Nova Scotia Utility and Review Board

IN THE MATTER OF Section 35A of *The Public Utilities Act*, R.S.N.S. 1989, c.380, as amended

- and -

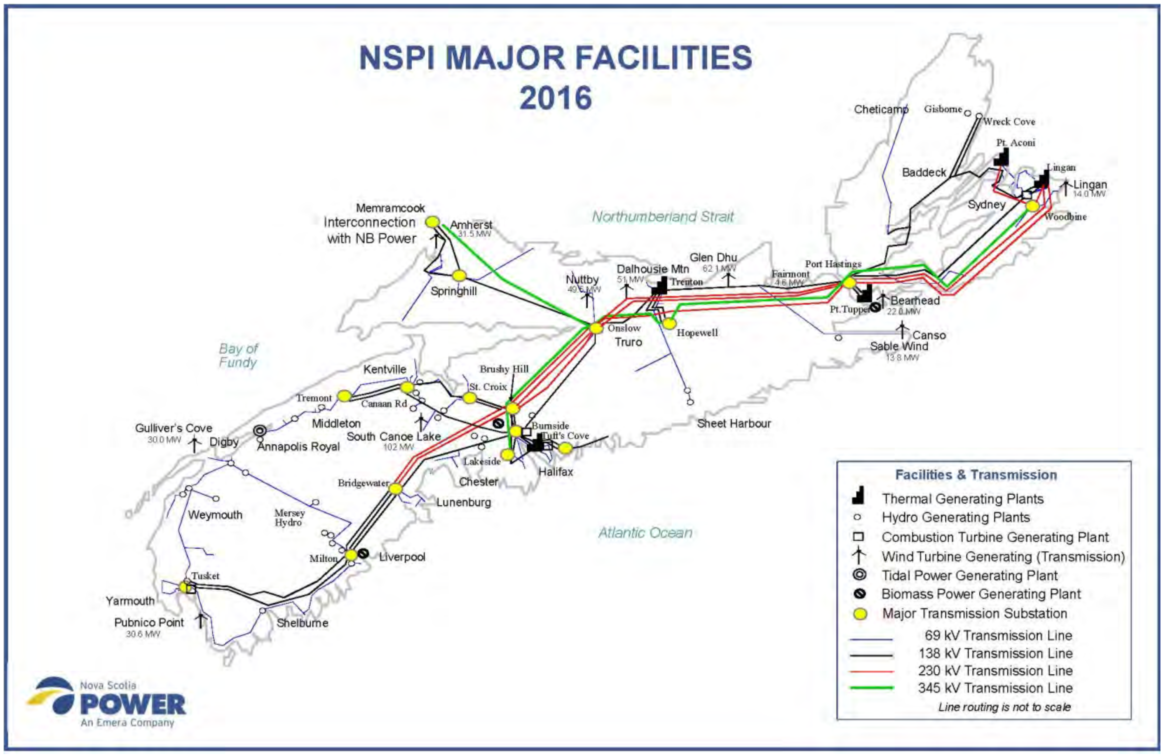
IN THE MATTER OF an Application by Nova Scotia Power Inc. for Approval of the **2017 Annual Capital Expenditure (ACE) Plan**

2017 ACE Plan

Date Filed: November 14, 2016

Nova Scotia Power

2017 Annual Capital Expenditure Plan



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EXECUTIVE SUMMARY

NS Power’s Annual Capital Expenditure (ACE) Plan Application is an important part of NS Power’s capital program, providing the Nova Scotia Utility and Review Board (Board, UARB), stakeholders and customers with a complete and transparent overview of the capital projects and expenditures expected for the year ahead. It focuses on providing safe, reliable service, and on sustaining and compliance capital work on NS Power’s system. In support of NS Power’s continued efforts to provide thorough and transparent ACE Plan submissions, the 2017 ACE Plan incorporates revisions and improvements as a result of stakeholder consultations undertaken as a result of last year’s ACE Plan.

The 2017 capital budget is $398 million. In this Application, NS Power is requesting UARB approval of $152.8 million in capital spending made up of 71 capital work orders plus the capital routine program. The majority of capital work orders submitted for approval are less than $1 million each: 24 projects are forecast between $250,000 and $500,000; 28 are forecast between $500,000 and $1 million, and 19 exceed $1 million. Overall capital expenditures in 2017 have increased compared to recent years largely due to strategic capital projects. The 2016 ACE Plan total budget was $279.9 million as compared to the 2017 ACE Plan total budget of $398 million.

These capital work orders are required for sustaining and compliance capital work on the Company’s system. These projects include rebuilding or refurbishing aging and deteriorated plant and equipment and investments in assets to comply with regulations. In addition to sustaining capital projects, there are a number of strategic capital projects. Those projects include the re-implementation of our Enterprise Resource Planning systems, the installation of Advanced Metering Infrastructure, Maritime Link transmission system upgrades, and transmission upgrades to support the economic dispatch of the Tuft’s Cove generating station. These strategic capital projects are subject to separate capital work order submissions outside of the 2017 ACE Plan.

While NS Power carries out these capital investments, the Company must also consider and adapt to evolving regulatory requirements, such as the adoption of renewable energy and recently introduced performance standards. NS Power complies with one of the most ambitious renewable energy requirements and emissions reductions in Canada. Over the last 10 years the Company has made tremendous gains in renewable energy production. It has tripled its renewable energy production to 27% as of the end of 2015 and, over the same period, reduced greenhouse gas emissions by 36%. This reduction surpasses the Federal target of reducing CO_2 emissions by 30% from 2005 levels by 2030. In addition, in 2016, the installed wind generation on the NS Power system is expected to exceed 600MW. When considered as a percentage of the power system peak of approximately 2,000MW, this places NS Power amongst the leaders in wind integration in North America.

The Company's 2017 ACE Plan is developed to meet our customers' expectations of affordability and rate stability. Customers have told NS Power that they want stable, predictable and affordable rates. This is why there is a three year rate stability period for the years 2017-2019. NS Power's capital program is expected to have a minimal impact on rates over the next five years. The 2017 ACE Plan provides for investing in assets where needed to keep costs low and as affordable as possible for NS Power customers.

NS Power respectfully requests Board approval of the following:

- 71 Capital Items with 2017 budget spending of \$54.8 million and total project spending of \$72.6 million. (Please refer to Section 2.2); and

- Capital routine programs with 2017 budget spending of \$80.2 million. (Please refer to Section 7.1).

1.0 INTRODUCTION

1.1 2017 ACE Plan and Future Outlook

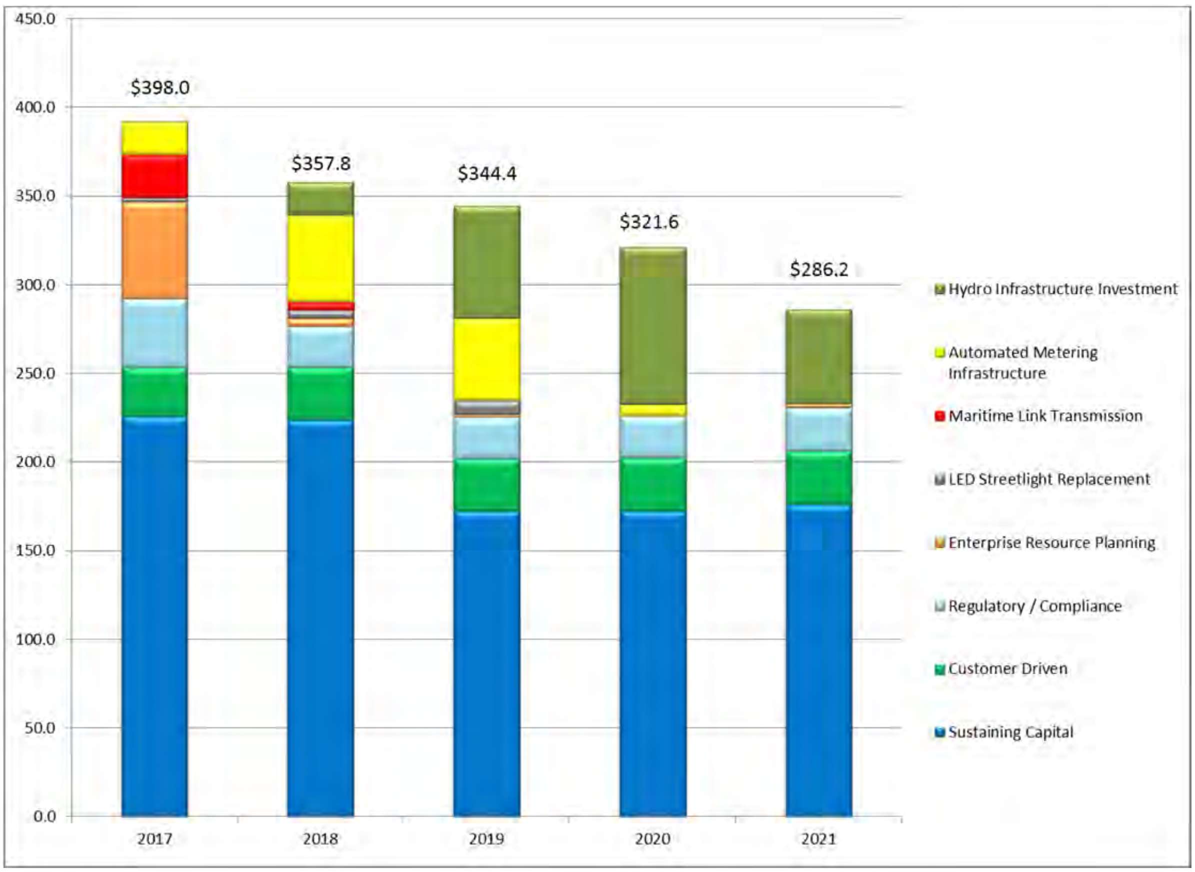
NS Power's 2017 ACE Plan was developed to meet customers' expectations for safe, reliable service, less reliance on fossil fuel generation, while minimizing upward pressure on revenue requirement and rates.

Overall expenditures in 2017 compared to 2016 have increased due primarily to large strategic capital projects. Notwithstanding, the Company's capital program continues to be a largely sustaining capital program representing cost-effective investments to maintain system performance for its customers. The emphasis continues to be on making timely investments based on equipment condition and criticality and maximizing the value of existing assets for customers.

Section 8.1.1, Impact of 2017 ACE Plan on Revenue Requirement and Affordability, shows that NS Power's capital expenditures have a minimal effect on NS Power's revenue requirement over the next five years when one considers the contribution to fixed costs provided by new customer additions. This ensures that NS Power continues to address the affordability of investments while minimizing upward pressure on rates.

The Electricity Plan Implementation (2015) Act (EPIA) requires the Board to establish performance standards. NS Power, the Board and stakeholders recently engaged in a proceeding on this matter. A Decision from the UARB regarding performance standards is pending. Performance standards are not driving the transmission and distribution capital investment selection for the 2017 ACE Plan. The performance standards supported by NS Power are not expected to result in increases related to transmission and distribution capital investments.

As shown in the figure below, the investments on sustaining NS Power's assets, customer driven investments, and investments required by regulatory or environmental standards are forecasted to be reasonably stable. Strategic capital investments, such as the re-implementation of the Enterprise Resource Planning systems, the installation of Advanced Metering Infrastructure (AMI), Maritime Link transmission system upgrades, and transmission projects that support the economic dispatch of Tuft's Cove Generating Station, require larger capital investments in 2017. Hydro infrastructure investment, which includes re-development of the Mersey Hydro System and a major overhaul of our Wreck Cove Hydro generating station, will contribute to increases in related capital expenditures in 2018 and beyond.



Investment Type	2017	2018	2019	2020	2021
Sustaining Capital	225.5	223.4	172.2	172.3	176.3
Customer Driven	27.7	29.7	29.8	29.9	30.0
Regulatory / Compliance	38.7	23.0	23.5	23.9	24.4
Enterprise Resource Planning	54.4	4.7	1.3	0.5	2.5
LED Streetlight Replacement	2.5	4.8	8.2	0.0	0.0
Maritime Link Transmission	24.7	5.0	0.0	0.0	0.0
Metro Transmission Upgrades	5.8	0.0	0.0	0.0	0.0
Smart Grid / Advanced Metering Infrastructure	18.4	48.3	45.9	6.1	0.0
Hydro Infrastructure Investment	0.3	19.0	63.6	88.8	53.0
	398.0	**357.8**	**344.4**	**321.6**	**286.2**

*Totals may be off slightly due to rounding. Figures are noted in $millions.

2018 and beyond represent the Company's current forecast of the future years. These will evolve as new information informs the potential investments.

The Sustaining, Customer Driven, and Regulatory/Compliance Capital portion of the annual forecast in 2018 – 2021 is more certain than the large scale strategic capital profile. The Sustaining Capital estimates are built up from well-established asset management and replacement programs. Strategic Capital reflects projections of spending in later years, and is based on estimates subject to change as project scope becomes better defined.

1.2 Asset Class Capital Investment Approaches

NS Power's selection of capital investments for generation, transmission and distribution is based on the methodology described in Section 6.2 of the Capital Expenditure Justification Criteria (CEJC). This allows NS Power to determine how best to invest sustaining capital in assets critical to the safe and reliable delivery of electricity to NS Power customers.

Information technology (IT) capital investments are governed by their own requirements, and are equally important in the operation of the business. As NS Power's operating environment evolves due to changing regulatory requirements and the rapid advancement of technology, so too must NS Power's approach to capital investments in each of its major asset classes.

These approaches are described in the sections below.

1.2.1 Generation

NS Power's selection of generation capital investments is based on an asset management approach. NS Power mitigates challenges related to generation through its asset management approach, as described in Section 6.2 of the CEJC. This approach enables the Company to determine how best to invest sustaining capital in its generation fleet to deal with complexity from federal regulatory uncertainty,[1] aging units, changing unit utilization and renewable integration.

The Company's asset health and risk profiling determines the condition and criticality of equipment and allows implementation of the most appropriate risk mitigation strategy, including effective investment of sustaining capital.

The utilization of several generation units in NS Power's fleet will continue to change in the coming years because of the integration of intermittent renewable electricity. NS Power integrates forecasted future unit utilization factors to select the most effective mitigating measures to address risk. Historically, this has resulted in traditional investment such as equipment replacement or refurbishment. Now, as units approach the end of their utilization, alternate mitigating measures to address risks must be considered.

For example: Lingan Unit #2 (near end of operating life) and Lingan Unit #4 (long-term operation, high utilization) have different mitigating measures for the same risks. These units have different utilization profiles, meaning different mitigating measures and

[1] Such as the Federal government's carbon policy announcement of October 3, 2016.

corresponding capital investment are most cost effective for customers. With increased inspections, investment has been deferred (or eliminated) in turbine blades on Lingan Unit #2, while several capital investments have been made on Lingan Unit #4. The result of these alternate mitigating measures is minimized risk of undepreciated costs while managing equipment health and performance to end of life.

Behind NS Power's asset management approach is an integrated spectrum of programs and processes enabling a detailed understanding of asset health and risk. Key elements include:

- Delivering fleet wide asset class programs;
- Incorporating the latest technologies to enhance understanding of asset health;
- Building effective operational support tools and infrastructure; and
- Expanding risk based inspection programs.

NS Power's generation asset management approach is focused on optimizing generation resources by mitigating risks through various methods (capital investment, monitoring, assessment, operating procedures, etc.) and continuing to develop and improve asset health profiling and risk assessment, as the generation fleet transforms to a renewable future.

1.2.2 Transmission and Distribution

Transmission and Distribution (T&D) investment in the ACE Plan is driven by the asset management approach as described in Section 6.2 of the CEJC. The asset management approach evaluates the condition, criticality and risk of different asset groups and provides priorities for the maintenance and replacement of assets. NS Power's asset management strategy and inspection program results feed up into this selection process, aimed largely at sustaining capital investments.

Inspection programs are established for Transmission Line, Substation and Distribution Line assets. The frequency for inspection varies by asset and ranges from on-line monitoring to monthly to bi-annual assessments. The inspection results play an important role in identifying deteriorated equipment and are used to identify and prioritize capital projects. Regulatory and compliance requirements also drive T&D projects, such as the T&D polychlorinated biphenyl (PCB) contaminated equipment replacement projects included in the 2017 ACE Plan.

The Electricity Plan Implementation (2015) Act (EPIA) requires the Board to establish performance standard benchmarks. The Board held a hearing on these standards in September 2016, and a final decision on the matter is pending. As previously stated, the performance standards supported by NS Power are not expected to result in increases related to transmission and distribution capital investments. At present, NS Power continues to focus T&D investments on sustaining capital, supported by the established asset management approach.

Increases in storm reliability focused investments are being pursued primarily as a result of weather events such as Post-Tropical Storm Arthur (PTSA). As a result of the findings of the PTSA proceeding, increases in the transmission and distribution right-of-way widening routines (T010 and D010, respectively) were proposed in the 2016 ACE Plan. This year, in accordance with the Board's 2016 ACE Plan Decision and Order, the increased spend related to T010 has been separated into a separate capital work order for individual Board approval (CI 49992). Furthermore, NS Power has elected to take the same approach with the distribution right-of-way widening routine, separating the increased spend related to D010 into a capital work order for individual Board approval (CI 49611). CI 49611 was submitted to the Board on November 1, 2016.

T&D capital expenditures in the 2017 ACE Plan are focused on sustaining capital to maintain the significant reliability gains achieved in recent years, and to improve storm related reliability through T010, CI 49992, CI 49611 and D010.

1.2.3 Information Technology

As noted in the CEJC, projects related to General Plant, including Information Technology (IT), are too diverse for a single selection methodology, and are selected based on technical justifications or economic benefit. In the case of IT capital expenditures, rapid technological advancements, end of useful life of current systems, and changing customer expectations are driving NS Power's IT investments.

There has been a significant increase in the pace of change related to technology requirements. Drivers influencing this include:

1. An increase in customer expectations to access information, control services, and conduct business with NS Power on multiple technology platforms, making interactions with NS Power easier and quicker and enabling customers to conduct business with NS Power 24 hours a day, 7 days a week.

2. An increase in regulatory[2] and legal compliance requirements to implement new controls and provide information in more detail and in a timely manner.

3. An increase in the level of integration of business processes within the Company and with external businesses and agencies.

4. Software vendors increasing the frequency of patches and releases and expanding the amount of business functionality.

5. An acceleration in technology turnover has resulted in increased technology obsolescence.

[2] NS Power is required to comply with the NERC reliability standards that fall under the Critical Infrastructure Protection (CIP) program.

6. An increase in the volume and sophistication of cyber-related threats.

As a result, NS Power needs to update its approach to managing technology. This is being done in accordance with key principles such as leveraging accepted industry standards, using commercial off-the-shelf solutions, reducing the number of technology investments where possible, and designing for ease of integration, flexibility and cost.

NS Power has a number of major technology assets that are at or near end-of life. The corresponding near-term technology investments include the following:

1. Enterprise Resource Planning (ERP) Re-implementation ($89.7 million)
2. Cyber security enhancements ($15 million)
3. T&D Work and Asset Management ($28 million)
4. Customer Information System (CIS) replacement ($30 million)

As a result of these strategic investments, IT capital expenditures over the next several years will be higher than the low historically investment profile. These investments will address many of the aforementioned issues currently facing NS Power, and set up the Company for more regular, incremental IT upgrades to better keep pace with the rapid evolution of technology and customer demands.

1.3 2016 Stakeholder Engagement

Over the last several years, NS Power has been actively engaged with stakeholders regarding improvements to the ACE Plan. In 2016, NS Power engaged with consultants for the Small Business Advocate (SBA) and the Consumer Advocate (CA) pursuant to the Board's 2016 ACE Plan Decision and Order. A report regarding these discussions was submitted to the UARB on August 19, 2016, along with a revised Detailed and Summary CEJC for the Board's information and approval, respectively. Highlights of those discussions and the report are provided below.

1.3.1 Revenue Requirement

NS Power has continued to work with stakeholders and their consultants on the issue of the revenue requirement directive (Section 8.1.1). On April 1, 2016, NS Power submitted the 2016 ACE Plan Terms of Consensus (Terms of Consensus). The Terms of Consensus provided:

> NS Power agrees to make the following revisions to NS Power's "Long-Term Capital Planning & Revenue Requirement" table for future ACE Plans:
>
> 1. Move the incremental revenue requirement of five-year capital plan rows to the bottom of the table.
>
> 2. Amend the calculation of "New Incremental Regulated Capital Assets" to the total of capital spend in the five year capital plan less depreciation of all assets.
>
> 3. Treat the entire amount of spend in the final year of the revenue requirement directive as an addition to property, plant and equipment.
>
> In addition, the Parties have reached an agreement in principle to include an additional revenue requirement table in the next 2017 ACE Plan to address issues raised by the CA and the SBA in their evidence with respect to NS Power's Revenue Requirement Analysis. This new revenue requirement table will be in addition to (and not in substitution of) the existing "Long-Term Capital Planning & Revenue Requirement" table which NS Power will continue to include in future ACE Plans.
>
> The Parties agree to defer discussion of the details of this additional revenue requirement table to a subsequent stakeholder consultation process between NS Power and interested stakeholders, including the CA, the SBA and the IG. This stakeholder consultation process will begin within 30 days of the Board issuing its decision in this matter.[3]

In its 2016 ACE Plan Decision, the UARB directed that these issues be dealt with in the stakeholder consultative process.

[3] NS Power 2016 ACE Plan, Terms of Consensus Agreement, Appendix A, M07176, April 1, 2016, page 3.

NS Power discussed the revenue requirement directive with consultants for the SBA and CA in 2016. In NS Power's report on stakeholder consultations, submitted to the UARB on August 19, 2016, NS Power re-affirmed the incorporation of the revisions to the "Long-Term Capital Planning & Revenue Requirement" table, and the inclusion of the CA and SBA's revenue requirement table alongside NS Power's table in the 2017 ACE Plan. This is in Section 8.1.1 – Impact of 2017 ACE Plan on Revenue Requirement and Affordability.

NS Power also provides additional detailed information on the revenue requirement impact of certain classes of expenditures. For example, Section 8.1.1 also provides the revenue requirement impact of economically justified and work support facility projects.

1.3.2 Economic Analysis Model

The 2016 ACE Plan Terms of Consensus included a commitment to discuss several items with respect to NS Power's Economic Analysis Model (EAM):

1. Replacement Energy Cost (REC)
2. Timing of Capital Projects
3. Useful Life Analysis Period

Replacement Energy Calculation

As part of the stakeholder consultation process, it was agreed that revisions to the REC calculation methodology would be premature without further testing. NS Power committed to examine the effects of the SBA's locational marginal pricing adjustments to the hydro unit REC calculation, and report on the results in the 2017 ACE Plan. This report is provided in Section 8.1.9 and includes (1) a description of the methodology used for calculating the REC for hydro, and (2) justification for the methodology currently used by NS Power as compared to alternatives examined such as locational marginal pricing.

Timing of Capital Projects

As part of the stakeholder consultation process, NS Power confirmed the pre-existing timing sensitivity in the EAM, and provided an Excel version of the EAM to the consultants for the CA and SBA for further review. As a result of that review, the consultant for the CA proposed a revised timing calculation, which factors in the change in the value of capital costs, offset by the avoided expenses in the year the project is deferred.

NS Power and the consultants for the CA and SBA agreed to the following revised EAM timing calculation:[4]

- Sum of Total Net Present Value of: Depreciation, Interest, AFUDC, Earnings before tax and Operating expenses.

- Times: 1/(1+Pretax Weighted Average Cost of Capital)^N-1) where N is the number of years of deferral.

- Less: Present value of operating income and avoided expenses for the number of years in which the project is delayed.

- Added 2 percent annual inflation to capital project cost for the number of years of deferral.

All EAMs in the 2017 ACE Plan have adopted this methodology.

[4] Letter NS Power UARB, September 30, 2016 (M07628).

Useful Life Analysis Period

During the 2016 ACE Plan proceeding, the CA raised a concern with depreciation expenses, associated interest and taxes in the EAM.[5] These expenses are calculated past the expected retirement date for certain generation units. Pursuant to the Terms of Consensus, the parties agreed to defer discussion of the CA's comments to a subsequent stakeholder consultation process.

NS Power discussed this matter with the consultants for the CA and the SBA, and reached the following conclusions:

- Adjusting the depreciation expense, associated interest and taxes to stop at the expected retirement date of a generation unit has a minimal impact on the economic analysis and would not affect the outcome of the economic analysis.

- All economics for projects on generation units with expected retirement dates have pay-back periods prior to the expected retirement date of the unit.

Accordingly, no revisions to this aspect of the EAM are required.

1.3.3 Inconsistent Project Justifications

The CA also raised a concern during the 2016 ACE Proceeding with respect to inconsistencies in project justifications.[6] The Terms of Consensus provided the following:

> The Parties agree to consider improvements in NS Power's categorization of project justifications, especially for projects with more than one justification (e.g., economics and safety) and for projects at units driven by

[5] NS Power 2016 ACE Plan, Exhibit N-7, CA Evidence, M07628, February 12, 2016, pages 13-14.
[6] NS Power 2016 ACE Plan, Exhibit N-7, CA Evidence, M07628, February 12, 2016, pages 10-13.

capacity rather than energy (e.g., at Tufts Cove) in a subsequent stakeholder consultation process between NS Power and interested stakeholders, including the CA, the SBA and the IG.[7]

The issue was discussed with the consultants for the CA and SBA and NS Power provided the following clarifications:

- Projects may be pursued primarily under one justification (i.e. refurbishment of a generating unit to prevent failure), but may also feature secondary justifications (i.e. economics or safety).

- The vast majority of economic projects are pursued primarily because of the need to complete the project for system purposes. Their completion also avoids replacement energy costs making them economic.

- These economic projects may rely on their primary justification for system purposes without the need for associated economics.

NS Power committed to identifying the primary and secondary justifications, where applicable, in the capital work order description pages in future ACE Plans. Those 2017 ACE Plan projects with multiple justifications have adopted this approach.

1.4 2017 AFUDC Rate

In the Board's Weighted Average Cost of Capital (WACC) and Allowance for Funds Used During Construction (AFUDC) Order dated May 30, 2016, the UARB provided the following:

1. The WACC and AFUDC rates are established at 7.01%, effective June 1, 2016;

[7] NS Power 2016 ACE Plan, Terms of Consensus Agreement, Appendix A, M07176, April 1, 2016, page 2.

2. NSPI is directed to file an application for approval annually, no later than November 30, of the calculation of WACC/AFUDC, unless there is a general rate application in the same year, using the principles outlined in the Board's Decision.[8]

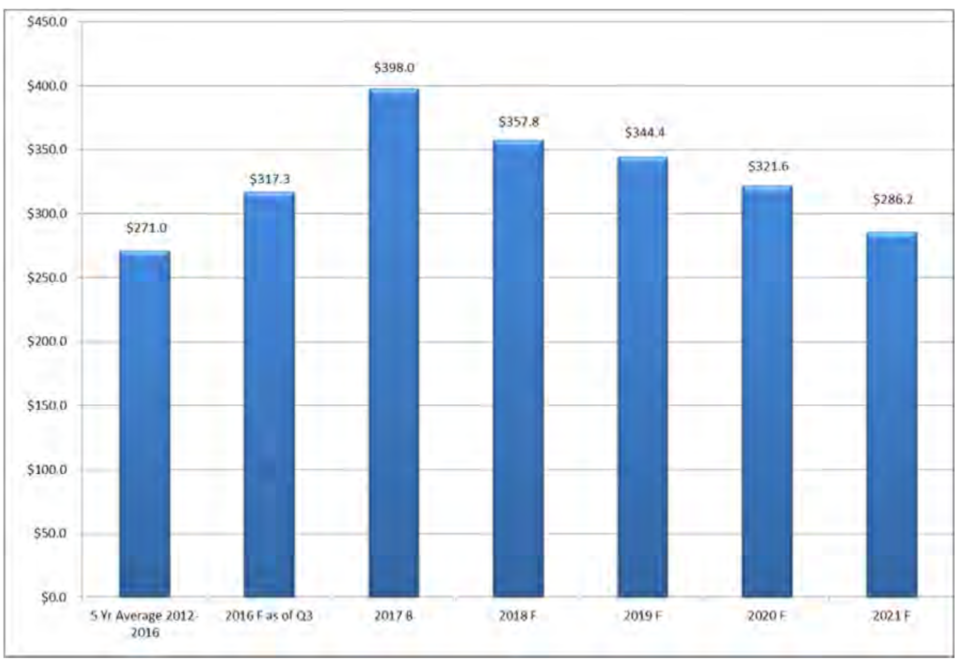
Consistent with the Board's Order, the 2017 ACE Plan projects use the Board's approved AFUDC rate of 7.01 percent.

NS Power anticipates that an application for the calculation of the updated WACC/AFUDC rate will be filed by the Company on or before November 30, 2016.

1.5 Capital Spending History and Forecast Overview

Historical, Budget and Forecast

(Millions of Dollars)



F = Forecast, B = Budget in above figure

[8] NS Power WACC/AFUDC Application, UARB Order, M07215, May 30, 2016, page 2.

Total Annual Capital Expenditures by Function

(Millions of Dollars)

Year	Actuals 2012	2013	2014	2015	2016 Q3 F	2016 ACE Budget	ACE Plan 2017	Forecast 2018	2019	2020	2021
Generation	88.7	68.4	66.0	127.5	114.8	105.0	106.0	112.5	136.8	161.3	127.6
New Renewables	53.2	15.2	82.8	-	-	-	-	-	-	-	-
Transmission	45.4	31.0	51.0	54.4	55.4	56.1	$91.2	68.3	52.3	53.4	54.4
Distribution	68.7	62.9	52.8	62.5	69.7	74.8	$83.9	118.0	118.1	70.3	64.0
General Plant	28.5	29.9	21.7	27.1	77.3	44.0	$116.9	59.1	37.2	36.6	40.2
Total	**284.5**	**207.4**	**274.3**	**271.5**	**317.3**	**279.9**	**398.0**	**357.8**	**344.4**	**321.6**	**286.2**

NOTES: 1. Figures presented may include $0.1M in rounding differences on some line items.

2. Includes Maritime Link Transmission Spend that is currently removed from rate base.

1.6 2016 ACE Capital Items Deferred/Cancelled

NS Power's list of deferred and cancelled capital work orders relative to the 2016 ACE Plan are noted in the following table. This table does not include 2016 ACE Plan Subsequent Submittal items that are planned to be submitted prior to year-end and does not include additional 2017 expenditures.

Of the 51 projects listed, 1 project was included in the 2016 ACE Plan for approval. 20 of these projects were listed in the 2016 ACE Plan subsequent submittal list, to be filed separately as individual capital items. The remaining 30 projects were listed in the 2016 ACE Plan as projects under $250,000.

These 51 projects were originally included in the 2016 ACE Plan with a forecasted spend of $21 million in 2016. 14 of these projects have been cancelled, while 37 have been deferred to future years.

2016 ACE Items – Deferred or Cancelled

CI	Project Title	2016 ACE Project Total	Cancelled/ Deferred	Deferred To	Prior Approval	Prior ACE Plan Reference	2017 ACE Plan Reference
Generation							
29807	HYD - Tusket Falls Main Dam	6,534,233	Deferred	2017		Subsequent Submittal	Subsequent Submittal
	Consultation with First Nations was required in 2016 in order to proceed with this project, pushing the start of this project into 2017.						
46254	HYD - Mill Lake Surge Tank Refurbishment	1,421,366	Deferred	2018		Subsequent Submittal	
	Further inspection of the surge tank showed that this refurbishment could be safely deferred to 2018.						
47687	POT Boiler Chemical Recondition	855,348	Deferred	2017		Subsequent Submittal	Request Approval
	During 2016, additional assessments of boiler tube deposits were performed during the planned outage in order to determine the appropriate method to complete this work. Further testing performed on tube samples to simulate results was also completed in order to determine the approach for completing this work in 2017.						
47870	LIN Cofferdam Outer Cell Refurbishment	850,609	Deferred	2017		Subsequent Submittal	Less than $250k
	Temporary repairs and increased monitoring / inspection allowed this project to be deferred to 2017.						
47871	LIN Stack Re-Coating	707,696	Deferred	2018		Subsequent Submittal	
	Further assessment in 2016 showed sufficient coating protection remains and can be safely deferred to 2018.						

CI	Project Title	2016 ACE Project Total	Cancelled/ Deferred	Deferred To	Prior Approval	Prior ACE Plan Reference	2017 ACE Plan Reference
47953	LIN Rail Car Positioner Upgrade *Further assessment of this project indicated it could safely be deferred to 2017.*	507,812	Deferred	2017		Subsequent Submittal	Request Approval
47961	LIN1 Condenser Tube Coating *The planned outage for Lingan 1 was deferred to 2018, as inspection / engineering determined it could safely be deferred.*	333,944	Deferred	2018		Request Approval	
47893	TUC3 Generator Hydrogen Panel Upgrade *This project was deferred due to the Major TUC3 Shutdown being moved out to 2017.*	301,806	Deferred	2017		Subsequent Submittal	Request Approval
44788	BGT1 Vibration Monitoring & Protection System Upgrade *Further inspection of this work is required to determine the needs / scope of the project.*	252,674	Deferred	2018		Subsequent Submittal	
47894	TUC2 Boiler Natural Gas Ignitors *Subsequent to the 2016 ACE Plan filing, NS Power performed further investigation and changed some set points around the turbine which has mitigated the issue this project was designed to solve. Continued monitoring will determine if this project will be required in the future.*	244,362	Deferred	2018		Less than 250K	
47812	BGT Fuel Tank 3 Refurbishment *Further inspection completed in early 2016 indicated that the tank did not require refurbishment.*	212,149	Cancelled			Less than 250K	

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CI	Project Title	2016 ACE Project Total	Cancelled/ Deferred	Deferred To	Prior Approval	Prior ACE Plan Reference	2017 ACE Plan Reference
47960	LIN1 Control Valve Rebuild *The planned outage for Lingan 1 was deferred to 2017, as inspection / engineering determined it could safely be deferred. This project will now be completed as part of a planned outage in 2017.*	197,976	Deferred	2017		Less than 250K	Less than $250K
46371	POT - Refurbish 4160kV motors *Ongoing assessment, through condition based monitoring, indicated that the motors at POT can be safely deferred to 2018.*	186,020	Deferred	2018		Less than 250K	
43239	LIN4 BFP Proportional Recirculation Line Control *At this time the control valve on the recirculation line is operational and, for the short term is functional, allowing this project to be safely deferred to 2017*	158,524	Deferred	2017		Less than 250K	Less than $250K
47602	TRE Oil Forwarding Pump Area Fire Protection *A re-evaluation of the 5 year Fire Protection program across NS Power re-prioritized this project, indicating it can be safely deferred to 2017.*	157,172	Deferred	2017		Less than 250K	Less than $250K

CI	Project Title	2016 ACE Project Total	Cancelled/ Deferred	Deferred To	Prior Approval	Prior ACE Plan Reference	2017 ACE Plan Reference
47900	TUC1 MgOH Powder System Upgrade *Further scoping and engineering efforts completed in 2016 have indicated that the method of the MgOH delivery system needs to be reconsidered. Replacing the powder system may only require changes to the front-end additive system which could change the scope or mitigate the need for this project. Project deferred to 2018 in order to determine the best path forward.*	156,145	Deferred	2018		Less than 250K	
47688	POT - Refurbish condensate extraction pump *Condition based monitoring indicates refurbishment not required at this time. Pump will be monitored until action is required.*	154,069	Deferred	2018		Less than 250K	
47963	LIN Waster Water Stand Pipe Refurbishment *Further inspection, completed after the 2016 ACE Plan filing, indicated the condition was not deteriorated to the point originally expected and is being monitored until this project is completed in 2017.*	152,065	Deferred	2017		Less than 250K	Less than $250K
44357	LIN 3 4 Stack Cap Refurbishment *An inspection, completed by a chimney specialist in early 2016 indicated the condition of the stack cap is such that this work is not necessary at this time.*	135,801	Deferred	2018		Less than 250K	

CI	Project Title	2016 ACE Project Total	Cancelled/ Deferred	Deferred To	Prior Approval	Prior ACE Plan Reference	2017 ACE Plan Reference
47605	TRE Carbon Sulphur Analyzer Replacement *This project has been cancelled as Trenton is able to utilize the analyzer from Pt. Tupper.*	124,788	Cancelled			Less than 250K	
47166	HYD - McAskill Brook Decommissioning *First Nations, archeological and stakeholder engagement is required throughout 2016 and into 2017 to determine the best approach to completing this work.*	110,990	Deferred	2017		Less than 250K	Subsequent Submittal
47674	POT - Circulating Water Pumphouse Motor Control Center Refurbishment *Further assessment of this asset indicated it could be safely deferred to future years.*	104,836	Deferred	2018		Less than 250K	
47642	TRE6 Feeder Controls Upgrade *Further risk evaluation indicated that this project could safely be deferred to 2017. Additionally, in the event of a failure, these feeders are redundant to each other so one feeder can maintain generator output on unit 6, with a small loss of generation.*	104,734	Deferred	2017		Less than 250K	Less than $250K
43407	TRE5 Cable Rooms Fire Protection *A re-evaluation of the 5 year Fire Protection program across NS Power re-prioritized this project, indicating it can be safely deferred to 2018.*	99,011	Deferred	2018		Less than 250K	

CI	Project Title	2016 ACE Project Total	Cancelled/ Deferred	Deferred To	Prior Approval	Prior ACE Plan Reference	2017 ACE Plan Reference
47903	TUC2 Lube Oil Coolers' Inlet/Outlet Waterbox Replacement *Through further inspections / assessment, NS Power was able to defer the TUC2 planned outage from 2016 to March 2017.This project will now be completed during that outage.*	87,877	Deferred	2017		Less than 250K	Less than $250K
47708	POT - Vacuum cleaning system upgrade *Further assessment, followed by minor repairs mitigated the issue, allowing for the cancellation of this project.*	77,847	Cancelled			Less than 250K	
47710	POT - Replace selected Polisher valves and solenoid panel *Temporary repairs and the use of manual valves has allowed for this project to be safely deferred to 2018.*	57,840	Deferred	2018		Less than 250K	
47709	POT - Replace raw water flow meter *Issues with existing meter resolved at this time. Will revisit if necessary.*	57,117	Cancelled			Less than 250K	
47907	TUC6 Vacuum Pumps' Seal Water Cooler Upgrade *Weld repairs and a coating technique have been applied to this equipment that have temporarily proven an acceptable solution to the corrosion issues with these coolers. This measure is being monitored to determine if this is a temporary measure (project deferral) or a permanent solution (project cancellation).*	55,068	Deferred	2017		Less than 250K	Less than $250K

2017 Annual Capital Expenditure Plan

CI	Project Title	2016 ACE Project Total	Cancelled/ Deferred	Deferred To	Prior Approval	Prior ACE Plan Reference	2017 ACE Plan Reference
47909	TUC Nat Gas Valves Refurbishment *This project is deferred due to the TUC3 and TUC2 longer shutdowns being moved out to 2017. Insufficient time to refurbish valves during 2016 outage durations.*	54,855	Deferred	2017		Less than 250k	Less than $250k
47647	TRE5 4kV Switch Gear Room Fire Protection *This project is included in the scope of CI 43407 TRE5 Cable Rooms Fire Protection*	45,544	Cancelled			Less than 250K	
47646	TRE5 Relay Room Fire Protection *The scope of this project is included in the scope of CI 43407 TRE5 Cable Rooms Fire Protection*	44,564	Cancelled			Less than 250K	
47944	TUC4 LM6000 Higgot Kane Crack Repair *Inspection completed subsequent to the 2016 ACE Plan filing showed the Higgot Kane is not cracked as originally anticipated.*	33,063	Cancelled			Less than 250K	
Transmission							
48025	L7018 Upgrade to 345kV & Capacitor Bank Addition *Further transmission study showed that this work is currently not an economic alternative. The project will continue to be evaluated based on market conditions and may be brought forward in the future.*	21,495,059	Cancelled			Subsequent Submittal	

2017 Annual Capital Expenditure Plan

CI	Project Title	2016 ACE Project Total	Cancelled/ Deferred	Deferred To	Prior Approval	Prior ACE Plan Reference	2017 ACE Plan Reference
41519	Harbour East 138 kV Transmission Line *Further analysis on this project is needed in order to determine the most feasible and economic approach to complete this scope.*	11,672,021	Deferred	2018		Subsequent Submittal	
43678	Separate L8004/L7005 on Canso Crossing Double Circuit Tower(DCT) *This project will be executed in 2017. Engineering efforts continued throughout 2016 with construction now scheduled for 2017 to align with the completion of the Maritime Link.*	10,767,280	Deferred	2017		Subsequent Submittal	Subsequent Submittal
48024	90H - Sackville: Capacitor Bank Addition & L-6010/L6005 Breaker Upgrades *Further transmission study showed that this work is currently not an economic alternative. The project will continue to be evaluated based on market conditions and may be brought forward in the future.*	3,852,989	Cancelled			Subsequent Submittal	
48023	103H - Lakeside: Capacitor Bank Additions & L-6003 Breaker Upgrades *Further transmission study showed that this work is currently not an economic alternative. The project will continue to be evaluated based on market conditions and may be brought forward in the future.*	3,231,190	Cancelled			Subsequent Submittal	
48154	L5527 Reconductor *Inspection completed in April 2016 indicated the condition of the conductor was adequate to safely defer this project to subsequent years. NS Power will continue to monitor the condition of this conductor.*	497,606	Cancelled			Subsequent Submittal	

2017 Annual Capital Expenditure Plan

CI	Project Title	2016 ACE Project Total	Cancelled/ Deferred	Deferred To	Prior Approval	Prior ACE Plan Reference	2017 ACE Plan Reference
43268	9W-B53 Tusket Replace Supporting Structure *Further inspection indicated the condition of the structure allowed for a safe deferral to 2018.*	354,151	Deferred	2018		Subsequent Submittal	
Distribution							
47787	2H Armdale New Feeders *This project is related to the new transformer for 2H (CI 46811) which is now being completed in 2017.*	1,272,415	Deferred	2017		Subsequent Submittal	Subsequent Submittal
47792	Distribution Automation Remote Communications *Further engineering/scoping efforts required due to evolving remote communications technology.*	415,762	Deferred	2018		Subsequent Submittal	
47775	67C/58C Inverness Transfer Scheme *Further engineering/scoping efforts required due to evolving remote communications technology.*	141,564	Deferred	2018		Less than 250K	
General Plant							
48232	T&D Scheduling & Dispatch *This work order is now being completed under CI 46075 IT – Work and Asset Management.*	5,306,971	Cancelled			Subsequent Submittal	
48251	T&D Field Design *This work order is now being completed under CI 46075 IT – Work and Asset Management.*	4,022,082	Cancelled			Subsequent Submittal	

2017 Annual Capital Expenditure Plan

CI	Project Title	2016 ACE Project Total	Cancelled/ Deferred	Deferred To	Prior Approval	Prior ACE Plan Reference	2017 ACE Plan Reference
47751	Dynamic Transmission Limits *Further efforts to determine final project scope has pushed this project into 2017.*	552,560	Deferred	2017		Subsequent Submittal	Subsequent Submittal
48044	Bentley Nevada Upgrade and Integration to Fleet Monitoring *Continued work with suppliers to develop, test and assess a fleet-wide solution was required in 2016 in order to properly scope this project.*	228,862	Deferred	2017		Less than 250K	Subsequent Submittal
48117	2H Armdale RTU Replacement *This work is being completed concurrently with the 2H Armdale Transformer project (CI 46811). The transformer project is now being completed in 2017, which led to this project being deferred as well.*	130,975	Deferred	2017		Less than 250K	Less than $250K
48073	2016 NSPI GIS Upgrade *This work order is now being completed under CI 46075 IT – Work and Asset Management*	124,915	Cancelled			Less than 250K	
47671	PTMT - Cathodic Protection System Refurbishment *Engineering efforts are underway to evaluate other protection options other than sacrificial anodes, including impressed current which may offer better corrosion protection.*	90,799	Deferred	2017		Less than 250K	Less than $250K
48035	DL NERC Module *Further project scope definition is required in order to complete this work. This scope definition will be completed throughout 2017 with the project being executed in 2018*	81,889	Deferred	2018		Less than 250K	

2.0 2017 ANNUAL CAPITAL EXPENDITURE PLAN

2.1 Summary of Expenditures

The following table provides the proposed capital investment by category for NS Power's 2017 ACE Plan filing. This Application seeks UARB approval of the 2017 routine capital and other 2017 projects, which total $134.9 million of forecast spending in 2017. Certain items do not require UARB approval, but are included in NS Power's annual capital plan for transparency and stakeholders' information. The 2017 ACE Plan budget also includes spending on multi-year projects that were previously approved by the UARB (Carryover Projects).

2017 ACE Plan Spend	2017 UARB Approval Request ($M)	UARB Approval Not Required ($M)	Capital Items Forecast for Later Filing & Approval in 2016/2017 ($M)	Previously Approved Capital Projects with 2017 Carryover ($M)	2017 ACE Plan ($M)
Capital Item Approval Sought through the 2017 ACE Process (Including Routine Capital Projects*)	134.9				**134.9**
Capital Items Forecast for Later Filing in 2016/2017			109.5		**109.5**
2017 Carryover Projects				120.6	**120.6**
Capital Items Less Than $250K		21.5			**21.5**
Point Aconi Capital Spend		11.4			**11.4**
2017 ACE Plan	**$134.9**	**$33.0**	**$109.5**	**$120.6**	**$398.0**

** NS Power is seeking approval of $80.2 million of Routine spending in 2017.*

NOTE: Figures presented in the ACE Plan document reflect rounding which may cause $0.1 million in rounding differences on some line items.

2.2 2017 ACE Plan Capital Items Submitted for Approval

This table provides the list of new Capital Items for which NS Power seeks UARB approval by this Application, totaling $55 million of spend in 2017, with a total forecast spend of $73 million.

Tab #	CI#	Project Title	2017 Budget ($)	Project Total ($)
Hydro				
G01	48535	HYD Scragg Lake Dam and Spillway Refurbishment	1,861,306	1,956,298
G02	48631	HYD Gulch Spillway Refurbishment	549,231	617,034
Total New Hydro Spending			**$2,410,537**	**$2,573,332**
Steam				
Boiler				
G03	49532	TRE6 Air Heater Refurbishment	1,428,236	1,428,236
G04	49533	TRE6 Boiler Refurbishment	1,259,454	1,259,454
G05	47687	POT Boiler Chemical Recondition	794,560	974,604
G06	49419	POT Boiler Refurbishment 2017	969,292	969,292
G07	49536	TRE5 Boiler Refurbishments 2017	717,589	717,589
G08	41511	TRE6 Condenser Waterbox and Cooling Water Piping Refurbishment	700,809	700,809
G09	49433	LIN1 SH5 Boiler Tube Replacement	493,396	493,396
Generator				
G10	49057	TRE6 Excitation System Replacement	474,066	904,011
G11	49707	TUC2 High Voltage Bushing	440,082	440,082
Chemical				
G12	49537	TRE6 Analytical Panel Upgrade	438,216	438,216
G13	47893	TUC3 PE Generator Hydrogen Panel Replacement	421,182	423,798
Balance of Plant				
G14	49535	TRE6 Mills Refurbishment 2017	822,141	822,141
G15	47597	TRE6 Bottom Ash Chain Replacement	793,792	793,792
G16	49431	LIN Mill Refurbishment 2017	665,839	665,839
G17	49675	TUC2 Cooling Water Piping Refurbishment	568,673	568,673
G18	47953	LIN Railcar Positioner Upgrade	566,619	566,619
G19	49897	POT Fire System Upgrades 2017	538,437	538,437
G20	49430	LIN CW Pump Refurbishment 2017	516,270	516,270
G21	49466	PTMT Dock and Inhaul Conveyor Replacement	467,607	467,607
G22	49427	LIN Coal Plant Structural Refurbishment Phase 3	365,003	365,003
G23	49434	LIN CW Screen Refurbishment 2017	347,062	347,062
G24	49463	POT Coal Mill Overhauls 2017	328,410	328,410
G25	49429	LIN Coal Pile Run Off Pond Expansion	311,793	311,793
G26	49437	LIN Vacuum Pump Cooler Refurbishment	282,034	282,034
Total New Steam Spending			**$14,710,562**	**$15,323,167**
Total New Generation Spending			**$17,121,099**	**$17,896,499**
Transmission				
T01	49992	2017 Transmission Right of Way Widening	5,400,855	5,400,855
T02	47954	L7012 Replacements and Upgrades	2,073,902	4,428,520
T03	49838	2017/2018 Substation Polychlorinated Biphenyl (PCB) Equipment Removal Program	2,653,789	4,127,023
T04	49948	2017/2018 Isolated Structure Replacements	1,209,834	3,822,487
T05	49793	L7011 Replacements and Upgrades	1,304,384	3,343,484
T06	49789	L6515 Replacements and Upgrades	1,097,771	2,340,989

2017 Annual Capital Expenditure Plan

Tab #	CI#	Project Title	2017 Budget ($)	Project Total ($)
T07	49815	2017/2018 Steel Tower Refurbishment	929,792	2,003,317
T08	49774	L5527 Replacements and Upgrades	722,891	1,537,852
T09	49813	2017 Sacrificial Anode Installation Program	1,427,340	1,532,340
T10	49814	2017/2018 Steel Tower Life Extension	427,938	1,462,100
T11	49778	L5535 Replacements and Upgrades	1,261,920	1,261,920
T12	49790	L5505 Replacements and Upgrades	575,817	1,223,571
T13	49782	L5027B Replacements and Upgrades	1,093,542	1,093,542
T14	49818	2017/2018 Transmission Switch & Breaker Replacement	496,339	1,074,472
T15	49775	L5004 Replacements and Upgrades	995,712	995,712
T16	49776	L7008 Replacements and Upgrades	876,277	876,277
T17	43200	2017 Wood Pole Retreatment Program	841,821	841,821
T18	47915	L5053 Replacements and Upgrades	692,706	692,706
T19	47956	L7004 Replacements and Upgrades	672,131	672,131
T20	49792	2017 Transmission Line Retirement Program	526,064	526,064
T21	49821	Mersey River Hydro Spare Transformer	101,450	519,994
T22	49878	2017 Substation Insulator Replacement Program	508,893	508,893
T23	48057	Replace 69kV cables between 2S and 83S	459,931	459,931
T24	49833	2017 Oil Containment Program	397,993	432,518
T25	49798	2017/2018 Capacitor Bank Breaker Replacements	175,347	378,150
Total New Transmission Spending			**$26,924,440**	**$41,556,670**
Distribution				
D01	49919	2017 PCB Pole Top Transformer Replacement	2,257,603	2,446,051
D02	49806	2017 Padmount Replacement Program	1,573,814	1,703,774
D03	41350	16W-301 Hebron Rebuild Phase 2	445,140	904,732
D04	49836	11S-302 11S-401 Rebuild Coxheath Phase 2	340,322	807,456
D05	49841	23H-Rockingham Voltage Conversion-Phase 2	424,818	743,213
D06	49799	532N Elm Street Conversion Phase 1	548,688	548,688
D07	49918	54H-303 Underground Device Replacements Phase I	469,604	469,604
D08	47769	509V-301 Overcove Rd Replacements	402,493	402,493
D09	49791	3N Oxford Conversion Phase 3	358,369	358,369
D10	49867	55V-313-Berwick North Replacements	345,565	345,565
D11	49591	3S Feeder Exit Cable Replacement	312,334	335,842
D12	49891	509V Recloser and Voltage Regulator Replacement	319,649	319,649
D13	50073	4S-332 Bernard Lind Drive Conversion	302,893	302,893
D14	49866	512N-Toney River Replacements	285,219	285,219
Total New Distribution Spending			**$8,386,513**	**$9,973,549**
General Plant				
GP01	49861	IT - PI System Upgrade	667,366	801,253
GP02	46572	2017 RTU Replacement Program	350,914	693,354
GP03	48774	HYD Milton Shop HVAC Upgrade	553,090	564,347
GP04	50071	T&D Inspection Application Upgrade Phase I	263,602	411,191
GP05	49880	Meter Shop Test Console Replacement	208,631	410,457
GP06	49902	2017 Telecom Building Replacement - Wittenburg	294,000	294,000
Total New General Plant Spending			**$2,337,603**	**$3,174,602**
Total New Capital Spending			**$54,769,654**	**$72,601,321**
Total Routine Capital Spending			**$80,167,979**	**$80,167,979**
Total Capital Items for which Approval is Sought			**$134,937,633**	**$152,769,300**

2.3 2017 ACE Plan Capital Items Forecast for Subsequent Approval

The following table identifies 2017 projects that are not yet ready for submission to the UARB, and that NS Power anticipates will be filed for review and approval throughout 2017. NS Power estimates $109.5 million of spending in 2017 on these projects, which are currently estimated for total spending of $356 million. The budget numbers indicated below are estimates as NS Power needs additional time to refine the specific project budget proposals. This section of NS Power's filing is designed to provide an indication of these anticipated 2017 projects.

CI#	Project Title	2017 Budget ($)	Project Total ($)
Hydro			
39472	HYD Mersey Hydro System Re-Development *This project is the first phase of the re-development of the Mersey Hydro System and includes the replacement of the Big Falls PowerHouse and Lower Great Brook Dam Structure.*	300,000	84,000,000
29807	HYD - Tusket Falls Main Dam *This project includes the refurbishment of the dam and spillway to meet the requirements of the Canadian Dam Association (CDA) Dam Safety Guidelines.*	3,697,643	9,940,664
47654	HYD - Gulch Penstock & Surge Tank Replacement *This project includes the replacement of the pipeline and surge tank at the Gulch Hydro System.*	3,526,825	3,629,655
48533	HYD - Lequille Headpond Water Retaining Structures Refurbishment *This project includes the refurbishment of the headpond water retaining structures on the Lequille Hydro system in Annapolis Royal.*	1,809,228	1,919,166
48052	HYD - Annapolis HVAC Upgrade *This project includes the upgrade of the Heating, Ventilation and Cooling system in the Annapolis Hydro Generating Plant*	1,420,463	1,498,367
47648	HYD - Lequille Pipeline Replacement *This project includes the replacement of the pipeline at the Lequille Hydro Station.*	1,329,928	1,384,448
47876	HYD - Lequille Overhaul *This project includes the refurbishment of the 13 MW unit at the Lequille Hydro Station in Annapolis Royal.*	1,075,450	1,155,418
38931	HYD - Harmony Partial Decommissioning *This project includes decommissioning and returning the site to its natural state by removing the pipeline, intake hoist assembly, powerhouse and generating equipment. The dam and spillway structure will remain intact in order to maintain the safety of the site and still provide a habitat for fish in McGowen Lake headpond.*	586,469	1,106,122
49596	HYD - Hells Gate 2 Overhaul	962,316	970,827

CI#	Project Title	2017 Budget ($)	Project Total ($)
	This project includes the refurbishment of the 3.6 MW Unit #2 at the Hells Gate Hydro Station on the Black River Hydro System in Eastern Valley.		
47678	HYD - Prince Mine Dam Decommissioning *This project includes the removal of the Prince Mine Dam structure located near the Point Aconi Generating Station.*	761,647	819,451
47682	HYD - Lequille Switchgear Replacement *This project includes the replacement of the switchgear at the Lequille Hydro Station in Annapolis Royal.*	651,251	698,659
48913	HYD - Tusket Facility Refurbishment *This project includes the refurbishment of the building and structural components of the Tusket Powerhouse on the Tusket Hydro System.*	656,308	657,956
49835	HYD - Dive Site Risk Mitigation *This project includes modifications to railings and installation of land access-ways at all dive sites across the NS Power hydro facilities.*	315,851	650,533
49598	HYD - Gisborne Switchgear Replacement *This project includes the replacement of the switchgear at the Gisborne Hydro Station on the Wreck Cove Hydro System.*	593,754	623,814
47166	HYD - McAskill Brook Decommissioning *This project includes the removal of the McAskill Brook Dam structure located near the decommissioned Glace Bay Generating Station site.*	459,736	562,684
48914	HYD - Malay Falls Facility Repair *This project includes the refurbishment of the building and structural components of the Malay Falls Powerhouse on the Sheet Harbour Hydro System.*	444,589	446,237
48396	HYD - Bridge Remediation *This project includes the remediation of deteriorated access bridges across many of the Hydro River Systems.*	338,935	404,616
47660	HYD - Dickie Brook Controls Upgrade *This project includes the installation of a new control system and instrumentation on the Dickie Brook Hydro System.*	94,032	307,251
49039	HYD - Lequille Controls Upgrade *This project includes the installation of a new control system and instrumentation on the Lequille Hydro System.*	298,302	304,121
	Total New Hydro Spending for Subsequent Approval	**19,322,727**	**111,079,989**
Gas Turbine			
44776	CT - TUC#5 LM6000 Generator Stator Re-wedge *This project includes a stator re-wedge on Tuft's Cove #5 LM6000 and also includes preparatory work around sound wall disassembly, procurement of removal tooling, rotor removal, and generator inspection.*	1,041,614	1,073,280
49273	CT - BGT2 Engine Refurbishment *This project includes the refurbishment of the Burnside Unit #2 combustion turbine engine.*	908,102	1,019,832
49940	LM6000 TUC5 Control System Upgrade	1,018,769	1,018,769

CI#	Project Title	2017 Budget ($)	Project Total ($)
	This project includes the upgrade of the control system on the Tufts Cove Unit #5 LM6000.		
49594	LM6000 TUC5 - Airhouse Upgrade *This project includes the upgrade of the air house and its components on the Tufts Cove Unit #5 LM6000.*	833,200	833,200
49926	LM6000 TUC4 - Airhouse Upgrade *This project includes the upgrade of the air house and its components on the Tufts Cove Unit #4 LM6000.*	815,633	815,633
49949	LM6000 TUC4 - Control System Replacement *This project includes the upgrade of the control system on the Tufts Cove Unit #4 LM6000.*	710,815	710,815
47118	CT - Tusket Hydraulic Starter *This project includes the replacement of the existing original air start system with a hydraulic start system.*	317,015	317,015
	Total New Gas Turbine Spending for Subsequent Approval	**5,645,148**	**5,788,543**
Steam			
46499	Stator Rewind Kit Capital Spare *This project is for the procurement of a spare Stator Rewind kit that will be utilized at either the Pt. Tupper or Tufts Cove Generating Stations.*	2,668,808	5,219,939
48893	TUC3 - IP Turbine Refurbishment *This project is for the refurbishment of the intermediate pressure (IP) section of the turbine on the Tufts Cove Generating Station Unit #3.*	4,338,274	4,798,475
47531	TRE6 - Turbine Refurbishments *This project is for the refurbishment of the turbine blades and components on Trenton Unit #6 as part of the planned major outage being completed in 2017.*	1,500,000	2,322,487
49438	LIN - A Gallery Floor Replacement *This project includes the replacement of the A coal gallery floor and refurbishment of the structural steel supporting the gallery.*	593,814	593,814
49499	PHB - Boiler Refurbishment 2017 *This project includes the refurbishment of boiler components on the Port Hawkesbury Biomass Generation Station.*	484,730	484,730
49111	POT - Air Heater Refurbishment *This project includes the refurbishment and replacement of Air Heater components on the Pt. Tupper Generating Station.*	462,168	471,204
49538	TRE6 - Generator Refurbishment *This project is for the refurbishment of the generator on Trenton Unit #6 as part of the planned major outage being completed in 2017.*	411,766	411,766
47553	TRE6 - Turbine Main Valves *This project is for the refurbishment of the turbine valves on Trenton Unit #6 as part of the planned major outage being completed in 2017.*	392,887	392,887
49674	TUC2 - Boiler Selective Waterwall Tube Replacements	390,898	390,898

CI#	Project Title	2017 Budget ($)	Project Total ($)
	This project includes the replacement of tube sections on the waterwall in the Tufts Cove Unit #2 boiler.		
49060	POT - Condenser Dog Bone Expansion Joint Replacement *This project consists of the replacement of the rubber expansion joint between the LP section of the turbine and the condenser at the Point Tupper Generating Station.*	298,253	298,253
48868	AMO Fleet TWIP Upgrades *This project includes upgrades to the Turbine Water Induction Protection components across multiple generating stations.*	257,442	280,608
	Total New Steam Spending for Subsequent Approval	**11,799,041**	**15,665,061**
	Total New Generation Spending for Subsequent Approval	**$36,766,915**	**$132,533,594**
Transmission			
43678	Separate L8004/L7005 on Canso Crossing Double Circuit Tower (DCT) *This is a network upgrade project required to support the Maritime Link. This project will be executed in 2017 and approval sought as part of the next GRA or Maritime Link Tariff hearing pursuant to the Board's 2014 ACE Plan Decision.*	13,892,444	16,183,691
45053	69kV Structure Replacements West *This project includes the upgrading of multiple 69kV Transmission lines in the western part of Nova Scotia.*	321,656	4,818,017
50342	Western Transmission System Voltage Support *This project is designed to reduce voltage sag from transient faults on the transmission system in the Western part of the province.*	300,000	4,000,000
49922	Western Switching Upgrades *This project is to upgrade switches on the western transmission system to reduce customer outages. Project scope may include work on L5027, L5535 and L5532.*	353,906	353,906
49879	77V-T52 Replacement *This project seeks to address load growth on the Digby feeder by replacing the current transformer with a 5/6.66 MVA unit.*	746,631	775,082
50021	91H Tufts Cove Bus and Line Upgrades *This work is to provide bus and line upgrades at 91H Tufts Cove substation. This includes structural upgrades to the 138 and 69kV buses and possible line conversions on L-5049 and L-5012.*	417,178	417,178
49928	3S Gannon Road Bus Reconfiguration *This project is to replace aging disconnect switches on the 69 kV side of the distribution transformers and extend the bus to allow for faster response time in the event of a transformer failure.*	364,777	364,777
49929	Tap Changer Replacements	262,526	262,526

CI#	Project Title	2017 Budget ($)	Project Total ($)
	This project is the first year of a multiple year program to replace aging tap changers at substations throughout the province.		
	Total New Transmission Spending for Subsequent Approval	**16,659,116**	**27,175,176**
Distribution			
50343	Advanced Metering Infrastructure *This project includes the implementation of Advanced Metering Infrastructure to NS Power customers.*	11,352,709	111,707,380
47124	Advanced Metering Infrastructure - Pilot Project *This is the pilot project for CI 50343 Advanced Metering Infrastructure. This project is intended to evaluate AMI benefits and support NS Power's operational readiness for full deployment.*	5,756,276	8,274,738
47776	111S Prime Brook Feeder Exits & Feeders *The material and work to build four overhead feeder exits and feeders out of the new 111S Prime Brook Substation.*	456,805	1,503,986
47787	2H Armdale New Feeders *This Project will address the addition of 4 new feeders at the 2H Armdale substation to address the load growth on the peninsula, St Margaret's Bay and the Herring Cove Road Areas. The 4 new feeders will provide additional capacity to both areas and reduce load on adjacent feeders.*	1,253,299	1,285,679
47760	85S-402 Re-Insulate *This project includes replacement of approximately 750 insulators along 85S-402, from Wreck Cove to Jersey Cove, along Hwy 19.*	499,495	1,259,666
44749	Tiverton Tower Refurbishment *This project includes the design and the replacement of the steel distribution tower in Tiverton and replacement of conductor over Petit Passage.*	689,416	1,058,200
50341	2017 Substation Recloser Replacements *This project provides for the costs associated with replacing substation reclosers, controls and associated framing.*	577,388	577,388
49899	10H Halifax 4kV Conversion Year 4 *This project is the fourth phase of a multi-phase project to convert the remaining 4kV distribution plant on the peninsula of Halifax to 25kV.*	254,608	254,608
	Total New Distribution Plant Spending for Subsequent Approval	**20,839,997**	**125,921,646**
General Plant			
46075	IT –Work and Asset Management *This project will upgrade NS Power's version of Maximo to the current, vendor supported release, and integrate the Maximo system with the NS Power GIS system. This will enable a spatial view of work and assets in Maximo. It also includes work previously covered under cancelled projects CI 48232 - T&D Scheduling & Dispatch, CI 48251 - T&D Field Design, and CI 48073 - 2016 NSPI GIS Upgrade.*	8,008,495	28,027,680
43202	Replace Mobile Radio System	2,975,666	6,537,700

CI#	Project Title	2017 Budget ($)	Project Total ($)
	This project provides for the replacement of NS Power's existing province-wide Mobile Radio System. This system provides voice communications for NS Power personnel who are working in the field.		
49857	IT - Storage Infrastructure Upgrade *This project includes a refresh of the main storage system for all NS Power data as part of NS Power's technology lifecycle management. The Storage Area Network (SAN) is at end of life and must be replaced.*	945,955	5,045,955
49860	IT - SharePoint Upgrade *This project includes the upgrade to a new supported version of SharePoint.*	1,971,915	4,021,915
49093	IT - Security Operations Center (SOC) and Security Information Event Monitoring (SIEM) *This project will design, deploy and configure the required software and hardware to facilitate third party services agreement for security event monitoring.*	2,191,284	2,476,976
49787	Intelligent Feeder/Storage Project (SDTC) *This is a pilot project that will manage utility-scale and behind-the-meter residential energy storage solutions to balance variability in distribution-connected wind generation. This project will give NS Power practical experience with operation of a small grid-connected storage system. It is partially funded through a grant from Sustainable Development Technology Canada (SDTC).*	1,276,653	2,399,368
49859	IT - Windows Server 2008 Upgrade *This project will upgrade all Windows 2008 servers that will be at end of life in January 2020 as part of NS Power's technology lifecycle management. The project will start in 2017 and end in 2019 to be ahead of the end of support date.*	158,886	2,069,258
49855	IT - Window 10 Migration Project *This project will upgrade NS Power's current Windows 7 desktop computing environment to Windows 10 as part of NS Power's technology lifecycle management.*	1,804,339	2,013,034
50153	Customer Experience Self Serve Development Phase 2 *This project will continue the development of self-serve options for NS Power customers through e-form automation and payment arrangements.*	1,827,720	1,827,720
49094	IT - Identity Access Management Infrastructure *This project will assess, design, and deploy hardware and software related to controlled access and use of NS Power IT systems and applications.*	1,500,000	1,711,147
49858	IT - Microsoft Exchange Upgrade *This project will upgrade the Microsoft Exchange environment as part of NS Power's technology lifecycle management. Microsoft Exchange 2010 is the platform that manages and delivers all email to NS Power employees, schedules calendars and manages contacts.*	1,500,000	1,500,000
48773	IT - VOIP Expansion to NS Power sites *This project will deploy Voice Over Internet Protocol (VoIP) technology to NS Power locations to replace end of life PBX and Centrex technology.*	1,400,000	1,499,731
49480	IT - Disaster Recovery	1,270,691	1,483,365

CI#	Project Title	2017 Budget ($)	Project Total ($)
	This project will review, design, and deploy the necessary infrastructure to ensure disaster recovery capabilities and processes are in place for all NS Power IT systems based on their classification of criticality.		
49601	IT - Data loss Prevention *This project will deploy a Data Loss Prevention system to monitor and control the flow of sensitive information through NS Power's endpoints, networks, storage and data egress points.*	1,158,633	1,199,013
49600	IT - Network Architecture Redesign *This project will design and implement the required hardware and software to limit employee network access to systems which they have a defined business need.*	1,033,597	1,183,826
49876	Real Time Economic Dispatch *This project will optimize the real time economic dispatch of committed thermal generating units on the NS Power system by enhancing the capabilities of existing automatic generation control software.*	816,638	1,161,618
50112	Customer Experience Consolidated Customer Web Portal *This project includes developing, testing and implementing phase 1 of a consolidated web portal to give customers access to various account information in a single online tool (e.g. outage information, billing information, usage information, etc.).*	770,977	770,977
50113	Customer Experience - Streetlight Improvements *This project includes IT system enhancements required to develop a new online tool for submitting street light repair requests. Scope of work will include streetlight location data collection across the province and the technology required to display the location of the lights on a map for order entry.*	679,394	679,394
47751	Dynamic Transmission Limits *This project is for the design and implementation of dynamic transmission limits in the Ragged Lake SCADA/EMS system.*	524,616	537,466
49603	IT - Patch Management *This project will review, design and deploy the necessary infrastructure to, in conjunction with configuration management tools, manage the deployment of both critical and routine software and operating system patches.*	500,970	536,350
48238	Customer Experience Customer Billing Experience Improvements *This project will provide bill enhancements and additional supporting tools to improve the billing experience for customers.*	124,280	490,878
48044	Bentley Nevada Upgrade and Integration to Fleet Monitoring *This project is to upgrade the existing Bentley Nevada turbine monitoring and data management system across NS Power's fleet of thermal generating stations.*	383,621	401,459
48155	2016 SCADA Application Upgrade *This project includes an upgrade to NS Power's Supervisory Control And Data Acquisition (SCADA) Application.*	261,387	400,688

CI#	Project Title	2017 Budget ($)	Project Total ($)
50295	Electric Vehicle Infrastructure Deployment *This project includes the installation of up to 12 electric vehicle charging stations at locations across Nova Scotia. This project will be partially funded through Natural Resources Canada.*	300,000	400,000
50132	Joint Regulation *This project will provide the capability for the Nova Scotia Power System Operator (NSPSO) to provide regulation service for the Maritimes Area when there is economic benefit to NSPSO taking over this service from New Brunswick Power System Operator. This project will see the implementation of software systems and processes to allow NSPSO to regulate the Maritimes Area.*	236,175	387,704
49953	IT - CIS High Availability *This project includes the purchase and deployment of required infrastructure as standby/backup for the critical Customer Information System (CIS) application.*	354,578	354,578
50292	FAC - Kempt Road Depot Truck Bay *This project provides for the costs associated with site remediation and construction of a 40’ x 100’ truck bay at the Kempt Road depot in Halifax.*	340,655	340,655
50115	Customer Support System Enhancement *This project includes system enhancements required to improve key customer experience support systems. Improvements around customer request dates in CIS and linking wiring permits with PLT work orders in Maximo are two improvements currently planned.*	310,647	332,847
48837	AMO Fleet Environmental Data Management *This project includes development and integration of an Environmental Data Management System to improve consistency, eliminate duplication and increase automation with respect to environmental reporting and compliance to NS Power’s Environmental Management System (EMS).*	304,404	317,215
49856	IT - ITSM Replacement *This project will implement an IT Service Management tool (ITSM) which allows IT and internal IT customers to communicate, track, report and manage work and assets. All IT incidents and requests are tracked and reported through an ITSM tool.*	300,000	300,000
	Total New General Plant Spending for Subsequent Approval	**35,232,175**	**$70,408,516**
	Total Capital Items for Subsequent Approval	**$109,498,205**	**$356,038,931**

2.4 2017 ACE Plan Capital Items with Estimated Total Project Cost of Less Than $250,000

This table includes capital items with a total project cost of less than $250,000. In accordance with Section 35 of the Public Utilities Act, these projects do not require UARB approval but are provided for transparency and stakeholder information.

