Q. **Reference: 2024 Capital Budget Application (Revision 1), Program 7, Wood Pole Line Management Program (2024), page 14, Table 8.**

a) Please provide a copy of the Wood Pole Line Management Program Progress Report (2018-2022), April 21, 2023.

b) Please provide a table showing the components listed in Table 8 broken out by transmission line number.

A. **a)** Please refer to NP-NLH-006, Attachment 1 for Newfoundland and Labrador Hydro's "Wood Pole Line Management Program Progress Report (2018–2022)."[1]

b) Table 1 shows the components scheduled for refurbishment in 2024, summarized by transmission line number.

Table 1: 2024 Refurbishment Plan

Component	TL201	TL210	TL221	TL233	TL234	TL239	TL260	Total
Poles	37	16	4	1	3	4	3	**68**
Crossarms	41	-	1	11	5	1	-	**59**
Cross bracing	48	-	-	3	19	1	-	**71**
Knee bracing	21	-	-	1	3	-	-	**25**
Foundations	1	-	-	-	-	-	-	**1**
Miscellaneous (Insulators, hardware, etc.)	87	19	14	5	10	-	6	**141**

[1] "Wood Pole Line Management Program Progress Report (2018–2022)," Newfoundland and Labrador Hydro, April 21, 2023.

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April 21, 2023

Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, NL A1A 5B2

Attention: Cheryl Blundon
Director of Corporate Services and Board Secretary

Re: Wood Pole Line Management Program – Progress Report

Please find enclosed Newfoundland and Labrador Hydro's ("Hydro") Wood Pole Line Management Program Progress Report (2018–2022). This progress report is the fourth, and final, report filed on the program[1] and covers two complete inspection cycles.

Should you have any questions, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Shirley A. Walsh
Senior Legal Counsel, Regulatory
SAW/kd

Encl.

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Bernice Bailey, Browne Fitzgerald Morgan & Avis
Bernard M. Coffey, KC

[1] The first report was filed with Hydro's 2005 Capital Budget Application ("CBA"); the second with the 2013 CBA, and the third with Hydro's 2019 CBA.

Wood Pole Line Management Program

Progress Report (2018–2022)

April 21, 2023

A report to the Board of Commissioners of Public Utilities

newfoundland labrador hydro

Contents

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") maintains approximately 2,300 km of wood pole transmission lines operating at 69 kV, 138 kV and 230 kV voltage levels. The pole plant asset includes approximately 23,000 transmission size poles. Figure 1 presents the overall Island Interconnected System transmission line network.

Figure 1: Island Map showing all High Voltage Transmission Lines and Study Area

The Wood Pole Line Management ("WPLM") Program is a condition-based asset renewal program that uses reliability-centred maintenance ("RCM") principles and strategies.[1] Under the program, data from transmission line inspections is analyzed on an annual basis and recommendations are made, as required, for refurbishment or replacement of line components, including poles, structures, hardware, and conductors. Hydro first initiated the WPLM Program as a pilot study in 2003. Under this pilot study, Hydro completed the inspection of poles on the Avalon Peninsula. Following the conclusion of the pilot study, Hydro assessed the benefits of the WPLM Program, and determined that it should continue as a

[1] RCM is a maintenance strategy that is implemented to optimize the maintenance program of a company or facility.

long-term asset management and life-extension program. The WPLM Program was approved by the Board of Commissioners of Public Utilities ("Board") as part of Hydro's 2005 Capital Budget Application ("CBA"),[2] and supported by an internal report titled *"Wood Pole Line Management Using RCM Principles".*

The WPLM Program was introduced to support a planned shift from a time-based to a condition-based maintenance program. The purpose of the WPLM Program is to detect and treat deteriorating wood poles and line components before the integrity of a structure is jeopardized. If the deterioration of the structure or components is not detected early, the reduced integrity of the structure could affect the reliability of the line. It could also lead to increased failure costs and, potentially, customer interruptions. Safety issues and hazards for Hydro personnel and the public could also result from wood poles that have weakened structural integrity.

