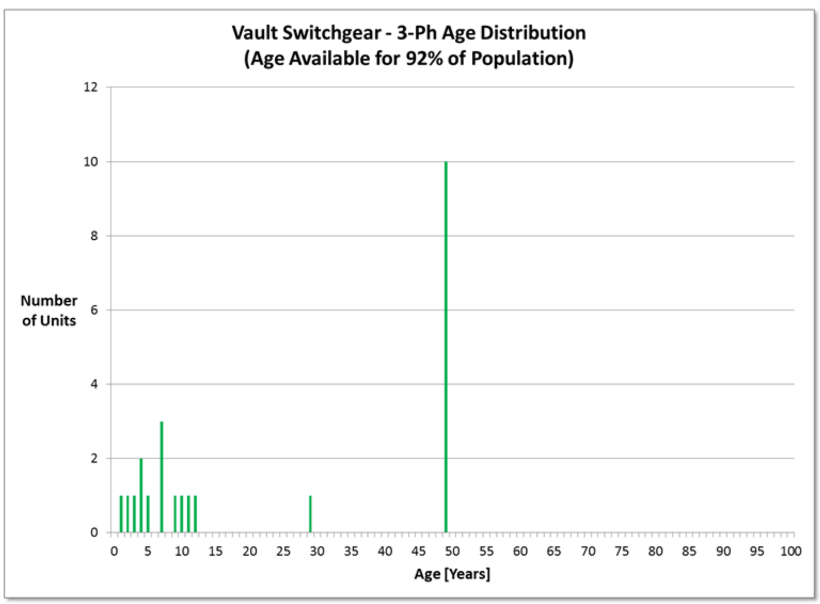

Figure 9-2 Age Distribution - Vault Switchgear

9.3 Health Index Results

There were a total of 26 units of Vault Switchgear. Among them, 24 units had sufficient data for a Health Indexing.

The average Health Index score for this asset group was 68%.

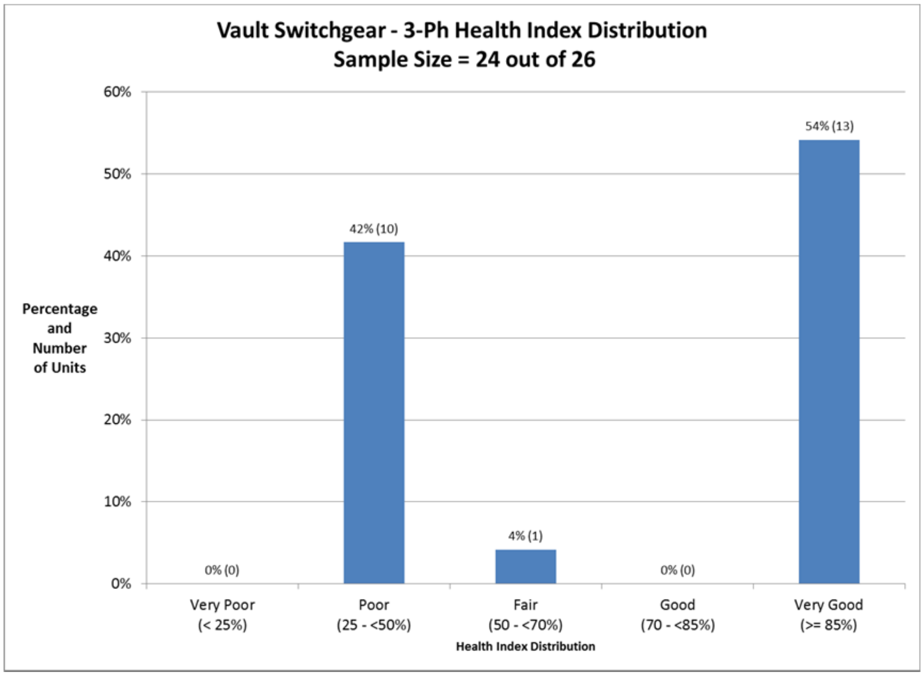

Figure 9-3 Health Index Distribution - Vault Switchgear

9.4 Flagged for Action Plan

The flagged for action plan of Vault Switchgear was based on the asset removal rate.

The flagged for action plans for Vault Switchgear were based on the data from sample size and extrapolated to the entire population. The following diagram shows the flagged for action plans:

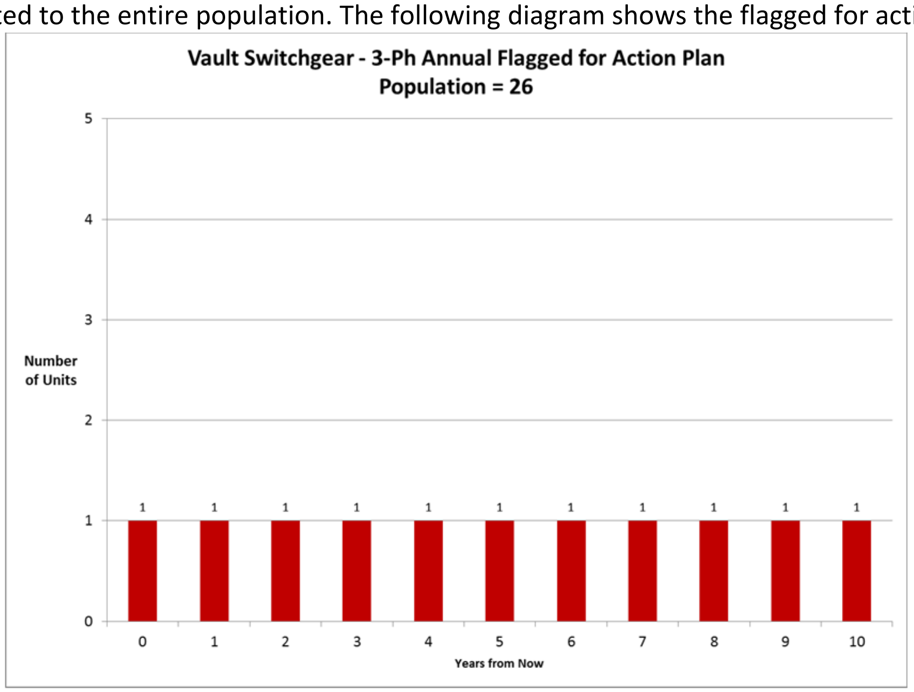

Figure 9-4 Flagged for Action Plan - Vault Switchgear

9.5 Data Gaps

The data used for Vault Switchgear assessment included age and inspection results.

The data gaps are as follows.

Data Gap (Sub-Condition Parameter)	**Parent Condition Parameter**	**Priority**	**Object or Component Addressed**	**Description**	**Source of Data**
Insulators	Insulation Condition	✮✮	Insulation	Insulation defect	On-site visual inspection
Historic Removal Record		✮✮✮	Switchgear Unit	Age at removal	Inventory Database

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10 TRANSFORMER VAULTS

10.1 Health Index Formula

Assume a parameter scoring system of 0 through 4, where 0 and 4 represent the “worst” and “best” scores respectively. Thus, the maximum score for any condition or sub-condition parameter (maximum CPS and CPF) is “4”.

10.1.1 Condition and Sub-Condition Parameters

Table 10-1 Condition Parameter and Weights - Transformer Vaults

m	Condition parameter	WCP_m	Sub-Condition Parameters
1	Structure	3	Table 10-2
2	Ventilation and Drainage	2	Table 10-3
3	Lighting	1	Table 10-4
4	Access	1	Table 10-5
5	Service Record	2	Table 10-6
	Age Limiting Factor		Figure 10-1

Table 10-2 Structure Sub-Condition Parameters and Weights (m=1) - Transformer Vaults

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Roof	3	Table 10-7
2	Wall	3	Table 10-7
3	Floor	1	Table 10-7

Table 10-3 Ventilation and Drainage Sub-Condition Parameters and Weights (m=2) - Transformer Vaults

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Sump Pump	2	Table 10-7
2	Flooding	1	Table 10-7
3	Dirt	1	Table 10-7

Table 10-4 Lighting Sub-Condition Parameters and Weights (m=3) - Transformer Vaults

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Lighting	2	Table 10-7
2	Cabling	1	Table 10-7
3	Grounding	1	Table 10-7

Table 10-5 Access Sub-Condition Parameters and Weights (m=4) - Transformer Vaults

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Entrance	1	Table 10-7
2	Ladder	1	Table 10-7
3	Lock	1	Table 10-7

Table 10-6 Service Record Sub-Condition Parameters and Weights (m=5) - Transformer Vaults

n	Sub-Condition Parameter	$WSCP_n$	Condition Criteria Table
1	Overall	1	Table 10-8

10.1.2 Condition Criteria

Defect

All the condition scores are based on Kingston's inspection grading results as follows.

Table 10-7 Defect Criteria - Transformer Vaults

Score	Condition Description
0	Applicable
1	Major
2	Minor
4	(No Input)

Overall Status

Table 10-8 Overall Maintenance Count Criteria - Transformer Vaults

Score	Condition Description
3	Satisfactory
1	Needs Attention

Age Limiting Factor

Age was used as a limiting factor to reflect the degradation of asset unit as time passed by. Refer to section 1.1.2 for principle.

In this project, the parameters of Transformer Vaults age limiting curve are shown in the following table, based on industry practice.

Table 10-9 Age Limiting Curve Parameters - Transformer Vaults

Asset Type	α	β
Transformer Vaults	**56.4249**	**2.005**

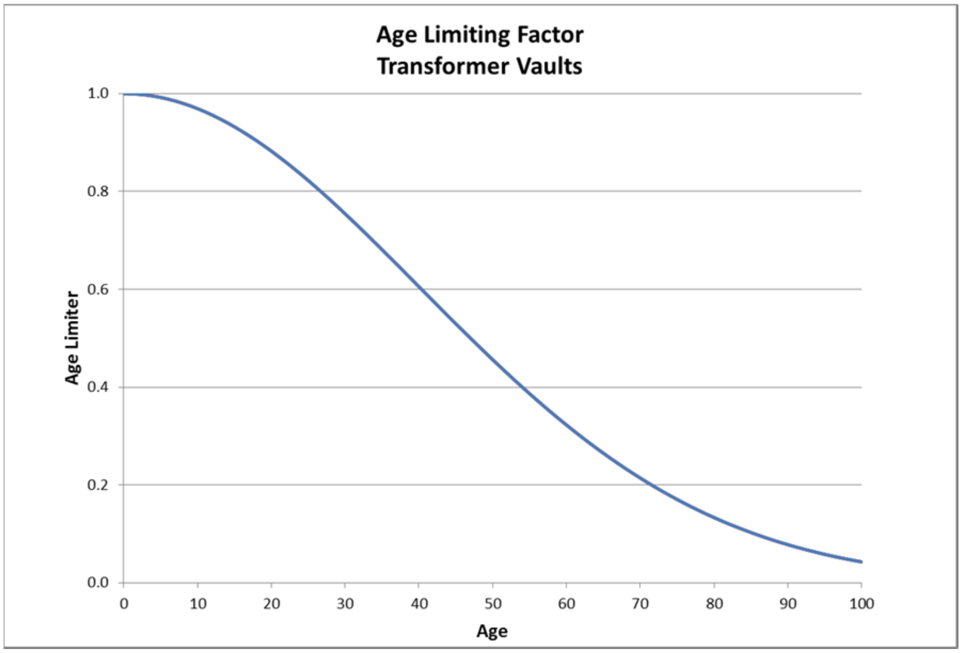


Figure 10-1 Age Limiting Factor Criteria - - Transformer Vaults

10.2 Age Distribution

The average age was 27 for Transformer Vaults. The age distributions were as follows.

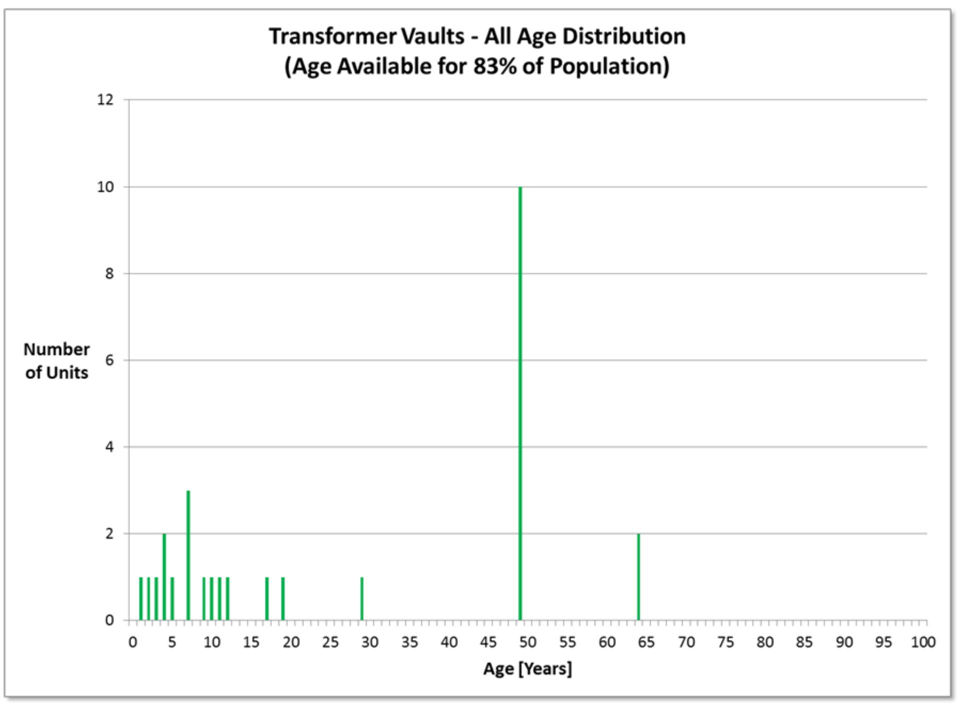


Figure 10-2 Age Distribution –Transformer Vaults

10.3 Health Index Results

There were 36 units of Transformer Vaults. Among them, 30 units had sufficient data for a Health Indexing.

The average Health Index was 73% for the asset units.

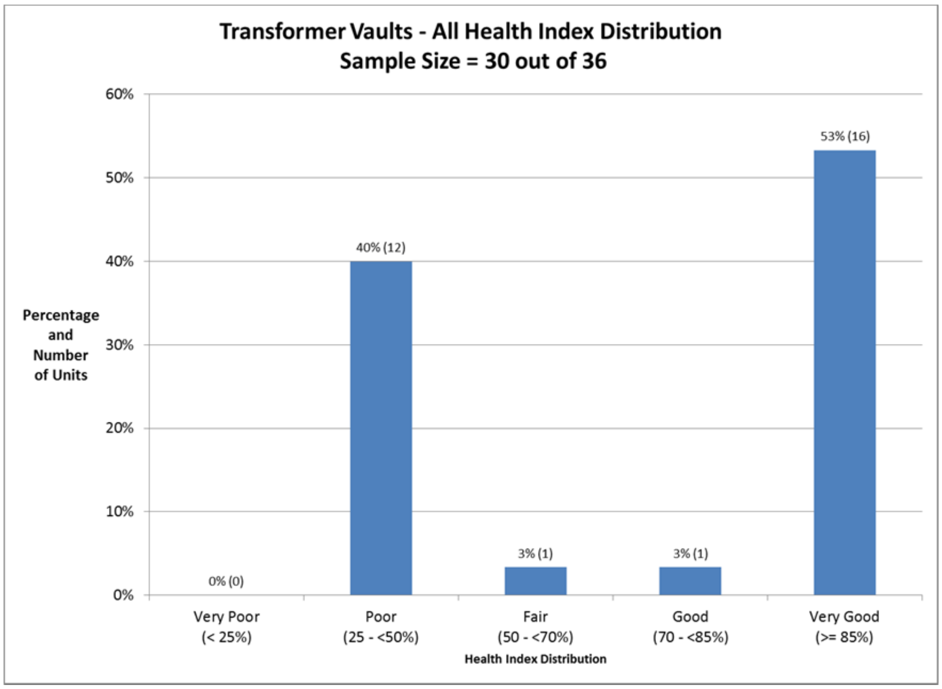


Figure 10-3 Health Index Distribution –Transformer Vaults

10.4 Flagged for Action Plan

The flagged for action plan of Transformer Vaults was based on the asset removal rate.

The flagged for action plans for Transformer Vaults were based on the data from sample size and extrapolated to the entire population. The following diagram shows the flagged for action plans:

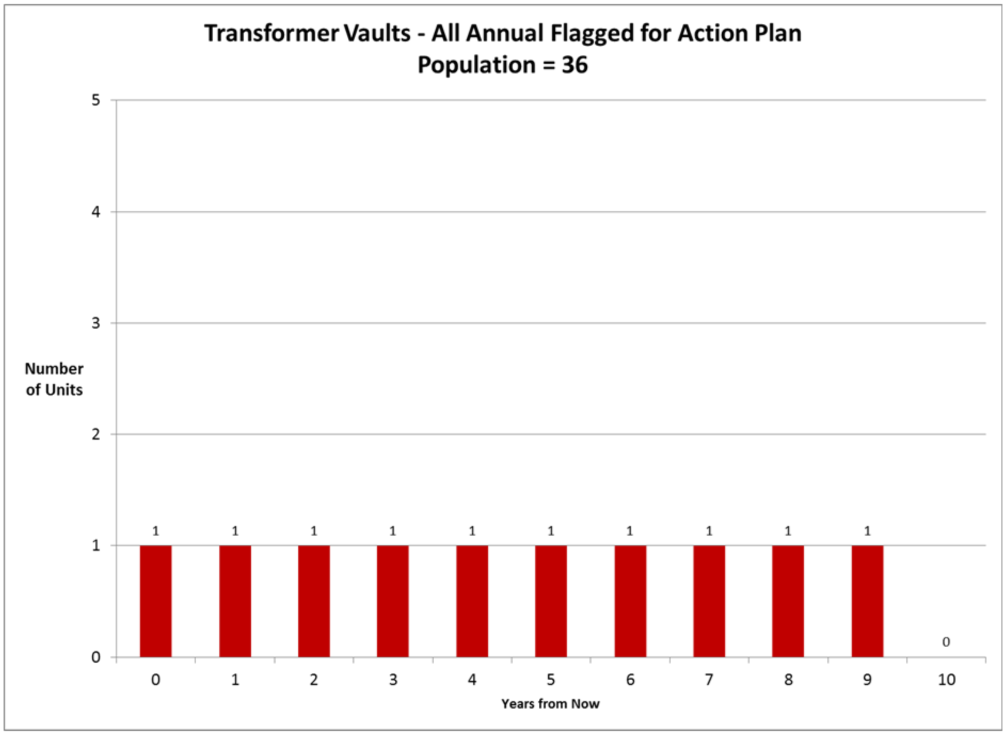


Figure 10-4 Flagged for Action Plan – Transformer Vaults

10.5 Data Gaps

Data for Transformer Vaults included age and inspection results.

The following table shows the data gaps.

Table 10-10 Data Gap for Transformer Vaults

Data Gap (Sub-Condition Parameter)	**Parent Condition Parameter**	**Priority**	**Description**	**Source of Data**
Historic Removal Record		☆☆☆	Age at demolition	Inventory Database

11 UG PRIMARY CABLES - PILC

11.1 Health Index Formula

As there was insufficient condition data available, the HI assessment for this asset category was based simply on age and the cumulative likelihood of survival at a given age.

Age was used as a limiting factor to reflect the degradation of asset unit as time passed by. Refer to section 1.1.2 for principle.

In this project, the parameters of UG Primary Cables - PILC age limiting curve are shown in the following table, based on industry practice.

Table 11-1 Age Limiting Curve Parameters - UG Primary Cables - PILC

Asset Type	α	β
PILC cables	**60.5**	**7.6**

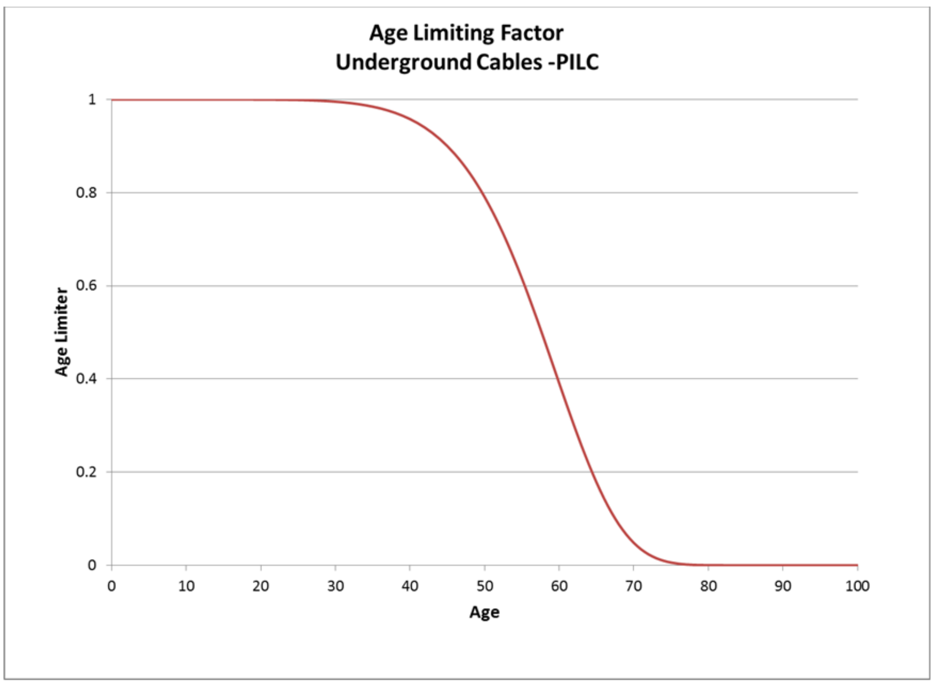


Figure 11-1 Age Limiting Factor Criteria - - UG Primary Cables - PILC

11.2 Age Distribution

The average ages of all in service cable segments were 53, 25, 8 years, for 44 kV, Non 44 kV 1-Ph and Non 44 kV 3-Ph UG Primary Cables - PILC respectively. The age distributions for UG Primary Cables - PILC were as follows.

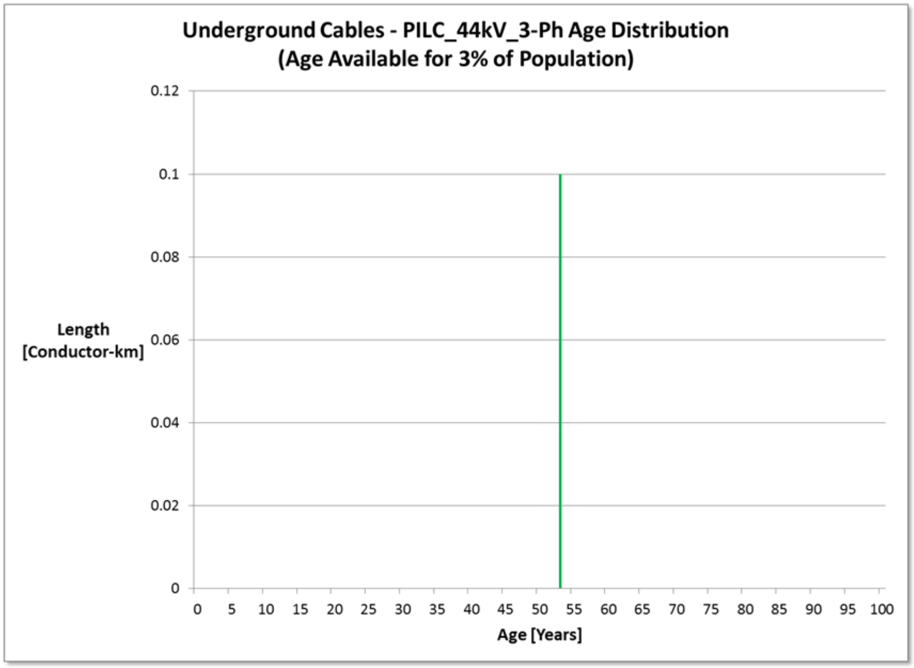


Figure 11-2 Age Distribution - UG Primary Cables - PILC (44 kV)

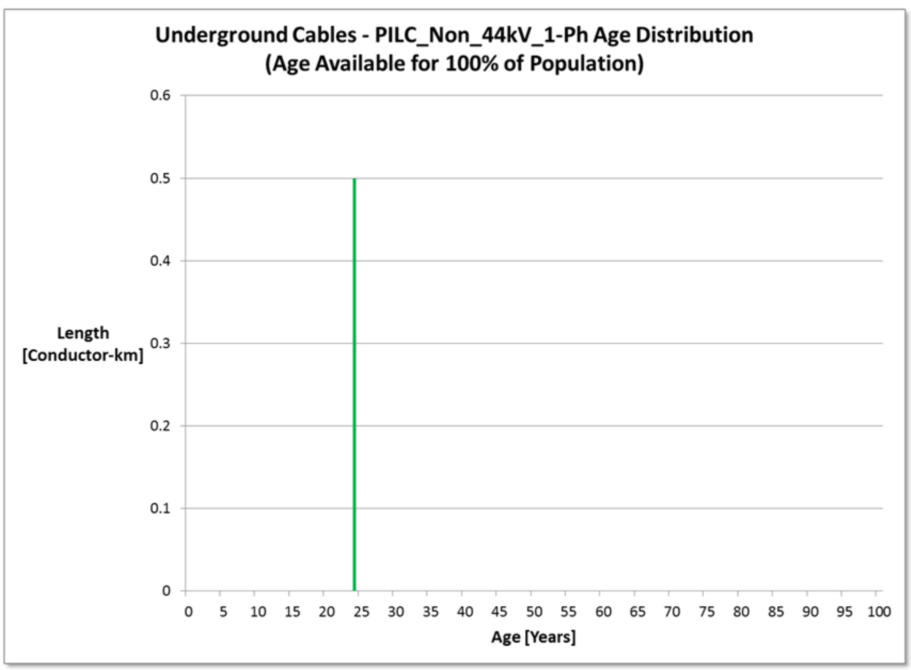


Figure 11-3 Age Distribution - UG Primary Cables - PILC (Non 44 kV 1-Ph)

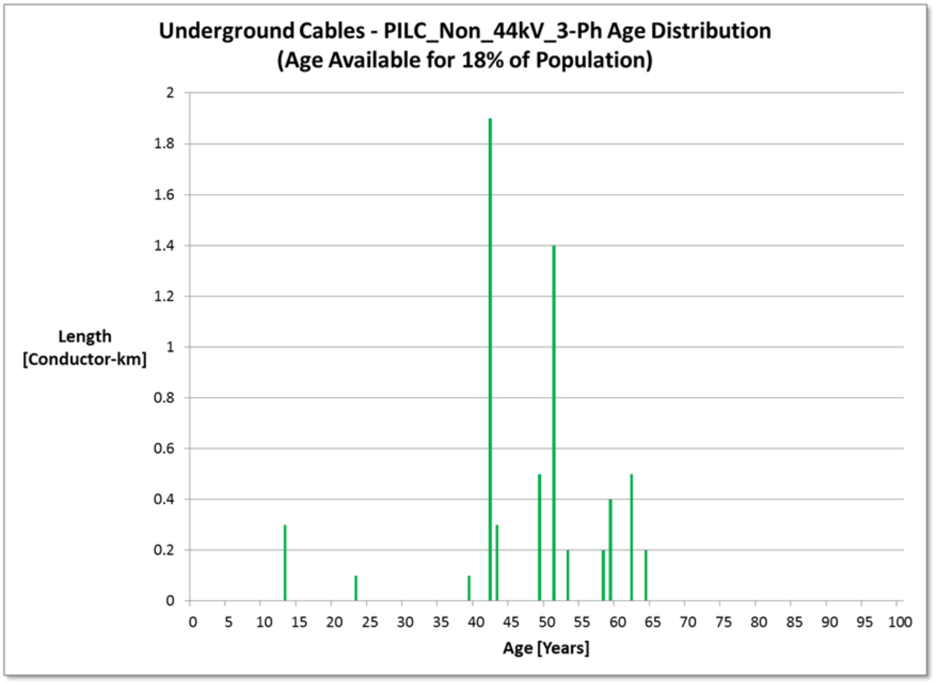


Figure 11-4 Age Distribution - UG Primary Cables - PILC (Non 44 kV 3-Ph)

11.3 Health Index Results

There were 4.1 km 44 kV UG Primary Cables - PILC. Among them, 0.1 km had age data for a Health Indexing.

There were 0.5 km Non 44 kV 1-Ph UG Primary Cables - PILC. All of them had age data for a Health Indexing.

There were 34 km 1-Phase UG Primary Cables - PILC. Among them, 6.1 km had age data for a Health Indexing.

The average Health Index for this asset group was 69%, 99 and 76%, for 44 kV, Non 44 kV 1-Ph, and Non 44 kV 3-Ph UG Primary Cables - PILC respectively.

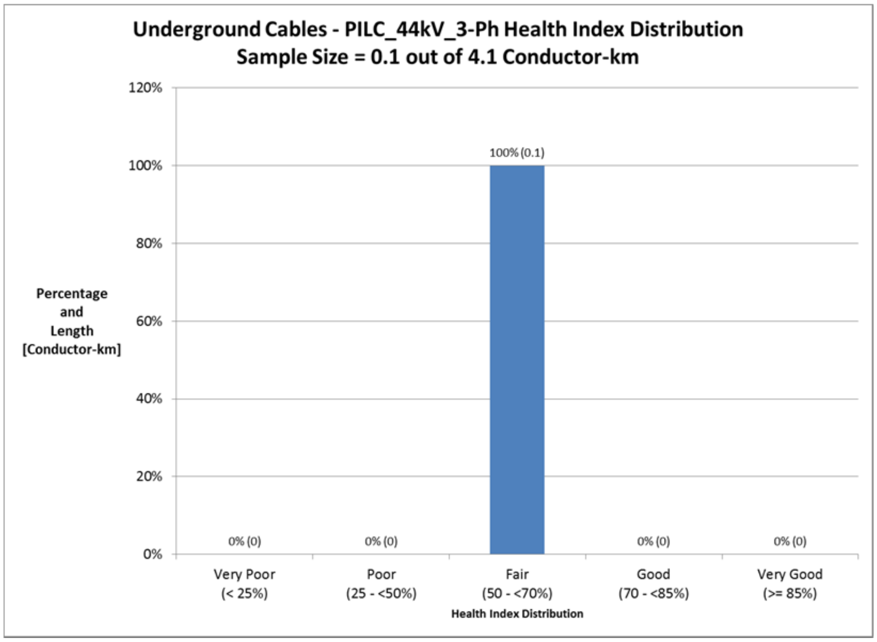


Figure 11-5 Health Index Distribution - UG Primary Cables - PILC (44 kV)

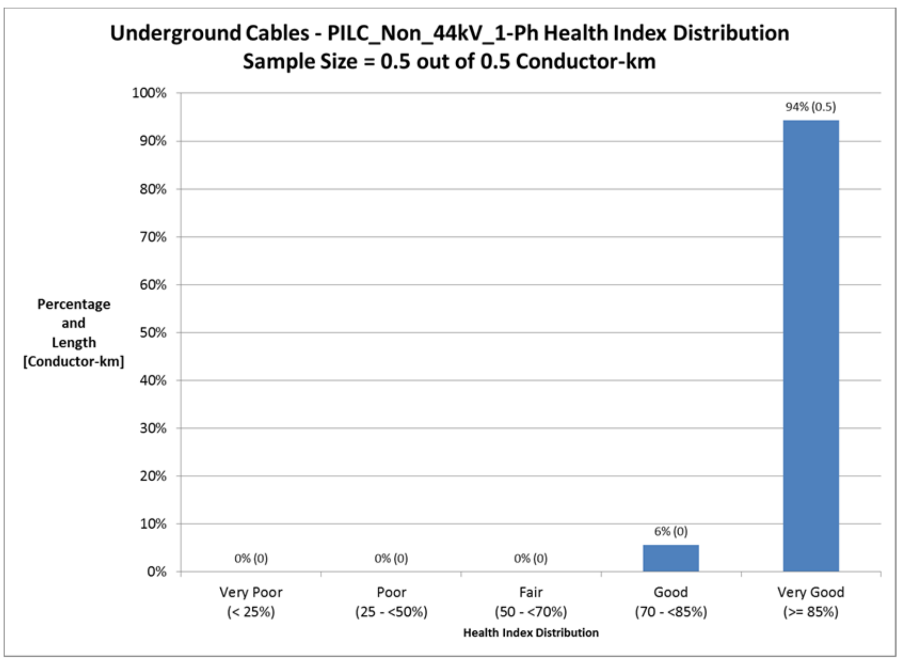


Figure 11-6 Health Index Distribution - UG Primary Cables - PILC (44 kV 1-Ph)

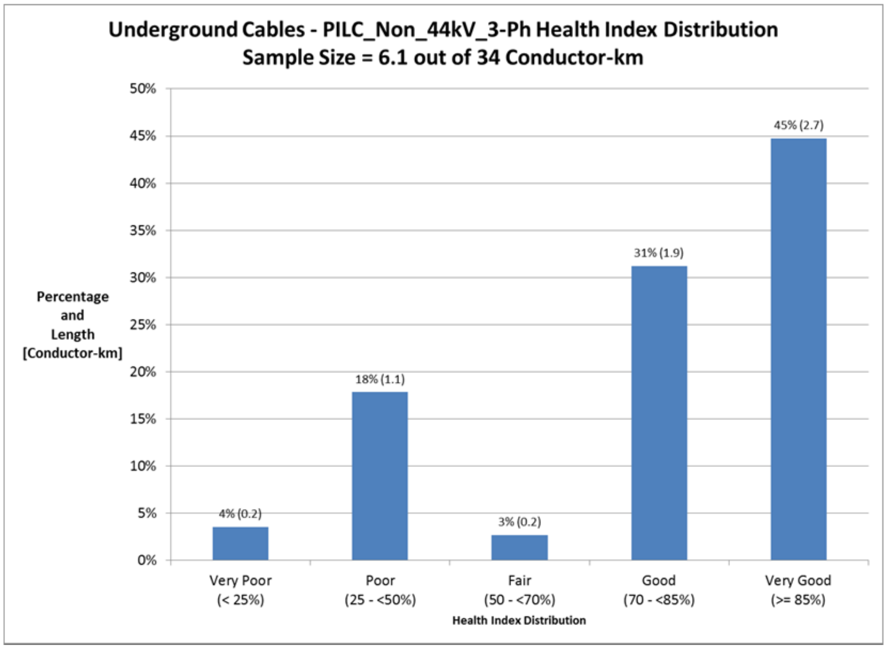


Figure 11-7 Health Index Distribution - UG Primary Cables - PILC (Non 44 kV 3-Ph)

11.4 Flagged for Action Plan

The flagged for action plan for UG Primary Cables - PILC were based on the data from sample size and extrapolated to the entire population.

The following diagram shows the flagged for action plan:

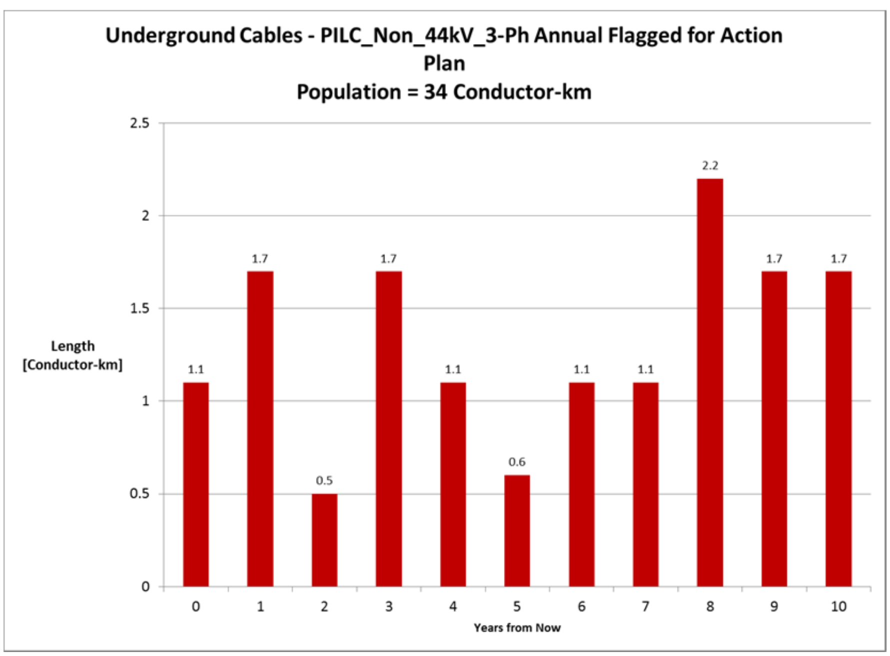


Figure 11-8 Flagged for Action Plan – UG Primary Cables - PILC (Non 44 kV 3-Ph)

There was no 44 kV or Non 44 kV 1-Ph UG Primary Cables - PILC cables flagged for action.

11.5 Data Gaps

The data used for UG Primary Cables - PILC assessment included age only.

Kingston has a plan to phase out all the PILC cables. As a consequence, no data gaps are listed in this study.

12 UG PRIMARY CABLES - XLPE

12.1 Health Index Formula

As there was insufficient condition data available, the HI assessment for this asset category was based simply on age and the cumulative likelihood of survival at a given age.

Age was used as a limiting factor to reflect the degradation of asset unit as time passed by. Refer to section 1.1.2 for principle.

In this project, the parameters of UG Primary Cables - XLPE age limiting curve are shown in the following table, based on industry practice.

Table 12-1 Age Limiting Curve Parameters - UG Primary Cables - XLPE

Asset Type	α	β
XLPE cables	**43**	**7.3**

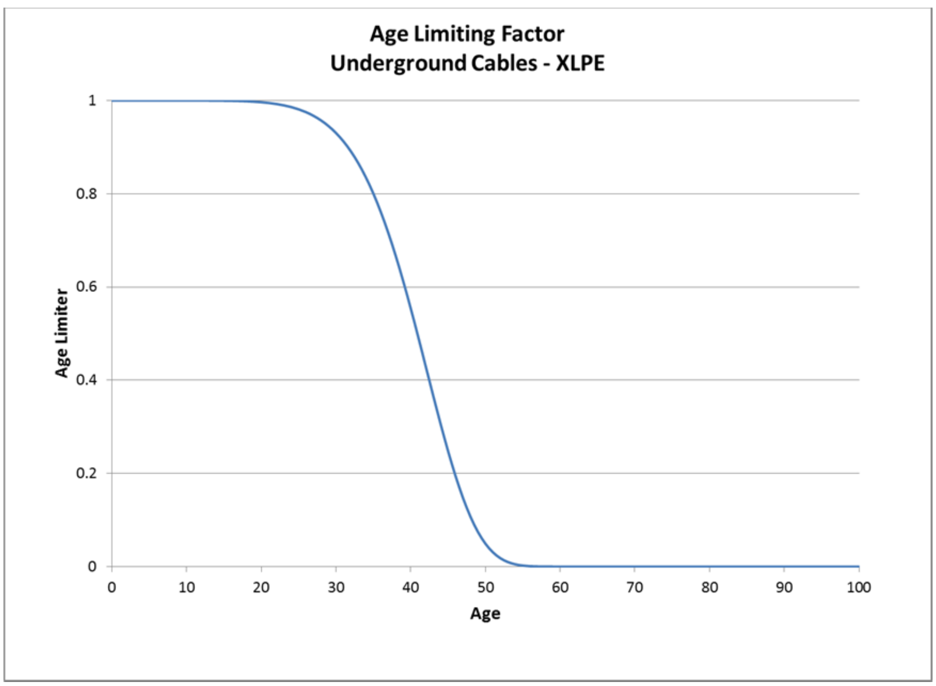


Figure 12-1 Age Limiting Factor Criteria - - UG Primary Cables - XLPE

12.2 Age Distribution

The average ages of all in service cable segments were 5, 11, 5 years, for 44 kV, Non 44 kV 1-Ph and Non 44 kV 3-Ph UG Primary Cables - XLPE respectively. The age distributions for UG Primary Cables - XLPE were as follows.