CI#	Project Title	2017 Budget ($)	Project Total ($)
Hydro			
47659	HYD - Fall River Controls Upgrade	95,201	226,054
48397	HYD - Mink Lake Dam Repair	158,959	223,783
48712	HYD - Dam Instrumentation Upgrade	195,996	219,643
47655	HYD - Paradise Controls Upgrade	87,796	207,802
49623	HYD - Grand Lake Radio Communications Upgrade	139,204	139,204
49622	HYD - Fourth Lake PLC Upgrades	116,767	116,767
49945	HYD - Malay Falls Switchgear Replacement	43,459	54,729
46253	HYD - Lequille Tailrace Gate	27,719	34,298
	Total Hydro Items Less Than $250,000	**$865,101**	**$1,222,279**
Steam			
49440	LIN 1&2 - GSCW Piping Reconditioning	247,116	247,116
49151	LIN - Grating Refurbishment	246,871	246,871
47116	LIN - PE Flyash Surge System Bypass	187,126	244,923
49912	ICP - Armour Stone Refurbishment Phase 2	242,644	242,644
47834	ICP - Ranger Motor Upgrade	242,512	242,512
49873	LIN - Seaweed Picker Upgrade	242,227	242,227
49313	ICP - Mile 8.0 Track Replacement	240,653	240,653
47960	LIN1 - Control Valve Rebuild	237,623	237,623
49452	LIN3 - Heater Level Controls Upgrade	235,135	235,135
49439	LIN - Plant Siding Replacement	233,859	233,859
49436	LIN - Reclaim Refurbishment	233,494	233,494
49672	TUC3 - Feedwater Valve Replacement	232,799	232,799
49684	TUC - 4kv/600V Breaker Replacement	232,694	232,694
49553	TRE - Asbestos Abatement 2017	226,451	226,451
49666	TUC1 - South Boiler Feedpump Refurbishment	226,025	226,025
49716	TUC - Asbestos Abatement	222,812	222,812
48776	LIN - PA Plant Lighting Upgrade	222,312	222,312
49693	TUC - HFO Piping Refurbishments	219,022	219,022
49432	LIN - PF Line Refurbishment	215,899	215,899
49519	POT - Asbestos management 2017	213,811	213,811
49420	POT - Plant siding 2017	211,116	211,116
49444	LIN1 - Misc. Valve Refurbishment	210,463	210,463
49435	LIN - Heavy Oil Line Refurbishment Phase 2	210,252	210,252
49540	TRE6 - 6C Hydrogen/Water/Water Cooler Replacement	208,260	208,260
41226	LIN - Boiler Feed Pump Proportional Valve Replacements - Unit #1	207,980	207,980
49539	TRE6 - Burner Automation System Replacement	207,072	207,072
49541	TRE6 - 6B Hydrogen/Water/Water Cooler Replacement	207,072	207,072
49542	TRE5 - Main Boiler Stop Valves Rebuild	205,883	205,883
41229	LIN - Cable Spreading Rooms Fire Protection	161,946	200,252
49545	TRE5 - DCS Server Upgrade	200,031	200,031
49428	LIN - Ash Site Capping	195,122	195,122
49546	TRE6 - FW Heater Level Control	187,434	187,434
49547	TRE5 - 5-1 BFP Refurbishment	185,294	185,294

CI#	Project Title	2017 Budget ($)	Project Total ($)
49549	TRE5 - 5-3 Mill Refurbishment	180,147	180,147
49500	PHB - Fuel System Refurbishment 2017	178,127	178,127
47642	TRE6 - Feeder Controls Upgrade	171,040	171,040
50020	LIN - CEM Replacement Phase 1	170,281	170,281
49550	TRE5 - FW Heater Level Controls	169,776	169,776
49551	TRE5 - CEMS Replacement	162,647	162,647
43239	LIN4 - BFP Proportional Recirculation Line Control	160,757	160,757
49667	TUC1 - Oil Purifier I&C Heater Replacement	160,593	160,593
49501	PHB - Selective Turbine Valve Refurbishment	160,479	160,479
49991	TUC1 – CEMS Replacement	159,167	159,167
49554	TRE - Ash Site Management 2017	157,989	157,989
47602	TRE - Oil Forwarding Pump Area Fire Protection	157,695	157,695
49677	TUC2 - Replace Bailey Control Valves	156,173	156,173
47963	LIN - Waster Water Stand Pipe Refurbishment	152,791	152,791
49676	TUC2 – CEMS Replacement	150,374	150,374
49913	ICP - Railway Tie Upgrade Program	149,894	149,894
49680	TUC - Heavy/Light Oil Pump Area Fire Protection	143,448	143,448
49467	POT - SSC refurbishment	142,988	142,988
45832	TUC6 - Boiler Purge Credit	138,577	138,864
49704	TUC3 - Replace Coils	137,236	137,236
49455	LIN1 - Bus Duct IR Window and Temperature Sensor Installation	135,782	135,782
49697	TUC2 - Replace Oil Purifier I&C Heater	135,621	135,621
49654	TUC - Refurbishment Gas Compressor 6A/6B	133,870	133,870
49711	TUC - Low Load Oil Operation, Flue Gas monitoring	130,429	130,429
49678	TUC2 - Replace Secondary Air Damper Drives	130,404	130,404
49543	TRE6 - Conveyor Refurbishments	130,163	130,163
49556	TRE - Excavator GPS System	129,416	129,416
46485	TUC1 - Gas Block Valves	98,418	127,619
49708	TUC2 - HEP/FAC Refurbishments	125,409	125,409
49512	POT - PLC Migration - Coal system	125,038	125,038
49449	LIN - GSCW Line Replacement	121,615	121,615
49443	LIN - Coal System Guard Upgrade Phase 3	120,131	120,131
49709	TUC2 - Replace Coils	116,612	116,612
49456	LIN1 - Electric Motor Refurbishment	113,171	113,171
49457	LIN3 - Electric Motor Refurbishment	111,829	111,829
49458	LIN4 - Electric Motor Refurbishment	111,829	111,829
49921	TRE6 - 6-4, 6-5, 6-6 Feedwater Heater Refurbishments	110,358	110,358
49516	PTMT - Fire System Refurbishment	109,189	109,189
50012	ICP #2 Gate/Chute Refurbishment	108,186	108,186
49459	LIN3&4 - HMI TSC Upgrades	106,912	106,912
49689	TUC3 - HP Heater Level Controls Replacement	106,055	106,055
49682	TUC2 - HP Heater Level Controls Replacement	105,984	105,984
49670	TUC1 - 4kv/600V Breaker Replacement	104,851	104,851
49442	LIN - Facilities Upgrade	104,630	104,630
49453	LIN - Stores Fire Protection Upgrade	104,232	104,232
49464	POT - E Coal Conveyor Refurbishment	103,388	103,388
49915	ICP - Railcenter Security System Upgrade	101,139	101,139

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CI#	Project Title	2017 Budget ($)	Project Total ($)
49715	TUC - Upgrade PLC Control Panel	99,875	99,875
49279	POT - Bay Door Replacements 2017	98,378	98,378
49510	POT - Refurbish Travelling Screens and Replace Panels	98,297	98,297
49445	LIN - Feeder Controls Upgrades	93,733	93,733
50011	ICP - Ranger Conveyor Structural Refurbishment Phase 2	92,330	92,330
49511	POT - Replace ID Fan Damper Drives	92,186	92,186
49695	TUC - Paint Roofs of HFO Storage Tank 2&4	81,390	81,390
49686	TUC3 - Boiler Modulation Control Upgrade	80,024	80,024
49514	POT - LP Heaters Level Controls	79,992	79,992
49681	TUC2 - Boiler Modulation Control Upgrades	79,641	79,641
49544	TRE5 - Conveyor Refurbishments	78,098	78,098
49557	TRE6 - Coal Feeder Gauge Replacements	78,098	78,098
44587	POT - Selective Ash Site Capping	76,971	76,971
49663	TUC - Nitrogen Generator Replacement	74,658	74,658
49454	LIN3 - Generator Bus Duct Temperature Sensors	73,153	73,153
43033	POT - Breaker Replacements and Refurbishments	67,757	67,757
49517	PTMT - Replace Dock Transformer	65,784	65,784
49502	PHB - Fire Suppression Expansion	65,599	65,599
49687	TUC3 - Bus Duct/Gen Terminal Monitoring System	64,674	64,674
49699	TUC6 - Access Doors Replacement	64,304	64,304
49558	TRE6 - Bus Bar Repairs/IR Windows	62,478	62,478
49917	ICP - Coal Load Out Hydraulics Upgrades	60,541	60,541
49671	TUC1 - Rotating Element Extraction Pump Refurbishment	60,000	60,000
49515	POT - Replacement of Graver Valves and Solenoids	59,496	59,496
49683	TUC2 - Bus Bar Inspection/Repair IR Windows	57,644	57,644
49688	TUC3 - Analytical Panel Upgrades	55,050	55,050
49700	TUC6 - Vacuum Cooler Replacement	54,610	54,610
47903	TUC2 - Lube Oil Coolers' Inlet/Outlet Waterbox Replacement	54,494	54,494
47909	TUC - Nat Gas Valves Refurbishment	54,153	54,153
49705	TUC3 - Bus Bar IR Windows	52,995	52,995
49653	TUC - Dehumidifier Air Unit Purchase	51,073	51,073
49701	TUC6 - Turbine Control Valves Refurbishment	50,584	50,584
49662	TUC - Aquarian Migration Replacement	48,757	48,757
49673	TUC1 - Extraction Pump Rotork Valve Actuator Replacement	48,479	48,479
47870	LIN - Cofferdam Outer Cell Refurbishment	44,692	44,692
47907	TUC6 - Vacuum Pumps' Seal Water Cooler Upgrade	40,501	40,501
	Total Steam Items Less Than $250,000	**$15,954,341**	**$16,079,932**
Gas Turbine			
49972	CT - LM6000 191-253 HPC Stages 3-5 Bushing Replacement	238,547	238,547
49971	CT - LM6000 191-332 HPC Stages 3-5 Bushings Replacement	237,952	237,952
49874	CT-BGT Replace Halon Fire Protection	226,366	226,366

CI#	Project Title	2017 Budget ($)	Project Total ($)
49950	LM6000 TUC4 - SPRINT Nozzle Refurbishment	166,061	166,061
49951	LM6000 TUC5 - SPRINT Nozzle Refurbishment	166,061	166,061
49973	CT - TUS Control Room Halon Replacement	84,304	84,304
49936	CT - VJ2 Enclosure Coating Refurbishment	57,550	57,550
49935	CT - VJ1 Enclosure Coating Refurbishment	55,933	55,933
49937	CT - BGT1 Exterior Coating Refurbishment	52,117	52,117
49938	CT - BGT2 Exterior Coating Refurbishment	52,117	52,117
49939	CT - BGT3 Exterior Coating Refurbishment	52,117	52,117
49976	CT - BGT4 Exterior Coating Refurbishment	52,117	52,117
49974	CT - TUC4 LM6000 Metal Scan Upgrade	44,304	44,304
49975	CT - TUC5 LM6000 Metal Scan Upgrade	44,304	44,304
49960	CT - VJ Exhaust Stack Grating Replacement	41,500	41,500
49932	CT - TUC4 LM6000 Roof Skid Access	33,161	33,161
49933	CT - TUC5 LM6000 Roof Skid Access	33,161	33,161
49959	CT - VJ Varec Gauges Upgrade/Refurbishment	29,904	29,904
49961	CT - TUS Exhaust Stack Grating Replacement	25,205	25,205
	Total Gas Turbine Items Less Than $250,000	**$1,692,780**	**$1,692,780**
	Total Generation Items Less Than $250,000	**$18,512,222**	**$18,994,991**
Transmission			
49795	100C Cape Porcupine Switch Additions	128,441	128,441
	Total Transmission Items Less Than $250,000	**$128,441**	**$128,441**
Distribution			
49868	2017 Hydraulic Recloser Replacements	232,348	248,578
49862	50N-410 Trenton Rebuild	247,773	247,773
49877	23H-302 Clayton Park Rebuild Phase 2	215,859	215,859
49957	93V New Feeder	165,912	165,912
49056	65V-302HAA Old Liverpool Road Rebuild	127,408	154,653
46305	103W-311G Gold River Reconductor - Phase 3	118,563	118,563
47777	70W-321 Wiles Lake Road	99,876	99,942
49863	73W-411H New Germany Recloser	53,820	53,820
49956	505V Station Retirement	33,049	33,049
	Total Distribution Items Less Than $250,000	**$1,294,608**	**$1,338,150**
General Plant			
48046	Enhanced Fleet Monitoring Instrumentation	176,269	240,744
49602	IT - Internal Vulnerability Assessment	203,251	238,543
49825	Radio Site Grounding Review & Upgrade	228,414	228,414
46309	2015 Multiplexer & Teleprotection Equipment Replacement	161,021	161,021
48117	2H Armdale RTU Replacement	133,595	133,595
49615	AMO Competency Based Training & Procedure Management Phase 2	79,617	128,526
47671	PTMT - Cathodic Protection System Refurbishment	101,393	101,393
50016	AMO Meridium Dashboard Phase 2	101,312	101,312

CI#	Project Title	2017 Budget ($)	Project Total ($)
49651	TUC - Office Block Facility Upgrade	83,716	83,716
49958	CT - BGT Road Repairs	82,161	82,161
48039	Meridium 4.0	76,328	76,328
49832	Victoria Junction Substations Fiber Links	65,972	65,972
49617	AMO Handheld Module Additions	59,803	59,803
49460	AMO DirectLine Permit Module Additions	43,411	59,517
	Total General Plant Items Less Than $250,000	**$1,596,265**	**$1,761,046**
	Total Capital Items Less Than $250,000	**$21,531,537**	**$22,222,628**

2.5 2017 ACE Plan Capital Items – Point Aconi Generating Station

This table provides the Point Aconi capital projects for 2017. These projects do not require UARB Approval but are provided for transparency and stakeholder information.

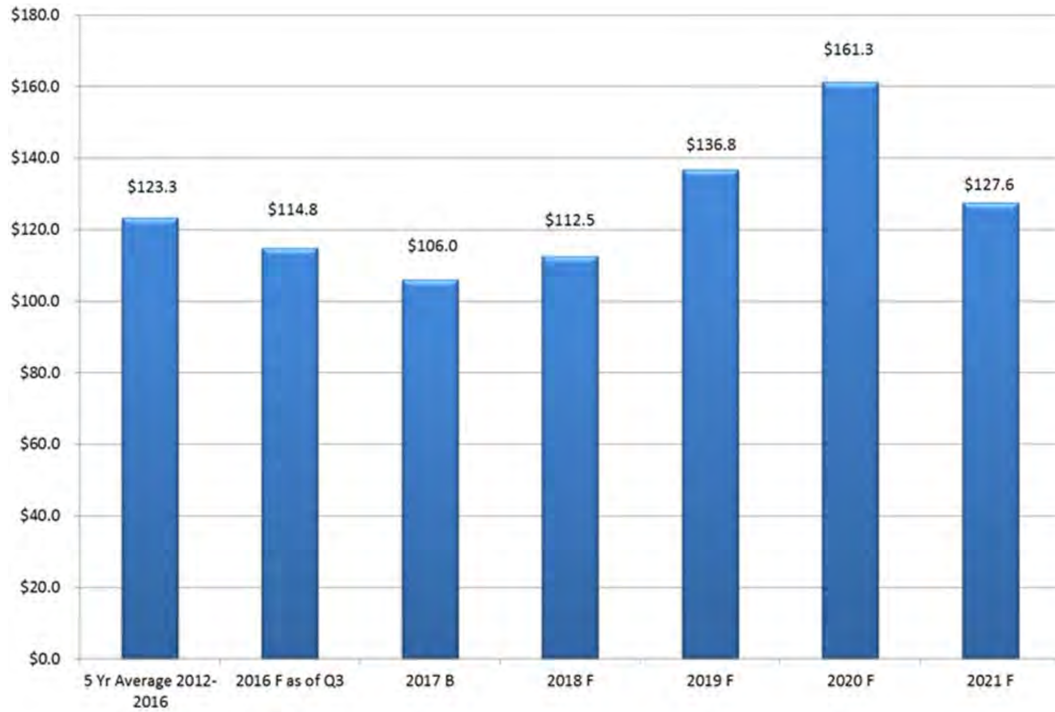
CI#	Project Title	2017 Budget ($)	Project Total ($)
49477	POA ID Fan Motor Replacement	902,961	902,961
49473	POA Boiler Refurbishment	857,179	857,179
49469	POA Boiler Refractory Replacement	727,515	727,515
49475	POA Air Heater Tube Replacement Phase 2	584,171	584,171
49476	POA SH3 Tube Replacement Phase 3	513,967	513,967
47859	POA CEM Replacement	375,062	375,062
49482	POA Coal System Refurbishment	279,400	279,400
49494	POA CW 4160V Cable Replacement	263,426	263,426
49478	POA Pedestrian Bridge Replacement	253,729	253,729
49490	POA SA Compressor Controls Upgrade	241,187	241,187
49483	POA Ash System Refurbishment	240,180	240,180
49470	POA Boiler Arrowhead Replacement	207,515	207,515
49487	POA Turbine Valve Refurbishment	202,062	202,062
49468	POA Boilerhouse Window Upgrade Phase 1	199,397	199,397
49493	POA Reheat Bypass Actuator Upgrade	198,749	198,749
50142	POA Frontwall Pipe Replacement	189,061	189,061
49496	POA Lime Stone Fan Replacement	160,124	160,124
49471	POA Expansion Joint Replacement	147,883	147,883
49486	POA Cable Spreading Room Fire Stop	145,788	145,788
50143	POA BA Center Drain Valve Replacement	134,194	134,194
49472	POA Valve Component Replacement	126,391	126,391
50131	POA Coal Cracker Refurbishment	111,286	111,286
49481	POA Plant Access Replacement	105,315	105,315
49474	POA Coal System Guard Upgrade Phase 3	91,943	91,943
49484	POA Diesel Generator Controls Upgrade	82,646	82,646
49491	POA ISO Phase Buss Temperature Monitor	72,009	72,009

49495	POA 4160v Motor Refurbishment	67,125	67,125
49492	POA 4KV 600V Breaker Refurbishment	63,924	63,924
	Total Point Aconi New Spending	**$7,544,189**	**$7,544,189**
	Point Aconi Carryover Spending	**$3,397,144**	**$6,053,297**
	Point Aconi Routine Spending		
25647	POA DCMS Equipment Replacement	35,000	35,000
21485	POA - Kelly Rock Limestone Quarry	21,291	21,291
21484	POA Plant Tools & Equipment	52,530	52,530
10718	POA - Routine Equipment Replacement	225,568	225,568
27858	POA Roofing Routine	110,759	110,759
33865	POA Heat Rate Routine	44,725	44,725
	Point Aconi Routine Spending	**$489,873**	**$489,873**
	Total Point Aconi Capital Spending	**$11,431,206**	**$14,087,359**

3.0 GENERATION

Generation includes all items for NS Power's generation facilities. This includes replacements and additions to Thermal, Hydro, Wind, Tidal, Combustion Turbine and Biomass plants.

(Millions of Dollars)



F = Forecast, B=Budget in above figure

3.1 Generation – Highlights

The focus for Generation capital investments in 2017 is investment in hydro infrastructure renewal and sustaining the current thermal asset base. The $106 million Generation capital investment plan for 2017 is as follows:

i	New 2017 capital spending for projects with total estimated project spend greater than $250,000 and for which approval is sought. (As provided in Section 2.2)	$17.1
ii	2017 capital spending for projects with total estimated project spend greater than $250,000 for which approval will be sought subsequent to the filing of the 2017 ACE Plan. (As provided in Section 2.3)	36.8
iii	New capital spending for projects with total estimated spend less than $250,000 for which approval is not sought. (As provided in Section 2.4)	18.5
iv	Point Aconi Generating Station Capital Spending. (As provided in Section 2.5)	11.3
v	Carry-over capital spending. (As provided in Section 3.2)	18.2
vi	Routine capital Spending. (As provided in Section 7)	4.1
	Total 2017 Generation Capital Investment Plan	$106.0 M
	Request for ACE Approval (Items i and vi)	$21.2 M

*Totals may be off slightly due to rounding. Figures are noted in $millions.

3.2 Generation – Carry-over Capital Spending Summary

Project Number	CI#	Project Title	Start Date	Final Date	Previous Expenditure ($)	2017 Budget ($)	Subsequent Spending ($)	Total Estimate ($)
Hydro Generation Plant								
H517	16374	HYD - Gaspereau Dam Safety Remedial Works	2007/05	2018/01	7,736,563	6,280,504	12,150	14,029,217
H715	44978	HYD - Wreck Cove Controls Upgrade	2014/01	2018/06	1,945,778	2,284,545	-	4,230,324
H629	12079	HYD - SHH - RUF 1&2 Runner Replacement	2011/10	2017/12	1,011,884	447,079	-	1,458,963
H739	47551	HYD - SHH Controls Upgrade	2015/07	2017/12	90,419	1,309,702	-	1,400,121
H685	43128	HYD - Gisborne Gearbox and Bearing Replacement	2015/08	2017/12	561,718	118,358	-	680,076
H729	47163	HYD - Tusket Controls Upgrade	2015/03	2017/12	94,770	550,989	-	645,759
					$11,441,132	**$10,991,178**	**$12,150**	**$22,444,460**
Steam Generation Plant								
SB90	44267	TRE - Ash Lagoon Site Closure	2013/05	2017/11	6,381,196	2,759,566	-	9,140,761
	47761	LIN1 - Boiler Refurbishment	2017/04	2017/11	-	398,673	-	398,673
SF22	46434	TRE6 - Coal Pile Reclaim Markers	2015/12	2017/11	140,524	92,888	-	233,412
SG65	47593	TRE - Dechlorination System	2016/04	2019/12	12,424	25,179	188,451	226,054
SF73	47703	POT - Replace DCS servers	2016/01	2017/12	161,814	37,337	-	199,151
SF67	43386	POT - LP dosing automation	2016/01	2017/12	19,047	11,407	-	30,454
	Total Steam Generation Plant				**$6,715,004**	**$3,325,051**	**$188,451**	**$10,228,506**
Gas Turbine Generation Plant								
G180	33142	CT- Burnside #4 Unit Restoration	2014/03	2018/02	4,515,069	3,784,820	-	8,299,889
G181	46191	Tusket Fuel System Upgrade	2014/06	2017/08	864,290	69,934	-	934,223
	Total Gas Turbine Generation Plant				**$5,379,359**	**$3,854,754**	**$0**	**$9,234,113**
Total Generation Carry Over Spending					**$23,535,495**	**$18,170,982**	**$200,601**	**$41,907,078**

3.3 Generation – New 2017 Capital Items for ACE Plan Approval

Tab #	CI#	Project Title	2017 Budget ($)	Project Total ($)
	Hydro Generation Plant			
G01	48535	HYD - Scragg Lake Dam and Spillway Refurbishment	1,861,306	1,956,298
G02	48631	HYD - Gulch Spillway Refurbishment	549,231	617,034
		Total Hydro Generation Plant	**$2,410,537**	**$2,573,332**
	Steam Generation Plant			
Boiler				
G03	49532	TRE6 - Air Heater Refurbishment	1,428,236	1,428,236
G04	49533	TRE6 - Boiler Refurbishment	1,259,454	1,259,454
G05	47687	POT - Boiler Chemical Recondition	794,560	974,604
G06	49419	POT - Boiler Refurbishment 2017	969,292	969,292
G07	49536	TRE5 - Boiler Refurbishments 2017	717,589	717,589
G08	41511	TRE6 - Condenser Waterbox and Cooling Water Piping Refurbishment	700,809	700,809
G09	49433	LIN1 - SH5 Boiler Tube Replacement	493,396	493,396
Generator				

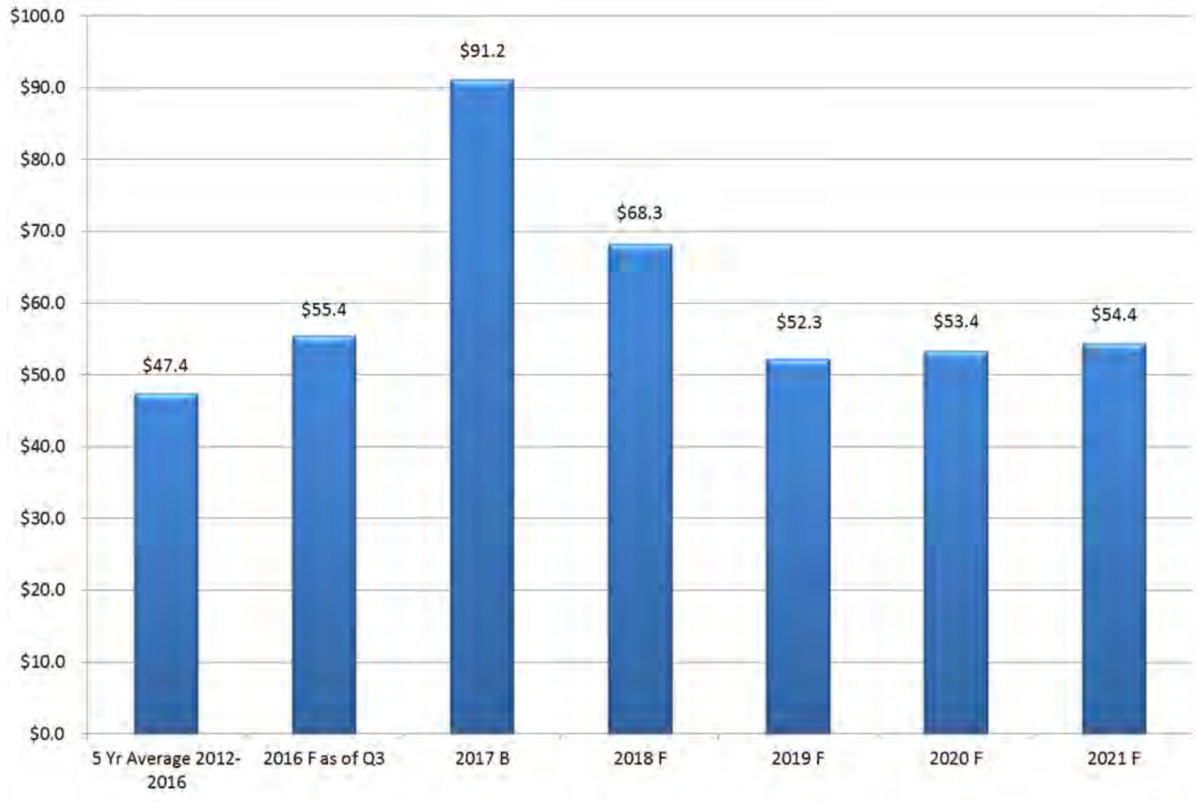
2017 Annual Capital Expenditure Plan

Tab #	CI#	Project Title	2017 Budget ($)	Project Total ($)
G10	49057	TRE6 - Excitation System Replacement	474,066	904,011
G11	49707	TUC2 - High Voltage Bushing	440,082	440,082
Chemical				
G12	49537	TRE6 - Analytical Panel Upgrade	438,216	438,216
G13	47893	TUC3 - PE Generator Hydrogen Panel Replacement	421,182	423,798
Balance of Plant				
G14	49535	TRE6 - Mills Refurbishment 2017	822,141	822,141
G15	47597	TRE6 - Bottom Ash Chain Replacement	793,792	793,792
G16	49431	LIN - Mill Refurbishment 2017	665,839	665,839
G17	49675	TUC2 - Cooling Water Piping Refurbishment	568,673	568,673
G18	47953	LIN - Railcar Positioner Upgrade	566,619	566,619
G19	49897	POT - Fire System Upgrades 2017	538,437	538,437
G20	49430	LIN - CW Pump Refurbishment 2017	516,270	516,270
G21	49466	PTMT - Dock and Inhaul Conveyor Replacement	467,607	467,607
G22	49427	LIN - Coal Plant Structural Refurbishment Phase 3	365,003	365,003
G23	49434	LIN - CW Screen Refurbishment 2017	347,062	347,062
G24	49463	POT - Coal Mill Overhauls 2017	328,410	328,410
G25	49429	LIN - Coal Pile Run Off Pond Expansion	311,793	311,793
G26	49437	LIN - Vacuum Pump Cooler Refurbishment	282,034	282,034
		Total Steam Generation Plant	**$14,710,562**	**$15,323,167**
	Total Generation New Spending		**$17,121,099**	**$17,896,499**

4.0 TRANSMISSION

Transmission includes items for replacement, reinforcement or expansion of the transmission system, which transmits electrical energy from the generation plants and throughout the province. Transmission includes assets and equipment operating at 69 kV level or higher. The increased investment in 2017 includes $24.7 million in Maritime Link Transmission and $5.8 million in Metro Transmission Upgrades.

(Millions of Dollars)



F = Forecast, B=Budget in above figure

4.1 Transmission – Highlights

The focus for Transmission capital investments in 2017 is on system reliability, as well as transmission required to integrate the Maritime Link. The $91.2 million Transmission capital investment plan for 2017 is as follows:

i	New 2017 capital spending for projects with total estimated project spend greater than $250,000 and for which approval is sought. (As provided in Section 2.2)	$26.9
ii	2017 capital spending for projects with total estimated project spend greater than $250,000 for which approval will be sought subsequent to the filing of the 2017 ACE Plan. (As provided in Section 2.3)	16.7
iii	New capital spending for projects with total estimated spend less than $250,000 for which approval is not sought. (As provided in Section 2.4)	0.1
iv	Carry-over capital spending. (As provided in Section 4.2)	37.1
v	Routine capital Spending. (As provided in Section 7)	10.4
vi	Total 2017 Transmission Capital Investment Plan	$91.2 M
	Request for ACE Approval (Items i and v)	$37.3 M

*Totals may be off slightly due to rounding. Figures are noted in $millions.

4.2 Transmission – Carry-over Capital Spending Summary

Project Number	CI#	Project Title	Start Date	Final Date	Previous Expenditure	2017 Budget	Subsequent Spending	Total Estimate
Transmission Plant								
T782	43324	L6513 Rebuild / Upgrade Line Terminals	2013/01	2018/06	2,478,851	10,472,566	4,983,508	17,934,924
T828	46591	88S Lingan Replace 230kV GIS	2014/11	2018/12	567,303	4,835,511	7,102,611	12,505,425
T825	46339	120H Brushy Hill - SVC Controls Replacement	2014/11	2017/06	6,949,629	3,268,919	-	10,218,548
T888	48022	Spider Lake Substation Addition	2015/09	2017/12	298,810	5,849,143	-	6,147,953
T822	45306	Prime Brook Substation Addition	2014/12	2017/10	2,414,322	973,184	-	3,387,506
T856	46587	Metro Voltage Support Add Capacitor	2014/11	2017/10	2,072,652	1,204,111	-	3,276,763
T867	46757	88S Lingan 230kV BPS Upgrades	2015/09	2018/12	287,487	1,561,855	1,231,321	3,080,663
T801	45067	67N Onslow 345 KV Node Swap	2014/03	2017/12	2,775,336	181,185	-	2,956,521
T802	45066	Upgrade L6511 and L7019 Thermal Rating	2014/02	2017/12	2,527,099	153,847	-	2,680,946
T872	46811	2H Armdale Transformer Addition	2015/12	2017/09	287,468	2,303,896	-	2,591,364
T884	48061	New Mobile Substation 7.5MVA	2015/12	2018/12	16,561	520,609	1,899,622	2,436,792
T881	47950	L5017 Replacements & Upgrades	2015/12	2017/09	1,305,526	873,013	-	2,178,539
T871	44981	2C Port Hastings Transformer Replacement	2015/10	2018/03	217,987	1,695,987	-	1,913,974
T893	48114	2016 Steel Tower Life Extension - HRM	2015/12	2017/08	894,195	591,115	-	1,485,310
T874	47914	L6537 Replacements and Upgrades	2015/12	2017/05	636,124	553,521	-	1,189,645
T910	49253	U&U 20V-T1 Transformer Replacement	2016/04	2018/04	457,127	697,343	-	1,154,470
T876	47949	L5028 Replacements and Upgrades	2015/12	2017/10	540,310	473,039	-	1,013,349
T835	43267	13V Gulch Hydro Replace 13V-GT1 and 13V-VR1	2014/12	2017/12	422,881	414,950	-	837,830
T878	48062	2016/2017 Reactor Breaker Replacements	2015/11	2018/06	285,506	190,330	-	475,836
T879	48063	2016/2017 Capacitor Bank Breaker Replacements	2015/11	2017/10	98,358	203,101	-	301,459
T854	46366	65V Middleton Substation RTU Addition	2016/01	2017/12	172,715	79,860	-	252,574
		Total Transmission Plant			**$25,706,247**	**$37,097,083**	**$15,217,061**	**$78,020,391**
Total Transmission Carry Over Spending					**$25,706,247**	**$37,097,083**	**$15,217,061**	**$78,020,391**

4.3 Transmission – New 2017 Capital items for ACE Plan Approval

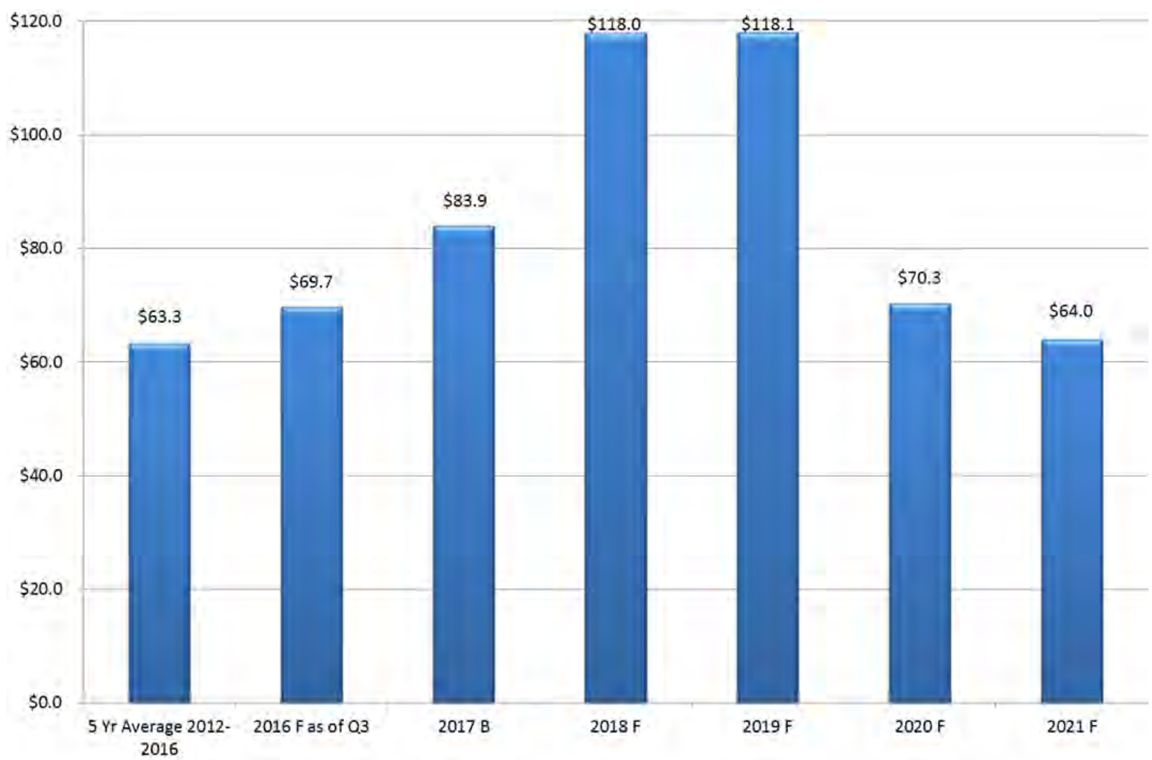
Tab #	CI#	Project Title	2017 Budget	Project Total
	Transmission Plant			
T01	49992	2017 Transmission Right of Way Widening	5,400,855	5,400,855
T02	47954	L7012 Replacements and Upgrades	2,073,902	4,428,520
T03	49838	2017/2018 Substation Polychlorinated Biphenyl (PCB) Equipment Removal Program	2,653,789	4,127,023
T04	49948	2017/2018 Isolated Structure Replacements	1,209,834	3,822,487
T05	49793	L7011 Replacements and Upgrades	1,304,384	3,343,484
T06	49789	L6515 Replacements and Upgrades	1,097,771	2,340,989
T07	49815	2017/2018 Steel Tower Refurbishment	929,792	2,003,317
T08	49774	L5527 Replacements and Upgrades	722,891	1,537,852
T09	49813	2017 Sacrificial Anode Installation Program	1,427,340	1,532,340
T10	49814	2017/2018 Steel Tower Life Extension	427,938	1,462,100
T11	49778	L5535 Replacements and Upgrades	1,261,920	1,261,920
T12	49790	L5505 Replacements and Upgrades	575,817	1,223,571
T13	49782	L5027B Replacements and Upgrades	1,093,542	1,093,542
T14	49818	2017/2018 Transmission Switch & Breaker Replacement	496,339	1,074,472
T15	49775	L5004 Replacements and Upgrades	995,712	995,712

T16	49776	L7008 Replacements and Upgrades	876,277	876,277
T17	43200	2017 Wood Pole Retreatment Program	841,821	841,821
T18	47915	L5053 Replacements and Upgrades	692,706	692,706
T19	47956	L7004 Replacements and Upgrades	672,131	672,131
T20	49792	2017 Transmission Line Retirement Program	526,064	526,064
T21	49821	Mersey River Hydro Spare Transformer	101,450	519,994
T22	49878	2017 Substation Insulator Replacement Program	508,893	508,893
T23	48057	Replace 69kV cables between 2S and 83S	459,931	459,931
T24	49833	2017 Oil Containment Program	397,993	432,518
T25	49798	2017/2018 Capacitor Bank Breaker Replacements	175,347	378,150
		Total Transmission Plant	**$26,924,440**	**$41,556,670**
		Total Transmission New Spending	**$26,924,440**	**$41,556,670**

5.0 DISTRIBUTION

Distribution includes replacement of and additions to equipment for delivering electric energy from points on the transmission system to customers served at voltages below 69 kV. The increased investment levels in 2017-2019 are primarily due to investment related to the potential implementation of Advanced Metering Infrastructure.

(Millions of Dollars)



F = Forecast, B=Budget in above figure

5.1 Distribution – Highlights

The focus for Distribution capital investments in 2017 continues to reflect localized customer load growth and customer reliability. The $83.9 million Distribution capital investment plan for 2017 is comprised of the following:

i	New 2017 capital spending for projects with total estimated project spend greater than $250,000 and for which approval is sought. (As provided in Section 2.2)	$8.4
ii	2017 capital spending for projects with total estimated project spend greater than $250,000 for which approval will be sought subsequent to the filing of the 2017 ACE Plan. (As provided in Section 2.3)	20.8
iii	New capital spending for projects with total estimated spend less than $250,000 for which approval is not sought. (As provided in Section 2.4)	1.3
iv	Carry-over capital spending. (As provided in Section 5.2)	6.4
v	Routine capital Spending. (As provided in Section 7)	47.0
	Total 2017 Distribution Capital Investment Plan	$83.9 M
	Request for ACE Approval (Items i and v)	$55.4 M

*Totals may be off slightly due to rounding. Figures are noted in $millions.

5.2 Distribution – Carry-over Capital Spending Summary

Project Number	CI#	Project Title	Start Date	Final Date	Previous Expenditure	2017 Budget	Subsequent Spending	Total Estimate
Distribution Plant								
D454	40320	LED Street Light Conversion	2012/07	2019/09	20,526,470	2,481,049	12,902,363	35,909,883
	49611	New Distribution Rights-of-Way Phase 1	2016/09	2017/12	569,427	1,641,722	-	2,211,149
D686	48093	2016 Padmount Transformer Replacement Program	2015/12	2017/09	1,378,330	425,591	-	1,803,921
D688	47753	24C-442GB Highway 16 Reconductor Phase 2	2015/11	2017/08	1,379,296	83,353	-	1,462,649
D573	43217	24C-442G Hwy 16 Rebuild Phase 1	2014/03	2017/06	830,189	72,259	-	902,447
D562	44826	2014 Build-to-Roadside	2014/03	2017/12	718,985	152,425	-	871,410
D630	45031	3N Oxford Conversion Phase 1	2015/03	2017/06	839,329	30,593	-	869,922
D758	49311	93V-312 Lower Saulnierville Conductor Overload P&A	2016/08	2017/12	116,451	463,733	-	580,184
D704	47765	58C-405 / 11C Belle Cote Phase 2	2015/12	2017/06	250,815	253,027	-	503,843
D760	47403	Load Research Sample Update	2016/01	2017/12	390,852	81,190	-	472,042
	47734	1C-411 Highway 4 Reconductor	2016/12	2018/06	5,585	200,751	228,610	434,946
D762	48195	Halifax 4kV Conversion Phase 3	2016/06	2017/05	204,129	184,822	-	388,951
D517	43278	Halifax 4kV Conversion Part 1	2013/05	2017/12	274,273	76,760	-	351,033
D476	43195	2013 Remote Communication on Reclosers	2013/03	2017/12	145,781	98,558	-	244,339
D666	46623	Rights for Existing Facilities on Railway Lands	2015/06	2017/10	6,719	180,739	-	187,458
D766	47774	546C-311 West Bay Upgrade	2016/06	2017/07	109,022	10,816	-	119,838
	Total Distribution Plant				**$27,745,653**	**$6,437,388**	**$13,130,973**	**$47,314,014**
Total Distribution Carry Over Spending					**$27,745,653**	**$6,437,388**	**$13,130,973**	**$47,314,014**

5.3 Distribution – New 2017 Capital Items for ACE Plan Approval

Tab #	CI#	Project Title	2017 Budget	Project Total
	Distribution Plant			
D01	49919	2017 PCB Pole Top Transformer Replacement	2,257,603	2,446,051
D02	49806	2017 Padmount Replacement Program	1,573,814	1,703,774
D03	41350	16W-301 Hebron Rebuild Phase 2	445,140	904,732
D04	49836	11S-302 11S-401 Rebuild Coxheath Phase 2	340,322	807,456
D05	49841	23H Rockingham Voltage Conversion Phase 2	424,818	743,213
D06	49799	532N Elm Street Conversion Phase 1	548,688	548,688
D07	49918	54H-303 Underground Device Replacements Phase I	469,604	469,604
D08	47769	509V-301 Overcove Road Replacements	402,493	402,493
D09	49791	3N Oxford Conversion Phase 3	358,369	358,369
D10	49867	55V-313 Berwick North Replacements	345,565	345,565
D11	49591	3S Feeder Exit Cable Replacement	312,334	335,842
D12	49891	509V Recloser and Voltage Regulator Replacement	319,649	319,649

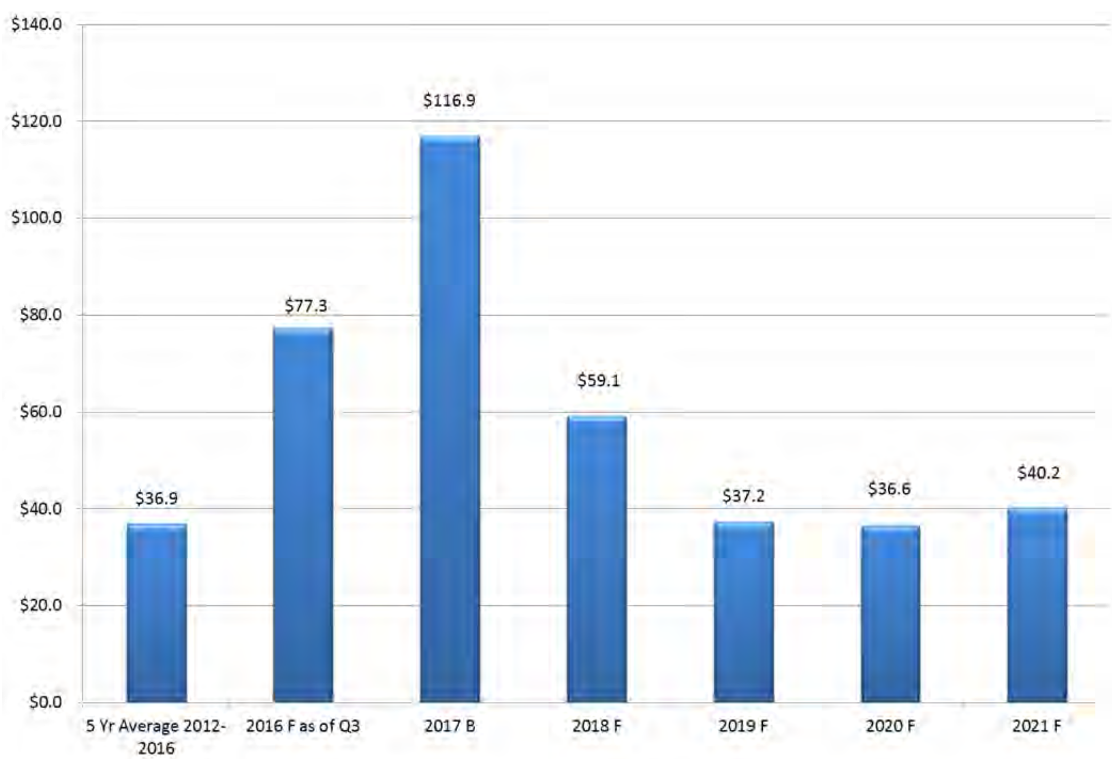
D13	50073	4S-332 Bernard Lind Drive Rebuild	302,893	302,893
D14	49866	512N Toney River Replacements	285,219	285,219
		Total Distribution Plant	**$8,386,513**	**$9,973,549**
	Total Distribution New Spending		**$8,386,513**	**$9,973,549**

6.0 GENERAL PLANT

General Plant includes computer infrastructure and communication equipment, which comprise the majority of capital expenditures incurred under this function. Other items such as furniture, office equipment, capital tools, vehicles, and construction equipment are also included under this function.

The General Plant function also includes all buildings except generating and substation facilities. It primarily pertains to customer service, work depot and head office facilities. The increased investment in 2016-2018 is largely driven by investment in IT applications, such as ERP, cyber security, and infrastructure.[9]

(Millions of Dollars)



F = Forecast, B=Budget in above figure

[9] A separate capital application for CI 44671 – ERP was submitted to the UARB on November 10, 2016.

6.1 General Plant – Highlights

General Plant capital investment in 2017 is primarily on Information Technology. The General Plant capital investment plan for 2017 is comprised of the following:

i	New 2017 capital spending for projects with total estimated project spend greater than $250,000 and for which approval is sought. (As provided in Section 2.2)	$2.3
ii	2017 capital spending for projects with total estimated project spend greater than $250,000 for which approval will be sought subsequent to the filing of the 2017 ACE Plan. (As provided in Section 2.3)	35.2
iii	New capital spending for projects with total estimated spend less than $250,000 for which approval is not sought. (As provided in Section 2.4)	1.6
iv	Point Aconi Generating Station Capital Spending. (As provided in Section 2.5)	0.1
v	Carry-over capital spending. (As provided in Section 6.2)	58.9
vi	Routine capital Spending. (As provided in Section 7)	18.8
	Total 2017 General Plant Capital Investment Plan	$116.9 M
	Request for ACE Approval (Items i and vi)	$21.1 M

*Totals may be off slightly due to rounding. Figures are noted in $millions.

6.2 General Plant – Carry-over Capital Spending Summary

Project Number	CI#	Project Title	Start Date	Final Date	Previous Expenditure	2017 Budget	Subsequent Spending	Total Estimate
Telecommunications								
P960	46552	Backbone Communications System Upgrade	2015/02	2018/02	5,780,581	2,163,570	577,762	8,521,912
P943	43227	2014 RTU Replacements	2014/06	2017/12	700,817	46,729	-	747,546
	Total Telecommunications				**$6,481,397**	**$2,210,299**	**$577,762**	**$9,269,458**
Computers								
P981	44671	IT - Enterprise Resource Plan (ERP)	2015/08	2017/12	35,267,288	54,396,712	-	89,664,000
P967	47477	IT - Next Generation Firewall	2015/05	2017/06	2,690,010	409,787	-	3,099,798
	49043	IT - Contact Centre Telephony Infrastructure	2016/03	2017/04	1,774,670	729,439	-	2,504,109
	48254	IT - Outage Comm Tech Cap Improvement	2015/11	2017/06	1,195,195	677,904	-	1,873,099
	46073	IT - Lotus Notes/Oracle Applications Replacement	2015/01	2017/03	667,224	105,395	-	772,619
P987	48635	IT - Security Enhancements - Endpoint Data Encryption and Malware Protection	2015/12	2017/03	692,382	64,760	-	757,142
P108	46365	Maximo Enhancements for Substation Field Mobility	2015/03	2017/11	122,699	140,979	-	263,678
	Total Computers				**$42,409,468**	**$56,524,976**	**$0**	**$98,934,444**
Other General Plant								
	48072	2016 ADMS Switch Order Management	2016/10	2017/08	159,438	133,672	-	293,109
P946	46411	Hydro Asset Management Implementation	2014/08	2017/09	564,107	26,974	-	591,082
	Total Equipment Replacement				**$723,545**	**$160,646**	**$0**	**$884,191**
Total General Plant Carry Over Spending					**$49,614,410**	**$58,895,921**	**$577,762**	**$109,088,093**

6.3 General Plant – New 2017 Capital Items for ACE Plan Approval

Tab #	CI#	Project Title	2017 Budget	Project Total
Outage Performance				
GP01	49861	IT - PI System Upgrade	667,366	801,253
GP02	46572	2017 RTU Replacement Program	350,914	693,354
GP03	48774	HYD - Milton Shop HVAC Upgrade	553,090	564,347
GP04	50071	T&D Inspection Application Upgrade Phase 1	263,602	411,191
GP05	49880	Meter Shop Test Console Replacement	208,631	410,457
GP06	49902	2017 Telecom Building Replacement - Wittenburg	294,000	294,000
Total Outage Performance Spending			**$2,337,603**	**$3,174,602**
Total New General Plant Spending			**$2,337,603**	**$3,174,602**

7.0 ROUTINE CAPITAL PROGRAM

This category includes recurring annual expenditures for replacement of equipment (like-for-like replacement), additions to existing equipment base resulting from system growth, and addition of customers to the system.

7.1 Routine Capital Spending by Function Yr/Yr

	2015 Actual	2016 Budget	2016 Forecast	2017 ACE Plan
Generation				
Generation Equipment Replacements	$3,577,848	$2,972,800	$2,789,265	$3,382,030
Generation Other Hydro	490,979	419,472	489,225	402,705
Generation Other Thermal	301,327	336,781	328,254	289,096
	4,370,154	3,729,053	3,606,744	4,073,830
Transmission				
Transmission Substation Replacement, Add'ns/Mod'ns	3,417,403	2,913,829	2,875,828	3,070,404
Primary Equipment Spares	162,829	250,000	250,000	250,000
Protection Modification & Replacement	365,325	433,690	384,640	449,111
Transmission Line Replacement, Add'ns/Mod'ns	5,531,192	5,640,857	7,044,096	6,003,899
Transmission Right-of-Way Widening	612,936	5,999,956	5,999,958	598,698
	10,089,686	15,238,332	16,554,522	10,372,112
Distribution				
Meters	2,949,397	3,053,662	3,004,319	3,216,686
Distribution Upgrades and Replacement	18,571,886	19,425,941	22,695,940	20,263,362
New Customers	23,992,703	21,475,541	21,721,441	22,382,605
Joint Use	679,952	599,541	474,384	508,021
Distribution Right-of-Way Widening	598,907	600,000	779,064	598,698
	46,792,845	45,154,686	48,675,148	46,969,372
General Plant				
Work Vehicles	6,167,662	6,953,300	6,805,710	7,898,672
Tools and Test Equipment	1,607,747	1,422,000	1,407,969	1,474,000
Telecommunications	799,510	796,256	782,236	796,387
Computing Asset Management	2,128,814	2,754,623	2,655,589	2,122,443
Property Improvements and Furniture	2,904,589	2,205,000	2,146,667	5,115,724

	2015 Actual	2016 Budget	2016 Forecast	2017 ACE Plan
Other	978,185	1,343,213	1,371,344	1,345,438
	14,586,508	15,474,393	15,169,515	18,752,665
Total Routine Capital Spending	**$75,839,192**	**$79,596,463**	**$84,005,929**	**$80,167,979**

Note: The entire Routine program totals $80.7 million including Pt. Aconi routines. The totals presented above and in the following information do not include Point Aconi routines.

