newfoundland labrador hydro
a nalcor energy company

Hydro Place. 500 Columbus Drive.
P.O. Box 12400. St. John's. NL
Canada A1B 4K7
t. 709.737.1400 f. 709.737.1800
www.nlh.nl.ca

July 28, 2016

Board of Commissioners
of Public Utilities
P.O. Box 21040
St. John's, NF
A1A 5B2

Attention: Cheryl Blundon – Director of Corporate Services and Board Secretary

Dear Ms. Blundon:

Re: Newfoundland and Labrador Hydro – 2017 Capital Budget Application

Please find enclosed twelve copies, plus the original, of Hydro's 2017 Capital Budget Application, in three volumes, filed in accordance with the Provisional Capital Budget Application Guidelines issued by the board in October of 2007 and in accordance with the guidelines and conditions for capital budget proposals as outlined by the Board in Order No. P.U. 7(2002-2003). Under this Application, Hydro is seeking approval of $271.4 million in capital expenditures.

Hydro trusts that you will find the enclosed to be in order and satisfactory. Should you have any questions or comments about any of the enclosed, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Tracey L. Pennell
Senior Counsel, Regulatory

TLP/cp

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales
Dean Porter – Poole Althouse
Sheryl Nisenbaum – Praxair Canada Inc.
Thomas Johnson, Q.C. – Consumer Advocate
Thomas J. O'Reilly, Q.C. – Cox & Palmer
Larry Bartlett – Teck Resources Limited

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IN THE MATTER OF the *Public Utilities Act*, (the "Act"); and

IN THE MATTER OF an Application by Newfoundland and Labrador Hydro for an Order approving: (1) its 2017 capital budget pursuant to s.41(1) of the Act; (2) its 2017 capital purchases, and construction projects in excess of $50,000 pursuant to s.41 (3) (a) of the Act; (3) its leases in excess of $5,000 pursuant to s. 41 (3) (b) of the Act; and (4) its estimated contributions in aid of construction for 2017 pursuant to s.41 (5) of the Act.

TO: The Board of Commissioners of Public Utilities (the Board)

THE APPLICATION of Newfoundland and Labrador Hydro (Hydro) states that:

1. Hydro is a corporation continued and existing under the Hydro *Corporation Act, 2007,* is a public utility within the meaning of the *Act* and is subject to the provisions of the *Electrical Power Control Act, 1994*.

2. Section A to this Application is Hydro's proposed 2017 Capital Budget in the amount of approximately $271.4 million prepared in accordance with the guidelines and conditions outlined in Order No. P.U. 7(2002-2003) and the Capital Budget Application Guidelines issued October 29, 2007.

3. Section B to this Application is Hydro's proposed 2017 Capital Budget with multi-year projects listed separately and prepared in accordance with the guidelines and conditions outlined in Order No. P.U. 7(2002-2003) and the Capital Budget Application Guidelines issued October 29, 2007.

4. Section C to this Application is a list of the proposed 2017 Construction Projects and Capital Purchases for $500,000 and over, prepared in accordance with Order No. P.U. 7(2002-2003) and the Capital Budget Application Guidelines.

5. Section D to this Application is a list of the proposed 2017 Construction Projects and Capital Purchases for $200,000 and over, but less than $500,000, prepared in accordance with Order No. P.U. 7(2002-2003) and the Capital Budget Application Guidelines.

6. Section E to this Application is a list of the proposed 2017 Construction Projects and Capital Purchases in excess of $50,000 but less than $200,000 prepared in accordance with Order No. P.U. 7(2002-2003) and the Capital Budget Application Guidelines.

7. Section F to this Application summarizes Hydro's proposed 2017 capital projects by definitions, by classification and by materiality as required by the Capital Budget Application Guidelines.

8. Section G contains no new leases proposed for 2017 in excess of $5,000 per year.

9. Section H to this Application is a Schedule of Hydro's Capital Expenditures for the period 2012 to 2021.

10. Section I to this Application is a report on the status of the 2016 capital expenditures including those approved by Order No. P.U. 33(2015), projects under $50,000 not included in these Orders, and the 2015 capital expenditures carried forward to 2016.

11. Section J to this Application is a report on the ten year Plan of Maintenance Expenditures for the Holyrood Generating Station required to be filed by Order No. P.U. 14(2004).

12. Volume II and Volume III to this Application contain the supplementary reports referred to in various capital budget proposals.

13. The proposed capital expenditures for 2017 as set out in this Application are required to allow Hydro to continue to provide to its customers service and facilities which are reasonably safe, adequate and reliable as required by Section 37 of the Act.

14. Hydro has estimated the total of contributions in aid of construction for 2017 to be approximately $300,000 for distribution upgrades and service extensions. The information contained in the 2017 Capital Budget (Section A) takes into account this estimate of the contributions in aid of construction to be received from customers. All contributions to be recovered from customers shall be calculated in accordance with the relevant policies as approved by the Board.

15. Communications with respect to this Application should be forwarded to Tracey L. Pennell, Senior Counsel, Regulatory, Telephone: (709) 778-6671, P.O. Box 12400, St. John's, Newfoundland and Labrador, A1B 4K7, Fax: (709) 737-1782.

16. Hydro requests that the Board make an Order as follows:

    (1) Approving Hydro's 2017 Capital Budget as set out in Section A hereto, pursuant to section 41 (1) of the Act;

    (2) Approving Hydro's 2017 Capital Purchases and Construction Projects in excess of $50,000 as set out in Sections C, D, and E hereto, and its leases as set in Section G, pursuant to section 41 (3) of the Act; and

    (3) Approving the proposed estimated contributions in aid of construction as set out in paragraph 14 hereof for 2017 as required by section 41 (5) of

the Act, with all such contributions to be calculated in accordance with the policies approved by the Board.

DATED at St. John's, Newfoundland, this 28th day of July 2016.

NEWFOUNDLAND AND LABRADOR HYDRO

Tracey L. Pennell,
Senior Counsel, Regulatory
Newfoundland and Labrador Hydro,
500 Columbus Drive, P.O. Box 12400
St. John's, Newfoundland, A1B 4K7
Telephone: (709) 778-6671
Facsimile: (709) 737-1782

IN THE MATTER OF the *Public Utilities Act*, (the "Act"); and

IN THE MATTER OF an Application by Newfoundland and Labrador Hydro for an Order approving: (1) its 2017 capital budget pursuant to s.41(1) of the Act; (2) its 2016 capital purchases, and construction projects in excess of $50,000 pursuant to s.41 (3) (a) of the Act; (3) its leases in excess of $5,000 pursuant to s. 41 (3) (b) of the Act; and (4) its estimated contributions in aid of construction for 2017 pursuant to s.41 (5) of the Act.

AFFIDAVIT

I, James R. Haynes, Professional Engineer, of St. John's in the Province of Newfoundland and Labrador, make oath and say as follows:

1. I am President, Newfoundland and Labrador Hydro, the Applicant named in the attached Application.

2. I have read and understand the foregoing Application.

3. I have personal knowledge of the facts contained therein, except where otherwise indicated, and they are true to the best of my knowledge, information and belief.

SWORN at St. John's in the Province of Newfoundland and Labrador, this 28th day of July 2016, before me:

Barrister – Newfoundland and Labrador

James R. Haynes

A Report to the

Board of Commissioners of Public Utilities

2017 Capital Projects Overview

newfoundland labrador hydro
a nalcor energy company

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1 INTRODUCTION

Pursuant to the provisions of the *Hydro Corporation Act, 2007*, the *Electrical Power Control Act, 1994*, and the *Public Utilities Act*, Hydro is required to provide reliable service to its customers. The provision of safe, reliable, least cost supply of electricity requires that Hydro continuously maintain, refurbish, renew, and expand its generation, transmission and distribution assets, and the assets that support those systems. Hydro must also address changing environmental and other regulatory requirements, challenges which often require the acquisition of new assets or improvement to existing assets. Hydro's long term planning initiatives are framed in the context of the following key drivers: the interconnection between Labrador and the Island via the HVdc link, the interconnection of the Island with Nova Scotia system via the Maritime link, and continued load growth on the Avalon Peninsula. This Overview will discuss the projects proposed for 2017. Discussion of the five year plan is contained in the section entitled "2017-2021 Capital Plan".

2 2017 PLAN CONSIDERATIONS

Maintaining Hydro's systems in reliable operating condition is accomplished through a combination of planned maintenance, rehabilitation of existing assets, and replacement of assets which have reached the end of their useful lives. Replacement of assets may result in lower life cycle costs or improved operational characteristics. Assets may be also replaced, as required, for load growth or reliability criteria violations.

The majority of Hydro's installed assets, like the hydroelectric installation at Bay d'Espoir, the Holyrood Thermal Generating Station, and much of Hydro's transmission and distribution systems, are more than 40 years old. In addition, many other generation assets, such as the Stephenville Gas Turbine, the Hardwoods Gas Turbine and the Hinds Lake Generating Station are more than 30 years old.

The sustaining capital proposals, focused on maintaining current assets, contained in this application and in previous applications, appropriately consider both the age and condition of Hydro's existing assets in determining whether to renew or replace them. The number of these sustaining capital proposals can be expected to increase with the continuous assessment of the condition of the aging assets. In other cases, the introduction of newer, more efficient technologies justifies the replacement of equipment.

The age of Hydro's assets also has implications for efficient operating methods and safety. Some of Hydro's generating plants were constructed at a time when most systems and auxiliary equipment were manually operated. Today, most equipment is automated or remotely controlled, allowing operators to focus on maximizing efficiency and equipment monitoring. This Application contains proposals which seek to improve the safety of Hydro's workplaces and to implement automation or improvements in the control of equipment that enable the safe and efficient operation of assets.

In the development of a capital proposal, consideration is given to:

- System performance and reliability criteria;
- Long term asset management strategy;
- Load growth and system planning criteria;
- Maintenance history;
- Condition assessment;
- Performance assessment;
- Legislative requirements;

- Cost efficiencies;
- Operating experience;
- Changing operating conditions;
- Familiarity with equipment;
- Operating and Maintenance cost; and
- Professional judgment.

There are three broad categories of replacement criteria:

- Time and condition based, such as diesel generators (100,000 hours of operation) and vehicles (combination of years and operating hours for some classes);
- Condition based, such as transmission line wood poles; and
- Technical assessment based, where an evaluation of reliability, performance, condition, costs and other factors results in a capital proposal.

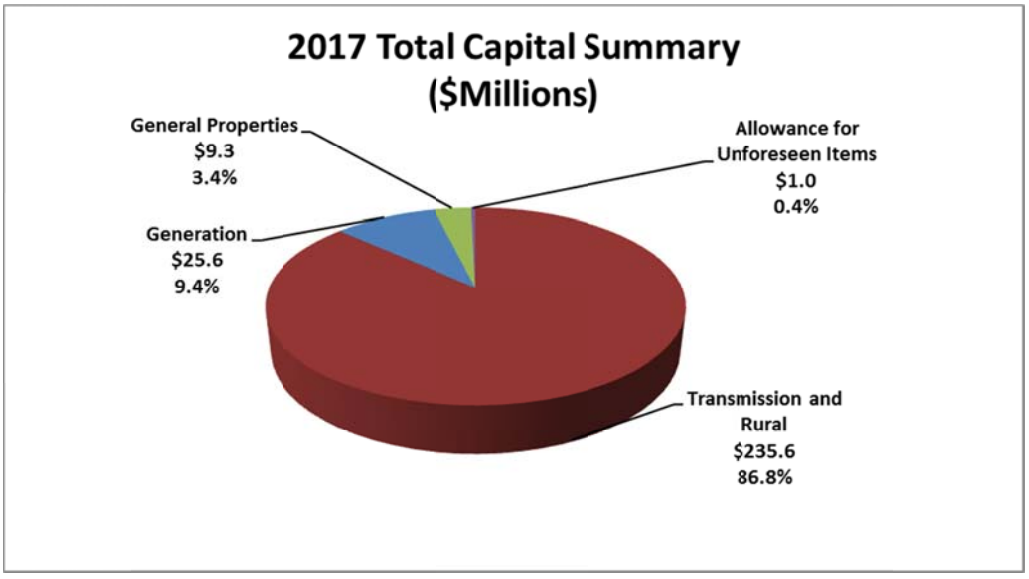
3 2017 CAPITAL BUDGET

This Application contains a capital plan in which the primary consideration is least cost and reliable generation, transmission and distribution of electricity while maintaining and enhancing safety and environmental performance.

This 2017 Capital Budget Application contains 64 new projects. These new projects include the refurbishment of generation facilities, planned life extension of gas turbines, and terminal station modernization and upgrades. Including budgets for previously approved projects, the 2017 capital expenditure totals $271.4 million. Expenditures in 2017 also include $408,000 for Front End Engineering and Design (FEED) on a number of projects planned for 2017. All 2017 projects address both the need to sustain the existing asset base and to grow the asset base in response to growing customer demand.

Chart 1 shows the 2017 Capital Budget Summary by major category. The categories, other than the Allowance for Unforeseen Items, which represents 0.4% of the 2017 budget, are discussed further in the Overview.

Chart 1: 2017 Capital Budget – Summary



3.1 GENERATION

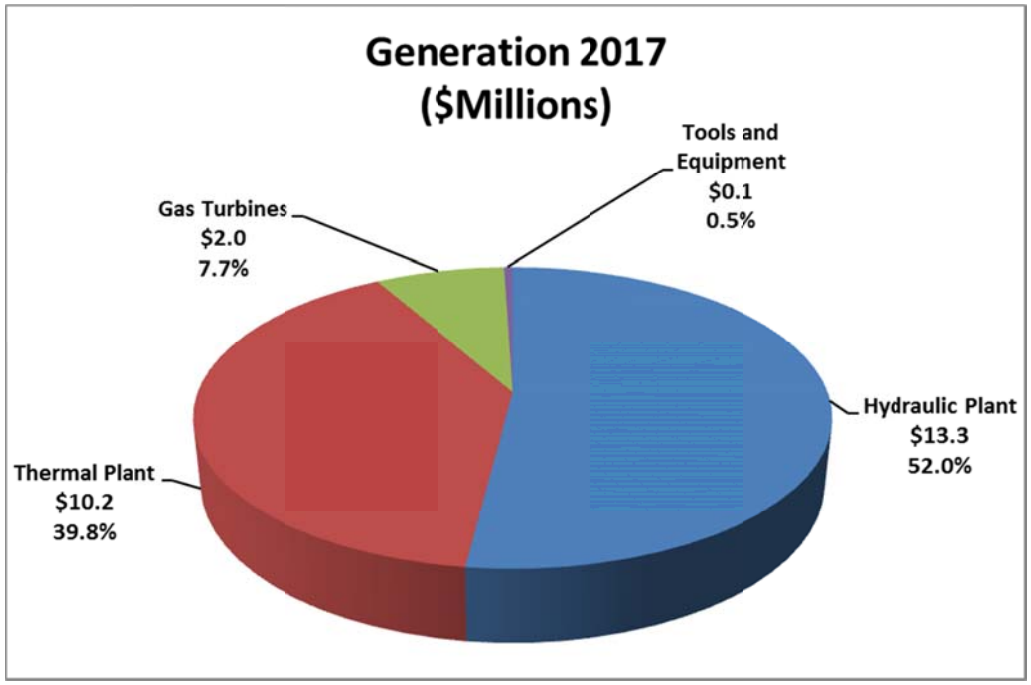
On the Island Interconnected System, power and energy are provided by Hydro through a mix of hydroelectric and fossil fuel fired generation, supplemented by power purchases. This energy production,

along with the transmission system, is managed by the Energy Control Centre to ensure economic and reliable dispatch of available resources.

The Generation category expenditures of $25.6 million account for 9.4% of overall expenditures for 2017.

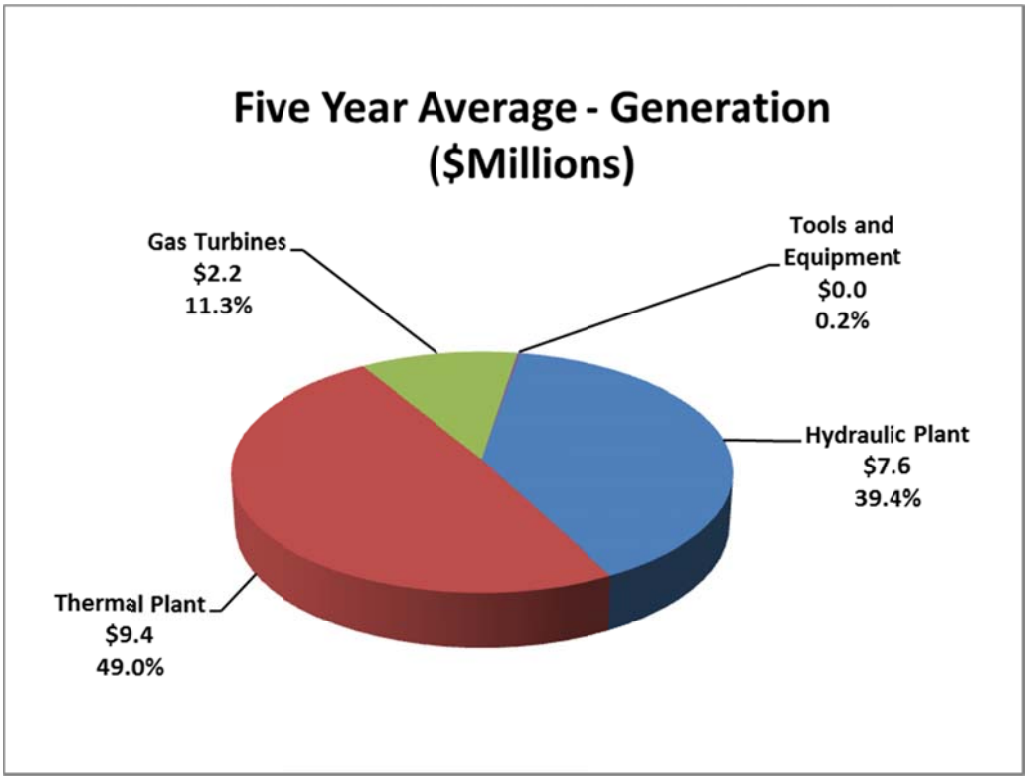
The division of the 2017 Capital Budget for Generation among Hydraulic Plant, Thermal Plant, Gas Turbines and Tools and Equipment expenditures is shown in Chart 2.

Chart 2: 2017 Capital Budget – Generation



The five-year (2011-2015) average capital expenditures for generation are shown in Chart 3.

Chart 3: Five-Year Average Capital Expenditures – Generation (2011-2015)



For 2017, Thermal Plant projects represent 39.8% of the Island Interconnected generation capital budget, compared with an average of 49.0% over the past five years. Thermal plant projects continue to require major capital expenditures as the majority of the equipment and systems have reached the final phase of their life cycle and, in some cases, have undergone life extension. Expenditures are required to ensure that these important generating assets can continue to operate reliably until retired and replaced. Projects at Hydraulic Plants represent 52.0% of the 2017 capital budget for generation, compared with an average of 39.4% over the past five years. The increase in Hydraulic Plant expenditures is primarily a result of the need to refurbish aging assets, particularly at Bay d'Espoir. Expenditures for Gas Turbines and Tools and Equipment represent 7.7% and 0.5%, respectively, of the total budgeted generation expenditures for 2017, compared with five year average expenditures of 11.3% and 0.2%, respectively.

3.1.1 Hydraulic Plant

Hydro's major hydraulic generating plants range from 13 to 49 years of age. Capital expenditures are required to ensure reliability and to maximize the useful operating lives of these assets, many of the

components of which have reached or are nearing the end of their expected service lives in the older plants. Examples of projects to be completed at the hydraulic plants include a proposal for refurbishment of control structures at generation plants and overhauls of two turbine generators, one at Cat Arm and one at Bay d'Espoir.

3.1.2 Thermal Plant

The three units of the Holyrood Thermal Generating Station have now reached or exceeded their generally expected service life of 30 years. Continued condition assessment and selective life extension will permit them to operate reliably until the Labrador Island Link[1] is in service and providing power to the Island Interconnected customers. In the interim, Holyrood remains critical to the reliable supply of power to the Island Interconnected System and is required to supply electricity in the short to medium term.

The long term operational plan for this facility has been developed in the context of the development of Muskrat Falls[1] with a high voltage direct current transmission link to the Island. Holyrood will remain a critical facility during construction and commissioning of the Muskrat Falls Project. When the Labrador Island Link goes into service, the Holyrood plant will continue to be an essential component of the Island Interconnected System. Initially, the plant will function as a fully capable standby facility during the early years of operation of the HVdc system. After commissioning of the Muskrat Falls Project, the thermal assets will then be decommissioned and the facility will be partially converted to a synchronous condensing configuration.

The challenges faced by Hydro are complex because circumstances require that Holyrood must operate in a manner quite different than the norm for thermal plants. Conventional practice is that a thermal plant is base loaded throughout its life until it reaches maturity and is then operated as a peaking or standby facility in its final years, operating at a very low capacity factor, often less than 10%. The Holyrood thermal plant has passed the age at which other utilities have performed condition assessment and life extension studies, similar to Hydro's approach, and have either retired their facilities or have initiated major life extension projects. However, until the Muskrat Falls Generating Plant is completed and power is brought to the Island Interconnected System via an HVdc link, the Holyrood plant must continue to operate at or near its historical

[1] The 2017 Capital Budget Application does not detail modifications to Hydro's infrastructure due to implementation of the Lower Churchill Project (LCP), given that all aspects of incorporation of LCP are fully funded by the project. (Labrador Hydro Project Exemption Order (O.C. 2000-206 & O.C. 2000-207) Newfoundland and Labrador Regulation 92/00 and Muskrat Falls Project Exemption Order (O.C. 2013-342) Newfoundland and Labrador Regulation 120/13)

levels with annual capacity factor in the range of 35 to 45% and at higher levels through the winter period when availability is critical to meet peak demand. The Holyrood capital projects contained in this application are necessary to refurbish and renew assets which are at the end of their useful service lives, and which must be replaced to maintain reliability through to the completion of the Muskrat Falls development.

Please see the Holyrood Overview section for further discussion pertaining to the proposed 2017 Holyrood projects.

3.1.3 Gas Turbines

Hydro's gas turbine plants at Stephenville and Hardwoods are more than thirty years old, exceeding the generally accepted life expectancy of twenty-five to thirty years for gas turbine plants. As noted in a previous application, further complicating the age of the facilities, is the lack of availability of factory technical support and spare parts for these facilities.

Therefore, based on the issues noted above and the results of condition assessments of the Hardwoods and Stephenville gas turbines, Hydro has planned for refurbishment of these facilities to ensure that they operate reliably and that their useful service lives can be extended as long as can be financially justified. The maintenance of the gas turbines at Hardwoods and Stephenville Gas Turbine will remain a part of Hydro's integrated generation plan until their expected retirement in 2025 and 2028 for Hardwoods and Stephenville, respectively.

3.2 TRANSMISSION AND RURAL OPERATIONS

Hydro owns and operates diesel and gas turbine generation with 32.1 MW of net capacity on the Labrador Interconnected system; 14.7 MW of diesel generation on the Island Interconnected system; and diesel generation assets with 33.7 MW of net capacity in 21 isolated rural systems. On the Island Interconnected system, Hydro owns and operates 3,473 kilometers of transmission lines and more than 50 high voltage terminal stations operating at voltages of 230, 138 and 69/66 kV. On the Labrador Interconnected System, Hydro owns and operates 269 kilometers of 138 kV transmission line and the associated terminal stations interconnecting Happy Valley/Goose Bay to Churchill Falls. As of January 1, 2015, Hydro took over operating responsibility for the Wabush Terminal Station and the two 230 kV transmission lines that were previously owned by TwinCo. In addition, Hydro owns and operates approximately 3,400 kilometers of distribution lines, principally in rural Newfoundland and Labrador.

Hydro's Transmission and Rural Operations assets are replaced based on age and condition, and require ongoing capital expenditures to maintain reliable service, to comply with environmental regulations, and to ensure the safety of employees, contractors, and the general public. Capital expenditures to provide service extensions remain significant in many areas; however, capital expenditures to provide service extensions on the Labrador Interconnected System have softened considerably with average expenditures in the past two years amounting to 55% of the average expenditures in the previous three years.

Expenditures in the Transmission and Rural Operations category account for 86.8% of overall expenditures for 2017, totaling $235.6 million.

The division of the 2017 Capital Budget for Transmission and Rural Operations is shown in Chart 4. Chart 5 provides the five year average expenditures in the Transmission and Rural Operations category. The increase in expenditure related to transmission in 2017, over the five year average expenditure, is mainly attributable to the already approved transmission lines between Western Avalon and Bay d'Espoir Terminal Stations (TL267) and between Soldier's Pond and Hardwoods (TL266), of which $150.0 million and $17.5 million are allocated in the 2017 Capital Budget, respectively. The increase in rural generation over the five year average expenditures is primarily attributable to the proposed installation of the replacement of diesel units at Port Hope Simpson and Charlottetown. The increase in expenditure at terminal stations over the five year average is largely attributable to the accelerated transformer and breaker replacement program.

Chart 4: 2017 Capital Budget - Transmission and Rural Operations

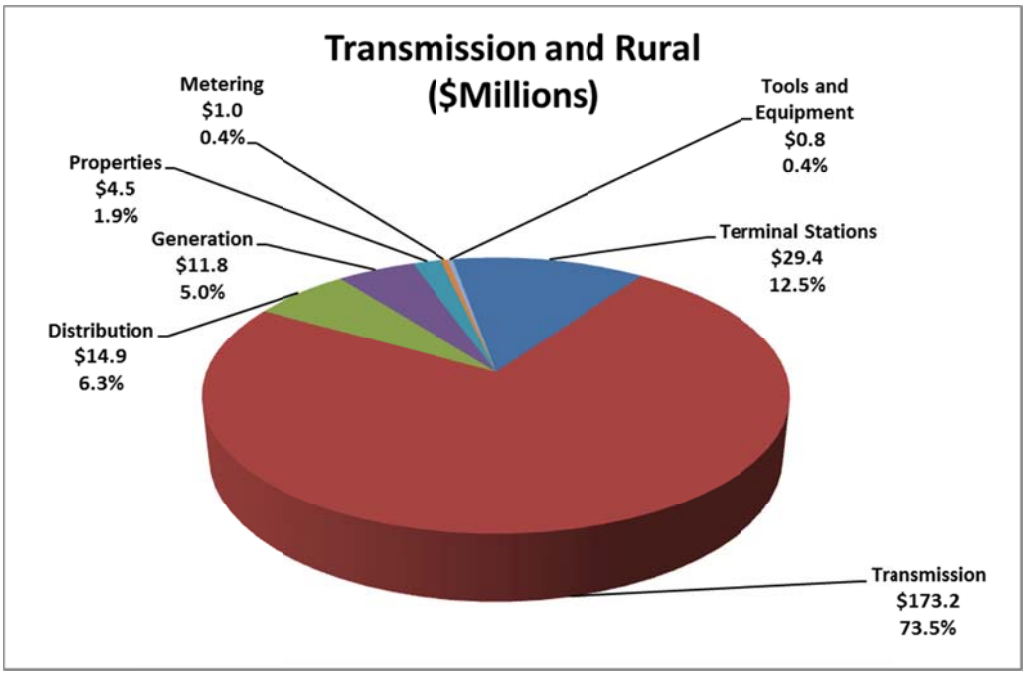
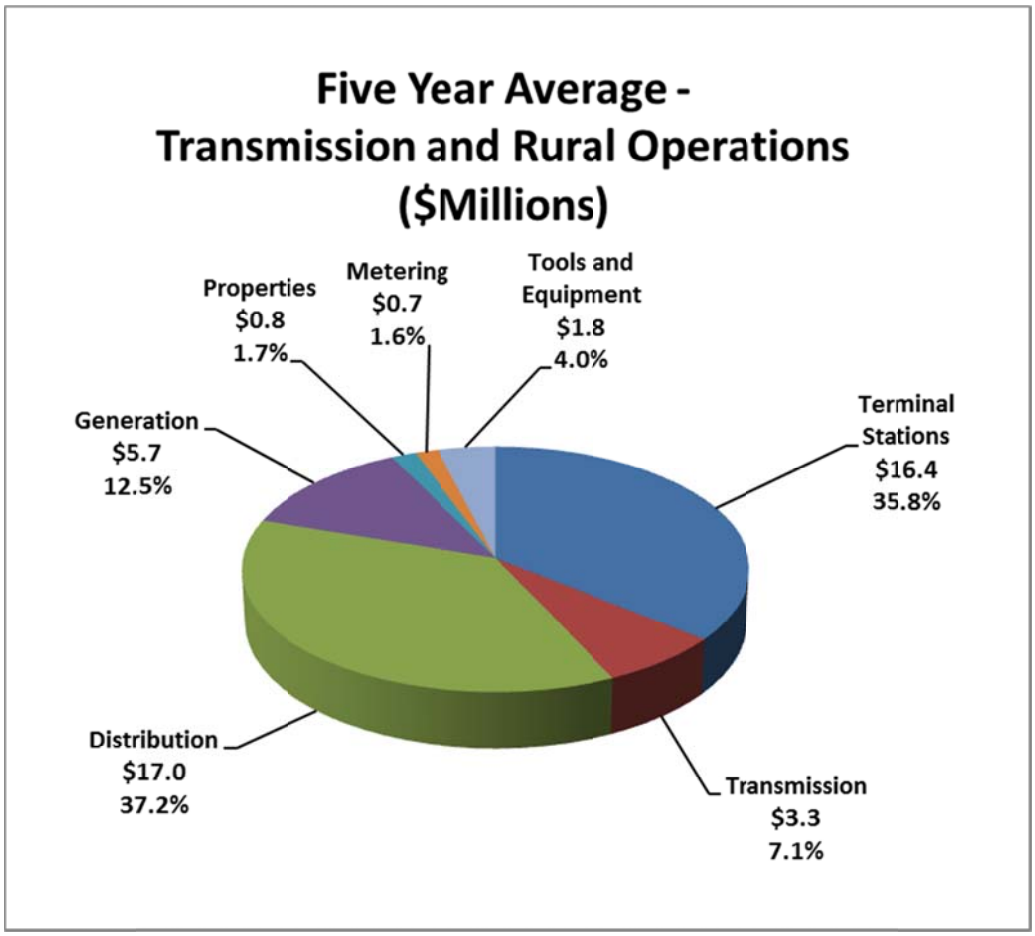


Chart 5: Five-Year Average Capital Expenditures – Transmission and Rural Operations (2011-2015)



3.2.1 Terminal Stations and Transmission

Many of Hydro's transmission lines and terminal stations were constructed in the 1960s with expected useful lives in the range of 40 years. Annual reconstruction and general upgrades are needed to ensure that Hydro can continue to provide customers with reliable electrical service. Within the 2017 submission, projects are proposed for the continued upgrade of power transformers and circuit breakers, as well as the replacement of surge arrestors, instrument transformers and disconnect switches. The transmission line projects include the ongoing transmission corridor upgrades between Bay d'Espoir and Western Avalon and between Soldier's Pond and Hardwoods, the continuation of the wood pole line management program, and the upgrade of tower foundations.

3.2.2 Distribution and Rural Generation

The 21 remote electrical systems along the coasts of Labrador and the Island are primarily served by diesel generation. Providing service to customers in these communities requires that the fuel storage, diesel generating units, facilities, and distribution systems all be kept in safe, reliable and environmentally responsible working order. This application includes projects specifically directed towards safely meeting load growth requirements, including the additions for load growth in isolated generation stations and the ongoing installation of fire protections systems in diesel plants. In addition, engine overhauls and replacements will be completed in various diesel plants.

Hydro also provides service to residential and general service customers on the Island and Labrador Interconnected Systems. Hydro has included projects in this application that are intended to ensure that distribution lines and equipment that require replacement due to age and condition are replaced prior to failure, thereby reducing the probability of interrupting service to customers. These projects include the upgrade of the distribution systems in various locations. This Application also includes projects to provide service extensions to new customers throughout Hydro's service area.

3.3 GENERAL PROPERTIES

The General Properties classification expenditures account for 1.9% of overall expenditures for 2017 and total $4.5 million.

The General Properties classification includes projects related to Hydro's information systems, where technology is strategically deployed in a wide variety of business applications. This section of the

Application also includes proposals for vehicle replacements and telecommunications system replacements which are all necessary for the provision of reliable and cost effective service to customers.

Charts 6 and 7 show the breakdown of the General Properties Capital Budget for 2017 and the previous five year average, respectively.

Chart 6: 2017 Capital Budget - General Properties

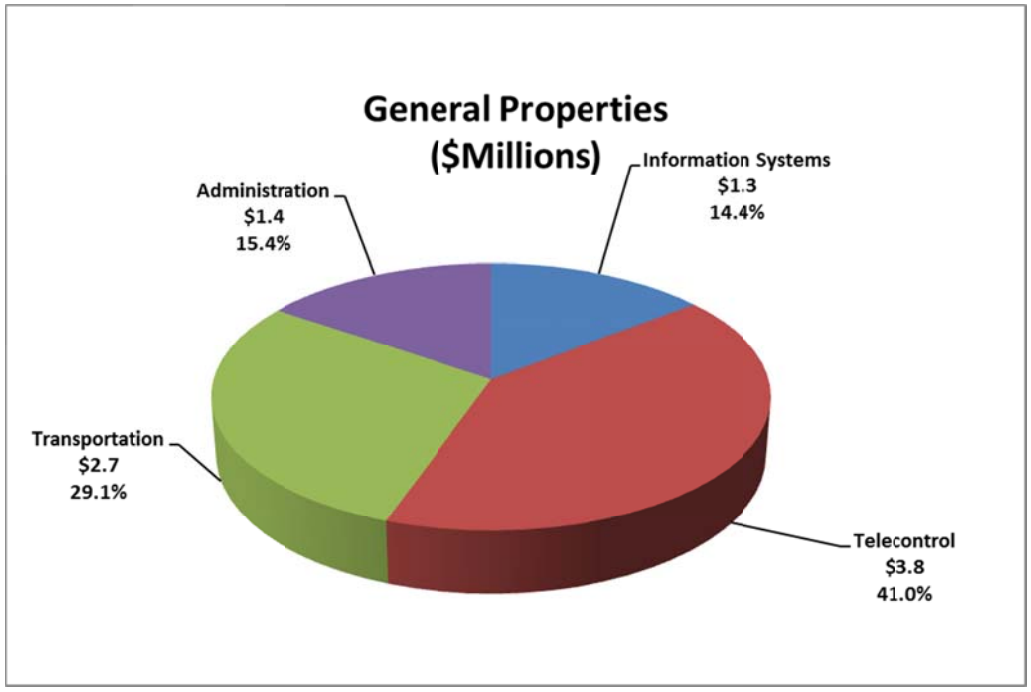
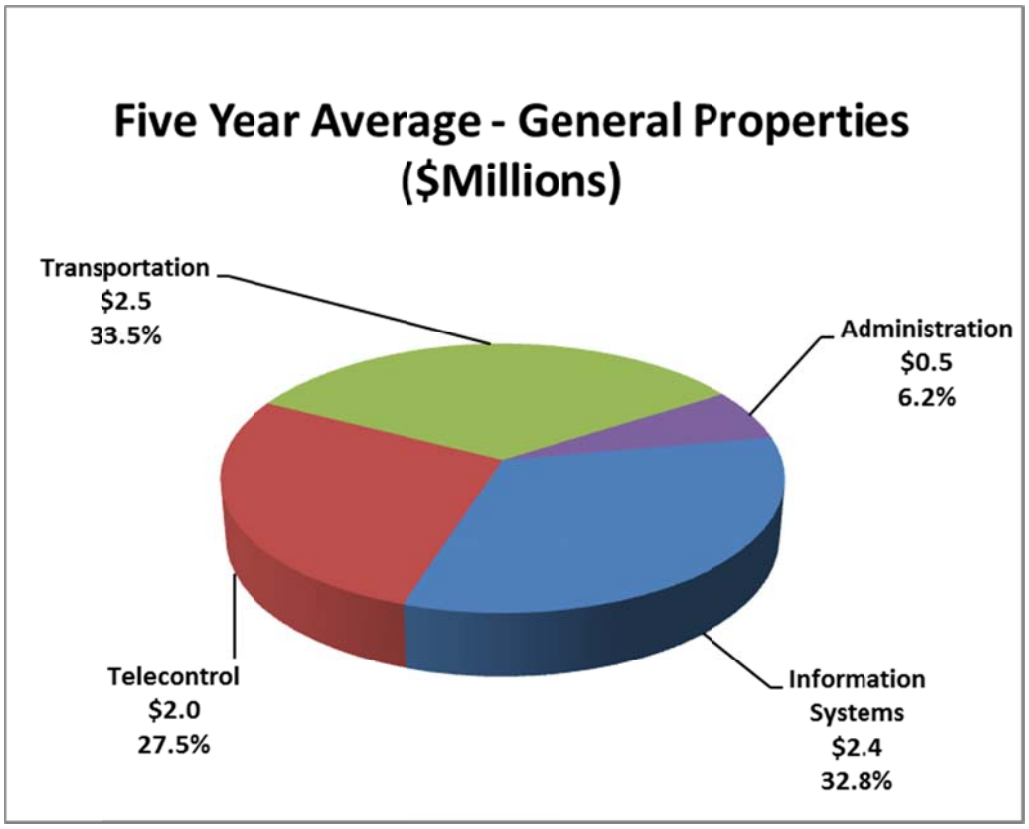


Chart 7: Five-Year Average Capital Expenditures - General Properties (2011-2015)



3.3.1 Information Systems

The Information Systems proposals are directed towards maintaining Hydro's computing capacity and associated infrastructure, ensuring that it remains current and reliable. Projects include upgrades to the software applications used throughout Hydro, upgrades to the energy management system, as well as the replacement of personal computers and peripheral infrastructure.

3.3.2 Telecontrol

Operating an integrated electrical system requires reliable communication systems across Hydro's province-wide facilities both to control equipment and to support employee communications, many of whom work in remote locations. The 2017 capital budget proposals in this category include infrastructure replacements, ongoing replacement or refurbishment programs for such items as battery banks and chargers, and network communications equipment.

4 GENERAL

4.1 Project Prioritization and Ranking

An overall ranking of 2017 projects is attached as Appendix A.

4.2 Phase 1 Engineering Costs

Hydro has tracked the Phase 1 engineering costs specific to each project and these costs form part of the 2017 capital budget submission. Therefore, Hydro's 2017 capital projects include Phase 1 engineering costs incurred in 2016 in association with those 2017 capital projects and Hydro proposes that the inclusion of those costs be approved.

Hydro has included Phase 1 costs in its capital budget proposals only in those cases in which the Phase 1 costs exceed $1,000 for that specific project. Phase 1 costs related to any specific project not receiving Board approval will not be capitalized. The total of these costs included in the 2017 capital budget submission is $408,000.

APPENDIX A

2017 Project Prioritization

PRIORITIZATION EXPLANATIONS

The following table shows the ranking of Hydro's 2017 capital projects. Rank 1 indicates the projects of the highest importance and in 2017; no projects with a ranking of more than 41 were included in the Application. The total of the projects included is determined based on balancing unit load, overall budget, and other logistical considerations. Projects that received the same score through the prioritization process have the same ranking. The seven projects which are Rank 1 are considered high priority projects required to address safety, mandatory or system load issues. Please note that the non-prioritized projects in the table are multi-year projects and necessary programs.

2017 Capital Budget and Five Year Plan 2017 Project Prioritization			
Project Description	**Cost ($000)**	**Rank**	**Cumulative Project Costs ($000)**
Multi-Year Projects (2017 is 2nd or 3rd Year)	46,170.3	******	46,170.3
TRO Service Extensions and Upgrades	8,140.0	******	54,310.3
Transportation	3,112.4	******	57,422.7
Tools & Equipment	880.1	******	58,302.8
Upgrade Public Safety Around Dams and Waterways - Bay d'Espoir	489.0	1	58,791.8
Install Fall Protection Equipment - Various Sites	194.7	1	58,986.5
Replace Recloser - Wabush	199.2	1	59,185.7
Install Demand Metering - Various Sites	89.7	1	59,275.4
Remove Safety Hazards - Various Sites	198.6	1	59,474.0
Inspect Fuel Storage Tanks - Various Sites	1,058.8	1	60,532.8
Purchase New Meter Calibration Test Console - Hydro Place	196.9	1	60,729.7
Install Automated Metering - Happy Valley	78.6	2	60,808.3
Overhaul Turbine Generator - Bay d'Espoir and Cat Arm	476.2	3	61,284.5
Overhaul Pumps - Holyrood	633.0	4	61,917.5
Overhaul Diesel Engines - Various Sites	2,095.9	5	64,013.4
Overhaul Turbine Valves, Unit 2 - Holyrood	2,302.1	5	66,315.5

2017 Capital Budget and Five Year Plan **2017 Project Prioritization**			
Project Description	**Cost ($000)**	**Rank**	**Cumulative Project Costs ($000)**
Condition Assessment and Miscellaneous Upgrades- Holyrood	2,437.3	6	68,752.8
Purchase Critical Spares - Hydraulic	487.4	6	69,240.2
Purchase Critical Spares - Thermal	321.5	6	69,561.7
Purchase Critical Spares - Gas Turbine	185.0	6	69,746.7
Purchase Critical Spares - Terminals	495.8	6	70,242.5
In Service Failures – Various Sites	1,000.0	6	71,242.5
Wood Pole Line Management Program - Various Sites	2,404.1	7	73,646.6
Terminal Station Refurbishment and Modernization	10,831.3	8	84,477.9
Upgrade Office Facilities and Control Buildings - Various Sites	2,197.3	9	86,675.2
Upgrade Energy Management System - Hydro Place	427.0	10	87,102.2
Replace Personal Computers - Hydro Place	401.4	10	87,503.6
Replace Network Communications Equipment - Various Sites	199.3	11	87,702.9
Upgrade Site Facilities - Various Sites	49.0	11	87,751.9
Upgrade Access Roads to Microwave Sites - Various Sites	118.4	11	87,870.3
Replace Battery Banks and Chargers -Various Sites	379.3	11	88,249.6
Replace Roof - Hydro Place	923.4	12	89,173.0
Upgrade Underground Plant Drainage System - Holyrood	923.1	13	90,096.1
Refurbish Main Generator Breaker - Upper Salmon	271.1	14	90,367.2
Refurbish Powerhouse Station Service - Bay d'Espoir	413.2	15	90,780.4
Replace Exciter Controls Units 1 to 6 - Bay d'Espoir	119.2	16	90,899.6
Control Structure Refurbishment	1,735.3	17	92,634.9
Water System Replacements	265.5	18	92,900.4
Refurbish Sump Level System for Powerhouse 2 - Bay d'Espoir	38.7	19	92,939.1
Replace Insulators - TL227	145.6	19	93,084.7
Upgrade Holyrood Access Road - Holyrood	579.3	20	93,664.0
Install Wind Monitoring Station North Salmon Dam SD-2 - Bay d'Espoir	165.5	21	93,829.5
Transmission Line Upgrades - TL212 and TL218	1,378.2	22	95,207.7

2017 Capital Budget and Five Year Plan **2017 Project Prioritization**			
Project Description	**Cost ($000)**	**Rank**	**Cumulative Project Costs ($000)**
Install Recloser Remote Control - Bottom Waters	47.1	23	95,254.8
Distribution Upgrades 2017	64.2	24	95,319.0
Replace Slip Rings, Units 1 to 6 - Bay d'Espoir	312.6	25	95,631.6
Upgrade Aluminum Support Structures - Holyrood	352.9	26	95,984.5
Upgrade Telecontrol Facilities - Mary March Hill and Blue Grass Hill	91.2	27	96,075.7
Replace 66 kV Station Service Feed - Holyrood	62.8	28	96,138.5
Gas Turbine Life Extension - Hardwoods	675.3	29	96,813.8
Gas Turbine Life Extension - Stephenville	847.5	29	97,661.3
Diesel Plant Engine Auxiliary Upgrades	790.6	29	98,451.9
Replace Ventilation in Both Powerhouses - Bay d'Espoir	134.1	30	98,586.0
Upgrade Corner Brook Frequency Converter - Corner Brook	194.6	31	98,780.6
Replace Floor Annunciator Panels - Bay d'Espoir	46.8	32	98,827.4
Replace Power Transformers - Oxen Pond	297.5	33	99,124.9
Diesel Genset Replacements - Port Hope Simpson and Charlottetown	658.8	34	99,783.7
Purchase Backup Diesel for Station Service - Grand Falls and Buchan's	188.9	35	99,972.6
Replace Substation - Holyrood	439.4	36	100,412.0
Line Depots Condition Assessment and Refurbishment Strategy	1,458.8	37	101,870.8
Replace Fuel Tank 22E - St. Anthony	199.8	38	102,070.6
Replace Automation Equipment - Mary's Harbour	120.3	39	102,190.9
Install Asset Health Monitoring Equipment - Upper Salmon	438.0	40	102,628.9
Construct New Facilities - Various Sites	422.0	41	103,050.9

The table below presents the prioritization criteria and the assigned weights used for the 2017 budget.

Criteria		Factors	Factor Weights
1	Work Classification	Normal	5
	(maximum weight = 85)	Justifiable: Payback (70)	15
		Justifiable: Payback (40)	45
		Justifiable: Payback (10)	85
2	Net present Value	NPV ($0)	0
	(maximum weight = 85)	NPV (<$100K)	5
		NPV (<$500K)	15
		NPV (<1M)	45
		NPV (>1M)	85
3	Goal 1: Safety	Minor	10
	(maximum weight = 100)	Treatment	50
		Lost Time	80
		Disability	100
4	Goal 2: Environment	None	10
	(maximum weight = 100)	Minor	50
		Moderate	80
		Significant	100
5	Goals 3-5: Alignment	None	15
	(maximum weight = 65)	Maps but no documentation	40
		Maps but with documentation	65
6	Schedule Risk	External and internal conflicts	10
	(maximum weight = 65)	Externals affecting completion	20
		No external but internal conflicts	40
		No conflicts	65
7	Continue service to customers	Can	20
	(maximum weight = 70)	Can but with high costs	50
		Cannot	70

Criteria		Factors	Factor Weights
8	Number of customers impacted (maximum weight = 70)	<100 <1000 <10,000 >10,000	10 30 50 70
9	System Impact: Critical to … (maximum weight = 90)	None specific System with standby unit Plant or station Entire system	5 50 70 90
10	Impact intensity (maximum weight = 90)	Minor Moderate Significant High	4 40 70 90
11	Loss Type: Loss of … (maximum weight = 90)	No type Equipment Facility Production Customer delivery	5 40 50 70 90
12	Loss mitigation (maximum weight = 90)	Redundant unit Backup option Nothing	30 60 90
13	Percent Improvement in 5-Year Average SAIDI or SAIFI (maximum weight = 50)	% SAIDI or SAIFI (0) % SAIDI or SAIFI (<1) % SAIDI or SAIFI (<2) % SAIDI or SAIFI (<3) % SAIDI or SAIFI (>3)	0 10 15 30 50
14	Estimated Project Cost Range (maximum weight = 50)	N.R.P. Cost (>$1M) Cost ($500K - $1M) Cost ($200K - $500K) Cost (<$200K)	0 5 15 30 50

A. Level 1

Immediate HIGH Priority Projects

- **Extreme Safety**

The project is required to prevent an incident that could cause a fatality or correct a condition that otherwise left unattended may lead to a fatality.

- **Mandatory**

A capital expenditure that Hydro is obliged to carry out as a result of Legislation, Board Order, Environmental or Safety risk.

- **Load Driven**

The project is needed to meet load requirements determined by Hydro's latest load forecasts. Without the project, Hydro's firm load and/or reliability criteria will be compromised.

B. Level 2

1. Work Classification

- **Normal**

A capital expenditure which is required based on an identified need or historical patterns of repair and replacement.

- **Justifiable**

A capital expenditure which is justified based on a positive cost savings for Hydro. A cost-benefit analysis is required for the project.

- **Payback (70)**

A cost-benefit analysis indicates that the payback period for the project is within 70% of the anticipated life of the project.

- **Payback (40)**

A cost-benefit analysis indicates that the payback period for the project is within 40% of the anticipated life of the project.

- **Payback (10)**

A cost-benefit analysis indicates that the payback period for the project is within 10% of the anticipated life of the project.

2. Net Present Value

- **NPV ($0)**

The capital proposal generates $0 cost savings to Hydro.

- **NPV (<$100K)**

A cost-benefit analysis indicates that the capital proposal generates a positive cost savings of less than $100K for Hydro.

- **NPV (<$500K)**

A cost-benefit analysis indicates that the capital proposal generates a positive cost savings of less than $500K for Hydro.

- **NPV (<$1M)**

A cost-benefit analysis indicates that the capital proposal generates a positive cost savings of less than $1M for Hydro.

- **NPV (>$1M)**

A cost-benefit analysis indicates that the capital proposal generates a positive cost savings of more than $1M for Hydro.

3. Goal 1: Safety

- **Minor**

The project has no or minor safety issues that are insignificant in impact.

- **Treatment**

The project is required to prevent an incident or correct a condition that otherwise left unattended may result in the need for medical treatment.

- **Lost Time**

The project is required to prevent an incident or correct a condition that otherwise left unattended may result in worker(s) incurring lost time for a short duration.

- **Disability**

The project is required to prevent an incident or correct a condition that otherwise left unattended may result in worker(s) incurring long time leave due to inability to continue working on the job.

4. Goal 2: Environment

- **None**

The project has no environmental issues.

- **Minor**

The project is required to prevent an incident or correct a condition that otherwise left unattended may result in an environmental impact that:

  - Is irreversible within 2 years; and/or
  - Will cost more than $10,000 to mitigate; and/or
  - Has aspects observed on Hydro's property (at point of impact); and/or
  - Is perceived as in conflict with specific individuals in the local community.

- **Moderate**

The project is required to prevent an incident or correct a condition that otherwise left unattended may result in an environmental impact that:

  - Is irreversible within 4 years; and/or
  - Will cost more than $25,000 to mitigate; and/or
  - Has aspects observed within a 1 km radius of Hydro's property (from point of impact); and/or
  - Is perceived as in conflict with the local community or other industries.

- **Significant**

The project is required to prevent an incident or correct a condition that otherwise left unattended may result in an environmental impact that:

  - Is irreversible within the foreseeable future; and/or
  - Will cost more than $50,000 to mitigate and/or
  - Has aspects observed at more than 5 km radius of Hydro's property (from point of impact); and/or
  - Is perceived as in conflict with the local community and the general public and other industries.

5. Goals 3-5 Alignment

- **None**

This project does not align with or support any department or corporate goals or objectives.

- **Maps but no Documentation**

This project does align with or support a department or corporate goal or objective but no documentation exists to describe how it maps to the goal or objective.

- **Maps but with Documentation**

This project does align with or support a department or corporate goal or objective and there is documentation that clearly describes how.

6. Schedule Risk

- **Externals and Internal Conflicts**

The project has external (to Hydro) dependencies that affect the completion of the project on time and on budget and has major interfaces with other internal initiatives. Examples of external dependencies are: non-Hydro projects that interfere with Hydro proceeding with its project; unavailability of external contractors.

- **Externals Affecting Completion**

The project has only external dependencies that affect the completion of the project on time and on budget.

- **No Externals but Internal Conflicts**

The project conflicts with other internal initiatives that affect the completion of the project on time and on budget.

- **No Conflicts**

The project will not encounter any external or internal conflicts that affect its completion.

7. Continue Service to Customers

- **Can**

Service to customers can continue whether or not this project proceeds. Customers can be defined as either internal or external to Hydro.

- **Can but with High Costs**

Service to customers can continue whether or not this project proceeds but a delay in the project will result in Hydro incurring costs. Customers can be defined as either internal or external to Hydro.

- **Cannot**

Service to customers cannot continue without this project. Customers can be defined as either internal or external to Hydro.

8. # Customers Impacted

- **<100**

The project will impact up to 100 customers.

- **<1000**

The project will impact up to 1000 customers.

- **<10000**

The project will impact up to 10,000 customers.

- **>10000**

The project will impact more than 10,000 customers.

9. System Impact: Critical to.....

- **None Specific**

The project is not critical to any particular system.

- **System with Standby Unit**

The project is critical to a system that has a standby unit which could be used to maintain operation or support continued service in the event of failure.

- **Plant or Station**

The project is critical to the proper operation of a generating plant or a terminal station.

- **Entire System**

The project is critical to ensure the reliable operation of the Hydro system.

10. Impact Intensity

- **Minor**

If this project does not proceed, the repair time is ***less than half*** the Maximum Acceptable Downtime (MAD) of 830 MWh of unsupplied energy or 2 days (whichever comes first).

- **Moderate**

If this project does not proceed, the repair time is ***greater than the half but less than 90%*** of the Maximum Acceptable Downtime (MAD) of 830 MWh of unsupplied energy or 2 days (whichever is comes first).

- **Significant**

If this project does not proceed, the repair time is ***within plus or minus 10%*** of the Maximum Acceptable Downtime (MAD) of 830 MWh of unsupplied energy or 2 days (whichever is comes first).

- **High**

If this project does not proceed, the repair time ***exceeds by more than 10%*** the Maximum Acceptable Downtime (MAD) of 830 MWh of unsupplied energy or 2 days (whichever is comes first).

11. Loss Type: Loss of.....

- **No Type**

If the project does not proceed, no loss is expected.

- **Equipment**

If the project does not proceed, there exists a risk of the loss of some equipment.

- **Facility**

If the project does not proceed, there exists a risk of the loss of a facility.

- **Production**

If the project does not proceed, there exists a risk of the loss of production at a Hydro generating plant.

- **Customer Delivery**

If the project does not proceed, there exists a risk of being unable to deliver power to Hydro customer(s).

12. Loss Mitigation

- **Redundant Unit**

If the project does not proceed the expected loss will be mitigated by a redundant unit present on the system.

- **Back-up Option**

If the project does not proceed the expected loss will be mitigated by a back-up option which ensures that service continues.

- **Nothing**

This project is required because there is no available means to mitigate the expected loss.

13. Percent Improvement in 5-Year Average SAIDI or SAIFI

- **% SAIDI or SAIFI (0)**

This project will have no effect on the System Average Interruption Duration Index (SAIDI) or System Average Interruption Frequency Index (SAIFI). All non-reliability projects will receive this rating.

- **% SAIDI or SAIFI (<1)**

This project is expected to improve the SAIDI or SAIFI factor by less than one percent.

- **% SAIDI or SAIFI (<2)**

This project is expected to improve the SAIDI or SAIFI factor by less than two percent but greater than five percent is implied.

- **% SAIDI or SAIFI (<3)**

This project is expected to improve the SAIDI or SAIFI factor by less than three percent but greater than ten percent is implied.

- **% SAIDI or SAIFI (>3)**

This project is expected to improve the SAIDI or SAIFI factor by at least three percent.

14. Estimated Project Cost Range

- **N.R.P.**

This project is a Non Reliability Project.

- **Cost (>$1M)**

The cost of the project is estimated to be more than a million dollars.

- **Cost ($500K - $1M)**

The cost of the project is estimated to be between five hundred thousand and a million dollars.

- **Cost ($200K - $500K)**

The cost of the project is estimated to be between two hundred and five hundred thousand dollars.

- **Cost (<$200K)**

The cost of the project is estimated to be less than two hundred thousand dollars.

PROBABILITY

- **Not Likely**

The risk of the impact is very low if the project does not proceed. It would be surprising that there is an impact.

- **Low Likelihood**

The risk of the impact is low if the project does not proceed. There is about 30% chance of the impact in the proposal year. It's less likely to happen than not.

- **Likely**

The risk of the impact is possible if the project does not proceed. There is about 50% chance of the impact in the proposal year. It's as likely to happen as not.

- **Highly Likely**

The risk of the impact is considerable if the project does not proceed. There is about 75% chance of the impact in the proposal year. It's more likely to happen than not.

- **Near Certain**

The risk of the impact is almost certain if the project does not proceed. There is more than 90% chance of the impact in the proposal year. It would be surprising if the impact did not occur.

CONFIDENCE LEVEL

- **Low**

The confidence in the assessment of the impact is low. There are some uncertainties that could significantly change the assessment. The projects risks are not well defined.

- **Medium**

The confidence in the assessment of the impact is uncertain but most likely correct. There are some uncertainties that might moderately change the assessment. The project risks are defined but with some uncertainty.

- **High**

The confidence in the assessment of the impact is very high. The uncertainties won't measurably change the assessment. The project risks are well defined and well controlled.

A Report to the

Board of Commissioners of Public Utilities

2017 - 2021 Capital Plan

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APPENDIX A A1
APPENDIX B B1

1 INTRODUCTION

Newfoundland and Labrador Hydro (Hydro) has a responsibility to provide safe, reliable, and least-cost service to meet the needs of its customers. Providing a reliable supply of electrical energy depends on maintaining assets in sound condition. Utility assets are kept in reliable working condition by routine maintenance and replacement as necessary. Asset additions are also determined through analysis of long term requirements to address future demands for power and energy.

In Order No. P.U. 30(2007), Hydro was directed to file a five-year capital expenditure plan. The Board of Commissioners of Public Utilities (the Board) indicated the plan should focus on strategic spending priorities beginning with the current year of the Capital Budget Application. As well, the capital expenditure plan should identify shifts in spending priorities over the five-year period, the circumstances contributing to these shifts, and alternative approaches under consideration. Additionally, the Board requested a separate section concerning the Holyrood Thermal Generating Station (Holyrood), which at the time had an uncertain future due to alternative developments under consideration. With the sanction of the Muskrat Falls Project in December 2012, the future of the Holyrood plant has been established. The Holyrood section of this plan addresses Hydro's forecasted maintenance and capital requirements for the plant for the next five years.

Hydro maintains an asset base of $1.6 billion. Some assets have reached or exceeded their expected service lives and many others are approaching that juncture. Other major assets have not reached their expected service lives but some of their components, auxiliary equipment and systems have, or are about to do so. This includes components of major facilities such as the Bay d'Espoir Generating Station, the Holyrood Thermal Generating Station, the Hardwoods and Stephenville gas turbines and much of Hydro's transmission and distribution systems. Hydro uses an asset management framework to manage these assets.

Hydro has a five year capital plan which contains detail on costs and timing of asset replacement and refurbishment. The five-year plan is a living document and is revised on an ongoing basis as new information about the condition of assets becomes available, as asset management strategies evolve, and as demands and priorities change within asset classes.

The five-year plan supports Hydro's responsibility to maintain its infrastructure providing safe, reliable and least cost electricity for home and business use.

2 FIVE-YEAR PLAN

Hydro plans to invest $0.97 billion in plant and equipment over the 2017 to 2021 period for an average annual capital expenditure of $194 million. Individual year expenditures will range from a low of $129 million in 2021 to a high of $271 million in 2017. Over the period 2012 to 2015, the average annual capital expenditure was $123.0 million. The growth in overall capital expenditure reflects the requirement for projects related to replacement and upgrade of deteriorating facilities, ensuring compliance with legislation, additions required to meet load growth, and inflation.

Expenditures for new transmission assets are included in these estimates, specifically for the upgrade of the transmission line corridor between Bay d'Espoir and Western Avalon (TL267) and the transmission line between Soldiers Pond and Hardwoods (TL266), as well as expenditures in terminal stations, including replacing, in an expedited fashion, aging circuit breakers. As well, the Terminal Station Refurbishment and Modernization program groups as many as 15 smaller, separate projects into one program.

3 STRATEGIC SPENDING PRIORITIES

Hydro's strategic spending priorities over the next five years address the following areas:

1. Mandatory Issues:
    - Ensuring the safety of Hydro personnel, its contractors, and the general public;
    - Compliance with legislative and regulatory requirements; and
    - Managing environmental risks.
2. Meeting projected load growth and customer requests;
3. Applying a consistent asset maintenance philosophy to ensure system reliability and maintain acceptable asset performance as identified by:
    - Operating experience;
    - Maintenance history;
    - Condition assessments; and
    - Performance evaluation and monitoring.
4. Achieving cost efficiencies.

Hydro's detailed five year capital investment plan is presented in Appendix A. Over this period, the level of capital expenditure is primarily driven by:

- Growth in system demand; and
- Age and condition of current infrastructure and assets.

4 GENERATION

The requirement to invest sustaining capital in generation facilities increased several years ago as parts of Hydro's generating plants approached or surpassed their normal expected service lives. Primary drivers for these projects are the realization of end of service lives for equipment with resulting deterioration causing reductions in reliability or performance, the availability of more efficient technology, and considerations for safety.

4.1 Hydraulic

The condition of key components of Hydro's hydraulic facilities, including auxiliary systems and equipment as well as the control structures, have deteriorated and some have reached the end of their service lives. Capital investment is required in these areas to ensure the safe reliable operation of the system. The 2017 Capital Plan includes projects to refurbish critical control structures, overhaul turbine/generators in Bay d'Espoir and Cat Arm, and to replace slip rings and exciter controls on units 1 to 6 at Bay d'Espoir. Other projects proposed for the 2017 budget include the refurbishment powerhouse station service and to install an asset health monitoring system in Upper Salmon.

4.2 Thermal

On December 17, 2012, the Government of Newfoundland and Labrador announced official sanction of the Muskrat Falls Project. Holyrood will be required for prime power production until the Labrador Island Link (LIL) is in service, and it is intended that the facility will remain fully available for generation in stand-by mode until the post Winter 2021 timeframe. Unit 3 will operate in synchronous condenser mode during this stand-by production phase, with the option to return to full generating mode if required. Post Winter 2021, Units 1 and 2 and the steam components of Unit 3 at Holyrood will be decommissioned, and Unit 3 will continue to operate in synchronous condenser mode, with no generation capability.

Holyrood Units 1 and 2 are 46 years old, while Unit 3 is 37 years old. The generally accepted life expectancy for thermal plants is 30 years. Holyrood remains critical to the reliable power supply on the Island Interconnected System. The capital upgrades contained in this plan are necessary to replace or refurbish assets which are approaching the end of their useful service lives.

Also see the Holyrood Overview section for further discussion pertaining to the five year plan for Holyrood, and Appendix J - Plan of Projected Operating Maintenance Expenditures 2017 – 2026 For Holyrood Generating Station.

4.3 Gas Turbines

Maintaining the reliability of Hydro's gas turbine assets, which are relied upon to provide emergency and peaking power, and (with the exception of the Holyrood combustion turbine) to function as synchronous condensers to help control voltage on the Island and Labrador Interconnected Systems, is a priority. These facilities accumulate fewer operating hours than other sources generating electricity but are crucial sources of power and energy during emergencies and system peaks and provide voltage support, especially when operating as synchronous condensers.

The 50 MW plants at Hardwoods and Stephenville have required relatively little capital expenditure until recent years. Despite their lower operating hours, these units are beyond their normal life expectancy and are deteriorating, requiring an increase in capital expenditures to extend their reliable economic service lives. Multiyear life extension projects for the Hardwoods plant began in 2010. Similar projects for Stephenville began in 2014.

The new 123.5 MW combustion turbine at Holyrood is available for service and is part of Hydro's fleet. A Turbine Hot Gas Inspection is in the capital plan for this unit in 2018.

Hydro's gas turbine plant located at Happy Valley was constructed in 1992. This plant has required only minor upgrades since that time. No new projects are budgeted for 2017.

Future additional refurbishments will be required at Hardwoods, Stephenville and Happy Valley. Of note, a control system upgrade is planned in Hardwoods and Stephenville starting in 2019, and an engine overhaul will be required at Happy Valley in 2019.

5 TRANSMISSION AND RURAL OPERATIONS

The total investment of capital in transmission and rural operations facilities is seeing an increase for several coming years, primarily due to requirements for new transmission facilities. Other categories of assets are being replaced or refurbished due to condition, and a number of components in various facilities have reached or surpassed their normally expected service lives. Projects in the Transmission and Rural Operations category are to address assets that are at, or near the end of, their service lives, to improve reliability or performance, to improve safety, or to implement more efficient technology.

5.1 Terminal Stations

Increasing load and maintaining reliability are the principal drivers for terminal station expenditures over the next five years. Aging equipment is considered when reviewing short and long term plans. The five-year plan contains expenditures, such as programs to upgrade power transformers, install on-line transformer gas monitoring units, replace circuit breakers, and replace disconnect switches. The plan also contains station-specific projects such as performing site work at various terminal stations to accommodate the mobile substation, and installing fire protection. For 2017, Hydro has consolidated 15 individual terminal station projects into the Terminal Station Refurbishment and Modernization Program, and plans on continuing with this philosophy going forward.

Hydro continues its plan to accelerate air blast circuit breaker replacements and has included the requirements for the 2016 - 2020 accelerated work within its 2017 Capital Budget Application. As part of its Terminal Station Refurbishment and Modernization Project Hydro continues to install breaker failure protection, upgrade fault recorders, upgrade data alarm systems, and upgrade protection and control.

5.2 Transmission

Transmission investment in the five year plan reflects customer growth and reliability requirements. The major project to upgrade the transmission line corridor between Bay d'Espoir and Western Avalon (TL267) is underway to facilitate additional power and energy delivery to the system and meet transmission planning criteria. Hydro received approval for TL267 in Order No. P. U. 53(2014). As part of that approval, Hydro is required to file, with each capital budget application filed until the completion of the project, a report on the construction of TL267 addressing the work progress, the expenditure and budget status, and an explanation for any deviations from the project scope and budget. This report is presented in Appendix B.

Another key investment in the transmission system in the five year plan is the upgrading of the transmission corridor from Soldier's Pond to Hardwoods (TL266). This project is required to ensure the reliable supply of electricity to the St. John's area once power is coming to the Island from the Muskrat Falls Project, and the supply from Holyrood diminishes. TL266 is currently in the design phase.

Reliability improvements are also a driver for transmission investment. The wood pole line management program forms the backbone of Hydro's asset management strategy for these facilities. This strategy has been in place for eleven years and its effectiveness and value have been tested and demonstrated, enabling Hydro to realize the maximum useful life from these transmission systems. The program is based on periodic assessment of the wooden transmission poles and facilitates their replacement before failure, while extracting the maximum possible reliable life from each pole. Hydro is also continuing to replace insulators and associated hardware on transmission lines, reducing the risk of service interruptions for customers due to insulator failure.

5.3 Distribution

New customer additions and maintaining reliability are the strategic areas addressed by the five-year capital plan for distribution assets. Deteriorated portions of distribution assets must be replaced to ensure reliable service. The majority of the distribution system expenditures for the next five years will consist of service extensions and upgrades to distribution systems, distribution pole replacement, and substation upgrading. A significant project for the next five years is the replacement of the submarine cables between Farewell Head, Change Islands and Fogo.

5.4 Rural Generation

The replacement of aging infrastructure is required to ensure reliability for Hydro's 21 isolated electrical systems which are supplied with electricity by diesel generating sets. Hydro's diesel generating sets have the shortest lives of all its generating assets, requiring replacement after approximately 100,000 hours of operation. Chart 1 provides the age distribution of the diesel engines in Hydro's rural generating plants. During the next five years Hydro plans to replace or add generating sets in various isolated diesel plants. These replacements and additions are required to ensure that reliable service is provided to Hydro's isolated rural customers. Many of Hydro's diesel plants will require refurbishment or replacement in the near to medium term. To prioritize this process, Hydro is continuing with its prioritized process to assist in planning the replacement or modification in a logical sequence. Projects for the replacement and upgrade of diesel plant infrastructure and auxiliary systems are included over the coming five years.

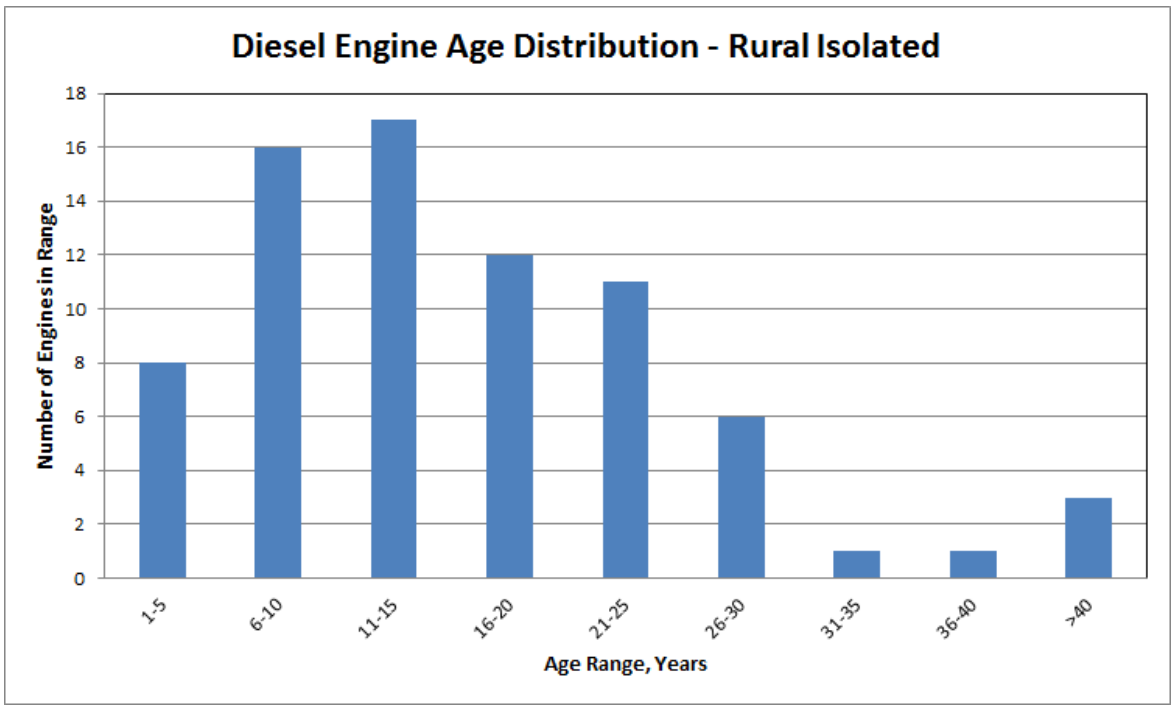

Chart 1: Diesel Engine Age Distribution – Rural Isolated System

6 GENERAL PROPERTY

Hydro's category of general properties is a broad ranging group of assets, and includes assets such as vehicles, facilities of all size, and information systems infrastructure. Similar to other categories, the assets in general properties requires replacement or refurbishment due to deterioration, age, obsolescence, and at times, due to growth constraints.

6.1 Information Systems

Obsolete technology and aging hardware are the strategic drivers which most significantly contribute to the five-year plan for information systems. Hydro's information systems provide the data required to effectively manage and control the activities of the business. Projects in this category include personal computer and software replacements, and this type of replacement is expected to continue over the next five years.

6.2 Telecontrol

Obsolete technology and aging hardware are also the strategic reasons which most significantly contribute to the five-year plan for Telecontrol assets. Hydro's communications network is vital to the operation and control of the power systems. Communications must be reliable and rapid to protect and control the generation, transmission and distribution equipment. The five-year plan contains expenditures in the form of several programs to replace battery banks and chargers, replace air conditioners, refurbish microwave sites, and replace obsolete radio equipment. The plan also includes site-specific projects to replace obsolete teleprotection equipment, upgrade telecontrol facilities, and replace UPS units.

6.3 Transportation

Hydro's vehicles and mobile equipment must continue to be both safe and reliable. Hydro operates a diversified and dispersed fleet of mobile equipment throughout the Province that is required to operate and maintain our facilities in a challenging and sometimes harsh physical environment. Hydro selects, operates and maintains this equipment in a manner designed to achieve the least life cycle cost and replacements are scheduled in accordance with criteria submitted to the Board on previous occasions.

6.4 Administration

Safety, cost efficiencies, reliability and security are the primary drivers of the five-year administration capital plan. Hydro expects to spend an average of over $1 million annually on items such as office equipment, building auxiliary systems, and building infrastructure, during the next five years.

APPENDIX A

Five-Year Capital Plan

	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
GENERATION	4,690.8	25,556.1	38,718.3	34,000.9	48,554.9	18,685.6	169,390.6
TRANSMISSION AND RURAL OPERATIONS	112,154.0	235,587.4	163,850.3	146,322.3	110,559.9	96,238.3	864,712.2
GENERAL PROPERTIES	2,944.3	9,292.9	8,192.2	9,767.5	7,708.6	13,102.1	51,007.6
ALLOWANCE FOR UNFORESEEN ITEMS		1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	5,000.0
TOTAL CAPITAL BUDGET	119,789.1	271,436.4	211,760.8	191,090.7	167,823.4	129,026.0	1,090,110.4

	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
GENERATION							
Hydraulic Plant	1,967.0	13,285.6	20,566.9	13,831.6	30,712.7	9,928.7	89,476.5
Thermal Plant	2,723.8	10,166.2	8,636.7	11,190.3	14,152.1	2,334.8	49,203.9
Gas Turbines		1,974.8	9,263.0	8,879.7	3,650.0	6,381.0	30,148.5
Tools and Equipment		129.5	251.7	99.3	40.1	41.1	561.7
TOTAL GENERATION	4,690.8	25,556.1	38,718.3	34,000.9	48,554.9	18,685.6	169,390.6
TRANSMISSION AND RURAL OPERATIONS							
Terminal Stations	12,235.1	29,434.8	46,500.6	44,417.7	53,289.8	31,148.5	217,026.5
Transmission	93,011.5	173,193.3	79,093.1	65,159.4	3,517.1	9,154.9	423,129.3
Distribution	285.6	14,890.5	14,366.6	13,205.0	27,924.0	34,149.7	104,821.4
Generation	6,172.8	11,780.8	13,454.3	12,513.4	18,082.3	14,248.2	76,251.8
Properties	15.2	4,453.2	6,944.8	7,741.7	5,062.8	4,992.2	29,209.9
Metering	433.8	1,007.7	2,170.2	1,266.7	1,239.6	198.8	6,316.8
Tools and Equipment		827.1	1,320.7	2,018.4	1,444.3	2,346.0	7,956.5
TOTAL TRANSMISSION AND RURAL OPERATIONS	112,154.0	235,587.4	163,850.3	146,322.3	110,559.9	96,238.3	864,712.2
GENERAL PROPERTIES							
Information Systems	366.6	1,339.6	1,616.7	876.2	590.2	963.0	5,752.3
Telecontrol	717.3	3,809.9	2,798.2	4,896.7	4,002.1	9,026.7	25,250.9
Transportation	1,825.8	2,708.3	1,981.6	2,833.3	2,662.0	2,271.2	14,282.2
Administrative	34.6	1,435.1	1,795.7	1,161.3	454.3	841.2	5,722.2
TOTAL GENERAL PROPERTIES	2,944.3	9,292.9	8,192.2	9,767.5	7,708.6	13,102.1	51,007.6
ALLOWANCE FOR UNFORESEEN ITEMS		1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	5,000.0
TOTAL CAPITAL BUDGET	119,789.1	271,436.4	211,760.8	191,090.7	167,823.4	129,026.0	1,090,110.4

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
HYDRAULIC PLANT							
Replace Site Facilities - Bay d'Espoir	928.3	4,736.3	6,316.7				11,981.3
Upgrade Work - Cat Arm	558.3	1,353.0					1,911.3
Replace Spherical By-Pass Valves Units 1 and 2 - Bay d'Espoir	183.6	167.9					351.5
Rehabilitate Shoreline Protection - Cat arm	112.2	1,030.7					1,142.9
Rewind Units 5 and 6 - Bay d'Espoir					200.0		200.0
Refurbish Station Water System - Upper Salmon	96.6	197.6					294.2
Replace Powerhouse 1 Station Service Transformer - Bay d'Espoir	46.7	354.5					401.2
Replace Control Room/Communications Room Air Conditioning - Hinds Lake	41.3	53.0					94.3
Control Structure Refurbishments - Various Sites		1,735.3	452.9				2,188.2
Upgrade Public Safety Around Dams and Waterways - Bay d'Espoir		489.0	484.9	478.2	350.0	316.0	1,802.1
Purchase Capital Spares - Hydraulic		487.4	505.1	502.1	500.0	500.0	1,994.6
Overhaul Turbine/Generators - Bay d'Espoir and Cat Arm		476.2					476.2
Overhaul Turbine/Generators - Various Sites			666.3	467.1	543.4	395.0	2,071.8
Install Asset Health Monitoring System - Upper Salmon		438.0	203.4				641.4
Refurbish Powerhouse Station Service - Bay d'Espoir		413.2	2,473.3	1,460.6			4,347.1
Replace Slip Rings Units 1-6 - Bay d'Espoir		312.6	159.7				472.3
Refurbish Main Generator Breaker - Upper Salmon		271.1					271.1
Water System Replacements - Bay d'Espoir and Cat Arm		265.5	2,288.3				2,553.8
Install Wind Monitoring Station North Salmon Dam SD-2 - Bay d'Espoir		165.5					165.5
Upgrade Ventilation in Powerhouse 1 and 2 - Bay d'Espoir		134.1	863.8				997.9
Replace Exciter Controls Units 1 to 6 - Bay d'Espoir		119.2	921.2	877.0	1,429.6		3,347.0
Replace Floor Annunciator Panels - Bay d'Espoir		46.8					46.8
Refurbish Sump Level System for Powerhouse 2 - Bay d'Espoir		38.7	264.5				303.2
Replace Interior and Exterior Coating on Surge Tank 1 - Bay d'Espoir			3,317.6				3,317.6
Refurbish Hydraulic Structures - Various Sites				1,152.4	4,661.5	1,000.0	6,813.9
Replace Control Cable - Bay d'Espoir			508.1	419.1	335.6	813.2	2,076.0
Install Diesel Fuel Metering Devices - Various Sites			461.4				461.4
Upgrade Generator Bearings - Bay d'Espoir			249.8	464.0	474.2	501.8	1,689.8
Install Protective Guards in Turbine Pits - Various Sites			245.0	297.9	348.0		890.9
Install Infrared Viewports - Various Sites			141.3	137.3			278.6
Replace PH High Bay Lighting - Bay d'Espoir			43.6	193.3			236.9
Refurbish Generation Unit - Snook's Arm				1,641.5	7,613.1		9,254.6
Replace Site Domestic Water Piping - Bay d'Espoir				1,141.6			1,141.6
Refurbish Turbine - Bay d'Espoir				973.5	1,349.2	750.0	3,072.7
Refurbish Draft Tube Deck - Bay d'Espoir				869.8	258.6		1,128.4
Upgrade Station Service - Various Sites				503.5	553.4	933.7	1,990.6
Stabilize Powerhouse Slope (Phase 1) - Cat Arm				501.9			501.9

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
HYDRAULIC PLANT (cont'd)							
Perform Probable Maximum Flood Study - Bay d'Espoir				477.2			477.2
Install Automated Fuel Monitoring System - Various Sites				375.4	542.9		918.3
Replace Data Acquisition System Units 1 to 7 - Bay d'Espoir				357.5	364.8	376.4	1,098.7
Refurbish Road Between Powerhouse and NS Spillway - Upper Salmon				178.3	612.2		790.5
Refurbish Generator Rotor - Hind's Lake				112.8	1,177.3		1,290.1
Replace Dual Fuel Tank - Bay d'Espoir				89.3			89.3
Replace T/G Cooling Water Pump and Strainer - Hind's Lake				88.2	281.4		369.6
Replace Drainage Pumps - Hind's Lake and Paradise River				72.1	384.5		456.6
Resurface Access Road and Intake - Paradise River					918.5		918.5
Resurface All On Site Roads - Bay d'Espoir					900.8		900.8
Refurbish Access Road to Ebbegunbaeg - Bay d'Espoir					860.0		860.0
Install Partial Discharge Continuous Monitors - Various Sites					694.2		694.2
Replace Office Area Roof on Powerhouse 1 - Bay d'Espoir					534.3		534.3
Replace Road Culverts Between Powerhouse and Grey River - Granite Canal					500.0		500.0
Replace Emergency Diesel Generator - Hind's Lake					466.6		466.6
Replace Sump Pumps 1 and 2 in Powerhouse 1 - Bay d'Espoir					395.9		395.9
Replace Powehouse 1 Wet Air Compressors 3 and 4 - Bay d'Espoir					379.5		379.5
Resurface Access Road - Granite Canal					345.0		345.0
Install New Vent Chambers, Units 1 to 6 - Bay d'Espoir					311.1	297.8	608.9
Replace Firewater Pumps - Upper Salmon and Cat Arm					310.9	298.1	609.0
Replace Diesel Generator 2 at Victoria Control Structure - Bay d'Espoir					301.8		301.8
Refurbish Intake, Main Dam, and Section of Penstock - Snook's Arm					283.3		283.3
Replace Chart Recorders - Various Sites					261.0		261.0
Install Dynamic Air Gap Monitoring System - Upper Salmon and Hind's Lake					250.6	521.4	772.0
Replace PA System Powerhouse 1 and 2 - Bay d'Espoir					244.7		244.7
Stabilize Powerhouse Slope (Phase 2) - Cat Arm					229.2		229.2
Replace Powerhouse Septic System - Hind's Lake					227.3		227.3
Refurbish Burnt Dam Workshop Building and Diesel Building - Bay d'Espoir					207.5		207.5
Replace Units 1-7 Flow Measuring Devices - Bay d'Espoir					110.8	340.3	451.1
Refurbish Fire Systems and Controls - Bay d'Espoir						385.0	385.0
Replace Powerhouse2 AC Distribution Panels - Bay d'Espoir						375.0	375.0
Install Sprinkler Fire Protection in North End of Powehouse 1 - Bay d'Espoir						325.0	325.0
Replace Underground Oily Water Separator - Bay d'Espoir						300.0	300.0
Refurbish Station Service Transformer - Cat Arm						250.0	250.0
Replace Diesel Fuel Tank 2 at Burnt Dam - Bay d'Espoir						250.0	250.0
Replace Powehouse Station Service and Distribution Panels - Paradise River						250.0	250.0
Replace Sump Pump 3 - Hind's Lake						210.0	210.0
Install Trashrake System at Intake/Control Structure - Hind's Lake						160.0	160.0
Replace HP Air Compressor 1 - Hind's Lake						145.0	145.0
Install Solar Powered Devices in Remote Reservoirs - Various Sites						140.0	140.0
Replace Network Switches for ABB RTU's - Granite Canal						95.0	95.0
TOTAL HYDRAULIC PLANT	1,967.0	13,285.6	20,566.9	13,831.6	30,712.7	9,928.7	89,476.5

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
THERMAL PLANT							
Upgrade Powerhouse Building Envelope - Holyrood	2723.8	2,969.9	784.1				6,477.8
Condition Assessment and Miscellaneous Upgrades- Holyrood		2,437.3	2,267.4	1,858.8			6,563.5
Overhaul Turbine Valves Unit 2 - Holyrood		2,302.1					2,302.1
Upgrade Underground Plant Drainage System - Holyrood		923.1					923.1
Overhaul Pumps - Holyrood		633.0					633.0
Upgrade Holyrood Access Road - Holyrood		579.3	583.4				1,162.7
Purchase Capital Spares - Holyrood		321.5	250.0	250.0	250.0	250.0	1,321.5
Overhaul Unit 1 Turbine Valve - Holyrood			2,485.7				2,485.7
Install Plant Heating System - Holyrood			1,488.8	3,478.7			4,967.5
Overhaul Unit 2 Boiler Feed Pump East - Holyrood			301.8				301.8
Upgrade Fire Systems - Holyrood			180.9				180.9
Install New Raw Water Line - Holyrood			163.5	1,156.0			1,319.5
Upgrade Cranes and Hoists - Holyrood			81.0	282.8			363.8
Overhaul Unit 2 Vacuum Pump South - Holyrood			50.1				50.1
Replace Stage II Electrical Distribution Equipment - Holyrood				2,446.2	2,208.6		4,654.8
Rewind Unit 3 Stator - Holyrood				1,359.6	5,789.0		7,148.6
Replace Unit 3 258VDC Battery Charger and Batteries - Holyrood				358.2			358.2
Overhaul Unit 3 Turbine Valve - Holyrood					2,756.2		2,756.2
Replace Stage 1 4160V AC Breakers - Holyrood					1,030.0		1,030.0
Upgrade Boiler Stop Values Units 1 and 2 - Holyrood					707.6	207.9	915.5
Overhaul Unit 3 Boiler Feed Pump West - Holyrood					335.0		335.0
Upgrade Cooling Water System Wet Well Stop Log Unit 3 - Holyrood					300.0		300.0
Upgrade UPS 3 and 4 - Holyrood					266.7		266.7
Install New Lube Oil / Seal Oil Systems Unit 3 - Holyrood					255.0	765.9	1,020.9
Upgrade UPS 1 and 2 - Holyrood					254.0		254.0
Replace Instrument Air Receiver System Unit 3 - Holyrood						753.0	753.0
Replace Service Air Receivers Unit 3 - Holyrood						308.0	308.0
Upgrade Property Fencing - Holyrood						50.0	50.0
TOTAL THERMAL PLANT	2,723.8	10,166.2	8,636.7	11,190.3	14,152.1	2,334.8	49,203.9

