APPENDIX B

Review of Current WPLM Program, Interim Report

1.0 Introduction

Hydro maintains approximately 2,500 km of wood pole transmission lines operating at 69, 138 and 230 kV voltage levels. The pole plant asset includes 26,000 transmission size poles. Figure 1 presents the overall Island interconnected transmission line network.

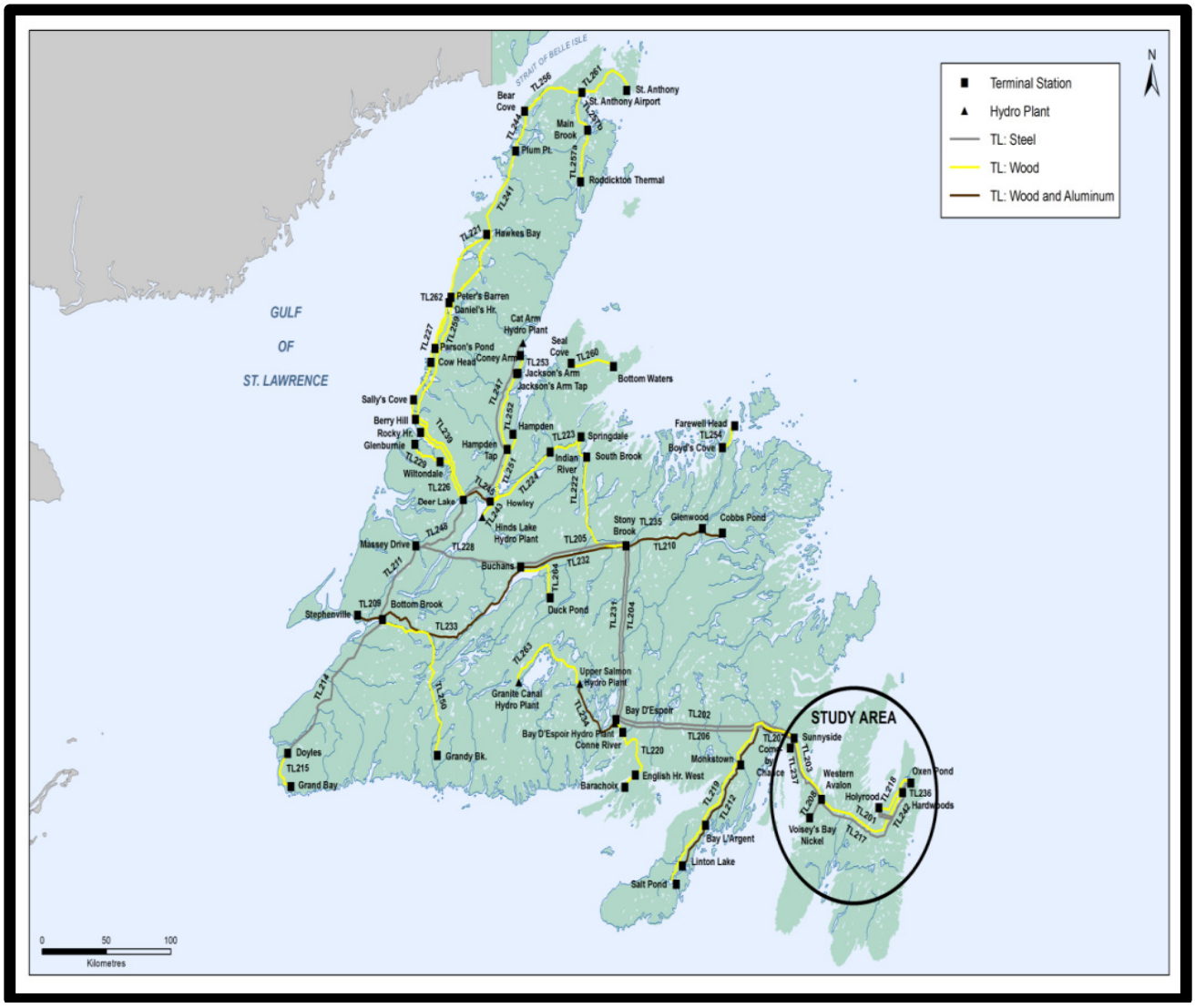

Figure 1: Island Map showing all High Voltage Transmission Lines

Hydro first initiated the Wood Pole Line Management (WPLM) program as a pilot study in 2003. Under this pilot study, Hydro completed the inspection of poles on the Avalon Peninsula. After the pilot study, Hydro determined that the program should continue as a long term asset