7.2 Routine Capital Spending Project Breakdown Yr/Yr

Project #	CI #	Project Title	2015 Actual	2016 Budget	2016 Forecast	2017 ACE Plan
G001	10634	CT - Routine Equipment Replacements	$227,958	$144,000	$144,000	144,000
H001	11622	HYD - Routine Equipment Replacement	990,964	723,687	565,233	697,087
H004	27867	HYD-Roofing Routine	52,835	170,104	87,549	89,371
S001	23428	GS - Routine Capital	117,987	0	0	0
	10645	POT - Routine Equipment Replacement	248,720	242,162	233,862	266,813
	10673	TRE - Routine Equipment Replacement	449,516	380,517	392,904	377,929
	43646	PHB - Routine Equipment Replacement	81,146	147,565	148,199	170,000
	10621	TUC - Routine Equipment Replacement	316,433	254,504	352,558	327,423
	10626	LIN - Routine Equipment Replacement	355,233	382,564	288,708	383,162
S004	27856	TRE - Roofing Routine	438,883	55,105	337,916	100,000
	27855	POT - Roofing Routine	2,000	270,126	14,889	163,963
	27854	TUC - Roofing Routine	106,683	101,637	94,218	63,228
	45206	PHB - Roofing Routine	0	0	0	98,675
	27857	LIN - Roofing Routine	108,621	0	39,396	400,000
W001	41830	Wind - Routine Equipment Replacement	78,392	100,828	97,916	100,379
	Generation Equipment Replacements Total		**$3,575,371**	**$2,972,800**	**$2,789,265**	**$3,382,030**
H005	35583	HYD - Oil Release Risk Assessment	280,307	225,467	288,757	218,370
H006	35584	HYD - Gate Refurbishment	210,672	194,005	200,468	184,335
	Generation Hydro Total		**$490,979**	**$419,472**	**$489,225**	**$402,705**
S005	33871	TUC-Heat Rate Routine	119,464	104,913	106,609	47,690
	33867	POT-Heat Rate Routine	26,954	80,499	72,184	84,967
	33869	TRE-Heat Rate Routine	69,345	74,069	91,306	80,000
	33863	LIN-Heat Rate Routine	85,564	77,300	58,154	76,439
	Generation Thermal Total		**$301,327**	**$336,781**	**$328,254**	**$289,096**
T003	23120	Provincial-Trans Substation Primary	2,965,811	2,081,372	2,526,679	2,199,801
T004	23121	Provincial - Substation Additions & Replacements	451,593	832,457	349,150	870,603
	Transmission Subs Replace, Adds/Mods Total		**$3,417,403**	**$2,913,829**	**$2,875,828**	**$3,070,404**
T018	14973	Primary Equipment Spares	162,829	250,000	250,000	250,000
	Primary Equipment Spares Total		**$162,829**	**$250,000**	**$250,000**	**$250,000**
T016	14841	Protection Modification & Replacement	365,325	433,690	384,640	449,111
	Protection Modification & Replacement Total		**$365,325**	**$433,690**	**$384,640**	**$449,111**
T001	23115	Provincial Transmission Line Replace	2,253,832	876,369	1,406,695	882,026

2017 Annual Capital Expenditure Plan

Project #	CI #	Project Title	2015 Actual	2016 Budget	2016 Forecast	2017 ACE Plan
T011	23118	Provincial - Planned Trans Line Replacement	3,277,360	4,764,488	5,637,402	5,121,873
		Transmission Line Replacements Total	**$5,531,192**	**$5,640,857**	**$7,044,096**	**$6,003,899**
T010	43827	Transmission Right-of-Way Widening	612,936	5,999,956	5,999,958	598,698
		Transmission Right-of-Way Widening Total	**$612,936**	**$5,999,956**	**$5,999,958**	**$598,698**
D009	26496	Meter Routine	2,949,397	3,053,662	3,004,319	3,216,686
		Meters Total	**$2,949,397**	**$3,053,662**	**$3,004,319**	**$3,216,686**
D005	23158	Unplanned Replace Deteriorated	9,499,783	8,802,794	10,264,377	8,443,160
D006	23135	Regulatory Replacements - Province	983,157	993,306	1,774,659	1,078,010
D008	23361	Provincial Storm	597,281	2,391,974	2,810,771	2,418,069
D051	29038	System Performance Improvement Routine	821,050	450,562	412,230	599,717
D055	23137	Planned Replacement Of Distribution	6,579,787	6,787,307	7,433,902	7,724,405
		Distribution Upgrades and Replacement Total	**$18,481,058**	**$19,425,941**	**$22,695,940**	**$20,263,362**
D004	26716	New Customer Upgrades	7,880,505	7,779,098	6,907,247	7,740,351
D018	23511	Primary Equipment Spares - Distribution	90,828	150,000	150,000	175,000
D061	39766	New Customers - Residential	8,876,711	8,124,181	8,827,199	8,422,167
D062	39770	New Customers - Commercial	7,235,487	5,422,263	5,836,996	6,045,087
		New Customers Total	**$24,083,530**	**$21,475,541**	**$21,721,441**	**$22,382,605**
D007	23136	Contractual Replacements (Joint Use)	679,952	599,541	474,384	508,021
		Joint Use Total	**$679,952**	**$599,541**	**$474,384**	**$508,021**
D010	23127	Provincially Widening	598,907	600,000	779,064	598,698
		Right of Way Widening Total	**$598,907**	**$600,000**	**$779,064**	**$598,698**
P006	20945	Replacement and Additional Work Vehicles	191,723	200,000	191,809	210,202
P009	16192	Mobile Transformer & Track Routine	15,611	70,862	70,861	70,978
P063	39304	Class 3 Work Vehicle Replacements	161,509	323,000	321,917	335,000
P062	39305	Work Vehicle Replacements	3,830,436	4,579,438	4,511,376	5,429,993
P061	40236	Transportation Vehicle Replacements	1,968,382	1,780,000	1,709,747	1,852,500
		Work Vehicles Total	**$6,167,662**	**$6,953,300**	**$6,805,710**	**$7,898,672**
P002/P016		Meter Shop - Tools and Equipment	1,525,646	1,332,000	1,317,610	1,384,000
P015	11611	Hydro Production Tools, Test Equipment	84,578	90,000	90,359	90,000
		Tools and Test Equipment Total	**$1,610,224**	**$1,422,000**	**$1,407,969**	**$1,474,000**
P025	16365	Mobile Radio Routine	16,051	57,702	45,659	46,048
P027	16551	Telecommunication Radio and Fibre Optics	146,055	141,043	140,963	141,942
P028	16550	Telecommunication Systems Replace & Modifications	518,554	465,998	465,364	476,554
P814	38243	Telecommunications Spares	118,850	131,512	130,250	131,844
		Telecommunications Total	**$799,510**	**$796,256**	**$782,236**	**$796,387**
P010	16073	SCADA Improvements Routine	97,977	131,831	126,376	131,525
P031	29114	NSPI Non-CGI Infrastructure	1,876,308	2,439,489	2,402,302	1,810,000
P040	28522	CT'S DCMS Routine	0	20,000	0	20,000
	25667	POT - DCMS Equipment Replacement Routine	28,117	30,000	18,431	30,000
	25626	TRE - DCMS Equipment Replacement Routine	30,534	44,950	28,577	40,000
	25646	TUC - DCMS Equipment Replacement Routine	60,266	50,000	63,923	60,917
	25668	LIN - DCMS Equipment Replacement Routine	35,611	38,353	15,980	30,000

Project #	CI #	Project Title	2015 Actual	2016 Budget	2016 Forecast	2017 ACE Plan
		Computing Asset Management Total	**$2,128,814**	**$2,754,623**	**$2,655,589**	**$2,122,443**
P001/P030		Property Improvement and Furniture	2,912,492	2,205,000	2,146,667	5,115,724
		Property Improvement and Furniture Total	**$2,912,492**	**$2,205,000**	**$2,146,667**	**$5,115,724**
P012/P041		Other (HYD - Security Imp. & Land Acq)	555,649	646,913	679,954	623,267
P018	48158	Environment Equipment Replacement Routine	0	100,000	138,939	100,000
P816	38897	FAC Enviro Property Remed Routine	133,948	222,500	211,002	216,733
P815	38896	FAC Environment Site Assess Routine	70,039	173,800	174,795	205,438
P032	38848	Purchasing Equip & Warehouse Routine	210,646	200,000	166,654	200,000
		Other Total	**$970,282**	**$1,343,213**	**$1,371,344**	**$1,345,438**
Routine Capital Spending			**$75,839,192**	**$79,596,463**	**$84,005,929**	**$80,167,979**

7.3 2017 Routine Capital Spending Project Details

<u>Transmission</u>

Transmission Substation Replacements, Additions and Modifications

T003 Provincial: Transmission Substation Primary Equipment	ACE 2017 Forecast
Unplanned failures	1,232,555
PT and CT Replacements	87,992
Battery Bank & Charger Replacements	43,996
Transformer Radiator Replacements	120,000
Transformer Cooler Replacement	65,994
Substation Fencing and Gravel Replacement	50,000
Footing Remediations	219,600
Substation Yard Lighting Installation	15,000
Low Voltage Bus Pole Structure Replacement	35,000
Switch Frame Replacements	21,700
Replace 4kV metering unit	17,000
Re-gasket transformers	290,964
Total T003 Provincial: Transmission Substation Primary Equipment	**$2,199,801**
T004 Provincial- Substation Additions & Replacements	
Unknown Additions	304,711
Install Animal Guards - Substations	251,445
Switch Upgrades	36,000
MOD Switch Upgrade	34,092
Transformer Refurbishment	244,356
Total T004 Provincial- Substation Additions & Replacements	**$870,603**

Total Transmission Substation Replacements, Additions and Modifications	**$3,070,404**

Primary Equipment Spares

T018 Primary Equipment Spares	**ACE 2017 Forecast**
Spare 138kV Synchronous Cap Bank Breaker	125,000
Spare Post type CTs 138kV	45,000
Spare Post type CTs 69kV	30,000
Spare 25kV Cap bank breaker	50,000
Total Primary Equipment Spares	**$250,000**

Protection Modification and Replacement

T016 Protection Modification & Replacement	**ACE 2017 Forecast**
L6020 & L6021 Add Perm & TT	95,740
Replace L8001 & L8002 A&B Line Protection at 67N Onslow	170,326
Replace A Protection on L6513 at 1N Onslow	36,736
Replace Primary & Secondary Protection on L6513 at 74N	70,471
Upgrade Closing/ synchronizing Logic at 2S VJ	16,423
Unplanned Relay Replacement	59,415
Total Protection Modification & Replacement	**$449,111**

Transmission Line Replacement, Additions/Modifications

T001 Provincial Transmission Line Replacement (Unplanned)	**ACE 2017 Forecast**
This routine has budgeted a 3% increase from 2016 Approved ACE amounts.	882,026

T011 Provincial- Planned Transmission Line Replacement

LINE #	**Description**	**ACE 2017 Forecast**
L5003	99H Farrell ST-124H Akerly- 90H Sackville	216,810
L5011	40H Woodlawn to 58H Imperial	159,962
L5011	99H Farrell ST to 40H Woodlawn	195,558
L5036	L5053 tap to 52V Berwick	24,805
L5037	East River 86E (L5031 Tap) to 85W Canexel	368,376
L5042	99H Farrell ST to 62H Albro Lake	74,134
L5049	91H Tufts Cove to 99H Ferrrall ST	50,777

L5500	50N Trento to 62N Stellerton	80,216
L5502	50N Trenton to 54N Ambercrombie PT	157,164
L5019	43V Cannan Road to 6V Hollow Bridge	323,556
L5512	95H Malay Falls to 96H Ruth Falls	15,871
L5549	30N Maccan to 17V Brownell ST	392,965
L6003	91H Tufts Cove to 90H Sackville	2,903
L6005A	120H Brushy Hill to 131H Lucasville	73,182
L6005B	90H Sackville to 131H Lucasville	90,491
L6507	50N Trenton to 79N Hopewell	3,044
L6010	90H Sackville to 120H Brushy Hill	186,284
L6014	90H Sackville to 104H Kempt Road	20,703
L6038	103H Lakeside to 129H Kearney Lake	2,347
L6040	91H Tufts Cove to 113H Dartmouth East	1,072
L6523	1C PT Tupper to 47c Stora	5,594
L6534	2S VJ to 88S Lingan	1,205
L6007	91H Tufts Cove to 108H Burnside	115,283
L6516	2C PT Hastings to 47C PT Tupper	69,655
L7015	89S PT Aconi to 101S Woodbine	207,185
L8003	67N Onslow to 79N Hopewell	5,656
L5031	86W (L5037) to 84W Robinsons Corner	135,711
L5050	15V Sissaboo to 91V Fourth Lake	129,049
L5017	43V Cannan Rd to 15V Five Points	12,212
L6515	100C Cape Porcupine to 2C Port Hastings	232,098
L5050	15V Sissaboo to 91V Fourth Lake	129,049
L6533	2S VJ to 88S Lingan	268,979
L5550	30N Maccan to 37N Parsborro	229,814
L5555	3S Gannon Road to 86S Prince Mine	379,596
L7005/L8004	7005/8004-hold offs	45,586
L6545	L6545- hold offs	89,921
L8002/L7001	L8002/L7001 -hold offs	46,792
Various	1-6 Month Inspection Driven Work	578,269
T011 Provincial - Planned Transmission Line Replacement		$5,121,873
	Transmission Line Replacement Total	**$6,003,899**

T010 – Provincial: Transmission Right of Way Widening

This forecast is developed based on the known level of widening in the current year.

138kV & 230kV	
L6001	46,807
L6004	57,609
L6012	76,812

L6503	28,805
L7003	174,028
L7009	40,610
L6514	78,012
L6539	96,015
Total T010	598,698

Pursuant to CI 49992 - 2017 Transmission Right-of-Way Widening 69kV, the Board's 2016 ACE Plan Order provided the following directive:

> The Board directs that the Routine for Transmission widening be treated as a separate project, and not a routine, in future ACE Plan Applications. NSPI is to provide an annual progress report on the expenditure, works undertaken, results achieved and future plans as part of the annual ACE Plan submissions.[10]

CI 49992 is submitted in the 2017 ACE Plan in compliance with the Board's directive. With the addition of CI 49992, the transmission vegetation management program will be carried-out under three broad initiatives:

1. Operating activities for transmission vegetation management
2. Capital Routine T010 - Transmission Right-of-Way Widening (for 138kV, 230kV and 345kV RoWs)
3. New Transmission Rights-of-Way Widening individual capital projects (i.e. CI 49992 for 69kV RoWs and subsequent phases)

Capital routine T010 remains for the widening of 138kV, 230kV and 345kV RoWs. This is the traditional scope of T010, but it has also previously included 69kV rights-of-way which are now assumed under CI 49992 and subsequent phases. This was the scope of work included in the $36 million eight-year program ($4.5 million per year, increased to $5 million per year due to administrative overhead), which the UARB approved in principle and directed NS

[10] NS Power 2016 ACE Plan, UARB Order, M07176, June 8, 2016, page 2. NS Power's annual progress report on the expenditure, works undertaken, results achieved and future plans can be found in the 2017 ACE Plan Reliability Directive.

Power to include in ACE Plan filings for final approval.[11] The 69kV work was removed from T010 but the budget for T010 remains approximately the same due to increased funding to for NERC requirements at the other voltage levels (specifically 138kV).

[11] Review of Nova Scotia Power Inc.'s (NSPI) state of preparedness and response to Post-Tropical Storm Arthur, UARB Supplemental Decision, M06321, September 21, 2015, page 16. NS Power 2016 ACE Plan, UARB Decision, M07176, June 8, 2016, pages 26-28.

Distribution

Meters – D009 Meter Routine

Item#	Prg#	Meter Type	Meter Style	Description	2017 Forecast	Current Unit Cost	Capital for meters
1.0 Element, 120-240 volt							
1	294	FOCUS AL (Form 1S)	L+G	240V, 10A, 2W, 4 Jaw, 4 dial	200	41.00	$8,200.00
2	220	S4e w/battery + 1KYZ (Form 3S)	L+G	T/R, 2W, 4Jaw, TOU (KWH) c/w L.C. (ETS)	60	198.00	$11,880.00
3	230	FOCUS AXe (Form 3S)	L+G	T/R, 2W, 4Jaw, KW/KVA dmd	140	198.00	$27,720.00
4	239	AXRS4e w/battery + 1KYZ + modem	L+G	T/R, 2W, 4Jaw, TOU(KWH) c/w modem, L.P,L.C. (ETS)	0	308.00	$0.00
5	240	RXRS4e w/battery + modem	L+G	T/R, 2W, 4Jaw, KW/KVA dmd, c/w modem, L.P.	0	308.00	$0.00
6	296	S4e w/battery + 1KYZ (Form 3S)	L+G	T/R, 2W, 4jaw, BID, TOU LC(ETS)	20	198.00	$3,960.00

1.5 Element, 120-240 volt							
7	*N/A*	C1S	Centron	240V, 200A, 3W,4 Jaw, 5 dial	17000	22.50	$382,500.00
8	219	SS1S1T	Sentinel	S/C, 3W, 4Jaw, TOU(KWH) c/w L.C. (ETS)	700	130.00	$91,000.00
9	231	SS1S2D	Sentinel	S/C, 3W, 4Jaw, KW/KVA dmd	700	110.00	$77,000.00
10	232	SS1S2D	Sentinel	T/R, 3W, 4Jaw, KW/KVA dmd	0	125.00	$0.00
11	236	SS1S1L	Sentinel	S/C, 3W, 4Jaw, (KWH) c/w modem & L.P.	10	290.00	$2,900.00
12	241	SS1S3L	Sentinel	S/C, 3W, 4Jaw, KW/KVA dmd, c/w modem, L.P.	0	350.00	$0.00
13	266	SS1S1D	Sentinel	S/C, 3W, 4Jaw, (kWh), BID	20	130.00	$2,600.00
14	291	SS1S1T	Sentinel	SC, 3W, 4Jaw, (kWh) TOU, BID, LC (ETS)	12	150.00	$1,800.00
15	292	SS1S1D	Sentinel	S/C, 3W, 4Jaw, kWh/kW, BID	8	130.00	$1,040.00

2.0 Element, 120-480 volt							
16	N/A	CN1S	Centron	120V,200A,3W,5Jaw(9o,clock pos:), 5 dial	1600	52.00	$83,200.00
17	226	SS2S2D	Sentinel	S/C, 3W, 5Jaw(9 o’clock pos:) KW/KVA dmd,(Mult: 25)	60	110.00	$6,600.00
18	227	SS3S2D	Sentinel	T/R, 3W, 8Jaw, KW/KVA dmd, c/w KYZ pulses	0	160.00	$0.00
19	233	SS2S1T	Sentinel	S/C, 3W, 5Jaw(9 o,clock pos:)TOU(KWH) c/w	60	135.00	$8,100.00

Item#	Prg#	Meter Type	Meter Style	Description	2017 Forecast	Current Unit Cost	Capital for meters
				L.C.(ETS)			
20	235	SS3S3L	Sentinel	T/R, 3W, 8Jaw, KW/KVA dmd, c/w modem, L.P.	4	290.00	$1,160.00
21	246	SS3S3L	Sentinel	T/R, 3W, 8Jaw, KW/KVA dmd, c/w modem, L.P, KYZ	4	315.00	$1,260.00
22	254		Sentinel	S/C,3W, 5jaw(9 o,clock pos:)KW/KVA dmd, modem, LP,(Mult 25)	4	315.00	$1,260.00
23	271		Sentinel	T/R, 3W, 8 Jaw, kW/kVA dmd, Modem, LP (5-min int)	4	290.00	$1,160.00
24	272	SS3S3L	Sentinel	T/R , 3W, 8Jaw, kW/kVA dwd, Modem, LP (5-min int) KYZ	0	425.00	$0.00
25	297	SS3S2D	Sentinel	T/R, 3W, 8Jaw, KW/KVA dmd	150	116.00	$17,400.00
2.5 Element, 120-347 volt							
26	281	SS5S0	Sentinel	T/R,4W, 13Jaw, 120-480V, 0.1-10A (KWH)	40	105.00	$4,200.00
27	228	SS2S2D	Sentinel	T/R, 4W, 13Jaw, KW/KVA dmd	200	102.00	$20,400.00
28	229	SS5S2D	Sentinel	T/R, 4W, 13Jaw, KW/KVA dmd, c/w KYZ	0	135.00	$0.00
29	234	SS5S3L	Sentinel	T/R,4W, 13Jaw, KW/KVA dmd c/w modem, L.P.	40	315.00	$12,600.00
30	273	SS5S3L	Sentinel	T/R, 4W, 13 Jaw, kW/kVA dmd, modem, LP (5 min int)	0	290.00	$0.00
31	274	SS5S3L	Sentinel	T/R, 4W, 13 Jaw, kW/kVA dmd, modem, LP (5 min int), KYZ	0	350.00	$0.00
32	288	SS5S1D	Sentinel	T/R, W, 13 Jaw, kW BID	8	140.00	$1,120.00
3.0 Element, 120-347 volt							
33	247	SS4S0D	Sentinel	S/C, 4 W, 7Jaw, (KWH)	300	105.00	$31,500.00
34	248	SS4S0	Sentinel	T/R, 4W, 13Jaw, (KWH)	0	105.00	$0.00
35	218	SS4S3L	Sentinel	T/R, 4W, 13Jaw, KW/KVA dmd, c/w modem, L.P.	20	315.00	$6,300.00
36	222	SS4S2D	Sentinel	S/C, 4W, 7Jaw, KW/KVA dmd, (Mult 25)	1000	105.00	$105,000.00
37	223	SS4S2D	Sentinel	T/R, 4W, 13Jaw, KW/KVA dmd	400	102.00	$40,800.00
38	225	SS4S2D	Sentinel	T/R,4W, 13Jaw, KW/KVA dmd, c/w KYZ	0	150.00	$0.00
39	243	SS4S3L	Sentinel	T/R, 4W, 13Jaw, KW/KVA, dmd, c/w modem, L.P, KYZ	20	350.00	$7,000.00
40	275	SS4S3L	Sentinel	T/R, 4W, 13 Jaw, kW/kVA dmd, modem, LP (5 min int)	4	315.00	$1,260.00

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Item#	Prg#	Meter Type	Meter Style	Description	2017 Forecast	Current Unit Cost	Capital for meters
41	276	SS4S3L	Sentinel	T/R, 4W, 13 Jaw, kW/kVA dmd, modem, LP (5 min int), KYZ	0	400.00	$0.00
42	283	SS4S1D	Sentinel	T/R, 4W, 13 Jak, kWh/kW, BID	20	128.00	$2,560.00
43	295	SS4S1D	Sentinel	S/C, 4W, 7Jaw, kWh/kW, BID	20	128.00	$2,560.00
44	211	SS4S1T	Sentinel	T/R, 4W, 13 Jaw, TOU, kWh	4	128.00	$512.00
45	n/a	Y72596-351E	EMT-XMC	TWACS Modules for C1SX Centrons	100	26.00	$2,600.00
				Total Meters	**22932**		**$969,152**
				Misc Meters "ION"	5	$ 8,000	**$40,000**
				Cellular Meters	100	$ 900	**$90,000**
				CT and PT requirements			**$150,000**
				Wire, Adapters and switches			**$90,000**
				Total Materials			**1,339,152**
				Applied Overhead			**1,054,509**
				Labour			**823,025**
			D009 Meters Total				**$ 3,216,685**

Distribution Upgrades and Replacement

		ACE 2017 Forecast
D005 Unplanned Replacement Deteriorated Equipment		
	The forecast was developed based on an estimated 3,159 person days of work at a unit cost of $2,673/person day	**$8,443,160**
D006 Regulatory Replacements		
	The forecast is developed based on past experiences or information from various government agencies. This amount could vary based on current year decisions by these agencies.	**$1,078,010**
D008 Provincial Storm		
	This forecast is developed based on past experience. There can be significant variation in this amount based on yearly storm activity.	**$2,418,069**
D051 System Performance Improvement		
	Install Fuse Savers	28,089
	19C Canso New 25KV Recloser	30,000
	57S-401 Automatic Sectionalizing on Catallon Takeoff	35,000
	87H-313G Harbourview Drive Rebuild	42,530
	78W-301/302 Line Reconfiguration	46,796
	54H Recloser Control Upgrade	50,000
	57C-426 New Sectionalizer	50,000
	530W-201 John's Cove Causeway Reinsulate	74,728
	7N-301G Ferry Road Phase Extension	106,535
	51V-301 Tremont Reconductor	136,039
Total D051 System Performance Improvement		**$599,717**
D055 Planned Replacement of Distribution Equipment		
	Bin Work (Work resulting from NS Power's distribution line inspection program that has been identified as requiring follow up within one year.)	1,929,189
	Streetlight/service removal (This funding is to support system upgrades required for street light installations. This includes transformer installs, service upgrades and/or new pole installations.)	726,307
	Field Driven Work/Unapproved Bin	400,056
	5N-301 Debert Beach Road Rebuild	37,690
	695H-311 Alan Street Stepdown Removal	45,586
	56W Charleston Abandoned Line Removal	47,462
	627N-311 Spencer Point Road Pole Replacement	70,786
	50V-2017 Kentville URD Replacement	48,555
	2H-411 Cowie Hill Underground System Replacements	56,849
	48H-304 Mount Hope Avenue Mini Sub	58,229
	23W-301 Clyde River Line Relocation	58,941
	36W-301G Sable River Branch Crossing	61,700
	87W-312 Tilley Point Road Rebuild	68,231
	4C-430G Old Maryvale Road Deteriorated Poles	77,321
	73W-411GCA Chesley Road Repole	77,393
	Voltage Regulator Replacements - Various	85,000
	22W-312G-ICP	87,500
	548C-311 Big Brook Rail Crossing Removals	90,000
	510W-211 Cresent Beach Road Rebuild	94,083
	23H-301 Forest Hill Drive and Tremont Drive-Rebuild	100,000
	62N-416 Stellarton Cutout Replacement	100,000

	2017 Vault Upgrade - Various	107,076
	102W-311G Surrett Cross Road Rebuild	112,000
	79V-401 Windsor Deteriorated Poles	114,707
	2017 Manhole Cover Replacement - Various	121,724
	2017 Manhole Repairs -Various	125,000
	13V-303 Lake Lemerchant Rebuild Ph 1	125,000
	108H-411 Simmonds Drive Deteriorated Poles	126,710
	551C-301 Little Liscomb Road Rebuild	122,385
	16W-301 Sanford Reconductor	135,702
	15N-401 Willow Street Pole Replacement	135,710
	585C-311 Jimtown Rebuild Deteriorated Line	112,256
	58C-405-Margaree Forks Rebuild	150,000
	622V-211 King Street Windsor 4kV Conversion	153,328
	67C-411 Mabou Harbour Crossing	180,000
	12V-302J Milbury Lake Road Repole	106,000
	2017 Padmount Switch Replacement	192,468
	70V-311GA Arlington Road Reconductor	199,043
	641V-311G Indian Road Rebuild	255,778
	543C-211 Mauger Road Rebuild	205,000
	36N-Boars Back Road Stepdown	230,617
	3S-302 3S-308 Reconfigure	263,109
	25W-301 Upper Clyde Road Relocation	129,914
Total D055 Planned Replacement of Distribution Equipment		**$7,724,405**
	Distribution Upgrades and Replacement Total	**$20,263,361**

New Customers

		ACE 2017 Forecast
D004 New Customer Upgrades	This forecast developed as a % of D061 and D062 net of capital contributions. In 2017 this is estimated to be 54%.	**$7,740,351**
D018 Primary Equipment Spares Distribution	This forecast is developed based on the probable amount of distribution spare equipment required during the year.	**$175,000**
D061 New Customers - Residential	This forecast is for the costs associated with new residential customers net of capital contributions. Costs include metered services, unmetered services, line extensions and underground services.	**$8,422,167**
D062 New Customers - Commercial	This forecast is for the costs associated with new commercial customers net of capital contributions. Costs include metered services, unmetered services, line extensions and underground services.	**$6,045,087**
	Total New Customers	**$22,382,605**

Joint Use

Joint Use Total

This forecast is developed based on prior spending levels for both Joint Use requests from Nova Scotia Power's Joint Use Partner, Bell Aliant and communication utility requests.	**$508,021**

Distribution Right of Way Widening

This forecast is developed based on an identified level of widening in the current year. The spend in this Routine reflects the work that will be required to widen the following rights-of-way to standard.

Feeder Section	Geographic Location	Length (Km)	Managed Length (Km)	Avg Cost per Km	Cost	Contract Overhead	Total Segment Cost
7N-302	Wentworth (Lower Wentworth-Wallace Station)	6.60	6.60	18,000	115,436	23,109	138,545
5N-301	Debert (Upper Debert River)	4.40	4.40	18,000	79,200	15,855	95,055
2C-401	Port Hastings (Clear Cut Buffer - Hilltop Drive)	0.30	0.30	18,000	5,400	1,081	6,481
3N-303G	Amherst (Clear Cut Buffer - Rockley)	0.20	0.20	18,000	3,600	721	4,321
88H-402H	Upper Musquodoboit (Clear Cut Buffer - Highway 224)	1.10	1.10	18,000	19,800	3,964	23,764
512W-311	East Dalhousie (Clear Cut Buffer - Lakeview Road)	0.30	0.30	18,000	5,400	1,081	6,481
16W-302	Yarmouth (Lake George Rd--D311-098 to Skyco Drive)	0.55	0.55	18,000	9,900	1,982	11,882
84W-301G	Chester-Vaughn (Highway 14)	6.60	3.00	18,000	54,000	10,810	64,810
103W-312	Chester-New Ross (Highway 12)	0.55	0.55	18,000	9,900	1,982	11,882
1V-443	New Ross (NewRossRoad-R414-001)	2.70	2.70	18,000	48,600	9,729	58,329
665H-311	Malay Falls (clear cut buffer - Lochaber Mines Road)	1.10	1.10	18,000	19,800	3,964	23,764
50N-410GA	Earltown-Denmark	1.10	1.10	18,000	19,800	3,964	23,764
7N-302G	Fountain Road-Maligash	5.50	5.50	18,000	99,000	19,819	118,819
525W-311	Buckfield (Clear Cut Buffer - Wellington Rd/Highway 210)	0.50	0.50	18,000	9,000	1,802	10,802
Total Distribution Right of Way Widening							**598,698**

Pursuant to CI 49611 - New Distribution Rights-of-Way Phase I, submitted to the UARB on November 1, 2016, Liberty's report on its review of NS Power's response to PTSA included a recommendation that for distribution rights-of-way NS Power should "develop a comprehensive plan for reclaiming and/or widening the overgrown ROW corridors".[12] In its Supplemental Decision on September 21, 2015, the Board provided:

> [36] A circumstance where it will take 32 years for the distribution vegetation management program to become sustainable causes the Board significant concern.
> //
> [38] The Board is intrigued by the stakeholder discussion concerning innovative financing options and directs NSPI to pursue that issue and report back to the Board the results of those discussions. [13]

In response to the Board's concerns, and in order to further reduce the likelihood of tree contact related outages like those during the PTSA event, NS Power increased the budget for the D010 in the 2016 ACE Plan. NS Power's 2016 ACE Plan provided the following:

> NS Power is seeking approval as part of the 2016 ACE Plan of $3 million for the distribution widening routine, D010, in 2016. The $3 million comes from the portion of the annual $10.4 million that is spent on managing the vegetation in distribution ROWs to a sustainable state.[14]

The UARB provided the following in its 2016 ACE Plan Decision regarding D010:

> …the Board assumes that NSPI has increased the distribution Routine budget by an amount of $2.4 million from the operating budget over the $600,000 in the 2015 ACE Plan. This means that NSPI is reducing its operating expenses by $2.4 million in 2016, thus increasing profits, with a corresponding increase in its rate base. This action will only increase rates which the Board does not approve. Accordingly, the Board reduces the routine budget for D010 to $600,000, to be in line with the 2015 ACE Plan amount.[15]

[12] Review of Nova Scotia Power Inc.'s (NSPI) state of preparedness and response to Post-Tropical Storm Arthur, M06321, Liberty Consulting Group, Comments on Review of NS Power's Storm Response, Exhibit A-4, September 9, 2014, page 7.
[13] Review of Nova Scotia Power Inc.'s (NSPI) state of preparedness and response to Post-Tropical Storm Arthur, M06321, UARB Supplemental Decision, September 21, 2015, page 14. NS Power responded with its proposal to increase spend in D010 in the 2016 ACE Plan.
[14] NS Power 2016 ACE Plan Application, M07176, November 12, 2015, page 72.
[15] NS Power 2016 ACE Plan, UARB Decision, M07176, June 8, 2016, page 18.

For the 2017 ACE Plan, NS Power has not increased the budget of D010 in response to the PTSA findings. Rather, additional spending has been broken out into a separate capital work order, CI 49611. Distribution vegetation management program will now be carried-out under three broad initiatives:

1. Operating activities for distribution vegetation management

2. Capital Routine D010 - Distribution Right-of-Way Widening

3. New Distribution Rights-of-Way individual capital projects (i.e. CI 49611 and subsequent phases)

No reductions in spend for operating activities have been transferred to fund either D010 or CI 49611.

The scope of work completed under operating activities will continue to focus on existing right-of-way asset reclamation, urban cycle trimming in municipalities, reactive maintenance, hazard tree mitigation, vegetation removal during storm events, customer requested tree trimming, and maintaining sustainability of existing rights-of-way.

The scope of work completed under the D010 routine will continue to focus on widening of existing rights-of-way to the current standard beyond the department of Nova Scotia Transportation and Infrastructure Renewal (NSTIR) right-of-way.

CI 49611 and subsequent phases will establish new rights-of-way where none have previously existed.

General Plant

Work Vehicles

P006 Replacement and Additional Work Vehicles	Quantity	Unit Price	ACE 2017 Forecast
Reel and Pole Trailers	7	$30,029	$210,202
Total P006 Replacement and Additional Work Vehicles			**$210,202**
P009 Mobile Transformer & Track			
This forecast is developed based on estimated repairs or modifications to track machines or the mobile transformers.			**$70,978**
P061 Transportation Vehicle Replacements	60	$32,208	$1,932,500
		Salvage	-$80,000
			$1,852,500
P062 Work Vehicle Replacements	20	$286,500	$5,729,993
		Salvage	-$300,000
			$5,429,993
P063 Class 3 Work Vehicle Replacements	3	$115,000	$345,000
		Salvage	-$10,000
			$335,000
	Total Work Vehicles		**$7,898,672**

Tools and Test Equipment

Description	Quantity	Estimated Unit Cost	Estimated Total
Meter Shop Tools and Equipment			**50,000**
Provincial Line Tools & Equipment			
Western Territory			
Tension Stringing Kit	1	48,000	48,000
Battery (Robo) Cutters	8	2,850	22,800
Hot Stick AMP Probe	1	2,000	2,000
Hilti Drill Kit	8	1,500	12,000
Gas Powered Ext. Stick Saw #HT131	8	1,010	8,080
Die Kit	4	2,000	8,000
Hot Line Ratchet Cutters	4	1,100	4,400
Underground Tool Kit	1	1,700	1,700
Hydraulic Stick Saw	2	1,500	3,000
Hotline Lever Action Cutter	3	2,200	6,600

2017 Annual Capital Expenditure Plan

Description	Quantity	Estimated Unit Cost	Estimated Total
Western Territory Total			**116,580**
Eastern Territory			
HYD Stick Saws w/ Hose	4	2,345	9,380
Underground Grounding Kit to establish an Equi-Zone	2	5,420	10,841
Dewalt Battery Powered Tools (9 piece set)	10	2,200	22,000
Break-Safe 600 Load Break & Pick-up Tool	1	1,400	1,400
PMI Guardian Meter Socket Recorder	1	3,470	3,470
HYD Drills w/ Hose	7	1,800	12,600
Compression Die kit	2	2,000	4,000
MegaBEAST	2	5,000	10,000
Rope for U/G on a reel, complete with swivels and kellems grip, and reel stand/wind up	1	2,400	2,400
Drantz Meter Upgrade/Exchange	1	2,995	2,995
Eastern Territory Total			**79,086**
Central Territory			
Husky 6 Ton and 12 Ton Die Kits	8	1,500	12,000
3 Phase Patten Jumper Sets - 15' - 2/0	8	2,200	17,600
Hydraulic Chain Saw	6	1,700	10,200
Y46 Press - Cutter Head for y46 Press	1	3,000	3,000
Dewalt Battery Powered Tools (9 piece set)	2	1,200	2,400
Cable Locator Kit	1	8,500	8,500
Live Line Phasing Sticks	2	2,000	4,000
Box Locator	2	2,000	4,000
TTR - Transformer Tested 3/0	2	2,500	5,000
Tension Stringing Kit	1	48,000	48,000
Man-Hole Retractor and Tripod	1	5,000	5,000
Inverter	1	1,200	1,200
Hilti Power Utility 4 Tool Cordless Kit	4	1,640	6,560
Candura Power Pro	1	8,000	8,000
Hubbell U/G Pulling Kit	2	1,300	2,600
Huskie Remote U/G Die Kit	2	4,600	9,200
Load Looker Ammeter Part #MEAMP32RN	26	1,800	46,800
Huskie Hydraulic Pump R-14EF	1	2,300	2,300
Underground DRAs	2	7,500	15,000
Generator 2000 Watt	2	2,000	4,000
Central Territory Total			**215,360**
T&D Asset			
Breakdown Allowance	1	63,265	63,265
Portable Ground Sets	25	1,300	32,500
Rope Tester	2	2,918	5,836
Dielectric Rope	2	2,200	4,400
Wire Cutters REC Y33 - Additions to Complement	25	2,850	71,250

Description	Quantity	Estimated Unit Cost	Estimated Total
6 Ton Presses for Rotational Spares and Replacements	36	2,350	84,600
Hydraulic Drills for Rotational Spares and Replacements	24	1,585	38,040
T&D Asset Total			**299,891**
System Maintenance			
Spectrum Analyzer	1	55,000	55,000
Protocol Analyzer (RTU)	2	5,000	10,000
SF6 Analyzer	1	31,776	31,776
CT Test Set	2	36,601	73,202
Magnetic Base Drill	3	1,500	4,500
Cordless Tool Combo	4	1,500	6,000
Ground Rod Pounder	1	2,000	2,000
Ohmic Battery Tester	1	8,000	8,000
Ground Resistance Test Set	1	5,000	5,000
GE Kelman Gas Analyzer	1	57,605	57,605
Dies (Y35)	6	2,000	12,000
System Maintenance Total			**265,083**
P002 Tools and Equipment Total			**1,026,000**
P015 Hydro Production Tools & Test Equipment			**$90,000**
P016 Thermal Production Tools & Test Equipment			
POT Tools & Equipment			$75,000
TUC Tools & Equipment			80,000
TRE Tools & Equipment			80,000
LIN Tools & Equipment			55,000
CT Tools & Equipment			28,000
PHB Tools & Equipment			40,000
P016 Thermal Production Tools & Test Equipment Total			**$358,000**
Tools and Test Equipment Total			**$1,474,000**

Telecommunications

P025 Mobile Radio	**ACE 2017 Forecast**
Replacement Radio Equipment Hardware and Upgrades	26,432
Equipment Repairs - Nova and Pantel Standing Pos	8,028
Miscellaneous Support for Existing System	11,588
P025 Mobile Radio Total	**46,048**

P027 Telecommunication Radio & Fibre Ops	
HVAC & Generator Upgrades - 2 sites	102,127
Radio Site Repairs - Miscellaneous	19,823
Add Generator Alarms And Controls at Various Sites	5,501
Miscellaneous Replacements	14,491
P027 Telecommunication Radio & Fibre Ops Total	**141,942**
P028 Telecommunication Systems Replace & Modifications	
Replace DPR and Tone Protection Equipment	51,700
Upgrade Site Access Equipment	27,848
RAL Move Circuits	33,193
Remove Old Bayly Multiplex Equipment	14,538
Backup Control Center Circuits	16,831
Backup Time Synch for Backup Control Centre	5,493
Battery Replacements Various Sites	18,248
Replace Miscellaneous Power Supplies	7,500
UPS Replacements Various Sites	7,500
Upgrade Ethernet Radios and Equipment (Wide Area Network -WAN)	28,874
Cable & Entrance Protection - Positron	17,250
Switched Communications - System Operations Phones	12,500
Replace Fibre Optic Equipment (NEC & ADC)	32,500
Install One Fibre Link from Substation to Radio Site	61,787
Network Monitoring - Upgrade TMON Alarming System	34,816
Alarm Commissioning for New Sites into SCADA	16,816
Review and Update System Drawings and Records	42,499
Support Services for Newbridge Multiplex Network - Nokia/ALU	28,500
Tower Lighting Upgrades	18,161
P028 Telecommunication Systems Replace & Modifications Total	**476,554**
P814 Telecommunications Spares	
Alcatel-Lucent MPR9500 Microwave Radio	25,100
Net Guardian Alarm Monitoring Equipment	25,100
Ethernet Spares	10,100
MDS SD9, Transnet, INet	10,100
SEL 2505, 2506 Spares	10,100
RFL IMUX and 9745 Spares	25,100
Battery Charger Spare	10,100
RTU and Misc. Spares	16,144
P814 Telecommunications Spares Total	**131,844**
Telecommunications Total	**796,387**

1

1 *Computing Asset Management*

P010 SCADA Improvements		**ACE 2017 Forecast**
	This forecast is developed based on SCADA equipment/operator interfaces failures or modifications	
P010 SCADA Improvements Total		**$131,525**

P031 NS Power IT Infrastructure

Infrastructure Component	**Asset Management Plan**	**Volume to be Refreshed**	**ACE 2017 Forecast**
Voice and Data Network	Network Infrastructure & Equipment		$810,000
Servers	Servers Refresh, Licenses, & Storage		230,000
Laptop and Desktop Computers, Personal Devices	Computers that have or will reach four (4) years old	250	350,000
	New laptop or desktop computers	150	180,000
	Laptop/Desktop Mgmt Tool-capacity upgrade		100,000
	Software & software licenses		100,000
Power Supplies	Replaced after 10 years		10,000
Accessories	Accessories		30,000
P031 NS Power IT Infrastructure Total			**$1,810,000**

P040 DCMS Equipment Replacement		
	CTs DCMS Equipment Replacement	$20,000
	LIN DCMS Equipment Replacement	30,000
	POT DCMS Equipment Replacement	30,000
	TRE DCMS Equipment Replacement	40,000
	TUC DCMS Equipment Replacement	60,917
		$180,917
	Computing and Asset Management Total	**$2,122,443**

2 *Property Improvement and Furniture*

3

Property Improvement and Furniture		
P001	FAC - Property Improvements	$5,115,724
	Property Improvement and Furniture Total	**$5,115,724**

PLANNED PROJECT WORK	ACE 2017 ($)
Building Protective Coatings (4-6 Depots)	50,000
Roofing (6-12 Depots)	150,000
Grading/Drainage	175,000
Fence Gate Repairs	83,000
Pole Brows (Bridgewater)	300,000
General Contract Work	416,000
Fall River Storage Building	100,000
Consultant / Property Improvement Mngmt	70,000
HVAC Refurbishment / Upgrades	235,000
Substations	175,000
Generator	50,000
Protective Signage	10,000
Security	20,000
1H Office Building General Repairs	271,000
Sub-Total	**2,105,000**
Energy Control Centre Roof	554,267
Lakeside Office/Storeroom Building Roof	1,742,950
ECC Generator Fuel Storage & Electrical	498,707
CN Bridge Massachusetts Avenue	214,800
Sub-Total	**3,010,724**
Total P001	**5,115,724**

Other

Other		
P012	HYD - Security Improvement	$523,267
P018	Environmental Equipment Replacement	100,000
P041	FAC - Land Acquisition Routine	100,000
P816	FAC - Environment Property Remediation	216,733
P815	FAC - Environment Site Assessment	205,438
P032	FAC - Equipment & Warehouse	200,000
	Other Total	**$1,345,438**
	General Plant Total	**$18,752,664**

8.0 DIRECTIVES AND MISCELLANEOUS

8.1 UARB ACE Plan Directives and Stakeholder Commitments

NS Power has received a number of Directives from prior ACE Plan Decisions. It has also agreed to a number of commitments with stakeholders. In accordance with the format developed in prior ACE Plans, responses to each of these Directives and stakeholder commitments are provided below.

8.1.1 Impact of 2017 ACE Plan on Revenue Requirement and Affordability

Introduction

Revenue requirement and its effect on rates are well understood: increases in revenue requirement create upward pressure on rates. NS Power recognizes that rate increases are of particular concern for our customers and stakeholders which, through ongoing engagements with them, is frequently expressed in terms of affordability.

As such, over the years the UARB has directed NS Power to provide information regarding the ACE Plan's revenue requirement impact. Directive 7 of the 2011 ACE Plan Decision and Directive 12 of the 2012 ACE Plan Decision direct NS Power to provide the estimated effect the ACE Plan may have on revenue requirement over the next five years. This is provided in the tables that follow.

This information has been provided in prior ACE Plans and, through discussion and agreement with stakeholders as well as further direction from the UARB, has grown to include tables breaking out the revenue requirement impact of:

- Economically Justified capital investments (2013 CEJC stakeholder engagement);
- Current Asset capital investments (2014 stakeholder engagement);

- Work Support Facilities capital investments (UARB 2013 ACE Plan Decision Directive 13); and
- A version of NS Power's "Long-Term Capital Planning & Revenue Requirement" table incorporating stakeholder assumptions (2016 stakeholder engagement).

Considered as a whole, NS Power's assumptions and corresponding information provides the UARB and stakeholders an impression of the impact NS Power's capital program is expected to have on revenue requirement and helps inform discussions on affordability. Although there is an increase in spend in 2017 compared to most recent years, the 2017 ACE Plan is designed largely as a sustaining capital program and continues to be about investing where required to best maintain the performance and reliability of the Company's assets, while minimizing upward pressure on rates.

The overall revenue requirement table, "Long-Term Capital Planning & Revenue Requirement", shows that NS Power's capital expenditures have a minimal effect on NS Power's revenue requirement for current customers over the next five years when one considers the contribution to fixed costs provided by new customer additions.

Overall Revenue Requirement

The overall revenue requirement calculation that follows shows the effect on rate base and the effect on revenue requirement. The underlying assumption of this calculation is that, to the extent capital expenditures equal depreciation expense in a given year, there is no incremental effect on rate base or associated revenue requirement and therefore it is not included in the calculation.

The revenue requirement assessment incorporates the following inputs:

- Capital expenditures compared to forecasted depreciation expense annually.

- Administrative overhead credit based on the proration of capital expenditures in excess of depreciation expense in each year.

- Depreciation expense of assets added during the examined timeframe based on the proportion of capital expenditures in excess of depreciation expense of all assets in each year.

- Incremental interest based on the cost of debt multiplied by the portion of debt to total capital of the incremental rate base.

- AFUDC based on the proportion of capital expenditures in excess of depreciation expense of all assets in each year.

- Income taxes based on the resultant effects and prorated Capital Cost Allowance for tax purposes.

- Net earnings based on the rate of return multiplied by the portion of equity to total capital of the incremental rate base.

- Additional fixed cost recovery received from customer growth achieved through capital investment to serve these customers.

Depreciation expense and additional fixed cost recoveries are delineated in the overall revenue requirement calculation.

This method does not address the revenue requirement effect should the capital projects not be completed. Costs resulting from not completing certain projects include items such as increased operating costs, increased fuel costs, increased repair costs, and other risks or implications. The Economic Analysis Model used to decide whether an economically justified capital project is the best option for customers includes estimates of the avoided expenses; these avoided cost benefits are not included in this revenue requirement calculation. The effect of economic projects and their savings is broken out separately in the subsequent section.

LONG-TERM CAPITAL PLANNING & REVENUE REQUIREMENT[16]

NOVA SCOTIA POWER ($M)	2017 ACE	2018	2019	2020	2021
Estimated Spend Related to five-year Capital Plan					
Capital Expenditures (Spend)	$398.0	$357.8	$344.4	$321.6	$286.2
Less: Depreciation of all assets	206.2	214.5	222.5	229.6	236.6
Incremental Spend over Depreciation (Growth)	191.8	143.3	121.9	91.9	49.6
Incremental Spend as a portion of Total Spend	48.2%	40.1%	35.4%	28.6%	17.3%
New Incremental Regulated Capital Assets					
Beginning Balance	-	191.8	335.1	457.0	549.0
Capital Spend	398.0	357.8	344.4	321.6	286.2
Depreciation	206.2	214.5	222.5	229.6	236.6
Ending Balance	191.8	335.1	457.0	549.0	598.5
Average Incremental Net Book Value of projects in five-year plan	95.9	263.5	396.1	503.0	573.7
Capital Cost Allowance					
Depreciation of Assets added 2017-2021	5.9	14.7	21.0	22.6	16.7
Impact on Net Earnings					
Expenses					
OM&G	(4.2)	(8.3)	(12.5)	(16.6)	(20.8)
Administrative Overhead	(20.4)	(15.5)	(13.6)	(10.0)	(5.5)
Depreciation	2.0	5.0	7.2	7.9	6.0
Interest	3.5	9.7	14.6	18.5	21.2
AFUDC	(4.0)	(2.7)	(2.4)	(2.2)	(1.1)
Earnings before tax	(5.3)	2.4	7.8	13.9	21.0
Income Tax less Impact of Administrative Overhead	(4.1)	(3.1)	(2.6)	(0.9)	2.8
Income Tax Impact of Administrative Overhead	(4.4)	(3.4)	(2.9)	(2.2)	(1.2)
Net Earnings	$3.2	$8.9	$13.4	$17.0	$19.4

[16] This table has been modified pursuant to the 2016 ACE Plan Terms of Consensus and as noted section 1.3.1. It does not include avoided costs related to economically justified projects.

Incremental Revenue Requirement of five-year capital plan					
Including Fixed Cost Recovery:					
Incremental Revenue Requirement of five-year capital plan	(28.2)	(9.3)	1.2	11.5	20.8
Change in Incremental Revenue Requirement from Previous Year	(28.2)	18.9	10.6	10.3	9.3
Rate Impact of five-year capital Plan	-2.2%	-0.7%	0.1%	0.9%	1.6%
Excluding Fixed Cost Recovery:					
Incremental Revenue Requirement of five-year capital plan	(24.1)	(1.0)	13.7	28.1	41.6
Change in Incremental Revenue Requirement from Previous Year	(24.1)	23.1	14.7	14.4	13.5
Rate Impact of five-year capital Plan	-1.9%	-0.1%	1.1%	2.2%	3.3%

The overall revenue requirement shown above, in the line item “Incremental Revenue Requirement of five-year capital plan”, shows a decreasing revenue requirement for years 2017 and 2018 as a result of the new capital investment. This is due to additional fixed cost recovery received from customer growth achieved through capital investments to serve these customers, Administrative Overhead and AFUDC credits related to construction of capital assets, and the income tax impact of new capital investment.

Years 2019 to 2021 are forecasted to have an increase in revenue requirement in each year as a result of the new capital investment due to increased depreciation expense, interest and return on equity related to capital assets. However, the cumulative effect of all years 2017 to 2021 results in minimal upward pressure on rates.

Stakeholder Revenue Requirement Table

In compliance with the 2016 ACE Plan Terms of Consensus and subsequent stakeholder engagement process, NS Power has included an additional revenue requirement table using assumptions determined by stakeholders. The stakeholder table shown below includes the following significant differences from NS Power’s “Long-Term Capital Planning & Revenue Requirement” table above:

- Elimination of the impact of additional fixed cost recovery as well as the administrative overhead and AFUDC credits from the revenue requirement calculation.

- Elimination of the application of the incremental spend as a portion of total spend percentage to the calculated depreciation expense and capital cost allowance in the revenue requirement calculation.

- Estimation of depreciation expense based on ending depreciable base as opposed to average depreciable base.

NS Power believes these assumptions do not accurately reflect the impact of the Company's capital program and maintains that:

- Including the reduction in fixed costs in the model demonstrates the decrease in revenue requirement for current customers related to having more customers connected and sharing the fixed costs.

- Including the AO and AFUDC credits in the calculation of revenue requirement is consistent with how rates are calculated and that the inclusion of these credits in the revenue requirement directive is appropriate.

- Since NS Power does not have the option to cease investment in its capital infrastructure at a sustaining level, a five year capital plan should be viewed in the context of costs that the capital program is driving in comparison to maintaining the assets.

- Estimating depreciation expense based on average depreciable base more closely matches the actual pattern of assets being added throughout the year, and is better aligned to demonstrate the impact the capital plan will have on revenue requirement during the next five years.

LONG-TERM CAPITAL PLANNING & REVENUE REQUIREMENT (STAKEHOLDER TABLE)[17]

NOVA SCOTIA POWER ($M)	2017 ACE	2018	2019	2020	2021
Capital Expenditures (Spend)	$398.0	$357.8	$344.4	$321.6	$286.2
Less: Depreciation of all assets	206.2	214.5	222.5	229.6	236.6
Incremental Spend over Depreciation (Growth)	191.8	143.3	121.9	91.9	49.6
Incremental Spend as a portion of Total Spend	48.2%	40.1%	35.4%	28.6%	17.3%
Revenue Requirement Calculation					
OM&G	-	-	-	-	-
Depreciation	8.2	16.6	24.2	31.0	38.1
Interest	7.1	12.4	16.9	20.2	22.1
AFUDC	-	-	-	-	-
Return on Equity	6.5	11.3	15.4	18.5	20.2
Income Tax less Impact of Administrative Overhead	1.2	(3.7)	(8.8)	(13.1)	(17.0)
Administrative Overhead	-	-	-	-	-
Income Tax Impact of Administrative Overhead	-	-	-	-	-
Incremental Revenue Requirement of five-year capital plan	**23.0**	**36.6**	**47.7**	**56.7**	**63.3**
Change in Incremental Revenue Requirement from Previous Year	23.0	13.55	11.15	8.95	6.69
Rate Impact of five-year capital Plan	1.8%	2.9%	3.8%	4.5%	5.0%
RECAP					
Expenses					
OM&G	-	-	-	-	-
Administrative Overhead	-	-	-	-	-
Depreciation	8.2	16.6	24.2	31.0	38.1
Interest	7.1	12.4	16.9	20.2	22.1
AFUDC	-	-	-	-	-
Earnings before tax	7.7	7.6	6.7	5.5	3.2
Income Tax less Impact of Administrative Overhead	1.2	(3.7)	(8.8)	(13.1)	(17.0)
Income Tax Impact of Administrative Overhead	-	-	-	-	-
Net Earnings	$6.5	$11.3	$15.4	$18.5	$20.2
New Incremental Regulated Capital Assets					
Beginning Balance	-	191.8	335.1	457.0	549.0
Capital Spend	191.8	143.3	121.9	91.9	49.6
Ending Balance	191.8	335.1	457.0	549.0	598.5

[17] This table does not included avoided costs related to economically justified projects.

Average Incremental Net Book Value of projects in five-year plan	95.9	263.5	396.1	503.0	573.7
Capital Cost Allowance					
Depreciation of Assets added 2017-2021	12.0	36.3	59.1	78.6	96.2

Categories of Capital Expenditures and Revenue Requirement

Not unlike the functional classes of capital expenditures noted throughout the ACE Plan, overall revenue requirement can be broken down into different sub-categories. A table breaking out "Current Asset Investment" is provided in the following table.

Current Asset Investment is made up of all capital investment on our current asset base which includes both compliance and sustaining capital projects. It does not include investment that creates new assets (e.g. customer growth and wind farms) or substantially alters current assets (e.g. transmission upgrades for Wind/Maritime Link).

CURRENT ASSET INVESTMENT

NOVA SCOTIA POWER ($M)	2017 ACE	2018	2019	2020	2021
Estimated Spend Related to five-year Capital Plan					
Capital Expenditures (Spend)	$320.7	$248.1	$195.9	$195.8	$283.7
Less: Depreciation of all assets	206.2	212.6	218.0	222.5	228.1
Incremental Spend over Depreciation (Growth)	114.5	35.5	(22.0)	(26.8)	55.6
Incremental Spend as a portion of Total Spend	35.7%	14.3%	-11.3%	-13.7%	19.6%
Average Incremental Net Book Value of projects in five-year plan	57.3	132.3	139.0	114.6	129.0
Impact on Net Earnings					
Expenses					
OM&G					
Administrative Overhead	(10.2)	(3.3)	2.2	2.9	(6.2)
Depreciation	1.2	1.4	(1.7)	(2.7)	5.0
Interest	2.1	4.9	5.1	4.2	4.8

AFUDC	(2.6)	(0.8)	0.4	0.5	(1.2)
Earnings before tax	(2.6)	3.9	9.1	8.9	0.0
Income Tax less Impact of Administrative Overhead	(2.3)	0.1	3.9	4.4	(3.0)
Income Tax Impact of Administrative Overhead	(2.2)	(0.7)	0.5	0.6	(1.3)
Net Earnings	$1.9	$4.5	$4.7	$3.9	$4.4
Incremental Revenue Requirement of five-year capital plan					
Incremental Revenue Requirement of five-year capital plan	(12.0)	6.1	15.2	13.9	2.3
Change in Incremental Revenue Requirement from Previous Year	(12.0)	18.1	9.1	(1.3)	(11.6)
Rate Impact of five-year capital Plan	-0.9%	0.5%	1.2%	1.1%	0.2%

Compliance investment is required to meet a variety of regulatory requirements.

Sustaining investment includes projects in Transmission & Distribution (T&D), Work Support Facilities, and Generation necessary to sustain those assets:

- Sustaining investment in Work Support Facilities is based on technical, economic or regulatory requirements of the assets.

- Sustaining investment in our generation, transmission and distribution assets is done through our asset management program and developed through ongoing inspection programs and based on condition and criticality of the asset. Sustaining investments in generation are backed up with economic analysis stating it is more economical to complete this project compared to a “do nothing” option.

Current Asset Investments represent those projects that NS Power is required to complete to maintain system reliability and performance.

Reductions in NS Power’s current asset investment in T&D assets could lead to a decrease in reliability. Likewise, reductions in current asset investment in generation assets, and corresponding economically justified projects, could lead to reduced generation performance and outages resulting in an increase in revenue requirement due to incurring expenses that would otherwise be avoided.

Effect of Economically Justified Projects

NS Power's overall revenue requirement, of which NS Power's capital revenue requirement is a part, is influenced by economically justified projects. Economically justified projects contribute to minimizing upward pressure on rates by keeping NS Power's overall revenue requirement lower than it otherwise would be.

The table below includes the effect of all new economically justified projects in the 2017 ACE Plan.

ECONOMICALLY JUSTIFIED PROJECTS

NOVA SCOTIA POWER ($M)	2017	2018	2019	2020	2021
Capital Expenditures (Spend)	$11.2	$0.4	$0.0	$0.0	$0.0
Electric Revenue	($4.3)	($10.0)	($9.5)	($5.1)	($5.6)
Operating Expense	(0.7)	(0.0)	-	-	-
Avoided Expenses	(3.7)	(11.0)	(10.5)	(6.2)	(6.6)
Depreciation Expense	0.1	0.3	0.3	0.3	0.3
Interest	0.2	0.4	0.4	0.4	0.4
AFUDC	(0.1)	(0.0)	-	-	-
Earnings before taxes	(0.1)	0.3	0.3	0.3	0.4
Income taxes	(0.3)	(0.1)	(0.0)	(0.0)	(0.0)
Net Earnings	$0.2	$0.4	$0.4	$0.4	$0.4
Revenue Requirement of Capital Investment	($0.6)	$1.0	$1.0	$1.0	$1.0
Total Revenue Requirement	($4.3)	($10.0)	($9.5)	($5.1)	($5.6)

NS Power's revenue requirement in 2017, if NS Power did not pursue its economically justified capital projects, would be $4.3 million higher.

As shown in the above table, the avoided $4.3 million in Revenue Requirement is composed mostly of avoided expenses. These avoided expenses do not represent a reduction in NS Power's capital. Rather, they are primarily avoided replacement energy costs, as shown in each economically justified project's Economic Analysis Model.

Upward pressure on rates caused by NS Power's overall revenue requirement is minimized when economically justified projects are completed as compared to not completing them. The benefit of completing these projects is seen immediately in the first year.

Conclusion

NS Power's revenue requirement shows a decrease in 2017 and 2018 as a result of undertaking this capital plan, while 2019 to 2021 are forecasted to have an increase in revenue requirement. The cumulative effect of all years 2017 to 2021 is minimal upward pressure on rates.

Investment in the Current Asset Base has a small impact on revenue requirement while still maintaining reliability and performance of assets, and is justified based on need or economics in accordance with the requirements of the CEJC.

Investment in economically justified projects minimizes upward pressure on overall revenue requirement and rates by avoiding considerable expenses primarily related to replacement energy that would otherwise be incurred.

NS Power recognizes that this describes the influence of our capital program only. NS Power also recognizes that all aspects of our business contribute to the complete picture of our revenue requirement in any given year. Those other aspects include, broadly, fuel costs, operating, maintenance, and general (OM&G) costs, and past investments.

The 2017 ACE Plan, as with prior ACE Plans, emphasizes affordability for customers by maintaining its focus on sustaining capital expenditures, and prudently maintaining NS Power's Generation, Transmission and Distribution systems.

Addendum: Work Support Facilities

NS Power has broken out the revenue requirement effect of Work Support Facilities projects. Work Support Facilities projects, according to the CEJC, are those typically associated with building, facilities replacement, and modifications, telecontrol and telecommunications, and information technology.

Those Work Support Facilities projects that NS Power submits for approval either provide a clear benefit or are considered necessary pursuant to indvidual project justifications. For example, Information Technology related capital projects are frequently necessary due to a number of factors including obsolescence of previous technology, manufacturer support expiring, or improving work practices in line with industry trends. Capital work orders for Work Support Facilities will be assessed and submitted in accordance with the criteria found in the CEJC, and will describe the corresponding justification for the project, be it technical or economic.

WORK SUPPORT FACILITIES

NOVA SCOTIA POWER ($M)	**2017 ACE**	**2018**	**2019**	**2020**	**2021**
<u>Estimated Spend Related to five-year Capital Plan</u>					
Capital Expenditures (Spend)	$113.1	$115.4	$117.7	$120.1	$122.5
Less: Depreciation of all assets	58.6	69.2	75.9	85.6	101.0
Incremental Spend over Depreciation (Growth)	54.5	46.2	41.7	34.5	21.4
Incremental Spend as a portion of Total Spend	48.2%	40.1%	35.5%	28.7%	17.5%
Average Incremental Net Book Value of projects in five-year plan	27.3	77.6	121.6	159.7	187.7
<u>Impact on Net Earnings</u>					
Expenses					
OM&G					
Administrative Overhead	(1.8)	(1.5)	(1.4)	(1.1)	(0.7)
Depreciation	0.8	2.1	3.2	3.7	3.0
Interest	1.0	2.9	4.5	5.9	6.9
AFUDC	(1.4)	(1.2)	(1.1)	(0.9)	(0.5)
Earnings before tax	(0.3)	1.7	3.4	5.3	7.4
Income Tax less Impact of Administrative Overhead	(0.8)	(0.6)	(0.4)	0.1	1.2
Income Tax Impact of Administrative Overhead	(0.4)	(0.3)	(0.3)	(0.2)	(0.2)
Net Earnings	$0.9	$2.6	$4.1	$5.4	$6.3
<u>Incremental Revenue Requirement of five-year capital plan</u>					
Incremental Revenue Requirement of five-year capital plan	(1.7)	3.9	8.6	12.9	16.0
Change in Incremental Revenue Requirement from Previous Year	(1.7)	5.6	4.8	4.2	3.2

*NS Power has not determined the future planned investments in Work Support Facilities beyond 2017. As such, the analysis assumes that the level of investment would increase by an inflation rate of 2 percent annually. The incremental spend as a portion of total spend is assumed to be the same as the entire capital program. The revenue requirement effect includes the same factors as those used in the Long-Term Capital Planning & Revenue Requirement table.

8.1.2 Sustaining Capital – 2017 ACE Plan Alignment with the Integrated Resource Plan (IRP)

The 2015 ACE Plan Terms of Consensus provide the following:

> (8) NS Power will also engage with interested stakeholders on the issue of NS Power including information in future ACE Plans to show how its long-term planning assumptions regarding projections of sustaining capital investment in existing thermal plants presented in the IRP and future ACE Plans are consistent. This stakeholder consultation process will begin within 30 days of the Board issuing its decision in this matter.[18]

During the stakeholder consultation process in early 2015, NS Power discussed the issue of including information in future ACE Plans to show how its long-term planning assumptions regarding projections of sustaining capital investment in existing thermal plants presented in the IRP and future ACE Plans are consistent. A mock-up of this commitment was provided to and agreed upon by stakeholders pursuant to NS Power's report submitted to the Board on June 30, 2015.[19] NS Power provides this information below.

NS Power introduced sustaining capital assumptions for the thermal generating fleet for the first time in the 2014 IRP. This was made necessary by efforts to include unit retirement assumptions in the IRP analysis. The 2017 ACE Plan was derived using the same asset management practices used for the sustaining capital forecast assumptions for the 25 year planning period of the 2014 IRP.