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
GAS TURBINES							
Replace Fuel Piping - Hardwoods and Stephenville		267.0					267.0
Gas Turbine Life Extension - Stephenville		847.5	505.7				1,353.2
Gas Turbine Life Extension - Hardwoods		675.3	281.4				956.7
Purchase Capital Spares - Gas Turbines		185.0	300.0	300.0	300.0	300.0	1,385.0
Perform Turbine Hot Gas Inspection - Holyrood			5,844.8	4,288.5			10,133.3
Upgrade Electrical Systems - Hardwoods			952.6	1,408.4			2,361.0
Upgrade Air Intake and Exhaust Stack - Stephenville and Hardwoods			829.2				829.2
Replace Compressors - Hardwoods			246.8				246.8
Replace Demister - Hardwoods and Stephenville			197.2	301.0			498.2
Inspect/Align PT Bearing - Hardwoods			105.3				105.3
Overhaul Engine - Happy Valley				1,564.1			1,564.1
Upgrade Control System - Hardwoods and Stephenville				326.9	100.0	1,531.0	1,957.9
Purchase Spare Parts & Heated Lube Oil Storage - Hardwoods and Stephenville				308.0			308.0
Refurbish Bus Duct - Hardwoods and Stephenville				270.5	150.0		420.5
Replace 15kV Cable to 750 kVA Transformer - Hardwoods				112.3			112.3
Perform Combustor Inspection - Holyrood					2,500.0	2,500.0	5,000.0
Install Infrared Scanning Ports - Happy Valley and Stephenville					250.0	250.0	500.0
Inspect Power Turbine Clutch A and B - Various Sites					300.0	100.0	400.0
Replace Fuel Unloading Pumps - Hardwoods and Stephenville					50.0	50.0	100.0
Overhaul Gas Turbine End A - Hardwoods						1,100.0	1,100.0
Replace Snow Doors - Happy Valley						350.0	350.0
Replace Lube Oil and Glycol Pumps - Happy Valley						100.0	100.0
Inspect PT - Happy Valley						50.0	50.0
Replace Voltage Regulator - Happy Valley						50.0	50.0
TOTAL GAS TURBINES	0.0	1,974.8	9,263.0	8,879.7	3,650.0	6,381.0	30,148.5
TOOLS AND EQUIPMENT							
Purchase Tools and Equipment Less than $50,000		129.5	251.7	99.3	40.1	41.1	561.7
TOTAL TOOLS AND EQUIPMENT		129.5	251.7	99.3	40.1	41.1	561.7
TOTAL GENERATION	4,690.8	25,556.1	38,718.3	34,000.9	48,554.9	18,685.6	169,390.6

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
TERMINAL STATIONS							
Upgrade Circuit Breakers - Various Sites (2016-2020)	6,969.1	10,808.7	15,408.6	15,247.3	13,026.8		61,460.5
Upgrade Circuit Breakers - Various Sites						5,200.0	5,200.0
Replace Instrument Transformers - Various Sites	3,196.1	471.9					3,668.0
Replace Protective Relays - Various Sites	700.6	1,156.4					1,857.0
Replace Disconnect Switches - Various Sites (2016-2017)	646.9	1,320.9					1,967.8
Install Fire Protection in 230 kV Stations - Bay d'Espoir	200.0	566.0					766.0
Upgrade Digital Fault Recorders - Various Sites	197.9	304.6					502.5
Replace Surge Arrestors - Various Sites	144.4	53.0					197.4
Upgrade Data Alarm Systems - Stony Brook	74.4	234.1					308.5
Install Breaker Failure Protection - Various Sites	65.7	211.3					277.0
Upgrade Terminal Station for Mobile Substation - Cow Head	40.0	444.7				194.6	679.3
Upgrade Terminal Station for Mobile Substation - Various Sites			1,017.7				1,017.7
Terminal Station Refurbishment and Modernization - Various Sites		10,831.3	21,697.2	21,534.5	22,669.1	12,523.1	89,255.2
In Service Failures - Various Sites		1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	5,000.0
Purchase Capital Spares - Terminals		495.8	500.0	500.0	500.0	500.0	2,495.8
Replace Substation - Holyrood		439.4	758.6				1,198.0
Upgrade Aluminum Support Structures - Holyrood		352.9	342.7				695.6
Replace Power Transformers - Oxen Pond		297.5	850.1				1,147.6
Upgrade Corner Brook Frequency Converter - Corner Brook		194.6	2,749.2				2,943.8
Purchase Backup Diesel for Station Service - Grand Falls and Buchans		188.9					188.9
Replace 66 kV Station Service Feed - Holyrood		62.8	1,198.6				1,261.4
Install Remote Control Sectionalizer TL251, TL252 and TL253 - Hampden			395.5	1,525.5			1,921.0
Perform Condition Assessment of Substation - Wabush			191.1				191.1
Upgrade Reclosing for Circuit Breakers - Various Sites			168.6	233.2	100.0	300.0	801.8
Install Firewall Between Transformer and GT - Stephenville			139.5	617.0			756.5
Install 66 kV Breaker By-Pass Switches - Various Sites			83.2	1,440.9	802.2	500.0	2,826.3
Upgrade Substation - Wabush				1,000.8	7,242.3	6,816.3	15,059.4
Purchase New Mobile Substation - Bishop's Falls				809.4	3,714.1		4,523.5
Install Alternate Station Service - Grand Falls				351.8			351.8
Install Fire Barriers Between T10 and T12 and Between T10 and T11 - Bay d'Espoir				157.3	1,175.1		1,332.4
Install Data Acquisition and Trending - Corner Brook					500.0	200.0	700.0
Install Telephone System - Bottom Waters					500.0		500.0
Upgrade Control Building for Staff Working Spaces - South Brook and Doyles					453.4	773.5	1,226.9
Replace Capacitor Bank C1 - Oxen Pond					363.6	369.8	733.4
Construct Fire Separation Wall between Transformers - Happy Valley					300.0		300.0
Upgrade Access Road with New Topping - Buchans					243.4		243.4
Replace Corroded Junction Boxes - Various Sites					200.0	200.0	400.0
Upgrade Station Lighting - Various Sites					200.0	200.0	400.0
Install Fire Barriers between T1, T2 and T3 and the Substation - Massey Drive					100.0	400.0	500.0
Upgrade AC_DC Station Service - Various Sites					75.0	150.0	225.0
Install Drainage to Stop Surface Flooding - Various Sites					67.8	457.2	525.0
Replace Telecontrol Building and Upgrade Equipment - Daniel's Harbour					57.0	764.0	821.0
Upgrade Station Access Road - Various Sites						400.0	400.0
Upgrade Drainage to Stop Frost Heaving - Various Sites						200.0	200.0
TOTAL TERMINAL STATIONS	12,235.1	29,434.8	46,500.6	44,417.7	53,289.8	31,148.5	217,026.5

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
TRANSMISSION							
Construct 230 kV Transmission Line - Bay d'Espoir to Western Avalon	87,444.6	149,895.7	54,317.7				291,658.0
Construct 230 kV Transmission Line - Soldiers Pond to Hardwoods	3,699.0	17,489.8	5,372.1				26,560.9
Refurbish Anchors and Footings TL202 and TL206 - Bay d'Espoir to Sunnyside	1,278.3	901.6					2,179.9
Replace Aircraft Markers at Grand Lake Crossing - TL228	589.6	978.3					1,567.9
Perform Wood Pole Line Management Program - Various Sites		2,404.1	3,593.7	2,761.9	2,181.1	3,228.1	14,168.9
Transmission Line Upgrades - TL212 and TL218		1,378.2	1,133.3				2,511.5
Replace Insulators - TL227		145.6	271.3				416.9
Interconnect Muskrat Falls to Happy Valley - L1302			13,909.9	61,319.9			75,229.8
Replace Dampers - TL247			495.1				495.1
Upgrade Tower Foundations (2019) - Various Sites				1,077.6	1,085.2	1,130.4	3,293.2
Replace Line - TL218						1,700.0	1,700.0
Reliability Improvements for Terminal Station - Hawkes Bay						1,540.0	1,540.0
Replace Line - TL203						1,300.0	1,300.0
Conduct LIDAR Surveys - Various Sites					250.8	256.4	507.2
TOTAL TRANSMISSION	93,011.5	173,193.3	79,093.1	65,159.4	3,517.1	9,154.9	423,129.3

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
DISTRIBUTION							
Upgrade Distribution System - Various Sites (2016-2017)	285.6	6,350.3					6,635.9
Upgrade Distribution System - Various Sites							0.0
Upgrade Distribution System - Various Sites							0.0
Distribution Upgrades - Various Sites (2017-2018)		64.2	1,130.9				1,195.1
Upgrade Distribution System - Various Sites			173.3	3,060.5	5,782.4	7,016.0	16,032.2
Provide Service Extensions - All Service Areas		4,330.0	4,920.0	5,020.0	5,130.0	5,240.0	24,640.0
Upgrade Distribution Systems - All Service Areas		3,810.0	3,820.0	3,630.0	3,610.0	3,680.0	18,550.0
Replace Recloser - Wabush		199.2					199.2
Install Demand Metering - Various Sites		89.7					89.7
Install Recloser Remote Control - Bottom Waters		47.1	418.6				465.7
Install Recloser Remote Control - Various Sites			46.7	339.6	207.0	550.0	1,143.3
Increase Feeder Capacity for Cold Load Pickup - Happy Valley			2,099.3				2,099.3
Additions for Load - Distribution Systems			1,499.2	1,000.0	500.0	500.0	3,499.2
Install Recloser - English Harbour West			258.6				258.6
Replace Submarine Cable Farewell Head to Change Islands - Fogo				121.8	11,867.4	16,748.7	28,737.9
Install Sectionalizer and Replace Poles, L3 - Bottom Waters				33.1	442.2		475.3
Install Sectionalizing for Cold Load Pickup - Port Hope Simpson					250.0		250.0
Implement Geographical Information System - Various Sites					100.0	100.0	200.0
Convert La Scie L7 to 25 kV - Bottom Waters					35.0	315.0	350.0
TOTAL DISTRIBUTION	285.6	14,890.5	14,366.6	13,205.0	27,924.0	34,149.7	104,821.4

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
GENERATION							
Install Fire Protection in Diesel Plants - Various Sites	3,030.7	1,376.4	176.0	1,754.4	999.7	1,000.0	8,337.2
Replace Diesel Units - Charlottetown	1,384.9	46.1					1,431.0
Additions for Load Growth - Isolated Generation Stations - Various Sites	883.4	4,746.0	1,556.6	1,237.6	1,853.6	500.0	10,777.2
Replace Programmable Logic Controllers - Various Sites	712.9	245.1			250.0	250.0	1,458.0
Replace Human Machine Interface - Various Sites	114.0	320.0	167.4	159.3	299.0	400.0	1,459.7
Install Variable Frequency Drives - Grey River	46.9	123.0					169.9
Overhaul Diesel Engines - Various Sites		2,095.9	2,339.0	2,319.8	2,370.3	2,424.2	11,549.2
Inspect Fuel Storage Tanks - Various Sites		1,058.8	1,031.2	856.3	714.8	700.0	4,361.1
Diesel Plant Engine Auxiliary Upgrades - Various Sites		790.6	416.3				1,206.9
Diesel Genset Replacements - Charlottetown and Port Hope Simpson		658.8	5,148.0				5,806.8
Replace Fuel Tank 22E - St. Anthony		199.8					199.8
Replace Automation Equipment - Mary's Harbour		120.3	1,021.7				1,142.0
Replace Unit 2059 - Makkovik			576.5	4,244.0			4,820.5
Replace Radiators - Various Sites			527.3	562.6			1,089.9
Install Fire Detection System - North Bay			338.3				338.3
Upgrade Fuel Piping - McCallum			156.0				156.0
Replace Unit 2052 - Cartwright				1,009.5	2,665.4		3,674.9
Replace Unit 2037 - Mary's Harbour				369.9	1,464.9		1,834.8
Purchase Mobile Diesel - Bishop's Falls					1,400.0		1,400.0
Perform Plant Improvements - Various Sites					1,011.0	3,058.5	4,069.5
Install Unit Fuel Metering - Various Sites					600.0		600.0
Replace Existing Bus with 1,600 Amp Bus - Hopedale					500.0		500.0
Replace Main Breaker and Extend Plant - Little Bay Islands					500.0		500.0
Upgrade Septic System - Nain					500.0		500.0
Build Roadway for Freight Delivery - North Bay					307.0		307.0
Construct Site Fencing - North Bay and Port Hope Simpson					300.0		300.0
Install Sequence of Events Monitor in Diesel Plants - Various Sites					281.0	289.1	570.1
Upgrade Water Line to Diesel Plant - Makkovik					250.0		250.0
Replace Diesel Plant - Rigolet					210.2	2,101.4	2,311.6
Purchase and Install Sewage Lift System - Rigolet					210.1		210.1
Install Automatic Oil Filling System -Various Sites					200.0		200.0
Install Engine Starting System - Various Sites					200.0		200.0
Upgrade and Add Site Fencing - L'Anse au Loup					200.0		200.0
Replace Unit 2039 - St. Lewis					150.0	1,300.0	1,450.0
Install Waste Oil Storage Tank - Various Sites					150.0		150.0

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
GENERATION (cont'd)							
Upgrade Fuel Storage - Little Bay Islands					125.3		125.3
Construct Lube Oil Ramp For Waste Oil - Nain					120.0		120.0
Build Fire Separation Wall Between Transformers - St. Anthony and L'Anse Au Loup					50.0	250.0	300.0
Replace Bulk Storage Piping - Black Tickle						300.0	300.0
Replace PLCs and Software - Various Sites						300.0	300.0
Replace Fuel Lines and Control Valves to Bulk Storage - Various Sites						250.0	250.0
Replace PML 3800 Series Mini RTUs - Various Sites						250.0	250.0
Upgrade Fuel Piping Bulk Tanks to Units - Grey River						200.0	200.0
Increase Plant Storage - Various Sites						150.0	150.0
Install Infrared Scanning Ports - Various Sites						150.0	150.0
Replace Unit Breakers - Various Sites						150.0	150.0
Replace DSLC and MSLC - Various Sites						100.0	100.0
Install Electric Trolley on Jib Crane - Various Sites						75.0	75.0
Replace Radiator Stands - Black Tickle						50.0	50.0
TOTAL GENERATION	6,172.8	11,780.8	13,454.3	12,513.4	18,082.3	14,248.2	76,251.8

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
PROPERTIES							
Upgrade Warehouse Lighting - Bishop's Falls	15.2	180.4					195.6
Upgrade Office Facilities & Control Buildings - Various Sites		2,197.3	1,603.0	2,370.4	1,779.9	1,951.7	9,902.3
Line Depot Condition Assessment and Refurbishment Program - Various Sites		1,458.8					1,458.8
Construct New Facilities - Various Sites		422.0	1,034.1				1,456.1
Install Fall Protection Equipment - Various Sites		194.7	199.7	199.8	209.6	215.3	1,019.1
Upgrade Line Depots - Various Sites			1,742.2	1,785.6	1,829.1	1,875.7	7,232.6
Upgrade Services and Warehouse Facilities - Bishop's Falls			688.7				688.7
Widen Right Of Ways for Distribution and Transmission Lines - Various Sites			673.7	558.5			1,232.2
Upgrade Outside Property - Various Sites			602.9	376.2	120.0		1,099.1
Upgrade Classroom and Boardroom in Main Office - Bishop's Falls			165.3				165.3
Construct Storage Building - Springdale			125.9	691.6			817.5
Upgrade Fire System - Bishop's Falls			109.3	860.0			969.3
Install Pole Storage Ramps - Various Sites				899.6	924.2	949.5	2,773.3
Replace Roof on Garage - Bishop's Falls					100.0		100.0
Upgrade HVAC System - Stephenville					100.0		100.0
TOTAL PROPERTIES	15.2	4,453.2	6,944.8	7,741.7	5,062.8	4,992.2	97,891.3
METERING							
Install Automated Meter Reading - Happy Valley (2017-18)		78.6	1,891.6				1,970.2
Install Automated Meter Reading - Labrador West	433.8	533.4					967.2
Install Automated Meter Reading - Various Sites			80.7	1,067.0	1,041.0		2,188.7
Purchase Meters and Metering Equipment- Various Sites		198.8	197.9	199.7	198.6	198.8	993.8
Purchase New Meter Calibration Test Console - Hydro Place		196.9					196.9
TOTAL METERING	433.8	1,007.7	2,170.2	1,266.7	1,239.6	198.8	6,316.8
TOOLS AND EQUIPMENT							
Purchase Tools and Equipment Less than $50,000		423.0	497.7	375.5	300.4	253.0	1,849.6
Replace Light Duty Mobile Equipment - Various Sites		270.9					270.9
Purchase Front End Loader with Backhoe - Wabush		133.2					133.2
Replace Light Duty Mobile Equipment - Various Sites			436.3				436.3
Replace Off Road Track Vehicle Unit No. 7954 - Bay d'Espoir			200.0				200.0
Replace Front End Loader Unit No. 9628 - Bay d'Espoir			173.0				173.0
Replace Off Road Track Vehicle Unit No. 7239 - Bishop's Falls			13.7	986.3			1,000.0
Replace Light Duty Mobile Equipment - Various Sites				469.6			469.6
Replace Back Hoe Unit No. 9813 - Holyrood				173.0			173.0
Replace Off Road Track Vehicle Unit No. 7565 - Stephenville				14.0	441.9		455.9
Replace Light Duty Mobile Equipment - Various Sites					484.4		484.4
Replace Off Road Track Vehicle Unit No. 7799 - Springdale					200.0		200.0
Replace Off Road Track Vehicle Unit No. 7974 - Stephenville					8.8	741.2	750.0
Replace Off Road Track Vehicle Unit No. 7698 - Stephenville					8.8	455.2	464.0
Replace Light Duty Mobile Equipment - Various Sites						620.6	620.6
Replace Excavator Unit No. 7063 - Bay d'Espoir						92.0	92.0
Replace Excavator Unit No. 7064 - Springdale						92.0	92.0
Replace Excavator Unit No. 7065 - Bay d'Espoir						92.0	92.0
TOTAL TOOLS AND EQUIPMENT	0.0	827.1	1,320.7	2,018.4	1,444.3	2,346.0	7,956.5
TOTAL TRANSMISSION AND RURAL OPERATIONS	112,154.0	235,587.4	163,850.3	146,322.3	110,559.9	96,238.3	933,393.6

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
INFORMATION SYSTEMS							
SOFTWARE APPLICATIONS							
Upgrade of Technology							
Upgrade Microsoft Office Products - Hydro Place	683.7	953.4	957.3				2,594.4
Cost Recovery	(317.1)	(442.2)	(444.0)				(1,203.3)
Upgrade Energy Management System - Hydro Place		427.0	352.0	361.5	371.5	381.5	1,893.5
TOTAL SOFTWARE APPLICATIONS	366.6	938.2	865.3	361.5	371.5	381.5	3,284.6
COMPUTER OPERATIONS							
Infrastructure Replacement							
Replace Personal Computers - Hydro Place		401.4	493.1	425.9	76.5	371.2	1,768.1
Replace Peripheral Infrastructure - Hydro Place			258.3	88.8	142.2	210.3	699.6
TOTAL COMPUTER OPERATIONS	0.0	401.4	751.4	514.7	218.7	581.5	2,467.7
TOTAL INFORMATION SYSTEMS	366.6	1,339.6	1,616.7	876.2	590.2	963.0	5,752.3

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
TELECONTROL							
NETWORK SERVICES							
Replace Battery Banks and Chargers - Various Sites (2016-2017)	425.0	456.6					881.6
Replace Battery Banks and Chargers - Various Sites (2017-2018)		379.3	566.2				945.5
Replace Battery Banks and Chargers - Various Sites			230.5	578.3	663.5	800.0	2,272.3
Upgrade Telecontrol Facilities - Sandy Brook Hill	101.6	462.4					564.0
Upgrade Telecontrol Facilities - Mary March Hill and Blue Grass Hill		91.2	665.9				757.1
Upgrade Telecontrol Facilities - Various Sites				96.0	796.9	716.4	1,609.3
Replace MDR 4000 Microwave Radio East - Various Sites	77.4	1,093.1					1,170.5
Replace Powerline Carrier - Various Sites	73.4	763.4					836.8
Replace Air Conditioners - Massey Drive and Happy Valley	39.9	152.0					191.9
Replace Air Conditioners - Various Sites			75.7	173.9	150.0	150.0	549.6
Replace Network Communications Equipment - Various Sites		199.3	206.6	199.9	185.0	180.0	970.8
Upgrade Access Roads to Microwave Sites - Various Sites		118.4	124.5	127.6	127.2	132.0	629.7
Upgrade Site Facilities - Various Sites		49.0	49.8	49.8	49.1	48.0	245.7
Purchase Tools and Equipment Less than $50,000		45.2	46.0	47.1	48.2	49.3	235.8
Replace Radomes - Various Sites			385.6	257.4	185.0	180.0	1,008.0
Replace RTUs - Various Sites			109.6	109.1	100.0	100.0	418.7
Replace GPS Clocks - Various Sites			96.9				96.9
Replace PBX Phone Systems - Various Sites			88.5	1,153.2			1,241.7
Replace Teleprotection - TL244 & TL256			87.3	830.5			917.8
Replace Massey Drive 6000 Microwave Radio (East) - Various Sites			65.1	1,095.5			1,160.6
Replace Teleprotection - TL202 & TL206				89.2	848.6		937.8
Replace Teleprotection - TL261 & TL259				89.2	848.6		937.8
Replace VHF Mobile Radio System - Various Sites						5,000.0	5,000.0
Replace SCADA Communications Equipment - TL241						805.0	805.0
Replace SCADA Communications Equipment - TL221						666.0	666.0
Replace Back-up Generators - Microwave Sites						200.0	200.0
TOTAL TELECONTROL	717.3	3,809.9	2,798.2	4,896.7	4,002.1	9,026.7	13,384.2

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
				($000)			
TRANSPORTATION							
Replace Vehicles and Aerial Devices - Various Sites (2016-2017)	1,443.3	534.2					1,977.5
Purchase Vehicles and Aerial Devices - Various Sites	382.5	172.7					555.2
Replace Vehicles and Aerial Devices - Various Sites (2017-2018)		2,001.4	398.8				2,400.2
Replace Vehicles and Aerial Devices - Various Sites			1,582.8	2,833.3	2,662.0	2,271.2	9,349.3
TOTAL TRANSPORTATION	1,825.8	2,708.3	1,981.6	2,833.3	2,662.0	2,271.2	14,282.2
ADMINISTRATION							
Replace Air Conditioning Units 8 and 14 - Hydro Place	34.6	229.5					264.1
Replace Roof - Hydro Place		923.4					923.4
Remove Safety Hazards - Various Sites		198.6	198.1	197.9	214.2	219.6	1,028.4
Purchase Office Equipment - Various Sites		83.6	90.0	39.1	40.1	71.6	324.4
Upgrade Exterior of Building - Hydro Place			651.9				651.9
Construct Additional Parking Spaces and Access Ramp - Hydro Place			371.9				371.9
Makkovike Security Improvements - Hydro Place			245.7				245.7
Replace Washroom Fixtures - Hydro Place			129.0				129.0
Replace Parking Lot Light Poles - Hydro Place			109.1				109.1
Replace Transfer Switch - Hydro Place				427.5			427.5
Pave Middle Parking Lot and Replace Curb & Drainage - Hydro Place				323.1			323.1
Refurbish Stairways, Railings and Entrance Ways - Hydro Place				126.3			126.3
Replace Domestic Water Entrance - Hydro Place				47.4			47.4
Replace Elevator Motors and Controls Equipment - Hydro Place					200.0		200.0
Replace Roof on Office Building - Bishop's Falls						300.0	300.0
Upgrade HVAC System - Bishop's Falls and William's Harbour						200.0	200.0
Replace Warehouse Ramps - Postville						50.0	50.0
TOTAL ADMINISTRATION	34.6	1,435.1	1,795.7	1,161.3	454.3	841.2	5,722.2
TOTAL GENERAL PROPERTIES	2,944.3	9,292.9	8,192.2	9,767.5	7,708.6	13,102.1	39,140.9

APPENDIX B

TL267 PROJECT – 230 kV Transmission

Bay d'Espoir to Western Avalon

Report

SUMMARY

The Board of Commissioners of Public Utilities (the Board) approved the Newfoundland and Labrador Hydro (Hydro) Upgrade of Transmission Line Corridor (the Project) on December 12, 2014, with a total capital expenditure of approximately $291M and an in-service date of May 1, 2018. As TL267 has a material impact on system reliability and eliminates system constraints relating to power flow to the Avalon Peninsula, the schedule has recently been accelerated to be in service by October 31, 2017.

The Project includes two terminal station expansions and 188 km of 230 kV transmission line. Engineering for both the transmission line and terminal stations is ongoing and is on schedule. Procurement plans are on track with purchase orders and contracts in place for the majority of items. The first construction activity began on June 27, 2016 with the commencement of transmission line clearing.

The environmental assessment (EA) process was protracted, with the project submitted for registration on July 16, 2015 and environmental assessment release only granted on June 15, 2016. Overall, at this early point of execution, the project is tracking on schedule to meet the in-service date of October 31, 2017. Given the late release from the EA process, the schedule is considered challenging; however, Hydro has taken steps to mitigate the delays caused by the late EA release, such as advancing procurement, and tendering construction contracts, in parallel with the EA review period.

Cost expenditure is tracking as expected, with much of the cost to occur in the 2016 to 2017 years. The re-baselined schedule has been developed based on the new start date and is being used for tracking and control purposes.

Overall, the project is on target for completion, earlier that originally planned and within budget.

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APPENDIX A B23

1 INTRODUCTION

The Board approved the Project on December 12, 2014. The Project, now known as TL267, involves design and construction of 188 km of 230 kV steel tower transmission line, as well as station expansions at Bay d'Espoir and Western Avalon at Chapel Arm. The approved capital expenditure is $291,658,000. As directed by the Board as part of the approval of the Project, an annual report shall be filed with each capital budget application until completion of the Project. The Project will continue with scheduled commissioning on or before October 31, 2017.

2 PROJECT DESCRIPTION

On April 30, 2014, Hydro filed an application for approval to construct a 230 kV transmission line between Bay d'Espoir (BDE) Hydroelectric Generation Station and Western Avalon Terminal Station (WAV) at Chapel Arm, including upgrades at both stations to accommodate the new infrastructure. The Project was justified based on maintaining system reliability and meeting the long-term power requirements of the Island Interconnected System. It will provide additional capacity, enhance resiliency to system faults and relieve congestion on the existing transmission system. Based on the information supplied by Hydro as part of the Project review process, the Board released Order P.U. 53(2014) on December 12, 2014 approving the Project as described.

The Project is comprised of three distinct projects, and two sub projects. The three distinct projects are:

1) the addition of portions of a third breaker and one half station diameter including two circuit breakers, four disconnect switches and associated electrical and protection and control equipment in BDE Terminal Station 2 (BDE-TS2) using traditional Air Insulated Switchgear (AIS),
2) the addition of gas insulated switchgear (GIS) ring bus in WAV at Chapel Arm , and
3) a new 230 kV transmission line 188 km in length linking the two stations.

The two sub-projects are:

1. modifications to BDE-TS2 to allow for independent isolation of TL206, converting the existing ring bus to a breaker and one half scheme, and
2. modifications to WAV to connect TL208, which currently services the VALE site, to the new station expansion.

Given limited outage opportunities, the two sub-projects will be executed after TL267 goes in service, and as outage coordination and limitations permit.

3 ENGINEERING

The Project, including all station modifications and line designs, will utilize all of the latest industry standards and practices and design criteria currently in use by Hydro. Modifications to the stations will include the latest electrical and protection and control equipment that is currently maintained in the system and form the basis of new designs going forward. Transmission line design will utilize Hydro's operational experience and design criteria applicable along the existing corridor to ensure a reliable addition to the Island Interconnected grid. Two icing zones have been identified for the transmission line: between Bay d'Espoir and Pipers Hole Park with 50 mm radial glaze and between Pipers Hole Park and WAV with 75 mm radial glaze.

The engineering for TL267 involves the creation of a new tower family capable of structurally maintaining reliable service with the inclusion of shield wire for lighting outage protection. This new tower family includes two new suspension towers, modelled along the same design fundamentals of the 315 kV lines for the Lower Churchill Project. These towers follow the guyed-Y configuration (see Section 9) with the A-Type tower capable of 0° to 1° line angles, and a B-Type tower designed for angles of 0° to 6°. Two new strain towers are required, with a self-supported C-Type tower capable of angles from 0° to 30°, and a full-tension deadend D-Type tower for 0° to 45°. The D-Type tower is capable of anti-cascade failure containment within the range of angles of the tower. The existing Hydro NDD-Type tower, designed for the Avalon Upgrade in the early 2000s, has been verified as adequate for this application and will be utilized for angles between 45° and 90°. Shield wires, including one standard overhead ground wire and one optical ground wire which includes optical fibres for the communication system, will be utilized along the entire length.

Design for the new tower family commenced in January 2015, and foundation design began in May 2015 once tower loads and reaction forces were finalized. All towers are being fully designed in-house, including all necessary documentation for eventual detailing of the tower

connection plates, prototype assembly of all towers, full-scale tower testing of the A-type and D-type towers, as well as mass production by the tower manufacturer.

To date, and as planned, all tower designs are 100% complete. Tower foundations are also 100% complete. The contract for the supply of the towers and tower foundations has been awarded and work is well underway. Prototype assembly of the each tower type is complete and the full-scale tower testing of the A-type tower and D-type were successfully completed. Tower foundation prototyping is also complete and mass fabrication is underway. The first foundation deliveries are expected in August 2016 and the first tower deliveries are expected in September 2016.

The first step in line design is assessing and selecting a line route. The line route has been finalized since the environmental assessment release has been granted. Preliminary line design, which has been completed as planned, quantifies the number, types and heights of the required towers for the entire line using “stick models”. Stick models are representative towers used in the design software and are based on the "as-designed" capacity. Final line design requires the use of the final tower model capacities after detailing by the manufacturer, and will be completed in 2016. The preliminary line design allows for quantification of the towers and hardware for tendering purposes, allowing for accurate bid quantities and initial ordering of the first material deliveries.

Station design involves a significant amount of detailed engineering prior to tendering, given that both station modifications are in existing terminal stations, and it is more efficient to provide the design details to the potential bidders.

For the BDE-TS2, the original station design included space for an additional electrical breaker and one-half diameter, and therefore expansion outside the existing station footprint is not required. The new station diameter will include standard AIS using modern circuit breakers and associated equipment and infrastructure. Support equipment, including take-off structures for

the overhead lines, will be similar to the existing infrastructure. New protection and control panels will be required in the existing control building, as well as associated station modifications to run the control wiring. Connection to the SCADA system for communication with the Energy Control Centre is also required.

The WAV station involves a new GIS module given the lack of easily usable space around the station, and the cost of developing new land in the area. An investigation confirming the requirement for GIS was completed and verified that GIS is the most economical solution for WAV. Hydro currently has a GIS at the Cat Arm Generating Station which has operated reliably for the past 30 years, and GIS solutions are common in areas when the footprint is limited.

WAV will be executed as an Engineer Procure and Construct (EPC) contract. This contract has been tendered and awarded and the detailed engineering phase has commenced. Engineering for BDE-TS2 is complete and the procurement package for the AIS circuit breakers has been awarded. Engineering for the protection, control, and communications panels is nearing completion as well, with a tender for this equipment expected to be issued in July 2016.

4 ENVIROMENTAL ASSESSMENT

Given the size and nature of the Project, registration for environmental assessment (EA) under the Environmental Protection Act is required. EA is an evaluation of a project's potential environmental risks and effects before it is carried out. EA also identifies ways to improve project design and implementation to prevent, minimize, mitigate, or compensate for adverse environmental effects and to enhance positive effects. The EA Registration Document for this project is an enhanced registration document, which includes baseline studies for key environmental components such as caribou, avifauna, historic resources, rare plants, and an assessment of the effects of the Project on these components.

Consultation is a cornerstone of the EA process. Hydro consulted with key stakeholders, and held open house sessions in June 2015, in select communities including Bay d'Espoir, Come By Chance and Chapel Arm to inform stakeholders about the new line and to have meaningful discussions and identify concerns.

The Project was submitted for registration as an undertaking under Part 10 of the provincial *Environmental Protection Act* on July 16, 2015. Following a public review period, the Minister of Environment and Conservation normally has 45 days from registration to notify the proponent of release, or that an environmental preview report or environmental impact statement is required. However, the preferred and primary routing through the Bay du Nord Wilderness Reserve (BDNWR) delayed the decision by the Minister until the process described in the following paragraph was completed.

The primary route for TL267 is parallel and adjacent to existing transmission lines along the entire 188 km to minimize the environmental impact. The primary route is located within the BDNWR for 13 km. The reserve was established as a Wilderness Reserve under the Newfoundland and Labrador Wilderness and Ecological Reserve Act in 1990. Although it contains two existing transmission lines constructed in the mid-1960s, the Wilderness Reserve Regulations do not allow for the construction of a new transmission line through the BDNWR.

Provisions in the Act outline the process to allow for the Lieutenant-Governor in Council to reduce the size of the reserve. In order to allow for line construction through the BDNWR, the proposed right of way, 40 m wide and 13 km long, would have to be removed from the reserve. The process required for this removal was initiated in May 2015, and was concluded in early June 2016. The release from further Environmental Assessment was subsequently issued by the Department of Environment and Conservation on June 15, 2016.

With the release from the EA process construction can now proceed. All other required environmental activity is on schedule as planned.

5 PROCUREMENT

Procurement activities are well advanced with most of the packages tendered and awarded (refer to Table 1).

The contract for the supply of the towers and tower foundations, which is on the critical path for the Project, has been awarded and work is well underway. Prototype assembly of each tower type is complete and both full-scale tower testing programs (A-type tower and D-type tower) were successfully completed in June and July, respectively. With the successful full-scale tower test completed, mass fabrication for all towers has now begun. Tower foundation prototyping is also complete and mass fabrication is underway. The first foundation deliveries are expected in August 2016 and the first tower deliveries are expected in September 2016. Photos of tower and tower foundations are included in Section 9.0.

The tender for the transmission line clearing contract was awarded in June and clearing activities started June 27, after the EA release and subsequent clearing permits were acquired.

The tender for the transmission line construction contract was opened on March 29, 2016, closed on June 1, 2016, and bids were evaluated. Six bids were received as part of the tender call and all bidders indicated that the revised October 31, 2017 in-service date was achievable. The contract was awarded in July.

The tender for the EPC contract for the WAV GIS module was awarded in June and engineering for the module was initiated immediately upon award. The tender for the AIS electrical equipment has been awarded and the final package to be tendered is for the protection and control equipment for BDE-TS2. The tender for the BDE-TS2 modifications has closed and is currently being evaluated.

Currently all procurement activities remain on track to support the 2017 in-service date.

Table 1: Procurement Status Update

Item	Contract Name	Status
1	Supply of Steel Towers and Foundations	Awarded
2	Supply of Line Conductor	Awarded
3	Supply of 220 kN Insulator	Awarded
4	Supply of Steel Towers (2 – NDD, 3 – AA)	Awarded
5	Supply of Line Hardware	Closed – Under Evaluation
6	Supply of Steel Wire	Awarded
7	Supply of Anchor Materials	Awarded
8	Supply of Optical Ground Wire	Awarded
9	Supply of Dampers	Awarded
10	TL267 – Line Clearing Contract	Awarded
11	TL267 – Line Construction Contract	Awarded
12	Four – 245 kV AIS Circuit Breakers for Bay d'Espoir	Awarded
13	Western Avalon – TS GIS Turnkey Solution	Awarded
14	Protection, Control, Comms Equipment Supply	Under preparation – Tender in July
15	Bay d'Espoir Installation Contract	Closed – Under Evaluation

6 CONSTRUCTION

Construction has started with the commencement of the line clearing. With the EA release received on June 15, 2016 and subsequent clearing permits received the following week, the first tree cut was on June 27, 2016.

The transmission line construction contract was awarded in July. Mobilization will begin in July with an initial ground truthing exercise, establishment of construction offices and camps, and start of construction of access roads/trails. Tower foundation work is planned to start in September after arrival of the foundation materials.

7 COST

A significant portion of the expenditure for this Project will occur in 2016 and 2017. The 12 months covered by this annual report primarily includes EA, engineering, and planning expenditures. The rate of spend across the project duration will increase significantly going forward, now that the majority of the contracts have been awarded, construction has commenced, and materials are arriving on site.

As part of the project execution, a re-baseline of the cash flow was completed based on the revised in-service date of the project, and based on the execution model detailed previously. This re-baseline will include expenditures of $2.1M (2015), $85.4M (2016), $149.9M (2017) and $54.3M (2018). Approximately $6M has been expended to date on transmission and station engineering, environmental work, material procurement, and project management. Significant material and construction expenditure will be realized prior to the next update, when most of the line materials arrive, clearing is well advanced, and line construction has begun. A more detailed report will be presented at that time.

Tender results recently received for the major equipment and construction contracts support the advancement of the in-service date, and demonstrate that the budget expectation is accurate and that the acceleration of the schedule has no negative impact to overall project cost. The project remains forecasted to be on budget at $291,658,000.

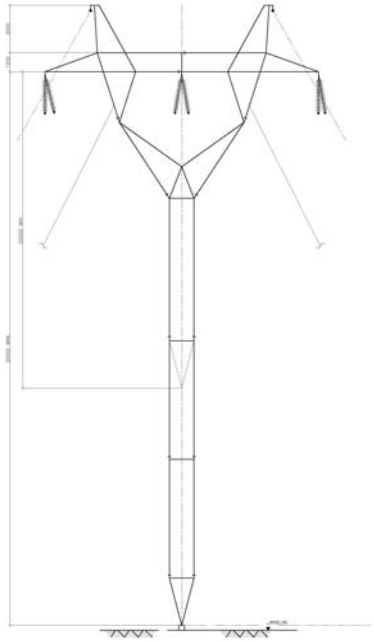
8 SCHEDULE

The updated milestone schedule is included in Appendix A.

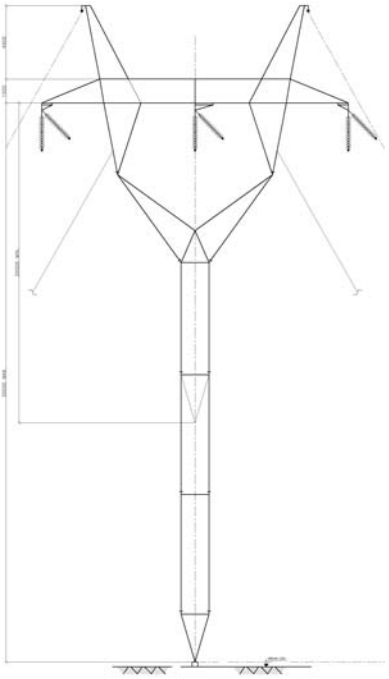
This schedule is currently being used to track progress, and is based on the EA release by the Minister in June 2016, which allowed clearing activities to start in June 27, 2016. Overall, at this early point of field execution, the project is tracking on schedule to meet the in-service date of October 31, 2017. Given the late release from the EA process, the schedule is considered challenging; however, Hydro has taken steps to mitigate the delays caused by the late EA release by:

1. Advancing the procurement of transmission tower structures, terminal station equipment, and other transmission line materials to support the advanced construction schedule.
2. Issuing the transmission line construction contract tender call and evaluating the bids in parallel with the Environmental Assessment review period so that schedule savings could be achieved. EA Release was granted on June 15, 2016.
3. Including the advanced in-service date as a part of the transmission line construction contract tender. Six bids were received as part of the tender call and all bidders indicated that the 2017 in-service date was achievable.

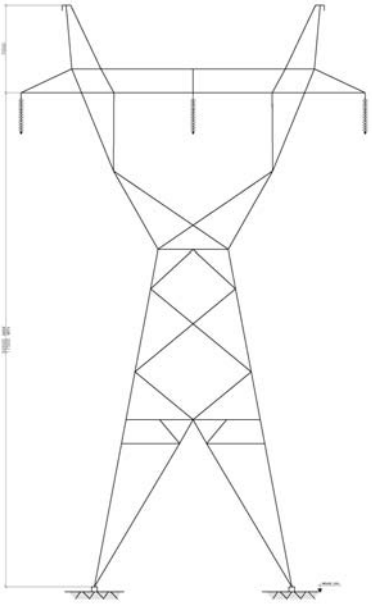
9 DRAWINGS AND PHOTOS



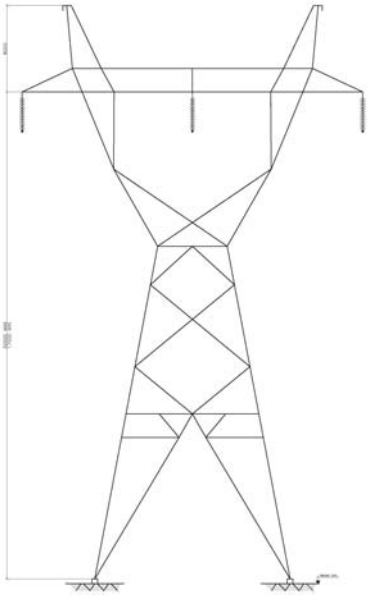
Tower Type A



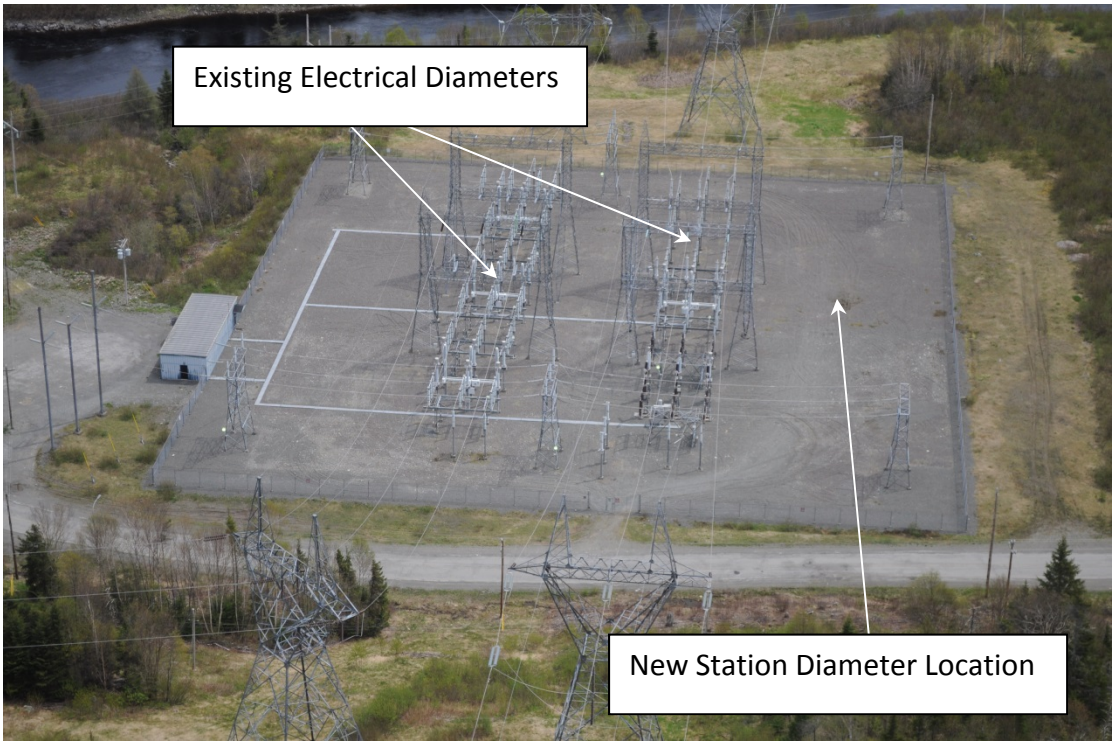
Tower Type B



Tower Type C



Tower Type D



Bay d'Espoir Terminal Station 2

Western Avalon Terminal Station

Typical TL202/TL206 right of way near BDE; TL267 will be on the right

Typical TL202/TL206 right of way near BDE; TL267 will be on the right

TL202/TL206 right of way with existing Hydro access bridge within the Bay Du Nord Wilderness Reserve

Typical TL202/TL206 right of way in limited available access zone west of Pipers Hole Park

Typical TL203/TL237 right of way on the Avalon Peninsula; TL267 will be on the right

Start of Clearing Near Chapel Arm – June 27, 2016

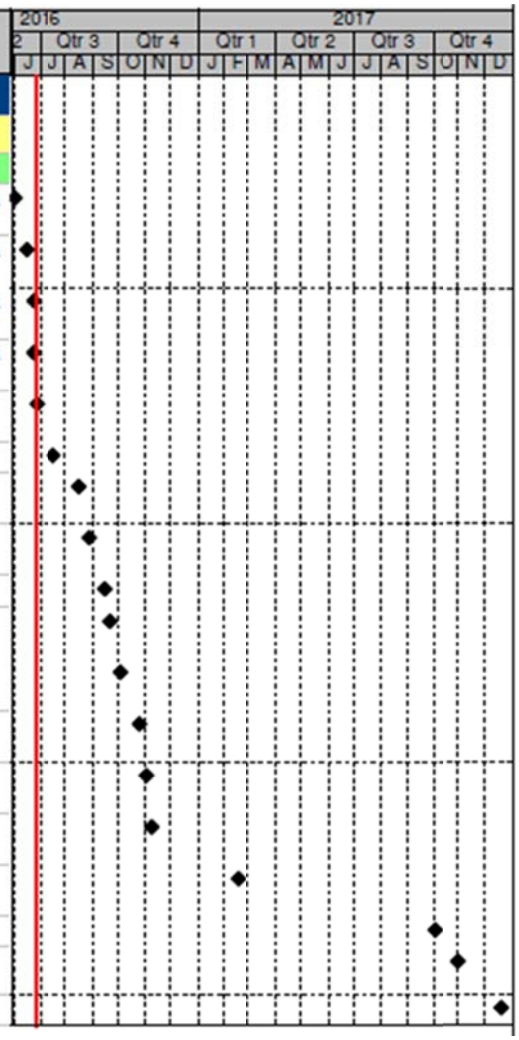
Foundation Steel Preparation for Shipping – Ankara, Turkey

A-Tower Full Scale Load Test - Romania

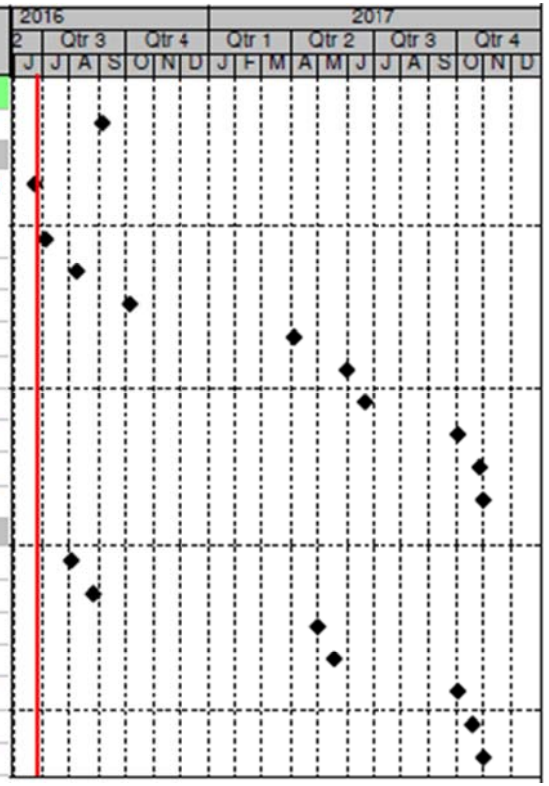
A-Tower Full Scale Load Test - Romania

APPENDIX A

Activity ID	Activity Name	Physical % Complete	Start	Finish
System Upgrades TL267			01-Jun-16 A	19-Dec-17
Key Project Milestones			01-Jun-16 A	19-Dec-17
TL267 Milestones			01-Jun-16 A	19-Dec-17
267.MS.200	TL267 Construction Contract Tender Close	100%		01-Jun-16 A
267.MS.100	EA Release TL267	100%		15-Jun-16 A
267.MS.280	Award LNTP for TL267 Construction Contract # 65473	100%		24-Jun-16 A
267.MS.140	Award TL267 Right of Way (ROW) Clearing Contract # 64095	100%		24-Jun-16 A
267.MS.150	TL267 ROW Clearing Start	100%	27-Jun-16 A	
267.MS.120	Award TL267 Construction Contract # 65473	0%		18-Jul-16
267.MS.160	TL267 Foundations Steel (Lot 1A 25% of all) Received at Marshalling Yard	0%		16-Aug-16*
267.MS.260	TL267 Foundations Steel (Lot 1B 25% of all) Received at Marshalling Yard	0%		29-Aug-16*
267.MS.130	TL267 Construction Start	0%	15-Sep-16	
267.MS.170	TL267 Tower Steel (Lot 2A & B Tower) Received at Marshalling Yard	0%		20-Sep-16*
267.MS.230	TL267 Foundations Steel (Lot 3 Remaining 50% of all) Received at Marshalling Yard	0%		04-Oct-16*
267.MS.220	TL267 Tower Steel (Lot 2 C & D Tower) Received at Marshalling Yard	0%		24-Oct-16*
267.MS.270	TL267 Towers & Foundations AA & NDD Received at Marshalling Yard	0%		02-Nov-16*
267.MS.240	TL267 Tower Steel (Lot 4 Towers 75% of all) Received at Marshalling Yard	0%		08-Nov-16*
267.MS.250	TL267 Tower Steel (Lot 5 Towers 100% of all) Received at Marshalling Yard	0%		16-Feb-17*
267.MS.180	TL267 Substantial Completion	0%		02-Oct-17*
267.MS.190	TL267 In-service	0%		31-Oct-17*
267.MS.210	TL267 Reclamation Complete - Package # XXX	0%		19-Dec-17*



Activity ID	Activity Name	Physical % Complete	Start	Finish
TL267 Terminal Station Milestones			24-Jun-16 A	30-Oct-17
TS.MS.210	Award PCC Equipment Supply Contract # XXXX	0%		06-Sep-16*
WAV			24-Jun-16 A	30-Oct-17
TS.MS.280	Award LNTP for WAV TS GIS Turnkey Solution Contract # 66452	100%		24-Jun-16 A
TS.MS.110	Award WAV TS GIS Turnkey Solution Contract # 66452	0%		05-Jul-16
TS.MS.120	WAV TS GIS Design Complete	0%		08-Aug-16
TS.MS.150	WAV TS GIS Construction Start	0%	05-Oct-16	
TS.MS.130	WAV TS GIS Equipment Manufacturing Complete	0%		04-Apr-17
TS.MS.230	WAV PCC Equipment Received	0%	01-Jun-17*	
TS.MS.140	WAV TS GIS Equipment Received	0%		22-Jun-17
TS.MS.240	WAV TS GIS Substantial Completion	0%		02-Oct-17*
TS.MS.160	WAV TS GIS Commissioning Start	0%	27-Oct-17	
TS.MS.250	WAV TS GIS In-service	0%		30-Oct-17*
BDE			03-Aug-16	30-Oct-17
TS.MS.170	Award BDE TS Installation Contract # 66780	0%	03-Aug-16	
TS.MS.190	BDE TS Construction Start	0%	26-Aug-16	
TS.MS.220	BDE PCC Equipment Received	0%	01-May-17*	
TS.MS.180	BDE TS AIS Equipment Received	0%	18-May-17	
TS.MS.260	BDE TS AIS Substantial Completion	0%		02-Oct-17*
TS.MS.200	BDE TS Commissioning Start	0%	19-Oct-17	
TS.MS.270	BDE TS AIS In-service	0%		30-Oct-17*



A Report to the

Board of Commissioners of Public Utilities

Holyrood Overview

Future Operation and Capital Expenditure Requirements

July 2016

newfoundland labrador hydro
a nalcor energy company

BACKGROUND

In Orders No. P.U. 5(2012) and No. P.U. 4(2013), the Board of Commissioners of Public Utilities (the Board) directed Newfoundland and Labrador Hydro (Hydro) to file, in conjunction with its 2014 Capital Budget Application, an overview in relation to the proposed capital expenditures for the Holyrood Thermal Generating Station. The Board required that the overview include the following[1]:

1. *An updated outlook regarding anticipated changes in the role of Holyrood on the system;*

2. *An updated schedule of anticipated changes in Holyrood operations that may reasonably be expected to have an impact on capital expenditure requirements;*

3. *A summary description of all proposed Holyrood capital projects, including an explanation of how such projects relate to one another and whether such projects may be impacted by decisions yet to be taken regarding Holyrood's role on the system;*

4. *A summary guide to all internal and external reports filed in support of the capital expenditure proposals, summarizing alternatives considered and recommendations made; and*

5. *An explanation of the necessity of all proposed capital expenditures in the context of the anticipated changes in Holyrood operations.*

In Order No. P.U. 42(2013), the Board further required Hydro to update and file the Holyrood Overview report with future capital budgets. This report contains the update to the future operation and capital expenditure requirements for the Holyrood Thermal Generating Station.

[1] *Order No. P.U. 5(2012)*

INTRODUCTION

Hydro's Holyrood Thermal Generating Station (Holyrood) is a critical part of the Island Interconnected System (IIS). With three oil fired generating units providing an installed capacity of 490 MW (465 MW net), the plant represents approximately one third of Hydro's total IIS generating capacity, and approximately one quarter of the total IIS capacity, when included with all other Customer Owned generation. Units 1 and 2 were commissioned in 1970 and 1971 respectively and Unit 3 in 1979. Units 1 and 2 were originally designed to produce 150 MW, but were upgraded to 170 MW in 1988 and 1989, respectively. Unit 3 retains its original configuration and is rated at 150 MW. In 1986, Unit 3 was retrofitted with synchronous condensing capability to provide voltage support on the eastern area of the IIS during periods when power generation from this unit is not required.

The three major components of the thermal generating process are the boiler, the turbine and the generator, with supporting systems such as fuel storage and delivery, controls, and cooling and feed water supply systems. Through combustion of No. 6 heavy fuel oil, the power boiler provides high energy steam to the turbine. The turbine is directly coupled to the generator and provides the rotating energy necessary for the generator to produce rated output power to the IIS. The generator itself is pressurized and cooled by hydrogen gas to provide maximum efficiency both in heat transfer and reduced windage losses.

The Holyrood Generating Station is essential for meeting winter peak demand as well as overall Island annual energy requirements. Hydro's hydro-electric generation is dependent on rainfall and inflows to the reservoirs. Holyrood is required to supply the difference between what is produced by Hydro's other generation sources (including purchases from non-utility generators) and what is required to meet the Island load. During a period of reduced inflows and low water storage levels, this may be significant. The Holyrood units are also critical for securing the transmission and providing voltage support for the major load centres on the Avalon Peninsula.

Figure 1: Holyrood Thermal Generating Station

CURRENT OPERATIONAL OUTLOOK AND SCHEDULE

On December 17, 2012, the Government of Newfoundland and Labrador announced official sanction of the Muskrat Falls (MF) development. As per the most recent schedule update, the Labrador Island Link (LIL) is expected to be in service by the end of the second quarter of 2018. The construction activities and final commissioning of the Muskrat Falls Project are expected to be completed in 2020. In addition, the Maritime Link (ML) and the transmission line between Bay d'Espoir and Western Avalon, TL267, are scheduled to be in-service in the fourth quarter of 2017. During the interim period between when the interconnections are complete and the completion of the Muskrat Falls plant, the Holyrood plant's production level may be reduced by importing energy over the HVdc interconnections. The HVdc connection from Labrador will have a capacity to deliver approximately 200 MW without any generating units in operation at Muskrat Falls. During this period, Hydro will maintain required operating reserves using Holyrood, and as satisfactory operating experience is obtained from the HVdc interconnections, the Holyrood units will be placed in standby mode. The number of units placed in standby mode will depend on the availability of reliable capacity and energy off the Island through Labrador or Nova Scotia, and sustained reliable operation of the HVdc interconnections. While in standby mode, the plant will remain fully available for generation and will be periodically operated to ensure availability until the end of the winter of 2021. At the end of the winter of 2021, it is projected that the remaining fuel in the

tanks will be consumed, Units 1 and 2 and the steam components of Unit 3 will be decommissioned, and Unit 3 will continue to operate in synchronous condenser mode only, with no generation capability.

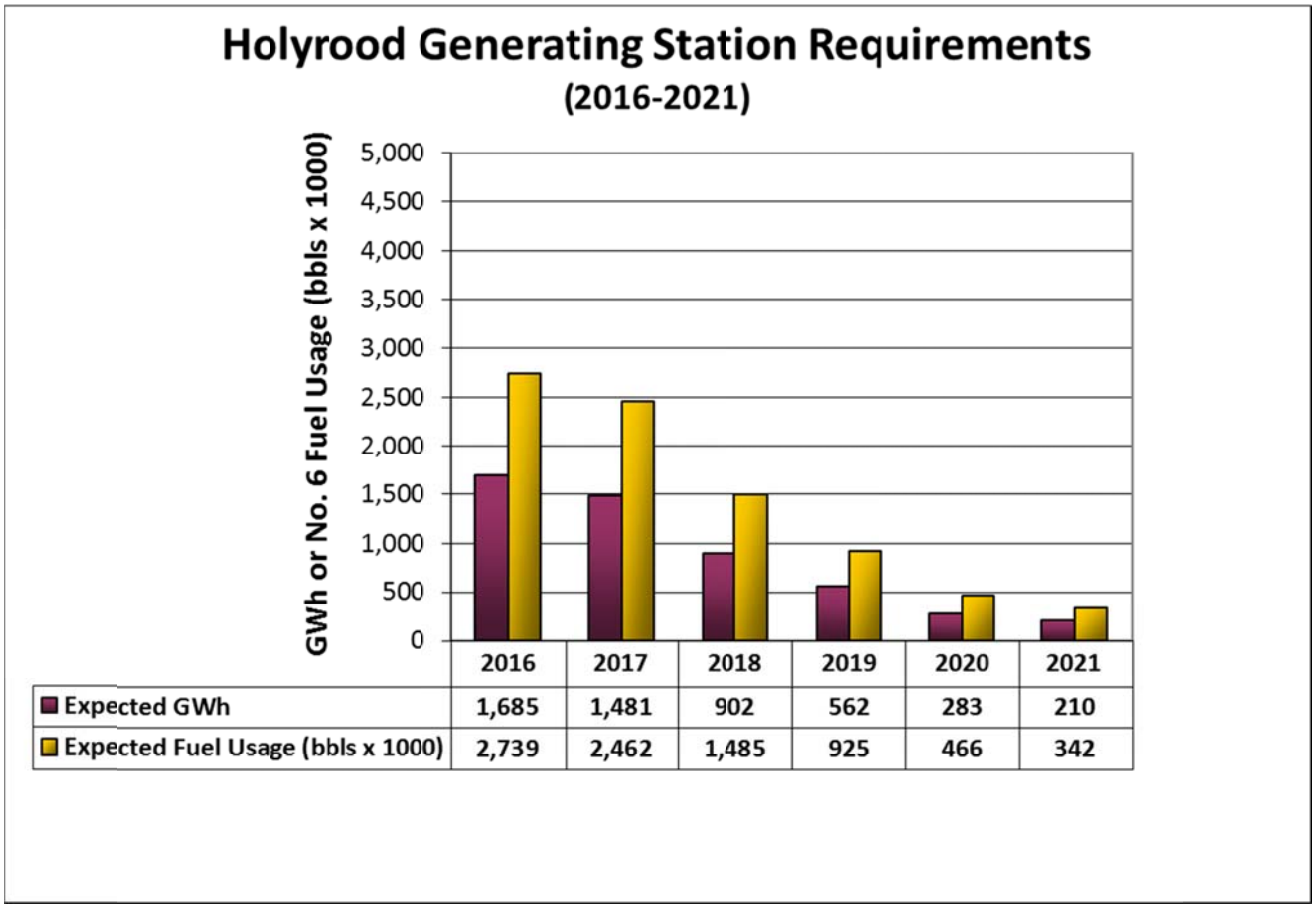


Figure 2: Holyrood Annual Production Requirements 2016 to 2021

Figure 2 indicates the forecasted annual Holyrood production requirements for the six year period from 2016 to 2021. The forecast for 2016 to 2017 is based on actuals to the end of March 2016 with average Island hydrologic inflow conditions for the remainder of the period. By the end of the second quarter of 2018, the LIL is expected to be in-service to supplement the supply to the IIS with recall power from Churchill Falls which is in excess to Labrador customer requirements. The Holyrood production shown for 2018 through the first half of 2019 assumes only recall energy is available off the Island and that there is sufficient firm capacity available from recall during the winter to enable the placing of one of the Holyrood units in standby during the winter. There may be other opportunities for power and energy purchases, but at this time it is prudent to assume only recall power will be readily available after Labrador needs are fulfilled. In 2020 the construction activities and final commissioning of the Muskrat

Falls Project are expected to be completed. As the Muskrat Falls units become available, the LIL will be load tested above the 200 MW level up to full capability of 900 MW. During this period the Holyrood units will be operated at minimum levels to provide required reliable capacity should the HVdc interconnection have issues during testing and early operation at higher loads. As the operation of the HVdc interconnection is proven reliable at the higher levels, the Holyood plant will be shut down and all units placed in standby mode as the reserve capacity will now be provided by the Muskrat Falls plant's capacity.

The production at Holyrood may vary from that forecasted depending on the timing of in-service of the Lower Churchill assets and the availability of off-Island firm capacity and the load needs of the Island. In addition, hydrologic conditions may influence Hydro's hydraulic energy supply capability. During a high inflow period, production from the Holyrood plant will be kept to minimum levels, with units operated only as required for system reserve capacity and Avalon Peninsula transmission reliability considerations. Production during a wet period could be less than 1,000 GWh annually. On the other hand, during a repeat of the critical dry sequence, and with no off-Island energy sources to draw upon, annual required production from Holyrood would be significantly higher depending on the hydraulic circumstances at the time. This would require all units to be operated reliably, outside of their annual planned and maintenance outage requirements.

In summary, the specific phases of operation and the timeframes for each phase are anticipated to be as follows:

Phase 1 Normal Production Phase (2016 through to the second quarter 2018): All three units are available for prime power generation with Unit 3 also available for synchronous condenser operation as required.

Phase 2 Standby Production Phase (second quarter 2018 through to the end of the winter 2021): The units will be placed in Standby mode as off-Island firm capacity is made available from recall power, other firm capacity arrangements, and from the Muskrat Falls units. Unit 3 will be operated in synchronous condenser mode when its capacity is not required, but will be available for conversion to generation mode as required.

Phase 3 Synchronous Condenser Operation Phase (Post winter 2021): Unit 3 continues to operate as a synchronous condenser.

Phase 1 – Normal Production Phase

Prior to the in-service of the LIL and the ML, there will be continued prime power demands on Holyrood to serve system load requirements. While within the past decade, Island industrial demand has declined primarily due to the closure of two paper mills and a reduction of demand at the remaining mill, there has been continued growth in Utility customer requirements. On the Avalon Peninsula, over the next two years, industrial load growth is expected to continue to increase as a result of the nickel processing facility at Long Harbour.

Holyrood remains critical to the reliable supply of power to the IIS, as it serves the base load of the system and will be required to do so in the short to medium term. Holyrood will remain a critically important facility during construction of the Muskrat Falls Project. During this phase of operation, the capability to operate Holyrood is essential to meeting the energy and capacity requirements of the Island portion of the province.

Hydro has not developed longer term hourly forecast requirements for synchronous condenser operation. Typically, Unit 3 has been converted between synchronous condenser or generate mode seasonally as system conditions dictate.

Phase 2 – Standby Production Phase

Following the in-service of the LIL and the ML, and prior to full availability of MF generation, the Holyrood plant will continue to be an essential component of the Provincial electrical grid. Until the end of the winter 2021, the plant will function as a standby facility and depending on the availability of off-Island capacity operating at some level of base loading. While in standby mode, it can be called upon to provide energy and capacity to the Island in the event of a loss of supply from Labrador due to operational issues on the HVdc interconnection. At the end of the standby period, the remaining fuel inventory will be consumed.

During the period of standby operation, Unit 3 is expected to operate primarily in synchronous condenser mode as required for system security, with the option to return to full generating mode if required.

Table 1, found at the end of this section, provides the forecasted Holyrood unit operating data from 2016 to 2021.

Phase 3 – Synchronous Condenser Operation Phase

Following the Standby Production Phase, the thermal aspect of the station required for power production will be decommissioned. After this period, the reliability of the HVdc transmission system is expected to be well established, having been reliably operated for a number of years. At that time, Unit 3 will continue to operate as a synchronous condenser. The end of power production is currently projected to be at the end of the winter 2021. Hydro does not plan to use Holyrood for emergency power post winter 2021. If future system studies necessitate additional synchronous condenser capacity, the option to convert Unit 1 or 2 to synchronous condenser capability on a permanent basis would be considered. If required, this will generate some additional future capital work, as well as incremental O&M, beyond what is currently planned.

Systems to be decommissioned when no longer required include the following:

- The fuel storage and delivery system, including the tank farm and day tank;
- The boilers, including air systems and emission monitoring systems;
- The feedwater and condensate systems, including the deaerator systems; and
- The marine terminal.

Systems required for synchronous condenser operation following the standby phase include:

- Unit 3 synchronous condenser specific equipment including the unit generator and exciter; and
- Auxiliary systems including electrical, controls, cooling water, fire protection, etc.

Table 1: Holyrood Operating Requirements 2016-2021

Holyrood Production and Island Interconnected Load 2016-2021

Year	Holyrood Net Production (GWh)	Total Unit Operating Hours	Holyrood Capacity Factor (%)	Total Island Interconnected Load (GWh)	Holyrood Percentage of Total Load (%)
2016	1,685	16,515	41	7,112	24
2017	1,481	17,123	36	7,146	21
2018	902	9,405	22	7,152	13
2019	562	5,782	14	7,109	8
2020	283	2,879	7	7,102	4
2021	210	1,911	5	7,113	3

Notes:
Load Forecast for 2016 as per March 2016 OLF.
Load Forecast for 2017-2021 as per May 2016 Initiation LF.

MAINTENANCE STRATEGY THROUGH THE OPERATIONAL PHASES

During Phase 1 of Holyrood's future operation, no changes are expected in terms of maintenance strategy as the plant is expected to produce with high reliability. The scheduled overhaul of plant equipment such as auxiliary system pumps will continue through this period to ensure plant reliability. The upgrade of equipment at or near the end of its useful service life will also continue, as will replacement of obsolete equipment which can no longer be maintained. While there may be efforts to reduce routine planned loading of the Holyrood units to reduce overall risk, it is necessary to be able to operate at maximum capacity under emergency conditions.

During Phase 2 of Holyrood's future operation, few changes are expected in terms of maintenance strategy since the plant must be fully available for emergency use until the post winter 2021 timeframe. Hydro has not yet established the maintenance regime required for standby production. The detailed work associated with this analysis is expected to be performed prior to commencement of stand-by production and will likely evolve during this phase, but no significant changes are anticipated to the maintenance regime as all three units are expected to operate reliably during the standby period. While

the maintenance strategy is not expected to change, equipment maintenance intervals, which are based on annual operating hours, may be extended beyond normal timeframes during the standby period, depending on actual operating hours, in order to reduce cost while ensuring reliability.

During Phase 3 of operation, assets with operational requirements beyond the post winter 2021 timeframe will continue to be optimally maintained with investment reflecting that continued requirement.

HOLYROOD 2017 CAPITAL PLAN SUMMARY

The complexity of thermal generating units, along with the age of the Holyrood plant, necessitates a rigorous review of the assets to ensure its future generating requirements can be met. In order to ensure that critical systems receive the appropriate level of refurbishment, Hydro has been concentrating on condition assessments, inspections, and the formulation of requirements to get Holyrood to the end of its life as a generating facility, and for Unit 3 to operate in synchronous condenser mode beyond that time.

The following tables summarize the projects included in the 2017 capital plan for Holyrood. The plan was prepared in recognition of the anticipated completion of the LIL during the second quarter of 2018 and in support of Holyrood generation availability requirements until post winter 2021. The plan was prepared considering asset condition, equipment obsolescence (both end of life and availability of support) and forecast production requirements, to identify the necessary rehabilitation and replacement projects to ensure customer needs can be met. In the event of unforeseen failure, or unexpected as-found condition, adjustments or additions may be required beyond the current plan.

Table 2 provides a summary description of all proposed Holyrood capital projects for 2017. All of the proposed projects are required to ensure that the Holyrood facility is available to meet the energy and capacity requirements of the Island portion of the province through the construction and commissioning of the Muskrat Falls Project.

It should be noted that Hydro is managing several degrading pieces of infrastructure outside of the capital plan, notably the waste water basins building and the concrete exhaust stacks, in an attempt to reach end of generation life with minimal refurbishment cost. Condition is being assessed annually and

minor interventions are addressed as a means to mitigate safety and asset integrity risk. If the condition of these assets reaches an unacceptable point before end of generation, then Hydro will seek capital refurbishment at that time.

The Upgrade Underground Plant Drainage project relates to plant common support systems and infrastructure which is required to ensure the plant can continue to be operated safely, reliably and with regulatory compliance through the normal operation and standby production phases to post winter 2021. These systems support the overall operation of the plant.

The Overhaul Holyrood Pumps, Overhaul Unit 2 Turbine Valves, and Condition Assessment and Miscellaneous Upgrades projects relate directly to the major components of the power generation process, the boiler, turbine and generator, and their supporting systems. The first of these projects is related to the boiler feedwater and condensate systems for the generating units. The remaining projects relate to the steam turbines, generators and boilers and their systems required for safe operation and shut down.

Table 3 provides a summary guide to all internal and external reports filed in support of the capital expenditure proposals summarizing the alternatives considered and recommendations made.

Table 4 provides an explanation of the necessity of all proposed capital expenditures in the context of the changes in Holyrood operation.

Table 2: Holyrood Projects Included in the 2017 Capital Plan

Project	Scope Summary	Proposal Location
Overhaul Holyrood Pumps	This project involves overhauling the Unit 3 west circulating water pump, the Unit 3 north condensate extraction pump, and the Unit 1 west boiler feed pump.	>$500k Projects
Overhaul Unit 2 Turbine Valves	This project is to perform a scheduled overhaul of Unit 2 Turbine valves. This overhaul consists of total dismantling of all turbine valves, inspection of the valves, lapping of the valve seats, and adjustment of valve clearances.	>$500k Projects Tab 5
Upgrade Underground Plant Drainage	This proposal is for the refurbishment of the Holyrood underground plant drainage system. The underground drainage system delivers the effluent, generated during plant operation, to the appropriate outlets, where it is treated prior to its release into the environment. The scope of work consists of: the replacement of approximately 100 meters of underground piping, the replacement of existing valves, the supply and installation of additional drainage valves, the supply and installation of a new oil-water separator at the outlet of the waste water basin building, upgrades to oil-water separator no. 2, and the removal and disposal of contaminated soil.	>$500k Projects Tab 11

Condition Assessment and Miscellaneous Upgrades	The project scope consists of three separate pieces of work. The primary piece of work is to perform condition assessment related to internal components of the main steam generators (boilers) and also associated external high energy piping (HEP). The work that will take place in 2017 is part of a three year program that will be completed in 2019. In addition to the condition assessment work, other upgrades will take place. These upgrades will include the Unit 1 cooling water travelling screen replacement and boiler replacements such as the replacement of expansion joints and burner/floor tubes.	>$500k Projects Tab 4
Upgrade Holyrood Access Road	This project includes the replacement of the asphalt and all work associated along the access road into the Holyrood Thermal Generating Facility. Specifically, the scope of work will include: removal of the existing deteriorated asphalt surface, replacement of existing culverts, minor subgrade preparation, as required, reshaping of ditches and shoulder of the roadway, as required, placement of Class A material, installation of approximately 2 km of asphalt along the access road, material testing by an external consultant, and installation of removable speed bumps and signs along the roadway.	>$500k Projects Tab 8
Purchase Capital Spares	This project includes the purchase of critical capital spares that are required to be on hand to reduce downtime and increase availability should a failure of a key component occur.	>$200k and <$500k Projects

Table 3: Reports Filed in Support of the 2017 Project Proposals

Project	Reports filed	Alternatives Considered	Recommendation
Overhaul Unit 2 Turbine Valves	- Alstom Major Overhaul Report FSRG024647 - Hartford Steam Boiler (HSB) Turbine Outage Optimization Program (TOOP) - AMEC Condition Assessment and Life Assessment Study - General Electric Steam Turbine Inspection Report	There are no alternatives[2]	Overhaul turbine valves
Upgrade Underground Plant Drainage	- Upgrade Underground Plant Drainage System Inspection and Assessment Report	There are no alternatives	Upgrade underground plant drainage.
Overhaul Holyrood Pumps	- Flowserve Review – Overhaul Schedule	There are no alternatives	Overhaul Pumps
Condition Assessment and Miscellaneous Upgrades	- Holyrood Level II Condition Assessment Follow-Up Inspection - 2015	There are no alternatives	Perform condition assessment and upgrades.

[2] The only other alternative for each of these items is to run to failure, which is not acceptable for safety or reliability reasons.

Table 4: 2017 Project Necessity in the Context of Changing Role of Holyrood

Major System or Subsystem	Project	Necessity by Operational Phase		
		Phase 1[3]	**Phase 2[4]**	**Phase 3[5]**
Fuel Storage & Delivery	No Projects included			
Feedwater & Condensate	Overhaul Holyrood Pumps	Required	Required	Not required
Boiler	Condition Assessment and Miscellaneous Upgrades	Required	Required	Not required
Turbine Generator	Overhaul Unit 2 Turbine Valves	Required	Required	Not required[6]
Cooling Water Systems	Overhaul Holyrood Pumps	Required	Required	Not required
	Condition Assessment and Miscellaneous Upgrades	Required	Required	Not required
Buildings & Grounds	Upgrade Holyrood Access Road	Required	Required	Required
Common Systems	Upgrade Underground Plant Drainage	Required	Required	Required

[3] Phase 1 – 2016 to Q2 2028 – normal production
[4] Phase 2 – Q2 2018 to end of Winter 2021 – stand-by production
[5] Phase 3 – Post Winter 2021 – synchronous condenser operation
[6] The generator is needed, but not the turbine, for the synchronous condense mode of operations.

Holyrood 2017-2021 Capital Expenditures Outlook

To ensure continued security of supply, capital investment will be necessary throughout the period of 2017 to 2021 to ensure Holyrood can provide the level of service required in generation and synchronous condenser operation. Various types of investments and expenditures for the Holyrood facility are anticipated, including refurbishment, upgrade or replacement of failed or obsolete equipment and general plant infrastructure work.

Holyrood continues to be a critical asset that must be maintained in a reliable least cost manner to meet demand and energy requirements of the IIS.

In reviewing future capital projects for Holyrood going forward, Hydro has considered the three phases discussed previously and will submit for approval, only those projects necessary for the safe and reliable operation of the plant as a generator up to the time of decommissioning. Additional capital investment requirements will continue through to synchronous condenser operation.

Capital projects proposed as part of this and upcoming future budget submissions have been, and will continue to be, reviewed in light of the future plant requirements and are considered to be the minimum amount that is essential to fulfill Hydro's mandate to serve its customers and meet safety and environmental requirements.

The maintenance strategy for Holyrood going forward to its end of life as a generating station is to extend the life of the existing assets at least cost through continued preventative maintenance, repair, and rehabilitation where critical, to provide safe and reliable energy at the forecast levels. In cases where repair and rehabilitation are not viable alternatives, and where the associated assets remain critical to operation, assets will be renewed in the least cost manner. For Phases 1 and 2 of Holyrood's future operation, few changes are expected in terms of maintenance strategy since the plant is generally expected to produce with high reliability through to commissioning of the Muskrat Falls Project and must be fully available for emergency/standby use until the 2020–2021 timeframe. Non-critical assets will receive minimal attention and may be allowed to degrade where such action does not significantly increase risk to safe and reliable production. Assets with operational requirements beyond 2021 will continue to be optimally maintained with investment reflecting that continued requirement. Data will be collected from inspections, on line monitoring and formal condition assessments and used to

determine the right work, on the right assets, at the optimal time in light of the changing role of Holyrood.

Figure 3 provides the planned level of expenditure for Holyrood over the 2017 to 2021 period. The annual average expenditure is $9.3 million, ranging from a high of $14.2 million in 2020 to a low of $2.3 million in 2021. Projects planned for the pending five years include:

- $5.0 million for the installation of a plant heating system;
- $4.6 million to replace Stage II Electrical Distribution Equipment; and
- $7.1 million for the rewind of Unit 3 generator stator.

Planned expenditures for the five year period total $46.5 million.