Based on data collected to date, the WPLM Program has improved reliability, extended the life of wood transmission poles and reduced the total cost of ownership over the complete life of the poles. It should be noted that the results reported in this study consider only the pole inspection data since 1998, and excludes data such as line failures under extreme wind and ice conditions, or any other poles replaced previous to the initiation of the WPLM Program.

1.1 Benefits of the WPLM Program

The implementation of the WPLM Program enables Hydro to realize benefits including:

- Identification of "danger poles" (i.e., non-climbable) that require immediate replacement to avoid safety hazards;
- Identification of poles that need to be replaced to maintain structural integrity and reliability;
- Collection and maintenance of accurate pole plant asset data;
- Streamlining of capital budgeting process based on condition data;
- Treatment of poles to protect against decay and ant attacks, thus extending the life of the asset;
- Extension of asset life;

[2] *Public Utilities Act*, RSNL 1990, c P-47, Board Order No. P.U. 53(2004), Board of Commissioners of Public Utilities, December 23, 2004.

- Reduction of environmental footprint due to reduced pole disposal and elimination of vegetation clearing for new line construction;
- Reduction of total ownership costs; and
- Prevention of premature retirement of other transmission line components such as conductor and hardware which have longer effective life spans.

2.0 Scope of WPLM Program

The scope of the WPLM Program regularly consists of four specific items as follows:

1) Inspection of poles and associated line components such as conductor, hardware and insulators;

2) Preservative treatment of all poles;

3) Use of an electronic data collection system to facilitate field data collection and subsequent data analysis; and

4) Data based, optimized decisions to rehabilitate, or replace poles and associated hardware.

The aim of the program is to optimize sustaining renewal investment in wood pole transmission infrastructure, ensure that deteriorated components are identified and retreated to extend asset life, and identify in a timely manner components requiring replacement before in-service failures occur, thereby avoiding more extensive repairs, service outages and danger to line workers.

3.0 Report Scope

The intent of this report is to provide a cumulative summary of the results captured under the WPLM Program since its inception in 2003. With the filing of this report, 20 years of data has been collected and analysed with the intent to determine the overall effectiveness of the maintenance principals previously established. The first progress report was submitted to the Board with the original application for approval of the program in 2005. The second and third progress reports were submitted in the 2013 CBA,[3] and the 2019 CBA,[4] respectively. As directed by the Board in the 2013 CBA Order:

[3] "2013 Capital Budget Application," Newfoundland and Labrador Hydro, rev. August 31, 2012 (originally filed August 8, 2012), vol. II, tab 17, app B. <http://www.pub.nf.ca/applications/nlh2013capital/files/application/NLH2013Application-WoodPoolLineMgt.pdf>.
[4] "2019 Capital Budget Application," Newfoundland and Labrador Hydro, rev. October 9, 2018 (originally filed July 31, 2018), vol. I, 2019–2013 Capital Plan, app C.

This report should provide evidence of, for example, results of non-destructive testing undertaken to date, whether the program has met the stated objective of deferring replacement of assets, if the program has resulted in improved reliability of the system, and what the current best practice is in other jurisdictions with respect to wood pole asset management.[5]

To analyze and demonstrate the benefits of the WPLM program, Hydro assessed the following three areas:

1) System Reliability Improvements;

2) Asset Life Extension; and

3) Reduced Total Cost of Ownership.

Consistent with previous WPLM progress reports, analysis presented in this report is based on comprehensive inspection data for two of the lines in the Avalon Peninsula transmission line system. These lines were chosen because they are exposed to the most severe environmental conditions representing the worst-case scenario.

This final progress report covers two complete inspection cycles, and illustrates that the WPLM program is achieving the goals of increasing reliability, extending asset life, reducing Hydro's environmental footprint and reducing total cost of ownership.

4.0 Program Benefits

4.1 Reliability Improvements

Figure 2 illustrates the transmission reliability improvement of the Island Interconnected System. It shows the total forced outage hours due to structural failures on wooden transmission lines before and after implementation of the WPLM Program. The pilot project on WPLM started in 2003 with a two-year duration. The full program was launched in 2005.