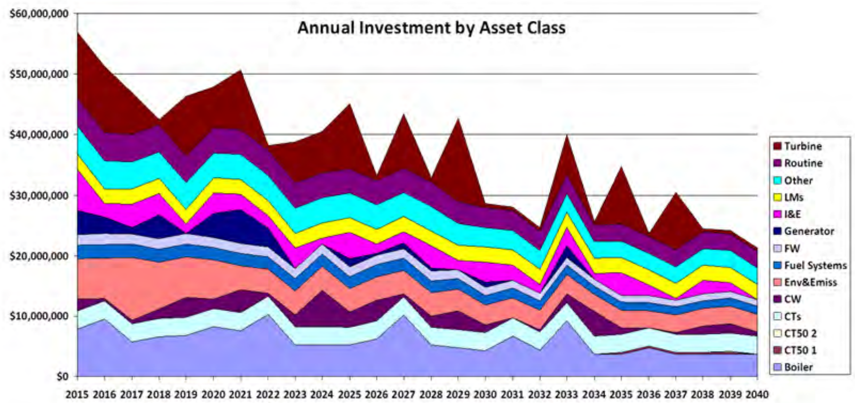
When comparing a single capital year from an ACE Plan to a long term planning exercise such as the IRP, it is important to take into consideration the leveling of investment done for the 25 year capital forecast used within the IRP. Outside of major asset classes

[18] NS Power 2015 ACE Plan, Terms of Consensus Agreement, M06514/P-128.15, February 18, 2015, page 2.
[19] NS Power 2015 ACE Plan Stakeholder Engagement Report, M06963, June 30, 2015.

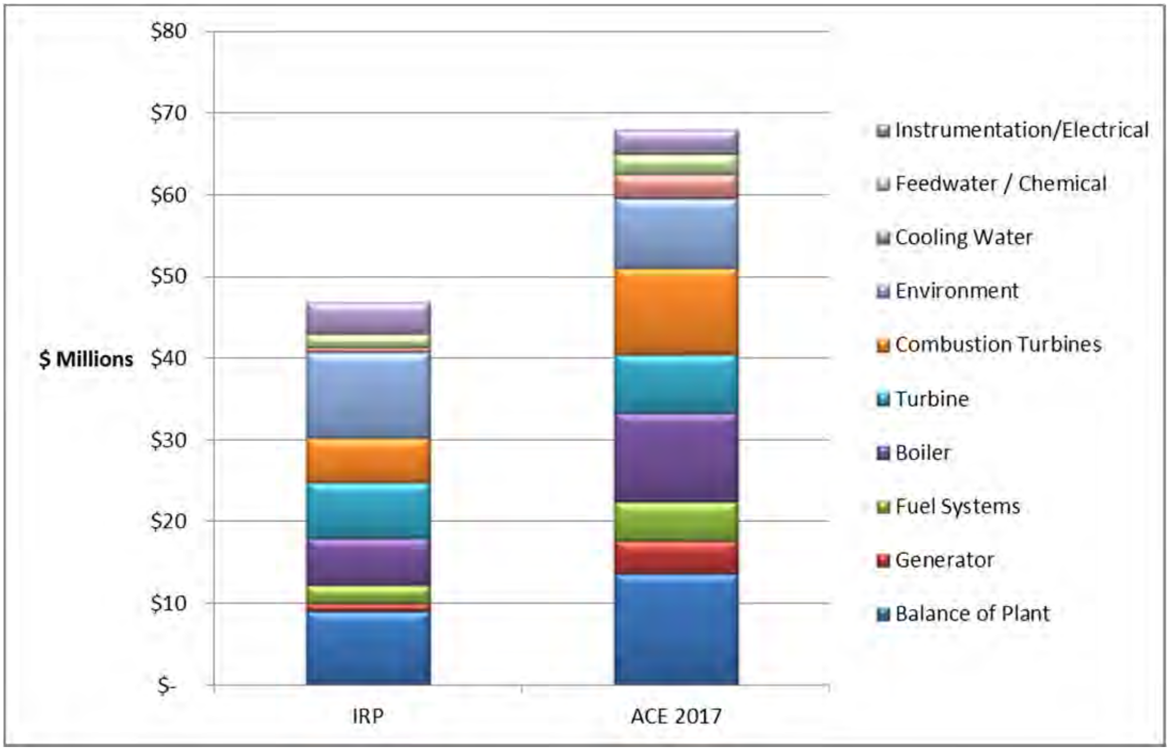
(turbines, generators, etc.), the investment in asset classes are levelized throughout the expected life of the associated generating unit.

The capital investment forecast used in the 2014 IRP is shown below.

2014 IRP Sustaining Capital Forecast



As shown in the table below, NS Power has completed a more detailed, single year capital forecast; the 2017 capital forecast has changed as compared to the amount used in the 2014 IRP.



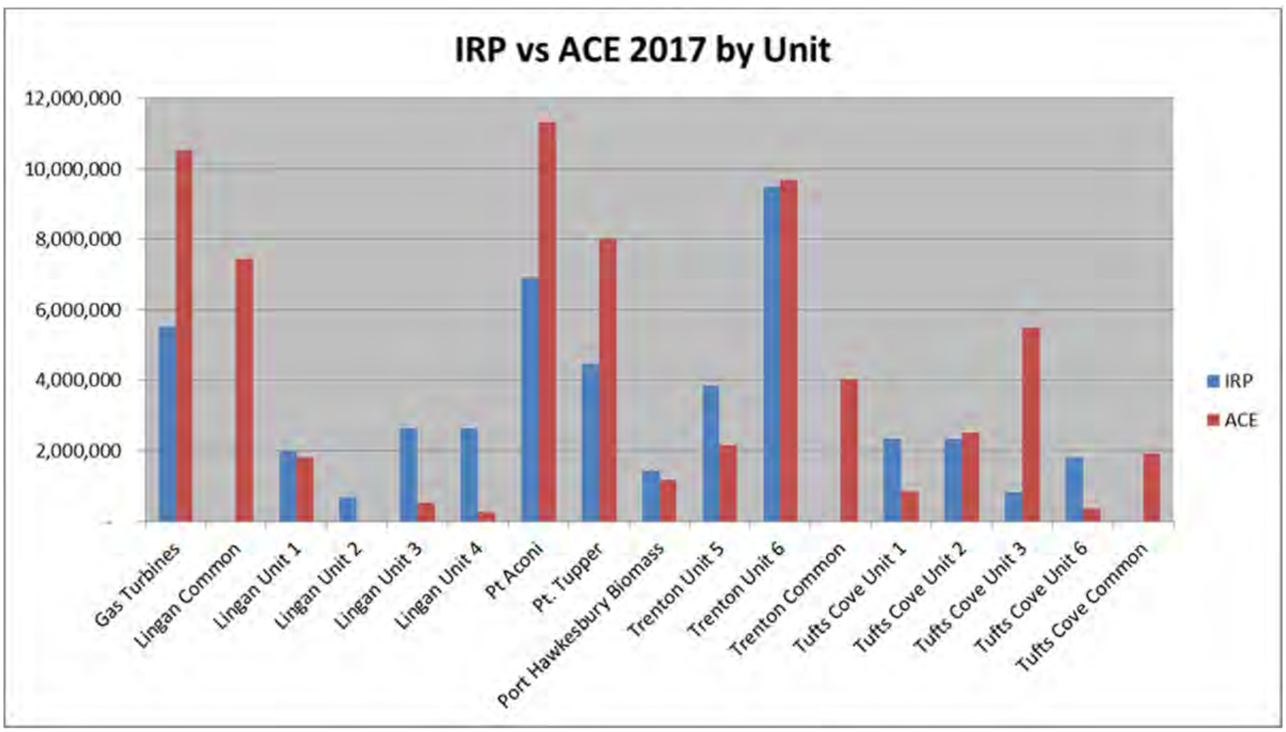
While the 2017 ACE Plan forecast is higher than the 2014 IRP forecast for 2017, the variance is largely due to the following:

- The 2014 IRP was completed using only 2014 dollars and did not include any form of inflation for future years and was at a time where the Canadian dollar was relatively on par with the US dollar. When applied to the 2014 IRP forecast, a conservative estimate of the increase in that forecast would be $6 million.

- 2017 also has a large investment in the combustion turbine units, that were included in the IRP forecast at $5.5 million levelized annually. The capital investment in 2017 is $10.5 million, largely due to the deferral of the Burnside Unit #4 Restoration project, as well as some significant investment in the LM6000 units on the Air House and Control Systems. This represents approximately a $5 million increase from the IRP forecast. This increased investment does not have an effect on alignment with the IRP as all Combustion Turbines are anticipated to operate throughout the IRP Planning Period, an assumption that was common to all of the Resource Plans evaluated in the IRP.

- Another driver for this increase is the investment in Tufts Cove Unit #3. In 2017, a significant investment in the Tufts Cove Unit #3 intermediate pressure (IP) blades is being made that was not known at the time of the IRP Planning process. This represents approximately $4 million of the increase from the IRP forecast.

- The remaining increase is due to an increase in the investment of boilers and balance of plant assets. The boiler investment across all units was levelized in the 2014 IRP. In actual practice, investments are expected to have years that vary above the IRP planning forecast. Significant investment on the Trenton Unit #6 boiler (air heater and selective boiler component refurbishment) is a large driver in 2017. Balance of Plant items would not have had a detailed future forecast in the IRP planning process. The condition of these assets is not known to the level of detail as many of the complex asset classes (turbines, boilers, etc) across the generating fleet.



Asset classes related to Lingan, Tufts Cove and Trenton Common include costs associated with ash and other elements of the station which are common to the generating units. While these are accounted for separately in the ACE Plan, the common costs were spread across the associated units in the IRP sustaining capital assumptions for the modeling purposes.

8.1.3 Summary of 2017 ACE Plan Capital Items Related to NERC and/or NPCC Standards

The table below is provided pursuant to the UARB's 2011 ACE Plan Decision Directive 9.

CI#	Project Title	2017 ACE Plan	Total Estimate	2017 ACE Category
46757	88S Lingan 230kV BPS Upgrades	$1,561,855	$3,080,663	Carryover
NERC and/or NPCC Compliance Total		**$1,561,855**	**$3,080,663**	

** The primary justification for the projects listed is compliance with NERC Standards and/or NPCC Criteria. Other capital projects (e.g. generation projects that preserve reserve margins or maintain Black-Start Capability) provide important compliance benefits but these are secondary to the project primary justification.*

8.1.4 Annual Ranking/Prioritization of Capital Projects

Pursuant to the UARB's 2011 ACE Plan directive 11 and 2013 ACE Plan directive 7, below is NS Power's capital project ranking criteria.

NS Power capital projects are ranked according to the following criteria:

- Health and Safety: Operating Permits, Personnel Safety
- Regulatory Compliance: Renewable Electricity Standards, GHG Regulations, Air, Emission Regulations, NERC/NPCC Requirements, Generating Unit Operating Approvals issued by NSE
- Customer Reliability: SAIDI, SAIFI, CAIDI
- Requirement to Serve

- Economics: Based on Net Present Value of the Project, Levelized Cost Analysis, $/Avoided Customer Hours of Interruption (ACHI)

Each year, the capital program includes those projects which are essential for health and safety objectives, regulatory compliance, and those which are required to provide service to an area. Projects which serve to address customer reliability are evaluated based on factors related to performance targets (System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI), Customer Average Interruption Duration Index (CAIDI), etc.). Economic initiatives are evaluated based on their economic ranking.

NS Power Ranking Methodology

NS Power's ranking is described in section 6.2 of the CEJC. This methodology uses a ranking matrix which results in a final ranking of 1 to 25. The ranking (also termed risk) is developed by determining the "Criticality" (ranked 1 to 5) and "Condition" (ranked 1to 5) of each asset and multiplying the two to determine the overall risk.

Criticality and Condition values are typically influenced by one predominant factor and ranked accordingly. However, other factors may also influence the ranking of a project. In the event that multiple factors are present for a project, individual rankings will be taken into consideration in determining the overall Criticality rankings. For example, Health and Safety considerations for a project may warrant a Criticality ranking of serious (3), while Environmental considerations for the same project may also independently warrant a Criticality ranking of serious (3); this project may therefore warrant a higher Criticality ranking of 4 or 5 due to multiple influencing factors.

Multiple influencing factors, rankings, and the order of completion of projects ahead of others, are all subject to the evaluation and professional judgment of NS Power staff and third party industry experts.

The tables that follow identify the projects included in the 2017 ACE Plan, their ranking category and ranking value, where applicable.

Generation

Hydro – 2017 ACE Plan Capital Item Rankings

CI	Project Title	2017 ACE Budget	Ranking Category	Criticality	Condition	Ranking
39472	HYD Mersey Hydro System Re-Development	300,000	Business Sustainability	4	5	20
29807	HYD - Tusket Falls Main Dam	3,697,643	Health & Safety	5	4	20
47654	HYD - Gulch Pipeline & Surge Tank Replacement	3,526,825	Business Sustainability	4	5	20
48535	HYD Scragg Lake Dam and Spillway Refurbishment	1,861,306	Health & Safety	4	5	20
48533	HYD - Lequille Headpond Water Retaining Structures Refurbishment	1,809,228	Health & Safety	4	5	20
48052	HYD - Annapolis HVAC Upgrade	1,420,463	Business Sustainability	4	5	20
47648	HYD - Lequille Pipeline Replacement	1,329,928	Business Sustainability	4	5	20
47876	HYD - Lequille Overhaul	1,075,450	Business Sustainability	4	4	16
38931	HYD - Harmony Partial Decommissioning	586,469	Health & Safety	4	5	20
49596	HYD - Hells Gate 2 Overhaul	962,316	Business Sustainability	4	5	20
47678	HYD - Prince Mine Dam Decommissioning	761,647	Health & Safety	3	5	15
47682	HYD - Lequille Switchgear Replacement	651,251	Business Sustainability	3	4	12
48913	HYD - Tusket Facility Refurbishment	656,308	Business Sustainability	4	4	16
49835	HYD - Dive Site Risk Mitigation	315,851	Health & Safety	5	4	20
49598	HYD - Gisborne Switchgear Replacement	593,754	Business Sustainability	4	4	16
48631	HYD - Gulch Spillway Refurbishment	549,231	Health & Safety	4	5	20
47166	HYD - McAskill Brook Decommissioning	459,736	Health & Safety	2	2	4
48914	HYD - Malay Falls Facility Repair	444,589	Business Sustainability	4	5	20
48396	HYD - Bridge Remediation	338,935	Health & Safety	4	4	16
47660	HYD - Dickie Brook Controls Upgrade	94,032	Business Sustainability	4	5	20
49039	HYD - Lequille Controls Upgrade	298,302	Business Sustainability	4	5	20
47659	HYD - Fall River Controls Upgrade	95,201	Business Sustainability	4	5	20
48397	HYD - Mink Lake Dam Repair	158,959	Health & Safety	4	4	16
48712	HYD - Dam Instrumentation Upgrade	195,996	Business Sustainability	4	4	16
47655	HYD - Paradise Controls Upgrade	87,796	Business Sustainability	4	5	20

CI	Project Title	2017 ACE Budget	Ranking Category	Criticality	Condition	Ranking
49623	HYD - Grand Lake Radio Communications Upgrade	139,204	Business Sustainability	4	5	20
49622	HYD - Fourth Lake PLC Upgrades	116,767	Business Sustainability	4	5	20
49945	HYD - Malay Falls Switchgear Replacement	43,459	Business Sustainability	4	4	16
46253	HYD - Lequille Tailrace Gate	27,719	Business Sustainability	4	4	16

Steam – 2017 ACE Plan Capital Item Rankings

CI	Project Title	2017 ACE Budget	Ranking Category	Criticality	Condition	Ranking
46499	Stator Rewind Kit Capital Spare	2,668,808	Business Sustainability	4	4	16
48893	TUC3 IP Turbine Refurbishment	4,338,274	Business Sustainability	5	4	20
47531	TRE6 Turbine Refurbishments	1,500,000	Business Sustainability	5	4	20
49532	TRE6 Air Heater Refurbishment	1,428,236	Business Sustainability	4	4	16
49533	TRE6 Boiler Refurbishment	1,259,454	Business Sustainability	4	5	20
47687	POT Boiler Chemical Recondition	794,560	Business Sustainability	4	4	16
49419	POT Boiler Refurbishment 2017	969,292	Business Sustainability	3	5	15
49057	TRE6 Excitation System Replacement	474,066	Business Sustainability	4	4	16
49535	TRE6 Mills Refurbishment 2017	822,141	Business Sustainability	4	4	16
47597	TRE6 Bottom Ash Chain Replacement	793,792	Business Sustainability	4	4	16
49536	TRE5 Boiler Refurbishments 2017	717,589	Business Sustainability	3	5	15
41511	TRE6 - Condenser Waterbox and Cooling Water Piping Refurbishment	700,809	Business Sustainability	3	5	15
49431	LIN Mill Refurbishment 2017	665,839	Business Sustainability	4	4	16
49438	LIN A Gallery Floor Replacement	593,814	Health & Safety	4	4	16
49675	TUC2 Cooling Water Piping Refurbishment	568,673	Business Sustainability	4	5	20
47953	LIN Railcar Positioner Upgrade	566,619	Business Sustainability	4	4	16
49897	POT - Fire System Upgrades 2017	538,437	Health & Safety	5	4	20
49430	LIN CW Pump Refurbishment 2017	516,270	Business Sustainability	4	4	16
49433	LIN1 SH5 Boiler Tube Replacement	493,396	Business Sustainability	3	5	15
49499	PHB - Boiler Refurbishment 2017	484,730	Business Sustainability	3	5	15
49111	POT - Air heater refurbishment	462,168	Business Sustainability	4	4	16

CI	Project Title	2017 ACE Budget	Ranking Category	Criticality	Condition	Ranking
49466	PTMT - Dock and Inhaul Conveyor Replacement	467,607	Health & Safety	4	4	16
49707	TUC2 High Voltage Bushing	440,082	Business Sustainability	4	4	16
49537	TRE6 Analytical Panel Upgrade	438,216	Business Sustainability	4	4	16
47893	TUC3 PE Generator Hydrogen Panel Replacement	421,182	Business Sustainability	4	4	16
49538	TRE6 Generator Refurbishment	411,766	Business Sustainability	4	4	16
47761	LIN1 Boiler Refurbishment	398,673	Business Sustainability	3	5	15
47553	TRE6 Turbine Main Valves	392,887	Business Sustainability	4	4	16
49674	TUC2 Boiler Selective Waterwall Tube Replacements	390,898	Business Sustainability	3	5	15
49427	LIN Coal Plant Structural Refurbishment Phase 3	365,003	Health & Safety	4	4	16
49434	LIN CW Screen Refurbishment 2017	347,062	Business Sustainability	3	5	15
49463	POT Coal Mill Overhauls 2017	328,410	Business Sustainability	3	5	15
49429	LIN Coal Pile Run Off Pond Expansion	311,793	Environment	5	4	20
49060	POT - Condenser Dog Bone Expansion Joint Replacement	298,253	Business Sustainability	4	4	16
49437	LIN Vacuum Pump Cooler Refurbishment	282,034	Business Sustainability	4	4	16
48868	AMO Fleet TWIP Upgrades	257,442	Business Sustainability	4	4	16
49440	LIN 1&2 GSCW Piping Reconditioning	247,116	Business Sustainability	3	5	15
49151	LIN Grating Refurbishment	246,871	Health & Safety	3	5	15
47116	LIN PE Flyash Surge System Bypass	187,126	Business Sustainability	4	4	16
49912	ICP - Armour Stone Refurbishment Phase 2	242,644	Health & Safety	4	5	20
47834	ICP Ranger Motor Upgrade	242,512	Business Sustainability	3	5	15
49873	LIN Seaweed Picker Upgrade	242,227	Business Sustainability	4	4	16
49313	ICP UU Mile 8.0 Track Replacement	240,653	Business Sustainability	3	5	15
47960	LIN1 Control Valve Rebuild	237,623	Business Sustainability	4	4	16
49452	LIN3 Heater Level Controls Upgrade	235,135	Business Sustainability	4	4	16
49439	LIN Plant Siding Replacement	233,859	Health & Safety	3	5	15
49436	LIN Reclaim Refurbishment	233,494	Business Sustainability	3	5	15
49672	TUC3 Feedwater Valve Replacement	232,799	Business Sustainability	4	4	16
49684	TUC 4kv/600V Breaker Replacement	232,694	Business Sustainability	4	4	16

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CI	Project Title	2017 ACE Budget	Ranking Category	Criticality	Condition	Ranking
49553	TRE Asbestos Abatement 2017	226,451	Health & Safety	3	5	15
49666	TUC1 South Boiler Feedpump Refurbishment	226,025	Business Sustainability	3	5	15
49716	TUC Asbestos Abatement	222,812	Health & Safety	4	4	16
48776	LIN PA Plant Lighting Upgrade	222,312	Health & Safety	4	4	16
49693	TUC HFO Piping Refurbishments	219,022	Business Sustainability	4	4	16
49432	LIN PF Line Refurbishment	215,899	Business Sustainability	4	4	16
49519	POT - Asbestos management 2017	213,811	Health & Safety	3	5	15
49420	POT - Plant siding 2017	211,116	Health & Safety	3	5	15
49444	LIN1 Misc. Valve Refurbishment	210,463	Business Sustainability	4	4	16
49435	LIN Heavy Oil Line Refurbishment Phase 2	210,252	Business Sustainability	4	4	16
49540	TRE6 6C Hydrogen/Water/Water Cooler Replacement	208,260	Business Sustainability	3	5	15
41226	LIN - Boiler Feed Pump Proportional Valve Replacements - Unit #1	207,980	Business Sustainability	4	4	16
49541	TRE6 6B Hydrogen/Water/Water Cooler Replacement	207,072	Business Sustainability	3	5	15
49539	TRE6 Burner Automation System Replacement	207,072	Business Sustainability	4	4	16
49542	TRE5 Main Boiler Stop Valves Rebuild	205,883	Business Sustainability	4	4	16
41229	LIN - Cable Spreading Rooms Fire Protection	161,946	Health & Safety	5	4	20
49545	TRE5 DCS Server Upgrade	200,031	Business Sustainability	4	4	16
49428	LIN Ash Site Capping	195,122	Environment	4	4	16
49546	TRE6 FW Heater Level Control	187,434	Business Sustainability	4	4	16
49547	TRE5 5-1 BFP Refurbishment	185,294	Business Sustainability	4	4	16
49549	TRE5 5-3 Mill Refurbishment	180,147	Business Sustainability	3	5	15
49500	PHB - Fuel System Refurbishment 2017	178,127	Business Sustainability	3	5	15
47642	TRE6 Feeder Controls Upgrade	171,040	Business Sustainability	4	4	16
50020	LIN CEM Replacement Phase 1	170,281	Environment	5	4	20
49550	TRE5 FW Heater Level Controls	169,776	Business Sustainability	4	5	20
49551	TRE5 CEMS Replacement	162,647	Environment	3	5	15
43239	LIN4 BFP Proportional Recirculation Line Control	160,757	Business Sustainability	4	4	16

CI	Project Title	2017 ACE Budget	Ranking Category	Criticality	Condition	Ranking
49667	TUC1 Oil Purifier I&C Heater Replacement	160,593	Business Sustainability	4	4	16
49501	PHB - Selective Turbine Valve Refurbishment	160,479	Business Sustainability	3	5	15
49991	TUC1 CEMS Replacement	159,167	Environment	4	4	16
49554	TRE Ash Site Management 2017	157,989	Environment	3	5	15
47602	TRE Oil Forwarding Pump Area Fire Protection	157,695	Business Sustainability	4	4	16
49677	TUC2 Replace Bailey Control Valves	156,173	Business Sustainability	4	4	16
47963	LIN Waster Water Stand Pipe Refurbishment	152,791	Business Sustainability	4	4	16
49676	TUC2 CEMS Replacement	150,374	Environment	4	5	20
49913	ICP - Railway Tie Upgrade Program	149,894	Business Sustainability	3	5	15
49680	TUC Heavy/Light Oil Pump Area Fire Protection	143,448	Business Sustainability	5	4	20
49467	POT - SSC refurbishment	142,988	Business Sustainability	3	5	15
45832	TUC6 Boiler Purge Credit	138,577	Business Sustainability	4	3	12
49704	TUC3 Replace Coils	137,236	Business Sustainability	4	4	16
49455	LIN1 Bus Duct IR Window and Temperature Sensor Installation	135,782	Health & Safety	3	5	15
49697	TUC2 Replace Oil Purifier I&C Heater	135,621	Business Sustainability	4	4	16
49654	TUC Refurbishment Gas Compressor 6A/6B	133,870	Business Sustainability	4	4	16
49711	TUC Low Load Oil Operation, Flue Gas monitoring	130,429	Business Sustainability	4	4	16
49678	TUC2 Replace Secondary Air Damper Drives	130,404	Business Sustainability	4	4	16
49543	TRE6 Conveyor Refurbishments	130,163	Business Sustainability	4	4	16
49556	TRE Excavator GPS System	129,416	Health & Safety	4	4	16
46485	TUC1 - Gas Block Valves	98,418	Business Sustainability	4	4	16
49708	TUC2 HEP/FAC Surveys	125,409	Business Sustainability	3	5	15
49512	POT - PLC Migration - Coal system	125,038	Business Sustainability	3	5	15
49449	LIN GSCW Line Replacement	121,615	Business Sustainability	3	5	15
49443	LIN Coal System Guard Upgrade Phase 3	120,131	Health & Safety	3	5	15
49709	TUC2 Replace Coils	116,612	Business Sustainability	4	4	16
49456	LIN1 Electric Motor Refurbishment	113,171	Business Sustainability	4	4	16

2017 Annual Capital Expenditure Plan

CI	Project Title	2017 ACE Budget	Ranking Category	Criticality	Condition	Ranking
49457	LIN3 Electric Motor Refurbishment	111,829	Business Sustainability	4	4	16
49458	LIN4 Electric Motor Refurbishment	111,829	Business Sustainability	4	4	16
49921	TRE6 6-4, 6-5, 6-6 Feedwater Heater Refurbishments	110,358	Business Sustainability	4	4	16
49516	PTMT - Fire system refurbishment	109,189	Health & Safety	5	3	15
50012	ICP #2 Gate/Chute Refurbishment	108,186	Business Sustainability	3	5	15
49459	LIN34 HMI TSC Upgrades	106,912	Business Sustainability	4	4	16
49689	TUC3 HP Heater Level Controls	106,055	Business Sustainability	4	4	16
49682	TUC2 HP Heater Level Controls	105,984	Business Sustainability	4	4	16
49670	TUC1 4kv/600V Breaker Replacement	104,851	Business Sustainability	4	4	16
49442	LIN Facilities Upgrade	104,630	Business Sustainability	4	4	16
49453	LIN Stores Fire Protection Upgrade	104,232	Health & Safety	4	4	16
49464	POT - E Coal Conveyor Refurbishment	103,388	Business Sustainability	3	5	15
49915	ICP Railcenter Security System Upgrade	101,139	Business Sustainability	3	5	15
49715	TUC Upgrade PLC Control Panel	99,875	Business Sustainability	4	4	16
49279	POT - Bay door replacements 2017	98,378	Business Sustainability	3	5	15
49510	POT - Refurbish travelling screens and replace panels	98,297	Business Sustainability	3	5	15
49445	LIN Feeder Controls Upgrades	93,733	Business Sustainability	3	5	15
50011	ICP Ranger Conveyor Structural Refurbishment Phase 2	92,330	Business Sustainability	3	5	15
49511	POT - Replace ID fan damper drives	92,186	Business Sustainability	3	5	15
49695	TUC Paint Roofs of HFO Storage Tank 2&4	81,390	Business Sustainability	3	5	15
49686	TUC3 Boiler Modulation Control Upgrade	80,024	Business Sustainability	4	4	16
49514	POT - LP heaters level controls	79,992	Business Sustainability	4	4	16
49681	TUC2 Boiler Modulation Control Upgrades	79,641	Business Sustainability	4	4	16
49544	TRE5 Conveyor Refurbishments	78,098	Business Sustainability	3	5	15
49557	TRE6 Coal Feeder Gauge Replacements	78,098	Business Sustainability	4	4	16
44587	POT - Selective Ash Site Capping	76,971	Environment	4	4	16
49663	TUC Nitrogen Generator	74,658	Business Sustainability	3	5	15

CI	Project Title	2017 ACE Budget	Ranking Category	Criticality	Condition	Ranking
49454	LIN3 Generator Bus Duct Temperature Sensors	73,153	Business Sustainability	4	4	16
43033	POT - Breaker replacements and refurbishments	67,757	Business Sustainability	3	5	15
49517	PTMT - Replace Dock Transformer	65,784	Business Sustainability	4	4	16
49502	PHB - Fire Suppression Expansion	65,599	Health & Safety	3	5	15
49687	TUC3 Bus Duct/Gen Terminal Monitoring System	64,674	Business Sustainability	4	4	16
49699	TUC6 Access Doors	64,304	Business Sustainability	4	4	16
49558	TRE6 Bus Bar Repairs/IR Windows	62,478	Health & Safety	4	4	16
49917	ICP Coal Load Out Hydraulics Upgrades	60,541	Business Sustainability	3	5	15
49671	TUC1 Rotating Element Extraction Pump Refurbishment	60,000	Business Sustainability	3	5	15
49515	POT - Replacement of Graver valves and solenoids	59,496	Business Sustainability	3	5	15
49683	TUC2 Bus Bar Inspection/Repair IR Windows	57,644	Business Sustainability	3	5	15
49688	TUC3 Analytical Panel Upgrades	55,050	Business Sustainability	4	4	16
49700	TUC6 Vacuum Cooler	54,610	Business Sustainability	4	4	16
47903	TUC2 Lube Oil Coolers' Inlet/Outlet Waterbox Replacement	54,494	Business Sustainability	3	5	15
47909	TUC Nat Gas Valves Refurbishment	54,153	Business Sustainability	4	4	16
49705	TUC3 Bus Bar IR Windows	52,995	Health & Safety	3	5	15
49653	TUC Dehumidifier Air Unit	51,073	Business Sustainability	3	5	15
49701	TUC6 Turbine Control Valves	50,584	Business Sustainability	4	4	16
49662	TUC Aquarian Migration	48,757	Business Sustainability	3	5	15
49673	TUC1 Extraction Pump Rotork Valve Actuator	48,479	Business Sustainability	3	5	15
47870	LIN Cofferdam Outer Cell Refurbishment	44,692	Business Sustainability	4	4	16
47907	TUC6 Vacuum Pumps' Seal Water Cooler Upgrade	40,501	Business Sustainability	4	4	16

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1 *Combustion Turbine – 2017 ACE Plan Capital Item Rankings*

CI	Project Title	2017 ACE Budget	Ranking Category	Criticality	Condition	Ranking
44776	CT - TUC#5 LM6000 Generator Stator Re-wedge	1,041,614	Business Sustainability	4	4	16
49273	CT-BGT2 Engine Refurbishment	908,102	Business Sustainability	4	5	20
49940	LM6000 TUC5 Control System Upgrade	1,018,769	Business Sustainability	4	4	16
49594	LM6000 TUC5 Airhouse Upgrade	833,200	Environment	4	5	20
49926	LM6000 TUC4 Airhouse Upgrade	815,633	Environment	4	5	20
49949	LM6000 TUC4 Control System Replacement	710,815	Business Sustainability	4	4	16
47118	CT Tusket Hydraulic Starter	317,015	Business Sustainability	4	4	16
49972	CT - LM6000 191-253 HPC Stages 3-5 Bushing Replacement	238,547	Business Sustainability	4	4	16
49971	CT - LM6000 191-332 HPC Stages 3-5 Bushings Replacement	237,952	Business Sustainability	4	4	16
49874	CT-BGT Replace Halon Fire Protection	226,366	Health & Safety	4	5	20
49950	LM6000 TUC4 SPRINT Nozzle Refurbishment	166,061	Business Sustainability	4	4	16
49951	LM6000 TUC5 SPRINT Nozzle Refurbishment	166,061	Business Sustainability	4	4	16
49973	CT - TUS Control Room Halon Replacement	84,304	Health & Safety	4	5	20
49936	CT - VJ 2 Enclosure Coating Refurbishment	57,550	Business Sustainability	3	5	15
49935	CT - VJ1 Enclosure Coating Refurbishment	55,933	Business Sustainability	3	5	15
49937	CT - BGT 1 Exterior Coating Refurbishment	52,117	Business Sustainability	4	4	16
49938	CT - BGT 2 Exterior Coating Refurbishment	52,117	Business Sustainability	4	4	16
49939	CT - BGT 3 Exterior Coating Refurbishment	52,117	Business Sustainability	4	4	16
49976	CT - BGT 4 Exterior Coating Refurbishment	52,117	Business Sustainability	4	4	16
49974	CT - TUC 4 LM6000 Metal Scan Upgrade	44,304	Business Sustainability	4	4	16
49975	CT - TUC 5 LM6000 Metal Scan Upgrade	44,304	Business Sustainability	4	4	16
49960	CT - VJ Exhaust Stack Grating Replacement	41,500	Health & Safety	4	5	20
49932	CT - TUC 4 LM6000 Roof Skid Access	33,161	Business Sustainability	4	4	16
49933	CT - TUC 5 LM6000 Roof Skid Access	33,161	Business Sustainability	4	4	16
49959	CT - VJ Varec Gauges Upgrade/Refurbishment	29,904	Business Sustainability	4	5	20
49961	CT - TUS Exhaust Stack Grating Replacement	25,205	Health & Safety	4	4	16

Transmission & Distribution

Transmission and Distribution – 2017 ACE Plan Capital Item Rankings

CI	Project Title	2017 ACE Budget	Ranking Category	Criticality	Condition	Ranking
Transmission Capital Items Included in 2017 ACE Plan						
43678	Separate L8004/L7005 on Canso Crossing Double Circuit Tower(DCT)	13,892,444	Business Sustainability	5	5	25
49992	2017 Transmission Right of Way Widening	5,400,855	Business Sustainability	4	4	16
45053	69Kv Structure Replacements West	321,656	Business Sustainability	4	4	16
47954	L7012 Replacements and Upgrades	2,073,902	Business Sustainability	4	5	20
49838	2017/2018 Substation Polychlorinated Biphenyl (PCB) Equipment Removal Program	2,653,789	Environment	5	4	20
50342	Western Transmission System Voltage Support	300,000	Business Sustainability	5	4	20
49948	2017/2018 Isolated Structure Replacements	1,209,834	Business Sustainability	4	5	20
49793	L7011 Replacements and Upgrades	1,304,384	Business Sustainability	4	5	20
49789	L6515 Replacements and Upgrades	1,097,771	Business Sustainability	4	5	20
49815	2017 / 2018 Steel Tower Refurbishment	929,792	Business Sustainability	4	4	16
49774	L5527 Replacements and Upgrades	722,891	Business Sustainability	4	5	20
49813	2017 Sacrificial Anode Installation Program	1,427,340	Business Sustainability	4	4	16
49814	2017 / 2018 Steel Tower Life Extension	427,938	Business Sustainability	4	4	16
49778	L5535 Replacements and Upgrades	1,261,920	Business Sustainability	4	5	20
49790	L5505 Replacements and Upgrades	575,817	Business Sustainability	4	5	20
49782	L5027B Replacements and Upgrades	1,093,542	Business Sustainability	4	5	20
49818	2017/2018 Transmission Switch & Breaker Replacement	496,339	Business Sustainability	4	5	20
49922	Western Switching Upgrades	353,906	Business Sustainability	4	5	20
49775	L5004 Replacements and Upgrades	995,712	Business Sustainability	5	4	20
49776	L7008 Replacements and Upgrades	876,277	Business Sustainability	4	4	16
43200	2017 Wood Pole Retreatment Program	841,821	Business Sustainability	4	4	16
49879	77V-T52 Replacement	746,631	Business Sustainability	4	5	20
47915	L5053 Replacements and Upgrades	692,706	Business Sustainability	4	5	20
47956	L7004 Replacements and Upgrades	672,131	Business Sustainability	4	5	20
49792	2017 Transmission Line Retirement Program	526,064	Health & Safety	4	4	16
49821	Mersey River Hydro Spare Transformer	101,450	Business Sustainability	4	4	16
49878	2017 Substation Insulator Replacement Program	508,893	Business Sustainability	4	4	16

CI	Project Title	2017 ACE Budget	Ranking Category	Criticality	Condition	Ranking
48057	Replace 69kV cables between 2S and 83S	459,931	Business Sustainability	4	4	16
49833	2017 Oil Containment Program	397,993	Environment	4	4	16
50021	91H Tufts Cove Bus and Line Upgrades	417,178	Business Sustainability	4	4	16
49798	2017 / 2018 Capacitor Bank Breaker Replacements	175,347	Business Sustainability	4	4	16
49928	3S Gannon Rd. Bus Reconfiguration	364,777	Business Sustainability	4	4	16
49929	Tap Changer Replacements	262,526	Business Sustainability	4	4	16
49795	100C Cape Porcupine Switch Additions	128,441	Business Sustainability	4	4	16
Distribution Capital Items Included in 2017 ACE Plan						
49919	2017 PCB Pole Top Transformer Replacement	2,257,603	Environment	5	4	20
49806	2017 Padmount Replacement Program	1,573,814	Business Sustainability	4	4	16
47776	111S Prime Brook Feeder Exits & Feeders	456,805	Business Sustainability	4	4	16
47787	2H Armdale New Feeders	1,253,299	Business Sustainability	4	4	16
47760	85S-402 Re-Insulate	499,495	Business Sustainability	4	4	16
44749	Tiverton Tower Refurbishment	689,416	Business Sustainability	5	4	20
41350	16W-301 Hebron Rebuild Phase 2	445,140	Business Sustainability	4	5	20
49836	11S-302 11S-401 Rebuild Coxheath Phase 2	340,322	Business Sustainability	4	5	20
49841	23H-Rockingham Voltage Conversion-Phase 2	424,818	Business Sustainability	4	4	16
50341	2017 Substation Recloser Replacements	577,388	Business Sustainability	4	4	16
49799	532N Elm Street Conversion Phase 1	548,688	Business Sustainability	5	4	20
49918	54H-303 Underground Device Replacements Phase I	469,604	Business Sustainability	5	4	20
47769	509V-301 Overcove Rd Replacements	402,493	Business Sustainability	5	4	20
49791	3N Oxford Conversion Phase 3	358,369	Business Sustainability	4	5	20
49867	55V-313-Berwick North Replacements	345,565	Business Sustainability	4	5	20
49591	3S Feeder Exit Cable Replacement	312,334	Business Sustainability	5	4	20
49891	509V Recloser and Voltage Regulator Replacement	319,649	Business Sustainability	5	4	20
50073	4S-332 Bernard Lind Drive Rebuild	302,893	Business Sustainability	4	5	20
49866	512N-Toney River Upgrade	285,219	Business Sustainability	5	4	20
49899	10H Halifax 4kV Conversion Year 4	254,608	Business Sustainability	5	4	20
49868	2017 Hydraulic Recloser Replacements	232,348	Business Sustainability	5	4	20
49862	50N-410 Rebuild Trenton	247,773	Business Sustainability	5	4	20

CI	Project Title	2017 ACE Budget	Ranking Category	Criticality	Condition	Ranking
49877	23H-302 Clayton Park Rebuild Phase II	215,859	Business Sustainability	4	4	16
49957	93V Feeder Expansion	165,912	Business Sustainability	5	4	20
49056	65V-302HAA Old Liverpool Rd Rebuild	127,408	Business Sustainability	4	5	20
46305	103W-311G Gold River Reconductor - Phase 4	118,563	Business Sustainability	5	4	20
47777	70W-321 Wiles Lake Road	99,876	Business Sustainability	4	5	20
49863	73W-411H New Germany Recloser	53,820	Business Sustainability	4	5	20
49956	505V Station Retirement	33,049	Business Sustainability	4	4	16

General Plant – Capital Item Rankings

The projects brought forward under General Plant primarily involve information technology, telecommunications, and facilities initiatives. These areas are too diverse to develop a comparable and useful ranking system across the groups, and therefore the determination of whether a project will proceed is based upon technical justifications or economic benefit.

8.1.5 2017 to 2021 Forecasted ACE Plan Expenditures by Functional Class and Spending Program

Pursuant to 2011 ACE Plan Directive 12, NS Power provides its forecasted spend by functional class and spending program. Justifications for projects determined as capital investments are scoped on an annual basis. Capital investment on the basis of health and safety, environmental compliance and requirement to serve remains non-discretionary. The following table identifies anticipated sustaining capital by function and specific notable investments included in this ACE Plan. Investment levels from 2017 to 2021 are subject to change based on operating conditions, updated asset assessments, regulatory directives, or legislation.

Sustaining capital funding levels represent typical annual investment by function in a given year to sustain the integrity of existing assets. Notable capital projections reflect specific projects. Included in these specific projects are transformative multi-year program investments and asset growth.

	2017 ACE	2018	2019	2020	2021
Base Capital Investment					
Thermal Generation	50.1	49.8	46.5	44.1	46.7
Combustion Turbines	11.3	8.5	5.5	8.0	5.5
Hydro Generation	34.5	35.1	21.1	20.3	22.2
Wind Generation	0.1	0.1	0.1	0.1	0.1
Transmission	55.8	56.2	52.3	53.4	54.4
Distribution	64.3	64.9	64.0	64.2	64.0
General Plant	45.5	27.1	25.9	26.1	30.7
Total Base Capital Expenditure	**261.6**	**241.8**	**215.4**	**216.2**	**223.7**
Notable Capital Investment					
Thermal:					
Trenton #6 Major Outage	9.7				
General Plant:					
IT - CIS Replacement	0.0	3.0	9.0	9.0	4.0
IT - Enterprise Resource Planning	54.4	4.7	1.3	0.5	2.5
IT – Work and Asset Management	8.0	18.3			
IT - Security Investment	6.0	3.0	1.0	1.0	3.0
Replace Mobile Radio System	3.0	3.0			
Distribution:					
Advanced Metering Infrastructure	17.1	48.3	45.9	6.1	
LED Streetlights	2.5	4.8	8.2		
Transmission:					
Maritime Link Transmission	24.7	5.0			
Metro Transmission Upgrades	5.8				
Lingan GIS Replacement	4.8	7.1			
Hydro:					
Hydro Infrastructural Renewal					
Wreck Cove Overhaul		1.2	24.5	40.8	21.1
Annapolis Overhaul		2.9	2.4	2.4	0.8

Mersey Re-Development	0.3	14.8	36.7	45.6	31.1
Total Notable Capital	**136.4**	**116.1**	**129.0**	**105.4**	**62.5**
Total Annual Capital Investment	**398.0**	**357.8**	**344.4**	**321.6**	**286.2**

8.1.6 Routine Expenditures

Pursuant to Directive 2 of the UARB's 2013 ACE Plan Decision, NS Power was directed "to analyze the routine expenditures to determine what are the "like-for-like" totals", and "explain why those totals, if they are similar in magnitude to the Board's analysis, are growing at an annual rate in excess of inflation."

A summary of NS Power's total routine and like-for-like routine spending is provided below:

ANNUAL COST OF LIKE-FOR-LIKE ROUTINE REPLACEMENTS

NOVA SCOTIA POWER ($M)	2013 Actual	2014 Actual	2015 Actuals	2016 Forecast	2017 ACE Plan
Total Routine Spending	$66.8	$68.2	$75.8	$84.0	$80.2
Less:					
New Customers	20.6	20.9	24.1	21.7	22.4
System Growth and Performance	3.0	2.0	2.8	7.9	3.0
Other	1.3	0.7	1.0	1.5	1.4
Like-for-Like	41.8	44.6	47.9	52.9	53.5
Work Vehicles (Like-for-like)	2.7	2.4	6.2	6.8	7.9
Net (Like-for-like)	39.1	42.1	41.8	46.1	45.6

*Point Aconi amounts have been removed in order to reflect the spend totals that require UARB approval.

Routine classifications are determined by the primary classification of each routine project. If the majority of the work completed under the routine is like-for-like replacements, the routine was classified as like-for-like. New Customer routines, System Growth and Performance routines (such as heat rate, system improvement and right-of-way widening routines) and other routines (such as environmental assessment routines) were not included in the like-for-like totals.

NS Power addresses reactive items within routines by using the professional judgment of its personnel to assess the urgency of each job. At an overall routine level, NS Power actively evaluates and prioritizes work in order to manage costs within budget. Each month, NS Power monitors the activities within the routines to evaluate whether the work is necessary.

8.1.7 Impact of Reliability Projects

The UARB's 2013 ACE Plan decision Directive 14 stated:

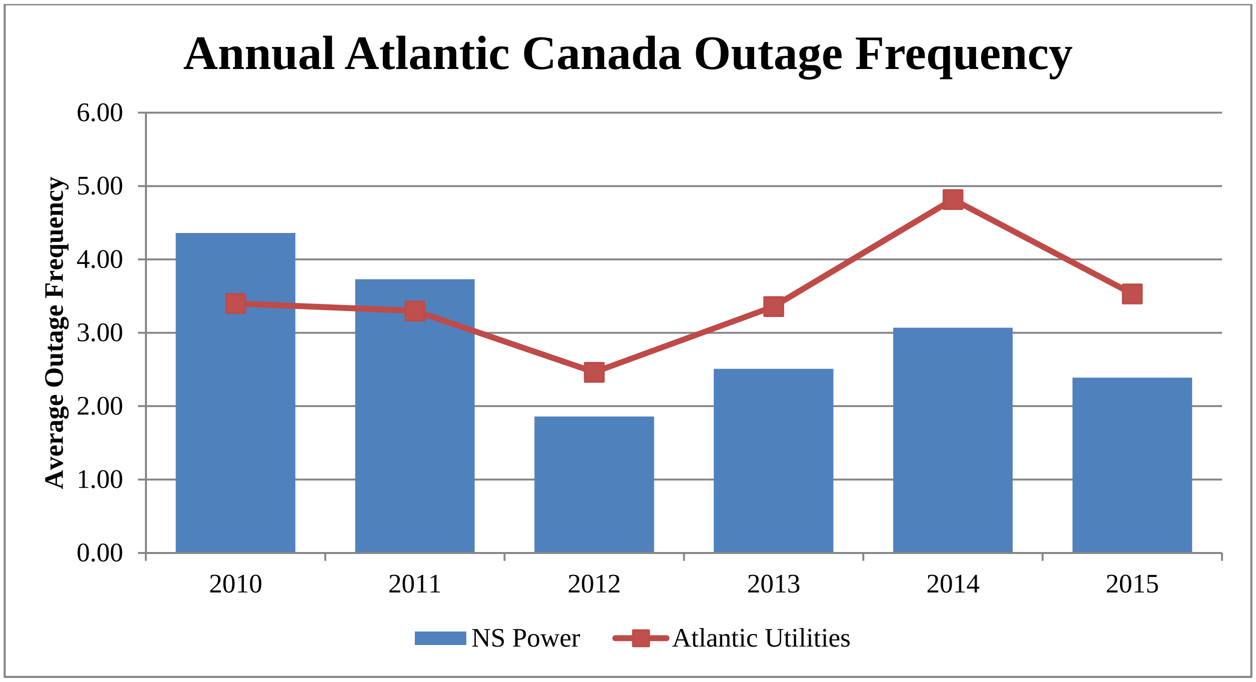
> …the Board expects NSPI to monitor the impact of the deferral of reliability projects in the original 2013 ACE Plan closely and to provide a report on the results in the next ACE Plan.[20]

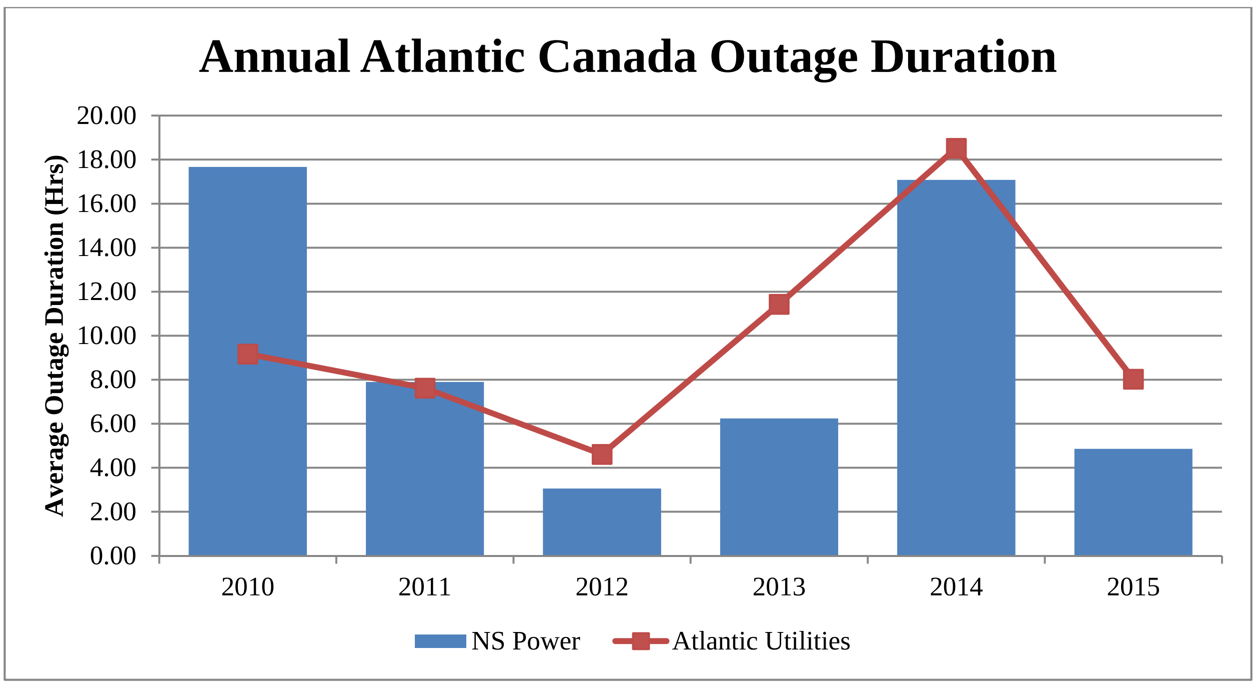
Pursuant to NS Power's commitment noted in the 2015 ACE Plan Terms of Consensus, this directive is expanded to include additional information regarding continued sustaining capital investments and maintaining reliability performance.

Reliability Statistics

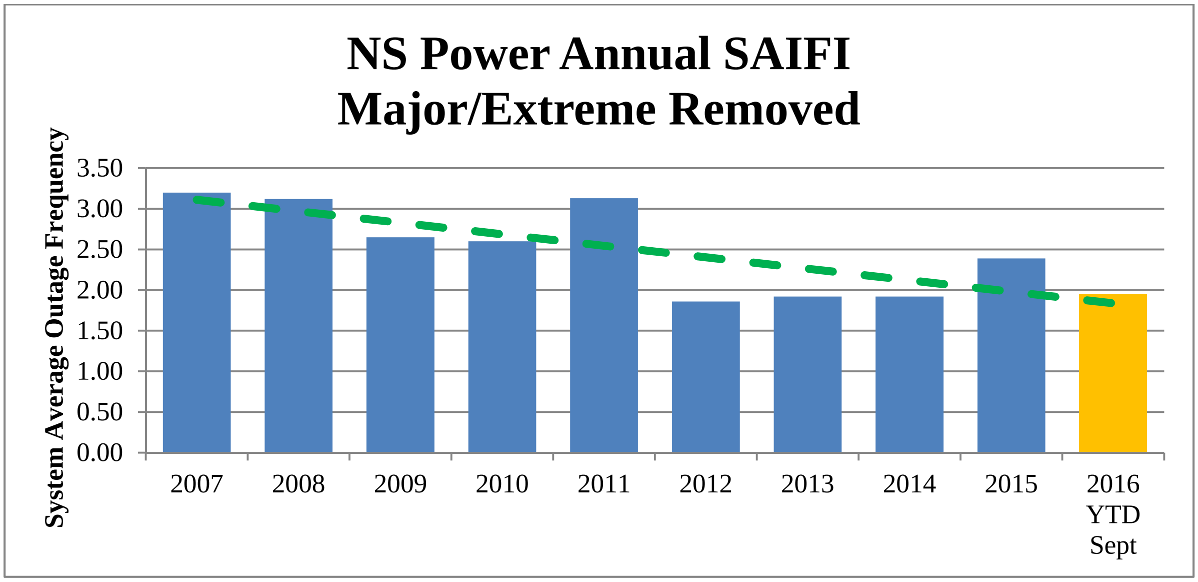
NS Power experienced its best reliability in recent years as a result of the five year Reliability Investment Strategy that started in 2009. As shown in the charts below, NS Power's annual outage frequency and duration continues to be below the average of Atlantic Canada utilities. The data for 2014 is higher due to Post Tropical Storm Arthur, but NS Power is still below the average of the Atlantic Canadian utilities, as reported annually to the CEA.

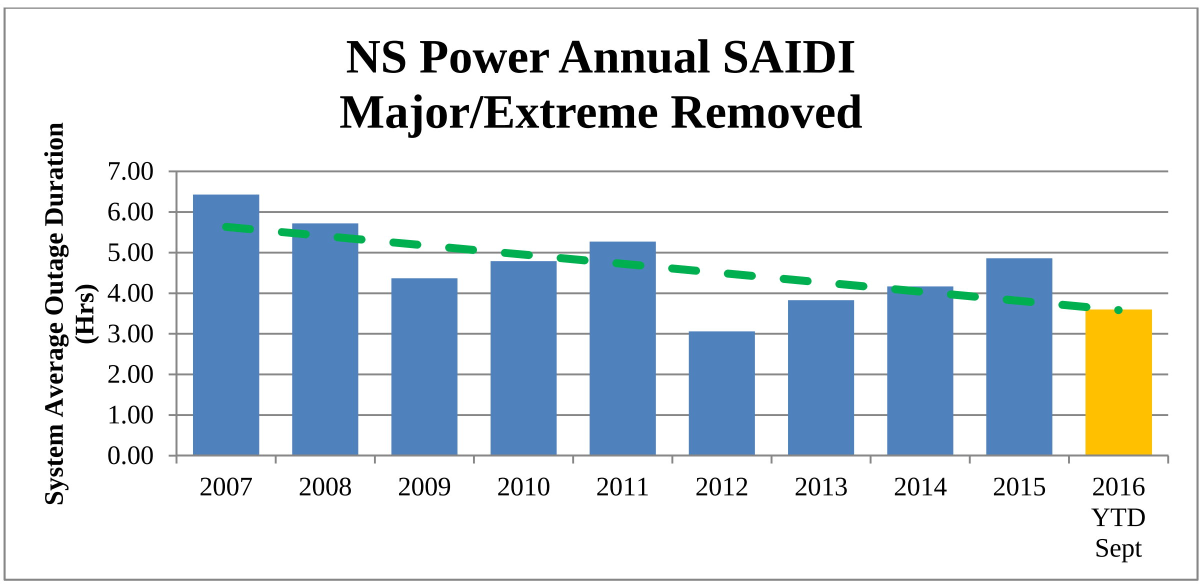
[20] NS Power 2013 ACE Plan, UARB Decision, M05339, May 27, 2013, page 44, line 174.



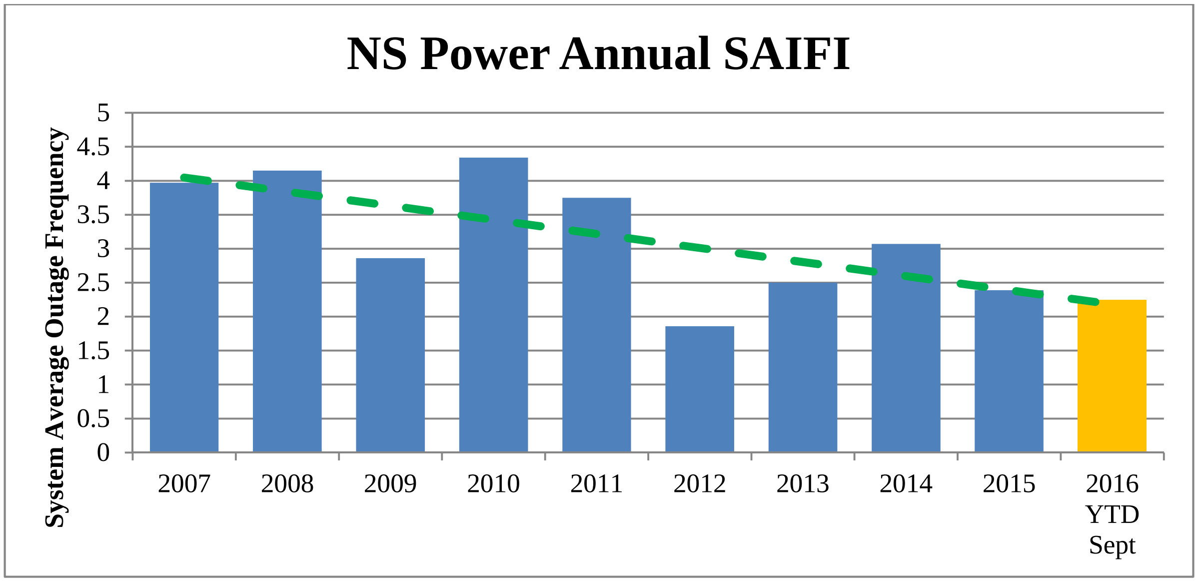


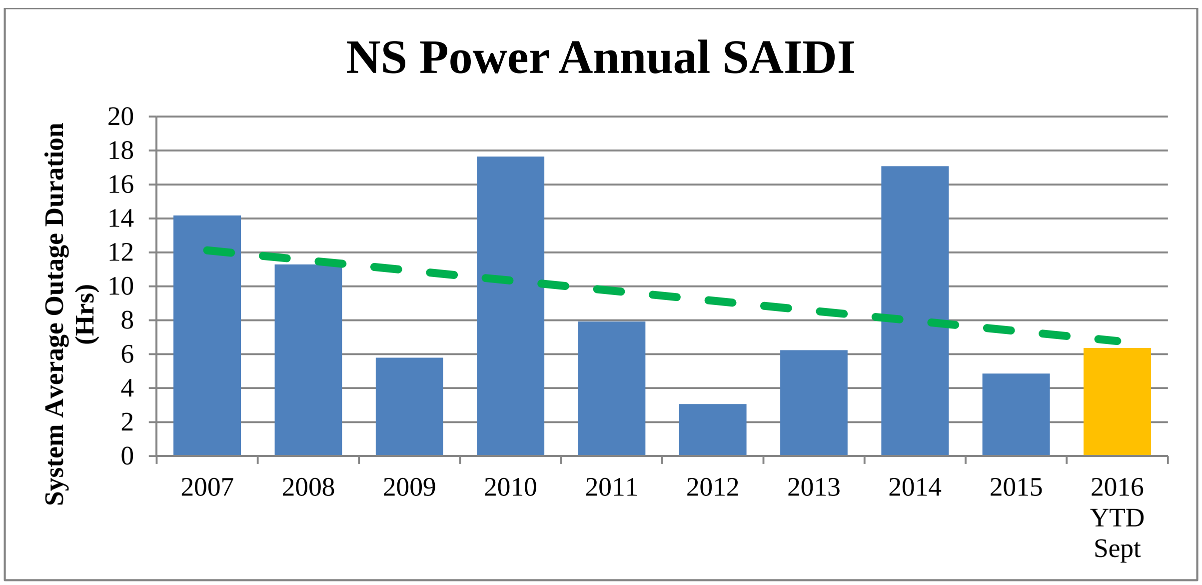
The two charts below represent NS Power's reliability statistics with Major and Extreme Events (such as Post-Tropical Storm Arthur and as defined by IEEE-1366) removed from the data. This shows a normalized comparison between yearly reliability performance. Increases in 2015 were largely the result of record snowfall leading to more frequent and longer smaller outages than would have been experienced in previous years, in turn leading to an increase in SAIFI and SAIDI. The 10 year trend shows overall reliability improvements for customers.





The following charts represent NS Power's reliability statistics with Extreme Events included.


NS Power Annual SAIFI
System Average Outage Frequency
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016 YTD Sept


NS Power Annual SAIDI
System Average Outage Duration (Hrs)
20
18
16
14
12
10
8
6
4
2
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016 YTD Sept

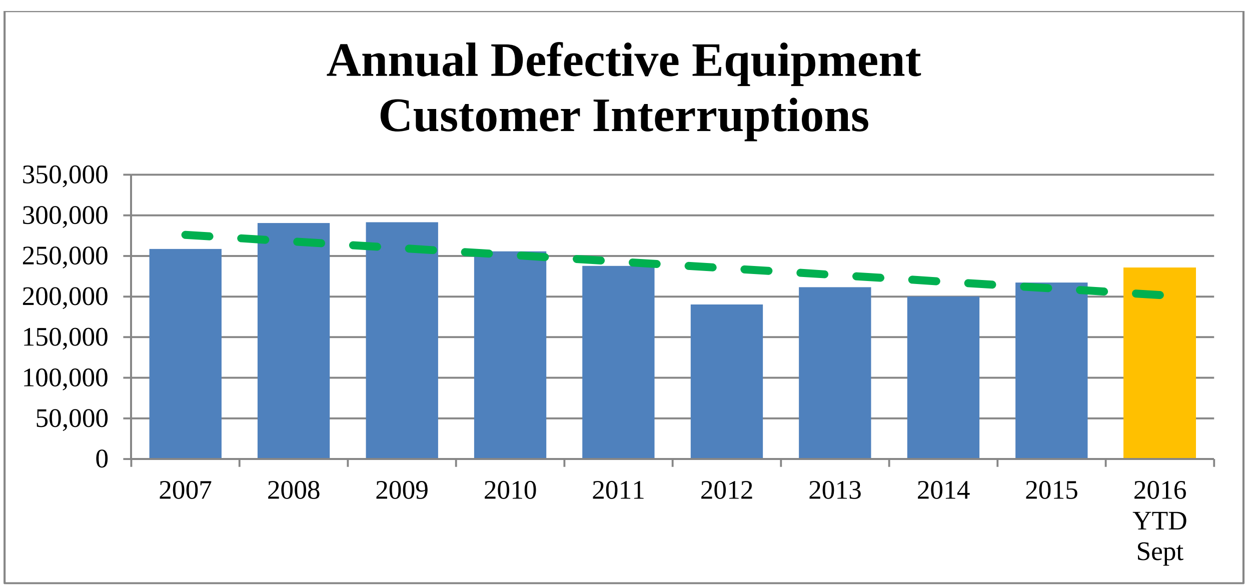
Outage Causes

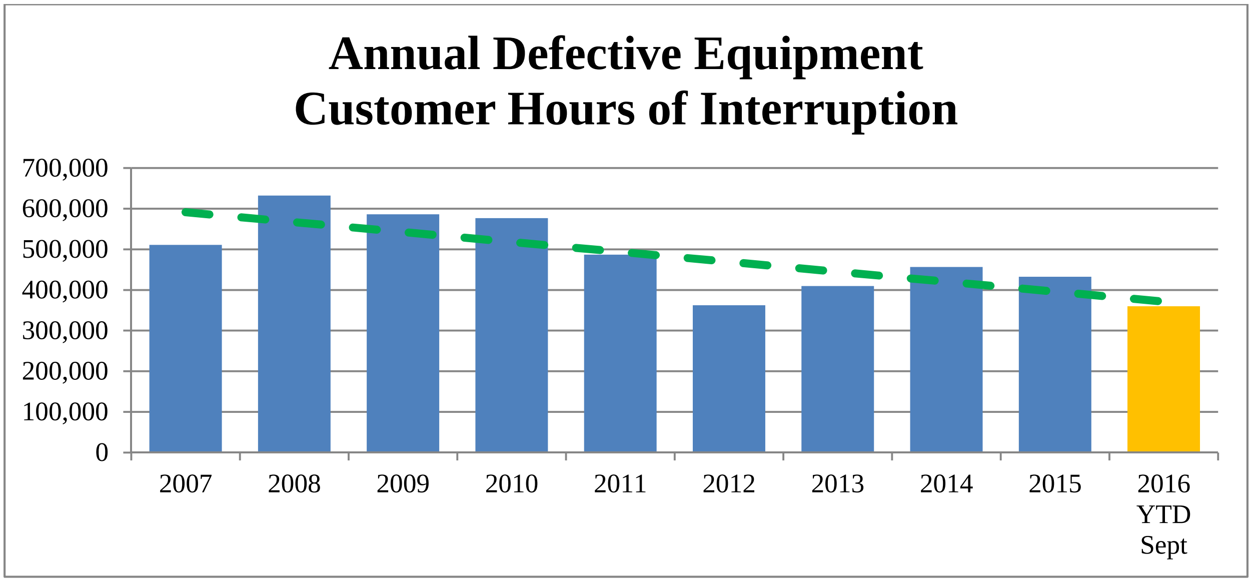
Historically, two of the leading causes of NS Power customer outages for all days (storm and non-storm) are Defective Equipment and Tree Contacts. These outage causes and NS Power's associated investments are described in more detail below.