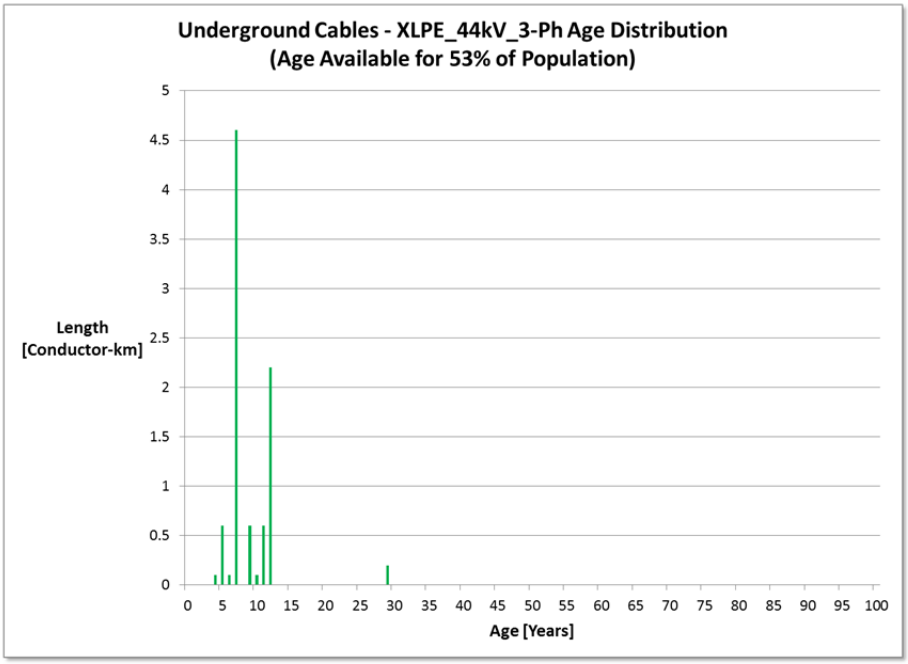


Figure 12-2 Age Distribution - UG Primary Cables - XLPE (44 kV)

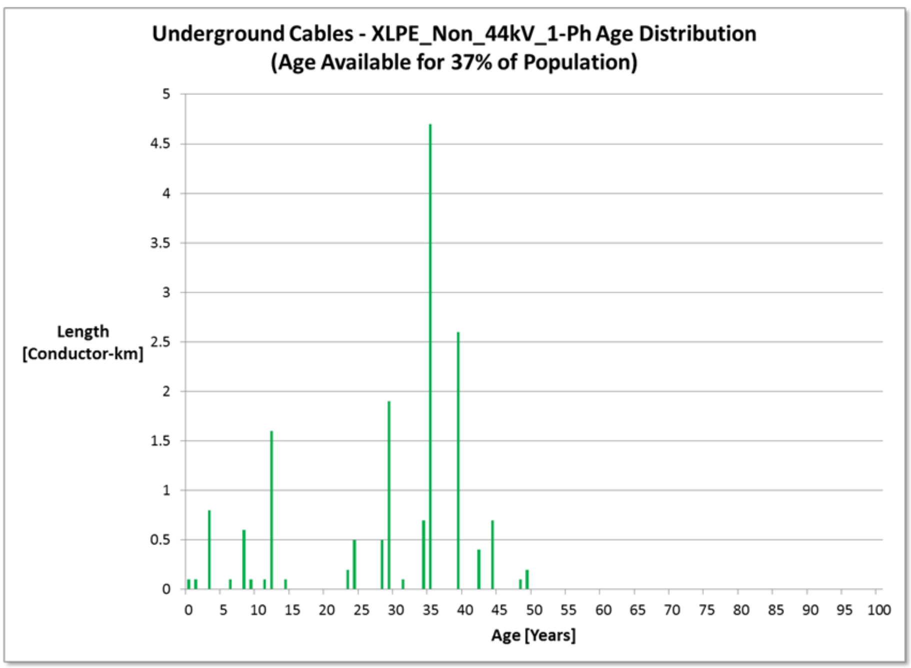


Figure 12-3 Age Distribution - UG Primary Cables - XLPE (Non 44 kV 1-Ph)

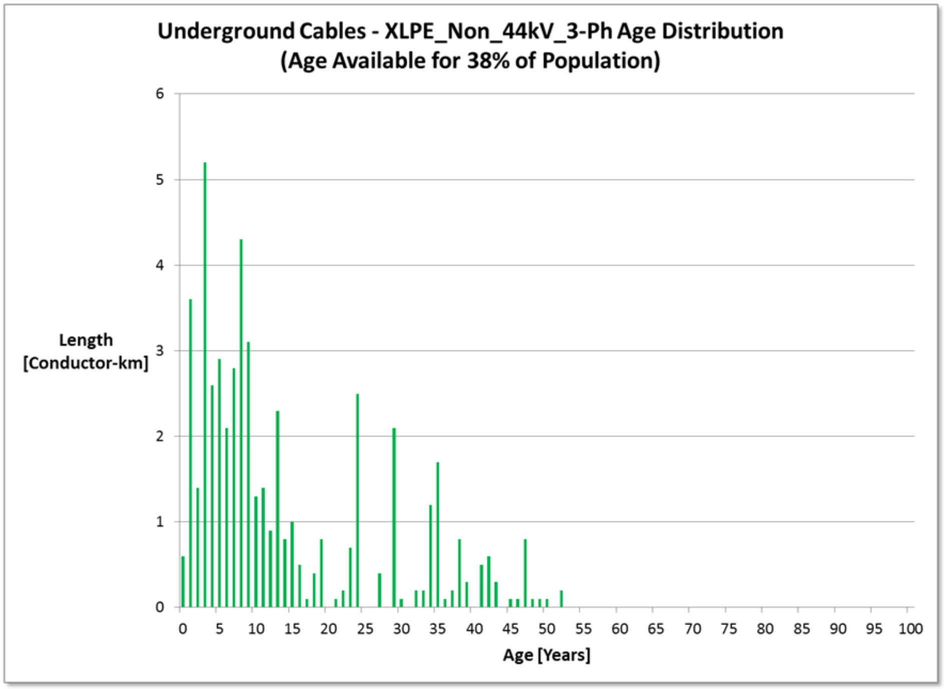


Figure 12-4 Age Distribution - UG Primary Cables - XLPE (Non 44 kV 3-Ph)

12.3 Health Index Results

There were 17.4 km 44 kV UG Primary Cables - XLPE. Among them, 9.2 km had age data for a Health Indexing.

There were 43.7 km Non 44 kV 1-Ph UG Primary Cables - XLPE. Among them, 16.1 km had age data for a Health Indexing.

There were 136.1 km Non 44 kV 3-Ph UG Primary Cables - XLPE. Among them, 51.8 km had age data for a Health Indexing.

The average Health Index for this asset group was 100%, 80 and 93%, for 44 kV, Non 44 kV 1-Ph, and Non 44 kV 3-Ph UG Primary Cables - XLPE respectively.

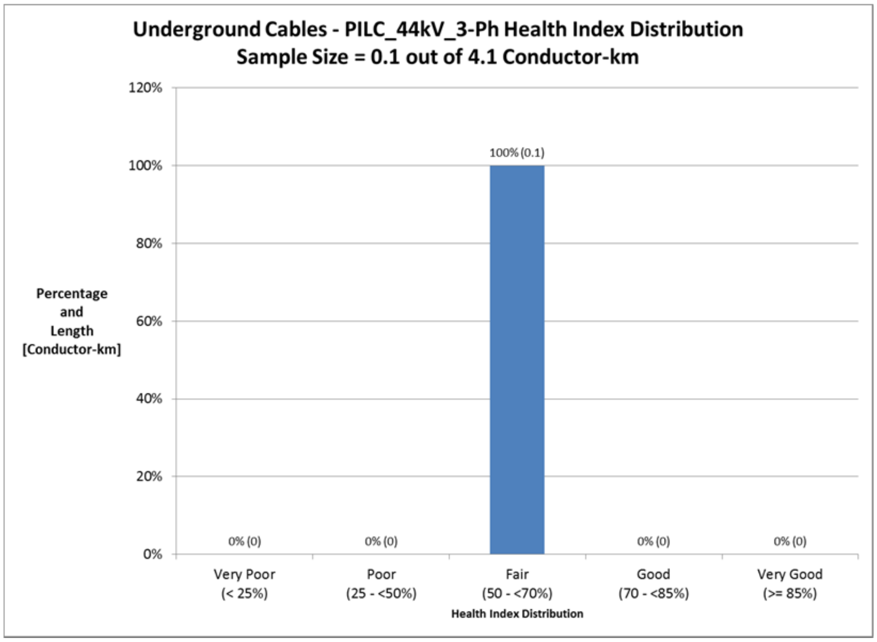


Figure 12-5 Health Index Distribution - UG Primary Cables - XLPE (44 kV)

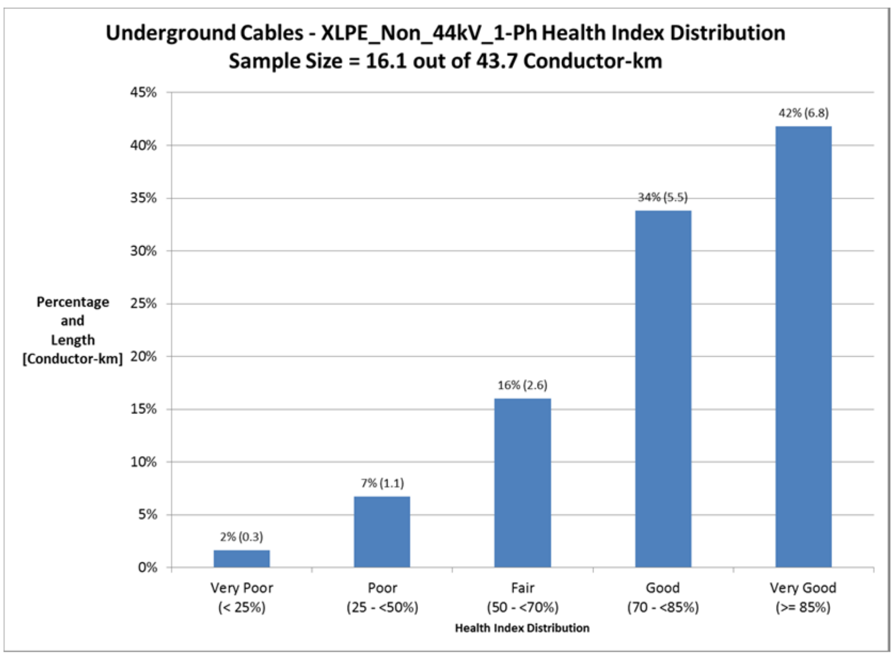


Figure 12-6 Health Index Distribution - UG Primary Cables - XLPE (Non 44 kV 1-Ph)

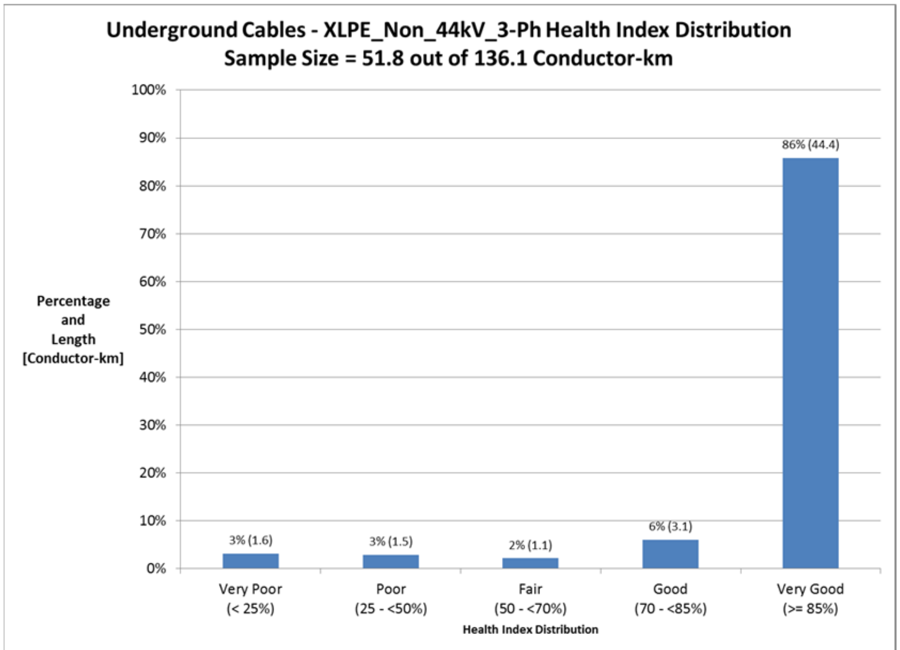


Figure 12-7 Health Index Distribution - UG Primary Cables - XLPE (Non 44 kV 3-Ph)

12.4 Flagged for Action Plan

The flagged for action plan for UG Primary Cables - XLPE were based on the data from sample size and extrapolated to the entire population.

The following diagram shows the flagged for action plan:

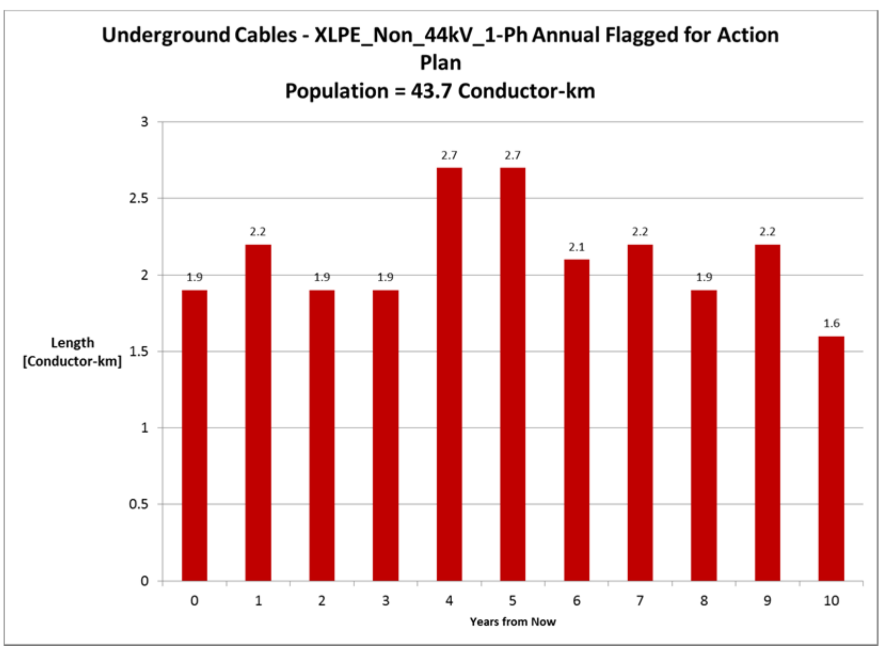


Figure 12-8 Flagged for Action Plan – UG Primary Cables - XLPE (Non 44 kV 1-Ph)

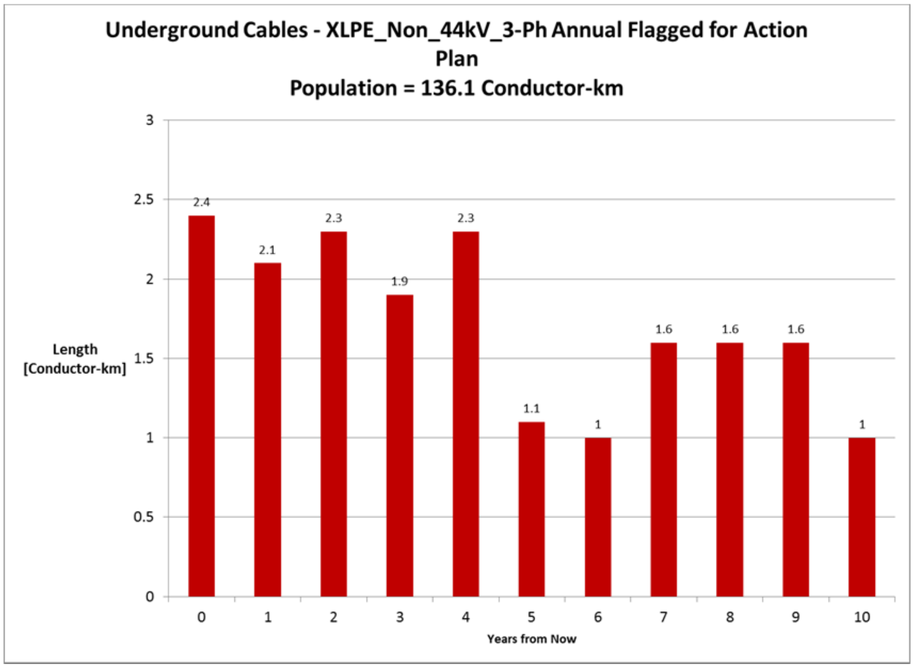


Figure 12-9 Flagged for Action Plan – UG Primary Cables - XLPE (Non 44 kV 3-Ph)

There was no 44 kV UG Primary Cables - XLPE cables flagged for action.

12.5 Data Gaps

The data used for UG Primary Cables - XLPE assessment included age only.

The data gaps are as follows:

Table 12-2 Data Gap for UG Primary Cables - XLPE

Data Gap (Sub-Condition Parameter)	**Parent Condition Parameter**	**Priority**	**Object or Component Addressed**	**Description**	**Source of Data**
Dielectric Loss	Insulation	☆☆☆	Cable	Insulation defect	On-site test
Splices	Accessories	☆☆	Cable Connection	Connection defect	On-site test
Terminations	Accessories	☆☆	Cable Connection	Connection defect	On-site test
Neutral Corrosion	Accessories	☆	Other Component	Neutral defect	On-site test
Fault rate at Segment Level	Service Record	☆☆☆	Cable	Failure records	Historic records
Historic Removal Record		☆☆☆	Age	Age at Removal	Inventory Database

Appendix C

Regional Planning

Appendix C.1

Peterborough to Kingston 2nd Cycle Needs Assessment Report – February 2020

https://www.hydroone.com/abouthydroone/CorporateInformation/regionalplans/peterboroughtokingston/Documents/Peterboroug%20to%20Kingston_2nd%20cycle%20NA%20report.pdf

Appendix C.2 - Peterborough to Kingston IRRP Main Report – November 2021

https://www.ieso.ca/-/media/Files/IESO/Document-Library/regional-planning/Peterborough-to-Kingston/p2k-IRRP-20211104.ashx

Appendix C.3 - Peterborough to Kingston IRRP Appendices – November 2021

https://www.ieso.ca/-/media/Files/IESO/Document-Library/regional-planning/Peterborough-to-Kingston/p2k-IRRP-appendices-20211104.ashx

Appendix C.4 - Peterborough to Kingston RIP Report – May 2022

https://www.hydroone.com/abouthydroone/CorporateInformation/regionalplans/peterboroughtokingston/Documents/Final_RIP_Report_Peterborough_to_Kingston_May_27_2022.pdf

Appendix D

Kingston Hydro – Full OEB Scorecard

Appendix A

9/28/2021

Scorecard - Kingston Hydro Corporation

Performance Outcomes	Performance Categories	Measures		2016	2017	2018	2019	2020	Trend	Target: Industry	Target: Distributor
Customer Focus Services are provided in a manner that responds to identified customer preferences.	**Service Quality**	New Residential/Small Business Services Connected on Time		100.00%	100.00%	100.00%	100.00%	100.00%	flat (green)	90.00%	
		Scheduled Appointments Met On Time		97.90%	100.00%	98.68%	99.73%	99.52%	up (green)	90.00%	
		Telephone Calls Answered On Time		66.00%	68.76%	60.78%	64.63%	64.65%	down (red)	65.00%	
	Customer Satisfaction	First Contact Resolution		98.86%	98.84%	98.96%	99.18%	99.06%			
		Billing Accuracy		99.75%	97.09%	99.71%	92.04%	99.57%	down (green)	98.00%	
		Customer Satisfaction Survey Results		'A'	'A'	'A'	'A'	'A'			
Operational Effectiveness Continuous improvement in productivity and cost performance is achieved; and distributors deliver on system reliability and quality objectives.	**Safety**	Level of Public Awareness		80.00%	79.00%	80.00%	79.00%	82.00%			
		Level of Compliance with Ontario Regulation 22/04 [1]		C	C	C	C	C	flat (green)		C
		Serious Electrical Incident Index	Number of General Public Incidents	0	1	0	0	0	flat (green)		0
			Rate per 10, 100, 1000 km of line	0.000	0.000	0.000	0.000	0.000	flat (green)		0.042
	System Reliability	Average Number of Hours that Power to a Customer is Interrupted [2]		1.32	1.40	1.50	0.88	1.57	down (red)		1.03
		Average Number of Times that Power to a Customer is Interrupted [2]		0.59	1.07	1.00	0.73	0.87	up (green)		0.95
	Asset Management	Distribution System Plan Implementation Progress		On track	on track	On track	Trending Up	On track			
	Cost Control	Efficiency Assessment		3	3	3	3	3			
		Total Cost per Customer [3]		$531	$538	$583	$574	$562			
		Total Cost per Km of Line [3]		$43,562	$44,400	$48,238	$47,559	$46,486			
Public Policy Responsiveness Distributors deliver on obligations mandated by government (e.g., in legislation and in regulatory requirements imposed further to Ministerial directives to the Board).	**Connection of Renewable Generation**	Renewable Generation Connection Impact Assessments Completed On Time									
		New Micro-embedded Generation Facilities Connected On Time		100.00%	100.00%	100.00%	100.00%	100.00%	flat (green)	90.00%	
Financial Performance Financial viability is maintained; and savings from operational effectiveness are sustainable.	**Financial Ratios**	Liquidity: Current Ratio (Current Assets/Current Liabilities)		1.10	1.84	1.57	1.47	1.69			
		Leverage: Total Debt (includes short-term and long-term debt) to Equity Ratio		1.36	1.41	1.10	1.11	1.12			
		Profitability: Regulatory Return on Equity	Deemed (included in rates)	9.19%	9.19%	9.19%	9.19%	9.19%			
			Achieved	6.43%	7.82%	7.48%	9.50%	7.25%			

1. Compliance with Ontario Regulation 22/04 assessed: Compliant (C); Needs Improvement (NI); or Non-Compliant (NC).
2. An upward arrow indicates decreasing reliability while downward indicates improving reliability.
3. A benchmarking analysis determines the total cost figures from the distributor 's reported information.
4. The CDM measure is based on the now discontinued 2015-2020 Conservation First Framework. 2019 results include savings reported to the IESO up until the end of February 2020.

Legend: 5-year trend: up, down, flat. Current year: target met, target not met

2020 Scorecard Management Discussion and Analysis (“2020 Scorecard MD&A”)

The link below provides a document titled “Scorecard - Performance Measure Descriptions” that has the technical definition, plain language description and how the measure may be compared for each of the Scorecard’s measures in the 2020 Scorecard MD&A:

http://www.ontarioenergyboard.ca/OEB/_Documents/scorecard/Scorecard_Performance_Measure_Descriptions.pdf

Scorecard MD&A - General Overview

Kingston Hydro presents its scorecard for the year 2020. The scorecard measures how well Ontario's electricity distributors are performing each year, with respect to customer focus, operational effectiveness, public policy responsiveness, and financial performance.

Utilities Kingston manages the assets of Kingston Hydro Corporation, along with municipal water, wastewater and gas utilities. This unique multi-utility model is a major contributor to Kingston Hydro’s strengths in customer service, safety, and financial and operating efficiency.

In 2020, the global COVID-19 crisis affected our company like nothing else has. In just a few months’ time, COVID-19 necessitated tremendous change in the way companies in all sectors and regions do business, and Utilities Kingston was no exception. Our employees adapted through various challenges, to ensure our customers and the community could continue to rely on the services provided by Utilities Kingston.

Persevering through the pandemic, in 2020 Kingston Hydro continued to perform strongly against the performance targets for the measures set out by the Ontario Energy Board (OEB).

Early in the pandemic, Utilities Kingston proclaimed an updated, temporary corporate mission: **to protect the health and safety of employees and the public, while ensuring the delivery of basic utility services that the community relies on.**

Recognized in the industry for our safety leadership, health and safety continues to be an important focus for our organization. Our health and safety management system reduces accidents and injuries, ensures safe work environments, educates the public about electrical safety and furthers a culture of safety. Utilities Kingston and Kingston Hydro performed well against many of the targets under the Safety category.

Throughout the pandemic, Utilities Kingston has focused on keeping employees and customers safe. In 2020, we developed 18 COVID-19 risk assessments, policies and procedures, and reported zero cases of COVID-19 in the workplace. Health and safety continues to be our number one focus.

We partnered with our customers to support them through this difficult time. Unfortunately, the economic downturn has had a disproportionate impact on some segments of the population. This, coupled with more people working and using increased utilities from home, is impacting utility customers across the province. From offering flexible payment plans to supporting government programs and changes, our team worked hard to offer pandemic relief and work with our customers who were most impacted.

We did not meet our *Telephone Calls Answered On Time* measure in this year. Leading up to 2020, Utilities Kingston had planned to implement operational changes at our contact centre, which were intended to improve performance on Service Quality measures. The pandemic delayed these plans to November 2020 and impacted our results. Once operational changes were implemented, service quality data from November to December improved and we feel confident that Utilities Kingston will meet this target in 2021.

System reliability is also a key focus for Utilities Kingston. We track all electricity outages and strive to reduce the length of time that they affect customers. While in 2020 we met our System Average Interruption Frequency Index (SAIFI) target, we did not meet our System Average Interruption Duration Index (SAIDI) target in the Safety performance category.

A single event involving end-of-life equipment contributed 24.3 per cent of the annual SAIDI in 2020, while defective equipment continues to be the main contributor to a high five-year rolling average. We continue to focus on infrastructure renewal to ensure customers can rely on Kingston Hydro’s electricity services in the future.

In terms of cost control, we manage costs to ensure our customers receive value for the cost of the service. Kingston Hydro’s total operating, maintenance and administrative expenses per customer for 2020 are significantly below provincial averages, and partly a reflection of the cost-saving scope economy benefits of our unique multi-utility model.

Utilities Kingston is committed to continually improve its service to customers. On behalf of Kingston Hydro, it continues to monitor performance, with a focus on safe, reliable and efficient services. Our customers and community can count on us to be safe and reliable.

Service Quality

- **New Residential/Small Business Services Connected on Time**
  - Utilities must connect new service for the customer within five business days, 90 per cent of the time, unless the customer agrees to a later date. Kingston Hydro exceeded this target for the 215 new low voltage (less than 750 volts) services connected in 2020. As in previous years, 100 per cent of these services were connected within the target of five working days (from the time all required permits were issued).

- **Scheduled Appointments Met On Time**
  - For appointments during the utility's regular business hours, the utility must offer a window of time that is not more than four hours long, and must arrive within that window, 90 per cent of the time. Customers make appointments with Utilities Kingston, on behalf of Kingston Hydro, for a variety of reasons, including for meter changes, service upgrades, and utility locates. Utilities Kingston strives to complete all requested appointments within five business days, and understands that being on time is important to deliver reliable customer service. In 2020, 209 of 210 (99.52 per cent) of scheduled appointments were met on time, surpassing the target of 90 per cent and similar to the 2019 result.

- **Telephone Calls Answered On Time**
  - During regular call centre hours, the utility's call centre staff must answer phone calls within 30 seconds of receiving the call directly, or having the call transferred to them, 65 per cent of the time.
  - In 2020, customer service representatives answered a total of 51,490 calls, a reduction of 15.3 per cent from 2019 call volume.
  - 64.65 per cent of calls (33,288) were answered within 30 seconds. We continue to focus efforts on improving this metric year over year.
  - Leading up to 2020, Utilities Kingston had planned to implement operational changes at our contact centre, which were intended to improve performance on Service Quality measures. The pandemic delayed these plans to November 2020 and impacted our results. Once operational changes were implemented, service quality data from November to December improved.
  - We recognize the importance of being available for our customers and expect to meet these targets in 2021.

Customer Satisfaction

- **First Contact Resolution**
  - Utilities should aim to address their customers' needs as quickly as possible. Ideally, their concerns and issues are resolved the first time the customer contacts the utility.
  - For Utilities Kingston, this is a measure of the number of times a customer inquiry/request, related to their account, is handled by the first person to receive the contact.
  - 99.06 per cent of contacts were answered without having to transfer to another staff member, a negligible decrease over the 2019 result of 99.18 per cent. First contact resolution is closely monitored to ensure that front line staff members have the information and

tools available so they can effectively address customer inquiries.

- **Billing Accuracy**
  - An important part of business is ensuring that customer bills are accurate. An accurate bill provides customers the right information, the first time.
  - For 2020, Utilities Kingston issued 346,767 bills on behalf of Kingston Hydro Corporation, with an overall billing accuracy of 99.57 per cent, an improvement over the previous year. This was above the industry standard threshold of 98 per cent of all bills being accurate.

- **Customer Satisfaction Survey Results**
  - Utilities use different ways to determine how satisfied their customers are with the service they receive. Distributors are required to report their results every second year, at a minimum.
  - A customer satisfaction survey was conducted by UtilityPulse on behalf of Kingston Hydro from August 22 – September 14, 2019 and the results are based on telephone interviews with 400 customers (both residential and commercial).
  - An overall rating of ‘A’ was reported in 2019, consistent with the previous surveys conducted in 2014 and 2016.
  - Highlighted in the 2019 Customer Satisfaction Survey was an overall satisfaction rate of 95 per cent, supported by a 91 per cent rating for trustworthiness. The Utilities Kingston overall credibility and trust score is 89 per cent, which exceeded the provincial and national benchmark of 84 per cent. The next customer satisfaction survey is being carried out in August to September of 2021.

Safety

- **Public Safety**

  - **Component A – Public Awareness of Electrical Safety**

    In January 2020, a public awareness telephone survey was carried out among 400 members of the public, residing in Kingston Hydro’s distribution area. The survey followed the requirements established in *Appendix B: Biannual Standardized Scorecard Public Awareness of Electrical Safety Telephone Questionnaire,* published by the OEB on November 25, 2015.

    The survey yielded an overall Public Safety Awareness Index Score of 82 per cent (an increase of three per cent from the 2018 survey result of 79 per cent), demonstrating that many people do have good knowledge or have received some information pertaining to the six core measurement questions. The next survey for Public Awareness of Electrical Safety will be carried out in 2022.

  - **Component B – Compliance with Ontario Regulation 22/04**

    For the year 2020, as in previous years, Kingston Hydro was fully compliant with the *Ontario Electrical Distribution Safety Regulation 22/04*. This is substantiated through the annual independent *Audit of Compliance and Declaration of Compliance*, as well as the

Electrical Safety Authority Due Diligence Inspections (DDI) and *Reports of Public Safety Concerns.*

- **Component C – Serious Electrical Incident Index**

Results				Target
Number of Incidents	km of Line	Rate Default Value	Serious Incident Index	Serious Incident Index
0	335	100	0.000	0.042

For the reporting period, Kingston Hydro did not have any serious electrical incidents.

System Reliability

- **Average Number of Hours that Power to a Customer is Interrupted**

Kingston Hydro tracks all electricity outages and strives to reduce the length of time they affect customers. The average of 1.57 hours on the scorecard includes both planned interruptions necessary to conduct work safely (0.26 hours) and unplanned/emergency power disruptions (1.31 hours).

Kingston Hydro satisfied the System Average Interruption Frequency Index (SAIFI) target of 0.95 for 2020. However, the target score for System Average Interruption Duration Index (SAIDI) of 1.03 hours in 2020 was not achieved.

A single event contributed 24.3 per cent of the annual SAIDI in 2020. A 44 kV oil circuit breaker at Municipal Substation No. 2 failed, causing a power outage to 3,041 customers, for a total of 10,593 customer-hours of interruptions, or 0.38 in SAIDI. This was the second such failure in recent years.

Seven end-of-life 44kV oil circuit breakers remain in service in the Kingston Hydro service area. The utility plans to replace four 44kV oil circuit breakers by 2027. This highlights the importance of the continued focus on infrastructure renewal, ensuring that customers can rely on Kingston Hydro’s electricity services for the future.

In 2020, defective equipment (0.66 hours), tree contact (0.36 hours) and adverse weather (0.18 hours) were the primary causes of interruptions.

Recognizing the importance of system reliability, Kingston Hydro strives to improve these areas for 2021 and beyond. The utility remains focused on proactive tree trimming, preventative inspection, and infrastructure renewal programs. By relocating pole lines (to behind the curb) and using protective coverings, Kingston Hydro will help reduce interference from motor vehicle collisions and animals.

- **Average Number of Times that Power to a Customer is Interrupted**
  On this measure, the average of 0.87 in 2020 and the current five-year rolling average of 0.85 all meet our target of 0.95. The utility continues to prioritize the safety and reliability of its electricity services.

Asset Management

- **Distribution System Plan Implementation Progress**

  Kingston Hydro completed its Distribution System Plan **(**DSP) in 2015 as part of its 2016 Custom Incentive Rate-Setting (Custom IR) rate application submission to the Ontario Energy Board (OEB) (EB-2015-0083). The DSP outlines the forecasted capital expenditures, from 2016 to 2020, required to maintain and expand Kingston Hydro's electricity system to serve its current and future customers. The DSP also includes the supporting asset management rationale used to develop the annual forecasted capital expenditures.

  Throughout 2020, the DSP guided Kingston Hydro's capital expenditures; however variances by investment category are to be expected due to the dynamic and ever-changing nature of competing investment priorities. The following tables summarize these variances:

Table 1 – 2020 Net Capital Additions by OEB Investment Category

Investment Category	Actual $	DSP Forecast $	Variance $
System Access	$713,523	$364,238	$349,285
System Renewal	$3,136,879	$3,054,210	$82,669
System Service	$25,040	$185,836	-$160,796
General Plant	$45,342	$298,266	-$252,924
Total	**$3,920,784**	**$3,902,550**	**$18,234**

***NOTE: Net Capital Additions = Total Actual Expenditures less Contributions**

Table 2 – 2020 Capital – Percentages by OEB Investment Category

Investment Category	% Actual Total	% DSP Forecast Total	% Variance of Actual wrt Forecast Category	% Variance of Actual wrt Forecast Total
System Access	18.20%	9.33%	95.89%	8.95%
System Renewal	80.01%	78.26%	2.71%	2.12%
System Service	0.64%	4.76%	-86.53%	-4.12%
General Plant	1.16%	7.64%	-84.80%	-6.48%
Total	**100.00%**	**100.00%**		0.47%

The System Access variance of 95.89 per cent ($349,285) between the actual and forecast amount is attributed to meter replacements due to seal expiration and smart meter communication upgrades (e.g., Regional Network Interface upgrades), which are deemed necessary and beyond the control of Kingston Hydro. When compared to the total DSP budget forecast amount, System Access expenditures represent an 8.95 per cent overall budget variance.

The System Service variance of -86.53 per cent (-$160,796) between the actual and forecast amount is attributed to deferral of a coordination study of dedicated feeder protections at Frontenac Transmission Station. When compared to the total DSP budget forecast amount, System Service contributes -4.12 per cent to the overall budget variance.

The General Plant variance of -84.80 per cent (-$252,924) between the actual and forecast amount is attributed to deferral of upgrades to financial management, customer information and customer relationship management systems. When compared to the total DSP forecast amount, General Plant contributes -6.48 per cent to the overall budget variance.

The majority of Kingston Hydro's capital investment planning (80 per cent of total actual expenditures) continues to focus on System Renewal, which involves replacing and/or refurbishing system assets to extend the original service life of the asset and thereby maintain the ability of the electrical system to provide safe and reliable electrical service to customers. The System Renewal variance of 2.71 per cent ($82,669) between the actual and forecast amount is slightly more than Kingston Hydro's $65,000 threshold of materiality and cannot be easily attributed to any specific project. When compared to the total DSP forecast amount, System Renewal contributes 2.12 per cent ($82,669) to the overall budget variance, which demonstrates Kingston Hydro's ability to responsibly manage a large number of system renewal projects with varying scope and scale.

Kingston Hydro considers the total annual capital expenditures for 2020 to be "on track" with the Kingston Hydro DSP. The overall variance of 0.47 per cent ($18,234) is well below Kingston Hydro's materiality threshold of $65,000.

Cost Control

- **Efficiency Assessment**

  - The utility must manage its costs successfully to help ensure customers receive value for the cost of the service. Utilities' total costs are evaluated to produce a single efficiency ranking. Total costs for Ontario LDCs are evaluated by the Pacific Economics Group on behalf of the OEB to divide LDCs into five groups, depending on the difference between their predicted and their actual costs.

  - For the ninth consecutive year, in 2020, Kingston Hydro maintained an efficiency assessment of Group 3, meaning Kingston Hydro's actual costs continue to be within +/-10 per cent of predicted costs. Group 3 is considered average efficiency.

  - Kingston Hydro's total costs in 2020 were 2.3 per cent lower than 2019 compared to an industry average reduction of 0.93 per cent.

  - Kingston Hydro's total costs were 6.8 per cent under expected costs compared to an industry average of 11.3 percent under expectations. Infrastructure renewal continues to be the focus of where funds are spent.

  - For the three-year period 2018 through 2020, Kingston Hydro's actual costs have been less than predicted by an average of 3.1 per cent, compared to an average of –8.4 per cent for the industry.

  - Kingston Hydro continues to manage its expenditures to ensure efficiencies will be maintained at a minimum of Group 3.

- **Total Cost per Customer**
  Total cost per customer is the sum of all the capital and operating costs incurred by Kingston Hydro to provide service to its customers, divided by Kingston Hydro's total number of customers.

  Kingston Hydro's result for 2020 is $562 per customer, a 2.1 percent decrease over 2019. This follows a 2019 decrease of 1.5 percent after an increase of 8.4 percent in 2018. Total operating, maintenance and administrative expenses per customer for Kingston Hydro was $266 per customer, compared to an industry average of $324 per customer.

- **Total Cost per km of Line**
  Total cost per km of line is the sum of all the capital and operating costs incurred by the Kingston Hydro to provide service to its customers, divided by Kingston Hydro's total kilometres of line.

  Kingston Hydro's result for 2020 is $46,486 per kilometre of line, compared to the 2019 cost of $47,559 per kilometre of line. This amount decreased by 2.2 per cent for the reasons noted above. Overall, these costs are expected to increase on a yearly basis, as

Kingston Hydro replaces old, fully-depreciated infrastructure with new infrastructure.

Kingston Hydro's 2016 Custom IR rate application has outlined capital and operating costs estimates for the 2016 through 2020 period.

Connection of Renewable Generation

- **Renewable Generation Connection Impact Assessments Completed on Time**
  Kingston Hydro did not receive any requests from customer for connection of renewable generation requiring a condition impact assessment in 2020.