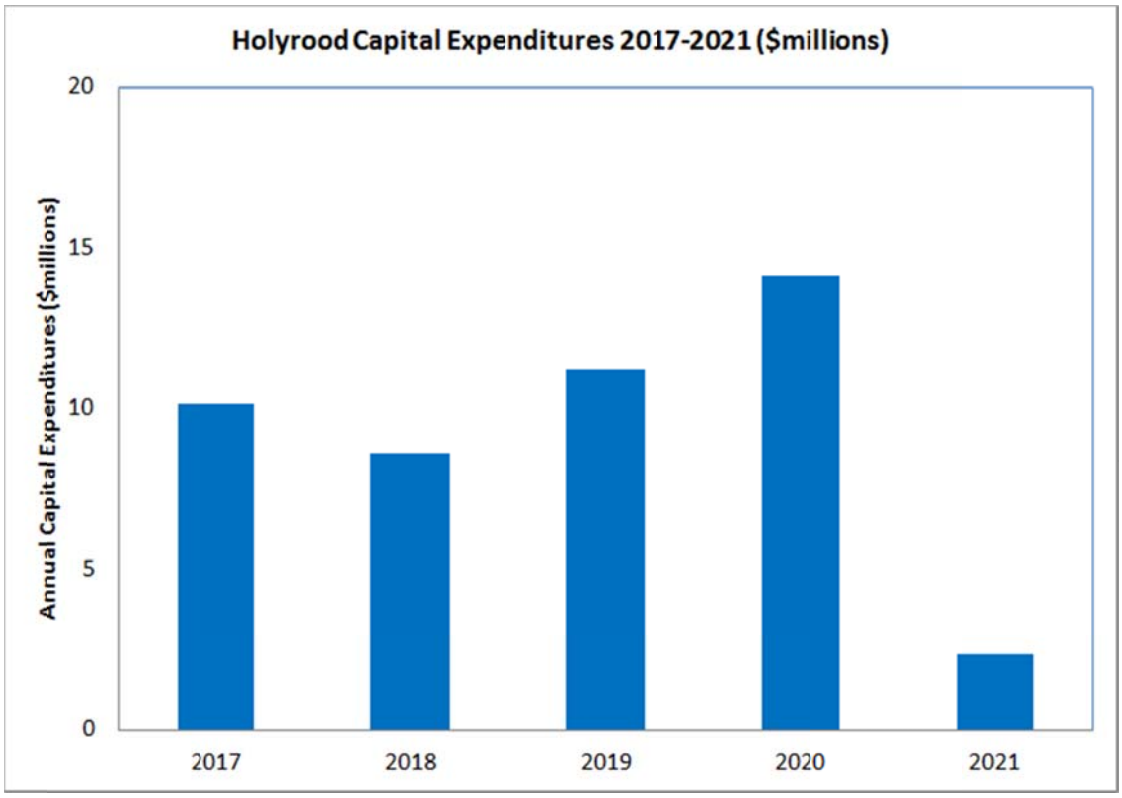


Figure 3: Holyrood Capital Expenditures 2017 to 2021

	Expended to 2016	2017	Future Years	Total
		($000)		
GENERATION	4,735.6	25,556.1	19,865.6	50,157.3
TRANSMISSION AND RURAL OPERATIONS	112,154.0	235,587.4	137,945.6	485,687.0
GENERAL PROPERTIES	2,944.3	9,292.9	2,144.2	14,381.4
ALLOWANCE FOR UNFORESEEN ITEMS		1,000.0		1,000.0
TOTAL CAPITAL BUDGET	119,833.9	271,436.4	159,955.4	551,225.7

	Expended to 2016	2017	Future Years	Total
		($000)		
GENERATION				
Hydraulic Plant	1,967.0	13,285.6	17,711.0	32,963.6
Thermal Plant	2,723.8	10,166.2	1,367.5	14,257.5
Gas Turbines	44.8	1,974.8	787.1	2,806.7
Tools and Equipment	0.0	129.5	0.0	129.5
TOTAL GENERATION	4,735.6	25,556.1	19,865.6	50,157.3
TRANSMISSION AND RURAL OPERATIONS				
Terminal Stations	12,235.1	29,434.8	65,790.0	107,459.9
Transmission	93,011.5	173,193.3	61,094.4	327,299.2
Distribution	285.6	14,890.5	1,549.5	16,725.6
Generation	6,172.8	11,780.8	6,586.0	24,539.6
Properties	15.2	4,453.2	1,034.1	5,502.5
Metering	433.8	1,007.7	1,891.6	3,333.1
Tools and Equipment	0.0	827.1	0.0	827.1
TOTAL TRANSMISSION AND RURAL OPERATIONS	112,154.0	235,587.4	137,945.6	485,687.0
GENERAL PROPERTIES				
Information Systems	366.6	1,339.6	513.3	2,219.5
Telecontrol	717.3	3,809.9	1,232.1	5,759.3
Transportation	1,825.8	2,708.3	398.8	4,932.9
Administrative	34.6	1,435.1	0.0	1,469.7
TOTAL GENERAL PROPERTIES	2,944.3	9,292.9	2,144.2	14,381.4
ALLOWANCE FOR UNFORESEEN ITEMS		1,000.0		1,000.0
TOTAL CAPITAL BUDGET	119,833.9	271,436.4	159,955.4	551,225.7

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Page Ref
			($000)		
HYDRAULIC PLANT					
Replace Site Facilities - Bay d'Espoir	928.3	4,736.3	6,316.7	11,981.3	
Refurbish Powerhouse Station Services - Bay d'Espoir		413.2	3,933.9	4,347.1	C-3
Replace Exciter Controls Units 1 to 6 - Bay d'Espoir		119.2	3,227.8	3,347.0	C-6
Water System Replacements - Bay d'Espoir and Cat Arm		265.5	2,288.3	2,553.8	C-8
Control Structure Refurbishments - Various Sites		1,735.3	452.9	2,188.2	C-15
Upgrade Work - Cat Arm	558.3	1,353.0		1,911.3	
Rehabilitate Shoreline Protection - Cat Arm	112.2	1,030.7		1,142.9	
Upgrade Ventilation in Powerhouse 1 and 2 - Bay d'Espoir		134.1	863.8	997.9	C-24
Install Asset Health Monitoring System - Upper Salmon		438.0	203.4	641.4	C-31
Upgrade Public Safety Around Dams and Waterways - Bay d'Espoir		489.0		489.0	D-2
Purchase Capital Spares - Hydraulic		487.4		487.4	D-27
Overhaul Turbine/Generators - Bay d'Espoir and Cat Arm		476.2		476.2	D-31
Replace Slip Rings Units 1-6 - Bay d'Espoir		312.6	159.7	472.3	D-39
Replace Powerhouse 1 Station Service Transformer - Bay d'Espoir	46.7	354.5		401.2	
Replace Spherical By-Pass Valves Units 1 and 2 - Bay d'Espoir	183.6	167.9		351.5	
Refurbish Sump Level System for Powerhouse 2 - Bay d'Espoir		38.7	264.5	303.2	D-46
Refurbish Station Water System - Upper Salmon	96.6	197.6		294.2	
Refurbish Main Generator Breaker - Upper Salmon		271.1		271.1	D-65
Install Wind Monitoring Station North Salmon Dam SD-2 - Bay d'Espoir		165.5		165.5	E-4
Replace Control Room/Communications Room Air Conditioning - Hinds Lake	41.3	53.0		94.3	
Replace Floor Annunciator Panels - Bay d'Espoir		46.8		46.8	
TOTAL HYDRAULIC PLANT	1,967.0	13,285.6	17,711.0	32,963.6	

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Page Ref
		($000)			
THERMAL PLANT					
Upgrade Powerhouse Building Envelope - Holyrood	2723.8	2,969.9	784.1	6,477.8	
Condition Assessment and Miscellaneous Upgrades- Holyrood		2,437.3		2,437.3	C-11
Overhaul Turbine Valves Unit 2 - Holyrood		2,302.1		2,302.1	C-13
Upgrade Holyrood Access Road - Holyrood		579.3	583.4	1,162.7	C-21
Upgrade Underground Plant Drainage System - Holyrood		923.1		923.1	C-28
Overhaul Pumps - Holyrood		633.0		633.0	C-33
Purchase Capital Spares - Holyrood		321.5		321.5	D-43
TOTAL THERMAL PLANT	2,723.8	10,166.2	1,367.5	14,257.5	
GAS TURBINES					
Gas Turbine Life Extension - Stephenville		847.5	505.7	1,353.2	C-19
Gas Turbine Life Extension - Hardwoods		675.3	281.4	956.7	C-26
Replace Fuel Piping - Hardwoods and Stephenville	44.8	267.0		311.8	
Purchase Capital Spares - Gas Turbines		185.0		185.0	E-2
TOTAL GAS TURBINES	44.8	1,974.8	787.1	2,806.7	
TOOLS AND EQUIPMENT					
Purchase Tools and Equipment Less than $50,000		129.5		129.5	
TOTAL TOOLS AND EQUIPMENT		129.5		129.5	
TOTAL GENERATION	4,735.6	25,556.1	19,865.6	50,157.3	

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Page Ref
		($000)			
TERMINAL STATIONS					
Upgrade Circuit Breakers - Various Sites (2016-2020)	6,969.1	10,808.7	43,682.7	61,460.5	
Terminal Station Refurbishment and Modernization - Various Sites		10,831.3	16,550.8	27,382.1	C-41
Replace Instrument Transformers - Various Sites	3,196.1	471.9		3,668.0	
Upgrade Corner Brook Frequency Converter - Corner Brook		194.6	2,749.2	2,943.8	C-53
Replace Disconnect Switches - Various Sites (2016-2017)	646.9	1,320.9		1,967.8	
Replace Protective Relays - Various Sites	700.6	1,156.4		1,857.0	
Replace 66 kV Station Service Feed - Holyrood		62.8	1,198.6	1,261.4	C-71
Replace Substation - Holyrood		439.4	758.6	1,198.0	C-75
Replace Power Transformers - Oxen Pond		297.5	850.1	1,147.6	C-80
In-Service Failures - Various Sites		1,000.0		1,000.0	C-86
Install Fire Protection in 230 kV Stations - Bay d'Espoir	200.0	566.0		766.0	
Upgrade Digital Fault Recorders - Various Sites	197.9	304.6		502.5	
Purchase Capital Spares - Terminal Stations		495.8		495.8	D-92
Upgrade Terminal Station for Mobile Substation - Cow Head	40.0	444.7		484.7	
Upgrade Aluminum Support Structures - Holyrood		352.9		352.9	D-106
Upgrade Data Alarm Systems - Stony Brook	74.4	234.1		308.5	
Install Breaker Failure Protection - Various Sites	65.7	211.3		277.0	
Replace Surge Arrestors - Various Sites	144.4	53.0		197.4	
Purchase Backup Diesel for Station Service - Grand Falls and Buchans		188.9		188.9	E-71
TOTAL TERMINAL STATIONS	12,235.1	29,434.8	65,790.0	107,459.9	
TRANSMISSION					
Construct 230 kV Transmission Line - Bay d'Espoir to Western Avalon	87,444.6	149,895.7	54,317.7	291,658.0	
Construct 230 kV Transmission Line - Soldiers Pond to Hardwoods	3,699.0	17,489.8	5,372.1	26,560.9	
Transmission Line Upgrades - TL212 and TL218		1,378.2	1,133.3	2,511.5	C-55
Wood Pole Line Management Program - Various Sites		2,404.1		2,404.1	C-57
Refurbish Anchors and Footings TL202 and TL206 - Bay d'Espoir to Sunnyside	1,278.3	901.6		2,179.9	
Replace Aircraft Markers at Grand Lake Crossing - TL228	589.6	978.3		1,567.9	
Replace Insulators - TL227		145.6	271.3	416.9	D-98
TOTAL TRANSMISSION	93,011.5	173,193.3	61,094.4	327,299.2	
DISTRIBUTION					
Upgrade Distribution Systems - Various Sites (2016-2017)	285.6	6,350.3		6,635.9	
Provide Service Extensions - All Service Areas		4,330.0		4,330.0	C-47
Upgrade Distribution Systems - All Service Areas		3,810.0		3,810.0	C-49
Distribution Upgrades - Various Sites (2017-2018)		64.2	1,130.9	1,195.1	C-78
Install Recloser Remote Control - Bottom Waters		47.1	418.6	465.7	D-94
Replace Recloser - Wabush		199.2		199.2	E-47
Install Demand Metering - Various Sites		89.7		89.7	E-75
TOTAL DISTRIBUTION	285.6	14,890.5	1,549.5	16,725.6	

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Page Ref
		($000)			
GENERATION					
Diesel Genset Replacements - Port Hope Simpson and Charlottetown		658.8	5,148.0	5,806.8	C-44
Additions for Load Growth - L'Anse au Loup and Postville	883.4	4,746.0		5,629.4	
Install Fire Protection Systems - Nain and Cartwright	3,030.7	1,376.4		4,407.1	
Overhaul Diesel Engines - Various Sites		2,095.9		2,095.9	C-62
Replace Diesel Units - Charlottetown	1,384.9	46.1		1,431.0	
Diesel Plant Engine Auxiliary Upgrades - Various Sites		790.6	416.3	1,206.9	C-73
Replace Automation Equipment - Mary's Harbour		120.3	1,021.7	1,142.0	C-82
Inspect Fuel Storage Tanks - Various Sites		1,058.8		1,058.8	C-84
Replace Programmable Logic Controllers - Various Sites	712.9	245.1		958.0	
Replace Human Machine Interface - Various Sites	114.0	320.0		434.0	
Replace Fuel Tank 22E - St. Anthony		199.8		199.8	E-7
Install Variable Frequency Drives - Grey River	46.9	123.0		169.9	
TOTAL GENERATION	6,172.8	11,780.8	6,586.0	24,539.6	
PROPERTIES					
Upgrade Office Facilities & Control Buildings - Various Sites		2,197.3		2,197.3	C-59
Line Depot Condition Assessment and Refurbishment Program - Various Sites		1,458.8		1,458.8	C-66
Construct New Facilities - Various Sites		422.0	1,034.1	1,456.1	C-69
Upgrade Warehouse Lighting - Bishop's Falls	15.2	180.4		195.6	
Install Fall Protection Equipment - Various Sites		194.7		194.7	E-55
TOTAL PROPERTIES	15.2	4,453.2	1,034.1	5,502.5	
METERING					
Install Automated Meter Reading - Happy Valley (2017-2018)		78.6	1,891.6	1,970.2	C-64
Install Automated Meter Reading - Labrador West	433.8	533.4		967.2	
Purchase Meters and Metering Equipment- Various Sites		198.8		198.8	E-51
Purchase New Meter Calibration Test Console - Hydro Place		196.9		196.9	E-53
TOTAL METERING	433.8	1,007.7	1,891.6	3,333.1	
TOOLS AND EQUIPMENT					
Purchase Tools and Equipment Less than $50,000		423.0		423.0	
Replace Light Duty Mobile Equipment - Various Sites		270.9		270.9	D-162
Purchase Front End Loader with Backhoe - Wabush		133.2		133.2	E-73
TOTAL TOOLS AND EQUIPMENT		827.1		827.1	
TOTAL TRANSMISSION AND RURAL OPERATIONS	112,154.0	235,587.4	137,945.6	485,687.0	

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Page Ref
		($000)			
INFORMATION SYSTEMS					
SOFTWARE APPLICATIONS					
Upgrade of Technology					
Upgrade Microsoft Office Products - Hydro Place	683.7	953.4	957.3	2,594.4	
Cost Recovery	(317.1)	(442.2)	(444.0)	(1,203.3)	
Upgrade Energy Management System - Hydro Place		427.0		427.0	D-168
TOTAL SOFTWARE APPLICATIONS	366.6	938.2	513.3	1,818.1	
COMPUTER OPERATIONS					
Infrastructure Replacement					
Replace Personal Computers - Hydro Place		401.4		401.4	D-172
TOTAL COMPUTER OPERATIONS		401.4		401.4	
TOTAL INFORMATION SYSTEMS	366.6	1,339.6	513.3	2,219.5	

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Page Ref
		($000)			
TELECONTROL					
NETWORK SERVICES					
Replace MDR 4000 Microwave Radio East - Various Sites	77.4	1,093.1		1,170.5	
Replace Battery Banks and Chargers - Various Sites (2017-2018)		379.3	566.2	945.5	C-91
Replace Battery Banks and Chargers - Various Sites (2016-2017)	425.0	456.6		881.6	
Replace Powerline Carrier - Various Sites	73.4	763.4		836.8	
Upgrade Telecontrol Facilities - Mary March Hill and Blue Grass Hill		91.2	665.9	757.1	C-95
Upgrade Telecontrol Facilities - Sandy Brook Hill	101.6	462.4		564.0	
Replace Network Communications Equipment - Various Sites		199.3		199.3	E-80
Replace Air Conditioners - Massey Drive and Happy Valley	39.9	152.0		191.9	
Upgrade Access Roads to Microwave Sites - Various Sites		118.4		118.4	E-86
Upgrade Site Facilities - Various Sites		49.0		49.0	
Purchase Tools and Equipment Less than $50,000		45.2		45.2	
TOTAL TELECONTROL	717.3	3,809.9	1,232.1	5,759.3	
TRANSPORTATION					
Replace Vehicles and Aerial Devices - Various Sites (2017-2018)		2,001.4	398.8	2,400.2	C-89
Replace Vehicles and Aerial Devices - Various Sites (2016-2017)	1,443.3	534.2		1,977.5	
Purchase Vehicles and Aerial Devices - Various Sites	382.5	172.7		555.2	
TOTAL TRANSPORTATION	1,825.8	2,708.3	398.8	4,932.9	
ADMINISTRATION					
Replace Roof - Hydro Place		923.4		923.4	C-93
Replace Air Conditioning Units 8 and 14 - Hydro Place	34.6	229.5		264.1	
Remove Safety Hazards - Various Sites		198.6		198.6	E-82
Purchase Office Equipment		83.6		83.6	
TOTAL ADMINISTRATION	34.6	1,435.1		1,469.7	
TOTAL GENERAL PROPERTIES	2,944.3	9,292.9	2,144.2	14,381.4	

NEWFOUNDLAND AND LABRADOR HYDRO
2017 CAPITAL BUDGET
($000)

	2017
GENERATION	8,691.2
TRANSMISSION AND RURAL OPERATIONS	20,875.7
GENERAL PROPERTIES	2,268.1
ALLOWANCE FOR UNFORESEEN EVENTS	1,000.0
TOTAL PROJECTS UNDER $50,000	777.1
MULTI-YEAR (2017 Expenditures):	
Multi-year Projects Commencing in 2017	23,561.6
Multi-year Projects Commencing in 2016	62,748.4
Multi-year Projects Commencing Prior to 2016:	
Construct 230 kV Transmission Line - Bay d'Espoir to Western Avalon	149,895.7
Refurbish Anchors and Footings TL202 and TL206 - Bay d'Espoir to Sunnyside	901.6
Replace Instrument Transformers - Various Sites	471.9
Replace Programmable Logic Controllers - Various Sites	245.1
TOTAL CAPITAL BUDGET	**271,436.4**

NEWFOUNDLAND AND LABRADOR HYDRO
2017 CAPITAL BUDGET
SINGLE YEAR PROJECTS OVER $50,000
($000)

PROJECT DESCRIPTION	**2017**
Generation	
HYDRAULIC PLANT	
Upgrade Public Safety Around Dams and Waterways - Bay d'Espoir	489.0
Purchase Capital Spares - Hydraulic	487.4
Overhaul Turbine/Generators - Bay d'Espoir and Cat Arm	476.2
Refurbish Main Generator Breaker - Upper Salmon	271.1
Install Wind Monitoring Station North Salmon Dam SD-2 - Bay d'Espoir	165.5
THERMAL PLANT	
Condition Assessment and Miscellaneous Upgrades- Holyrood	2,437.3
Overhaul Turbine Valves Unit 2 - Holyrood	2,302.1
Upgrade Underground Plant Drainage System - Holyrood	923.1
Overhaul Pumps - Holyrood	633.0
Purchase Capital Spares - Holyrood	321.5
GAS TURBINES	
Purchase Capital Spares - Gas Turbines	185.0
TOTAL GENERATION	8,691.2

NEWFOUNDLAND AND LABRADOR HYDRO
2017 CAPITAL BUDGET
SINGLE YEAR PROJECTS OVER $50,000
($000)

PROJECT DESCRIPTION	2017
Transmission and Rural Operations	
TERMINAL STATIONS	
In-Service Failures - Various Sites	1,000.0
Purchase Capital Spares - Terminal Stations	495.8
Upgrade Aluminum Support Structures - Holyrood	352.9
Purchase Backup Diesel for Station Service - Grand Falls and Buchans	188.9
TRANSMISSION	
Wood Pole Line Management Program - Various Sites	2,404.1
DISTRIBUTION	
Upgrade Distribution Systems - All Service Areas	3,810.0
Provide Service Extensions - All Service Areas	4,330.0
Replace Recloser - Wabush	199.2
Install Demand Metering - Various Sites	89.7
GENERATION	
Overhaul Diesel Engines - Various Sites	2,095.9
Inspect Fuel Storage Tanks - Various Sites	1,058.8
Replace Fuel Tank 22E - St. Anthony	199.8
PROPERTIES	
Upgrade Office Facilities & Control Buildings - Various Sites	2,197.3
Line Depot Condition Assessment and Refurbishment Program - Various Sites	1,458.8
Install Fall Protection Equipment - Various Sites	194.7
METERING	
Purchase Meters and Metering Equipment- Various Sites	198.8
Purchase New Meter Calibration Test Console - Hydro Place	196.9
TOOLS AND EQUIPMENT	
Replace Light Duty Mobile Equipment - Various Sites	270.9
Purchase Front End Loader with Backhoe - Wabush	133.2
TOTAL TRANSMISSION AND RURAL OPERATIONS	20,875.7

NEWFOUNDLAND AND LABRADOR HYDRO
2017 CAPITAL BUDGET
SINGLE YEAR PROJECTS OVER $50,000
($000)

PROJECT DESCRIPTION	2017
General Properties	
INFORMATION SYSTEMS	
SOFTWARE APPLICATIONS	
Upgrade of Technology	
Upgrade Energy Management System - Hydro Place	427.0
COMPUTER OPERATIONS	
Infrastructure Replacement	
Replace Personal Computers - Hydro Place	401.4
TELECONTROL	
NETWORK SERVICES	
Replace Network Communications Equipment - Various Sites	199.3
Upgrade Access Roads to Microwave Sites - Various Sites	118.4
ADMINISTRATION	
Replace Roof - Hydro Place	923.4
Remove Safety Hazards - Various Sites	198.6
TOTAL GENERAL PROPERTIES	2,268.1
TOTAL SINGLE YEAR PROJECTS OVER $50,000	**31,835.0**

NEWFOUNDLAND AND LABRADOR HYDRO
2017 CAPITAL BUDGET
PROJECTS OVER $50,000
MULTI-YEAR PROJECTS
($000)

Multi-year Projects Commencing in 2017

PROJECT DESCRIPTION	2017	2018	2019	2020	2021	Total
Terminal Station Refurbishment and Modernization - Various Sites	10,831.3	16,550.8				27,382.1
Diesel Genset Replacements - Port Hope Simpson and Charlottetown	658.8	5,148.0				5,806.8
Refurbish Powerhouse Station Services - Bay d'Espoir	413.2	2,473.3	1,460.6			4,347.1
Replace Exciter Controls Units 1 to 6 - Bay d'Espoir	119.2	3,227.8				3,347.0
Upgrade Corner Brook Frequency Converter - Corner Brook	194.6	2,749.2				2,943.8
Water System Replacements - Bay d'Espoir and Cat Arm	265.5	2,288.3				2,553.8
Transmission Line Upgrades - TL212 and TL218	1,378.2	1,133.3				2,511.5
Replace Vehicles and Aerial Devices - Various Sites (2017-2018)	2,001.4	398.8				2,400.2
Control Structure Refurbishments - Various Sites	1,735.3	452.9				2,188.2
Install Automated Meter Reading - Happy Valley (2017-2018)	78.6	1,891.6				1,970.2
Construct New Facilities - Various Sites	422.0	1,034.1				1,456.1
Gas Turbine Life Extension - Stephenville	847.5	505.7				1,353.2
Replace 66 kV Station Service Feed - Holyrood	62.8	1,198.6				1,261.4
Diesel Plant Engine Auxiliary Upgrades - Various Sites	790.6	416.3				1,206.9
Replace Substation - Holyrood	439.4	758.6				1,198.0
Distribution Upgrades - Various Sites (2017-2018)	64.2	1,130.9				1,195.1
Upgrade Holyrood Access Road - Holyrood	579.3	583.4				1,162.7
Replace Power Transformers - Oxen Pond	297.5	850.1				1,147.6
Replace Automation Equipment - Mary's Harbour	120.3	1,021.7				1,142.0
Upgrade Ventilation in Powerhouse 1 and 2 - Bay d'Espoir	134.1	863.8				997.9
Gas Turbine Life Extension - Hardwoods	675.3	281.4				956.7
Replace Battery Banks and Chargers - Various Sites (2017-2018)	379.3	566.2				945.5
Upgrade Telecontrol Facilities - Mary March Hill and Blue Grass Hill	91.2	665.9				757.1
Install Asset Health Monitoring System - Upper Salmon	438.0	203.4				641.4
Replace Slip Rings Units 1-6 - Bay d'Espoir	312.6	159.7				472.3
Install Recloser Remote Control - Bottom Waters	47.1	418.6				465.7
Replace Insulators - TL227	145.6	271.3				416.9
Refurbish Sump Level System for Powerhouse 2 - Bay d'Espoir	38.7	264.5				303.2
Total Multi-Year Projects over $50,000 commencing in 2017	23,561.6	47,508.2	1,460.6	0.0	0.0	72,530.4

NEWFOUNDLAND AND LABRADOR HYDRO
2017 CAPITAL BUDGET
PROJECTS OVER $50,000
MULTI-YEAR PROJECTS
($000)

Multi-year Projects Commencing in 2016

PROJECT DESCRIPTION	Expended to 2016	2017	2018	2019	2020	2021	Total
Upgrade Circuit Breakers - Various Sites (2016-2020)	6,969.1	10,808.7	43,682.7				61,460.5
Construct 230 kV Transmission Line - Soldiers Pond to Hardwoods	3,699.0	17,489.8	5,372.1				26,560.9
Replace Site Facilities - Bay d'Espoir	928.3	4,736.3	6,316.7				11,981.3
Upgrade Distribution Systems - Various Sites (2016-2017)	285.6	6,350.3					6,635.9
Upgrade Powerhouse Building Envelope - Holyrood	2,723.8	2,969.9	784.1				6,477.8
Additions for Load Growth - L'Anse au Loup and Postville	883.4	4,746.0					5,629.4
Install Fire Protection Systems - Nain and Cartwright	3,030.7	1,376.4					4,407.1
Replace Vehicles and Aerial Devices - Various Sites (2016-2017)	1,443.3	534.2					1,977.5
Replace Disconnect Switches - Various Sites (2016-2017)	646.9	1,320.9					1,967.8
Upgrade Work - Cat Arm	558.3	1,353.0					1,911.3
Replace Protective Relays - Various Sites	700.6	1,156.4					1,857.0
Replace Aircraft Markers at Grand Lake Crossing - TL228	589.6	978.3					1,567.9
Replace Diesel Units - Charlottetown	1,384.9	46.1					1,431.0
Upgrade Microsoft Office Products - Hydro Place	366.6	511.2	513.3				1,391.1
Replace MDR 4000 Microwave Radio East - Various Sites	77.4	1,093.1					1,170.5
Rehabilitate Shoreline Protection - Cat Arm	112.2	1,030.7					1,142.9
Install Automated Meter Reading - Labrador West	433.8	533.4					967.2
Replace Battery Banks and Chargers - Various Sites (2016-2017)	425.0	456.6					881.6
Replace Powerline Carrier - Various Sites	73.4	763.4					836.8
Install Fire Protection in 230 kV Stations - Bay d'Espoir	200.0	566.0					766.0
Upgrade Telecontrol Facilities - Sandy Brook Hill	101.6	462.4					564.0
Purchase Vehicles and Aerial Devices - Various Sites	382.5	172.7					555.2
Upgrade Digital Fault Recorders - Various Sites	197.9	304.6					502.5
Upgrade Terminal Station for Mobile Substation - Cow Head	40.0	444.7					484.7
Replace Human Machine Interface - Various Sites	114.0	320.0					434.0
Replace Powerhouse 1 Station Service Transformer - Bay d'Espoir	46.7	354.5					401.2
Replace Spherical By-Pass Valves Units 1 and 2 - Bay d'Espoir	183.6	167.9					351.5
Replace Fuel Piping - Hardwoods and Stephenville	44.8	267.0					311.8
Upgrade Data Alarm Systems - Stony Brook	74.4	234.1					308.5
Refurbish Station Water System - Upper Salmon	96.6	197.6					294.2
Install Breaker Failure Protection - Various Sites	65.7	211.3					277.0
Replace Air Conditioning Units 8 and 14 - Hydro Place	34.6	229.5					264.1
Replace Surge Arrestors - Various Sites	144.4	53.0					197.4
Upgrade Warehouse Lighting - Bishop's Falls	15.2	180.4					195.6
Replace Air Conditioners - Massey Drive and Happy Valley	39.9	152.0					191.9
Install Variable Frequency Drives - Grey River	46.9	123.0					169.9
Replace Control Room/Communications Room Air Conditioning - Hinds Lake	41.3	53.0					94.3
Total Multi-Year Projects over $50,000 commencing in 2016	27,202.0	62,748.4	56,668.9	0.0	0.0	0.0	146,619.3

Multi-year Projects Commencing before 2016

	Expended to 2016	2017	2018	2019	2020	2021	Total
Construct 230 kV Transmission Line - Bay d'Espoir to Western Avalon	87,444.6	149,895.7	54,317.7				291,658.0
Replace Instrument Transformers - Various Sites	3,196.1	471.9					3,668.0
Refurbish Anchors and Footings TL202 and TL206 - Bay d'Espoir to Sunnyside	1,278.3	901.6					2,179.9
Replace Programmable Logic Controllers - Various Sites	712.9	245.1					958.0
Total Multi-Year Projects over $50,000 commencing before 2016	92,631.9	151,514.3	54,317.7	0.0	0.0	0.0	298,463.9

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Page Ref
			($000)		
GENERATION					
Replace Site Facilities - Bay d'Espoir	928.3	4,736.3	6,316.7	11,981.3	
Upgrade Powerhouse Building Envelope - Holyrood	2,723.8	2,969.9	784.1	6,477.8	
Refurbish Powerhouse Station Services - Bay d'Espoir		413.2	3,933.9	4,347.1	C-3
Replace Exciter Controls Units 1 to 6 - Bay d'Espoir		119.2	3,227.8	3,347.0	C-6
Water System Replacements - Bay d'Espoir and Cat Arm		265.5	2,288.3	2,553.8	C-8
Condition Assessment and Miscellaneous Upgrades- Holyrood		2,437.3		2,437.3	C-11
Overhaul Turbine Valves Unit 2 - Holyrood		2,302.1		2,302.1	C-13
Control Structure Refurbishments - Various Sites		1,735.3	452.9	2,188.2	C-15
Upgrade Work - Cat Arm	558.3	1,353.0		1,911.3	
Gas Turbine Life Extension - Stephenville		847.5	505.7	1,353.2	C-19
Upgrade Holyrood Access Road - Holyrood		579.3	583.4	1,162.7	C-21
Rehabilitate Shoreline Protection - Cat Arm	112.2	1,030.7		1,142.9	
Upgrade Ventilation in Powerhouse 1 and 2 - Bay d'Espoir		134.1	863.8	997.9	C-24
Gas Turbine Life Extension - Hardwoods		675.3	281.4	956.7	C-26
Upgrade Underground Plant Drainage System - Holyrood		923.1		923.1	C-28
Install Asset Health Monitoring System - Upper Salmon		438.0	203.4	641.4	C-31
Overhaul Pumps - Holyrood		633.0		633.0	C-33
TOTAL GENERATION	4,322.6	21,592.8	19,441.4	45,356.8	
TRANSMISSION AND RURAL OPERATIONS					
Construct 230 kV Transmission Line - Bay d'Espoir to Western Avalon	87,444.6	149,895.7	54,317.7	291,658.0	
Upgrade Circuit Breakers - Various Sites (2016-2020)	6,969.1	10,808.7	43,682.7	61,460.5	
Terminal Station Refurbishment and Modernization - Various Sites		10,831.3	16,550.8	27,382.1	C-41
Construct 230 kV Transmission Line - Soldiers Pond to Hardwoods	3,699.0	17,489.8	5,372.1	26,560.9	
Upgrade Distribution Systems - Various Sites (2016-2017)	285.6	6,350.3		6,635.9	
Diesel Genset Replacements - Port Hope Simpson and Charlottetown		658.8	5,148.0	5,806.8	C-44
Additions for Load Growth - L'Anse au Loup and Postville	883.4	4,746.0		5,629.4	
Install Fire Protection Systems - Nain and Cartwright	3,030.7	1,376.4		4,407.1	
Provide Service Extensions - All Service Areas		4,330.0		4,330.0	C-47
Upgrade Distribution Systems - All Service Areas		3,810.0		3,810.0	C-49
Replace Instrument Transformers - Various Sites	3,196.1	471.9		3,668.0	
Upgrade Corner Brook Frequency Converter - Corner Brook		194.6	2,749.2	2,943.8	C-53
Transmission Line Upgrades - TL212 and TL218		1,378.2	1,133.3	2,511.5	C-55
Wood Pole Line Management Program - Various Sites		2,404.1		2,404.1	C-57
Upgrade Office Facilities & Control Buildings - Various Sites		2,197.3		2,197.3	C-59
Refurbish Anchors and Footings TL202 and TL206 - Bay d'Espoir to Sunnyside	1,278.3	901.6		2,179.9	
Overhaul Diesel Engines - Various Sites		2,095.9		2,095.9	C-62
Install Automated Meter Reading - Happy Valley (2017-2018)		78.6	1,891.6	1,970.2	C-64

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Page Ref
			($000)		
TRANSMISSION AND RURAL OPERATIONS (cont'd)					
Replace Disconnect Switches - Various Sites (2016-2017)	646.9	1,320.9		1,967.8	
Replace Protective Relays - Various Sites	700.6	1,156.4		1,857.0	
Replace Aircraft Markers at Grand Lake Crossing - TL228	589.6	978.3		1,567.9	
Line Depot Condition Assessment and Refurbishment Program - Various Sites		1,458.8		1,458.8	C-66
Construct New Facilities - Various Sites		422.0	1,034.1	1,456.1	C-69
Replace Diesel Units - Charlottetown	1,384.9	46.1		1,431.0	
Replace 66 kV Station Service Feed - Holyrood		62.8	1,198.6	1,261.4	C-71
Diesel Plant Engine Auxiliary Upgrades - Various Sites		790.6	416.3	1,206.9	C-73
Replace Substation - Holyrood		439.4	758.6	1,198.0	C-75
Distribution Upgrades - Various Sites (2017-2018)		64.2	1,130.9	1,195.1	C-78
Replace Power Transformers - Oxen Pond		297.5	850.1	1,147.6	C-80
Replace Automation Equipment - Mary's Harbour		120.3	1,021.7	1,142.0	C-82
Inspect Fuel Storage Tanks - Various Sites		1,058.8		1,058.8	C-84
In-Service Failures - Various Sites		1,000.0		1,000.0	C-86
Install Automated Meter Reading - Labrador West	433.8	533.4		967.2	
Replace Programmable Logic Controllers - Various Sites	712.9	245.1		958.0	
Install Fire Protection in 230 kV Stations - Bay d'Espoir	200.0	566.0		766.0	
Upgrade Digital Fault Recorders - Various Sites	197.9	304.6		502.5	
TOTAL TRANSMISSION AND RURAL OPERATIONS	111,653.4	230,884.4	137,255.7	479,793.5	
GENERAL PROPERTIES					
Replace Vehicles and Aerial Devices - Various Sites (2017-2018)		2,001.4	398.8	2,400.2	C-89
Replace Vehicles and Aerial Devices - Various Sites (2016-2017)	1,443.3	534.2		1,977.5	
Upgrade Microsoft Office Products - Hydro Place	366.6	511.2	513.3	1,391.1	
Replace MDR 4000 Microwave Radio East - Various Sites	77.4	1,093.1		1,170.5	
Replace Battery Banks and Chargers - Various Sites (2017-2018)		379.3	566.2	945.5	C-91
Replace Roof - Hydro Place		923.4		923.4	C-93
Replace Battery Banks and Chargers - Various Sites (2016-2017)	425.0	456.6		881.6	
Replace Powerline Carrier - Various Sites	73.4	763.4		836.8	
Upgrade Telecontrol Facilities - Mary March Hill and Blue Grass Hill		91.2	665.9	757.1	C-95
Upgrade Telecontrol Facilities - Sandy Brook Hill	101.6	462.4		564.0	
Purchase Vehicles and Aerial Devices - Various Sites	382.5	172.7		555.2	
TOTAL GENERAL PROPERTIES	2,869.8	7,388.9	2,144.2	12,402.9	
TOTAL PROJECTS $500,000 AND OVER	118,845.8	259,866.1	158,841.3	537,553.2	

Project Title: Refurbish Powerhouse Station Services

Location: Bay d'Espoir

Category: Generation - Hydraulic

Definition: Other

Classification: Normal

Project Description:

The scope of the proposed project includes the following upgrades:

- the replacement of a recloser with a new 25 kV vacuum breaker;
- the replacement of two 13.8 kV air blast breakers in Powerhouse 1 with new vacuum breakers;
- the replacement of seven existing overcurrent trip units with digital trip units on the 600 V main station service bus in Powerhouse 1;
- the replacement of ten 600 V main breakers on panelboards in Powerhouse 1;
- the addition of a zig-zag grounding transformer to the main station service busses of both Powerhouse 1 and Powerhouse 2;
- the replacement of a bank of distribution transformers which supplies Powerhouse 2 with a new 1.0 MVA transformer;
- the replacement of protective relays for the station service transformer on Powerhouse 2 with relays capable of very inverse time-current characteristics; and
- the replacement of five 600 V main breakers for panelboards in Powerhouse 2.

The budget estimate for this project is shown in Table 1.

Table 1: Project Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**2019**	**Beyond**	**Total**
Material Supply	0.0	607.0	607.0	0.0	607.0
Labour	336.1	396.3	510.3	0.0	1,242.7
Consultant	45.0	163.5	0.0	0.0	208.5
Contract Work	0.0	1,069.0	0.0	0.0	1,069.0
Other Direct Costs	7.7	10.4	0.0	0.0	18.1
Interest and Escalation	24.4	227.1	321.2	0.0	572.7
Contingency	0.0	0.0	629.1	0.0	629.1
TOTAL	**413.2**	**2,473.3**	**1,460.6**	**0.0**	**4,347.1**

Operating Experience:

The station service systems have worked well since their installation, but a review of the systems indicates that there are a number of issues which need to be addressed.

Project Justification:

The justification for this project is based upon the results of a study ("Station Service Review – Powerhouse No.1 & No. 2") completed in December 2012 by Diesel Injection Sales and Service (see Appendix A) which consisted of a review of the electrical equipment included with the station service systems and an overcurrent protective coordination study.

The work proposed in this project will replace some assets which are approaching the ends of their service lives (recloser and air blast breakers), upgrade the performance of the existing station service system via the replacement of relays and breakers, and improve the phase-to-ground detection capabilities of the system via the introduction of zig-zag transformers and associated protection equipment.

The purpose of the station service systems is to provide power to the critical and auxiliary electrical equipment necessary for the operation of the generating units within these facilities. The protective devices included within these systems are required to monitor the flow of electricity and to interrupt this flow, in a selective and timely manner, in the event of an electrical fault. Although electrical faults

are rare events, they have the potential to cause significant damage. The overcurrent protective coordination study identified issues with the equipment which indicated that misoperations are likely if an electrical fault occurred, and identified upgrades to address these issues. These upgrades will improve the condition of the powerhouse station service systems and decrease the risk of a misoperation (which is a safety concern). A misoperation where the removal of fault current is not performed in a timely manner has the potential to cause unnecessary damage to equipment. A misoperation due to poor coordination has the potential to cause a larger portion of the station service system to be subjected to an outage unnecessarily, which is a risk to the operation of the generating units within the powerhouses.

Future Plans:

Future upgrades will be prioritized and submitted via the capital program as required.

Attachments:

See report entitled “Refurbish Powerhouse Station Services - Bay d’Espoir” located in Volume II, Tab 1, for further project details.

Project Title: Replace Exciter Controls, Units 1 to 6

Location: Bay d'Espoir

Category: Generation - Hydraulic

Definition: Other

Classification: Normal

Project Description:

The scope of the work is to replace the control section of the existing Asea Brown Boveri (ABB) Unitrol P exciter to the ABB Unitrol 6080 model on Units 1 to 6 at Bay d'Espoir between 2018 and 2020. The Unitrol P exciter consists of four sections, one containing the controls and Human Machine Interface (HMI) and three containing the power sections and field breaker.

ABB offers an upgrade where the existing controls are removed and replaced with the Unitrol 6080 control hardware and software. The replacement will include the controller, power supplies, stabilizer, HMI and applicable software. Although the existing control cabinet will be kept in place, the cables between the exciter and the generator field, and control cables connected to the exciter, will be replaced.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	133.6	20.0	153.6
Labour	105.4	165.6	315.2	586.2
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	519.3	1,037.6	1,556.9
Other Direct Costs	6.2	11.0	22.0	39.2
Interest and Escalation	7.6	91.7	444.6	543.9
Contingency	0.0	0.0	467.2	467.2
TOTAL	**119.2**	**921.2**	**2,306.6**	**3,347.0**

Operating Experience:

Overall, the ABB Unitrol P exciters for Units 1 to 6 worked well since their installation up until five years ago; however, in the last five years, four communication boards and seven processor boards have failed. There have been four outages in the last five years caused by the exciters.

Project Justification:

As per the Unitrol P Life Cycle Management Plan, the Unitrol P is in the Obsolete Phase and in this phase spare parts will be more difficult to procure. ABB recommended a replacement of the Unitrol P control sections to the Unitrol 6080 platform which will ensure a readily available supply of spare parts and technical support.

A consultant, Kestrel Power Engineering, was hired to assess the condition of the exciters. They recommended that Hydro replace the exciter controls on Units 1 to 6 at Bay d'Espoir.

Future Plans:

Unit 7 exciter at Bay d'Espoir will need to be assessed once its exciter, the Unitrol F model, enters the limited phase of its life cycle plan.

Attachment:

See report entitled, “Replace Exciter Controls, Units 1 to 6” located in Volume II, Tab 2, for further project details.

Project Title: Water System Replacements

Location: Bay d'Espoir and Cat Arm

Category: Hydraulic Plant Construction

Definition: Other

Classification: Normal

Project Description:

This project involves the replacements of the water systems at two generating stations within the Bay d'Espoir Development:

1) Bay d'Espoir (BDE) – Replace Cooling Water System and Drainage Pump – Unit 7;
2) Bay d'Espoir (BDE) – Replace Main Fire Header; and
3) Cat Arm (CAT) – Replace Domestic Water System.

Within each system the piping and their auxiliary systems are approaching the end of their useful lives. No replacements have occurred since the time of their installations. Each system will be replaced with a like system, with minor design changes and component additions. The cost estimate for the project is shown in Table 1.

Table 1: Project Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	7.0	0.0	7.0
Labour	108.7	272.3	0.0	381.0
Consultant	127.5	120.0	0.0	247.5
Contract Work	0.0	1,287.5	0.0	1,287.5
Other Direct Costs	11.3	27.2	0.0	38.5
Interest and Escalation	18.0	181.8	0.0	199.8
Contingency	0.0	392.5	0.0	392.5
TOTAL	**265.5**	**2,288.3**	**0.0**	**2,553.8**

Operating Experience:

Cooling Water System and Main Fire Header - BDE:

The existing systems at the BDE plant (Cooling Water and Main Fire Header) have operated as intended but they are approaching the end of their useful lives. The strong presence of organics and

bacteria in the systems have created pipe fouling and blockage issues. Also, due to age, rusting has deteriorated the piping.

Domestic Water System – CAT:

The chlorine injector has not been working since 2014 due to a failure of the flow meter. The lines are fouled to the point where the buildup is depleting the chlorine levels before the water reaches the accommodation facility. The strong presence of organics and bacteria in the systems have created pipe fouling and blockage issues. Rusting has deteriorated the piping. Finally, the 100 meter line to the accommodations unit experiences freeze-ups in the winter.

Project Justification:

Cooling Water System – BDE

The cooling water piping at Unit 7 has exceeded its recommended useful life. It was installed 44 years ago, and it needs to be replaced to ensure continued reliability of the cooling water system. In recent years, similar replacements have been completed for other units at the BDE Powerhouse 1 due to pipe fouling.

Main Fire Header – BDE

Recent upgrades to this piping (automation of the generator deluge) where sections of pipe have been removed has caused concerns with the reliability of this system. Excessive bacterial growth has been building up in this pipe since installation and reduced flow rates have resulted. This fire header was installed when the powerhouse was built in 1960's.

Domestic Water System – CAT

The water distribution pipes and the storage tank are corroded and the chlorination system is not working properly. Testing for chlorine at the accommodation facility reveals that the chlorine level is near to zero and not sufficient for potable water. Also, the water flow is restricted due to corroded pipes. The existing piping, chlorination system and storage system are more than 30 years old. Over the years, corrosion and pipe fouling has significantly reduced the pipe internal diameter and reduced the flow rate and volume. This system is required to ensure supply of safe water to the accommodation facility as a part of safe workplace requirement.

Attachments:

See report entitled “Water System Replacements”, located in Volume II, Tab 3, for further project details.

Project Title: Condition Assessment and Miscellaneous Upgrades

Location: Holyrood

Category: Generation - Thermal

Definition: Other

Classification: Normal

Project Description:

The project scope of work consists of three separate pieces of work. The primary piece of work is to perform a condition assessment related to internal components of the main steam generators (boilers) and also associated external high energy piping (HEP). The work that will take place in 2017 is the first year of a three year program that will be completed in 2019. In addition to the condition assessment work, other two mechanical upgrades will take place. These upgrades are the Unit 1 cooling water travelling screen replacement and boiler replacements which will include the replacement of expansion joints and burner/floor tubes.

The project budget estimate is provided in Table 1.

Table 1: Project Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	60.0	0.0	0.0	60.0
Labour	161.7	0.0	0.0	161.7
Consultant	240.0	0.0	0.0	240.0
Contract Work	1,454.0	0.0	0.0	1,454.0
Other Direct Costs	2.0	0.0	0.0	2.0
Interest and Escalation	136.1	0.0	0.0	136.1
Contingency	383.5	0.0	0.0	383.5
TOTAL	**2,437.3**	**0.0**	**0.0**	**2,437.3**

Operating Experience:

Since the plant was commissioned the primary purpose of Holyrood was to support the power generation requirements of the Avalon Peninsula. In addition it provides synchronous condensing capacity to ensure voltage regulation on the Avalon portion of the Island Interconnected System (IIS).

In the last two years the boiler tubes experienced failures as follows:

- 1 tube failure on the primary superheater tubes (boiler No. 2) in 2014;

- 4 tube failures on the lower reheater tubes (boiler No. 2) in 2016;
- 3 tube failures on the upper reheater tubes (boiler No. 2) in 2016; and
- 1 tube failure on the lower reheater tubes (boiler No. 1) in 2016.

Project Justification:

Holyrood has exceeded the normal life expectancy for thermal generating stations. Units 1 and 2 at Holyrood are 46 years old. Unit 3 is 36 years old. Considering the age, there are areas that need to undergo more detailed condition assessment work to ensure the equipment can continue to remain in service from a reliability perspective. The condition assessment will provide information that will allow Hydro to make decisions on any actions needed to ensure a safe reliable operation for Holyrood as a power generating station until 2021, and thereafter as a SC station. The overhaul of Unit 1 CW travelling screen, and boiler upgrades and replacements are justified by age and deterioration to the extent that end of service life has been reached.

Attachments:

See report entitled “Condition Assessment and Miscellaneous Upgrades”, located in Volume II, Tab 4, for further project details.

Project Title: Overhaul Turbine Valves - Unit 2

Location: Holyrood

Category: Generation - Thermal

Definition: Other

Classification: Normal

Project Description:

This project is required to perform a scheduled major overhaul of Unit 2 turbine valves located at the Holyrood Thermal Generating Station (Holyrood).

This valve overhaul consists of:

- Total dismantling of all turbine valves;
- Inspection of the valves;
- Blue checks;
- Lapping of the valve seats;
- Adjustment of valve clearances;
- Repairs/replacements as required; and
- Re-assembly of all turbine valves.

The steam seal regulator will be removed and overhauled as well.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	200.0	0.0	0.0	200.0
Labour	100.0	0.0	0.0	100.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	1,550.0	0.0	0.0	1,550.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	82.1	0.0	0.0	82.1
Contingency	370.0	0.0	0.0	370.0
TOTAL	**2,302.1**	**0.0**	**0.0**	**2,302.1**

Operating Experience:

The Unit 2 operating hours up to May 2016 is 189,600 hours. Assuming the generator operates for approximately 5,000 hours per year until 2017, it is expected to attain approximately 194,600 hours before the next valve overhaul in 2017. Unit 2 has undergone scheduled valve overhauls on a three year basis since 1970.

Project Justification:

The valves of a turbine control the steam flow to the steam turbine generator and hence the electricity production. The purpose of the valve overhaul is to return the turbine, and auxiliary systems to design or near design specifications such that they can perform safely, efficiently, and reliably to meet system demands until the next overhaul. It will also identify any unusual findings (internally or externally) that if not corrected or controlled could lead to premature failure of the equipment. The three year overhaul frequency is supported by industry practice, consultants and original equipment manufacturers.

Future Plans:

A turbine valve overhaul for Unit 1 is scheduled to be completed in 2018.

Attachments:

See report entitled “Overhaul Turbine Valves - Unit 2” located in Volume II, Tab 5, for further project details.

Project Title: Control Structure Refurbishment

Location: Various Sites

Category: Generation - Hydraulic

Definition: Pooled

Classification: Normal

Project Description:

Ebbegunbaeg Control Structure

This is the first project to address the aging Ebbegunbaeg Control Structure; the project will start with a level 2 condition assessment and replacement of gain heaters. The assessment is to be performed by a qualified consultant familiar with this type of equipment. The assessment will include a thorough inspection of all components, including:

- Gates and all associated hardware (rollers, bushings, seals);
- Gate Hoists;
- Gate Gains;
- Emergency Gate Gains;
- Mini-trash rack;
- Bottom Sill;
- Embedded Parts; and
- Building Structure.

The consultant will provide a report on the Control Structure identifying short, medium and long term issues with cost estimates for the refurbishment. The gain heaters at the control structure are also not in operation and require replacement

North Salmon Spillway

The project at North Salmon Spillway (NSS) is for the replacement of the diesel engine for the portable emergency lift system for the gates in the NSS control structure, and to refurbish the gate guide slot due to severe concrete cracking.

Granite Canal Intake

The project at the Granite Canal Intake will replace the primitive frazil ice[1] detection system currently in place, as well as other equipment.

Burnt Dam Spillway Structure

This project consists of the upgrade of the emergency backup hydraulic system to each of the two spillway gates; a level 2 condition assessment of embedded parts and surrounding concrete structure; and the completion of drainage improvements around the diesel building to address flooding problems.

The budget estimate for all the projects above are in Table 1 below.

Table 1: Project Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	75.0	37.3	0.0	112.3
Labour	358.7	125.4	0.0	484.1
Consultant	232.8	0.0	0.0	232.8
Contract Work	693.0	123.9	0.0	816.9
Other Direct Costs	33.6	36.9	0.0	70.5
Interest and Escalation	89.8	38.2	0.0	128.0
Contingency	252.3	91.1	0.0	343.4
TOTAL	**1,735.3**	**452.8**	**0.0**	**2,188.2**

Operating Experience:

Ebbegunbaeg Control Structure

The Ebbegunbaeg Control Structure has performed well during the years of service, but now requires a condition assessment to ensure reliable operation over the next 25 years. There has also been an issue with gain heating, and it has been determined to replace the existing heaters with dual voltage controllers for winter/summer operation to prevent the heaters from overheating in the summer and burning out.

[1] Frazil ice: Develops in open (no ice cover), turbulent, supercooled water. Clear nights in the winter time when the water and air temperatures plunge to very cold readings are the ideal conditions for Frazil Ice development. It consists of loose, randomly oriented needle-like ice crystals.

North Salmon Spillway

The engine used to raise and lower the gate in the event of loss of electrical supply is 34 years old and at the end of its service life and requires replacement. The concrete gate guides (or sills) are severely cracked at the North Salmon structure. The cracking is visible for most of the height of the sill down to the apron slab.

Granite Canal Intake

The current detection system at the Granite Canal Intake is inadequate and only detects frazil ice less than 50% of the time. If frazil ice is not detected and builds up on the trash rack the unit can be forced off-line. Typically if the unit is forced off-line it can take 2 to 3 days to return the unit to service to clean the trash rack.

The current bubbler system requires an operator to travel to Granite to be operated.

Burnt Dam Spillway Structure

The Burnt Dam Spillway is a two gated structure that is required to discharge water in a controlled manner from the Burnt Pond Reservoir in the event of flood conditions. It is also used in the summer to discharge water for fishery compensation. The spillway structure was placed in service in 1967, is now approximately 50 years old, and until now has never undergone a major overhaul. Since 2011, there has been project work underway to refurbish the control structure at Burnt Dam Spillway.

In 2006 there was an incident whereby the gates at Burnt Spillway failed to operate when required. A crew was dispatched from Bay d'Espoir to perform emergency work on both gates but could not get either of the gates to open to the position requested by Hydro's Energy Control Centre (ECC) to lower the reservoir water level. Once the gates were eventually opened, they could not be closed when required causing a loss of a significant amount of reservoir water.

Project Justification:

All the control structures and spillways are critical assets to Hydro's reservoir system. These assets are required for flood control and fisheries compensation and must be maintained at a high level of reliability. This project is required to ensure these assets perform as intended and when required.

Future Plans:

Based on results from the condition assessments further projects are anticipated and will be proposed in future Capital Budget Applications.

Attachments:

See report entitled “Control Structure Refurbishment” located in Volume II, Tab 6, for further project details

Project Title: Gas Turbine Life Extension

Location: Stephenville Gas Turbine

Category: Generation - Gas Turbines

Definition: Other

Classification: Normal

Project Description:

The project scope of work will include the following:

1- Replace filtration system;

2- Upgrade instrumentation; and

3- Replace alternator bed heater and associated cabling and conduits.

The project budget estimate is provided in Table 1.

Table 1: Project Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	346.7	0.0	0.0	346.7
Labour	256.0	109.2	0.0	365.2
Consultant	64.0	30.0	0.0	94.0
Contract Work	100.0	40.0	0.0	140.0
Other Direct Costs	31.9	31.0	0.0	62.9
Interest and Escalation	48.9	93.7	0.0	142.6
Contingency	0.0	201.8	0.0	201.8
TOTAL	**847.5**	**505.7**	**0.0**	**1,353.2**

Operating Experience:

The Stephenville gas turbine has been in service for over 40 years. The performance of the gas turbine has been compromised at various times due to issues with the filtration. The majority of instrumentation at Stephenville is beyond its useful life and is obsolete. Spares are no longer available for many components. Stephenville was out of service for 5 weeks due to a potential loss in oil flow. There is no flow meter installed in the lube oil system; thus, the operators are not able to quickly determine if there is adequate lube oil flow to the bearings. The existing alternator bed heater in Stephenville is no longer operational and temporary heaters are currently being used to provide heat to the alternator.

Project Justification:

This project is justified by the following:

- Replacement of obsolete, beyond design service life filtration system and upgrade instrumentation to maintain the operational reliability and improve equipment protection of the Stephenville gas turbine.
- The existing alternator bed heater is original. It is currently not working and replacement is recommended by the original equipment manufacturer.

Future Plans:

Hydro will continue to assess life extension requirements and will propose additional projects in future Capital Budget Applications.

Attachments:

See report entitled “Gas Turbine Life Extension – Stephenville” located in Volume II, Tab 7, for further project details.

Project Title: Upgrade Holyrood Access Road

Location: Holyrood

Category: Generation - Thermal

Definition: Other

Classification: Normal

Project Description:

This project includes the replacement of the asphalt and all work associated along the access road into the Holyrood Thermal Generating Facility.

Specifically, the scope of work will include:

1. Removal of the existing deteriorated asphalt surface;
2. Replacement of existing culverts;
3. Minor subgrade preparation, as required;
4. Reshaping of ditches and shoulder of the roadway, as required;
5. Placement of Class A material;
6. Installation of asphalt along the access road, approximately 2 km;
7. Perform material testing by external consultant; and
8. Installation of removable speed bumps and signs along the roadway.

The project costs are identified in the Table 1.

Table 1: Project Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	0.0	0.0	0.0
Labour	60.5	54.0	0.0	114.5
Consultant	45.0	45.0	0.0	90.0
Contract Work	353.9	353.9	0.0	707.8
Other Direct Costs	1.2	1.2	0.0	2.4
Interest and Escalation	26.6	38.5	0.0	65.1
Contingency	92.1	90.8	0.0	182.9
TOTAL	**579.3**	**583.4**	**0.0**	**1,162.7**

Operating Experience:

The access road was originally owed and serviced by the Government of Newfoundland and Labrador until ownership was transferred to Hydro in October 2015. While the provincial government owned and operated the road, little maintenance work was completed. The last repairs completed by the Government were in 2014. These repairs only included placement of cold patch in potholes along the roadway.

The access road to the Holyrood Thermal Generating Facility has surpassed its intended service life and requires a major upgrade. The weekly maintenance that has been implemented since the transfer of ownership is only a temporary fix until permanent repairs are completed.

Project Justification:

The access road into the Holyrood Thermal Generating Facility requires major upgrades. Currently, this road is travelled by Hydro employees and contractors on a daily basis. Additionally, transport trucks, line trucks, heavy equipment and fuels delivery trucks all travel this road to help operate and maintain the facility.

The road contains large potholes along the entire length. In other areas along the roadway the driving surface has been reduced to one lane due to the degradation of the asphalt surface near the roads edges. There are two areas in particular along the road that has lengths in excess of 80m where the road is deteriorated down to one lane. Other shorter areas exist where degradation or potholes near one or both of the roads edges cause traffic to swerve into the oncoming lane. A roadway in which two on coming vehicles do not have the adequate road width to safely pass one another creates a safety hazard and is dangerous to all users traveling along the road.

When the thermal units are decommissioned post interconnection, this road will continue to be used by Hydro. This road will be used by employees, contractors and suppliers for regular access to operate and service the switchyard, synchronous condenser, and combustion turbine. The roadway will also be used to supply fuel to the combustion turbine.

Future Plans:

None.

Attachments:

See report entitled “Upgrade Holyrood Access Road” located in Volume II, Tab 8, for further project details.

Project Title: Upgrade Ventilation in Powerhouse #1 and #2

Location: Bay d'Espoir

Category: Hydraulic Plant Construction

Definition: Other

Classification: Normal

Project Description:

This is a two year project to replace each of the existing ventilation systems at the Bay d'Espoir (BDE) Powerhouses #1 and #2. For Powerhouse #1, the project will supplement the existing ventilation system by capturing the waste heat at the generators. This waste heat can be ducted to the outside for cooling in the summer or ducted to the lower levels for waste heat redistribution in the winter. For Powerhouse #2, the project will provide additional fans for the required ventilation.

The budget estimate for the project is shown in Table 1.

Table 1: Project Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	1.0	0.0	1.0
Labour	59.1	119.6	0.0	178.7
Consultant	60.0	67.5	0.0	127.5
Contract Work	0.0	445.2	0.0	445.2
Other Direct Costs	6.5	6.5	0.0	13.0
Interest and Escalation	8.5	70.8	0.0	79.3
Contingency	0.0	153.2	0.0	153.2
TOTAL	**134.1**	**863.8**	**0.0**	**997.9**

Operating Experience:

Powerhouse #1

Currently each generator bay is capable of removing approximately 29,094 m3/h (17,124 CFM). The required ventilation rates calculated by Hatch, and shown in the attached report, range from 58,597 – 117,244 m3/h (34,489 – 69,007 CFM), depending on the cooling water performance. In conjunction with the existing rooftop fans, each bay would need to exhaust an additional 29,503 – 88,150 m3/h (17,365 - 51,883CFM).

Powerhouse #2

Currently the system is capable of removing approximately 65,242 m3/h (38,400 CFM). The required ventilation rate calculated by Hatch is 121,428 m3/h (71,470 CFM). In conjunction with the existing rooftop fans, there is a need to have additional air flow of 56,186 m3/h (33,070 CFM).

Project Justification:

Due to the requirement to run Bay d'Espoir hydro units more often (specifically during the summer), the current ventilation systems are not sufficient in keeping the powerhouse temperatures at acceptable levels. With the existing ventilation system, temperatures on the generator floor can be expected to regularly exceed 40°C during the summer. These increased temperatures make it difficult for work crews to complete their work. According to the American Conference of Governmental Industrial Hygienists (ACGIH), these temperatures exceed the allowable thermal exposure limits for workers. Additionally, due to the natural rising of heat, the overhead hoists located in these powerhouses are even more difficult to operate and maintain in the summer months due to the high temperatures.

In winter, ducting the waste heat through the existing floor penetrations would reduce the need for forced air heaters and power consumption, and should reduce the demand on the fans. If space permits, the ducting could be routed to cover the majority of the turbine floor eliminating the need for 13 of the forced air heaters. Having the heat directed to the turbine level would also allow a more even heat distribution for the generator floor which would make it possible to remove an additional 10 forced air heaters located on this floor.

Attachments:

See report entitled "Replace Ventilation in Both Powerhouses" located in Volume II, Tab 9, for further project details.

Project Title: Gas Turbine Life Extension

Location: Hardwoods Gas Turbine

Category: Generation - Gas Turbines

Definition: Other

Classification: Normal

Project Description:

The project scope of work will include the following:

1- Replace filtration system ; and

2- Upgrade instrumentation.

The project budget estimate is provided in Table 1.

Table 1: Project Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	266.0	0.0	0.0	266.0
Labour	201.4	62.2	0.0	263.6
Consultant	64.0	0.0	0.0	64.0
Contract Work	100.0	0.0	0.0	100.0
Other Direct Costs	5.0	12.2	0.0	17.2
Interest and Escalation	38.9	64.8	0.0	103.7
Contingency	0.0	142.2	0.0	142.2
TOTAL	**675.3**	**281.4**	**0.0**	**956.7**

Operating Experience:

The Hardwoods gas turbine has been in service for over 38 years. The performance of the gas turbine has been compromised due to issues with the filtration at various times. The majority of instrumentation at Hardwoods is beyond its useful life and obsolete. Spares are no longer available for many components. There is additional information that could be gathered from the operating equipment. This information is not currently being gathered by the DCS and has resulted in extended outages due to uncertainty of equipment condition. The additional instrumentation will be installed and wired to the DCS to gather this information for improved protection, operation, maintenance and troubleshooting of the gas turbine.

Project Justification:

This project is justified by the upgrade of obsolete, beyond design service life filtration system and instrumentation to maintain the operational reliability and improve equipment protection at Hardwoods gas turbine.

Future Plans:

Hydro will continue to assess life extension requirements and will propose additional projects in future Capital Budget Applications.

Attachments:

See report entitled “Gas Turbine Life Extension – Hardwoods” located in Volume II, Tab 10, for further project details

Project Title: Upgrade Underground Plant Drainage

Location: Holyrood

Category: Generation - Thermal

Definition: Other

Classification: Normal

Project Description:

This proposal is for the refurbishment of the Holyrood underground plant drainage system. The underground drainage system delivers the effluent generated during plant operation to the appropriate outlets, where it is treated prior to its release into the environment.

The scope of work consists of:

- replacement of approximately 100 meters of underground piping;
- replacement of existing valves;
- supply and installation of additional drainage valves;
- supply and installation of a new oil-water separator at the outlet of the waste water basin building;
- upgrades to oil-water separator no. 2; and
- removal and disposal of contaminated soil around the piping as required.

The budget estimate for the project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	55.0	0.0	0.0	55.0
Labour	151.8	0.0	0.0	151.8
Consultant	55.0	0.0	0.0	55.0
Contract Work	473.2	0.0	0.0	473.2
Other Direct Costs	6.8	0.0	0.0	6.8
Interest and Escalation	32.9	0.0	0.0	32.9
Contingency	148.4	0.0	0.0	148.4
TOTAL	**923.1**	**0.0**	**0.0**	**923.1**

Operating Experience:

The underground plant drainage system consists of a network of pipes, valves and manholes, which direct the effluent produced during the powerhouse operations to a series of grease traps, oil-water separators and equalization basins. In recent years, damaged sections of pipe, pipe blockages and inoperable valves have resulted in the premature leakage of effluent into the environment.

Project Justification:

Waste water control and treatment is a mandatory component of the thermal generation process. Any interruption to, or loss of flow throughout the underground piping network in the waste water treatment system could result in negative environmental impacts. Effluent moving through this piping network often contains trace amounts of contaminant and/or hydrocarbons. Consequently, this waste water requires treatment prior to being released into the environment. To provide this treatment, the wastewater is conveyed through the drainage system to the appropriate outlets where it is retained, treated and, in the case of the boiler effluent, tested for compliance prior to its release into the environment.

The effluent treatment and disposal process is monitored and regulated by the Provincial DOEC to ensure compliance with the Environmental Control Water and Sewage Regulations, 2003. Should a leak in the system result in discharge of effluent to the environment prior to its treatment, this could result in contamination of the environment, which would be a violation of regulatory requirements.

An engineering assessment of the underground plant drainage system was approved in Hydro's 2014 capital budget application under Board Order No. P.U. 42(2013). This assessment has confirmed the presence of leaks and the consequent loss of effluent. This premature release of effluent is an environmental non-compliance and a direct violation of the regulations. Failure to address this non-compliance could result in penalties, fines or an order to cease plant operations pending remediation of the deficiencies. This project will prevent additional effluent from entering the surrounding soil.

Future Plans:

None.

Attachments:

See report entitled “Upgrade Underground Plant Drainage System” located in Volume I, Tab 11, for further project details.

Project Title: Install Asset Health Monitoring System

Location: Upper Salmon

Category: Generation - Tools & Equipment - Hydraulic

Definition: Other

Classification: Normal

Project Description:

The proposed automated data collection system will enhance the present data collection method by providing plant operators with a centralized view of real-time data for all critical operating parameters. This will enable immediate identification of problems and, in addition, store the collected data in the Hydro PI system for access by plant engineering and maintenance planning staff for proactive condition assessment and maintenance planning. The project will require the addition of condition monitoring equipment to monitor the generator and turbine systems.

As this is a proposed two year program, the following is a yearly breakdown of the work:

- 2017 - Install data collection equipment; and
- 2018 - Install field devices and configure system. Expand alarm points to ECC.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	68.0	2.0	0.0	70.0
Labour	195.0	71.0	0.0	266.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	101.0	0.0	0.0	101.0
Other Direct Costs	49.5	3.0	0.0	52.5
Interest and Escalation	24.5	29.5	0.0	54.0
Contingency	0.0	97.9	0.0	97.9
TOTAL	**438.0**	**203.4**	**0.0**	**641.4**

Operating Experience:

The Upper Salmon facility has been in operation since 1983 with much of the original monitoring equipment still in place. With only manual data acquisition, and no on-line trending capabilities, it is difficult to evaluate asset health. With present information collection methods, most maintenance tactics are presently time based preventative maintenance. The existing method of data collection and storage and is not conducive to asset health analysis.

Project Justification:

This project is justified on the basis of enhancing the operating data collection for the Upper Salmon generating unit. This system would aid to enhance diagnostics and maintenance tactics by providing real-time operating data versus periodic manual collection.

Future Plans:

Future installations at other locations are intended based on these enhancements.

Attachment:

See report entitled “Install Asset Health Monitoring Equipment” located in Volume II, Tab 12, for further project details.

Project Title: Overhaul Pumps

Location: Holyrood

Category: Generation - Thermal

Definition: Other

Classification: Normal

Project Description:

This project will involve overhauling the Unit 3 west circulating water pump, the Unit 3 north condensate extraction pump, and the Unit 2 west boiler feed pump.

The unit circulating water (CW) pumps provide circulating water to the turbine condenser, which is required for unit operation. Each pump, east and west, provides approximately 50% of the required circulating water necessary for full operation of the unit. The CW pumps, located in the pump houses, draw sea water from Conception Bay to the turbine condenser located on the first floor of the power house.

The condensate extraction pumps supplies water at moderate pressure for the low pressure feed water system. Unit 3 has two condensate extraction pumps which can each provide up to approximately 90% of the units required maximum capacity. The condensate extraction pumps draw condensate from the condenser.

The boiler feed water pump supplies water at high pressure to the boiler for steam production. Unit 2 boiler has two boiler feed water pumps; each pump is capable of supplying feed water for 50% capacity of the boiler. The boiler feed water pump draws water from the deaerator feed water tank.

The budget estimate for the pump overhauls is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	95.0	0.0	0.0	95.0
Labour	100.0	0.0	0.0	100.0
Consultant	50.0	0.0	0.0	50.0
Contract Work	265.0	0.0	0.0	265.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	21.0	0.0	0.0	21.0
Contingency	102.0	0.0	0.0	102.0
TOTAL	**633.0**	**0.0**	**0.0**	**633.0**

Figure 1: Unit 3 Condensate Extraction Pump

Figure 2: Unit 2 Boiler Feed Pump

Figure 3: Unit 3 Circulating Water Pump

Operating Experience:

One CW pump is in service until Unit 3 reaches approximately 50% of its operating capacity at which point the second pump is needed to provide sufficient volume of circulating water to generate above 80 MW. With two pumps available, they also provide some protection against a forced outage should a single CW pump fail, when the unit is operating below 80 MW.

One condensate extraction pump is in service up to 90% of Unit 3's capacity at which point the second pump is put into service. Below 90% the other extraction pump is in standby, ready to be taken into service when the normal operating pump fails or is out of service for maintenance. The limit is due to the age of the condensate extraction pumps and the increased pressure losses of the addition of the condensate polishers.

Typically one boiler water feed pump is in service until Unit 2 is producing 80 MW, at which point a second boiler water feed pump is necessary to provide sufficient feed water if the generation is to be increased above 80 MW.

Project Justification:

All pumps are required to be operating for the generating units at Holyrood to produce 100% power. Pump specialists Flowserve, were consulted for optimization of the overhaul schedule for pumps at the Holyrood Thermal Generating Station. Flowserve agreed upon overhaul schedules for pumps can be found in Appendix A.

Future Plans:

Additional pump overhaul projects will be proposed in future Capital Budget Applications.

Project Schedule:

The anticipated project schedule is shown in Table 5. Schedule may adjust based on finalizing annual maintenance outage timings.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Project initialization, refine schedule	January 2017	January 2017
Design	Project design	February 2017	February 2017
Procurement	Equipment/part procurement	March 2017	March 2017
Construction	Remove and repairs to pumps	April 2017	June 2017
Commissioning	Commissioning and testing of pumps	June 2017	July 2017
Closeout	Project completion and closeout, lessons learned	August 2017	September 2017

APPENDIX A

FLOWSERVE REVIEW – OVERHAUL SCHEDULE

Pumps	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
1 CW Pump East			X												76,762.00					1 CW Pump East
1 CW Pump West			X								75,000.00									1 CW Pump West
2 CW Pump East	X				X												84,438.00			2 CW Pump East
2 CW Pump West												66,750.00								2 CW Pump West
3 CW Pump East		X									75,000.00									3 CW Pump East
3 CW Pump West						75,000.00												105,500.00		3 CW Pump West
1 Ext Pump North	X												79,000.00							1 Ext Pump North
1 Ext Pump South			X												92,500.00					1 Ext Pump South
2 Ext Pump North					10,000.00												100,500.00			2 Ext Pump North
2 Ext Pump South		X												80,500.00						2 Ext Pump South
3 Ext Pump North						60,000.00												75,000.00		3 Ext Pump North
3 Ext Pump South				X											68,000.00					3 Ext Pump South
1 Vac Pump North											25,000.00									1 Vac Pump North
1 Vac Pump South			X												28,000.00					1 Vac Pump South
2 Vac Pump North				X												29,000.00				2 Vac Pump North
2 Vac Pump South							15,000.00												32,000.00	2 Vac Pump South
3 Vac Pump North				X											29,000.00					3 Vac Pump North
3 Vac Pump South			X												28,000.00					3 Vac Pump South
1 BF Pump East		X								100,000.00						140,000.00				1 BF Pump East
1 BF Pump West				X							160,000.00						154,500.00			1 BF Pump West
2 BF Pump East					70,000.00								160,000.00						162,000.00	2 BF Pump East
2 BF Pump West			X									179,500.00						147,000.00		2 BF Pump West
3 BF Pump East	X							100,000.00	100,000.00					145,000.00						3 BF Pump East
3 BF Pump West	X					10,000.00								188,000.00						3 BF Pump West
Total					80,000.00	145,000.00	15,000.00	100,000.00	100,000.00	100,000.00	335,000.00	246,250.00	239,000.00	218,500.00	368,262.00	266,000.00	339,438.00	327,500.00	194,000.00	

Project Title: Terminal Station Refurbishment and Modernization

Location: Various Sites

Category: Transmission and Rural Operations - Terminal Stations

Definition: Other

Classification: Normal

Project Description:

Terminal stations play a critical role in the transmission and distribution of power across the province. Terminal stations contain electrical equipment, such as transformers, circuit breakers, instrument transformers, disconnect switches, and all associated protection and control relays and equipment, required to protect, control, and operate the province's electrical grid. Terminal stations act as transition points in the transmission system, and interface points with the lower voltage distribution and generation systems. Hydro owns and operates 69 terminal stations across the Island and Labrador Interconnected Systems.

Hydro aims to replace or refurbish failing or failed terminal station assets to ensure the delivery of safe, reliable, least-cost electricity in an environmentally responsible manner.

In the 2017 Capital Budget Application, Hydro proposes the following activities under the Terminal Station Refurbishment and Modernization Program:

- Replacement of Instrument Transformers;
- Replacement of Disconnect Switches;
- Replacement of Surge Arrestors;
- Refurbishment and Modernization of Power Transformers;
- Replacement of Insulators;
- Refurbishment and Upgrade of Station Grounding;
- Refurbishment of Equipment Foundations;
- Installation of Fire Suppression Systems in Control Buildings; and
- Protection, Control, and Monitoring replacements and modernization.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	1,891.9	2,382.4	0.0	4,274.3
Labour	2,529.9	4,747.0	0.0	7,276.9
Consultant	315.2	434.4	0.0	749.6
Contract Work	3,769.5	4,248.2	0.0	8,017.7
Other Direct Costs	544.1	755.1	0.0	1,299.2
Interest and Escalation	346.8	1,094.2	0.0	1,441.0
Contingency	1,433.9	2,889.6	0.0	4,323.5
TOTAL	**10,831.3**	**16,550.9**	**0.0**	**27,382.2**

In the 2017 Capital Budget Application, Hydro has consolidated program-type Terminal Station projects into a single project, *Terminal Station Refurbishment and Modernization*. Year after year, these program-type projects proposed work to address the required refurbishment or replacement of assets such as disconnects or instrument transformers, and had similar justifications and other information presented each year. By eliminating the preparation and review of repetitious information, Hydro estimates that with this change it could save up to $120,000 annually, not including time and costs for review by the Board and Intervenors.

In alignment with this consolidation, Hydro is changing its presentation for this Project. The *Terminal Station Asset Management Overview* (Overview), which is submitted with the 2017 Capital Budget Application, outlines Hydro's philosophies for the assessment of equipment plus the selection and justification of projects. Also, this summary document and the supporting proposal report have been altered to eliminate repetitive and low content information. Additionally, as the requirement for the work is founded on condition assessment practices or previously approved long term programs, data such as individual equipment operating experience and future plans has been removed.

The Terminal Station Refurbishment and Modernization will not include projects related to growth, or projects related to an isolated issue in a particular Terminal Station. These projects will be proposed separately.

Hydro will continue to maintain individual records with regards to the asset capital, maintenance and retirement expenditures, assessments and performance.

Project Justification:

Hydro replaces or refurbishes assets that have deteriorated, or pose a safety or environmental risk, such as those assets containing PCBs. The replacement of such assets is required to ensure Hydro continues to deliver safe, reliable, least-cost electricity in an environmentally responsible manner. Further details on Hydro's philosophies for the assessment of equipment condition and selection and justification of projects can be found in the *Terminal Station Asset Management Overview*.

Future Plans:

Hydro will submit a proposal for the *Terminal Station Refurbishment and Modernization* project on an annual basis.

Attachment:

See report entitled "Terminal Station Refurbishment and Modernization" located in Volume II, Tab 13, for further project details.

Project Title: Diesel Genset Replacements

Location: Port Hope Simpson and Charlottetown

Category: Transmission and Rural Operations - Generation Labrador

Definition: Pooled

Classification: Normal

Project Description:

Port Hope Simpson

This project will require two years and involve the replacement of Units 2042 and 2043 with a 750 kW and 455 kW diesel genset, respectively.

The new genset will require a new exhaust stack, radiator, fuel cooler, aftercooler, switchgear with breaker and all other necessary equipment to facilitate a new unit. Due to the replacements, upgrades to some of the protection and control equipment will be required. Modifications to the existing cooling system will also be necessary to accommodate the new 750 kW diesel genset. Due to the increase in unit size with the installation of the 750 kW genset, the plant automation will require significant changes. The physical location of the genset will change, resulting in the need for new power cables.

Charlottetown

This project will require two years and involve the replacement of Unit 2034 with a straight replacement of the 300 kW unit.

The new genset will require a new exhaust stack, radiator, fuel cooler, aftercooler, switchgear with breaker and all other necessary equipment to facilitate a new unit. Due to the replacement, upgrades to some of the protection and control equipment will be required. The physical location of the genset will change, resulting in the need for new power cables.

The estimate to replace all three gensets is shown in Table 1.

Table 1: Project Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	179.4	1234.2	0.0	1413.6
Labour	308.2	1371.6	0.0	1679.8
Consultant	105.0	793.5	0.0	898.5
Contract Work	0.0	100.0	0.0	100.0
Other Direct Costs	28.0	320.7	0.0	348.7
Interest and Escalation	38.2	439.9	0.0	478.1
Contingency	0.0	888.1	0.0	888.1
TOTAL	**658.8**	**5,148.0**	**0.0**	**5,806.8**

Operating Experience:

Port Hope Simpson

The replacement of Units 2042 and 2043 in Port Hope Simpson is required by 2018 because they are projected to reach the end of their service lives. Hydro has established the service life of a diesel genset to be either:

a.) 25 years of service; or

b.) Accumulation of 100,000 operating hours.

Although Units 2042 and 2043 currently have 20 years of service, Unit 2042 is already exceeding 100,000 hours and it is projected Unit 2043 will reach 100,000 hours by the end of 2018. A unit replacement job requires approximately two years to complete and therefore must begin by the summer of 2017.

Charlottetown

Unit 2034 has been in service for 22 years. During the 22 years of service life the unit has been overhauled six times. In 2018 the unit is forecast to have incurred over 100,000 hours of operation. To continue operating Unit 2034 beyond 2018 will mean reducing the reliability of the Charlottetown Diesel Plant.

Project Justification:

This project is justified based on reliability. All three of these Hydro assets have neared the end of their service life. Units 2042 and 2043 in Port Hope Simpson and Unit 2034 in Charlottetown are expected to exceed 100,000 operating hours by the end of 2018. To maintain a reliable electrical supply to the community of Port Hope Simpson and Charlottetown, Units 2042, 2043, and Unit 2034 must be replaced before the winter of 2018/2019.

Unit 2034 in Charlottetown will be replaced with a unit of similar size, 300 kW. In Port Hope Simpson, Unit 2042 will be replaced with a larger 750 kW unit, and Unit 2043 will be replaced with a similar sized 455 kW unit. In conclusion, the work proposed in this report is the least cost alternative to satisfy the requirement of providing a reliable electrical supply to the customers in Port Hope Simpson and Charlottetown.

Attachment:

See report entitled “Diesel Genset Replacements” located in Volume II, Tab 14, for further project details.

Project Title: Provide Service Extensions

Location: All Service Areas

Category: Transmission and Rural Operations – Distribution

Definition: Pooled

Classification: Normal

Project Description:

This project is an annual allotment based on past expenditures to provide for service connections including street lights to new customers.

Table 1 identifies the total budget for the Central, Northern and Labrador operating regions.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	2,000.0	0.0	0.0	2,000.0
Labour	1,690.0	0.0	0.0	1,690.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	145.0	0.0	0.0	145.0
Other Direct Costs	115.0	0.0	0.0	115.0
Interest and Escalation	190.0	0.0	0.0	190.0
Contingency	390.0	0.0	0.0	390.0
Sub-Total	4,530.0	0.0	0.0	4,530.0
Cost Recoveries	(200.0)	0.0	0.0	(200.0)
TOTAL	**4,330.0**	**0.0**	**0.0**	**4,330.0**

Operating Experience:

In recent years, rural areas of the Island have generally experienced increased expenditures for service extensions due to customer growth and economic activity. In recent years in Labrador, expenditures for service extensions increased dramatically for similar reasons as the Island but expenditures have now been declining since 2012.

The five year actual expenditures for service extensions by region are shown in Table 2.

Table 2: Five Year Expenditures

Expenditures ($000)										
	2011		2012		2013		2014		2015	
Region	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual
Central	1,200	1,231	1,437	1,231	1,437	1,751	1,490	1,600	1,600	1,842
Northern	1,267	1,728	1,371	1,728	1,371	1,218	1,460	1,366	1,460	1,498
Labrador	1,705	3,073	2,198	3,073	2,198	2,720	3,220	1,848	3,020	1,242
Total	4,172	6,032	5,006	6,032	5,006	5,689	6,170	4,814	6,080	4,582

Project Justification:

The forecast budget estimate for 2017 is based on an analysis of the historical expenditures on new customer connections by region supplemented with regional planning input with respect to future activity expenditure levels.

The service extension budget for Labrador is forecast for 2017 on the basis of actual 2015 expenditures with expenditures forecast to increase once again across the next three to four years. A four year historical average was used for the Central Region and a five year historical average was used for the Northern Region respectively. The 2017 budget was developed assuming distribution line cost escalation of approximately 2% over 2016. The budget by region is shown in Table 3 below.

Table 3: Budget for 2017 Distribution System

Region	Budget ($000)
Central	1,750
Northern	1,290
Labrador	1,290
Total	**4,330**

Future Plans:

This is an annual allotment which is adjusted from year to year depending on historical expenditures. Please see the five-year capital plan (2017 Capital Plan Tab, Appendix A).

Project Title: Upgrade Distribution Systems

Location: All Service Areas

Category: Transmission and Rural Operations - Distribution

Definition: Pooled

Classification: Normal

Project Description:

This project is an annual allotment based on historical expenditures which provide for the replacement of deteriorated poles, substandard structures, corroded and damaged conductors, transformers/street lights/reclosers and other associated equipment. Upgrading requirements for distribution system are identified through preventive maintenance inspections or when there is damage caused to equipment by adverse weather conditions such as storms or salt contaminations.

The budget estimate for this project is shown in Table 1 below.

Table 1 : Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**Beyond**	**Total**
Material Supply	2,066.0	0.0	2,066.0
Labour	1,196.0	0.0	1,196.0
Consultant	0.0	0.0	0.0
Contract Work	150.0	0.0	150.0
Other Direct Costs	3.0	0.0	3.0
Interest and Escalation	165.0	0.0	165.0
Contingency	330.0	0.0	330.0
Sub-Total	3,910.0	0.0	3,910.0
Cost Recoveries	(100.0)	0.0	(100.0)
TOTAL	**3,810.0**	**0.0**	**3,810.0**

Operating Experience:

Expenditures for upgrading distribution systems in rural areas were lower in 2015 than in the previous four years with all regions experiencing lower expenditures than in 2014 on an inflation adjusted basis.

The five-year expenditures for distribution upgrades by region are shown in Table 2.

Table 2: Five Year Expenditures

Expenditures ($000)										
	2011		2012		2013		2014		2015	
Region	**Budget**	**Actual**	**Budget**	**Actual**	**Budget**	**Actual**	**Budget**	**Actual**	**Budget**	**Actual**
Central	998	1,365	993	1,854	1,095	1,692	1,700	1,861	1,720	1,887
Northern	1,051	1,489	1,089	1,010	1,237	678	1,270	854	1,210	730
Labrador	450	548	426	270	458	604	400	859	410	370
Total	2,499	3,402	2,508	3,134	2,790	2,974	3,370	3,574	3,340	2,987

Other specifically approved projects for 2011 – 2015 are listed in Table 4.

Project Justification:

The forecast budget estimate for 2017 is based on an analysis of the historical expenditures for distribution upgrading by region supplemented with regional planning input with respect to future activity expenditure levels. The 2017 budget for the Central region is based on the level of expenditures experienced in 2015. The 2017 budget developed for the Northern region is based on the five-year average for distribution system upgrades for the period 2011 – 2015. The 2017 budget developed for the Labrador region is based on expenditures experienced in 2014. Inflation adjusted budgets for 2017 were developed assuming distribution upgrading cost escalation of approximately 2% over 2016.

Table 3: Budget for 2017 Distribution System

Region	Budget ($000)
Central	1,890
Northern	1,010
Labrador	910
Total	**3,810**

Future Plans:

This is an annual allotment which is adjusted from year to year depending on historical expenditures. See the five-year capital plan (2017 Capital Plan Tab, Appendix A).

Table 4 shows the history of other specific distribution system upgrades that have been completed over the past five years as well as the budget for 2016.

Table 4: Historical Information

Year	Project Description	Budget ($000)	Actuals ($000)
2016B	Farewell Head Pole Replacements (Year 1 of 2)	31.9	
	King's Point Pole Replacement (Year 1 of 2)	32.0	
	Replace Recloser CA1-R2 – Cat Arm (Year 1 of 2)	20.6	
	Replace Recloser GB1-R1 – Grandy Brook (Year 1 of 2)	15.4	
	Bay d'Espoir Underground Upgrade (Year 1 of 2)	32.0	
	Happy Valley Upgrade Distribution (L16) (Year 1 of 2)	32.0	
	Paradise River Pole Replacements (Year 1 of 2)	32.1	
	L'Anse au Loup Distribution Upgrade (Year 1 of 2)	74.2	
	Sally's Cove Upgrade Distribution System (Year 1 of 2)	15.4	
	Upgrade Distribution Feeder – Line 1, 3, 4, 6 and 7 Bottom Waters (Year 2 of 2)	818.8	
2015	Upgrade Distribution Feeder – Line 1, 3, 4, 6 and 7 Bottom Waters (Year 1 of 2)	42.7	163.2
	Upgrade Distribution Feeder Line 7 North West River (Year 2 of 2)	700.1	806.5
	Pole Replacements – Pinsent's Arm and Labrador City	593.4	754.6
	Insulator Replacements – Farewell Head	500.0	461.3
	Relocate Voltage Regulators – Hawke's Bay	166.4	116.6
	Install Second Distribution Feeder - Nain	1050.3	1,139.4
	Upgrade Distribution Feeder – Line 1 Nain (Year 2 of 2)	261.0	339.0
	Upgrade Distribution Feeder – Line 1 Daniel's Hr. (Year 2 of 2)	877.8	980.5
	Upgrade Distribution Feeder – Line 1 and 2 Main Brook (Year 2 of 2)	837.1	811.9
	Upgrade Distribution Feeder – Line 1 Plum Point (Year 2 of 2)	1,440.9	1,342.9
	Upgrade Distribution Feeder – Line 1 Hampden (Year 2 of 2)	733.2	728.8
2014	Upgrade Distribution Feeder Line 7 North West River (Year 1 of 2)	64.3	26.6
	Upgrade Distribution Feeder – Line 1 Nain (Year 1 of 2)	43.0	10.0
	Upgrade Distribution Feeder – Happy Valley (Year 1 of 2)	64.3	26.6
	Upgrade Distribution Feeder – Line 1 Daniel's Hr. (Year 1 of 2)	69.7	14.9
	Upgrade Distribution Feeder – Line 1 and 2 Main Brook (Year 1 of 2)	64.3	104.7
	Upgrade Distribution Feeder – Line 1 Plum Point (Year 1 of 2)	75.3	6.4
	Upgrade Distribution Feeder – Line 1 Hampden (Year 1 of 2)	53.6	30.5
	Upgrade Distribution Feeder – Line 1 McCallum	359.1	320.1
	Upgrade Distribution Feeder – Line 1, 2, 4 and 5 Barachoix	583.7	553.8
	Upgrade Distribution Feeder – Line 1 Bay d'Espoir	692.6	632.3
	Upgrade Distribution Feeder – Line 1 Conne River	494.2	443.2
	Upgrade Distribution Feeder – Line 1 St. Lewis (Year 2 of 2)	908.1	740.5
	Upgrade Distribution Feeder – Line 1 and 3 Roddickton (Year 2 of 2)	1,259.5	1366.7
	Upgrade Distribution System – Charlottetown (Year 2 of 2)	365.0	269.2
	Upgrade Distribution System – South Brook (Year 2 of 2)	975.8	846.2
	Upgrade Distribution Feeder – Line 1 Grey River (Year 2 of 2)	487.1	410.8

Year	Project Description	Budget ($000)	Actuals ($000)
2013	Upgrade Distribution Feeder – Line 1 St. Lewis (Year 1 of 2)	76.9	23.3
	Upgrade Distribution Feeder – Line 1 and 3 Roddickton (Year 1 of 2)	98.4	106.5
	Upgrade Distribution System – Charlottetown (Year 1 of 2)	27.8	22.8
	Upgrade Distribution System – South Brook (Year 1 of 2)	76.3	108.5
	Upgrade Distribution Feeder – Line 1 Grey River (Year 1 of 2)	32.5	111.9
	Upgrade Distribution Feeder – Line 1 Cow Head	665.6	658.4
	Upgrade Distribution Feeder – Line 1 St. Brendan's	330.2	310.7
	Upgrade Distribution Feeder – Line 1 Holyrood	632.4	372.1
	Upgrade Distribution Feeder – Line 11 Wabush	400.8	513.2
	Upgrade Distribution Voltage – Line 6 St. Anthony	641.9	648.6
	Upgrade Distribution Feeder – Line 6 Farewell Head	961.9	980.0
	Upgrade Distribution Feeder – Line 5 Farewell Head	1,110.1	1,184.9
	Upgrade Distribution Feeder – Line 2 Plum Point (Year 2 of 2)	1,110.5	1,276.2
2012	Upgrade Distribution Feeder – Line 1 Bay d'Espoir	856.6	896.9
	Upgrade Distribution Feeder – Line 2 Bay d'Espoir	952.9	811.2
	Upgrade Distribution Feeder – Line 1 Francois	440.9	650.4
	Upgrade Distribution Feeder – Line 1 Parson's Pond	381.9	344.7
	Upgrade Distribution Feeder – Line 2 Plum Point (Year 1 of 2)	50.4	33.2
	Upgrade Distribution Feeder – Line 7 Happy Valley	1,260.1	1,163.6
	Upgrade Distribution Feeder – Line 2 Glenburnie (Year 3 of 4)	2,114.6	1,895.0
	Reconfigure Feeders – Wabush	55.4	55.4
	Upgrade Distribution Feeder – Line 1 Rigolet (Year 2 of 2)	725.7	658.5
	Upgrade Distribution Feeder – Line 1 Makkovik (Year 2 of 2) (Materials ordered in 2011)	799.5	612.6
2011	Replace Poles – Westport	256.4	279.3
	Replace Poles – Grandy Brook	286.4	312.4
	Replace Poles – Farewell Head	339.6	393.9
	Upgrade Distribution Feeder – Line 1 Rigolet (Year 1of 2)	72.0	10.5
	Upgrade Distribution Feeder – Line 1 Francois	440.9	116.0
	Upgrade Distribution Feeder – Line 8 Happy Valley	553.5	488.2
	Upgrade Distribution Feeder – Line 4 Roddickton (Year 2 of 2)	902.6	1,106.2
	Upgrade Distribution Feeder – Line 1 Makkovik (Year 2 of 2)	742.4	137.3
	Upgrade Distribution Feeder – Line 2 Glenburnie (Year 2 of 4)	578.2	527.8

Project Title: Upgrade Corner Brook Frequency Converter

Location: Corner Brook

Category: Transmission and Rural Operations - Terminal Stations

Definition: Other

Classification: Normal

Project Description:

This proposal is to upgrade the Corner Brook Frequency Converter, which includes rotor wedging, stator rewinding, stator and rotor cleaning, exciter refurbishment, replacement of bellows between air outlets with a suitable material and the installation of fans and air ducting to provide ventilation in the transformer vault.

The budget estimate for this project is shown in Table 1

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	2.0	3.0	0.0	5.0
Labour	161.2	416.6	0.0	577.8
Consultant	0.0	120.0	0.0	120.0
Contract Work	0.0	1,451.0	0.0	1,451.0
Other Direct Costs	20.2	101.4	0.0	121.6
Interest and Escalation	11.2	202.1	0.0	213.3
Contingency	0.0	455.1	0.0	455.1
TOTAL	**194.6**	**2,749.2**	**0.0**	**2,943.8**

Operating Experience:

The Corner Brook Frequency Converter has been in operation since the mid 1960's and during this period has provided very reliable operation. Both the 50 and 60 Hz synchronous machines still have their original stator coils, but due to concerns with age and expected condition of the coils, the unit has been load restricted to 19 MVA. A 2015 condition assessment by Siemens recommended that the converter not be operated at its maximum output of 25 MW, but limited to 19 MVA, until both machines have been upgraded.

In February 2014, during maintenance work, an abnormal noise in the machine was noted and Siemens were called on site to do an investigation. The investigation revealed that one of the wedges between the spider and the rotor pole had become loose.

During recent modifications to the transformer vault for fire protection, it was observed that the converter transformers were not cooling efficiently. During periods of warmer weather, transformer temperatures escalate to levels that are detrimental to transformer life.

Project Justification:

The Corner Brook Frequency Converter is an important component of the Island Interconnected System in that it enables 50 Hz power generation from Deer Lake Power to be accessible to the 60hz Island grid. The stator windings and exciters have reached the end of their reliable service life and were recommended for refurbishment by Siemens in a July 2015 condition assessment report. The rotor wedging requires replacement to allow for the safe and reliable operation of the machines. Installation of a ventilation system in the transformer vault is essential to ensure that the transformers do not fail prematurely as a result of overheating.

Future Plans:

None.

Attachments:

See report entitled “Upgrade Corner Brook Frequency Converter” located in Volume II, Tab 15, for further project details.

Project Title: Transmission Line Upgrades

Location: TL212 and TL218

Category: Transmission and Rural Operations - Transmission

Definition: Other

Classification: Normal

Project Description:

This proposal includes two individual transmission line upgrade projects located on two transmission lines within Hydro's Island Interconnected System. A brief description of each project is as follows:

1. Replace four anchors on Structure 435 of Transmission Line 212 (TL212); and
2. Replace insulators on 190 structures of Transmission Line 218 (TL218).

Issues that pose a risk of structural failure have been identified on each of the two lines listed above. These include significantly corroded anchors on TL212 and defective and deteriorating insulators on TL218. Failure to rectify these issues presents a reliability issue for customers and a safety issue for workers and the general public.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	311.2	301.2	0.0	612.4
Labour	146.2	100.5	0.0	246.7
Consultant	0.0	0.0	0.0	0.0
Contract Work	560.5	410.5	0.0	971.0
Other Direct Costs	100.3	90.6	0.0	190.9
Interest and Escalation	36.5	50.1	0.0	86.6
Contingency	223.5	180.4	0.0	403.9
TOTAL	**1,378.2**	**1,133.3**	**0.0**	**2,511.5**

Operating Experience:

Structure 435 on TL212 is located along the edge of Linton Lake and its anchors are located in the lake itself. Structure 434 is located on an island in the middle of Linton Lake and it is cumbersome to access as it is only accessible during the winter months when the pond is covered in ice. If Structure 435 were to fail due to its corroded anchors, it is possible that a cascading effect could cause Structure 434 to fail as well. If this were to happen, the repair time would be quite lengthy at a high cost due to the particularly difficult access to the line here as helicopters cannot land on this island.