management and life extension program. The program was presented to the Board of Commissioners of Public Utilities (Board) in October 2004 as part of Hydro's 2005 Capital Budget Application. The proposal was supported in the application by the Hydro Internal Report titled "Wood Pole Line Management Using RCM principles". The program was approved by Board Order No. 53 (2004). The emphasis was to support a planned shift from time based to condition based maintenance program. Based on data collected to date, the WPLM program has improved the reliability, extended the life of the pole plant asset and reduced the total cost of ownership over the complete life of the poles.

Basic facts of our WPLM program:

- Identification of "danger poles (non climbable)" that require quick replacement to avoid safety hazards;
- Inspections conducted to identify poles that need to be replaced to maintain structural integrity and reliability;
- Long term 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;
- Asset life can be extended;
- Life extension also provides an opportunity to reduce environmental footprint because Hydro needs less poles; and
- Reduction of total ownership costs.

2.0 Scope of WPLM Program

The objectives of WPLM program were to address four specific items as follows: (1) inspect poles and associated line components such as conductor, hardware and insulators (2) test and treat all poles (3) develop and implement an electronic data collection system to facilitate field data collection and subsequent data analysis and (4) make data based, optimized decisions to rehabilitate, or replace poles and associated hardware. The aim of the program is to ensure that deteriorated poles are identified and retreated for life extension, and identify in a timely manner poles requiring replacement before failures occur in service, thereby avoiding more expensive repairs, service outages and danger to line workers.

3.0 Specific Questions Raised in Board Order No. 2 (2012)

"*This report should provide, evidence of, for example results of non-destructive testing, undertaken to date, whether the program has met the stated objectives 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. The Board will approve this project for 2012 but will require additional demonstrable evidence of the actual and expected long term benefits of the 2013 capital budget application".*

In order to provide evidence with specific examples to show what Hydro has accomplished so far with this WPLM program, the following areas are presented in this report to show the validity and the justification of continuing such a program in the future. The analysis presented in this report primarily considers the data for Avalon transmission line system. This system was chosen because it is exposed to the most severe environmental conditions representing the worst case scenario, and it has data available for multiple inspection years.

The following specific areas have been addressed:

- improved reliability of the system
- current industry's best practice in other jurisdictions
- demonstrated evidence of the actual and expected long term benefits

4.0 Improved Reliability of the System

Figure 2 illustrates the reliability improvement of the Island Interconnected System. The pilot project on WPLM started in 2003 with a 2 year duration. Full program was launched in 2005.

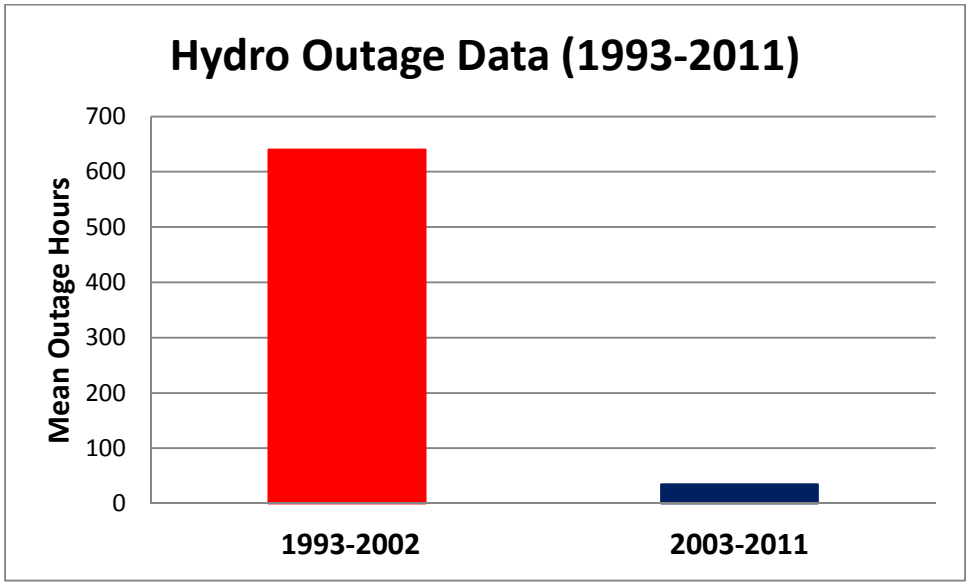

Figure 2a: Outage Data for NLH Transmission Line Network (Wood Pole Lines)