- **New Micro-embedded Generation Facilities Connected On Time**
  One micro-embedded generation facility connected in 2020, and it was connected within the required timeframe.

Financial Ratios

- **Liquidity: Current Ratio (Current Assets/Current Liabilities)**
  A common way of measuring the financial health of a company is through financial ratios.

  This first ratio measures whether or not the utility has enough resources (assets) on hand at a particular point in time to pay the debts that could become due over the next 12 months. Kingston Hydro's Current Ratio is at 1.69:1.00 (compared to 1.47:1.00 in 2019), as at December 31, 2020. This indicates that for every $1.00 of short-term liabilities due, Kingston Hydro has $1.69 of assets available to fund those payments.

  This ratio will fluctuate somewhat on a year-to-year basis, but should remain within the range of 1.4:1.0 to 1.9:1.0.

- **Leverage: Total Debt (includes short-term and long-term debt) to Equity Ratio**

  This measures the degree to which the utility is leveraging itself through its use of borrowed money.

  The OEB uses a deemed capital structure (debt:equity) of $1.50 to $1.00. This means that for $1.00 invested in infrastructure, the company's deemed regulatory capital financing structure is 60 per cent funding with new debt and 40 per cent with available cash.

  Kingston Hydro's debt:equity ratio is $1.12 to $1.00. This means that for every $1.00 the company has invested in assets, 53.1 per cent has been funded with debt and 46.9 per cent has been funded with equity. Over the 2016-2020 period, as the company continues to invest in infrastructure, Kingston Hydro expects this ratio to move toward $1.50:1.00 as it borrows more money to finance capital infrastructure.

- **Profitability: Regulatory Return on Equity – Deemed (included in rates)**

  Return on equity is the rate of return that the utility is allowed to earn through its distribution rates, as approved by the OEB. Kingston Hydro's current approved deemed return on equity is 9.19 per cent, which was awarded in its latest cost of service proceeding for 2016 – 2020 rates.

- **Profitability: Regulatory Return on Equity – Achieved**

  This shows the utility's actual return on equity earned each year for the period 2015 through 2019. Kingston Hydro achieved a return on equity of 7.25 per cent for 2020, down from 2019. This return on equity is within 300 basis points of our deemed return on equity.

Note to Readers of 2020 Scorecard MD&A

The information provided by distributors on their future performance (or what can be construed as forward-looking information) may be subject to a number of risks, uncertainties and other factors that may cause actual events, conditions or results to differ materially from historical results or those contemplated by the distributor regarding their future performance. Some of the factors that could cause such differences include legislative or regulatory developments, financial market conditions, general economic conditions and the weather. For these reasons, the information on future performance is intended to be management's best judgement on the reporting date of the performance scorecard, and could be markedly different in the future.

Appendix E

Planning Reference Information

Appendix E.1 – City Planning Memo - Williamsville – July 8, 2020

Appendix E.2 – Pages from City Report # PC-21-052 – August 12, 2021

Appendix E.3 – Excerpts from 44kV Electric Master Plan – January 21, 2013

Appendix E.4 – Excerpts from 5/15kV Electric Master Plan – January 13, 2014

where history and innovation thrive

City of Kingston
216 Ontario St.
Kingston, ON K7L 2Z3
613-546-4291

July 8 2020

Jim Miller
COO Utilities Kingston

Dear Mr Miller,

As discussed, we are in the process of refining allocations of the City's projected growth and are anticipating that 5-7% of the total growth will be absorbed in the Williamsville Corridor, Princess Street between Bath Road and Division Street, by 2046. Beyond what has already been approved in the Corridor, we anticipate an additional 3400 residential units.

We understand you require confirmation of these growth numbers in order to justify anticipated electrical capital requirements before the Ontario Energy Board.

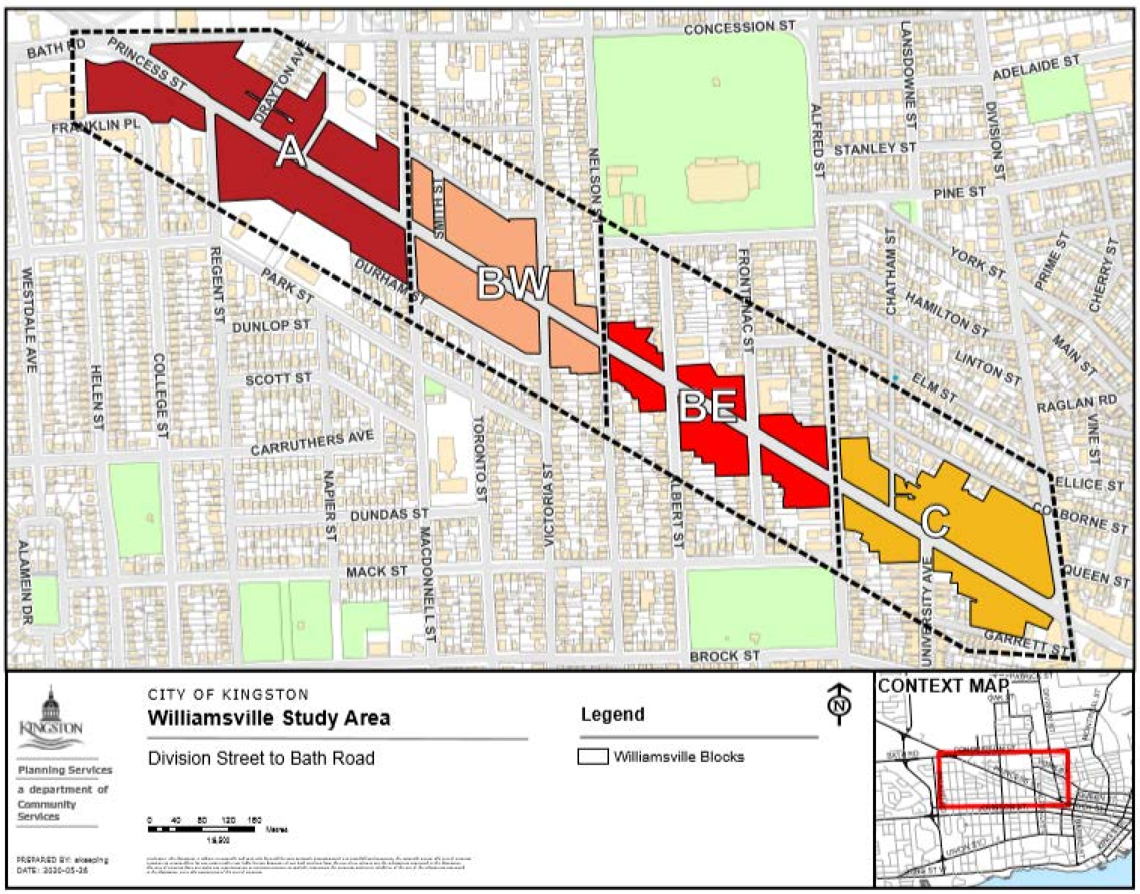
The rate of development of these units is difficult to determine since they are based on the ability and willingness of owners to undertake projects. The City does provide incentives related to multi-unit residential development, and we have observed growth pressure in this area of the City in recent years. We estimate that the units could be built within 10 years based on growth pressure and market demand, but the timing of this will depend heavily on the availability of infrastructure to support those developments.

We know that in the short-term the development of additional units depends upon investments in water and wastewater infrastructure, and that additional capacity will be available by approximately 2023. At this time we are not allocating any units to Area A, at the northwest end of the Corridor, due to the lack of available water and sewer infrastructure.

The table below shows estimates of the total number of units for each section of the Corridor to 2046, based on the current proposed growth allocations. We anticipate the future allocation of additional units to Area A and the Kingston Centre beyond, once servicing capacity is available to support redevelopment of these underutilized areas.

AREA NUMBER	Number of Units	Number of People	Residential GFA (m2)	Number of Jobs	Commercial GFA (m^2)
Area A	184	423	12,880	456	9,120
Area BW	1,435	3,301	100,450	345	6,900
Area BE	1,691	3,889	118,370	483	9,660
Area C	2,329	5,357	163,030	804	16,080
TOTAL	**5,639**	**12,970**	**394,730**	**2,088**	**41,760**

Assumptions
Population: 2.3 people per unit
Residential GFA: 70 m2 per dwelling unit Commercial GFA: 20 m2 per employee
Area A contains only existing and approved development
Areas BW, BE, & C contain existing and approved development, and future growth



Best regards,
Andrea Gummo
Manager of Policy Planning
agummo@cityofkingston.ca

City of Kingston
Report to Planning Committee
Report Number PC-21-052

To:	**Chair and Members of the Planning Committee**
From:	**Paige Agnew, Commissioner, Community Services**
Resource Staff:	**Tim Park, Director, Planning Services**
Date of Meeting:	**August 12, 2021**
Subject:	**Central Kingston Growth Strategy Final Recommendations Report**

Council Strategic Plan Alignment:

Theme: 2. Increase housing affordability

Goal: 2.1 Pursue development of all types of housing city-wide through intensification and land use policies.

The Central Kingston Growth Strategy involves the development of a policy and regulatory framework to guide infill and intensification in the central area of the city. The study identifies strategic locations within the central area of the city where future residential growth and intensification could appropriately be located.

Executive Summary:

The purpose of this report is to present the final recommendations of the Central Kingston Growth Strategy (CKGS). The study was initiated in response to Council's direction and Report Number 17-139 to undertake a review of the land use policies and regulations regarding residential infill and intensification in the central area of the City and provide recommendations to guide the future of this area. The outputs of this work include Official Plan policies and zoning recommendations, supplemented by urban design guidelines and a servicing and infrastructure review. The recommendations were developed in collaboration with WSP Canada Group Ltd.

This report includes a summary of the background of the project, public engagement process and the policy and zoning recommendations in support of creating new intensification areas, and for the existing low and medium to high density residential areas within the study area.

The policy recommendations for the proposed intensification areas will be brought forward through a City-initiated Official Plan amendment expected in the fall of 2021. The recommended zoning regulations have been integrated into the second draft of the New Zoning By-Law. Opportunities for further comment and revision will present themselves through these other planning processes.

Recommendation:

That the Planning Committee recommends to Council:

> **That** the Central Kingston Growth Strategy Final Recommendations Report, dated July 2021, the Servicing and Infrastructure Assumptions, and the Transportation Review of Intensification Areas (Exhibits A, B, and C to Report Number PC-21-052) be approved.

Authorizing Signatures:

ORIGINAL SIGNED BY COMMISSIONER

Paige Agnew, Commissioner,
Community Services

ORIGINAL SIGNED BY CHIEF ADMINISTRATIVE OFFICER

Lanie Hurdle, Chief
Administrative Officer

Consultation with the following Members of the Corporate Management Team:

Peter Huigenbos, Commissioner, Business, Environment & Projects	Not required
Brad Joyce, Commissioner, Corporate Services	Not required
Jim Keech, President & CEO, Utilities Kingston	Not required
Desirée Kennedy, Chief Financial Officer & City Treasurer	Not required
Sheila Kidd, Commissioner, Transportation & Public Works	Not required

Options/Discussion:

Background

In response to the consideration of an Interim Control By-Law in 2017 to prohibit any new development or alterations to residential dwellings within the Sydenham, Portsmouth and Williamsville Districts (the "Near Campus Neighbourhoods"), Council directed staff to report back with options and recommendations to help guide appropriate infill and intensification in the three Electoral Districts. Undertaking the Central Kingston Growth Strategy (CKGS) that holistically considers the larger residential area of Central Kingston, was one of the long-term recommendations identified by staff in Report Number 17-139. On August, 2017, Council approved the terms of reference for the CKGS (Report Number 17-215), followed by approval to award the contract to WSP Canada Group Limited to undertake the study on December 5, 2017 (Report Number 18-004). A Community Working Group was also established as part of this study. The CKGS was kicked-off with an open house on March 28, 2018.

The Study was to include the following components:

- Identify strategic areas appropriate for intensification, including locations where land assembly is possible for consolidation and development policies and a regulatory framework in support of these areas.
- Develop a policy and regulatory framework to more appropriately manage development in areas outside of the identified intensification areas.
- Prepare area-specific design guidelines to assist with future residential development.
- Assess available infrastructure and services of proposed intensification areas in order to determine existing and future capacity requirements in support of the proposed intensification.

The intent of the above was to ultimately implement this work through a City-initiated Official Plan amendment and through the New Zoning By-Law. The CKGS study area is included in Exhibit D.

The CKGS study was divided into 4 separate phases, first developing a background analysis to understand the policy and regulatory, as well as physical context of the study area. The second phase saw the identification of the proposed intensification areas, while the third phase established recommended directions for the development of a recommended policy and regulatory framework for the study area. The Background Report and the Strategic Directions Report prepared by WSP are available on the City's website. The fourth and final phase presents the final recommendations for future Official Plan amendments and zoning recommendations for integration with the New Zoning By-Law. Throughout the life of the study, public engagement played a key role in identifying concerns, helping to guide the final recommendations and general feedback. The various engagement activities are outlined in a later section.

Other Key City Initiatives

Since the start of the CKGS project, several other important City initiatives have been undertaken that influenced the direction of this Study. Those studies include the first phase of Density by Design (DbD) which closely looked at the appropriate ways in which to integrate more intensive development along the Williamsville Corridor and how it relates to the main street as well as surrounding lower density development. In addition, the DbD study introduced a "greenlight strategy" wherein the City looks to ensure that intensification in appropriate locations is not impeded by unforeseen barriers, and to make it easier to develop in the right places. This approach as well as other lessons learned from Phase 1 of DbD influenced the development of the recommendations of the CKGS.

In addition, in April 2021, Council approved an Official Plan amendment and zoning by-law amendments relating to second residential units and bedroom limits. The effect of this decision was the endorsement of further regulation with respect to the height and location of detached second residential units to address concerns over the potential negative impacts caused by these forms of development. Furthermore, a limit of 8 bedrooms per lot was endorsed by Council for low density forms of housing. These amendments have subsequently been appealed and are awaiting confirmation of a hearing date. The significance of this initiative was the clear direction of the City to address concerns related to the unintended overdevelopment and high occupancy levels in low density forms of housing across the City, a concern also raised throughout the CKGS process.

Additionally, the Lifecycle Fiscal Impacts of Development study, that was presented to Council on June 22, 2021, implies that more compact and strategic development patterns within the central area of the City are more financially efficient, as compared to Kingston East and Kingston West. The recommendations for intensification as presented in the CKGS are further reinforced through the conclusions of the Lifecycle Fiscal Impacts of Development study.

Lastly, it is recognized that in the coming years the City of Kingston will undertake the next review of its Official Plan, as mandated in the *Planning Act*. This review will provide the City an opportunity to perform a comprehensive review of its suite of policies governing development across the municipality.

These initiatives are necessary to identify as they both influence and are influenced by the recommendations put forward through this present study. It is in the best interest of the City to ensure that lessons learned from other projects are carried into other active projects and that each initiative supports and does not unintentionally contradict directions taken in previous work.

As a result, the recommended policies relating to the intensification areas will be brought forward through a City-initiated Official Plan amendment in fall 2021. The urban design guidelines will be integrated into the next Official Plan review. The Strategic Directions Report prepared by WSP included recommendations for Section 2 of the Official Plan. These will also be further reviewed through the next Official Plan review. This decision was made as it became apparent that these policies affect areas outside the study area. As this was beyond the scope of the CKGS project, it was determined to be in the best interest of the City to delay the consideration of these recommendations. The proposed regulatory recommendations are being brought forward through the second draft of the New Zoning By-Law.

The project team met over a series of workshops to refine the Official Plan and zoning recommendations that were developed as part of the Strategic Directions Report. The project team identified the following definitions of success to provide context to the recommendations. They include consideration of the original intent of the study, more recent Council priorities and direction, and the broader aspirations for strategic and timely infill development in the City in keeping with recent new thinking as part of the Density by Design exercise.

The following “definitions of success” were identified and utilized:

- Respect for the existing neighbourhoods and their built form character while also achieving other City objectives including demonstrating leadership on climate action, directing growth and intensification to strategic areas, support for housing affordability and social equity, and meeting other concurrent policy objectives, where applicable;
- Respect for and reflect new needs and aspirations that have arisen in the City, the intent of the Official Plan, and more recent or current Council direction;
- An approach that is clear and understandable and is easy to implement by avoiding unnecessary complexity; and
- An approach that supports market attractiveness of strategically located intensification areas and allows many/most individual projects to be viable under reasonable assumptions, with enough projects "green lit" (i.e. allowing development to proceed easily) to address strategic smart growth goals.

Public Engagement

The project team hosted and participated in a range of public engagement activities through each phase of the CKGS project. Those activities included:

- Open house (project launch – March 2018)
- A public survey at the initiation of the project in 2018
- Neighbourhood walks (Summer 2018)
- Urban design workshop (June 2018)
- Two public workshops (July 2019)
- Virtual open house (May 2020)
- Various Community Working Group meetings (four consultant led meetings in March 2018, May 2018, January 2019, and March 2020 and one City led meeting in July 2021)
- Meetings with various stakeholders at their request

Social Media (i.e. Facebook, news releases), Curbex signs, updates on Get Involved Kingston and the project website, and direct communication to the project email list were used to promote public consultation events, share project details and to solicit feedback and discussion.

The feedback informed the recommendations presented and allowed the project team to revise the proposed policy and regulatory framework presented in this final report. The recommendations will further be available for public comment through future planning processes including the New Zoning By-Law and future Official Plan amendments. The notes from the Community Working Group meetings are included in Exhibit E.

Comments and feedback received varied across a range of topics but were generally along the following themes:

- Concern that the current zoning permits development out of scale with existing neighbourhoods;
- Protection of the existing neighbourhood character and the promotion of good architecture;
- The level of intensity expected within the intensifications areas and potential impacts they may have on other desired intensification areas, such as the Williamsville Main Street Corridor;
- Availability of sufficient servicing capacity as well as transportation infrastructure within the Study Area;
- Transition to surrounding existing neighbourhoods, particularly as it relates to the intensification areas;
- Sustainability and the environmental impacts of the recommendations;
- Relationship of the CKGS to the on-going parking review;
- Amount of existing green space and parkland with the Study Area; and
- General accessibility and improvements for pedestrian movement and safety.

Throughout the Study, the project team strongly heard the preference for mid-rise development located along arterials and collector roads. Through the public workshops held in July 2019, the project team also heard support for taller buildings up to 12 storeys, on properties located south of the Kingston Centre. Taking this feedback into consideration, the CKGS report recommends establishing three new intensification areas with the following height maximums:

- Johnson Street and Brock Street Corridor – maximum height of 6 storeys,
- Portsmouth Avenue and Johnson Street Corridor – maximum height of 4 storeys, and
- Sir John A. Macdonald Boulevard and Bath Road area – maximum height of 12 storeys along the Sir John A. Macdonald Boulevard and Bath Road frontages and 6 storeys along the Wright Crescent frontage.

These intensification areas as well as the proposed transition strategies to adjacent residential areas are further discussed in a later section of this report.

As noted above, concerns were identified by residents that the current zoning regulations permit development that is out of scale with existing neighbourhoods. Regulations such as floor space index and lot coverage, which are measured based on lot area are not proposed to be used for low density zones (with the exception of landscaped open space), as lot sizes vary significantly within the study area, and such regulations have the potential to result in oversized buildings. A new maximum building depth approach is proposed for the low density zones to address long buildings, as discussed later in this report. Also, staff have added the maximum permitted number of storeys, in addition to the maximum permitted height in metres for the low density zones. Consideration has also been given to different height maximums for flat roofs versus other roofs for these zones in the second draft of the New Zoning By-Law.

The project team also heard the public's desire for greater consideration of the heritage areas within the CKGS study area. The Old Sydenham Heritage Conservation District (HCD) is proposed to be brought into its own zone to better reflect the existing character of this area. A new zone is also proposed for the Portsmouth Village Heritage Character Area.

A detailed review of the comments and correspondence received throughout the Study are included in the Background Report, the Strategic Directions Report, and in the Final Recommendations Report in Exhibit A, Appendix A.

Study Recommendations

The Final Recommendations Report includes a number of recommendations for the Official Plan primarily focused on the proposed intensification areas, and zoning recommendations for the entire study area, including up-zoning of the intensification areas. A set of urban design guidelines have also been prepared. These are included in Appendices B, C and D of Exhibit A.

Intensification Areas

The report recommends establishing three new intensification areas (Exhibit F) which are intended to accommodate the most growth within the central area of the City and simultaneously ease the development pressures on the areas less suited for such intensive development. These intensification areas were selected based on several criteria including:

- Frontage on major corridors along the edges of neighbourhoods,
- Existing multi-unit higher-density developments,
- Access to transit and active transportation networks,
- Proximity of amenities, services, and institutional uses, and
- Infrastructure capacity.

A new Section 10G is proposed to be added to the Official Plan which would specifically include policies to guide the development of the intensification areas (Appendix C of Exhibit A). The following intensification areas have been identified:

Area 1 – Johnson Street and Brock Street Corridor: The Campus Expansion Area, located north of the Queen's University Main Campus, was previously identified as a proposed intensification area in the Strategic Directions Report. This area will need to be further reviewed as there are servicing constraints in the area given the combined sewers. A market feasibility assessment of purpose-built rental apartments will also be completed. This review will be undertaken in the context of the next Official Plan update, proposed to be initiated in 2023.

Because of the above reasons, this intensification area has been refined to only include the properties located along the Johnson Street and Brock Street frontages, west of Division Street. This area is expected to be developed to a maximum height of 6 storeys, stepped back 2 metres above the 4th storey for the façades fronting along Johnson Street and Brock Street. This area includes a proposed minimum 10 metre rear setback, including a 2-metre landscape buffer along the rear lot line as a transition to the adjacent low density residential development. A minimum streetwall height of four storeys is proposed. It is proposed that ground floor neighbourhood commercial uses be permitted in this area. It is expected that intensification in this area will occur through lot consolidation. The market feasibility analysis that was completed as part of the update to the Williamsville Main Street Study reviewed the financial viability of six storey wood frame construction. This analysis influenced the project team's thinking for this intensification area with respect to the proposed six storey height and other zoning considerations, including setbacks and stepbacks, along with the parking requirements being proposed in the second draft of the New Zoning By-Law, to address increased financial viability of this built form.

Area 2 – Portsmouth Avenue and Johnson Street Corridor: This intensification area is composed of two general areas with a portion consisting of the properties approximately one block east and west of the intersection of Portsmouth Avenue and Johnson Street as well as the east side of Portsmouth Avenue between the KFL&A Public Health property and King Street West.

The majority of this area is expected to be developed to a maximum of 4 storeys, largely in the form of low-rise apartment buildings or stacked townhouse developments. The strategy of a 10-metre rear setback is recommended to permit a suitable transition to neighbouring properties, including a 2 metre landscaped buffer along the rear lot line.

The area across from St. Lawrence College is further divided into two sections, with the lots along Calderwood Drive and the lots between the south side of Calderwood Drive and Baiden Street. Across both areas, the maximum heights are proposed to be 4 storeys. In the first area, between the two ends of Calderwood Drive, there are a number of through lots, which presented a unique situation requiring separate zoning provisions. For this area, rather than establish a rear setback, the frontage of Portsmouth Avenue and Calderwood Drive are treated similarly with development expected to address both frontages. The form of development for this area is envisioned to include back-to-back townhomes or townhouses with internalized parking areas.

For the area south of Calderwood Drive, development is expected to take on low-rise apartment buildings or stacked townhouses. A minimum 10 metre rear setback, including a 2-metre landscaping buffer, is recommended to transition to the low density residential development east of the proposed intensification area. It is expected that intensification within these areas will occur through lot consolidation.

Area 3 – Sir John A. Macdonald Boulevard & Bath Road: The area is located immediately south of the Kingston Centre and excludes the properties that are currently already developed with apartment buildings and that is occupied by the Calvin Park Branch of the public library.

This area is expected to accommodate 12-storey developments along the Sir John A. Macdonald Boulevard and Bath Road frontages, with a six-storey built form along Wright Crescent, without requiring consolidation with adjacent lots. Provisions have been included for towers along the Sir John A. Macdonald Boulevard and Bath Road frontages where buildings taller than six storeys, up to a maximum of 12 storeys would be permitted. A maximum floor plate of 790 square metres, similar to what is included in the Williamsville Main Street corridor, is proposed. A maximum height of six storeys is proposed along the Wright Crescent frontage as a transition between the high-rise buildings and the existing townhouse development. A minimum streetwall height of four storeys is proposed for this area.

A maximum floor space index is proposed for all three intensification areas identified above.

Transitioning of Density

The following strategies are proposed to provide a transition between the intensification areas and the adjacent existing development:

- Building separation through rear setback and side setback requirements that provide transition between mid-rise/tall buildings and low-rise building forms;
- The use of stepbacks on upper floors of buildings taller than 4 storeys;
- Combination of a minimum rear setback and a landscaped buffer that provides visual screening and aesthetic enhancement; and
- Intervening streets that are utilized as a form of separation between buildings.

Holding Symbol

A Holding symbol has been added to the intensification area zones. The Holding symbol is directly related to the availability of servicing in the proposed intensification areas, and for the requirement to complete a more detailed transportation analysis. Interim uses that are reflected in the existing zoning of these areas would continue to be permitted.

Non-Intensification Areas

The areas outside of the proposed intensification areas include existing low, medium and high-density residential areas.

The following section summarizes the recommendations for the low-density zones:

- Floor space index and lot coverage are not proposed to be used for low density zones, including the existing One-Family Dwelling and Two-Family Dwelling ‘A’ Zone. Lot sizes in these zones vary significantly and using a floor space index and lot coverage approach (which are measured based on lot area) has the potential to result in oversized buildings.

- A maximum building depth requirement of 18 metres is proposed to be added to the low-density zones to regulate the length of the main residential building. The maximum building depth is proposed to be measured from the required front setback to the rear wall of the main building. Any new residential buildings, or proposed additions to existing residential buildings, would be subject to this requirement. Additionally, a regulation has been included to require that the rear wall be located at a minimum distance of either 6 metres or 7.5 meters from the rear lot line, depending on the zone. This is intended to ensure adequate rear yard space on shallow lots.

- The maximum number of storeys, in addition to the maximum permitted height in metres, has been included for greater clarity. Staff note that the CKGS zoning recommendations for the low-density zones did not include the proposed height for flat roofs as staff were reviewing this separately as part of the New Zoning By-Law project. The proposed approach to how height is measured and the proposed height for flat roofs have been included by staff in the second draft of the New Zoning By-Law.
- Most of the existing side setback regulations are proposed to be carried forward.
- Given that this area is already built, regulations have been included to recognize existing deficient front setbacks.
- The minimum front setback in several zones, including the existing One-Family Dwelling and Two-Family Dwelling A, A4, and A5 Zones, is proposed to be determined based on the average setbacks of adjacent buildings, and do not need to exceed 4.5 metres.
- All low-density residential zones are proposed to have minimum lot frontage requirements.
- The Old Sydenham Heritage Conservation District (HCD) is proposed to be brought into its own HCD zone with new zone provisions to reflect the existing built fabric of this area.
- New zones are also proposed for the Portsmouth Village Heritage Character Area and the Kingscourt area, which more closely reflect the existing character of these areas.
- Areas within the Residential designation, but currently in the Special Education and Medical Uses ‘E’ Zone are proposed to be brought into the Urban Residential 5 Zone, which corresponds with the existing A Zone.
- A small number of properties located at the intersection of Frontenac Street and Jenkins Street which are currently zoned Multiple Family Dwelling ‘B3’ Zone (Exhibit A, Appendix B) are proposed to be brought into the into the Urban Residential 5 ‘UR5’ Zone, which corresponds with the existing A Zone. This change is proposed to better reflect the existing built form of this area.

In most cases, the existing zoning framework for medium and high-density residential areas is proposed to be carried forward into the second draft of the New Zoning By-Law. The primary changes to the medium and high-density zones include:

- For the Three to Six Family Dwelling ‘B’ Zone, a minimum lot frontage of 10 metres is proposed. The minimum front setback proposed to be determined based on the average front setbacks of adjacent buildings and does not need to exceed 4.5 metres. A similar minimum exterior setback and a maximum building depth of 18 metres, as measured from the minimum front setback are also proposed. Floor space index and lot coverage are not proposed to be used.

- For the Multiple Family Dwelling ‘B1’ Zone, the density required have been translates into minimum lot area requirements based on the number of units on a property.

- Properties located in the Multiple Family Dwelling ‘B3’ Zone located west of Division Street, in the Chatham Street/Colborne Street area north of the Williamsville Main Street Corridor are proposed to be brought into their own zone to reflect the character of the area.

- Minimum dwelling unit size requirements have been removed as these are regulated by the Ontario Building Code.

Urban Design Guidelines

The Report includes a set of Urban Design Guidelines which are intended to ensure that new development is generally compatible (while considering the many public interest goals of the City), fits harmoniously with the existing built form fabric, supports an attractive and safe pedestrian realm and modes of transportation, is environmentally sustainable, and promotes the general urban design objectives of the City. The guidelines are included in Appendix D of Exhibit A.

The guidelines address development within the various sub-areas of the CKGS study area, development within the proposed intensification areas, as well as general development guidelines. Topics include transition, materiality, the public and private realm and parking and servicing. As noted previously, these guidelines will be further reviewed in the context of the next Official Plan review.

Servicing and Infrastructure and Transportation

An analysis of existing conditions undertaken in relation to servicing, utilities and capacity and conditions of the transportation network, was previously included in the Appendices to the Background Report completed in 2019. Further to that work, WSP has provided revised assumptions for the intensification areas related to density, and gas, electric load, sanitary servicing, water servicing and stormwater management calculations (Exhibit B). Staff note that the Excel sheets referred to in the Servicing and Infrastructure Assumptions memo are not included in Exhibit B for accessibility reasons, but are available upon request. This information will need to be further assessed and conclusions derived for the assessment/analysis, which is anticipated to be completed by the end of this year.

The Transportation memorandum assessed the transportation conditions surrounding the proposed intensification areas within the CKGS area, taking into account existing transportation policies, future mode share targets, future population and employment growth, recent and planned investments in sustainable transportation, and trip generation. Staff note that references to any timing related to the Kingston Transit Business Plan in the Transportation memorandum are subject to review given delays in implementing new transit service during the pandemic. The Transportation memorandum found that the intensification areas will increase pressure on some arterial roadways that have capacity deficiencies during peak travel times.

Ultimately, as noted previously, a Holding symbol will be included with the zoning by-law for the new intensification zones as impacts to the available servicing capacity and transportation network will need to be managed, to ensure sufficient capacity is available to support those developments.

Next Steps

The zoning recommendations from the CKGS have been included in the second draft of the New Zoning By-Law. Staff have refined the recommendations to ensure that the text aligns with the definitions and format of the second draft. Staff will be initiating an Official Plan amendment related to the proposed policy recommendations for the intensification areas in the fall of 2021. These processes will include a statutory Public Meeting before the Planning Committee in the fall of 2021 and will therefore provide further opportunities for public feedback and comment.

Existing Policy/By-Law:

Provincial Policy Statement, 2020

City of Kingston Official Plan

City of Kingston Zoning By-Law Number 8499

Notice Provisions:

An email notification of this report was sent to all individuals who have expressed an interest in the Central Kingston Growth Strategy and have provided their contact information.

Accessibility Considerations:

None

Financial Considerations:

On August 8, 2017, Council approved a budget of $400,000 to be funded from the Working Fund Reserve to complete the Central Kingston Growth Strategy.

Contacts:

Sukriti Agarwal, Acting Manager, Policy Planning, 613-546-4291 extension 3217

Mike Szilagyi, Senior Planner, 613-546-4291 extension 3294

Other City of Kingston Staff Consulted:

None

Exhibits Attached:

Exhibit A Central Kingston Growth Strategy Final Recommendations Report

Exhibit B Servicing and Infrastructure Assumptions

Exhibit C Transportation Review of Intensification Areas

Exhibit D Map showing the study area

Exhibit E Community working group meeting notes

Exhibit F Proposed intensification areas

Utilities Kingston

Electric Master Plan
For
Kingston Hydro 44kV System

Issue Date: January 21, 2013

Rev 2

Prepared by: Tom Brackenbury, P.Eng.

Utilities Engineer

Utilities Kingston

6 Proposed System Upgrade Projects and Cost Estimates

The following capacity and operating upgrade projects are proposed to meet the 20 year load forecast. Item 1.1 and 1.2 are required to meet the 20 year load forecast. Item 1.3 and 1.4 should be monitored and may be required. Operability improvements associated with recommendations 2.1 through 2.3 should be considered within the next 3 to 5 years. A portion of each of the upgrades under sub-section 3 will provide additional line capacity which is expected to improve operating flexibility of the 44kV system. The projects proposed under sub-section 2 and 3 require further cost-benefit analysis to determine feasibility and timing of implementation.

Recommendations

1 Capacity and Expansions

1.1 Balance existing feeder loads and shift load from Frontenac TS to Gardiner TS using existing switch points to optimize system loading. Refer to Option 1 and Option 2. NOTE: The balancing of feeder

1.2 Construct a new feeder from Gardiner TS to supply new load growth and provide additional network flexibility. This would require negotiation with Hydro One. This work could be completed in stages. First stage could involve building a new line along South side of Bath Road to Parallel the existing M7 line on the North side of Bath Road.

1.3 Monitor new development in the NorthWest sector (Dalton, Binnington Ct & Grant Timmins Dr.) and extend 44kV distribution as required

1.4 Monitor system capacity vs. load growth over the next 20 years. There is potential for a 6.5MW shortfall in Emergency system capacity during Summer months if the predicted 20 year load growth is realized. It is expected that there will be sufficient Normal system capacity when 4 of 4 transformers are in service at the Hydro One TS supply points. The Emergency capacity only applies when 3 of 4 transformers are in service at the Hydro One TS supply points (one transformer out of service at Gardiner TS). It may be possible to deal with this shortfall through CDM programs.

1.5 The following developments should be monitored as they are expected to trigger extensions and/or expansions to the 44kV distribution system over the next 20 years to service new development:

- Williamsville
- The Commercial park along the Dalton Avenue corridor (Dalton Ave., Binnington Ct & Grant Timmins Dr.) should be carefully monitored and may trigger an expansion of the 44kV distribution system if a customer requires a service greater than 750kVA in size. This 44kV expansion is not required if the electric services of new developments are 750kVA or less since small services of this size would be serviced from the 5kv/15kV distribution system instead.
- Novelis & Former Alcan industrial lands
- North Block
- Kingston Psychiatric Hospital
- Queen’s West Campus

2 Operability

2.1 Negotiate the purchase of the M7, M9 and M12 distribution lines from Hydro One. This could potentially eliminate distribution charges currently paid to Hydro One for power delivered from the Gardiner M7, M9 and M12 lines. As a comparison, Kingston Hydro only pays IESO Transmission rates for electricity delivered from the Frontenac M2, M4 and M5 lines. This could potentially reduce overall delivery costs to Kingston Hydro customers in the long term.

2.2 Upgrade the Pilot Wire Protection Scheme on the M4 and M5 feeders.

2.3 Add a 44kV Breaker at Substation MS9 and create a 44kV interconnection between Substation MS9 and the M7-75 Overhead line section near the intersection of Johnson and Division.

2.4 Complete 44kV underground loop between customer-owned switchgear at 450 Princess (Bell Canada) and riser pole on Adelaide, East of Division Street.

2.5 Construct a Back-up supply for Kingston Hydro's M3 feeder and the Ravensview Treatment Plant which is located in Hydro One territory but served from the same feeder – Install a submarine cable across Cataraqui River at LaSalle Causeway

2.6 Construct a Back-up Supply for Kingston Hydro station MS15

2.7 Isolate and de-energize the abandoned portion of 44kV overhead line that used to serve Kingston Regional Laundry. This may help limit exposure of the 44kV system to lightning strikes.

2.8 Perform routine testing and monitoring of 44kV Underground Cables that are protected solely by the upstream feeder breaker at the Hydro One TS. This includes cables owned by Kingston Hydro and Customer-owned cables (OHIP, KPH, etc.).

2.9 Consider a protective blocking scheme to prevent reclosing the feeder breaker on 44kV cable faults. This is a novel concept that could be implemented under a Smart Grid initiative

2.10 Install Fault indicators on all 44kV cable risers and overhead branches to facilitate fault locating. The cost will vary depending upon the monitoring features but is estimated at $10K per location.

2.11 Pay extra care to preventative maintenance and tree trimming along radial overhead supplies to customer stations (River St. PS, KP, RMC, DND Vimy Station, QPAC) where customer stations must be isolated to perform repairs.

2.12 Reconfigure the 44kV bus at MS1 to allow isolation of both MS1 transformer buses without requiring the M451 breaker to be removed from service. This could be done as part of the MS1 upgrade.

2.13 Autotransfer schemes at MS11, MS2 and MS9 should be upgraded and maintained. Auto transfer schemes could potentially be implemented at MS3, MS8, MS6, MS12, MS4, MS13and MS10.

2.14 Monitor the performance of the new S&C 44kV motor operators that are being installed on the M12-123, M2-123 and M22-12 switches over the next few years. Consider implementing a 44kV auto-sectionalizing scheme in the future with the installation of additional 44kV motor operators as required. This is a novel concept at 44kV and could be implemented under a Smart Grid initiative.

2.15 Install switches just outside Frontenac TS to enable ties between the Frontenac 3M2, 3M4, 3M5 feeders and Gardiner M12, M7 feeders.

2.16 Bury Portion of the M5 Line from Riser Pole on Barrack Street to OHIP Building

2.17 Add Motor Operated Switches at Harbourplace to split load of M451 feeder between Frontenac TS and Gardiner TS

2.18 Upgrade all 44kV Feeder Protection from Over-current protection scheme to Impedance protection scheme.

3 <u>Future upgrades to existing 44kV System:</u>

The following existing 44kV underground cables should be replaced with 1000MCM Copper conductors when these cables reach the end of their useful life and/or additional capacity is required:

3.1 Replace 4/0 Copper PILC cable between Switch M124-ILS-2 on Princess Street and Switch M12-22 on Concession Street

3.2 Replace 500MCM Copper XLPE cable between Riser Pole M74-RT on Union Street and QSA Substation Switch CS18-74

3.3 Replace 500MCM Copper XLPE cable between QSA Substation Switch CS18-74 and MS9 Substation Breaker 9M76

3.4 Replace 500MCM Copper PILC cable between MS9 Substation Breaker 9M455 and KGH Substation Breaker CS7-455

3.5 Replace 500MCM Copper PILC cable between Harbourplace Switch CS8-452 and Hotel Dieu Hospital Switch CS9-452

3.6 Replace 500MCM Copper PILC cable between Hotel Dieu Hospital Switch CS9-451 and MS1 Substation Breaker 1M451

3.7 Replace all PILC cable transitions between Substations and riser poles on street. Locations include the incoming cable to the 11A-7 Switch at MS11 and both incoming cables at MS2.

<u>Cost Estimates</u>

Cost Estimates for implementing the proposed projects in sub-sections 1 through 3 above are summarized in Appendix D.

The recommendations in sub-section 1 outline Capacity and System Expansion upgrades and should be given the highest priority. Specifically, recommendations 1.1 and 1.2 will need to be implemented within the next 20 years. Recommendations 1.3 and 1.4 require monitoring and action may be required depending upon how development evolves.