<u>Defective Equipment</u>

The following two charts demonstrate reliability gains realized through upgrades and replacements of targeted distribution equipment resulting from the Reliability Investment Strategy. There has been an improvement in both customer interruptions and customer hours of interruption due to defective equipment.

The increased customer interruptions for 2016 is a result of a number of failures of a particular type of in-line disconnect switches in Metro Halifax. These resulted in high customer interruptions but short duration outages; as shown in the second chart, customer hours of interruptions is lower YTD. These devices were not previously included in targeted device replacement programs, but have been scoped throughout Metro for planned replacements.





Taking a further look into the 2015 reliability data, defective equipment outages can be classified by device type. This is shown in the table below.

Customer Hours of Interruption		
Device Type	**2015**	**% of Hours**
Pin Insulator	83,455	19.28%
Primary Conductor	65,777	15.20%
Cutout	44,581	10.30%
Tie Wire	40,500	9.36%
Voltage Regulator	22,750	5.26%
Wood Pole	22,200	5.13%
U/G Primary Cable	17,805	4.11%
Recloser	15,777	3.65%
Inline Disconnect	13,401	3.10%
Fuse Link	11,588	2.68%

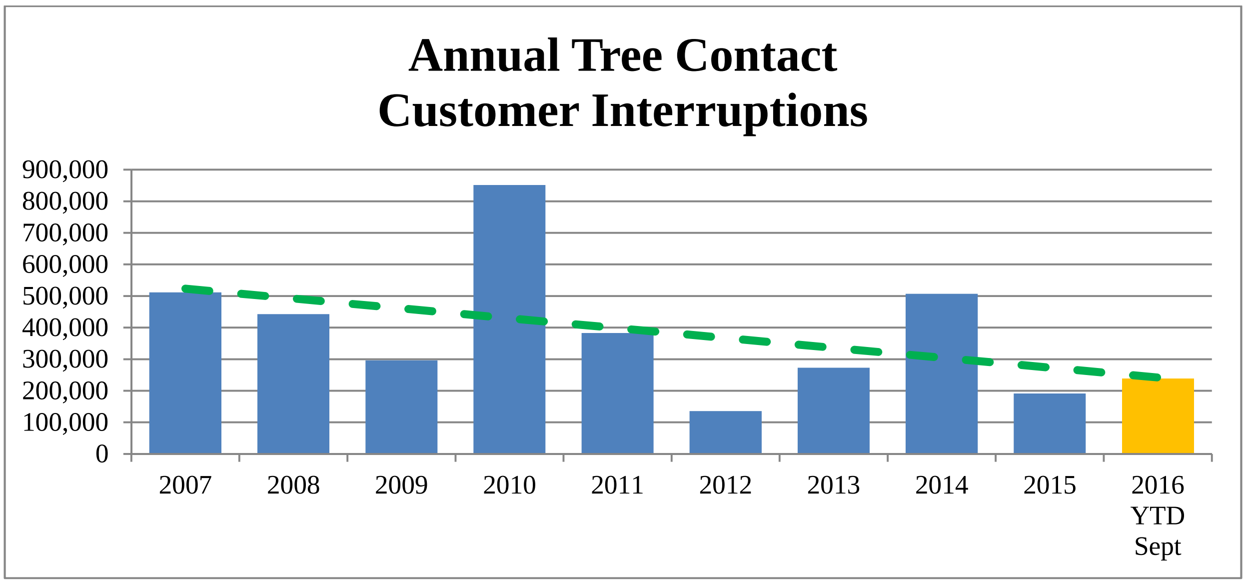
All Distribution capital projects and Routines that replace deteriorated equipment will sustain system reliability and address the device failures referenced in the table above. The scope of the following capital projects also include elements that will result in improved reliability by improving outage response:

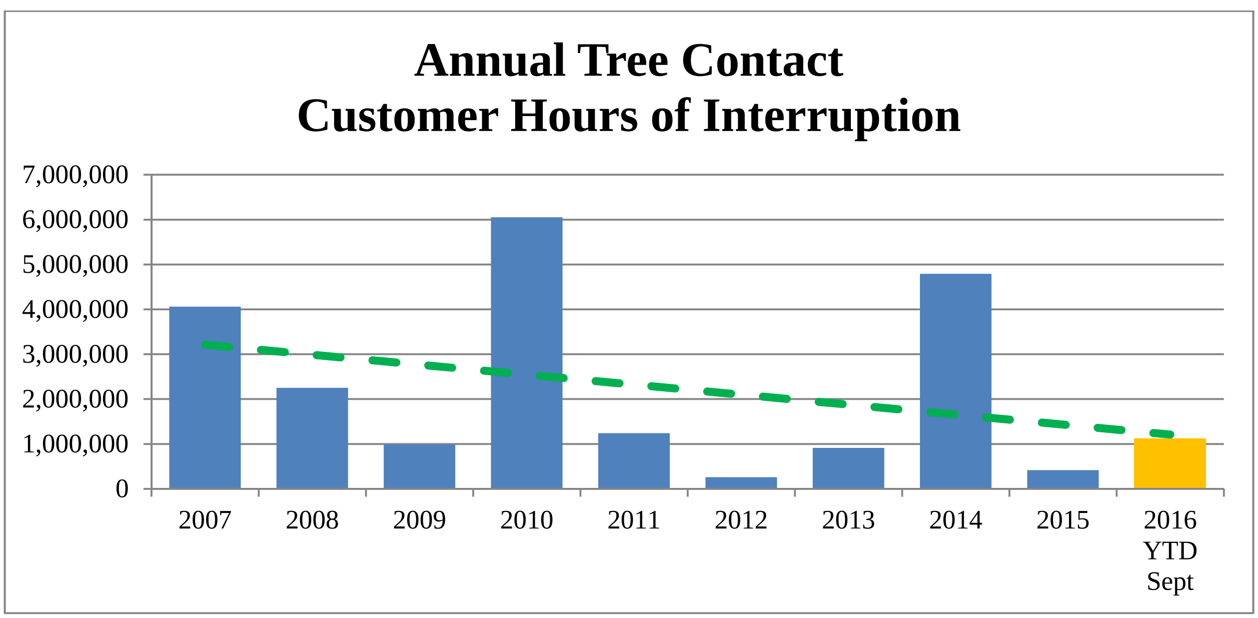
- CI 41350 - 16W-301 Hebron Rebuild Phase 2

- CI 49836 - 11S-302 11S-401 Rebuild Coxheath Phase 2
- CI 49891 - 509V Recloser and Voltage Regulator Replacement

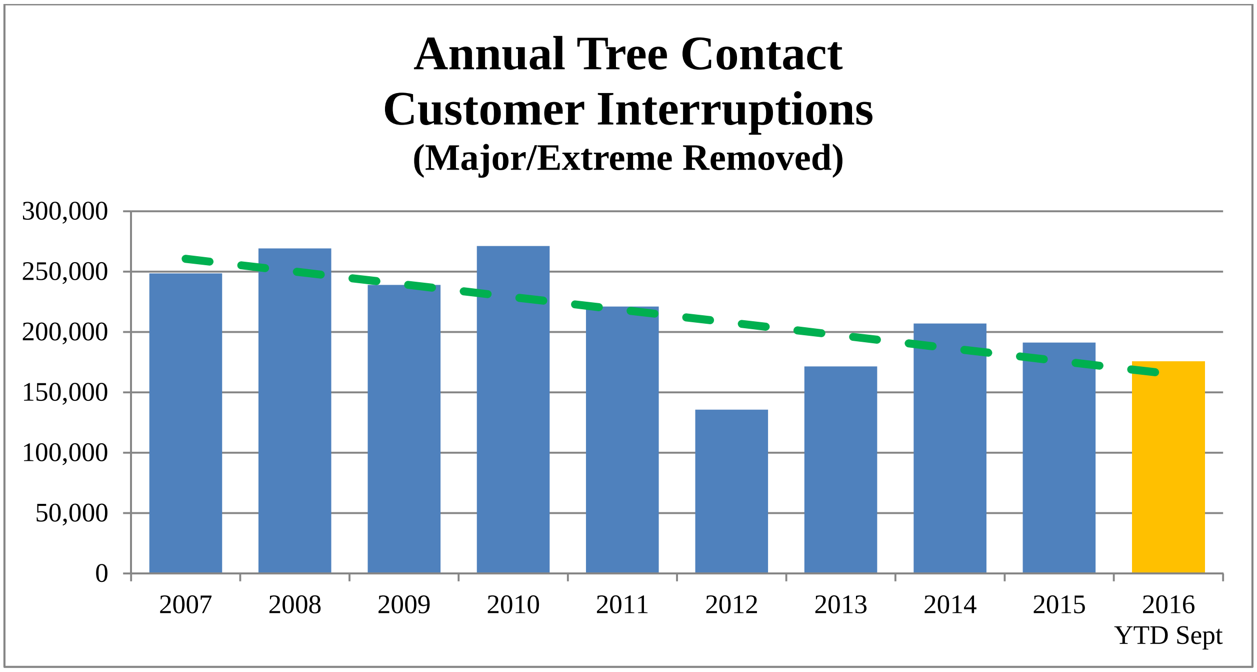
Tree Contacts

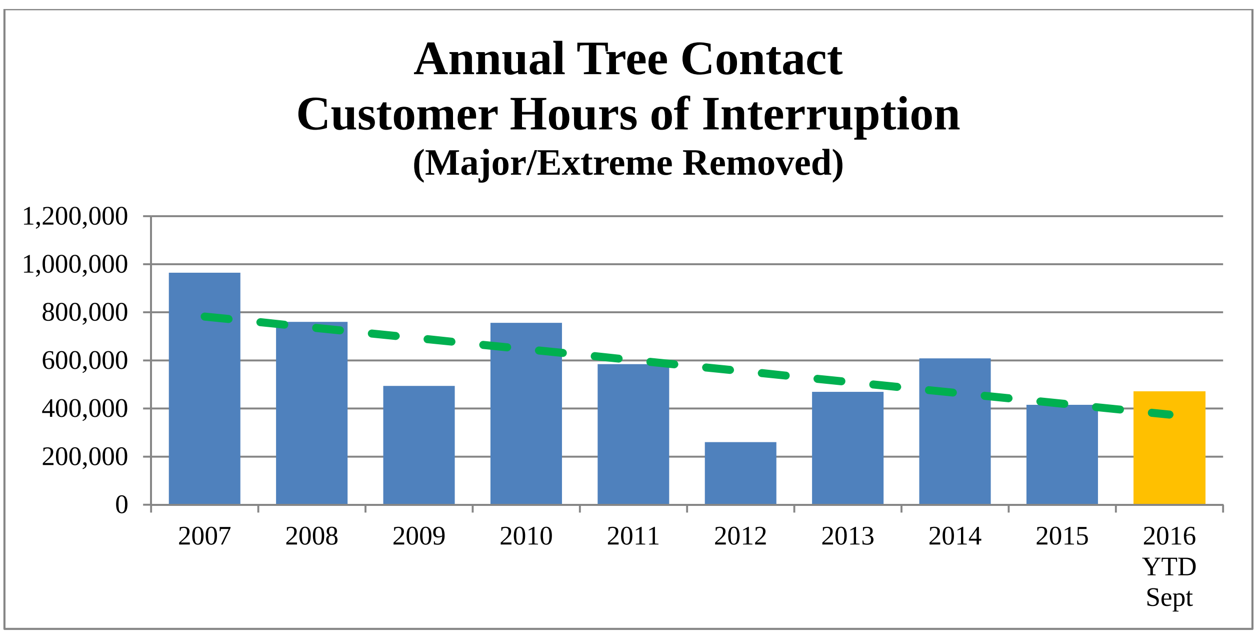
Tree Contacts are the largest source of outage hours for NS Power's customers. The following two charts demonstrate both customer interruptions and customer hours of interruption due to tree contacts under normal and severe weather conditions.





The two charts below show the data normalized with Major and Extreme Events removed. With these events removed, the data demonstrates the vegetative effects of major storms and their impact for months following the extreme event. There were no Major or Extreme Event Days in 2015, however from January through September 2016, there has been 1 Extreme and 1 Major Event Day.





In a continued effort to minimize storm effects and overall reliability, NS Power has proposed the following spending in 2017 for Transmission and Distribution vegetation management. These targeted investments for managing vegetation aim to minimize outage frequency and duration, while seeking to improve access to the system.

- CI 49611 – New Distribution Rights-of-Way Phase I – Submitted separately on November 1, 2016

- CI 49992 - 2017 Transmission Right-of-Way Widening 69kV – Included in the 2017 ACE Plan.

- D010 Dist Distribution Right of Way Routine

- T010 Transmission Right of Way Routine

Plans for Replacement of Aging T&D Equipment & Storm Performance

The 2015 ACE Plan Terms of Consensus included two commitments with respect to reliability:

> (4) As part of the reliability directive in future ACE Plans, NS Power will provide additional information regarding its plans for replacement of aging transmission and distribution equipment in accordance with the following recommendation on this matter made by the SBA's consultant, Mary Neal, at page 12 of her evidence in this proceeding dated January 16, 2015:
>
> "I recommend NSPI provide more information regarding its plans for replacement of aging transmission and distribution equipment to better show how it justified the target investments. This should include (where possible):
>
> - Descriptions of assets to be replaced and their ages,
> - Goals for strategic replacement programs, such as targets for age profiles of different asset classes,

- Expected improvements in asset age profiles due to each ACE Plan project involving replacement of transmission and distribution equipment considered at end-of-life,
- More detailed descriptions of how NSPI targets specific assets every year, whether based on age, performance degradation, or other factors, and
- Any recent, relevant inspection data"

(5) As part of the reliability directive in future ACE Plans, NS Power will provide an update on its storm performance and related capital investment strategies to improve storm performance.

The Terms of Consensus were approved by the UARB on May 5, 2015. These are addressed below.

Plans for Replacement of Aging Transmission and Distribution Equipment

The multi-year Reliability Investment Strategy has resulted in a step-change towards improved reliability for NS Power customers. NS Power continually monitors outages and performance of transmission, substation and distribution assets, and future investments will continue at an appropriate level to ensure affordable and reliable service. To sustain these reliability performance improvements, NS Power is implementing asset management principles to prioritize investments in T&D plant.

These asset management principles follow existing project ranking principals of utilizing condition and criticality to determine replacement rankings for asset classes. These asset management principals will also deploy replacement targets to reduce the overall risk for the asset class.

Annual estimated replacement targets developed based on asset age profiles and the Iowa Survivor curves for equipment failure are used to reduce the overall risk for each asset class. While the suitable investments for a specific asset class may vary from year to year depending on system performance, the estimated replacements analysis provides a working range in which to evaluate the appropriateness of proposed sustaining capital investments.

NS Power uses a variety of factors to determine the specific assets targeted for replacement as part of the annual capital investment program. Generally, targeted assets have experienced degradation in performance manifesting in decreased reliability, increased maintenance frequency and cost, or reduced functionality. These effects are identified through reliability tracking, field inspections, and test results of the impacted assets. Considerations such as criticality of the asset to continued operations of the NS Power system and any risks posed to people and the environment can also play a role in determining specific assets for replacement.

Asset age is a concern when the frequency of required maintenance is increased, the availability of replacement parts or critical spares is limited, or performance is negatively impacted. This information can be used to inform project prioritization. However, age profiles are used in concert with asset condition, performance, and legislated requirements; it is never the single determining element in an investment decision. Capital project justifications outline the reasoning behind a given replacement program considering all relevant elements.

In 2014, NS Power embarked on further formalizing the identification and prioritization of assets for replacement by creating a regimented framework to determine the condition, criticality, and risk individual assets within a given class pose to the NS Power system. While the risk score of an asset does not determine its suitability for replacement alone, it can aid in identifying assets requiring more detailed investigation by technical experts and subsequent risk mitigation activities.

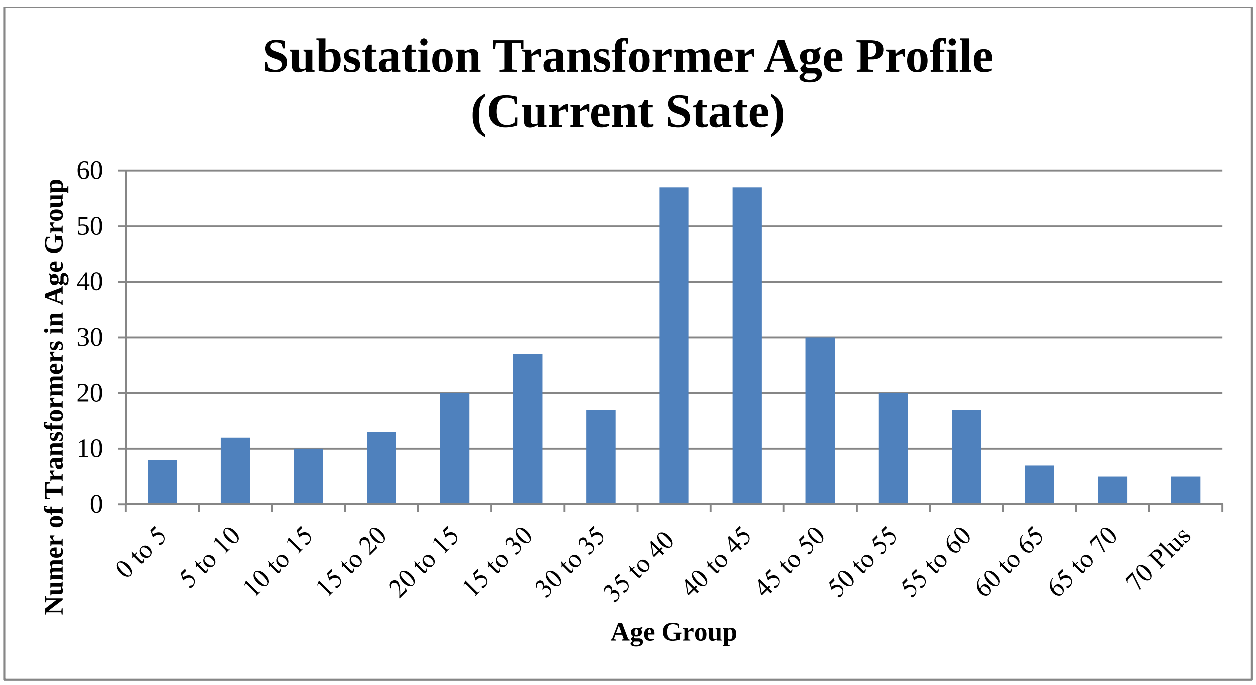
The target ranges for T&D assets covered by this analysis is provided in the table below.

		High Band Replacements		Low Band Replacements	
Asset Classification	**Quantity on Grid**	**Estimated Useful Life**	**Annual Replacements**	**Estimated Useful Life**	**Annual Replacements**
Distribution Conductor (km)	42,561	45	946	55	774
Distribution Structure	350,047	50	7,001	60	5,834
Distribution Secondary	28,763	45	639	55	523
Pole Top Transformer	122,717	35	3,506	45	2,727
Underground Conductor (km)	745	45	17	55	14
Padmount Transformers	3,984	35	114	45	88
Transmission Conductor (km)	5,140	55	93	65	80
Transmission Structure	30,605	55	556	65	471
Breakers	548	45	12	55	10
Substation Transformer	315	50	6	60	5

Age demographics information is presently not available for all transmission and distribution asset classes. Substation Transformers, Substation Breakers, Transmission Conductor, Downline Reclosers and Padmount Transformers are assets classes where this information is available at this time. As asset information improves for individual asset classes, their age profiles provide a more complete picture of the current state across the T&D system. Over last year, NS Power has collected more age data. As a result, downline reclosers now have an age profile as seen below.

As T&D equipment reaches end-of-life, capital investments are used to mitigate impacts related to aging infrastructure. Over time this will result in an overall positive shift in age profile towards a younger equipment fleet.

Substation Transformers

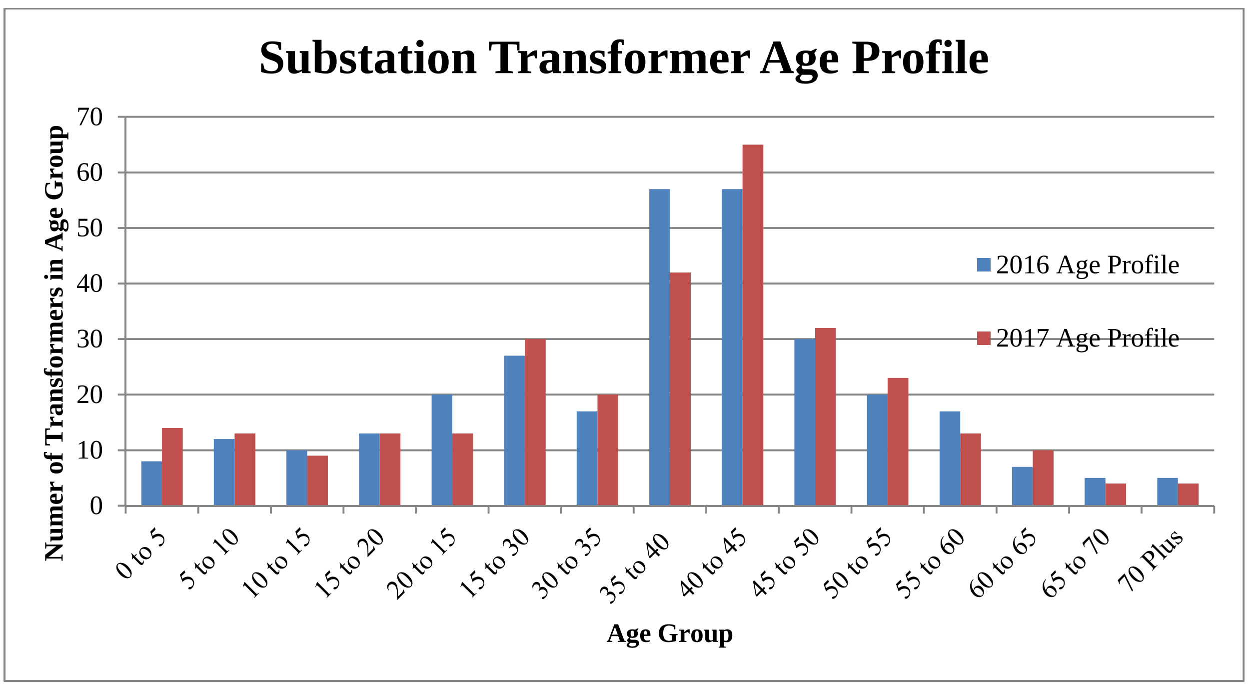


- Expected useful life of 50-60 years depending on the transformer type, loading, and environmental conditions.

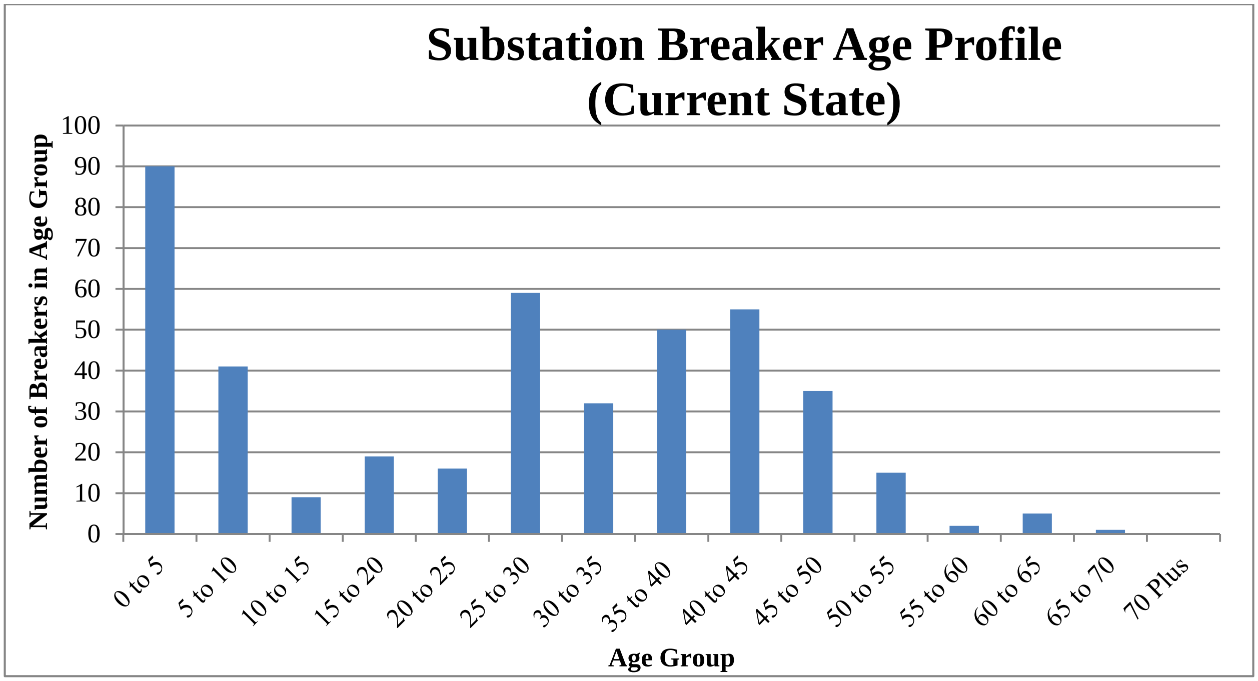
- Age Demographics – 18% of Transformers are beyond 50 years of service.

- Targeted number of replacements – 5 to 6 units per year.

- Improvements to age demographics – As a result of the proposed 2017 capital investments in substation transformers, the age profile for this asset class will experience no overall change in assets beyond 50 years of age. Age is only one of multiple factors in determining targeted assets in a given year. However, it is expected that over time an overall positive shift in age profile towards a younger equipment fleet will occur. To support mitigation of risk associated with this asset class, continuation of the strategic transformer spares program and purchase of an additional mobile substation unit is planned. Proactive transformer replacements in future years will again focus on the overall condition of each unit and system criticality. The following graph illustrates the overall change in asset age profile for Substation Transformers between 2016 and 2017.



Substation Breakers

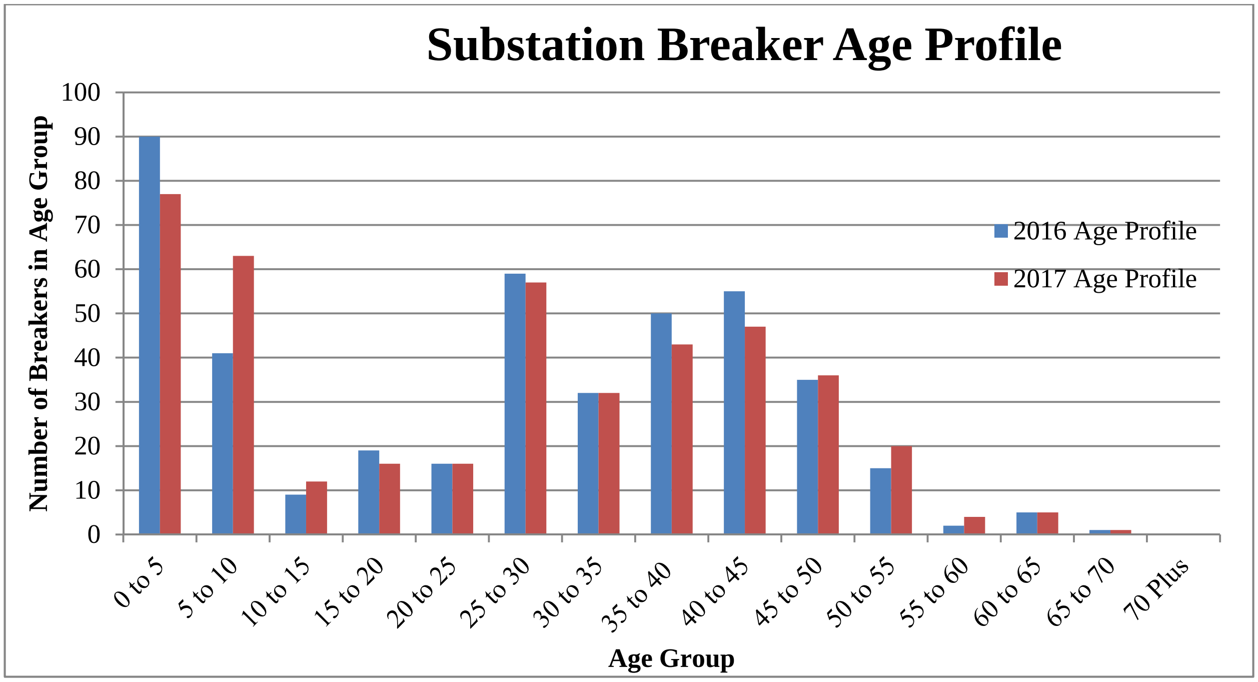


- Expected useful life of 45-55 years depending on the breaker type, operations count, and environmental conditions.

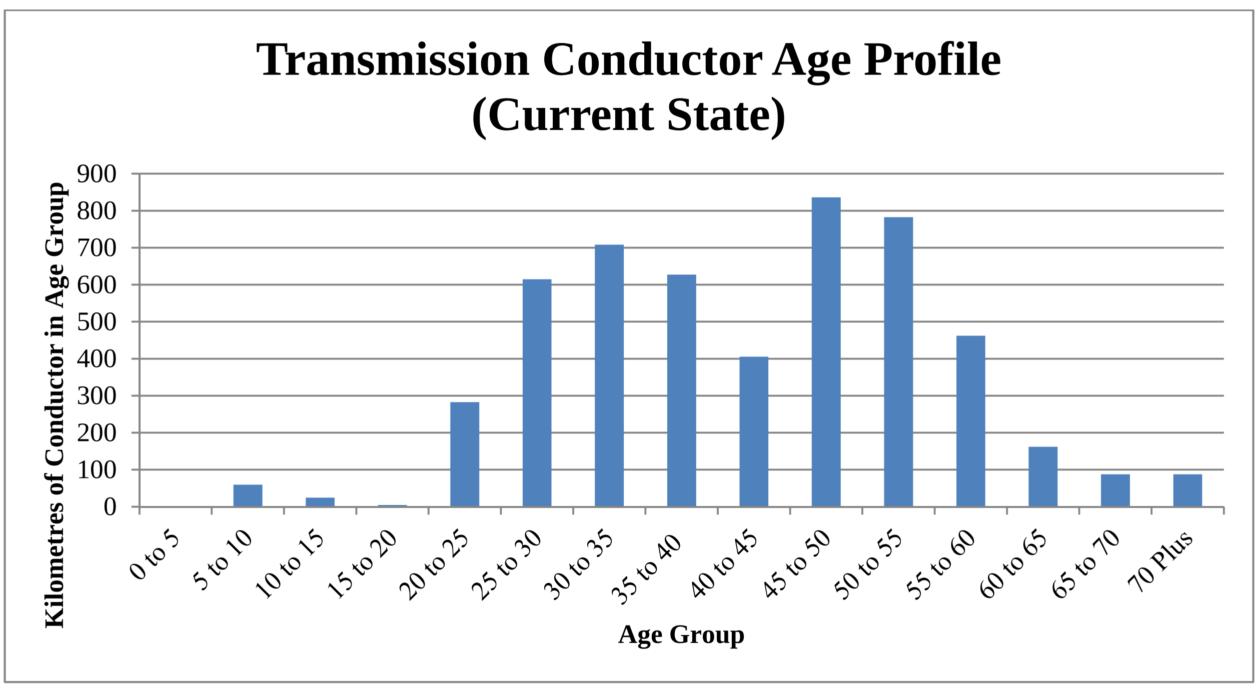
- Age Demographics – 13% of breakers are beyond 45 years of service.

- Targeted number of replacements – 10-12 units per year.

- Improvements to age demographics – As a result of the proposed capital investments in Substation Breakers during 2017, the age profile for this asset class will experience an approximately 0.5% reduction in assets beyond 45 years of age. The following graph illustrates the overall change in asset age profile for Substation Breakers between 2016 and 2017.



Transmission Conductor

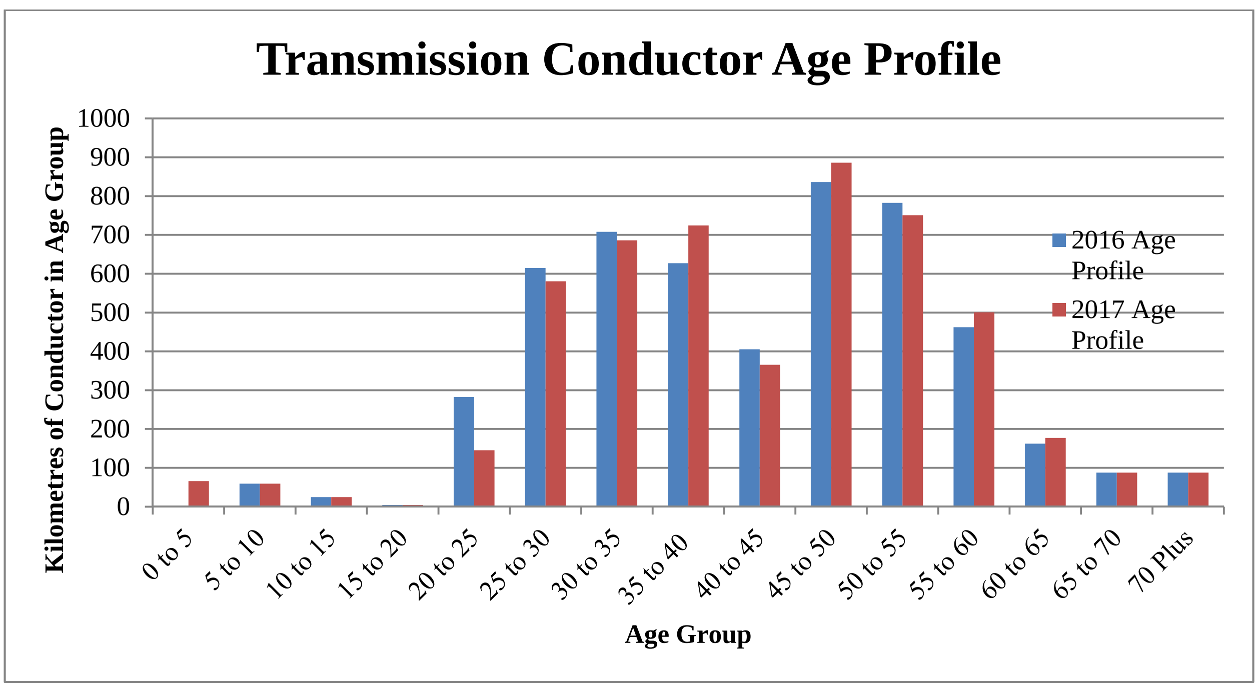


- Expected useful life of 55-65 years depending on the conductor design and environmental conditions.

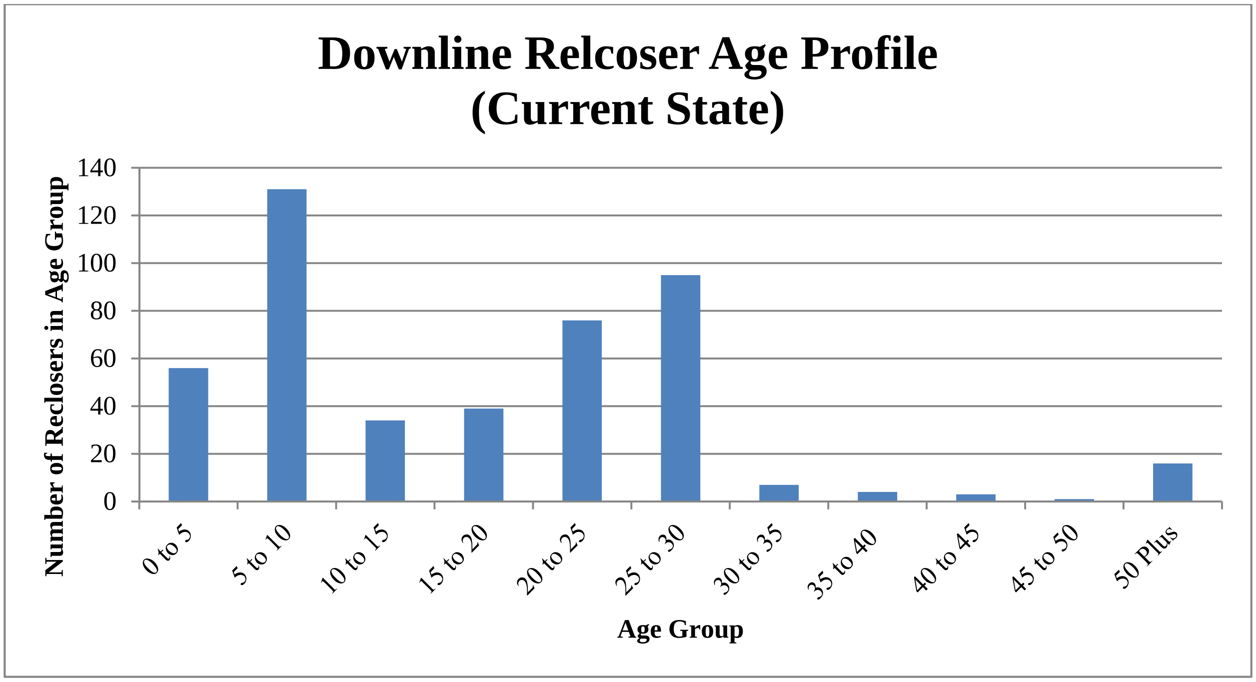
- Age Demographics – 16.6% of conductor is beyond 55 years of service.

- Targeted number of replacements – 80 to 94 km per year.

- Improvements to age demographics – As a result of proposed capital investments in transmission conductor in 2017, the age profile for this asset class will experience an approximately 1.0% increase in assets beyond 55 years of age. Age is only one of multiple factors in determining targeted assets in a given year. However, it is expected that over time an overall positive shift in age profile towards a younger equipment fleet will occur. In order to help mitigate risks associated with transmission conduction, innovative testing of conductor over 60 years old is taking place to further assess condition as required. The following graph illustrates the overall change in asset age profile for Transmission Conductor between 2016 and 2017.



Downline Reclosers

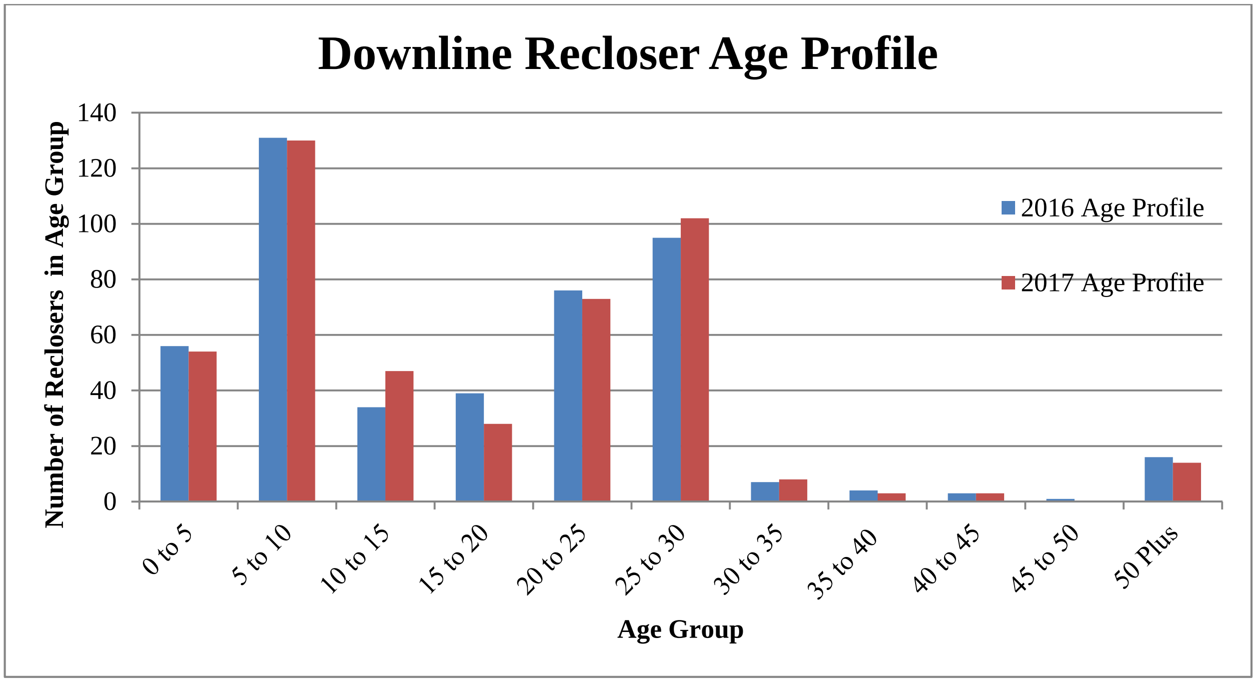


- Expected useful life of 30-40 years depending on the downline recloser design, loading, and environmental conditions.

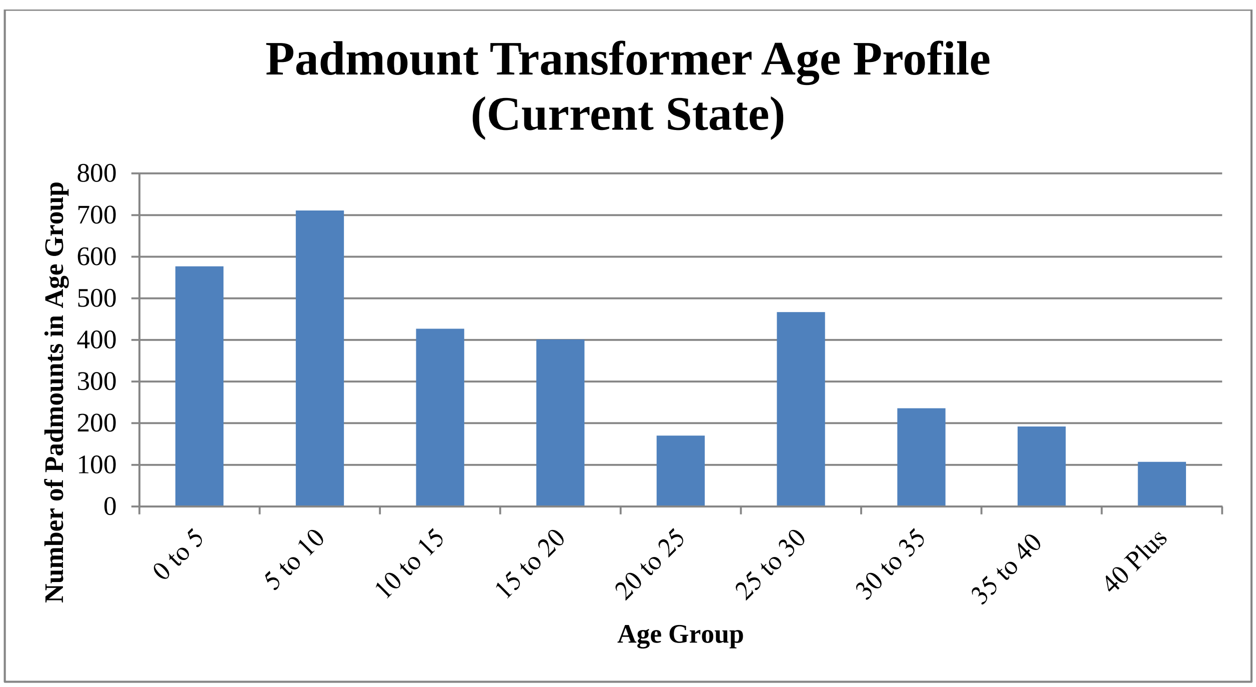
- Age Demographics – 6.7% of Downline Reclosers are beyond 30 years of service.

- Targeted number of replacements – 15 to 20 units per year.

- Improvements to age demographics – As a result of the proposed capital investments in Downline Reclosers during 2017, the age profile for this asset class will experience an approximately 0.5% reduction in assets beyond 30 years of age. The following graph illustrates the overall change in asset age profile for Downline Reclosers between 2016 and 2017.



Padmount Transformers

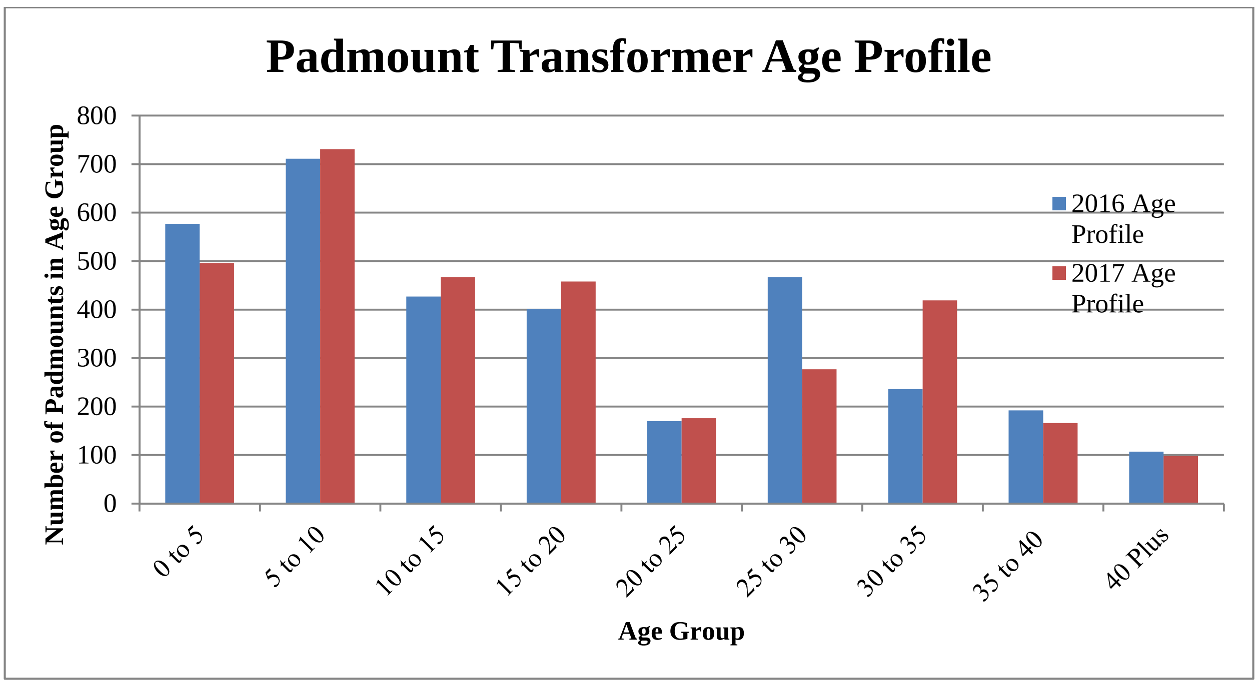


- Expected useful life of 35-45 years depending on the padmount design, loading, and environmental conditions.

- Age Demographics – 9.1% of padmounts are beyond 35 years of service.

- Targeted number of replacements – 88 to 114 units per year.

- Improvements to age demographics – As a result of the proposed capital investments in Padmount Transformers during 2017, the age profile for this asset class will experience an approximately 1.0% reduction in assets beyond 35 years of age. The following graph illustrates the overall change in asset age profile for Padmount Transformers between 2016 and 2017.



Update on storm performance and related capital investments

The impact of storms and storm response varies storm-to-storm and year-to-year. The wind speeds, rainfalls, time of year, time of day and weather forecast accuracy all contribute to a storm's impact.

NS Power utilizes the 2.5 Beta Method (IEEE-3366 Standard) to classify Major Event Days. The same methodology is applied to further classify storms for Storm Days (2.0 Beta) and Extreme Event Days (3.5 Beta).

As of September 30, 2016, NS Power has experienced 7 storm days, 1 major event day and 1 extreme event day.

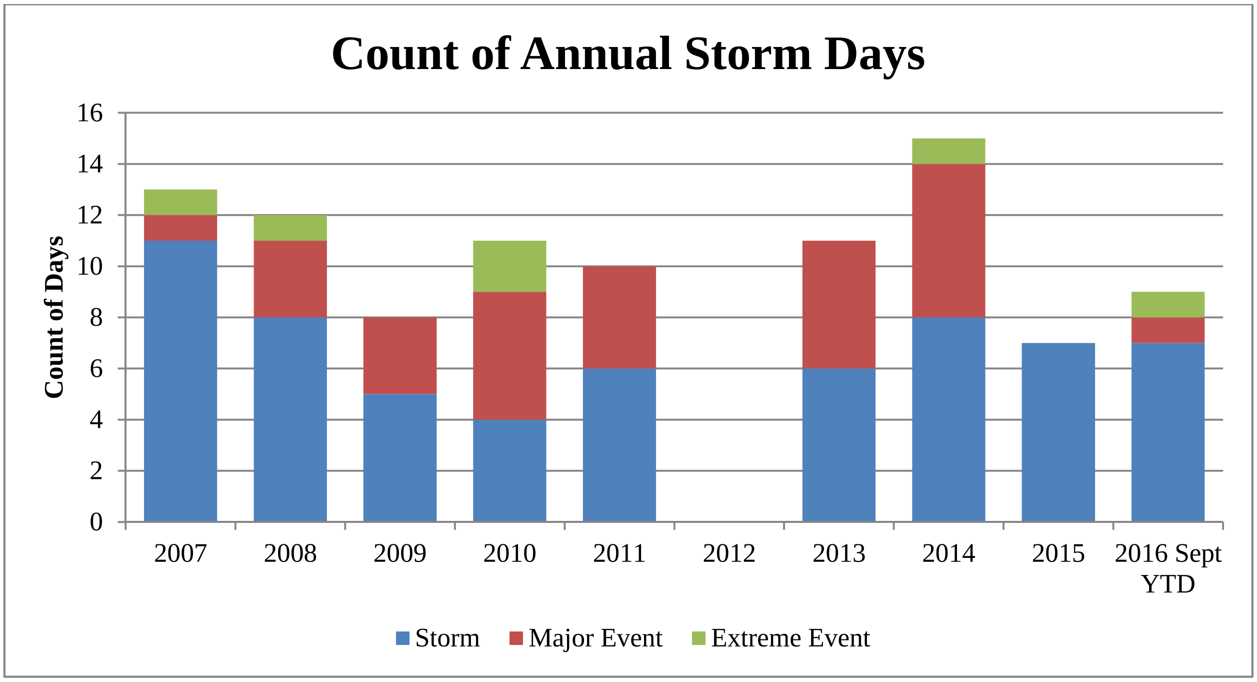
NS Power has the following capital programs for storm response and reactive work for 2017:

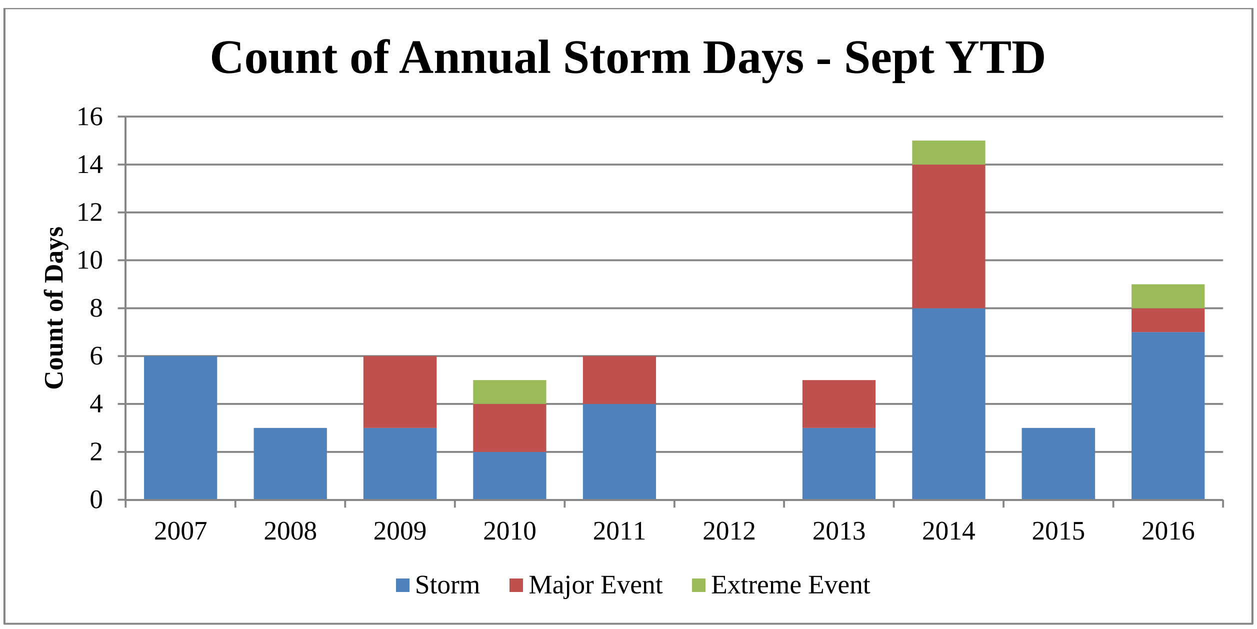
- D008 – Provincial Storm Distribution
- T001 – Transmission Line Unplanned

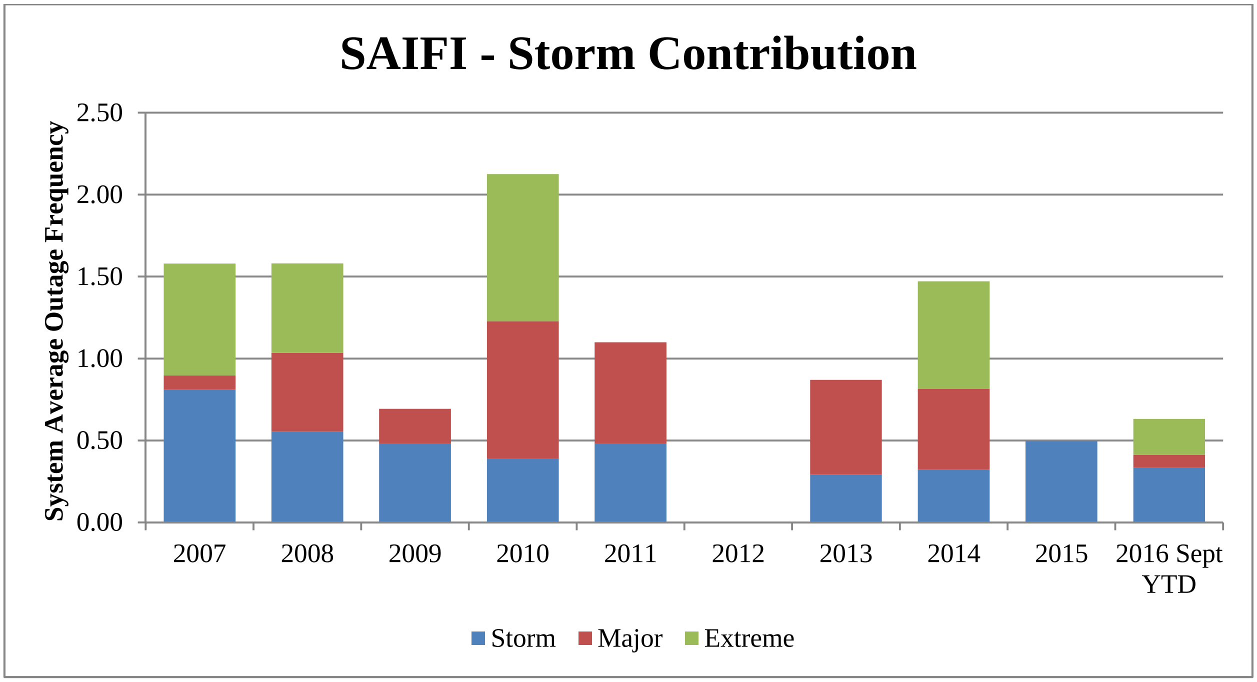
As noted above, NS Power continues to invest on vegetation management. These investments aim to minimize tree contact and maximize access to our Transmission and Distribution systems as provided for in routines T010 and D010, as well as capital work orders CI 49611 and CI 49992.

2016 Storm Performance vs. Previous Years

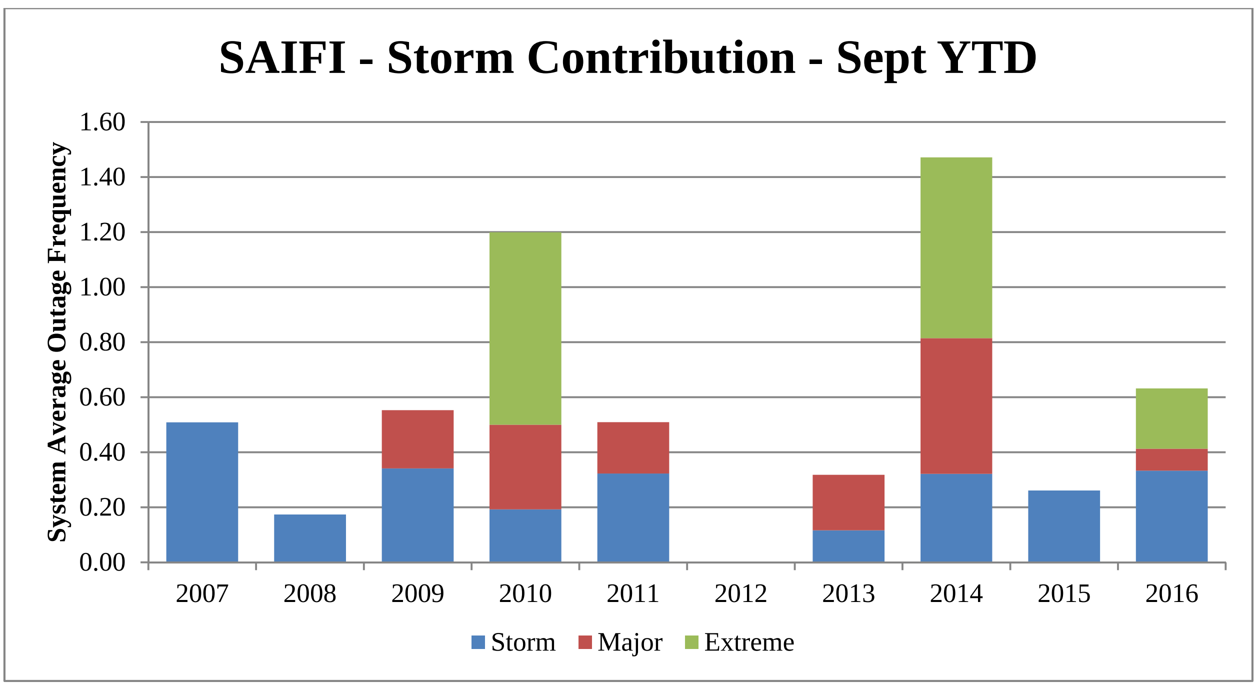
The graphs below show the count of the previously identified storm classifications, and their SAIFI and SAIDI contributions annually. These graphs outline the frequency and impact of storm days to customers.