[5] *Public Utilities Act*, RSNL 1990, c P-47, Board Order No. P.U. 2(2012), Board of Commissioners of Public Utilities, January 24, 2012.

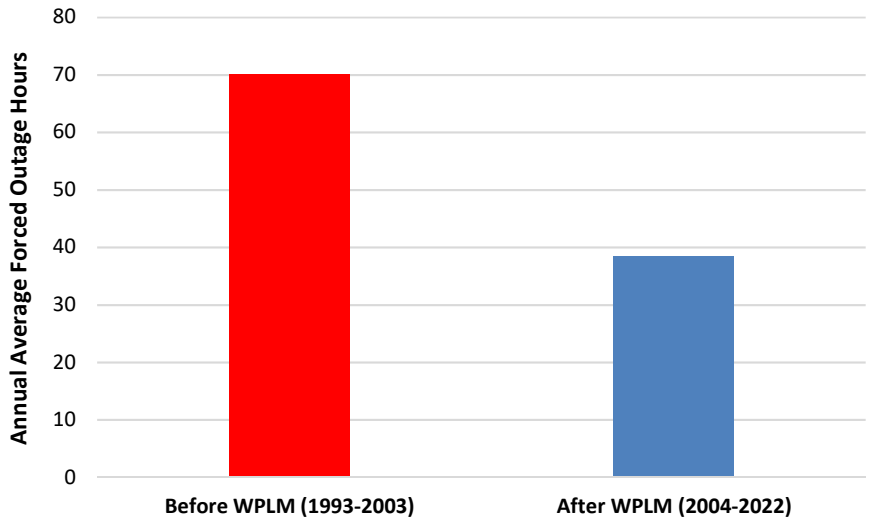

Figure 2: Outage Data for Hydro's Wooden Transmission System (1993–2022)

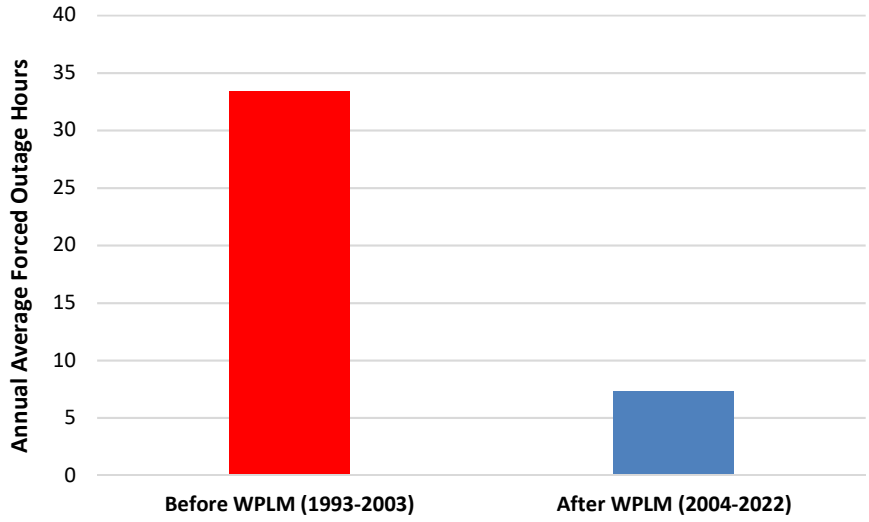

Figure 3: Outage Data for Hydro's Wooden Transmission System on the Avalon Peninsula (1993–2022)

As shown in Figure 2 and Figure 3, there has been an Island-wide step change reduction in failures since the WPLM Program was launched, despite the line system experiencing severe ice storm events in 2008 and 2010, as well as a number of wind storms including Hurricane Igor in 2010, the wind storm of March 2017, Hurricane Larry in 2021 and Hurricane Fiona in 2022. The improvement on the Avalon Peninsula is approximately 78%, and the improvement for the entire wooden transmission system is approximately 45%. This improved performance is attributable to the on-going inspection and preventive treatment

program, and demonstrates that the WPLM Program has provided material reliability improvement. This is consistent with industry best practice; a 2012 survey conducted by the CEATI[6] Wind and Ice Storm Mitigation Interest Group indicated that the majority of utilities have realized asset life extension of wood poles through a regular inspection and treatment program.