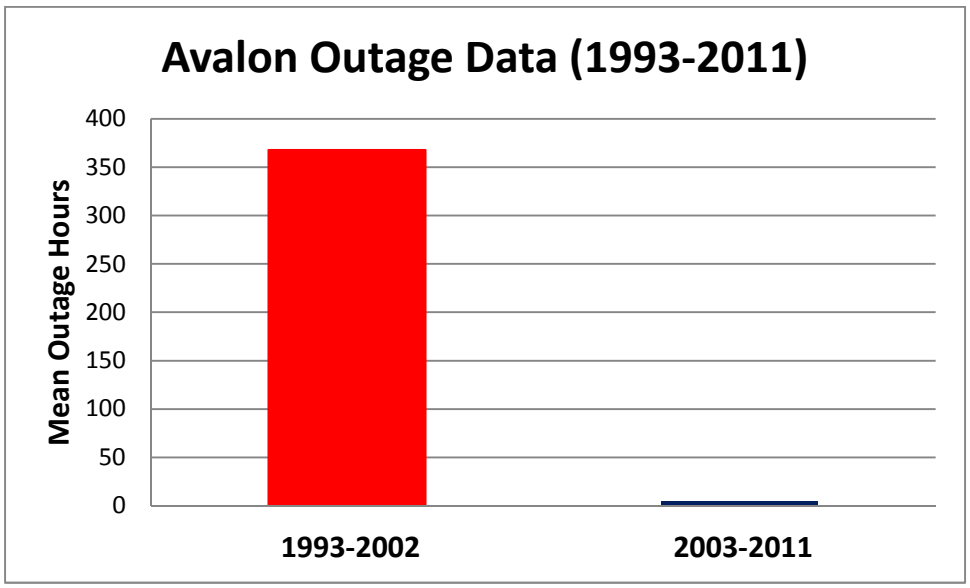

Figure 2b: Outage Data for Avalon Transmission Line Network (Wood Pole Lines)

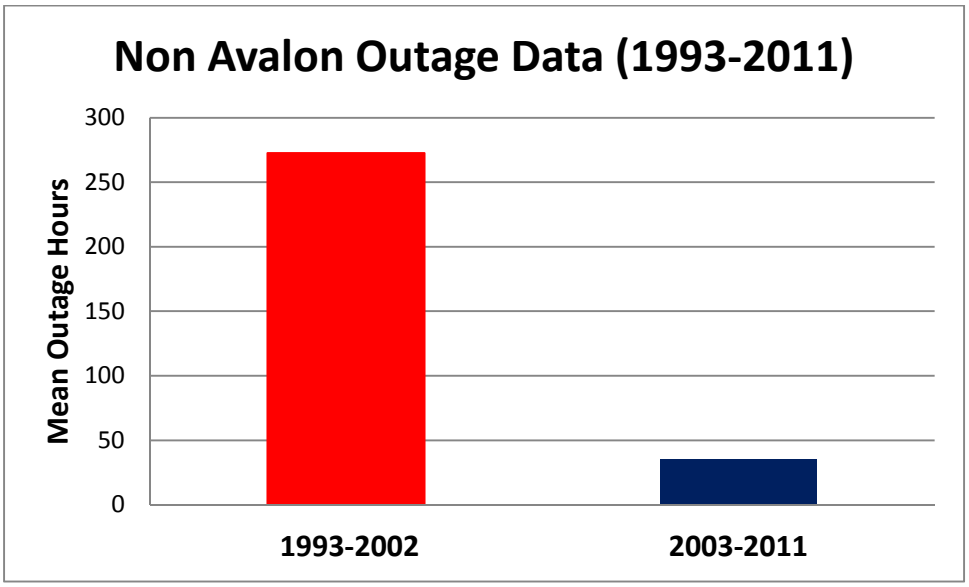

Figure 2c: Outage Data for Non Avalon Transmission Line Network (Wood Pole Lines)

As shown in the above figures the outage data demonstrates that there have been no failures on Hydro's transmission system on the Avalon Peninsula since the WPLM program was launched in 2005. During this same period, the Avalon has experienced severe wind and ice storm events. On the Avalon Peninsula the improvement is 100 percent. The non Avalon Island Interconnected System has experienced an 85 percent reliability improvement. A step change improvement in reliability has been realized throughout the province in conjunction with the implementation of the WPLM program.