Count of Annual Storm Days
Count of Days
0
2
4
6
8
10
12
14
16
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016 Sept YTD
Storm
Major Event
Extreme Event

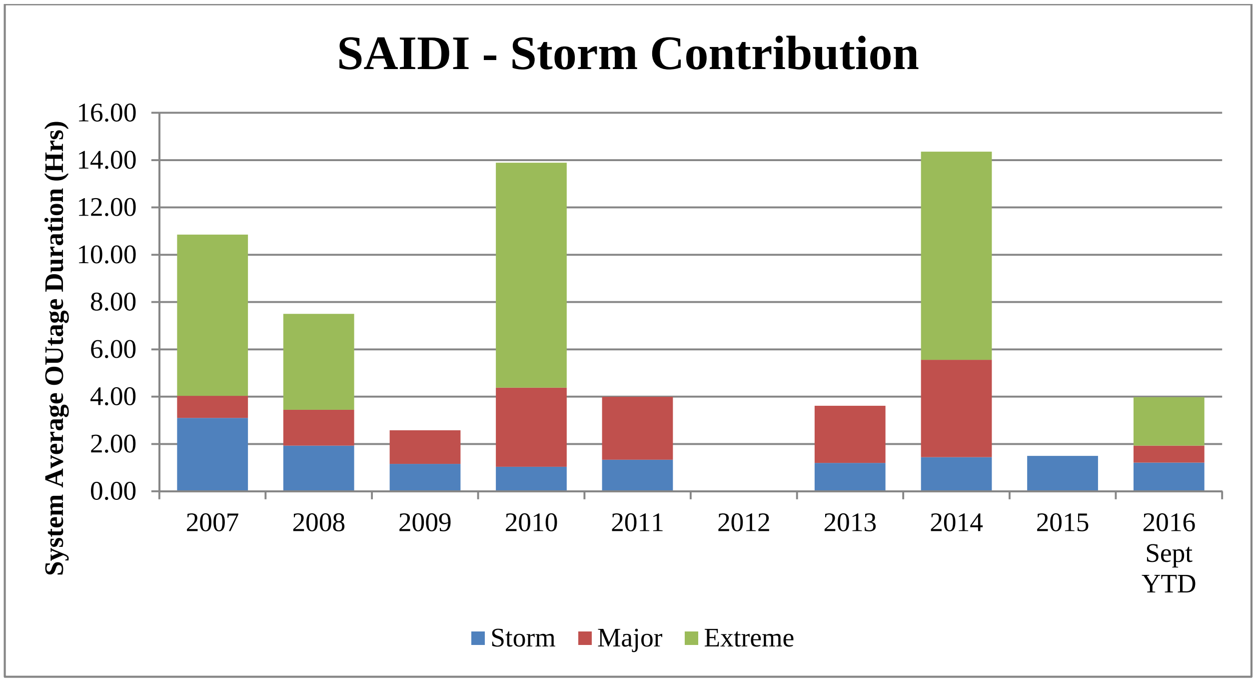

Count of Annual Storm Days - Sept YTD
Count of Days
0
2
4
6
8
10
12
14
16
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Storm
Major Event
Extreme Event

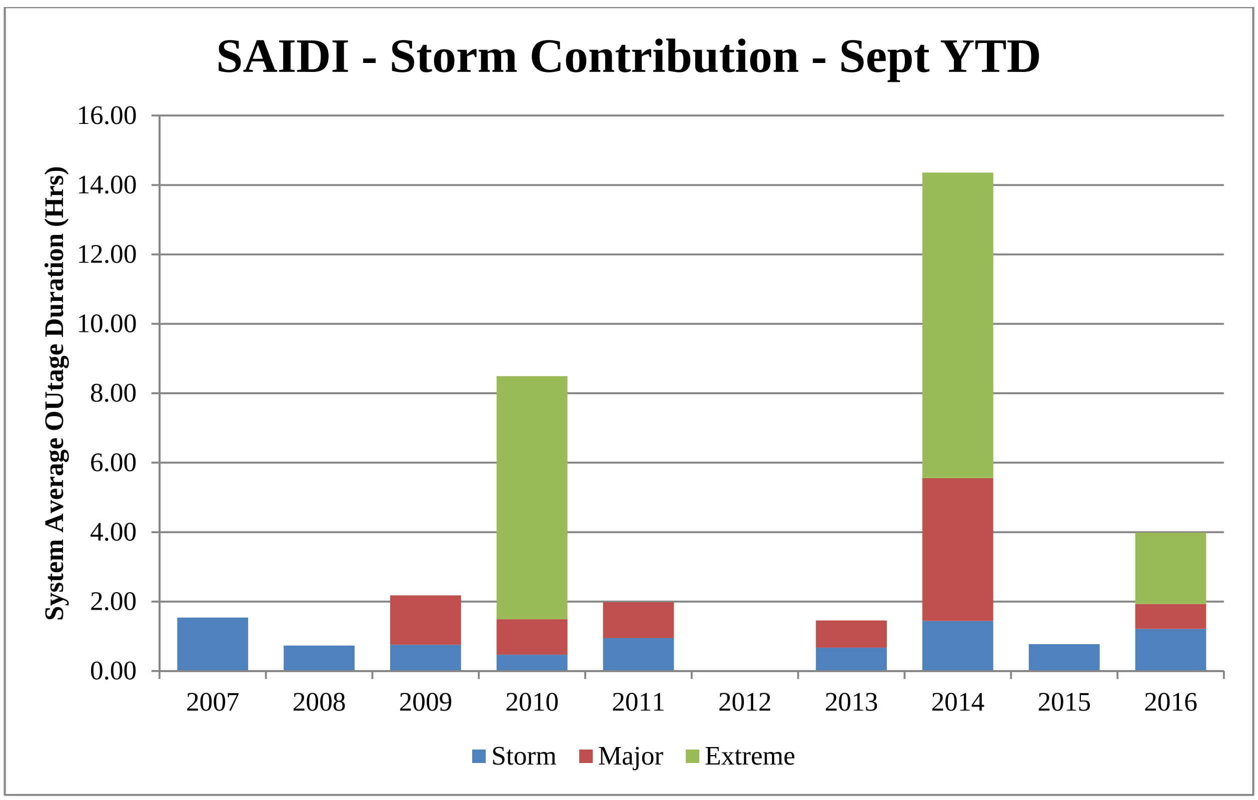

SAIFI - Storm Contribution
System Average Outage Frequency
2.50
2.00
1.50
1.00
0.50
0.00
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016 Sept YTD
Storm
Major
Extreme

1


SAIFI - Storm Contribution - Sept YTD
System Average Outage Frequency
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Storm
Major
Extreme

2





Note: 2012 experienced no severe weather days.

Through the first nine months of 2016, customers experienced one severe weather event starting on January 29, 2016. The first day of this event was an Extreme Event day and the second and third days were a Major Event and Storm day, respectively. This event compared to past Extreme Events had less of an impact to overall SAIFI and SAIDI as noted in the previous graphs.

The table below provides detail on outage causes for the 9 severe weather days experienced so far in 2016.

		Storm	Major	Extreme	
CEA Cause Code	**Description**	**Hours of Interruption**	**Hours of Interruption**	**Hours of Interruption**	**% of Hours**
0	Unknown/Other	13,636	1,038	5,389	1%
1	Scheduled Outage	731		5	0%
2	Loss of Supply	167,385		194	8%
3	Tree Contacts	252,112	192,567	452,674	45%
4	Lightning	86,920			4%
5	Damaged Equipment	15,582	13,493	31,452	3%
6	Adverse Weather	63,131	152,247	537,535	38%
7	Adverse Environment	8	8		0%
8	Human Element				0%
9	Foreign Interference	10,225		5,683	1%
	Total	**609,730**	**359,353**	**1,032,933**	

45% of storm outages year to date in 2016 have been caused by tree contacts. While NS Power always strives to minimize tree caused outages, the importance is further stressed in storm conditions. Continued investment for vegetation management and right-of-way widening will help minimize these outages in all weather conditions.

The following capital projects are identified to address vegetation management and right-of-way widening for 2017:

- CI 49611 – New Distribution Rights-of-Way Phase I – Submitted separately on November 1, 2016

- CI 49992 – 2017 Transmission Right-of-Way Widening 69kV – Included in the 2017 ACE Plan.

- D010 Dist Distribution Right of Way Routine

- T010 Transmission Right of Way Routine

<u>T010 and D010 Report</u>

In the 2016 ACE Plan Order, the UARB provided the following directive:

> The Board approves the 2016 Routine capital expenditures, with the exception of the Distribution ROW widening (D010) which is reduced to $600,000. The Board directs that the Routine for Transmission widening be treated as a separate project, and not a routine, in future ACE Plan Applications. NSPI is to provide an annual progress report on the expenditure, works undertaken, results achieved and future plans as part of the annual ACE Plan submissions.[21]

In accordance with the Board's directive, NS Power provides its progress report on D010 and T010 below as of September 30, 2016.

Expenditures, Works Undertaken, and Results

The following progress was made on 69kV Transmission Widening under T010:

- 88% of planned work has been completed as of September 30, 2016
- 100% completion is forecasted for year end 2016
- Forecasted year end spend is approximately $5,406,120

[21] NS Power 2016 ACE Plan, UARB Order, M07176, June 8, 2016, page 2.

- Three substitutions have been made from the original plan, due to revised priorities:
    - L-5023 replaced with L-5501;
    - L-5039 replaced with L-5539; and
    - L-5054 replaced with L-5576
- Savings in easement acquisition costs allowed for the additional completion of L-5512

The following progress was made on >69kV Transmission Widening under T010:

- 45% of planned work has been completed as of September 30, 2016
- 100% completion is forecasted for year end 2016
- Forecasted year end spend is approximately $596,589
- Three substitutions have been made from the original plan, due to revised priorities:
    - L-6503, L-6552 and L-6538 were replaced with L-6513, L-6515 and L-8001

The following progress was made on Distribution Widening under D010:

- 100% of planned work has been completed and pending final costing
- Forecasted year end spend is approximately $779,064[22]
- 7N-302G Middleboro was completed, and substitutions have been made from the original plan, due to revised priorities, including:
    - 57C-417 South River Lake Road
    - 50N-410 Woodburn Road and Fraser Mountain Road
- 13V-303 and 77V-302H Sissiboo

[22] The 2016 ACE Plan D010 proposed increased expenditures of $2.4M are now assumed under CI 49611 submitted to the Board on November 1, 2016.

Future Plans – Transmission Rights-of-Way

Going forward, the transmission vegetation management program will be carried-out under three broad initiatives:

1. Operating activities for transmission vegetation management

2. Capital Routine T010 - Transmission Right-of-Way Widening (for 138kV, 230kV and 345kV RoWs)

3. New Transmission Rights-of-Way Widening individual capital projects (i.e. CI 49992 for 69kV RoWs and subsequent phases)

The scope of work completed under operating activities will continue to focus on maintaining existing transmission rights-of-way through mechanical mowing, manual brush cutting, hazard-tree removal, trimming in urban areas, and the application of herbicides.

Capital routine T010 remains for the widening of 138kV, 230kV and 345kV RoWs. This is the traditional scope of T010, but has also previously included 69kV rights-of-way which are now assumed under CI 49992 and subsequent phases.

The scope of work to be completed under CI 49992 and subsequent phases will be on 69kV rights-of-way.

Future Plans – Distribution Rights-of-Way

Going forward, distribution vegetation management program will now be carried-out under three broad initiatives:

1. Operating activities for distribution vegetation management

2. Capital Routine D010 - Distribution Right-of-Way Widening

3. New Distribution Rights-of-Way individual capital projects (i.e. CI 49611 and subsequent phases)

The scope of work completed under operating activities will continue to focus on existing right-of-way asset reclamation, urban cycle trimming in municipalities, reactive maintenance, hazard tree mitigation, vegetation removal during storm events, customer requested tree trimming, and maintaining sustainability of existing rights-of-way.

The scope of work completed under the D010 routine will continue to focus on widening of existing rights-of-way to the current standard beyond the department of Nova Scotia Transportation and Infrastructure Renewal (NSTIR) right-of-way.

The scope of work to be completed under CI 49611 and subsequent phases will be on establishing new distribution rights-of-way where none have previously existed.

8.1.8 Interruptible Customers

The UARB's 2013 ACE Plan Decision Directive 15 stated:

> …an annual report, as part of the ACE Plan filing, tracking interruptions to interruptible customers is useful and reasonable. The Board directs NSPI to provide this information in future ACE Plans.[23]

The North American Electric Reliability Corporation (NERC) requires NS Power to maintain defined levels of Operating Reserve capacity (capacity or load that can be activated/reduced within ten minutes). While NS Power begins each day with a generation plan designed to serve customers and to maintain the required Operating Reserves, circumstances do arise where this reserve requirement cannot be met with

[23] NS Power 2013 ACE Plan, Decision, M05339, May 27, 2013, page 44, line 175.

available resources. In these situations, interruptible customers are called upon to temporarily cease their electricity consumption to protect service to firm customers and maintain or restore Operating Reserves.

NS Power offers four tariffs that require customers to reduce their loads within 10 minutes when instructed to do so. The four tariffs are:

(1) The Large Industrial Interruptible Rider (LIIR) Tariff
(2) The Port Hawkesbury Paper Load Retention Mechanism (PHP LRM) Tariff
(3) The Generation Replacement and Load Following (GR&LF) Tariffs
(4) The Shore Power Tariff

The process for interruption of loads for each group is essentially the same: telephone notification with the requirement to reduce load within 10 minutes. Some customers can be controlled with remote switching, but are notified by phone as well.

In exchange for allowing their load to be interrupted, interruptible customers receive a discount based on the avoided capital costs associated with peaking units that would otherwise have been required to serve a larger firm peak load. If an interruptible customer is unable to comply with the provisions of their tariff, a financial penalty is applied, except for GR&LF Tariffs customers.

The LIIR class was historically seldom interrupted and would experience periods where they were not called at all for several years. Years 2009 and 2013 saw more frequent interruptions largely due to the absence of the priority interruption provided by customers subscribed to the Extra Large Industrial tariff (paper mills).

Thus far in 2016, there has only been one LIIR and no PHP interruptions. This due in part to the telemetry provisions approved following the conclusion of the Interruptible

Tariffs Pilot. On February 19, 2016,[24] the UARB approved an Application to amend the interruption provisions of the LIIR and LRT tariffs. The amendment has provided NS Power with the option to control participating customers' load, which enables this load to be counted as 10 minute reserve under NERC requirements. This reduced the number and duration of customer interruptions. Eligible customers were required to install the necessary equipment at their own cost. In the case of the PHP mill, the equipment was already in place as it was installed during construction of the supply infrastructure. Customers who have provided direct load control to NS Power provide 10-minute reserve without having to interrupt to free up generation. There are six customers that have installed telemetry equipment with a combined load of approximately 50 MW, depending on their production levels.

Below is a table summarizing interruptions in the LIIR customer class from 2009 to October 31, 2016.

Year	**LIIR Customers**			
	Date	**Number of LIIR customers interrupted**	**Estimated load interrupted (MW)**	**Estimated average duration**
2009	January 26	26	80	2 hours
	April 9	25	67	1.5 hours
	December 1	7	30	1.2 hours
	December 17	25	82	1.5 hours
2010	February 1	8	25	40 minutes
2011	January 23	25	74	45 minutes
2012	N/A	0	0	
2013	January 2	8	26	55 minutes
	January 3	2	16	1 hour
	January 16	22	69	40 minutes
	February 8	10	34	2 hours
2014	April 25	6	28	4 hours
2015	N/A	0	0	0
2016	January 5	10	28.6	1 hour

[24] NS Power Large Industrial Interruptible Rider and Port Hawkesbury Paper Load Retention Mechanism, UARB Orders, M07179/P-895.15, February 19, 2016.

Below is a table summarizing recent interruptions to the PHP LRT.

PHP LRT Interruptions*		
Date	**Load Interrupted (MW)**	**Estimated Average Duration**
Jan 2, 2013	15	1.5 hours
Jan 3, 2013	11	50 minutes
Jan 16, 2013	37	1.75 hours
Feb 8, 2013	41	2.67 hours
2015	0	0
2016	0	0

*PHP LRT came into effect September 27, 2012.
*As PHP is counted as 10-minute reserve and the LIIR interruptions called in April 2014 were intended to restore reserves to 171 MW, no interruption was called for PHP.

Below is a table summarizing recent interruptions to the GR&LF customers.

GR&LF Interruptions*	
Date	**Estimated Average Duration**
Sept 6, 2012	1.5 hours
Dec 1, 2012	1.75 hours
Jan 2, 2013	1.58 hours
Jan 3, 2013	1 hour
Jan 6, 2013	1.25 hours
Jan 16, 2013	1.75 hours
Feb 8, 2013	2.75 hours
April 25, 2014	3 hours
June 1, 2015	3.5 hours
January 5, 2016	1.5 hours

*There is no significant load relief associated with GR&LF interruptions.

All interruptions to these classes of customers were required to maintain the system operator's 10-minute reserve requirements and were executed in accordance with the applicable tariff.

8.1.9 Hydro Replacement Energy Calculation

The 2016 ACE Plan Terms of Consensus included a commitment to discuss the Replacement Energy Calculation (RES) found in NS Power's Economic Analysis Model (EAM). As part of the stakeholder consultation process, stakeholders proposed an alternative hydro REC calculation methodology based on locational marginal pricing adjustments, but it was agreed that formally adopting revisions to the REC calculation methodology would be premature without further testing.

NS Power committed to further examine the effects of the locational marginal pricing adjustments to the hydro unit REC calculation, and report on the results in the 2017 ACE Plan.

This report is provided below and includes (1) a description of the current methodology used for calculating the REC for hydro, and (2) justification for the methodology compared to the alternative of locational marginal pricing.

Current Hydro REC Methodology: Variable Dispatch

Hydro replacement energy cost is calculated using a variable dispatch methodology. It uses the weighted average generation cost of the entire fleet and imports, excluding generating units considered to be fully dispatched as they are unable to provide replacement energy.

Hydro fleet variable dispatch replacement energy cost calculation also considers RES compliance. In case of renewable energy deficit forecast, hydro energy replacement is represented by the cost of additional renewable generation, which can be provided by biomass fired generation as the only other renewable resource with availability of additional renewable generation.

The benefits of the variable dispatch methodology include the isolation of energy costs from those of ancillary service provision, thus avoiding potential double counting of resource benefits when justifying economics of a capital investment, as well as replacement energy costs consistent with the fuel and purchased power cost trends.

The drawbacks of this methodology include that it does not differentiate among hydro generation locations and as such does not fully reflect the value of hydro energy located closer to load center. However, the geographical advantage of a hydro generator may be considered separately in the economic justification, and in that case not having it included in replacement energy cost is beneficial as it avoids double counting.

Taken as a whole, this methodology remains the most reliable predictor of hydro replacement energy costs. This is expanded upon below in comparison to an alternative methodology adjusted for marginal pricing.

Alternative Hydro REC Methodology: Locational Marginal Pricing

A marginal pricing adjusted (marginal cost) methodology uses forecasted hourly system marginal cost, combined with forecasted hourly energy production from individual hydro resources, in order to calculate hydro replacement energy cost.

The advantage of this approach is that it can distinguish between run of river hydro and peaking hydro units based on their forecasted hourly dispatch profile. It appears to be advantageous because it differentiates between assets according to their estimated value on the system.

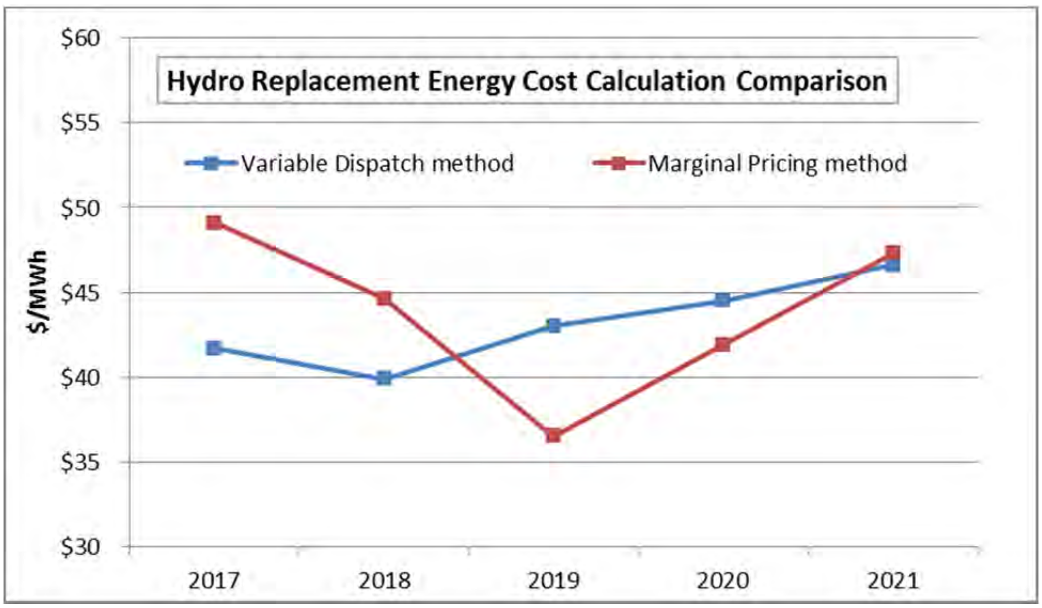
However, by differentiating energy replacement cost among generating units, the marginal cost method inherently must include some aspects of services other than energy in order to produce different replacement energy costs among generating units using the same fuel. This differentiation of units can lead to double counting since ancillary service provision is considered in a separate capital expenditure justification.

The table below[25] is a comparison of the variable dispatch and locational marginal pricing REC results.

Hydro REC

	2017	2018	2019	2020	2021
Variable Dispatch	$41.7	$39.9	$43.0	$44.5	$46.6
Locational Marginal Pricing	$49.1	$44.6	$36.5	$41.9	$47.3

The graph below illustrates the Variable Dispatch methodology's hydro replacement energy cost pattern.



The variable dispatch methodology results in a clear trend with a more consistent increase due to the forecasted fuel and purchased power cost increase, and is a more conservative estimate of replacement energy costs in 2017 and 2018.

The marginal cost methodology relies on forecasted hourly marginal costs which are sensitive to forecasted system maintenance schedule, the outcome of randomized

[25] The Replacement Energy Costs were calculated using the 2017-2019 Fuel Stability Plan Base Cost of Fuel (BCF) Refresh results which were filed with the UARB as part of the rate stability period application proceeding. NS Power Fuel Stability Plan, Exhibit N-19, NS Power Reply Evidence and Fuel Refresh, M07348, May 27, 2016.

distribution of generating fleet forced outages, and to the way the simulator decomposes annual emissions caps into daily dispatch targets, among other factors. The marginal cost methodology leads to cost fluctuations that are partially out of step with actual forecasted fuel and purchased power costs.

Due to the results of the foregoing comparison, NS Power submits that the current variable dispatch methodology continues to be the most reliable predictor of replacement energy costs for hydro units.

8.1.10 Storage Technology Update

On October 30, 2015, NS Power submitted CI 33142 CT - Burnside Unit #4 Restoration to the UARB for review and approval. The Board approved CI 33142 by letter on March 31, 2016, and provided the following directive:

> The approval of this project in the requested amount is subject to the following conditions:
>
> 1. Actively investigate energy storage technology options and consider them as a viable alternative to future investment in NSPI's combustion turbine fleet or to new thermal fast-acting generation;
>
> 2. Develop models to estimate costs and benefits of fast-acting generation and energy storage technologies. These models should include all operating costs as well as capital costs for different sized units; and
>
> 3. Update the Board and Stakeholders on the results of NSP's investigation of storage technology as part of the 2017 ACE Plan filing.[26]

In compliance with the Board's directive, NS Power provides an update on its energy storage investigation below.

[26] NS Power CT - Burnside Unit #4 Restoration, Capital Work Order Application, CI 33142, UARB Decision, M07456, March 31, 2016, page 5.

In the fall of 2015, NS Power established a technical team whose purpose was to gather information on energy storage technologies to better understand these technologies and the potential solutions they offer, how they might enhance the reliable operation of our power system, and whether they are cost effective.

Accordingly, NS Power has gathered information on the current state of the various storage technologies through a variety of activities. Those activities included presentations from vendors and energy storage project developers, attendance at energy storage industry conferences, and discussions with other utilities that have installed or are planning to install storage systems.

At this time, there is potential for the incorporation of energy storage technologies in grid operations. However, they are not yet cost effective when compared to traditional transmission and power generation solutions. NS Power expects the cost competitiveness of storage systems will improve as the technologies evolve over time. In an effort to further assess the potential of these technologies, two pilot projects are being planned for implementation. These pilot projects will further our understanding of the of storage systems.

The first pilot project was recently announced by Sustainable Development Technology Canada (SDTC). SDTC will also be providing partial funding for the project. NS Power is partnering with Tesla and Opus One Solutions to undertake the 'Intelligent Feeder Project', which will involve installing a grid-size battery (Tesla Powerpack) and up to 10 residential batteries (Tesla Powerwalls) on a feeder powered by a distributed energy resource, such as a wind turbine. Sensors will be placed on the feeder to gather real-time information about system activity and, using the Opus One GridOS system, will be fed back to NS Power's control centre. This will test whether there is an energy storage based long-term, sustainable solution to balance the intermittency of wind generation, minimize customer effects of power outages, and use the most efficient mix of our available resources. This work will be completed under CI 49787 - Intelligent Feeder /

Storage Project, listed in the 2017 ACE Plan as a Subsequent Submittal item. It is anticipated construction will be in 2017 and that the project will be active in 2018.

The second pilot project is a modelling project working with the Wind Energy Institute of Canada (WEICAN), an organization funded by the federal government and providing free consulting services to the pilot project, to understand storage benefits outside of simply providing energy to our system, and the potential to provide ancillary services such as automated generation control, frequency regulation and voltage control. The objective of work is to evaluate the technical capabilities and economics of using energy storage devices in grid support and stabilization. The modeling will involve real feeder data from NS Power to simulate typical operation and integrating our data with a system including WEICAN's 10 MW Wind R&D Park and 1 MW/2 MWh storage system located in PEI.

The findings of these projects will allow NS Power to better develop models to estimate costs and benefits of energy storage technologies compared to traditional solutions, and understand when energy storage solutions provide cost effective value for our customers.

8.2 2017 Capital Spending by Justification Criteria

Items in the 2017 ACE Plan have been developed in accordance with the CEJC. Definitions of the various criteria referenced in the following table are included in the CEJC.

2017 Annual Capital Expenditure Plan

(Millions of Dollars)

Justification Criteria	2017 Budget	Projects included for Approval	Routine Spend	Less than $250K	Items for Later Filing 2017	Carryover	Pt. Aconi
Distribution System*	$62.8	$6.1	$43.8	$1.3	$5.0	$6.6	$0.0
Thermal	56.7	13.0	3.0	13.8	15.2	4.4	7.3
Work Support*	113.1	1.8	17.4	1.2	34.0	58.7	0.0
Hydro	18.5	0.0	1.7	0.7	11.4	4.7	0.0
Health and Safety	23.5	4.9	0.0	3.3	8.6	6.3	0.5
Transmission Plant	87.6	23.3	10.4	0.1	16.7	37.1	0.0
Environmental	15.4	5.6	0.6	1.1	1.6	2.8	3.7
Metering Equipment	20.3	0.0	3.2	0.0	17.1	0.0	0.0
System Design	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Facilities/Land and Right-of-Way	0.1	0.0	0.1	0.0	0.0	0.0	0.0
Total	**$398.0**	**$54.8**	**$80.2**	**$21.5**	**$109.5**	**$120.6**	**$11.4**

*Details of justification sub-criteria are provided on the following section.

8.3 2017 Capital Spending by Justification Sub-Criteria

(Millions of Dollars)

Justification Sub-Criteria	2017 Budget	Projects included for Approval	Routine Spend	Less than $250K	Items for Subsequent Submission	Carryover
Distribution System						
Requirement to Serve	$36.8	$0.0	$34.9	$0.0	$1.7	$0.2
Pole Strength	8.0	0.0	7.7	0.0	0.0	0.3
Joint Use Agreement	0.5	0.0	0.5	0.0	0.0	0.0
Deteriorated Conductor	2.9	1.5	0.0	0.7	0.0	0.7
Equipment Replacement	8.0	2.7	0.0	0.4	1.8	3.2
Outage Performance	2.5	0.0	0.6	0.0	0.0	1.9
Overloaded Equipment	0.5	0.3	0.0	0.2	0.0	0.0
Capacity	2.0	1.6	0.0	0.0	0.3	0.1
Other Distribution System	1.5	0.0	0.0	0.0	1.3	0.2
Total	**$62.8**	**$6.1**	**$43.8**	**$1.3**	**$5.0**	**$6.6**
Work Support Facilities						
Buildings	$5.8	$0.0	$5.3	$0.1	$0.3	$0.0
Furniture & Fixtures	0.0	0.0	0.0	0.0	0.0	0.0
Telecommunications	7.7	0.6	0.8	0.5	3.5	2.2
Computers / IT	89.8	0.9	2.0	0.6	29.8	56.5
Tools & Equipment	1.6	0.2	1.4	0.0	0.0	0.0
Vehicles	7.9	0.0	7.9	0.0	0.0	0.0
Equipment Replacement	0.0	0.0	0.0	0.0	0.0	0.0
Other	0.3	0.0	0.0	0.0	0.3	0.0
Total	**$113.1**	**$1.8**	**$17.4**	**$1.2**	**$34.0**	**$58.7**

8.4 Quick Reference Sheet

2017 AFUDC Rate for Capital 7.01%

Please refer to **Section 1.4** regarding NS Power's use of the 2017 AFUDC rate.

2017 O/H Rates

Generation		**Customer Operations**		**Shared Services**	
PP Regular	21.46%	Regular	76.49%	IT	33.21%
Hydro	51.90%	Contract	20.02%	Proj. Support	48.09%
Contractor	10.76%	Vehicle	51.64%		

8.5 2017 Depreciation Rates

	2017
Steam Production Plant	
Lingan	
Lingan 1-2	4.12%
Lingan 3-4	2.28%
Lingan - Common	4.48%
Total Lingan	3.35%
Point Aconi 1	2.27%
Point Tupper	
Point Tupper 1 (Common)	3.97%
Point Tupper 2	2.82%
Total Point Tupper	2.89%
Trenton	
Trenton 5	3.10%
Trenton 6	2.34%
Trenton - Common	0.47%
Total Trenton	2.47%
Tufts Cove	
Tufts Cove 1	4.24%
Tufts Cove 2	3.68%
Tufts Cove 3	2.33%
Tufts Cove - Common	3.44%
Total Tufts Cove	3.27%
Port Hawkesbury Biomass	2.50%
Point Tupper Marine Terminal	4.06%
International Coal Pier	2.60%
General	2.82%
Total Steam Production Plant	**2.82%**

	2017
Hydro Production Plant	
Avon	3.02%
Bear River	1.80%
Black River	2.04%
Dickie Brook	3.16%
Fall River	1.82%
Harmony	4.55%
Lequille System	2.33%
Roseway	2.29%
Mersey	2.00%
St. Margaret's	2.85%
Sheet Harbour	3.38%
Tusket	2.64%
Wreck Cove System	1.67%
Annapolis Tidal	2.32%
General	2.10%
Total Hydro Production	**2.10%**

	2017
Other Production - Combustion Turbines	
Burnside	2.40%
Tusket	6.42%
Victoria Junction	3.17%
Tufts Cove Unit 4	2.55%
Tufts Cove Unit 5	2.77%
Tufts Cove Unit 6	3.03%
Wind Turbines	
Pre 2009 Wind	5.52%
Post 2009 Wind	4.0%
Transmission Plant	
Land Rights - Easements	1.26%
Station Equipment	2.14%
Towers & Fixtures	1.26%
Poles & Fixtures	4.32%
Overhead Conductors & Devices	1.96%
Underground Conduit	1.53%
Underground Conductors & Devices	2.61%
Roads, Trails & Bridges	1.74%
Total Transmission Plant	**2.35%**

2017 Annual Capital Expenditure Plan

	2017
Distribution Plant	
Land Rights - Easements, Surveys & Clearing	1.56%
Structures & Improvements	5.31%
Station Equipment	1.28%
SCADA Equipment	9.68%
Remote Monitoring Equipment	10.32%
Station Equipment - Miscellaneous	12.49%
Poles, Towers & Fixtures	3.79%
Overhead Conductors & Devices	3.33%
Underground Conduit	1.51%
Underground Conductors & Devices	3.17%
Line Transformers	4.09%
Services	5.33%
Meters	6.87%
Street Lighting & Signal Systems	5.33%
Total Distribution Plant	**3.89%**

2017 Annual Capital Expenditure Plan

	2017
General Plant	
Land Rights - General Plant	1.93%
Structures & improvements	2.85%
Office Furniture & Equipment	9.26%
Office Furniture & Equip - Comp Hardware	20.00%
Office Furniture & Equip - Comp Software	10.00%
Transportation Equipment	9.55%
Stores Equipment	14.97%
Communication Equipment	4.38%
Communication Equipment - SCADA Eq	1.33%
Remote Monitoring Equipment	10.27%
Miscellaneous Equipment	5.02%
Roads, Bridges & Traps (Kelly Rock)	2.58%
Mining Equipment (Kelly Rock)	2.92%
Total General Plant	**8.16%**

8.6 Summary of Economically Justified Projects

Revenue Requirement Summary							Change in Revenue Requirement due to:				PV of Revenue Requirement by Year							
CI	Project	Alternative	Rank as Filed	As Filed	Capital Spend Increased 10%	Avoided Expenses Reduced 10%	Deferral of 1 year	Deferral of 2 years	Deferral of 3 years		Year 0 / 2016	Year 1 / 2017	Year 2 / 2018	Year 3 / 2019	Year 4 / 2020	Year 5 / 2021	Years 6 to end of life / 2022+	Total
47597	TRE6 Bottom Ash Chain Replacement	Chain Replacement vs Replacement Energy Costs	1	-3,625,762	-3,535,603	-3,173,027	247,058	4,705,339	4,369,898		0	-305,385	-4,179,682	55,014	51,692	48,457	704,141	-3,625,762
47597	TRE6 Bottom Ash Chain Replacement	Bar-Loop Replacement vs Replacement Energy Costs	2	-3,504,809	-3,402,555	-3,052,074	241,395	4,694,278	4,353,693		0	-303,871	-4,203,129	38,576	42,019	44,372	877,223	-3,504,809
47687	POT Boiler Chemical Recondition	Recondition Boiler vs Avoided Fuel & Repair Costs	1	-3,723,024	-3,631,178	-3,258,875	399,978	866,163	1,456,765		(16,449)	(463,534)	(449,012)	(509,614)	(617,561)	(686,433)	-980,420	-3,723,024
47953	LIN Railcar Positioner Upgrade	Upgrade Railcar Positioner vs Avoided Fuel & Repair Costs	1	-5,370,253	-5,314,200	-4,777,175	151,161	334,291	583,162		0	-183,593	-159,315	-199,357	-236,995	-272,320	-4,318,674	-5,370,253
49057	TRE6 Excitation System Replacement	Replace Excitation System vs Avoided Fuel & Repair Costs	1	-7,418,317	-7,332,738	-6,590,906	193,521	326,408	577,006		6,812	(269,129)	(120,067)	(198,635)	(253,797)	(380,002)	-6,203,498	-7,418,317
49419	POT Boiler Refurbishment 2017	Refurbish Boiler vs Avoided Fuel & Repair Costs	1	-3,906,802	-3,814,627	-3,423,947	584,980	1,216,587	1,982,805		0	-653,512	-626,523	-674,685	-790,049	-857,542	-304,490	-3,906,802
49430	LIN CW Pump Refurbishment 2017	CW Pump Refurbishment vs Avoided Fuel & Repair Costs	1	-481,067	-431,495	-383,389	131,897	219,639	360,583		0	-153,809	-83,870	-113,856	-71,763	-114,739	56,970	-481,067
49431	LIN Mill Refurbishment 2017	Mill Refurbishment vs Avoided Fuel & Repair Costs	1	-1,691,100	-1,630,105	-1,460,995	142,038	333,723	610,451		0	-207,951	-175,852	-232,000	-204,231	-227,113	-643,952	-1,691,100
49433	LIN1 SH5 Boiler Tube Replacement	Boiler Tube Replacements vs Avoided Fuel & Repair Costs	1	-1,371,137	-1,325,300	-1,188,186	74,412	211,052	361,947		0	-125,571	-111,312	-115,082	-98,992	-111,635	-808,545	-1,371,137
49434	LIN CW Screen Refurbishment 2017	CW Screen Refurbishment vs Avoided Fuel & Repair Costs	1	-400,062	-369,744	-329,738	128,213	224,423	476,257		0	-178,745	-93,621	-214,220	-180,141	21,344	245,320	-400,062
49437	LIN Vacuum Pump Cooler Refurbishment	Vacuum Pump Cooler Refurb vs Avoided Fuel & Repair Costs	1	-931,774	-907,210	-814,033	135,725	224,009	334,774		0	-176,995	-89,249	-92,902	-65,933	-76,171	-430,524	-931,774
49463	POT Coal Mill Overhauls 2017	Coal Mill Overhaul vs Avoided Fuel & Repair Costs	1	-569,670	-538,245	-481,278	80,753	250,974	519,212		0	-101,961	-157,572	-232,872	-325,131	21,174	226,691	-569,670
49532	TRE6 Air Heater Refurbishment	Air Heater Refurbishment vs Avoided Fuel & Repair Costs	1	-2,147,899	-2,017,442	-1,802,652	382,762	698,690	1,195,269		0	-533,615	-296,045	-406,822	-487,594	-646,576	222,752	-2,147,899
49533	TRE6 Boiler Refurbishment	Boiler Refurbishment vs Avoided Fuel & Repair Costs	1	-4,801,216	-4,689,478	-4,209,357	94,790	273,436	490,449		0	-263,437	-136,771	-156,553	-284,185	-326,174	-3,634,095	-4,801,216
49535	TRE6 Mills Refurbishment 2017	Mill Refurbishment vs Avoided Fuel & Repair Costs	1	-5,644,762	-5,570,792	-5,006,315	66,613	2,004,910	6,915,248		0	-165,588	-1,792,857	-4,371,378	54,143	50,708	580,211	-5,644,762
49536	TRE5 Boiler Refurbishments 2017	Boiler Refurbishment vs Avoided Fuel & Repair Costs	1	-2,422,397	-2,355,347	-2,113,107	65,585	223,559	405,945		0	-129,834	-127,842	-140,304	-226,193	-217,628	-1,580,597	-2,422,397
49821	Mersey River Hydro Spare Transformer	Purchase Spare Transformer vs Avoided Fuel Costs	1	-1,977,991	-1,933,070	-1,735,271	36,147	118,264	268,745		0	(62,323)	(108,992)	(119,924)	(166,649)	(212,940)	-1,307,163	-1,977,991
	Summary of all Economically Justified Projects		**1**	-50,004,815	-48,817,578	-43,817,096	3,157,813	16,927,280	25,264,457		0	-4,342,438	-12,863,572	-7,685,550	-3,862,225	-3,944,012	-17,307,019	-50,004,815

Generation

Hydro

CI Number: 48535

Title: HYD Scragg Lake Dam and Spillway Refurbishment

Start Date:	2015/12
In-Service Date:	2017/10
Final Cost Date:	2018/04
Function:	Hydro
Forecast Amount:	$1,956,298

DESCRIPTION:

This project will involve the refurbishment of the Scragg Lake Dam and Spillway/Sluiceway to address structural deficiencies and to meet the requirements of the Canadian Dam Association (CDA) Dam Safety Guidelines. Scragg Lake Dam is on the Nictaux Hydro River system and was originally constructed in 1956. The Scragg Lake reservoir is located on Scragg Brook, approximately 0.5 miles upstream of its confluence with the Nictaux River. The Scragg Lake Dam is located at the southwestern end of the reservoir. The earthfill dam has a crest length of 1,000 feet, a maximum height of 13 feet, and a crest elevation of 626 feet. The spillway/sluiceway control structure is a concrete gravity structure. The structure is constructed between the left and right embankment sections of the earthfill dam and consists of a low level gated sluice integrated into an ogee shape, with the concrete spillway on either side of the sluice. The spillway crest elevation is 620 feet and it is approximately 50 feet long.

This refurbishment will include the spillway/sluiceway being replaced with a larger structure, sized to meet the stability requirements and will be of similar configuration as to what is currently in-place. In addition, the upstream slope of the embankment dam sections will be rehabilitated with new riprap and the downstream slopes will be flattened with new earth-fill material.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

Depreciation Class: Hydraulic Production Plant - St. Margaret's Bay Hydro System

Estimated Life of the Asset: 50 Years

JUSTIFICATION:

Justification Criteria: Health & Safety

Why do this project?

The most recent Dam Safety Review (Hatch, 2012) concluded that the Scragg Lake Dam was in fair condition but did not meet the stability requirements for the Sunny Day condition (the steady state flow condition with the reservoir at full supply level). The Spillway/Sluiceway was in poor condition and did not meet the stability requirements for the usual, usual with ice, and flood loading conditions.

The Scragg Lake Dam was classified as Significant as part of the 2010 Flood Study For a Significant classification dam the inflow design flood (IDF) is the 1/1,000-year flood.

Why do this project now?

This project was identified as a priority due to its degrading condition and dam safety risks. The rehabilitation of the dam is scheduled to be implemented in 2017 as part of a general dam safety improvement program.

NS Power carries out dam safety projects on a priority basis based on risk. NS Power maintains a dam safety risk prioritization to identify which projects should be considered for rehabilitation/redevelopment. NS Power's operating license is tied to its water control structures meeting the Canadian Dam Association (CDA) guidelines. Therefore, the dam prioritization is based on the Canadian Dam Association categories: life safety, environment, and economic/ infrastructure and includes assessment of sub-categories including freeboard, stability, and condition against CDA guidelines.

At present, Scragg Lake Dam does not meet CDA stability guidelines and was identified as a priority due to its degrading condition and dam safety risks. The rehabilitation of the dam is scheduled to be implemented in 2017 as part of a general dam safety improvement program.

Generation from NS Power's legacy hydro facilities qualify under the provisions of the Nova Scotia Renewable Electricity Regulations. Generation from hydro facilities is an important part of NS Power's compliance plan to serve 40 percent of sales from qualifying renewable generation sources by 2020. The refurbishment of the dams is scheduled to be implemented in 2017 as part of a general dam safety improvement program.

Why do this project this way?

Based on the initial assessment of the existing spillway/sluiceway structure, it was determined that replacement of the structure would be the best long-term option for the refurbishment of this structure. All design upgrades will meet the requirements of the CDA Guidelines. The other option considered was to place the sluiceway on one side of the spillway as opposed to the current location in the middle of the spillway. However, civil constraints (bridge work required to complete the geotechnical studies required to understand the bedrock profile) led to the current location being selected.

CI Number : 48535-H752 - HYD Scragg Lake Dam and Spillway Refurbishment **Project Number** H752

Parent CI Number : -

Cost Centre : 431 - 431-Nictaux/Paradise System **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		36,425	0	36,425
095		095-Hydro Regular Labour AO		1,326	0	1,326
095		095 - Proj Supp Regular Labour AO		34,861	0	34,861
095		095-Thermal & Hydro Contracts AO		136,908	0	136,908
001	001	001 - Regular Labour (No AO)	001 - HGP - Land	1,193	0	1,193
001	028	001 - Regular Labour (No AO)	028 - HGP - Dams & Spillways	2,336	0	2,336
001	028	001 - HYDRO Regular Labour	028 - HGP - Dams & Spillways	2,555	0	2,555
011	028	011 - Travel Expense	028 - HGP - Dams & Spillways	11,811	0	11,811
012	028	012 - Materials	028 - HGP - Dams & Spillways	60,000	0	60,000
013	028	013 - POWER PRODUCTION Contracts	028 - HGP - Dams & Spillways	1,272,500	0	1,272,500
028	028	028 - Consulting	028 - HGP - Dams & Spillways	96,809	0	96,809
041	028	041 - Meals & Entertainment	028 - HGP - Dams & Spillways	2,505	0	2,505
066	028	066 - Other Goods & Services	028 - HGP - Dams & Spillways	227,841	0	227,841
001	085	001 - Proj Supp Regular Labour	085 Design	69,229	0	69,229
			Total Cost:	1,956,298	0	1,956,298
			Original Cost:			

Capital Project Detailed Estimate

Location: Hydro
CI# / FP#: 48535
Title: Scragg Lake Dam and Spillway Refurbishment
Execution Year: 2017

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
	001 Regular Labour						
	Hydro River Staff - Construction	day	7	$ 365	$ 2,555		
	Project Support Staff	day	171	$ 405	$ 69,229		
	T&D Labour	day	3	$ 365	$ 1,193		
	Regular Labour (No AO)	day	6	$ 365	$ 2,336		
				Sub-Total	$ 75,313		
	011 Travel Expenses						
	Engineering Staff	lot	1	$ 11,811	$ 11,811		
				Sub-Total	$ 11,811		
	012 Materials						
	Sluice Gate	lot	1	[redacted]			
	Misc. Steel	lot	1	[redacted]			
				Sub-Total	$ 60,000		20758
	013 Power Production Contracts						
	Contractor Misc. Costs (Mob/Demob)	lot	1	[redacted]			
	Site Accesss (Road Upgrade, Stream Crossing, etc.)	lot	1	[redacted]			
	Water Control (Headpond Diversion)	lot	1	[redacted]			
	Enclosure	lot	1	[redacted]			
	Environmantal (Tree Clearing, etc.)	lot	1	[redacted]			
	Demolition and Disposal of Existing Spillway Sturcture	lot	1	[redacted]			
	Embankment Excavation for Demolition and Construction	lot	1	[redacted]			
	Embankment Dam Backfill	lot	1	[redacted]			
	Riprap and Filter on Upstream Slope	lot	1	[redacted]			
	Granular Fill for Crest Regarding	lot	1	[redacted]			
	Concrete for Sluiceway	Cu. Yd	850	[redacted]			
	Gate and Handrail Installation	lot	1	[redacted]			
	Construction Supervisor - Consultant	Month	7	[redacted]			
				Sub-Total	$ 1,272,500		20758
	028 Consulting						
	Conceptual	lot	1	$ 34,309	$ 34,309		
	Detailed Design	lot	1	$ 35,000	$ 35,000		
	Design Consultant	lot	1	$ 27,500	$ 27,500		
				Sub-Total	$ 96,809		
	041 Meals and Entertainment						
	Engineering Staff	lot	1	$ 2,505	$ 2,505		
				Sub-Total	$ 2,505		
	066- Other Goods and Services						
	Contingency	%	15%	$ 1,518,937	$ 227,841		
				Sub-Total	$ 227,841		
	094 Interest Capitalized						
	AFUDC				$ 36,425		
					$ -		
				Sub-Total	$ 36,425		
	095 Administrative Overhead						
	Hydro Regular Labour AO				$ 1,326		
	Project Support Labour AO				$ 34,861		
	Thermal & Hydro Contracts AO				$ 136,908		
				Sub-Total	$ 173,095		
				Sub-Total (no AO, AFUDC)	$ 1,746,778		
				TOTAL (AO, AFUDC included)	$ 1,956,298		
	Original Cost						

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 48631

Title: HYD Gulch Spillway Refurbishment

Start Date:	2016/02
In-Service Date:	2017/10
Final Cost Date:	2018/04
Function:	Hydro
Forecast Amount:	$617,034

DESCRIPTION:

This project will involve the refurbishment of the Gulch Spillway on the Bear River Hydro system to meet the requirements of the Canadian Dam Association (CDA) Dam Safety Guidelines. Gulch Spillway does not meet current CDA design guidelines for stability. The concrete has also delaminated in several locations and areas of section loss (erosion of the concrete which has reduced the cross sectional area of the spillway) are visible. The scope of this project includes adding reinforced concrete to the downstream face of the existing spillway in order to increase its stability.

Summary of Related CIs +/- 2 years:
2018 CI 47654 HYD - Gulch Surge Tank and Penstock Replacement $TBD

JUSTIFICATION:

Justification Criteria: Health & Safety

Why do this project?

In 2014, NS Power carried out a flood study and dam safety review of its Bear River Hydro system in accordance with CDA Dam Safety Guidelines. According to CDA guidelines, the Gulch dam is classified as HIGH, and the inflow design flood is 1/3 between the 1/1000-year flood and the PMF.

The dam safety review concluded that, at present, the Gulch concrete spillway does not meet current stability requirements. The structure also has areas where the concrete is delaminating resulting in section loss. The concrete spillway is inspected on a regular basis.

Why do this project now?

NS Power carries out dam safety projects on a priority basis based on risk. Based on the current condition of the Gulch spillway this work will be completed in 2017 NS Power's operating license stipulates that water control structures should meet CDA guidelines. At present Gulch spillway does not meet CDA stability guidelines.

Generation from NS Power's legacy hydro facilities qualify under the provisions of the Nova Scotia Renewable Electricity Regulations. Generation from hydro facilities is an important part of NS Power's compliance plan to serve 40 percent of sales from qualifying renewable generation sources by 2020. The refurbishment of the dams is scheduled to be implemented in 2017 as part of a general dam safety improvement program.

Why do this project this way?

Several options were considered. The addition of rock anchors would increase the stability, but this was not considered the best option as rock anchors may lose their effectiveness over time, and the deteriorated concrete would still have to be replaced. The more reliable option is to remove unsound concrete and increase the spillway's concrete cross section to meet CDA guidelines for stability.

CI Number : 48631-H755 - HYD - Gulch Spillway Refurbishment **Project Number** H755

Parent CI Number : -

Cost Centre : 410 - 410-Bear River Hydro System **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		12,289	0	12,289
095		095 - Proj Supp Regular Labour AO		17,304	0	17,304
095		095-Hydro Regular Labour AO		2,273	0	2,273
095		095-Thermal & Hydro Contracts AO		31,992	0	31,992
001	028	001 - Proj Supp Regular Labour	028 - HGP - Dams & Spillways	34,080	0	34,080
001	028	001 - HYDRO Regular Labour	028 - HGP - Dams & Spillways	4,380	0	4,380
001	028	001 - Regular Labour (No AO)	028 - HGP - Dams & Spillways	2,703	0	2,703
011	028	011 - Travel Expense	028 - HGP - Dams & Spillways	5,418	0	5,418
013	028	013 - POWER PRODUCTION Contracts	028 - HGP - Dams & Spillways	[redacted]	0	[redacted]
028	028	028 - Consulting	028 - HGP - Dams & Spillways	[redacted]	0	[redacted]
041	028	041 - Meals & Entertainment	028 - HGP - Dams & Spillways	550	0	550
066	028	066 - Other Goods & Services	028 - HGP - Dams & Spillways	72,153	0	72,153
			Total Cost:	617,034	0	617,034
			Original Cost:	150,063		

Capital Project Detailed Estimate

Location: Hydro
CI# / FP#: 48631
Title HYD Gulch Spillway Refurbishment
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Hydro River Staff - Construction	day	12	365	$ 4,380		
Engineering Staff	day	72	405	$ 29,180		
Environmental Staff	day	12	405	$ 4,900		
Regular Labour (No AO)	day	7	365	$ 2,703		
			Sub-Total	$ 41,163		
011 Travel Expenses						
Travel to site	lot	1	$ 5,418	$ 5,418		
			Sub-Total	$ 5,418		
013 Power Production Contracts						
Spillway Refurbishment	lot	1	[redacted]			
			Sub-Total	[redacted]		
028 Consulting						
Design	lot	1	$ 80,542	$ 80,542		
Construction supervision	lot	1	[redacted]			
			Sub-Total	[redacted]		
041 Meals and Entertainment						
Meals	lot	1	$ 550	$ 550		
			Sub-Total	$ 550		
066- Other Goods and Services						
Contingency	%	15%	$ 481,023	$ 72,153.45		
			Sub-Total	$ 72,153		
094 Interest Capitalized						
AFUDC				$ 12,289		
			Sub-Total	$ 12,289		
095 Administrative Overhead						
095 - Hydro Regular Labour AO				$ 2,273		
095 - Project Support Labour AO				$ 17,304		
095 - Thermal & Hydro Contracts AO				$ 31,992		
				$ -		
			Sub-Total	$ 51,569		
			Sub-Total (no AO, AFUDC)	$ 553,176		
			TOTAL (AO, AFUDC included)	$ 617,034		
12 **Original Cost**						
12.1				$ 150,063		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

Gulch Spillway Contract Cost Estimate

Cost Estimate

item	Description	Quantity	Unit	Unit Price	Total
1	**Mobilization and demobilization**				
1.1	Mobilization	1	L.S.	[redacted]	[redacted]
1.2	Demobilization	1	L.S.	[redacted]	[redacted]
1.3	water control and silt barriers	1	L.S.	[redacted]	[redacted]
1.4	Access to dam	1	L.S.	[redacted]	[redacted]
Subtotal					[redacted]
2	**Demolition**				
2.1	Concrete Demolition	12	m3	[redacted]	[redacted]
2.2	Surface Preparation	300	m2	[redacted]	[redacted]
Subtotal					[redacted]
3	**Construction**				
3.1	15M Dowels installation	1500	Ea	[redacted]	[redacted]
3.2	Rebar	6	ton	[redacted]	[redacted]
3.3	New Concrete	150	m3	[redacted]	[redacted]
3.4	Hydrotite	5	10 m	[redacted]	[redacted]
3.5	Labor	1120	Hour	[redacted]	[redacted]
Subtotal					[redacted]
TOTAL					[redacted]

Steam

Boiler

CI Number: 49532

Title: TRE6 Air Heater Refurbishment

Start Date:	2017/02
In-Service Date:	2017/10
Final Cost Date:	2018/04
Function:	Steam
Forecast Amount:	$1,428,236

DESCRIPTION:

This project includes the replacement of Air Heater components including hot end, intermediate and cold end baskets, support grids, and miscellaneous mechanical systems related to the Trenton Unit 6 air heaters.

Trenton Unit 6 air heaters (designated as 6A & 6B) transfer heat from the gas streams exiting Unit 6 boiler to the incoming primary air streams (pulverized fuel transport and drying air) and the incoming secondary air streams (boiler combustion air). Air Heaters are directly in the Boiler gas pass and subjected to continuous use. These Air Heaters incorporate three layers of heat transferring elements referred to as hot-end baskets, intermediate baskets and cold-end baskets which act to recover energy and improve the operating efficiency of the unit. As these operate within the hot flue gas flow of the boiler they are subject to the effects of heating and erosion. The frequency of repair is a function of operating hours, gas velocity and ash loading.

This project is being completed as part of the planned major outage on Trenton Unit 6 in 2017.

The investment completed in 2015 to the Trenton #6 Air Heater (CI 46300) was focused on replacing the hot end sector plates, as well as refurbishment of the cold end sector plates, circumferential seals and stationary T-bar seal surfaces, rotor post seals, guide bearing shaft seal assemblies.

Summary of Related CIs +/- 2 years:
2015 CI 46300 TRE6 Air Heater Refurbishment $2,040,366

Depreciation Class: Steam Production Plant - Trenton Unit 6

Estimated Life of the Asset: 25 years

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement/Refurbishment

Why do this project?

The air heaters are part of the original design of the plant. Their function is to recover heat (transfer from outgoing flue gas to incoming fuel transport and combustion air). Air Heater performance deteriorates over operating time. Air Heater baskets wear out, seal clearances and integrity deteriorate and air heater drive components wear. Refurbishment is required to maintain the Air Heater in service and to maintain its effectiveness to transfer heat and have a positive effect on efficiency. Inspection of the air heater (attached), completed in July 2016, recommended changing the baskets and support grids.

This project is being undertaken primarily to prevent air heater failure and preserve the unit's availability, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

Regular assessment by NS Power and the OEM indicated the condition of the components is such that replacement is required at this time to ensure the reliability and performance of the generating unit. Risk profiling (compared to similar equipment in NS Power's fleet) provides guidance on the timing of refurbishment.

Why do this project this way?

As the Air Heater is situated in the Boiler Gas Pass, this work must be completed during a unit outage. Typically, the duration of the work is greater than 2 weeks (depending on scope). It is not good practice to have an issue advance to critical between outage intervals as it would cause unplanned extended outages. The deteriorated condition of the Air Heater components is such that they cannot be refurbished and replacement is the only option.

CI Number : 49532 - TRE6 Air Heater Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 345 - 345-Trenton unit 6 Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		16,459	0	16,459
095		095-Thermal Overtime Labour AO		1,519	0	1,519
095		095-Thermal Term Labour AO		1,423	0	1,423
095		095-Thermal Regular Labour AO		3,938	0	3,938
095		095-Thermal & Hydro Contracts AO		84,889	0	84,889
001	010	001 - THERMAL Regular Labour	010 - SGP - Turbo Gen.Instal.	18,349	0	18,349
002	010	002 - THERMAL Overtime Labour	010 - SGP - Turbo Gen.Instal.	14,156	0	14,156
004	010	004 - THERMAL Term Labour	010 - SGP - Turbo Gen.Instal.	6,628	0	6,628
012	010	012 - Materials	010 - SGP - Turbo Gen.Instal.	412,310	0	412,310
013	010	013 - POWER PRODUCTION Contracts	010 - SGP - Turbo Gen.Instal.	789,000	0	789,000
033	010	033 - Rental and Maintenance of	010 - SGP - Turbo Gen.Instal.	12,000	0	12,000
066	010	066 - Other Goods & Services	010 - SGP - Turbo Gen.Instal.	60,066	0	60,066
028	085	028 - Consulting	085 Design	5,000	0	5,000
011	087	011 - Travel Expense	087 Field Super.& Ops.	1,000	0	1,000
021	087	021 - Telephones	087 Field Super.& Ops.	500	0	500
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	1,000	0	1,000
			Total Cost:	1,428,236	0	1,428,236
			Original Cost:	767,452		

Capital Project Detailed Estimate

Location: Trenton Generating Station
CI# : 49532
Title: TRE6 Air Heater Refurbishment
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Mech (Millwrights)	PD	5	$ 365	$ 1,824		
Mech (Welders)	PD	5	$ 365	$ 1,824		
Utility	PD	20	$ 240	$ 4,804		
Internal Supervision	PD	20	$ 405	$ 8,106		
Electricians	PD	5	$ 358	$ 1,791		
			Sub-Total	$ 18,349		
002 OT Labour						
Mech (Millwrights)	PD	5	$ 730	$ 3,648		
Utility	PD	10	$ 811	$ 8,106		
Mech (Welders)	PD	5	$ 480	$ 2,402		
				$ -		
			Sub-Total	$ 14,156		
004 Term Labour						
Mech (Millwrights)	PD	5	$ 365	$ 1,824		
Utility	PD	20	$ 240	$ 4,804		
				$ -		
			Sub-Total	$ 6,628		
011 Travel Expense						
	lot	1.00	$ 1,000	$ 1,000		
				$ -		
			Sub-Total	$ 1,000		
012 Materials						
Hot End Baskets	lot	1	[redacted]	[redacted]	Cost Support Item #1	
Intermediate Baskets	lot	1	[redacted]	[redacted]	Cost Support Item #1	
Cold End Baskets	lot	1	[redacted]	[redacted]	Cost Support Item #1	
Cold End Support Gratings	lot	1	[redacted]	[redacted]	Cost Support Item #1	
Pin racks	lot	1	[redacted]	[redacted]		
Scaffolding	lot	1	$ 10,000	$ 10,000		
			Sub-Total	$ 412,310		
013 Contracts						
Alstom- Installation labour	PD	540	$ 1,000	$ 540,000		46352
Supervision- Alstom	PD	150	$ 1,200	$ 180,000		
Inspection Tacten	lot	1	$ 10,000	$ 10,000		
Insulation R/R	lot	1	$ 5,000	$ 5,000		
Outside supervision	pd	45	$ 1,200	$ 54,000		
			Sub-Total	$ 789,000		
021 Phones						
Phones	lot	1	$ 500	$ 500		
				$ -		
			Sub-Total	$ 500		
028 Consulting						
Outside engineering	lot	1.00	$ 5,000	$ 5,000		
				$ -		
				$ -		
			Sub-Total	$ 5,000		
033 Rentals						
Trailer rentals	lot	1	$ 12,000	$ 12,000		
				$ -		
			Sub-Total	$ 12,000		
041 Meals & Entertainment						
Meals	lot	1.00	$ 1,000	$ 1,000		
				$ -		
			Sub-Total	$ 1,000		
066 Other Goods & Services						
Contingency	%	5%	$ 1,201,310	$ 60,065.52		
				$ -		
			Sub-Total	$ 60,066		
094 Interest Capitalized						
AFUDC				$ 16,459		
				$ -		
			Sub-Total	$ 16,459		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 3,938		
Thermal OT Labour AO				$ 1,519		
Thermal Term Labour AO				$ 1,423		
Thermal / Hydro Contracts AO				$ 84,889		
			Sub-Total	$ 91,768		
			SUB-TOTAL (no AO, AFUDC)	$ 1,320,009		
			TOTAL (AO, AFUDC included)	$ 1,428,236		
Original Cost				$ 767,452.19		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

TRE6 Air Heater Refurbishment
Summary of Alternatives

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Trenton Generating Station	**CI Number:**	49532
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Air Heater Refurbishment vs Avoided F	5.90%	-2,147,899	1,447,557	1	42.31%	2.8 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

The recommendation is to complete this project to prevent air heater failure and preserve the unit's availability.

Notes/Comments :

Air Heater Refurbishment vs Avoided Fuel & Repair Costs

As time passes the probabilty of air heater failure increases. This analysis does not include efficiency losses as seals break down, considerations in this anaylsis were only made for the loss of generation and costs of completing repairs for one set of baskets.