4.2 Asset Life Extension

The ability to predict asset degradation is important in the management of any asset. One method to statistically estimate the remaining life of a utility's wooden poles is through the development of Iowa curves using real rejection rate data from inspections.[7] Each curve represents a probability distribution and supports realistic forecasting of the remaining life of groups of assets.

The 50-year curve shown in Figure 4 indicates that 50% of a pole plant asset is typically replaced by the time the asset age has reached 50 years. At the inception of the WPLM Program, this standard 50-year Iowa curve (i.e., average pole life of approximately 50 years) was chosen as a benchmark for the program, as pole inspection data from 1998 to 2003 correlated well with this curve. Since then, Hydro has tracked its inspection data and developed its own survival curves using the Iowa curve methodology. Figure 4 illustrates the survival curve for the pole plant asset for Hydro's entire wood pole line network alongside the 50-year Iowa curve for comparison.

[6] Centre for Energy Advancement through Technological Innovation ("CEATI").
[7] Iowa curves are a type of survivor curve developed by the University of Iowa, utilized to model the predicted rate of failure or replacement of a population of assets over time.

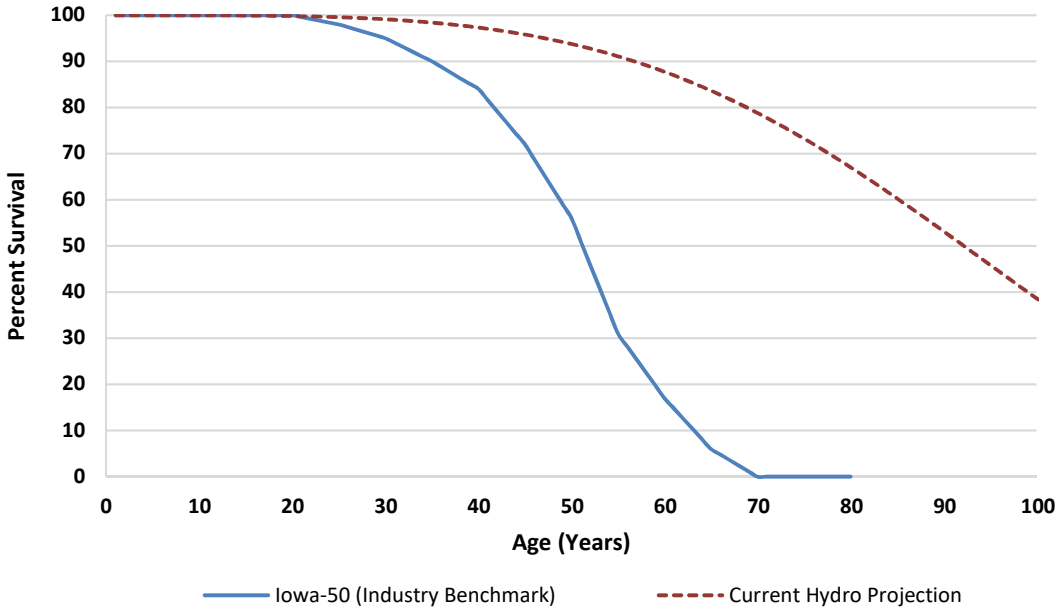

Figure 4: Survival Curves for the Pole Plant Asset (Island Interconnected System) and the Asset Age Distribution

As can be seen in Figure 4, data analysis from the first 20 years of the WPLM Program demonstrates an incremental increase in average pole life. Based on the current Hydro projection, the expected mean life for a wood pole in Hydro's transmission network is approximately 90 years. This curve will continue to become more refined as more inspection data is collected; however, the curve based on 20 years of data collected since the inception of the WPLM demonstrates that the WPLM Program has significantly extended the expected life of wood pole transmission infrastructure.

Figure 5 depicts Hydro's survival curve for its wooden lines on the Avalon Peninsula only.