Part of TL218 is among the oldest transmission lines in Hydro's system. It is a critical line, supplying electrical service to the most densely populated areas of the province. Much of the line traverses very rough terrain which is subject to high winds and icing conditions. The frequency of failures on OB and COB insulators makes the reliability of the line a concern and future issues are likely.

Project Justification:

The reliability of the anchors and insulators on transmission lines affects the reliability of the lines and the system as a whole. Transmission line upgrades as described in this proposal are justified on the requirement to replace deteriorated infrastructure and prohibit further deterioration to prevent structural failure of the lines. Failures will have a negative effect on the safety and reliability performance of the line. The failure of a line may result in unplanned power outages to customers at a time when required repairs may be hampered by severe weather conditions.

Attachments:

See report entitled "Transmission Line Upgrades" located in Volume II, Tab 16, for further project details.

Project Title: Wood Pole Line Management Program

Location: Various Sites

Category: Transmission and Rural Operations - Transmission

Definition: Other

Classification: Normal

Project Description:

The objective of the Wood Pole Line Management (WPLM) program is to maintain a comprehensive pole inspection and testing program using the conventional sound and bore methods supplemented by Non Destructive Evaluation (NDE), periodic full scale tests of poles removed from service, and remedial treatment application. Structural analysis to assess the line reliability, taking into account the system concept, is applied against all inspection information. Any replacement and/or refurbishment will be based on the assessment of quantitative risk with respect to in-service pole strength.

Under the program, transmission line inspection data in each year is analyzed and appropriate recommendations made for necessary refurbishment and/or replacement of line components such as poles/structures, hardware, and conductor in the subsequent year. The inspection data and any refurbishment and/or replacement of assets are recorded in a centralized database for future access and tracking.

The budget estimate for the project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	366.7	0.0	0.0	366.7
Labour	1,364.3	0.0	0.0	1,364.3
Consultant	100.0	0.0	0.0	100.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	68.2	0.0	0.0	68.2
Interest and Escalation	125.1	0.0	0.0	125.1
Contingency	379.8	0.0	0.0	379.8
TOTAL	**2,404.1**	**0.0**	**0.0**	**2,404.1**

Operating Experience:

Hydro operates approximately 2,500 kilometers of wood pole transmission lines, including approximately 26,000 poles. Hydro inspects and treats approximately 10% of these poles each year, and these inspections indicate decreasing preservative levels and increasing decay in aging poles.

Project Justification:

As wood poles age, their preservative retention levels decrease and the poles become increasingly subjected to deterioration by different agents including fungi and insects. Wood poles must be regularly inspected and treated in-situ to proactively identify and assess any deterioration. The WPLM program detects "danger poles" and other deteriorated line components early to avoid safety hazards and to identify poles that are at early stages of decay to ensure that corrective measures can be taken to extend the average life of these poles. Money is saved in the long term through the deferring of rebuilding lines and avoiding forced outages.

In addition to proactively managing wood poles, the project detects deteriorated line components before the integrity of a structure is jeopardized. If the deterioration of the components is not detected early enough then the reduced integrity of the structure will affect the reliability of the line and the system as a whole and could lead to increased failure costs and, potentially, customer interruptions.

Future Plans:

The program is based on two ten year inspection cycles that began in 2003. It provides annual data to identify problem areas for the regional asset managers and to develop recommendations for appropriate pole replacements, as well as other components in the following years. Please see the anticipated five-year capital schedule in Appendix A of the attached report entitled "Wood Pole Line Management Program."

Attachments:

See report entitled "Wood Pole Line Management Program" located in Volume II, Tab 17, for further project details.

Project Title: Upgrade Office Facilities and Control Buildings

Location: Various Sites

Category: Transmission and Rural Operations - Properties

Definition: Other

Classification: Normal

Project Description:

The program will include detailed assessments, engineering and refurbishment of the aging facilities, including the regional offices, area offices, and control buildings at terminal stations within Hydro's Transmission and Rural Operations (TRO) regions.

2017 - Office Facilities Upgrades:

Condition assessments were completed for the Bishop's Falls Service Building and Port Saunders Site Office. Recommendations from these condition assessments include civil, mechanical and electrical replacements and/or upgrades. The scope of work for this project includes replacement of overhead doors, interior finishes, installation of new air handling units including electrical upgrades of the exhaust fans, installation of waterproof enclosures, and installation of fire stopping around wall penetrations. As well, additional building condition assessments will be completed for other TRO facilities to identify future work that will be required.

2017 - Control Building Upgrades:

A condition assessment was completed for the Control building at Sunnyside Terminal Station. Recommendations from the condition assessments include civil, mechanical and electrical replacements and/or upgrades. The work includes replacement of doors and frames, flooring, and wall finishes, ceilings, air handling units, exhaust fans and upgrades to the lighting and electrical.

The budget estimate for this project is shown in Table 1.

Table 1: Project Estimate

Project Cost: *($ x1,000)*	2017	2018	Beyond	Total
Material Supply	0.0	0.0	0.0	0.0
Labour	189.9	0.0	0.0	189.9
Consultant	401.6	0.0	0.0	401.6
Contract Work	1,113.5	0.0	0.0	1,113.5
Other Direct Costs	24.0	0.0	0.0	24.0
Interest and Escalation	123.1	0.0	0.0	123.1
Contingency	345.7	0.0	0.0	345.7
TOTAL	**2,197.3**	**0.0**	**0.0**	**2,197.3**

Operating Experience:

The TRO regional offices, area offices and terminal station facilities are used by personnel as office space, storage space, workshops and control buildings. These offices and workshops are essential in continuing the daily planning and operations of Hydro. The control buildings ensure that reliable electricity is distributed to the customers of Newfoundland and Labrador. All Hydro's facilities need to be in good operating condition, structurally sound, secure and weather tight to ensure a safe and healthy environment for all employees.

Project Justification:

As outlined in the Upgrade Office Facilities and Control Building report filed with the 2016 Capital budget application, these structures are in the range of 25-40 years old. Having facilities that are sound, well maintained and functional is essential in allowing employees to perform their work safely and efficiently. Many of the overhead doors, entry doors, windows and exterior envelope systems require replacement/repair. There have also been a number of building code and fire safety deficiencies identified.

Future Plans:

A schedule has been developed prioritizing the office and control building condition assessments and upgrades. It is anticipated that this program will continue until 2025. Condition assessments will be completed in the first year of the identified schedule, the assessments will be reviewed and work prioritized in the second year, detailed engineering will be completed in the third year and construction will be completed in either the third and/or fourth year depending on the upgrades required.

Attachments:

See report entitled “Upgrade Office Facilities and Control Buildings” located in Volume III, Tab 18, for further project details.

Project Title: Overhaul Diesel Engines

Location: Various Sites

Category: Transmission and Rural Operations - Generation Northern

Definition: Pooled

Classification: Normal

Project Description:

This project is required to overhaul the diesel engines at diesel generating plants. The project consists of the ten overhauls that are projected to become due in 2017. This projection is based on the engines being overhauled every 20,000 hours of operation (with the exception of the 100,000 hours milestone at which point the engine is replaced instead of being overhauled).

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	936.5	0.0	0.0	936.5
Labour	386.6	0.0	0.0	386.6
Consultant	0.0	0.0	0.0	0.0
Contract Work	241.0	0.0	0.0	241.0
Other Direct Costs	103.5	0.0	0.0	103.5
Interest and Escalation	94.8	0.0	0.0	94.8
Contingency	333.5	0.0	0.0	333.5
TOTAL	**2,095.9**	**0.0**	**0.0**	**2,095.9**

Operating Experience:

Isolated diesel generation plants operate continuously since they provide the primary source of electricity to communities isolated from the province's electrical grid. A given unit is not in service continually since the number of units in service varies based on the demand. Emergency backup diesel generation plants operate only in emergency situations, which are rare but critical. In automated plants the engine mix is automatically controlled by a control system to maximize fuel efficiency while in a manual plant this control is completed by the operator. In any of the plants the operator has the

flexibility to shut down engines for maintenance provided there is another engine available to take the load for that time. As a result, outages to engines can occur without outages to customers.

Project Justification:

Newfoundland and Labrador Hydro's current maintenance philosophy is to complete an engine overhaul on all diesel engines every 20,000 hours. This philosophy was established as a result of a 2003 review of the maintenance tactics and failure history. Performing overhauls too frequently results in additional expenditure for negligible improvement in reliability. An overhaul interval of 20,000 hours is considered to be the optimum interval for providing least-cost, reliable electrical service.

Future Plans:

The overhaul of diesel engines is a continuous program that will need to continue as long as there are prime power diesel generating plants. The long term plan for diesel engine overhauls forecasts 46 overhauls over the next five years (i.e. 2017 - 2021) which is an average of 9.2 overhauls annually and is based on an overhaul interval of 20,000 operating hours. The long term plan is based on the present-day operating conditions which are subject to change as the loading on a plant or other factors change with time. Changes to the operating conditions can change the average number of annual overhauls.

Attachments:

See report entitled "Overhaul Diesel Engines" located in Volume III, Tab 19, for further project details.

Project Title: Install Automated Meter Reading

Location: Happy Valley

Category: Transmission and Rural Operations - Metering

Definition: Other

Classification: Justifiable

Project Description:

This project is required to install Automatic Meter Reader (AMR) equipment in the Happy Valley area to replace retiring meter readers. The AMR head end equipment shall be installed in the Happy Valley substation. Customers shall include both residential as well as demand customers who shall have their current meters replaced with new AMR units. The use of AMR equipment allows for customer usage (billing) data to be retrieved without requiring meter reader personnel to physically visit a customer's property. The system will allow accurate billing throughout the year regardless of the weather conditions thus eliminating most cases of estimated billings.

The budget estimate for this project is shown in Table 1.

Table 1: Project Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	2.5	1,189.1	0.0	1,191.6
Labour	44.7	212.1	0.0	256.8
Consultant	0.0	0.0	0.0	0.0
Contract Work	20.0	22.1	0.0	42.1
Other Direct Costs	7.7	18.6	0.0	26.3
Interest and Escalation	3.7	146.4	0.0	150.1
Contingency	0.0	303.3	0.0	303.3
TOTAL	**78.6**	**1,891.6**	**0.0**	**1,970.2**

Operating Experience:

The AMR system will replace:

(i) manual handheld devices used to collect meter readings at each customer's site;

(ii) supporting infrastructure (computers and modems) used to retrieve the data; and

(iii) a requirement for personnel to travel to each customer location to read meters.

Previous AMR projects have been completed by Hydro in a number of other the service areas. The AMR system being implemented has proven to be reliable and accurate.

Project Justification:

This project is primarily justified on the results of a cost-benefit analysis which shows that the new AMR system has economic benefits over the existing system through a reduction in controllable costs. The new system also provides benefits in customer service through improvements in accuracy, frequency and detail of reporting. Implementation of AMR will also enhance safety by reducing employee risk exposure and will provide a benefit to the environment as a result of less vehicle usage.

Future Plans:

This proposed project is part of an ongoing program to implement AMR in Hydro's service areas.

Attachments:

See report entitled “Automated Meter Reading” located in Volume III, Tab 20, for further project details.

Project Title: Line Depot Condition Assessment and Refurbishment Program

Location: Various Sites

Category: Transmission and Rural Operations - Distribution

Definition: Other

Classification: Normal

Project Description:

This report outlines the 2017 year of a multiyear program to refurbish Hydro's aging line depot infrastructure over the next twelve years. This program includes continuing detailed assessment, engineering and construction of line depot upgrades and replacements as well as replacements of specific line depot storage ramps and storage sheds which have been identified previously as needing replacement.

2017 Line Depot Project:

The 2017 project includes a level 2 condition assessment for Burgeo, detailed engineering for Ramea, Flower's Cove and Roddickton and upgrades to the Change Island Depot.

A condition assessment was completed for the Change Island Line Depot in 2015. Recommendations from this condition assessment include extensive structural component replacements to the building. A Cost Benefit Analysis was completed to compare refurbishment of the existing to replacement, with the least cost results favouring the replacement of the depot building.

The budget estimate and forecast for the next five years in this multiyear program is shown in Table 1.

Table 1: 5 Year Budget Forecast

Project Cost: *($ x1,000)*	**2017**	**2018**	**2019**	**2020**	**2021**
Material Supply	0.0	0.0	0.0	0.0	0.0
Labour	304.9	474.0	474.0	474.0	474.0
Consultant	0.0	48.0	48.0	48.0	48.0
Contract Work	818.0	840.0	840.0	840.0	840.0
Other Direct Costs	29.0	0.0	0.0	0.0	0.0
Interest and Escalation	76.5	107.8	151.2	194.7	241.3
Contingency	230.4	272.4	272.4	272.4	272.4
TOTAL	**1,458.8**	**1,742.2**	**1,785.6**	**1,829.1**	**1,875.7**

Operating Experience:

As outlined in the Line Depot Condition Assessment and Refurbishment Strategy Report filed with the 2015 Capital Budget Application, the purpose of these buildings and ramps is to provide line workers with a safe and protected area to store, load and prepare materials and equipment used to maintain the integrity of Hydro's transmission lines. During emergency repairs in winter, under adverse weather conditions, working with frozen transmission line materials is difficult for the workers and many times, the weather conditions can be too adverse to assemble materials on site. As such, the line depots provide a sheltered location to repair equipment and keep materials protected from the weather so they don't freeze together. These depots also provide a safe reprieve from the adverse weather that workers are required to be in during emergencies, sometimes for exceptionally long hours.

Project Justification:

As outlined in the Line Depot Condition Assessment and Refurbishment Strategy Report filed with the 2015 Capital Budget Application, these depot buildings are in the range of 25-40 years old. Many of the windows and doors, as well as heating and cooling units are at the end of their expected life cycle and need replacement. Many of the Heat Recovery Ventilation (HRV) systems do not meet code requirements for ventilation and require new HRV systems installed at each depot office. There have been a number of items identified as safety issues relating to the electrical system such as incorrectly wired exterior plugs, code deficient panel barriers, overloaded circuits for identified use, and lack of

Ground Fault interrupt circuits in wet areas. There have also been a number of fire safety deficiencies identified including missing fire detectors, illuminated exits signs and emergency light wall packs. These condition assessments also identify the replacement of storage ramps that are dilapidated and unsafe for workers to use.

Future Plans:

A schedule has been developed prioritizing line depot detailed assessments and upgrades. It is anticipated this program will continue to 2026 where, in general, the detailed assessments will be completed in the first year of the identified schedule, detailed engineering will be completed in the second year and construction will be completed in the third or fourth year.

Attachment:

See report entitled "Line Depot Condition Assessment and Refurbishment Program" located in Volume III, Tab 21, for further project details.

Project Title: Construct New Facilities

Location: Various Sites

Category: Transmission and Rural Operations - Properties Labrador

Definition: Other

Classification: Normal

Project Description:

This project proposes the construction of new facilities required at various Hydro sites.

1) Construction of wooden storage building at Charlottetown diesel plant. The building is to be 4.9m x 7.3m (16' x 24'). The design and construction are to be completed in 2017.

2) Construction of a steel storage building at Makkovik diesel plant. The building is to be 6.1m x 9.1m (20' x 30'). The design is to be completed in 2017 and the construction is to be completed in 2018.

3) Construction of Pole Storage Ramps:
   a) Bay d'Espoir – 2 ramps – Design in 2017 and Construction in 2018.
   b) Hopedale – 1 ramp – Design in 2017 and Construction in 2018.
   c) Makkovik – 1 ramp – Design in 2017 and Construction in 2018.

The budget estimate for this project is shown in Table 1.

Table 1: Project Cost

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	0.0	0.0	0.0
Labour	142.1	139.9	0.0	282.0
Consultant	99.0	96.0	0.0	195.0
Contract Work	130.0	440.0	0.0	570.0
Other Direct Costs	28.0	30.5	0.0	58.5
Interest and Escalation	22.9	106.5	0.0	129.4
Contingency	0.0	221.2	0.0	221.2
TOTAL	**422.0**	**1,034.1**	**0.0**	**1,456.1**

Operating Experience:

Currently, Hydro sites do not have enough storage areas and additional structures are required.

At the diesel plants there is limited storage area to store equipment and parts. In some instances the items are placed on the engine hall floor.

The existing pole storage areas are not adequate. Additional storage areas are required as currently the wood poles are stored directly on the ground where wood pole treatments could leach into the soil, contaminating the ground.

Project Justification:

Installation of storage buildings and pole storage ramps are required to ensure that Hydro has the appropriate facilities required to operate safely and efficiently.

Future Plans:

Design 2018/Construction 2019

- Rigolet (1 ramp), Cartwright (1 ramp) and Wabush (5 ramps)

Design 2019/Construction 2020

- Postville (1 ramp), Mary's Harbour (1 ramp), Black Tickle (1 ramp) and Norman Bay (1 ramp)

Design 2020/Construction 2021

- HVGB (12 ramps), Fogo Island (1 ramp)

Attachment:

See report entitled "Construct New Facilities" located in Volume III, Tab 22, for further project details

Project Title: Replace 66 kV Station Service Feed

Location: Holyrood

Category: Transmission and Rural Operations - Terminal Stations

Definition: Other

Classification: Normal

Project Description:

This project involves the replacement of the 66 kV underground cable feed, between Holyrood Terminal Station bus B6 and Holyrood Thermal Generating Station transformer SST34, which is one of two station service supplies to the Holyrood Thermal Generating Station.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	10.0	0.0	10.0
Labour	45.6	222.2	0.0	267.8
Consultant	0.0	30.0	0.0	30.0
Contract Work	13.8	652.9	0.0	666.7
Other Direct Costs	0.4	3.6	0.0	4.0
Interest and Escalation	3.0	84.2	0.0	87.2
Contingency	0.0	195.7	0.0	195.7
TOTAL	**62.8**	**1,198.6**	**0.0**	**1,261.4**

Operating Experience:

The station service system at the Holyrood Thermal Generating Station provides power to critical ancillary devices, such as pumps, motors, and lighting. The system consists of two feeds from the Holyrood Terminal Generating Station; one feeding transformer SST12 via 66 kV overhead line, and the other feeding transformer SST34 via single phase, 66 kV underground cables. The 66kV underground cable system was installed in 1978, and is due for replacement.

Project Justification:

This project is justified based on the fact that the existing SST34 cable feed is approaching the end of its life. Failure of the cable feed to SST12 (subsequently replaced by a 66 kV overhead line) in 2002, as well as the failure of one phase of cable to SST34, indicates that the existing cables have reached the end of their useful service life. The SST34 cable system utilized its spare cable when it suffered a cable failure in 2000. A further cable failure would eliminate the feed to SST34 resulting in a lack of redundancy in the station service system, thereby increasing the risk of outages to the Holyrood Thermal Generating Station.

Future Plans:

None.

Attachments:

See report entitled "Replace 66 kV Station Service Feed" located in Volume III, Tab 23, for further project details

Project Title: Diesel Plant Engine Auxiliary Upgrades

Location: Various Sites

Category: Transmission and Rural Operations - Generation Central

Definition: Other

Classification: Normal

Project Description:

This is a two year project to replace the cooling and silencer systems at four diesel generating plants located on the south coast of Newfoundland:

- **McCallum:** The radiators, coolant lines and valves will be replaced at the McCallum (MCC) diesel plant.
- **Ramea:** The radiators, coolant lines and valves will be replaced at the Ramea (RAM) diesel plant.
- **Grey River:** The silencers, radiators, coolant lines and valves will be replaced at the Grey River (GRY) diesel plant.
- **Francois:** At Francois (FRS), the existing combined silencer/radiator unit will be removed and replaced with a standard radiator. In addition, the radiator coolant lines and valves will be replaced.

The cost estimate for the project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	211.4	153.4	0.0	364.8
Labour	297.3	123.1	0.0	420.4
Consultant	66.4	8.8	0.0	75.2
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	54.2	23.6	0.0	77.8
Interest and Escalation	44.2	37.6	0.0	81.8
Contingency	117.1	69.8	0.0	186.9
TOTAL	**790.6**	**416.3**	**0.0**	**1,206.9**

Operating Experience:

The current radiator, cooling and silencer systems at each of these diesel plants have operated as intended, with the exception to the rusting issues; however, the existing systems are approaching the end of their useful service lives. The strong presence of salt in the atmosphere due to the close proximity of these plants to the ocean has deteriorated these systems. There have been no major upgrades since the time of their installations.

Project Justification:

The silencers, radiators coolant lines and valves have become deteriorated due to rusting and are approaching the end of their useful lives. This project is justified on the need to protect critical assets at the McCallum, Ramea, Grey River and Francois diesel plants in the event of a cooling system failure. These four plants are located in coastal, isolated communities with diesel generation as the main source of energy. The communities can only be accessed by ferry or helicopter. As these plants are not attended 24 hours per day, catastrophic damage could result if the cooling systems failed. The community could be left without power for an extended period of time depending on the scope of damage.

The fuel system in Ramea was recently replaced with stainless steel piping, at which time it was noted that some of the existing piping had almost rusted through. Due to this finding it was decided that all black iron pipe systems (at all coastal plants of this era) and associated equipment should be replaced with stainless steel systems. Based on the condition of the radiators, silencers and coolant piping of these four plants it is clearly evident that these systems have experienced the same deterioration because they are in the same corrosive marine environment and should be replaced.

Attachments:

See report entitled “Diesel Plant Engine Auxiliaries Upgrades” located in Volume III, Tab 24, for further project details.

Project Title: Replace Substation

Location: Holyrood

Category: Transmission and Rural Operations - Terminal Stations

Definition: Other

Classification: Normal

Project Description:

This project involves the construction of a new substation to replace the existing Holyrood substation. The replacement of the Holyrood substation is required to improve the safety and maintain reliability of this facility.

The scope of work includes the following:

- Civil work to prepare a new site adjacent to the existing substation;
- Completion of grounding measurements and study;
- Design and installation of a grounding grid;
- Installation of foundations for the electrical equipment;
- Design and installation of a new 66 kV "take off" structure and a new 4.16 kV structure. The "take off" structure is used to terminate the incoming 66 kV transmission line inside the substation. The 4.16 kV structure is used to support the equipment required for the outgoing distribution feeder;
- Relocation of the 66 kV fused disconnect switch and the 66 kV manual disconnect switch (these high voltage switches will be reused from the existing substation);
- Installation of new equipment: a 4.16 kV recloser, a recloser bypass switch, insulators, and hardware;
- Relocation of the 1.5 MVA power transformer from the old substation to the new substation;
- Commissioning of the new substation; and
- Removal and disposal of the equipment from the old substation.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	71.6	0.0	71.6
Labour	160.5	150.4	0.0	310.9
Consultant	61.8	34.5	0.0	96.3
Contract Work	193.0	227.0	0.0	420.0
Other Direct Costs	0.5	11.1	0.0	11.6
Interest and Escalation	23.6	81.9	0.0	105.5
Contingency	0.0	182.1	0.0	182.1
TOTAL	**439.4**	**758.6**	**0.0**	**1,198.0**

Operating Experience:

The Holyrood Substation was originally constructed over 40 years ago. Most of the substation poles and crossarms were installed at the time of original construction and have exceeded their economic and useful life spans. The transformer was installed in 1996 and does not need to be replaced.

Project Justification:

A technical assessment (TA) was performed in March 2015 to evaluate the condition of the Holyrood substation. The TA concluded that the poles and crossarms have deteriorated and have limited life remaining before widespread failure occurs. The recloser and metering tank have also reached the end of their service lives.

The Holyrood Substation's grounding system does not comply with Hydro's current standards. In its present condition there are potential electrical shock hazards to operating personnel inside the station and to members of the general public outside the station. As well, the ineffective grounding system may cause protection and control equipment to operate improperly which leads to lower system reliability.

Future Plans:

None.

Attachments:

See report entitled “Replace Substation – Holyrood” located in Volume III, Tab 25, for further project details.

Project Title: Distribution Upgrades – 2017

Location: Various Sites

Category: Transmission and Rural Operations - Distribution Central

Definition: Other

Classification: Normal

Project Description:

Hydro provides service to residents in select rural communities within the province through the use of distribution systems. The distribution systems typically consist of a substation coupled with a wood pole distribution line that supplies power from the station to service drops throughout the community. This project proposal includes distribution lines located in the distribution systems of Ramea and Grandy Brook that have been identified as requiring upgrades to the existing infrastructure. The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	330.0	0.0	330.0
Labour	60.0	180.0	0.0	240.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	350.0	0.0	350.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	4.2	86.9	0.0	91.1
Contingency	0.0	184.0	0.0	184.0
TOTAL	**64.2**	**1,130.9**	**0.0**	**1,195.1**

Operating Experience:

The distribution lines were originally constructed over 40 years ago. Most of the line components were installed at the time of original construction and have exceeded the expected service life of 30 years. In addition, standardized inspection and testing procedures indicate line components are deteriorated and have remaining life spans of only one to five years before widespread failure occurs.

Project Justification:

This project is justified based on reliability. The conditions of the components could result in system failures and have a negative effect on the safe and reliable performance of the line. The failure of a line may also result in unplanned power outages to customers at a time when required repairs may be hampered by severe weather conditions.

Future Plans:

Future distribution line upgrades will be proposed in future capital budget applications. See five-year capital plan (2017 Capital Plan Tab, Appendix A).

Attachments:

See report entitled "Distribution Upgrades - 2017" located in Volume III, Tab 26, for further project details.

Project Title: Replace Power Transformers

Location: Oxen Pond

Category: Transmission and Rural Operations - Terminal Stations

Definition: Other

Classification: Normal

Project Description:

This proposal is for a two year project to replace Oxen Pond GT1. Design and procurement will take place in 2017 with installation and commissioning in 2018. The existing transformer will be removed from service and foundations will be refurbished if required. A transformer supplier will supply, install and commission the new transformer with support from internal labour.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	8.5	0.0	8.5
Labour	92.0	133.4	0.0	225.4
Consultant	25.7	10.7	0.0	36.4
Contract Work	160.0	415.2	0.0	575.2
Other Direct Costs	6.4	29.7	0.0	36.1
Interest and Escalation	13.4	76.3	0.0	89.7
Contingency	0.0	176.3	0.0	176.3
TOTAL	**297.5**	**850.1**	**0.0**	**1,147.6**

Operating Experience:

Hydro's transformer fleet is assessed for replacement based on two key indicators: (1) Degree of Polymerization (DP) value approaching 400, and (2) dissolved gas analysis (DGA).

Project Justification:

There is an immediate need to replace Oxen Pond GT1 as it has failed and station service is currently being provided by a Newfoundland Power feeder with a temporary diesel generator as backup. Oxen Pond GT1 is required to maintain a permanent, reliable station service supply.

Future Plans:

Future capital budgets will be proposed as per Hydro's long term power transformers replacement plan.

Attachments:

See report entitled "Replace Power Transformers" located in Volume III, Tab 27, for further project details.

Project Title: Replace Automation Equipment

Location: Mary's Harbour

Category: Transmission and Rural Operations - Generation Northern

Definition: Other

Classification: Normal

Project Description:

The scope of the work is to replace the four obsolete Programmable Logic Controllers (PLCs) in Mary's Harbour Diesel Plant with a modern controller and distributed input/output drops for the diesel units. This equipment will be fully supported by the supplier for spare parts and technical assistance. A new Human Machine Interface (HMI) using Tridehral VTScada software, which is the Hydro standard for diesel plants, will be installed and connected to the PLC communications network. The automation program for dispatch of the units to meet load demand will be installed and commissioned. The project will start in 2017 with the procurement of equipment and the preparation of engineering drawings. The installation and commissioning of the system will be done in 2018.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	47.6	10.0	0.0	57.6
Labour	60.2	464.4	0.0	524.6
Consultant	0.0	76.6	0.0	76.6
Contract Work	0.0	130.0	0.0	130.0
Other Direct Costs	6.5	88.2	0.0	94.7
Interest and Escalation	6.0	75.8	0.0	81.8
Contingency	0.0	176.7	0.0	176.7
TOTAL	**120.3**	**1,021.7**	**0.0**	**1,142.0**

Operating Experience:

The PLCs and HMI have been in service since 1992. They worked well for a number of years but are presently limited in their functionality. The automation program is not working due to the obsolescence of the hardware and software.

Presently, the HMI is only able to provide monitoring of the engine and discrete inputs and outputs. The automatic start/stop function for the units is not available.

Project Justification:

The existing Schneider Electric Compact 984 PLCs installed in Mary's Harbour Diesel Plant for control and monitoring of the units are obsolete. Schneider Electric has said that the commercial life for those PLCs ended in 2006 and service ended in 2014. The Compact 984 PLC has been replaced by the Schneider Electric model M340. This model uses Unity Pro software for control programming and it is not able to use the ProWorx 32 software running in the existing Compact 984 PLCs.

The existing HMI uses Schneider Electric Monitor Pro SCADA software. The version of software used in Mary's Harbour is no longer available and is not supported by the supplier. The HMI computer runs Windows 2003 and since the Monitor Pro is obsolete, operating system patches released for Windows 2003 were not integrated into the Monitor Pro software. The automation program utilizing the PLCs and HMI was installed at Mary's Harbour when the plant was built in 1992. The program will start generating units as required to meet the load demand and to remove units once the load decreases. This is done without operator intervention. The automation program is not presently working.

Future Plans:

None.

Attachments:

See report entitled “Replace Automation Equipment – Mary’s Harbor” located in Volume III, Tab 28, for further project details.

Project Title: Inspect Fuel Storage Tanks

Location: Various Sites

Category: Transmission and Rural Operations - Generation Labrador

Definition: Other

Classification: Normal

Project Description:

The purpose of this project is to complete detailed inspections of the above ground fuel storage tanks and associated fuel supply systems owned and operated by Hydro. Results from these inspections will be used to determine the necessary work that needs to be completed to ensure the tank is at operational standards, as well as plan for the replacement of those assets which are nearing the end of their service life.

The scope of work for this project involves the completion of internal tank inspections and, where applicable, the completion of routine upgrades identified during the inspection while the tank is empty. The tanks to be inspected under this proposal in 2017 include: three 314,000 liter, vertical fuel storage tanks and two 68,190 liter, single-wall horizontal fuel storage tanks at the Makkovik diesel plant. Hydro may inspect a higher priority tank should conditions change and defer a lower priority tank.

Routine upgrade costs have been included based on expected condition from similar tank inspections in the past. Where applicable, Hydro will complete the work necessary to enable the tanks to continue to perform as designed, ensuring that they are structurally sound, suitable for operation, and not at risk of releasing fuel into the environment.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	0.0	0.0	0.0
Labour	154.2	0.0	0.0	154.2
Consultant	75.0	0.0	0.0	75.0
Contract Work	595.0	0.0	0.0	595.0
Other Direct Costs	13.8	0.0	0.0	13.8
Interest and Escalation	53.2	0.0	0.0	53.2
Contingency	167.6	0.0	0.0	167.6
TOTAL	**1,058.8**	**0.0**	**0.0**	**1,058.8**

Operating Experience:

The fuel storage tanks serve as a fuel supply for the plant's diesel generation units. These tanks are critical to ensuring the continued supply of reliable power to the community of Makkovik.

Project Justification:

To maximize the service life of its assets and adhering to its Environmental Policy and Guiding Principles, Hydro has formalized its tank inspections into a coordinated program.

Hydro must ensure that its fuel storage tanks are maintained in a safe, reliable operating condition. Tank inspections serve to identify necessary maintenance and repair items, as well as forecast the remaining service life. These inspections are necessary to ensure that the tanks continue to perform as designed, ensuring that they are structurally sound, suitable for operation, and not at risk of releasing fuel into the environment.

Future Plans:

Future plans will see the continuation of the multi-year tank inspection program.

Attachments:

See report entitled "Inspect Fuel Storage tanks" located in Volume III, Tab 29, for further project details.

Project Title: In-Service Failures

Location: Various Sites

Category: Transmission and Rural Operations - Terminal Stations

Definition: Pooled

Classification: Normal

Project Description:

Hydro conducts its asset management activities to proactively identify, replace, repair, or refurbish equipment to minimize the disruption of service and to avoid unsafe working conditions due to equipment failure. An objective of Hydro's Asset Management Program is to identify refurbishment and replacement activities which require Board approval early enough to include in a Capital Budget Application. The identification is done through the terminals station preventative maintenance program using various condition based assessments testing procedures. Hydro has had success in projecting the deterioration rate of equipment so as to submit refurbishment or replacement work in Capital Budget Applications. However, there are situations were immediate refurbishment or replacement has to be undertaken due to actual failures or the recognition of an incipient failure, as well as faster than anticipated equipment deterioration. These situations can be caused by events such as vandalism, storm damage, lightning, accidental damage, abnormal electrical system operations, corrosion, etc.

Similar to Newfoundland Power's In-Service Failures Project, Hydro will use a stand-by pool of equipment, and undertake the timely refurbishment and replacement work required to maintain the integrity and reliability of the electrical system. These activities will be undertaken in accordance with the philosophies outlined throughout the *Terminal Station Asset Management Overview* document. Hydro uses historical data and engineering judgement to predict the magnitude of in-service failures. Under this project, Hydro anticipates the following equipment will be required to address failures or to maintain appropriate equipment levels in the stand-by pool:

- One 230 kV Circuit Breaker;
- One 138 kV Circuit Breaker;
- One 69 kV Circuit Breaker;
- Two 230 kV High-Voltage Switches;
- Two 138 kV High-Voltage Switches; and

- Two 69 kV High-Voltage Switches.

Hydro's estimated project cost of the Terminal Stations In-Service Failures project is outlined in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	649.7	0.0	0.0	649.7
Labour	258.0	0.0	0.0	258.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	36.0	0.0	0.0	36.0
Interest and Escalation	56.3	0.0	0.0	56.3
Contingency	0.0	0.0	0.0	0.0
TOTAL	**1,000.0**	**0.0**	**0.0**	**1,000.0**

Operating Experience:

On an electrical system like that of Hydro's, in-service failures are inevitable occurrences. For example, in the past year, Hydro has experienced the following in-service failures:

- One 69 kV Circuit Breaker;
- One 138 kV Circuit Breaker;
- Two High-Voltage Switches;
- 12 Instrument Transformers; and
- Three Surge Arrestors.

This program will allow Hydro to address failures without impacting planned sustaining projects in terminal stations.

Project Justification:

The failure of terminal station equipment, if not addressed in a timely manner, affects the robustness of the electrical system. This project provides the resources to address such failures promptly, to minimize impacts to Hydro's electrical system.

Future Plans:

This project will be proposed annually. With each annual submission, Hydro will include a concise summary of activities completed under the *Terminal Station In-Service Failures* project in the previous year.

Project Title: Replace Vehicles and Aerial Devices

Location: Various Sites

Category: General Properties - Transportation

Definition: Other

Classification: Normal

Project Description:

This project proposes the replacement of 36 light-duty vehicles and ten heavy-duty vehicles in accordance with the established replacement criteria for vehicle age and kilometers (km) as follows in Table 1.

Table 1: Replacement Criteria - Hydro

Hydro	
Light-duty vehicles	5-7 years or > 150,000 km and Condition/Maintenance Cost
Heavy-duty vehicles:	
- Class 4, 5 and 6	6-8 years or > 200,000 km and Condition/Maintenance Cost
- Class 7 and 8	7-9 years or > 200,000 km and Condition/Maintenance Cost

Table 2: Replacement Criteria - Other Utilities

Utility #1	
Light-duty vehicles	5 years or 200,000 km
Heavy-duty vehicles:	8 years or 300,000 km
Utility #2	
Light-duty vehicles	5-6 years or 200,000 km
Heavy-duty vehicles:	
- Class 3, 4, 5 and 6	8 years or 300,000 km
- Class 7 and 8	10 years or 300,000 km
Utility #3	
Light-duty vehicles	5 years or 150,000 km
Heavy-duty vehicles	10 years or 250,000 km

All vehicles that meet the criteria are being replaced. In addition, one light duty vehicle was added to the list because it met the replacement criteria.

The budget estimate for this project is shown in Table 3.

Table 3: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	1,935.0	270.0	0.0	2,205.0
Labour	5.5	1.0	0.0	6.5
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	4.0	0.0	0.0	4.0
Interest and Escalation	56.9	17.0	0.0	73.9
Contingency	0.0	110.8	0.0	110.8
TOTAL	**2,001.4**	**398.8**	**0.0**	**2,400.2**

Operating Experience:

Hydro's transportation section maintains a close liaison with other utilities across Canada and has established the replacement criteria based on industry standards and Hydro's operating experience. Extension of the service life of a vehicle beyond the replacement criteria result in increased operating and maintenance costs.

Project Justification:

Hydro operates in many diverse locations across the Province and it is critical to the provision of economical and reliable electricity that employees are provided with safe and reliable vehicles.

Future Plans:

Future replacement of vehicles and aerial devices will be proposed in future Capital Budget Applications.

Attachments:

See report entitled "Replace Vehicles and Aerial Devices" located in Volume III, Tab 30 for further project details.

Project Title: Replace Battery Banks and Chargers

Location: Various Sites

Category: Transmission and Rural Operations - Transmission

Definition: Other

Classification: Normal

Project Description:

This project is part of Hydro's ongoing program to replace stationary batteries and chargers at generating sites, terminal stations and telecommunications microwave sites. These batteries are the source of power for telecommunications and protection and control equipment during the loss of station service. The batteries are either a direct current (DC) power source and thus require a charging system that converts alternating current (AC) to direct current, or Uninterruptible Power Supply (UPS) batteries that also convert back to AC.

In addition Hydro has identified that the UPS at Ramea plant requires replacement due to internal failure of two of the five power module bays.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	191.7	192.6	0.0	384.3
Labour	119.2	119.7	0.0	238.8
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	47.8	46.5	0.0	94.4
Interest and Escalation	20.6	63.9	0.0	0.0
Contingency	0.0	143.5	0.0	143.5
TOTAL	**379.3**	**566.2**	**0.0**	**945.5**

Operating Experience:

Hydro generally inspects its batteries semi-annually but more often as needed depending on age and condition. From these inspections and testing, Hydro determines which banks need to be replaced. The rate of battery deterioration increases with age and reaches a point where they are unable to provide the required power level to operate equipment in the event of an outage.

Project Justification:

When the capacity of a battery falls to 80% of its rated capacity it has to be replaced as recommended by IEEE standards 450 and 1188. The batteries to be replaced are near the end of their useful lives when they have deteriorated to the 80% capacity level. Batteries have to be replaced before total failure occurs to ensure continued reliable operation.

The UPS at Ramea plant is malfunctioning and requires early replacement to ensure reliability of the electrical system on Ramea Island.

Future Plans:

Replacement of battery banks and chargers will be proposed in future Capital Budget Applications.

Attachments:

See report entitled “Replace Battery Banks and Chargers” located in Volume III, Tab 31, for further project details.

Project Title: Replace Roof

Location: Hydro Place

Category: General Properties - Administrative

Definition: Other

Classification: Normal

Project Description:

This project comprises the final year of a three year program for the completion of roof upgrades at Hydro Place. Upgrades include the supply and installation of a new, mechanically fastened roofing system and the installation of fall protection roof anchors. The level 2 roof area will be upgraded in 2017. The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	0.0	0.0	0.0
Labour	116.6	0.0	0.0	116.6
Consultant	20.0	0.0	0.0	20.0
Contract Work	605.0	0.0	0.0	605.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	33.5	0.0	0.0	33.5
Contingency	148.3	0.0	0.0	148.3
TOTAL	**923.4**	**0.0**	**0.0**	**923.4**

Operating Experience:

Hydro Place serves as the main headquarters for the Hydro group of Companies. It provides office space for approximately 500 employees, and houses Hydro's Energy Control Center, which allows System Operators to monitor, at a glance, how much power is being generated throughout the system, voltage conditions across the system and the status of virtually all equipment on the main power grid. This allows for the optimization of system performance and reliability. It is occupied year round.

Project Justification:

A condition assessment, completed by BAE-Newplan Group Limited in 2009, noted that the existing roofing system was nearing the end of its service life and its replacement was recommended. In an effort to prolong the requirement for a complete roof replacement, Hydro has closely monitored the roofs condition, particularly during the spring thaw when snow melt and rainfall combine to generate an influx of water. Numerous repairs have been enacted to remedy noted leaks; however, the repairs are often short lived - in some instances the leaks have reoccurred and/or new leaks have formed at different locations.

Given the roofing system's age, the formation leaks will continue to pose a problem to building maintenance personnel and occupants alike. If left unaddressed these leaks may impact the use of the building and result in deterioration and mold growth.

The replacement of the roof must be completed to mitigate this risk and to provide a new roofing system capable of providing maintenance free protection for the next 20 years.

Future Plans:

This project concludes the three year roof replacement program for Hydro Place. There are no future plans.

Attachments:

See report entitled "Replace Roof, Hydro Place" located in Volume III, Tab 32, for further project details.

Project Title: Upgrade Telecontrol Facilities

Location: Mary March Hill and Blue Grass Hill

Category: General Properties - Telecontrol

Definition: Other

Classification: Normal

Project Description:

This project includes the following:

- Refurbishment of the microwave shelter at MMH including replacement of siding, insulation, ice shield roofing, front porch, refurbishment of concrete foundations and damaged grounding wire, installation of two new foundations and installation of a new porch.
- Refurbishment of the microwave shelter at BGH including replacement of siding, insulation, ice shield roofing, front porch, refurbishment of concrete foundations, installation of two new foundations, installation of a new porch and installation of a new ice protection shelter for the existing propane tanks.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	0.0	0.0	0.0
Labour	68.0	105.1	0.0	173.1
Consultant	0.0	0.0	0.0	0.0
Contract Work	12.0	360.0	0.0	372.0
Other Direct Costs	5.4	28.6	0.0	34.0
Interest and Escalation	5.8	56.4	0.0	62.2
Contingency	0.0	115.8	0.0	115.8
TOTAL	**91.2**	**665.9**	**0.0**	**757.1**

Operating Experience:

The Mary March Hill and Blue Grass Hill communications sites are microwave hubs on the communications and SCADA control system for Hydro.

Each microwave shelter protects critical communications equipment from water, ice and wind damage which ensures uninterrupted communications between ECC and Hydro's facilities around the island. Both shelters show signs of deterioration of the external components, namely siding, foundations and roof. The typical life expectancy of siding and roofing is 15 to 20 years and these components on both microwave shelters are now 35 to 40 years old and require significant upgrades to ensure the shelters continue to resist leaking and settlement; both of which can cause damage to the equipment inside.

Project Justification:

The microwave shelter refurbishment project is justified on the requirement to upgrade aged and deteriorated infrastructure in order for Hydro to provide safe, least-cost, reliable electrical service.

Future Plans:

Other similar sites are planned for refurbishment over the next four years.

Attachments:

See report entitled "Upgrade Telecontrol Facilities" located in Volume III, Tab 33, for further project details.

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Page Ref
			($000)		
GENERATION					
Upgrade Public Safety Around Dams and Waterways - Bay d'Espoir		489.0		489.0	D-2
Purchase Capital Spares - Hydraulic		487.4		487.4	D-27
Overhaul Turbine/Generators - Bay d'Espoir and Cat Arm		476.2		476.2	D-31
Replace Slip Rings Units 1-6 - Bay d'Espoir		312.6	159.7	472.3	D-39
Replace Powerhouse 1 Station Service Transformer - Bay d'Espoir	46.7	354.5		401.2	
Replace Spherical By-Pass Valves Units 1 and 2 - Bay d'Espoir	183.6	167.9		351.5	
Purchase Capital Spares - Holyrood		321.5		321.5	D-43
Replace Fuel Piping - Hardwoods and Stephenville	44.8	267.0		311.8	
Refurbish Sump Level System for Powerhouse 2 - Bay d'Espoir		38.7	264.5	303.2	D-46
Refurbish Station Water System - Upper Salmon	96.6	197.6		294.2	
Refurbish Main Generator Breaker - Upper Salmon		271.1		271.1	D-65
TOTAL GENERATION	371.7	3,383.5	424.2	4,179.4	
TRANSMISSION AND RURAL OPERATIONS					
Purchase Capital Spares - Terminal Stations		495.8		495.8	D-92
Upgrade Terminal Station for Mobile Substation - Cow Head	40.0	444.7		484.7	
Install Recloser Remote Control - Bottom Waters		47.1	418.6	465.7	D-94
Replace Human Machine Interface - Various Sites	114.0	320.0		434.0	
Replace Insulators - TL227		145.6	271.3	416.9	D-98
Upgrade Aluminum Support Structures - Holyrood		352.9		352.9	D-106
Upgrade Data Alarm Systems - Stony Brook	74.4	234.1		308.5	
Install Breaker Failure Protection - Various Sites	65.7	211.3		277.0	
Replace Light Duty Mobile Equipment - Various Sites		270.9		270.9	D-162
TOTAL TRANSMISSION AND RURAL OPERATIONS	294.1	2,522.4	689.9	3,506.4	
GENERAL PROPERTIES					
Upgrade Energy Management System - Hydro Place		427.0		427.0	D-168
Replace Personal Computers - Hydro Place		401.4		401.4	D-172
Replace Air Conditioning Units 8 and 14 - Hydro Place	34.6	229.5		264.1	
TOTAL GENERAL PROPERTIES	34.6	1,057.9	0.00	1,092.5	
TOTAL PROJECTS OVER $200,000 AND UNDER $500,000	700.4	6,963.8	1,114.1	8,778.3	

Project Title: Upgrade Public Safety Around Dams and Waterways

Location: Bay d'Espoir

Category: Generation - Hydraulic

Type: Pooled

Classification: Normal

Project Description:

This project is a continuation of a program that started in 2011. It is required to comply with the Canadian Dam Association Guidelines pertaining to public safety around dams and associated waterways. The guidelines apply to appropriate signage, alarms, warnings, buoys, waterway booms and public awareness as a result of public interaction around dams and waterways. The Canadian Dam Association recognized a need for guidelines pertaining to public safety around dams so that dam owners could meet their responsibilities to protect the public as a result of increased public interaction around dams. This increased presence by the public has led to incidents at dams, the most notable occurring at an Ontario Power Generation Facility in 2002 in which two people drowned and seven more were injured during release of water from one of their reservoirs.

The work plan is dictated by a phased approach to risk treatment. The plan is as follows:

2016 - Purchase and install Phase II control improvements on the Granite Reservoir System structures that were identified in the 2013 risk assessment.

2016 - Conduct Public Safety Risk Assessment of structures on the Cat Arm Reservoir System.

2017 - Purchase and install Phase III control improvements on the Granite Reservoir System structures that were identified in the 2013 risk assessment.

2017 - Purchase and install Phase I control improvements on the Burnt Pond and Victoria Reservoirs structures that were identified in the 2015 risk assessment.

2017 - Conduct Public Safety Risk Assessment of structures on the Upper Salmon Reservoir System.

Typical control improvements are as follows:

- Public education;
- Operational control measures;
- Effective signage;
- Spillway emergency signals;
- Fencing;
- Buoys; and
- Safety Booms.

Of those mentioned above, lower cost control improvements include effective signage and fencing, whereas control improvements such as buoys and safety booms would fall under the category of higher cost control improvements.

A Public Safety Risk Assessment of the Burnt Pond and Victoria Reservoir Systems was completed in 2015. Coming out of this risk assessment a Public Safety Measures Plan was prepared and issued, outlining the required control measures and an associated cost estimate to supply and install these control measures. The order-of-magnitude cost estimate provided for budgetary purposes was $500,000 - $650,000. These control measures will be implemented over two years. The Public Safety Measures Plan included a number of recommendations that are attached as Appendix A.

The budget estimate is for year three of the Granite Reservoir System improvements and for year one of a two year project for the Burnt Dam and Victoria Reservoir Systems improvements as shown in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	105.0	0.0	0.0	105.0
Labour	197.0	0.0	0.0	197.0
Consultant	90.0	0.0	0.0	90.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	31.0	0.0	0.0	31.0
Interest and Escalation	23.7	0.0	0.0	23.7
Contingency	42.3	0.0	0.0	42.3
TOTAL	**489.0**	**0.0**	**0.0**	**489.0**

Introduction:

The Canadian Dam Association (CDA) is recognized as the Leading authority in Canada when it comes to dam safety issues. They published the Canadian Dam Safety Guidelines in 2007 dealing with the safe operation, surveillance and maintenance of dams. Utilities across Canada have adopted these CDA guidelines, in the absence of Provincial Regulations, to manage their Dam Safety Programs. These guidelines address the various hazards which can lead to failure of a dam and present methods for management of those risks.

A new CDA guideline entitled "Guidelines for Public Safety Around Dams" was released in 2011. (Refer to a similar 2015 submission on Upgrading Public Safety Around Dams and Waterways). The document provides guidance for dam owners to meet their responsibilities to protect the public. Guidance in this matter is needed for the following reasons:

- Increased public interaction;
- Perceived right of the public to access sites;
- Increased public interest in extreme sports;
- Improved access by use of recreational vehicles;
- Public unawareness of the hazards;
- Remote operation of dams and Hydro stations; and
- Occurrence of fatalities and serious injuries.

These guidelines address the risk of accidents or incidents in which a member of the public encounters a hazard created by the presence or operation of a dam.

Justification:

Dam owners are responsible for assessing and managing the risks to the public caused by the presence and operation of a dam. The first principle of the CDA guidelines identifies this responsibility. It states "*The dam owner is responsible for managing the public safety risks caused by a dam, as far upstream and downstream as the owner has property rights. Beyond this property, the dam owner may have additional responsibility to assess locations where the hazards are known by the owner to result directly from the dam or its operations and to inform the public and other affected property owners of these hazards".*

Accidental deaths have occurred around dams and associated structures in North America. The cause of these deaths is often an unawareness of the hazards in the area. Hydro does not have any documented cases of near misses or incidents on its systems; however, Hydro has a due diligence obligation to offer protection to the general public from potential hazards around dams and waterways. Therefore, Hydro needs to proceed with a managed system to make people more aware of the hazards around dams but to also protect them from those hazards when they interact with dams and waterways.

Operating Experience:

Hydro currently operates more than 100 dams, dykes and hydraulic structures on the island of Newfoundland. During the 2015 Public Safety Audit of the Burnt Pond and Victoria Reservoir structures, gaps were identified at the dams, and flow control structures, in the form of inadequate control measures warning the public of potential safety hazards. The accepted standard for proper control measures has evolved in light of incidents experienced over the past ten years at other utilities. As such, the original design of the Bay d'Espoir system did not address these measures.

This Public Safety Audit was a continuation of the program started by Hydro in 2011 to look more closely at existing control measures that are in place. The Burnt Pond and Victoria Reservoirs could be considered remote but are accessed by fishermen, hunters and other occasional users. The risk assessment completed in 2015 identified the lack of appropriate signage, alarms and/or warning systems that alert the public to potential safety hazards and further identified the need for control measures at dams and structures on the Burnt Pond and Victoria Reservoirs.

<u>Industry Experience</u>

As noted earlier, in 2002, downstream of an Ontario Power Generation facility, seven people sustained injuries and two people drowned during release of water from a reservoir. As a result of this, Ontario Power Generation started a comprehensive program addressing the safety of the public around their hydroelectric facilities. Additional research by Ontario Power Generation has identified more than 300 incidents associated with fatalities, injuries or rescues at dams throughout North America since 2003. As a result of these fatalities, larger utilities have taken an active role in assessing hazards at their hydroelectric facilities and installing control measures to either mitigate or eliminate identified hazards.

Safety Performance

This project is being done to protect the public from hazards associated with the normal operation of hydroelectric facilities including dams and waterways. There are inherent hazards around these facilities such as fast moving water, remotely operated gates and extreme changes in water levels of which the public may be unaware. This project will help educate and thus protect the public from those hazards.

Legislative and Regulatory Requirements

Although there are no specific legislative or regulatory requirements, Hydro follows the industry accepted CDA guidelines.

Status Quo

The only control measures that Hydro has in place to alert the public of hazards are some signs that are inconsistent in the messaging and sizing as well as others with faded out or words that are worn off. Not all sites have signage and where there are signs they lack sufficient visibility due to their size and do not conform to the CDA guidelines. In addition, some water control structures and spillways have audible alarms. There are no larger control measures such as buoys and booms in place. Fencing upgrades and additions are also required.

Historical Information

Similar project costs that have been incurred to date are included in Table 2 below.

Table 2: Historical Information

Year	Capital Budget ($000)	Actual Expenditures ($000)	Comments
2016B	489.0		On-going
2015	483.9	468.7	
2014	352.8	246.7	
2013	298.1	340.6	
2012	48.3	50.1	

Conclusion:

Hydro has been following the CDA "Dam Safety Guidelines" pertaining to dam safety for more than ten years as part of an overall dam safety program and have also made a decision to follow the new CDA guideline entitled, "Guidelines for Public Safety Around Dams", dealing with public safety around dams, which was released in 2011.

Incidents involving the public have occurred at hydroelectric facilities throughout North America. This is a concern for utilities and as a result, utilities have accepted the responsibility to protect the public by making them aware of hazards around dams, waterways and hydroelectric facilities. Hydro recognizes this trend in the industry and is putting a program in place that addresses those responsibilities.

By following the CDA guidelines, Hydro is taking a proactive approach to ensure that the public are aware of hazards around hydroelectric facilities and to install protection from those hazards. Hydro plans to undertake risk assessments of hazards around hydroelectric facilities, rank the hazards in order of significance, evaluate the need for control measures, such as signage, fencing, alarms, buoys and/or safety booms and install control measures. This project is a continuation of that effort started in 2011. The risk assessment done at the Burnt Pond and Victoria Reservoir Systems was a continuation of a program that started in 2011 and will be continuing for the next several years and the 2017 program continues with the implementation of significant control measures at the Burnt Pond and Victoria Reservoir Systems.

Project Schedule:

The anticipated project schedule is shown in Table 3.

Table 3: Project Schedule

Activity		Start Date	End Date
Planning	Open Project File	March 2017	March 2017
Design	Finalize sign requirements	April 2017	April 2017
Procurement	Purchase Materials for Control Measures	May 2017	June 2017
Construction	Install Control Measures	June 2017	September 2017
Closeout	Finalize Payments and prepare closeout documentation	October 2017	November 2017

Future Plans:

Hydro plans to continue with this program on an annual basis by installing necessary control measures identified in specific risk assessments. This will continue for all risks identified at a particular site by addressing the most appropriate means of mitigating the risk, either by reducing the likelihood of the hazard and or by reducing the consequence. Risk levels will be addressed on a priority basis from high to medium to low.

An Asset Management Strategy Report is attached in Appendix B outlining Hydro's plans for identifying hazards at their various facilities through on-going risk assessments and procurement and installation of appropriate control measures to either warn the public of the hazard or to prevent exposure of the public to the hazard.

APPENDIX A

Risk Assessment

Recommendations

Location	Activity	Current Risk Rating Level	Recommended Risk Treatments	Anticipated Risk Rating
Victoria Reservoir	Boating under power	Low (6)	Install appropriately messaged and sized red Danger signage at all known access locations to Victoria Reservoir.	Low (6)
Victoria Reservoir	Snowmobiling	High (15)	Install appropriately messaged and sized red Danger signage at all known access locations to Victoria Reservoir.	High (15)
Burnt Reservoir	Snowmobiling	High (15)	Install appropriately messaged and sized red Danger signage at all known access locations to Burnt Reservoir.	High (15)
Burnt Canal	Fishing from Shore	Medium (8)	Install appropriately messaged and sized red Danger signage at intermittent locations along the dyke	Medium (8)
VD-1, VD-2, VD-5 and VD-6	Camping	Medium (8)	It is recommended that fencing be installed along the VD-1S access road to prevent members of the public from accessing the structures by vehicle or on foot. Appropriately messaged and sized signage should be installed on the fence.	Low (4)
VD-1, VD-2, VD-5 and VD-6	ATVing	Medium (8)	It is recommended that fencing be installed along the VD-1S access road to prevent members of the public from accessing the structures by vehicle or on foot. Appropriately messaged and sized signage should be installed on the fence.	Low (4)
VD-1, VD-2, VD-5 and VD-6	Driving	Medium (12)	It is recommended that fencing be installed along the VD-1S access road to prevent members of the public from accessing the structures by vehicle or on foot. Appropriately messaged and sized signage should be installed on the fence.	Low (6)
VD-1, VD-2, VD-5 and VD-6	Hunting	Medium (8)	It is recommended that fencing be installed along the VD-1S access road to prevent members of the public from accessing the structures by vehicle or on foot. Appropriately messaged and sized signage should be installed on the fence.	Low (4)
VD-3, VD-4A and VD-4B	Camping	Medium (8)	It is recommended that fencing be installed at the west end of VD-3 to prevent members of the public from accessing the structures by vehicle or on foot. Appropriately messaged and sized signage should be installed on the fence.	Low (4)
VD-3, VD-4A and VD-4B	ATVing	Medium (12)	It is recommended that fencing be installed at the west end of VD-3 to prevent members of the public from accessing the structures by vehicle or on foot. Appropriately messaged and sized signage should be installed on the fence.	Low (6)

VD-3, VD-4A and VD-4B	Driving	High (20)	It is recommended that fencing be installed at the west end of VD-3 to prevent members of the public from accessing the structures by vehicle or on foot. Appropriately messaged and sized signage should be installed on the fence.	Medium (10)
VD-3, VD-4A and VD-4B	Campfires	Medium (8)	It is recommended that fencing be installed at the west end of VD-3 to prevent members of the public from accessing the structures by vehicle or on foot. Appropriately messaged and sized signage should be installed on the fence.	Low (4)
MD-11	ATVing	Medium (12)	It is recommended that existing fencing be modified and new fencing be installed to prevent access to the structure. Appropriately messaged and sized signage should be installed on the fence.	Low (6)
MD-11	Driving	High (20)	It is recommended that existing fencing be modified and new fencing be installed to prevent access to the structure. Appropriately messaged and sized signage should be installed on the fence.	Medium (10)
MD-11	Snowmobiling	Medium (12)	It is recommended that existing fencing be modified and new fencing be installed to prevent access to the structure. Appropriately messaged and sized signage should be installed on the fence.	Low (6)
MD-BC	ATVing	Medium (10)	It is recommended that appropriately messaged and sized signage be installed.	Medium (10)
MD-BC	Driving	High (15)	It is recommended that appropriately messaged and sized signage be installed.	High (15)
MD-BC	Hunting	Medium (10)	It is recommended that appropriately messaged and sized signage be installed.	Medium (10)
VD-1S (upstream)	Boating under power	High (15)	It is recommended that appropriately messaged and sized signage be installed. Additionally, it is recommended that existing operating procedures for the structure be modified.	Medium (5)
VD-1S (upstream)	Fishing from shore	Low (6)	It is recommended that appropriately messaged and sized signage be installed. Additionally, it is recommended that existing operating procedures for the structure be modified.	Low (2)
VD-1S	ATVing	High (20)	It is recommended that fencing be installed along the VD-1S access road to prevent members of the public from accessing the structures by vehicle or on foot. Appropriately messaged and sized signage should be installed on the fence.	Medium (10)

VD-1S	Driving	High (20)	It is recommended that fencing be installed along the VD-1S access road to prevent members of the public from accessing the structures by vehicle or on foot. Appropriately messaged and sized signage should be installed on the fence.	Medium (10)
VD-1S (downstream)	Fishing from shore	High (12)	It is recommended that appropriately messaged and sized signage be installed at the access paths to the downstream channel. Additionally, it is recommended that existing operating procedures for the structure be modified.	Low (6)
VD-4S	ATVing	High (20)	It is recommended that fencing be installed at the west end of VD-3 to prevent members of the public from accessing the structures by vehicle or on foot. Appropriately messaged and sized signage should be installed on the fence.	Medium (10)
VD-4S	Driving	High (20)	It is recommended that fencing be installed at the west end of VD-3 to prevent members of the public from accessing the structures by vehicle or on foot. Appropriately messaged and sized signage should be installed on the fence.	Medium (10)
MD-11S	ATVing	High (20)	It is recommended that existing fencing be modified and new fencing be installed to prevent access to the structure. Appropriately messaged and sized signage should be installed on the fence.	Medium (10)
MD-11S	Driving	High (20)	It is recommended that existing fencing be modified and new fencing be installed to prevent access to the structure. Appropriately messaged and sized signage should be installed on the fence.	Medium (10)
MD-11S	Snowmobiling	High (20)	It is recommended that existing fencing be modified and new fencing be installed to prevent access to the structure. Appropriately messaged and sized signage should be installed on the fence.	Medium (10)
Burnt Canal Weir (Headpond)	Fishing from shore	High (25)	It is recommended that fencing be installed along the south shoreline near Burnt Canal Weir and appropriately messaged and sized signage be installed. Additionally it is recommended that a safety boom be installed in the canal upstream of the weir and appropriately messaged and sized signage be installed at the location of the boom.	High (15)
Burnt Canal Weir	Fishing from shore	High (25)	It is recommended that fencing be installed along the south shoreline near Burnt Canal Weir and appropriately messaged and sized signage be installed.	High (15)

APPENDIX B

PUBLIC SAFETY AROUND DAMS

ASSET MANAGEMENT STRATEGY REPORT

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Appendix B – Public Safety Around Dams Project List

1.0 INTRODUCTION

This report outlines Hydro's responsibilities, as an Owner, for managing the public safety risks caused by the presence and operation of dams and associated hydraulic structures.

Keeping the public safe is one of the main reasons why the dam industry works hard to ensure structural integrity and prevent failures. However, an increasing number of incidents are giving cause for concern that non-structural hazards are also endangering lives at dam projects.

It is more common in most countries for people to die as a result of operational issues at dams than because of actual dam failures. It is no different in Canada or the United States as these statistics demonstrate. Dating from 1905, there have been only 11 fatalities in Canada as a result of 5 recorded dam failures – with the last being in 1966. In contrast, according to the Canadian Lifesaving Society, 27 people have drowned at dams across the country during the period from 1995 – 2004. During an even smaller time span from June 21 to July 8, 2013, 39 public safety incidents at North America dams which led to 23 fatalities were reported in the media.

These alarming figures have made public safety around dams an area of increasing importance for the dam industry. These incidences appear to be on the rise because the public is changing and there is an increase in public interaction at facilities. People are participating in more recreational and extreme sporting activities near dams. Previously, access to projects was difficult, but all-terrain vehicles and personal watercraft have made dams more accessible.

The potential risks associated with dams and hydro facilities are also often underestimated by the public. The sudden opening of spillways or start up of hydropower generation on a sunny day can turn relatively tranquil conditions into dangerous turbulent waters. This is not always obvious to the public, especially those unfamiliar with rivers and the operations. Problems can also be exacerbated as many dams are no longer managed and operated by on site personnel. More are remotely controlled.

All dams pose some level of risk to public safety, regardless of size or impoundment. Outlined below is a long term program for Hydro to identify and manage risk to the public associated with the operation of their numerous hydroelectric generating plants, hydraulic structures, dykes and dams. The report identifies the numerous assets owned by Hydro, introduces a management system to manage the risks associated with those structures and identifies some of the control measures that will have to be implemented to warn and protect the public against risks associated with the operation of hydroelectric plants and their associated hydraulic structures and dams.

To that end, Hydro is embarking on a program of identifying the hazards at its facilities to determine the appropriate control measures that can be put in place to either warn the public of the hazard or to remove the hazard.

2.0 BACKGROUND

2.1 Hydro's Hydroelectric Generating Stations

Hydro is the primary generator of power on the island of Newfoundland. The generating assets are varied and include nine hydroelectric plants, one oil-fired plant, four gas turbines and 25 diesel plants. The focus here will be on the nine hydroelectric generating plants.

These generating plants are located all over the island of Newfoundland and are comprised of multiple assets consisting of reservoir systems, powerhouses, intakes, spillways, control structures, dams and dykes.

The following outlines the totals of each:

Generating Stations	-	9
Reservoirs	-	21
Hydraulic Structures	-	44
Dams and Dykes	-	61

2.2 Canadian Dam Association Guidelines

The Canadian Dam Association (CDA) Dam Safety Guidelines were revised and published in 2007 to address the various hazards which can lead to failure of a dam and to present methods for management of those risks. However, as mentioned above, in Canada, more people have died in accidents around dam sites that are not associated with structural failure of dams but rather normal operational issues at dams. This is a matter of considerable concern to dam owners, who are seeking guidance on how they can meet their responsibilities to protect public safety.

As a result, in 2011, CDA published Guidelines for Public Safety Around Dams. These guidelines address the risks of accidents or incidents in which a member of the public encounters a hazard created by the presence or operation of a dam.

Hydro has been following the 2007 Dam Safety Guidelines when it comes to managing its Dam Safety Program and more recently made a decision to follow the 2011

Guidelines for Public Safety Around Dams. Hydro has formed an internal work group to ensure best practices with regard to a Public Safety Around Dams Program which includes the following:

- Develop and maintain the Corporate Public Safety Around Dams Program;
- Ensure the Public Safety Around Dams Program is consistent with industry best practice;
- Develop Public Safety Around Dams Standards that promotes consistency with regard to identification of hazards, risk assessment and implementation of control measures that help warn and protect the public.

3.0 PUBLIC SAFETY AROUND DAMS IMPLEMENTATION PLAN

Outlined below is a brief description of the many parts to implementation of a successful Public Safety Around Dams Program.

3.1 Risk Assessment

Risk assessment includes identification analysis and evaluation of risks. The assessment addresses the risk of a "public safety incident" which is defined as a potential or actual interaction between a member of the public and a hazard created as a direct result of the dams operation. In general, any analysis of the risk associated with public interaction at a dam involves the determination of:

- Exposure to hazards (number of people exposed to hazardous event);
- Likelihood of adverse consequences occurring if a person is exposed to the hazards;
- Consequences (outcome of the adverse event)

3.2 Risk Treatment

After the risks have been identified at a site, decisions can then be made related to the most appropriate means to mitigate the risk, either by reducing the likelihood or by reducing the consequence. Risk treatment and control can take the following forms:

- Eliminate the hazards where practical, as the most effective means of risk reduction;
- Mitigate the hazards where practical, for example by altering operations;
- Control the exposure to the hazards typically by installing physical control measures to warn or deter access by the public to hazardous zones;

- Educate the public of the hazards associated with the operation of dams and generating stations; and
- Prepare for emergency response, for example by providing 24/7 emergency contact numbers, or discuss plans for rescue with first responders.

3.3 Phased Approach

The risk assessment provides information needed to prioritize and implement control measures in a phased approach as outlined in Table 1 below.

Table 1 – Phased Approach to Risk Treatment

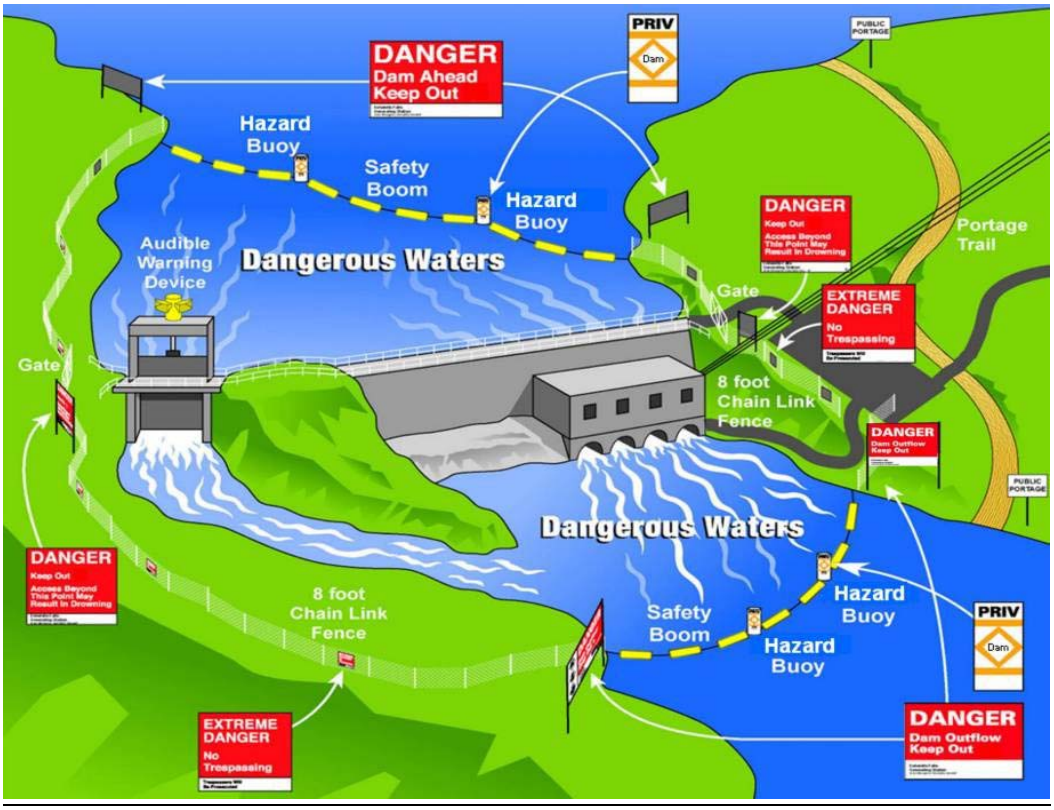
Phase	Control Measures for Risk Treatment
	• Public Education • Operational control measures • Effective signage • Spillway emergency signals • Buoys • Safety booms
	• Additional fencing, gates and barricades • Additional safety booms
	• Security patrols • Video surveillance

3.4 Physical Control Measures

Once it has been determined that it is not practical to eliminate the hazards, physical control measures should be considered, including such items as signage, booms, buoys, audible alarms , strobe lights, fencing and barricades.

An example of physical control measures that may be implemented at a facility following a risk assessment is shown in Figure 1 below.

Figure 1 – Example of Public Safety Control Measures at a Control Structure



4.0 APPROACH

Work started on this program in 2011 and continues today. To date four risk assessments have been completed and control measures have been put in place on two reservoir systems. The third reservoir system was started in 2015 and will continue in 2016. Additionally, estimated costs for implementation of control measures on the fourth reservoir system have been completed and this will form the basis of the 2017 budget proposal.

The program plan going forward is viewed as a 4 – 5 year rotating cycle, depending on the size of the reservoir system, as follows:

Year 1 – Reservoir Risk Assessment
Year 2 – Costs identified from risk assessment submitted for approval
Year 3 – Design and Procurement of Control Measures
Year 4 – Implementation of Phase 1 Control Measures
Year 5 – Implementation of Phase 2 Control Measures

With this template in place and the number of reservoirs and structures to be completed, as identified earlier in the report, the work is estimated to be complete by 2024. The proposed plan is included in Appendix A.

5.0 PUBLIC SAFETY AROUND DAMS CAPITAL BUDGET PRESENTATION

As indicated above, there has already been work done on three reservoirs, including Long Pond, Meelpaeg and Granite. Each of the reservoirs had risk assessments completed and control measures have been installed on the Long Pond and Meelpaeg reservoir systems. In addition, control measures have been started on the Granite Reservoir System. In 2017, the majority of the costs identified in the capital program will be associated with costs for the Burnt Pond and Victoria Reservoir System. These were identified during a risk assessment in 2015. During the risk assessment that was completed in 2015. 2017 will include year three of the three year Granite Reservoir Program and year one of the two year program identified for Burnt Pond and Victoria Reservoir Systems. This involves procurement and installation of fencing and signs identified in the 2015 risk assessment, as well cost associated with conducting a risk assessment of the Upper Salmon Reservoir System. (See Appendix A).

The budget estimate for this project is shown in Table 2.

Table 2: 2017 Budget Estimate

Project Cost:*($ x1,000)*	2017	2018	Beyond	Total
Material Supply	105.0	0.0	0.0	105.0
Labour	197.0	0.0	0.0	197.0
Consultant	90.0	0.0	0.0	90.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	31.0	0.0	0.0	31.0
IDC and Escalation	23.7	0.0		23.7
Contingency	42.3	0.0	0.0	42.3
TOTAL	**489.0**	**0.0**	**0.0**	**489.0**

APPENDIX A

PUBLIC SAFETY AROUND DAMS PROJECTED SCHEDULE

	YEAR	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
RESERVOIR											
GRANITE		Year 1 Implementation	Year 2 Implementation	Year 3 Implementation							
BURNT/VICTORIA		Risk Assessment	Cost Estimates	Year 1 Implementation	Year 2 Implementation						
CAT ARM			Risk Assessment	Cost Estimates	Year 1 Implementation	Year 2 Implementation					
UPPER SALMON				Risk Assessment	Cost Estimates	Year 1 Implementation	Year 2 Implementation	Year 3 Implementation			
HINDS LAKE					Risk Assessment	Cost Estimates	Year 1 Implementation	Year 2 Implementation	Year 3 Implementation		
PARADISE RIVER						Risk Assessment	Cost Estimates	Year 1 Implementation	Year 2 Implementation		
SNOOK'S ARM & VENAM'S BIGHT							Risk Assessment	Cost Estimates	Year 1 Implementation	Year 2 Implementation	

APPENDIX B

Location	Description	Comment
Meelpaeg		
Ebbegunbaeg	Fencing Signage Boom – anchor design, purchase and install	Completed in 2015
Pudops	Signage	Completed in 2015
Grey River	Fencing Signage Purchase and install buoys	Completed in 2014

Location	Description	Comment
Granite		
Granite Canal Development and Granite Reservoir	Signage Fencing, railings and guiderails Boom –anchor design, purchase and install	Started in 2015 Planned for 2016 Planned for 2017
Burnt & Victoria		
Burnt & Victoria Structures	Risk Assessment	Completed in 2015

Location	Description	Comment
Burnt & Victoria		
Burnt Structures	Fencing	Planned for 2017
	Signage	Planned for 2017 and 2018
	Booms and/or buoys	Planned for 2018
Victoria Structures	Fencing	Planned for 2017
	Signage	Planned for 2017 and 2018
Cat Arm		
Cat Arm Structures	Risk Assessment	Planned for 2016
	Signage	Future projects
	Fencing	Future projects
	Booms and/or buoys	Future projects
Upper Salmon		
Upper Salmon Structures	Risk Assessment	Future projects
	Signage	Future projects
	Fencing	Future projects
	Booms and/or buoys	Future projects
Hinds Lake		
Hinds Lake Structures	Risk Assessment	Future projects
	Signage	Future projects
	Fencing	Future projects
	Booms and/or buoys	Future projects
Paradise River		
Paradise River Structures	Risk Assessment	Future projects
	Signage	Future projects
	Fencing	Future projects
	Booms and/or buoys	Future projects
Snook's Arm and Venam's Bight		
Snook's Arm and Venam's Bight Structures	Risk Assessment	Future projects
	Signage	Future projects
	Fencing	Future projects
	Booms and/or buoys	Future projects

Roddickton		
Roddickton Structure	Risk Assessment Signage Fencing Booms and/or buoys	Future projects Future projects Future projects Future projects

Project Title: Purchase Capital Spares – Hydraulic

Location: Various Sites

Category: Generation - Hydraulic

Definition: Other

Classification: Normal

Project Description:

To date, Hydro has identified critical items that, when purchased and located at the generating facilities, will shorten forced generation outages in the event of a failure of the existing component. The components in this proposal were identified as critical if they met certain factors: impact on generating capacity, lead time for delivery, operating condition of in-service components and previous experience of failed components.

The capital spares that have been identified for Hydro's hydraulic generating facilities are:

- High Pressure Compressor, All Sites;
- Excitation Transformer, Bay d'Espoir Unit 7;
- Excitation Transformer, Hinds Lake; and
- Slip Rings, Hinds Lake.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	365.0	0.0	0.0	365.0
Labour	16.6	0.0	0.0	16.6
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	29.5	0.0	0.0	29.5
Contingency	76.3	0.0	0.0	76.3
TOTAL	**487.4**	**0.0**	**0.0**	**487.4**

Justification:

High Pressure Compressor, All Sites

The high pressure air system and the equipment it controls (governor, air blast breakers) is critical to the operation and reliability of a generating station. This air pressure is produced by two high pressure reciprocating compressors that are used in a lead-lag circuit. Long run times and lowered outputs on these compressors are being experienced due to the age and condition of the compressors. The reliability of compressed air system must be maintained as at peak air demand times all compressors are required. In the event of a failure of one of the compressors a spare would allow Hydro to limit outage times. The removed or failed compressor could then be rebuilt and placed in inventory as a spare. The typical lead time to receive a high pressure compressor is 12 weeks after the order is placed.

Excitation Transformer, Bay d'Espoir Unit 7

This excitation transformer is a part of the excitation system used to convert generator terminal voltage to a lower voltage that is used to supply the rectifier. Failure of this transformer will ultimately cause a failure of the unit. Without this transformer, Hydro is unable to generate power with unit 7. This unit, rated at 154 MW, is the largest hydro-electric generator on the island. Due to the secondary voltage being 550 volts, this transformer is a long lead item (typically 16 weeks) that will have to be fabricated by the supplier/manufacturer upon purchase. Hydro experienced a failure on unit 6 in Bay d'Espoir in winter 2014 and experienced a loss of 85MW for 6 months which negatively impacted Hydro's ability to supply reliable power during winter a critical period.

Excitation Transformer, Hinds Lake

Similar to Unit 7, this excitation transformer is a part of the excitation system used to convert generator terminal voltage to a lower voltage that is used to supply the rectifier, and failure of this transformer will ultimately cause a failure of the unit. Without this transformer Hydro will not be able to generate power with the Hinds Lake unit, a critical unit for Hydro's ability to supply reliable power. Due to the secondary voltage being 550 volts, this transformer is also a long lead item (typically 16 weeks) that will have to be fabricated by the supplier/manufacturer when purchased.

Slip Rings, Hinds Lake

The purpose of the slip ring is to allow the excitation DC current to reach the rotor. Carbon brushes slide against the slip ring as the rotor rotates, and the excitation current passes from the brush to the ring. These rotating rings have been replaced on all NL Hydro's generators except for Hinds Lake.

Wear on the slip ring is caused by a constant rotation of the ring while spring loaded carbon brushes press against the face of the slip ring. Operating these units with worn slip rings will result in increased maintenance costs and a higher potential for both forced and unplanned maintenance outages. When the slip ring is worn, increased wear on the carbon brushes is experienced. The carbon dust, generated from this wear is drawn into the unit and has the potential to create shorts to ground (tracking) in the electrical system. The removal of this carbon dust can only be accomplished by dismantling major components on the unit to perform manual cleaning. This cleaning activity is costly and time consuming. To provide reliable least cost power from Hinds Lake generating station, this critical spare part is required due to the long lead time (typically 24 weeks) to fabricate and deliver this part. Hydro currently does not have a spare slip ring in stock for this unit.

Conclusion:

This critical spare equipment will facilitate an expedited return to service should a facility experience an outage due to the failure of an in-service critical asset. Critical spares are identified during ongoing critical spares evaluations undertaken by Hydro and requested annually. It is the intention of Hydro to purchase these critical spares and have them on site to provide ongoing, reliable service to customers.

Project Schedule

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Open the project	January 2017	February 2017
Procurement	Prepare specification documentation and order equipment	February 2017	April 2017
Fabrication	Parts fabricated at supplier location	April 2017	September 2017
Delivery	Critical spares arrived at Bay D'Espoir	August 2017	October 2017
Closeout	Project physical and financial close-out tasks	November 2017	December 2017

Project Title: Overhaul Turbine/Generators

Location: Bay d'Espoir and Cat Arm

Category: Generation - Hydraulic

Type: Other

Classification: Normal

Project Description:

This project is required to partially dismantle and reassemble Cat Arm Unit 1 and Bay d'Espoir (BDE) Unit 4[1] turbine/generators to inspect, test, clean, repair and replace defective components. This overhaul involves cleaning and inspection of rotor and stator assembly, electrical testing on rotor/stator assembly, calibration and testing of turbine and generator protection devices, verification of bearing and seal clearances and a thorough inspection of turbine, needles and draft tube. Overhaul work on the needles which act as the water jets for the pelton turbine will also be completed on Unit 1 at Cat Arm during the overhaul.

The budget estimate for the project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	72.0	0.0	0.0	72.0
Labour	243.4	0.0	0.0	243.4
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	60.9	0.0	0.0	60.9
Interest and Escalation	24.6	0.0	0.0	24.6
Contingency	75.3	0.0	0.0	75.3
TOTAL	**476.2**	**0.0**	**0.0**	**476.2**

[1] Hydro notes that the work contained in this proposal for BDE Unit 4 was planned prior to the current supplemental capital project "Turbine Rehabilitation BDE Unit 4", approved in order P.U. 28(2016). The supplemental project is currently being executed and is on track for completion through August and return to service in early September at the latest. In addition to completing the advanced refurbishment work described in the supplemental, by virtue of the dismantling, cleaning and reassembling of Unit 4, a significant portion of the work contained in this 2017 proposal for that unit is expected to be captured in the 2016 work. This is not additional scope to the supplemental plan, but work that is achieved through the completion of the 2016 work. At the time of submitting this 2017 capital proposal, Hydro is optimistic the BDE Unit 4 2017 project will not have to proceed, but cannot confirm this until the 2016 project is further into the work execution. Therefore, Hydro included the 2017 work but will respectfully remove the scope if it is so confirmed the tasks have indeed been achieved. This decision will be communicated formally to the Board in August 2016.

Justification:

These large turbine/generator units are required to be operating efficiently and effectively, therefore regular overhauls and inspections are required. During the winter months these units are collectively required to be available nearly 100% of the time in order to meet the electricity demands of the Island Interconnected System. To achieve the winter readiness availability targets and annual system load requirements, these units need to have all major components inspected, tested and/or repaired on a six year frequency to minimize forced outages, forced de-ratings or unplanned maintenance outages, which could result in customer interruptions. This frequency is based on the recommendations as outlined in Hydro's Asset Management Strategy (AMS) program. In addition, these inspections/overhauls are re-evaluated regularly by Hydro's Long Term Asset Planning team and maintenance groups to ensure they are efficient and effective.

It has been determined that Cat Unit 1 needs new generator bearing coolers and once these are replaced the older coolers will be refurbished to be available for spares if their condition warrants. The current installed coolers have previously been removed, refurbished and reinstalled, and given their age and material of manufacture (non stainless steel) their reliability level has been reduced. If these existing coolers are not able to be refurbished then new coolers will have to be purchased as critical spares.

Existing System:

Hydro's hydroelectric generating units at Bay d'Espoir, Upper Salmon, Hinds Lake, Cat Arm, Paradise River, Granite Canal, Snooks Arm and Venams Bight, have a total installed capacity of 957 MW. The seven generating units at Bay d'Espoir utilize approximately 176 m of head to produce a rated output of 604 MW with a rated flow of 397m^3/s. The Bay d'Espoir Generating Plant produces an average of 2,650 GWh annually making it the largest hydroelectric plant on the Island. The Cat Arm Plant has two generating units each with an output of 67 MW for a total plant capacity of 134 MW. All hydro electric generators, intakes, spillways, control structures and plant auxiliary equipment are inspected annually but major inspections/overhauls are conducted on a six year frequency.

Age of Equipment or System

- Bay d'Espoir Unit 4 – 1968 (47 years)
- Cat Arm Unit 1 – 1985 (31 years)

Unit capacity

- Bay d'Espoir Unit 4 – 76.5 MW
- Cat Arm Unit 1 – 67 MW

Figure 1 is a photograph of the Bay d'Espoir Generating Station

Figure 1: Bay d'Espoir Hydro Generating Station

Figure 2 is a photograph of the Cat Arm Generating Station

Figure 2: Cat Arm Hydro Generating Station

Major Work/or Upgrades

Table 2 details major upgrades on Bay d'Espoir Unit 4 hydroelectric generator.

Table 2: Major Work or Upgrades – Bay D'Espoir Unit 4

Year	Major Work/Upgrade	Comments
2015	Auto Greasing System replaced	Part of a multi-year in-house project
2015	Excitation Transformer replaced	Completed by Hydro Staff
2014	Thrust/Guide Bearing Coolers replaced	Stainless Steel Cooler installed
2012	Stator Rewind	By Voith
2012	Generator Rotor Pole Refurbished	By Voith
2012	Replaced and Upgraded Unit Protection	New Protection Relays
2012	Air Gap Monitoring and Continuous PDA	Installed during Stator rewind work
2011	Major Unit Overhaul completed	Preventive Maintenance
2009	Cooling Water Piping Upgrade	Replaced with Stainless Steel
2001	Spherical Valve Controls Upgrade	Includes automated controls
1998	Exciter Replacement	Unitrol P
1994	Turbine Runner Replacement	By Voith to increase efficiency
1998	Exciter Replacement	Unitrol P

Table 3 details major upgrades on Cat Arm Unit 1 hydroelectric generator.

Table 3: Major Work or Upgrades – Cat Arm Unit 1

Year	Major Work/Upgrade	Comments
2011	Major Unit Overhaul completed	Preventive Maintenance
2009	Generator Oil Level System replacement	Critical to avoid alarms and trip due to low oil
2009	Turbine Bearing Oil Level System replaced	Critical to avoid alarms and trip due to low oil
2009	Tack Pak Speed Sensor replaced	Used for unit speed reference
2008	Spherical Valve Duplex Strainer replaced	Ensure water quality maintained
2008	Spherical Valve Seal Refurbishment	Maintenance Seal refurbished
2006	Governor Controls Replacement	Includes automated controls
2002	Replaced Exciter with ABB Unitrol F	Boveri Unitrol M obsolete – no parts
1999	Spherical Valve Seal Replacement	Replaced upstream and downstream seals

Operating Experience

Bay d'Espoir Unit 4 and Cat Arm Unit 1 turbine/generator units are two of sixteen hydroelectric generating units that Hydro operates and maintains to meet Island system load requirements. These units went into service in 1967 and 1985 respectively.

All turbine/generator units are given a major overhaul every six years as per the recommendations in the Asset Management Strategy which is based on operating and maintenance experience and the Original Equipment Manufacturer (OEM) recommendations.