5.0 Industry Best Practice

Two benchmarking criteria were used to compare Hydro's WPLM program data with industry best practice. The first considers the annual cost of maintenance with respect to the replacement asset value (RAV). Based on Avalon pole plant asset data, the ratio of average annual maintenance cost over RAV is 0.32 percent, well below the generally accepted industry best practice of one to four percent.

The second criterion uses other utilities' replacement rate data obtained from various sources Hydro's current WPLM program is in line with many utilities' best practices within North America. A recent CEATI survey (Goel, 2012) conducted by the Wind and Ice Storm Mitigation Interest Group (WISMIG) indicated that most utilities have

- Regular inspection program
- Preventative treatment program
- Realized life extension

The comparison of our replacement rate and the expected mean life is also in line with other utility data when one considers the variability in climatic conditions. Our comprehensive inspection and maintenance program enables measurement and comparison on an ongoing basis to ensure the program continues to deliver against stated objectives.

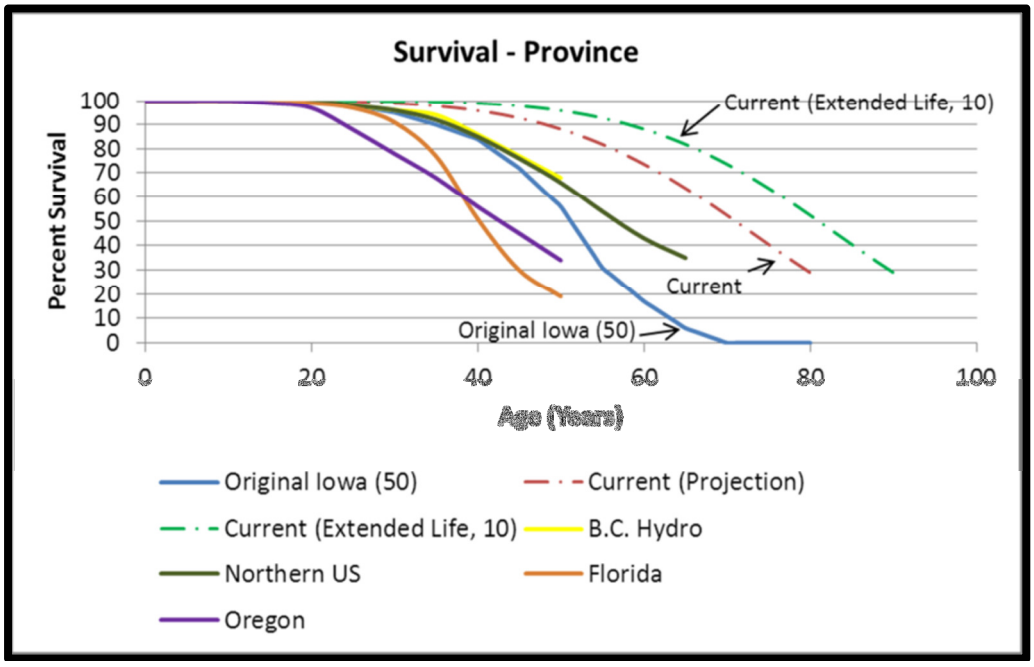

Figure 3: Comparison with Other Utilities Data

Figure 3 compares typical wood pole plant survival rates and indicates demonstrable value from the WPLM program as compared to other North American utilities.

The comprehensive inspection and maintenance program of the WPLM program provides the basis to ensure the right money is spent, on the right assets, at the right time. To put this into perspective, Hydro's pole replacement rate is 0.33 percent per year compared to the published data of 0.5 percent to 0.7 percent per year for the west coast of North America. The continued collection and analysis of field data through the WPLM program is critical to extracting this demonstrated value.