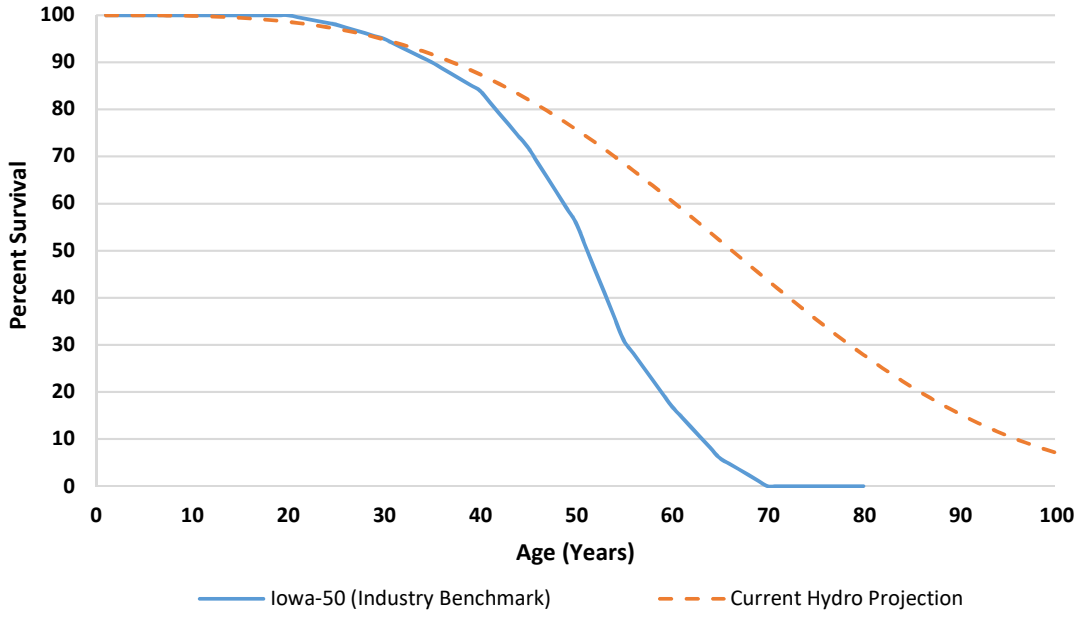

Figure 5: Survival Curves for Avalon Pole Plant Asset

This curve utilizes data from five inspection cycles between 1985 and 2022 for the Avalon Peninsula pole system. Asset data preceding the implementation of the WPLM Program closely follows the 50-year Iowa curve. Based on the current Hydro projection, the expected mean life is approximately 67 years,[8] which is significantly higher than the conventional economic life of 40 years historically used in the industry, and approximately 17 years longer than the 50-year expected mean life modeled by the Iowa-50 benchmark.[9]

In 2012, as a result of asset life extension following the implementation of the WPLM Program, Hydro revised its asset depreciation period for wood transmission poles from an average economic life of 40 years to an average life of 53 years. In 2015, Hydro further revised this number to a depreciation period of approximately 60 years. The extension of the depreciation period moderates the rate impacts associated with wood transmission pole investment by enabling cost recovery over a longer period.

[8] The 67-year projected life determined in this study is greater than the approximately 60-year estimated useful life derived in the 2015 depreciation study. The difference is primarily because this study considers only the pole inspection data since 1998, and excludes data such as line failure under extreme wind and ice conditions, or any other poles replaced previous to the initiation of the WPLM Program.

[9] Mankowski, Hansen and Morrell, "Wood Pole Purchasing, Inspection and Maintenance: A survey of Utility Practices," Forest Product Journal, vol. 52, no. 11/12.

4.3 Reduced Total Cost of Ownership (Net Present Value Analysis and Results)

Figure 6 compares the estimated average inspection and treatment costs, planned replacement cost and unplanned replacement cost of a pole.