Reliability Performance

Tables 4 and 5 show the forced, maintenance and planned outages for both units.

Table 4 and 5: Outage Statistics

Bay d'Espoir Unit 4

Year	Forced Outages	Maintenance and Planned Outages	Total Outages
2015	1	6	7
2014	2	2	4
2013	1	3	4
2012	4	4	8
2011	0	3	3

Cat Arm Unit 1

Year	Forced Outages	Maintenance and Planned Outages	Total Outages
2015	2	2	4
2014	1	5	6
2013	1	3	4
2012	1	2	3
2011	3	3	6

Environmental Performance

There are no environmental performance issues with respect to the overhaul of these units.

Industry Experience

Work performed during major inspections and overhauls is based on operational experience and manufacturer recommendations. These inspections/overhauls are also based on best practices being utilized by other utilities.

Vendor Recommendations

Vendor maintenance recommendations were considered and applied where applicable when the major PM inspection programs were developed.

Maintenance or Support Arrangements

Maintenance of hydroelectric generators is conducted internally by Hydro personnel. Contractors and consultants are typically used to perform large, exceptional pieces of work where the skill sets are not available internally.

Maintenance History

The five-year maintenance history for Bay d'Espoir Unit 4 is shown in Table 6.

Table 6: Five-Year Maintenance History Bay d'Espoir Unit 4

Year	Preventive Maintenance ($000)	Corrective Maintenance ($000)	Total Maintenance ($ 000)
2015	29	39	68
2014	31	33	64
2013	38	42	80
2012	8	29	37
2011	49	89	138

The five-year maintenance history for Cat Arm Unit 1 is shown in Table 7.

Table 7: Five-Year Maintenance History Cat Arm Unit 1

Year	Preventive Maintenance ($000)	Corrective Maintenance ($000)	Total Maintenance ($ 000)
2015	37	51	88
2014	78	36	114
2013	45	25	70
2012	24	26	50
2011	90	63	153

Historical Information

The historical cost information for unit overhauls is recorded in Table 8.

Table 8: Hydraulic Unit Overhaul Capital Budget and Expenditures History

Year	Capital Budget ($000)	Actual Expenditures ($000)	Locations
2016B	1,345.6		Bay d'Espoir Unit 6 and Unit 7
2015	304.4	325.8	Paradise River and Bay d'Espoir Unit 5
2014	485	481.2	Hinds Lake and Bay d'Espoir Unit 3
2013	428.1	214.4	Bay d'Espoir Unit 1 and Cat Arm Unit 2

Hydraulic turbine/generator inspection/overhauls are typically performed on a six year frequency. Typically two hydraulic turbine/generator units in the Hydro fleet are overhauled every year.

Anticipated Useful Life

The useful life of the major overhaul of the turbine/generator unit is six years.

Development of Alternatives

All hydroelectric generators require regularly scheduled major overhauls. To ensure long term reliability of these assets, maintenance repairs and major overhauls have no viable alternative.

Conclusion:

Hydroelectric generators are required to operate in an efficient manner and are required to be available nearly 100% of the time in winter in order to meet system energy requirements on a daily basis. Major inspections and overhauls are essential to ensure continued safe, reliable and efficient operation of the Island Interconnected System.

Project Schedule:

Major inspections and overhauls are performed by Hydro personnel. The schedule varies between three and four weeks per unit however the actual outage schedule for each unit is not identified until December of the previous year based on operating experience of the year before.

The anticipated project schedule is shown in Table 9.

Table 9: Project Schedule

Activity		Start Date	End Date
Planning	Detailed Plan for the overhaul outage	January 2017	June 2017
Procurement	Specify material requirements	March 2017	September 2017
Construction	Perform the Major Inspection/Overhauls	May 2017	November 2017
Commissioning	Return the Units to Service	July 2017	November 2017
Closeout	Closeout the project	November 2017	December 2017

Project Title: Replace Slip Rings Units 1-6

Location: Bay d'Espoir Powerhouse No.1

Category: Generation - Hydraulic

Type: Other

Classification: Normal

Project Description:

This proposal is for a two year project to replace the slip (collector) rings for Units 1 through 6 at the Bay d'Espoir Hydroelectric Generating Station. Procurement of slip rings for all six units will take place in 2017 as well as the replacement of slip rings on two units. Slip ring replacement on the remaining four units will take place in 2018. A slip ring is a rotary coupling used to transfer electric current from a stationary unit to a rotating unit. New slip rings will be manufactured and supplied by the original equipment manufacturer (OEM) representative, Andritz Hydro, to ensure that the standards and dimensions of the original equipment are met.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	10.0	20.0	0.0	30.0
Labour	45.4	71.0	0.0	116.4
Consultant	25.0	35.0	0.0	60.0
Contract Work	168.6	0.0	0.0	168.6
Other Direct Costs	4.2	0.0	0.0	4.2
Interest and Escalation	8.8	8.5	0.0	17.3
Contingency	50.6	25.2	0.0	75.8
TOTAL	**312.6**	**159.7**	**0.0**	**472.3**

Justification:

This replacement of the slip rings is required to ensure the continued supply of reliable, least cost electricity from the Bay d'Espoir Units. The slip ring is a critical piece of equipment in the operation of the unit and replacement rings have a lead time of up to three months. The existing slip rings on the six units have been machined over the period 2007 to 2012 but the machining only extends the life of the slip rings by 5 to 10 years. Machining the slip rings involves wearing away the surface to remove grooves and high points which results in a level, uniform surface. Wear on each slip ring is

caused by the constant rotation of the ring while spring loaded carbon brushes press against the face of the slip ring. Machining of slip rings can typically be done once before replacement is required. Operating these units with worn slip rings will result in increased maintenance costs and higher potential for both forced and unplanned maintenance outages. When the slip ring is worn, wear on the carbon brushes occurs at a higher rate which produces more carbon dust. The carbon dust is drawn into the unit and has the potential of creating electrical shorts to ground (tracking) in the electrical system that needs to be addressed immediately. The removal of this carbon dust is a costly and time consuming task and can only be accomplished by dismantling major components on the unit and having a maintenance crew manually clean it out. As the slip rings have previously been machined and are once again showing signs of wear, replacement is required to prevent failure and ensure reliable operation of the Bay d'Espoir generating units.

Existing System:

Hydro's largest hydroelectric generating station in the Island Interconnected System is located at Bay d'Espoir. Powerhouse No.1 at the Bay d'Espoir Hydroelectric Generating Station is equipped with six 75 MW generating units producing a total capacity of 450 MW. This is approximately 30 percent of the Island Interconnected System's installed capacity. Units 1 through 6, manufactured and supplied by Canadian General Electric (CGE), were installed during original construction in the late 1960's and have now been in operation for nearly 50 years. The slip rings currently installed were supplied by CGE as replacement slip rings and have been in operation for nearly 30 years. Each set of slip rings has been previously machined once as needed to extend their service life by 5 to 10 years. Between 2007 and 2012 one unit was machined per year based on the condition of the slip rings. All units are once again showing signs of wear and cannot be machined any further.

Operating Experience:

The slip rings on Units 1 through 6 are approaching 30 years old and are well beyond their expected useful service life of 25 years. Each set were previously machined once to extend their service life but are now showing signs of wear. These generating units make up a large portion of the Island Interconnected System's installed capacity and will remain in service for many years to come. Continuous operation of these units with worn slip rings can have adverse effects on the units and could potentially lead to forced outages and unplanned maintenance. In the event of a slip ring

failure, arcing would occur but the damage would be limited to the slip rings and assemblies. Major components would not be affected but the unit would be inoperable.

Reliability Performance

Continuous operation of these generating units with worn slip rings will reduce the reliability of the units and increase the risk of unplanned maintenance and capital work. It is expected that a unit outage would last 10 to 12 weeks for procurement and installation of new parts.

Outage Statistics

There have been no outages associated with the existing slip rings.

Maintenance History

The maintenance history directly associated with the slip rings on these units has been limited to machining of the slip rings between 2007 and 2012. Maintenance for this equipment is recorded at a higher asset level as part of a larger preventative maintenance inspection on the entire units. When the units are dismantled for slip ring machining or replacement they are typically cleaned out, carbon brushes are replaced and brush gear including brush holders and holder springs are replaced as required. The average corrective maintenance cost associated with slip ring machining is approximately $30,000 per unit.

Anticipated Useful Life

The anticipated useful service life for new slip rings would be approximately 25 years.

Development of Alternatives

There are no alternatives to the replacement of the slip rings on Units 1 through 6 as they have already been machined once to extend their useful service life as much as possible and are now in need of replacement.

Conclusion

Operation of the Bay d'Espoir Units 1 to 6 using slip rings beyond acceptable thickness level will result in increased maintenance costs. It may also result in the failure of rings causing unit

emergency outages. This project is necessary to ensure continued reliable, cost efficient operation of the generating units at Bay d'Espoir Generating Station.

Project Schedule:

The anticipated project schedule for this project is shown in Table 3.

Table 3: Project Schedule

Activity		Start Date	End Date
Planning	Project initiation, scheduling, etc.	January 2017	March 2017
Design and Procurement	Design and procurement of OEM replacement slip rings by PETS Engineering	March 2017	April 2017
Procurement	Delivery of slip rings	August 2017	August 2017
Construction	Replacement of slip rings on first two units	September 2017	September 2017
Commissioning	Commissioning of first two units.	October 2017	October 2017
Construction	Replacement of slip rings on remaining four units	August 2018	September 2018
Commissioning	Commissioning of remaining four units.	September 2018	October 2018
Closeout	Lessons learned, project closeout, etc.	November 2018	December 2018

Project Title: Purchase Capital Spares – Thermal

Location: Holyrood Thermal Generating Station

Category: Generation Thermal

Definition: Other

Classification: Normal

Project Description:

Hydro has identified a Capstan Gearbox, Clear Well Pump and Rectifying Transformer to be procured as critical spares for the Holyrood Thermal Generating Station (HTGS). Purchase of these critical spares for HTGS would decrease downtime in the event of a failure of an in-service component, and therefore faster reinstatement of generating capacity than if the critical parts had to be procured post failure.

The capital spares that have been identified as being required for the HTGS are as follows:

- Capstan Gearbox;
- Clear Well Pump; and
- Rectifying Transformer Stage 1.

The budget estimate for this project is provided in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	294.5	0.0	0.0	294.5
Labour	0.0	0.0	0.0	0.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	12.0	0.0	0.0	12.0
Contingency	15.0	0.0	0.0	15.0
TOTAL	**321.5**	**0.0**	**0.0**	**321.5**

Justification:

Hydro proposes the procurement of the identified capital spares to be a part of the 2017 Capital Budget. The importance of having critical spares on hand is illustrated by the failure of a critical fan motor at HTGS on December 26th, 2013 and the associated de-rating of 100 MW of capacity. It is

required to procure the identified spares in order to minimize the risk of outage or de-rating of HTGS for a significant period of time.

Capstan Gearbox

Six capstan gearboxes are required to safely moor tanker ships for fuel deliveries at the marine terminal at the HTGS. Without all six capstan gearboxes in operation, the tanker ship cannot be moored to offload fuel, and Hydro incurs daily fees for the delay. In addition, a delay on the fuel delivery could lead to a lack of fuel for generation, especially during the peak generation season when fuel usage is high. With a lead time of 8 months to receive a new capstan gearbox, the total cost of the daily fees would amount to a significant sum compared to having a spare on hand and replacing the broken one within two days.

Clear Well Pump

The clear well pumps transfer clarified water from the clear well to the water treatment plant. These pumps also provide water to the General Service Cooling Water Tank.

These are the only pumps which can transfer water to the water treatment plant to produce demineralized water, which is then used in the boilers to produce steam. Without these pumps, the water treatment plant cannot produce demineralized water for use in the boilers. Without the pumps in service, HTGS has only a maximum 24 hour supply of demineralized water and the lack of demineralized water will result in the shutdown of the boilers and loss of production of power.

Rectifying Transformer, Stage 1

The stage 1 rectifying transformers provide power to the excitation system of the generators on Unit 1 and Unit 2. This power is used by the exciter to control the characteristic of the magnetic field of the rotor. The turning magnetic field of the rotor is the electromechanical force that generates electricity. In the event of a failure of a rectifying transformer, the corresponding unit would be unable to generate power. As the transformers are custom built equipment, having a spare unit on site will enable the HTGS to quickly replace the faulty transformer and bring the unit back into operation.

To summarize, the components proposed for purchase at the HTGS are listed in Table 2. This table compares the downtime expected with available spares on hand to the expected downtime without spares.

Table 2: Associated Downtime

Unit	Description	Downtime	Downtime with Spare on Hand
Holyrood Common	Capstan Gearbox	8 Months	2 Days
Holyrood Common	Clear Well Pump	12 Weeks	2 Days
Holyrood Unit 1 or 2	Rectifying Transformer	4 Months	7 Days

Conclusion:

Experience has shown that key components of the HTGS may experience failure earlier than anticipated and without warning. Through a critical spares review for the HTGS, Hydro identified key components to procure and have located onsite. Purchasing and locating these spares at the HTGS will provide for expedited return to service of a generating unit should there be failures of critical components.

Expedited return to service following equipment failure is an expectation of customers. To expedite return to service, critical spares availability is vital and one of the most important aspects of provision of reliable service.

Project Schedule:

The anticipated project schedule is provided in Table 3.

Table 3: Project Schedule

Activity		Start Date	End Date
Planning	Open project	January 2017	January 2017
Design	Prepare specifications for spares	February 2017	February 2017
Procurement	Procure spares	March 2017	November 2017
Closeout	Prepare closeout documents.	December 2017	December 2017

Project Title: Refurbish Sump Level System for Powerhouse 2

Location: Bay d'Espoir

Category: Generation – Hydraulic

Type: Other

Classification: Normal

Project Description:

This project involves the replacement of the existing sump level control system at Bay d'Espoir Powerhouse 2 which has reached the end of its useful service life and must be replaced. The system controls three dewatering pumps for the powerhouse sump and is used to remove water from the plant through the powerhouse drainage system. Further to replacement of this end of life system, the new system design will provide increased personnel, equipment and environmental safety through the addition of a top of sump mounted guided wave radar with oil in water detection, continuous remote monitoring, and a pump seal priming system. The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	51.3	0.0	51.3
Labour	33.4	94.1	0.0	127.5
Consultant	0.0	35.0	0.0	35.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	3.2	17.6	0.0	20.8
Interest and Escalation	2.1	19.6	0.0	21.7
Contingency	0.0	46.9	0.0	46.9
TOTAL	**38.7**	**264.5**	**0.0**	**303.2**

Justification:

This project is justified on the requirement to replace deteriorated, end of life infrastructure in order for Hydro to provide safe, least-cost, reliable electrical service. A reliable sump level control system is critical to the operation of Powerhouse 2 and generating Unit 7, the largest hydraulic generation unit connected to the Island Interconnected System. A new level control system with a remote Human Machine Interface (HMI) will allow operators to closely monitor the status of the sump from the Powerhouse 1 control room, reducing the risk of powerhouse flooding or pump damage as sump information will be readily available in the control room. The addition of oil contamination detection

will allow operators to prevent discharge of oil into the environment and an automatic pump priming system will allow the pumps to be started without the risk of damage. As an added benefit, a new guided wave radar level detection probe can be maintained from the top of the sump pit, eliminating the need to personnel to enter a confined space to perform maintenance, increasing personnel safety and reducing labour requirements for maintenance.

Existing System

The existing sump level control system, shown in Figure 2, was installed in 1976 and is approaching the end of its useful service life of 40 years. It consists of electromechanical relays and timers which are prone to inaccuracies and failures, especially as they age. The system can only be controlled and monitored from the dewatering gallery, located at the very bottom level of the powerhouse (approximately 3m below sea level; shown in Figure 1. Operations personnel cannot continuously monitor its status due to its remote location in the powerhouse.

All drains within the powerhouse flow into the sump pit which is in turn de-watered by a 10 horsepower (HP) sump pump (shown in Figure 3) that discharges into the tailrace. The sump pump, in conjunction with two 40HP dewatering pumps (shown in Figure 4), is also used for dewatering of the scroll case and draft tube of generating Unit 7 for inspection and maintenance. The existing system uses an array of float switches to detect changes in the sump water level which are prone to contamination by the sump effluent, requiring frequent maintenance and cleaning in the hazardous confined space of the sump pit. Failure of a level switch can result in flooding of the powerhouse, damage to the pumps if they are allowed to run at a low suction head (water level above the pump's impeller) or discharge of oil contamination into the tailrace if a pump does not cut out at the appropriate level. In addition to this, the system is not equipped with a pump priming system to lubricate the pump's seals before they are started. This has resulted in past damage to pump seals, particularly in the draft tube dewatering pumps which are used infrequently, requiring the pumps to be rebuilt. Finally, the existing system has no means to automatically detect oil contamination in the sump, resulting in the possibility of discharging oil into the environment.

Figure 1: Powerhouse 2 Dewatering Gallery (Sump Pit located at end of gallery)

Figure 2: Dewatering System Controller and Starter (1 of 3)

Figure 3: Sump Pump

Figure 4: Dewatering Pumps 1 and 2

Table 1 shows the major work or upgrades performed within the past five years.

Table 2: Major Work or Upgrades

Year	Major Work/Upgrade	Comments
2014	Float Switches Replaced	Due to switch failure
2012	Dewatering Pump 1 Rebuilt	Due to pump failure
2012	Dewatering Pump 2 Rebuilt	Due to pump failure

Operating Experience

The sump level control system is used continuously to remove water from the powerhouse sump. The 10HP sump pump runs on a regular basis when water levels in the sump rise above its cut-in level. The two 40HP dewatering pumps are generally only used during unit maintenance periods to remove water from the scroll case and draft tube areas to provide a safe working environment for personnel. By manipulation of the sump's control valves, the dewatering pumps can also act as a backup for the main sump pump. Operators in the control room receive loss of power supply to the pumps or a high water condition alarms from the sump level system. As a result of this, the operators have no way to remotely monitor on-going state of the sump, and only receive an alarm when immediate action is required. A remote monitoring human machine interface (HMI) in the powerhouse control room would allow the operators to proactively monitor the sump status, and to mitigate potential issues before they require immediate action.

Reliability Performance

Dewatering pumps 1 and 2 failed in July 2012, requiring both to be rebuilt. Investigation of the failure showed that the shaft seals had adhered to the stainless steel shafts of the pumps while they were at rest for an extended period. Due to the nature of the pumps' infrequent operation (generally usually only for one period of three to four weeks a year) and the fact that a sump level system has no means to prime the pumps with lubricating water, this failure is likely to happen in the future. An automatic priming line will prevent future failures of this nature by providing the pumps with lubricating water before starting and periodically throughout their non-operation period.

Outage Statistics

Failure of the sump level control system has not directly resulted in an outage to Unit 7. A failure of the system in July 2003 did however result in the flooding of the lower level of the powerhouse, including the dewatering and draft tube galleries. If water were to enter electrical or control equipment located on this level, there would be a risk for a potential trip of the unit.

Legislative or Regulatory Requirements

Federal and Provincial legislative statutes prohibit the release of contaminants into the environment. In the case of a powerhouse sump pit, waste oil is of the highest concern. The applicable regulations are highlighted below:

> *Environmental Protection Act, 2002, SNL 2002, c. E-14.2 (as amended), Section 7, Part 1:* A person shall not release or permit the release of a substance into the environment in an amount, concentration or level or at a rate of release that in the opinion of the minister causes or may cause an adverse effect, unless authorized under this Act or an approval issued under this Act.
>
> *Fisheries Act, 1985, RSC 1985, c. F-14 (as amended), Section 36, Part 3:* No person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water.

Based upon this legislative requirement, it is imperative that the sump be operated in a manner that prevents the release of contaminated effluent.

Safety Performance

Maintenance of the sump level control system requires entry into the confined space of the sump pit. This presents hazards to personnel which are generally mitigated using personal protective equipment (PPE) and confined space entry procedures. By replacing the float switches of the sump level control system with a guided wave radar, maintenance can be performed from the top of the sump pit, outside of the confined space. This will result in a safer work environment for personnel performing maintenance.

Environmental Performance

The proposed system will monitor the sump continuously, alerting operators immediately of sump contamination, thus complimenting existing operation procedures and providing a greater level of environmental protection.

Maintenance or Support Arrangements

Preventative Maintenance (PM) is performed by Hydro personnel on the Powerhouse 2 Sump Level Control System on an annual basis. Typical maintenance activities include lubrication and assessment of the health of the pumps and attached motors, as well as inspection and functional testing of the control system wires, relays, and switches. The annual maintenance check sheets are included in Appendix A.

Maintenance History

The five-year maintenance history for the Powerhouse 2 Sump Level Control System is shown in Table 2.

Table 2: Five-Year Maintenance History

Year	Preventive Maintenance ($000)	Corrective Maintenance ($000)	Total Maintenance ($ 000)
2015	0.5	4.5	5.0
2014	0.6	8.9	9.5
2013	2.0	4.0	6.0
2012	2.6	56.9	59.5
2011	1.6	0.0	1.6

Note: Dewatering pumps 1 and 2 were rebuilt in 2012, resulting in significantly higher maintenance costs for that year.

Anticipated Useful Life

The components of a new sump pump control system have an estimated service life as identified below:

- Combination Starters – 40 years;
- Programmable Logic Controller and Instrumentation – 30 years;
- Mechanical Piping and Valves – 40 years.

Development of Alternatives

There are no viable alternatives for the replacement of the sump level control system. Different technologies, as identified in **Error! Reference source not found.**, exist for the measurement of water levels in sump pits (e.g. pressure transducer, ultrasonic sensor, free space radar, level switches). However, a guided wave radar is the most practical type of sensor this application.

Table 4: Alternative Measurement Technologies

Method	Key Features/Issues	Suitable
Pressure	-Does not detect oil in water -Requires access to pit for maintenance	No
Ultrasonic	-Does not detect oil in water -Obstructions within sump (pipes, valves, etc.) interfere with measurement	No
Free Space Radar	-Does not detect oil in water -Obstructions interfere with measurement	No
Level Switches	-Does not provide continuous measurement. -Requires access to pit for maintenance	No
Guided Wave Radar	-Does not require access to pit for maintenance -Obstructions do not interfere with measurement -Can detect oil in water	Yes

Conclusion:

This project is necessary to provide reliable, safe, and environmentally compliant operation of Bay d'Espoir Powerhouse 2 and Unit 7. The existing control system, including its motor starters, has reached the end of its useful service life and should be upgraded to a modern, PLC based solution. The addition of a pump priming system and oil in water detection will ensure trouble-free, environmentally compliant operation of the pumps for the future.

Project Schedule:

The anticipated project schedule is shown in Table .

Table 3: Project Schedule

Activity		Start Date	End Date
Planning	Project Kick-Off	February 2017	February 2017
	Site Assessment	May 2017	June 2017
	Information Collection	May 2017	June 2017
Design	P&C Design	June 2017	January 2018
	Mechanical Design	June 2017	January 2018
Procurement	Tender for Motor Starters	February 2018	March 2018
	Award of Tender	April 2018	April 2018
	Order PLC and instrumentation	April 2018	April 2018
	Order mechanical components	April 2018	April 2018
	Arrival of Materials	June 2018	June 2018
	Bench Testing & Configuration	June 2018	July 2018
Construction	Install system components	August 2018	September 2018
Commissioning	Commissioning	September 2018	September 2018
	As-built drawings and documentation	September 2018	September 2018
Closeout	Project closeout	October 2018	October 2018

APPENDIX A

Preventative Maintenance Check Sheets

NEWFOUNDLAND & LABRADOR HYDRO HYDRO GENERATION PREVENTIVE MAINTENANCE CHECKSHEETS	Sheet: 1 of 3 Rev. No.: 2 Rev. Date: 02-01-30 Index No.: 1541 Binder No.: 25

JDE Item No.: PM6 - 60558 - EBDE
Item No. & Description: 60558 - Sump Pump System - Powerhouse #2
Type of Inspection: PM6 (Annual)
Department: Electrical — Asset Approval:
Inspection Start Date: — Insp. Comp. Date:
Supervisor's Review Signature & Date:
Reference Drawing and Manuals:

ACTIVITIES (Initial Box Upon Completion)		REMARKS
CRITICAL PARTS INSPECTION		
1. <u>Dewatering Pump Control for Pumps #1 and #2</u>		
a. Check all wire connections in control panel.	( )	
b. Check operation of float switch LS-1.	( )	
c. Check operation of float switch LS-2.	( )	
d. Check operation of lead #1/lead #2 control switch - Switch SSW3.	( )	
e. Check operation of control switch SSW1 - Manual – Off – Auto.	( )	
f. Check operation of control switch SSW2 - Manual – Off – Auto.	( )	
g. Check all indication lamps for both pumps – white-red/ white-red (power on - pump running).	( )	
h. Check operation of control switch. Manual - Off - Auto Normal - Auto Dewatering.	( )	
i. Check operation of float switch LS-4.	( )	
j. Check operation of float switch LS-5.	( )	
k. Check operation of float switch LS-6.	( )	
l. Check overloads. Record overload. Type and/or setting.	( )	
m. Check operation of high water level alarm (SW) LS-3.	( )	
n. Check motor contactor for free movement.	( )	
o. Clean and/or replace contacts. Y/N _____	( )	

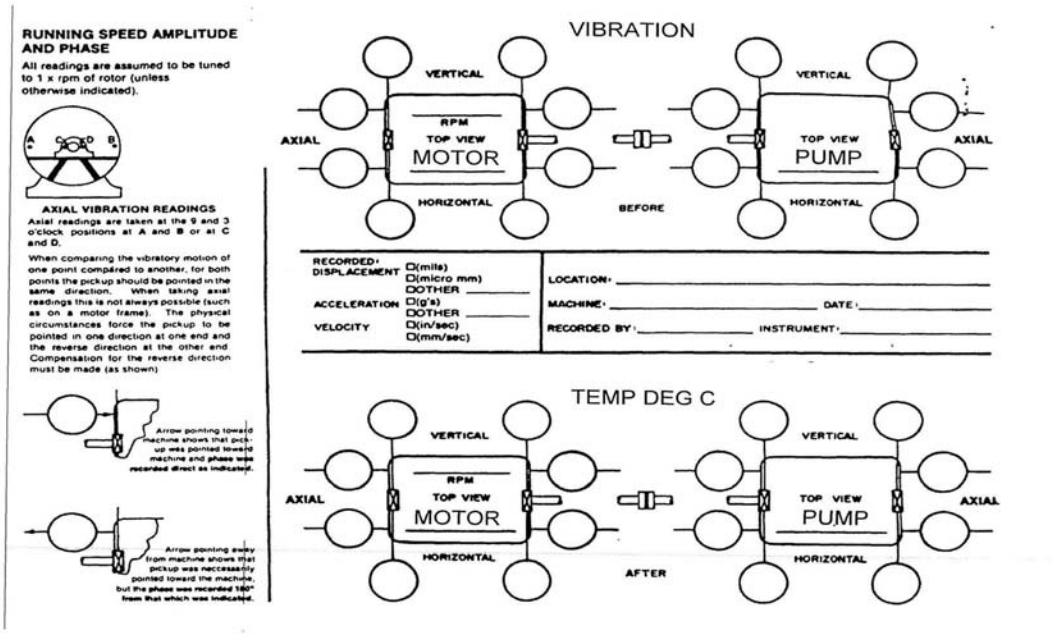
Item No. & Description: 60558 - Sump Pump System - Powerhouse #2 Type of Inspection: PM6 Department: Electrical	Sheet: 2 of 3 Rev. No.: 2 Rev. Date: 02-01-30 Index No.: 1541 Binder No.: 25
ACTIVITIES (Initial Box Upon Completion)	**REMARKS**
2. <u>Dewatering Pump Motor #1</u> a. Check all wire connections in motor connection box. ( ) b. Meggar motor leads to GR. _____ m ohm ( ) c. Take correct readings. ( ) Phase A ____ amps Phase B ____ amps Phase C ____ amps d. Check bearings for abnormal noise or overheating. ( ) e. Check bearings at 10,000 hours. ( ) Front _____ Drive _____ <u>Bearing Types</u> Front - 7309 Drive - 6209 f. Check operation of indication lamps red-white. ( ) g. Record motor running hours. _____ ( )	
3. <u>Dewatering Pump Motor #2</u> a. Check all wire connections in motor connection box. ( ) b. Meggar motor leads to GR. _____ m ohm ( ) c. Take correct readings. ( ) Phase A ____amps Phase B ____ amps Phase C ____ amps d. Check bearings for abnormal noise or overheating. ( )	
4. <u>Sump Pump Powerhouse No. 2</u> a. Amp reading A _____ ( ) b. Amp reading B _____ ( ) c. Amp reading C _____ ( )	

Item. No. & Description: 60558 Sump Pump System - Powerhouse #2 Type of Inspection: PM6 Department: Electrical	Sheet: 3 of 3 Rev. No.: 2 Rev. Date: 02-01-30 Index No.: 1541 Binder No.: 25
ACTIVITIES (Initial Box Upon Completion)	**REMARKS**
4. Sump Pump Powerhouse No. 2 (Cont'd) d. Meggar motor _____ ( ) e. Overloads _____ ( ) f. Check connections ( ) g. Check loss of AC power alarm. ( )	

NEWFOUNDLAND & LABRADOR HYDRO HYDRO GENERATION PREVENTIVE MAINTENANCE CHECKSHEETS	Sheet: 1 of 2 Rev. No.: Rev. Date: Index No.: 2116 Binder No.: 18

PM Checksheet No.: PM6 - 60642 - MBDE
JDE Item No. & Description: 60642 - Dewatering Pump #1 - P.H. #2 - BDE
Type of Inspection: PM6 (Annual)
Department: Mechanical — Dept. Approval:
Inspection Start Date: — Insp. Comp. Date:
Supervisor's Review Signature & Date:
Reference Drawing and Manuals:

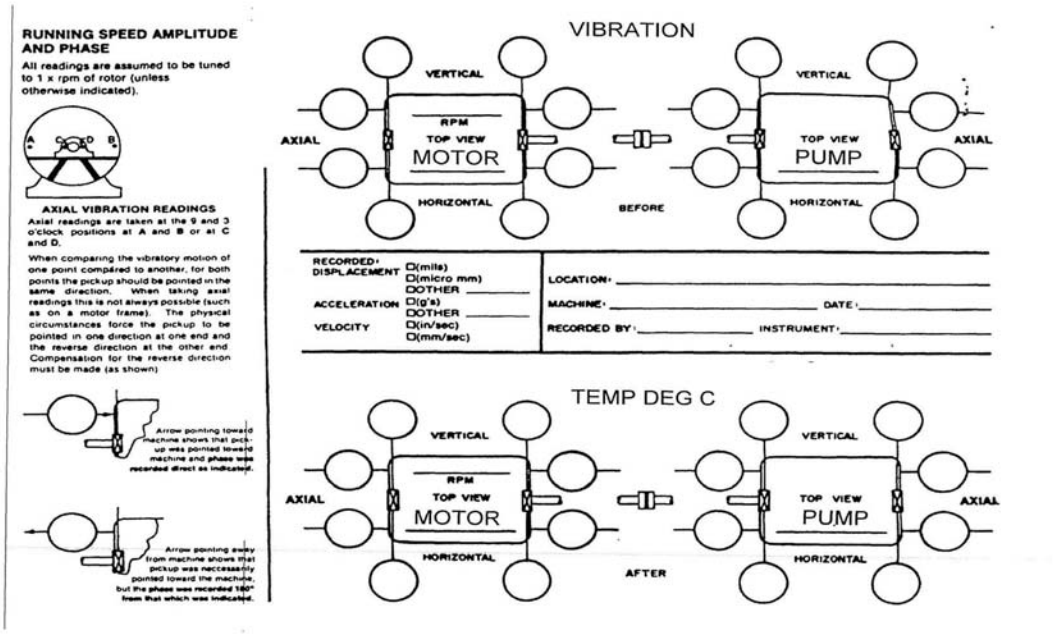
ACTIVITIES (Initial Box Upon Completion)	REMARKS
1. Check and adjust packing if required. Re-pack pump if required. ( )	
2. Lubricate motor bearings. ( )	
3. Lubricate gland bushing. ( )	
4. Run pump and check for vibration and noises. ( )	
5. Record vibration on attached sheet. ( )	
6. Record temperature on attached sheet. ( )	


RUNNING SPEED AMPLITUDE AND PHASE
All readings are assumed to be tuned to 1 x rpm of rotor (unless otherwise indicated).
A
C
D
B
AXIAL VIBRATION READINGS
Axial readings are taken at the 9 and 3 o'clock positions at A and B or at C and D.
When comparing the vibratory motion of one point compared to another, for both points the pickup should be pointed in the same direction. When taking axial readings this is not always possible (such as on a motor frame). The physical circumstances force the pickup to be pointed in one direction at one end and the reverse direction at the other end. Compensation for the reverse direction must be made (as shown)
Arrow pointing toward machine shows that pick-up was pointed toward machine and phase was recorded direct as indicated.
Arrow pointing away from machine shows that pickup was necessarily pointed toward the machine, but the phase was recorded 180° from that which was indicated.
VIBRATION
VERTICAL
AXIAL
RPM
TOP VIEW
MOTOR
HORIZONTAL
BEFORE
VERTICAL
TOP VIEW
PUMP
AXIAL
HORIZONTAL
RECORDED DISPLACEMENT
☐(mils)
☐(micro mm)
☐OTHER
ACCELERATION
☐(g's)
☐OTHER
VELOCITY
☐(in/sec)
☐(mm/sec)
LOCATION:
MACHINE:
DATE:
RECORDED BY:
INSTRUMENT:
TEMP DEG C
VERTICAL
AXIAL
RPM
TOP VIEW
MOTOR
HORIZONTAL
AFTER
VERTICAL
TOP VIEW
PUMP
AXIAL
HORIZONTAL

NEWFOUNDLAND & LABRADOR HYDRO HYDRO GENERATION PREVENTIVE MAINTENANCE CHECKSHEETS	Sheet: 1 of 2 Rev. No.: Rev. Date: Index No.: 2117 Binder No.: 18

PM Checksheet No.: PM6 - 60646 - MBDE
JDE Item No. & Description: 60646 - Dewatering Pump #2 - P.H. #2 - BDE
Type of Inspection: PM6 (Annual)
Department: Mechanical — Dept. Approval:
Inspection Start Date: — Insp. Comp. Date:
Supervisor's Review Signature & Date:
Reference Drawing and Manuals:

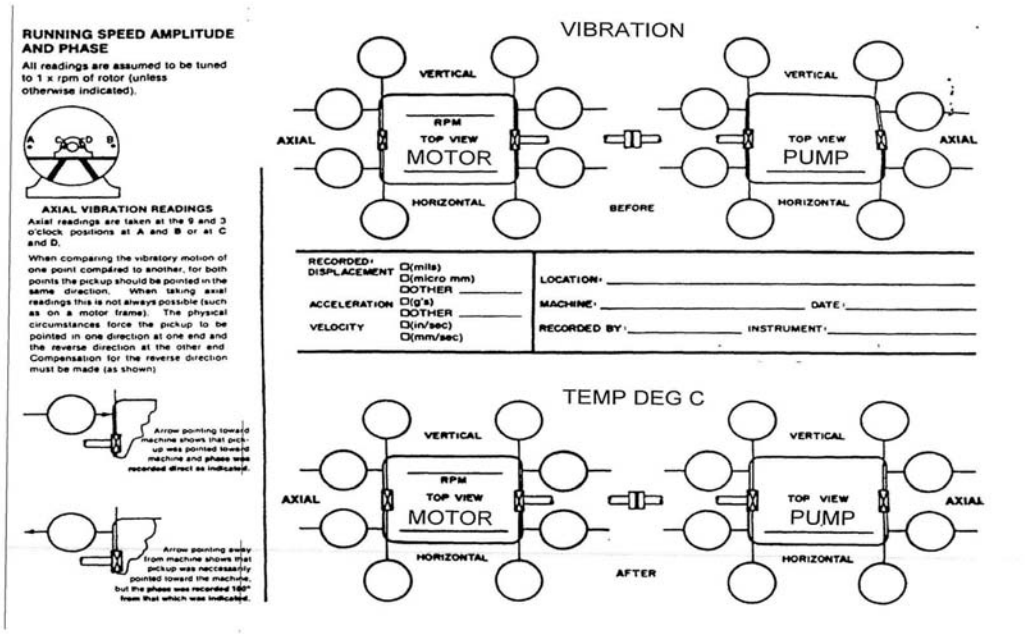
ACTIVITIES (Initial Box Upon Completion)		REMARKS
1. Check and adjust packing if required. Re-pack pump if required.	( )	
2. Lubricate motor bearings.	( )	
3. Lubricate gland bushing.	( )	
4. Run pump and check for vibration and noises.	( )	
5. Record vibration on attached sheet.	( )	
6. Record temperature on attached sheet.	( )	


RUNNING SPEED AMPLITUDE AND PHASE
All readings are assumed to be tuned to 1 x rpm of rotor (unless otherwise indicated).
A
C
D
B
AXIAL VIBRATION READINGS
Axial readings are taken at the 9 and 3 o'clock positions at A and B or at C and D.
When comparing the vibratory motion of one point compared to another, for both points the pickup should be pointed in the same direction. When taking axial readings this is not always possible (such as on a motor frame). The physical circumstances force the pickup to be pointed in one direction at one end and the reverse direction at the other end. Compensation for the reverse direction must be made (as shown)
Arrow pointing toward machine shows that pick-up was pointed toward machine and phase was recorded direct as indicated.
Arrow pointing away from machine shows that pickup was necessarily pointed toward the machine, but the phase was recorded 180° from that which was indicated.
VIBRATION
VERTICAL
AXIAL
RPM
TOP VIEW
MOTOR
HORIZONTAL
BEFORE
VERTICAL
TOP VIEW
PUMP
AXIAL
HORIZONTAL
RECORDED DISPLACEMENT
☐(mils)
☐(micro mm)
☐OTHER
ACCELERATION
☐(g's)
☐OTHER
VELOCITY
☐(in/sec)
☐(mm/sec)
LOCATION:
MACHINE:
DATE:
RECORDED BY:
INSTRUMENT:
TEMP DEG C
VERTICAL
AXIAL
RPM
TOP VIEW
MOTOR
HORIZONTAL
AFTER
VERTICAL
TOP VIEW
PUMP
AXIAL
HORIZONTAL

NEWFOUNDLAND & LABRADOR HYDRO HYDRO GENERATION PREVENTIVE MAINTENANCE CHECKSHEETS	Sheet: 1 of 2 Rev. No.: Rev. Date: Index No.: 2118 Binder No.: 18

PM Checksheet No.: PM6 - 60650 - MBDE
JDE Item No. & Description: 60650 - Drainage Pump - P.H. #2 - BDE
Type of Inspection: PM6 (Annual)
Department: Mechanical **Dept. Approval:**
Inspection Start Date: **Insp. Comp. Date:**
Supervisor's Review Signature & Date:
Reference Drawing and Manuals:

ACTIVITIES (Initial Box Upon Completion)		REMARKS
1. Check and adjust packing gland if needed. Re-pack pump if required.	( )	
2. Lubricate motor bearings.	( )	
3. Lubricate gland bushing.	( )	
4. Run pump and check for vibration and noises.	( )	
5. Record vibration on attached sheet.	( )	
6. Record bearing temperature on attached sheet.	( )	


RUNNING SPEED AMPLITUDE AND PHASE
All readings are assumed to be tuned to 1 x rpm of rotor (unless otherwise indicated).
AXIAL VIBRATION READINGS
Axial readings are taken at the 9 and 3 o'clock positions at A and B or at C and D.
When comparing the vibratory motion of one point compared to another, for both points the pickup should be pointed in the same direction. When taking axial readings this is not always possible (such as on a motor frame). The physical circumstances force the pickup to be pointed in one direction at one end and the reverse direction at the other end. Compensation for the reverse direction must be made (as shown)
Arrow pointing toward machine shows that pick-up was pointed toward machine and phase was recorded direct as indicated.
Arrow pointing away from machine shows that pickup was necessarily pointed toward the machine, but the phase was recorded 180° from that which was indicated.
VIBRATION
VERTICAL
AXIAL
RPM
TOP VIEW
MOTOR
HORIZONTAL
BEFORE
PUMP
RECORDED DISPLACEMENT
ACCELERATION
VELOCITY
LOCATION:
MACHINE:
DATE:
RECORDED BY:
INSTRUMENT:
TEMP DEG C
AFTER

Project Title: Refurbish Main Generator Breaker

Location: Upper Salmon

Category: Generation - Hydraulic

Type: Other

Classification: Normal

Project Description:

This proposal is to refurbish the main generator air blast breaker at Upper Salmon Hydroelectric Generating Station. ABB, the original equipment manufacturer (OEM), will supply and install all parts with support from Hydro's internal labor. The scope of work includes replacement of all worn parts including contacts, contacts tube, nozzle, damper discs, insulating cylinders and tubes, resistor stacks, isolator blade drive, main valve, compression spring and bolts. The purpose of this project is to extend the service life of the breaker. The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	1.0	0.0	0.0	1.0
Labour	36.3	0.0	0.0	36.3
Consultant	30.0	0.0	0.0	30.0
Contract Work	141.4	0.0	0.0	141.4
Other Direct Costs	5.8	0.0	0.0	5.8
Interest and Escalation	13.7	0.0	0.0	13.7
Contingency	42.9	0.0	0.0	42.9
TOTAL	**271.1**	**0.0**	**0.0**	**271.1**

Justification:

This proposal is justified based on the results of a 2012 condition assessment (see Appendix A) performed by the OEM. The condition assessment indicated that the breaker had parts that were worn but still operable at the time. This breaker was originally installed in 1982 and has been in operation for over 30 years, and these parts are nearing end of life. The continued operation of this breaker without refurbishment results in an increasing risk of failure. Due to its low number of operations it is expected that the breaker could operate for up to another 30 years after refurbishment. It is prudent to refurbish the breaker before failure occurs; maintaining the status quo and running the breaker until failure is not a viable option. Upon failure, the generating unit at Upper Salmon would not operate. Such a failure would negatively impact reliability. Refurbishment of this

breaker is required to allow safe and reliable operation of the Upper Salmon Hydroelectric Generating Station as this is the main protective device between the generating unit and the Island Interconnected System (IIS).

Existing System:

The Upper Salmon Hydroelectric Generating Station is a remote, unmanned hydraulic plant that is part of the Bay d'Espoir Development. This station was constructed in 1982 and has one generating unit with a capacity of 84 MW. The ABB air blast circuit breaker was installed during original construction. It is a major protection device for the generating unit step-up transformer against any short circuit fault current from the generator. It also provides protection for the generator against short circuit fault current from the IIS that may occur during operation of the unit.

Operating Experience:

This air blast circuit breaker has been in operation since 1982 and has a very low number of operations when compared to other similar breakers in the system. During the 2012 condition assessment the operations counter was found to be inoperable and was replaced. It was estimated that this breaker had approximately 500 operations between 1982 and 2012. In comparison, at the Hinds Lake Hydroelectric Generating Station, the same model breaker, which was replaced in 2013, had operated approximately 500 times every year.

Outage Statistics

There have been no outages associated directly with this air blast breaker.

Vendor Recommendations

The OEM recommends this refurbishment to provide continued reliable operation based on the condition of several breaker components.

Maintenance History

Maintenance of the air blast circuit breaker is performed by Hydro's internal labor based on vendor recommendations and industry best practices. Preventative maintenance is performed annually with corrective maintenance being performed as required. Since 2000 the average total maintenance cost for this breaker was approximately $1,300 per year which is not representative of its age and

condition. Ongoing preventative and corrective maintenance does not provide a viable alternative to the required refurbishment. The five-year maintenance history for the air blast circuit breaker is shown in Table 2.

Table 2: Five-Year Maintenance History

Year	Preventive Maintenance ($000)	Corrective Maintenance ($000)	Total Maintenance ($ 000)
2015	0.90	0.00	0.90
2014	1.23	0.00	1.23
2013	0.65	1.35	2.00
2012	2.46	0.00	2.46
2011	0.00	0.00	0.00

Anticipated Useful Life

Upon refurbishment the anticipated useful service life of this air blast breaker would be approximately 30 years.

Development of Alternatives

There are two additional alternatives to refurbishing the Upper Salmon main generator breaker which are retrofitting the system to install a new replacement breaker or maintaining the status quo until failure.

Evaluation of Alternatives

The results of a cost benefit analysis to compare the cumulative present worth of refurbishment versus replacement of the breaker are shown below in Table 3. The economic analysis shows that the least cost alternative is to refurbish the breaker. Maintaining the status quo until failure would have the same, if not higher, capital costs as the replacement alternative which also makes it less economical than refurbishment. It is generally accepted that reacting to a failure is more costly than replacing an asset in a planned capital project. If the breaker were to fail, procurement of a new breaker would take a few months and during that time the breaker and generator would remain out of service, resulting in lost generation. During the winter such a failure could result in a power outage which would negatively affect public safety and therefore this option is not viable. Refurbishing the breaker prior to failure would maintain the reliability of the system.

The 2012 condition assessment performed by ABB indicated that this breaker was in good health overall but required the replacement of worn parts to ensure continued reliable future operation. It is expected that this breaker could operate for up to an additional 30 years upon refurbishment. The expected useful service life of a new circuit breaker is approximately 40 years. The low number of operations (500 operations between 1982 and 2012) explains why the breaker is in good condition after 34 years of operation and justifies the extension of its useful service life by 30 years upon refurbishment. Based on the operating experience of this breaker and the cost of refurbishment versus replacement, refurbishment as proposed by the OEM is preferred.

Economic Analysis

Table 3 shows the outcome of the cost benefit analysis using the Cumulative Present Worth method. The results show that the least cost alternative is to refurbish the breaker.

Table 3: Cost Benefit Analysis Summary Table

Overhaul Main Generator Breaker - USL		
Alternative Comparison ***Cumulative Net Present Value*** ***To The Year*** **2016**		
Alternatives	**Cumulative Net Present Value (CPW)**	**CPW Difference between Alternative and the Least Cost Alternative**
Refurbish	362,491	0
Replace	524,687	162,196

Conclusion:

Based on the operating experience of this breaker and the cost benefit analysis performed, refurbishment is the least cost alternative.

Project Schedule:

The anticipated project schedule is shown in Table 4.

Table 4: Project Schedule

Activity		Start Date	End Date
Planning	Project initiation, scheduling, etc.	January 2017	March 2017
Procurement	Preparation of contract, tender package, bid review and contract award by PETS. Supply and delivery of replacement parts by ABB.	March 2017	May 2017
Construction	Replacement of worn parts.	June 2017	July 2017
Commissioning	Testing and commission of breaker.	July 2017	August 2017
Closeout	Project closeout, lessons learned, etc.	September 2017	October 2017

APPENDIX A

ABB Power Products Service Group

Nalcor order: 19356-000 OB

ABB job number: 492338

Breaker type: DBG 20 qc 1000 *Serial number:* C-6152 / F7208

Mechanism type: Air Blast *Control block's serial number:* HA1887724

Reason for visit: Maintenance *On site dates*: 2012-09-21 to 2012-09-23

Report presented to: M. Somkene Mbakwe

Daniel Martin

..... Date: April 2, 2013

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1. *Reason for visit :*

   - Maintenance inspection and testing of a DBG 20 qc 1000 breaker

2. *Summary:*

   - September 2012, Daniel Martin travelled to Upper Salmon in order to perform a DB breaker inspection.

3. *Problems:*

   - Routine inspection, no specific problem.

4. September 2012, Daniel Martin travelled to Upper Salmon in order to perform a DB breaker inspection.

5. *Technical information:*

DB BREAKER	
Type:	DBG 20 qc 1000
Order Number	P5455-0136 / 43056DA / F7208
Serial number	C.6152
Control Block s/n	HA 1887724
Year	1982
NL Hydro Designation	G1T1
Rated Voltage	20 kV
Rated Current	4000 Amp
Symm. breaking current	41.8 kA
Frequency	60 Hz
Minimum/trip/close (pressure)	150 / 200 psi
Manufactured in	Canada
Rated Breaking cap.	1000 MVA
Operating Pressure	215-230 psi
Number of operations	Operation counter found not working. Estimated of 500 op. Since commissioning

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6 *Findings and work carried out*

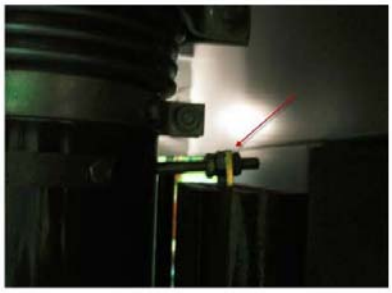
- Position number (PN) refer to tabulation of parts DB (HAGG 600 280).

Summary of findings

- The breaker was de pressurized and grounded, ready.

Breaker frame and pressure vessel

- Still in good condition
- No leaks



- Found a resistor on phase A1, that was not correctly installed. We installed it correctly after inspection.

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- We found rust inside B1 chamber. We cleaned everything and looked around. No trace of water infiltration from the roof. The vessel as no traces of water nor humidity. We recommend to make a monthly visual inspection inside the breaker fence to look for water infiltration

100..... Arc extinction chamber

- The contacts were found damaged. They were badly worn for contacts that as about 500 operations since commissioning.
- Spring assembly **100006** (rounded new type) in good condition, cleaned and oiled.
- The extinction contacts **100005** were the new type electron beam welded and were still in good conditions.
- The nozzle **100900** found in places were badly worn.
- The bolts were already secured with loctite on the contact tube **100007**. The contact tubes were also badly worn out. Both as been changed (the **100005**, **100007** and **100900** and on all phases) the by the ones you had in spare the old type. We recommend tighten the contacts every 200 C-O switching cycles, or latest after 1 year, and to replace them by the new type.
- Damper disc **100051** inspected, cleaned and oiled. They will have to be replace on each chamber (4 disc / chamber) bended more than 1,2mm.
- The insulating cylinders 100001 are worn due to copper / silver debris. **They will have to be replace**
- Insulating tubes **100054** are the old type wrapped hard paper, inspected and cleaned. We recommend to replace all 3 of them by the new type made of glass fibre reinforce epoxy.

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OLD TYPE NEW TYPE

- *Contact pre-tension gap: (minimum 3.5 mm)*

A1 chamber : 9.03 mm	B1 chamber : 9.09 mm	C1 chamber : 8.41 mm

- Contact tube assembly **100007** worn out on all 3 phases.

- Nozzle **100900** worn out on all 3 phases.

- Insulating cylinder **100001** new type glass reinforced wrapped hard paper found worn due to copper / silver debris. They will have to be replaced.

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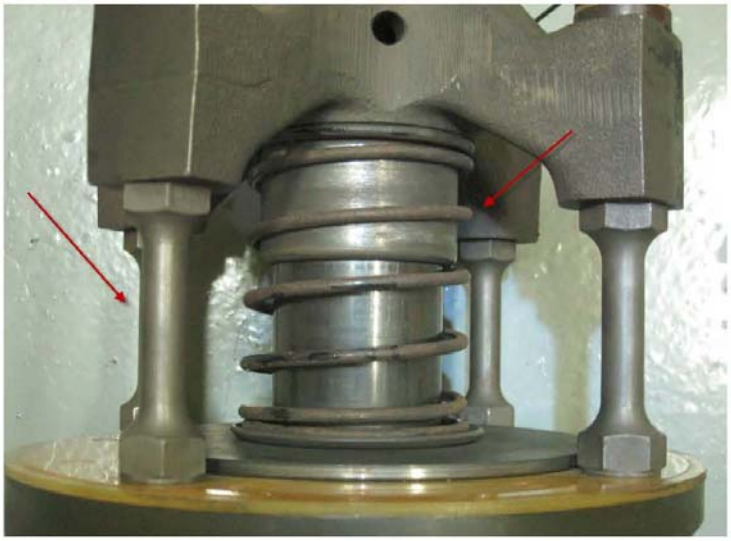
101..... Resistors

- Cleaned and inspected. Nominal value : 3.6 Ω
- Impedance: A1= 3.91 Ω, B1= 7.24 Ω, C1= 3.64 Ω. We recommend to replace resistor stack on B1 phase. The impedance is twice the Nominal value. Also, the resistors are the old type with the insulating cord made of asbestos. The new resistors are asbestos free.
- **101200** resorbit resistors: Inspected, still in good conditions.

103..... Main Valve

- We recommend an overhaul on the next inspection.
- Size 4.
- Compression spring **103406**: rusted old type black. Cleaned and lubricated. We recommend replacing it by the new type red.
- Bolts **103105** for main valve: old type. We recommend replacing the bolts. The new type improves the centering and the guidance of the main valve gasket.
- 

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104..... Insulator blades

- The contact pieces **104041** are in good condition. They were cleaned and greased.
- The brushes **104042** are in good condition. Cleaned and greased.

105..... Support insulators

- Extinction chamber's insulators **105001** and supporting insulators **105010** inspected and cleaned.

106..... Air lines

- Found a nut that was not tightened on the above air line underneath the vessel. We have tight the nut adequately.
- All the other air lines are in good conditions.

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107.... Isolator blade drive.

- We recommend overhauling the drive, with kit number 15.6 on the next overhaul.

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108....Auxiliary switch

- Inspected, cleaned and greased.

150.... Control Unit assembly.

- The control block as been overhauled, with kit number 1
- Impedance measured on CC= 113.72 Ω
- Impedance measured on TC1= 112.74 Ω
- Impedance measured on TC2= 114.48 Ω

Minimum operation voltage

- Closing: 34.90 Vdc
- Opening 34.90 Vdc

Operation counter

- *The operation counter was found not working. We replaced it with a new one you had in stock.*

Recommendations

- It is important to clean the isolator blades contact pieces and brushes yearly and apply a coat of contact grease shell Alvania.
- It is important to lubricate the control block, yearly as detailed in the breaker manual with graphite oil spec 2.
- Generally retighten extinction contacts to prescribe torque after 200 CO switching cycles, or after 1 year

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Overview of the breaker

Contact resistance

Before the replacement of the contacts

- *A1= 21 Ω*
- *B1= 23 Ω*
- *C1= 22 Ω*

After replacement of the contacts (end of the job)

- *A1= 26 Ω*
- *B1= 29 Ω*
- *C1= 29 Ω*

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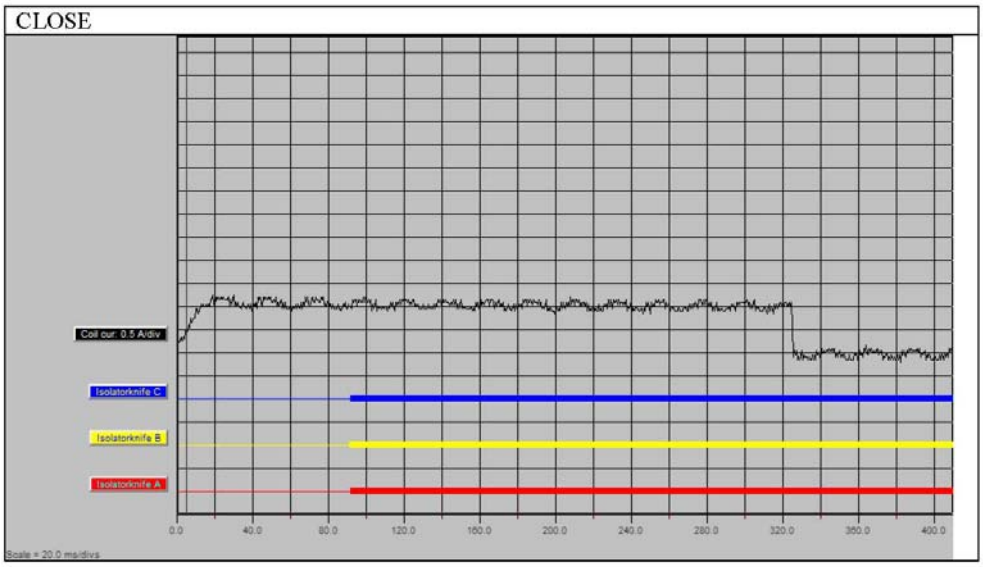
Circuit Breaker Data			**Test Data**	
Breaker ID1	492338		Test Id	
Breaker ID2	NALCOR Upper Salmon		Test date	9/21/2012
Breaker ID3	DBG 20qc1000		Test time	06 : 00 AM
Breaker ID4	G1T1		Type	Inspection
Serial no.	C-6152		Reference	
Commission date	1983		CO-Counter	
Interruping medium	Air blast		Operator	Daniel Martin
Rated frequency	60.0	Hz	Plan Id	BL-8016E R01A
Rated voltage	10	kV	Plan description	Testplan for DB breaker, 1 imp.chamb.
Rated current	4 000	A		
Rated short-circuit breaking current	41.8	kA		
Rated motor voltage		V		
Rated supply voltage	110V DC	V		



ParameterTable:

Parameters	Value	Unit	Minimum	Maximum	Nominal	Pass / Fail
Cls t, Isolator A	92.2	ms	65.0	100.0		Pass
Cls t, Isolator B	91.5	ms	65.0	100.0		Pass
Cls t, Isolator C	92.2	ms	65.0	100.0		Pass

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Circuit Breaker Data			**Test Data**	
Breaker ID1	492338		Test Id	
Breaker ID2	NALCOR Upper Salmon		Test date	9/21/2012
Breaker ID3	DBG 20qc1000		Test time	06 : 00 AM
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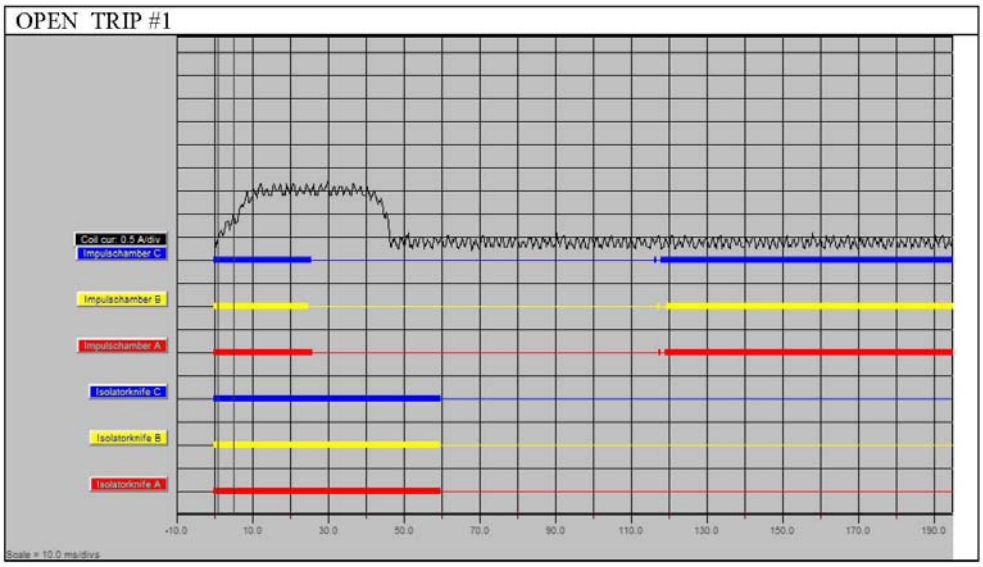
Commission date	1983		CO-Counter	
Interruping medium	Air blast		Operator	Daniel Martin
Rated frequency	60.0	Hz	Plan Id	BL-8016E R01A
Rated voltage	10	kV	Plan description	Testplan for DB breaker, 1 imp.chamb.
Rated current	4 000	A		
Rated short-circuit breaking current	41.8	kA		
Rated motor voltage		V		
Rated supply voltage	110V DC	V		



ParameterTable:

Parameters	Value	Unit	Minimum	Maximum	Nominal	Pass / Fail
Open time	26.0	ms	20.0	30.0		Pass
Open time	24.8	ms	20.0	30.0		Pass
Open time	25.8	ms	20.0	30.0		Pass
Del IC-Iso		ms	30.0	70.0		Pass
Del IC-Iso	33.9	ms	30.0	70.0		Pass
Del IC-Iso	34.9	ms	30.0	70.0		Pass
OC time	1.0	ms	80.0	130.0		Pass
OC time	91.4	ms	80.0	130.0		Pass
OC time	92.4	ms	80.0	130.0		Pass

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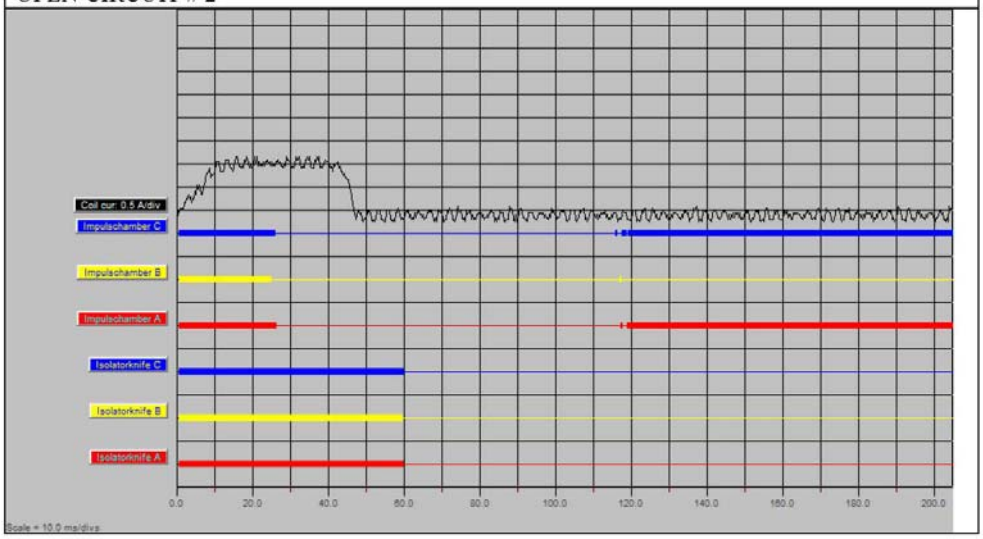
Test Data

Circuit Breaker Data

Breaker ID1	492338		Test Id	
Breaker ID2	NALCOR Upper Salmon		Test date	9/21/2012
Breaker ID3	DBG 20qc1000		Test time	06 : 00 AM
Breaker ID4	G1T1		Type	Inspection
Serial no.	C-6152		Reference	
Commission date	1983		CO-Counter	
Interruping medium	Air blast		Operator	Daniel Martin
Rated frequency	60.0	Hz	Plan Id	BL-8016E R01A
Rated voltage	10	kV	Plan description	Testplan for DB breaker, 1 imp.chamb.
Rated current	4 000	A		
Rated short-circuit breaking current	41.8	kA		
Rated motor voltage		V		
Rated supply voltage	110V DC	V		

OPEN CIRCUIT # 2



ParameterTable:

Parameters	Value	Unit	Minimum	Maximum	Nominal	Pass / Fail
Open time	26.5	ms	20.0	30.0		Pass
Open time	25.2	ms	20.0	30.0		Pass
Open time	26.2	ms	20.0	30.0		Pass
Del IC-Iso		ms	30.0	70.0		Pass
Del IC-Iso	33.6	ms	30.0	70.0		Pass
Del IC-Iso	34.7	ms	30.0	70.0		Pass
OC time	1.1	ms	80.0	130.0		Pass
OC time	90.9	ms	80.0	130.0		Pass
OC time	92.0	ms	80.0	130.0		Pass

ABB Power Products Service Group

Circuit Breaker Data			**Test Data**	
Breaker ID1	492338		Test Id	
Breaker ID2	NALCOR Upper Salmon		Test date	9/21/2012
Breaker ID3	DBG 20qc1000		Test time	06 : 00 AM
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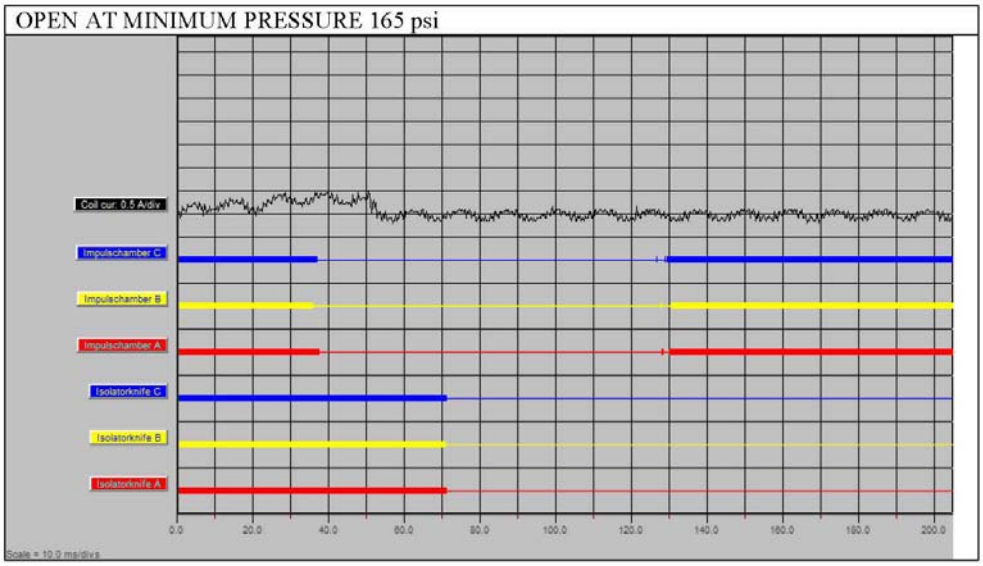
Serial no.	C-6152		Reference	
Commission date	1983		CO-Counter	
Interruping medium	Air blast		Operator	Daniel Martin
Rated frequency	60.0	Hz	Plan Id	BL-8016E R01A
Rated voltage	10	kV	Plan description	Testplan for DB breaker, 1 imp.chamb.
Rated current	4 000	A		
Rated short-circuit breaking current	41.8	kA		
Rated motor voltage		V		
Rated supply voltage	110V DC	V		
Nominal stroke	256.2	mm		



ParameterTable:

Parameters	Value	Unit	Minimum	Maximum	Nominal	Pass / Fail
Open time	37.9	ms	20.0	30.0		Fail
Open time	36.3	ms	20.0	30.0		Fail
Open time	37.3	ms	20.0	30.0		Fail
Del IC-Iso		ms	30.0	70.0		Pass
Del IC-Iso		ms	30.0	70.0		Pass
Del IC-Iso	33.5	ms	30.0	70.0		Pass
OC time	90.2	ms	80.0	130.0		Pass
OC time	91.7	ms	80.0	130.0		Pass
OC time	89.5	ms	80.0	130.0		Pass
DfB IC ABC	2.2	ms				

ABB Power Products Service Group

Circuit Breaker Data			**Test Data**	
Breaker ID1	492338		Test Id	
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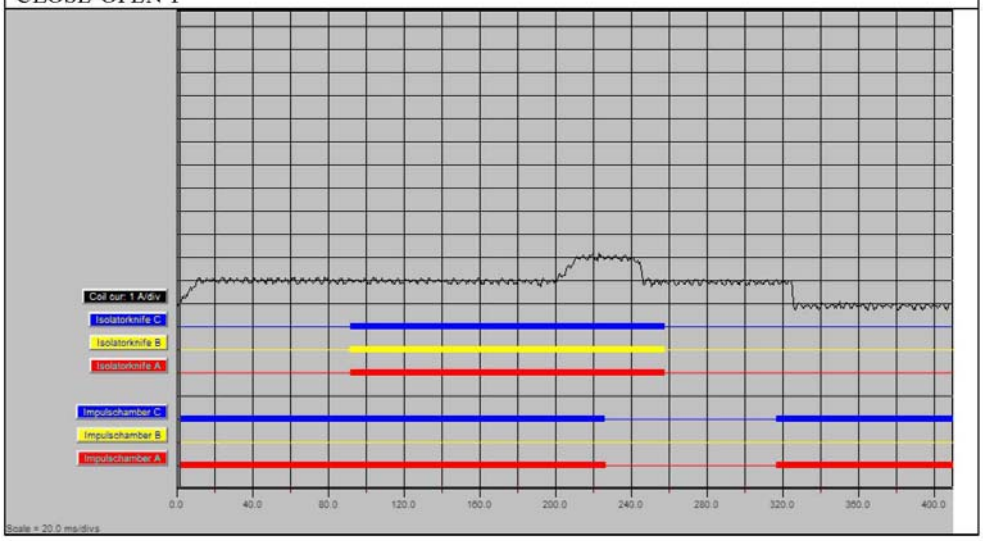
Rated motor voltage		V		
Rated supply voltage	110V DC	V		
Nominal stroke	256.2	mm		

CLOSE-OPEN 1



ParameterTable:

Parameters	Value	Unit	Minimum	Maximum	Nominal	Pass / Fail
Close time	92.0	ms	65.0	100.0		Pass
Close time	91.3	ms	65.0	100.0		Pass
Close time	92.0	ms	65.0	100.0		Pass
CO time	166.1	ms				
CO time	166.8	ms				
CO time	166.2	ms				
OC time	88.1	ms	80.0	130.0		Pass
OC time	-- -- --	ms	80.0	130.0		Fail
OC time	87.4	ms	80.0	130.0		Pass
CO time	166.9	ms				
DfCO t ABC	0.7	ms				
Del IC-Iso	31.1	ms	30.0	70.0		Pass
Del IC-Iso	-- -- --	ms	30.0	70.0		Fail
Del IC-Iso	31.6	ms	30.0	70.0		Pass

ABB Switzerland Ltd

HAGG 600 452

DB - Maintenance report

Customer	Nalcor	Breaker type	DBG 20 QC 1000
Plant	Upper Salmon	Serial number B/HA	C.6512 / F7208
Order number		Year of construction	1982

Technical information

No. of switching cycles at:	CO	Date
- last overhaul	NEVER	
- present overhaul	?	2012/09/23
Expected at next overhaul	1500	2015/09/23

A = Old type
M = Modification
E = Replaced
K = Checked
S = Servicing recommended
Mod = Modification point

Part #	Part name	Criteria			A	M	E	K	S	Mod
100	**Arc extinction chamber**									
100001	Insulating cylinder	fibreglass without flange			X			X	X	1.4.1
100001	Insulating cylinder	fibreglass with flange								1.4.2
		Torque:	84	Nm						
100002	Flange	Fissures / fractures			X			X	X	1.5
100...	Contact - prestress	Minimum: X= 3,5 mm								
		Measured data : Phase R Phase S Phase T								
	Disconnector side--Arcing chamber		9.03	9.09 8.41						
	Brush side- Arcing chamber:									
	Disconn. side--Current chamber									
	Brush side - Current chamber t									
100005	Extinction contact	Torque:	300	Nm				X		
		Flanged: mechanical / electrical wear						X		
		Welded: mechanical / electrical wear								1.6
		Cast-in: mechanical / electrical wear			X			X		1.6.1
100006	Spring body	Cross section of spring, rectangular, round / fractures				X		X		1.3
100007	Contact tube assembly	Bolts secured with Loctite / wear			X	X		X	X	1.2
100008	Contact carrier	Jumps / burn-up marks								
100009	Flow screen	Copper fractures / steel type								
100051	Damper disc	Bending > 1.2 mm / fractures / fissure						X	X	
100054	Insulating tube assembly	Cracks in laminated paper / fibreglass			X			X	X	1.1
100.1	Extinct. chamber housing	Damaged silver coating / cracks in Housing						X		
100101	Contact screw	Damaged thread						X		
100102	Connection	Damaged thread						X		
100900	Contact nozzle	Mechanical-/ electrical – wear					X	X	X	
100910	Exhaust cooler	Damage/ tight fit of straps/ tight fit of electrode						X		
100920	Cooler plate	> 1/3 damaged						X		
101	**Resistor**									
101...	Value of resistance	According to order:	3.6	Ohm				X		
100931	Threaded bolt, top	Incipient cracks/fractures (s.extinct.chamb.resistor)						X		
100932	Threaded bolt, bottom	Incipient cracks/fractures (s.extinct.chamb.resistor)						X		
101001	Insulating jacket	No asbestos / damaged connections			X			X	X	7
		Fixation secured								
101050	Leaf spring (potential connection)	Existing / fractured								
								X		

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Part #	Part name	Criteria		A	M	E	K	S	Mod
101200	**Resistor, resorbit**	Roller class:	16						
101910	Roller, resorbit	Contact surfaces, surfases damaged					X		
101911	Contact disc	Wear					X		

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Part #	Part name	Criteria	A	M	E	K	S	Mod
101952	Threaded bolt	Incipient cracks / fractures				X		
101954	Support assembly	Incipient cracks / fractures				X		
103	**Main valve**	**Size:** 4						6
103.01	Piston assembly	Piston or pin loose / pin scured with Loctite				X		6.1
103.02	Dished spring	Cracks / fractures new type - stronger material				X		6.2
103.03	Damping cylinder	Cracks / fractures new type - stronger material				X		6.3
103.04	Damping piston	Cracks / fractures new type - stronger material				X		6.4
103.05	Pin	Lengthened / new type-improved m.-valve seal-guide	X			X	X	6.5
103.06	Compression spring	Setting / new type - stronger material / end of Spring marked RED	X			X	X	6.6
103.07	Buffer	Wear				X		
103...	Main valve rod	Wear				X		
103.31	Valve disc	Mechanical wear / fractures				X		
103.32	Piston ring	Fractures				X		
103.33	Seal	Damages				X		
1039..	Set of seals WHITE	Wear / break-aways / new type - improved guide				X	X	6.7
103	**Main valve**	**Size:**						6
103.01	Piston assembly	Piston or pin loose / pin scured with Loctite						6.1
103.02	Dished spring	Cracks / fractures new type - stronger material						6.2
103.03	Damping cylinder	Cracks / fractures new type - stronger material						6.3
103.04	Damping piston	Cracks / fractures new type - stronger material						6.4
103.05	Pin	Lengthened / new type-improved m.-valve seal-guide						6.5
103.06	Compression spring	Sagging / new type - stronger material / end of Sprin marked RED						6.6
103.07	Buffer	Wear						
103...	Main valve rod	Wear						
103.31	Valve disc	Mechanical wear / fractures						
103.32	Piston ring	Fractures						
103.33	Seal	Damages						
1039..	Set of seals	Wear / disruption / new type - improved guide						6.7
104	**Isolator**							
104...	Contact brushes	Sag: specified size = 1,3 ... 1,7 mm				X		
104...	Isolator blade - movement	CLOSE = forward- / OPEN = backward-travel				X		
104041	Contact piece	Mechanical / electrical wear				X		
104042	Contact brush	Mechanical / electrical wear				X		
104100	Insulating rod	Mechanical wear / new type – fiberglass				X		5
105	**Insulators**							
105001	Extinct. chamber insulator	Torque Top: 50 Nm bottom: 80 Nm				X		
105010	Supporting insulator	Damages				X		
106	**Air lines**							
106...	Air lines	Flanged, damaged				X		
		Soldered				X		4
107	**Isolator blade drive**	**Important: After an extended operating period (many years) or after fitting**						
107400	Adjusting device	**new device check and readjust damping**				X		
107500	Driving mechanism	Replace set if damaged Set no						
107521	Buffer rings	Factures / wear (parts included in set)						
.....	**Remarks**							

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Part #	Part name	Criteria	A	M	E	K	S	Mod

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Part #	Part name	Criteria	A	M	E	K	S	Mod
108	**Auxiliary switch**							3
108...	Auxiliary switch rod	Wear / play				X		
108...	Contact finger	Sag: specified size = 1,0 ... 1,4 mm				X		
108...	Contact pressure	Specified value = 150 ... 250 p						
108900	Auxillary swich set no.5	Aux.switch type 1 / 2 / 3, securing of screws						3.a
108...	Auxiliary switch	Aux.switch type 4 / 5, securing screws - Loctite				X		3.b
1089..	Auxiliary switch set no.10	Worn bevel wheels/new type-made of bronze				X		3.1
		Replace Set no.						
109	**Delay valve**							
1090.0	Delay valve set no.14...	Wear / fractures Set. no						
1090.1	Diaphragm	Fractures / rust (parts included in set no.14...)						
1090.2	Compression spring	Fractures (parts included in set no. 14...)						
1090.3	Ring seal	Wear / ageing (parts included in set no. 14...)						
110	**DB – Breaker materials**	(see Instruction manual HAGG 600 011 E)						
110010	Securing of bolts							8
110010	Gate valve	Securing of bolts acc. to instructions for modification						8 A
110010	Contr.valve of main valve	Securing of bolts acc. to instructions for modification						8 B
110010	Contr.valve, 2.main valve	Securing of bolts acc. to instructions for modification						8 C
110010	Control valve bearing	Securing of bolts acc. to instructions for modification						8 D
110010	Control valve bearing	Securing of bolts acc. to instructions for modification						8 E
110010	Insulator flanges	Securing of bolts acc. to instructions for modification						8 F
110010	Insulating cylinder	Securing of bolts acc. to instructions for modification						8 G
110010	Extingt.chamber exhaust	Securing of bolts acc. to instructions for modification						8 H
110010	One low value resistor	Securing acc. to instructions for modification						8 J
110010	One low value resistor	Securing acc. to instructions for modification						8 K
110010	Two low value resistor	Securing acc. to instructions for modification						8 L
110010	Two low value resistor	Securing acc. to instructions for modification						8 M
110010	Exhaust cooler	Securing acc. to instructions for modification						8 N
110020	Control valve set no.2.1	Replace seals if worn and after expiration of interval						
110050	Control valve set no.2.2	Replace piston and spindle if worn						
110060	Control valve set no.2.3	Piston closed, replace if worn						
110070	Control valve set no.2.4	Materials for securing						
110130	Pressure vessels set 13..	Wear / ageing Replace set no						
		Seals / disc of non-return valve (parts in set)						
100200	Breaker shaft	Welds chapped / brackets beaten						
110...	Shaft bearing	Beaten						
		Lubricating nipple existing						
110...	Pressure vessels	Dry / checked for contamination						
.....	**Remarks**							

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Part #	Part name	Criteria		A	M	E	K	S	Mod
150	**Control unit assembly**	Total state estimation							
		Number of CO - switching cycles	?				X		
150...	Control unit	Check play / instructions for inspection					X		
150051	Piston assembly	Wear					X		
150052	Valve spindle	Wear					X		
150060	Spring body	Wear / proper functionality				X	X		
150070	Valve cartridge	Wear / tightness				X	X		
150100	Control unit set no. 1	Auxiliary materials (Replace seals after expiration of interval)				X	X		
150150	Control unit set no. 3	Uprating: pins, springs, locking devices							2.1
150200	Control unit set no. 4.1	Uprating: locking devices, material							2.2
150220	Control unit set no. 4.2	Auxiliary materials: check parts for wear-nuts and bolts							
150230	Control unit set no. 4.3	Auxiliary materials: replace worn parts - control shaft							
150250	Control unit set no. 6.1	Auxiliary materials: check power accumulator CLOSE and OPEN for wear							2.1.1
150300	Control unit set no. 7	Upratng: retainer - lengthened retaining ratchet							
150...	Control unit	Uprating: secured retainer - pinned / Loctite							
150350	Control unit set no. 8.1	Auxiliary materials: closed circuit current magnet - wear							
150350	Control unit set no. 8.2	Auxiliary materials: blocking magnet - wear							
150400	Control unit set no. 9.1	Auxiliary materials: 2.operating current release - wear							
150410	Control unit set no. 9.2	Uprating: 2.operating current release, fixation reinforce.							
150430	Control unit set no. 9.3	Uprating: 2.operating current release, fixation and housing reinforcement							
110...	Control unit rods	Wear							

..... **Remarks**

AIR CONSUMPTION	
CLOSE	**5 PSI**
OPEN	**33 PSI**
CLOSE-OPEN	**35 PSI**

..... **Special remarks**

100005	**Extinction contact**	**Generally retighten extinction contacts to prescribed torque after 200 CO switching cycles, or latest after 2 years. For DB breakers type n, p, q, r again after 1,000 cycles.**

Place, date, signatures

ABB: *Daniel Martin*

Customer: **Somkene Mbakwe**

Project Title: Purchase Capital Spares – Terminals

Location: Various Sites

Category: Transmission & Rural Operations - Terminal Stations

Type: Other

Classification: Normal

Project Description:

This proposal is for a one year project for the procurement of isolated phase bus ducts (IPBs) to allow for installation of an available spare generator step-up (GSU) transformer at various sites, depending on the location of the failed GSU. This estimate includes the purchase and delivery of the IPBs plus all associated hardware and connection kits. This estimate also includes a site visit by a Third Party Contractor to verify IPB design and measurements.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	0.0	0.0	0.0
Labour	76.3	0.0	0.0	76.3
Consultant	0.0	0.0	0.0	0.0
Contract Work	322.5	0.0	0.0	322.5
Other Direct Costs	3.2	0.0	0.0	3.2
Interest and Escalation	13.3	0.0	0.0	13.3
Contingency	80.4	0.0	0.0	80.4
TOTAL	**495.8**	**0.0**	**0.0**	**495.8**

Justification:

Lead times for isolated phase bus ducts can be up to 24 weeks. Procurement of the IPBs ahead of time is required to allow for the installation of an available spare transformer in a reasonable time frame (4-6 weeks) in the event of a GSU transformer failure.

Operating Experience

A spare transformer is available and can be installed to replace various GSUs. In the event of a GSU failure the spare transformer can be installed in about 4-6 weeks. The isolated phase bus ducts will

also require replacement and therefore must be procured ahead of time due to long lead times and manufacturer's factory loading.

Conclusion:

This critical spare equipment will facilitate an expedited return to service should a facility experience an outage due to the failure of an in-service critical transformer. Critical spares are identified during ongoing critical spares evaluations undertaken by Hydro and requested annually. It is the intention of Hydro to purchase these critical spares and have them on site to provide ongoing, reliable service to customers.

Project Schedule:

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Design review, field verifications.	January 2017	March 2017
Procurement	Procurement of bus ducts.	March 2017	May 2017
Closeout	Project finance close-out, lessons learned, etc.	May 2017	May 2017

Project Title: Install Recloser Remote Control

Location: Bottom Waters Terminal Station

Category: General Properties - Telecontrol

Type: Other

Classification: Normal

Project Description:

This project is to install remote control and monitoring of the existing reclosers at the Bottom Waters Terminal Station. The reclosers will be controlled from Hydro's Energy Control Center (ECC) in St. John's.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	118.6	0.0	118.6
Labour	38.1	147.3	0.0	185.4
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	6.0	43.0	0.0	49.0
Interest and Escalation	3.0	39.1	0.0	42.1
Contingency	0.0	70.6	0.0	70.6
TOTAL	**47.1**	**418.6**	**0.0**	**465.7**

Justification:

This project is justified on the requirements to deliver reliable power to customers by connecting the Bottom Waters Terminals Station reclosers to ECC. The primary benefit is the reduction in power outage durations.

A Recloser operates to maintain service continuity by automatically restoring power after a temporary fault. If the current reaches an amount which is above a set limit, then the recloser will operate and trip the line, thus disconnecting the line from its source. It can operate a number of times to give a transient fault a chance to clear. Reclosers are also used as a means to disconnect power to a distribution line for the purpose of maintenance and troubleshooting activities. This

switching could be conducted manually; or remotely by connecting the reclosers to the Supervisory Control and Data Acquisition (SCADA) system.

The main advantage of automated reclosers is their ability to be opened and/or closed much more quickly than manual operation; their reliability impact can easily be recognized. The SCADA connection will allow for remote control of recloser operations by ECC, thereby improving restoration times. Additionally, many of the outages affecting the distribution lines in Bottom Waters system result from adverse weather conditions. This requires crews to travel in adverse weather to the terminal station when road conditions can often be a safety hazard. Enabling remote operation of these reclosers will reduce customer outage time and cut down on the amount of travel time and associated exposure to these adverse driving conditions.

The additional benefits would be the addition of inputs and outputs for SCADA. If the reclosers are connected with the SCADA network, ECC could remotely operate the recloser and would have remote access to data such as real-time load data, recloser events, number of operations, monthly peak loads, and maintenance flags.

This project is strictly reliability based. The alternative which is the status quo will be no improvement to customer reliability. The Bottom Waters Distribution System is the worst performing system in Hydro. While this project will not reduce the frequency of outages it will reduce their duration thus improving overall reliability.

Existing System

The three existing reclosers at the Bottom Waters Terminal Station are shown in Table 2.

Table 2: Reclosers

Recloser	Location	Panel Type
BW1 – R1	Distribution Line 1	Form 6
BW2 – R1	Distribution Line 2	Form 6
BW3 – R1	Distribution Line 3	Form 6

All the above reclosers are electronic units with “Form 6” control panels (Figure 1). These panels are microprocessor-based with the ability to connect to several different types of networks in order to

supply supervisory control and data transfer. These control panels will be able to provide the necessary inputs and outputs to facilitate a SCADA connection without any major upgrades or modifications being completed.

Figure 1: Existing Recloser Form 6 Control Panels (which can accommodate remote control)

Operating Experience:

Bottom Waters Terminal Station has three reclosers- BW1-R1, BW2-R1, and BW3-R1 connected to three different distribution feeders respectively Line 1, Line 2, and Line 3. Line 1 currently services Rambler mine, Anaconda Mine, and the communities of Pacquet, Woodstock, and Ming's Bight. Line 2 services Nugget Pond mine site and Nipper's Harbour community. Line 3 provides power supply to Brent's cove substation and La Scie substation.

Reliability Performance:

Table 2 lists five year average (2010-2014) SAIFI[2], SAIDI[3], and CAIDI[4] data for Bottom waters system (Line 1, 2, and 3), and Hydro corporate.

Outage Statistics:

Table 2: Five Year Averages KPI (2010 to 2014)

System	All Causes		Planned Outage		Loss of supply		All Causes excluding planned outage and loss of supply		
	SAIFI	SAIDI	SAIFI	SAIDI	SAIFI	SAIDI	SAIFI	SAIDI	CAIDI
Bottom Water Line 1	5.70	49.48	0.02	0.02	1.00	6.69	4.68	42.77	9.13
Bottom Water Line 2	3.33	16.89	0.20	0.36	1.40	7.17	1.73	9.36	5.40
Bottom Water Line 3	4.73	55.61	0.00	0.00	1.00	6.82	3.73	48.78	13.08
Hydro Corporate	5.25	13.78	1.02	3.86	2.27	4.02	1.96	5.90	3.01

Development of Alternatives:

There are no other viable alternatives.