6.0 Demonostrated Benefits

6.1 Reliability Improvements

The outage data shows that 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 and a number of wind storms including Hurricane "Igor" in 2010. This excellent performance is attributable to the on-going inspection and preventative treatment program that Hydro has carried out since 2005.

6.2 Asset Life Extension

A standard 50-year IOWA curve is an accepted industry benchmark. The 50-year curve shown below indicates that 50 percent of pole plant asset is typically replaced by the time the asset age has reached 50 years. Figure 4 illustrates the survival curve for the pole plant asset (NLH Wood Pole Transmission Line System).

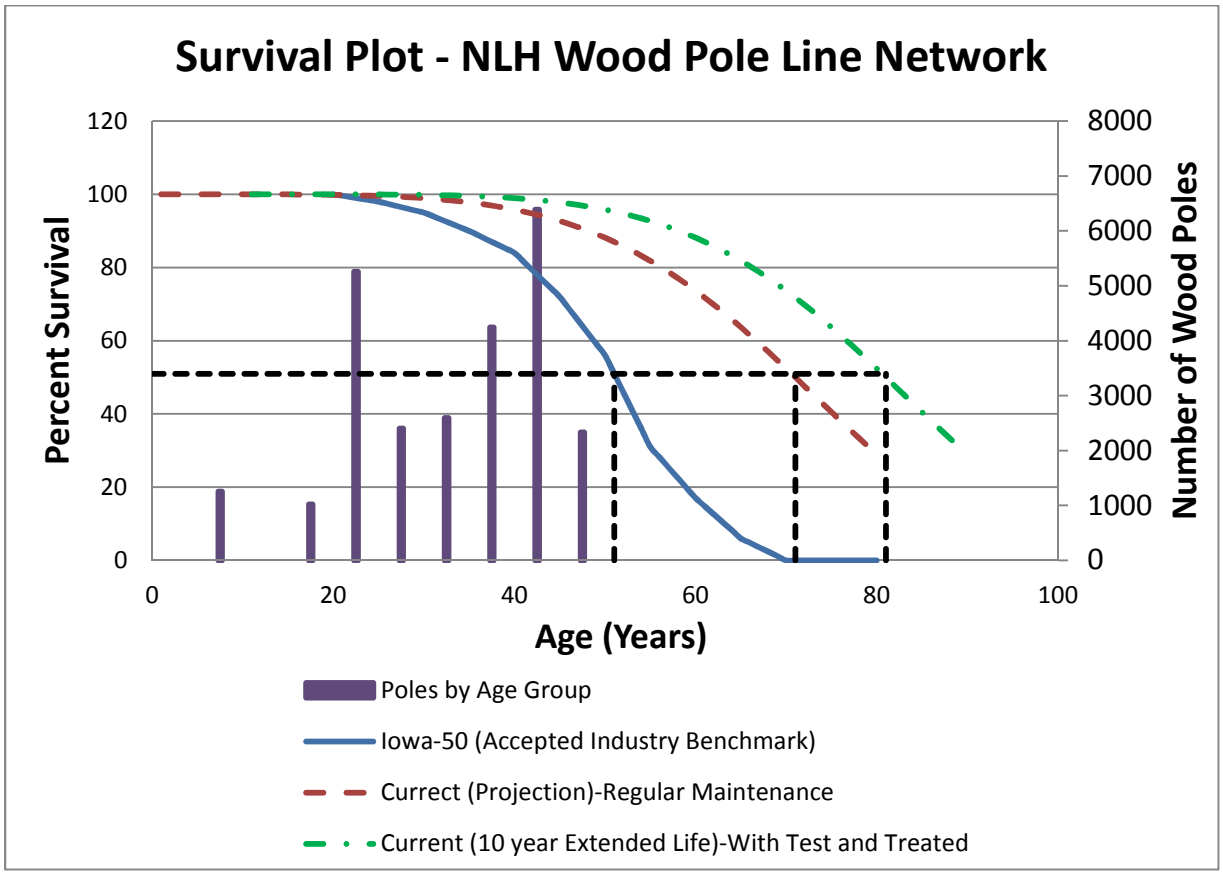

Figure 4: Survival Curves for the Pole Plant Asset (NLH Transmission Line System) and the Asset Age Distribution

Data analysis from the first seven years of the WPLM program is aligned with an incremental increase in effective average pole life. This gain in the expected asset life of the entire pole plant asset can be achieved through the successful continuation of this WPLM program.