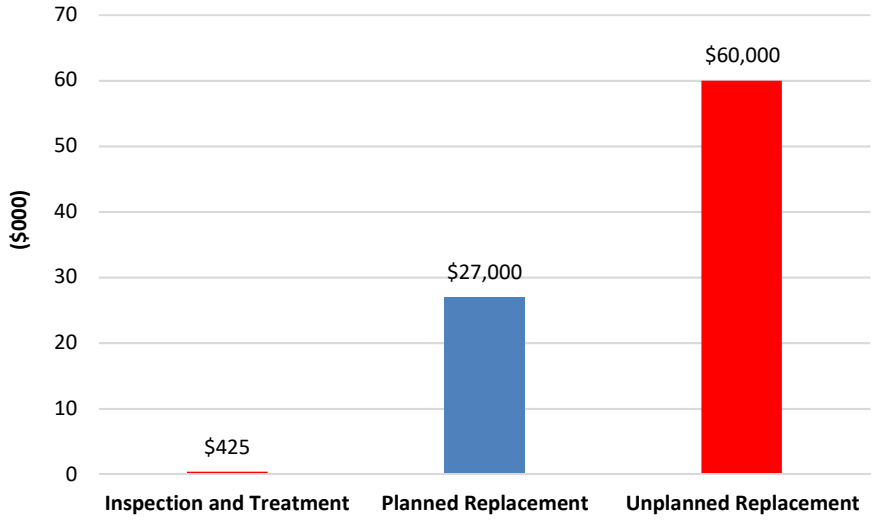

Figure 6: Comparison of Wood Pole Maintenance Costs ($)

To illustrate the effectiveness of the WPLM Program in minimizing life cycle costs for wooden transmission lines, a net present value exercise was performed for a hypothetical transmission line using the survival plot for the Avalon Peninsula wood pole line network as depicted in Figure 5. The survival plot for the Avalon Peninsula's wood pole line network was chosen as it is more conservative than the survival plot for the entire Hydro wood pole line network. Lines on the Avalon Peninsula are exposed to the most severe environmental conditions representing the worst case scenario for degradation, and the plot was derived from data across five inspection cycles under the program (the remainder of Hydro's wood pole transmission lines having only gone through two inspection cycles to date).

For this exercise, a 100 km line with 1,100 poles and a voltage of 69 kV is assumed. The costs associated with managing this hypothetical line under the WPLM Program are presented in Table 1. To compare this approach to a "run to failure" asset management philosophy, Table 2 presents the estimated costs of rebuilding the line in a new right-of-way every 50 years. This is assuming that a line not managed under a program like Hydro's WPLM Program would have a useful life of 50 years. The estimated cost for rebuilding is based on historical average capital costs. It is assumed that the average inspection cycle for the line under the WPLM Program will be 10 years. Conservatively, no preventative or corrective

maintenance has been estimated for the "run to failure" option. It has been assumed that portable generation is not required to maintain electrical supply in any case, and no maintenance or construction would be executed using hot line methods. It has also been assumed that a line managed under the WPLM Program will require re-conductoring at 80 years; however, Hydro considers this to be a conservative estimate as Hydro has not experienced significant issues necessitating re-conductoring to date. It should also be noted that the 69 kV case study is conservative, as the complete rebuild costs will increase as the voltage increases due to the requirement for larger components such as conductor, hardware and insulators. Figure 7 depicts the differences in cumulative present worth ("CPW") for the two scenarios over time.

Table 1: Costs Associated with Wood Pole Line Management on a Hypothetical 69 kV Line

Years from Original Construction	Work	Cost ($000)
20	Inspect and Treat 1,100 Poles	468
	Replace 15 Poles	415
30	Inspect and Treat 1,100 Poles	468
	Replace 41 Poles	1,107
40	Inspect and Treat 1,100 Poles	468
	Replace 82 Poles	2,210
50	Inspect and Treat 1,100 Poles	468
	Replace 129 Poles	3,489
60	Inspect and Treat 1,100 Poles	468
	Replace 171 Poles	4,622
70	Inspect and Treat 1,100 Poles	468
	Replace 195 Poles	5,267
80	Inspect and Treat 1,100 Poles	468
	Replace 195 Poles	5,252
	Re-conductor 100 km	3,400
90	Inspect and Treat 1,100 Poles	468
	Replace 174 Poles	4,709
100	Inspect and Treat 1,100 Poles	468
	Replace 149 Poles	4,020
	Total	**38,698**