The recommendations in sub-section 2 outline Operability improvements. These options will require further discussion with Operators and Hydro staff to determine essential vs. “nice-to-have” options. A cost-benefit analysis is also recommended. Operability improvements associated with recommendations 2.1 through 2.3 should be considered within the next 3 to 5 years.

A portion of each of the upgrades under sub-section 3 will provide additional line capacity. Cable ampacity has been used in the following table to show how capital costs could be allocated to replacement and expansion work:

		Ampacity (A)		Upgrade Allocation	
From	To	From	To	Replacement	Expansion
4/0	500MCM	345	564	61%	39%
4/0	1000MCM	345	823	42%	58%
500MCM	1000MCM	564	823	69%	31%

NOTE: Ampacities Based on Diagram B4-2 and Appendix D of the OESC

Appendix D

1	Capacity and Expansion Projects	Expense type	Cost ($,000)	Comments
1.1	Balance Existing Feeder Loads	Operating	$ -	
1.2	Construct a new feeder from Gardiner TS to Bath & Palace Road	Capital	$ 2,100	Does not include H1 Connection Costs. Work could be completed in stages over several years
1.3	Extend 44kV Distribution to Dalton/Binnington area	Capital	$ 1,800	Worst case cost for complete loop feed
1.4	Manage capacity shortfall during Emergency operating conditions thru DR and DG	Operating	TBD	

2	Operability Improvement Projects (additional items)	Expense type	Cost ($,000)	Comments
2.1	Purchase M7, M9 and M12 Lines from Hydro One	Capital	$ 5,000	estimated cost to build new lines ourselves. Residual value should be less
2.2	Upgrade Pilot Wire Protection Scheme on M4 and M5 feeders	Capital	$ 280	
2.3	Construct interconnect between MS9 and M7-75 Overhead line at Johnson & Division	Capital	$ 1,300	
2.4	Complete 44kV underground loop between 450 Princess and M124 line at Adelaide & Division	Capital	$ 500	
2.5	Construct a back-up supply for M3 Feeder using submarine cable across Cataraqui River at Lasalle Causeway	Capital	$ 2,500	Environmental and archeological costs have not been considered
2.6	Construct a Back-up supply for MS15	Capital	$ 1,200	Cost could be reduced if we keep a small radial section near station to eliminate extra metal clad switch and cabling
2.7	Isolate and de-energize abandoned portion of 44kV overhead line that formerly served Kingston Regional Laundry	Operating	$ -	
2.8	Additional monitoring and preventative maintenance activities for 44kV underground cables	Operating	TBD	
2.9	Smart Grid - Implement protective blocking scheme to prevent reclosing feeder breaker on 44kV cable faults. Sensing and communication scheme required at each end of a cable to detect fault within the cable zone.	Smart Grid	$ 75	Cost per location.
2.10	Install Fault indicators on cable risers and overhead branch circuits	Capital?	$ 10	Cost per location. Recommend either 2.9 or 2.10 not both
2.11	Additional preventative maintenance activies for 44kV overhead radial line sections	Operating	TBD	
2.12	Reconfigure 44kV Bus at MS1 to facilitate isolation of both MS1 transformer buses and keep M451 energized.	Capital	TBD	Part of MS1 Upgrade
2.13	a) Upgrade existing autotransfer schemes at MS11, MS2 and MS9	Capital	$ 50	Cost per location. Upgrade at MS11 already started
2.13	b) Add autotransfer schemes at MS3, MS8, MS6, MS12, MS4, MS13 and MS10	Capital	$ 50	Cost per location.
2.14	Replace all 44kV switches with motor operated switches and implement auto-sectionalizing scheme	Capital	$ 2,100	this will likely need to be spread over many years. Cost could be reduced depending upon scale and timing
2.15	Install switches just outside Frontenac TS to enable ties between M2, M4, M5, M12 and M7 feeders	Capital	$ 1,100	Cost could be reduced depending on configuration

2.16	Bury portion of the M5 line from Riser pole on Barrack Street to OHIP Building	Customer Funded	$	340	To improve aesthetics of North Block for City Master Plan. Approx. 175m
2.17	Add Motor Operated Switches at Harbourplace	Capital	$	150	To allow M451 load to be remotely sectionalized between Gardiner TS and Frontenac TS
2.18	Upgrade all 44kV Feeder Protection from Over-current protection scheme to Impedance protection scheme.	Capital	$	150	Estimated cost per feeder assuming one feeder is done at a time. Cost savings may be achieved if all protection is upgraded in one shot with a Prefab Control Building (PCT-in-a-box with D60 feeder relays)

3 **Future Upgrades to Existing Cables**

3.1	Replace 4/0 Copper PILC cable between Switch M124-ILS-2 on Princess Street and Switch M12-22 on Concession Street	Capital	$	130	2013 Budget item. This budget assumes 4" ducts may be reused. Approx. 350m
3.2	Replace 500MCM Copper XLPE cable between Riser Pole M74-RT on Union Street and QSA Substation Switch CS18-74	Capital	$	120	This budget assumes ducts may be reused. Approx. 300m
3.3	Replace 500MCM Copper XLPE cable between QSA Substation Switch CS18-74 and MS9 Substation Breaker 9M76	Capital	$	340	This budget assumes ducts may be reused. Approx. 900m
3.4	Replace 500MCM Copper PILC cable between MS9 Substation Breaker 9M455 and KGH Substation Breaker CS7-455	Capital	$	810	This budget assumes all ducts must be replaced. Approx. 1200m
3.5	Replace 500MCM Copper PILC cable between Harbourplace Switch CS8-452 and Hotel Dieu Hospital Switch CS9-452	Capital	$	375	This budget assumes 50% of ducts must be replaced. Approx. 650m
3.6	Replace 500MCM Copper PILC cable between Hotel Dieu Hospital Switch CS9-451 and MS1 Substation Breaker 1M451	Capital	$	400	This budget assumes 50% of ducts must be replaced. Approx. 700m
3.7	Replace all PILC cable transitions between Substations and riser poles on street. Locations include the incoming cable to the 11A-7 Switch at MS11 and both incoming cables at MS2.	Capital	$	240	Assume $80K for each incoming cable section based on the 11A-9 cable replacement at MS11 in 2012

Electric Master Plan

For

Kingston Hydro 5/15kV System

Issue Date: Jan 13, 2014

Rev 1

Prepared by: Tom Brackenbury, P.Eng.

Utilities Engineer

Utilities Kingston

5 Proposed System Upgrade Projects and Cost Estimates

1 Capacity Upgrade Projects Initially identified by Staff

The following upgrade projects were identified by Operations and Engineering staff in June 2013 prior to initiating a detailed capacity assessment:

1.1 Address capacity concerns at MS5 due to failed T1 transformer

1.2 Consider the following transformer upgrades at MS1:

- Upgrade East Bus at MS1 from 9MVA (3x3MVA Water-cooled) to 12/16MVA (2 x 6/8MVA ONAN/ONAF rating). Size To Be Determined.
- Upgrade West Bus at MS1 from 9MVA (3x3MVA Water-cooled) to 12/16MVA (2 x 6/8MVA ONAN/ONAF rating). Size To Be Determined.

1.3 Consider the following transformer upgrades at MS4

- Replace MS4-T1 and MS4-T2 with one new 7.5/10MVA transformer

1.4 Consider future 5kV/15kV distribution in vicinity of the North Block and City Pier at the foot of Queen Street due to future load growth (Feeder 107, 108, 111, 112)

1.5 Make reinforcement of 1402 feeder a priority (Extend spare feeder 1400)

1.6 Make reinforcement of 108 feeder a priority (tie with 809 back-up feeder)

2 List of Worst Substation Transformers

An Asset Condition Assessment of substation transformers was initiated by Kinectrics in 2012 and completed in 2013. The following transformers have been “Flagged-for-Action” within the next 10 years due to condition.

TX ID	Location	Size [MVA]	Age	HI	HI Category
MS5-T1	MS #5	3	58	34%	Poor
MS17-T1	MS #17	3	59	43%	Poor
MS8-T2	MS #8	5	62	44%	Poor
MS4-T1	MS #4	3	58	45%	Poor
MS1-T3	MS#1	3	52	48%	Poor
MS1-T6	MS#1	3	52	49%	Poor
MS1-T4	MS#1	3	62	50%	Poor
MS1-T5	MS#1	3	51	51%	Fair

Generally speaking, the substation transformers with the worst condition also appear to have some of the heaviest loading (refer to Section 4) and have been flagged for action under the Asset Condition Assessment.

3 Upgrade Projects and Cost Estimates

Upgrade projects and cost estimates have been identified in Appendix A to address the most important capacity and development issues.

5 Future Master Plan Studies

Future Master Plan Studies may wish to consider the following:

- More Detailed Asset Condition info
- Tracking real-time network operating state using SCADA master station and/or GIS system
- Coincident load reporting tools
- Recording Real and Reactive power for each feeder to determine potential for power factor correction
- Weather correlation methods
- Tracking of under/over voltage alarms on each feeder using 3-phase smart meter data.
- Analysis of feeder loading by Rate Class

Appendices

Appendix	Description
A	Cost Estimates
B	Reference Documents
B.1	June 20, 2013 5kV Master Plan Staff Meeting Notes
B.2	July 17, 2013 – E-mails – Request Substation Transformer & Feeder Readings
B.3	Aug 30, 2013 5kV Master Plan Progress Notes
B.4	Sept. 10, 2013 5kV Master Plan Staff Meeting Notes
B.5	Oct 9, 2013 – E-mail – 5kV Feedback - Request Feedback on specific feeders
B.6	Sept 12, 2012 – Memo - Williamsville District – Revised Electrical Load Growth Support Plan & Preliminary Estimates
B.7	Feb 8, 2012 – Memo - Servicing North Block
B.8	Dec. 29, 2011 – E-mail – Dalton Avenue Voltage Conversion Budget Plan
B.9	06/09/2011 Master Plan & Block Plan Report for Ontario Realty Corporation Kingston Provincial Campus (including Kingston Psychiatric Hospital grounds) (Report Cover only – Refer to File K01_01_75 – 752 King St. W.)

Appendix A – Cost Estimates

Substation Upgrades

Item	Description	Estimate (x $ 1,000)	Timeline	Drivers
1.1	Add Fans to MS3-T1	$ 25	1-5 years	Backup Capacity
1.2	Add Fans to MS3-T2	$ 25	1-5 years	Backup Capacity
1.3	Add Fans to MS13-T1	$ 25	1-5 years	Backup Capacity
1.4	Replace transformer at MS5 to address reduced capacity due to failure of transformer T1	$ 300	1-5 years	Backlog
1.5	Replace MS4-T1 and MS4-T2 with one 7.5/10MVA transformer	$ 300	1-5 years	Condition,
1.6	Upgrade existing 3MVA transformer at MS17 to 5MVA transformer by reusing T2 from MS4. *NOTE: depends on item 1.2 above	$ 75	1-5 years	Condition, Capacity
1.7	Replace MS8-T2 with a 7.5/10MVA transformer	$ 300	5-10 years	Condition, Backup Capacity for MS8-T3
1.8	Upgrade East Transformer bank at MS1 from 9MVA to 12/16MVA	$ 3,600	1-5 years	Condition, Capacity
1.9	Upgrade West Transformer bank at MS1 from 9MVA to 12/16MVA	$ 3,600	5-10 years	Condition, Capacity
1.10	Add a transformer at MS2 and MS13 to facilitate a voltage conversion from 5kV to 13.8kV and facilitate load growth in Williamsville district	*	5-25 years	Capacity *NOTE: See Feeder Upgrades for Williamsville below
		$ 8,250	**Total**	

***NOTE: Refer to item 4.5 for total estimated costs for Williamsville capacity upgrades**

Feeder Upgrades

Item	Description	Estimate (x $ 1,000)	Timeline	Drivers
New Commercial load due to infill of Industrial Park Area North of John Counter Blvd. and West of Division St.				
2.1	Extend Feeder 1400 from MS14 to Sir John A. Macdonald at Terry Fox Dr. and transfer load from Feeder 1402 to Feeder 1400.	$ 225	1-5 years	Capacity of 1701, Back-up for 1304/405
2.2	Rebuild Feeder 1401 from MS14 to MS17 (includes railway crossing). Transfer some load from Feeder 1701 to 1401 and 1400.	$ 190	1-5 years	Capacity of 1701
2.3	Voltage Conversion from 5kV to 15kV North of John Counter Blvd. and West of Division St.	$ 7,200	5-25 years	Capacity of 1701
New Commercial/Residential load due to miscellaneous redevelopment North of Queen St. and East of Bagot St. NOTE: Excludes North Block and Waterfront Redevelopment				
3.1	Upgrade Feeder 108 cable between TV27 and GS100 from 1/0 to 500MCM. Shift some load from Feeder 108 to Feeder 809	$ 75	1-5 years	Capacity and backup of 108
Williamsville				
4.1	Shift load from Feeder 1302 and Feeder 201 to Feeder 1301 using existing switches	$ -	1-5 years	Capacity of Feeders serving the Williamsville district
4.2	Shift load from Feeder 104 to Feeder 201 after shifting load from Feeder 201 to Feeder 1301	$ -	1-5 years	Capacity of Feeders serving the Williamsville district
4.3	Shift load from Feeder 207 to Feeder 208 by moving normally open point from Regent St. and Park St. to Macdonnell St. and Park St. respectively. Extend Feeder 207 to feed new development at vacant lot V1 of Williamsville development	$ 700	1-10 years	Capacity of Feeders serving the Williamsville district
4.4	Extend Feeder 204 from Brock St. to Princess St. via Albert St. Install switchgear in new vault (Princess @ Frontenac St.) to provide a tie point between Feeders 201 and 204. Existing load on Princess St. southeast of Albert St. to Division St. can be transferred to Feeder 204 and any new loads can also be served by Feeder 204	$ 310	1-10 years	Capacity of Feeders serving the Williamsville district
4.5	Add transformers at substation MS2 and MS13. Replace and extend existing 5kV switchgear with new 15kV rated switchgear. Extend new 15kV lines from each station to Princess St. via by upgrading existing end-of-life pole line (e.g. 1301 along Macdonnell).	$ 4,500	5-25 years	Capacity of Feeders serving the Williamsville district
New Commercial/Residential load due to redevelopment of KPH property				
5.1	Extend Feeder 704 from MS7 to supply new commercial/residential load at KPH development. Avoid adding load to 705	$ 100	5-25 years	Capacity of 705 and New Development
		$ 13,300	**Total**	

Appendix F

2023 Material Capital Project Descriptions

F.1 General Plant – CIS/WMS Software Systems

F.2 General Plant – Non-CIS Software Systems

F.3 General Plant – New Vehicles

F.4 System Access – 13.8kV Voltage Conversion – Third Avenue

F.5 System Access – PCB Oil Testing and Transformer Replacement

F.6 System Access – 2023 Metering

F.7 System Access - New Transformers/Connections funded by Capital Contributions

F.8 System Access – New Development

F.9 System Renewal – Pole Replacement Sir John A Macdonald Ave.-Union to Johnson

F.10 System Renewal – Bagot St – Replace End of life poles and 44kV switch

F.11 System Renewal – Princess St. Reconstruction – Phase 5 – Division to Alfred St.

F.12 System Renewal – Annual Deteriorated Pole Replacement – Spot Replacements

F.13 System Renewal – 5kV PILC Cable Replacement – 104, 105, 106, 110 Circuits

A. General Information					
Project/Activity	Customer Information System / Work Management System / Customer Experience				
Project Number	100450				
Investment Category	**General Plant**				
Capital Cost (5.4.3.2 A.1)	$ 92,000				
Capital Contribution	$ -				
Net Cost	$ 92,000				
O&M Cost (5.4.3.2 A.1)	-				
Capital Contributions to Transmitters (5.4.3.2 A.2)	-				

Any capital contributions made or forecast to be made to a transmitter with respect to a Connection and Cost Recovery Agreement. Details to be provided include: initial forecast used to calculate contribution, amount of contribution (if any), true-up dates and potential true-up payments.

Not Applicable

Customer Attachments and Load (5.4.3.2 A.3)

Related customer attachments and load, as applicable

Not Applicable

Start Date (5.4.3.2 A.4)	01-May-23			**In Service Date (5.4.3.2 A.4)**	31-Dec-23
Expenditure Timing for the Test Year (5.4.3.2 A.4)	**2023 Q1**	**2023 Q2**	**2023 Q3**	**2023 Q4**	
	$ -	$ 23,000	$ 34,500	$ 34,500	

Project Summary

Kingston Hydro currently shares core customer information system (billing) and work management systems with Utilities Kingston. The existing CIS solution is based on a software product from Sierra Systems. Over the past 20+ years Utilities Kingston has been maintaining the source code of this software to update billing requirements for Kingston Hydro. The existing CIS solution also contains rudimentary work management functions predominately related to those activities that involve billing. Utilities Kingston has maintained this system to meet regulatory requirements successfully, however this is an increasingly complex task for limited benefits. Through 2016 Utilities Kingston worked with other local distribution companies in the Grid Smart City Cooperative to pursue a new shared CIS system. Unfortunately, in early 2017 the consortium working on this CIS project was not able to gain sufficient support to make it happen. Consequently, the existing billing system was kept and has continued to be maintained.

We have included a provision to start the replacement project for the CIS as part of this rate application. The total estimated cost of to convert to a new system is $6,000,000. The capital cost is spread across all the utilities that are billed by Utilities Kingston. Approximately 40% is allocated to Kingston Hydro billing based on the significantly more complex requirements of the utility.

The 2023 year includes provisions for maintaining the existing CIS, while investing in a new IVR and customer portal upgrades.

Risk Identification & Mitigation (5.4.3.2 A.5)

The risks to the completion of the project or program as planned and the manner in which such risks will be mitigated

Information system conversion and implementations are inherently risky. To mitigate this risk to timeline and budget, a business process review will be included as part of the project to ensure needs are captured accurately and adjustments can be made for the new system. A project management plan which identifies all of the required steps will also be generated and followed. There have been several local distribution companies that have implemented new CIS solutions over the past 3-4 years. Utilities Kingston will learn from these peers to help inform our project execution.

Availability of support services is not expected to be a risk, nor does supply chain for software pose a risk to this project. Availability and capacity of internal resources is a risk to the successful completion of this project. To mitigate this risk, additional temporary resources will be used through out the project to supplement the project team, as well as backfilling subject matter experts from within the company as needed.

Comparative information on expenditures for equivalent projects/activities (5.4.3.2 A.6)

If not evident from Chapter 2 Appendix 2-AA, comparative information on expenditures for equivalent projects/programs over the historical period, where available

There is not a historical expenditure from the past 20 years that Utilities Kingston is able to draw upon to inform this expenditure. However, Utilities Kingston worked with several peers from the GridSmartCity co-operative over 2016/2017 to evaluate CIS and WMS solutions. Through that process several different software solutions were identified and costed and are used as a foundation for our estimates moving forward.

REG Investment Details including Capital and OM&A costs (5.4.3.2 A.7)

Information on total capital and OM&A costs associated with REG investment, if any, included in a project/program; and a description of how the REG investment is expected to improve the system's ability to accommodate the connection of REG facilities

There is no REG investment associated with this requirement.

Leave to Construct approval under Section 92 of the OEB Act (5.4.3.2 A.8)

Where a proposed project within the five year forecast period requires Leave to Construct approval under Section 92 of the OEB Act, the applicant must provide a summary of the evidence, to the extent that it is available, for that project consistent with the requirements set out in Chapter 4 of these Filing Requirements (sections 4.3 and 4.4 in particular).

This investment does not require Leave to Construct approval

B. Evaluation criteria and information requirements for each project/activity

Efficiency, Customer Value & Reliability - Investment Main Driver (5.4.3.2 B.1.a)

Identify the main driver (trigger) of the project/program…

The main driver for this project is the reliability. Utilities Kingston maintains it's own source code for the existing cis/wms solution and with the ever evolving regulatory requirements maintaining a complex billing system is becoming increasinly risky to do on it's own. The benefit of moving to a modern CIS that is used by other LDCs means that we will benefit from a greater number of people working to implement changes and keep up with the evolving landscape.

Efficiency, Customer Value & Reliability - Investment Secondary Driver (5.4.3.2 B.1.a) (where applicable)

[Identify...] where applicable any secondary drivers.

Additonal drivers to this project also include efficiency and increased customer value. A new CIS will present the opportuniy to review the processes that effect the billing processes, this will allow for exploring new ways of completing our work and reducing the number of steps it takes to complete a task. Additionally, this will be an opportunity to reduce manual paperwork and reduce data transcription errors, and introduce automation into workflows.

Customer value is also driving this project, as we believe a new CIS will allow for an improved customer experience for those customers that are moving into, within, or out of our service territory. A new CIS allows for a new look at exitsing processes with a view toward digitizing as much as we can that will allow customers to interact with us in their increasingly preferred method (online).

Efficiency, Customer Value & Reliability - Investment Objectives and/or Performance Targets (5.4.3.2 B.1.a)

Identify related objectives and/or performance targets,...

Detailed objectives and performance levels of a new CIS are expected to be developed as part of this project. At this preliminary stage high level goals are identfied such as: other LDCs in the province use the software and can collaborate on changes and updates, the solution offers a rich online toolset for customers to interact with us and automatically generate work orders when required, the project will review and provide documented business processes for those effected by the project.

Efficiency, Customer Value & Reliability - Source and nature of the information used to justify the investment (5.4.3.2 B.1.a)

[Identify,…] by reference to the distributor's asset management process (section 5.3.1), the source and nature of the information used to justify the investment.

The existing CIS/WMS solution has been maintained by Utilities Kingston employees for over 20 years. The original software vendor stopped doing business in Ontario and left without any enduring support structures in place. Utilities Kingston has dutifully and dilligently kept the software up to date with changing requirements and regulations. However Utilities Kingston is not a software development organization and has not had a lot of effort put into developing new features or functionality beyond meeting regulatory requirements. As Utilities Kingston looks to the future and what kind of services modern electricity customers are expecting/demanding from local distribution companies the time is right for Utilities Kingston to replace the existing CIS/WMS solution set.

Demonstrate Good Utility Practice in Reliability Planning (5.4.3.2 B.1.b)

Demonstrate good utility practice in reliability planning through designing a resilient distribution system that addresses existing reliability performance concerns and is capable of adapting to future challenges (e.g. grid modernization and climate change)

One of the fundamentals in asset management is properly funding the maintanece and replacement programs. Properly funding the utility can only happen if customer billing is completed accuratley, and on time every month. A foundational core of good utility practice is therefore ensuring that customers are charged accuratley and on time for the services they use.

Efficiency, Customer Value & Reliability - Priority Level/Project Prioritization and Reasoning (5.4.3.2 B.1.c)

Indicate the priority of the investment relative to others, giving reasons for assigning this priority that clearly reflect the distributor's approach to identifying, selecting, prioritizing and pacing projects in each investment category described in response to section 5.4.1.

The priority level of this project is 5.

Analysis of Project & Alternatives - Effect of the investment on system operation efficiency and cost-effectiveness (5.4.3.2 B.1.d.i)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):
(i) The effect of the investment on system operation efficiency and cost-effectiveness

If Utilities Kingston does not replace it's CIS/WMS then resources and expertise will continue to be put toward maintaining the existing system without a priority given to new functionality or features. This would effect the ability of the company to digitize it's work processes effectively and would hinder the ability to offer customers new and unqiue ways of accessing their customer data.

A new CIS allows for business processes to be reviewed and digitized with the new tools. This not only helps increase the accuracy of data within the CIS/WMS by reducing transcription errors, but it also improved the speed with which work is completed as the number of steps in processes can be reduced with new modern tools.

Analysis of Project & Alternatives - Net benefits accruing to customers (5.4.3.2 B.1.d.ii)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):
(ii) The net benefits accruing to customers as a result of the investment

Preliminary high level investigation has been completed at this point, such that benefits accruing to customers could include:

* More online options for interfacing with Utilities Kingston for move in/move outs.
* More online options for data from the billing system (in addition to green button requirements).
* Increased efficiency of Utilities Kingston processes

Analysis of Project & Alternatives - Impact of the investment on reliability performance including frequency and duration of outages (5.4.3.2 B.1.d.iii)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):
(iii) The impact of the investment on reliability performance including on the frequency and duration of outages

This project will not have an effect on outages.

Project Alternatives (Design, Scheduling, Funding/Ownership) (5.4.3.2 B.1.d)

Where alternatives have been considered and the ranking of a proposed project relative to alternatives has been affected by the assessment of benefits and costs, these benefits and costs should be described and explained in relation to the proposed project and alternatives.

Where a distributor's choices for technical design, component characteristics, how the work is carried out, etc., have been affected by a decision to configure a project to meet both a trigger driver and secondary drivers, the effect on costs and benefits must be explained.

The primary object of this project will be difficult to achieve without extensive resourses and costs. Continuing with the existing systems will limit the ability to provide the current and future levels of service customers

Health and Safety (5.4.3.2 B2)

Provide information on the effect of the investment on health and safety protections and performance for both the utility and the public.

This project will at a minimum maintain the existing level of detail on dangers at customer premises and make it easier for field staff to see the dangers through an updated WMS on their work devices when attending a customer site.

Cyber-Security, Privacy (5.4.3.2 B.3) (where applicable)

Where applicable, provide information showing that the investment conforms to all applicable laws, standards and good utility practices pertaining to customer privacy, cyber security and grid protection. Cyber security is expected to be incorporated into the distributor's risk management decision making and investment planning to form part of its business plans and DSP.

Cyber security and privacy will be identified early as a mandatory requirement and will be reviewed and tested during implementation and post implementation.

Co-Ordination, Interoperability (5.4.3.2 B.4.a) Recognized Standards, co-ordination with utilities, regional planning, and/or 3rd party providers (where applicable)

Where applicable, explain how the investment reflects co-ordination with utilities, regional planning, and/or links with 3rd party providers and/or industry.

Kingston Hydro is managed by Utilities Kingston which also manages the water, wastewater and natural gas systems in the city of Kingston. Costs will be shared by the other utilities and employees will be able to coordinate work at customer premises more efficiently.

Co-Ordination, Interoperability (5.4.3.2 B.4.b) Future technological functionality and/or future operational requirements

Describe how the investment potentially enables future technological functionality and/or addresses future operational requirements.

This project will allow the backbone for greater connectivity for enhanced online presence and will allow customers more efficient self serve options.

Environmental Benefits (5.4.3.2 B.5) (where applicable)

Where applicable, describe the effect of the investment on the use of clean technology, conservation and more efficient use of existing technologies
System requirements will include enhanced ability to provide paperless operations.

Using less paper and continuing to be paperless is a goal for all our software and hardware applications.

Conservation and Demand Management (5.4.3.2 B.6) (where applicable)

Where applicable, describe incremental conservation initiatives, over and above those established in cooperation with the IESO, to defer or avoid future infrastructure projects.
For proposed distribution rate funded CDM programs the following details are required:

(i) Where measurable, an assessment of the benefits of the project for customers in terms of cost impacts to customers
(ii) The number of years the proposed CDM program would be in place and the number of years that the required infrastructure would be deferred A description of how advanced technology has been incorporated into the project (if applicable), including how standards relating to interoperability and cyber-security have been met

Not Applicable

C. Category-Specific Requirements - General Plant
Results of quantitative and qualitative analyses of the proposed project or program (5.4.3.2 GP-D1.1)
Information used by a distributor to justify material projects/programs in this category should include but need not be restricted to: *(i) The results of quantitative and qualitative analyses of the proposed project/program, including assessments of financially feasible options to the proposed project (including the 'do nothing option' where applicable), identifying the (net) benefits of the proposed investment in monetary terms where practicable* Implementation of new software will allow benefits to customers that could include: * More online options for interfacing with Utilities Kingston for move in/move outs. * More online options for data from the billing system (in addition to green button requirements). * Increased efficiency of Utilities Kingston processes, Implementation of "Off the Shelf" systems will reduce costs from both a maintenance perspective as well as implementing new features in a custom (existing) system.
Business Case documenting the justifications for expenditures, alternatives considered, long/short term benefits for customers and long/short term impact on distributor costs (5.4.3.2 GP-D1.2)
Information used by a distributor to justify material projects/programs in this category should include but need not be restricted to: *(ii) Where the capital cost of a project substantially exceeds the materiality threshold, (e.g. CIS, GIS, new office building) the distributor shall file a thorough business case documenting the justifications for the expenditure, alternatives considered, benefits for customers (short/long term), and impact on distributor costs (short/long term).* The systems proposed in this program do not substantially exceed the materiality threshold.

A. General Information						
Project/Activity	Non-CIS Software Systems					
Project Number	100450					
Investment Category	**General Plant**					
Capital Cost (5.4.3.2 A.1)	$ 129,000					
Capital Contribution	$ -					
Net Cost	$ 129,000					
O&M Cost (5.4.3.2 A.1)	-					
Capital Contributions to Transmitters (5.4.3.2 A.2)	-					

Any capital contributions made or forecast to be made to a transmitter with respect to a Connection and Cost Recovery Agreement. Details to be provided include: initial forecast used to calculate contribution, amount of contribution (if any), true-up dates and potential true-up payments.

Not Applicable

Customer Attachments and Load (5.4.3.2 A.3)

Related customer attachments and load, as applicable

Not Applicable

Start Date (5.4.3.2 A.4)	01-Jan-23		**In Service Date (5.4.3.2 A.4)**	31-Dec-23	
Expenditure Timing for the Test Year (5.4.3.2 A.4)	**2023 Q1**	**2023 Q2**	**2023 Q3**	**2023 Q4**	
	$ 32,250	$ 32,250	$ 32,250	$ 32,250	

Project Summary

Kingston Hydro currently shares technology systems with its affiliate, Utilities Kingston and its parent Company, the City of Kingston. This project covers the capital costs associated with maintaining Kingston Hydro's share of software and hardware applications that support the effective and efficient operations of Kingston Hydro.

Capital programs associated with this project along with Kingston Hydro's percentage of costs are:

Client Services CRM Solutions - 25%

Financial Management System/DAX 365 – 23%

Information Management System – 23%

Enterprise Applications – GIS – 25%

Business Applications (IS&T) – 25%

The remaining costs related to the above technology systems are paid for by the other utilities under the management of Utilities Kingston. CRM, GIS and IS&T costs are split between Kingston Hydro and the natural gas, water and wastewater utilities as all four of these utilities utilize the software. The financial management system and the information management system have a reduced percentage to Kingston Hydro as the fibre optic business utilizes this software.

Risk Identification & Mitigation (5.4.3.2 A.5)

The risks to the completion of the project or program as planned and the manner in which such risks will be mitigated

Kingston Hydro bears a reduced amount of risk on the cost as this project is being jointly implemented with a cost sharing split with Utilities Kingston and the City of Kingston. Software should have no delay, but hardware related items could be affected by supply chain issues. If delays happen the capital expenses would occur in the following year when the issues are resolved.

Comparative information on expenditures for equivalent projects/activities (5.4.3.2 A.6)

If not evident from Chapter 2 Appendix 2-AA, comparative information on expenditures for equivalent projects/programs over the historical period, where available

We partner with the City of Kingston, who provides an overall cost/budget each year based on previous years. The City allocated to Kingston Hydro based on a set percentage.

REG Investment Details including Capital and OM&A costs (5.4.3.2 A.7)

Information on total capital and OM&A costs associated with REG investment, if any, included in a project/program; and a description of how the REG investment is expected to improve the system's ability to accommodate the connection of REG facilities

Not Applicable

Leave to Construct approval under Section 92 of the OEB Act (5.4.3.2 A.8)

Where a proposed project within the five year forecast period requires Leave to Construct approval under Section 92 of the OEB Act, the applicant must provide a summary of the evidence, to the extent that it is available, for that project consistent with the requirements set out in Chapter 4 of these Filing Requirements (sections 4.3 and 4.4 in particular).

Not Applicable

B. Evaluation criteria and information requirements for each project/activity
Efficiency, Customer Value & Reliability - Investment Main Driver (5.4.3.2 B.1.a)
Identify the main driver (trigger) of the project/program…
Software and Hardware are being upgraded to avoid using obsolete software and hardware. Continual upgrades to improve the functionality of the programs we use daily to provided better and more efficient services. Financial Management system is no longer supported by Microsoft, required to move to cloud version. Required funding for support and maintenance/subscription and professional services costs for the sustainment of our Corporate Financial Management System Microsoft Dynamics AX 2012 soon to be Dynamics 365. Subscription access to cloud-based information management related tools such Email, Office, SharePoint, PowerApps/PowerAutomate, Planner, OneDrive and Teams on virtually any device. Provide support and maintenance services for our location-focused, ArcGIS platform that enables asset and facilities data management, applications, and systems administration functions. This in turn supports geographically related program areas in the UK org by enabling GIS capabilities into a suite of geocentric and geo-enabled business applications i.e. Capital Projects, Parcel & Easement and UK Operations Dashboard websites/portals and non-GIS application software packages that have been geo-enabled through application or database integrations e.g. Survalent - UK's Outage Management System. In terms of GIS product development, improvements and expansion of the platform UK has provided a roadmap of future needs and requirements for system enhancements and optimization of operations and maintenance processes and workflows. E.g data modelling, and application development to enhance asset and facility management systems. Other systems are in good working order but required updates on regular cadences.
Efficiency, Customer Value & Reliability - Investment Secondary Driver (5.4.3.2 B.1.a) (where applicable)
[Identify...] where applicable any secondary drivers.
Not Applicable
Efficiency, Customer Value & Reliability - Investment Objectives and/or Performance Targets (5.4.3.2 B.1.a)
Identify related objectives and/or performance targets,...
Upgrading software enables us to improve Kingston Hydro's efficiency to be able to continue to provide exceptional service to our customers. Increase the efficiency and reliability of the programs and hardware that Kingston Hydro uses daily.
Efficiency, Customer Value & Reliability - Source and nature of the information used to justify the investment (5.4.3.2 B.1.a)
[Identify,…] by reference to the distributor's asset management process (section 5.3.1), the source and nature of the information used to justify the investment.
Efficiency and customer value will be achieved by ensuring that the most cost-effective solution is identified. Reliability will be maintained by managing risks with strong project management methodology.
Demonstrate Good Utility Practice in Reliability Planning (5.4.3.2 B.1.b)
Demonstrate good utility practice in reliability planning through designing a resilient distribution system that addresses existing reliability performance concerns and is capable of adapting to future challenges (e.g. grid modernization and climate change)
Continual upgrades to improve the functionality of the programs we use daily to provided better and more efficient services. Software is used in almost all aspects and areas of Kingston Hydro, including operations, engineering, business planning and customer service.
Efficiency, Customer Value & Reliability - Priority Level/Project Prioritization and Reasoning (5.4.3.2 B.1.c)
Indicate the priority of the investment relative to others, giving reasons for assigning this priority that clearly reflect the distributor's approach to identifying, selecting, prioritizing and pacing projects in each investment category described in response to section 5.4.1.
Cyber security and software reliability are crutial to ongoing protestion of both the customer and the distribution system, ranking these investments high with respect to other investments in the system.
Analysis of Project & Alternatives - Effect of the investment on system operation efficiency and cost-effectiveness (5.4.3.2 B.1.d.i)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *(i) The effect of the investment on system operation efficiency and cost-effectiveness* Continual upgrades improve the functionality of the programs we use daily to provided better and more efficient services.
Analysis of Project & Alternatives - Net benefits accruing to customers (5.4.3.2 B.1.d.ii)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *(ii) The net benefits accruing to customers as a result of the investment* Software costs are shared with Utilities Kingston and The City of Kingston for greater effeciencies.
Analysis of Project & Alternatives - Impact of the investment on reliability performance including frequency and duration of outages (5.4.3.2 B.1.d.iii)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):
(iii) The impact of the investment on reliability performance including on the frequency and duration of outages

The GIS system is supported by the ArcGis platform which helps to isolate and quickly resolve outage areas. Kingston Hydro continues to provide online access for customers to outage information.

Project Alternatives (Design, Scheduling, Funding/Ownership) (5.4.3.2 B.1.d)

Where alternatives have been considered and the ranking of a proposed project relative to alternatives has been affected by the assessment of benefits and costs, these benefits and costs should be described and explained in relation to the proposed project and alternatives.
Where a distributor's choices for technical design, component characteristics, how the work is carried out, etc., have been affected by a decision to configure a project to meet both a trigger driver and secondary drivers, the effect on costs and benefits must be explained.

Kingston Hydro, working together with the city of Kingston and Utilities Kingston, has a very effective and efficient working model and did not consider alternatives.

Health and Safety (5.4.3.2 B2)

Provide information on the effect of the investment on health and safety protections and performance for both the utility and the public.
Software selection and upgrades have little effect ,if any, on Health and safety.

Cyber-Security, Privacy (5.4.3.2 B.3) (where applicable)

Where applicable, provide information showing that the investment conforms to all applicable laws, standards and good utility practices pertaining to customer privacy, cyber security and grid protection. Cyber security is expected to be incorporated into the distributor's risk management decision making and investment planning to form part of its business plans and DSP.

Cyber security and privacy will be identified early as a mandatory requirement and will be reviewed and tested during implementation and post implementation.

Co-Ordination, Interoperability (5.4.3.2 B.4.a) Recognized Standards, co-ordination with utilities, regional planning, and/or 3rd party providers (where applicable)

Where applicable, explain how the investment reflects co-ordination with utilities, regional planning, and/or links with 3rd party providers and/or industry.

Not Applicable

Co-Ordination, Interoperability (5.4.3.2 B.4.b) Future technological functionality and/or future operational requirements

Describe how the investment potentially enables future technological functionality and/or addresses future operational requirements.
The software Kingston Hydro invests in will enable us to improve Kingston Hydro's efficiency and functionality to be able to continue to provide exceptional service to our customers.

Environmental Benefits (5.4.3.2 B.5) (where applicable)

Where applicable, describe the effect of the investment on the use of clean technology, conservation and more efficient use of existing technologies
System requirements will include enhanced ability to provide paperless operations.

Using less paper and continuing to be paperless is a goal or all our software and hardware applications.

Conservation and Demand Management (5.4.3.2 B.6) (where applicable)

Where applicable, describe incremental conservation initiatives, over and above those established in cooperation with the IESO, to defer or avoid future infrastructure projects.
For proposed distribution rate funded CDM programs the following details are required:

Not Applicable

C. Category-Specific Requirements - General Plant

Results of quantitative and qualitative analyses of the proposed project or program (5.4.3.2 GP-D1.1)

Information used by a distributor to justify material projects/programs in this category should include but need not be restricted to:
(i) The results of quantitative and qualitative analyses of the proposed project/program, including assessments of financially feasible options to the proposed project (including the 'do nothing option' where applicable), identifying the (net) benefits of the proposed investment in monetary terms where practicable

The software purchases/upgrades are needed to reliably and securily continue day to day operations required by Kingston Hydro

Business Case documenting the justifications for expenditures, alternatives considered, long/short term benefts for customers and long/short term impact on distributor costs (5.4.3.2 GP-D1.2)

Information used by a distributor to justify material projects/programs in this category should include but need not be restricted to:
...
(ii) Where the capital cost of a project substantially exceeds the materiality threshold, (e.g. CIS, GIS, new office building) the distributor shall file a thorough business case documenting the justifications for the expenditure, alternatives considered, benefits for customers (short/long term), and impact on distributor costs (short/long term).