Figure 5 utilizes the data from three inspection cycles (1985, 1998 and 2005) for the Avalon pole system. Our own original data closely follows the IOWA curve. Furthermore, it is expected that the pole treatment program will extend the life of pole plant asset. This is shown by the dotted green curve. Based on this curve, the expected mean life is 70 years, which is significantly higher than the conventional economic life of 40 years normally used in the industry (Mankowski, Hansen and Morrell, 2002), and 20 years longer than the benchmark IOWA. As a result of the life extension now being realized, Hydro has revised our asset

depreciation of pole life from an average economic life of 40 years to an average life of 53 years.

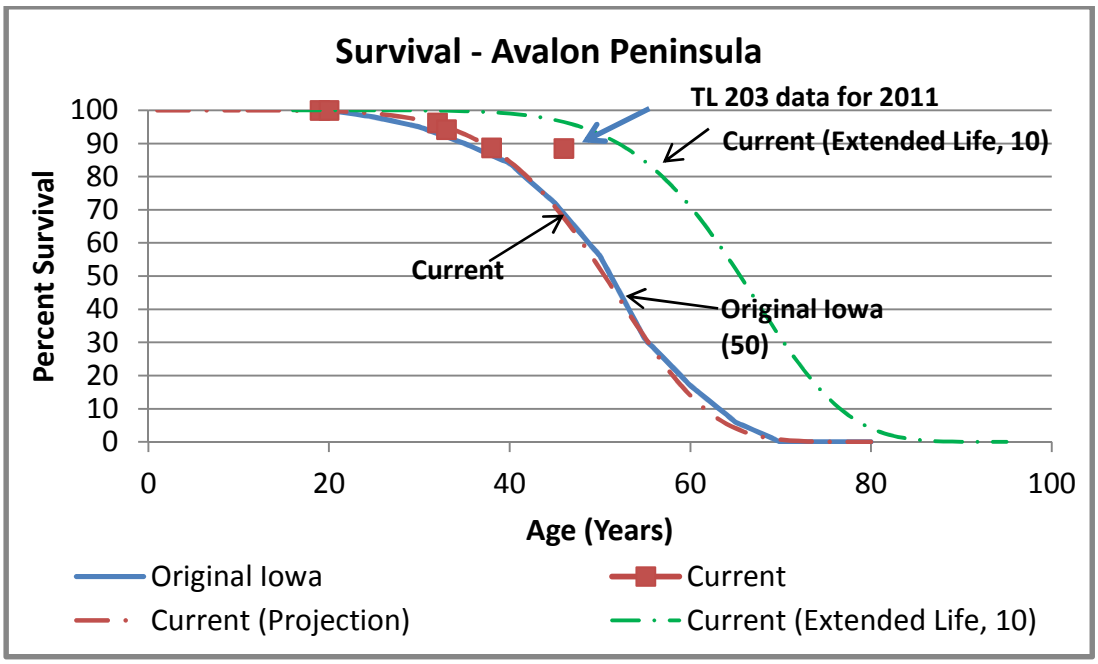

Figure 5: Survival Curves for Avalon Pole Plant Asset

6.3 Reduced Total Cost of Ownership

Based on our own cost data, Figure 6 compares the unplanned replacement cost versus planned replacement cost of a pole.