Test 2

Test 3

Test 4

TRE6 Air Heater Refurbishment
Summary of Sensitivities

Nova Scotia POWE An Emera Compa

Division :	Power Production		**Date :**	**28-Oct-16**
Department :	Trenton Generating Station		**CI Number:**	49532
			Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Air Heater Refurbishment vs Avoided Fuel & Repa	5.90%	-2,147,899	1,447,557	1	42.31%	2.8 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Air Heater Refurbishment vs Avoided Fuel & Repa	10%	-2,017,442	1,344,163	1	36.46%	3.1 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
	Change:	**A**	130,457	-103,394	0	-5.85%	0.3 years
		B	0	0	0	#NUM!	0.0 years
		C	0	0	0	#NUM!	0.0 years
		D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Air Heater Refurbishment vs Avoided Fuel & Repa	-10%	-1,802,652	1,199,407	1	35.88%	3.1 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
	Change:	**A**	345,247	-248,150	0	-6.43%	0.3 years
		B	0	0	0	#NUM!	0.0 years
		C	0	0	0	#NUM!	0.0 years
		D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	382,762	698,690	1,195,269	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

TRE6 Air Heater Refurbishment
Avoided Cost Calculations

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Trenton Generating Station	**CI Number:**	49532
		Project No. :	

Air Heater Refurbishment vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			380,000	395,312		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	50%	60%	50%	60%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	160.0	160.0				
Duration (Hours or Years)	672	672				
Totals	$284,952	$223,375	$190,000	$237,187	$474,952	$460,562

Total Capital Cost of Alternative **$1,428,236**

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative **$0**

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative **$0**

Test 4

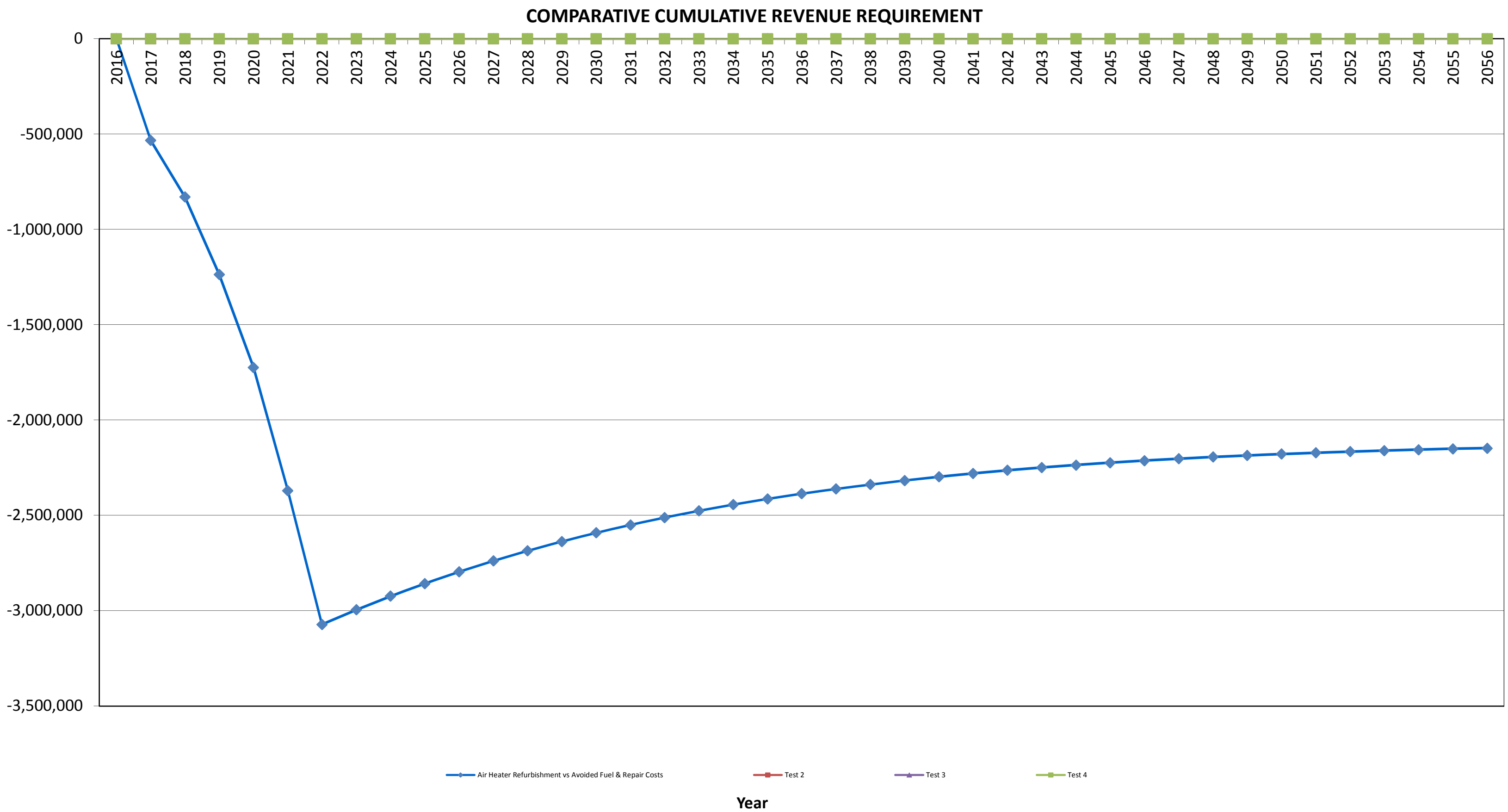
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative **$0**

TRE6 Air Heater Refurbishment

Air Heater Refurbishment vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	474,952.4	(1,336,467.9)	52,800.4	1,292,536.5	(861,515.5)	(130,867.1)	(992,382.6)	(937,094.1)	0.94	(937,094.1)
2018	-	-	460,562.2	-	101,376.7	1,186,931.2	460,562.2	(111,347.5)	349,214.7	311,387.1	0.89	(625,707.0)
2019	-	-	620,942.0	-	93,266.6	1,089,774.3	620,942.0	(163,579.4)	457,362.6	385,099.4	0.84	(240,607.6)
2020	-	-	762,376.2	-	85,805.2	1,000,389.9	762,376.2	(209,737.0)	552,639.2	439,397.8	0.80	198,790.2
2021	-	-	1,030,579.8	-	78,940.8	918,156.3	1,030,579.8	(295,008.1)	735,571.7	552,262.1	0.75	751,052.2
2022	-	-	1,177,022.7	-	72,625.5	842,501.3	1,177,022.7	(342,363.1)	834,659.6	591,743.7	0.71	1,342,795.9
2023	-	-	-	-	66,815.5	772,898.8	-	20,712.8	20,712.8	13,866.5	0.67	1,356,662.4
2024	-	-	-	-	61,470.3	708,864.5	-	19,055.8	19,055.8	12,046.4	0.63	1,368,708.8
2025	-	-	-	-	56,552.6	649,952.9	-	17,531.3	17,531.3	10,465.3	0.60	1,379,174.1
2026	-	-	-	-	52,028.4	595,754.2	-	16,128.8	16,128.8	9,091.7	0.56	1,388,265.8
2027	-	-	-	-	47,866.2	545,891.4	-	14,838.5	14,838.5	7,898.3	0.53	1,396,164.1
2028	-	-	-	-	44,036.9	500,017.7	-	13,651.4	13,651.4	6,861.6	0.50	1,403,025.7
2029	-	-	-	-	40,513.9	457,813.8	-	12,559.3	12,559.3	5,961.0	0.47	1,408,986.7
2030	-	-	-	-	37,272.8	418,986.3	-	11,554.6	11,554.6	5,178.6	0.45	1,414,165.3
2031	-	-	-	-	34,291.0	383,265.0	-	10,630.2	10,630.2	4,498.9	0.42	1,418,664.1
2032	-	-	-	-	31,547.7	350,401.3	-	9,779.8	9,779.8	3,908.4	0.40	1,422,572.5
2033	-	-	-	-	29,023.9	320,166.8	-	8,997.4	8,997.4	3,395.4	0.38	1,425,967.8
2034	-	-	-	-	26,702.0	292,351.0	-	8,277.6	8,277.6	2,949.7	0.36	1,428,917.5
2035	-	-	-	-	24,565.8	266,760.5	-	7,615.4	7,615.4	2,562.5	0.34	1,431,480.1
2036	-	-	-	-	22,600.5	243,217.2	-	7,006.2	7,006.2	2,226.2	0.32	1,433,706.3
2037	-	-	-	-	20,792.5	221,557.4	-	6,445.7	6,445.7	1,934.0	0.30	1,435,640.3
2038	-	-	-	-	19,129.1	201,630.4	-	5,930.0	5,930.0	1,680.1	0.28	1,437,320.4
2039	-	-	-	-	17,598.8	183,297.5	-	5,455.6	5,455.6	1,459.6	0.27	1,438,780.0
2040	-	-	-	-	16,190.9	166,431.3	-	5,019.2	5,019.2	1,268.0	0.25	1,440,048.0
2041	-	-	-	-	14,895.6	150,914.4	-	4,617.6	4,617.6	1,101.6	0.24	1,441,149.6
2042	-	-	-	-	13,704.0	136,638.8	-	4,248.2	4,248.2	957.0	0.23	1,442,106.6
2043	-	-	-	-	12,607.6	123,505.2	-	3,908.4	3,908.4	831.4	0.21	1,442,938.0
2044	-	-	-	-	11,599.0	111,422.4	-	3,595.7	3,595.7	722.3	0.20	1,443,660.3
2045	-	-	-	-	10,671.1	100,306.2	-	3,308.0	3,308.0	627.5	0.19	1,444,287.7
2046	-	-	-	-	9,817.4	90,079.2	-	3,043.4	3,043.4	545.1	0.18	1,444,832.8
2047	-	-	-	-	9,032.0	80,670.5	-	2,799.9	2,799.9	473.6	0.17	1,445,306.4
2048	-	-	-	-	8,309.5	72,014.4	-	2,575.9	2,575.9	411.4	0.16	1,445,717.8
2049	-	-	-	-	7,644.7	64,050.8	-	2,369.9	2,369.9	357.4	0.15	1,446,075.2
2050	-	-	-	-	7,033.1	56,724.3	-	2,180.3	2,180.3	310.5	0.14	1,446,385.7
2051	-	-	-	-	6,470.5	49,983.9	-	2,005.8	2,005.8	269.7	0.13	1,446,655.4
2052	-	-	-	-	5,952.8	43,782.8	-	1,845.4	1,845.4	234.3	0.13	1,446,889.8
2053	-	-	-	-	5,476.6	38,077.7	-	1,697.7	1,697.7	203.6	0.12	1,447,093.3
2054	-	-	-	-	5,038.5	32,829.1	-	1,561.9	1,561.9	176.9	0.11	1,447,270.2
2055	-	-	-	-	4,635.4	28,000.3	-	1,437.0	1,437.0	153.6	0.11	1,447,423.8
2056	-	-	-	-	4,264.6	23,557.9	-	1,322.0	1,322.0	133.5	0.10	1,447,557.3
Total	**-**	**-**	**4,526,435.4**	**(1,336,467.9)**	**1,270,966.3**		**3,189,967.4**	**(1,009,195.4)**	**2,180,772.0**	**1,447,557.3**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
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Air Heater Refurbishment vs Avoided Fuel & Repair Costs
Test 2
Test 3
Test 4
Year

Quotation (Aftermarket)

ISO 9001:2008 Certified

Howden

Attention:	Fred Jordan	From:	Phillip Edgerton
Company/Representative:	Trenton Thermal Generating Station	Phone:	919-324-2388
Plant/Site:	Trenton Thermal Generating Station	Email:	phillip.edgerton@howden.com
Your Reference:	Single Sealing Option		
Our Reference:	25 VIT 70/82 (1124/1101)	Fax:	866-810-9419
Market:	Power	Quote #:	HNAGAT.AFM.000151/B
General Assembly Drawing:		Date:	8/23/2016

Howden North America presents our offer as follows:

Item	Part Number	Description	Qty	Price Each	Lead Time to Ship
1	BASE: HOT LAYER	Hot End Baskets BASKETS: Heater Designation: 25 VIT 70 (82") Number of Sets: 2 Total Number Baskets: 144 Baskets Material : LACRS (EN 10025-5) Baskets Type: MK-IV ELEMENTS: Elements Depth: 42.0 inches Element Profile: HC11 Element Thickness: 24 gauge Element Material : LACRS (EN 10025-5) Total Aprx. Shipping Weight: 172503 lbs	1	[redacted]	[redacted]
2	BASE: INT LAYER	Intermediate Baskets BASKETS: Heater Designation: 25 VIT 70 (82") Number of Sets: 2 Total Number Baskets: 144 Baskets Material : LACRS (EN 10025-5) Baskets Type: MK-IV ELEMENTS: Elements Depth: 16.0 inches Element Profile: HC11 Element Thickness: 24 gauge Element Material : LACRS (EN 10025-5) Total Aprx. Shipping Weight: 73503 lbs	1	[redacted]	[redacted]
3	BASE: COLD LAYER	Cold End Baskets BASKETS: Heater Designation: 25 VIT 70 (82") Number of Sets: 2 Total Number Baskets: 216 Baskets Material : LACRS (EN 10025-5)	1	[redacted]	[redacted]

		Baskets Type: Full Wrapper ELEMENTS: Elements Depth: 12.0 inches Element Profile: HC12 Element Thickness: 18 gauge Element Material : LACRS (EN 10025-5) Total Aprx. Shipping Weight: 97231 lbs			
4	Support Grating	Cold End Support Gratings	1	[redacted]	[redacted]

**** PLEASE NOTE ABOVE PRICING INCLUDES TRANSPORTATION TO JOBSITE ****
Unloading of containers and site logistics is the responsibility of the customer.

Howden Field Service is available to Supervise or Assist at the jobsite, see attached Rate Sheet.

All orders are subject to credit approval by Howden's Accounting Department.

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Prices are in USD

Freight:	DDP at Trenton Station. Incoterms 2010. Freight Allowed.

This quote is subject only to Howden North America’s Standard Terms and Conditions of Sale, (available at www.howden.com). Unless otherwise negotiated and agreed to by HNA in writing, no other terms shall apply regardless of any statement on Buyer’s documents to the contrary.

Howden North America does not accept Liquidated Damages or in place warranty as standard business practice.

*If quoted lead time does not meet your requirements, please advise.

For Prepay and Charge orders, there will be a 4% charge of the net selling price applied to Buyer’s invoice as a separate item to cover the standard transportation and handling expenses to the first North American destination. This does not apply to overseas or expedited shipments. In addition, any expense incurred by Seller because of special delivery arrangements requested by Buyer shall be billed to Buyer. Howden does not provide copies of freight invoices.

Pricing does not include Federal, State, Local, or Export taxes or duties.

Payment terms are 30% with order, 40% upon ready to dispatch date from Howden Spain facility, 30% upon delivery, payable Net 30 days.

Quote expires 30 days from noted and is subject to customer credit approval.

Minimum order value is $350.00.

Non inventory parts are not returnable; returned inventory parts are subject to restocking charges.

Quoted lead time is based upon material availability and factory loading at time of quotation, and may be subject to adjustment at order placement/acknowledgement.

If you have any questions, please contact us.

Sincerely,

Phillip Edgerton

Howden North America Inc.
2475 George Urban Blvd.
Suite 120
Depew, NY 14043
Tel: 716-817-6900
Fax: 716-817-6905
www.howden.com

Inspection Report

PROJECT INFORMATION			
Project #:		**Customer:**	Nova Scotia Power
On-site Date & Time:	7/7/16 to 7/8/2016	**Project Site:**	Trenton Generating Station
Estimated Duration On-site:	2 days	Site Contact Information:	Fred Jordon - Engineer
Equipment:	Unit #6 Air Preheaters	Sales Office & Rep Info:	Gary Seely- Sales Rep
Original Equipment Order Number:	HOW #1124	Customer PO:	
Serial #:	S/N # 1101/1102	Assigned Technical Specialist	Frank R. Parise - TS
G.A. Drawing #:		Assigned Performance Engineer	Don Gorski Performance Engineer
Parts Project #:		Parts Project Manager:	
HNA Project Manager:			
Testing Equipment Used On Project (Brand-Model & S/N):		Project Completion Date:	
FOLLOW UP (TA…check appropriate boxes)			
Service Complete:	☒Yes ☐No	Quote Required:	☐Yes ☒No
Return Trip Required:	☐Yes ☒No	Parts List provided to Customer:	☐Yes ☒No
Additional Info. Required:	☒Yes ☐No	Does HNA Sales Rep need to contact Customer:	☐Yes ☒No

24/7 EMERGENCY SERVICE 800.458.FANS (3267)

Objective/Job Scope:
Discuss with plant engineers the current leakage percentage after the retrofit (2015) for the air preheaters 6-A & 6-B. Take seal clearance measurements of hot end and cold end seals.

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Nova Scotia Power

Trenton Generating Station

Unit #6

HOW - 1124

S/N- 1101/1102

(2) Size - 25 VIT Howden Air Preheaters

Visit Date:
July 9, 2016

Field Service Technical Specialist:
Frank R. Parise

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Suite 120
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OBJECTIVE:

The purpose of this visit was to provide technical assistance with the leakage issues of the Air Preheaters 6-A & 6-B on Boiler #6. Both Air Preheaters 6-A & 6-B were water washed before the start of the job. Don Gorski (Performance Engineer) and I had our safety orientation before we met with Fred Jordan and Darryl Myette with Nova Scotia Power to discuss the scope of this work. The following report details our inspection findings and provides recommendations to improve the efficiency & reliability of these particular units while in operation. The information provided below pertains to both air preheaters unless otherwise specified.

Inspection Performed This Outage:

APH 6-A 25 VIT (ccw rotation) S/N #1101
APH 6-B 25 VIT (cw rotation) S/N #1102
HOW – #1124

- **The cold end secondary air inlet duct was not inspected this outage due to no access (scaffold) in the duct on APH's 6-A & 6-B.**
- **The cold end primary air inlet duct was not inspected this outage due to no access (scaffold) in the duct on APH 6-B.**

OBSERVATIONS:

Rotor Structure:

APH's 6-A & 6-B; the hot end rotor structure is in serviceable condition with no hot end rotor diaphragm-to-rotor post, diaphragm-to-stay plate, or diaphragm-to-rotor shell cracks observed at this time.
APH's 6-A & 6-B; the cold end rotor structure is in good serviceable condition with no cold end rotor diaphragm-to-rotor post, diaphragm-to-stay plate, or diaphragm-to-rotor shell cracks observed at this time.

APH's 6-A & 6-B; the cold end basket support grating and blocks have seen a good amount of erosion and repairs, especially outboard. See ***Photo #1. Recommend replacing the cold end basket support grating and blocks when the baskets are replaced due to moderate to severe erosion observed on APH's 6-A & 6-B.***

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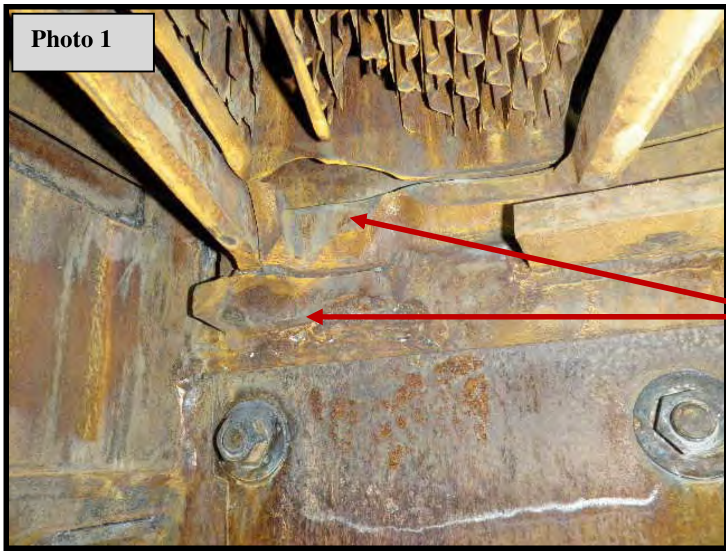
Photo 1



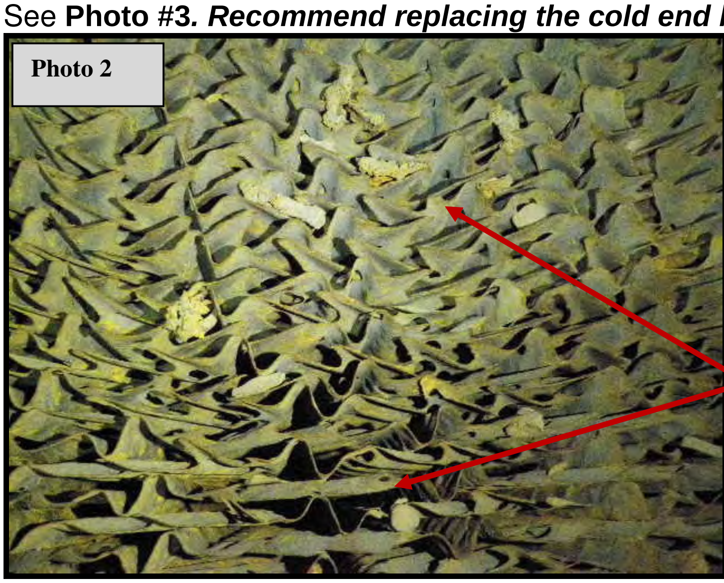
Severely eroded cold end basket support grating and support blocks on APH's 6-A & 6-B

Heat Transfer Element:

APH's 6-A & 6-B have the DN7 element (heat transfer surface) in the hot end and intermediate. The hot end on 6-A & 6-B APH's has fracturing and thinning of the element with some pluggage in the outer "D" baskets. See ***Photo #2.*** The intermediate baskets were not inspected this outage. ***Recommend replacing the hot end and intermediate baskets.***

APH's 6-A & 6-B have the NF6 element in the cold end. There are signs in both APH's 6-A & 6-B of fracturing and thinning of the element with pockets of spiking of over 1" (25.4 mm) deep. See **Photo #3*. Recommend replacing the cold end baskets.***

Photo 2



Fracturing and thinning of the hot end element on APH's 6-A & 6-B

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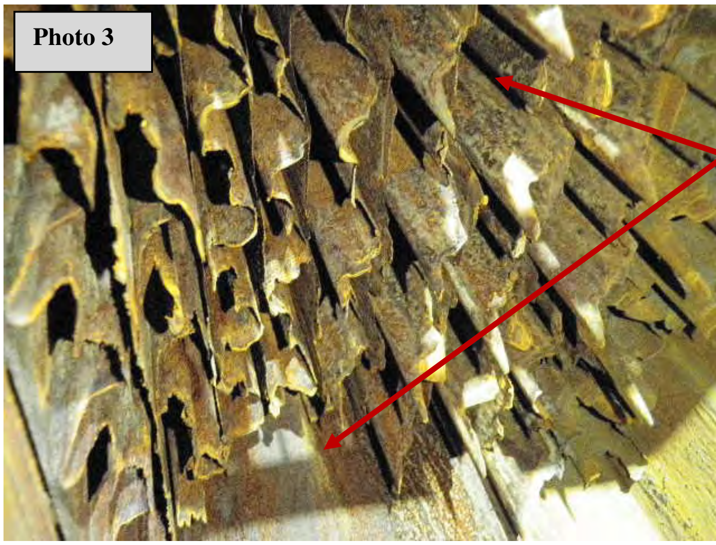
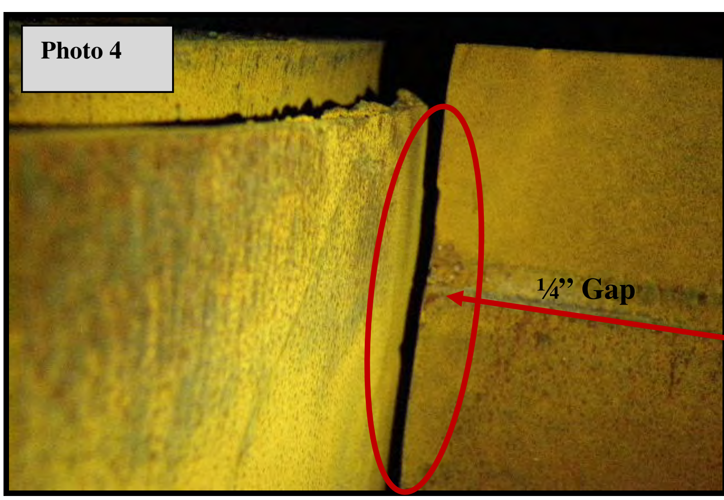


Fracturing, thinning and some pluggage with pockets of spiking of over 1” (25.4 mm deep in the cold end baskets on APH’s 6-A & 6-B

Rotor Seals:

The hot end sector plates (3) were all replaced to the VN design in the Fall of 2015 on APH’s 6-A & 6-B. The hot end sector plate sealing surfaces are in good serviceable condition from inboard to outboard.

The hot end radial seals are in good serviceable condition on APH’s 6-A & 6-B. However, there were excessive gaps between the inner radial seals edge, up to ¼” (6.4 mm), and the rotor post seal. See **Photo #4.** There is also an excessive gap between the inner radial seal and the intermediate seal joint. See **Photo # 5. Recommend resetting the hot end radial seals during the next outage on APH’s 6-A & 6-B.**



Excess gap on the hot end inner radial seals to post seal on APH’s 6-A & 6-B

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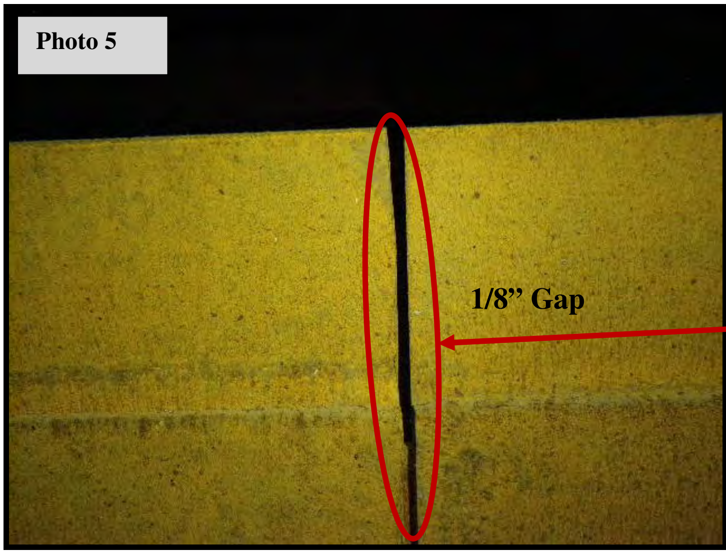

Gap between the inner and the intermediate hot end radial seals on APH's 6-A & 6-B

The hot end T-bar sealing surface was in good serviceable condition on APH's 6-A & 6-B. The hot end T-bar was replaced during the 2015 outage. The bypass seals are in good serviceable condition. The hot end bypass seal readings on APH's 6-A & 6-B were found to be about:

- .125" (3.2 mm) at the sector plate
- .250" (6.4 mm) at the center of the housing

The cold end sector plate sealing surfaces are in serviceable condition on APH's 6-A & 6-B. However, there is wear (washed out) of about 1/8" (3.2 mm) on the outboard end of the flue gas duct (flue gas to primary air & secondary air to flue gas) See **Photo #6**. The cold end static seal in the flue gas duct is in serviceable condition with moderate erosion on the outboard ends See **Photo #6**.

Wear to the cold end flue gas outboard sector plate and static seal on APH's 6-A & 6-B

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The cold end T-bar sealing surface was in serviceable condition on APH's 6-A & 6-B. The bypass seals were in serviceable condition. The cold end bypass seal readings on APH's 6-A & 6-B were found to be at about:

- .078 (2.0 mm) at the sector plate
- .125 (3.2 mm) at the center of the housing

The hot end and cold end post seal was in serviceable condition on APH's 6-A & 6-B.

Housing:

The outside APH housing remains in serviceable condition on APH's 6-A & 6-B. The support feet and the center section area are in serviceable condition on both APH's.

The hot end and cold duct stiffeners were in serviceable condition on APH's 6-A & 6-B.

The hot end and cold end expansion joints are in serviceable condition on APH's 6-A & 6-B.

Soot Blower/Cleaning Device:

The operation of the swing arm cleaning device in the cold end gas outlet duct was not observed on APH's 6-A & 6-B during my inspection. The sequence of operation should be checked when the unit is back online. The lance and nozzle seem to be in serviceable condition. The random spiking observed indicates some "lost motion", dwelling, or erratic travel of the swing arm cleaning device.

Recommend inspecting and checking the sequence of operations and the steam pressure on the swing arm soot blower when the unit is back on line. High pressure (over the design pressures) and moisture in the steam may have adverse effects on the air preheater's performance and reduce heat transfer surface life.

Rotor Drive:

An external inspection was made to the rotor drive gearbox to APH's 6-A & 6-B. The oil was clean and seems to be at the correct level. The rotor started easily using the auxiliary air drive and coasted smoothly to a stop. We did not operate the rotor using the main electric drive motor. **Recommend performing regular oil sampling/analysis on the rotor gearbox to APH's 6-A & 6-B.**

The pinion gear was not inspected this outage. Wear to the pins are moderate to severe 3/32" (2.4 mm) to 7/64" (2.8 mm). **Recommend replacing the pin rack assemblies along with the**

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pinion gear/taper lock bushing and carbon ring & spring during the next scheduled outage on APH's 6-A & 6-B.

Rotor Bearings:

The guide bearing and support bearing were not inspected this outage on APH's 6-A & 6-B. **Recommend performing regular oil sampling/analysis on the rotor guide bearing and support bearing on APH's 6-A & 6-B.**

The following pages (9 to 14) have the run outs of the hot end and cold end sector plates and axial seal plates on APH's 6-A & 6-B.

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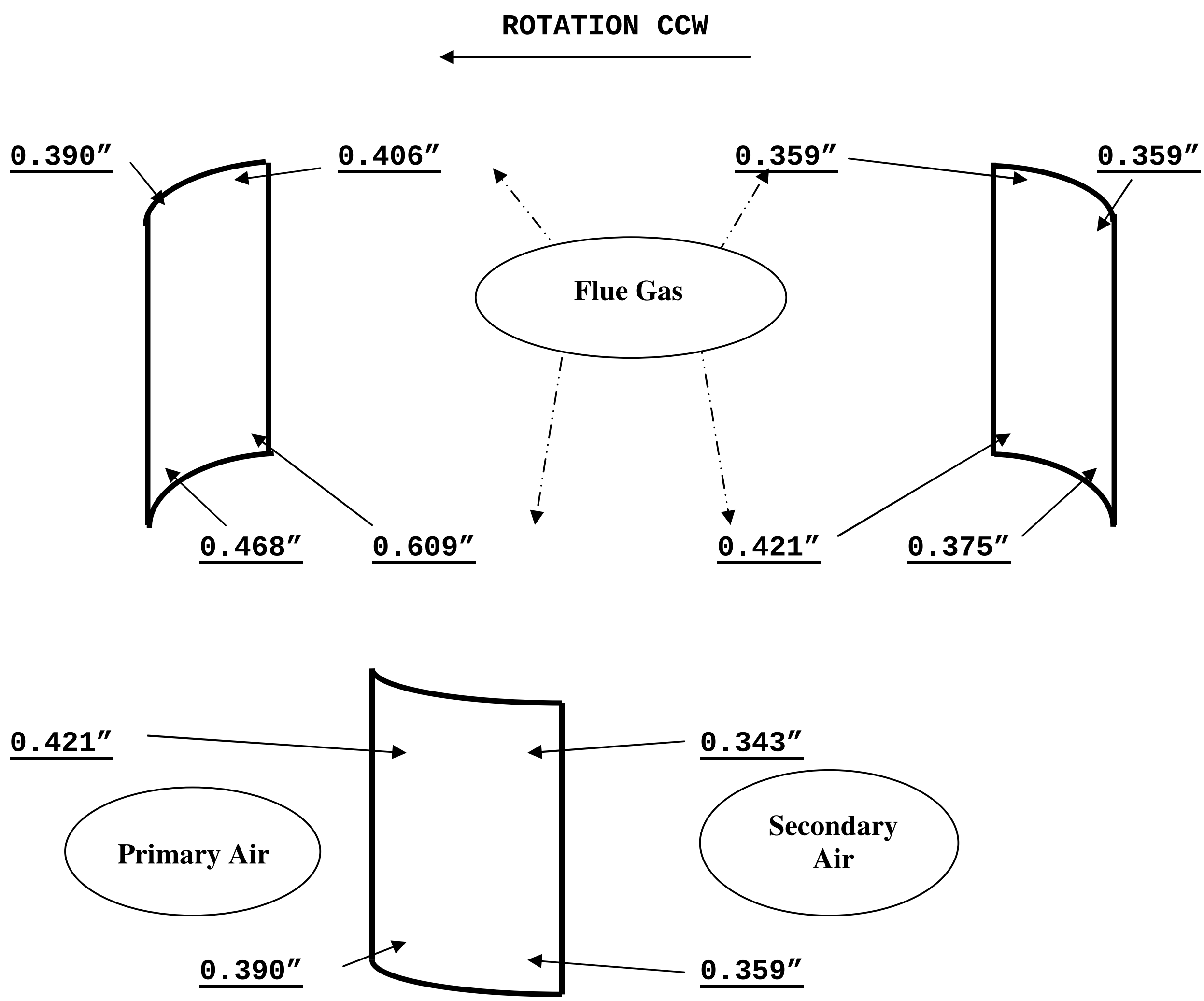
APH 6-A
Axial Seal Plate Plane



NOTE:
All readings are actual seal clearances measured by rotating one axial seal 360°. SEAL CLEARANCE SPECS: Hot End = 0.275” Cold End = 0.155”

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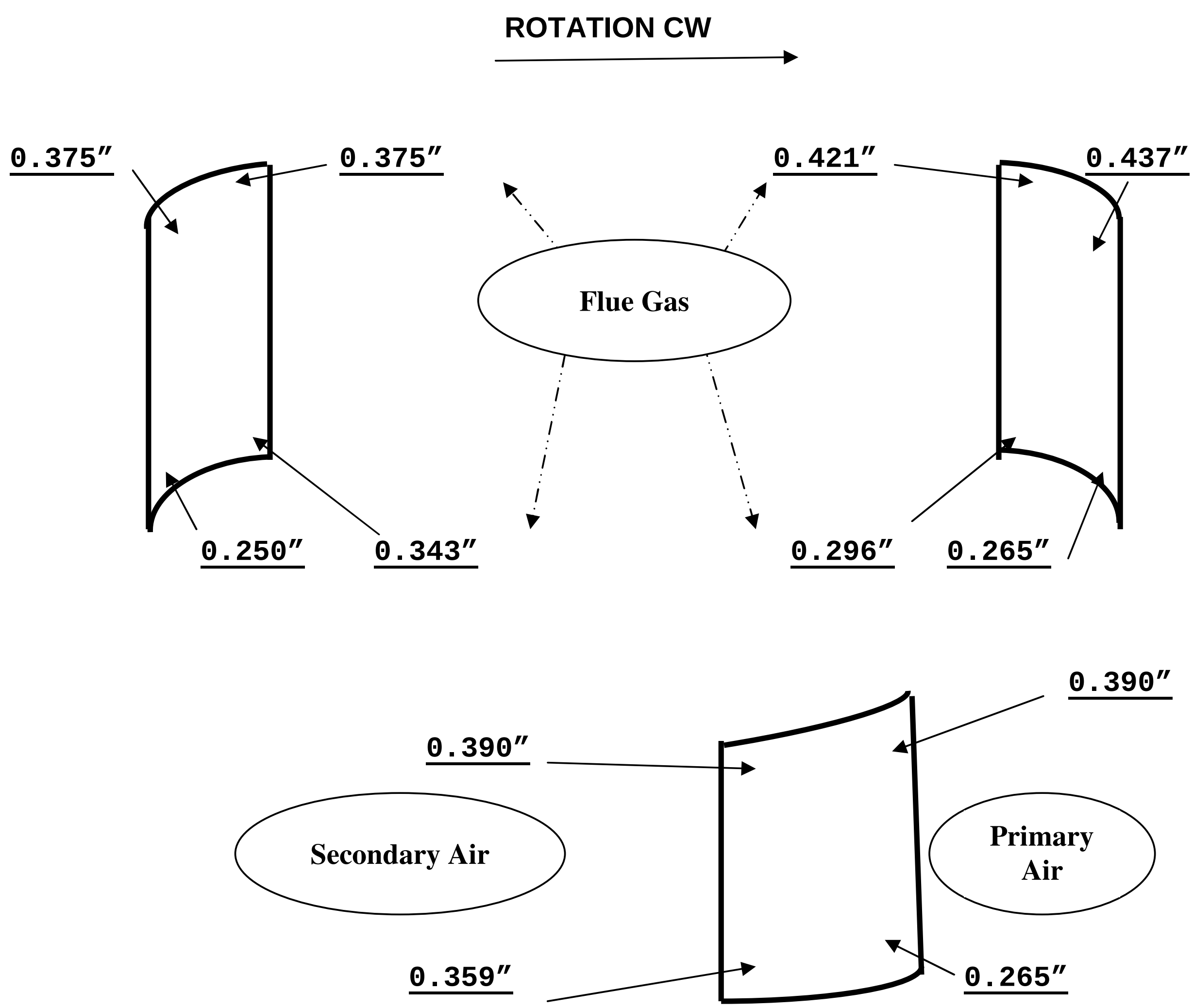
APH 6-B
Axial Seal Plate Plane



NOTE:
All readings are actual seal clearances measured by rotating one axial seal 360°. SEAL CLEARANCE SPECS: Hot End = 0.275″ Cold End = 0.155″

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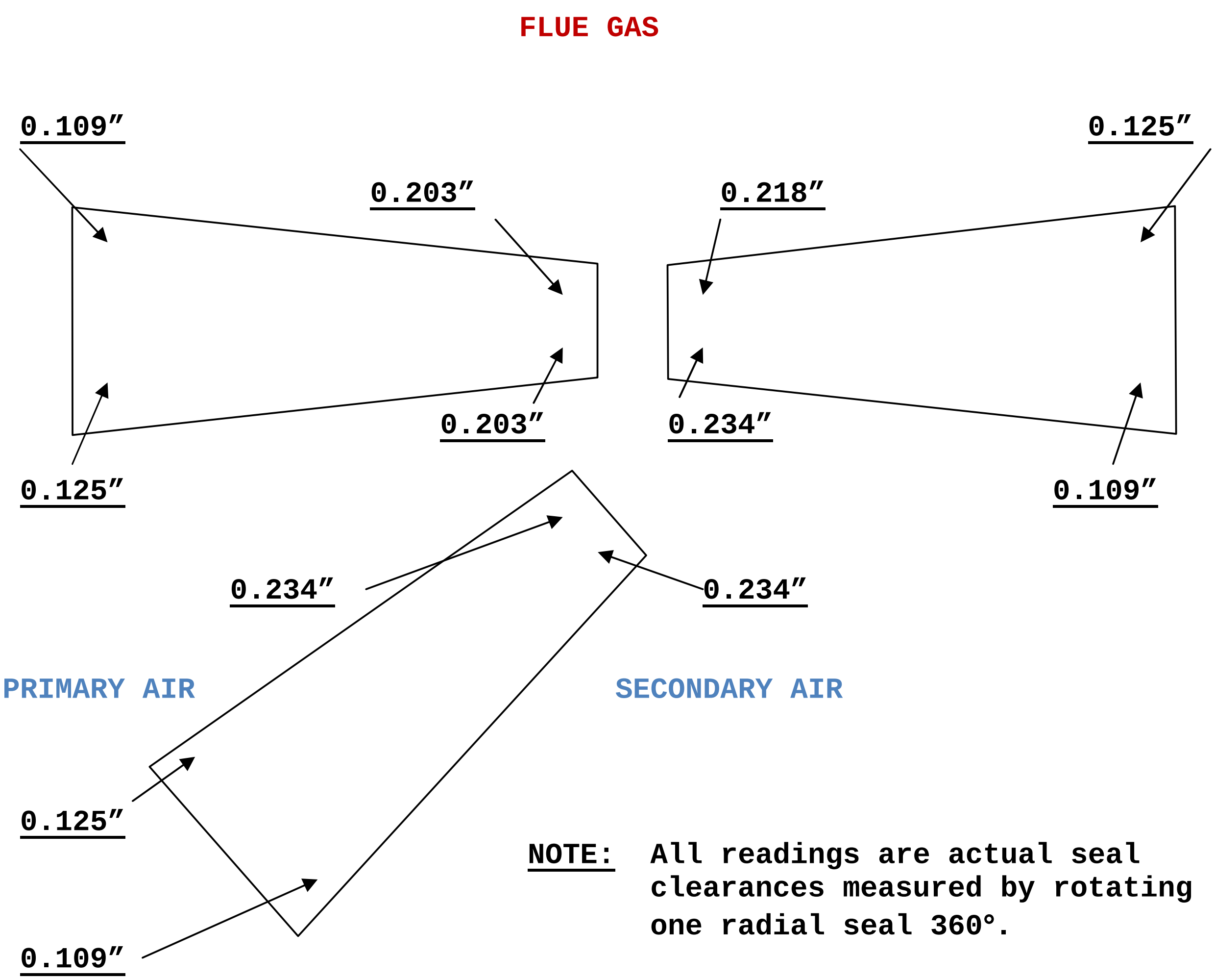
APH 6-A
Hot End - Sector Plate Plane

ROTATION - CCW



NOTE: All readings are actual seal clearances measured by rotating one radial seal 360°.

SEAL SETTING SPECS: Inboard = 0.275” Outboard = 0.040”

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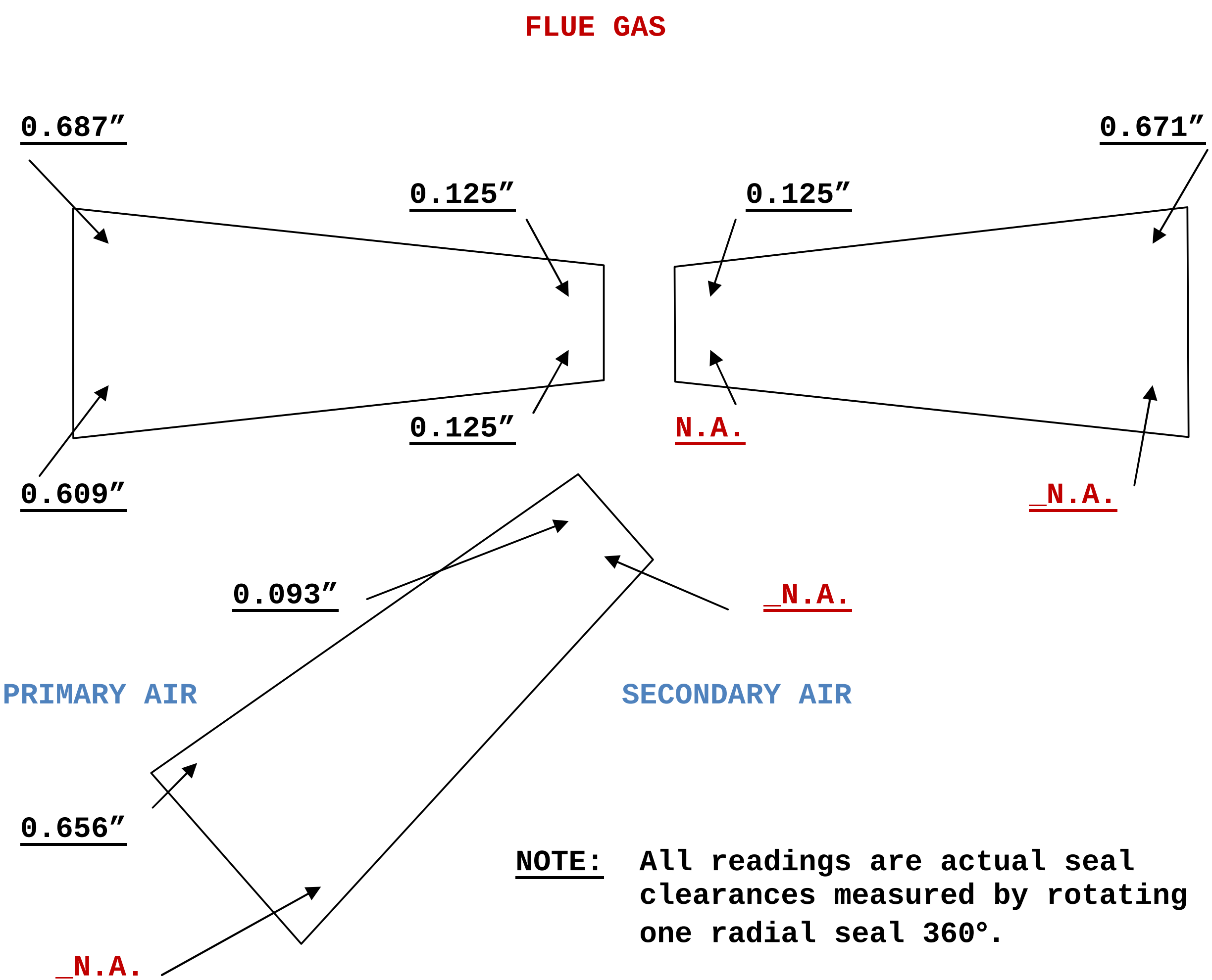
APH 6-A
Cold End - Sector Plate Plane

ROTATION - CCW



NOTE: All readings are actual seal clearances measured by rotating one radial seal 360°.

SEAL SETTING SPECS: Inboard = 0.040″ Outboard = 0.430″

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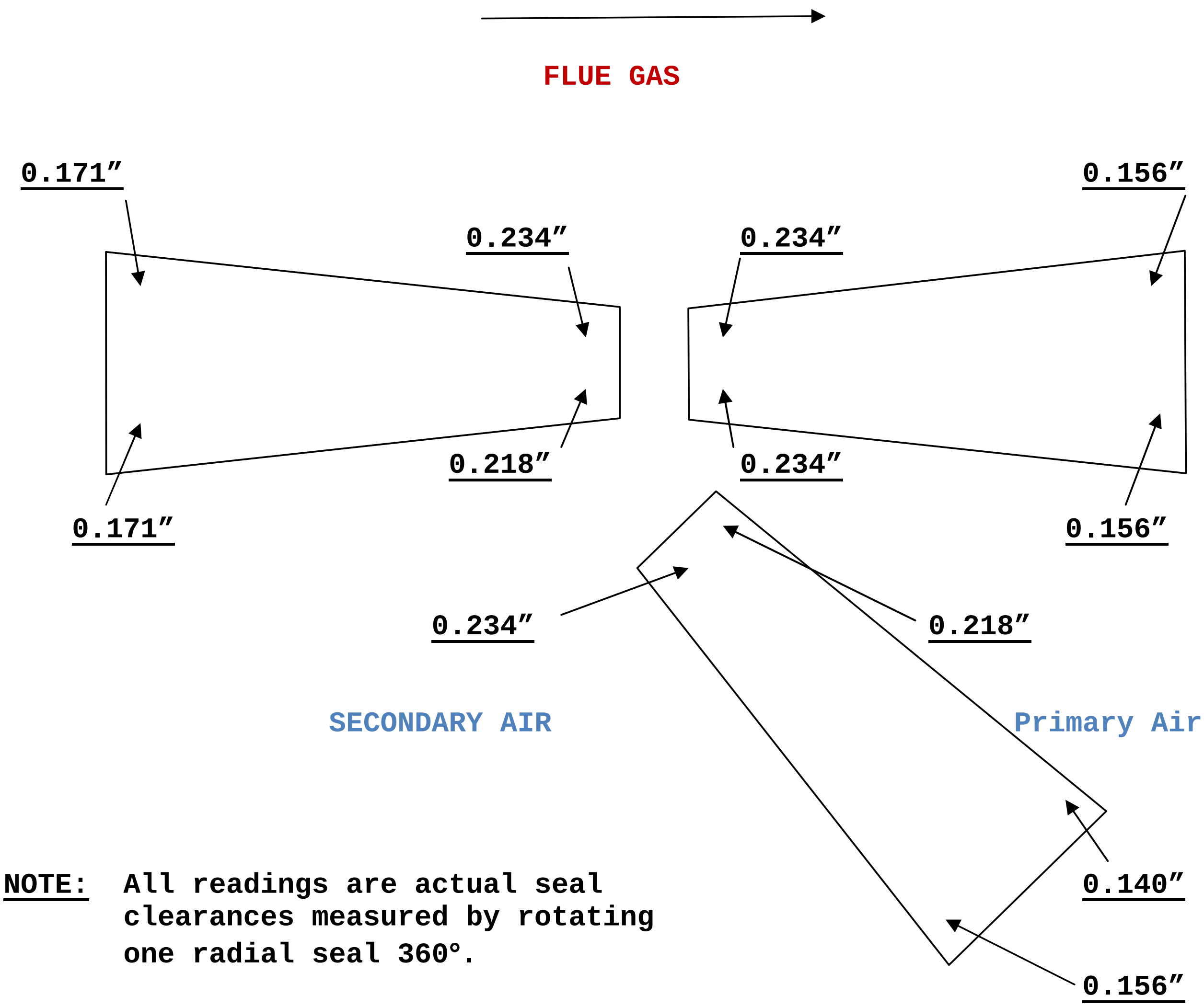
APH 6-B
Hot End - Sector Plate Plane

ROTATION - CW



NOTE: All readings are actual seal clearances measured by rotating one radial seal 360°.

SEAL SETTING SPECS: Inboard = 0.275″ Outboard = 0.040″

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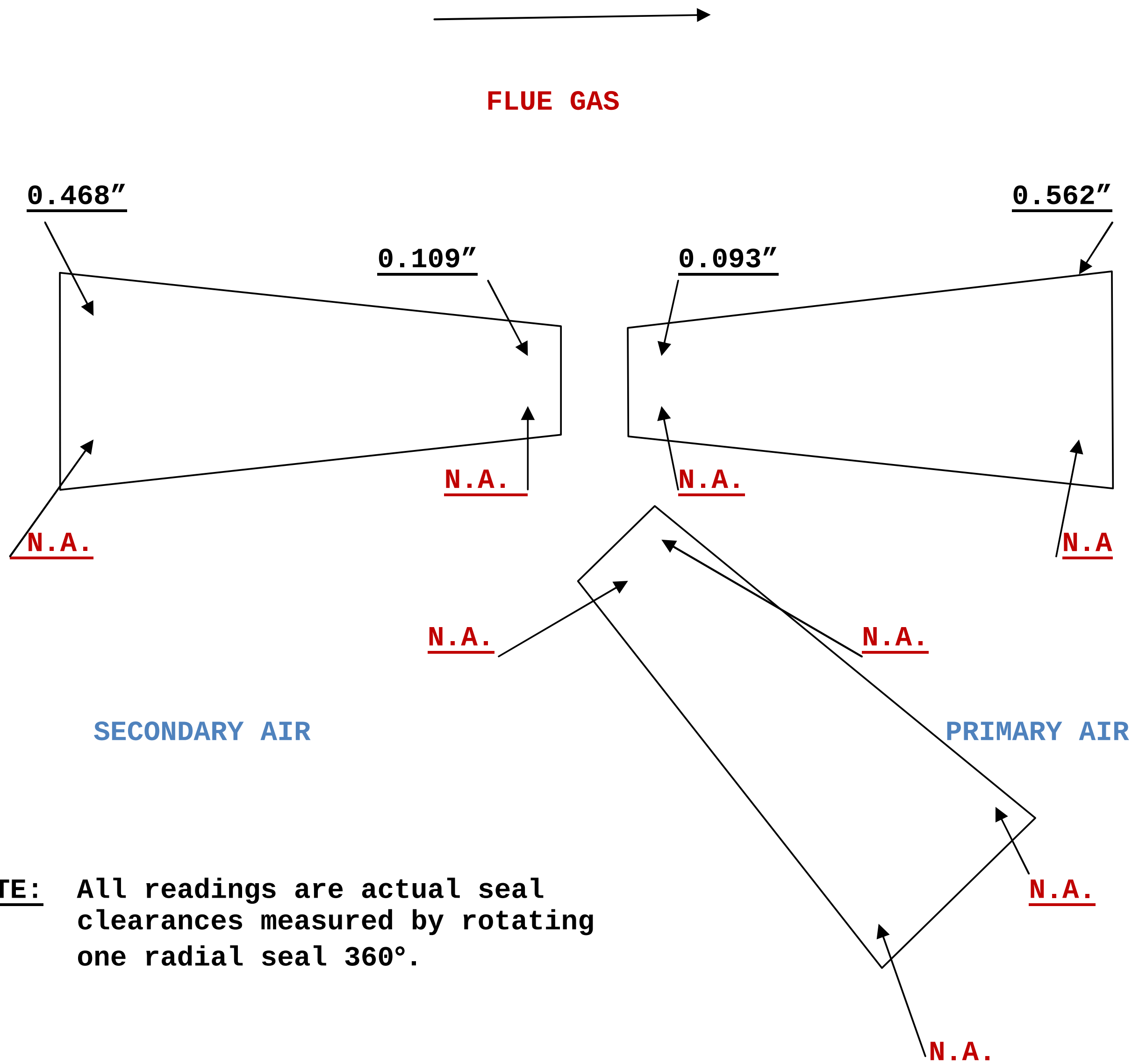
APH 6-B
Cold End - Sector Plate Plane

ROTATION - CW



NOTE: **All readings are actual seal clearances measured by rotating one radial seal 360°.**

SEAL SETTING SPECS: Inboard = 0.040″ Outboard = 0.430″

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RECOMMENDATIONS - Future Outage:

1. **Replace complete set of hot end, intermediate and cold end baskets on APH's 6-A & 6-B.**

2. **Replace the cold end support grating and support blocks when the cold end baskets are being replaced on APH's 6-A & 6-B.**

3. **Recommend resetting the hot end and cold end radial seals, axial seals and bypass seals to the correct seal settings to improve the leakage by 2% to 2.5% on APH's 6-A & 6-B.**

4. **Recommend inspecting and checking the sequence of operations and the steam pressure on the swing arm soot blower when the unit is back on line. High pressure (over the design pressures) and moisture in the steam may have adverse effects on the air preheater's performance and reduce heat transfer surface life.**

5. **Replace the pin rack assemblies along with the pinion gear/taper lock bushing and carbon ring & spring on APH's 6-A & 6-B next outage.**

6. **Replace the guide bearing cuno oil filters and replace with a spin on type oil filter conversion if possible to APH's 6-A & 6-B.**

7. **Ensure that the guide bearing oil circulating system is working properly and the coolers and the cooling water lines are clear and repair any leakage on APH's 6-A & 6-B.**

8. **Recommend performing regular oil sampling/analysis on the rotor guide bearing, support bearing and main rotor drive gearbox to APH's 6-A & 6-B.**

9. **Continue to maintain the air preheaters as per the O&M Manual.**

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A brief discussion was held, subsequent to the inspection, to summarize the observations. The discussion also included Howden's observations and comments on the December 2015 leakage test conducted by Nova Scotia Power. Recording oxygen concentrations simultaneously in the inlet and outlet gas ducts will minimize measurement uncertainty to load fluctuation during testing. Fitting the existing 4" (102 mm) with 2" (51 mm) pipe nipples will simplify sealing the test ports during sampling, minimizing infiltration into the test ports. The close proximity of the exit gas duct test ports to a 90° turn in the duct ahead of the ports likely results in a recirculation, or eddy, zone at the top of the duct. More points recorded in each port will help identify the size of the recirculation zone and its impact on the measured oxygen concentration in the duct.

Mr. Jordan indicated that the unit experienced heavy carryover of flyash to the mills. This carryover is the result of the rotation of the air preheater rotor from the gas stream to the Primary Air (PA) stream. Flyash entrained in the gas stream is carried into the PA section of the air preheater and carried to the mills by the PA flow. The quantity of ash carried to the mills may be reduced by reversing the rotation of the air preheater rotor from the current Gas-Primary Air-Secondary Air, to Gas-Secondary Air-Primary Air. With G-SA-PA rotation, most of the entrained flyash will be carried into the Secondary Air duct and returned to the furnace via the windbox. Reversing the rotation of the air preheater will result in a lower Primary Air temperature leaving the air heater. Most, if not all of this loss in PA leaving temperature can be recovered with an air preheater element upgrade if reversing rotation is considered at the time of the next element replacement.

Thank you again for this opportunity to assist with the inspection of the air preheaters. Following the recommendations I have made will insure the reliability & efficiency of the air preheater while in operation. If any questions should arise from the contents of this report feel free to contact our engineering staff at (716) 817-6900 or myself at (716) 536-1754 at any time. We greatly appreciate your business and look forward to assisting you with your future air preheater requirements.

Respectfully,

Frank R. Parise
Technical Specialist
Canada - Northeast, Western Region, USA

Howden North America Inc.
ISO 9001:2008 Certified
2475 George Urban Blvd., Suite 120
Depew, NY 14043 USA

m: **+1 (716) 536-1754**
e: frank.parise@howden.com
w: www.howden.com
24\7 Emergency (800) 458-3267 or (800) 458-FANS

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CI Number: 49533

Title: TRE6 Boiler Refurbishment

Start Date:	2017/08
In-Service Date:	2017/10
Final Cost Date:	2018/04
Function:	Steam
Forecast Amount:	$1,259,454

DESCRIPTION:

The scope of work for this project is to refurbish and replace deteriorated boiler tubes, tube bends and shields on the Trenton Unit 6 boiler as part of the planned outage in 2017. Approximately 40 tube cut-outs are planned for this outage. The scope of this project is determined as part of the annual boiler condition data collection and analysis. This effort includes evaluation and prioritization of activities to be undertaken during the annual outage. Protective erosion shields identified as missing or degraded will be replaced with new shields. Tubes and bends will be replaced in the areas where the thickness readings are below American Society of Mechanical Engineers (ASME) specifications. This tolerance maximizes the economic tube life while maintaining boiler reliability.

Summary of Related CIs +/- 2 years:
2015 CI 46299 TRE6 Boiler Refurbishment $1,094,508
2018 CI TBD TRE6 Boiler Refurbishment 2018 $TBD
2019 CI TBD TRE6 Boiler Refurbishment 2019 $TBD

Depreciation Class: Steam Production Plant - Trenton Unit 6

Estimated Life of the Asset: 25 years

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement/Refurbishment

Why do this project?

Ongoing asset management activities have identified the requirement for boiler component replacement to maintain the long term reliability of the boiler and mitigate the risk of unplanned outages due to tube leaks. In the utility industry Boiler Tube failures represent the single largest source of outages for steam-based generation. NS Power has a long history of managing this issue with comprehensive Boiler Inspection and Investment Programs to match the various failure mechanisms.

This project is being undertaken primarily to prevent boiler failure and preserve the unit's availability, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

To mitigate the risk of unplanned outages, regular boiler refurbishment activities are required. Some of the tubes to be inspected and replaced are difficult to access and sufficient time during a planned outage is required to complete refurbishment or replacements. The annual planned outage duration will afford the time necessary to complete this refurbishment.

Why do this project this way?

Replacing deteriorated tubes, tube bends and shields will mitigate the risk of tube leaks and minimize the number of unplanned outages. Based on boiler assessments, these upgrades are necessary to maintain reliable operation of the boiler. Refurbishment of these components is not an option once they are outside acceptable tolerances. For tubes, tolerances are established by industry standard (ASME). Shield replacement is determined by inspector assessment of the degree of deterioration.

CI Number : 49533 - TRE6 Boiler Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 345 - 345-Trenton unit 6 Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		5,571	0	5,571
095		095-Thermal Overtime Labour AO		1,031	0	1,031
095		095-Thermal & Hydro Contracts AO		97,477	0	97,477
095		095-Thermal Regular Labour AO		14,549	0	14,549
095		095-Thermal Term Labour AO		8,248	0	8,248
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	67,792	0	67,792
002	013	002 - THERMAL Overtime Labour	013 - SGP - Boiler	9,607	0	9,607
004	013	004 - THERMAL Term Labour	013 - SGP - Boiler	38,429	0	38,429
012	013	012 - Materials	013 - SGP - Boiler	109,750	0	109,750
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	906,000	0	906,000
011	087	011 - Travel Expense	087 Field Super.& Ops.	500	0	500
021	087	021 - Telephones	087 Field Super.& Ops.	250	0	250
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	250	0	250
			Total Cost:	1,259,454	0	1,259,454
			Original Cost:	619,189		

Capital Project Detailed Estimate

Location: **Trenton Generating Station**
CI# : 49533
Title: TRE6 Boiler Refurbishment
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Engineering	PD	10	$ 405	$ 4,053		
Maintenance Trades	PD	20	$ 365	$ 7,296		
Utility worker	PD	100	$ 240	$ 24,018		
Supervision	PD	80	$ 405	$ 32,425		
			Sub-Total	$ 67,792		46299
002 OT Labour						
Utility worker	PD	20	$ 480	$ 9,607		
				$ -		
			Sub-Total	$ 9,607		
004 Term Labour						
Utility worker - confined space attendant	PD	160	$ 240	$ 38,429		
				$ -		
			Sub-Total	$ 38,429		
011 Travel Expense						
	lot	1	$ 750	$ 750		
			Sub-Total	$ 750		
012 Materials						
Waterwall Panel	lot	1	$ 16,000	$ 16,000		
Tubes	ft	450	$ 35	$ 15,750		
Bifrucates	ea	30	$ 2,600	$ 78,000		
			Sub-Total	$ 109,750		
013 Contracts						
Suspended Floor	lot	1	$ 25,000	$ 25,000		
Vacuum Services	lot	1	$ 50,000	$ 50,000		
Inspection	Ea	80	$ 950	$ 76,000		
Boilermaker Labour	Ea	395	$ 1,000	$ 395,000		
Installation of Overlay Bifrucates and Hanger Tubes	Ea	360	$ 1,000	$ 360,000	Alstom budgetary quote	
			Sub-Total	$ 906,000		46299
041 Meals & Entertainment						
meals	lot	1	$ 250	$ 250		
			Sub-Total	$ 250		
094 Interest Capitalized						
AFUDC				$ 5,571		
			Sub-Total	$ 5,571		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 14,549		
Thermal OT Labour AO				$ 1,031		
Thermal Term Labour AO				$ 8,248		
Thermal / Hydro Contracts AO				$ 97,477		
			Sub-Total	$ 121,305		
			SUB-TOTAL (no AO, AFUDC)	$ 1,132,578		
			TOTAL (AO, AFUDC included)	$ 1,259,454		
Original Cost				$ 619,189		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

TRE6 Boiler Refurbishment
Summary of Alternatives

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Trenton Generating Station	**CI Number:**	49533
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Boiler Refurbishment vs Avoided Fuel &	5.90%	-4,801,216	3,670,806	1	32.75%	4.2 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

It is recommended to fund this project to perform Unit 6 boiler refurbishment. This project is being undertaken primarily to prevent boiler failure and preserve the unit's availability. Work can be completed during the planned outage, therefore avoiding unplanned replacement energy costs associated with an unplanned outage.

Notes/Comments :

Boiler Refurbishment vs Avoided Fuel & Repair Costs

This model compares the refurbishment costs to the replacement energy costs associated with unplanned outages due to tube leaks in the boiler. Assumptions are that there is a 75% chance of one tube leak in 2017, with increasing likelihood of failure in subsequent years. The unit would be down an average of 120 hours to perform repairs such that the unit could be returned to service. The failure rate considers the age of the boiler (1991).