None of the software/hardware upgrades substantially exceed the materiality threshold

A. General Information					
Project/Activity	New Vehicles				
Project Number	100-454-01				
Investment Category	**General Plant**				
	2023				
Capital Cost (5.4.3.2 A.1)	$ 450,000				
Capital Contribution	$ -				
Net Cost	$ 450,000				
O&M Cost (5.4.3.2 A.1)	-				
Capital Contributions to Transmitters (5.4.3.2 A.2)	-				

Any capital contributions made or forecast to be made to a transmitter with respect to a Connection and Cost Recovery Agreement. Details to be provided include: initial forecast used to calculate contribution, amount of contribution (if any), true-up dates and potential true-up payments.

Not Applicable

Customer Attachments and Load (5.4.3.2 A.3)

Related customer attachments and load, as applicable

There are no customer loads or attachments related to this project

Start Date (5.4.3.2 A.4)	01-Jan-23		**In Service Date (5.4.3.2 A.4)**	31-Dec-23
Expenditure Timing for the Test Year (5.4.3.2 A.4)	**2023 Q1**	**2023 Q2**	**2023 Q3**	**2023 Q4**
	$ -	$ -	$ -	$ 450,000

Project Summary

A 2003 Freightliner M4 aerial bucket truck will be replaced in 2023 with a similar truck. The truck will be 22 years old by time of its replacement and Fleet mechanics have recommended that it not be extended beyond that date.

Risk Identification & Mitigation (5.4.3.2 A.5)

The risks to the completion of the project or program as planned and the manner in which such risks will be mitigated

A risk for this project is under current supply chain issues, a new vehicles can sometimes be delayed for procurement.

Comparative information on expenditures for equivalent projects/activities (5.4.3.2 A.6)

If not evident from Chapter 2 Appendix 2-AA, comparative information on expenditures for equivalent projects/programs over the historical period, where available

Comparitive information is less applicable in this project. No vehicles were purchased in 2022.

REG Investment Details including Capital and OM&A costs (5.4.3.2 A.7)

Information on total capital and OM&A costs associated with REG investment, if any, included in a project/program; and a description of how the REG investment is expected to improve the system's ability to accommodate the connection of REG facilities

Not Applicable

Leave to Construct approval under Section 92 of the OEB Act (5.4.3.2 A.8)

Where a proposed project within the five year forecast period requires Leave to Construct approval under Section 92 of the OEB Act, the applicant must provide a summary of the evidence, to the extent that it is available, for that project consistent with the requirements set out in Chapter 4 of these Filing Requirements (sections 4.3 and 4.4 in particular).

Not Applicable

B. Evaluation criteria and information requirements for each project/activity
Efficiency, Customer Value & Reliability - Investment Main Driver (5.4.3.2 B.1.a)
Identify the main driver (trigger) of the project/program… The main driver of the project is reliability; replacing aging vehicles with new makes for safer equipment for staff and will reduce downtime of the vehicle and crew due to repair time. Downtime of the bucket truck will increase as the truck requires additional repair and maintenance. When the unit is taken out of service for this – and particularly for unscheduled repair work – it is disruptive to power line work being conducted, creating delays and unnecessary crew inefficiencies.
Efficiency, Customer Value & Reliability - Investment Secondary Driver (5.4.3.2 B.1.a) (where applicable)
[Identify...] where applicable any secondary drivers. Not Applicable
Efficiency, Customer Value & Reliability - Investment Objectives and/or Performance Targets (5.4.3.2 B.1.a)
Identify related objectives and/or performance targets,... Reliability objective is to improve the safety of the vehicle for the staff utilizing the vehicle, and to reduce downtime of the vehicle being out of service for repairs.
Efficiency, Customer Value & Reliability - Source and nature of the information used to justify the investment (5.4.3.2 B.1.a
[Identify,…] by reference to the distributor's asset management process (section 5.3.1), the source and nature of the information used to justify the investment. The source of the information used to justify the vehicle replacment stems from the mechanics who work on the vehicle; who recommended replacement based on their skills, expertise, and experience, and experience with the vehicles upkeep and maintenance history.
Demonstrate Good Utility Practice in Reliability Planning (5.4.3.2 B.1.b)
Demonstrate good utility practice in reliability planning through designing a resilient distribution system that addresses existing reliability performance concerns and is capable of adapting to future challenges (e.g. grid modernization and climate change) Replacing aging and deteriorating equipment, in this the project's new vehicle, allows for better reliability of that vehicle for use by staff. This will allow the crew to utilize the bucket truck for safer working of arieal works.
Efficiency, Customer Value & Reliability - Priority Level/Project Prioritization and Reasoning (5.4.3.2 B.1.c)
Indicate the priority of the investment relative to others, giving reasons for assigning this priority that clearly reflect the distributor's approach to identifying, selecting, prioritizing and pacing projects in each investment category described in response to section 5.4.1. The current priority for this project is 7, and is the lowest priority of the projects for 2023.
Analysis of Project & Alternatives - Effect of the investment on system operation efficiency and cost-effectiveness (5.4.3.2 B.1.d.i
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *(i) The effect of the investment on system operation efficiency and cost-effectiveness* Replacing the vehicles with different models of vehcile was analyzed, but did not achieve the versitility and functionaility of each vehicle proposed to be selected through this project.
Analysis of Project & Alternatives - Net benefits accruing to customers (5.4.3.2 B.1.d.ii)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *...* *(ii) The net benefits accruing to customers as a result of the investment* The net benefit accruing to the customers are a more reliable, and more effcient vehicle and a safe piece of equipment for staff to effceintly, safely, reliably, and effectively work

Analysis of Project & Alternatives - Impact of the investment on reliability performance including frequency and duration of outages (5.4.3.2 B.1.d.iii

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):
(iii) The impact of the investment on reliability performance including on the frequency and duration of outages

Having a more recent, and reliable vehicle means the staff can utilize the vehicle with less downtime for repairs.

Project Alternatives (Design, Scheduling, Funding/Ownership) (5.4.3.2 B.1.d)

Where alternatives have been considered and the ranking of a proposed project relative to alternatives has been affected by the assessment of benefits and costs, these benefits and costs should be described and explained in relation to the proposed project and alternatives.

Where a distributor's choices for technical design, component characteristics, how the work is carried out, etc., have been affected by a decision to configure a project to meet both a trigger driver and secondary drivers, the effect on costs and benefits must be explained.

Not Applicable

Health and Safety (5.4.3.2 B2)

Provide information on the effect of the investment on health and safety protections and performance for both the utility and the public.

Failure to replace the project's bucket truck introduces serious risk associated with the operational safety of employees who would be using it for aerial work. Fleet mechanics have noted that the vehicle will have increased mechanical failures, and the safety of the power line workers is put at risk. Failure to replace the current bucket truck introduces serious risk associated with the operational safety of employees who would be using it for aerial work. Fleet mechanics have noted that the vehicle will have increased mechanical failures, and especially with an aerial device, the safety of the powerline workers is put at risk.

Cyber-Security, Privacy (5.4.3.2 B.3) (where applicable)

Where applicable, provide information showing that the investment conforms to all applicable laws, standards and good utility practices pertaining to customer privacy, cyber security and grid protection. Cyber security is expected to be incorporated into the distributor's risk management decision making and investment planning to form part of its business plans and DSP.

Not Applicable

Co-Ordination, Interoperability (5.4.3.2 B.4.a) Recognized Standards, co-ordination with utilities, regional planning, and/or 3rd party providers (where applicable)

Where applicable, explain how the investment reflects co-ordination with utilities, regional planning, and/or links with 3rd party providers and/or industry.

Not Applicable

Co-Ordination, Interoperability (5.4.3.2 B.4.b) Future technological functionality and/or future operational requirements

Describe how the investment potentially enables future technological functionality and/or addresses future operational requirements.

Investment in new vehicles allows for safer work conditions, and will support the field staff in completing their works of upgrading the electrical grid to new technologies.

Environmental Benefits (5.4.3.2 B.5) (where applicable)

Where applicable, describe the effect of the investment on the use of clean technology, conservation and more efficient use of existing technologies
System requirements will include enhanced ability to provide paperless operations.

Not Applicable

Conservation and Demand Management (5.4.3.2 B.6) (where applicable)

Where applicable, describe incremental conservation initiatives, over and above those established in cooperation with the IESO, to defer or avoid future infrastructure projects.
For proposed distribution rate funded CDM programs the following details are required:

(i) Where measurable, an assessment of the benefits of the project for customers in terms of cost impacts to customers
(ii) The number of years the proposed CDM program would be in place and the number of years that the required infrastructure would be deferred A description of how advanced technology has been incorporated into the project (if applicable), including how standards relating to interoperability and cyber-security have been met

Not Applicable

C. Category-Specific Requirements - General Plant
Results of quantitative and qualitative analyses of the proposed project or program (5.4.3.2 GP-D1.1)
Information used by a distributor to justify material projects/programs in this category should include but need not be restricted to: *(i) The results of quantitative and qualitative analyses of the proposed project/program, including assessments of financially feasible options to the proposed project (including the 'do nothing option' where applicable), identifying the (net) benefits of the proposed investment in monetary terms where practicable* New vehicle upgrades were evaluated for this year, as the age and condition of the selected vehicle has been noted by the mechanical staff responsible for the vehicle's upkeep which made the decision to purchase the vehicle over continuing to defer the vehicle's replacement to future years.
Business Case documenting the justifications for expenditures, alternatives considered, long/short term benefits for customers and long/short term impact on distributor costs (5.4.3.2 GP-D1.2
Information used by a distributor to justify material projects/programs in this category should include but need not be restricted to: *(ii) Where the capital cost of a project substantially exceeds the materiality threshold, (e.g. CIS, GIS, new office building) the distributor shall file a thorough business case documenting the justifications for the expenditure, alternatives considered, benefits for customers (short/long term), and impact on distributor costs (short/long term).* Not Applicable

A. General Information						
Project/Activity	Voltage Conversion to 13.8kV – Third Avenue					
Project Number	100440					
Investment Category	**System Access**					
Capital Cost (5.4.3.2 A.1)	$ 120,000					
Capital Contribution	$ -					
Net Cost	$ 120,000					
O&M Cost (5.4.3.2 A.1)						
Capital Contributions to Transmitters (5.4.3.2 A.2)	$ -					

contribution (if any), true-up dates and potential true-up payments.

Customer Attachments and Load (5.4.3.2 A.3)

Related customer attachments and load, as applicable

Several developments in the Williamsville area, the first at 600 Princess St in 2024.

Start Date (5.4.3.2 A.4)	01-Jan-23		**In Service Date (5.4.3.2 A.4)**	31-Dec-23
Expenditure Timing for the Test Year (5.4.3.2 A.4)	**[•] Q1**	**[•] Q2**	**[•] Q3**	**[•] Q4**
	$ 30,000	$ 30,000	$ 30,000	$ 30,000

Project Summary

This project is the third stage of a multi-stage project to extend a new 13.8kV overhead circuit from MS 16 to the Williamsville Area. This new 13.8kV circuit will be utilized as a future express feeder to the Princess Street at Victoria Street to support the proposed future development and planned intensification in the area. This project consists of the replacement and upgrade of the existing poles surrounding MS 13 and overhead circuit extension from the existing 13.8kv circuit dead end on the Leroy Grant Drive Trail to Connaught Street at Third Avenue.

Risk Identification & Mitigation (5.4.3.2 A.5)

The risks to the completion of the project or program as planned and the manner in which such risks will be mitigated

Lack of labour resourses due to covid, Weather conditions. Mitigation methods include extending project into following year were possible.

Comparative information on expenditures for equivalent projects/activities (5.4.3.2 A.6)

If not evident from Chapter 2 Appendix 2-AA, comparative information on expenditures for equivalent projects/programs over the historical period, where available

The cost estimate for this project was based on actual costs experienced in the similar projects Kingston Hydro conducted in the past.

REG Investment Details including Capital and OM&A costs (5.4.3.2 A.7)

Information on total capital and OM&A costs associated with REG investment, if any, included in a project/program; and a description of how the REG investment is expected to improve the system's ability to accommodate the connection of REG facilities.

Not Applicable

Leave to Construct approval under Section 92 of the OEB Act (5.4.3.2 A.8) - What is this?

Where a proposed project within the five year forecast period requires Leave to Construct approval under Section 92 of the OEB Act, the applicant must provide a summary of the evidence, to the extent that it is available, for that project consistent with the requirements set out in Chapter 4 of these Filing Requirements (sections 4.3 and 4.4 in particular).

Not Applicable

B. Evaluation criteria and information requirements for each project/activity
Efficiency, Customer Value & Reliability - Investment Main Driver (5.4.3.2 B.1.a)
Identify the main driver (trigger) of the project/program…
This project was driven by recent development and proposed future development and intensification in the Williamsville area. The extension of a future use 13.8kV will increase the capacity in the Williamsville area for the future development.
Efficiency, Customer Value & Reliability - Investment Secondary Driver (5.4.3.2 B.1.a) (where applicable)
[Identify...] where applicable any secondary drivers.
Not Applicable
Efficiency, Customer Value & Reliability - Investment Objectives and/or Performance Targets (5.4.3.2 B.1.a)
Identify related objectives and/or performance targets,...
The new 13.8kV circuit will increase the reliability and increase the capacity available for the 5kV circuits in the area.
Efficiency, Customer Value & Reliability - Source and nature of the information used to justify the investment (5.4.3.2 B.1.a)
[Identify,…] by reference to the distributor's asset management process (section 5.3.1), the source and nature of the information used to justify the investment.
The City of Kingston's development review process has identified several large development projects planned for the Williamsville area. Details in the developer applications to the city provide loading calculations, unit counts, specific addresses to halp determine the required capacity and locations for that capacity. Due to existing developments comming online in the area in the last five years, the existing circuits have reached capacity.
Demonstrate Good Utility Practice in Reliability Planning (5.4.3.2 B.1.b)
Demonstrate good utility practice in reliability planning through designing a resilient distribution system that addresses existing reliability performance concerns and is capable of adapting to future challenges (e.g. grid modernization and climate change)
The voltage conversion planned will allow three times the existing capacity, reducing the chance of failure due to thermal loading of the circuits and at the same time allow capacity for new connections in the city promoted expansion area.
Efficiency, Customer Value & Reliability - Priority Level/Project Prioritization and Reasoning (5.4.3.2 B.1.c)
Indicate the priority of the investment relative to others, giving reasons for assigning this priority that clearly reflect the distributor's approach to identifying, selecting, prioritizing and pacing projects in each investment category described in response to section 5.4.1.
The city has been promoting development in the Williamsville area, converting the voltage in this project area along with the other voltage conversion projects in this area will provide the needed capacity for the developments that have connected and the developments that will connect in the next five years. Kingston Hydro has placed a high priority of level 1 on this project.
Analysis of Project & Alternatives - Effect of the investment on system operation efficiency and cost-effectiveness (5.4.3.2 B.1.d.i)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *(i) The effect of the investment on system operation efficiency and cost-effectiveness*
The poles in this section of line are solely owned by Kingston Hydro. There are existing third party communications companies renting space on the poles with provision for additional communications
Analysis of Project & Alternatives - Net benefits accruing to customers (5.4.3.2 B.1.d.ii)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd
Kingston Hydro provides access to communications companies to space on it's poles, in some areas of Kingston Hydro distribution, communications companies provide space to Kingston Hydro on Communications
Analysis of Project & Alternatives - Impact of the investment on reliability performance including frequency and duration of outages (5.4.3.2 B.1.d.iii)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *(iii) The impact of the investment on reliability performance including on the frequency and duration of outages*
Any deteriorated poles supporting this circuit will be replaced, the risk of failure of poles greatly decreases and increasing the capacity causes a lower risk of unplanned outages

Project Alternatives (Design, Scheduling, Funding/Ownership) (5.4.3.2 B.1d)

Where alternatives have been considered and the ranking of a proposed project relative to alternatives has been affected by the assessment of benefits and costs, these benefits and costs should be described and explained in relation to the proposed project and alternatives.

Where a distributor's choices for technical design, component characteristics, how the work is carried out, etc., have been affected by a decision to configure a project to meet both a trigger driver and secondary drivers,

The voltage conversion of the powerlines in this project phase provides a relatively direct line from the substation to the Williamsville development intensification area. When combined with replacement of deteriorated poles within this existing poleline it proved to be the least costly option as compared to alternate routes.

Health and Safety (5.4.3.2 B2)

Provide information on the effect of the investment on health and safety protections and performance for both the utility and the public.

Replacing these assets increases safety to the public by avoiding potential risk that could result from a failure of a wood pole.

Cyber-Security, Privacy (5.4.3.2 B.3) (where applicable)

Where applicable, provide information showing that the investment conforms to all applicable laws, standards and good utility practices pertaining to customer privacy, cyber security and grid protection. Cyber security is

not applicable

Co-Ordination, Interoperability (5.4.3.2 B.4.a) Recognized Standards, co-ordination with utilities, regional planning, and/or 3rd party providers (where applicable)

Where applicable, explain how the investment reflects co-ordination with utilities, regional planning, and/or links with 3rd party providers and/or industry.

The design of the asset replacement in this projet will be brought up to the latest USF and CSA standards. This project will be coordinated with third party communications currently existing on the poles.

Co-Ordination, Interoperability (5.4.3.2 B.4.b) Future technological functionality and/or future operational requirements

Describe how the investment potentially enables future technological functionality and/or addresses future operational requirements.

The existing circuit involved in this project is operated at 5kV, like all distribution projects in the last 20 - 25 years at this voltage level, current construction standards and clearances will allow operation at a higher voltage level in the future with minimal changes. With the increased conductor size and provision for higher voltage operation, capacity for future growth is enhanced.

Environmental Benefits (5.4.3.2 B.5) (where applicable)

Where applicable, describe the effect of the investment on the use of clean technology, conservation and more efficient use of existing technologies

Increasing the voltage will reduce the line losses in this section of line.

Conservation and Demand Management (5.4.3.2 B.6) (where applicable)

Where applicable, describe incremental conservation initiatives, over and above those established in cooperation with the IESO, to defer or avoid future infrastructure projects.

For proposed distribution rate funded CDM programs the following details are required:

Not Applicable

C. Category-Specific Requirements - System Service
Factors affecting the timing or priority of implementing the project (5.4.3.2 SA-A1.1)
Factors affecting the timing/priority of implementing the project The timing for this project is dictated by the proposed development applications for the Williamsville Area. This project is the third stage of a four stage 13.8kV extension and expansion project to be completed over the next 4 years to support the developments and future development/intensification in the Williamsville Area.
Factors relating to customer preferences or customer and third-party input (5.4.3.2 SA-A1.2)
Factors relating to customer preferences or input from customers and other third parties Once complete, this project will allow new customers in the Williamsville area to connect to the new 13.8kV circuit with larger loads than permitted on the 5kV distribution system existing in the area. Customers between 1000kW and 1500kW loads will not be required to connect to the 44kV distribution system, greatly reducing customer equipment costs.
Factors affecting the final cost of the project (5.4.3.2 SA-A1.3)
Factors affecting the final cost of the project The majority of cost for this project involves replacement of 5kV distribution transformers and some underground cabling. Both supply chain issues and the volatile costs for the copper and steel in the transformers (and 15kV cabling) may effect the final cost of the project.
Explanation of how controllable costs have been minimized (5.4.3.2 SA-A1.4)
How controllable costs have been minimized For many years, Kingston Hydro distribution systems at 5kV, including pole framing and cablin,g requiring end of life replacement, have been built to 15kV standards. This has enabled existing pole framing and underground cabling to be re-utilized, thus, many of the pole locations will require no additional work for the conversion minimizing the controllable costs.
Description of the planning objectives met by the project (5.4.3.2 SA-A1.5)
Whether other planning objectives are met by the project or have intentionally been combined into the project and if so, which objectives and why This project also involves the replacement of end of life poles and other components. Additionally, converting the voltage will tripple the allowable load on the circuit.
Other project designs and implementation options considered (5.4.3.2 SA-A1.6)
Whether other project design and/or implementation options were considered and if not, why not The alternative for this project is to extend 44kV distribution to the williamsville area at a much greater cost ot both Kingston Hydro and to customers.
Comparison of the least costly option and the most cost efficent option (5.4.3.2 SA-A1.7)
Where such options were considered and project decision support tools and methods described in response to section 5.4.1 were used to help identify the proposed option, distributors must provide a summary of the results of the analysis, including where applicable: *(a) The least cost option: a comparison of the life cycle cost of all options considered (including the proposed project) – over the service life of the proposed project* *(b) The cost efficient option: a comparison of net project benefits and costs over the service life of the proposed project including:* *(1) A project configured solely to meet the obligation* *(2) The proposed project and other options to the proposed project that meet the same objectives* Since the voltage conversion included many existing assets, the cost and project duration to construct for this option was far less than the alternative option that was reviewed. Eventually, other circuits in the area will also be converted from 5kV to 13.8kV. This project will benefit Kingston Hydro and its customers for many years and will be in service until its end of life. Since the chosen option was the most beneficial and the 44kV in general always has higher associated costs, it was not studied in great detail.
Results of final econjomic evaluation doncuted as per section 3.2 od the DSC (5.4.3.2 SA-A1.8) (where applicable)
Where applicable, the results of the final economic evaluation carried out as per section 3.2 of the DSC Not applicable
Nature and Magnitude of the system impacts of the project and costs of system modifications required to commodate these impacts (e.g. REG Investment) (5.4.3.2 SA-A1.9) (where applicable
Where applicable (e.g. REG investment), information on the nature and magnitude of the system impacts of the project, the costs of any system modifications required to accommodate these impacts and the means by which these costs are to be recovered Not applicable

A. General Information

Project/Activity	UK-KHC- PCB Oil Testing and Transformer Replacement				
Project Number	100434-03				
Investment Category	**System Access**				
Capital Cost (5.4.3.2 A.1)	$ 87,500				
Capital Contribution	$ -				
Net Cost	$ 87,500				
O&M Cost (5.4.3.2 A.1)					
Capital Contributions to Transmitters (5.4.3.2 A.2)					

contribution (if any), true-up dates and potential true-up payments.

Customer Attachments and Load (5.4.3.2 A.3)

Related customer attachments and load, as applicable

Not Applicable

Start Date (5.4.3.2 A.4)	01-Jan-23		**In Service Date (5.4.3.2 A.4)**	31-Dec-23
Expenditure Timing for the Test Year (5.4.3.2 A.4)	**[•] Q1**	**[•] Q2**	**[•] Q3**	**[•] Q4**
	$ 21,875	$ 21,875	$ 21,875	$ 21,875

Project Summary

The PCB transformer testing program is an annual program for confirming, testing and/or replacing distribution transformers older than 1984 for PCB contaminants. THis project ends in 2025.

There will be planned outages to residents and a few commercial customers in areas where a transformer requires an oil sample for testing, and when a transformer tests positive for PCBs and requires a replacement.

Risk Identification & Mitigation (5.4.3.2 A.5)

The risks to the completion of the project or program as planned and the manner in which such risks will be mitigated

Lack of labour resources due to other ongoing projects, Weather conditions, planning power outages and notifying customers when testing/replacing transformers. Order delays with supply chain issues for pad mount transformers. These risks will be mitigated by extending the project as needed.

Comparative information on expenditures for equivalent projects/activities (5.4.3.2 A.6)

If not evident from Chapter 2 Appendix 2-AA, comparative information on expenditures for equivalent projects/programs over the historical period, where available

This project was new for 2021, and does not have a comparable project with a similar scope. Budgets were estimated based on typicall time to access transformer oil and projected labour rates.

REG Investment Details including Capital and OM&A costs (5.4.3.2 A.7)

Information on total capital and OM&A costs associated with REG investment, if any, included in a project/program; and a description of how the REG investment is expected to improve the system's ability to accommodate the connection of REG facilities.

Not Applicable

Leave to Construct approval under Section 92 of the OEB Act (5.4.3.2 A.8) - What is this?

Where a proposed project within the five year forecast period requires Leave to Construct approval under Section 92 of the OEB Act, the applicant must provide a summary of the evidence, to the extent that it is available, for that project consistent with the requirements set out in Chapter 4 of these Filing Requirements (sections 4.3 and 4.4 in particular).

Not applicable

B. Evaluation criteria and information requirements for each project/activity
Efficiency, Customer Value & Reliability - Investment Main Driver (5.4.3.2 B.1.a)
Identify the main driver (trigger) of the project/program… This project is driven by provincial regulations where all transformers that contain PCBs in the insulating oil must be removed from the distribution system by the end of 2025
Efficiency, Customer Value & Reliability - Investment Secondary Driver (5.4.3.2 B.1.a) (where applicable]
[Identify...] where applicable any secondary drivers. Not Applicable
Efficiency, Customer Value & Reliability - Investment Objectives and/or Performance Targets (5.4.3.2 B.1.a]
Identify related objectives and/or performance targets,... Some transformers on backyard pole lines will be relocated to poles that are accessible by bucket truck.
Efficiency, Customer Value & Reliability - Source and nature of the information used to justify the investment (5.4.3.2 B.1.a]
[Identify,…] by reference to the distributor's asset management process (section 5.3.1), the source and nature of the information used to justify the investment. Transformers manufactured prior to 1984 could contain PCBs. All transformers in our distribution system are inspected through our annual transformer inspections, and photos were taken of the nameplates where possible. This allowed us to remove several of the transformers from the program since we were able to identify them as non pcb oil type.
Demonstrate Good Utility Practice in Reliability Planning (5.4.3.2 B.1.b)
Demonstrate good utility practice in reliability planning through designing a resilient distribution system that addresses existing reliability performance concerns and is capable of adapting to future challenges (e.g. grid Removal of PCB contaminated transformers eliminates the risks associated with PCBs (ex: toxic smoke from ignition)
Efficiency, Customer Value & Reliability - Priority Level/Project Prioritization and Reasoning (5.4.3.2 B.1.c)
Indicate the priority of the investment relative to others, giving reasons for assigning this priority that clearly reflect the distributor's approach to identifying, selecting, prioritizing and pacing projects in each investment category described in response to section 5.4.1. This program is a relatively high priority at a level of 2 as it pcb transformers are a concern to Kingston Hydro and regulation requires their removal.
Analysis of Project & Alternatives - Effect of the investment on system operation efficiency and cost-effectiveness (5.4.3.2 B.1.d.i)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *(i) The effect of the investment on system operation efficiency and cost-effectiveness* Replacing pad mount transformers containing PCBs with new transformers with better switching and isolation capabilities allows reduced outage times.
Analysis of Project & Alternatives - Net benefits accruing to customers (5.4.3.2 B.1.d.ii)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd Removing pcb transformers provides an additional level of safety to the public, removing the risk of toxic fumes if the transformer overheats or burns. Customers will also benefit from shorter outages as replacement
Analysis of Project & Alternatives - Impact of the investment on reliability performance including frequency and duration of outages (5.4.3.2 B.1.d.iii)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd

parties):

(iii) The impact of the investment on reliability performance including on the frequency and duration of outages

The frequency of events causing outages may not be reduced but the duration could be reduced by advanced switching capabilities.

Project Alternatives (Design, Scheduling, Funding/Ownership) (5.4.3.2 B.1d)

Where alternatives have been considered and the ranking of a proposed project relative to alternatives has been affected by the assessment of benefits and costs, these benefits and costs should be described and explained in relation to the proposed project and alternatives.

Where a distributor's choices for technical design, component characteristics, how the work is carried out, etc., have been affected by a decision to configure a project to meet both a trigger driver and secondary drivers,

We have reduced the number of potenntial transformers that require testing by utilizing the Annual transformer inspection data. Specifically, the transformer nameplate pictures.

Health and Safety (5.4.3.2 B2)

Provide information on the effect of the investment on health and safety protections and performance for both the utility and the public.

Replacing these assets increases safety to the public by avoiding potential risk of toxic emmisions if the contaminated PCB oil were to ignite.

Cyber-Security, Privacy (5.4.3.2 B.3) (where applicable)

Where applicable, provide information showing that the investment conforms to all applicable laws, standards and good utility practices pertaining to customer privacy, cyber security and grid protection. Cyber security is

Cyber security protection is not applicable to this project.

Co-Ordination, Interoperability (5.4.3.2 B.4.a) Recognized Standards, co-ordination with utilities, regional planning, and/or 3rd party providers (where applicable)

Where applicable, explain how the investment reflects co-ordination with utilities, regional planning, and/or links with 3rd party providers and/or industry.

Not Applicable

Co-Ordination, Interoperability (5.4.3.2 B.4.b) Future technological functionality and/or future operational requirements

Describe how the investment potentially enables future technological functionality and/or addresses future operational requirements.

Replacement of backyard transformers and relocating them to poles that are accessible by bucket truck reduces unplanned outage times. Dual switches in pad mounted transformers allows re-routing of looped feeds to reduce outages.

Environmental Benefits (5.4.3.2 B.5) (where applicable)

Where applicable, describe the effect of the investment on the use of clean technology, conservation and more efficient use of existing technologies

All new liquid filled transformers used by Kingston Hydro are filled with oils that are safe for the evviroment in case of a spill.

Conservation and Demand Management (5.4.3.2 B.6) (where applicable)

Where applicable, describe incremental conservation initiatives, over and above those established in cooperation with the IESO, to defer or avoid future infrastructure projects.

For proposed distribution rate funded CDM programs the following details are required:

(i) Where measurable, an assessment of the benefits of the project for customers in terms of cost impacts to customers

(ii) The number of years the proposed CDM program would be in place and the number of years that the required infrastructure would be deferred A description of how advanced technology has been incorporated into the project (if applicable), including how standards relating to interoperability and cyber-security have been met

Not Applicable

C. Category-Specific Requirements - System Access
Factors affecting the timing or priority of implementing the project (5.4.3.2 SA-A1.1)
Factors affecting the timing/priority of implementing the project This project needs to be completed by the end of 2025 by regulation.
Factors relating to customer preferences or customer and third-party input (5.4.3.2 SA-A1.2)
Factors relating to customer preferences or input from customers and other third parties Where possible, outages to test or replace transformers will be completed at times most convien for the majority of customers.
Factors affecting the final cost of the project (5.4.3.2 SA-A1.3)
Factors affecting the final cost of the project The number of transformers tested and containing PCBs will effect the final cost.
Explanation of how controllable costs have been minimized (5.4.3.2 SA-A1.4)
How controllable costs have been minimized Having transformer inspection records and protos have narrowed the number of transformersrequiring testing, thus reducing the costs.
Description of the planning objectives met by the project (5.4.3.2 SA-A1.5)
Whether other planning objectives are met by the project or have intentionally been combined into the project and if so, which objectives and why Replacing older distribution transformers with new transformers built to current standards may decrease O&M costs in some instances.
Other project designs and implementation options considered (5.4.3.2 SA-A1.6)
Whether other project design and/or implementation options were considered and if not, why not There are no alternatives for this project.
Comparison of the least costly option and the most cost efficent option (5.4.3.2 SA-A1.7)
Where such options were considered and project decision support tools and methods described in response to section 5.4.1 were used to help identify the proposed option, distributors must provide a summary of the results of the analysis, including where applicable: *(a) The least cost option: a comparison of the life cycle cost of all options considered (including the proposed project) – over the service life of the proposed project* *(b) The cost efficient option: a comparison of net project benefits and costs over the service life of the proposed project including:* *(1) A project configured solely to meet the obligation* *(2) The proposed project and other options to the proposed project that meet the same objectives* There are no other options to this program
Results of final econjomic evaluation doncuted as per section 3.2 od the DSC (5.4.3.2 SA-A1.8) (where applicable)
Where applicable, the results of the final economic evaluation carried out as per section 3.2 of the DSC Not applicable
Nature and Magnitude of the system impacts of the project and costs of system modifications required to commodate these impacts (e.g. REG Investment) (5.4.3.2 SA-A1.9) (where applicable
Where applicable (e.g. REG investment), information on the nature and magnitude of the system impacts of the project, the costs of any system modifications required to accommodate these impacts and the means by which these costs are to be recovered Not applicable

A. General Information					
Project/Activity	2023 Metering				
Project Number	100449				
Investment Category	**System Access**				
	2023				
Capital Cost (5.4.3.2 A.1)	$375,000				
Capital Contribution	$ -				
Net Cost	$375,000				
O&M Cost (5.4.3.2 A.1)	**$ -**				
Capital Contributions to Transmitters (5.4.3.2 A.2)	**$ -**				

Related customer attachments and load, as applicable

Not Applicable

Customer Attachments and Load (5.4.3.2 A.3)

Related customer attachments and load, as applicable

Related customer attachments include the load customers coming onto Kingston Hydro's distribution network, and existing customers that opt to upgrade their electrical services. This project covers an esitmated 300 residential GS<50 services; 20 interval type services; and one 1 Tiepoint.

Start Date (5.4.3.2 A.4)			**In Service Date (5.4.3.2 A.4)**	
Expenditure Timing for the Test Year (5.4.3.2 A.4)	**[2023] Q1**	**[2023] Q2**	**[2023] Q3**	**[2023] Q4**
	$93,750	$93,750	$93,750	$93,750

Project Summary

This project involves the installation of electric meters for new services within the KHC service territory. The budget amount here is based on historical trends and forecasted additional services as a result of development within the KHC service territory. The forecast for new services also takes into account the trend emerging for multi-unit buildings to convert from bulk metering to unit metering. This project also involves meter exchanges due to defects, with the quantity budgeted based on a historical average.

Risk Identification & Mitigation (5.4.3.2 A.5)

The risks to the completion of the project or program as planned and the manner in which such risks will be mitigated

Risks to completing this project include availability of equipment from meter manufacturers. We are mitigating these risks by communicating early with our vendors and suppliers about our needs. Another risk is non-compliance with Measurement Canada.

Comparative information on expenditures for equivalent projects/activities (5.4.3.2 A.6)

Comparable costs from previous years include: 2017 - $376,000; 2018 - $440,000; 2019 - $540,000 (340,000+200,000); 2020 - $650,000; 2021 - $205,888.91.
We are also experiencing an inflationary increases on meters, along with additional 5% surcharges due to COVID on freight shipments.

REG Investment Details including Capital and OM&A costs (5.4.3.2 A.7)

Information on total capital and OM&A costs associated with REG investment, if any, included in a project/program; and a description of how the REG investment is expected to improve the system's ability to accommodate the connection of REG facilities.

Not Applicable

Leave to Construct approval under Section 92 of the OEB Act (5.4.3.2 A.8)

Where a proposed project within the five year forecast period requires Leave to Construct approval under Section 92 of the OEB Act, the applicant must provide a summary of the evidence, to the extent that it is available, for that project consistent with the requirements set out in Chapter 4 of these Filing Requirements (sections 4.3 and 4.4 in particular).

Not Applicable

B. Evaluation criteria and information requirements for each project/activity

Efficiency, Customer Value & Reliability - Investment Main Driver (5.4.3.2 B.1.a)

Identify the main driver (trigger) of the project/program…

This project's driver is reliability; especially concerning the accuracy of customer billing. Accurate measurement is of utmost importance and keeping up with new installs and asset management maintenance and is vital to ensuring KHC customers are billed fairly and accurately for the electricity they use; accuracte meausrement is also a legal regulatory requirement.

Efficiency, Customer Value & Reliability - Investment Secondary Driver (5.4.3.2 B.1.a) (where applicable)

[Identify...] where applicable any secondary drivers.

Not Applicable

Efficiency, Customer Value & Reliability - Investment Objectives and/or Performance Targets (5.4.3.2 B.1.a)

Identify related objectives and/or performance targets,…

Once installed, the smart meter functionality is used to support our OutageManagement System ("OMS") and continues to be used daily. Multiple simultaneous smart meter messages received through the AMI network allow System Control Operators to identify customers experiencing power outages.

Efficiency, Customer Value & Reliability - Source and nature of the information used to justify the investment (5.4.3.2 B.1.a)

[Identify,…] by reference to the distributor's asset management process (section 5.3.1), the source and nature of the information used to justify the investment.

With the AMI network triggering a notification to the operators it allows for a more reliable and localized accouning of a power outage. This allows Kingston Hydro to begin the process of restoration of customers, and provide value to the customer by reducing outage time.

Demonstrate Good Utility Practice in Reliability Planning (5.4.3.2 B.1.b)

Demonstrate good utility practice in reliability planning through designing a resilient distribution system that addresses existing reliability performance concerns and is capable of adapting to future challenges (e.g. grid modernization and climate change)

With each specific customer initiated request for a service will utilize: historic utility practices, current and future grid planning, and modern utility practices to develop a site specific soluton taylored to each customer's project needs.

Efficiency, Customer Value & Reliability - Priority Level/Project Prioritization and Reasoning (5.4.3.2 B.1.c)

Indicate the priority of the investment relative to others, giving reasons for assigning this priority that clearly reflect the distributor's approach to identifying, selecting, prioritizing and pacing projects in each investment category described in response to section 5.4.1.

This project is of the highest priority with regarcs to other projects, witha ranking in the 1 tier of priority, to ensure compliance with all codes and regulations, and Measurement Canada.

Analysis of Project & Alternatives - Effect of the investment on system operation efficiency and cost-effectiveness (5.4.3.2 B.1.d.i)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

(i) The effect of the investment on system operation efficiency and cost-effectiveness

Some of the meter changes are customer driven, and the most effective metering choice for compliance with Measurement Canada and Kingston Hydro's conditions of service. Other meter replacement are due to ensuring compliance with the smart meter replacement requirements.

Analysis of Project & Alternatives - Net benefits accruing to customers (5.4.3.2 B.1.d.ii)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

...

(ii) The net benefits accruing to customers as a result of the investment

The net benefit to customers is the accurate and reliable reading of their electicity used to ensure proper and accurate billing.

Analysis of Project & Alternatives - Impact of the investment on reliability performance including frequency and duration of outages (5.4.3.2 B.1.d.iii)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

...

(iii) The impact of the investment on reliability performance including on the frequency and duration of outages

The replacement of meters, and their interconnection to the outage management system, allows better reliability through accurate billing.

Project Alternatives (Design, Scheduling, Funding/Ownership) (5.4.3.2 B.1.d)

Where alternatives have been considered and the ranking of a proposed project relative to alternatives has been affected by the assessment of benefits and costs, these benefits and costs should be described and explained in relation to the proposed project and alternatives.

Where a distributor's choices for technical design, component characteristics, how the work is carried out, etc., have been affected by a decision to configure a project to meet both a trigger driver and secondary drivers, the effect on costs and benefits must be explained.

New development requests are reviewed in accordance with the Kingston Hydro conditions of service and the Capital Cost Recovery model. Various options are reviewed and evaluated in terms of design, scheduleing, funding and ownership.

Health and Safety (5.4.3.2 B2)

Provide information on the effect of the investment on health and safety protections and performance for both the utility and the public.

Meter replacements and installations will be completed to modern design standards and use good utilitiy practices

Cyber-Security, Privacy (5.4.3.2 B.3) (where applicable)

Where applicable, provide information showing that the investment conforms to all applicable laws, standards and good utility practices pertaining to customer privacy, cyber security and grid protection. Cyber security is expected to be incorporated into the distributor's risk management decision making and investment planning to form part of its business plans and DSP.

Cyber-security and privacy are important to account for, when dealing with electric meters and data from electric meters. We continue to monitor and improve Cyber Security to meet requirements of the OEB Mandate.

Co-Ordination, Interoperability (5.4.3.2 B.4.a) Recognized Standards, co-ordination with utilities, regional planning, and/or 3rd party providers (where applicable)

Where applicable, explain how the investment reflects co-ordination with utilities, regional planning, and/or links with 3rd party providers and/or industry.

Not Applicable

Co-Ordination, Interoperability (5.4.3.2 B.4.b) Future technological functionality and/or future operational requirements

Describe how the investment potentially enables future technological functionality and/or addresses future operational requirements.