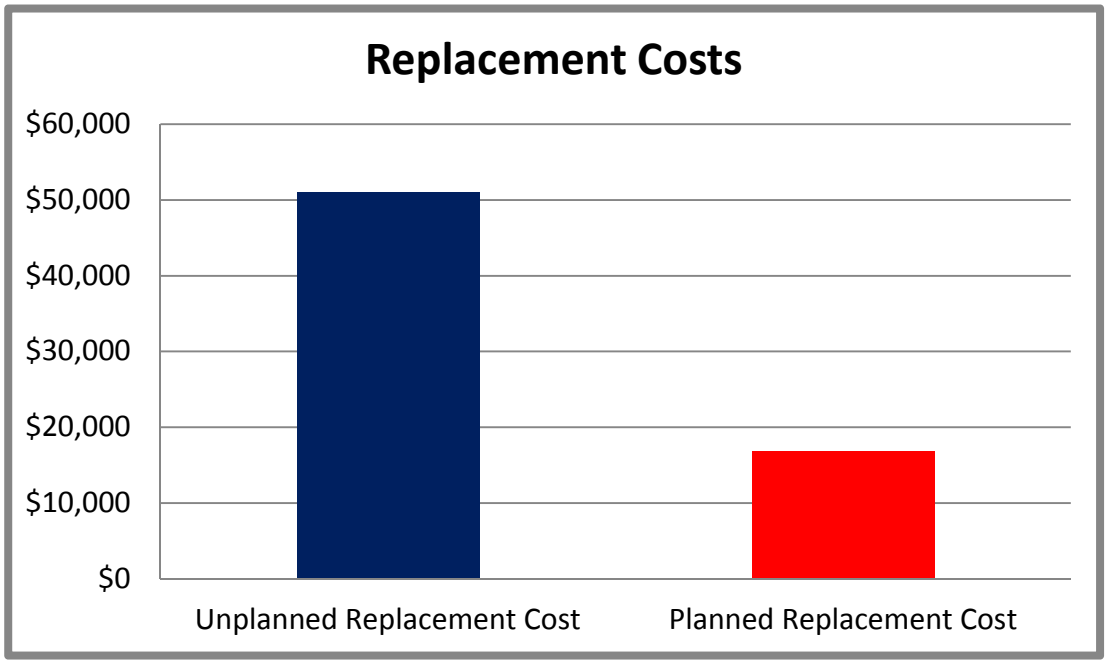

Figure 6: Comparison of Costs – Unplanned versus Planned (ratio 3:1)

6.3.1 NPV Analysis of Cost Deferral - New asset versus Existing asset

By maintaining the asset health in good condition, Hydro will be able to defer the cost of replacing the pole plant asset (i.e. building new lines). Figure 7 shows the net present value of the asset replacement cost for a service life of 50 years calculated for the 10 year period of 2017-2026. This cost is compared with the maintenance cost under the WPLM program during the same period. The rate payer will benefit from cost avoidance by not replacing the Avalon pole line system in 2017 because the lines can be maintained for an incremental ten year period until 2026 and potentially beyond 2026 depending on what Hydro finds during the next 5 year inspection cycle.

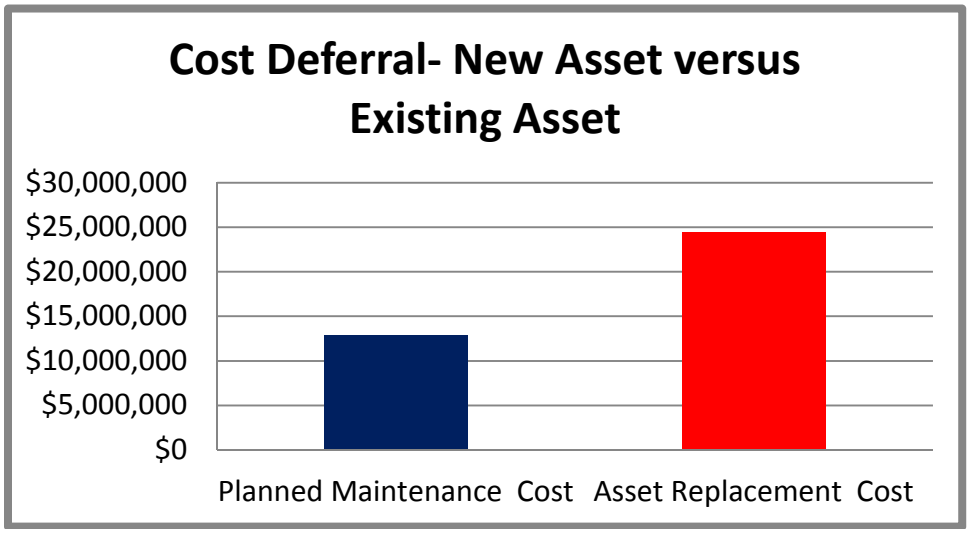

Figure 7: Benefit of WPLM program – Cost Deferral for New Asset

7.0 Non-destructive Tests

Hydro's WPLM program is a comprehensive pole inspection, test and treatment program. It consists of two 10-year cycles initiated in 2005. Under this program poles are inspected by sounding, boring and visual means. Poles are then internally treated with preservative where appropriate, and identified for scheduled repair, or replacement if deemed necessary. A limited number of full scale tests are also done each year to validate the field data. Figure 8 presents the summary of defects found during the inspection of Island Interconnected System.