Table 2: Costs Associated with "Run to Failure" Approach on a Hypothetical 69 kV Line

Years from Original Construction	Work	Cost ($000)
50	Rebuild Line	23,500
100	Rebuild Line	23,500
	Total	**47,000**

In this example, to manage the hypothetical line under the WPLM Program would cost an estimated total of $38.7 million over the course of 100 years. To apply the "run to failure" approach to managing the line would cost approximately $47 million over the same time period, more than 20% greater than the WPLM Program approach. This 20% difference in cost could be as high as 80% in other areas of the province based on the survival plot for the entire Hydro wood pole line network from Figure 4. This savings estimate is conservative and demonstrates the benefits and justification for the continued execution of the WPLM Program.

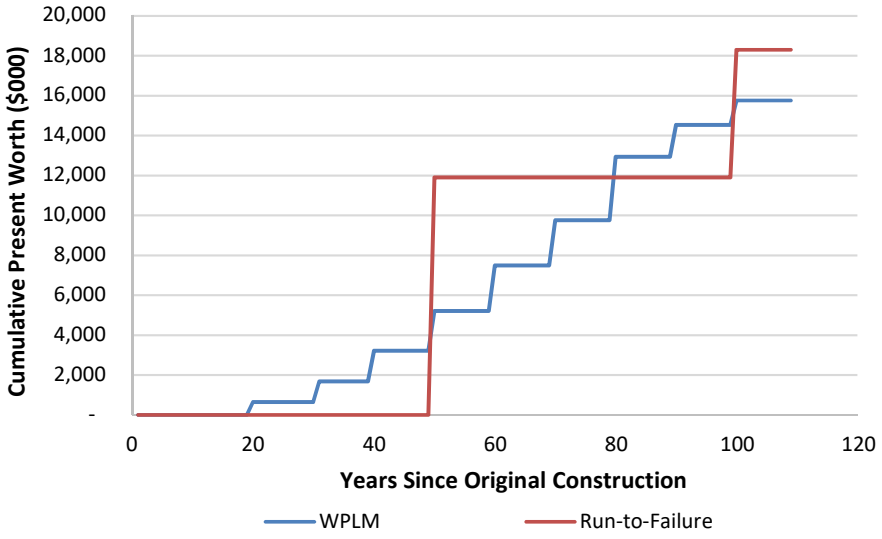

Figure 7: Comparison of Wood Pole Maintenance Costs (CPW)

5.0 Summary

In summary, Hydro's WPLM Program is achieving the goals of increasing reliability, extending asset life, reducing Hydro's environmental footprint and reducing total cost of ownership. Hydro is projecting an average life extension of its transmission wood pole plant of at least 17 years beyond the benchmark Iowa-50 survival curve. Hydro's WPLM Program is well aligned with best practices used in the industry. Hydro's assessment demonstrates that the cost of the WPLM Program is well justified by cost avoidance savings through reduced in-service failures and reduced unplanned repair costs, as well as reliability improvements and life extension of existing pole plant assets. In addition, the program has been effective in preventing the premature retirement of viable components which still have continued life expectancy. The development of a rigorous methodology to assess and analyze the pole inspection data allows Hydro to continue to proactively identify the right level of expenditure on the right components at the right time. The WPLM Program is an important part of Hydro's ongoing asset renewal, and supports Hydro's mandate to provide safe and reliable service to customers at the lowest possible cost.

6.0 References

Goel, Anand 2012 End of Life of Wood Structures (confidential report prepared for the WISMIG participants, CEATI Report No. T103700-3372, -http://www.ceati.com/)

Haldar, Asim 2018 Condition Based Asset Management of Overhead Lines – a Probabilistic Framework, CEATI Report No. T073700 – 3263, Montreal, TODEM Interest Group

Mankowski, M, Hansen, E and Morrell, J 2002 Wood Pole Purchasing, Inspection and Maintenance: A survey of Utility Practices, Forest Product Journal, Vol. 52, No. 11/12