The installation of smart meters allows for the future possibility of data analysis, and for further refinement of the the outage management system.

Environmental Benefits (5.4.3.2 B.5) (where applicable)

Where applicable, describe the effect of the investment on the use of clean technology, conservation and more efficient use of existing technologies

Using Smart meters allows us to read and troubleshoot the meters remotely, reducing GHG emmisions from disbatching staff and vehicles

Conservation and Demand Management (5.4.3.2 B.6) (where applicable)

Where applicable, describe incremental conservation initiatives, over and above those established in cooperation with the IESO, to defer or avoid future infrastructure projects.
For proposed distribution rate funded CDM programs the following details are required:

(i) Where measurable, an assessment of the benefits of the project for customers in terms of cost impacts to customers
(ii) The number of years the proposed CDM program would be in place and the number of years that the required infrastructure would be deferred A description of how advanced technology has been incorporated into the project (if applicable), including how standards relating to interoperability and cyber-security have been met

Not Applicable

C. Category-Specific Requirements - System Access
Factors affecting the timing or priority of implementing the project (5.4.3.2 SA-A1.1)
Factors affecting the timing/priority of implementing the project Supply chain issues are known; due to the COVID 19 Pandemic lead times provided from manufacturers/suppliers for new meters are 40+ weeks, which could make it difficult to order and complete meter changes with-in the same calendar year.
Factors relating to customer preferences or customer and third-party input (5.4.3.2 SA-A1.2)
Factors relating to customer preferences or input from customers and other third parties As noted above, there are customers that once utilized bulk metering, and are moving towards multi-meter installations.
Factors affecting the final cost of the project (5.4.3.2 SA-A1.3)
Factors affecting the final cost of the project (5.4.3.2 SA-A1.3) A factor that could affect the final cost of the project could be the delay in being able to recieve new meters from manufactueres/suppliers, there is also the factor of increased inflation which could raise the cost of materials.
Explanation of how controllable costs have been minimized (5.4.3.2 SA-A1.4)
How controllable costs have been minimized Customer driven projects will be done effciently, and appropriately with the customer's site specific information. Meter replacements will be done as mandated.
Description of the planning objectives met by the project (5.4.3.2 SA-A1.5)
Whether other planning objectives are met by the project or have intentionally been combined into the project and if so, which objectives and why Upon completion of the project a review of the factors affecting the final costs of the project is completed and used to factor in the decision making for future projects.
Other project designs and implementation options considered (5.4.3.2 SA-A1.6)
Whether other project design and/or implementation options were considered and if not, why not Alternative metering options, meeting the regulations and Kingston Hydro Conditions of ervice, will be analyzed and reviewed at the time of application for each customer driven project.
Comparison of the least costly option and the most cost efficent option (5.4.3.2 SA-A1.7)
Where such options were considered and project decision support tools and methods described in response to section 5.4.1 were used to help identify the proposed option, distributors must provide a summary of the results of the analysis, including where applicable: *(a) The least cost option: a comparison of the life cycle cost of all options considered (including the proposed project) – over the service life of the proposed project* *(b) The cost efficient option: a comparison of net project benefits and costs over the service life of the proposed project including:* *(1) A project configured solely to meet the obligation* *(2) The proposed project and other options to the proposed project that meet the same objectives* Not Applicable
Results of final econjomic evaluation doncuted as per section 3.2 od the DSC (5.4.3.2 SA-A1.8) (where applicable)
Where applicable, the results of the final economic evaluation carried out as per section 3.2 of the DSC Not Applicable
Nature and Magnitude of the system impacts of the project and costs of system modifications required to commodate these impacts (e.g. REG Investment) (5.4.3.2 SA-A1.9) (where applicable)
Where applicable (e.g. REG investment), information on the nature and magnitude of the system impacts of the project, the costs of any system modifications required to accommodate these impacts and the means by which these costs are to be recovered Not Applicable

A. General Information					
Project/Activity	New Transformers or New Connections funded by Capital Contributions				
Project Number					
Investment Category	**System Access**				
	2023				
Capital Cost (5.4.3.2 A.1)	$ 150,000				
Capital Contribution	$ 150,000				
Net Cost	$ -				
O&M Cost (5.4.3.2 A.1)					
Capital Contributions to Transmitters (5.4.3.2 A.2)					

contribution (if any), true-up dates and potential true-up payments.

Customer Attachments and Load (5.4.3.2 A.3)

Related customer attachments and load, as applicable

Unplanned customer connections may require a transformer and cabling to connect to the distribution system

Start Date (5.4.3.2 A.4)			**In Service Date (5.4.3.2 A.4)**		
Expenditure Timing for the Test Year (5.4.3.2 A.4)	**[2023] Q1**	**[2023] Q2**	**[2023] Q3**	**[2023] Q4**	
	$ 37,500	$ 37,500	$ 37,500	$ 37,500	

Project Summary

This is a program for allocation of capital contributions from new customers that fund transformers and primary cabling for services greater than 400A.

Risk Identification & Mitigation (5.4.3.2 A.5)

The risks to the completion of the project or program as planned and the manner in which such risks will be mitigated.

For each expansion that is required, to connect a general service customer greater than 50kW, an economic evaluation is calculated to determine if revenues cover the costs of the connection. If new connections generate adequate revenue, or if there are fewer connection requests than anticipated, there will not be an increase to the capital contribution fund and transformers/cabling will be funded solely from the New Connections buget item.

Comparative information on expenditures for equivalent projects/activities (5.4.3.2 A.6)

If not evident from Chapter 2 Appendix 2-AA, comparative information on expenditures for equivalent projects/programs over the historical period, where available.

The capital contributions are based on five year past average for capital contributions from new connections.

REG Investment Details including Capital and OM&A costs (5.4.3.2 A.7)

Information on total capital and OM&A costs associated with REG investment, if any, included in a project/program; and a description of how the REG investment is expected to improve the system's ability to accommodate the connection of REG facilities.

This fund is not associated with REG facilities.

Leave to Construct approval under Section 92 of the OEB Act (5.4.3.2 A.8)

Where a proposed project within the five year forecast period requires Leave to Construct approval under Section 92 of the OEB Act, the applicant must provide a summary of the evidence, to the extent that it is available, for that project consistent with the requirements set out in Chapter 4 of these Filing Requirements (sections 4.3 and 4.4 in particular).

This program does not require Leave to Construct.

B. Evaluation criteria and information requirements for each project/activity

Efficiency, Customer Value & Reliability - Investment Main Driver (5.4.3.2 B.1.a)

Identify the main driver (trigger) of the project/program.
The main driver is new customer connections and upgrades, and results of the economic evaluations.

Efficiency, Customer Value & Reliability - Investment Secondary Driver (5.4.3.2 B.1.a) (where applicable)

[Identify...] where applicable any secondary drivers.
Not applicable.

Efficiency, Customer Value & Reliability - Investment Objectives and/or Performance Targets (5.4.3.2 B.1.a)

Identify related objectives and/or performance targets.
Capital contributions result only from those new or upgraded connections that are not supported by the revenue or increase in revenue for that customer, the objective is ensure the rates that generate the revenues are sufficient to not require a capital contribution.

Efficiency, Customer Value & Reliability - Source and nature of the information used to justify the investment (5.4.3.2 B.1.a)

[Identify,…] by reference to the distributor's asset management process (section 5.3.1), the source and nature of the information used to justify the investment.
UK calulates economic evaluations and has kept record of the capital contributions required by customers. The buget amount and investment of the of those contributions have been averaged for the last five years.

Demonstrate Good Utility Practice in Reliability Planning (5.4.3.2 B.1.b)

Demonstrate good utility practice in reliability planning through designing a resilient distribution system that addresses existing reliability performance concerns and is capable of adapting to future challenges (e.g. grid modernization and climate change)
This program is not impacted by reliability planning or performance, nor does it have an effect on climate change initiatives.

Efficiency, Customer Value & Reliability - Priority Level/Project Prioritization and Reasoning (5.4.3.2 B.1.c)

Indicate the priority of the investment relative to others, giving reasons for assigning this priority that clearly reflect the distributor's approach to identifying, selecting, prioritizing and pacing projects in each investment category described in response to section 5.4.1.

This project has a priority of level 2. Capital contributions will only be funding customer connection transformers and cabling if they materialize.

Analysis of Project & Alternatives - Effect of the investment on system operation efficiency and cost-effectiveness (5.4.3.2 B.1.d.i)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):
(i) The effect of the investment on system operation efficiency and cost-effectiveness
Capital contributions have no impact on efficiency.

Analysis of Project & Alternatives - Net benefits accruing to customers (5.4.3.2 B.1.d.ii)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):
...
(ii) The net benefits accruing to customers as a result of the investment
This program has no net benefits to the customer.

Analysis of Project & Alternatives - Impact of the investment on reliability performance including frequency and duration of outages (5.4.3.2 B.1.d.iii)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

...

(iii) The impact of the investment on reliability performance including on the frequency and duration of outages

This program has no impact on reliability performance.

Project Alternatives (Design, Scheduling, Funding/Ownership) (5.4.3.2 B.1.d)

Where alternatives have been considered and the ranking of a proposed project relative to alternatives has been affected by the assessment of benefits and costs, these benefits and costs should be described and explained in relation to the proposed project and alternatives.

Where a distributor's choices for technical design, component characteristics, how the work is carried out, etc., have been affected by a decision to configure a project to meet both a trigger driver and secondary drivers, the effect on costs and benefits must be explained.

Alternatives have not been considered for this program

Health and Safety (5.4.3.2 B2)

Provide information on the effect of the investment on health and safety protections and performance for both the utility and the public.

This program has no effect on health and safety.

Cyber-Security, Privacy (5.4.3.2 B.3) (where applicable)

Where applicable, provide information showing that the investment conforms to all applicable laws, standards and good utility practices pertaining to customer privacy, cyber security and grid protection. Cyber security is expected to be incorporated into the distributor's risk management decision making and investment planning to form part of its business plans and DSP.

Not applicable

Co-Ordination, Interoperability (5.4.3.2 B.4.a) Recognized Standards, co-ordination with utilities, regional planning, and/or 3rd party providers (where applicable)

Where applicable, explain how the investment reflects co-ordination with utilities, regional planning, and/or links with 3rd party providers and/or industry.

Not applicable

Co-Ordination, Interoperability (5.4.3.2 B.4.b) Future technological functionality and/or future operational requirements

Describe how the investment potentially enables future technological functionality and/or addresses future operational requirements.

This program does not have an effect on future technological functionality or operational requirements.

Environmental Benefits (5.4.3.2 B.5) (where applicable)

Where applicable, describe the effect of the investment on the use of clean technology, conservation and more efficient use of existing technologies.

Not applicable

Conservation and Demand Management (5.4.3.2 B.6) (where applicable)

Where applicable, describe incremental conservation initiatives, over and above those established in cooperation with the IESO, to defer or avoid future infrastructure projects.

For proposed distribution rate funded CDM programs the following details are required:

(i) Where measurable, an assessment of the benefits of the project for customers in terms of cost impacts to customers

(ii) The number of years the proposed CDM program would be in place and the number of years that the required infrastructure would be deferred A description of how advanced technology has been incorporated into the project (if applicable), including how standards relating to interoperability and cyber-security have been met

Not applicable

C. Category-Specific Requirements - System Access

Factors affecting the timing or priority of implementing the project (5.4.3.2 SA-A1.1)

Factors affecting the timing/priority of implementing the project.
The timing of this project is determined by the timing of new connections and the receipt of capital contributions.

Factors relating to customer preferences or customer and third-party input (5.4.3.2 SA-A1.2)

Factors relating to customer preferences or input from customers and other third parties.
Customer and third party input do not apply to this program.

Factors affecting the final cost of the project (5.4.3.2 SA-A1.3)

Factors affecting the final cost of the project.
The one and only factor effecting this project is the results of the economic evaluations.

Explanation of how controllable costs have been minimized (5.4.3.2 SA-A1.4)

How controllable costs have been minimized.
Costs in this program are not directly controllable.

Description of the planning objectives met by the project (5.4.3.2 SA-A1.5)

Whether other planning objectives are met by the project or have intentionally been combined into the project and if so, which objectives and why.
No other planning objectives have been combined into this project.

Other project designs and implementation options considered (5.4.3.2 SA-A1.6)

Whether other project design and/or implementation options were considered and if not, why not.
No other options were considered.

Comparison of the least costly option and the most cost efficent option (5.4.3.2 SA-A1.7)

Where such options were considered and project decision support tools and methods described in response to section 5.4.1 were used to help identify the proposed option, distributors must provide a summary of the results of the analysis, including where applicable:
(a) The least cost option: a comparison of the life cycle cost of all options considered (including the proposed project) – over the service life of the proposed project
(b) The cost efficient option: a comparison of net project benefits and costs over the service life of the proposed project including:
(1) A project configured solely to meet the obligation
(2) The proposed project and other options to the proposed project that meet the same objectives
Not applicable.

Results of final econjomic evaluation doncuted as per section 3.2 od the DSC (5.4.3.2 SA-A1.8) (where applicable)

Where applicable, the results of the final economic evaluation carried out as per section 3.2 of the DSC.
This program is dependant on future economic evaluations.

Nature and Magnitude of the system impacts of the project and costs of system modifications required to commodate these impacts (e.g. REG Investment) (5.4.3.2 SA-A1.9) (where applicable)

Where applicable (e.g. REG investment), information on the nature and magnitude of the system impacts of the project, the costs of any system modifications required to accommodate these impacts and the means by which these costs are to be recovered
Not applicable

A. General Information

Project/Activity	System Access-100440 -Annual New Development					
Project Number	100440					
Investment Category	**System Access**					
	2023					
Capital Cost (5.4.3.2 A.1)	$ 300,000					
Capital Contribution	$ -					
Net Cost	$ 300,000					
O&M Cost (5.4.3.2 A.1)	**$ -**					
Capital Contributions to Transmitters (5.4.3.2 A.2)	$ -					

Related customer attachments and load, as applicable

Any capital contributions made or forecast to be made to a transmitter with respect to a Connection and Cost Recovery Agreement. Details to be provided include: initial forecast used to calculate contribution, amount of contribution (if any), true-up dates and potential true-up payments.

Customer Attachments and Load (5.4.3.2 A.3)

Related customer attachments and load, as applicable

Each application is driven by a specific customer, and will have specific site details that will vary.

Start Date (5.4.3.2 A.4)	01-Jan-23		**In Service Date (5.4.3.2 A.4)**	31-Dec-23
Expenditure Timing for the Test Year (5.4.3.2 A.4)	**[2023] Q1**	**[2023] Q2**	**[2023] Q3**	**[2023] Q4**
	$ 75,000	$ 75,000	$ 75,000	$ 75,000

Project Summary

This project represents a number of projects to be completed during the year, driven primarily by customer requests for new and/or upgraded services greater than 200A 120/240V residential service connections. These projects are generally unplanned or unforeseen, and require capital infrastructure expansions or upgrades to accommodate the service connection requirements of each individual connection request. The scope of this project includes new commercial and industrial service connections, including primary and secondary transformations and/or extensions, requests for equipment relocation and in-fill projects sometimes including purchase and installation of various pieces of equipment, including but not limited to pole or pad-mount transformers, primary cabling, and underground distribution structures.

Risk Identification & Mitigation (5.4.3.2 A.5)

The risks to the completion of the project or program as planned and the manner in which such risks will be mitigated

This project/program was established to address the changing priorities and service connection/development requirements over the year. Depending on the development request Kingston Hydro may need to shift the project schedule to accommodate the development connection requirements.

Comparative information on expenditures for equivalent projects/activities (5.4.3.2 A.6)

If not evident from Chapter 2 Appendix 2-AA, comparative information on expenditures for equivalent projects/programs over the historical period, where available

Comparable investments for the 2017 to 2021 new service developemnt connections are

2017 $288,239.04
2018 $351,889.94
2019 $306,911.76
2020 $667,761.50
2021 $289,725.93

REG Investment Details including Capital and OM&A costs (5.4.3.2 A.7)

Information on total capital and OM&A costs associated with REG investment, if any, included in a project/program; and a description of how the REG investment is expected to improve the system's ability to accommodate the connection of REG facilities.

Not Applicable

Leave to Construct approval under Section 92 of the OEB Act (5.4.3.2 A.8)

Where a proposed project within the five year forecast period requires Leave to Construct approval under Section 92 of the OEB Act, the applicant must provide a summary of the evidence, to the extent that it is available, for that project consistent with the requirements set out in Chapter 4 of these Filing Requirements (sections 4.3 and 4.4 in particular).

This program generally does not involve projects where the Leave to Construct approval is required.

B. Evaluation criteria and information requirements for each project/activity
Efficiency, Customer Value & Reliability - Investment Main Driver (5.4.3.2 B.1.a)
Identify the main driver (trigger) of the project/program… This project is driven by customer service requests. Kingston Hydro has obligations to provide customers with access to its distribution system under regulatory requirements and obligations and Kingston Hydro’s Conditions of Service.
Efficiency, Customer Value & Reliability - Investment Secondary Driver (5.4.3.2 B.1.a) (where applicable)
[Identify...] where applicable any secondary drivers. Not Applicable
Efficiency, Customer Value & Reliability - Investment Objectives and/or Performance Targets (5.4.3.2 B.1.a)
Identify related objectives and/or performance targets,… Kingston Hydro has obligations to provide customers with access to its distribution system under regulatory requirements and obligations and Kingston Hydro’s Conditions of Service, which make this project a high priority. Scheduling of this work is based on customer requirements and expectations.
Efficiency, Customer Value & Reliability - Source and nature of the information used to justify the investment (5.4.3.2 B.1.a)
[Identify,…] by reference to the distributor’s asset management process (section 5.3.1), the source and nature of the information used to justify the investment. Each individual project/development request is customer initiated. Kingston Hydro will provide new services to meet the customers’ expectations in terms of time and cost.
Demonstrate Good Utility Practice in Reliability Planning (5.4.3.2 B.1.b)
Demonstrate good utility practice in reliability planning through designing a resilient distribution system that addresses existing reliability performance concerns and is capable of adapting to future challenges (e.g. grid modernization and climate change) Modern construction standards and materials are utilized as well as a review of the existing distribution infrastructure around a proposed development is assess and improvements/changes are conducted as required.With each specific customer initiated request for a service will utilize: historic utility practices, current and future grid planning, and modern utility practices to develop a site specific soluton taylored to each customer's project needs.
Efficiency, Customer Value & Reliability - Priority Level/Project Prioritization and Reasoning (5.4.3.2 B.1.c)
Indicate the priority of the investment relative to others, giving reasons for assigning this priority that clearly reflect the distributor’s approach to identifying, selecting, prioritizing and pacing projects in each investment category described in response to section 5.4.1. Kingston Hydro has obligations to provide customers with access to its distribution system under regulatory requirements and obligations and Kingston Hydro’s Conditions of Service, which make this project a high priority. Scheduling of this work is based on customer requirements and expectations. This is in the first tier of priority with regards to other projects for the year.
Analysis of Project & Alternatives - Effect of the investment on system operation efficiency and cost-effectiveness (5.4.3.2 B.1.d.i)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *(i) The effect of the investment on system operation efficiency and cost-effectiveness* New development requests are reviewed in accordance with the Kingston Hydro conditions of service and the Capital Cost Recovery model. Various options are reviewed and evaluated for system operation efficiency and cost-effectiveness before a final project scope is determined
Analysis of Project & Alternatives - Net benefits accruing to customers (5.4.3.2 B.1.d.ii)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *...* *(ii) The net benefits accruing to customers as a result of the investment* New development requests are reviewed in accordance with the Kingston Hydro conditions of service and the Capital Cost Recovery model. Various options are reviewed and evaluated for net benefit accruing to Customers before a final project scope is determined

Analysis of Project & Alternatives - Impact of the investment on reliability performance including frequency and duration of outages (5.4.3.2 B.1.d.iii

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

...

(iii) The impact of the investment on reliability performance including on the frequency and duration of outages

New development requests are reviewed in accordance with the Kingston Hydro conditions of service and the Capital Cost Recovery model. Various options are reviewed and evaluated for the reilability of the distribution system before a final project scope is determined

Project Alternatives (Design, Scheduling, Funding/Ownership) (5.4.3.2 B.1.d)

Where alternatives have been considered and the ranking of a proposed project relative to alternatives has been affected by the assessment of benefits and costs, these benefits and costs should be described and explained in relation to the proposed project and alternatives.

Where a distributor's choices for technical design, component characteristics, how the work is carried out, etc., have been affected by a decision to configure a project to meet both a trigger driver and secondary drivers, the effect on costs and benefits must be explained.

New development requests are reviewed in accordance with the Kingston Hydro conditions of service and the Capital Cost Recovery model. Various options are reviewed and evaluated in terms of design, scheduleing, funding and ownership.

Health and Safety (5.4.3.2 B2)

Provide information on the effect of the investment on health and safety protections and performance for both the utility and the public.

Replacing these assets increases safety to the public by avoiding potential risk that could result from a failure of a wood pole.

Cyber-Security, Privacy (5.4.3.2 B.3) (where applicable)

Where applicable, provide information showing that the investment conforms to all applicable laws, standards and good utility practices pertaining to customer privacy, cyber security and grid protection. Cyber security is expected to be incorporated into the distributor's risk management decision making and investment planning to form part of its business plans and DSP.

Not Applicable

Co-Ordination, Interoperability (5.4.3.2 B.4.a) Recognized Standards, co-ordination with utilities, regional planning, and/or 3rd party providers (where applicable)

Where applicable, explain how the investment reflects co-ordination with utilities, regional planning, and/or links with 3rd party providers and/or industry.

Not Applicable

Co-Ordination, Interoperability (5.4.3.2 B.4.b) Future technological functionality and/or future operational requirements

Describe how the investment potentially enables future technological functionality and/or addresses future operational requirements.

The investment into connecting site specific customer connections allows for updating and servincing future operational requirements.

Environmental Benefits (5.4.3.2 B.5) (where applicable)

Where applicable, describe the effect of the investment on the use of clean technology, conservation and more efficient use of existing technologies

Not Applicable

Conservation and Demand Management (5.4.3.2 B.6) (where applicable)

Where applicable, describe incremental conservation initiatives, over and above those established in cooperation with the IESO, to defer or avoid future infrastructure projects.
For proposed distribution rate funded CDM programs the following details are required:

(i) Where measurable, an assessment of the benefits of the project for customers in terms of cost impacts to customers
(ii) The number of years the proposed CDM program would be in place and the number of years that the required infrastructure would be deferred A description of how advanced technology has been incorporated into the project (if applicable), including how standards relating to interoperability and cyber-security have been met

Not Applicable

C. Category-Specific Requirements - System Access
Factors affecting the timing or priority of implementing the project (5.4.3.2 SA-A1.1)
Factors affecting the timing/priority of implementing the project Kingston Hydro has obligations to provide customers with access to its distribution system under regulatory requirements and obligations and Kingston Hydro's Conditions of Service, which make this project a high priority. Scheduling of this work is based on customer requirements and expectations.
Factors relating to customer preferences or customer and third-party input (5.4.3.2 SA-A1.2)
Factors relating to customer preferences or input from customers and other third parties Kingston Hydro reviews the Develoment service requests and evaluates the options and inputs from the customers and impacted third parties for mutual benefits and preferences
Factors affecting the final cost of the project (5.4.3.2 SA-A1.3)
Factors affecting the final cost of the project (5.4.3.2 SA-A1.3) For the indivdual projects completed Kingston Hydro reviews the factors affecting the final costs of the project is completed and used to factor in the decision making for future projects.
Explanation of how controllable costs have been minimized (5.4.3.2 SA-A1.4)
How controllable costs have been minimized Upon completion of the project a review of the factors affecting the final costs of the project is completed and used to factor in the decision making for future projects.
Description of the planning objectives met by the project (5.4.3.2 SA-A1.5)
Whether other planning objectives are met by the project or have intentionally been combined into the project and if so, which objectives and why Where applicable Kingston Hydro evaluates the impacts and potential outcomes of other planning objectives during the project evaluation and design. Where applicable considerations are made for future expansion and potential future development request requirements.
Other project designs and implementation options considered (5.4.3.2 SA-A1.6)
Whether other project design and/or implementation options were considered and if not, why not Where applicable, multiple design and implementation options are considered and evalutaed.
Comparison of the least costly option and the most cost efficent option (5.4.3.2 SA-A1.7)
Where such options were considered and project decision support tools and methods described in response to section 5.4.1 were used to help identify the proposed option, distributors must provide a summary of the results of the analysis, including where applicable: *(a) The least cost option: a comparison of the life cycle cost of all options considered (including the proposed project) – over the service life of the proposed project* *(b) The cost efficient option: a comparison of net project benefits and costs over the service life of the proposed project including:* *(1) A project configured solely to meet the obligation* *(2) The proposed project and other options to the proposed project that meet the same objectives* Not Applicable
Results of final econjomic evaluation doncuted as per section 3.2 od the DSC (5.4.3.2 SA-A1.8) (where applicable)
Where applicable, the results of the final economic evaluation carried out as per section 3.2 of the DSC Kingston Hydro prepares an economic evaluation is carried out for the new development service requests the results of which vary depending on the scope of the project and the service connection requirements.
Nature and Magnitude of the system impacts of the project and costs of system modifications required to commodate these impacts (e.g. REG Investment) (5.4.3.2 SA-A1.9) (where applicable)
Where applicable (e.g. REG investment), information on the nature and magnitude of the system impacts of the project, the costs of any system modifications required to accommodate these impacts and the means by which these costs are to be recovered New developemnt service connections are subject to evaltation through the capital cost recovery model

A. General Information						
Project/Activity	UK-KHC- 44KV & 5KV Pole replacement Sir John A Macdonald Ave. from Union St towards Johnson					
Project Number						
Investment Category	**System Renewal**					
	2023					
Capital Cost (5.4.3.2 A.1)	$ 100,000					
Capital Contribution	$ -					
Net Cost	$ 100,000					
O&M Cost (5.4.3.2 A.1)	$ -					
Capital Contributions to Transmitters (5.4.3.2 A.2)	$ -					

Any capital contributions made or forecast to be made to a transmitter with respect to a Connection and Cost Recovery Agreement. Details to be provided include: initial forecast used to calculate contribution, amount of contribution (if any), true-up dates and potential true-up payments.

Not Applicable

Customer Attachments and Load (5.4.3.2 A.3)

Related customer attachments and load, as applicable

There are 205 customers on the circuit effected by this project at an average load of 1300 kW.

Start Date (5.4.3.2 A.4)	01-Sep-23		**In Service Date (5.4.3.2 A.4)**	31-Dec-23	
Expenditure Timing for the Test Year (5.4.3.2 A.4)	**2023 Q1**	**2023 Q2**	**2023 Q3**	**2023 Q4**	
			$ 50,000	$ 50,000	

Project Summary

The Annual Deteriorated Overhead Infrastructure Program focuses on replacement of deteriorated poles, pole mount transformers and other deficiencies identified through annual overhead infrastructure inspections. A number of the poles in this section of Sir John A Macdonald Ave and Union St. are beyond end of life.

There will be planned outages to residents and a few commercial customers in these areas in order to transfer loads to the new constructed pole line.

Risk Identification & Mitigation (5.4.3.2 A.5)

The risks to the completion of the project or program as planned and the manner in which such risks will be mitigated

Lack of labour resourses due to covid, Weather conditions, greater than average numbers of customer connection requests could delay this project.
There is a risk to O&M if this project is deferred and an unplanned outage occurs.
Mitigation methods include advancing the work to Q1 or Q2?

Comparative information on expenditures for equivalent projects/activities (5.4.3.2 A.6)

If not evident from Chapter 2 Appendix 2-AA, comparative information on expenditures for equivalent projects/programs over the historical period, where available

Kingston Hydro regularly reviews pole conditions and switch replacements. The cost estimate for this project was based on actual costs experienced in the similar projects Kingston Hydro conducted in the past. Past information has provided unit costs for materials and labour hours, the work for 2023 has been adjusted for inflation.

REG Investment Details including Capital and OM&A costs (5.4.3.2 A.7)

Information on total capital and OM&A costs associated with REG investment, if any, included in a project/program; and a description of how the REG investment is expected to improve the system’s ability to accommodate the connection of REG facilities.

There is no REG investment associated with this requirement.

Leave to Construct approval under Section 92 of the OEB Act (5.4.3.2 A.8]

Where a proposed project within the five year forecast period requires Leave to Construct approval under Section 92 of the OEB Act, the applicant must provide a summary of the evidence, to the extent that it is available,

This investment does not require Leave to Construct approval

B. Evaluation criteria and information requirements for each project/activity
Efficiency, Customer Value & Reliability - Investment Main Driver (5.4.3.2 B.1.a)
Identify the main driver (trigger) of the project/program… This project is driven by Kingston Hydro's deteriorated pole program. Reliability is the main driver for this project. This project involves the replacement of wood poles that have a high risk of failing.
Efficiency, Customer Value & Reliability - Investment Secondary Driver (5.4.3.2 B.1.a) (where applicable)
[Identify...] where applicable any secondary drivers. Wherever possible, Kingston Hydro prefers to re-design and rebuild continuous sections of an overhead line (multiple pole spans) for efficiency and to upgrade the construction to new standards.
Efficiency, Customer Value & Reliability - Investment Objectives and/or Performance Targets (5.4.3.2 B.1.a)
Identify related objectives and/or performance targets,... Some conductors in this line will be upgraded and 5kV insulators will be upgraded to 15kV for future capacity/growth. Increasing the reliability will help meet the performance targets and objectives and the SAIDI/SAIFI calculations.
Efficiency, Customer Value & Reliability - Source and nature of the information used to justify the investment (5.4.3.2 B.1.a)
[Identify,…] by reference to the distributor's asset management process (section 5.3.1), the source and nature of the information used to justify the investment. Wood poles are visually inspected at least once every three years in accordance with Ontario Energy Board requirements. A competent line person may also perform a hammer test in addition to the visual inspection depending upon the pole condition and history. Poles in this project have been identified as being at end of life.
Demonstrate Good Utility Practice in Reliability Planning (5.4.3.2 B.1.b)
Demonstrate good utility practice in reliability planning through designing a resilient distribution system that addresses existing reliability performance concerns and is capable of adapting to future challenges (e.g. grid Renewal of these assets is necessary to avoid potential risk to public safety that could result from a failure of a wood pole. Also Reliability, less unplanned outages.
Efficiency, Customer Value & Reliability - Priority Level/Project Prioritization and Reasoning (5.4.3.2 B.1.c)
Indicate the priority of the investment relative to others, giving reasons for assigning this priority that clearly reflect the distributor's approach to identifying, selecting, prioritizing and pacing projects in each investment category described in response to section 5.4.1. The poles on Sir John A Macdonald Ave. and a short section of Union St. were identified by pole inspections are prioritized for action within the next 5 years. This project has a priority level of 3
Analysis of Project & Alternatives - Effect of the investment on system operation efficiency and cost-effectiveness (5.4.3.2 B.1.d.i)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *(i) The effect of the investment on system operation efficiency and cost-effectiveness* Increasing conductor size and insulator voltage class will future proof the installation.
Analysis of Project & Alternatives - Net benefits accruing to customers (5.4.3.2 B.1.d.ii)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *(ii) The net benefits accruing to customers as a result of the investment* Customers benefit from a more reliable system with lower risk of outages and enhanced capacity for future growth. Kingston Hydro provides access to communications companies to space on it's poles, in some areas of Kingston Hydro distribution, communications companies provide space to Kingston Hydro on Communications company owned poles. The poles in the area of this project are owned by Kingston Hydro. Coordination using this method allows for better design, installation and replacement plans which in turn, provides greater efficiences and improved O&M costs.
Analysis of Project & Alternatives - Impact of the investment on reliability performance including frequency and duration of outages (5.4.3.2 B.1.d.iii)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *(iii) The impact of the investment on reliability performance including on the frequency and duration of outages*

Investing in deteriorated pole replacements greatly decreases the risk of pole failures causing a lower risk of unplanned outages.

Project Alternatives (Design, Scheduling, Funding/Ownership) (5.4.3.2 B.1d)

Where alternatives have been considered and the ranking of a proposed project relative to alternatives has been affected by the assessment of benefits and costs, these benefits and costs should be described and explained in relation to the proposed project and alternatives.
Where a distributor's choices for technical design, component characteristics, how the work is carried out, etc., have been affected by a decision to configure a project to meet both a trigger driver and secondary drivers, the effect on costs and benefits must be explained.

The location of the powerlines in this project is relatively a direct line from the substation and alongside existing roadways. Replacing deteriorated poles within this existing poleline was the least costly option for both installation and for future maintenance. It also allows for convient access points for existing and future customers.
What are the consequences of the "Do Nothing" alternative?
Were other alternatives were considered?
Was planned maintenance an option to extend life of pole line?
Rebuilding was more expensive option but provides better reliability and lower maintenance

Health and Safety (5.4.3.2 B2)

Provide information on the effect of the investment on health and safety protections and performance for both the utility and the public.

Replacing these assets increases safety to the public by avoiding potential risk that could result from a failure of a wood pole.

Cyber-Security, Privacy (5.4.3.2 B.3) (where applicable)

Where applicable, provide information showing that the investment conforms to all applicable laws, standards and good utility practices pertaining to customer privacy, cyber security and grid protection. Cyber security is expected to be incorporated into the distributor's risk management decision making and investment planning to form part of its business plans and DSP.

Cyber security protection is not applicable to this project.

Co-Ordination, Interoperability (5.4.3.2 B.4.a) Recognized Standards, co-ordination with utilities, regional planning, and/or 3rd party providers (where applicable)

Where applicable, explain how the investment reflects co-ordination with utilities, regional planning, and/or links with 3rd party providers and/or industry.

This project will be coordinated with third party telecoms and street lights currently attached on the existing poles.

Co-Ordination, Interoperability (5.4.3.2 B.4.b) Future technological functionality and/or future operational requirements

Describe how the investment potentially enables future technological functionality and/or addresses future operational requirements.

One of the existing circuits involved in this project is operated at 5kV, like all distribution projects at this voltage level, construction will allow for operation at a higher voltage level in the future with minimal changes.
With the increased conductor size and provision for higher voltage operation, capacity for future growth is enhanced.

Environmental Benefits (5.4.3.2 B.5) (where applicable)

Where applicable, describe the effect of the investment on the use of clean technology, conservation and more efficient use of existing technologies

Not Applicable

Conservation and Demand Management (5.4.3.2 B.6) (where applicable)

Where applicable, describe incremental conservation initiatives, over and above those established in cooperation with the IESO, to defer or avoid future infrastructure projects.
For proposed distribution rate funded CDM programs the following details are required:

Not Applicable

C. Category-Specific Requirements - System Renewal
Asset Performance-related operational targets & asset lifecycle optimization policies and practices (refer to 5.2.3 & 5.3.3) (5.4.3.2 SR-B1.a)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *(a) The distributor's asset performance-related operational targets and asset lifecycle optimization policies and practices (i.e. filings in relation to sections 5.2.3 and 5.3.3)* The poles proposed to be replaced in this project are at end of asset life, however, one of the existing circuits has existing conductors that will continue to endure and will be transferred to new poles, other conductors will be replaced with larger conductors to facilitate future growth and asset renewal.
Information on the condition of the assets relative to their typical life-cycle and performance record (5.4.3.2 SR-B1.b)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *(b) Information on the condition of the assets relative to the typical life-cycle and performance record of the assets targeted by the project* Most of the poles proposed for replacement in this project have reached end of life and have an increased risk of failure. The poles were identified by pole inspections to be replaced within the next 5 years.
The number of customers in each class potential affected by failure of the assets (5.4.3.2 SR-B1.c)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *(c) The number of customers in each customer class potentially affected by a failure of the assets included in the project* 8 commercial and 181 residential customers would potentially be effected by a short term outage due to a failure of poles in this project. Eight comercial and 113 Residential could possible be effected for a longer term.
Quantitative customer impacts (5.4.3.2 SR-B1.d)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *(d) Quantitative customer impacts (e.g. frequency or duration of interruptions or number of customers affected) with associated risk level(s)* Ther is a medium risk level that nine comercial and 196 Residential could possibly be effected for a longer term outage.
Qualitative customer impacts (5.4.3.2 SR-B1.e)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *(e) Qualitative customer impacts (e.g. customer satisfaction, customer migration) with associated risk level(s)* As per customer engagement feedback, fewer outages will lead to better customer satisfaction.
Value of customer impact in terms of characteristics of customers potentially affected by failure that have bearing on the criticality and/or cost of failure (5.4.3.2 SR-B1.f)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *(f) The value of customer impact (e.g. high, medium, low) considering the characteristics of customers potentially affected by asset failure and the cost of failure* Since ther are a number of comercial customers and potential length of unplanned outages, on this circuit, the risk level by a failure would be considered medium. The customer impact will be much lower for a short planned interruption of power to the customer as compared to the length of and timing of an outage due to a failure of the assetts.
Factor affecting the Timing and Priority of Project (5.4.3.2 SR-B2)
Other factors that may affect the timing of the proposed project such as the pacing of investments and the priority relative to other projects The timing for this project is dictated by the pole condition analysis results and the number of end of life poles in this section of line as well as well as the fact there is a 44kV main circuit on these poles.

Consequences for system O&M costs (5.4.3.2 SR-B3]

The consequences for system O&M costs, including the implications for system O&M of not implementing the project

This project will not materially impact system O&M costs.

Impact on reliability performance and/or safety factors (5.4.3.2 SR-B4)

The impact on reliability and safety factors

Renewal of these assets is necessary to avoid potential risk to public safety that could result from a failure of a wood pole as well as to provide a more robust and reliable system

Analysis of Project Benefits and Cost Comparing Alternatives to the Timing of the proposed Project (5.4.3.2 SR-B5)

An analysis of project benefits and costs comparing alternatives to the timing of the proposed project, highlighting the trade-offs between rate of expenditure and mitigation of the consequences of asset performance deterioration. Where the ranking of the proposed project relative to the alternatives has been adjusted to account for significant benefits and costs, the value of which cannot readily be quantified, these should be described and explained in relation to the proposed project and all alternatives.

The project involves a relatively short section of lines, alternatives such as alternate routes, REGs, DER and BESS were not practical economical alternatives. Because of the number of poles that have reached end of life, repair of the assets would not be a cost effective alternative.

Like for Like Renewal Analysis, Alternatives Comparison (like for like vs. not like for like, timing, rate of replacements, etc.) (5.4.3.2 SR-B6)

Where the proposed project is a 'like for like' renewal but has been configured at extra cost to address other distributor planning objectives, an analysis of project benefits and costs must be provided comparing

The existing location is the most direct routing and therefore replacing the deteriorated poles within the same pole line location will be the least expensive option. Poles along Union will be spaced out more evenly and further apart thus reducing replacement and future maintenance costs. Replacements assets on the distribution circuit will be upgraded to accomodate 13.8kV, at little or no increase in installation cost, in preperation for future voltage conversion.

A. General Information						
Project/Activity	UK-KHC- Bagot St - Complete 5kV loop feed for Circuit 805 including pole replacements for end of life poles and 44kV switch replacement					
Project Number						
Investment Category	**System Renewal**					
	2023					
Capital Cost (5.4.3.2 A.1)	$ 150,000					
Capital Contribution	$ -					
Net Cost	$ 150,000					
O&M Cost (5.4.3.2 A.1)						
Capital Contributions to Transmitters (5.4.3.2 A.2)						

contribution (if any), true-up dates and potential true-up payments.