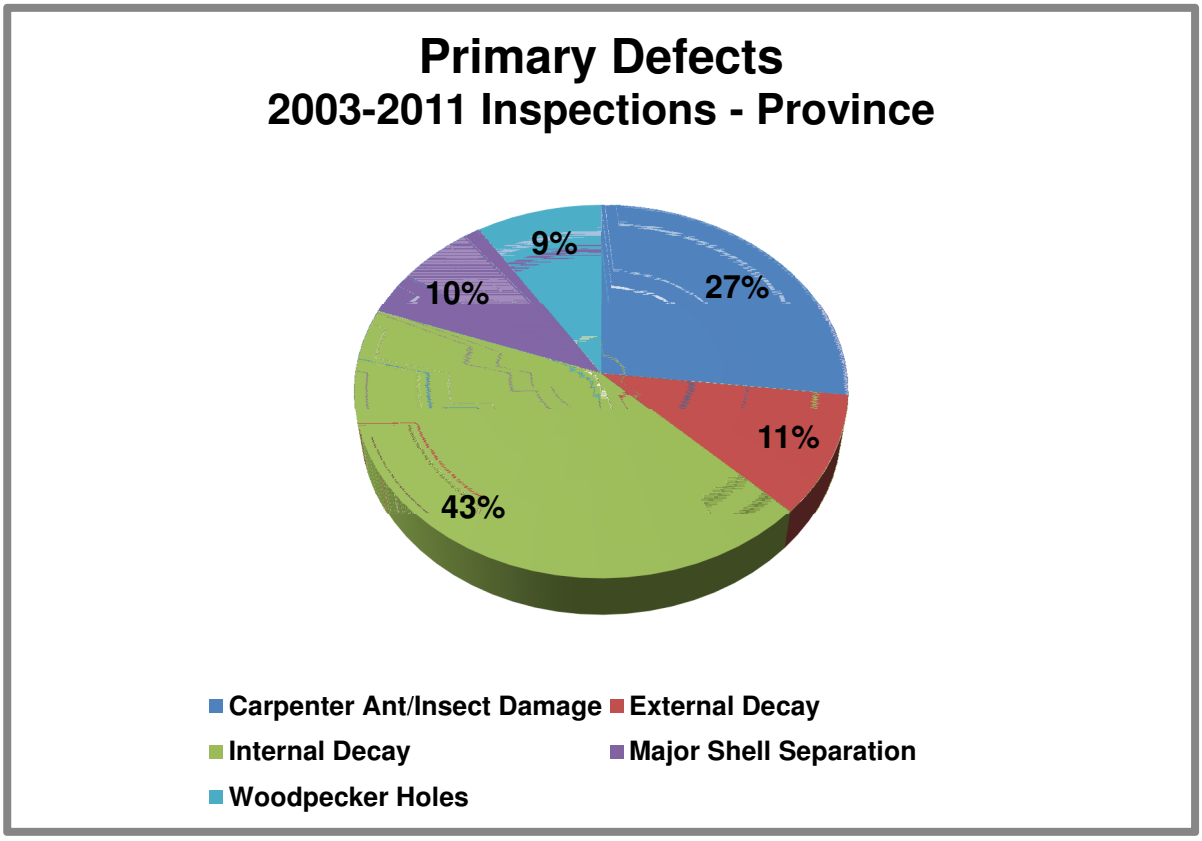

Figure 8: Primary Defects found During the Inspection of Avalon Pole System

Major findings from the field tests are:

- Pole strength and capacity declines with age; and
- Danger poles (not climbable) or the poles that do not meet the design strength must be replaced to maintain safety and avoid forced outages.

8.0 Summary

In summary, Hydro's WPLM program is achieving the goals of increasing reliability, extending asset life, and reducing total cost of ownership. This WPLM program is well aligned with best practices used in the industry. The results clearly demonstrate 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 life extension of existing pole plant assets by at least 10 years. The overall pole replacement rate per year is well below the published industry data. The development of a rigorous methodology to assess and analyze the pole inspection data ensures we continue to proactively identify the right level of expenditure on the right poles at the right time.

9.0 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/)

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