Conclusion:

The implementation of this project is justified on the reduction of outage time due to line faults.

Project Schedule:

The anticipated project schedule is shown in Table 4.

Table: 4 Project Schedule

Activity		Start Date	End Date
Planning	Project Setup and Overall Design Completion	January 2017	February 2017
Design	Detailed Design	March 2017	November 2017
Procurement	Procurement	November 2017	April 2018
Construction	Construction	May 2018	August 2018
Commissioning	Commissioning	September 2018	October 2018
Closeout	Closeout	November 2018	December 2018

[2] System Average Interruption Frequency Index.
[3] System Average Interruption Duration Index.
[4] Customer Average Interruption Duration Index.

Project Title: Replace Insulators

Location: TL227 Berry Hill to Daniel's Harbor

Category: Transmission and Rural Operations - Transmission

Type: Other

Classification: Normal

Project Description:

This project is for the replacement of vertical line post insulators on TL227 with insulator that are resistant to higher levels of salt contamination between structures 583 and 677, a distance of approximately ten kilometers. This will reduce the frequency of outages to TL227 due to salt contamination.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:($ x1,000)	**2017**	**2018**	**Beyond**	**Total**
Material Supply	90.0	0.0	0.0	90.0
Labour	43.0	44.0	0.0	87.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	120.0	0.0	120.0
Other Direct Costs	6.0	15.0	0.0	21.0
Interest and Escalation	6.6	28.7	0.0	35.3
Contingency	0.0	63.6	0.0	63.6
TOTAL	**145.6**	**271.3**	**0.0**	**416.9**

Justification:

This section of TL227, a 69 kV transmission line, runs along the coastline and is exposed to frequent, high level salt contamination as a result of strong salt laden onshore ocean winds.

The presence of higher levels of surface contamination, higher than the insulators were designed to sustain, will allow uncontrolled leakage current (electricity) to flow along the insulator to the structure, or bypass the insulator by flashing over the insulators length. If the flow is strong enough, it will subsequently cause an outage to the line. The existing insulators on TL227 have a low level of resistance to salt contamination, as shown by the outage frequency in Figure 1. The data shows the outage rates for both TL221 (same design and insulation level as TL227) and TL227 compared to

other 69 kV lines for the years between 2005 and 2015. Insulators on TL221 were replaced in 2009, with a significant level of reliability improvement.

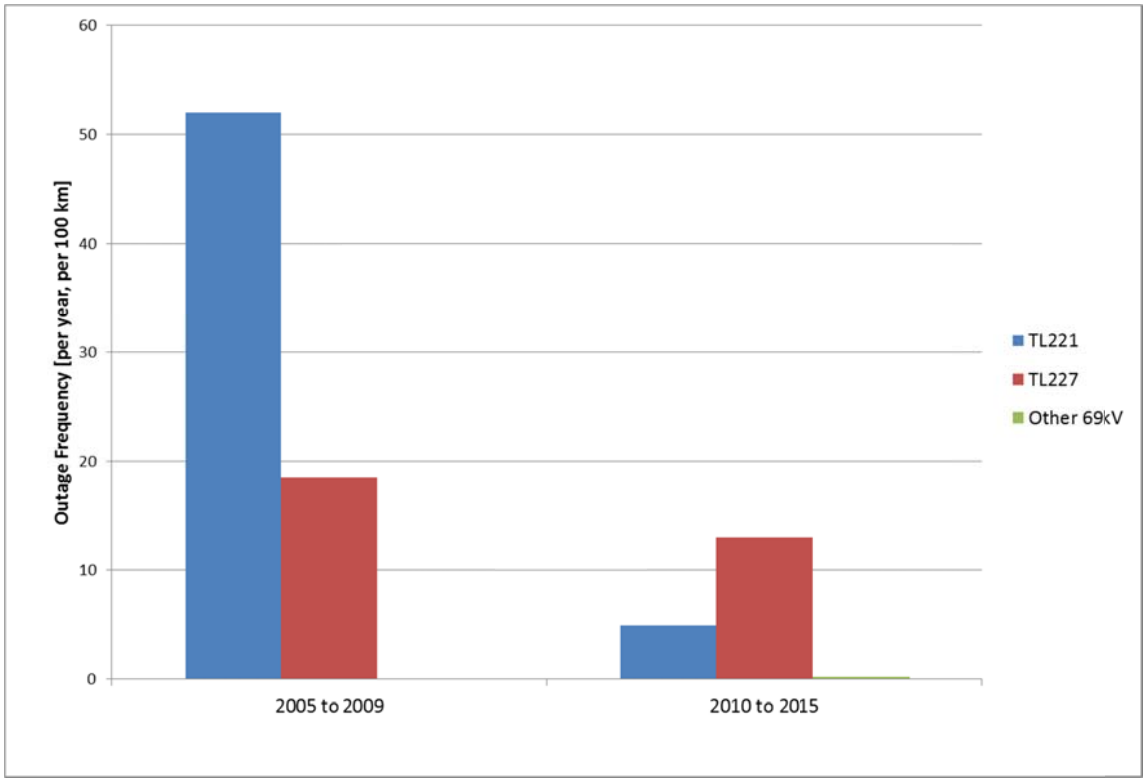

Figure 5: Outage Frequency of 69 kV Lines due to Salt Contamination

These types of outages result in one of two impacts on the electrical system. The first impact is a short outage, as the protective relaying will de-energize the line and then shortly thereafter re-energize the line (reclose) to allow the cause of a fault to clear itself from the electrical system. The outage before the line is reclosed is seconds in duration. If the fault remains, the protective relaying will de-energized the line and the source of the fault has to be investigated before the protective relaying can be reset and the line re-energized. This outage is much longer in duration. In either case customers supplied by TL227 are affected.

Figure 2 provides five year average SAIFI and SAIDI values for the delivery points of TL227. These values provide a measure of the average number of sustained interruptions (SAIFI) and the duration of these outages (SAIDI). The chart on the left provides the data for all fault causes, while the data on the right is a subset that isolates the faults that were causes by salt contamination only. A

comparison of the two tables will provide the expected reliability improvement by replacing the insulators.

Delivery Point Five Year Averages (Forced Outages)
All Fault Causes

Delivery Point Affected	T-SAIFI	T-SAIDI
Cow Head (2011-2015)	6.00	408.80
Daniel's Harbour (2011-2015)	3.40	291.20
Parson's Pond (2011-2015)	7.80	693.60
Northern Region (2011-2015)	6.20	347.32
Hydro System (2011-2015)	1.85	111.63
CEA (2010-2014)	0.81	77.94

Delivery Point Five Year Averages (Forced Outages)
Salt Contimation Related Only

Delivery Point Affected	T-SAIFI	T-SAIDI
Cow Head (2011-2015)	2.00	36.80
Daniel's Harbour (2011-2015)	0.40	46.00
Parson's Pond (2011-2015)	3.60	277.80
Northern Region (2011-2015)	1.38	48.02
Hydro System (2011-2015)	0.30	10.14
CEA (2010-2014)	N/A	N/A

T-SAIFI(S) is the System Average Interruption Frequency Index for Sustained. Delivery Point Interruptions. This provides a measure of the average number of sustained interruptions that a delivery point experiences during a specified period.

$$T-SAIFI(S)=\frac{Total\ No.of\ Sustained\ Interruptions}{Total\ No.of\ Delivery\ Points\ Monitored}$$

T-SAIDI is the System Average Interruption Duration Index. This index provides a measure of the average duration of sustained interruptions that a delivery point experiences during a specified period.

$$T-SAIDI=\frac{Total\ Duration\ of\ All\ Interruptions}{Total\ No.\ of\ Delivery\ Points\ Monitored}$$

Figure 6: SAIFI(s) AND SAIDI(s) for TL227 Delivery Points

For example, the community of Parson's Pond should expect a 40% improvement in both SAIFI(s) and SAIDI(s) once the insulators are replaced.

Replacing the low contamination resistant insulators in the section between structures 583 and 677 on TL227 with a higher resistant insulator will reduce salt contamination related outages on TL227. As illustrated in Figure 1, a similar project on TL221 was completed in 2009. There has been a 92% reduction in the number of outages comparing the periods before and after the replacement.

The remainder of TL227 does not experience similar high levels of salt related outages as it is either located in more sheltered areas, or was built with more expensive structures with suspension insulators, which are more resistant to salt contamination.

As detailed above, salt contamination can result in uncontrolled current flow. Any uncontrolled current flow represents a safety risk of electrocution to both Hydro employees and to the general public. Also uncontrolled flow can start a pole fire which could result in a forest fire.

Existing System:

TL227 is part of Hydro's Island Interconnected System and provides service to the Northern Peninsula. TL227 is a 69 kV wood pole transmission line from Berry Hill to Daniels Harbour, a distance of approximately 82 km. The existing insulators, on this section of TL227, are referred to as line post type insulators. The line was commissioned in 1970 and consists of a variety of wood pole structure types. TL227 is part of the loop transmission system on the Northern Peninsula and is built in parallel to TL259 (138 kV) which is the primary transmission line to the Northern Peninsula. Figure 3 shows the location of TL227.

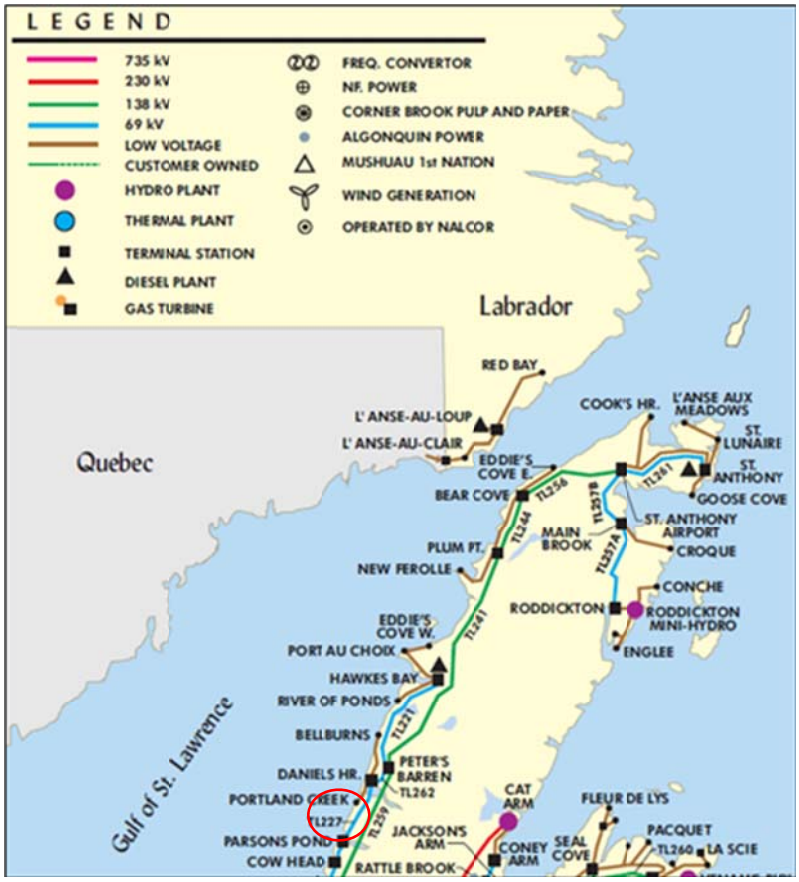

Figure 7: Route Photo of TL 227

Table 3 is a summary of major work or upgrades performed on the line in the past five years.

Table 3: TL227 Major Work or Upgrades

Year	Major Work/Upgrade ($000)	Comments
2015	28.3	Replace Poles, Hardware and Insulators
2014	0.0	No major work completed in 2014
2013	4.7	Inspection and Minor Repairs
2012	10.1	Minor Repairs
2011	0.0	No major work completed in 2011

Operating Experience:

This line runs primarily along the coast and as a result, is exposed to high winds, icing, and salt contamination. It has experienced a significant number of trips due to salt contamination on the line post insulators.

Reliability Performance:

As a result of excessive salt spray accumulation on the insulators located on TL 227, the transmission line experiences a high rate of flashover resulting in numerous service interruptions to local customers as shown in Figures 1 and 2 above.

Outage Statistics:

Five Year Averages from 2011 to 2015 are tabulated below:

Table 4: Outage Statistics of TL227 for 2011 to 2015

No. of Outages	Frequency (per a)	Unavailability (%)	Frequency (per 100km a)
29	5.80	1.120	6.905

Outage Frequency (per 100 kilometre-years for transmission lines) – is the number of forced outages divided by the number of kilometer-years and which is in turn divided by 100.
Outage Frequency (per component year) – is the number of forced outages divided by the number of component years.
Unavailability (%) – is the product of the outage frequency and the average outage duration, in years.

Safety Performance:

There are no documented safety performance issues on the line.

Environmental Performance:

This project is not justified on the basis on environmental performance.

Maintenance or Support Arrangements:

TL227 is inspected and maintained as part of the Wood Pole Line Management Program. All wood pole lines, province-wide, are inspected as part of a ten-year cycle.

Maintenance History:

The five year maintenance history of TL227 is outlined in Table 5 below.

Table 5: TL227 Five-Year Maintenance Costs History

Year	Preventive Maintenance ($000)	Corrective Maintenance ($000)	Total Maintenance ($000)
2015	42.0	28.0	70.0
2014	58.0	0.0	58.0
2013	22.0	0.0	22.0
2012	0.0	0.0	0.0
2011	0.0	0.0	0.0

Historical Information:

Salt contamination has been identified as the root cause of several outages on TL227 throughout the years of collected data. This is illustrated in Figures 1 and 2.

Anticipated Useful Life:

Replacing the existing insulators on this section of line will not directly increase the useful life of this asset, since the remaining life of this transmission line will be dependent on the condition of the other existing components.

TL227 is maintained under Hydro's Wood Pole Line Management Program, which ensures that the line undergoes regular inspection, maintenance, and refurbishment as required. Under the program, it is anticipated that the useful life of TL227 should be extended well beyond 50 years.

The existing line is currently 45 years old and overall appears to be in good condition as a result of scheduled inspections and regular maintenance.

Forecast Customer Growth:

This project is not justified on the basis of future load growth.

Development of Alternatives:

The alternatives for this project include;

1) Replace existing insulators; and
2) Rebuild this section of line using new structures, constructed with Davit Arms and suspension insulators as shown in Figure 4. The proposed budget of this option was estimated to be $4.8 million dollars.

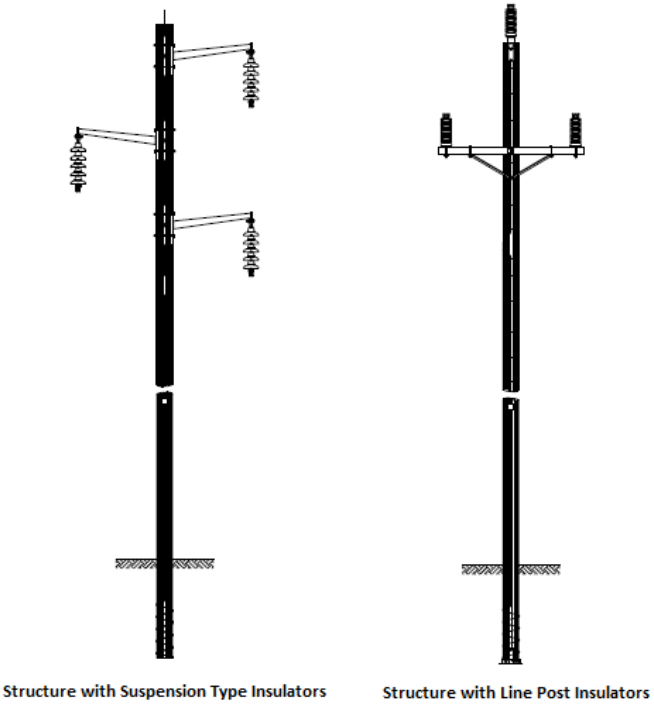

Figure 4: Structure/Insulator Types

Evaluation of Alternatives:

While the rebuild of TL227 is a solution to the high levels of salt contamination in the section, the costs are very high when compared to re-insulating the affected line section. The higher cost cannot be justified when a cheaper, sufficiently reliable, alternative exists.

Energy Efficiency Benefits:

There are no energy efficiency benefits that can be attributed to this project.

Economic Analysis:

A net present value calculation was not performed in this instance. Since there is no difference in life-cycle and maintenance costs other than initial upfront capital cost, the least cost option is to change the insulators.

Conclusion:

The current level of salt contamination resistance of the insulators in the section between structures 583 and 677 on TL227 is not adequate for the level of contamination experienced in the area. Replacing them with higher salt resistant insulators will ensure safe, reliable operation of TL227.

Project Schedule:

The anticipated project schedule is shown in Table 6.

Table 6: Project Schedule

Activity		Start Date	End Date
Planning	Engineering Design and Planning	January 2017	March 2017
Procurement	Material Procurement	March 2017	March 2017
Assessment	Field Access Assessment	August 2017	September 2017
Construction	Project Construction	June 2018	July 2018
Closeout	Project Closeout	August 2018	September 2018

Project Title: Upgrade Aluminum Support Structures

Location: Holyrood

Category: Transmission and Rural Operations - Terminal Stations

Type: Other

Classification: Normal

Project Description:

This project is the second year of a three year program to upgrade aluminum support structures at the Holyrood Terminal Station. The 2017 upgrades will focus on all Priority 'A' and 'B' structures as identified by Hatch Engineering (Hatch) in their 2015 report, *"Re-Assessment of Aluminum Structures"* (see Appendix A). The scope of work, generally, includes: the engagement of a third party consultant to complete the detailed engineering design; the installation of temporary support bracing; removal of existing nuts; lifting of structure baseplates; removal and disposal of aluminum oxide deposits; cleaning of the concrete foundation surface; completion of foundation refurbishments; replacement of damaged structure baseplates; replacement of broken anchor bolts; application of a coating system to the bottom of aluminum baseplates; and installation of new nuts and washers. The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	1.5	0.0	0.0	1.5
Labour	125.8	0.0	0.0	125.8
Consultant	25.0	0.0	0.0	25.0
Contract Work	120.3	0.0	0.0	120.3
Other Direct Costs	8.2	0.0	0.0	8.2
Interest and Escalation	15.9	0.0	0.0	15.9
Contingency	56.2	0.0	0.0	56.2
TOTAL	**352.9**	**0.0**	**0.0**	**352.9**

Justification:

Corrosion of the aluminum baseplates, for the high voltage support structures at the Holyrood Terminal Station, has resulted in the accumulation of aluminum corrosion byproducts between the baseplate and the surface of the concrete foundation, see Figure 1.

Figure 1: Aluminum Oxide Formation between Concrete Surface and Aluminum Baseplate

With time, the voluminous exfoliated aluminum oxide has swelled and expanded, creating tremendous stress on both the support structures and their associated anchor bolts.

As a result of these stresses, aluminum structural members have deformed and a number of anchor bolts have failed. This damage has jeopardized the integrity of the support structures, see Figures 2 and 3.

Figure 2: Deformation of Baseplate Due to Aluminum Oxide Uplift

Figure 3: Deformation of Aluminum Structure Legs as Result of Uplift Stresses

These structures support high voltage electrical equipment. This equipment is critical to the Island Interconnected System and its continued operation is required to ensure the delivery of safe, reliable power to Hydro's customers. To ensure their ability to perform as originally designed, the

proposed upgrades must be completed. Failure to complete the necessary upgrades could result in a catastrophic failure causing outages, personal injury or death.

Existing System:

The Holyrood Terminal Station was constructed in three stages. Aluminum support structures are unique to the first two stages of the Holyrood terminal station construction, with stage 3 support structures consisting of galvanized steel.

Stage 1 was completed in 1965, Stage 2 in 1975, and Stage 3 followed in 1982. The support structures are original to each respective stage and have not received any major work or upgrades since their original installation.

Operating Experience:

The aluminum structures are utilized to support high voltage electrical equipment within the Holyrood Terminal Station. The continuous operation of this equipment is required to maintain energy supply to the Island Interconnected System.

In 2012, the failure of anchor bolts on a 230 kV bus structure required the enactment of emergency repairs to restore the structure's integrity, See Figure 4.

Figure 4: Anchor Bolt Failure on Tension Side of B11 Bus Structure

Following the incident, Hydro engaged Hatch to conduct an investigation into the mode of failure. The investigation revealed that the failure was the result of overstressing, induced via the accumulation of aluminum oxide between the base plate and concrete foundation surface. The aluminum oxide is a byproduct of a corrosive reaction, resulting from the direct contact of the aluminum baseplate and concrete foundation. The results of the investigation are contained in the attached report entitled, *"Newfoundland and Labrador Hydro Holyrood Thermal Generation Plant Sub Station Aluminum Structure Inspection",* See Appendix B.

Safety Performance

Given the sudden nature of the 2012 anchor bolt failure, the completion of the proposed upgrades is required to ensure the safety of personnel working in and around the terminal station. These structures support high voltage electrical equipment and failure to complete the necessary upgrades could result in a catastrophic failure causing personal injury or death.

Maintenance or Support Arrangements

Maintenance of terminal station infrastructure is completed by Hydro Operations personnel. Major upgrades and repair work is typically completed by external contractors.

Maintenance History

The aluminum steel support structures are, generally, self- sufficient and do not require any maintenance. They do not corrode and deteriorate in typical weather conditions, but rather, the corrosion, and subsequent deterioration of these structures appears to be the result of a corrosive reaction which occurs at the interface between the underside of the structure baseplate and the concrete foundation's surface. It is believed that this corrosion is due to the absence of a corrosion preventing coating during stage 1 construction. Structures erected during stage 2 yard construction appear to have been fitted with a coating and there is no evidence of any corrosion and deterioration on these structures. Likewise, the stage 3 structures all appear to be in sound condition, given their galvanized steel make-up, so there are no instances of direct contact between the concrete and aluminum.

The only maintenance record for the aluminum support structures involves the emergency structure upgrades completed in 2013. Four structures were upgraded at a cost of $91,747.

Outside of routine visual inspections, completed for all of Hydro's support structures, no future maintenance costs are anticipated for the aluminum support structures upon the completion of this three year program.

Historical Information

Hydro became aware of the deterioration of the aluminum support structures in 2012. The issue was brought to light after the sudden failure of three of four anchor bolts, on the tension side of a high voltage bus structure, required the enactment of emergency repairs to restore the structure's integrity. As a result of this failure, Hydro commissioned Hatch to assess the condition of the remaining support structures and complete an investigation into the root cause of the anchor bolt failure. Based on the assessment findings, Hatch recommended that emergency repairs be enacted on four structure bases. It was also recommended that continued monitoring of the remaining structure bases be completed.

As per the 2012 assessment recommendation to implement continued monitoring of the structures, Hatch was again consulted to complete a re-assessment of the structure bases in 2014. The re-assessment constituted a visual inspection of the structure bases to determine whether or not their condition had changed since the original assessment; the completion of "wrench" removal tests on a select sample of anchor bolts; and the completion of ultrasonic thickness[5] (UT) tests on sample fabricated anchor bolts to determine the effectiveness of UT tests for establishing the magnitude of damage to remaining bolts. The information garnered through the completion of the "wrench" and UT testing aided in the development of a repair strategy.

While minimal change was noted in the condition of the structure bases, when cross-referenced with the 2012 assessment findings, it is recognized that the process of aluminum oxide build-up is continual. Failure to mitigate this process will inevitably result in the failure of the structure bases and/or the anchor bolts. The only means of eliminating its continued progression is to eliminate contact between the aluminum base plates and concrete foundations. Consequently, the 2015

[5] **Ultrasonic thickness** is a method of performing non-destructive measurement (gauging) of the local thickness of a solid element (typically made of metal, if using ultrasound testing for industrial purposes) basing on the time taken by the ultrasound wave to return to the surface. This type of measurement is typically performed with an ultrasonic thickness gauge.

Hatch report recommends that upgrades be enacted for all priority A and B bases as soon as possible, with continued monitoring implemented for priority C bases.

Anticipated Useful Life

Capital asset accounting lists the anticipated useful life of terminal station support structures as 45 years. While this value is used to track the depreciation of the asset group for accounting purposes, the actual service life of these structures has proven to be much higher and is estimated to be in the range of 65 years.

Development of Alternatives:

The support structures, at the Holyrood Terminal Station, are subject to overstressing as a result of an aluminum corrosion byproduct, which is accumulating at the aluminum-concrete interface. A number of structures have already failed and it is inevitable that others will fail if left and not rehabilitated. There are no viable alternatives outside of the completion of the proposed upgrades.

Conclusion:

The aluminum support structures are subject to a build-up of aluminum oxide, which is occurring between the baseplate and the concrete foundation. The progressive accumulation of this byproduct is generating a tremendous amount of stress on both the aluminum structures and their associated anchor bolts. The magnitude of the stress, and its potential impact on the structures, became evident after the sudden failure of a structure in 2012.

The structures support high voltage electrical equipment. This equipment is critical to the Island Interconnected System and its continued operation is required to ensure the delivery of safe, reliable power to Hydro's customers. To ensure their ability to perform as originally designed, upgrades to the structures must be completed. Failure to complete the necessary upgrades could result in a catastrophic failure causing outages, personal injury or death.

Project Schedule:

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Scheduling, Risk Management, Scope Statement, Resource Allocation	January 2017	February 2017
Consultant Engagement	Prepare RFP, Select Third Party Consultant	February 2017	March 2017
Detailed Engineering	Technical Specification and Drawing preparation	March 2017	April 2017
Tender	Tender and Award Support Structure Upgrade Contract	May 2017	June 2017
Construction	Complete Support Structure Upgrades	July 2017	August 2017
Commissioning	Final Inspection and Acceptance	-	August 2017
Closeout	Project Closeout, Final Billing, PIR	-	September 2017

APPENDIX A

Re-Assessment of Aluminum Support Structures

HATCH
Newfoundland and Labrador Hydro
Final Report
For
Re-Assessment of Aluminum Structures
H347862-0000-35-124-0001
Rev. 0
February 16, 2015
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Newfoundland and Labrador Hydro

Final Report

For

Re-Assessment of Aluminum Structures

H347862-0000-35-124-0001
Rev. 0
February 16, 2015

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HATCH

Newfoundland and Labrador Hydro
Re-Assessment of Aluminum Structures
H347862

Final Report

Re-Assessment of Aluminum Structures

H347862-0000-35-124-0001

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This Permit Allows
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To practice Professional Engineering in Newfoundland and Labrador.
Permit No. as issued by PEG D0090
which is valid for the year 2015.

REGISTERED PROFESSIONAL ENGINEER
J.E. SNOOK
SIGNATURE
Feb 16/15
DATE
NEWFOUNDLAND & LABRADOR

			L. McPhail	J. Snook	J. Snook
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HATCH

Newfoundland and Labrador Hydro
Re-Assessment of Aluminum Structures
H347862

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1. Introduction

In 2014, Hatch Ltd. was engaged by Newfoundland and Labrador Hydro (NL Hydro) to re-assess the aluminum structures at the substation of the Holyrood Thermal Generating Station (HTGS). This re-assessment serves as a follow-up to the 2012 Aluminum Structure Investigation and subsequent repair recommendations completed by Hatch.

A visual inspection of the piers, baseplates and anchors was once again completed to determine if the condition of any structure bases had changed since the 2012 investigation. Using the new site observations, the 2012 recommendations have been revised to address the current state of the HTGS aluminum structure bases.

Additionally, in an effort to determine a methodology for future detailed anchor rod condition assessments, the following trial tests were performed:

- Hydraulic Systems carried out hydraulic wrench removal tests of sample anchor rod nuts at site. The purpose of these tests was to determine whether the nuts can be removed efficiently without damaging the anchor rods.
- TEAM Industrial services carried out trial Ultrasonic Thickness (UT) tests on sample fabricated anchor rods to determine the effectiveness of UT for measuring deformation or damage to anchor rods. If effective, UT could be recommended as a means for detailed in-situ assessment of the anchors at critical locations.

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2. Background

In 2012, Hatch assessed the HTGS aluminum structures. An inspection was completed to evaluate the damage at the structure bases and to provide recommendations on a phased approach for completing repairs. The structure supports were sorted into five categories based on the damage to the piers and connection components. Using this classification and the relative importance of each structure, Hatch identified which structure bases were to be given immediate attention (Priority A), which were to be addressed within the next 12 months (Priority B), and which were not of pressing concern (Priority C).

In total, four structures were identified as requiring immediate repairs, which were completed in early 2013. These structure bases were D1, D3, J1, and R2, of Section I (a legend for the structure base numbering scheme can be found in Appendix A). The 2012 prioritization of the remaining structure bases is summarized in Table 2-1.

Table 2-1: 2012 Structure Base Prioritization

Priority A		Priority B		Priority C
Section I	Section II	Section I	Section II	Sections I & II
A4, B1, J2, J7, J11, J12, O3, P2, R6, R11, R12, W2	R7	C5, F2, H1, J9, K1, K2, P1, R5, S3, U5, V1, X3	H2, X1	All remaining structure bases

**Note: Section I consists of older aluminum structures, constructed circa 1965. Section II consists of newer aluminum structures, constructed in 1975.*

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3. Trip Report Summary

On November 13, 2014, Jacob Tucker and Elizabeth McPhail of Hatch, accompanied by Matthew Leonard of NL Hydro, carried out a follow-up inspection of the aluminum structures at the HTGS substation. Any changes in the overall conditions of the structure bases observed during the 2012 inspection were noted.

Checklists summarizing the 2012 observations were used to facilitate the inspection. The following information about each structure base, where applicable, was included in the checklists (included in Appendix B):

- Baseplate: incorrect anchor bolt hole diameter, corrosion build-up, deformed or cracked
- Bolts: incorrect size, corroded or missing
- Washers: corroded, cupped or missing
- Nuts: corroded or missing
- Welds: cracked
- Concrete and grout: spalled or cracked
- Structural damage of aluminum members

A total of 201 structure bases (105 in Section I and 96 in Section II) were inspected. Some general observations from the inspection include:

- Little to no change was noted at the majority of the support bases inspected.
- The structure bases in Section I remain in poorer condition than those in Section II.
- The structure bases J1, R2, D1 and D3, which were repaired in early 2013, all appear to be in good condition.
- Several structures have been replaced or are in the process of being replaced, therefore the associated structure bases were not inspected, including H1-H4, N1 and N2 of Section I and M1-M3 and N4-N6 of Section II.

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4. Investigation Results

The 2012 rating system used to classify the severity of damage was once again applied to each structure base. The rating categories are as follows:

0. No corrosion product or damage to the pier
1. Minimal corrosion present OR minor concrete cracks
2. More than 6 mm but less than 15 mm of corrosion build-up OR corroded bolts OR cupped/missing washers OR deformed baseplate
3. More than 15 mm of corrosion build-up OR missing bolt/nut OR cracked baseplate/weld OR severe concrete crack
4. More than one missing bolt OR bolts passing through baseplate holes
5. Failure of pier or connections

The summary of the 2012 ratings and 2014 ratings can be found in Table 4-1.

Table 4-1: Summary of Structure Base Ratings

Rating Category	Number of Occurrences			
	Section I		Section II	
	2012	2014	2012	2014
5	1	0	0	0
4	4	2	0	0
3	23	22	3	3
2	52	53	50	53
1	30	24	46	40
0	1	4	3	0
No Rating*	12	18	10	16
Total	123	123	112	112

**No rating was assigned to structure bases no longer in use or modified to support steel structures*

4.1 Category 5

As identified above, a structure base falling into Category 5 would have experienced complete failure of the structure support. There are currently no Category 5 structure bases.

4.2 Category 4

A structure falling into Category 4 would have either more than one missing bolt or bolts passing through the holes in the baseplate. In 2012, this was observed in B1, J1, P2 and R2 of Section I. B1 and P2 are still missing two of four bolts (see Figure 4-1). J1 and R2 have since been repaired.

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Figure 4-1: B1, Section I – Category 4 Structure Base

4.3 Category 3

There are several Category 3 structure bases in Section I and three instances in Section II. The most common occurrence was a missing bolt/nut. In Section I, structure base D3 has since been repaired and structure base H1 has been removed. The condition is unchanged at the remaining structure bases that had this issue in 2012 (A4, C5, F2, J9, K1, K2, P1, R5, V1, X3 of Section I and H2, X1 of Section II).

The severe corrosion build-up, noted at J2, J7, J11, J12, R6, R11 and R12 of Section I in 2012, has not increased by any appreciable amount over the past two years. The cracks in the baseplates at J2 and J7 and the deformations in the baseplates at J11 and J12 also do not appear to have worsened. Figure 4-2 shows the current condition of structure base J7.

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Figure 4-2: J7, Section I – Category 3 Structure Base

The severe cracks in the concrete piers appear to have worsened slightly at S3 (see Figure 4-3 and Figure 4-4) and W2 (see Figure 4-5 and Figure 4-6) of Section I. The severe crack at R7 of Section II appears unchanged.

Figure 4-3: S3, Section I, 2012 – Category 3 Structure Base

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Figure 4-4: S3, Section I, 2014 – Category 3 Structure Base

Figure 4-5: W2, Section I, 2012 – Category 3 Structure Base

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Figure 4-6: W2, Section I, 2014 – Category 3 Structure Base

No rating change was applied to the remaining category 3 structure bases – O3 (incorrect baseplate hole diameter for anchorbolts and cupped washers) and U5 (structural damage to angle) in Section I.

The rating for structure base J1 has been reduced from 4 to 3. The cracked plate, cupped washers and corroded nuts were replaced and the cracked weld was repaired. However, the 20mm of corrosion build-up is still present between the bottom plate and the concrete, as seen in Figure 4-7.

Figure 4-7: J1, Section I – Category 3 Structure Base

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4.4 Categories 1&2

The rating of few structure bases increased from Category 1 to Category 2. These include J3, J4, J5, and Q5 of Section I and A8, C2, C4, R2 and R6 of Section II. J3, J4, J5 and Q5 have severely corroded nuts and washers, as seen in Figure 4-8. At A8, C2, C4 and R6 of Section II there are cracks down the middle of the piers (the condition at A8 is shown in Figure 4-9). R2 has cupped washers.

Figure 4-8: J4, Section I – Category 2 Structure Base

Figure 4-9: A8, Section II – Category 2 Structure Base

The issues present at the nine structure bases identified above were present in 2012. No significant worsening of the condition has occurred; however additional field observations

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merited an increase in rating. As documented in 2012, there is no immediate concern at any of the Category 2 structure bases, although the progression of damage should be monitored closely, particularly at the larger structures that are subject to higher loads.

All of the remaining bases still in use were classified as Category 1 structure bases, with minimal corrosion residue or Category 0 structure bases, where no corrosion or damage was observed.

4.5 Anchor Rod Tests

4.5.1 Hydraulic Wrench Removal

Hydraulic wrench removal tests were carried out on November 13, 2014 by Hydraulic Systems Ltd. On site were Mr. Jeff Snook, P.Eng. of Hatch, Mr. Matthew Leonard, P. Eng. of NL Hydro, and Mr. Grant Moore, of Hydraulic Systems.

Various diameters of anchor nuts were tested using the hydraulic wrench. Torque readings were measured during the removal in an attempt to alleviate any overstressing of the bolt. Typical torque values for anchor rods were used as a guide.

A summary of the results is presented in Table 4-2 below;

Table 4-2: Hydraulic Wrench Removal Results

Mark Number	Diameter (inches)	Measured Torque (ft-lbs)	Typical Torque Value (Approximate)	Comments
C1	5/8	150	60	Nut rotated
J3	5/8	350	60	Anchor rotated in concrete
F1	¾	550	160	Anchor rotated in concrete
B2	¾	550-600	160	Nut rotated
A7	1	625	240	No movement – stopped torquing at this value. Note that another anchor nut on the same pier without a washer was tested and rotated at 150ft-lbs. See discussion for comment
R1	1	625	240	No movement – stopped torquing at this value

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As can be seen from the table above, the torque values required to remove the nuts were excessive. In a couple of cases the anchor rod itself rotated within the concrete prior to the nut moving. This is most likely due to the prying of the baseplates on the anchor nuts, creating excessive frictional forces on the anchor threads. This is particularly evident with the nut on pier A7 which removed easily at 150 ft lbs. This nut did not have an accompanying washer and thus no such 'prying' forces were in effect. A similar nut on the same pier did not move at 625 ft lbs.

4.5.2 *Ultrasonic Thickness Measurements*

Ultrasonic thickness (UT) measurements were carried out by TEAM Industrial on various lengths of A36 anchor rods to determine the effectiveness of the readings in assessing anchor rod damage. The UT readings were found to be indeterminate beyond a length of 8-10 inches along the rod.

The anchor rods at most of the major structures are embedded up to 3' – 4' below top of concrete. Thus the UT readings would only be effective for the top portion of anchors, which in most cases is exposed and can be assessed visually.

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5. Recommendations

The condition of each base along with the type of structure it supports was considered when making recommendations on prioritizing repair work. As in 2012, Priority A structures bases should be addressed as soon as possible, Priority B structure bases should be repaired within the next 12 months, and Priority C structure bases should be repaired within the next 24 months.

5.1 Priority A

The list of Priority A structure bases closely matches the list presented in 2012. The structure bases that were in critical state in 2012 have been repaired, leaving 14 structures in this group. All category 3 and 4 structure bases that support bus, box and take-off structures should be addressed as soon as possible. As well, all remaining structure bases classified as category 4 should also have top priority. The list of these structure bases is provided in Table 5-1.

Table 5-1: Priority A Structure Bases

Section I		Section I
A4 B1 J1*, J2, J7, J11, J12	O3 P2 R6, R11, R12 W2	R7

**Repairs were made to J1 in 2013; however, significant corrosion is still present between the bottom plate and concrete pier.*

A map identifying each of these structure bases is provided in Appendix C.

5.2 Priority B

The list of Priority B structure bases is the same as in 2012 (H1 of Section I has been removed because it no longer exists). These structure bases are listed in Table 5-2.

Table 5-2: Priority B Structure Bases

Section I			Section II
C5 F2 J9	K1, K2 P1 R5 S3	U5 V1 X3	H2 X1

Very little deterioration was noted over the past two years with the Priority B structure bases; however it is still recommended to rehabilitate these structure bases within a year to ensure the severity of damage does not progress and lead to failure of the support system.

A map identifying each of these structure bases is provided in Appendix D.

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5.3 Priority C

All remaining structure bases should be in the lowest priority category. The structure bases at this priority level are not cause for immediate concern. As with Priority B structures, they should be inspected regularly to ensure the conditions do not worsen, and repairs should be made within two years.

5.4 Removal of Anchor Nuts

Torque values measured during removal of anchor nuts proved excessive; in most cases torquing was stopped prior to nut rotation in order to avoid potential damage to the anchor rods.

For future base plate repairs which require anchor nut removal, it is recommended that torque values be measured during nut removal to ensure values are not excessive. Excessive torquing on anchor bolts could damage the anchor rod steel or compromise the integrity of the bond with the concrete. In the event of excessive torque values, the nut should be cut for removal.

5.5 Ultrasonic Thickness Measurements

Ultrasonic thickness readings were found to be ineffective as a practicable means of below-concrete anchor rod inspection. Future anchor rod inspections will be limited to visual assessment of the above-concrete portion only.

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Appendix A
Legend

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A
B
C
D
E
F
G
H
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K
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N
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P
Q
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T
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V
W
X
APPROVED

Appendix B
Checklists

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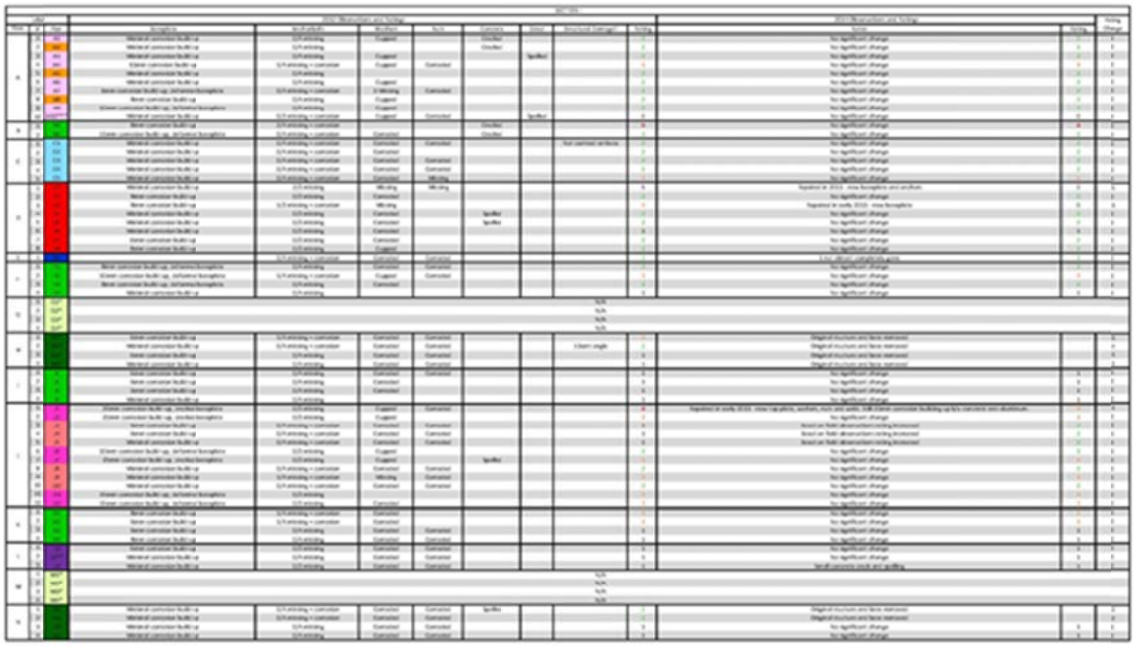

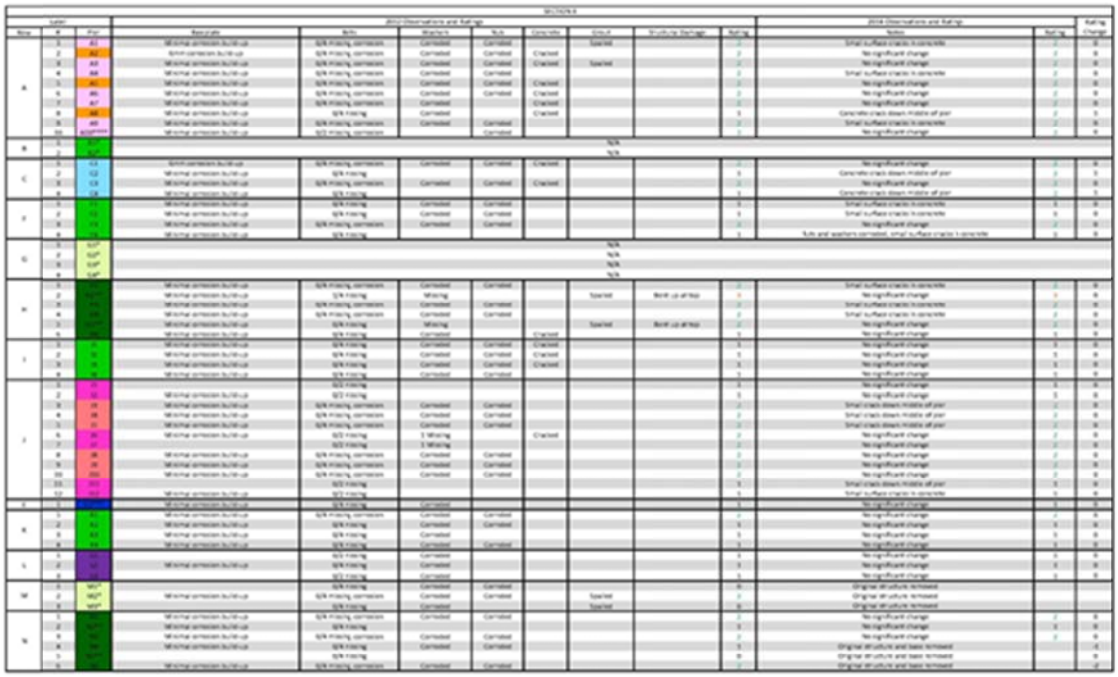

HATCH

Newfoundland and Labrador Hydro
Re-Assessment of Aluminum Structures
H347862

Appendix C
Map – Priority A Structure Bases

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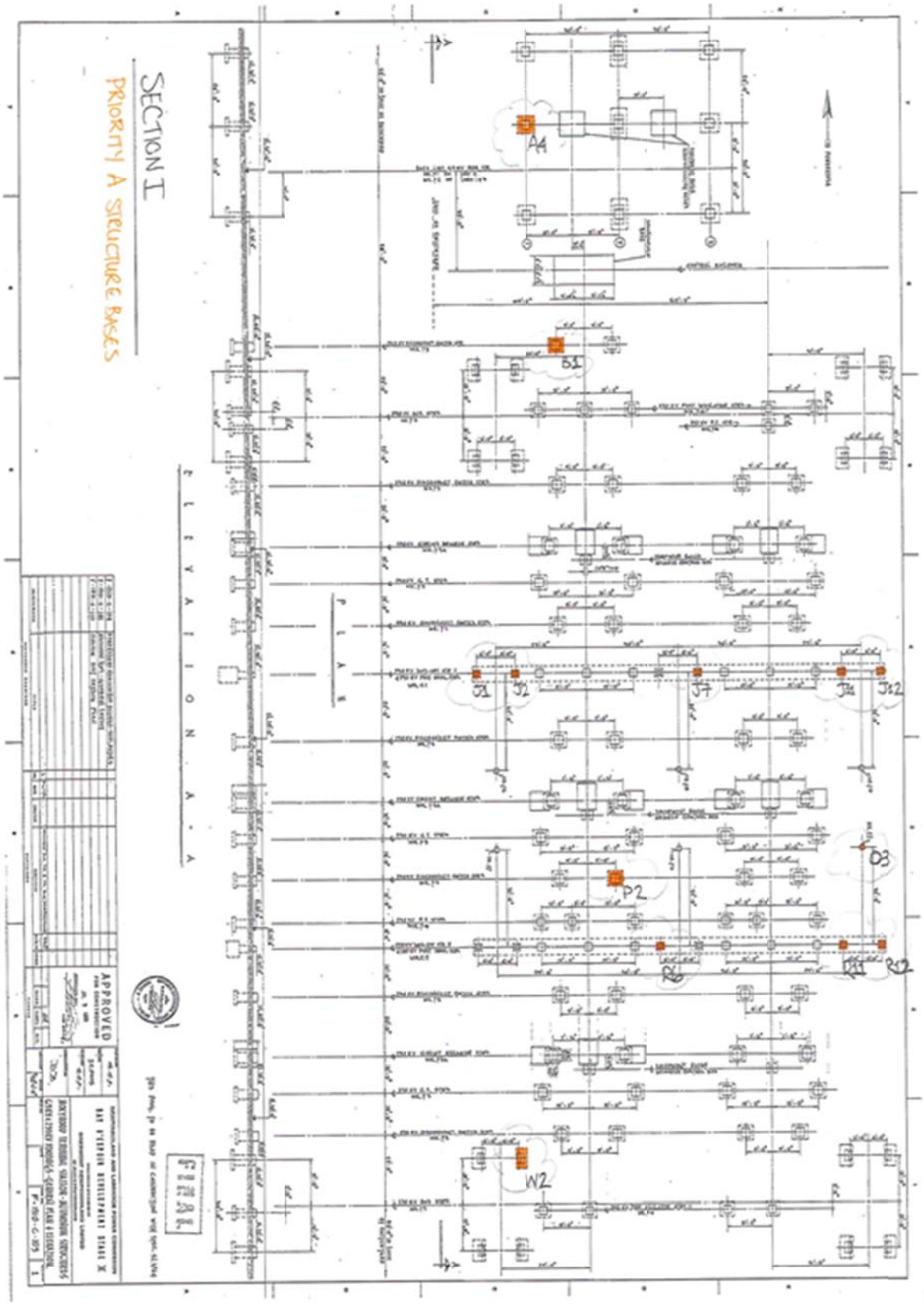
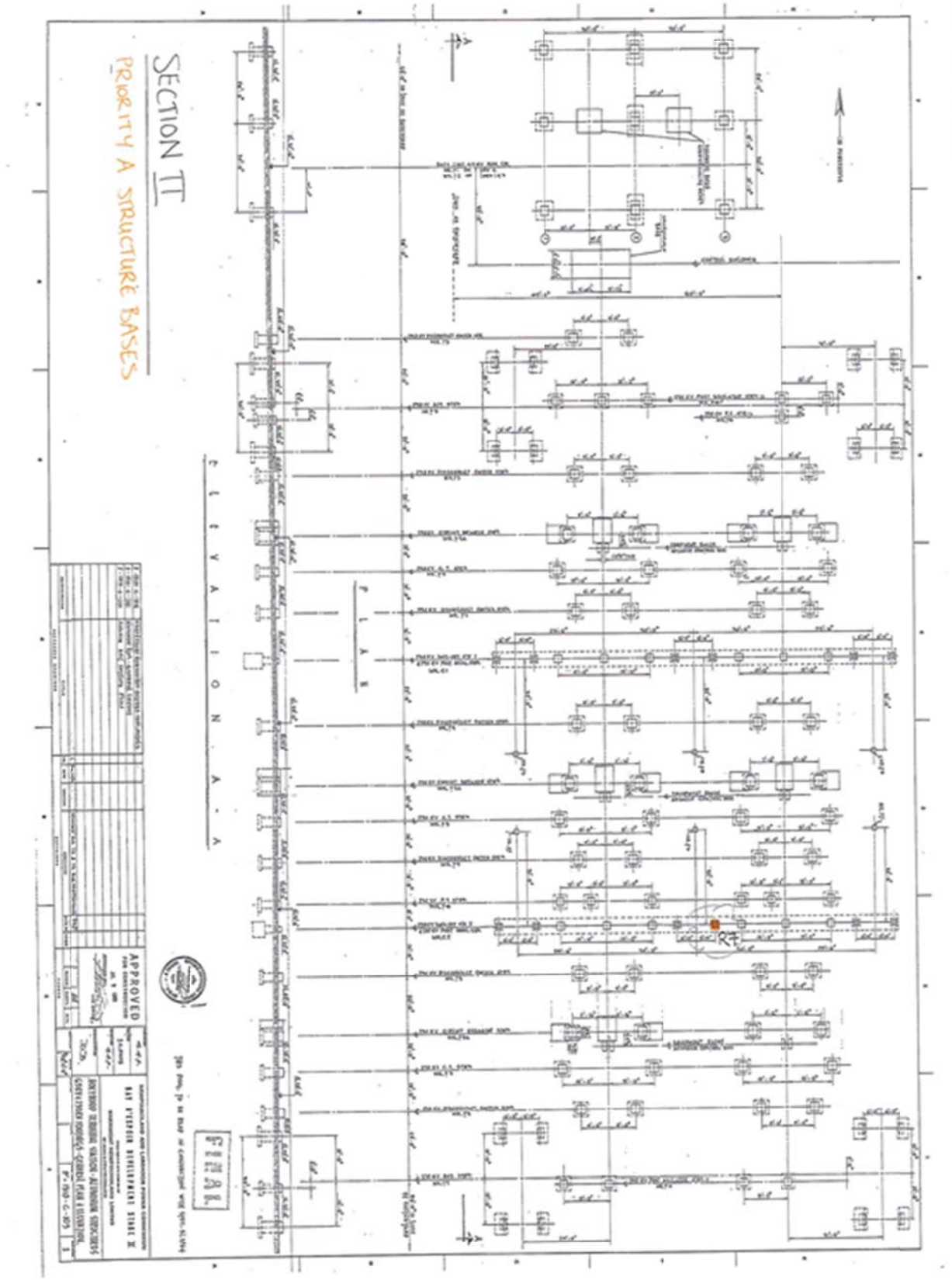

SECTION I
PRIORITY A STRUCTURE BASES
ELEVATION - A
PLAN
APPROVED
A4
S1
J1
J2
J3
J4
J12
P2
R2
W2


SECTION II
PRIORITY A STRUCTURE BASES
ELEVATION A-A
PLAN
APPROVED
FINAL

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Appendix D
Map – Priority B Structure Bases

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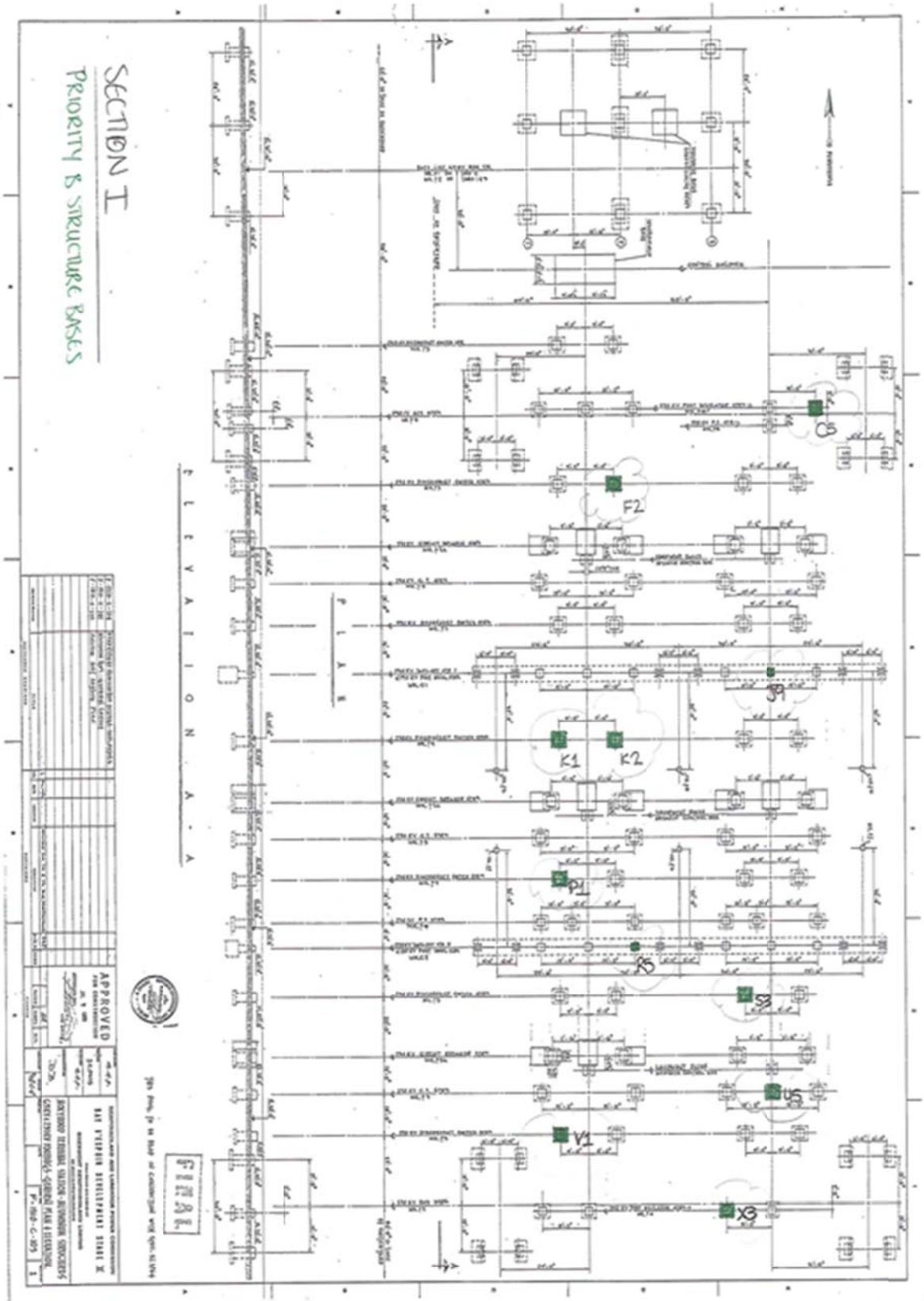
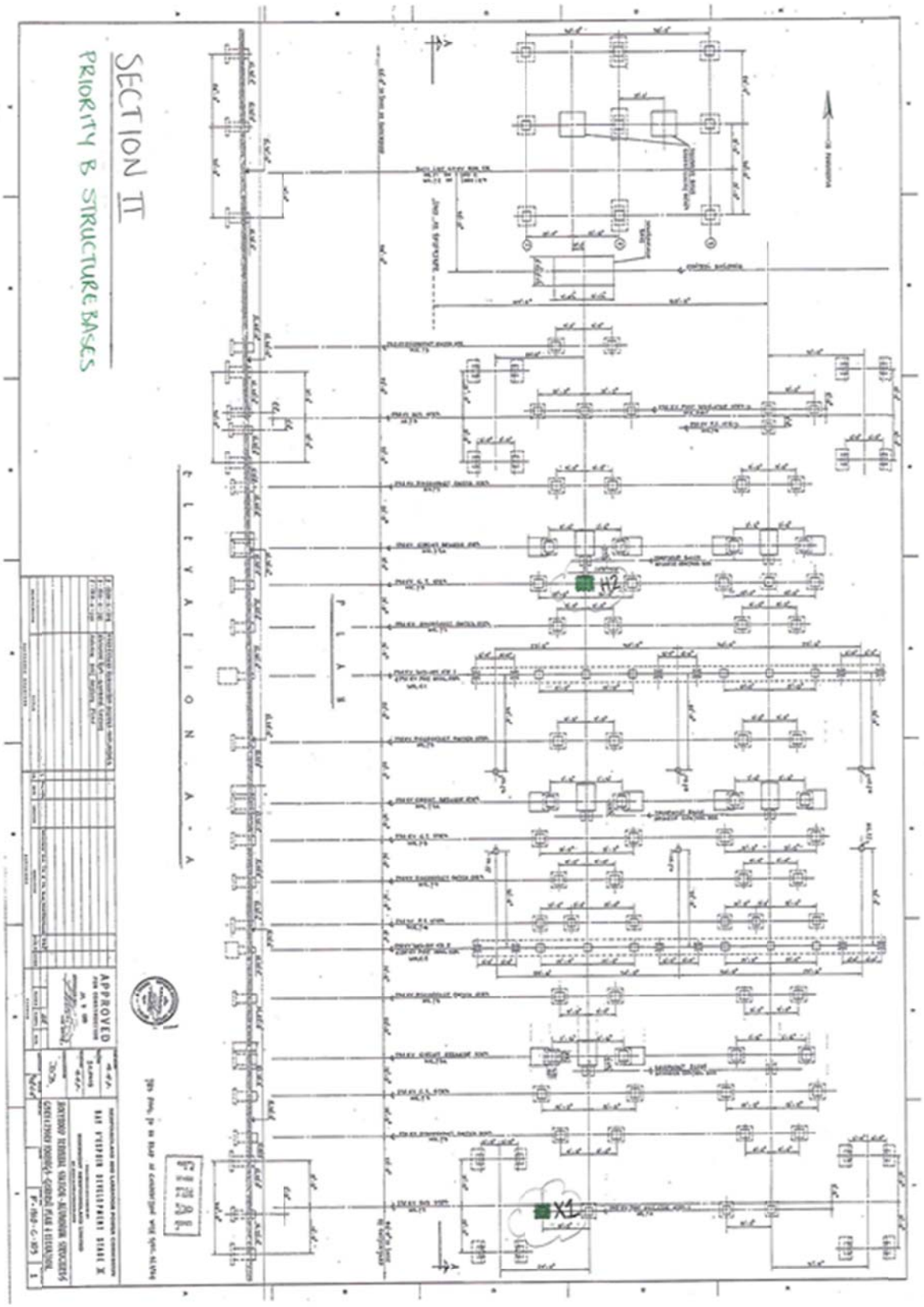

SECTION I
PRIORITY 8 STRUCTURE BASES
ELEVATION A - A
APPROVED
F2
K1
K2
P1
S3
S5
V1
X3


SECTION II
PRIORITY B STRUCTURE BASES
ELEVATION A-A
PLAN
H2
X1
APPROVED

Suite E200, Bally Rou Place, 370 Torbay Rd.
St. John's, Newfoundland, Canada A1A 3W8
Tel (709) 754 6933 • Fax (709) 754 2717

HATCH
Suite E200, Bally Rou Place, 370 Torbay Rd.
St. John's, Newfoundland, Canada A1A 3W8
Tel (709) 754 6933 • Fax (709) 754 2717

APPENDIX B

Newfoundland and Labrador Hydro

Holyrood Thermal Generation Plant

Sub-Station Aluminum Structure Inspection

Prepared for

Hatch

St. John's, NL

Consulting Services for

Newfoundland and Labrador Hydro Holyrood Thermal Generation Plant Sub Station Aluminum Structure Inspection

Prepared by:

Brouco Services Inc.
703 Cezanne Cres.
Orleans, ON
K4A 2A7

November 2012

INTRODUCTION

Brouco Services has been mandated by Mr. Greg Saunders of Hatch to perform an inspection of the aluminum footings of the power towers at the Holyrood thermal generation plant near Holyrood, NL. Heavy aluminum corrosion was observed on the bottom of the legs with the significantly more voluminous aluminum oxide corrosion products which created expansion forces that ultimatemely severed the lag bolts through stress corrosion cracking. This report presents our inspection results as performed in November 2012 by Rejean Brousseau, Ph.D.

RESULTS

Three main types of tower supports were observed during the inspection. These included the large main hydro tower supports mounted on a horizontal concrete surface, the large hydro tower supports on a sloped concrete surface, and miscellaneous small supports on a horizontal concrete surface. The tower legs were made with aluminum and the lag bolts were steel and nuts were galvanized steel.

Typically with aluminum, a protective dense oxide is formed on the surface in a neutral pH environment which provides excellent resistance to corrosion. However, concrete creates a high pH (alkaline) environment which breaks down the amphoteric aluminum oxide film causing additional corrosion and expansion forces generated by the accumulation of the aluminum corrosion products, i.e. a voluminous exfoliated aluminum oxide.

The worst areas were found on the large supports on the horizontal concrete surfaces (see photos #6-7). At these supports, extreme corrosion of the aluminum support had occurred where the aluminum was in contact with the concrete (see photos #1-4). The aluminum swelled and significantly expanded which caused the bolts to pop and crack. Since the concrete was flat, the water could accumulate and build up a high pH environment creating a corrosive environment. Under such tensile stress, the steel bolts became severed most likely by stress corrosion cracking. As a possible remedial measure we recommend lifting the supports, and removing the aluminum oxide under the support by

abrasive blasting. After the blasting, the surfaces between the concrete and aluminum support should be coated by epoxy injection using a coal tar epoxy such as Amercoat 78HB or equivalent. After completion, all bolts and nuts should be coated with an epoxy such as Amercoat 78HB or equivalent. A top plate under the nuts was observed to be cracked indicated high stressed at the bolting area, see photo #5.

The large supports on a sloped concrete surface had only mild corrosion. Since the concrete was sloped, the water did not accumulate and thus no pooling of corrosive higher pH water could result (see photos #8-9). Nevertheless, here we similarly recommend lifting the supports, and removing the aluminum oxide under the support by abrasive blasting. After the blasting, the surfaces between the concrete and aluminum support should be coated by epoxy injection using a coal tar epoxy such as Amercoat 78HB or equivalent. After completion, all bolts and nuts should be coated with an epoxy such as Amercoat 78HB or equivalent.

For the small supports on a horizontal concrete surface which had significant corrosion (see photos #10-12), bolting was found to be also damage at some locations due to the corrosion products generating expansionforces. Similarily, we recommend dismantling the supports, and removing the aluminum oxide under the support by abrasive blasting. After the blasting, the surfaces between the concrete and aluminum support should be coated along with the base component to be in contact with the concrete using a coal tar epoxy such as Amercoat 78HB or equivalent. After completion, all bolts and nuts should be coated with an epoxy such as Amercoat 78HB or equivalent.

CONCLUSIONS

The worse aluminum corrosion was observed at the bottom of the supports were the aluminum was in contact with a horizontal concrete surface. The aluminum corrosion caused significant expansion damaging the lab bolts. The high pH environment created by the concrete caused significant damage to the aluminum. We recommend removal of the aluminum oxide and application of the coal tar coating to prevent future corrosion.

APPENDIX – Photos

Photo #1: Corrosion expansion between leg and concrete

ii

Photo #2: Corrosion expansion between leg and concrete

Photo #3: Corrosion expansion between leg and concrete

Photo #4: Corrosion expansion between leg and concrete

Photo #5: Cracked plate

Photo #6: Leg Support on Flat Concrete

Photo #7: Leg Support on Flat Concrete

ix

Photo #8: Leg Support on Sloped Concrete

x

Photo #9: Leg Support on Sloped Concrete

Photo #10: Small Leg Support

Photo #11: Small Leg Support with Damaged Lag Bolt

Photo #12: Small Leg Support

xiv

Project Title: Replace Light-Duty Mobile Equipment

Location: Various

Category: General Properties - Transportation

Type: Other

Classification: Normal

Project Description:

This project proposes the replacement of ten all-terrain vehicles, ten snowmobiles, three light-duty trailers, and one forklift in accordance with the established replacement criteria as follows:

- Snowmobiles/All-Terrain Vehicles: Transmission Line crews 3-5 years
- Snowmobiles/All-Terrain Vehicles: Other 5-7 years
- Light-Duty Trailers 6-8 years
- Heavy-Duty Trailers 12-15 years

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	249.0	0.0	0.0	249.0
Labour	2.5	0.0	0.0	2.5
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	6.8	0.0	0.0	6.8
Contingency	12.6	0.0	0.0	12.6
TOTAL	**270.9**	**0.0**	**0.0**	**270.9**

Justification:

Hydro operates in many diverse locations across the province, and it is critical that employees are provided with safe and reliable equipment in order to provide support for economical and reliable electricity.

Existing System:

Newfoundland and Labrador Hydro (Hydro) operates a fleet of light-duty mobile equipment comprised of approximately 120 snowmobiles, 70 all-terrain vehicles, 120 trailers, ten forklifts and ten miscellaneous attachments (for example, lawn mowers, backhoes, salt spreaders, snow plows).

The mobile equipment fleet is strategically distributed across Hydro's operating areas throughout the Province and is utilized on a daily basis to support staff engaged in the maintenance and repair of the electrical system.

The Transportation Department of Hydro maintains a close liaison with other Canadian Utilities through participation on the Canadian Utility Fleet Council and has established mobile equipment replacement guidelines, which consider the age and operating conditions for the equipment.

Age of Equipment or System

Please see Appendix A for a detailed listing of the age of the assets being replaced under this system.

Major Work/or Upgrades

There have been no major upgrades since purchase of the original equipment.

Operating Experience

Failure to replace units in accordance with the replacement policy will lead to increasing maintenance costs and less reliable vehicles. Employees maintain the electrical system 24 hours a day, seven days a week, and require dependable and safe vehicles for their work. As equipment ages, the equipment is at risk of increasing downtime, which could negatively affect response times for emergency outages or planned maintenance.

Legislative or Regulatory Requirements

Hydro complies with the environmental requirements stipulated in the following:

- Canadian Environmental Protection Act; and
- Marine Spark-Ignition Engine and Off-Road Recreational Vehicle Emission Regulations.

Environmental Performance

Hydro complies with the Canadian Environmental Protection Act, Section 160, which applies to engines and vehicles of 2008 and later model years emissions requirements.

Industry Experience

Light-duty mobile equipment replacement scheduling varies depending on location, exposure to harsh environmental conditions, and the severity of the service use for the equipment.

Vendor Recommendations

There are no vendor recommendations with regards to this project.

Maintenance or Support Arrangements

The Hydro fleet of light-duty mobile equipment is maintained by external service garages.

Maintenance History

Hydro does not retain maintenance records for light duty equipment.

Historical Information

Table 1 provides a history of light-duty mobile equipment purchases.

Table 1: Mobile Equipment Less than $50,000

Year	Units Purchased					Budget ($000)	Actual ($000)
	All Terrain Vehicles	Snowmobiles	Trailers	Forklifts	Attachments		
2016B	13	8	6	0	0	348.0	
2015	14	21	3	1	0	494.4	423.0
2014	11	18	9	0	0	579.1	465.3
2013	14	21	3	1	0	476.5	448.2
2012	7	5	15	1	2	400.6	413.0
2011	14	12	29	1	0	757.0	582.5

Anticipated Useful life

The estimated service life for all-terrain vehicles, snowmobiles, trailers and attachments is as follows:

- Snowmobiles/All-Terrain Vehicles: Transmission Line crews 3-5 years
- Snowmobiles/All-Terrain Vehicles: Other 5-7 years
- Trailers: Light-Duty 6-8 years
- Trailers: Heavy-Duty 12-15 years

Evaluation of Alternatives

Purchase of this equipment is the only viable option to support the maintenance of Hydro assets.

Conclusion:

This project provides for the normal replacement of light-duty mobile equipment which is at the end of its useful life and is no longer dependable. Purchase of this equipment is the only viable option to support the maintenance of Hydro's assets.

Project Schedule:

This project is to be completed by December 31, 2017.

APPENDIX A

Replace Light-Duty Mobile Equipment – Various

Type	Unit	Age at retire	Life	AGE	KMS	Condition	LTD $ Maint
ATV	V7092	10.1	7	X			$1,322
ATV	V7198	8.1	7	X			$1,100
ATV	V7200	8.1	7	X			$1,170
ATV	V7201	8.1	7	X			$1,227
ATV	V7202	8.1	5	X			$4,312
ATV	V7203	8.1	7	X			$1,383
ATV	V7204	8.1	5	X			$2,017
ATV	V7228	7.2	7	X			$1,245
ATV	V7229	7.2	7	X			$1,650
ATV	V7230	7.2	7	X			$1,991
Forklift	V9795	24.2	20	X			$11,812
LD Trl	V8896	7.6	6	X			$3,500
LD Trl	V8911	7.0	6	X			$12,835
LD Trl	V8943	5.7	6	X			$1,237
Snowmobile	V7136	8.8	7	X			$1,233
Snowmobile	V7158	8.7	7	X			$2,422
Snowmobile	V7173	8.4	5	X			$1,410
Snowmobile	V7182	8.3	5	X			$1,125
Snowmobile	V7183	8.3	5	X			$1,117
Snowmobile	V7185	8.3	5	X			$1,891
Snowmobile	V7186	8.3	5	X			$1,066
Snowmobile	V7210	7.2	7	X			$1,857
Snowmobile	V7261	5.7	5	X			$1,598
Snowmobile	V7262	5.7	5	X			$1,201

Project Title: Upgrade Energy Management System

Location: Hydro Place

Category: General Properties - Information Systems

Type: Other

Classification: Normal

Project Description:

This project is required to upgrade the OSI Monarch Energy Management System (EMS). The EMS system is used by the Energy Control Centre (ECC) in St John's on a 24 hour basis to control and monitor the provincial transmission grid and generation facilities operated by Hydro.

The system software is upgraded on a yearly basis to allow for the inclusion of fixes and functionality changes to the software. The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	67.5	0.0	0.0	67.5
Labour	34.2	0.0	0.0	34.2
Consultant	0.0	0.0	0.0	0.0
Contract Work	243.7	0.0	0.0	243.7
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	12.5	0.0	0.0	12.5
Contingency	69.1	0.0	0.0	69.1
TOTAL	**427.0**	**0.0**	**0.0**	**427.0**

Justification:

This project is a normal continuation of annual upgrades to ensure proper functionality. The EMS is essential to the continued efficient and reliable operation of the provincial transmission grid and generation facilities operated by Hydro. The EMS provides a critical function for Hydro and the operation of the Island Interconnected System. Without a properly functioning EMS, remote control of any system would be impossible and therefore all major stations would have to be staffed. The increase in cost of the upgrade for 2017 over 2016 costs is attributed to exchange rate as upgrade is purchased in US Funds and two additional modules in the software needed to be upgraded.

Existing System:

The existing system was installed in 2006 and the software has been upgraded every year since then on an annual basis.

The EMS system is used by the ECC in St John's on a 24 hour basis to control and monitor the provincial transmission grid and generation facilities operated by Hydro.

The following upgrades have occurred over the past five years:

Table 2: Major Work or Upgrades

Year	Major Work/Upgrade	Comments
2015	Software Upgrade	Elimination of software bugs and increased functionality of software
2014	Software upgrade and Server Upgrade	Replaced servers and upgraded software for elimination of software Bugs fix and increased functionality of software
2013	Software Upgrade	Elimination of software bugs and increased functionality of software
2012	Software Upgrade	Elimination of software bugs and increased functionality of software
2011	Software Upgrade	Elimination of software bugs and increased functionality of software

Operating Experience:

The EMS was purchased from Open Systems International in June 2006. It has been in continuous operation since commissioning. The software had been upgraded on a yearly basis from 2007 to 2016 to remove any software bugs and to be able to take advantage of any functionality that would benefit operating of the power system.

Industry Experience

Hydro must keep the software it uses to control and monitor the provincial transmission grid and generation facilities up to date. Failure to keep this software current will put Hydro at risk of unplanned computer system outages which would affect the control and monitoring of the transmission grid and generation facilities. Other utilities use this approach.

Vendor Recommendations

The vendor recommends that the software be upgraded on a yearly basis to allow known software bug fixes to be eliminated and to increase the functionality of the software.

Maintenance or Support Arrangements

The software is on maintenance support which allows for the following from Open Systems International:

- Dedicated support staff for handling incoming support calls;
- After hours on-call support service;
- 24/7 support coverage;
- Web-based Customer Support portal;
- Fast response for critical support requests; and
- Comprehensive database tracking and reporting on support requests.

Historical Information

Table 3 provides information from previous capital budget applications.

Table 3: Historical Information

Year	Capital Budget ($000)	Actual Expenditures ($000)
2016B	246.2	
2015	194.4	185.1
2014	187.9	184.3
2013	129.9	133.7
2012	117.8	107.0

Anticipated Useful Life

The anticipated useful life of this software is limited by the functionality that it provides to support the requirements of Hydro and the ongoing support of this software by the vendor. Software is depreciated over a ten year period.

Conclusion:

This project is necessary as to allow Hydro to control and monitor the provincial transmission grid and generation facilities operated by Hydro. This project is performed on an annual basis to eliminate software bugs and increase the functionality of the software.

Project Schedule:

The project will be started in April 2017 and completed by the end of September 2017.

Project Title: Replace Personal Computers

Location: Hydro Place

Category: General Properties - Information Systems

Type: Other

Classification: Normal

Project Description:

The Personal Computer (PC) Replacement program is an on-going program required to enhance the efficiency of Hydro's employees by replacing the PCs used for their day to day requirements.

This project will enable Hydro to replace 142 Thin Client, Desktop, Workstation and Laptop computers that were deployed up to, and including, 2013. There are 13 Thin Clients, 100 Laptops, 21 Desktops, 8 Workstations and 60 monitors to be replaced. There are also 10 Workstations requiring hardware component upgrades to extend their overall useful life span. A Workstation is a more powerful desktop that is used for specialized applications that require more power and resources, such as AutoCAD for drafting. A Thin Client is a lightweight computer that is purpose-built for connection to a desktop virtualization environment.

The assignment of a particular device is determined by the employee's manager or supervisor. Generally, if an employee is expected to use their computer while away from the office, a laptop is assigned.

The projected costs of the units are as follows:

- Thin Client - $600;
- Laptop - $2,125;
- Desktop - $1,125;
- Workstation - $1,900;
- Monitor - $258; and
- Workstation Upgrades - $550.

In 2015, Hydro released a tender for the supply of PC equipment. This tender was awarded for a period of two years with the possibility of three one year extensions.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	280.1	0.0	0.0	280.1
Labour	33.5	0.0	0.0	33.5
Consultant	0.0	0.0	0.0	0.0
Contract Work	42.6	0.0	0.0	42.6
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	9.5	0.0	0.0	9.5
Contingency	35.7	0.0	0.0	35.7
TOTAL	**401.4**	**0.0**	**0.0**	**401.4**

Justification:

Hydro must keep computers current in order to adequately support and protect the Information Technology applications and information required to operate its business. The replacement and addition of PC components to achieve this goal requires investment over the life cycle of the computers.

The refresh program makes it possible for computers to be replaced in a planned and consistent manner. This allows for the even distribution of budgets and the timely replacement of computers to maintain efficient support while ensuring availability and reliability of computer hardware to support user applications. Continued review of the computer life cycle allows Hydro to adjust plans based on performance, technology changes and new business requirements.

In addition, the computers to be replaced under this project are approaching the end of their useful lives and failures can be expected. The maintenance agreements for these computers will have expired and replacement parts can no longer be guaranteed.

Existing System:

Hydro has approximately 1,200 end-user personal computers in service. It is important to refresh this equipment on a regular cycle to keep the technology current to maintain a reliable, efficient and productive workforce. Refreshing is the replacement of end user equipment, such as desktops, laptops and thin clients, on a life cycle depending on the type of device.

Minimum specifications for replacement of personal computers are reviewed on an annual basis to ensure that the PCs in service continue to remain effective. Industry best practices, technology and application trends are taken into consideration when specifications for computer devices are decided for the current year. The annual review continues the replacement life cycle for laptops of every four years, desktops every five years, workstations and thin clients every six years. The replacement of monitors and required hardware upgrades are assessed based on failure, compatibility with newer hardware, and user application requirements.

As this budget proposal is for the routine replacement of computing hardware based on a corporate standard consistent with industry practice, the following items under the existing system section are not relevant to the proposal:

- Major Work and/or Upgrades; and
- Operating Regime.

Age of Equipment or System

The existing PCs that are to be replaced under this project will have been in service between four and six years depending on the hardware platform used.

Availability of Replacement Parts

Replacement parts are readily available for the duration of the maintenance agreements. Once the maintenance agreement has expired there is no guarantee that replacement parts can be obtained.

Operating Experience

Status Quo

If the end user infrastructure is not kept current the following scenarios could potentially occur:

- New applications may not run on the old hardware platform;
- Decreased speed may result in lost production;
- Failure rates will exceed 50 percent;
- Maintenance agreements will not be offered by vendor; and
- Operating systems may be unsupported.

Alternatives

The only alternative is to consider leasing the equipment and a cost benefit analysis will be done in the year of replacement to ensure the least cost option is chosen in consideration of incentives or other benefits that may be offered by the providers.

As this budget proposal is for the routine replacement of computing hardware based on a corporate standard consistent with industry practice, the following items are not relevant to the justification of this proposal:

- Reliability Performance;
- Outage Statistics;
- Legislative or Regulatory Requirements;
- Safety Performance;
- Environmental Performance;
- Vendor Recommendation;
- Maintenance History;
- Forecast Customer Growth; and
- Energy Efficiency Benefits.

Industry Experience

Hydro has a similar life cycle plan for computer equipment as other companies in the utility industry, including Newfoundland Power.

Maintenance or Support Arrangements

Hydro has purchased maintenance agreements with Lenovo Corporation, the manufacturer, that cover laptops for four years and desktops for five years.

Historical Information

Historical information on computer replacement over the last five years as well as those budgeted for 2016 is presented in Table 2.

Table 2: Historical Information

Year	Capital Budget ($000)	Actual Expenditures ($000)	Units	Cost per unit ($000)
2016F	861.7			
2015	573.3	571.8	358	1.60
2014	463.9	529.1	271	1.95
2013	463.9	518.2	237	2.18
2012	490.6	499.0	183	2.73
2011	403.5	422.2	142	2.97

Anticipated Useful Life

According to Gartner[6], the useful life for a laptop is three years while for a desktop is four to five years. Gartner also states that notebooks (laptops) have higher failure rates than desktop PCs. In their research, Gartner recommends that organizations plan on a three-year replacement cycle for notebooks while exercising the option to extend the life another six to 12 months provided warranty has been extended to match the anticipated extended lifetime of the notebook. The North American industry standard life cycle for end-user devices is three years for laptops and five years for desktops. Hydro has adopted a four to five year life cycle and utilizes extended warranties to ensure reliable operation.

[6] Gartner Inc. provides research and analysis on the global Information Technology industry. They assist companies in making informed technology and business decisions by providing in-depth analysis and advice on virtually all aspects of technology.

Economic Analysis

This project is subject to a lease or purchase cost benefit analysis to determine the lowest cost alternative. The cost benefit analysis is done in the year of replacement to ensure consideration of incentives or other benefits that may be offered by the providers.

Conclusion:

The PC Replacement Program as proposed in this project is justified for the following reasons:

- It enables the end user equipment to remain current;
- It improves workforce efficiency by providing reliable hardware; and
- It allows for a consistent annual budget.

Project Schedule:

The project is scheduled to start in January 2017 and be completed before December 30, 2017.

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Page Ref
			($000)		
GENERATION					
Purchase Capital Spares - Gas Turbines		185.0		185.0	E-2
Install Wind Monitoring Station North Salmon Dam SD-2 - Bay d'Espoir		165.5		165.5	E-4
Replace Control Room/Communications Room Air Conditioning - Hinds Lake	41.3	53.0		94.3	
TOTAL GENERATION	41.3	403.5	0.0	444.8	
TRANSMISSION AND RURAL OPERATIONS					
Replace Fuel Tank 22E - St. Anthony		199.8		199.8	E-7
Replace Recloser - Wabush		199.2		199.2	E-47
Purchase Meters and Metering Equipment- Various Sites		198.8		198.8	E-51
Replace Surge Arrestors - Various Sites	144.4	53.0		197.4	
Purchase New Meter Calibration Test Console - Hydro Place		196.9		196.9	E-53
Upgrade Warehouse Lighting - Bishop's Falls	15.2	180.4		195.6	
Install Fall Protection Equipment - Various Sites		194.7		194.7	E-55
Purchase Backup Diesel for Station Service - Grand Falls and Buchans		188.9		188.9	E-71
Install Variable Frequency Drives - Grey River	46.9	123.0		169.9	
Purchase Front End Loader with Backhoe - Wabush		133.2		133.2	E-73
Install Demand Metering - Various Sites		89.7		89.7	E-75
TOTAL TRANSMISSION AND RURAL OPERATIONS	206.5	1,757.6	0.0	1,964.1	
GENERAL PROPERTIES					
Replace Network Communications Equipment - Various Sites		199.3		199.3	E-80
Remove Safety Hazards - Various Sites		198.6		198.6	E-82
Replace Air Conditioners - Massey Drive and Happy Valley	39.9	152.0		191.9	
Upgrade Access Roads to Microwave Sites - Various Sites		118.4		118.4	E-86
TOTAL GENERAL PROPERTIES	39.9	668.3	0.0	708.2	
TOTAL PROJECTS OVER $50,000 AND UNDER $200,000	287.7	2,829.4	0.0	3,117.1	

Project Title: Purchase Capital Spares – Gas Turbines

Location: Hardwoods and Stephenville

Category: Generation – Gas Turbine

Definition: Other

Classification: Normal

Project Description:

The critical spares assessment completed to date has identified a number of components that are critical to have readily available in the event of a forced outage at Hydro's gas turbine generating facilities. The availability of the parts contributes significantly to an expedited return to service of a generator or its support systems.

The capital spares that have been identified as being required for Hydro's gas turbine generating facilities are as follows:

- Alternator Bearings, Hardwoods Gas Turbine (Hardwoods); and
- Clutch Bearing Liners, Stephenville Gas Turbine (Stephenville).

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:*($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	170.0	0.0	0.0	170.0
Labour	0.0	0.0	0.0	0.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	9.0	0.0	0.0	9.0
Contingency	6.0	0.0	0.0	6.0
TOTAL	**185.0**	**0.0**	**0.0**	**185.0**

Justification:

Alternator Bearings, Hardwoods

The alternators at all Hydro's gas turbine plants are supported by two journal bearings and coated with babbit (soft metal). The clearance between the bearing and the rotating shaft is between 0.008"-0.010". Any interruption to the normal operation of the alternator will result in the major damage to

the bearings, resulting in the total outage of the gas turbine plant. Without a spare bearing onsite, the procurement and repair of the bearing can take between 10-12 weeks.

A set of alternator spare bearings is proposed for each gas turbine facility as the alternator bearings are different at each site and are different on each side of the alternator.

Clutch Bearing Liners, Stephenville

The clutches at all hydro's gas turbine plants are supported by internal journal bearings which are coated with babbit. Any interruption to the normal operation of the clutch will result in a major damage to the bearings, resulting in a derating or a total outage of the gas turbine plant. Without a spare bearing onsite, the procurement and repair of the bearing can take between 10-12 weeks.

Clutch bearing liners (re-babbitting) of a set of clutch spare bearings is proposed for Stephenville as the current ones require repair.

Conclusion:

This critical spare equipment will facilitate an expedited return to service should a facility experience an outage due to a failure of an in-service critical asset. Critical spares are identified during ongoing critical spares evaluations undertaken by Hydro and requested annually. It is the intention of Hydro to purchase these critical spares and have them on site to provide ongoing, reliable service to customers.

Project Schedule

The anticipated project schedule is provided in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Open project	January 2017	January 2017
Design	Prepare specifications for alternator bearings and clutch bearing liners	February 2017	February 2017
Procurement	Procure alternator bearings and clutch bearing liners	March 2017	August 2017
Closeout	Prepare closeout documents.	September 2017	September 2017

Project Title: Install Wind Monitoring Station North Salmon Dam SD-2

Location: Bay d'Espoir

Category: Generation - Hydraulic

Definition: Other

Classification: Normal

Project Description:

This project includes the installation of a wind monitoring station on the left abutment of North Salmon Dam located in Upper Salmon Reservoir. The project includes the installation of a ten meter high steel tower, wind anemometer, data logger, solar panel power source with rechargeable battery and all accessories.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	0.0	0.0	0.0
Labour	51.2	0.0	0.0	51.2
Consultant	0.0	0.0	0.0	0.0
Contract Work	74.0	0.0	0.0	74.0
Other Direct Costs	5.7	0.0	0.0	5.7
Interest and Escalation	8.6	0.0	0.0	8.6
Contingency	26.0	0.0	0.0	26.0
TOTAL	**165.5**	**0.0**	**0.0**	**165.5**

Operating Experience:

Dam owners are responsible for the safe management of their dams. As a dam owner, Hydro has adopted the Canadian Dam Association (CDA) Dam Safety Guidelines as the corporate standard of practice. As part of Hydro's Dam Safety Program and in accordance with CDA Dam Safety Guidelines, Dam Safety Reviews are periodically completed for each dam.