Customer Attachments and Load (5.4.3.2 A.3)

Related customer attachments and load, as applicable

Not Applicable

Start Date (5.4.3.2 A.4)	01-Mar-23		**In Service Date (5.4.3.2 A.4)**	31-Dec-23
Expenditure Timing for the Test Year (5.4.3.2 A.4)	**[2023] Q1**	**[2023] Q2**	**[2023] Q3**	**[2023] Q4**
		$ 50,000	$ 50,000	$ 50,000

Project Summary

The Annual Deteriorated Overhead Infrastructure Program focuses on replacement of deteriorated poles, pole mount transformers and other deficiencies identified through annual overhead infrastructure inspections. A number of the poles on Bagot St between Russell St and Cataraqui are at or nearing end of life.

There are no residential customers connected to this section of line, there are two commercial customers and sports field lighting. Any required outage will be coordinated the commercial customers.

Risk Identification & Mitigation (5.4.3.2 A.5)

The risks to the completion of the project or program as planned and the manner in which such risks will be mitigated

Lack of labour resourses due to covid, Weather conditions, greater than average numbers of customer connection requests could delay this project. Mitigation methods include extending project into following year were possible. Delays in permit requests will not be an issue for this build as location is already established.

Comparative information on expenditures for equivalent projects/activities (5.4.3.2 A.6)

If not evident from Chapter 2 Appendix 2-AA, comparative information on expenditures for equivalent projects/programs over the historical period, where available

Kingston Hydro regularly reviews pole conditions and switch replacements. The cost estimate for this project was based on actual costs experienced in the similar projects Kingston Hydro conducted in the past.

REG Investment Details including Capital and OM&A costs (5.4.3.2 A.7)

Information on total capital and OM&A costs associated with REG investment, if any, included in a project/program; and a description of how the REG investment is expected to improve the system's ability to accommodate the connection of REG facilities.

Not Applicable

Leave to Construct approval under Section 92 of the OEB Act (5.4.3.2 A.8]

Where a proposed project within the five year forecast period requires Leave to Construct approval under Section 92 of the OEB Act, the applicant must provide a summary of the evidence, to the extent that it is available, for that project consistent with the requirements set out in Chapter 4 of these Filing Requirements (sections 4.3 and 4.4 in particular).

Not Applicable

B. Evaluation criteria and information requirements for each project/activity
Efficiency, Customer Value & Reliability - Investment Main Driver (5.4.3.2 B.1.a)
Identify the main driver (trigger) of the project/program… This project is driven by Kingston Hydro's deteriorated pole program. This project involves the replacement of wood poles that have a high risk of failing. Wherever possible, Kingston Hydro prefers to re-design and rebuild continuous sections of an overhead line (multiple pole spans) for efficiency and to upgrade the construction to new standards.
Efficiency, Customer Value & Reliability - Investment Secondary Driver (5.4.3.2 B.1.a) (where applicable)
[Identify...] where applicable any secondary drivers. Not Applicable
Efficiency, Customer Value & Reliability - Investment Objectives and/or Performance Targets (5.4.3.2 B.1.a)
Identify related objectives and/or performance targets,... A portion of this line will be upgraded from single phase to three phase and to larger conductor to allow for future growth. The voltage will be converted to 13.8kV to increase the capacity of the conductors. It is also anticipated that a large customer will be connecting to the 13.8kV line.
Efficiency, Customer Value & Reliability - Source and nature of the information used to justify the investment (5.4.3.2 B.1.a)
[Identify,…] by reference to the distributor's asset management process (section 5.3.1), the source and nature of the information used to justify the investment. Wood poles are visually inspected at least once every three years in accordance with Ontario Energy Board requirements. A competent line person may also perform a hammer test in addition to the visual inspection depending upon the pole condition and history.
Demonstrate Good Utility Practice in Reliability Planning (5.4.3.2 B.1.b)
Demonstrate good utility practice in reliability planning through designing a resilient distribution system that addresses existing reliability performance concerns and is capable of adapting to future challenges (e.g. grid modernization and climate change) Renewal of these assets is necessary to avoid potential risk to public safety that could result from a failure of a wood pole.
Efficiency, Customer Value & Reliability - Priority Level/Project Prioritization and Reasoning (5.4.3.2 B.1.c)
Indicate the priority of the investment relative to others, giving reasons for assigning this priority that clearly reflect the distributor's approach to identifying, selecting, prioritizing and pacing projects in each investment category described in response to section 5.4.1. Poles on Bagot St and on Russell St. have been identified by pole inspections for replacemeny within the next 5 years. Replacement will be coordinated to accommodate customer requests for connection to the new voltage level. This project has been given a priority level of 3.
Analysis of Project & Alternatives - Effect of the investment on system operation efficiency and cost-effectiveness (5.4.3.2 B.1.d.i)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *(i) The effect of the investment on system operation efficiency and cost-effectiveness* The line size upgrade will help reduce line losses, the 44kV remote operated switch will allow low cost and faster response to facilitate isolation and emergency load transfering.
Analysis of Project & Alternatives - Net benefits accruing to customers (5.4.3.2 B.1.d.ii)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties): *(ii) The net benefits accruing to customers as a result of the investment* The alternative is to rebuild the pole line on the opposite side of the street, there are a few obstructions on the opposite side of the street and the road crossing of the overhead line was reconstructed recently; therefore, keeping the pole line where is, will be a less expensive alternative.
Analysis of Project & Alternatives - Impact of the investment on reliability performance including frequency and duration of outages (5.4.3.2 B.1.d.iii)
For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

(iii) The impact of the investment on reliability performance including on the frequency and duration of outages

Investing in deteriorated pole replacements, the risk of failure of poles greatly decreases causing a lower risk of unplanned outages. The design of the asset replacement in this projet will conform to the latest USF and CSA standards to ensure a robust and reliable system for weather patterns in this area.

Project Alternatives (Design, Scheduling, Funding/Ownership) (5.4.3.2 B.1d)

Where alternatives have been considered and the ranking of a proposed project relative to alternatives has been affected by the assessment of benefits and costs, these benefits and costs should be described and explained in relation to the proposed project and alternatives.

Where a distributor's choices for technical design, component characteristics, how the work is carried out, etc., have been affected by a decision to configure a project to meet both a trigger driver and secondary drivers, the effect on costs and benefits must be explained.

The location of the powerlines in this project is relatively a direct line from the substation and alongside existing roadways. Replacing deteriorated poles within this existing poleline was the least costly option for both installation and for future maintenance. It also allows for convient access points for existing and future customers. Timing of completion of the project will be coordinated with the service connection for the large customer.

Health and Safety (5.4.3.2 B2)

Provide information on the effect of the investment on health and safety protections and performance for both the utility and the public.

Replacing these assets increases safety to the public by avoiding potential risk that could result from a failure of a wood pole.

Cyber-Security, Privacy (5.4.3.2 B.3) (where applicable)

Where applicable, provide information showing that the investment conforms to all applicable laws, standards and good utility practices pertaining to customer privacy, cyber security and grid protection. Cyber security is expected to be incorporated into the distributor's risk management decision making and investment planning to form part of its business plans and DSP.

Cyber security protection and Privacy are not applicable to this project.

Co-Ordination, Interoperability (5.4.3.2 B.4.a) Recognized Standards, co-ordination with utilities, regional planning, and/or 3rd party providers (where applicable)

Where applicable, explain how the investment reflects co-ordination with utilities, regional planning, and/or links with 3rd party providers and/or industry.

Provision will be made for space for third party communications on the replacement poles.

Co-Ordination, Interoperability (5.4.3.2 B.4.b) Future technological functionality and/or future operational requirements

Describe how the investment potentially enables future technological functionality and/or addresses future operational requirements.

This project involves the replacement of an older, manually operated switch, the replacement switch will include technologies to allow operators to control the 44kV switch remotely from the control room at 85 Lappan's Ln.

Environmental Benefits (5.4.3.2 B.5) (where applicable)

Where applicable, describe the effect of the investment on the use of clean technology, conservation and more efficient use of existing technologies

Not Applicable

Conservation and Demand Management (5.4.3.2 B.6) (where applicable)

Where applicable, describe incremental conservation initiatives, over and above those established in cooperation with the IESO, to defer or avoid future infrastructure projects.

For proposed distribution rate funded CDM programs the following details are required:

Not Applicable

C. Category-Specific Requirements - System Renewal

Asset Performance-related operational targets & asset lifecycle optimization policies and practices (refer to 5.2.3 & 5.3.3) (5.4.3.2 SR-B1.a)

A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to:
(a) The distributor's asset performance-related operational targets and asset lifecycle optimization policies and practices (i.e. filings in relation to sections 5.2.3 and 5.3.3)

Some of the poles proposed to be replaced in this project are beyond typically assett life, however, there is a 44kV circuit that has existing conductors that will continue to endure and will be transferred to new poles, other conductors will be replaced with larger conductors and upgraded to three phase to facilitate future growth in the area and asset renewal.

Information on the condition of the assets relative to their typical life-cycle and performance record (5.4.3.2 SR-B1.b)

A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to:
(b) Information on the condition of the assets relative to the typical life-cycle and performance record of the assets targeted by the project

Some of the poles proposed for replacement in this project have survived beyond typical life of poles in this area some as long as 47 years and have an increased risk of failure. The poles were identified by pole inspections to be replaced within the next 5 years.

The number of customers in each class potential affected by failure of the assets (5.4.3.2 SR-B1.c)

A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to:
(c) The number of customers in each customer class potentially affected by a failure of the assets included in the project

One Recreation centre and a sports field, both general service less than 50kW, failure of the assetts will only effect existing customers if they are in operation at the time of failure, i.e. evenings, summer time. The total number of customers effected if an outage is required on a supporting circuit to complete the work is 370 and a load of approximately 975kW.

Quantitative customer impacts (5.4.3.2 SR-B1.d)

A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to:
(d) Quantitative customer impacts (e.g. frequency or duration of interruptions or number of customers affected) with associated risk level(s)

Because the existing customers are seasonal, there is little impact from outages, the furure residential and comercial customers connecting to this line will have significant impact, approx 1500 total customers.

Qualitative customer impacts (5.4.3.2 SR-B1.e)

A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to:
(e) Qualitative customer impacts (e.g. customer satisfaction, customer migration) with associated risk level(s)

A couple short duration outages will be required to transfer circuits to new assetts, as compared to possibly much longer outages upon assett failure. Impact will be significant with forcasted connections.

Value of customer impact in terms of characteristics of customers potentially affected by failure that have bearing on the criticality and/or cost of failure (5.4.3.2 SR-B1.f)

A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to:
(f) The value of customer impact (e.g. high, medium, low) considering the characteristics of customers potentially affected by asset failure and the cost of failure

The customer impact currently is low, the line upgrade is mainly to facilitate the service request for greater than 1500 connections.

Factor affecting the Timing and Priority of Project (5.4.3.2 SR-B2)

Other factors that may affect the timing of the proposed project such as the pacing of investments and the priority relative to other projects

The timing for this project is dictated by the pole analysis results and the number of end of life poles in this section of line as well as well as the fact there is a 44kV main circuit on these poles. There is also a customer request for connection to the proposed line in 2024.

Consequences for system O&M costs (5.4.3.2 SR-B3)

The consequences for system O&M costs, including the implications for system O&M of not implementing the project

This project will reduce system O&M costs by allowing switching operations from the control room and not needing to send a crew for manual switching when required.

Impact on reliability performance and/or safety factors (5.4.3.2 SR-B4)

The impact on reliability and safety factors

Renewal of these assets is necessary to avoid potential risk to public safety that could result from a failure of a wood pole as well as to provide a more robust and reliable system

Analysis of Project Benefits and Cost Comparing Alternatives to the Timing of the proposed Project (5.4.3.2 SR-B5)

An analysis of project benefits and costs comparing alternatives to the timing of the proposed project, highlighting the trade-offs between rate of expenditure and mitigation of the consequences of asset performance *deterioration. Where the ranking of the proposed project relative to the alternatives has been adjusted to account for significant benefits and costs, the value of which cannot readily be quantified, these should be described and explained in relation to the proposed project and all alternatives.*

The project involves a relatively short section of lines, alternatives such as alternate routes, REGs, DER and BESS were not practical economical alternatives. The location of the large proposed development supports an upgrade of the existing pole line in its current location. The project will be timed to accomodate the service connection request.

Like for Like Renewal Analysis, Alternatives Comparison (like for like vs. not like for like, timing, rate of replacements, etc.) (5.4.3.2 SR-B6)

Where the proposed project is a 'like for like' renewal but has been configured at extra cost to address other distributor planning objectives, an analysis of project benefits and costs must be provided comparing

This project is not a like-for-like renewal, however the pole line location will remain the same as existing pole line.

A. General Information					
Project/Activity	Princess St. Reconstruction - Phase 5, Division Street to Alfred Street				
Project Number	100441				
Investment Category	**System Renewal**				
	2023				
Capital Cost (5.4.3.2 A.1)	$350,000				
Capital Contribution	$ -				
Net Cost	$350,000				
O&M Cost (5.4.3.2 A.1)	$ -				
Capital Contributions to Transmitters (5.4.3.2 A.2)					

Any capital contributions made or forecast to be made to a transmitter with respect to a Connection and Cost Recovery Agreement. Details to be provided include: initial forecast used to calculate contribution, amount of contribution (if any), true-up dates and potential true-up payments.

Customer Attachments and Load (5.4.3.2 A.3)

Related customer attachments and load, as applicable

Princess St Reconstruction - Phase 5 project involves the full roadway reconstruction for three blocks of Princess street. The construction area is located within the Princess Street Corridor and acting as a gateway to the downtown and Queen's University neighbourhoods. The aging 5kV and secondary underground network in this area feeds restaurants, apartment buildings, offices and residential customers.

Start Date (5.4.3.2 A.4)	01-Jan-23		**In Service Date (5.4.3.2 A.4)**	31-Dec-23	
Expenditure Timing for the Test Year (5.4.3.2 A.4)	**[2023] Q1**	**[2023] Q2**	**[2023] Q3**	**[2023] Q4**	
	$116,667	$116,667	$116,667	$116,667	

Project Summary

The City of Kingston ("the City") is proposing a road reconstruction project involving the full roadway reconstruction from building face to building face for three (3) blocks of Princess Street from Division Street to Alfred Street on the gateway to the downtown core. The reconstruction work includes storm and sanitary sewer, water mains, lateral services, street lighting and traffic signals and communications infrastructure all impacting Kingston Hydro's assets. Kingston Hydro is proposing to co-ordinate the rebuilding of deteriorated underground infrastructure and installation of spare ducts for system expansion and future customer connections with this City initiative.

Risk Identification & Mitigation (5.4.3.2 A.5)

The risks to the completion of the project or program as planned and the manner in which such risks will be mitigated

Due to the high level of coordination required between the various underground utility infrastructure groups and the final surface treatment of this congested right-of-way, the completion of this project depends on the City's overall plan and schedule. Taking the advantage of the multi-utility model of Utilities Kingston, and through cooperation with other utilities and the City, Kingston Hydro is able to effectively coordinate design and construction as well as control costs to ensure project completion. This will be the fifth phase of an ongoing reconstruction of Princess Street that Kingston Hydro has participated with the City of Kingston on. Currently the City of Kingston has scheduled and budgeted to complete this project in 2023.

Comparative information on expenditures for equivalent projects/activities (5.4.3.2 A.6)

If not evident from Chapter 2 Appendix 2-AA, comparative information on expenditures for equivalent projects/programs over the historical period, where available

This project is the fifth phase of Princess Street Reconstruction. Kingston Hydro has completed electrical construction in all previous phases of this joint construction project. The project cost estimate for this phase is based on known asset conditions and actual costs experienced in the previous four phases. The equivalent cost per block, including preparation works for the Princess Street Reconstruction, is illustrated bellow:

2009/2010 Princess Street Reconstruction-Phase 1 $528,000/block
2012/2013 Princess Street Reconstruction-Phase 2 $417,000/block
2015/2016 Princess Street Reconstruction-Phase 3 $418,000/block
2018 Princess Street Reconstruction-Phase 4 $255,000/block
2023 Princess Street Reconstruction-Phase 5 (estimated) $117,000/block

The estimated equivalent cost per block for Phase 5 is lower than the per block cost of previous phases as there is less underground infrastructures to be replaced in the scope of this project for Kingston Hydro.

REG Investment Details including Capital and OM&A costs (5.4.3.2 A.7)
Information on total capital and OM&A costs associated with REG investment, if any, included in a project/program; and a description of how the REG investment is expected to improve the system's ability to accommodate the connection of REG facilities. Not Applicable
Leave to Construct approval under Section 92 of the OEB Act (5.4.3.2 A.8)
Where a proposed project within the five year forecast period requires Leave to Construct approval under Section 92 of the OEB Act, the applicant must provide a summary of the evidence, to the extent that it is available, for that project consistent with the requirements set out in Chapter 4 of these Filing Requirements (sections 4.3 and 4.4 in particular). Not Applicable

B. Evaluation criteria and information requirements for each project/activity

Efficiency, Customer Value & Reliability - Investment Main Driver (5.4.3.2 B.1.a)

Identify the main driver (trigger) of the project/program…

The main driver for this project is the deteriorated assets required replacement. Experiences from the previous phases of the Princess Street Reconstruction Project suggest the duct banks and maintenance holes in this area are deteriorated. Historical records indicate that several sections of concrete encased duct banks are in poor condition.

Efficiency, Customer Value & Reliability - Investment Secondary Driver (5.4.3.2 B.1.a) (where applicable)

[Identify...] where applicable any secondary drivers.

The second driver is the need to install spare ducts, and build tie points, between two secondary circuits for system expansion and customer connections in the future by coordinating with the City's current road reconstruction project(s). The construction area is located within the Princess Street Corridor which is a gateway to the downtown and Queen's University neighbourhoods. This area of the city has been targeted for intensification and redevelopment of old, underutilized buildings and properties. Installation of new spare ducts for future system enhancement, expansion, and customer connections minimizes disruption of newly built roads and sidewalks in the near future and allows for more cost efective connections of cutomer services in the medium to long term future.

Efficiency, Customer Value & Reliability - Investment Objectives and/or Performance Targets (5.4.3.2 B.1.a)

Identify related objectives and/or performance targets,...

Rebuilding of deteriorated underground infrastructure would eliminate potential for ductcollapses and/or cable faults, therefore, reduce risk of customer service interruptions and improve system service. It also reduces the duration of unplanned outages, since a more stable and functional duct structure will allow for a faster deployment of replacement of cable(s). Installation of new spare ducts for future system enhancement, expansion, and customer connection minimizes disruption of newly built roads and sidewalks in the near future and allows for more cost efective connections of cutomer services in the medium to long term future.

Efficiency, Customer Value & Reliability - Source and nature of the information used to justify the investment (5.4.3.2 B.1.a)

[Identify,…] by reference to the distributor's asset management process (section 5.3.1), the source and nature of the information used to justify the investment.

Experiences from the previous four phases of the Princess Street Reconstruction Project suggest that the duct banks and maintenance holes in this area arre deteriorated, and at their end of service life. Historical records and structural condition assessment indicate that a manhole has several large cracks and is in need of replacement. Several sections of concrete encased duct banks were in poor condition and required replacement, and the brick hand holes have degraded considerably and will be replaced with composite hand holes in accordance with the current Kingston Hydro standards.

Demonstrate Good Utility Practice in Reliability Planning (5.4.3.2 B.1.b)

Demonstrate good utility practice in reliability planning through designing a resilient distribution system that addresses existing reliability performance concerns and is capable of adapting to future challenges (e.g. grid modernization and climate change)

Renewal of these deteriorated ducts, manholes, and hanholes is necessary to avoid potential risk to the equipment damage and public safety that could result from structural failure and improve the service reliability and will be replaced with materials according to more modern construction standards.

Efficiency, Customer Value & Reliability - Priority Level/Project Prioritization and Reasoning (5.4.3.2 B.1.c)

Indicate the priority of the investment relative to others, giving reasons for assigning this priority that clearly reflect the distributor's approach to identifying, selecting, prioritizing and pacing projects in each investment category described in response to section 5.4.1.

The City plans to reconstruct Princess Street from Division Street to Alfred Street in 2023. By participating with the multi-utility reconstruction project, Kingston Hydro will save project costs attributable to reduced project management costs and restoration costs that will be borne by the city as a part of the joint construction project.

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

(i) The effect of the investment on system operation efficiency and cost-effectiveness

This area of the city has been targeted for intensification and redevelopment of old, underutilized buildings and properties. Installation of new spare ducts provides system access to the Kingston Hydro distribution network for future customer connections and new develpemnts.

Analysis of Project & Alternatives - Net benefits accruing to customers (5.4.3.2 B.1.d.ii)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

(ii) The net benefits accruing to customers as a result of the investment

The net benefit to customer's is a shortened construction timeframe, by partnering with the City of other utilites to complete construction on a corodinated project. There is also a cost savings for the ratepayer, as the restoration, excavation, and elements of the project will be shared with the City of Kingston. Future developments will also benefit from the new infrastructure to aide in facilitating their service connections.

Analysis of Project & Alternatives - Impact of the investment on reliability performance including frequency and duration of outages (5.4.3.2 B.1.d.iii)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

(iii) The impact of the investment on reliability performance including on the frequency and duration of outages

Rebuilding of deteriorated underground infrastructures would eliminate potential collapse and cable faults, therefore, reduce risk of customer service interruptions and improve system service. A new secondary network tie between 29-2 and 15-1 is planned in this project that will improve system reliability.

Project Alternatives (Design, Scheduling, Funding/Ownership) (5.4.3.2 B.1. d)

Where alternatives have been considered and the ranking of a proposed project relative to alternatives has been affected by the assessment of benefits and costs, these benefits and costs should be described and explained in relation to the proposed project and alternatives.

Where a distributor's choices for technical design, component characteristics, how the work is carried out, etc., have been affected by a decision to configure a project to meet both a trigger driver and secondary drivers, the effect on costs and benefits must be explained.

The project alternative is to delay the upgrade. Deferral of the project would simply prolong and increase the risk of unplanned outages due to cable or structural failures in the ducts, maintenance holes or hand holes located in this area. If KH selected to upgrade this infrastructure at a later date, KH would have to pay the cost for resurfacing and street restoration works, that otherwise would be borne by the city in a joint construction project. An added complication to deferral would be conflict with the Municipal Consent Requirements of the City, that prohibit the cutting of a new road surface within five years of new road construction . Given these factors and considering the extremely busy and sensitive nature of conducting work on the main commercial artery of the downtown core, conducting this rehabilitation work at any other time would be very challenging.

Health and Safety (5.4.3.2 B2)

Provide information on the effect of the investment on health and safety protections and performance for both the utility and the public.

Replacement of maintenance hole structures in poor structural condition eliminated the risk of potential collapse of these structures and protects the public safety. Separation of the electrical distribution elements from traffic and streetlight equipment in the project avoided unnecessary safety risks to Kingston Hydro and street light contractors.

Cyber-Security, Privacy (5.4.3.2 B.3) (where applicable)

Where applicable, provide information showing that the investment conforms to all applicable laws, standards and good utility practices pertaining to customer privacy, cyber security and grid protection. Cyber security is

Not Applicable

Co-Ordination, Interoperability (5.4.3.2 B.4.a) Recognized Standards, co-ordination with utilities, regional planning, and/or 3rd party providers (where applicable)

Where applicable, explain how the investment reflects co-ordination with utilities, regional planning, and/or links with 3rd party providers and/or industry.

The design co-ordinated with the City, other underground utilities and Bell to resolve any conflicts and maintain required clearance between utilities according to codes

Co-Ordination, Interoperability (5.4.3.2 B.4.b) Future technological functionality and/or future operational requirements

Describe how the investment potentially enables future technological functionality and/or addresses future operational requirements.

Spare ducts were installed for future 5kV PILC cable replacement, expansion along Princess Street and enhance the Kingston Hydro distribution network and will be tied into for this project.

Environmental Benefits (5.4.3.2 B.5) (where applicable)

Where applicable, describe the effect of the investment on the use of clean technology, conservation and more efficient use of existing technologies

Not Applicable

Conservation and Demand Management (5.4.3.2 B.6) (where applicable)
Where applicable, describe incremental conservation initiatives, over and above those established in cooperation with the IESO, to defer or avoid future infrastructure projects. *For proposed distribution rate funded CDM programs the following details are required:*
Not Applicable

C. Category-Specific Requirements - System Renewal
Asset Performance-related operational targets & asset lifecycle optimization policies and practices (refer to 5.2.3 & 5.3.3) (5.4.3.2 SR-B1.a)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *(a) The distributor's asset performance-related operational targets and asset lifecycle optimization policies and practices (i.e. filings in relation to sections 5.2.3 and 5.3.3)*
The underground infrastructure proposed to be replaced in this project are the end of their service life. The experience from last four phases of Princess Street Reconstruction project and annual inspection have indicated the existing ducts, manholes and handholes in this area are in poor condition. Kingston Hydro's plan to jointly reconstruct with the city for a mult-utilities project in accordance with Kingston Hydro asset management policy
Information on the condition of the assets relative to their typical life-cycle and performance record (5.4.3.2 SR-B1.b)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *(b) Information on the condition of the assets relative to the typical life-cycle and performance record of the assets targeted by the project*
The underground infrastructure in this construction area was built in the 1960's and was amongst the oldest assets in Kingston Hydro distribution system. Experiences from the previous four phases of the Princess Street Reconstruction Project suggested the duct banks and maintenance holes in this area were deteriorated, as they all were built at the same time, and show similar deteriorization and have similar end of service life characteristics. The underground infrastructure inspection indicated one manhole has several large cracks and needs to replace and several brick handholes are in poor conditions.
The number of customers in each class potential affected by failure of the assets (5.4.3.2 SR-B1.c)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *(c) The number of customers in each customer class potentially affected by a failure of the assets included in the project*
The asset failure could affect 5 greater-than-50kW customers and about 200 commercial and residential customers.
Quantitative customer impacts (5.4.3.2 SR-B1.d)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *(d) Quantitative customer impacts (e.g. frequency or duration of interruptions or number of customers affected) with associated risk level(s)*
The distribution network in this reconstruction area supplies two high-rise buildings, restaurants, stores, and small apartments. The restoration time of a typical electrical asset failure is two hours, but a duct or manhole failure requres a prolonged restoration time ranging from 4 hours to 24 hours or 820 customer-hours to 4920 customer-hour. The customer impact risk is high.
Qualitative customer impacts (5.4.3.2 SR-B1.e)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *(e) Qualitative customer impacts (e.g. customer satisfaction, customer migration) with associated risk level(s)*
Kingston Hydro also took the opportunity to install extra ducts for potential development to reduce future servicing costs and connection time meeting customers' expectations.
Value of customer impact in terms of characteristics of customers potentially affected by failure that have bearing on the criticality and/or cost of failure (5.4.3.2 SR-B1.f)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *(f) The value of customer impact (e.g. high, medium, low) considering the characteristics of customers potentially affected by asset failure and the cost of failure*
The customers in this construction area include high-rise condominium, businesses and residentials. Considering the nature of the underground distribution system, the customrt impact is high if the structural failure happened.
Factor affecting the Timing and Priority of Project (5.4.3.2 SR-B2)
Other factors that may affect the timing of the proposed project such as the pacing of investments and the priority relative to other projects
The customer connection requests, poor asset condition, high load criticality, and third party infrastructure development requirements make this project a high priority relative to other projects. The City has set Princess Street Reconstruction – Phase 5 as a high priority capital project. Kingston Hydro has also ranked this project in the first tier of priorities for projects of this year.
Consequences for system O&M costs (5.4.3.2 SR-B3)
The consequences for system O&M costs, including the implications for system O&M of not implementing the project
Replacement of deteriorated underground structures makes maintenance and troubleshooting more cost effective as it reduces the time and cost involved with identification of outages and replacement of damaged cable. It also reduces inspection time, by nature of being faster to conduct a thorough inspection; therefore, reduces O&M costs.

Impact on reliability performance and/or safety factors (5.4.3.2 SR-B4)

The impact on reliability and safety factors

The newly installed infrastructure will be more reliable equipment and improve system reliability and safety to the public and workers.

Analysis of Project Benefits and Cost Comparing Alternatives to the Timing of the proposed Project (5.4.3.2 SR-B5)

An analysis of project benefits and costs comparing alternatives to the timing of the proposed project, highlighting the trade-offs between rate of expenditure and mitigation of the consequences of asset performance deterioration. Where the ranking of the proposed project relative to the alternatives has been adjusted to account for significant benefits and costs, the value of which cannot readily be quantified, these should be described

The project alternative is to delay the upgrade. Deferral of the project would simply prolong and increase the risk of unplanned outages due to cable or structural failures in the ducts, maintenance holes or hand holes located in this area. If KH selected to upgrade this infrastructure at a later date, KH would have to pay the cost for resurfacing and street restoration works, that otherwise would be borne by the city in a joint construction project. An added complication to deferral would be conflict with the Municipal Consent Requirements of the City, that prohibit the cutting of a new road surface within five years of new road construction . Given these factors and considering the extremely busy and sensitive nature of conducting work on the main commercial artery of the downtown core, conducting this rehabilitation work at any other time would be very challenging.

Like for Like Renewal Analysis, Alternatives Comparison (like for like vs. not like for like, timing, rate of replacements, etc.) (5.4.3.2 SR-B6)

Where the proposed project is a 'like for like' renewal but has been configured at extra cost to address other distributor planning objectives, an analysis of project benefits and costs must be provided comparing

This project is a like-for-like renewal, however, some spare ducts will be installed for future customer connections and new developemnts. The construction area is located within the Princess Street Corridor and acting as a gateway to the downtown and Queen's University neighbourhoods. This area of the city has been targeted for intensification and redevelopment of old, underutilized buildings and properties. Two high-riser condominiums are currently in or near to start constructing. Kingston Hydro will also take the opportunity to install extra ducts for potential development to reduce future servicing costs. Installation of new spare ducts for future system enhancement, expansion, and customer connection minimizes disruption of newly built roads and sidewalks in the near future.

A. General Information					
Project/Activity	Annual Deteriorated Pole Replacement - Spot Pole Replacement				
Project Number					
Investment Category	**System Renewal**				
	2023				
Capital Cost (5.4.3.2 A.1)	$ 180,000				
Capital Contribution	$ -				
Net Cost	$ 180,000				
O&M Cost (5.4.3.2 A.1)	**$ -**				
Capital Contributions to Transmitters (5.4.3.2 A.2)					

Any capital contributions made or forecast to be made to a transmitter with respect to a Connection and Cost Recovery Agreement. Details to be provided include: initial forecast used to calculate contribution, amount of contribution (if any), true-up dates and potential true-up payments.

Not Applicable.

Customer Attachments and Load (5.4.3.2 A.3)

Related customer attachments and load, as applicable

Customer attachments in the specific areas will be supported and outages, if required, minimized to safely complete the works

Start Date (5.4.3.2 A.4)	January, 2023		**In Service Date (5.4.3.2 A.4)**	December, 2023
Expenditure Timing for the Test Year (5.4.3.2 A.4)	**[2023] Q1**	**[2023] Q2**	**[2023] Q3**	**[2023] Q4**
	$ 45,000.00	$ 45,000.00	$ 45,000.00	$ 45,000.00

Project Summary

The Annual Deteriorated Overhead Infrastructure Program - Spot Pole Replacement focuses on replacement of deteriorated poles, pole mount transformers, damaged conductor, and other deficiencies identified through annual overhead infrastructure inspections or that arise suddenly, as an example, froma motor vehicle collision. The program typically consists of numerous small projects involving single pole replacements, as well as replacement of short sections of overhead line, many of which fall below the materiality threshold.

The annual budget for this program has many drivers including pole conditions, available resources and equipment, and available funds. Sometimes it is necessary to allocate capital funds to other projects with competing and/or evolving priorities based on the identified condition(s).

Risk Identification & Mitigation (5.4.3.2 A.5)

The risks to the completion of the project or program as planned and the manner in which such risks will be mitigated

This program generally involves the replacement of overhead line infrastrucutres that have been identified through an annual inspection program, and have been noted to have deficiencies that could pose a risk of failing, or through some event have been damaged.

Comparative information on expenditures for equivalent projects/activities (5.4.3.2 A.6)

If not evident from Chapter 2 Appendix 2-AA, comparative information on expenditures for equivalent projects/programs over the historical period, where available

Kingston Hydro regularly reviews pole conditions and switch replacements through an inspection process. The cost estimate for this project is based on previous actual costs experienced with similar projects Kingston Hydro has conducted in the past.

REG Investment Details including Capital and OM&A costs (5.4.3.2 A.7)

Information on total capital and OM&A costs associated with REG investment, if any, included in a project/program; and a description of how the REG investment is expected to improve the system's ability to accommodate the connection of REG facilities.

Not Applicable

Leave to Construct approval under Section 92 of the OEB Act (5.4.3.2 A.8)

Where a proposed project within the five year forecast period requires Leave to Construct approval under Section 92 of the OEB Act, the applicant must provide a summary of the evidence, to the extent that it is available, for that project consistent with the requirements set out in Chapter 4 of these Filing Requirements (sections 4.3 and 4.4 in particular).

Not Applicable

B. Evaluation criteria and information requirements for each project/activity

Efficiency, Customer Value & Reliability - Investment Main Driver (5.4.3.2 B.1.a)

Identify the main driver (trigger) of the project/program…

Reliability is the a main driver of the project. This project involves the replacement of overhead infrastructure identified to have a high risk of failing, or has been damaged by an event.

Efficiency, Customer Value & Reliability - Investment Secondary Driver (5.4.3.2 B.1.a) (where applicable)

[Identify...] where applicable any secondary drivers.

Not Applicable

Efficiency, Customer Value & Reliability - Investment Objectives and/or Performance Targets (5.4.3.2 B.1.a)

Identify related objectives and/or performance targets,...

Wherever possible, Kingston Hydro prefers to re-design and rebuild continuous sections of an overhead line (multiple pole spans) for efficiency and to upgrade the construction to new standards. For example, the number of poles and pole transformers can often be reduced (optimized) through a re-design project whereas a like-for-like replacement approach may not always be optimal. Sections of overhead line containing multiple poles that have been identified as “Critical” or “Major” are therefore prioritized for re-design and replacement. If the re-design and replacement of a continuous section of overhead line must be deferred due to limited capital funds and/or resources then the alternative is like-for-like spot replacement within 12 months for poles identified as “Critical” status and deferral of pole replacement for poles identified as “Major” until sufficient capital funds and resources are available or until the next inspection cycle (whichever comes first).

Efficiency, Customer Value & Reliability - Source and nature of the information used to justify the investment (5.4.3.2 B.1.a)

[Identify,…] by reference to the distributor’s asset management process (section 5.3.1), the source and nature of the information used to justify the investment.

Wood poles are visually inspected at least once every three years in accordance with Ontario Energy Board requirements; a competent line person through the inspection process may also perform a hammer test in additio to the visual depending upon the pole condition and history.

Demonstrate Good Utility Practice in Reliability Planning (5.4.3.2 B.1.b)

Demonstrate good utility practice in reliability planning through designing a resilient distribution system that addresses existing reliability performance concerns and is capable of adapting to future challenges (e.g. grid

Renewal of these assets is necessary to avoid potential risk to public safety that could result from a failure of a wood pole. These replacements also improve the reliability of the system by targetting assets prior to failure, resulting in fewer unplanned outages.

Efficiency, Customer Value & Reliability - Priority Level/Project Prioritization and Reasoning (5.4.3.2 B.1.c)

Indicate the priority of the investment relative to others, giving reasons for assigning this priority that clearly reflect the distributor’s approach to identifying, selecting, prioritizing and pacing projects in each investment category described in response to section 5.4.1.

The poles are identified by inspection and are then prioritized for action in accordance with the risk of failure and the assets connected to the pole and their impact on customer connections. As it relates to other projects, this project is in the mid-range of the 3 level priority.

Analysis of Project & Alternatives - Effect of the investment on system operation efficiency and cost-effectiveness (5.4.3.2 B.1.d.i)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):
(i) The effect of the investment on system operation efficiency and cost-effectiveness

Each specific incident or replacement will be analyzed and reviewed for alternatives, then determination of the most effcient option, and then that choice will be selected.

Analysis of Project & Alternatives - Net benefits accruing to customers (5.4.3.2 B.1.d.ii)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

Each specific incident or replacement will be analyzed and alternatives reviewed, determine the of the most effcient option, and consider affect on customer's benefit from a more reliable system with lower risk of outages and enhanced capacity for future growth.

Analysis of Project & Alternatives - Impact of the investment on reliability performance including frequency and duration of outages (5.4.3.2 B.1.d.iii)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

...

(iii) The impact of the investment on reliability performance including on the frequency and duration of outages

Each specific incident or replacement will be analyzed and alternatives reviewed, determine the of the most effcient option, and consider affect replacing infastructure before failure, resulting in fewer outages and less frequent unplanned outages

Project Alternatives (Design, Scheduling, Funding/Ownership) (5.4.3.2 B.1. d)

Where alternatives have been considered and the ranking of a proposed project relative to alternatives has been affected by the assessment of benefits and costs, these benefits and costs should be described and explained in relation to the proposed project and alternatives.

Where a distributor's choices for technical design, component characteristics, how the work is carried out, etc., have been affected by a decision to configure a project to meet both a trigger driver and secondary drivers, the effect on costs and benefits must be explained.

Not Applicable

Health and Safety (5.4.3.2 B2)

Provide information on the effect of the investment on health and safety protections and performance for both the utility and the public.

Work will be conducted in a safe manner typical of good utility practices, and the work completed with public safety in mind (during and after construction).

Cyber-Security, Privacy (5.4.3.2 B.3) (where applicable)

Where applicable, provide information showing that the investment conforms to all applicable laws, standards and good utility practices pertaining to customer privacy, cyber security and grid protection. Cyber security is

Not Applicable

Co-Ordination, Interoperability (5.4.3.2 B.4.a) Recognized Standards, co-ordination with utilities, regional planning, and/or 3rd party providers (where applicable)

Where applicable, explain how the investment reflects co-ordination with utilities, regional planning, and/or links with 3rd party providers and/or industry.

This project will be coordinated with third party telecoms identifed as attachers on assests identified for replacement as applicable.

Co-Ordination, Interoperability (5.4.3.2 B.4.b) Future technological functionality and/or future operational requirements

Describe how the investment potentially enables future technological functionality and/or addresses future operational requirements.

This project will be take into considerations for future functinallity and operational requirements, where applicable for each site specific asset idenified.

Environmental Benefits (5.4.3.2 B.5) (where applicable)

Where applicable, describe the effect of the investment on the use of clean technology, conservation and more efficient use of existing technologies

Not Applicable

Conservation and Demand Management (5.4.3.2 B.6) (where applicable)

Where applicable, describe incremental conservation initiatives, over and above those established in cooperation with the IESO, to defer or avoid future infrastructure projects.
For proposed distribution rate funded CDM programs the following details are required:

Not Applicable

C. Category-Specific Requirements - System Renewal
Asset Performance-related operational targets & asset lifecycle optimization policies and practices (refer to 5.2.3 & 5.3.3) (5.4.3.2 SR-B1.a)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *(a) The distributor's asset performance-related operational targets and asset lifecycle optimization policies and practices (i.e. filings in relation to sections 5.2.3 and 5.3.3)* The poles proposed to be replaced through this project are identified as deteriorated, and are priotized for replacement based on that assessment.
Information on the condition of the assets relative to their typical life-cycle and performance record (5.4.3.2 SR-B1.b)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: The majority of the poles identified in this program have survived well beyond typical service life, and have an increased risk of failure due to their identified deficiencies noted from the asset assessment completed via the annual overhead infrastructure inspections.
The number of customers in each class potential affected by failure of the assets (5.4.3.2 SR-B1.c)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *...* *(c) The number of customers in each customer class potentially affected by a failure of the assets included in the project* Depending on the indivdual pole or poles to be replaced, the replacement could impact up to 10-20 Residential customer and 1-5 Commercial customers
Quantitative customer impacts (5.4.3.2 SR-B1.d)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *...* *(d) Quantitative customer impacts (e.g. frequency or duration of interruptions or number of customers affected) with associated risk level(s)* Depending on the nature of the repalcement, the impact of construction on customers is typicaly minimal.
Qualitative customer impacts (5.4.3.2 SR-B1.e)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *...* *(e) Qualitative customer impacts (e.g. customer satisfaction, customer migration) with associated risk level(s)* Depending on the nature of the repalcement, the impact of construction on customers is typicaly minimal.
Value of customer impact in terms of characteristics of customers potentially affected by failure that have bearing on the criticality and/or cost of failure (5.4.3.2 SR-B1.f)
A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to: *...* *(f) The value of customer impact (e.g. high, medium, low) considering the characteristics of customers potentially affected by asset failure and the cost of failure* The customer impact will be much lower for a short planned interruption of power, as exerienced by the customer(s), versus the length of and timing of an outage due to a failure of an assets.

Factor affecting the Timing and Priority of Project (5.4.3.2 SR-B2)

Other factors that may affect the timing of the proposed project such as the pacing of investments and the priority relative to other projects

Wherever possible, Kingston Hydro prefers to re-design and rebuild continuous sections of an overhead line (multiple pole spans) for efficiency and to upgrade the construction to new standards. For example, the number of poles and pole transformers can often be reduced (optimized) through a re-design project whereas a like-for-like replacement approach may not always be optimal. Sections of overhead line containing multiple poles that have been identified as "Critical" or "Major" are therefore prioritized for re-design and replacement. If the re-design and replacement of a continuous section of overhead line must be deferred due to limited capital funds and/or resources then the alternative is like-for-like spot replacement within 12 months for poles identified as "Critical" status and deferral of pole replacement for poles identified as "Major" until sufficient capital funds and resources are available or until the next inspection cycle (whichever comes first).

Consequences for system O&M costs (5.4.3.2 SR-B3)

The consequences for system O&M costs, including the implications for system O&M of not implementing the project

Generally speaking, these projects do not materially impact system O&M costs.

Impact on reliability performance and/or safety factors (5.4.3.2 SR-B4)

The impact on reliability and safety factors

The annual pole replacement program replaces poles identified as deteriorated, and identified for replacment. Replacing the deteriorated poles with new assets reduces the risks of failure and improves system reliability. Utilizing modern construction standards and equipment improves safety for the staff working on the assets as well as the general public.

Analysis of Project Benefits and Cost Comparing Alternatives to the Timing of the proposed Project (5.4.3.2 SR-B5)

An analysis of project benefits and costs comparing alternatives to the timing of the proposed project, highlighting the trade-offs between rate of expenditure and mitigation of the consequences of asset performance deterioration. Where the ranking of the proposed project relative to the alternatives has been adjusted to account for significant benefits and costs, the value of which cannot readily be quantified, these should be described and explained in relation to the proposed project and all alternatives.

Each site specific replacement will be looked at for possible alternatives, on a case by case basis, taking into account the site specific details of the sie conditions and incident.

Like for Like Renewal Analysis, Alternatives Comparison (like for like vs. not like for like, timing, rate of replacements, etc.) (5.4.3.2 SR-B6)

Where the proposed project is a 'like for like' renewal but has been configured at extra cost to address other distributor planning objectives, an analysis of project benefits and costs must be provided comparing

a) a project configured solely to meet the requirement;
b) the proposed project; and
c) technically feasible alternatives to the proposed project that meet the same objectives as the proposed project.

Where the ranking of the proposed project relative to alternatives has been adjusted to account for significant benefits and costs the value of which cannot readily be quantified, these should be described and explained in relation to the proposed project and all alternatives.

Like for like replacements are utilized for projects covered by the program, especialy in more emergent situations. Where possible, pre-planning and thorough analysis is used to support replacement design and construction.

A. General Information					
Project/Activity	Queen Street - 5kV PILC Cable Replacement - 104, 105, 106 and 110 Circuits				
Project Number	100437				
Investment Category	**System Renewal**				
	2023				
Capital Cost (5.4.3.2 A.1)	$ 540,000				
Capital Contribution	$ -				
Net Cost	$ 540,000				
O&M Cost (5.4.3.2 A.1)	$ -				
Capital Contributions to Transmitters (5.4.3.2 A.2)	$ -				

Customer Attachments and Load (5.4.3.2 A.3)

Related customer attachments and load, as applicable

Queen St - 5kV PILC Cable Replacement project involves the repalcement of exisitng deterioritaed underground infrastructure and the installation of spare ducts for future 5kV PILC cable replacement along Queen Street between Substation No.1, at 29 Queen Street to existing stubbed ducts on Wellington Street. The aging 5kV and secondary underground network in this area feeds restaurants, apartment buildings, offices, and residential customers. Thus, connected customers' impact will be minimized by the use of switching to limit the number and duration of required outages to complete the future cable replacements.

Start Date (5.4.3.2 A.4)	March, 2023		**In Service Date (5.4.3.2 A.4)**	October, 2023
Expenditure Timing for the Test Year (5.4.3.2 A.4)	**[2023] Q1**	**[2023] Q2**	**[2023] Q3**	**[2023] Q4**
	$ 70,000	$ 200,000	$ 200,000	$ 70,000

Project Summary

Kingston Hydro will be installing new duct structure on Queen Street, following the north sidewalk, between the existing future use ducts at King Street East and at Wellington Street. Kingston Hydro will install a future use pre-cast transformer vault to accommodate the anticipated new developments in the area. This project will entail the complete replacement of the existing PIL C cables for 103, 104, 105 106 and 110 circuits.

Risk Identification & Mitigation (5.4.3.2 A.5)

The risks to the completion of the project or program as planned and the manner in which such risks will be mitigated

A risk factor affecting this project is the condition of the existing duct structure and cables - the need for the cable replacements may be expedited due to unforeseen crcumstances causing premature failures. This can be mitigated by Kingston Hydro's existing system configuration, and redundancies, allowing for the affected circuits to be taken out of service for the duration of the project with minimal impacts to the timing and completion of the project by October 2023.

Comparative information on expenditures for equivalent projects/activities (5.4.3.2 A.6)

If not evident from Chapter 2 Appendix 2-AA, comparative information on expenditures for equivalent projects/programs over the historical period, where available

Kingston Hydro has completed electrical construction in the Downtown Area, specifically on Princess Street between Ontario Street and Division Street in recent years. The project cost estimate for this Queen Street rebuild project is based on known asset conditions and actual costs experienced in the previous projects. The equivalent cost per block, including preparation works for the Princess Street Reconstruction, is illustrated bellow:

2009/2010 Princess Street Reconstruction-Phase 1 $528,000/block
2012/2013 Princess Street Reconstruction-Phase 2 $417,000/block
2015/2016 Princess Street Reconstruction-Phase 3 $418,000/block
2018 Princess Street Reconstruction-Phase 4 $255,000/block
2023 Princess Street Reconstruction-Phase 5 (estimated) $117,000/block

The estimated equivalent cost per block for the Queen Street Rebuild is higher than the per block cost of previous projects due to the future use transformer vault structure within this project.

REG Investment Details including Capital and OM&A costs (5.4.3.2 A.7)

Information on total capital and OM&A costs associated with REG investment, if any, included in a project/program; and a description of how the REG investment is expected to improve the system's ability to accommodate the connection of REG facilities.

Not Applicable

Leave to Construct approval under Section 92 of the OEB Act (5.4.3.2 A.8)

Where a proposed project within the five year forecast period requires Leave to Construct approval under Section 92 of the OEB Act, the applicant must provide a summary of the evidence, to the extent that it is available, for that project consistent with the requirements set out in Chapter 4 of these Filing Requirements (sections 4.3 and 4.4 in particular).

Not Applicable

B. Evaluation criteria and information requirements for each project/activity

Efficiency, Customer Value & Reliability - Investment Main Driver (5.4.3.2 B.1.a)

Identify the main driver (trigger) of the project/program…

The main driver of the project is reliability; assets are nearing their end of service life and have potential for failure. Replacement of the PILC cables with TR-XLPE cables will improve asset performance, resulting in reduced risk to customer interruptions associated with cable failures. Implementation of the project will ensure that the existing circuits can be maintained in their normal network configurations, improving service reliability and operational efficiency, maintaining high customer satisfaction levels. Experiences from the Princess Street Reconstruction Project, as well as the Annual Infrastructure Inspections suggest the duct banks and maintenance holes in this area are deteriorated. Historical records indicate that several sections of concrete encased duct banks are in poor condition and sections between maintenance holes are unsuitable for cable replacements.

Efficiency, Customer Value & Reliability - Investment Secondary Driver (5.4.3.2 B.1.a) (where applicable)

[Identify...] where applicable any secondary drivers.

The secondary driver is effciency; a need to install spare ducts and build a new transformer vault, for the connections of future developemnt properties in the area, has been identified. The construction area is located within the in the downtowan area immediatley adjecant to MS 1 and acts as a gateway to the downtown and Queen's University neighbourhoods. This area of the city has been targeted for intensification and redevelopment of the existing older, underutilized buildings and properties. Installation of new spare ducts for future system enhancement, expansion, and customer connections minimizes disruption of newly built roads and sidewalks in the near future making this addtional future work a more effcient installation at this time.

Efficiency, Customer Value & Reliability - Investment Objectives and/or Performance Targets (5.4.3.2 B.1.a)

Identify related objectives and/or performance targets,...

Rebuilding of deteriorated underground infrastructures would eliminate potential collapse and cable faults, therefore, reduce risk of customer service interruptions and improve system service. It would also reduce the duration of unplanned outages, since a more stable and functional duct structure will allow for faster deployment of replacement cable. Installation of new spare ducts for future system enhancement, expansion and customer connection minimizes disruption of newly built roads and sidewalks in the near future.

Efficiency, Customer Value & Reliability - Source and nature of the information used to justify the investment (5.4.3.2 B.1.a)

[Identify,…] by reference to the distributor's asset management process (section 5.3.1), the source and nature of the information used to justify the investment.

Experiences from the Princess Street Reconstruction Project suggest that the duct banks and maintenance holes in this area are in a deteriorated condition. Several sections of concrete encased duct banks are in poor condition and require replacement, and the brick hand holes have degraded considerably and need to be replaced - with the current Kingston Hydro standard of composite hand holes

Demonstrate Good Utility Practice in Reliability Planning (5.4.3.2 B.1.b)

Demonstrate good utility practice in reliability planning through designing a resilient distribution system that addresses existing reliability performance concerns and is capable of adapting to future challenges (e.g. grid modernization and climate change)

Renewal of these deteriorated ducts, manholes, and hanholes is necessary to avoid potential risk to damage nearby equipment, and public safety aspect from a potential structural failure. Replacing these assets will also improve the service reliability, and allow for modern construction and good utility practices to be implemented.

Efficiency, Customer Value & Reliability - Priority Level/Project Prioritization and Reasoning (5.4.3.2 B.1.c)

Indicate the priority of the investment relative to others, giving reasons for assigning this priority that clearly reflect the distributor's approach to identifying, selecting, prioritizing and pacing projects in each investment category described in response to section 5.4.1.

The City of Kingston has identified the Queen Street, aka North Block Area, as a location for new development. Although The City of Kingston and the other utilities in the area have no immediate plans to reconstruct Queen Street, specifically from King Street East to Wellington Street, Kingston Hydro is taking a pro-active approach to replace the assets prior to the Ciy's complete road reconstruction project to reduce concerns with congestion and minimize conflicting project timings and priorities.

Analysis of Project & Alternatives - Effect of the investment on system operation efficiency and cost-effectiveness (5.4.3.2 B.1.d.i)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

(i) The effect of the investment on system operation efficiency and cost-effectiveness

Rebuilding of deteriorated underground infrastructures would eliminate potential collapse and cable faults; therefore, reduce the duration of unplanned outages, since a more stable and functional duct structure will allow for faster deployment of replacement cable.

Analysis of Project & Alternatives - Net benefits accruing to customers (5.4.3.2 B.1.d.ii)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

...

(ii) The net benefits accruing to customers as a result of the investment

This area of the city is being targeted for intensification and redevelopment of older, underutilized buildings and properties. Installation of new spare ducts will provide these future developments and customer connections system access to the Kingston Hydro distribution network.

Analysis of Project & Alternatives - Impact of the investment on reliability performance including frequency and duration of outages (5.4.3.2 B.1.d.iii)

For each project and project alternative provide the following quantitative and/or qualitative analyses on the design, scheduling, funding and/or ownership options (e.g. whole or part ownership solely by or jointly with 3rd parties):

...

(iii) The impact of the investment on reliability performance including on the frequency and duration of outages

Rebuilding of deteriorated underground infrastructures would eliminate potential duct collapse and cable faults, therefore, reduce the risk and severity of customer service interruptions and improve system service.

Project Alternatives (Design, Scheduling, Funding/Ownership) (5.4.3.2 B.1.d)

Where alternatives have been considered and the ranking of a proposed project relative to alternatives has been affected by the assessment of benefits and costs, these benefits and costs should be described and explained in relation to the proposed project and alternatives.

Where a distributor's choices for technical design, component characteristics, how the work is carried out, etc., have been affected by a decision to configure a project to meet both a trigger driver and secondary drivers, the effect on costs and benefits must be explained.

Due to already existing infrastrucutre in the ground, alternative options for the project are not as effcient, and do not meet the demands of the project. An added benefit of the current plan is not cause conflict with the Municipal Consent Requirements of the City, that prohibit the cutting of a new road surface within five years of new road construction. Alternative routing locations of the duct work also increases the distance for the ducts, thus the costs and time involved. Alternatively going overhead is not feasible given the tight quarters of the current landscape, and the knowledge that there are other high rise buildings proposed for the area. Given these factors and considering the extremely busy and sensitive nature of conducting work on the main commercial artery of the downtown core, conducting this rehabilitation work at any other time would be very challenging.

Health and Safety (5.4.3.2 B2)

Provide information on the effect of the investment on health and safety protections and performance for both the utility and the public.

Replacement of maintenance hole structures in poor structural condition will eliminate the risk of potential collapse of these structures and protect the public. Separatiing Kingston Hydro's electrical distribution elements from Utilities Kingston's Streetlight and Traffic Signals equipment in the project will also avoid any unnecessary safety risks to Kingston Hydro and street light contractors on future maintenance works.

Cyber-Security, Privacy (5.4.3.2 B.3) (where applicable)

Where applicable, provide information showing that the investment conforms to all applicable laws, standards and good utility practices pertaining to customer privacy, cyber security and grid protection. Cyber security is expected to be incorporated into the distributor's risk management decision making and investment planning to form part of its business plans and DSP.

Not Applicable

Co-Ordination, Interoperability (5.4.3.2 B.4.a) Recognized Standards, co-ordination with utilities, regional planning, and/or 3rd party providers (where applicable)

Where applicable, explain how the investment reflects co-ordination with utilities, regional planning, and/or links with 3rd party providers and/or industry.

The design and construction plans will be submitted for review and co-ordination with key stakeholders; the City of Kingston, other parties with underground utilities in the area, and telecommunication groups like Bell, to resolve any conflicts and maintain required clearances between the different utilities as required by the various codes and regulations.

Co-Ordination, Interoperability (5.4.3.2 B.4.b) Future technological functionality and/or future operational requirements

Describe how the investment potentially enables future technological functionality and/or addresses future operational requirements.

Spare ducts, as well as the transformer vault structure, will be installed for future 5kV PILC cable replacement and support development along Queen Street and enhance the Kingston Hydro distribution network.

Environmental Benefits (5.4.3.2 B.5) (where applicable)

Where applicable, describe the effect of the investment on the use of clean technology, conservation and more efficient use of existing technologies

Not Applicable

Conservation and Demand Management (5.4.3.2 B.6) (where applicable)

Where applicable, describe incremental conservation initiatives, over and above those established in cooperation with the IESO, to defer or avoid future infrastructure projects.
For proposed distribution rate funded CDM programs the following details are required:

(i) Where measurable, an assessment of the benefits of the project for customers in terms of cost impacts to customers
(ii) The number of years the proposed CDM program would be in place and the number of years that the required infrastructure would be deferred A description of how advanced technology has been incorporated into the project (if applicable), including how standards relating to interoperability and cyber-security have been met

Not Applicable

C. Category-Specific Requirements - System Renewal

Asset Performance-related operational targets & asset lifecycle optimization policies and practices (refer to 5.2.3 & 5.3.3) (5.4.3.2 SR-B1.a)

A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to:
(a) The distributor's asset performance-related operational targets and asset lifecycle optimization policies and practices (i.e. filings in relation to sections 5.2.3 and 5.3.3)

The underground infrastructure proposed to be replaced in this project are through our experience from last four phases of the Princess Street Reconstruction project and our annual asset inspections indicate the existing ducts, manholes and handholes in this area are in poor condition.

Information on the condition of the assets relative to their typical life-cycle and performance record (5.4.3.2 SR-B1.b)

A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to:
...
(b) Information on the condition of the assets relative to the typical life-cycle and performance record of the assets targeted by the project

The underground infrastructure in the project scope area is amongst the oldest assets in Kingston Hydro distribution system. Experience from the previous Princess Street Reconstruction Project phases, as well as the inspections of the the duct banks and maintenance holes in this area, indicate they are deteriorated. Further to that, the underground infrastructure inspection indicated one manhole has several large cracks and needs to be replaced; and several brick handholes are in poor condition and are in need or repair and/or replacement.

The number of customers in each class potential affected by failure of the assets (5.4.3.2 SR-B1.c)

A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to:

...

(c) The number of customers in each customer class potentially affected by a failure of the assets included in the project

The asset failure could affect up to 17 greater-than-50kW customers and approximatley 2000 commercial and residential customers.

Quantitative customer impacts (5.4.3.2 SR-B1.d)

A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to:

...

(d) Quantitative customer impacts (e.g. frequency or duration of interruptions or number of customers affected) with associated risk level(s)

Kingston Hydro's Substation No.1 is located on Queen Street in the Downtown Kingston neighbourhood. This substation supplies the major commercial businesses of the Downtown Kingston neighbourhood, multiunit residential apartments, as well as community centers, and medical offices. Substation No.1 circuits 103, 104, 105, 106 and 110 supply approximately 2000 mixed commercial and residential customers located within the Downtown Kingston Area. The customer impact risk is high.

Qualitative customer impacts (5.4.3.2 SR-B1.e)

A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to:

...

(e) Qualitative customer impacts (e.g. customer satisfaction, customer migration) with associated risk level(s)

Kingston Hydro plans to take the opportunity to install extra ducts and a future transformer vault structure for supporting development on Queen Street and to reduce future servicing costs and connection time to meet customers' expectations.

Value of customer impact in terms of characteristics of customers potentially affected by failure that have bearing on the criticality and/or cost of failure (5.4.3.2 SR-B1.f)

A description of the relationship between the characteristics of the assets targeted by a project and the consequences of asset performance deterioration or failure, referring to:

...

(f) The value of customer impact (e.g. high, medium, low) considering the characteristics of customers potentially affected by asset failure and the cost of failure

The customers in this project's scope area include high-rise condominium, businesses and residential. Considering the nature of the underground distribution system, the customer impact is high if the structural failure happens without the project infrastructure in place to allow for rapid deployment of replacement cabling to restore power connectivity.

Factor affecting the Timing and Priority of Project (5.4.3.2 SR-B2)

Other factors that may affect the timing of the proposed project such as the pacing of investments and the priority relative to other projects

The current and future incoming customer connection requests, poor asset condition, high load criticality and third party infrastructure development requirements make this project a high priority relative to other projects. The City has set Princess Street Reconstruction – Phase 5, as a high priority capital project which is tied to this civil infrastructure replacement. This project is the top priority of the level 3 rank, when evaluated amungst other projects for the year.

Consequences for system O&M costs (5.4.3.2 SR-B3)

The consequences for system O&M costs, including the implications for system O&M of not implementing the project

Replacement of deteriorated underground structures makes maintenance and troubleshooting more cost effective as it reduces the time and other project costs associated with identifying outages and replacment of damaged cable. It also reduces the time an inspection takes, therefore, reduces O&M costs via time savings.

Impact on reliability performance and/or safety factors (5.4.3.2 SR-B4)

The impact on reliability and safety factors

The new reliable equipment and underground infrastructure improves system reliability and safety to the public and workers.

Analysis of Project Benefits and Cost Comparing Alternatives to the Timing of the proposed Project (5.4.3.2 SR-B5)

An analysis of project benefits and costs comparing alternatives to the timing of the proposed project, highlighting the trade-offs between rate of expenditure and mitigation of the consequences of asset performance deterioration. Where the ranking of the proposed project relative to the alternatives has been adjusted to account for significant benefits and costs, the value of which cannot readily be quantified, these should be described and explained in relation to the proposed project and all alternatives.

Due to already existing infrastrucutre in the ground, alternative options for the project are not as effcient, and do not meet the demands of the project. An added benefit of the current plan is not cause conflict with the Municipal Consent Requirements of the City, that prohibit the cutting of a new road surface within five years of new road construction. Alternative routing locations of the duct work also increases the distance for the ducts, thus the costs and time involved. Alternatively going overhead is not feasible given the tight quarters of the current landscape, and the knowledge that there are other high rise buildings proposed for the area. Given these factors and considering the extremely busy and sensitive nature of conducting work on the main commercial artery of the downtown core, conducting this rehabilitation work at any other time would be very challenging.

Like for Like Renewal Analysis, Alternatives Comparison (like for like vs. not like for like, timing, rate of replacements, etc.) (5.4.3.2 SR-B6)

Where the proposed project is a 'like for like' renewal but has been configured at extra cost to address other distributor planning objectives, an analysis of project benefits and costs must be provided comparing

a) a project configured solely to meet the requirement;
b) the proposed project; and
c) technically feasible alternatives to the proposed project that meet the same objectives as the proposed project.

Where the ranking of the proposed project relative to alternatives has been adjusted to account for significant benefits and costs the value of which cannot readily be quantified, these should be described and explained in relation to the proposed project and all alternatives.

This project is a like-for-like renewal to modern standards and utility practices, in addition, spare ducts and a 'future use' transformer vault structure will be installed for future customer connections and new developemnts. This area of the city has been targeted for intensification and redevelopment of old, underutilized buildings and properties. Kingston Hydro will take this opportunity to install extra ducts for facilitating this future development and to reduce future customer servicing costs. Installation of new spare ducts for future system enhancement, expansion, and customer connection minimizes disruption of near future newly built roads and sidewalks.

Appendix G

Consultations with Telecommunications Entities

Appendix G.1 – Kingston Hydro Letter to Telecommunications Entities – March 3, 2022

Appendix G.2 – Reply Letter from UK Fibre – March 9, 2022

Kingston Hydro

March 3, 2022

Cogeco
Ryan Furniss
170 Colborne St
Kingston, ON
K7K 1E3

Dear Sir/Madam:

RE: Ontario Regulation 842/21 Electricity Infrastructure
Consultation with telecommunication entities

Kingston Hydro Corporation will be filing its capital plan (Distribution System Plan - DSP) with the Ontario Energy Board (OEB) as part of its Cost of Service application later this year.

Although much of the planning with respect to its capital plan has already been completed O/Reg 842/21, approved January 1, 2022, now requires licensed distributors to:

I. "consult with any telecommunication entity that operates within its service area when preparing a capital plan for submission to the OEB, for the purpose of facilitating the provision of telecommunication services, and

II. include the following information in its capital plan:

   i. The number of consultations that were conducted and a summary of the manner in which the distributor determined with whom to consult.
   ii. A summary of the results of the consultations.
   iii. A statement as to whether the results of the consultations are reflected in the capital plan and, if so, a summary as to how."

You are being consulted because you have either previously executed a Third Party Attachment agreement for your telecommunication assets on Kingston Hydro poles and are therefore a known entity operating in our distribution territory; or, you have previously expressed interest in doing so.
Attached you will find a map illustrating the limits of Kingston Hydro's distribution territory. This territory can be characterized as an existing urban built up area

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where most infrastructure work involves the replacement of assets that are at or near end of life. New "greenfield" infrastructure activity is rare.

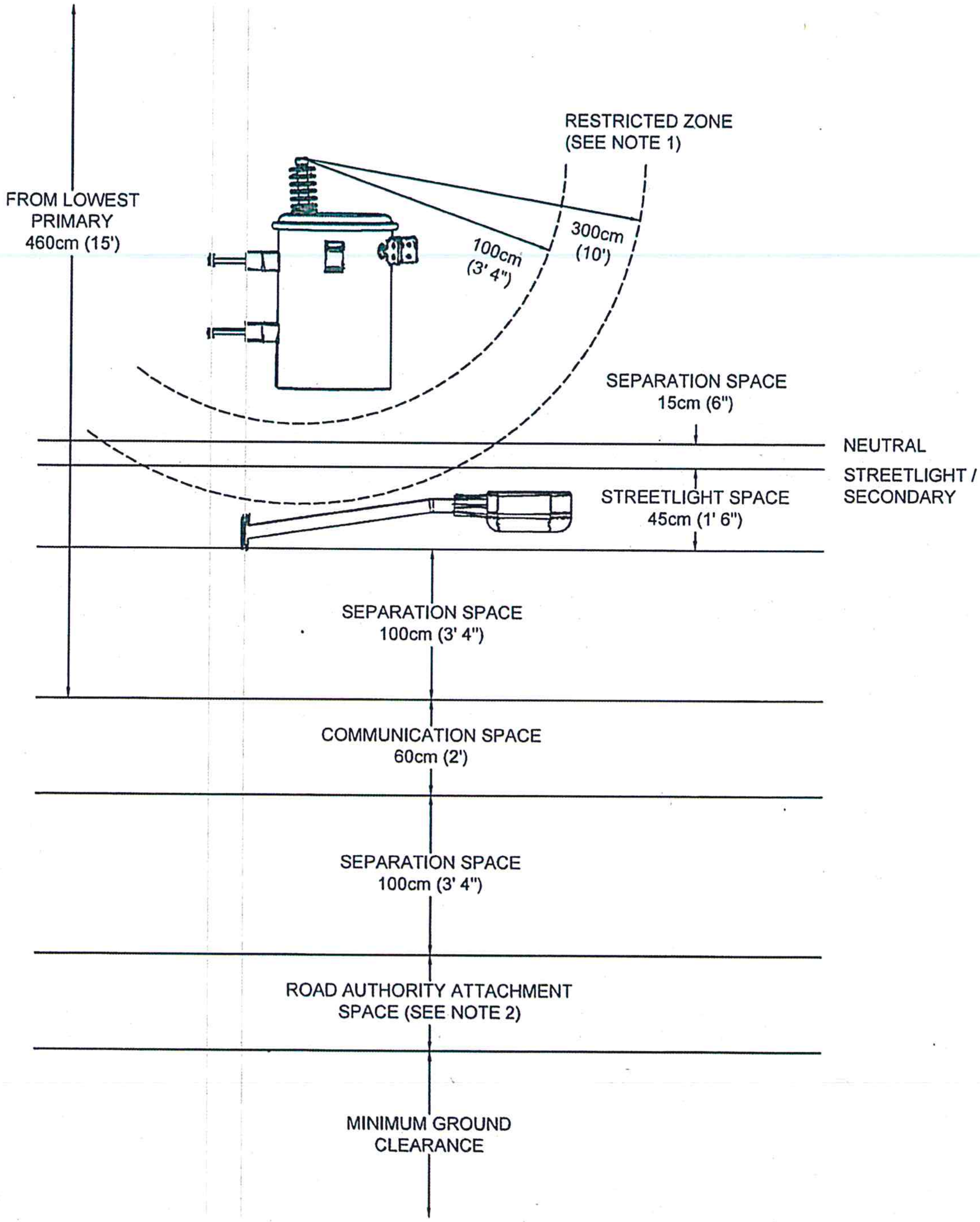
In keeping with the distribution system renewal theme, our over-head pole replacement program, undertaken annually, is a significant part of our capital program. We enclose as part of our consultation a typical cross-sectional drawing of a pole (Dwg. # K03-03-11-134) used in many of our pole replacement projects. It is noted that the Joint Use Pole Separation and Location drawing reserves space on the pole for telecommunication assets, labelled Communication Space. This space appears on all overhead poles regardless of height.

Kingston Hydro's submission of its DSP to the OEB will cover years 2023-2027. We therefore enclose a list of streets, by year, where the replacement of overhead poles is being planned because of asset management planning, resource availability and condition assessment analysis.

Should you wish to discuss or review this information further, or have input that you wish to provide, you can contact me at jmiller@utilitieskingston.com or at 613-546-1121, ext. 2475.

Sincerely,

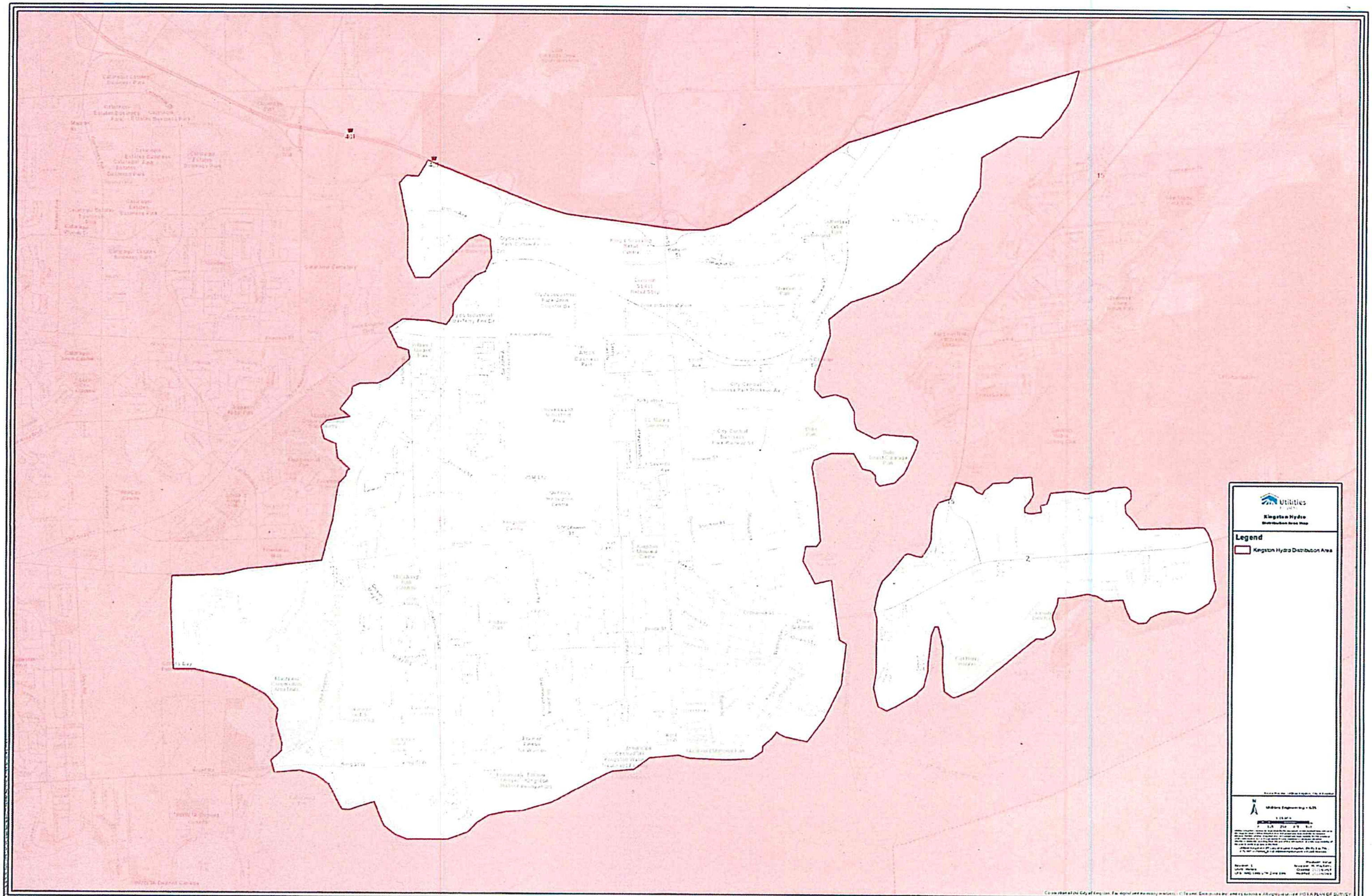
Jim Miller
Chief Operating Officer



NOTES:

1. THIRD PARTY ATTACHER MUST ENSURE EXISTING AND PROPOSED ATTACHMENTS (INCLUDING LDC ATTACHMENTS) MEET THE MINIMUM LOADING REQUIREMENTS OF THE LATEST VERSION OF CSA C22.3 OVERHEAD SYSTEMS
2. THE RESTRICTED ZONE DIMENSION MAY BE REDUCED TO 100cm (3' 4") PROVIDED THAT THE STREETLIGHT OWNER WARRANTS THAT ONLY QUALIFIED PERSONNEL SHALL BE PERMITTED TO INSTALL OR MAINTAIN THE LIGHT WITHIN THE RESTRICTED ZONE.
3. "ROAD AUTHORITY" MEANS THE MINISTRY OF TRANSPORTATION, A MUNICIPAL CORPORATION, BOARD, COMMISSION, OR OTHER RECOGNIZED BODY BEING IN CONTROL OF THE CONSTRUCTION, ALTERATION, IMPROVEMENT, MAINTENANCE AND REPAIR OF A HIGHWAY OR ROAD AND RESPONSIBLE THEREOF.

TITLE: JOINT USE POLE SEPARATION AND LOCATION	Utilities Kingston	Kingston Hydro
Drawn	Jan 25, 2022	SCALE NTS
DWG. K03-03-11-134		


Utilities
Kingston Hydro
Distribution Area Map
Legend
Kingston Hydro Distribution Area
N

2023-2027 Overhead Project Information for 3rd Party Engagement

Year	Full Description	Main Road, Intersection or Address	From	To	Description for Public
2023	MS13 to Connaught St	Third Avenue	MacDonnell St	Connaught St.	Overhead Pole Line Rebuild MS13 to Connaught St 13.8kV voltage conversion
2023	MS8 and Russell St,	Bagot St	Cataraqui	Russell	Electric pole line rebuild Bagot St - Cataraqui St. to Russell St.
2023	Sir John A Mcdonald/Union St	Sir John A. MacDonald	Union	Johnson	Replace 15 poles on Sir John A Macdonald (SJAM) from Union St towards Johnson and 4 poles on Union St West of SJAM
2024	Bagot @ Russel	Russel St. Extension	Bagot St.	Rideau St.	New overhead pole line along Russel St. Extensions from Bagot to Rideau St.
2024	Connaught; Victoria & Concession Streets	Connaught St.	Third Ave.	Concession St.	Pole Line Rebuild Connaught St to Princess St for 13.8kV voltage conversion
		Concession St	Connaught St	Victoria St	
		Victoria St	Third Ave	Princess St	
2024	Inverness Cres. Back yard pole line	Inverness Cres - Backyard *(Glenaire Mews)*	Westmoreland Rd	Sir John A MacDonald Blvd	Inverness Cres - Backyard pole line rebuild (12 Poles)
2024	O'Cconnor Park	O'Connor Park	Westmoreland Rd	Stormont Ave	Stormont Ave - Backyard Pole line Rebuild - (9 Poles along O'Connor Park)
2024	Portsmouth	Portsmouth	Bath Road	Miles Ave.	Pole Line rebuild - Portsmouth South of Bath to Miles Ave
2025	Garrett St	Garrett St	Division St	University Ave	Garrett St - Replace existing overhead pole line between Division St and University
2026	Mary St	Mary St.	Portsmouth Ave	McDonald St	Relocate pole line from back yard to front yard of Mary Street
2026	Portsmouth Ave	Portsmouth	Old Quarry Rd	Princess St	Pole Replacement - West Side of Portsmouth Ave. from Old Quarry Rd. to Princess St.
2027	Bath Rd	Bath Road	Sir John A Macdonald	Westdale	Pole Replacement - Bath Rd from Sir John A Macdonald to Westdale
2027	Johnson St)	Johnson St.	Gibson	MacDonnell	Pole Replacement Johnson St - from Gibson to Macdonnell
2027	Rideau St -	Rideau St.	North St.	Bay St.	Rideau St - from North to Bay - Pole Replacement
2027	King St E	King St. E.	Barrie St.	West St.	King St E - from Barrie to West - Pole Replacement
2027	Mulcaster Ave - Backyard Pole Replacement	Mulcaster Ave.	Backyard Pole replacement		Casterton Ave, Holland Cres, Mulcaster St - Backyard Pole Replacement
2027	Thomas St	Thomas St.	Montreal St.	Patrick St.	Thomas St - Pole Line Rebuild - Montreal St to Patrick St

Utilities Kingston

March 9, 2022

Kingston Hydro
Jim Miller
Chief Operating Officer
PO Box 790
Kingston, ON
K7L 4X7

Dear Sir/ Madam:

RE: Ontario Regulation 842/21 Electricity Infrastructure Consultation with telecommunication entities

On behalf of Utilities Kingston, the Networking Department would like to thank you for the consultation opportunity and sharing your pole replacement program with us. We currently do not have any feedback on the proposed pole program and will continue to reference the information provided as we look at our work program from 2023 to 2027.

Sincerely,

Joshua Landry
Network Operations Manager

Appendix H

IESO Comments – REG Plan

From:	Miriam Heinz
To:	Brackenbury,Thomas
Subject:	RE: Kingston Hydro REG Plan for Updated DSP
Date:	02-18-2020 2:58:26 PM
Attachments:	image002.png image003.png image004.png

Hello Tom. The IESO has reviewed Kingston Hydro's REG plan, and notes that Kingston Hydro is not proposing any large capital investments to facilitate the connection of REG for its DSP period 2020-2025. This is consistent with the ongoing regional planning work for the Peterborough-Kingston region.

In the case where a distributor has no REG investments during the 5-year Distribution System Plan (DSP) period no letter from the IESO is required, as the requirement is for when there are investments.

To illustrate this, provided below is an excerpt from the Ontario Energy Board's **Filing Requirements For Electricity Distribution Rate Applications** - Chapter 5, section 5.2.2 Coordinated planning with third parties:

d) For REG investments a distributor is expected to provide the comment letter provided by the IESO in relation to REG investments included in the distributor's DSP, along with any written response to the letter from the distributor, if applicable. The OEB expects that the IESO comment letter will include:

- Whether the distributor has consulted with the IESO, or participated in planning meetings with the IESO;
- The potential need for co-ordination with other distributors and/or transmitters or others on implementing elements of the REG investments; and
- Whether the REG investments proposed in the DSP are consistent with any Regional Infrastructure Plan.

The IESO appreciates having had the opportunity to review Kingston Hydro's REG Investment Plan.

Please let me know if you have any questions.

Thank you,
Miriam

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