A Dam Safety Review was completed for the Upper Salmon Reservoir dams in 2012. During a typical Dam Safety Review, the consultant will review items such as dam stability and minimum dam crest elevation. The crest of an embankment dam, like North Salmon Dam, is established using two criteria: reservoir water level and freeboard. Freeboard is the vertical distance between the maximum

operating reservoir level and the top of the dam or dam crest elevation. It is calculated using wind data to determine the maximum wave height against the dam face. According to CDA Dam Safety Guidelines, the sum of the calculated freeboard height and the maximum reservoir operating level results in a minimum dam crest elevation. In the case of North Salmon Dam, the sum of the freeboard height and the maximum reservoir operating level exceeds the existing crest elevation of the dam.

Dam design methods have changed since the installation of North Salmon Dam in the late 1960's which could explain why this structure does not meet the freeboard requirement as outlined by CDA. Another explanation may be that the wind speed and direction used in the freeboard calculation do not accurately represent the actual site conditions. During the development of the Dam Safety Review, the closest wind stations to this dam, Gander and Stephenville, were used to calculate the freeboard of North Salmon dam. To better determine the actual freeboard for North Salmon Dam, a project to collect wind data directly at the site was proposed so that the freeboard, and ultimately the minimum required dam crest elevation, can be recalculated using site specific data.

Project Justification:

The installation of a wind monitor on North Salmon dam was included as a recommendation in the Dam Safety Review of the Upper Salmon reservoir system in 2012. The wind monitor would be used to collect "at site" wind data to further investigate the calculated freeboard deficiency at the dam, ensuring the continued safety of this dam.

Project Schedule:

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Commission consultants	February 2017	March 2017
Design	Consultant design of concrete foundations Develop concrete foundation tender	February 2017 March 2017	March 2017 April 2017
Procurement	Procure wind monitor and equipment six week delivery time on equipment RFP for Concrete contractor	February 2017 March 2017	March 2017 April 2017 May 2017
Construction	Concrete foundation construction Tower and Wind monitor construction	June 2017 August 2017	July 2017 September 2017
Commissioning	Final Acceptance	October 2017	October 2017
Closeout	Project Close out	December 2017	December 2017

Future Plans:

Using data collected from this monitor, accurate “at site” calculations of the dam crest elevation will be completed.

Project Title: Replace Fuel Tank 22E

Location: St. Anthony

Category: Transmission and Rural Operations - Generation Northern

Definition: Other

Classification: Normal

Project Description:

This project involves the replacement of a 22,730 liter, single wall, horizontal fuel storage tank at Hydro's St. Anthony diesel generating station. Work includes:

- procurement of a new 22,730 liter, double wall, horizontal, fuel storage tank;
- cleaning, removal and disposal of the existing storage tank; and
- completion of modifications to the fuel header system to accommodate the new fuel storage tank.

The new tank and its associated piping will be installed to meet the Newfoundland and Labrador Storage and Handling of Gasoline and Associated Products Regulations, Section 27 (12). The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	28.0	0.0	0.0	28.0
Labour	82.0	0.0	0.0	82.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	42.0	0.0	0.0	42.0
Other Direct Costs	7.1	0.0	0.0	7.1
Interest and Escalation	8.9	0.0	0.0	8.9
Contingency	31.8	0.0	0.0	31.8
TOTAL	**199.8**	**0.0**	**0.0**	**199.8**

Operating Experience:

The St. Anthony diesel plant contains six diesel generating units with a total installed capacity of 9.7 MW. The diesel plant serves as a Stand-By generation source, which is frequently utilized to meet increased load requirements during the cold winter season.

Three 22,730 liter, horizontal fuel storage tanks provide the necessary fuel supply for the plant. An internal tank inspection, completed in 2014, as part of Hydro's Tank Inspection Program, revealed that tank 22E had a remaining service life of 3.4 years (See Appendix A).

Project Justification:

Tank 22E was fabricated in 1990. An internal tank inspection, completed in 2014, revealed that the tank's shell is severely pitted and its shell thickness reduced. Based on the reduction in shell thickness, it was deduced that the tank had a remaining service life of 3.4 years.

The Underwriters Laboratories of Canada (ULC) does not permit the field refurbishment of horizontal fuel storage tanks and, consequently, the completion of repairs to the tank is not a viable alternative. This project is justified on the requirement to replace a fuel storage tank which is approaching the end of its service life. Replacement of the tank, with a new double wall, vacuum sealed, horizontal fuel storage tank, is required to satisfy storage requirements and ensure continuity of fuel supply for the St. Anthony diesel plant.

Future Plans:

None.

Project Schedule:

The anticipated project schedule for this work is shown in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Budget Review, Develop Schedule, Scope Statement	April 2017	May 2017
Procurement	Purchase of Fuel Storage Tank	May 2017	July 2017
Design	Develop Tender Package	May 2017	June 2017
Tender	Tender and Award Installation Contract	June 2017	July 2017
Construction	Installation of New Fuel Storage Tank	July 2017	July 2017
Commissioning	Final Inspection	-	July 2017
Closeout	Project Closeout	-	August 2017

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HAST TANK NO. 22E
OUT-OF-SERVICE INSPECTION REPORT

Prepared For:

Baysteel Inc.
Holyrood
Harbour Main, NL
A0A 2R0

Attention: Don Corbett

Prepared By:

ACUREN

Acuren Group Inc.

Newfoundland Division

File Number: 5325-27-2
Date: August 31, 2014

Melissa Butler

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1. EXECUTIVE SUMMARY

1.1 OBSERVATIONS

An out-of-service inspection was performed on a Horizontal Atmospheric Storage Tank (HAST) Tank No. 22E. The inspection included the tank heads, tank shell, tank interior and the secondary containment.

A visual inspection was performed on the exterior and interior of the tank, containment, and the surroundings. The interior of the secondary containment has experienced significant corrosion and has previously leaked. All accessible welds are in fair condition.

The tank shell was examined with ultrasonic thickness inspection on all four quadrants of the tank shell. Areas of pitting were evident on the lower quadrant of the tank shell. The nominal shell thickness was 0.236 inches and the minimum wall thickness recorded was 0.218 inches.

The north and south heads were examined with ultrasonic thickness measurements. No evidence of corrosion or pitting was noted on either head. The nominal thickness of the head was 0.236 inches. The minimum thickness reading recorded on the north head was 0.249 inches. The minimum thickness reading recorded on the south head was 0.249 inches.

The external tank nozzles were visually examined. No sign of nozzle corrosion was evident on any of the nozzles.

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1.2 RECOMMENDATIONS

There is significant corrosion evident on the interior of the secondary containment and pitting on the lower 8" to 10" of the interior shell (with a remaining useful life of 3.4 years).

The tank MUST be repaired for those areas which have an RUL less than the intended operating period.

It is recommended the secondary containment be repaired at those areas with significant corrosion.

2. INTRODUCTION

On August 12-14, 2014 Acuren performed an out-of-service inspection of a Horizontal Atmospheric Storage Tank No. 22E, Serial Number 28716. The product stored in the tank is Diesel. This tank is owned and operated by NL Hydro.

Tank No. 22E is a welded construction, horizontal circular tank with a secondary containment compartment located in St. Anthony, NL. Tank nameplate shows the manufactured date to be 1990.

The purpose of this examination was to ensure compliance with the applicable regulatory requirements, to assess and determine causes of deterioration, to ensure overall tank reliability and to identify repairs required ensuring suitability for continued service.

This inspection included visual inspection in accordance with horizontal AST external inspection checklist, ultrasonic thickness survey of the tank head, shell and nozzles.

3. INSPECTION RESULTS

3.1 SECONDARY CONTAINMENT

A visual inspection was performed on the exterior and interior of the secondary containment, all accessible welds and its surroundings. Tank 22E sits in a secondary containment holding tank. The interior of the secondary containment is experiencing significant corrosion and coating failure due to inadequate water drainage. The external condition of the tank bottom was difficult to determine due to confined location. Refer to Appendix C of this report for photographs. The dyke is in good condition.

3.2 SHELL

An ultrasonic thickness scan was performed to validate the internal condition of the HAST Tank. Thickness readings were taken on all four quadrants. Please refer to Drawing SK5 in Appendix A of this report for UT thickness locations. No level or vapor vs. liquid corrosion was found.

A visual inspection was performed on the internal of the tank shell. Pitting was evident on the lower 8" to 10" of either side of the tank shell from the 6 o'clock position. Pit depths were measured between 0.030" to 0.140". When the shell pitting is deducted from the adjacent shell thickness, the minimum remaining useful life was found to be 3.4 years. Refer to SK4 for locations and Shell Pitting Locations Table.

Shell thickness measurements were taken on all four quadrants; six (6) readings were recorded along each line for a total of twenty-four (24) measurements. The minimum thickness found on the shell was 0.218 inches.

A complete list of all the shell ultrasonic thickness readings appears in Appendix B.

3.3 HEADS

A visual inspection was performed on the north and south heads. No visible sign of corrosion was found on either head. The paint coating on the tank heads was in satisfactory condition. Please refer to Appendix C for photographs.

An ultrasonic thickness survey was performed on the north head and south head of HAST Tank No. 22E. Thickness readings were taken in a horizontal and vertical line on each head. A total of twelve (12) readings were recorded on each head. No sign of corrosion or pitting was evident on either of the heads. Please refer to SK 1 and SK 2 in Appendix A of this report. The minimum thickness found on the north head was 0.249 inches. The minimum thickness found on the south head was 0.249 inches. A complete list of all the ultrasonic thickness readings appears in Appendix B.

3.4 APPURTENANCES

Visual inspection was performed on all the external nozzles. All nozzles are in satisfactory condition. The water draw off is located 1 ¾" above the bottom of the tank, water and sludge is then stagnant, pooling on the bottom of the tank, therefore accelerating corrosion. An ultrasonic thickness survey was performed on the 2" discharge nozzle at the south head and the 1" water draw nozzle at the north head. Refer to Appendix B for nozzle thickness.

4. RECOMMMENDATIONS

4.1. Secondary Containment

Due to significant corrosion, coating failure and a previous leak consideration should be given to sandblast and install coating on the secondary containment or replace.

4.2. Tank Shell

Due to significant corrosion and pitting on the lower 8" to 10" of the tank shell and a remaining useful life of 3.4 years a new tank replacement or repair of the above noted is recommended.

4.3. Tank Head

No recommendations at this time.

4.3. Tank Appurtenances

Water draw off nozzle should be lowered to allow for adequate drainage of sludge and water from bottom of tank.

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5. INSPECTION INTERVALS

Recommended inspection intervals of 5 year in-service and 10 year out-of-service cannot be determined due to low remaining useful life and until repairs have been made.

We trust that this report provides the information that you require; please contact me if you require any further information.

Sincerely,

ACUREN GROUP INC.

Melissa Butler
CWB Level 2
Newfoundland Operations

REVIEWED BY:

Craig Power
API 653 (Reg # 22559)
Newfoundland Operations

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Internal Inspection of HAST Tank No. 22E-St. Anthony

APPENDIX A: DRAWINGS

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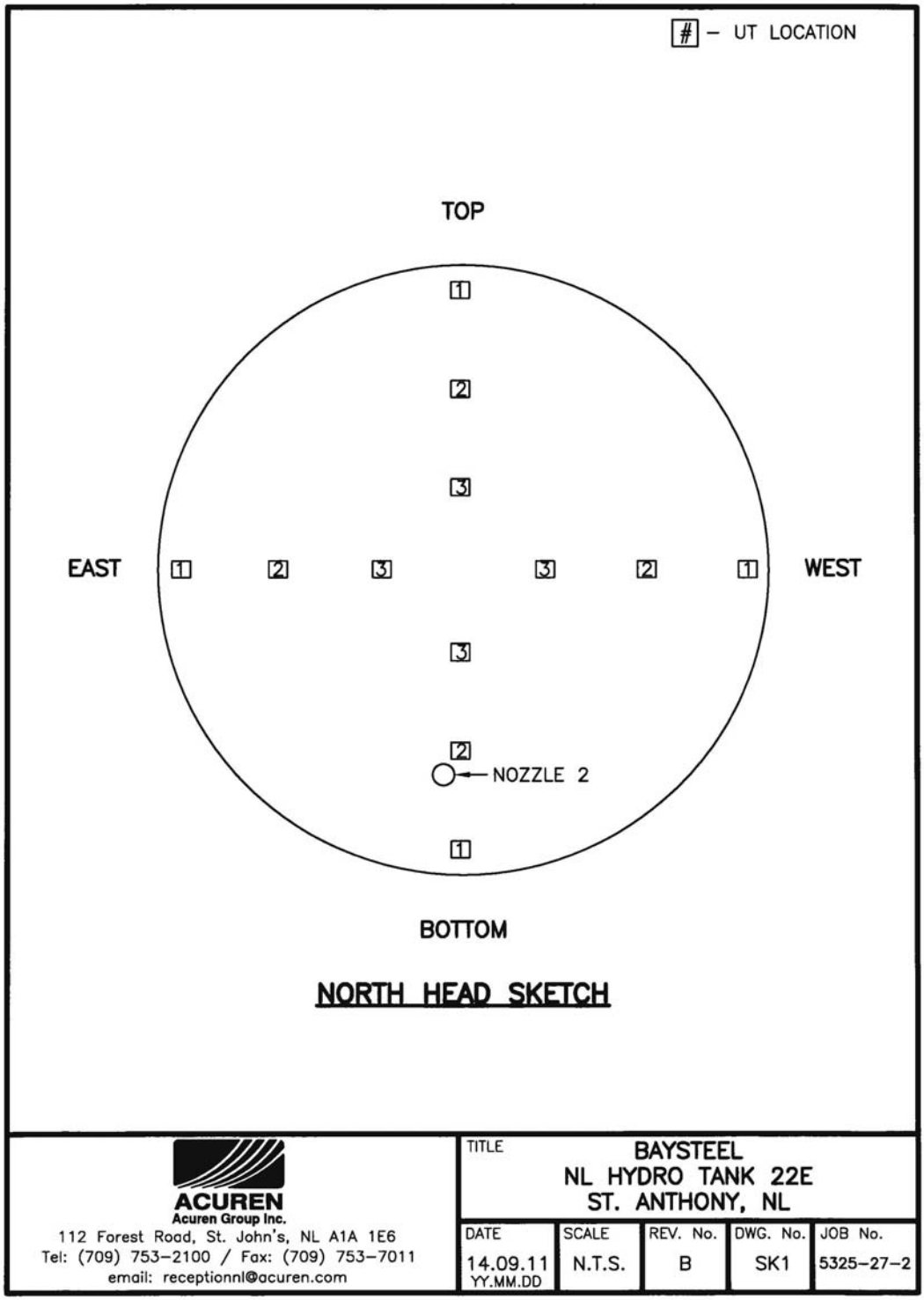
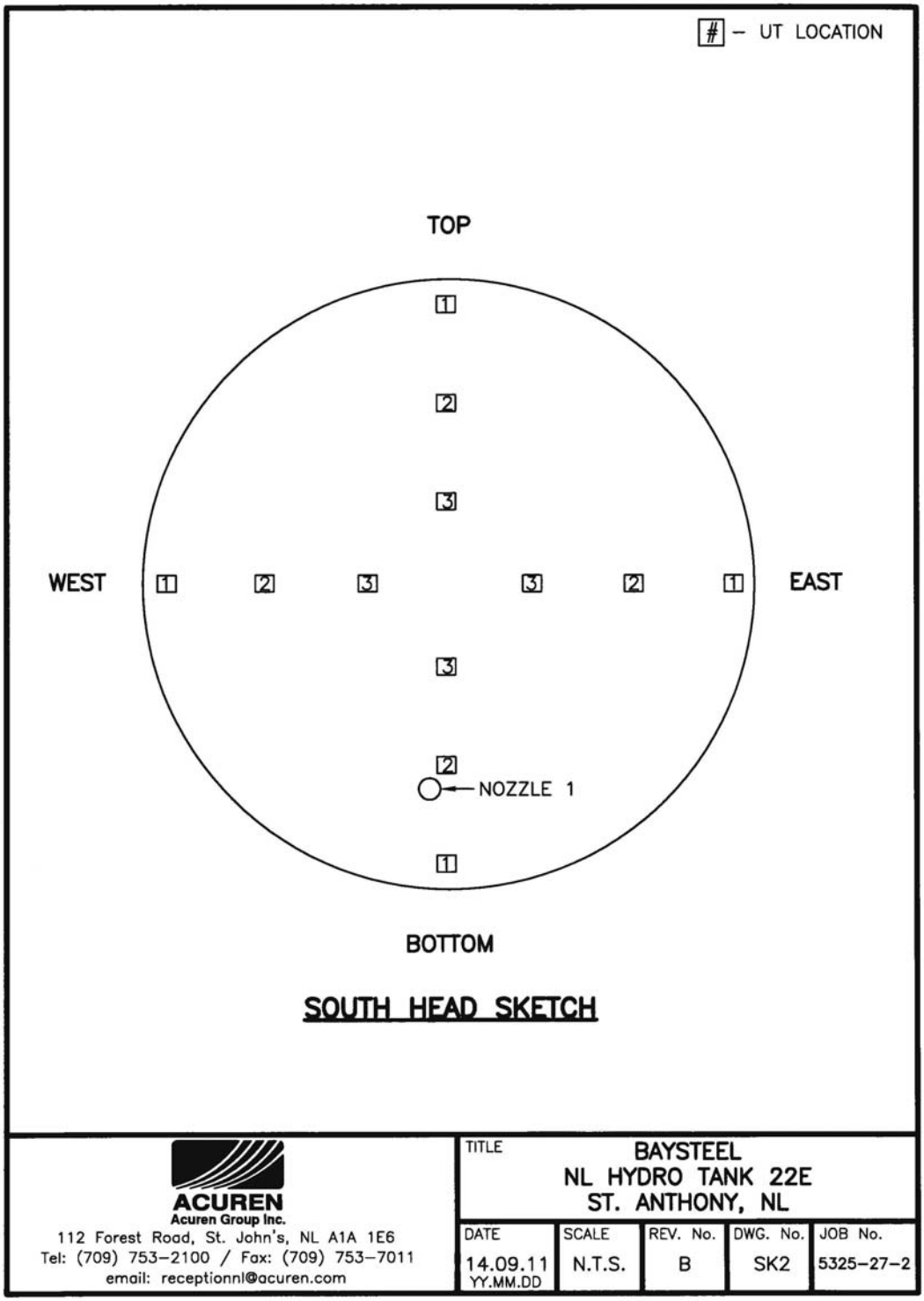
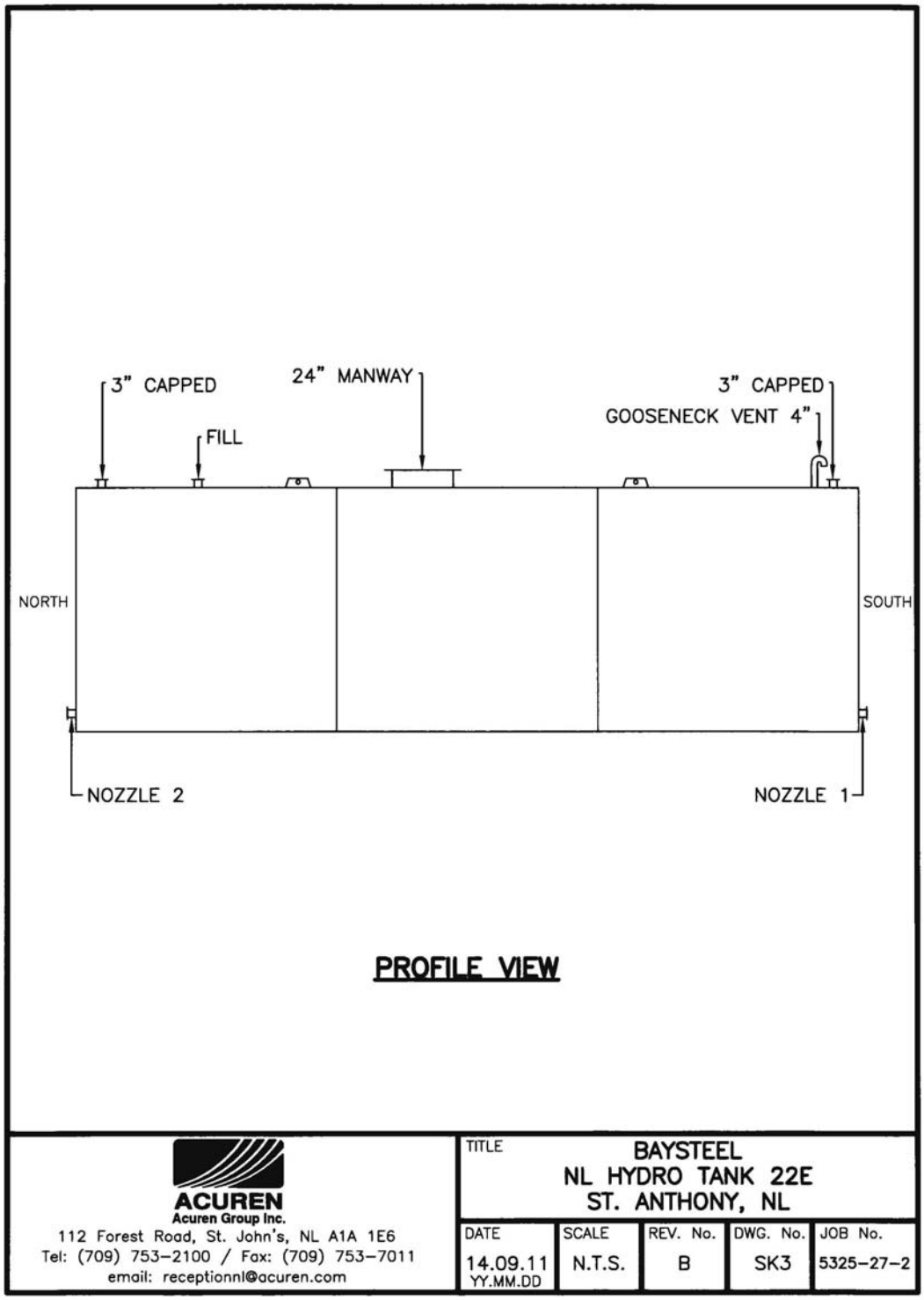
2 HUNTS LANE, ST. JOHN'S, NEWFOUNDLAND, CANADA • TELEPHONE (709) 753-2100 • FAX (709) 753-7011


– UT LOCATION
TOP
EAST
WEST
BOTTOM
NOZZLE 2
NORTH HEAD SKETCH
ACUREN
Acuren Group Inc.
112 Forest Road, St. John's, NL A1A 1E6
Tel: (709) 753–2100 / Fax: (709) 753–7011
email: receptionnl@acuren.com
TITLE
BAYSTEEL
NL HYDRO TANK 22E
ST. ANTHONY, NL
DATE
14.09.11
YY.MM.DD
SCALE
N.T.S.
REV. No.
B
DWG. No.
SK1
JOB No.
5325–27–2


– UT LOCATION
TOP
WEST
EAST
NOZZLE 1
BOTTOM
SOUTH HEAD SKETCH
ACUREN
Acuren Group Inc.
112 Forest Road, St. John's, NL A1A 1E6
Tel: (709) 753–2100 / Fax: (709) 753–7011
email: receptionnl@acuren.com
TITLE
BAYSTEEL
NL HYDRO TANK 22E
ST. ANTHONY, NL
DATE
14.09.11
YY.MM.DD
SCALE
N.T.S.
REV. No.
B
DWG. No.
SK2
JOB No.
5325–27–2


3" CAPPED
24" MANWAY
3" CAPPED
GOOSENECK VENT 4"
FILL
NORTH
SOUTH
NOZZLE 2
NOZZLE 1
PROFILE VIEW
ACUREN
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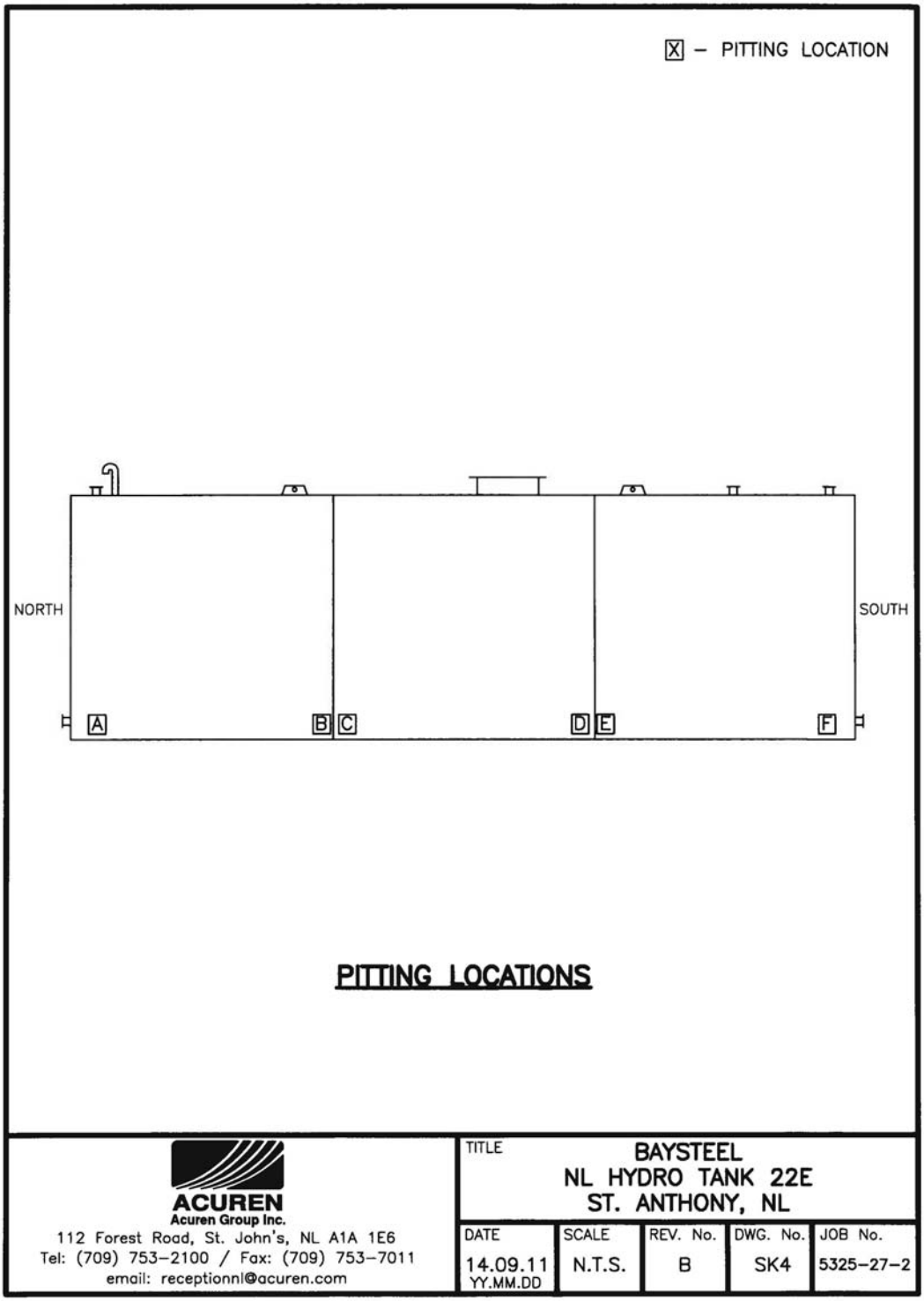
112 Forest Road, St. John's, NL A1A 1E6
Tel: (709) 753-2100 / Fax: (709) 753-7011
email: receptionnl@acuren.com
TITLE
BAYSTEEL
NL HYDRO TANK 22E
ST. ANTHONY, NL
DATE
14.09.11
YY.MM.DD
SCALE
N.T.S.
REV. No.
B
DWG. No.
SK3
JOB No.
5325-27-2


[X] – PITTING LOCATION
NORTH
SOUTH
A
B
C
D
E
F
PITTING LOCATIONS
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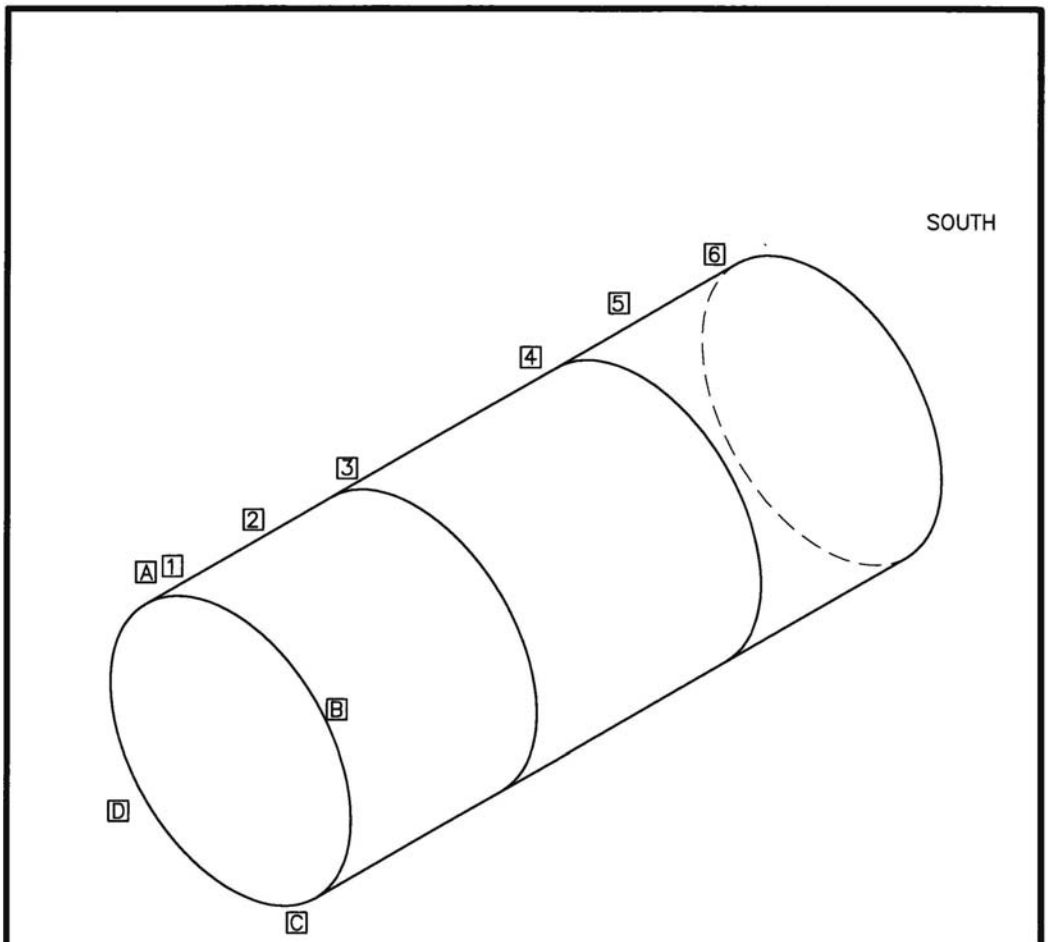
Acuren Group Inc.
112 Forest Road, St. John's, NL A1A 1E6
Tel: (709) 753–2100 / Fax: (709) 753–7011
email: receptionnl@acuren.com
TITLE
BAYSTEEL
NL HYDRO TANK 22E
ST. ANTHONY, NL
DATE
14.09.11
YY.MM.DD
SCALE
N.T.S.
REV. No.
B
DWG. No.
SK4
JOB No.
5325–27–2



UT THICKNESS READINGS LEGEND

ACUREN
Acuren Group Inc.
112 Forest Road, St. John's, NL A1A 1E6
Tel: (709) 753-2100 / Fax: (709) 753-7011
email: receptionnl@acuren.com

TITLE	BAYSTEEL NL HYDRO TANK 22E ST. ANTHONY, NL			
DATE	SCALE	REV. No.	DWG. No.	JOB No.
14.09.11 YY.MM.DD	N.T.S.	B	SK5	5325-27-2

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Internal Inspection of HAST Tank No. 22E-St. Anthony

APPENDIX B: ULTRASONIC THICKNESS READINGS

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Tank No. 22E NL Hydro
August 12-14, 2014

Shell Thickness Calculations

Units:	Inches	Internal Shell Coating Condition:	N/A	Nominal Thickness (inches):	0.236
Windgirder:	No	Internal Shell Coating Thickness:	N/A	External Shell Coating Condition:	Satisfactory
Paint Thickness:	N/A			External Shell Coating Thickness:	N/A

Number of Courses: 1

Shell Thickness Data
*thickness in inches

**Cells turn red for values less than 90% of specified nominal thickness*

North to South	Location A	Location B	Location C	Location D
1	0.239	0.242	0.233	0.232
2	0.242	0.237	0.260	0.218
3	0.226	0.222	0.249	0.226
4	0.239	0.236	0.237	0.229
5	0.229	0.242	0.220	0.219
6	0.246	0.239	0.242	0.246
Average	0.235			
Minimum	0.218			

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Baysteel Inc. Out-of-Service Tank Inspection Report
Tank No. 22E NL Hydro
August 12-14, 2014

Head Thickness Measurements

Units:	Inches	Nominal Thickness:	0.236
External Coating:	Paint	Age of Head (years):	24
Coating Condition:	Satisfactory	Minimum:	0.249
		Average:	0.257

Number of Locations: 24

Location	Thickness Reading			
	Top	West	Bottom	East
North Head	0.256	0.250	0.260	0.249
	0.263	0.260	0.259	0.260
	0.260	0.249	0.252	0.250
South Head	0.260	0.260	0.262	0.258
	0.258	0.249	0.253	0.260
	0.262	0.259	0.254	0.263

8 of 10

Baysteel Inc. Out-of-Service Tank Inspection Report
Tank No. 22E NL Hydro
August 12-14, 2014

Nozzle Thickness

*Thickness in inches

Nozzle #	Nozzle Description	NPS	Thickness Reading			
			Top	West	Bottom	East
1	Discharge Line at South Head	2"	0.150	0.145	0.148	0.164
2	Water Draw at North Head	1"	0.118	0.120	0.120	0.118

Baysteel Inc. Out-of-Service Tank Inspection Report
Tank No. 22E NL Hydro
August 12-14, 2014

Shell Pitting Locations

Units: Inches

Nominal Thickness (inches): 0.236

Number of Courses: 1

Shell Pitting Data
*thickness in inches

North to South	Pit Depth	Adjacent Shell Thickness	Remaining Thickness	Corrosion Rate	RUL Based Upon 0.100
A	0.070	0.233	0.163	0.003	21.6
B	0.140	0.260	0.120	0.006	3.4
C	0.050	0.249	0.199	0.002	47.5
D	0.040	0.237	0.197	0.002	58.2
E	0.030	0.220	0.190	0.001	72.0
F	0.030	0.242	0.212	0.001	89.6

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Internal Inspection of HAST Tank No. 22E-St. Anthony

APPENDIX C: PHOTOGRAPHS

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Internal Inspection of HAST Tank No. 22E-St. Anthony, NL

Photo 1:

HAST Tank No. 22E in St. Anthony, NL.

Photo 2:

South Head of Tank No. 22E.

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Internal Inspection of HAST Tank No. 22E-St. Anthony, NL

Photo 3:

Side View of Tank No. 22E.

Photo 4:

Tank No. 22E Nameplate.

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Photo 5:

View of HAST Tanks.

Photo 6:

Nozzle 1 – 2" Fill/Discharge Line.

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Photo 7:

Nozzle 2 – 1" Water Draw for the Secondary Containment.

Photo 8:

Stagnant Water in Secondary Containment Due to Poor Water Drainage.

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Photo 9:

Coating Failure on the Interior of the Secondary Containment.

Photo 10:

Typical Tank Support Structure.

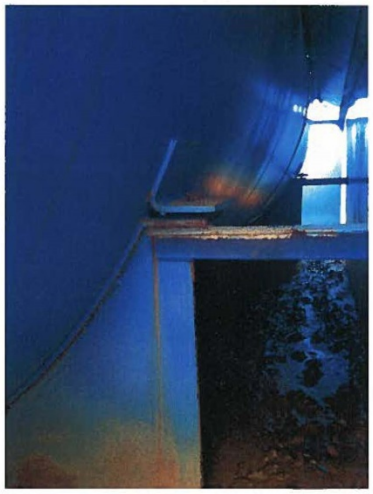

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Photo 11:

Nozzle 2 – 1" Water Draw Internal, 1 ¾" Height from Tank Bottom.

Photo 12:

Nozzle 1 – 2" Fill/Discharge Line Internal.

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Photo 13:

Shell Corrosion and Pitting
Measuring 0.080" Depth.

Photo 14:

Shell Pitting with Depths
Measuring 0.140".

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APPENDIX D: INSPECTION CHECKLIST

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Small Horizontal Tank Inspection Guidelines — Rev 0
August 31, 2006

Attachment 1
Horizontal AST EXTERNAL INSPECTION CHECKLIST

LOCATION: St. Anthony TAG NO. 22E INSPECTOR Craig Power
SERVICE DESCRIPTION: Diesel Date of Inspection Aug 2014
TYPE OF HAST: HAST ___ HAST Self Dike on Grade ___ HAST Self Dike on Supports ✓ HAST Double Wall ___

ITEM	INSPECTION CRITERIA	ASSESSMENT		
		OK	Abnormality (Explain)	N/A
	ALL HASTs			
a.	TANK SHELL CONDITION	✓		
b.	NOZZLES, ROOF HATCHES and MANWAYS INCLUDING REINFORCING PADS	✓		
c.	SMALL PIPING CONNECTIONS INCLUDING GUSSETS	✓		
d.	PLATFORM, LADDER or OTHER ATTACHMENT WELDS to VESSEL	✓		
e.	INSULATION / WEATHERPROOFING, Coating condition	✓		
f.	FIXED LADDERS, PLATFORMS, HANDRAILS and STAIRWAYS	✓		
g.	PV VENT INSTALLATION	✓		
h.	FLANGES and ASSOCIATED HARDWARE	✓		
i.	FOUNDATION PAD, CONCRETE PAD and BERM	✓		
j.	FOUNDATION BOLTS			✓
	HASTs SITTING ON SUPPORTS OR SADDLES:			
k.	SADDLE or SUPPORT including GROUND CABLE	✓		
	HASTs with SECONDARY CONTAINMENT			
l.	SECONDARY CONTAINMENT BOX EXTERNAL	✓		
m.	SECONDARY CONTAINMENT BOX INTERNAL		See Attached	
	HASTs with SECONDARY CONTAINMENT SITTING ON SUPPORTS OR LEGS			
n.	LEGS OR SUPPORTS	✓		
o.	UNDERSIDE OF SECONDARY CONTAINMENT FLOOR		Not Accessible	✓
	HAST's with DOUBLE WALL			
p.	Interstitial Space Monitoring Condition			✓

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Small Horizontal Tank Inspection Guidelines

Rev 0
August 31, 2006

ITEM COMMENTS (REFERENCE ITEM NO. WHERE APPROPRIATE)

TAG No. 22E

m. Coating failure in secondary containment. Employees informed us of previous leaks in containment.

RECOMMENDATIONS

m. Replace or Recoat internal Secondary containment.

SUMMARY OF INSPECTION

Authorized Inspector's Signature _____ Date: Aug 2014

Certification No 22559

Confidential - release or publication must be authorized by EMRE
8 of 10

Small Horizontal Tank Inspection Guidelines

Rev 0
August 31, 2006

Attachment 2
Horizontal AST VISUAL INTERNAL INSPECTION CHECKLIST

LOCATION: St. Anthony TAG NO. 22E INSPECTOR Craig Power
SERVICE DESCRIPTION: Diesel Date of Inspection Aug 2014
TYPE OF HAST: HAST ___ HAST Self Dike on Grade ___ HAST Self Dike on Supports ✓ HAST Double Wall ___

ITEM	INSPECTION CRITERIA	ASSESSMENT		
		OK	Abnormality (Explain)	N/A
	INDICATE IF OTHER NDE TYPES USED, DESCRIBE UNDER COMMENTS PT_ MT_ WFMT_ RT_ UT_			
	INTERNAL SURFACE OF TANK			
a.	TANK SHELL CONDITION		See Attached	
b.	THICKENSS EVALUATION	✓		
c.	PITTING EVALUATION		See Attached	
d.	LIQUID?VAPOUR OR LIQUID/LIQUID INTERFACE	✓		
e.	AREAS SUBJECT TO EROSION FROM IMPINGEMENT OR HIGH VELOCITY	✓		
f.	AREAS ADJACENT TO EXTERNAL ATTACHMENTS	✓		
g.	NOZZLES, HATCHES and MANWAYS INCLUDING ATTACHMENT WELDS	✓		
h.	SMALL DIAMETER NOZZLES INCLUDING ATTACHMENT WELDS	✓		
i.	THERMOWELLS OR OTHER PRESSURE RETAINING EQUIPMENT	✓		

Horizontal AST VISUAL INTERNAL INSPECTION CHECKLIST

ITEM COMMENTS (REFERENCE ITEM NO. WHERE APPROPRIATE) **TAG No. 22E**

a. Pitting on internal shell. See report
c. Significant pitting on internal surface at sludge/water interface. See Report.

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9 of 10

Small Horizontal Tank Inspection Guidelines

Rev 0
August 31, 2006

RECOMMENDATIONS

See Report for recommendations

SUMMARY OF INSPECTION

Authorized Inspector's Signature _____ Date: Aug 2014

Certification No 22559

BAYSTEEL INC.
Internal Inspection of HAST Tank No. 22E-St. Anthony

APPENDIX E: EQUIPMENT AND PERSONNEL

ACUREN GROUP INC.
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Baysteel Inc. Out-of-Service Tank Inspection Report
Tank No. 22E NL Hydro
August 12-14, 2014

Equipment

Next Calibration Due Date: December 3, 2014

Inspector 1: Craig Power (Name) 22559 (API 653 Certification No.)

Technician 1: _____ (Name) _____ (CGSB Certification No.)

Technician 2: _____ (Name) _____ (CWB Certification No.)

Instrument

Instrument Type	Manufacturer	Serial Number	Cal due Date	Couplant	Scan Type
Epoch XT	Panametrics	101174608	December 3, 2014	Sonoglide	Thickness

Transducers

Associated Instrument	Angle	Serial Number	Type	Frequency (MHz)	Cal Block	Cal Block Serial Number
Epoch XT	0°	ST1003	Dual	5	Step Wedge	10-3099

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BAYSTEEL INC.
Internal Inspection of HAST Tank No. 22E-St. Anthony

APPENDIX F: SCOPE OF SERVICES

ACUREN GROUP INC.
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ACURENSTANDARD SERVICE TERMS
Issued January 1, 2012

SCOPE OF SERVICES

Acuren will only perform those services specifically agreed to in writing, and will not be responsible for any matters beyond the agreed-upon, written scope of services. Any descriptions, statements, comments or expressions made reflect the opinion or observations of the Acuren examiner based solely upon data available at the time, and are not intended, nor can they be construed, as representations or warranties as to the actual circumstances. Acuren does not assume any responsibilities of its client ("Client"), which retains complete responsibility for all engineering, repair, modification and use decisions. The results of Acuren's services shall be used only for Client's internal purposes.

STANDARD OF CARE

Acuren shall use the degree of care and skill ordinarily exercised under similar circumstances by others performing such services in the same or similar locality. ***No other warranty, expressed or implied, is made or intended by Acuren, and all other warranties are expressly disclaimed.*** In the event of any breach of this warranty, Acuren's sole and exclusive obligation will be to correct or re-perform the deficient service or, at Acuren's option, to refund the amount paid for the deficient service.

LIMITATIONS OF LIABILITY

Acuren does not assume any liability or responsibility for losses or damages such as personal injuries and property damage except and only to the extent directly caused by the willful or negligent misconduct of Acuren in the course of performing the requested services. ***In no event shall Acuren's aggregate liability for any reason, in connection with any claim asserted, exceed the amount paid for the services in question***. Acuren shall not be held responsible or liable for any loss, damage or delay caused by accidents, strikes, fires, floods or other circumstances or causes beyond its control, including actions taken or not taken by Client or other third parties. ***In no event shall Acuren be liable for indirect, incidental, special, punitive or consequential damages including, without limitation, damages relating to reputation, lost business opportunities, lost profits, goodwill, downtime, overhead expenses, loss of use, business interruption, data loss or other economic loss***.

USE OF ACUREN'S INTELLECTUAL PROPERTY

Acuren's intellectual property, including software, designs, methodologies and processes ("IP") shall not be copied, transferred, licensed or used by anyone other than Client and only in connection with Acuren performing its services. Client shall not, and shall not permit anyone else to, reverse engineer, decompile, or disassemble the IP, or use the IP in any way to replicate or develop similar IP.

PAYMENT AND OTHER TERMS

Pricing is based on Acuren's standard service techniques and protocols unless otherwise specifically stated. Any request for non-standard techniques or protocols in performing the services must be identified by Client and accepted by Acuren in writing prior to commencement. Payment in full shall be made within 30 days of the date of invoice, and thereafter a late charge of 12% at an annualized rate on outstanding accounts may be charged. Acuren also reserves the right to charge for any extra costs that are incurred as a result of delays, cancellations, or postponements resulting from Client's instructions, lack of instructions or mistakes for which Acuren is not responsible. Film that is not accepted by Client when the report is issued will be disposed of by Acuren.

Any purported variation of these Standard Service Terms shall have no effect unless expressly agreed to in writing and signed by an authorized representative of Acuren. The provisions of these Standard Service Terms are severable and in the event any provision is held to be unenforceable, the remaining provisions will continue in full force and effect. It is understood that Acuren is an independent contractor and not an employee or agent of Client. Should any type of dispute arise, these Standard Service Terms shall be governed by and construed in accordance with the laws of the location where the services in question were performed without regard to conflict of law principles.

Acuren Standard Service Terms

ACUREN

ADDITIONAL TERMS THAT GOVERN ALL EXPERT TESTIMONY AND EXPERT LITIGATION SUPPORT ENGAGEMENTS

When Acuren is engaged as an expert in connection with any litigation or potential litigation matter (the "Engagement"), its fees will not be dependent upon the outcome of the actual or potential proceeding in which Acuren is acting as an expert for Client (the "Proceeding"). Objective conclusions will be presented without regard to how they will impact the Proceeding to ensure that Acuren is able to perform its services properly. Acuren will assume, for purposes of its Engagement, that information and data provided by or on behalf of Client will be sufficiently accurate, complete and comprehensive to enable Acuren to perform its services. Client and Acuren will agree in writing at the commencement of the Engagement on the precise scope of services to be provided by Acuren, including any opinion to be provided and how samples and other materials or information are to be examined, handled, stored and/or returned. Acuren will not be responsible for any matters beyond that written scope of services. Client shall be responsible for notifying Acuren of all relevant timelines in the Proceeding.

All reports and material developed by Acuren shall be used only for purposes of the Proceeding. Any other use requires Acuren's prior written consent. Client shall disclose sufficient information about the parties to enable Acuren to assess if there may be a potential conflict of interest. If Client wishes for Acuren to perform joint testing, Client shall be responsible for obtaining the agreement of the other parties regarding the testing protocol to be used, and shall instruct Acuren in writing as to what information and documents can be shared with the other parties.

Client will defend, indemnify and hold Acuren harmless against and from any and all claims, costs, actions, losses and liabilities, including attorneys' fees, arising or relating in any way to the Engagement other than those caused solely by Acuren's willful misconduct or gross negligence. If Client is representing another party in the Proceeding, Client represents that it has secured such party's agreement to be bound by these terms and conditions.

If the Engagement will not involve testimony, all material created by Acuren will be maintained as confidential and not disclosed to third parties (other than as required by the Proceeding) without Acuren's prior written consent. All samples provided to Acuren will be disposed of within 60 days of the end of the Engagement unless Acuren is instructed in writing to return them to Client or retain them for a fee.

ADDITIONAL TERMS THAT GOVERN ALL SERVICES PERFORMED AT AMUSEMENT PARKS, THEME PARKS AND CARNIVAL RIDES

Notwithstanding any other document to the contrary, Acuren's services at amusement parks, theme parks, carnival rides and similar facilities are always limited to performing specific tests and procedures on rails, tracks, welds and other structural components (the "Parts"). Such tests and procedures are not able to detect all flaws or defects, nor are they necessarily able to predict future failures of any such inspected Parts. Acuren does not, under any circumstances, certify or warrant that, or determine whether, rides and other equipment at amusement parks, theme parks, carnival rides or similar facilities are in good working order, are operating safely and properly, and/or comply with any federal, state, local or similar laws or regulations.

*****

THE FOREGOING TERMS APPLY TO AND SHALL GOVERN ALL SERVICES AND PRODUCTS PROVIDED BY ANY ACUREN BUSINESS, INCLUDING ACUREN INSPECTION, INC., ACUREN USA, INC., WIT PIPELINE INSPECTION, INC., ACUREN GROUP INC., ACUREN PIPELINE SERVICES INC., SASKTECH INSPECTION LTD. AND THEIR RESPECTIVE SUBSIDIARIES.

WE VERY MUCH APPRECIATE YOUR BUSINESS. SHOULD YOU HAVE ANY QUESTIONS, PLEASE CONTACT THE PERSON FROM WHOM YOU WISH TO ORDER PRODUCTS AND/OR SERVICES OR SEND AN EMAIL TO SERVICETERMS@ACUREN.COM.

Acuren Standard Service Terms

Project Title: Replace Recloser

Location: Wabush

Category: Transmission and Rural Operations - Terminal Stations

Definition: Other

Classification: Normal

Project Description:

This project involves the replacement of recloser WA11-R1 in the Wabush substation. The new recloser would be capable of supporting an interrupting rating under any designed station operating condition, including when both 12.5 kV buses are tied together. Some of the additional scope of work includes the replacement of the existing concrete pad and recloser controls including the control cable. The removal of the existing recloser and concrete pad will also be required.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	32.4	0.0	0.0	32.4
Labour	53.6	0.0	0.0	53.6
Consultant	4.8	0.0	0.0	4.8
Contract Work	61.5	0.0	0.0	61.5
Other Direct Costs	5.0	0.0	0.0	5.0
Interest and Escalation	10.4	0.0	0.0	10.4
Contingency	31.5	0.0	0.0	31.5
TOTAL	**199.2**	**0.0**	**0.0**	**199.2**

Operating Experience:

The Wabush substation has six distribution feeders that originate from two 12.5 kV buses. Under normal operating conditions these two buses are isolated from each other and each supply three feeders. In the event of transformer T6 failure, transformer T5 would be placed in service and paralleled with T3, therefore paralleling the two 12.5 kV buses (B3 and B5). By tying these two buses together, the fault levels at the reclosers would increase significantly.

Project Justification:

The existing recloser WA11-R1 currently has an interrupting rating of 6 kA. In the event of a failure to transformer T6 during peak conditions, buses B3 and B5 would have to be tied together to provide enough transformation capacity to the system. This would result in higher fault levels on the low-side of the power transformers (12.5 kV), which would exceed the interrupting rating of WA11-R1. This operating scenario has only been possible since recent modifications to the Wabush system (eg. voltage conversion). Refer to Figure 1 for a single line diagram of the Wabush Substation.

Additionally, the controls for recloser WA11-R1 are obsolete, and the associated critical components are no longer available. In order to not jeopardize the future reliability of the Wabush distribution system, WA11-R1 must be replaced with a recloser that has an adequate interrupting rating for all designed operating conditions. A protective device that is not capable of interrupting a fault under any expected condition is a safety risk, as the feeder would not be protected during the fault. WA11-R1 is also not physically equipped to handle maximum available fault levels and therefore a catastrophic failure could result endangering personnel who may be close to the recloser. A recloser failure could also create an environmental risk, as these devices are oil filled.

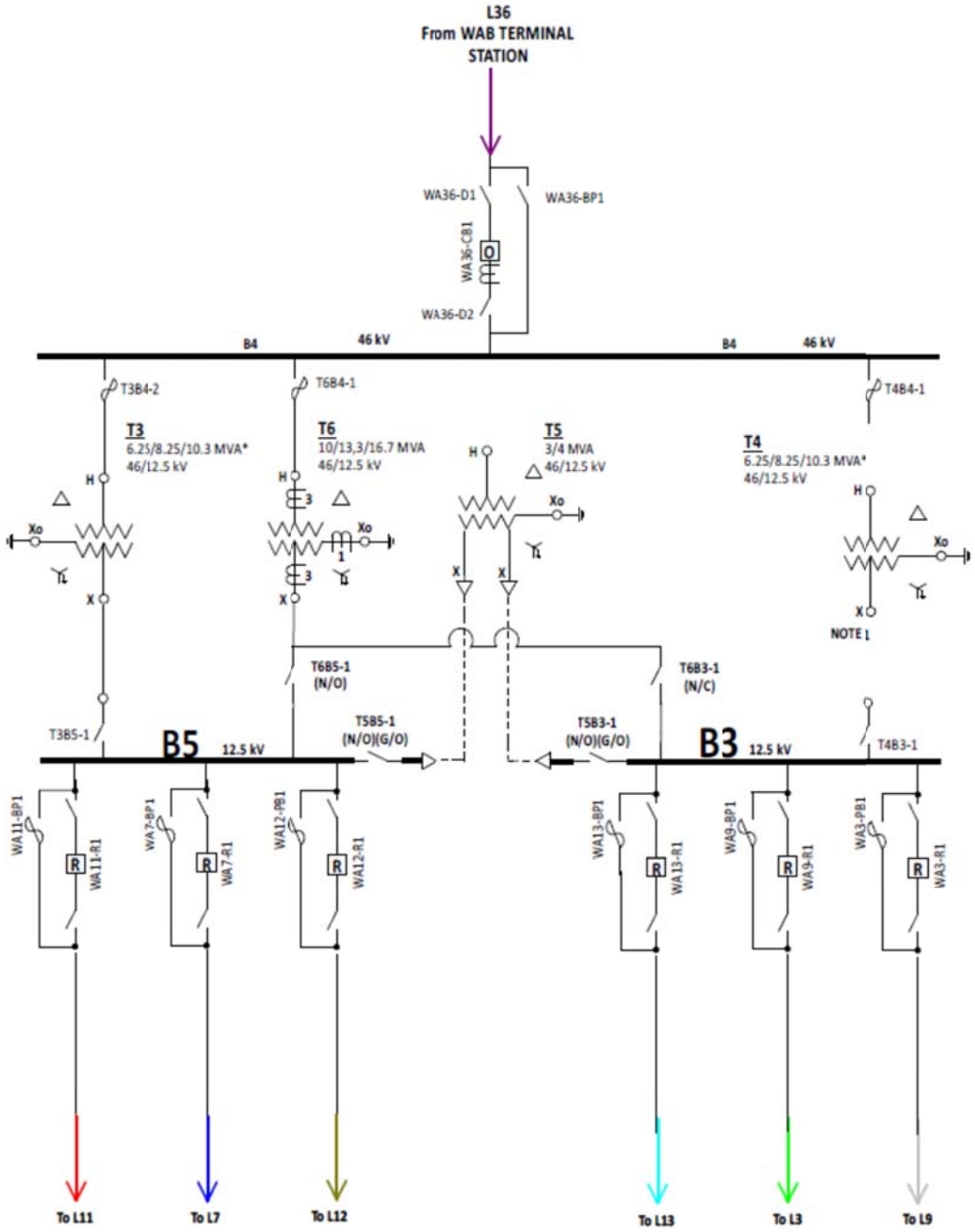

Figure 1: Wabush Substation - Single Line Diagram

Project Schedule:

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Project schedule development	January 2017	February 2017
Design	Electrical and Civil design, specification development	February 2017	April 2017
Procurement	Procurement and lead time of electrical equipment	April 2017	July 2017
Construction	Civil and Electrical Construction	July 2017	August 2017
Commissioning	Recloser Commissioning	August 2017	August 2017
Closeout	Project financial closeout	September 2017	December 2017

Project Title: Purchase Meters and Metering Equipment

Location: Various Sites

Category: Transmission and Rural Operations - Metering

Definition: Other

Classification: Normal

Project Description:

This project consists of purchasing 200 demand meters, 10 terminal station meters and associated equipment for use in revenue metering which require replacement each year due to government retest, technology changes or obsolescence. This project also includes purchasing equipment required to replace aging unsupported Automated Meter Reading (AMR) infrastructure.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	132.0	0.0	0.0	132.0
Labour	24.0	0.0	0.0	24.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	11.7	0.0	0.0	11.7
Contingency	31.2	0.0	0.0	31.2
TOTAL	**198.9**	**0.0**	**0.0**	**198.9**

Operating Experience:

Hydro's electromechanical revenue meters have reached or surpassed their life expectancy of 25 years. They are obsolete and can no longer be purchased. Electromechanical meters can still be recertified and sealed, however Measurement Canada has shortened its seal period from six years to four years due to accuracy concerns. Purchasing new electronic meters to replace these obsolete meters will improve metering accuracy and reliability.

Some of the AMR equipment has reached end of life and is unsupported from the manufacturer.

Project Justification:

Revenue meters are required to be purchased each year so that meters are available for new service applications and for replacements due to government retest, damaged meters, technology changes and obsolescence. Under the Electricity & Gas Inspection Act and Regulations, Hydro is mandated by Measurement Canada to ensure that in-service meters are accurate and in good working condition. Furthermore, revenue meters must be certified and sealed, and the requirement states that these meters are to be removed from service before its expiry date. Failure to replace meters that are due to be replaced may result in monetary penalties as per the new requirements under the Electricity & Gas Inspection Act and Regulations.

It is less economical to certify and seal electromechanical meters compared to purchasing electronic meters as the capital and operating costs to purchase new electronic meters is less than the cost of re-sealing electromechanical meters. As well, it is more efficient, accurate and cost effective to certify and seal electronic meters.

Due to aging and unsupported equipment Hydro must replace one of its AMR collectors. As proven in previous capital budgets, non-automated meter reading does not provide as much functionality and flexibility, and is less economical then the AMR options.

Project Schedule:

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Prepare Orders	January 2017	January 2017
Design	Prepare Drawings	January 2017	February 2017
Procurement	Order Meters and Equipment	January 2017	April 2017
Construction	Install Meters and Equipment	May 2017	October 2017
Commissioning	Verify Installations	May 2017	October 2017
Closeout	Closeout Projects	November 2017	December 2017

Project Title: Purchase New Meter Calibration Test Console

Location: Hydro Place Meter Shop

Category: Transmission and Rural Operations - Metering

Definition: Other

Classification: Mandatory

Project Description:

This project requires the purchase of a new fully automatic 10 position meter calibration test console compliant to Measurement Canada's standard EL-ENG-12-1, Specifications for the Calibration, Certification and Use of Electricity Calibration Consoles. The new test console will be capable of testing all electro-mechanical and electronic type meters that are used by electric utilities in today's revenue metering applications. The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	156.0	0.0	0.0	156.0
Labour	0.0	0.0	0.0	0.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	9.7	0.0	0.0	9.7
Contingency	31.2	0.0	0.0	31.2
TOTAL	**196.9**	**0.0**	**0.0**	**196.9**

Operating Experience:

Hydro presently has a fully automatic 10 position meter calibration test console that was purchased in 2014, a 10 position meter calibration test console that was purchased in 1987 and a 5 position meter calibration test console that was purchased in 1978. The newest test console has met all expectations in regards to accuracy, ease of use, reliability, support and operator safety. The two older test consoles no longer work[1] and have had software and hardware problems over the last 5 years, and are presently out of service.

[1] Up until 2016, both 10 position meter calibration test consoles were in service. The console purchased in 1987 failed in 2016.

Project Justification:

This project is justified on the requirement to replace obsolete non-functioning equipment along with the necessity to ensure that we have the capacity and reliability to meet our obligations as an accredited organization and authorized service provider. Hydro is a Measurement Canada accredited organization and provides testing, calibration and certification services for the sealing of revenue meters.

A new fully automatic 10 position meter calibration test console will ensure that Hydro can continue to function as an accredited organization and Authorized Service Provider under Measurement Canada's Electricity and Gas Inspection Act and Regulations.

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Prepare order	January 2017	January 2017
Design	Consult with manufacturer	January 2017	January 2017
Procurement	Order Test Console	January 2017	February 2017
Construction	Four to six months	February 2017	July 2017
Commissioning	Ensure compliance to EL-ENG-12-1	July 2017	August 2017
Closeout	Close out project	August 2017	September 2017

Future Plans:

None.

Project Title: Install Fall Protection Equipment

Location: Various Sites

Category: General Properties - Administrative

Definition: Pooled

Classification: Mandatory

Project Description:

This project is required to design, supply and install fall protection systems at several Hydro facilities. It includes the fabrication and galvanizing of an access ladder at the Salmon River Spillway, galvanizing and installation of a catwalk at Salmon River Spillway and the fabrication, galvanizing and installation of an access catwalk at the Burnt Dam spillway. The project estimate is $194,700, as shown in Table 1.

Table 1: Project Cost

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	0.0	0.0	0.0
Labour	80.1	0.0	0.0	80.1
Consultant	0.0	0.0	0.0	0.0
Contract Work	56.0	0.0	0.0	56.0
Other Direct Costs	16.1	0.0	0.0	16.1
Interest and Escalation	12.1	0.0	0.0	12.1
Contingency	30.4	0.0	0.0	30.4
TOTAL	**194.7**	**0.0**	**0.0**	**194.7**

Operating Experience:

Hydro initiated a program in 2005 to install fall protection systems on transformers, fuel tanks and roofs. This is the twelfth year of the program which started in 2005 and proceeded on a priority basis.

The following is a summary of the three basic types of fall protection systems installed by Hydro. The photographs illustrate how each system is used.

Roof Fall Protection Systems

Generally, a fall protection system is not a complex system. Picture 1 shows a worker tethered to a permanently installed system comprised of a cable secured to the roof by a series of fall arrest anchors. The tether is called a lifeline and the anchors are travel restraints. As the worker moves

around on the roof, they are able to attach the lifeline between the anchors as needed. If a fall occurs, the anchors will arrest the fall, thereby, saving the worker's life.

Picture 1: Roof Fall Protection System

Ladder Fall Protection System

In this system, a safety cable is installed vertically on the side of the ladder as shown in Pictures 2 and 3. The workers secure themselves to the ladder fall protection system by attaching themselves to a D ring, as shown in the pictures, which is attached to a cable grab which in turn rides on the cable. The cable grab allows the worker to move with ease up the ladder but in the event of a sudden downward movement, as in a fall, the cable grab is designed to abruptly grab the cable, securing the worker and preventing a fall. This action is similar to the operation of a seat belt in a car.

Picture 2: Ladder Fall Protection System

Picture 3: Ladder Fall Protection System

Transformer Fall Protection System

Picture 4 illustrates a transformer fall protection system used by the three workers standing on top of a transformer. This system is a portable system. The fall protection system is mounted on a fixed anchor plate welded to the top of the transformer. When work is completed, the fall protection system can be taken to another site.

The three basic types of fall protection systems shown are for illustrative purposes. Systems may vary when they are installed because of, for example, extra cable arrangements or the need for railings. The systems will be inspected annually. The anticipated useful life of a fall protection system is 20 years.

Picture 4: Transformer Fall Protection System

Project Justification:

This project is justified on the requirement to provide a safe work environment and to comply with Section 140, 141, and 142, under Part X: Fall Protection, of the Occupational Health and Safety Regulations. Fall protection systems are required to perform work safely at elevations above 3.05 meters. Hydro must conform to these sections of the Occupational Health and Safety Regulations. Section 141 "General Requirements" states in part "where a worker is exposed to the hazard of falling from a work area that is: 3 meters or more above the nearest safe surface or water; above a surface or thing; or above any open tank, pit or vat containing hazardous material, the employer shall ensure that the worker is provided with a fall arrest system that meets the requirements of section 142". The

complete regulations contained under sections 140, 141, and 142 are presented in Table 3. Without proper fall protections systems in place, a worker can refuse to perform his/her assigned duties.

The fall protection program, started in 2005, originally did not identify installations at all Hydro sites where fall protection systems were required. New sites were identified throughout the course of the program. Table 2 presents the annual budget and actual expenditures for years 2011 to 2016.

Table 2: Capital Expenditure History

Year	Capital Budget ($000)	Actual Expenditures ($000)	Comments
2016B	198.8		Purchase/Fabricate material, install ladders and life line
2015	198.9	180.7	Roof Anchors, Life Lines
2014	199.2	139.1	Railing, roofs and transformer
2013	196.6	163.5	Ladders and roofs
2012	199.2	186.5	Ladders and roofs
2011	198.4	213.2	Ladders and roofs

In order to be compliant with Section 140 “Fall Protection Systems”, Section 141 “ General Requirements and Section 142 “Fall Arrest Systems”, under Part X: Fall Protection, of the Occupational Health and Safety Regulations, this work must continue until all facilities are equipped with fall protection systems.

Table 3: Section 140 "Fall Protection Systems", Section 141 "General Requirements" & Section 142 "Fall Arrest System", Part X: Fall Protection of the Provincial Occupational Health and Safety Regulations

Fall Protection Systems

140. Where an employer determines it is impractical to provide adequate work platforms or staging, the employer shall ensure that fall protection systems are used by all workers who are exposed to the hazard of falling, as required in section **141**.

General requirements

141. Where a worker is exposed to the hazard of falling from a work area that is

(a) 3 metres or more above the nearest safe surface or water;

(b) above a surface or thing that could cause injury to the worker if the worker were to fall on the surface or thing; or

(c) above an open tank, pit or vat containing hazardous material,

the employer shall ensure that

(d) the worker is provided with a fall arrest system that meets the requirements of section **142**;

(e) a guardrail that meets the requirements of section **28** is constructed or installed at the work area;

(f) a personnel safety net that meets the requirements of section **143** is installed at the work area;

(g) temporary flooring that meets the requirements of section **146** is constructed or installed at the work area; or

(h) the worker is provided with another means of fall protection that provides a level of safety equal to or greater than a fall arrest system that meets the requirements of section **142**.

Fall arrest system

142. (1) A fall arrest system that is provided in accordance with section **141** shall

(a) be adequately secured to

(i) an anchorage point, or

(ii) a lifeline that is

(A) securely fastened to anchor points, or

(B) attached to a static line that is securely fastened to anchorage points and that is capable of withstanding either the maximum load likely to be imposed on the anchorage point or a load of 22.2 kilonewtons, whichever is the greater;

(b) include a lanyard

(i) that is attached to an anchorage point or lifeline, where practicable, above the shoulder of the worker, and

(ii) that complies with CSA Standard Z259.11 "Energy Absorbers and Lanyards";

(c) prevent a free fall greater than 1.22 metres where

(i) the fall arrest system is not equipped with a shock absorption system that complies with CSA Standard Z259.11 "Energy Absorbers and Lanyards" and that reduces the shock level of a fall to less than 4 kilonewtons, or

(ii) the combined free fall and shock absorbed deceleration distance exceeds the distance between the work area and a safe surface; and

(d) include a full body harness that

(i) is attached to a lanyard,

(ii) is adjusted to fit the user of the harness, and

(iii) complies with CSA Standard Z259.10 "Full Body Harnesses".

(2) Where a fall arrest system includes a lifeline, the lifeline shall

(a) comply with CSA Standard Z259.2.1 "Fall Arresters, Vertical Lifelines and Rails";

(b) extend to a safe surface below the work area and be securely attached to an anchorage point;

(c) be secured at the bottom of the lifeline to prevent tangling or disturbance of the line and be free of knots, lubricants and imperfections;

(d) be free of splices, except where they are necessary to connect the lifeline to an anchorage point;

(e) be provided with softeners at all sharp edges or corners to protect against cuts or chafing; and

(f) be clearly identified as a lifeline by colour or by another means that provides an equivalent level of safety.

(3) No worker shall

(a) use a lifeline in a fall arrest system while that fall arrest system is being used by another worker; or

(b) provide a rope for use, or permit a rope to be used, as a lifeline in a fall arrest system where the rope has been used for another purpose.

(4) Where a fall arrest system provided to a worker includes a rope grab, the rope grab used shall comply with CSA Standard Z259.2.1 "Fall Arresters, Vertical Lifelines and Rails".

(5) An employer who provides a worker with a fall arrest system shall ensure the fall arrest system is inspected by a qualified person before each work shift undertaken by the worker.

(6) A qualified person who carries out an inspection of a fall arrest system shall advise the employer where a component of the system is defective in condition or function and the employer shall ensure that the system is not used until the defective component is replaced or repaired.

(7) Where a fall arrest system has arrested the fall of a worker at a work area, the employer shall ensure that the fall arrest system

(a) is removed from service and inspected by a qualified person; and

(b) is repaired, before it is reused, to the original manufacturer's specifications, where an inspection under paragraph (a) reveals that a component of the system is defective.

(8) Where a fall arrest system includes a static line, the static line shall

(a) have a nominal diameter of at least 12.7 millimetres and be made of improved plow wire rope;

(b) be equipped with vertical supports at least every 9 metres and have a maximum deflection, when taut, of no greater than 381 millimetres for a 9 metre span;

(c) be equipped with turnbuckles or other comparable tightening devices that provide an equivalent level of protection, at the ends of the static line;

(d) be equipped with softeners at all sharp edges or corners to protect against cuts or chafing;

(e) be made only of components that are able to withstand either the maximum load likely to be imposed on the components or a load of 8 kilonewtons, whichever is the greater; and

(f) comply with CSA Standard Z259.13 "Flexible Horizontal Lifeline Systems" and CSA Standard Z259.16 "Design of Active Fall Protection Systems".

(9) Where a fall arrest system is provided to an arborist, the fall arrest system shall

(a) include a tree climbing or tree trimming harness or saddle;

(b) be adequately secured to

(i) an anchorage point, or

(ii) a lifeline that is

(A) securely fastened to anchorage points, or

(B) attached to a static line that is securely fastened to anchorage points;

(c) include a climbing rope or safety strap;

(d) where practicable, include a second climbing rope or safety strap that

(i) provides additional stability, and

(ii) back-up fall protection; and

(e) be capable of withstanding either the maximum load likely to be imposed or a load of 22.2 kilonewtons, whichever is the greater.

(10) Where an employer uses a fall arrest system or a personnel safety net as a means of fall protection, the employer shall have a written fall protection plan that specifies

(a) the procedure to assemble, maintain, inspect, use and disassemble the fall arrest system or personnel safety net; and

(b) the procedure for the rescue of a worker who has fallen and is suspended by the fall arrest system or personnel safety net, but is unable to effect self-rescue.

Future Plans:

A list of future fall protection installations are included in Appendix A and will be proposed in future Capital Budget Applications.

APPENDIX A

Fall Protection Project List

Planned 2016 Projects

Location	Description	Comment
Bay d'Espoir		
Hinds Lake	Fall Arrest Training Ladder – Purchase material /Fabricate Install - Design Completed in 2015	Planned for 2016
	Spillway Catwalk – Obtain Engineered Drawings	Planned for 2016
	Spillway Stoplog Catwalk – Purchase material /Fabricate - Design Completed in 2015	Planned for 2016
Salmon River	Stem Access Ladders – Purchase material	Planned for 2016
	Powerhouse Horizontal Lifeline – Purchase material/ Fabricate/Install - Design Completed in 2015	Planned for 2016
Upper Salmon	Powerhouse Horizontal Lifeline – Purchase material/ fabricate/Install - Design Completed in 2015	Planned for 2016
Cat Arm	Overhead Crane Ladder – Purchase material/Fabricate/Install - Design Completed in 2015	Planned for 2016
Bay d'Espoir – Powerhouse #1	Spillway access Catwalk – Purchase material - Design Completed in 2015	Planned for 2016
	Draft Tube Scaffolding – Design/purchase materials	Planned for

Burnt Dam Paradise River		2016 Planned for 2016

Planned 2017 Projects

Location	Description	Comment
<u>Bay d'Espoir</u>		
Salmon River	Spillway stem Access Ladders –Fabricate/ Galvanize - Design was completed in 2015 - Material to be purchased in 2016 Spillway Catwalk – Galvanize/Install - Design was completed in 2015 - Material/Fabrication to be completed in 2016	Planned for 2017 Planned for 2017
Burnt Dam	Spillway access Catwalk – Fabricate/Galvanize/Install - Design was completed in 2015 - Material to be purchased in 2016	 Planned for 2017

Future Projects

Location	Description	Comment
<u>Bay d'Espoir</u>		
Cat Arm	New ladder for spherical valve pit	Future projects
	Rail for stairs to fire pump room	Future projects
	Remove penstock access ladder safety slide	Future projects
	Ladder System on Powerhouse roof	Future projects

General	Surge Tank 1,2 &3 Balcony Gates	Future projects
	Support for Oil Tank Rescue	Future projects
	Intake #4 gate control access rail	Future projects
	Access catwalk for installing stoplogs	Future projects
	Intake #2 Access ladder modifications/safety slide	Future projects
	Intake #3 Access ladder modifications/safety slide	Future projects
	Intake #4 Access ladder modifications/safety slide	Future projects
	Platform Access to hoist control panel at Salmon Spillway	Future projects
	Intake Railing Modifications	
Granite Canal	By-pass stoplog railing	Future projects
	Gap in Rail on overhead crane landing	Future projects
	Modify rail to fire pump room	Future projects
	Extend ladder side rails for overhead crane	Future projects
	Draft tube crane access mezzanine extension	Future projects
		Future projects
	Sump pit ladder at powerhouse	
Hinds Lake	Ladder cable system at warehouse roof	Future projects
	Ladder with barrier at draft tube area – powerhouse	Future projects
	Spillway ladder modification/safety slide	Future projects
	Install handrail for stairs leading to penstock-powerhouse	Future projects
	Extend handrail near control room to close gap to	Future projects
	powerhouse	Future projects
	Remove intake safety slide rail	
	Remove control structure safety slide rail	Future projects
	Intake ladder modification/safety slide	Future projects
	Ladder with barrier at east end of powerhouse	Future projects
	Ladder with barrier at west end of powerhouse	Future projects
	Platform for powerhouse overhead crane	
Paradise River	Install intermediate rail	Future projects

	Overhead crane ladder modification/safety slide	Future projects
	Install flip rail or gate	Future projects
	Remove penstock access ladder safety slide	Future projects
	Install penstock access fall arrest	Future projects
	Unit #5 Spherical valve rail/ladder mod	Future projects
		Future projects
Location	**Description**	**Comment**
Bay d'Espoir		
Powerhouse 1	Unit #6 Spherical valve rail/ladder mod	Future projects
(con't)	Overhead crane access ladder	Future projects
	Downstream Unit 5 ladder	Future projects
	Downstream Unit 6 ladder	Future projects
	Cable Tunnel shelter ladder	Future projects
	Unit #1-6 Rotor/Stator access ladder	Future projects
	Unit #2 railing install toeboards	Future projects
	Grating unit #4 improvements	Future projects
	Grating unit #5 improvements	Future projects
	Grating unit #6 improvements	Future projects
Powerhouse 2	Railing Fire Pump Area	Future projects
	Sump pit Ladder	Future projects
Up Country	Ladder to upper deck at Victoria Control Structure	Future projects
	Ladder with barrier to Staffgauge at Victoria Control Structure	Future projects
	Burnt Diesel Tank Modifications	
	Suitable access to aircraft warning lights at Salmon Spillway	Future projects
	Burnt Catwalk for gate control building	Future projects
	Burnt gate control building access ladder	

		Future projects
	Ladder cable system at North Salmon spillway roof	Future projects
	Ladder cable system at West Salmon spillway roof	
Upper Salmon	Ladder cable system at warehouse roof	Future projects
	Rotor access platform/Stairway-Powerhouse	Future projects
		Future projects
		Future projects

Project Title: Purchase Backup Diesel for Station Service

Location: Buchan's and Grand Falls

Category: Transmission and Rural Operations - Terminal Stations

Definition: Other

Classification: Normal

Project Description:

This project involves the purchase of a mobile diesel unit as a station service backup for the Buchans (BUC) Terminal Station and the Grand Falls Frequency Converter Station.

As the two terminal sites are capable of accommodating a mobile unit, no on-site preparatory work is required. The mobile diesel unit will be stationed at Bishop's Falls.

The back-Up Mobile Diesel Generator System will include:

- 100kW generating capacity;
- Travel trailer;
- On-board fueling (24 hours); and
- On-board transformer (3 Phase, 600/208 Volt).

The cost estimate for the project is provided in Table 1.

Table 1: Project Costs

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	125.0	0.0	0.0	125.0
Labour	21.5	0.0	0.0	21.5
Consultant	3.8	0.0	0.0	3.8
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	0.0	0.0	0.0	1.0
Interest and Escalation	8.7	0.0	0.0	8.7
Contingency	29.9	0.0	0.0	29.9
TOTAL	**188.9**	**0.0**	**0.0**	**188.9**

Operating Experience:

Station service is required to provide power to terminal stations for operating equipment crucial to safety and system reliability. Such equipment includes battery banks and chargers for DC systems, compressed air systems for air blast circuit breakers, protection and control equipment, and communication equipment. In the event of a station service failure, transfer to a backup station service is required to maintain safety and reliability. The Liberty investigation of the transformer fire on January 4, 2014, at the Sunnyside Terminal Station identified inadequacy of station service as one of the root cause failure analysis factors. In the Liberty Report, it was recommended that 230 kV terminal stations have backup station service available.

Project Justification:

A review of Hydro's 230 kV terminal stations has identified a lack of backup station service at the Buchan's Terminal Station and the Grand Falls Frequency Converter. As both these terminal stations are located relatively close to Bishop's Falls, a mobile diesel unit located at there would provide reliable backup.

Future Plans:

Hydro will continue to assess its terminal stations and present proposals as required.

Project Schedule:

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Review system requirements with operations	January 2017	January 2017
Procurement	Tender, Award, Purchase Order	February 2017	April 2017
Shipping	Ship to Bishop’s Falls	April 2017	July 2017
Commissioning	On-Site Acceptance and Commissioning	July 2017	August 2017
Closeout	Closeout Documentation	August 2017	August 2017

Project Title: Purchase Front-End Loader with Backhoe

Location: TRO Labrador

Category: General Properties - Transportation

Definition: Other

Classification: Normal

Project Description:

Proposal is to purchase one front end loader with attachments (fork and bucket) for use by Hydro's Line Crew in Wabush.

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	122.5	0.0	0.0	122.5
Labour	0.5	0.0	0.0	0.5
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	0.5	0.0	0.0	0.5
Interest and Escalation	3.5	0.0	0.0	3.5
Contingency	6.2	0.0	0.0	6.2
TOTAL	**133.2**	**0.0**	**0.0**	**133.2**

Operating Experience:

As this is a new piece of equipment, there is currently no in house operating experience. Once the equipment is received, training will be arranged for line crew, to ensure there are qualified operators on site.

Project Justification:

A front end loader with fork and bucket attachments will make daily line construction in Labrador West more cost and time effective. In addition to utilizing the front end loader for construction work, it can also be used at the line depot as a forklift for handling heavy transformers, large reels of wire, loading poles and off-loading delivery trucks. Currently, all such work is performed by a rental forklift and operator. Contractors install poles and anchors on a regular basis (several times a week) using line trucks, and this piece of equipment will be utilized to load the poles. Hydro has had to wait

until the forklift operator was available for offloading since most times it cannot be scheduled beforehand due to transport trucks arriving unannounced. A cost benefit analysis showed that the purchase of a new loader is more cost effective than renting a unit.

Table 2 shows the results of the cost benefit analysis.

Table 2: Cost Benefit Analysis Results

Purchase One Front End Loader Backhoe		
Alternative Comparison ***Cumulative Net Present Value*** ***To The Year*** **2016**		
Alternatives	**Cumulative Net Present Value (CPW)**	**CPW Difference between Alternative and the Least Cost Alternative**
Purchase New Units	89,261	0
Rent Units	209,273	120,012

As can be seen from Table 2, the purchase option is the least cost alternative. By purchasing the new front-end loader with backhoe, Hydro will realize a cost savings of $120,012 over the five year period to 2021.

Future Plans:

None.

Project Title: Install Demand Metering

Location: Various Sites

Category: Transmission and Rural Operations - Distribution Central

Definition: Other

Classification: Normal

Project Description:

This project is to install electronic current meters at Conne River (CRV), English Harbour West (EHW) and Barachoix (BCX) Terminal Stations to provide regular interval and more detailed load data to benefit load forecasting of the areas.

The budget estimate for this project in provided in Table 1

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	8.5	0.0	0.0	8.5
Labour	57.0	0.0	0.0	57.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	6.0	0.0	0.0	6.0
Interest and Escalation	3.9	0.0	0.0	3.9
Contingency	14.3	0.0	0.0	14.3
TOTAL	**89.7**	**0.0**	**0.0**	**89.7**

Project Justification:

To inform and support the system planning process at Hydro, load forecasts for each of Hydro's rural distribution systems are prepared annually. For many systems these forecasts are produced by developing an energy forecast and multiplying it by a load factor[2], derived using historical peak demand information for the distribution system. Alternatively, distribution system peak demand forecasts are produced solely on historical peak demand readings for the respective systems. Both load forecasting methods rely on regularly tracked measurements of peak demand.

[2] A load factor is the ratio between the amount of energy a system uses and the amount of energy a system could use if it was operating at its peak load continually.

The CRV, EHW and BCX systems are not forecasted individually because there is no individual peak or load factor information available for each system. Instead, these systems are grouped into a single entity load forecast for the delivery point at the Hermitage Terminal Station.

When necessary, the Hermitage forecast has been broken into individual forecasts for each distribution system by applying load factors based on recloser readings for each system. This method has only been relied upon as a means of last resort as reliance on recloser readings can introduce error in a load forecast leading to inaccurate system analysis. Recloser readings only provide the peak kVA load on each phase for each month. Each phase on a distribution system typically does not peak at the same time, causing the recloser readings to be higher than the actual peak of the system. Also, recloser readings do not provide the timing of the recorded monthly peaks which prevents confirmation as to whether the recordings occurred after a cold load pick up event. A cold load pickup event will indicate higher demands than normally occur.

Due to the likelihood of increased error and inaccuracies, Hydro has to be more conservative when forecasting a distribution system using recloser readings because of the risk of overloading terminal station or distribution equipment. This can cause capital work to occur sooner than required.

In these three distribution systems, a change in load factor by +/- 5 %[3] has a significant effect on the state of each system. Based on the recloser readings, energy consumption in 2015 for each system, and a variance of +/- 5% the peak loads of each system could range as shown in Table 2.

Table 2: EHW, CRV, and BCX load factors and peak loads based on 2015 data

	EHW	**CRV**	**BCX**
2015 Load Factor based on Recloser Readings	54%	46%	~~84%~~[4] (50 %)
Peak Load at Load Factor -5% (MW)	3.5	3.4	9.0
Peak Load at Load Factor +5% (MW)	2.9	2.7	7.3

[3] This is a qualitative assessment as the actual percentage of load factor deviation is not documented.
[4] Recloser readings across Hydro's interconnected distribution system typically range between 30% and 55%. A load factor of 84% indicates a problem with recloser readings. Instead the average load factor of EHW and CRV is used.

There are no System Planning criteria violations present if the peak load is calculated using a load factor 5% less than the one based on 2015 recloser reading. However, if the peak load is calculated using a load factor 5% greater than the one based on 2015 recloser reading, the following system criteria violations are present:

- Low voltage on the Barachoix distribution system in Pass Island and before BC4-VR2;
- Overload of the transformer at Conne River Terminal station;
- Low voltage or high voltage in Conne River, depending on voltage regulator settings; and
- Low voltage on the English Harbour West distribution system from English Harbour West to Saint John's Bay.

Examples of the work that may be required to prevent these violations from occurring are listed below along with class 5 estimates.

- Upgrading 1 km of line from 1 phase to 3 phase in the English Harbour West distribution system, which would cost approximately $150k;
- upgrading 2.5 km line from 1 phase to 3 phase in the Conne River distribution system, which would cost approximately $300k;
- upgrading terminal station transformer at Conner River terminal station, which would cost approximately $750k; or
- installing a single phase voltage regulator in the Barachoix distribution system, which would cost approximately $170k.

The cost to install meters in Hermitage, Barachoix, and English Harbour West is approximately $30k per site. This is a relatively small cost to ensure that the large investments are only completed when necessary. This would eliminate the risk of spending money on work that is not required and eliminates the risk of operating a distribution system outside of established technical criteria.

Alternatives:

To improve load forecasting for CRV, EHW and BCX, the following metering solutions were considered:

1. Installing power meters in Conne River, English Harbour West and Barachoix

This alternative involves installing additional power meters at the Conne River, English Harbour West and Barachoix terminal stations. Power meters can sense the current and voltage of the systems being monitored and calculates current, power, voltage, power factor and energy readings. The installation of power meters also requires the addition of new potential transformers.

The estimated cost of this alternative is greater than $400,000.

2. Installing current meters in Conne River, English Harbour West and Barachoix

This alternative involves installing current meters at the Conne River, English Harbour West and Barachoix terminal station. Current meters differ from power meters in that they only record the current flow on the system being monitored and do not record voltage. These meters do not require additional potential transformers.

Although current meters do not provide as detailed information about the systems as power meters, they do record information continuously and will report the current back to Hydro's Energy Management System every 15 minutes. Appropriate assumptions and calculations can be used to determine additional information to produce a realistic forecast.

The estimated cost of this alternative is $89,700.

Conclusion:

It is recommended to install current meters in the Conne River, English Harbour West and Barachoix Terminal Station. This is the least cost alternative to improve forecasting in the Hermitage area and to ensure capital investment in these systems is only completed when necessary.

Project Schedule:

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Site assessment, project review	March 2017	March 2017
Design	Revise and develop drawings	April 2017	April 2017
Procurement	Identify, order and receive materials	May 2017	June 2017
Construction	Install meters, cablings and communications	August 2017	August 2017
Commissioning	Test operation	August 2017	August 2017
Closeout	Finalize project documentation	September 2017	September 2017

Project Title: Replace Network Communications Equipment

Location: Various Sites

Category: General Properties – Telecontrol

Definition: Other

Classification: Normal

Project Description:

Hydro has 39 networking devices in its communications network that have been deemed End-of-Life (EoL) since 2013[5] by the vendor Cisco Systems. The 39 devices are Cisco 2950-24 Ethernet switches. These switches will be replaced with updated technology equivalents from the same vendor (Cisco Systems).

The budget estimate for this estimate is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	83.8	0.0	0.0	83.8
Labour	66.5	0.0	0.0	66.5
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	6.0	0.0	0.0	6.0
Interest and Escalation	11.7	0.0	0.0	11.7
Contingency	31.3	0.0	0.0	31.3
TOTAL	**199.3**	**0.0**	**0.0**	**199.3**

Operating Experience:

Cisco Systems networking devices have been proven to be reliable and secure when properly maintained and kept up to date. Cisco regularly releases software updates to address any identified deficiencies and security updates. These updates only continue until Cisco deems the devices EoL as per its product life cycle management.

[5] Last date of hardware support was 2013.

Project Justification:

The devices are critical to daily operations for hundreds of users in the Hydro system who require corporate network access to e-mail, file server access and basic internet connection. The 39 devices that are now considered End-of-Life can no longer be covered by Cisco's maintenance and support packages. Cisco also no longer releases software updates to address software deficiencies or security updates for these devices. Therefore, devices not updated could leave Hydro's network susceptible to new security vulnerabilities.

Future Plans:

Hydro will continue to identify End-of-Life devices in its network and replace them on a year to year basis, as required.

Project Schedule:

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Scope Statement, Resource and network outage schedule	January 2017	February 2017
Design	Network drawings and design packages, Refine Bill of Materials	February 2017	March 2017
Procurement	Submit requisition for Cisco Equipment (Standing Offer)	March 2017	April 2017
Construction	Configure and install new equipment	April 2017	November 2017
Commissioning	Test network connectivity	May 2017	November 2017
Closeout	Update As-Built drawing and close out project	November 2017	December 2017

Project Title: Remove Safety Hazards

Location: Various Sites

Category: Generation - Thermal

Definition: Other

Classification: Normal

Project Description:

This project is required to ensure adequate capital funding is available to quickly address safety hazards as they are identified through Hydro's Safe Work Observation Program (SWOP). A component of this program involves identifying and reporting conditions that can potentially lead to an incident or an accident.

The budget estimate for the project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	45.0	0.0	0.0	45.0
Labour	91.6	0.0	0.0	91.6
Consultant	0.0	0.0	0.0	0.0
Contract Work	45.0	0.0	0.0	45.0
Other Direct Costs	6.5	0.0	0.0	6.5
Interest and Escalation	10.6	0.0	0.0	10.6
Contingency	0.0	0.0	0.0	0.0
TOTAL	**198.6**	**0.0**	**0.0**	**198.6**

Existing Systems:

In Hydro's 2016 Capital Budget Application, the Board approved a budget of $199,300 to address safety hazards in the workplace. Table 2 lists the projects completed in 2015, which total $176,900.

Table 2: Projects completed 2015

Location	Project Description	Cost ($000)
Holyrood	Waste Water Treatment Plant and Chemical Storage Repairs	$34.9
Holyrood	Tank #1 Walkway	$142.0
TOTAL:		**$176.9**

Process for Selecting Eligible Projects:

These safety hazards are identified through Hydro's SWOP Program by employees, contractors and others who access Hydro facilities. Often mitigation of the safety concern can be accomplished through an operating or procedural change, or as a communication or an operating budget item. When it is concluded that a mitigation measure is a capital item, a cost estimate is completed for the mitigation work which is submitted to Hydro's Project Execution and Technical Services (PETS) department for consideration under the Remove Safety Hazards category. These requests are reviewed, and if warranted, the funding is approved by the Vice President of Regulated Operations and Vice President of Project Engineering and Technical Services (PETS).

Historical Information:

Table 3 shows the budget and actual expenditures for years 2012 - 2016.

Table 3: Capital Expenditure History

Year	Capital Budget ($000)	Actual Expenditures ($000)
2016B	199.3	
2015	194.9	176.9
2014	257.8	207.6
2013	250.5	67.0
2012	249.1	141.4

Actual expenditures are subject to the magnitude of the approved work scopes, in conjunction with the location in which the work is to be completed – both of which are unknown during the budget proposal process. The requested funding amount will enable the successful elimination of safety hazards approved under the program. Only the actual capital expenditures incurred to remove safety

hazards are included in Hydro's rate base.

Project Justification:

This project is justified on Hydro's requirement to provide a safe work environment for its employees in compliance with the Occupational Health and Safety Regulations, Section 14 which states:
"14. (1) An employer shall ensure, so far as is reasonably practicable, that all buildings, structures, whether permanent or temporary, excavation, machinery, workstations, places of employment and equipment are capable of withstanding the stresses likely to be imposed upon them and of safely performing the functions for which they are used or intended.

(2) An employer shall ensure that necessary protective clothing and devices are used for the health and safety of his or her workers.

(3) The employer shall ensure that safe work procedures are followed at all workplaces.

(4) An employer shall ensure, so far as is reasonably practicable, that work procedures promote the safe interaction of workers and their work environment to minimize the potential for injury."

In an effort to avoid injury and/or fatality, Hydro has initiated a Safe Work Observation Program (SWOP). The SWOP program involves workers actively looking for safety hazards and problems that may otherwise go unnoticed, which could lead to serious health and/or safety issues for Hydro customers, employees, contractors, and the general public. This project provides Hydro with the budget to address unsafe situations where capital work is identified as the solution, and enables Hydro to respond quickly to address unsafe conditions rather than waiting for the normal capital budget process. These deficiencies, as reported under the SWOP program, need to be immediately corrected to provide a safe work environment. Criteria for the selection of acceptable projects include, but are not necessarily limited to, the remediation of safety deficiencies identified in the SWOP program.

Future Plans:

Future Safety Hazards Removal projects will be proposed in future Capital Budget Applications.

Project Schedule:

As this budget relates to unanticipated safety issues, no schedule is available.

Project Title: Upgrade Access Roads to Microwave Sites

Location: Various Sites

Category: General Properties - Telecontrol

Definition: Other

Classification: Normal

Project Description:

This project is the second year of a five year program for the completion of upgrades to the access roads for Hydro's microwave sites, including:

1. Petty Harbour Hill
2. Four Mile Hill
3. Chapel Arm Hill
4. Western Avalon Passive
5. Bull Arm Hill
6. Shoal Harbour Hill
7. Square Pond Hill
8. Notre Dame Hill
9. Sandy Brook Hill
10. Gull Pond Hill
11. Bay d'Espoir Hill
12. Godaleigh Hill
13. Granite Canal Hill
14. Mary March Hill
15. Blue Grass Hill
16. Deer Lake Passive

Upgrades for the roads will generally consist of:

- supply and installation of drainage culverts;
- completion of roadside ditching;
- completion of isolated subgrade improvements; and
- supply and placement of granular road topping to select sections of the roadway.

Upgrades in 2017 will be completed at Bluegrass Hill (BGH) and Mary March Hill (MMH); see Figures 1 and 2.

Hydro has received approval under Board Order No. P.U. 33(2015) to upgrade access roads in 2016 at the microwave sites located at Sandy Brook Hill and Gull Pond Hill.

Figure 2: Bluegrass Hill Site Location

Figure 3: Mary March Hill Site Location

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost: *($ x1,000)*	**2017**	**2018**	**Beyond**	**Total**
Material Supply	0.0	0.0	0.0	0.0
Labour	28.5	0.0	0.0	28.5
Consultant	0.0	0.0	0.0	0.0
Contract Work	70.5	0.0	0.0	70.5
Other Direct Costs	5.4	0.0	0.0	5.4
Interest and Escalation	3.6	0.0	0.0	3.6
Contingency	10.4	0.0	0.0	10.4
TOTAL	**118.4**	**0.0**	**0.0**	**118.4**

Operating Experience:

The majority of the access roads leading to Hydro's microwave communication sites were constructed in the late 1970's. They have not received any major work or upgrades in their forty plus years of service and are deteriorated, primarily as a result of localized flooding. The flooding is due to the inability of existing drainage ditches to divert water from the roadway's surface. During a flood event, the roadway's overexposure to water results in the development of soft spots and the removal of roadway topping material which exposes the larger, course road base aggregate.

Immediately following periods of substantial water runoff resulting from significant rainfall events and spring melt the roads are often impassable. Routine maintenance, completed to address problem areas, provides a short term solution with washouts typically reoccurring immediately during the next substantial runoff. The proposed upgrades are required to address the core issue of site drainage.

Hydro currently holds title to the land for the BGH and MMH access roads. This easement form of title has been determined to be appropriate for Hydro's needs as Hydro does not need to exclude others from using the road but it does require the legal right to have secure access over it, to make improvements to the road and to build and maintain structures such as guard rails, bridges and culverts. This is the form of title upon which Hydro holds a significant amount of its distribution and transmission plant.

Project Justification:

Hydro's microwave sites are critical for providing administrative networks, teleprotection of transmission lines and remote SCADA[6] control of major generation facilities and terminal stations. Frequent access to these sites is required by Hydro personnel for the completion of routine equipment maintenance and repairs. Private fuel suppliers are also required to access the sites on a routine basis to ensure an adequate fuel supply is maintained for the back-up generators.

To ensure the continued reliable operation of these microwave sites the access roads must be restored to an acceptable condition. The proposed upgrades are required to address the known drainage issues which result in road deterioration.

Future Plans:

Funding to complete similar upgrades at various Hydro microwave sites will be sought in future years.

Project Schedule:

The anticipated project schedule for this work is shown in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Site visit, Scheduling, Scope definition, Design transmittal	May 2017	May 2017
Design	Prepare tender package	May 2017	June 2017
Tender	Tender and award contract	June 2017	July 2017
Construction	Completion of road upgrades	August 2017	August 2017
Commissioning	Final inspection and acceptance	-	August 2017
Closeout	Final billing, Certificate of completion, asset assignment	-	September 2017

[6] **SCADA** (**supervisory control and data acquisition**) is a system operating with coded signals over communication channels so as to provide control of remote equipment

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Definition
			($000)		
MANDATORY PROJECTS					
Replace Aircraft Markers at Grand Lake Crossing - TL228	589.6	978.3		1,567.9	Other
TOTAL MANDADORY PROJECTS	589.6	978.3		1,567.9	
NORMAL PROJECTS					
Upgrade Circuit Breakers - Various Sites (2016-2020)	6,969.1	10,808.7	43,682.7	61,460.5	Other
Terminal Station Refurbishment and Modernization - Various Sites		10,831.3	16,550.8	27,382.1	Other
Construct 230 kV Transmission Line - Soldiers Pond to Hardwoods	3,699.0	17,489.8	5,372.1	26,560.9	Other
Replace Site Facilities - Bay d'Espoir	928.3	4,736.3	6,316.7	11,981.3	Other
Upgrade Distribution Systems - Various Sites (2016-2017)	285.6	6,350.3		6,635.9	Other
Upgrade Powerhouse Building Envelope - Holyrood	2,723.8	2,969.9	784.1	6,477.8	Other
Diesel Genset Replacements - Port Hope Simpson and Charlottetown		658.8	5,148.0	5,806.8	Pooled
Additions for Load Growth - L'Anse au Loup and Postville	883.4	4,746.0		5,629.4	Other
Install Fire Protection Systems - Nain and Cartwright	3,030.7	1,376.4		4,407.1	Other
Refurbish Powerhouse Station Services - Bay d'Espoir		413.2	3,933.9	4,347.1	Other
Provide Service Extensions - All Service Areas		4,330.0		4,330.0	Pooled
Upgrade Distribution Systems - All Service Areas		3,810.0		3,810.0	Pooled
Replace Instrument Transformers - Various Sites	3,196.1	471.9		3,668.0	Pooled
Replace Exciter Controls Units 1 to 6 - Bay d'Espoir		119.2	3,227.8	3,347.0	Other
Upgrade Corner Brook Frequency Converter - Corner Brook		194.6	2,749.2	2,943.8	Other
Water System Replacements - Bay d'Espoir and Cat Arm		265.5	2,288.3	2,553.8	Other
Transmission Line Upgrades - TL212 and TL218		1,378.2	1,133.3	2,511.5	Other
Condition Assessment and Miscellaneous Upgrades- Holyrood		2,437.3		2,437.3	Other
Wood Pole Line Management Program - Various Sites		2,404.1		2,404.1	Other
Replace Vehicles and Aerial Devices - Various Sites (2017-2018)		2,001.4	398.8	2,400.2	Other
Overhaul Turbine Valves Unit 2 - Holyrood		2,302.1		2,302.1	Other
Upgrade Office Facilities & Control Buildings - Various Sites		2,197.3		2,197.3	Other
Control Structure Refurbishments - Various Sites		1,735.3	452.9	2,188.2	Pooled
Overhaul Diesel Engines - Various Sites		2,095.9		2,095.9	Pooled
Replace Vehicles and Aerial Devices - Various Sites (2016-2017)	1,443.3	534.2		1,977.5	Other
Replace Disconnect Switches - Various Sites (2016-2017)	646.9	1,320.9		1,967.8	Pooled
Upgrade Work - Cat Arm	558.3	1,353.0		1,911.3	Other
Replace Protective Relays - Various Sites	700.6	1,156.4		1,857.0	Other
Line Depot Condition Assessment and Refurbishment Program - Various Sites		1,458.8		1,458.8	Other
Construct New Facilities - Various Sites		422.0	1,034.1	1,456.1	Other
Replace Diesel Units - Charlottetown	1,384.9	46.1		1,431.0	Pooled

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Definition
			($000)		
NORMAL PROJECTS (cont'd.)					
Upgrade Microsoft Office Products - Hydro Place	366.6	511.2	513.3	1,391.1	Other
Gas Turbine Life Extension - Stephenville		847.5	505.7	1,353.2	Other
Replace 66 kV Station Service Feed - Holyrood		62.8	1,198.6	1,261.4	Other
Diesel Plant Engine Auxiliary Upgrades - Various Sites		790.6	416.3	1,206.9	Other
Replace Substation - Holyrood		439.4	758.6	1,198.0	Other
Distribution Upgrades - Various Sites (2017-2018)		64.2	1,130.9	1,195.1	Other
Replace MDR 4000 Microwave Radio East - Various Sites	77.4	1,093.1		1,170.5	Other
Upgrade Holyrood Access Road - Holyrood		579.3	583.4	1,162.7	Other
Replace Power Transformers - Oxen Pond		297.5	850.1	1,147.6	Other
Rehabilitate Shoreline Protection - Cat Arm	112.2	1,030.7		1,142.9	Other
Replace Automation Equipment - Mary's Harbour		120.3	1,021.7	1,142.0	Other
Inspect Fuel Storage Tanks - Various Sites		1,058.8		1,058.8	Other
In-Service Failures - Various Sites		1,000.0		1,000.0	Pooled
Upgrade Ventilation in Powerhouse 1 and 2 - Bay d'Espoir		134.1	863.8	997.9	Other
Replace Programmable Logic Controllers - Various Sites	712.9	245.1		958.0	Other
Gas Turbine Life Extension - Hardwoods		675.3	281.4	956.7	Other
Replace Battery Banks and Chargers - Various Sites (2017-2018)		379.3	566.2	945.5	Other
Replace Roof - Hydro Place		923.4		923.4	Other
Upgrade Underground Plant Drainage System - Holyrood		923.1		923.1	Other
Replace Battery Banks and Chargers - Various Sites (2016-2017)	425.0	456.6		881.6	Other
Replace Powerline Carrier - Various Sites	73.4	763.4		836.8	Other
Install Fire Protection in 230 kV Stations - Bay d'Espoir	200.0	566.0		766.0	Other
Upgrade Telecontrol Facilities - Mary March Hill and Blue Grass Hill		91.2	665.9	757.1	Other
Install Asset Health Monitoring System - Upper Salmon		438.0	203.4	641.4	Other
Overhaul Pumps - Holyrood		633.0		633.0	Other
Upgrade Telecontrol Facilities - Sandy Brook Hill	101.6	462.4		564.0	Other
Purchase Vehicles and Aerial Devices - Various Sites	382.5	172.7		555.2	Other
Upgrade Digital Fault Recorders - Various Sites	197.9	304.6		502.5	Other
TOTAL NORMAL PROJECTS	29,099.5	107,478.5	102,632.0	239,210.0	
JUSTIFIABLE PROJECTS					
Construct 230 kV Transmission Line - Bay d'Espoir to Western Avalon	87,444.6	149,895.7	54,317.7	291,658.0	Other
Refurbish Anchors and Footings TL202 and TL206 - Bay d'Espoir to Sunnyside	1,278.3	901.6		2,179.9	Other
Install Automated Meter Reading - Happy Valley (2017-2018)		78.6	1,891.6	1,970.2	Other
Install Automated Meter Reading - Labrador West	433.8	533.4		967.2	Pooled
TOTAL JUSTIFIABLE PROJECTS	89,156.7	151,409.3	56,209.3	296,775.3	

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Definition
			($000)		
MANDATORY PROJECTS					
TOTAL MANDADORY PROJECTS		0.00		0.00	
NORMAL PROJECTS					
Purchase Capital Spares - Terminal Stations		495.8		495.8	Other
Upgrade Public Safety Around Dams and Waterways - Bay d'Espoir		489.0		489.0	Pooled
Purchase Capital Spares - Hydraulic		487.4		487.4	Other
Upgrade Terminal Station for Mobile Substation - Cow Head	40.0	444.7		484.7	Other
Overhaul Turbine/Generators - Bay d'Espoir and Cat Arm		476.2		476.2	Other
Replace Slip Rings Units 1-6 - Bay d'Espoir		312.6	159.7	472.3	Other
Install Recloser Remote Control - Bottom Waters		47.1	418.6	465.7	Other
Replace Human Machine Interface - Various Sites	114.0	320.0		434.0	Other
Upgrade Energy Management System - Hydro Place		427.0		427.0	Other
Replace Insulators - TL227		145.6	271.3	416.9	Other
Replace Personal Computers - Hydro Place		401.4		401.4	Other
Replace Powerhouse 1 Station Service Transformer - Bay d'Espoir	46.7	354.5		401.2	Other
Upgrade Aluminum Support Structures - Holyrood		352.9		352.9	Other
Replace Spherical By-Pass Valves Units 1 and 2 - Bay d'Espoir	183.6	167.9		351.5	Other
Purchase Capital Spares - Holyrood		321.5		321.5	Other
Replace Fuel Piping - Hardwoods and Stephenville	44.8	267.0		311.8	Other
Upgrade Data Alarm Systems - Stony Brook	74.4	234.1		308.5	Other
Refurbish Sump Level System for Powerhouse 2 - Bay d'Espoir		38.7	264.5	303.2	Other
Refurbish Station Water System - Upper Salmon	96.6	197.6		294.2	Other
Install Breaker Failure Protection - Various Sites	65.7	211.3		277.0	Other
Refurbish Main Generator Breaker - Upper Salmon		271.1		271.1	Other
Replace Light Duty Mobile Equipment - Various Sites		270.9		270.9	Other
Replace Air Conditioning Units 8 and 14 - Hydro Place	34.6	229.5		264.1	Other
TOTAL NORMAL PROJECTS	700.4	6,963.8	1,114.1	8,778.3	
JUSTIFIABLE PROJECTS					
TOTAL JUSTIFIABLE PROJECTS		0.00		0.00	

PROJECT DESCRIPTION	Expended to 2016	2017	Future Years	Total	Definition
			($000)		
MANDATORY PROJECTS					
Purchase New Meter Calibration Test Console - Hydro Place		196.9		196.9	Other
Install Fall Protection Equipment - Various Sites		194.7		194.7	Pooled
TOTAL MANDATORY PROJECTS	0.00	391.6	0.00	391.6	
NORMAL PROJECTS					
Replace Fuel Tank 22E - St. Anthony		199.8		199.8	Other
Replace Network Communications Equipment - Various Sites		199.3		199.3	Other
Replace Recloser - Wabush		199.2		199.2	Other
Purchase Meters and Metering Equipment- Various Sites		198.8		198.8	Other
Remove Safety Hazards - Various Sites		198.6		198.6	Other
Replace Surge Arrestors - Various Sites	144.4	53.0		197.4	Other
Upgrade Warehouse Lighting - Bishop's Falls	15.2	180.4		195.6	Other
Replace Air Conditioners - Massey Drive and Happy Valley	39.9	152.0		191.9	Other
Purchase Backup Diesel for Station Service - Grand Falls and Buchans		188.9		188.9	Other
Purchase Capital Spares - Gas Turbines		185.0		185.0	Other
Install Wind Monitoring Station North Salmon Dam SD-2 - Bay d'Espoir		165.5		165.5	Other
Purchase Front End Loader with Backhoe - Wabush		133.2		133.2	Other
Upgrade Access Roads to Microwave Sites - Various Sites		118.4		118.4	Other
Replace Control Room/Communications Room Air Conditioning - Hinds Lake	41.3	53.0		94.3	Other
Install Demand Metering - Various Sites		89.7		89.7	Other
TOTAL NORMAL PROJECTS	240.8	2,314.8	0.00	2,555.6	
JUSTIFIABLE PROJECTS					
Install Variable Frequency Drives - Grey River	46.9	123.0		169.9	Other
TOTAL JUSTIFIABLE PROJECTS	46.9	123.0	0.00	169.9	

Type	Number	($000)
Clustered	0	0.0
Pooled	12	27,948.6
Other	93	521,500.0
Total	**105**	**549,448.6**

Includes multi-year projects but excludes contingency fund

2017 LEASING COSTS

THERE ARE NO ITEMS FOR THIS SECTION

	ACTUALS				BUDGET					
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
GENERATION	24,297	43,000	122,571	54,189	26,065	26,052	39,214	34,497	49,051	19,182
TRANSMISSION AND RURAL OPERATIONS	45,705	35,820	75,771	62,202	157,678	236,033	164,296	146,768	111,006	96,684
GENERAL PROPERTIES	7,250	5,935	6,386	8,729	9,483	9,351	8,250	9,826	7,767	13,160
TOTAL CAPITAL EXPENDITURES	77,252	84,755	204,728	125,119	193,226	271,436	211,761	191,091	167,823	129,026

Total Capital Project Variance
2016 Overview
($000)

Asset Type	Board Approved Budget	Total Project Expenditures and Forecast	Variance
HYDRAULIC	28,981	29,063	82
THERMAL	17,094	17,094	-
GAS TURBINES	6,125	6,092	(33)
TERMINAL STATIONS	122,691	123,768	1,077
TRANSMISSION	326,871	326,871	-
DISTRIBUTION	19,464	19,118	(347)
RURAL GENERATION	34,197	34,911	714
PROPERTIES	4,553	4,818	265
METERING	2,119	2,119	-
RURAL SYSTEMS TOOLS AND EQUIPMENT	2,159	1,913	(246)
INFORMATION SYSTEMS	4,433	4,433	-
TELECONTROL	5,583	5,583	-
TRANSPORTATION	5,135	5,135	-
ADMINISTRATIVE	1,633	1,633	-
ALLOWANCE FOR UNFORESEEN	5,363	5,363	-
SUPPLEMENTAL PROJECTS	354,182	37,014	(317,168)
PROJECTS APPROVED FOR LESS THAN $50,000	271	271	-
TOTAL CAPITAL BUDGET	**940,854**	**625,198**	**(315,656)**

2016 Capital Expenditures By Year ($000)

Summary	Capital Budget[1]									Actual Expenditure and Forecast									
	A				B	C	D (B+C)	E	F (A+C+E)	G				H	I	J	K	L (G+H+I+J+K)	L-F
	2012	2013	2014	2015	Carryover 2016	Original 2016	Revised 2016	2017 and Beyond	Total	2012	2013	2014	2015	2016	Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Project Variance
2016 Projects						100,525.9	100,525.9	121,690.2	222,216.1				-	30,763.2	69,681.2	121,690.2	-	222,134.6	(81.5)
2015 Projects				28,736.9	4,792.1	29,024.3	33,816.4	245.1	58,006.3				23,772.8	13,855.1	19,833.6	245.1	-	57,706.6	(299.7)
2014 Projects			38,677.3	169,315.5	3,324.3	205,566.0	208,890.3	212,872.3	626,431.1			11,578.8	3,796.2	5,857.3	82,627.7	205,115.0	-	308,975.0	(317,456.1)
2013 Projects		6,457.0	25,221.1	538.4	183.1	1,511.7	1,694.8	471.9	34,200.1	37.4	1,580.7	22,163.8	10,115.2	530.0	1,482.8	471.9	-	36,381.8	2,181.7
Grand Total	-	6,457.0	63,898.4	198,590.8	8,299.5	336,627.9	344,927.4	335,279.5	940,853.6	37.4	1,580.7	33,742.6	37,684.2	51,005.6	173,625.3	327,522.2	-	625,198.0	(315,655.6)

2016 Capital Budget Approved by Board Order No. P.U. 33(2015)	183,082.8
New Project Approved by (O.C. 2014-033)[2]	128,962.6
New Project Approved by Board Order No. P.U. 27(2015)	428.3
New Project Approved by Board Order No. P.U. 8(2016)	4,363.1
New Project Approved by Board Order No. P.U. 17 & P.U. 23(2016)	3,960.0
New Project Approved by Board Order No. 19(2016)	11,800.0
New Project Approved by Board Order No. 20(2016)	717.0
New Project Approved by Board Order No. 22(2016)	3,047.1
2016 New Projects under $50,000 Approved by Hydro	267.0
Total Approved Capital Budget Before Carryovers	336,627.9
Carryovers from 2015 to 2016	8,299.5
TOTAL APPROVED CAPITAL BUDGET	344,927.4

[1] Annual budgets previous to 2016 pertain to projects that have expenditures in 2016.

[2] The construction of the Labrador West Transmission was approved by OC2014-033, February 2, 2014 of which $37.5M was included in the 2014 Capital Budget. The capital expenditures associated with this project are included in Work In Progress and as a result are currently excluded from average rate base. The costs to be included in rate base will be subject to review by the Board of Commissioners of Public Utilities.

2016 Capital Expenditures By Category
($000)

Hydraulic Generation Projects	Capital Budget									Actual Expenditure and Forecast										
	A				B	C	D (B+C)	E	F (A+C+E)	G				H	I	J	K	L (G+H+I+J+K)	L-F	
	2012	2013	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total	2012	2013	2014	2015	YTD Actual 2016	Forecast Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Project Variance	Notes
2016 Projects																				
Install Hydrometeorological Equipment - Various Sites	-	-	-	-	-	314.1	314.1	-	314.1	-	-	-	-	2.7	311.4	-	-	314.1	-	
Perform Condition Assessment of Control Structures - Hinds Lake	-	-	-	-	-	323.4	323.4	-	323.4	-	-	-	-	174.8	148.6	-	-	323.4	-	
Replace Generator Cooling Water Piping - Hinds Lake	-	-	-	-	-	181.7	181.7	-	181.7	-	-	-	-	11.6	170.1	-	-	181.7	-	
Replace Control Room/Communications Room Air Conditioning - Hinds Lake	-	-	-	-	-	41.3	41.3	53.0	94.3	-	-	-	-	15.1	26.2	53.0	-	94.3	-	
Refurbish Station Water System - Upper Salmon	-	-	-	-	-	96.6	96.6	197.6	294.2	-	-	-	-	15.7	80.9	197.6	-	294.2	-	
Upgrade Work - Cat Arm	-	-	-	-	-	558.3	558.3	1,353.0	1,911.3	-	-	-	-	43.0	515.3	1,353.0	-	1,911.3	-	
Rehabilitate Shoreline Protection - Cat Arm	-	-	-	-	-	112.2	112.2	1,030.7	1,142.9	-	-	-	-	44.7	67.5	1,030.7	-	1,142.9	-	
Replace Site Facilities - Bay d'Espoir	-	-	-	-	-	928.3	928.3	11,053.0	11,981.3	-	-	-	-	57.9	870.4	11,053.0	-	11,981.3	-	
Replace Interior and Exterior Protective Coating on Surge Tank 2 - Bay d'Espoir	-	-	-	-	-	2,959.6	2,959.6	-	2,959.6	-	-	-	-	418.2	2,541.4	-	-	2,959.6	-	
Upgrade Public Safety Around Dams and Waterways - Bay d'Espoir	-	-	-	-	-	477.6	477.6	-	477.6	-	-	-	-	95.8	381.8	-	-	477.6	-	
Replace PH1 Station Service Transformer - Bay d'Espoir	-	-	-	-	-	46.7	46.7	354.5	401.2	-	-	-	-	37.9	8.8	354.5	-	401.2	-	
Replace Monitoring Vibration System Unit 7 - Bay d'Espoir	-	-	-	-	-	366.0	366.0	-	366.0	-	-	-	-	56.5	309.5	-	-	366.0	-	
Replace Spherical By-Pass Valves Units 1 and 2 - Bay d'Espoir	-	-	-	-	-	183.6	183.6	167.9	351.5	-	-	-	-	33.6	150.0	167.9	-	351.5	-	
Assess Vent Chambers Units 1 to 6 - Bay d'Espoir	-	-	-	-	-	85.7	85.7	-	85.7	-	-	-	-	60.0	25.7	-	-	85.7	-	
Overhaul Turbine/Generator Units #6 and #7 - Bay D'Espoir	-	-	-	-	-	1,345.6	1,345.6	-	1,345.6	-	-	-	-	212.1	1,133.5	-	-	1,345.6	-	
Purchase Tools and Equipment Less than $ 50,000	-	-	-	-	-	96.1	96.1	-	96.1	-	-	-	-	30.6	65.5	-	-	96.1	-	
2015 Projects																				
Refurbish Unit Relay Protection - Paradise River	-	-	-	8.7	(0.3)	79.7	79.4	0.0	88.4	-	-	-	9.0	125.8	(46.4)	-	-	88.4	-	
Replace Station Service Breakers - Cat Arm	-	-	-	644.9	(1.2)	363.4	362.2	0.0	1,008.3	-	-	-	646.1	94.4	267.8	-	-	1,008.3	-	
Rehabilitate Salmon River Spillway - Bay d'Espoir	-	-	-	745.6	222.7	556.8	779.5	0.0	1,302.4	-	-	-	522.9	245.4	534.1	-	-	1,302.4	-	
Upgrade Generator Bearings Units 1 and 3 - Bay d'Espoir	-	-	-	14.7	6.6	633.3	639.9	0.0	648.0	-	-	-	8.1	236.0	403.9	-	-	648.0	-	
Replace Pump House and Associated Equipment - Bay d'Espoir	-	-	-	22.7	(114.3)	522.5	408.2	0.0	545.2	-	-	-	137.0	111.8	296.4	-	-	545.2	-	
Upgrade Equipment Doors - Various Sites	-	-	-	348.5	63.1	0.0	63.1	-	348.5	-	-	-	285.4	(3.0)	66.1	-	-	348.5	-	
Refurbish Intakes - Bay d'Espoir	-	-	-	72.6	46.2	262.3	308.5	0.0	334.9	-	-	-	26.4	226.0	82.5	-	-	334.9	-	
Install Infrared View Ports - Various Sites	-	-	-	83.7	29.0	113.1	142.1	0.0	196.8	-	-	-	54.7	68.9	73.2	-	-	196.8	-	
2014 Projects																				
Upgrade Burnt Dam Spillway - Bay d'Espoir	-	-	110.2	1,201.9	545.8	-	545.8	-	1,312.1	-	-	126.1	640.2	602.0	(56.2)	-	-	1,312.1	-	
Upgrade Victoria Control Structure - Bay d'Espoir	-	-	495.1	-	180.5	-	180.5	-	495.1	-	-	79.6	235.0	178.2	2.3	-	-	495.1	-	
Replace Spherical By Pass Valve Assemblies Units 1 and 2 - BDE	-	-	57.5	96.3	53.5	-	53.5	-	153.8	-	-	12.8	169.5	55.1	(1.6)	-	-	235.8	82.0	
Install Handheld Pendant to Overhead Crane - Bay d'Espoir	-	-	49.9	170.8	156.4	-	156.4	-	220.7	-	-	45.0	19.3	67.1	89.3	-	-	220.7	-	
Total Hydraulic Generation Projects	0.0	0.0	712.7	3,410.4	1,188.0	10,647.9	11,835.9	14,209.7	28,980.7	0.0	0.0	263.5	2,753.6	3,317.9	8,518.0	14,209.7	-	29,062.7	82.0	

2016 Capital Expenditures By Category
($000)

Thermal Generation Projects	Capital Budget									Actual Expenditure and Forecast											
	A				B	C	D (B+C)	E	F (A+C+E)	G				H	I	J	K	L (G+H+I+J+K)	L-F	
	2012	2013	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total	2012	2013	2014	2015	2016	Forecast Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Project Variance	Notes
2016 Projects																				
Upgrade Site Facility - Holyrood	-	-	-	-	-	2,723.8	2,723.8	3,754.0	6,477.8	-	-	-	-	188.2	2,535.6	3,754.0	-	6,477.8	-	
Overhaul Steam Turbine Generator Unit 3 - Holyrood	-	-	-	-	-	5,868.6	5,868.6	-	5,868.6	-	-	-	-	5,981.7	(113.1)	-	-	5,868.6	-	
Rewind Rotor and Install Flux Probe Unit 3 - Holyrood	-	-	-	-	-	2,755.5	2,755.5	-	2,755.5	-	-	-	-	1,919.0	836.5	-	-	2,755.5	-	
Study of Space Heating and Boiler Startup Assistance - Holyrood	-	-	-	-	-	148.7	148.7	-	148.7	-	-	-	-	115.4	33.3	-	-	148.7	-	
Overhaul Pumps - Holyrood	-	-	-	-	-	536.2	536.2	-	536.2	-	-	-	-	0.9	535.3	-	-	536.2	-	
Purchase Tools and Equipment Less than $ 50,000	-	-	-	-	-	15.8	15.8	-	15.8	-	-	-	-	-	15.8	-	-	15.8	-	
2015 Projects																				
Upgrade Powerhouse Roofing - Holyrood	-	-	-	1,047.8	244.9	-	244.9	-	1,047.8	-	-	-	802.9	57.6	187.3	-	-	1,047.8	-	
Upgrade Fire Protection (Main Warehouse) - Holyrood	-	-	-	46.2	(30.2)	197.6	167.4	-	243.8	-	-	-	76.4	179.8	(12.4)	-	-	243.8	-	
Total Thermal Generation Projects	-	-	-	1,094.0	214.7	12,246.2	12,460.9	3,754.0	17,094.2	-	-	-	879.3	8,442.6	4,018.3	3,754.0	-	17,094.2	-	

2016 Capital Expenditures By Category
($000)

Gas Turbine Generation Projects	Capital Budget									Actual Expenditure and Forecast											
	A				B	C	D (B+C)	E	F (A+C+E)	G				H	I	J	K	L (G+H+I+J+K)	L-F	
	2012	2013	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total	2012	2013	2014	2015	2016	Jul-Dec 2016	2017 and Beyond	Carryover to 2017	Total	Project Variance	Notes
2016 Projects																				
Replace Fuel Piping - Hardwoods and Stephenville	-	-	-	-	-	44.8	44.8	267.0	311.8	-	-	-	-	0.5	44.3	267.0	-	311.8	-	
Install Transfer Switches for Diesel Automation - Happy Valley	-	-	-	-	-	148.4	148.4	-	148.4	-	-	-	-	26.8	121.6	-	-	148.4	-	
2015 Projects																				
Upgrade Gas Turbine Plant Life Extension - Stephenville	-	-	-	2,655.2	41.6	2,525.4	2,567.0	-	5,180.6	-	-	-	2,613.6	895.4	1,671.6	-	-	5,180.6	-	
Replace Alternator Shaft - Happy Valley	-	-	-	484.4	320.0	-	320.0	-	484.4	-	-	-	131.1	349.9	(29.9)	-	-	451.1	(33.3)	
Total Gas Turbine Generation Projects	-	-	-	3,139.6	361.6	2,718.6	3,080.2	267.0	6,125.2	-	-	-	2,744.7	1,272.6	1,807.6	267.0	-	6,091.9	(33.3)	

2016 Capital Expenditures By Category
($000)

Terminal Stations Projects	Capital Budget										Actual Expenditure and Forecast											
	A					B	C	D (B+C)	E	F (A+C+E)	G					H	I	J	K	L (G+H+I+J+K)	L-F	
	2011	2012	2013	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total	2011	2012	2013	2014	2015	2016	Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Project Variance	Notes
2016 Projects																						
Upgrade Circuit Breakers - Various Sites (2016-2020)	-	-	-	-	-	-	6,969.1	6,969.1	54,491.3	61,460.4	-	-	-	-	-	2,262.1	4,707.0	54,491.3	-	61,460.4	-	
Replace Surge Arrestors - Various Sites	-	-	-	-	-	-	144.4	144.4	53.0	197.4	-	-	-	-	-	79.7	64.7	53.0	-	197.4	-	
Replace Protective Relays - Various Sites	-	-	-	-	-	-	700.6	700.6	1,156.4	1,857.0	-	-	-	-	-	592.7	107.9	1,156.4	-	1,857.0	-	
Replace Disconnect Switches - Various Sites (2016-2017)	-	-	-	-	-	-	646.9	646.9	1,320.9	1,967.8	-	-	-	-	-	40.4	606.5	1,320.9	-	1,967.8	-	
Upgrade Digital Fault Recorders - Various Sites	-	-	-	-	-	-	197.9	197.9	304.6	502.5	-	-	-	-	-	12.1	185.8	304.6	-	502.5	-	
Upgrade Roof - Indian River	-	-	-	-	-	-	48.3	48.3	-	48.3	-	-	-	-	-	8.9	39.4	-	-	48.3	-	
Upgrade Aluminum Support Structure - Holyrood - 2016	-	-	-	-	-	-	401.1	401.1	-	401.1	-	-	-	-	-	19.5	381.6	-	-	401.1	-	
Upgrade Terminal Station Equipment Foundations - Various Sites	-	-	-	-	-	-	319.9	319.9	-	319.9	-	-	-	-	-	32.2	287.7	-	-	319.9	-	
Upgrade Data Alarm Systems - Various Sites	-	-	-	-	-	-	74.4	74.4	234.1	308.5	-	-	-	-	-	22.7	51.7	234.1	-	308.5	-	
Install Breaker Failure Protection - Various Sites	-	-	-	-	-	-	65.7	65.7	211.3	277.0	-	-	-	-	-	16.3	49.4	211.3	-	277.0	-	
Install Fire Protection in 230 kV Stations - Bay d'Espoir	-	-	-	-	-	-	200.0	200.0	566.0	766.0	-	-	-	-	-	23.5	176.5	566.0	-	766.0	-	
Install Spare Transformer - Happy Valley	-	-	-	-	-	-	2,040.9	2,040.9	-	2,040.9	-	-	-	-	-	393.3	1,647.6	-	-	2,040.9	-	
Upgrade Terminal Station for Mobile Substation - Cow Head	-	-	-	-	-	-	40.0	40.0	444.7	484.7	-	-	-	-	-	17.5	22.5	444.7	-	484.7	-	
Replace Air Receivers and Compressors - St. Anthony	-	-	-	-	-	-	120.7	120.7	-	120.7	-	-	-	-	-	23.7	97.0	-	-	120.7	-	
2015 Projects																						
Upgrade Circuit Breakers - Various Sites (2015-2016)	-	-	-	-	6,189.1	(1,381.3)	6,873.8	5,492.5	-	13,062.9	-	-	-	-	7,570.4	2,673.0	2,819.5	-	-	13,062.9	-	
Install Transformer On line Gas Monitoring - Various Sites	-	-	-	-	700.5	(86.0)	975.7	889.7	-	1,676.2	-	-	-	-	786.5	695.2	194.5	-	-	1,676.2	-	
Upgrade Power Transformers - Various Sites	-	-	-	-	4,440.4	2,083.1	7,002.3	9,085.4	-	11,442.7	-	-	-	-	2,357.3	3,328.7	5,756.7	-	-	11,442.7	-	
Replace Disconnect Switches - Various Sites (2015-2016)	-	-	-	-	963.7	400.6	642.9	1,043.5	-	1,606.6	-	-	-	-	563.1	248.8	794.7	-	-	1,606.6	-	
Design and Install Fire Protection in 230 kV Station - Various Sites	-	-	-	-	67.6	(7.3)	424.3	417.0	-	491.9	-	-	-	-	74.9	43.2	373.8	-	-	491.9	-	
Upgrade Terminal Station Protection and Control - Various Sites	-	-	-	-	172.7	10.2	307.2	317.4	-	479.9	-	-	-	-	162.5	277.6	39.8	-	-	479.9	-	
Install Support Structures C2 Capacitor Bank - Hardwoods	-	-	-	-	199.3	26.4	0.0	26.4	-	199.3	-	-	-	-	58.0	12.1	14.3	-	-	84.4	(114.9)	1
Replace Station Lighting - Bay d'Espoir	-	-	-	-	16.7	(3.3)	160.3	157.0	-	177.0	-	-	-	-	20.0	112.6	44.4	-	-	177.0	-	
2013 Projects																						
Replace Instrument Transformers - Various Sites	-	-	593.2	552.8	538.4	(10.4)	1511.7	1,501.3	471.9	3,668.0	-	9.6	230.7	699.0	755.5	273.4	1,227.9	471.9	-	3,668.0	-	
Increase 230 kV Transformer Capacity - Oxen Pond	-	-	3823.6	15310.4	-	(200.2)	-	(200.2)	-	19,134.0	-	-	153.6	14,611.3	5,443.3	85.4	32.4	-	-	20,326.0	1,192.0	
Total Terminal Stations Projects	0.0	0.0	4,416.8	15,863.2	13,288.4	831.8	29,868.1	30,699.9	59,254.2	122,690.7	0.0	9.6	384.3	15,310.3	17,791.5	11,294.6	19,723.3	59,254.2	-	123,767.8	1,077.1	

2016 Capital Expenditures by Category
($000)

Transmission Projects	Capital Budget							Actual Expenditure and Forecast								
	A		B	C	D	E	F (A+C+E)	G		H	I	J	K	L (G+H+I+J+K)	L-F	
	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total	2014	2015	2016	Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Project Variance	Notes
2016 Projects																
Construct 230 kV Transmission Line - Soldiers Pond to Hardwoods	-	-	-	3,699.0	3,699.0	22,861.9	26,560.9	-	-	534.3	3,164.7	22,861.9	-	26,560.9	-	
Replace Insulators - TL203	-	-	-	1,985.6	1,985.6	-	1,985.6	-	-	926.6	1,059.0	-	-	1,985.6	-	
Replace Aircraft Markers at Grand Lake Crossing - TL228	-	-	-	589.6	589.6	978.3	1,567.9	-	-	18.6	571.0	978.3	-	1,567.9	-	
Perform Wood Pole Line Management Program - Various Sites	-	-	-	2,919.0	2,919.0	-	2,919.0	-	-	1,509.1	1,409.9	-	-	2,919.0	-	
2014 Projects																
Refurbish Anchors and Footings TL202 and TL206 - Bay d'Espoir to Sunnyside	211.5	28.4	0.2	1,038.4	1,038.6	901.6	2,179.9	211.5	28.2	2.2	1,036.4	901.6	-	2,179.9	-	
230 kV Transmission Line - Bay d'Espoir to Western Avalon	-	4,403.0	2,384.8	75,284.3	77,669.1	211,970.7	291,658.0	-	2,018.2	4,271.9	81,154.5	204,213.4	-	291,658.0	-	
Total Transmission Projects	211.5	4,431.4	2,385.0	85,515.9	87,900.9	236,712.5	326,871.3	211.5	2,046.4	7,262.7	88,395.5	228,955.2	-	326,871.3	-	

2016 Capital Expenditures By Category
($000)

Distribution Projects	Capital Budget							Actual Expenditure and Forecast								
	A		B	C	D (B+C)		F (A+C+E)	G		H	I	J	K	L (G+H+I+J+K)	L-F	
	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total	2014	2015	2016	Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Project Variance	Notes
2016 Projects																
Provide Service Extensions - All Service Areas	-	-	-	5,350.0	5,350.0	-	5,350.0	-	-	1,801.5	3,548.5	-	-	5,350.0	-	
Provide Service Extensions - All Service Areas - CIAC	-	-	-	(200.0)	(200.0)	-	(200.0)	-	-	(381.6)	(164.9)	-	-	(546.5)	(346.5)	2
Upgrade Distribution Systems - All Service Areas	-	-	-	3,990.0	3,990.0	-	3,990.0	-	-	1,421.1	2,568.9	-	-	3,990.0	-	
Upgrade Distribution Systems - All Service Areas - CIAC	-	-	-	(100.0)	(100.0)	-	(100.0)	-	-	(34.9)	(65.1)	-	-	(100.0)	-	
Upgrade Distribution Systems - Various Sites (2016/2017)	-	-	-	285.6	285.6	6,350.3	6,635.9	-	-	159.5	126.1	6,350.3	-	6,635.9	-	
Construct Overhead Distribution Line - Pilley's Island to Long Island	-	-	-	1,239.9	1,239.9	-	1,239.9	-	-	1.2	1,238.7	-	-	1,239.9	-	
Additions for Load Growth - Happy Valley	-	-	-	593.7	593.7	-	593.7	-	-	190.3	403.4	-	-	593.7	-	
2015 Projects																
Upgrade Distribution Systems - Various Sites (2015/2016)	-	1,136.1	-243.0	818.8	575.8	-	1,954.9	-	1,379.1	146.8	429.0	-	-	1,954.9	-	
Total Distribution Projects	-	1,136.1	(243.0)	11,978.0	11,735.0	6,350.3	19,464.4	-	1,379.1	3,303.9	8,084.6	6,350.3	-	19,117.9	(346.5)	

2016 Capital Expenditures By Category
($000)

Rural Generation Projects	Capital Budget									Actual Expenditure and Forecast									L-F	
	A				B	C	D	E	F (A+C+E)	G				H	I	J	K	L (G+H+I+J+K)		
	2012	2013	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total	2012	2013	2014	2015	2016	Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Project Variance	Notes
2016 Projects																				
Overhaul Diesel Units - Various Sites	-	-	-	-	-	2,078.4	2,078.4	-	2,078.4	-	-	-	-	1,114.9	963.5	-	-	2,078.4	-	
Upgrade Human Machine Interface - Various Sites	-	-	-	-	-	114.0	114.0	320.0	434.0	-	-	-	-	35.7	78.3	320.0	-	434.0	-	
Install Variable Frequency Drives - Grey River	-	-	-	-	-	46.9	46.9	123.0	169.9	-	-	-	-	11.8	35.1	123.0	-	169.9	-	
Inspect Fuel Storage Tanks - Various Sites	-	-	-	-	-	1,326.9	1,326.9	-	1,326.9	-	-	-	-	178.0	1,148.9	-	-	1,326.9	-	
Replace Diesel Unit - Charlottetown	-	-	-	-	-	1,384.9	1,384.9	46.1	1,431.0	-	-	-	-	1,207.7	177.2	46.1	-	1,431.0	-	
Install Fire Protection Systems - Cartwright and Nain	-	-	-	-	-	3,030.7	3,030.7	1,376.4	4,407.1	-	-	-	-	144.9	2,885.8	1,376.4	-	4,407.1	-	
Upgrade Transformers - Postville and Cartwright	-	-	-	-	-	465.2	465.2	-	465.2	-	-	-	-	55.2	410.0	-	-	465.2	-	
Additions for Load Growth - Various Sites	-	-	-	-	-	883.4	883.4	4,746.0	5,629.4	-	-	-	-	54.2	829.2	4,746.0	-	5,629.4	-	
2015 Projects																				
Overhaul Diesel Units - Various Sites	-	-	-	1,199.2	240.8	-	240.8	-	1,199.2	-	-	-	958.4	217.9	22.9	-	-	1,199.2	-	
Install Disconnect Switches for Mobile Generators - Various Sites	-	-	-	10.0	2.2	189.3	191.5	-	199.3	-	-	-	7.8	245.7	40.2	-	-	293.7	94.4	
Upgrade Ventilation Systems - Various Sites	-	-	-	175.9	(69.7)	317.3	247.6	-	493.2	-	-	-	245.6	233.4	14.2	-	-	493.2	-	
Replace Unit 2038 - Mary's Harbour	-	-	-	103.5	1.8	1,241.5	1,243.3	-	1,345.0	-	-	-	101.7	203.1	1,040.2	-	-	1,345.0	-	
Replace Unit 254 - Paradise River	-	-	-	66.8	(13.7)	429.3	415.6	-	496.1	-	-	-	80.5	76.1	339.5	-	-	496.1	-	
Replace Programmable Logic Controllers - Various Sites	-	-	-	366.9	(30.3)	346.0	315.7	245.1	958.0	-	-	-	397.2	70.4	245.3	245.1	-	958.0	-	
Install Fire Protection - L'Anse Au Loup	-	-	-	220.6	124.2	1,126.2	1,250.4	-	1,346.8	-	-	-	96.4	(20.1)	1,270.5	-	-	1,346.8	-	
2014 Projects																				
Upgrade Diesel Plant Production Data Collection Equipment-Various	-	-	268.9	269.8	3.1	280.7	283.8	-	819.4	-	-	107.8	57.8	286.9	(3.1)	-	-	449.4	(370.0)	3
2013 Projects																				
Additions for Load Isolator Generation Stations - Various Sites	-	2,040.2	9,357.9	-	393.7	-	393.7	-	11,398.1	27.8	1196.4	6,853.5	3,916.4	171.2	222.5	-	-	12,387.8	989.7	
Total Rural Generation Projects	-	2,040.2	9,626.8	2,412.7	652.1	13,260.7	13,912.8	6,856.6	34,197.0	27.8	1,196.4	6,961.3	5,861.8	4,287.0	9,720.2	6,856.6	-	34,911.1	714.1	

2016 Capital Expenditures By Category
($000)

Properties Projects	Capital Budget							Actual Expenditure and Forecast								
	A		B	C	D	E	F (A+C+E)	G		H	I	J	K	L (G+H+I+J+K)	L-F	
	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total	2014	2015	2016	Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Project Variance	Notes
2016 Projects																
Upgrade Warehouse Lighting - Bishops Falls	-	-	-	15.2	15.2	180.4	195.6	-	-	9.3	5.9	180.4	-	195.6	-	
Upgrade Line Depots - Various Sites	-	-	-	861.4	861.4	-	861.4	-	-	58.1	1,068.3	-	-	1,126.4	265.0	4
Upgrade Office Facilities and Control Buildings - Various Sites	-	-	-	1,134.0	1,134.0	-	1,134.0	-	-	81.3	1,052.7	-	-	1,134.0	-	
Replace Roof on Service Building - Bishops Falls	-	-	-	612.8	612.8	-	612.8	-	-	62.5	550.3	-	-	612.8	-	
Install Fall Protection Equipment - Various Sites	-	-	-	198.8	198.8	-	198.8	-	-	26.8	172.0	-	-	198.8	-	
2015 Projects																
Replace Accommodations and Septic System - Ebbegunbaeg	-	489.4	395.2	1,061.4	1,456.6	-	1,550.8	-	94.2	359.7	1,096.9	-	-	1,550.8	-	
Total Properties Projects	-	489.4	395.2	3,883.6	4,278.8	180.4	4,553.4	-	94.2	597.7	3,946.1	180.4	-	4,818.4	265.0	

2016 Capital Expenditures By Category
($000)

Metering Projects	Capital Budget							Actual Expenditure and Forecast								
	A		B	C	D	E	F (A+C+E)	G		H	I	J	K	L (G+H+I+J+K)	L-F	
	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total	2014	2015	2016	Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Project Variance	Notes
2016 Projects																
Install Automated Meter Reading - Labrador West	-	-	-	433.8	433.8	533.4	967.2	-	-	46.9	386.9	533.4	-	967.2	-	
Purchase Meters, Equipment and Metering Tanks - Various Sites	-	-	-	190.4	190.4	-	190.4	-	-	67.0	123.4	-	-	190.4	-	
2015 Projects																
Install Automatic Meter Reading - Various Sites (2015-2016)	-	559.9	469.3	401.8	871.1	-	961.7	-	90.6	300.9	570.2	-	-	961.7	-	
Total Metering Projects	-	559.9	469.3	1,026.0	1,495.3	533.4	2,119.3	-	90.6	414.8	1,080.5	533.4	-	2,119.3	-	

2016 Capital Expenditures By Category
($000)

Tools and Equipment	Capital Budget							Actual Expenditure and Forecast								
	A		B	C	D	E	F (A+C+E)	G		H	I	J	K	L (G+H+I+J+K)	L-F	
	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total	2014	2015	2016	Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Project Variance	Notes
2016 Projects																
Replace Light Duty Mobile Equipment - Various Sites	-	-	-	348.0	348.0	-	348.0	-	-	46.8	301.2	-	-	348.0	-	
Purchase Excavator - Bay d'Espoir	-	-	-	312.0	312.0	-	312.0	-	-	-	312.0	-	-	312.0	-	
Tools and Equipment Less than $50,000	-	-	-	477.0	477.0	-	477.0	-	-	167.8	309.2	-	-	477.0	-	
2015 Projects																
Replace Off Road Track Vehicles - Unit 7861, Stephenville (2015-2016)	-	1.1	(175.7)	397.8	222.1	-	398.9	-	176.8	-	-	-	-	176.8	(222.1)	5
Tools and Equipment Less than $50,000	-	622.7	35.8	-	35.8	-	622.7	-	563.1	30.4	5.4	-	-	598.9	(23.8)	
Total Tools and Equipment	-	623.8	(139.9)	1,534.8	1,394.9	-	2,158.6	-	739.9	245.0	927.8	-	-	1,912.7	(245.9)	

2016 Capital Expenditures By Category
($000)

Information Systems Projects	Capital Budget								Actual Expenditure and Forecast									
	A			B	C	D	E	F (A+C+E)	G			H	I	J	K	L (G+H+I+J+K)	L-F	
	2013	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total	2013	2014	2015	2016	Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Project Variance	Notes
2016 Projects																		
Perform Minor Application Enhancements - Hydro Place	-	-	-	-	346.7	346.7	-	346.7	-	-	-	308.9	37.8	-	-	346.7	-	
Cost Recoveries	-	-	-	-	(148.8)	(148.8)	-	(148.8)	-	-	-	(132.5)	(16.3)	-	-	(148.8)	-	
Implement Industrial Billing Software - Hydro Place	-	-	-	-	443.1	443.1	-	443.1	-	-	-	10.1	433.0	-	-	443.1	-	
Upgrade Microsoft Project - Hydro Place	-	-	-	-	683.7	683.7	1,910.7	2,594.4	-	-	-	657.8	25.9	1,910.7	-	2,594.4	-	
Cost Recoveries	-	-	-	-	(317.1)	(317.1)	(886.2)	(1,203.3)	-	-	-	(305.2)	(11.9)	(886.2)	-	(1,203.3)	-	
Upgrade Sharepoint/Document Repository - Hydro Place	-	-	-	-	267.6	267.6	-	267.6	-	-	-	51.9	215.7	-	-	267.6	-	
Cost Recoveries	-	-	-	-	(124.1)	(124.1)	-	(124.1)	-	-	-	(24.1)	(100.0)	-	-	(124.1)	-	
Upgrade Energy Management System - Hydro Place	-	-	-	-	246.2	246.2	-	246.2	-	-	-	265.0	(18.8)	-	-	246.2	-	
Refresh Security Software - Hydro Place	-	-	-	-	230.4	230.4	-	230.4	-	-	-	46.5	183.9	-	-	230.4	-	
Cost Recoveries	-	-	-	-	(106.9)	(106.9)	-	(106.9)	-	-	-	(21.6)	(85.3)	-	-	(106.9)	-	
Replace Peripheral Infrastructure - Various Sites	-	-	-	-	611.3	611.3	-	611.3	-	-	-	143.9	467.4	-	-	611.3	-	
Cost Recoveries	-	-	-	-	(186.8)	(186.8)	-	(186.8)	-	-	-	(43.9)	(142.9)	-	-	(186.8)	-	
Upgrade Enterprise Storage Capacity - Hydro Place	-	-	-	-	628.8	628.8	-	628.8	-	-	-	(4.1)	632.9	-	-	628.8	-	
Cost Recoveries	-	-	-	-	(291.6)	(291.6)	-	(291.6)	-	-	-	1.9	(293.5)	-	-	(291.6)	-	
Replace Personal Computers - Various Sites	-	-	-	-	861.7	861.7	-	861.7	-	-	-	524.0	337.7	-	-	861.7	-	
Upgrade Server Technology Program - Hydro Place	-	-	-	-	492.5	492.5	-	492.5	-	-	-	40.0	452.5	-	-	492.5	-	
Cost Recoveries	-	-	-	-	(228.5)	(228.5)	-	(228.5)	-	-	-	(18.5)	(210.0)	-	-	(228.5)	-	
Total Information Systems Projects	-	-	-	-	3,408.2	3,408.2	1,024.5	4,432.7	-	-	-	1,500.1	1,908.1	1,024.5	-	4,432.7	-	

2016 Capital Expenditures By Category
($000)

Telecontrol Projects	Capital Budget							Actual Expenditure and Forecast								
	A		B	C	D	E	F (A+C+E)	G		H	I	J	K	L (G+H+I+J+K)	L-F	
	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total	2014	2015	2016	Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Project Variance	Notes
2016 Projects																
Purchase Tools and Equipment less than $50,000	-	-	-	45.6	45.6	-	45.6	-	-	11.3	34.3	-	-	45.6	-	
Replace Battery Banks and Chargers - Various Sites	-	-	-	425.0	425.0	456.6	881.6	-	-	69.8	355.2	456.6	-	881.6	-	
Replace MDR 4000 Microwave Radio East - Various Sites	-	-	-	77.4	77.4	1,093.1	1,170.5	-	-	32.2	45.2	1,093.1	-	1,170.5	-	
Replace UPS Systems - Hydro Place	-	-	-	889.8	889.8	-	889.8	-	-	127.3	762.5	-	-	889.8	-	
Replace Network Communication Equipment - Various Sites	-	-	-	186.4	186.4	-	186.4	-	-	177.4	9.0	-	-	186.4	-	
Upgrade Site Facilities - Various Sites	-	-	-	49.5	49.5	-	49.5	-	-	33.4	16.1	-	-	49.5	-	
Replace Radomes - Various Sites	-	-	-	235.2	235.2	-	235.2	-	-	46.4	188.8	-	-	235.2	-	
Replace Air Conditioners - Various Sites	-	-	-	39.9	39.9	152.0	191.9	-	-	17.8	22.1	152.0	-	191.9	-	
Replace Video Conferencing Bridge - Hydro Place	-	-	-	182.6	182.6	-	182.6	-	-	166.8	15.8	-	-	182.6	-	
Upgrade Access Roads to Microwave Sites - Various Sites	-	-	-	141.1	141.1	-	141.1	-	-	8.4	132.7	-	-	141.1	-	
Upgrade Remote Terminal Units - Various Sites	-	-	-	89.6	89.6	-	89.6	-	-	40.0	49.6	-	-	89.6	-	
Replace Wescom Transceivers - Various Sites	-	-	-	49.3	49.3	-	49.3	-	-	9.1	40.2	-	-	49.3	-	
Replace Powerline Carrier - Various Sites	-	-	-	73.4	73.4	763.4	836.8	-	-	26.4	47.0	763.4	-	836.8	-	
Upgrade Telecontrol Facilities - Sandy Brook Hill	-	-	-	101.6	101.6	462.4	564.0	-	-	29.6	72.0	462.4	-	564.0	-	
2015 Projects																
Replace GDC Metroplex - Various Sites	-	69.2	30.5	-	30.5	-	69.2	-	38.7	51.5	(21.0)	-	-	69.2	-	
Total Telecontrol Projects	-	69.2	30.5	2,586.4	2,616.9	2,927.5	5,583.1	-	38.7	847.4	1,769.5	2,927.5	-	5,583.1	-	

2016 Capital Expenditures By Category
($000)

Transportation

Capital Budget

	A		B	C	D	E	F (A+C+E)
	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total
2016 Projects							
Replace Vehicles and Aerial Devices Hydro System (2016-2017)	-	-	-	1443.3	1,443.3	534.2	1,977.5
Purchase Vehicles and Aerial Devices - Various Sites	-	-	-	382.5	382.5	172.7	555.2
2015 Projects							
Replace Vehicles and Aerial Devices Hydro System (2015-2016)	-	2377.1	642.2	225.3	867.5	-	2,602.4
Total Transportation	-	2,377.1	642.2	2,051.1	2,693.3	706.9	5,135.1

Actual Expenditure and Forecast

	G		H	I	J	K	L (G+H+I+J+K)	L-F	
	2014	2015	2016	Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Project Variance	Notes
2016 Projects									
Replace Vehicles and Aerial Devices Hydro System (2016-2017)	-	-	21.5	1,421.8	534.2	-	1,977.5	-	
Purchase Vehicles and Aerial Devices - Various Sites	-	-	-	382.5	172.7	-	555.2	-	
2015 Projects									
Replace Vehicles and Aerial Devices Hydro System (2015-2016)	-	1,734.9	362.5	505.0	-	-	2,602.4	-	
Total Transportation	-	1,734.9	384.0	2,309.3	706.9	-	5,135.1	-	

Administrative

Capital Budget

	2014	2015	Carryover 2015	Original 2016	Revised 2016	2017 and Beyond	Total
2016 Projects							
Remove Safety Hazards - Various Sites - 2015	-	-	-	199.3	199.3	-	199.3
Replace Roof - Hydro Place	-	-	-	639.5	639.5	-	639.5
Replace Air Conditioning Units 8 and 14 - Hydro Place	-	-	-	34.6	34.6	229.5	264.1
Purchase Tools and Equipment less than $50,000	-	-	-	172.6	172.6	-	172.6
2015 Projects							
Replace Cooling Tower and Auxiliaries - Hydro Place	-	45.7	(6.8)	311.3	304.5	-	357.0
Total Administrative	-	45.7	(6.8)	1,357.3	1,350.5	229.5	1,632.5

Actual Expenditure and Forecast

	2014	2015	2016	Jul-Dec 2016	2017 and Beyond	Carryovers to 2017	Total	Variance	Notes
2016 Projects									
Remove Safety Hazards - Various Sites - 2015	-	-	63.3	136.0	-	-	199.3	-	
Replace Roof - Hydro Place	-	-	48.6	590.9	-	-	639.5	-	
Replace Air Conditioning Units 8 and 14 - Hydro Place	-	-	13.7	20.9	229.5	-	264.1	-	
Purchase Tools and Equipment less than $50,000	-	-	11.1	161.5	-	-	172.6	-	
2015 Projects									
Replace Cooling Tower and Auxiliaries - Hydro Place	-	52.5	264.2	40.3	-	-	357.0	-	
Total Administrative	-	52.5	400.9	949.6	229.5	-	1,632.5	-	

2016 Capital Expenditures By Category ($000)

Allowance For Unforeseen	Capital Budget				Actual Expenditure and Forecast						
	C	D	E	F (A+C+E)	H	I	J	K	L (G+H+I+J+K)	L-F	
	Original 2016	Revised 2016	2017 and Beyond	Total	2016	Jul-Dec 2016	2017 and Beyond	Carryover to 2017	Total	Project Variance	Notes
2016 Projects											
Contingency Fund	1,000.0	1,000.0	-	1,000.0	-	1,000.0	-	-	1,000.0	-	
Perform Upgrades - Western Avalon Transformer T5 Tap Changer	482.3	482.3	-	482.3	482.3	-	-	-	482.3	-	
Boiler Tube Replacement - Holyrood Generating Station Unit 2	1,565.6	1,565.6	-	1,565.6	1,565.6	-	-	-	1,565.6	-	
Boiler Tube Replacement - Holyrood Generating Station Unit 1	928.3	928.3	-	928.3	928.3	-	-	-	928.3	-	
Transmission Line TL 259 Rerouting at Sally's Cove	1,386.9	1,386.9	-	1,386.9	1,386.9	-	-	-	1,386.9	-	
Total Allowance For Unforeseen	5,363.1	5,363.1	-	5,363.1	4,363.1	1,000.0	-	-	5,363.1	-	

Supplemental Projects	Capital Budget				Actual Expenditure and Forecast						
	Original 2016	Revised 2016	2017 and Beyond	Total	2016	Jul-Dec 2016	2017 and Beyond	Carryover to 2017	Total	Project Variance	Notes
2016 Projects											
Upgrade Units 1 and 2 Lower Reheaters	11,800.0	11,800.0	-	11,800.0	1,327.20	10,472.8	-	-	11,800.0	-	
Purchase of 12 MW Diesel Generation - Holyrood	3,960.0	3,960.0	740.00	4,700.0	-	3,960.0	740.0	-	4,700.0	-	
TL 227 Distribution Line Sally's Cove L1	717.0	717.0	1,533.00	2,250.0	-	717.0	1,533.0	-	2,250.0	-	
Refurbish Gas Generator Engines - Hardwoods and Stephenville	3,047.1	3,047.1	-	3,047.1	4.30	3,042.8	-	-	3,047.1	-	
2015 Projects											
Purchase Critical Spares Generation Stations	-	1,041.1	-	1,536.3	727.5	313.6	-	-	1,536.30	-	
Replace Excitation Transformers - Holyrood Units 1 and 2	428.3	724.2	-	756.2	503.0	221.2	-	-	756.20	-	
Transformer VBN T1 Major Internal Assessment	-	178.4	-	500.1	21.9	156.5	-	-	500.10	-	
2014 Projects											
Labrador West Transmission Project - Construction Phase[6]	128,962.6	128,962.6	-	329,592.1	393.9	406.1	-	-	12,424.0	(317,168.1)	6
Total Supplemental Projects Approved by PUB	148,915.0	150,430.4	2,273	354,181.8	2,977.8	19,290.0	2,273	-	37,013.7	(317,168.1)	

Projects Less than $50,000	Capital Budget				Actual Expenditure and Forecast						
	Original 2016	Revised 2016	2017 and Beyond	Total	2016	Jul-Dec 2016	2017 and Beyond	Carryover to 2017	Total	Variance	Notes
2016 Projects											
Hardwoods Station Service Artificial Neutral	42.1	42.1	-	42.1	8.3	33.8	-	-	42.1	-	
Tank 1 External Inspection and Condition Assessment - Holyrood	39.8	39.8	-	39.8	3.7	36.1	-	-	39.8	-	
Exciter Refurbishment - Corner Brook Frequency Converter (CBFC)	49.0	49.0	-	49.0	-	49.0	-	-	49.0	-	
HWD Snow Door Overhaul	46.7	46.7	-	46.7	0.5	46.2	-	-	46.7	-	
2015 Projects											
Thrust Bearing Refurbishment Units 1 - 6, Bay d'Espoir	41.2	43.6	-	43.7	32.7	10.9	-	-	43.7	-	
Replace Interrupter Bottom Brook Breaker B3L50	48.2	49.2	-	49.2	48.3	0.9	-	-	49.2	-	
Total Projects Less than $50,000	267.0	270.4	-	270.5	93.5	176.9	-	-	270.5	-	

[6] The construction of the Labrador West Transmission was approved by OC2014-033, February 2, 2014. The capital expenditures associated with this project are included in Work In Progress and as a result are currently excluded from average rate base. The costs to be included in rate base will be subject to review by the Board of Commissioners of Public Utilities.

Explanations are provided below for projects whose overall expenditures, on a total project basis, have a forecasted variance of more than $100,000 and 10% from the budgeted amount. Due to this being a mid-year report, variances are based on focused management and reforecasting efforts, and are subject to change throughout the year as the projects proceed. Actual variances at completion of each project will be discussed in the year-end Capital Expenditures report when annual expenditures are final.

Terminal Stations Projects

1. Install Support Structures C2 Capacitor Bank – Hardwoods (2015)

Total Project Budget:	**$199.3**	**Total Project Forecast:**	**$84.4**	**Variance: ($114.9)**

This was a single year project originally scheduled for completion in 2015 and carried into 2016. The project is in progress with a forecast underspend of the total project budget. The project engineering and procurement were completed in 2015 and construction has been rescheduled for 2016. A less costly design to address the original issue is anticipated to result in an overall budget reduction. The deferral of the construction work to 2016 was based on winter readiness planning and a review of impacts on system capacity and reliability; the work was rescheduled to coordinate with the replacement of a disconnect switch (another project), thereby further reducing costs. This is a forecast variance; the actual variance, if material, will be reported in the 2017 Capital Expenditures and Carryover Report.

Distribution Projects

2. Provide Service Extensions - All Service Areas – CIAC

Total Project Budget:	**($200.0)**	**Total Project Forecast:**	**($546.5)**	**Variance: ($346.5)**

This is an annual budget created based on past CIACs to provide service extensions to customers. The variance is primarily due to the Duley Lake Cottage area line extension. As per Board Order P.U. 16(2016), the Board approved $13.9 per customer. As of June 30, 2016, 25 customers have requested connections and provided their funding, resulting in total contributions of $346.5.

Rural Generation Projects

3. Upgrade Diesel Plant Production Data Collection Equipment – Various (2014)

Total Project Budget:	**$819.4**	**Total Project Forecast:**	**$449.4**	**Variance: ($370.0)**

This is a three-year project that commenced in 2014 and is on schedule for completion in 2016. The project is in progress with a forecasted under spend of the total project budget. The variance is attributed to an overestimation of engineering and construction costs. This is a forecast variance; the actual variance, if material, will be reported in the 2017 Capital Expenditures and Carryover Report.

Properties Projects

4. Upgrade Line Depots – Various Sites (2016)

Total Project Budget:	**$861.4**	**Total Project Forecast :**	**$1,126.4**	**Variance: $265.0**

This is a single-year project scheduled for completion in 2016. The project is in progress with a forecasted over spend of the total project budget. The publically tendered price for the construction at Wabush Line Depot was higher than estimated. This is a forecast variance; the actual variance, if material, will be reported in the 2017 Capital Expenditures and Carryover Report.

Tools and Equipment Projects

5. Replace Off Road Track Vehicles – Unit 7861, Stephenville (2015 - 2016)

Budget:	**$398.9**	**Total:**	**$176.8**	**Variance: ($222.1)**

This was originally a two-year project initiated in 2015. As per variance explanation #32 included in the Capital Expenditures and Carryover Report for year ending December 31, 2015, the equipment was delivered early and the project was completed in 2015. The above variance relates to overall project cost savings.

Supplemental Projects

6. Labrador West Transmission Project – Construction Phase (2014)

Budget: $329,592.1 Total: $12,424.0 Variance: ($317,168.1)

In 2014, the Provincial Government approved the construction of the third transmission line in Labrador to help supply power for planned new developments in Labrador West, such as the Kami Iron Ore Project, and improve reliability for all customers in the region. In September 2014, work on the line was temporarily suspended until completion of Alderon's financing plan. All project costs incurred to date, are covered by the security Alderon has already provided. Construction will proceed should additional funding be secured.

Plan of Projected Operating Maintenance Expenditures 2017 - 2026 For Holyrood Generating Station

Newfoundland and Labrador Hydro

July 2016

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1 INTRODUCTION

In Decision and Order No. P. U. 14(2004), the Board of Commissioners of Public Utilities (the Board), directed Newfoundland and Labrador Hydro (Hydro) to **"**file a ten year plan of maintenance expenditures for the Holyrood Generating Station with its annual capital budget application, until otherwise directed by the Board."[1] As this requirement is specifically related to system equipment maintenance (SEM) costs, capital expenditures have not been included in the following report. Capital expenditures for Holyrood Thermal Generating Station (Holyrood) are submitted annually to the Board with other Hydro capital proposals as part of the annual capital budget application.

This report addresses the identified and expected maintenance expenditures for the years 2017 to 2026 inclusive. With respect to these expenditures, it should be noted that Units 1 and 2, as well as two of the main fuel storage tanks and other associated ancillary equipment, are in excess of 45 years old and that Unit 3 and its associated equipment, are in excess of 35 years old. While many components of this equipment have been replaced and additional items added through the maintenance and capital program over the years, numerous pieces of equipment and components are original.

An accurate, uniform ten-year plan of SEM is difficult to complete. The harsh operating environment, varied production requirements, and the age of units may trigger revision of the maintenance plan to address unforeseen events. Even though expenses for major overhauls are included in capital rather than operating budgets, some variability in the annual budget will remain as a result of the complexity of numerous components and integrated systems that form a fossil fuel fired thermal electric generating system. This report will endeavor to identify the regular variations in the annual operating costs for Holyrood.

[1] Order No. P. U. 14(2004), at page 166.

2 MAINTENANCE PHILOSOPHY

In Order No. P. U. 14(2004), the Board stated that "The Board will require NLH's 10 year plan of maintenance expenditures for the Holyrood Generating Station to be updated annually to reflect changing operating circumstances."[2]

Maintenance efforts aim to prevent functional failure and extend the operational life of assets, helping to minimize total asset life cycle cost. The type and amount of maintenance applied is dependent on the criticality of the asset and the impact of failure on service delivery. Hydro seeks to balance the cost of maintenance against the cost of failure and the impact on safe, reliable service when applying maintenance strategies and tactics. There are three main types or categories of maintenance undertaken at Holyrood: preventive maintenance; corrective maintenance; and projects.

2.1 Preventive Maintenance

Holyrood has used, and continues to use, up-to-date maintenance techniques and practices to maintain plant efficiency, availability and reliability. These include preventive, predictive and condition-based maintenance techniques, which are usually referred to by the overall term of "Preventive Maintenance". The basic principle underlying this approach to maintenance is timely intervention to prevent imminent or catastrophic failure which may cause a substantial safety exposure, an extended unavailability of the unit or system, or an increase in cost.

Preventive maintenance comprises routine inspections, minor checks, and component replacement at specific time intervals to prevent failures that are known, or reasonably expected to occur, within a definable time or operating hour interval during the life of the equipment (e.g. generator brush wear, air and oil filter replacements). This also includes discarding equipment or components rather than repairing them when it is less costly to do so.

[2] Order No. P. U. 14(2004), at page 64.

Predictive maintenance involves routine testing of equipment to determine deterioration rates and initiating and carrying out repairs in a timely manner before a failure occurs (e.g. ultrasonic thickness checks on fluid lines to monitor erosion wear rates, and non-destructive testing of boiler and turbine components to determine fatigue, wear or corrosion rates and remaining life). Predictive maintenance items include such things as boiler and auxiliary equipment annual overhaul, wherein an assessment is made of components or subsystems that are only accessible during these overhauls.

There is also regular or continual monitoring of equipment operating parameters with a comparison of the results with optimum conditions to determine the most economic time to intervene and perform remedial work that is intended to return the equipment to optimum performance levels (e.g. air heater washes, generator winding insulation condition, oil sampling and testing).

Since 2008, the Preventive Maintenance program has been enhanced to include the extra costs associated with plant cleaning in areas where asbestos and heavy metals have been identified as potential health hazards.

2.2 Corrective Maintenance

In addition to the preventive maintenance techniques outlined above, there are also corrective maintenance requirements. This includes work performed to identify, isolate and restore equipment, machines or systems to a level in which it can be operated safely and used for its intended purpose. The requirement of corrective maintenance may arise for various reasons including failure, wear and tear, and harsh environments such as humid or a salt laden atmosphere. Examples of corrective maintenance include wear and tear on pumps, pipes and valves in the main and auxiliary systems.

2.3 Projects

Operating projects are low cost repairs and annual inspections that are required to return structures and equipment to their original or near original condition, to maintain structural integrity, improve efficiency, improve availability and prevent or reduce environmental risks. Such projects include emissions monitoring and testing and periodic basin cleaning in the Waste Water Treatment Plant.

3 COST VARIABILITY

Preventive maintenance costs are generally incurred annually at a constant level and do not fluctuate significantly. This principle does not apply to corrective maintenance costs, which are unavoidable and unpredictable due to the changing energy production demands on the units from year to year. Due to accounting methodology changes approved in Order P.U. 13(2012), major overhauls and inspections with a frequency of greater than one year are capitalized, reducing the fluctuation in maintenance expenditures that were experienced in prior periods. Projects for Holyrood are planned on a five-year basis, but as with any plan, it is not fixed or definitive, as other events can cause a shift in the prioritization of such projects. The five-year maintenance plan is updated on a regular basis to reflect any shifts in priority.

4 DETAILED ANALYSIS

Attached are Appendices A to D, which set out the ten-year maintenance plan for Holyrood. Appendix A is a summary and indicates the expected expenditures in each of the major equipment groupings containing SEM costs for the years 2017 to 2026. Appendices B to D, inclusive, show the expected SEM costs categorized according to Preventive, Corrective, Annual Overhauls and Operating Projects for each of the major equipment groupings containing SEM costs.

It should be noted that this ten year plan spans the period during which the role of Holyrood will change as a result of the interconnection between Labrador and the Island. These events significantly impact cost and activity levels for Holyrood for the standby period and ensuing synchronous condenser period, as reflected in this plan. Generation from the Holyrood Thermal Plant will start to reduce once the high voltage direct current (HVdc) interconnection is in service. The units at Holyrood will start to be placed in standby as the HVdc systems are proven to be ready for reliable service. The timing of the final decision on the shut down and repurposing of the Holyrood plant will be made once commissioning of all infrastructure relating to the Muskrat Falls Project is complete in 2020, and reliable service has been demonstrated. This is anticipated to occur in the 2020/2021 time frame. For the purposes of projecting operating costs in this report a place holder assumption has been made that the standby phase begins in 2018 and continues through 2021. Starting in 2018, delivery of power and energy via the HVdc line could start, but are limited as the Muskrat Falls powerhouse is not yet in service.

This plan was prepared using the 2016 preventive, corrective and annual overhaul budget and the current 2017 to 2021 project lists from Hydro's five-year plan for Holyrood as the base data.

Hydro does not normally use any escalation in its five-year operating plan at the Plant or regional level as the five-year plan is primarily used for internal purposes and generation of work plans rather than detailed financial planning. However, in the attached ten-year plan, a

single escalation factor of 2.5% per year has been used for 2017 to 2026 based on an average rate from Hydro's current corporate assumptions.

Appendix B lists the categories of SEM costs for generating units for the years 2017 to 2026 in each of the major equipment groupings. The categories listed are:

Preventive	Routine preventive maintenance activities carried out every year
Corrective	Typical but unknown breakdown/emergency repairs carried out during the year
Boiler	Boiler overhauls carried out annually with one unit per year overhauled on a reduced scope as a result of better fuel quality. For 2020 and 2021, all boiler overhauls are expected to be on a reduced scope. No boiler overhauls are expected beyond 2021.
Operating Projects	Non-capitalized projects, justified on the basis of safety, environment, reliability or cost benefit analyses

Appendices C and D provide a listing of the remaining equipment groupings of Common Equipment, Building and Grounds, Water Treatment Plant, Waste Water Treatment Plant and Environmental Monitoring and use only Preventive, Corrective and Operating Projects.

It should be noted that the appendices do not itemize preventive and corrective items. The preventive maintenance program consists of approximately 1,200 preventive maintenance work orders performed on plant equipment annually. Corrective items include a large number of low cost projects, the majority of which are largely unknown until they happen; thus, it is not practical to provide a breakout of the costs.

5 SUMMARY

This Plan is based on the 2016 system equipment maintenance budget and adjusted using the best available information including up to date maintenance tactics and known restoration and inspection work to establish a ten-year forecast of the maintenance projects for the Holyrood Plant. As with any forecast, it is subject to change depending on the operating demands of the plant, the results of inspections and assessments of changing equipment conditions.

APPENDIX A

APPENDIX A
TOTAL HOLYROOD 10 YEAR SEM EXPENDITURES
($000)

	Base Year 2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Unit 1 Total SEM	$1,995	$1,533	$2,096	$1,127	$825	$182	$187	$192	$196	$201
Unit 2 Total SEM	$1,896	$1,943	$1,467	$1,128	$770	$151	$155	$159	$163	$167
Unit 3 Total SEM	$1,210	$1,753	$1,797	$897	$589	$159	$163	$168	$172	$176
Common Equipment Total SEM	$1,803	$1,848	$1,894	$1,456	$1,493	$513	$525	$538	$552	$566
Buildings & Grounds Total SEM	$186	$191	$195	$150	$154	$53	$54	$56	$57	$58
WT Plant Total SEM	$108	$111	$113	$87	$89	$31	$31	$32	$33	$34
WWT Plant Total SEM	$10	$10	$11	$8	$8	$3	$3	$3	$3	$3
Environmental Monitoring Total SEM	$116	$119	$122	$94	$96	$33	$34	$35	$36	$36
Total Operating Projects	$561	$174	$140	$122	$125	$0	$150	$0	$0	$0
Total Holyrood SEM	**$7,885**	**$7,682**	**$7,836**	**$5,068**	**$4,149**	**$1,125**	**$1,303**	**$1,182**	**$1,212**	**$1,242**

APPENDIX B

10 YEAR SEM EXPENDITURES FOR GENERATING UNITS
($000)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Unit No. 1										
Preventive	465	478	490	376	386	132	136	139	143	146
Corrective	329	337	346	266	272	50	51	53	54	55
Boiler O/H	1,200	718	1,261	485	166	0	0	0	0	0
Subtotal	$1,995	$1,533	$2,096	$1,127	$825	$182	$187	$192	$196	$201
Operating Projects										
Boiler Chemical Clean										
Total Op Projects - Unit 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total - Unit No. 1	**$1,995**	**$1,533**	**$2,096**	**$1,127**	**$825**	**$182**	**$187**	**$192**	**$196**	**$201**
Unit No. 2										
Preventive	357	366	375	288	296	101	104	107	109	112
Corrective	339	347	356	274	281	50	51	53	54	55
Boiler O/H	1,200	1,230	736	566	194	0	0	0	0	0
Subtotal	$1,895	$1,943	$1,467	$1,128	$770	$151	$155	$159	$163	$167
Operating Projects										
Boiler Chemical Clean										
Total Op Projects - Unit 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total - Unit No. 2	**$1,895**	**$1,943**	**$1,467**	**$1,128**	**$770**	**$151**	**$155**	**$159**	**$163**	**$167**
Unit No. 3										
Preventive	213	218	224	172	176	67	68	70	72	74
Corrective	297	304	312	240	246	93	95	98	100	103
Boiler O/H	700	1,230	1,261	485	166	0	0	0	0	0
Subtotal	$1,210	$1,753	$1,797	$897	$589	$159	$163	$168	$172	$176
Operating Projects										
Boiler Chemical Clean										
Total Op Projects - Unit 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total - Unit No. 3	**$1,210**	**$1,753**	**$1,797**	**$897**	**$589**	**$159**	**$163**	**$168**	**$172**	**$176**

APPENDIX C

APPENDIX C
10 YEAR SEM EXPENDITURES FOR ANCILLARY UNITS
($000)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Common Equipment										
Preventive	1,591	1,631	1,672	1,285	1,317	452	464	475	487	499
Corrective	212	217	223	171	176	60	62	63	65	67
Subtotal	$1,803	$1,848	$1,894	$1,456	$1,493	$513	$525	$538	$552	$566
Operating Projects										
Total Op Projects - Common	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total - Common Equipment	**$1,803**	**$1,848**	**$1,894**	**$1,456**	**$1,493**	**$513**	**$525**	**$538**	**$552**	**$566**
Buildings & Grounds										
Preventive	164	168	172	132	136	47	48	49	50	51
Corrective	22	23	23	18	18	6	6	7	7	7
Subtotal	$186	$191	$195	$150	$154	$53	$54	$56	$57	$58
Operating Projects										
Total Op Projects - Bldgs & Grounds	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total - Bldgs & Grounds	**$186**	**$191**	**$195**	**$150**	**$154**	**$53**	**$54**	**$56**	**$57**	**$58**
Water Treatment Plant										
Preventive	82	84	86	66	68	23	24	24	25	26
Corrective	26	27	27	21	22	7	8	8	8	8
Subtotal	$108	$111	$113	$87	$89	$31	$31	$32	$33	$34
Operating Projects										
Resin Replacement	80	82	84	65	66	0	0	0	0	0
Total Op Projects - WTP	$80	$82	$84	$65	$66	$0	$0	$0	$0	$0
Total - Water Treatment Plant	**$188**	**$193**	**$198**	**$152**	**$156**	**$31**	**$31**	**$32**	**$33**	**$34**

APPENDIX D

APPENDIX D
10 YEAR SEM EXPENDITURES FOR ANCILLARY UNITS
($000)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Environmental Monitoring										
Preventive	15	15	16	12	12	4	4	4	5	5
Corrective	101	104	106	82	84	29	29	30	31	32
Subtotal	$116	$119	$122	$94	$96	$33	$34	$35	$36	$36
Operating Projects										
Emmissions Monitoring	53	54	56	57	59	0	0	0	0	0
Stack Emmissions Testing	128									
Tube Bundle Replacement		38								
Total Op Projects - Environment	$181	$92	$56	$57	$59	$0	$0	$0	$0	$0
Total - Environmental Monitoring	**$297**	**$211**	**$178**	**$151**	**$155**	**$33**	**$34**	**$35**	**$36**	**$36**
Waste Water Treatment Plant										
Preventive	5	5	5	4	4	1	1	1	2	2
Corrective	5	5	5	4	4	1	1	1	2	2
Subtotal	$10	$10	$11	$8	$8	$3	$3	$3	$3	$3
Operating Projects										
WWTP Periodic Basin Cleaning	150						150			
WWTP Continuous Basin Clean-Out	150									
Total Op Projects - WWTP	$300	$0	$0	$0	$0	$0	$150	$0	$0	$0
Total - Waste Water Treatment	**$310**	**$10**	**$11**	**$8**	**$8**	**$3**	**$153**	**$3**	**$3**	**$3**