Test 2

Test 3

Test 4

TRE6 Boiler Refurbishment
Summary of Sensitivities

Nova Scotia POWE An Emera Compa

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Trenton Generating Station	**CI Number:**	49533
		Project No. :	

	Alternative	**After Tax WACC**	**PV of Revenue Requirement**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Boiler Refurbishment vs Avoided Fuel & Repair C	5.90%	-4,801,216	3,670,806	1	32.75%	4.2 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	**Variance (%)**	**PV of Revenue Requirement**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Boiler Refurbishment vs Avoided Fuel & Repair C	10%	-4,689,478	3,582,901	1	30.17%	4.5 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
	Change:	**A**	111,738	-87,906	0	-2.58%	0.3 years
		B	0	0	0	#NUM!	0.0 years
		C	0	0	0	#NUM!	0.0 years
		D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	**Variance (%)**	**PV of Revenue Requirement**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Boiler Refurbishment vs Avoided Fuel & Repair C	-10%	-4,209,357	3,215,820	1	29.91%	4.6 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
	Change:	**A**	591,859	-454,986	0	-2.84%	0.4 years
		B	0	0	0	#NUM!	0.0 years
		C	0	0	0	#NUM!	0.0 years
		D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	**PV of Revenue Requirement** 1	**PV of Revenue Requirement** 2	**PV of Revenue Requirement** 3	**Delay?**
	A	94,790	273,436	490,449	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

TRE6 Boiler Refurbishment
Avoided Cost Calculations

Nova Scotia POWER An Emera Company

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Trenton Generating Station	**CI Number:**	49533
		Project No. :	

Boiler Refurbishment vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			76,000	79,054		
Events/Outages (#)	1	2	1	2		
Probability of Occurance (%)	100%	100%	100%	100%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	160.0	160.0				
Duration (Hours or Years)	96	96				
Totals	$81,415	$106,369	$76,000	$158,109	$157,415	$264,478
Total Capital Cost of Alternative						$1,259,454

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

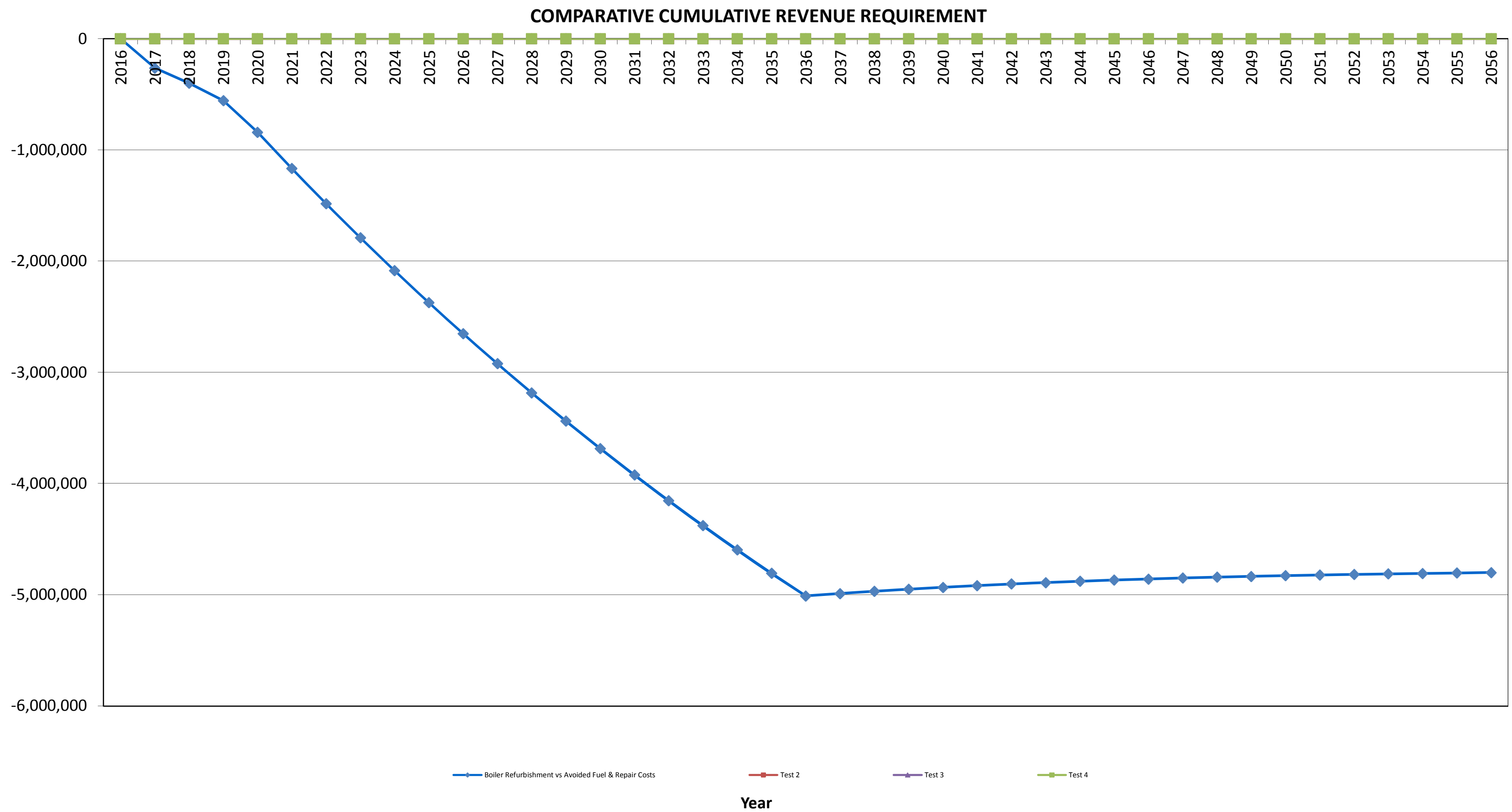
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

TRE6 Boiler Refurbishment
Boiler Refurbishment vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	157,415.0	(1,138,149.2)	45,303.1	1,120,754.6	(980,734.2)	(34,754.7)	(1,015,488.9)	(958,913.0)	0.94	(958,913.0)
2018	-	-	264,477.8	-	86,982.0	1,028,183.0	264,477.8	(55,023.7)	209,454.1	186,765.6	0.89	(772,147.4)
2019	-	-	300,411.4	-	80,023.4	943,017.0	300,411.4	(68,320.3)	232,091.1	195,420.7	0.84	(576,726.6)
2020	-	-	481,677.1	-	73,621.5	864,664.3	481,677.1	(126,497.2)	355,179.9	282,399.9	0.80	(294,326.7)
2021	-	-	566,938.6	-	67,731.8	792,579.9	566,938.6	(154,754.1)	412,184.5	309,465.2	0.75	15,138.5
2022	-	-	583,666.4	-	62,313.3	726,262.2	583,666.4	(161,619.5)	422,047.0	299,216.1	0.71	314,354.6
2023	-	-	600,945.4	-	57,328.2	665,249.9	600,945.4	(168,521.3)	432,424.1	289,493.1	0.67	603,847.7
2024	-	-	618,795.3	-	52,742.0	609,118.6	618,795.3	(175,476.5)	443,318.7	280,251.8	0.63	884,099.5
2025	-	-	637,236.5	-	48,522.6	557,477.8	637,236.5	(182,501.3)	454,735.2	271,453.2	0.60	1,155,552.7
2026	-	-	656,290.3	-	44,640.8	509,968.3	656,290.3	(189,611.4)	466,679.0	263,062.3	0.56	1,418,615.0
2027	-	-	675,978.8	-	41,069.5	466,259.5	675,978.8	(196,821.9)	479,156.9	255,048.2	0.53	1,673,663.1
2028	-	-	696,324.8	-	37,784.0	426,047.4	696,324.8	(204,147.7)	492,177.1	247,383.0	0.50	1,921,046.2
2029	-	-	717,352.1	-	34,761.2	389,052.3	717,352.1	(211,603.2)	505,748.9	240,042.1	0.47	2,161,088.3
2030	-	-	739,085.3	-	31,980.3	355,016.8	739,085.3	(219,202.5)	519,882.8	233,003.2	0.45	2,394,091.5
2031	-	-	761,550.1	-	29,421.9	323,704.2	761,550.1	(226,959.7)	534,590.3	226,246.4	0.42	2,620,337.9
2032	-	-	784,772.9	-	27,068.2	294,896.5	784,772.9	(234,888.5)	549,884.4	219,753.6	0.40	2,840,091.6
2033	-	-	808,781.4	-	24,902.7	268,393.5	808,781.4	(243,002.4)	565,779.0	213,508.7	0.38	3,053,600.3
2034	-	-	833,604.2	-	22,910.5	244,010.7	833,604.2	(251,315.1)	582,289.2	207,496.8	0.36	3,261,097.1
2035	-	-	859,271.0	-	21,077.7	221,578.5	859,271.0	(259,839.9)	599,431.1	201,704.7	0.34	3,462,801.8
2036	-	-	885,812.7	-	19,391.4	200,941.0	885,812.7	(268,590.6)	617,222.1	196,120.2	0.32	3,658,921.9
2037	-	-	-	-	17,840.1	181,954.4	-	5,530.4	5,530.4	1,659.4	0.30	3,660,581.3
2038	-	-	-	-	16,412.9	164,486.7	-	5,088.0	5,088.0	1,441.6	0.28	3,662,022.9
2039	-	-	-	-	15,099.9	148,416.5	-	4,681.0	4,681.0	1,252.4	0.27	3,663,275.2
2040	-	-	-	-	13,891.9	133,631.8	-	4,306.5	4,306.5	1,088.0	0.25	3,664,363.2
2041	-	-	-	-	12,780.5	120,030.0	-	3,962.0	3,962.0	945.2	0.24	3,665,308.4
2042	-	-	-	-	11,758.1	107,516.3	-	3,645.0	3,645.0	821.1	0.23	3,666,129.5
2043	-	-	-	-	10,817.5	96,003.7	-	3,353.4	3,353.4	713.3	0.21	3,666,842.8
2044	-	-	-	-	9,952.1	85,412.1	-	3,085.1	3,085.1	619.7	0.20	3,667,462.6
2045	-	-	-	-	9,155.9	75,667.8	-	2,838.3	2,838.3	538.4	0.19	3,668,000.9
2046	-	-	-	-	8,423.4	66,703.1	-	2,611.3	2,611.3	467.7	0.18	3,668,468.6
2047	-	-	-	-	7,749.5	58,455.5	-	2,402.4	2,402.4	406.3	0.17	3,668,874.9
2048	-	-	-	-	7,129.6	50,867.8	-	2,210.2	2,210.2	353.0	0.16	3,669,227.9
2049	-	-	-	-	6,559.2	43,887.0	-	2,033.4	2,033.4	306.7	0.15	3,669,534.6
2050	-	-	-	-	6,034.5	37,464.8	-	1,870.7	1,870.7	266.4	0.14	3,669,801.0
2051	-	-	-	-	5,551.7	31,556.3	-	1,721.0	1,721.0	231.4	0.13	3,670,032.4
2052	-	-	-	-	5,107.6	26,120.5	-	1,583.4	1,583.4	201.1	0.13	3,670,233.5
2053	-	-	-	-	4,699.0	21,119.5	-	1,456.7	1,456.7	174.7	0.12	3,670,408.1
2054	-	-	-	-	4,323.1	16,518.6	-	1,340.1	1,340.1	151.7	0.11	3,670,559.9
2055	-	-	-	-	3,977.2	12,285.8	-	1,232.9	1,232.9	131.8	0.11	3,670,691.7
2056	-	-	-	-	3,659.0	8,391.7	-	1,134.3	1,134.3	114.5	0.10	3,670,806.2
Total	**-**	**-**	**12,630,387.2**	**(1,138,149.2)**	**1,090,498.8**		**11,492,238.0**	**(3,577,365.4)**	**7,914,872.6**	**3,670,806.2**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
-1,000,000
-2,000,000
-3,000,000
-4,000,000
-5,000,000
-6,000,000
2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056
Boiler Refurbishment vs Avoided Fuel & Repair Costs
Test 2
Test 3
Test 4
Year

ALSTOM

EXECUTIVE SUMMARY REPORT

Nova Scotia Power Incorporated
Trenton Generating Station
Unit # 6
May/June, 2015 – Shutdown

Summary

The utility boiler for Unit # 6 at Trenton Generating Station was shut down as part of the Planned Annual Maintenance in May/June, 2015.

The major part of the boiler work carried out was the installation of two {2} wall panels on the east wall and six {6} spiral tubes, at {2} bifurcate locations, in the RH Outlet {8th} floor. The visual and ultrasonic survey carried out reveled seven hundred areas {700} totaling twenty-four hundred and seventy-five inches {2475"} identified for pad weld overlay in the upper furnace and ninety one areas {91} totaling eight hundred and sixteen inches {816"} identified for pad welding in the lower furnace.
Water seal dimple plate was replaced.
Replaced sector plates in both "A" & "B" air heaters.

Introduction

During the May/June, 2015 shutdown, the boiler was inspected internally to determine the condition and assessment. The boiler was repaired to ensure the Unit's integrity could be maintained.

Alstom under the Supervision of Shaun Simmons carried out the repairs. Alstom under the Supervision of Mr. Matthew Muise carried out the Non-Destructive Testing and Quality Control functions.

Lower Furnace

The north and south sides of the water seal trough dimple plate were replaced and repairs were carried out on the east and west ends. New chain curtains were also installed.

A visual and UT survey was carried out on the waterwalls with the following noted:

The North Waterwall {Front} was surveyed with fifteen {15} areas for a total of one hundred twelve inches {112"} overlayed with pad welding.

The South Waterwall {Rear} was surveyed with thirty-eight {38} areas for a total of four hundred three inches {403"} overlayed with pad welding.

The East Waterwall {Left} was surveyed twenty-one {21} areas for a total of one hundred forty-nine inches {149"} overlayed with pad welding. There were two {2} Waterwall panels replaced on the East Waterwall. These panels were from Tube 69 – 98 at Elevation 56' to 68'.

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New Waterford, N.S. Canada
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Fax: (902) 862-6087

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The West Waterwall {Right} was surveyed with seventeen {17} areas for a total of one hundred and fifty-two inches {152”} overlayed with pad welding.

All butt welds were radiographed and accepted. All pad welds were MT Inspected and accepted.

In addition to the above inspections, the IR’s were also inspected and rotations recorded and results given to NSPI.

Up Pass # 1 – 9th Floor – 56.6 M

Up Pass # 1 was visual and UT surveyed with one {1} area for a total of one inch {1”} identified for pad weld overlay. This weld was carried out, inspected and found acceptable.

Up Pass # 2 – 8 2/3 Floor – 54.0 M

Up Pass # 2 was visual and UT surveyed with one hundred and thirty-seven {137} areas for a total of four hundred and forty-four inches {444”} identified for pad weld overlay. These welds were carried out, inspected and found acceptable. In addition to the above, fifteen {15} shields were replaced during this shutdown.

Up Pass # 3 – 8 1/3 Floor – 51.8 M

Up Pass # 3 was visual and UT surveyed with one hundred and sixteen {116} areas for a total of three hundred and sixteen inches {316”} identified for pad weld overlay. These welds were carried out, inspected and found acceptable. In addition to the above, sixty-one {61} shields identified for replacement, with forty nine {49} being replaced during this shutdown.

Up Pass # 4 – 8th Floor – 49.2 M

Up Pass # 4 was visual and UT surveyed with forty-five {45} areas for a total of four hundred and ninety-three inches {493”} identified for pad weld overlay. These welds were carried out, inspected and found acceptable. There was also two {2} bifurcate replacements which consisted of a total of six {6} spiral overlayed tubes installed. There was 10% radiography carried out with no failures. In addition to the above, one hundred and eighty-eight {188} shields were replaced during this shutdown.

Up Pass # 5 – 7 ½ Floor – 46.4 M

Up Pass # 5 was visual and UT surveyed with eighty-one {81} areas for a total of three hundred and fifty-nine inches {359”} identified for pad weld overlay. These welds were carried out, inspected and found acceptable. In addition to the above, one hundred and twenty-seven {127} shields identified for replacement, with one hundred and eight {108} being replaced during this shutdown.

Up Pass # 6 – 7th Floor – 43.5 M

Up Pass # 6 was visual and UT surveyed with thirty-one {31} areas for a total of one hundred eighty-six inches {186”} identified for pad weld overlay. These welds were carried out, inspected and found acceptable.

Up Pass # 6 - Under Bulkhead

Up Pass # 6 {under bulkhead}, was visual and UT surveyed with two hundred and twenty-three {223} areas for a total of five hundred and seventy-two inches {572”} identified for pad weld overlay. These welds were carried out,

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inspected and found acceptable. In addition to the above, twenty-one {21} shields were replaced during this shutdown.

Down Pass # 1 – 8 2/3 Floor – 54.0 M

Down Pass # 1 was visual and UT surveyed with six {6} areas for a total of fifty-four inches {54"} identified for pad weld overlay. These welds were carried out, inspected and found acceptable.

Down Pass # 2 – 8 1/3 Floor – 51.6 M

This Section was visual inspected with six (6) shields identified for replacement.

Down Pass # 3 – 8th Floor – 49.2 M

This Section was visual inspected with two (2) shields identified for replacement.

Down Pass # 4 – 7th Floor – 43.5 M

Down Pass # 4, {economizer header}, was visual and UT surveyed with forty-six {46} areas for a total of fifty inches {50"} identified for pad weld overlay. These welds were carried out, inspected and found acceptable.

Steam Drum

There was a visual inspection carried out in the steam drum. There was one can on the west end that had hole in plate and there were two {2} ¼" indications in the box. These areas were repaired and inspected.

Deaerator

All attachment, circumferential and longitudinal welds in the Deaerator Storage Tank were inspected visually and with Wet Fluorescent Magnetic Particles with no defects noted during this shutdown. The attachment welds in the Deaerator Heater were visually and with Wet Fluorescent Magnetic Particles. No defects were noted. An ultrasonic thickness survey was carried out in the Heater on a few eroded areas with no repairs required. The weld on the center nozzle, on the heater side, was eroded and required to be repaired. This weld was repaired, inspected and accepted.

Blow Down Tank

The Blow Down tank was visually inspected with cracking of the liner to shell evident. These cracks were repaired and accepted.

Headers

Headers were not inspected.

Turbine

Turbine LP rotor diaphragms and upper and lower casings were Wet Fluorescent Magnetic Particles inspected. There were repairs done to the casing faces. In addition to the casings there were indications on some of the diaphragms and all findings were reported to NSPI.

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Air Heater

During the 2015 shutdown the stationary sector plates were replaced in both “A” & “B” sides.

“B” Boiler Feed Pump

During the 2015 shutdown there was a repair done, {weld overlay}, on the “B” Boiler feed pump discharge nozzle .

Miscellaneous

There were several attemporator lines cut to allow for internal inspections. Feed water line, SH lines and cold reheat line.

Conclusions and Recommendations

During the next Planned Shutdown, the following areas should be surveyed in addition to the normal boiler survey:

- Full water wall survey.
- Review UT readings in RH outlet for possible tube replacements. (Several tubes were shielded due to low UT readings)
- Due to the amount of pad welding carried under the bulkhead via swing stage, May 2015, re-inspect these areas to ensure tube integrity is maintained.
- Header inspections should be carried out.
- Inspect the I-Beams between the Air Heater and the ductwork due to cracking identified May 2013.
- Review possibility of replacing discharge nozzle on “B” boiler feed pump.
- Due to leak on the North wall just under the Primary SH Inlet, shortly after running the unit up, visual and MPI inspection should be carried out on all existing pad welds.
- Inspect wall tube that was pad welded with E9018. East wall tube # 97 @ elevation 121’.

CI Number: 47687

Title: POT Boiler Chemical Recondition

Start Date:	2015/12
In-Service Date:	2017/06
Final Cost Date:	2017/12
Function:	Steam
Forecast Amount:	$974,604

DESCRIPTION:

This project is for the chemical reconditioning of the POT Unit #2 boiler for the removal of metal oxides from the heat transfer surfaces (inner tube surfaces), which will allow for the base metal to be protected with an uncontaminated oxide layer. The level of deposition on heat transfer surfaces inside the boiler is directly proportional to the probability for failure mechanisms to occur in the system, such as failures to the boiler tube wall. Hydrogen Damage, Caustic Gouging, and Acid Phosphate corrosion can occur underneath heavy deposits leading to boiler tube failures and subsequent forced outages. Chemical Treatment is used to remove deposits and contaminants from the oxide layer to prevent under deposit corrosion mechanisms. This work can be expected to be completed every 10 – 20 years depending on the utilization of the generating unit.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

NS Power's Boiler Maintenance Strategy includes an annual Boiler Tube Analysis. Waterwall Tube Analysis from Pt. Tupper has shown a high level of deposition. Based on this condition measurement the unit should be reconditioned. Operating with heavy loading on the boiler tubes greatly increases the probability of boiler tube failures and subsequent forced outages.

This project is being undertaken primarily to prevent boiler tube failure and preserve the unit's availability, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

POT Unit #2, based on deposition measurement, is due for chemical cleaning in order to reduce corrosion mechanisms and subsequent tube failures. Postponing the cleaning of the unit could increase the number of Boiler Tube failures resulting in forced outages.

Why do this project this way?

Using chemical cleaning agents such as EDTA (Ethylenediaminetetraacetic acid), Citric Acid and HCl (hydrogen chloride) are proven technologies to remove metal oxides from boiler heat transfer surfaces. Chemical cleaning of boilers is the most effective method of deposit removal.

CI Number : 47687-SF30 - POT Boiler Chemical Recondition **Project Number** SF30

Parent CI Number : -

Cost Centre : 351 - 351-Pt.Tupper Admin./Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		2,060	0	2,060
095		095-Thermal & Hydro Contracts AO		63,251	0	63,251
095		095-Thermal Term Labour AO		1,801	0	1,801
095		095-Thermal Regular Labour AO		5,184	0	5,184
095		095-Thermal Overtime Labour AO		2,647	0	2,647
095		095 - Proj Supp Regular Labour AO		1,949	0	1,949
001	013	001 - Regular Labour (No AO)	013 - SGP - Boiler	0	0	0
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	24,783	0	24,783
001	013	001 - Proj Supp Regular Labour	013 - SGP - Boiler	4,053	0	4,053
002	013	002 - THERMAL Overtime Labour	013 - SGP - Boiler	25,243	0	25,243
004	013	004 - THERMAL Term Labour	013 - SGP - Boiler	8,451	0	8,451
011	013	011 - Travel Expense	013 - SGP - Boiler	2,000	0	2,000
012	013	012 - Materials	013 - SGP - Boiler	60,000	0	60,000
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	594,572	0	594,572
014	013	014 - Overtime Meals	013 - SGP - Boiler	1,000	0	1,000
041	013	041 - Meals & Entertainment	013 - SGP - Boiler	1,000	0	1,000
066	013	066 - Other Goods & Services	013 - SGP - Boiler	81,610	0	81,610
028	085	028 - Consulting	085 Design	90,000	0	90,000
028	087	028 - Consulting	087 Field Super.& Ops.	5,000	0	5,000
			Total Cost:	974,604	0	974,604
			Original Cost:	454,767		

Capital Project Detailed Estimate

Location: Pt. Tupper
CI# : 47687
Title: POT Boiler Chemical Recondition
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Electrician	PD	2	$ 358	$ 717		
Engineering	PD	10	$ 405	$ 4,053		
Maintenance Trades	PD	10	$ 365	$ 3,648		
Power Engineer	PD	40	$ 390	$ 15,615		
Utility worker	PD	20	$ 240	$ 4,804		
			Sub-Total	$ 28,836		
002 OT Labour						
Electrician	PD	4	$ 717	$ 2,866		
Power Engineer	PD	20	$ 781	$ 15,615		
Maintenance Trades	PD	4	$ 730	$ 2,918		
Utility worker	PD	8	$ 480	$ 3,843		
			Sub-Total	$ 25,243		
004 Term Labour						
Maintenance Trades	PD	10	$ 365	$ 3,648		
Utility worker	PD	20	$ 240	$ 4,804		
			Sub-Total	$ 8,451		
011 Travel Expense						
Travel	lot	1	$ 2,000	$ 2,000		
			Sub-Total	$ 2,000		
012 Materials						
Piping, supports, hose, etc.	lot	1	$ 50,000	$ 50,000		
Consumables	lot	1	$ 10,000	$ 10,000		
			Sub-Total	$ 60,000		
013 Contracts						
Prepping tubes, NDT, and analysis of deposits	lot	1	$ 130,902	$ 130,902		
Fabrication and installation of connections	lot	1	$ 70,000	$ 70,000		
Boiler chemical reconditioning	lot	1	$ 300,000	$ 300,000		
Hazardous waste disposal	lot	1	$ 114,127	$ 114,127		
Nonhazardous waste disposal	lot	1	$ 110,445	$ 110,445		
			Sub-Total	$ 594,572		
028 Consulting						
Engineering consulting	lot	1	$ 90,000	$ 90,000		
Field supervision	lot	1	$ 5,000	$ 5,000		
			Sub-Total	$ 95,000		
041 Meals & Entertainment						
Meals and expenses	lot	1	$ 1,000	$ 1,000		
OT meals (014)	lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 2,000		
066 Other Goods & Services						
Contingency	%	10%	$ 816,102	$ 81,610		
			Sub-Total	$ 81,610		
094 Interest Capitalized						
AFUDC				$ 2,060		
			Sub-Total	$ 2,060		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 5,184		
Thermal OT Labour AO				$ 2,647		
Thermal Term Labour AO				$ 1,801		
Thermal / Hydro Contracts AO				$ 63,251		
Project Support Regular AO				$ 1,949		
			Sub-Total	$ 74,832		
			SUB-TOTAL (no AO, AFUDC)	$ 897,712		
			TOTAL (AO, AFUDC included)	$ 974,604		
Original Cost				$ 454,767		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

POT Boiler Chemical Reconditioning
Summary of Alternatives

Division :	Power Production	**Date :**	**27-Oct-16**
Department :	Point Tupper Generating Station	**CI Number:**	47687
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Recondition Boiler vs Avoided Fuel & R	5.90%	-3,723,024	2,650,724	1	76.50%	1.9 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

This project is being undertaken primarily to prevent boiler tube failure and preserve the unit's availability, and is secondarily supported by positive replacement energy cost economics.

Notes/Comments :

Recondition Boiler vs Avoided Fuel & Repair Costs

This option compares the capital costs to the costs in the event of an unplanned failure (tube leaks).

Test 2

Test 3

Test 4

POT Boiler Chemical Reconditioning
Summary of Sensitivities

Division :	Power Production		Date :	27-Oct-16
Department :	Point Tupper Generating Station		CI Number:	47687
			Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Recondition Boiler vs Avoided Fuel & Repair Cost	5.90%	-3,723,024	2,650,724	1	76.50%	1.9 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Recondition Boiler vs Avoided Fuel & Repair Cost	10%	-3,631,178	2,580,361	1	68.48%	2.1 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
	Change:	A	91,847	-70,363	0	-8.01%	0.2 years
		B	0	0	0	#NUM!	0.0 years
		C	0	0	0	#NUM!	0.0 years
		D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Recondition Boiler vs Avoided Fuel & Repair Cost	-10%	-3,258,875	2,315,288	1	67.69%	2.1 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
	Change:	A	464,149	-335,435	0	-8.81%	0.2 years
		B	0	0	0	#NUM!	0.0 years
		C	0	0	0	#NUM!	0.0 years
		D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	399,978	866,163	1,456,765	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

POT Boiler Chemical Reconditioning
Avoided Cost Calculations

Nova Scotia POWER An Emera Company

Division :	Power Production	**Date :**	27-Oct-16
Department :	Point Tupper Generating Station	**CI Number:**	47687
		Project No. :	

Recondition Boiler vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			59,400	60,588		
Events/Outages (#)	4	5	4	5		
Probability of Occurance (%)	100%	100%	100%	100%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	150.0	150.0				
Duration (Hours or Years)	60	60				
Totals	$236,431	$299,857	$237,600	$302,940	$474,031	$602,797
Total Capital Cost of Alternative						$974,604

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

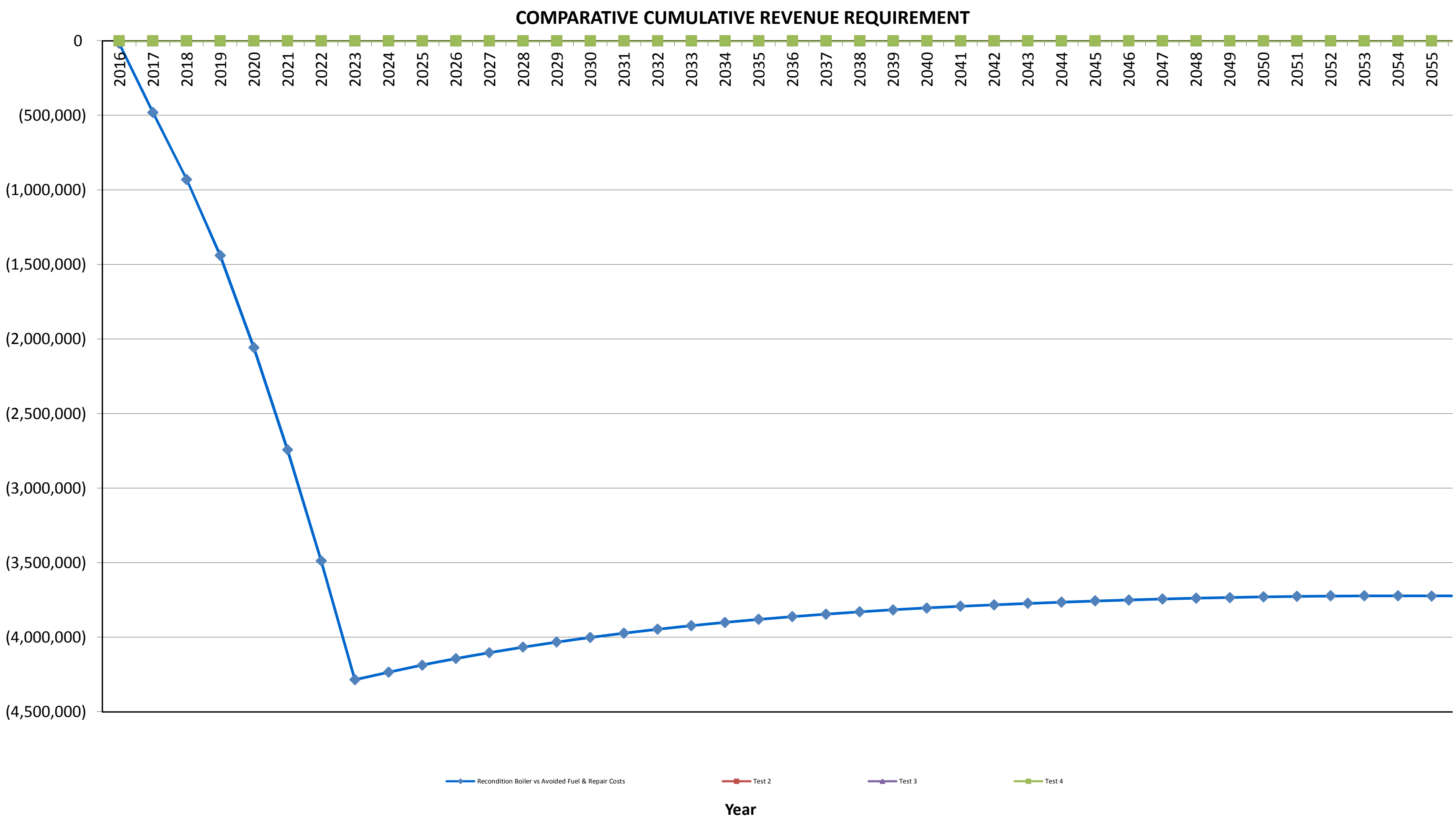
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

POT Boiler Chemical Reconditioning
Recondition Boiler vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	(163,166.8)	-	-	(163,166.8)	-	(163,166.8)	(163,166.8)	1.00	(163,166.8)
2017	-	-	474,031.4	(736,605.6)	35,908.5	882,457.4	(262,574.2)	(135,818.1)	(398,392.3)	(376,196.7)	0.94	(539,363.4)
2018	-	-	602,797.0	-	68,944.3	810,064.8	602,797.0	(165,494.3)	437,302.7	389,933.2	0.89	(149,430.2)
2019	-	-	713,298.7	-	63,428.8	743,463.7	713,298.7	(201,459.7)	511,839.0	430,968.5	0.84	281,538.2
2020	-	-	898,617.6	-	58,354.5	682,190.6	898,617.6	(260,481.6)	638,136.0	507,375.4	0.80	788,913.6
2021	-	-	1,051,832.1	-	53,686.1	625,819.4	1,051,832.1	(309,425.3)	742,406.8	557,393.8	0.75	1,346,307.5
2022	-	-	1,206,977.3	-	49,391.2	573,957.9	1,206,977.3	(358,851.7)	848,125.6	601,290.6	0.71	1,947,598.1
2023	-	-	1,367,907.6	-	45,439.9	526,245.3	1,367,907.6	(409,965.0)	957,942.6	641,309.7	0.67	2,588,907.7
2024	-	-	-	-	41,804.7	482,349.7	-	12,959.5	12,959.5	8,192.6	0.63	2,597,100.3
2025	-	-	-	-	38,460.3	441,965.8	-	11,922.7	11,922.7	7,117.2	0.60	2,604,217.5
2026	-	-	-	-	35,383.5	404,812.6	-	10,968.9	10,968.9	6,183.1	0.56	2,610,400.6
2027	-	-	-	-	32,552.8	370,631.6	-	10,091.4	10,091.4	5,371.5	0.53	2,615,772.1
2028	-	-	-	-	29,948.6	339,185.1	-	9,284.1	9,284.1	4,666.5	0.50	2,620,438.5
2029	-	-	-	-	27,552.7	310,254.3	-	8,541.3	8,541.3	4,054.0	0.47	2,624,492.5
2030	-	-	-	-	25,348.5	283,638.0	-	7,858.0	7,858.0	3,521.8	0.45	2,628,014.3
2031	-	-	-	-	23,320.6	259,151.0	-	7,229.4	7,229.4	3,059.6	0.42	2,631,073.9
2032	-	-	-	-	21,455.0	236,623.0	-	6,651.0	6,651.0	2,658.0	0.40	2,633,731.9
2033	-	-	-	-	19,738.6	215,897.2	-	6,119.0	6,119.0	2,309.1	0.38	2,636,041.0
2034	-	-	-	-	18,159.5	196,829.4	-	5,629.4	5,629.4	2,006.0	0.36	2,638,047.0
2035	-	-	-	-	16,706.7	179,287.1	-	5,179.1	5,179.1	1,742.7	0.34	2,639,789.8
2036	-	-	-	-	15,370.2	163,148.2	-	4,764.8	4,764.8	1,514.0	0.32	2,641,303.8
2037	-	-	-	-	14,140.6	148,300.4	-	4,383.6	4,383.6	1,315.3	0.30	2,642,619.0
2038	-	-	-	-	13,009.3	134,640.4	-	4,032.9	4,032.9	1,142.6	0.28	2,643,761.7
2039	-	-	-	-	11,968.6	122,073.2	-	3,710.3	3,710.3	992.7	0.27	2,644,754.3
2040	-	-	-	-	11,011.1	110,511.4	-	3,413.4	3,413.4	862.4	0.25	2,645,616.7
2041	-	-	-	-	10,130.2	99,874.5	-	3,140.4	3,140.4	749.2	0.24	2,646,365.8
2042	-	-	-	-	9,319.8	90,088.6	-	2,889.1	2,889.1	650.8	0.23	2,647,016.7
2043	-	-	-	-	8,574.2	81,085.5	-	2,658.0	2,658.0	565.4	0.21	2,647,582.1
2044	-	-	-	-	7,888.3	72,802.7	-	2,445.4	2,445.4	491.2	0.20	2,648,073.3
2045	-	-	-	-	7,257.2	65,182.6	-	2,249.7	2,249.7	426.7	0.19	2,648,500.0
2046	-	-	-	-	6,676.6	58,172.0	-	2,069.8	2,069.8	370.7	0.18	2,648,870.7
2047	-	-	-	-	6,142.5	51,722.3	-	1,904.2	1,904.2	322.1	0.17	2,649,192.8
2048	-	-	-	-	5,651.1	45,788.5	-	1,751.8	1,751.8	279.8	0.16	2,649,472.6
2049	-	-	-	-	5,199.0	40,329.5	-	1,611.7	1,611.7	243.1	0.15	2,649,715.6
2050	-	-	-	-	4,783.1	35,307.2	-	1,482.8	1,482.8	211.2	0.14	2,649,926.8
2051	-	-	-	-	4,400.4	30,686.6	-	1,364.1	1,364.1	183.4	0.13	2,650,110.2
2052	-	-	-	-	4,048.4	26,435.7	-	1,255.0	1,255.0	159.4	0.13	2,650,269.6
2053	-	-	-	-	3,724.5	22,524.9	-	1,154.6	1,154.6	138.4	0.12	2,650,408.0
2054	-	-	-	-	3,426.6	18,927.0	-	1,062.2	1,062.2	120.3	0.11	2,650,528.3
2055	-	-	-	-	3,152.4	15,616.8	-	977.3	977.3	104.5	0.11	2,650,632.8
2056	-	-	-	-	2,900.3	12,571.5	-	899.1	899.1	90.8	0.10	2,650,723.6
Total	**-**	**-**	**6,315,461.6**	**(899,772.3)**	**864,359.4**		**5,415,689.3**	**(1,689,841.7)**	**3,725,847.6**	**2,650,723.6**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
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Recondition Boiler vs Avoided Fuel & Repair Costs
Test 2
Test 3
Test 4
Year

Mr. Jonathan MacIntosh, P.Eng.
Senior Engineer, Chemical Assets – Generation Services
NOVA SCOTIA POWER, INC.
1123 Lower Water Street
Halifax, NS, Canada B3J 3S8

E-mail Transmittal
jonathan.macintosh@nspower.ca
Office: 902-428-6469
Cell: 902-240-4711
No Hard Copy to Follow

SUBJECT: Point Tupper Generating Station
Unit 2 Left (North) Waterwall Tube Cleaning Test, STPA-M-5814

Dear Mr. MacIntosh:

Enclosed are the results of the second tube cleaning test using ammonium bromate and ammonium EDTA. This letter summarizes the results.

SUMMARY OF TUBE TESTING

The following table provides a comparison of the current test based on EDTA and the prior test based on hydrochloric acid (HCl). While the EDTA cleaning removed much of the material, a greater amount of material remained after the EDTA/Bromate solvent combination than after the HCl/Bromate/HCl combination.

Criteria	Ammonium Bromate / EDTA	HCl/Ammonium Bromate/HCl
Material Removed (Expressed as g/ft^2 if all material had been removed just from the hot side.)		
Iron Removed	287 [a]	211 [a]
Copper Removed	28	43
Chromium Removed	<1 (0.3)	<1 (0.4)
Calcium Removed	2	Not Determined
Sludge Captured	31	(Not Fully Determined)
Total Removed	348	256
Material Remaining on Hot Side (g/ft^2)		
Brushed	5.3	0.2
Scraped	6.2	0.0
Vibrated	117.4 [b]	43.5
Total	128.9 [b]	43.7
Theoretical Percent of Initial Material Removed	73%	>83% (Probably higher because of sludge not weighed.)

[a] Laboratory tube cleaning has more iron because of air diffusion into solvent than in actual boiler cleaning.
[b] Back-calculated from weight loss during vibrating and bead blasting.

Since the first test (reported January 7, 2016) was not successful with more aggressive (HCl/thiourea) solvents, we did necessarily not expect the cleaning to be successful with EDTA. The goal of the test was to see what level of deposit removal could be achieved using solvents other than hydrochloric acid to clean another tube found to have localized deposits at the weld.

Excessive deposit (128 g/ft^2) remains in this location and the remaining deposits were still extremely hard and adherent. It was estimated that about 73% of the material originally present was removed with the EDTA combination. If one compares Photographs 1 (start), 21 (after cleaning) and 27 (after mechanical cleaning), we would have estimated that only about half of the material was removed. Since a significant portion of the iron concentration in the iron oxide removal solvent usually is significantly increased due to oxidation/reduction reactions occurring in an open air laboratory tube test, the initial deposit was probably much less than indicated in the prior table and so the percent removal was probably lower than the reported estimate.

The level of deposit removal may not be sufficient to significantly improve the life of these localized areas of deposits. Therefore, these areas eventually could fail due to deposit related damage mechanisms. Substantial wall loss already has occurred in these areas.

DISCUSSION OF TEST RESULTS

Photographs 1 and 2 show waterside surfaces before the tube cleaning test. The red color of the deposits was assumed to be primarily copper. Since the ammonium bromate solution quickly turned blue, this seemed to confirm this conclusion. Samples were collected periodically, but not run until later in the process. The initial stage was continued longer because it was hoped that a seam of copper would be removed and some deposit would be undercut and fall off of tube surfaces. This did not happen during the 72-hour soak. Copper was 0.17% in the first 24 hours and only increased to 0.19% by the end of the cleaning stage. Photographs 3 and 4 show hot side surfaces at 30 hours in the ammonium bromate stage (first time inspected). Substantial deposits were removed in the first 24 hours. The solution turned blue fairly quickly following the start of this test. Some black oxide is visible at the edges of the red area. The red area was believed to be mainly copper. The black areas were likely iron oxides. As shown in the top right edge of Photograph 5, a piece of red deposit was removed between 30 hours and 48 hours. Photograph 6 shows an undercut region of red deposit with black deposits beneath. Photograph 8 appeared to have a slightly blacker coloration (more than Photograph 7) on the left side, but colors can be misleading as the deposit dries. Photographs 9 and 10 do not seem to show any improvement at 56 hours. However, it was decided to let the stage go overnight to see if anything simply fell off by being undercut. Photographs 11, 12 and 13 show essentially no change by 72 hours. In fact, the difference between 24 hours and 72 hours was fairly minor. This observation was confirmed by analysis of the solvent samples. Therefore, for the actual boiler cleaning, a 24-hour bromate stage should be more than sufficient.

The EDTA iron oxide removal stage removed a lot of iron, but no copper plating was noted. Since the ammonium bromate only removed half of the copper removed by the prior tube cleaning test, we had expected copper dissolution and plating once the iron was removed and more copper was exposed to the solvent. In fact, it appears that some material that is relatively insoluble in EDTA (e.g., silica) may be present in the deposit and inhibiting both iron oxide and copper removal.

Photographs 14, 15 and 16 show tube surfaces after 24 hours in diammonium EDTA. This solvent still had residual EDTA present (0.5%), but the pH (7.23 units) was sufficiently elevated that iron oxide removal ceased prior to 24 hours' exposure. Therefore, actual contact time with an effective iron oxide removal solvent was less than 24 hours. The cold side membranes and the hot side up to but not including the crown were clean in less than 24 hours. However, a white patch remained above the area of heavy deposits on the hot side crown (Photographs 15-16) at 24 hours. After immersion in fresh (second) EDTA solution for another 24 hours (48 hours total), the patch of white deposit was removed (Photograph 17). While a chunk of deposit fell off by 70 hours during the EDTA iron oxide removal stage, a large amount of deposit remained (Photograph 18) – this despite having a substantial EDTA residual (4.1%). While the pH was a little elevated, only spending from 11% to 4% in 45.3 hours at temperature indicates a very slow dissolution rate. Surfaces still supported thick deposits on the hot side crown following the passivation stage (Photographs 19-21). A small to moderate amount of copper was removed during the passivation stage. The removal of a loosely adherent layer of black oxide (likely iron oxide) by brushing and scraping revealed a deposit layer that was red in color (Photograph 22). The next 30 g/ft^2 of mechanically removed deposit appeared to contain a large proportion of red material. Bead-blasting revealed a black underlying deposit (Photograph 24). The last 68 g/ft^2 of deposit removed was mainly black, but layers of red, black and off-white material also were apparent. Photograph 28 shows a large (one-half inch long) chunk of deposit that popped off during this final vibration period. The top side (not shown) was mainly grey. The underside contained a red deposit layer and a white layer. It was initially hypothesized that some of the white patches of deposit may have been flux between layers of weld metal and slag. Photograph 26 was designed to show what appeared to be a flux inclusion in the external membrane weld. However, all of the material initially thought to be metal (Photograph 23) eventually was removed and determined to be a brittle (nonmetallic) deposit.

The hot side crown appeared to have circumferential cracks on the exterior (Photograph 25), adjacent to the weld. These cracks are similar to *fatigue cracks*.

Changes to the deposits on the tube ring suggest the effectiveness of chemical cleaning to areas away from these weld-affected zones. Specifically, a 24-hour ammonium bromate stage is more than sufficient to remove the bulk of copper from tubes away from these welds. The iron oxide removal stage will need to be 24-48 hours, depending on the extent of layering and deposit tenacity. Additional testing of an area away from the weld could be used to refine this estimate.

This concludes our comments and suggestions at this juncture. Should you have any questions or comments on this letter or the enclosures, please let us know.

Very truly yours,

SHEPPARD T. POWELL ASSOCIATES, LLC

Robert D. Bartholomew, Associate

rdb

ENCLOSURES:
- Chemical Cleaning Trials
- Photographs 1-28

1st STAGE / Tube #65 (Section With Weld And Heavy Deposit)				
Test Conditions: 72 Hours @ 145-155°F			Tube Diameter: 2.0 Inches	
Immersion: 344 mL Solvent (4 Times Ring Volume)			Tube Ring Volume: ~86 mL	
Solvent Formulation		**Analytical Results Of Spent Solvent**		**Results**
% Ammonia, NH_3	2.4	% Copper (Cu) @ 24 Hrs	0.17	Solvent turns blue quickly. Heavy deposit remains. Loose sludge in beaker (0.20 gram).
% Sodium Bromate, $NaBrO_3$	0.9	% Copper (Cu) @ 30 Hrs	0.17	
% Ammonium Bicarbonate	1.8	% Copper (Cu) @ 48 Hrs	0.18	
		% Copper (Cu) @ 56 Hrs	0.18	
		% Copper (Cu) @ 72 Hrs	0.19	
		% Ammonia (NH_3) @ 72 Hrs	1.9	
		% $NaBrO_3$ @ 72 Hrs	0.75	
		pH, Units @ 72 Hrs	10.24	

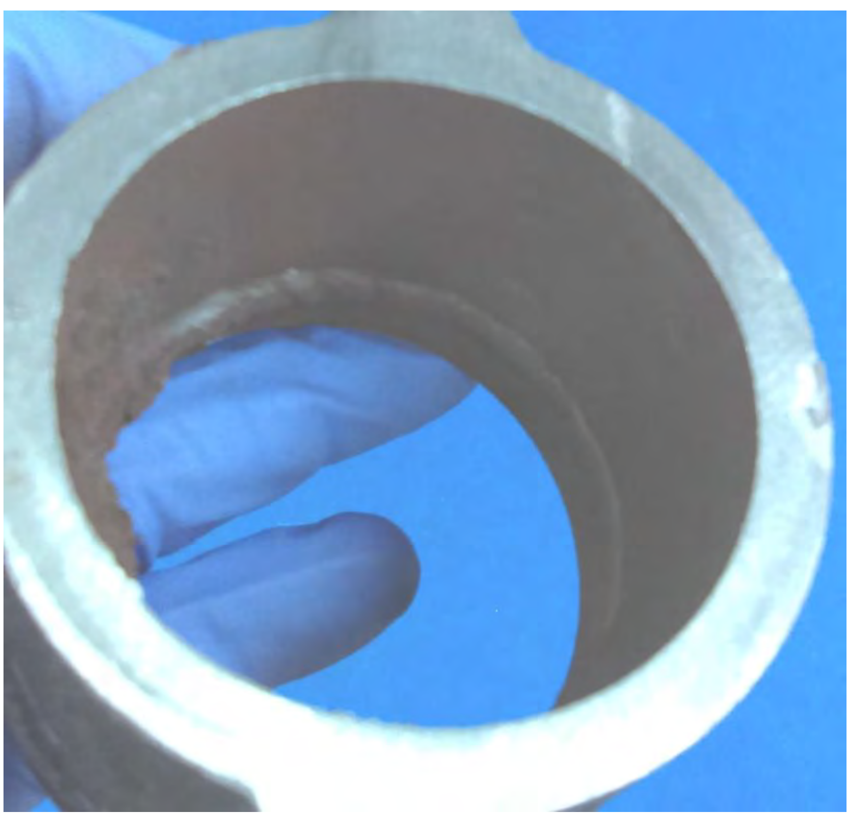
2ND STAGE / Tube #65 (Section With Weld And Heavy Deposit)				
Test Conditions: 24 Hours @190-195°F			Tube Diameter: 2.0 Inches	
Immersion: 344 mL Solvent (4 Times Ring Volume)			Tube Ring Volume: ~86 mL	
Solvent Formulation		**Analytical Results Of Spent Solvent**		**Results**
% Diammonium EDTA	10	pH, Units	7.23	Heavy deposit remains on the hot side. The remainder of the tube is clean. No copper plating. Loose sludge in beaker (0.17 gram).
% Cronox 240 Inhibitor	0.2	% Iron, Fe	1.70	
pH @ Start, Units	4.8	ppm Copper, Cu	9	
		% Free EDTA	0.5	
		Decant solvent to remove sludge.		

3rd STAGE / Tube #65 (Section With Weld And Heavy Deposit)				
Test Conditions: 45.3 Hours @ 190-195°F			Tube Diameter: 2.0 Inche	
Immersion: 344 mL Solvent (4 Times Ring Volume)			Tube Ring Volume: ~86 m	
Solvent Formulation / Fresh Batch Add 1% EDTA @ 24 Hours		**Analytical Results Of Spent Solvent**		**Results**
% Diammonium EDTA	10	pH @ 24 Hrs (@ 29°C)	5.22	Deposit remains. Loose sludge in beaker (0.47 gram).
% Cronox 240 Inhibitor	0.2	pH, Units	5.96	
pH @ Start, Units	4.8	% Iron, Fe	1.12	
		ppm Calcium, Ca	43	
		ppm Chromium, Cr	10	
		% Free EDTA	4.1	

<table>
<tr><th colspan="5">4th STAGE / Tube #65
(Section With Weld And Heavy Deposit)</th></tr>
<tr><td colspan="3">Test Conditions: 4 Hours @ 140°F</td><td colspan="2">Tube Diameter: 2.0 Inches</td></tr>
<tr><td colspan="3">Immersion: ------------</td><td colspan="2">Tube Ring Volume: ~86 mL</td></tr>
<tr><th>Passivation</th><th colspan="3">Analytical Results Of Spent Solvent</th><th>Results</th></tr>
<tr><td rowspan="5">To 2nd Stage solvent (1st EDTA), add 2% EDTA, raise the pH to 9.44 units with NH_4OH (takes 11 mL), and add 1.5% sodium nitrite.</td><td colspan="2">% Iron, Fe</td><td>1.02</td><td rowspan="5">Deposit remains. Loose sludge in beaker (0.25 gram).</td></tr>
<tr><td colspan="2">% Copper, Cu</td><td>0.040</td></tr>
<tr><td colspan="2">ppm Calcium, Ca</td><td>104</td></tr>
<tr><td colspan="2">ppm Chromium, Cr</td><td>14</td></tr>
<tr><td colspan="2">% Free EDTA</td><td>2.0</td></tr>
</table>

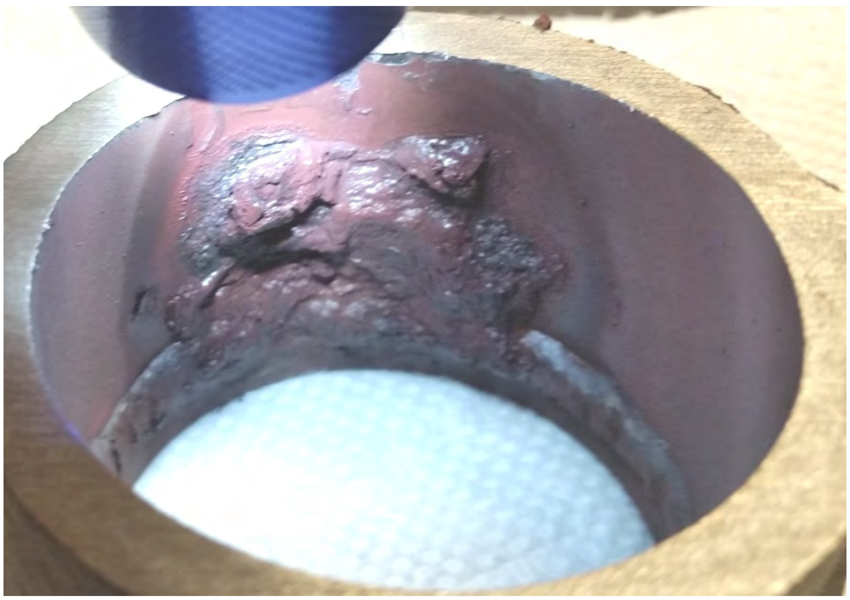
Photograph 1

Hot Side
Before Cleaning



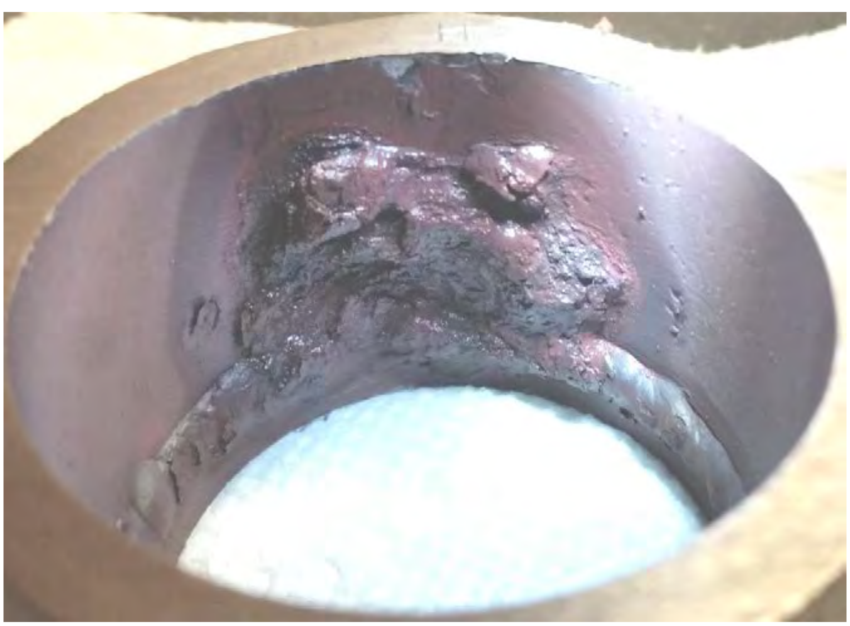
Photograph 2

Before Cleaning, Membrane (Center of Photograph) and Cold Side (Right of Photograph)



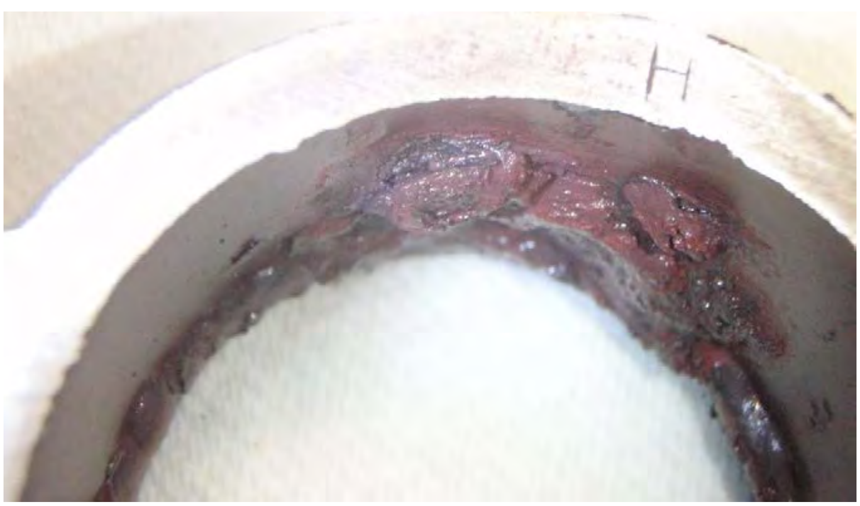
Photograph 3

Ammonium Bromate at 30 Hours, Hot Side – Top Edge Exposing Iron Oxide

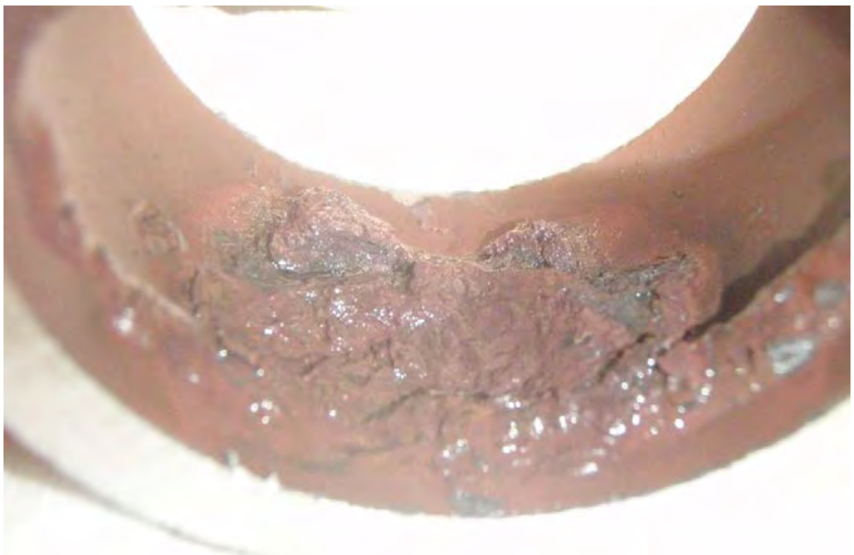


Photograph 4
Ammonium Bromate at 30 Hours, Hot Side – Right Side Exposing Iron Oxide

Photograph 5
Ammonium Bromate, 48 Hours, Hot Side (Water Rinsed Before Photograph)



Photograph 6
Ammonium Bromate, 48 Hours Hot Side End View (After Water Rinse)



Photograph 7
Ammonium Bromate, 48 Hours, Hot Side, View from Below

Photograph 8
Ammonium Bromate at 56 Hours, View from Bottom

The underside of the chunk on the top left may have lost some of the red surface color.

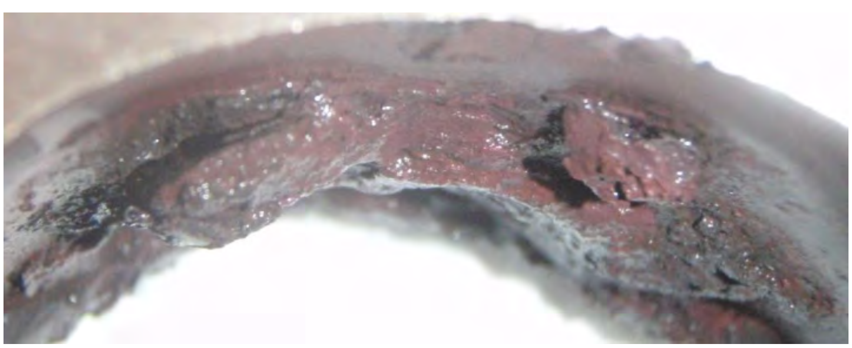
Photograph 9
Ammonium Bromate 56 Hours, Hot Side

Small triangular chip came off of protruding portion on top right

Photograph 10
Ammonium Bromate 56 Hours, Top View

Photograph 11
Ammonium Bromate, 72 Hours
Hot Side After Rinsing and Air Drying

No change visible since 56 hours



Photograph 12
Ammonium Bromate, 72 Hours, Top View

No change visible since 56 hours

Photograph 13
Ammonium Bromate, 72 Hours, View from Bottom

No change visible since 56 hours.

Photograph 14
End of 2nd Stage (EDTA at 24 Hours), Iron Oxide Removal Stage, Membrane and Cold Side

Membrane and cold side are clean

Photograph 15
End of 2nd Stage (EDTA at 24 Hours), Iron Oxide Removal Stage, Hot Side Crown

Photograph 16
End of 2nd Stage (EDTA at 24 Hours), Iron Oxide Removal Stage, Hot Side Top View

Photograph 17
3rd Stage at 24 Hours: Second EDTA at 24 Hours (or 48 hours total in Iron Oxide Removal Stage), Hot Side

Photograph 18
End of 3rd Solvent Stage (45.3 hours in 2nd Batch of EDTA) Iron Oxide Removal Stage(at ~69-70 Hours Total Contact)

Photograph 19
After 4th Stage (Final Copper Removal and Passivation Stage)

Photograph 20
Deposit Thickness at End

Photograph 21
Hot Side After Drying in Oven

Photograph 22
Hot Side After Brushing and Scraping

Brushing and vibrating removed 5.30 g/ft^2 and 6.23 g/ft^2, respectively.

Photograph 23
Hot Side After An Hour of Vibration of Surfaces

After vibrating had removed 30.36 g/ft^2 of deposit. It appeared that the etching tool was slowly working on metal slag and small inclusions of oxides or flux along the joints in the layers. Progress was very slow. Later realized vibrating tool needed replacement

Photograph 24
Hot Side Surface After Bead Blasting

At this point, the total post cleaning hot side deposit weight removed was 60.52 g/ft^2.

Some of the residual material has a fused (melted) appearance similar to slag, but the material looks like it is in a more oxidized state than the material shown in the prior photograph.

Photograph 25
Circumferential Cracks on Crown of Hot Side Exterior

Photograph 26
Membrane After Bead Blast, Example of Flux Inclusion in Weld

A similar material was noted in layers of slag on tube interior

Photograph 27
Hot Side After Final Vibration of Deposit

Photograph 28
Underside of 9/16 Inch Long Chunk That Was Removed During Final Vibration

(Top was dull gray color.)

CI Number: 49419

Title: POT Boiler Refurbishment 2017

Start Date:	2017/06
In-Service Date:	2017/06
Final Cost Date:	2017/12
Function:	Steam
Forecast Amount:	$969,292

DESCRIPTION:

The scope of work for this project is to repair and replace tubes, tube bends and shields on the Point Tupper boiler as part of a planned outage in 2017. The scope of this project is determined as part of the annual boiler condition data collection and analysis. This effort includes evaluation and prioritization of activities to be undertaken during the annual outage. Protective erosion shields identified as missing or degraded will be replaced with new shields. Tubes and bends will be replaced in the areas where the wall thickness readings are below American Society of Mechanical Engineers (ASME) specifications. This tolerance maximizes the economic tube life while maintaining boiler reliability.

Summary of Related CIs +/- 2 years:
2015 CI 46256 POT Boiler Refurbishment 2015 $1,063,977
2016 CI 47719 POT Boiler Refurbishment 2016 $240,082
2018 CI TBD POT Boiler Refurbishment 2018 $TBD
2019 CI TBD POT Boiler Refurbishment 2019 $TBD

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

Ongoing asset management activities have identified the requirement for boiler component replacement to maintain the reliability of the boiler and mitigate the risk of unplanned outages due to tube leaks. Boiler tube failures represent the industry's single largest source of outages for steam-based generation. NS Power has a long history of managing this issue with comprehensive Boiler Inspection and Investment Programs to match the various failure mechanisms.

This project is being undertaken primarily to prevent boiler failure and preserve the unit's availability, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

In order to mitigate the risk of unplanned outages, annual boiler refurbishment activities are required. Some of the tubes to be inspected and replaced are difficult to access and sufficient time during a planned outage is required to complete refurbishment or replacements. The annual planned outage duration will afford the time necessary to assess, locate and repair tubes and shields.

Why do this project this way?

Replacing deteriorated tubes, tube bends and shields will mitigate the risk of tube leaks and minimize the number of unplanned outages. Based on boiler assessments, these upgrades are necessary to maintain reliable operation of the boiler. Refurbishment of these components is not an option once they are outside acceptable tolerances. For tubes, tolerances are established by industry standard (ASME). Shield replacement is determined by inspector assessment of the degree of deterioration.

CI Number : 49419 - POT Boiler Refurbishment 2017 **Project Number**

Parent CI Number : -

Cost Centre : 351 - 351-Pt.Tupper Admin./Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
095		095-Thermal Regular Labour AO		9,075	0	9,075
095		095-Thermal & Hydro Contracts AO		43,036	0	43,036
095		095-Thermal Overtime Labour AO		2,165	0	2,165
095		095-Thermal Term Labour AO		2,165	0	2,165
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	42,284	0	42,284
002	013	002 - THERMAL Overtime Labour	013 - SGP - Boiler	20,175	0	20,175
004	013	004 - THERMAL Term Labour	013 - SGP - Boiler	10,087	0	10,087
011	013	011 - Travel Expense	013 - SGP - Boiler	500	0	500
012	013	012 - Materials	013 - SGP - Boiler	350,000	0	350,000
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	400,000	0	400,000
014	013	014 - Overtime Meals	013 - SGP - Boiler	1,000	0	1,000
033	013	033 - Rental and Maintenance of	013 - SGP - Boiler	5,000	0	5,000
041	013	041 - Meals & Entertainment	013 - SGP - Boiler	1,000	0	1,000
066	013	066 - Other Goods & Services	013 - SGP - Boiler	82,805	0	82,805
			Total Cost:	969,292	0	969,292
			Original Cost:	462,436		

Capital Project Detailed Estimate

Location: Pt. Tupper
CI# : 49419
Title: POT Boiler Refurbishment 2017
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Electrician	PD	2	$ 358	$ 717		
Maintenance Trades	PD	2	$ 365	$ 730		
Power Engineer	PD	80	$ 390	$ 31,231		
Utility worker	PD	40	$ 240	$ 9,607		
			Sub-Total	$ 42,284		
002 OT Labour						
Utility worker	PD	42	$ 480	$ 20,175		
			Sub-Total	$ 20,175		
004 Term Labour						
Utility worker	PD	42	$ 240	$ 10,087		
			Sub-Total	$ 10,087		
011 Travel Expense						
Travel	lot	1	$ 500	$ 500		
			Sub-Total	$ 500		
012 Materials						
Boiler tubing, shields, pins, etc.	lot	1	$ 350,000	$ 350,000		
			Sub-Total	$ 350,000		
013 Contracts						
Boiler tube replacement and refurbishment	lot	1	$ 400,000	$ 400,000		
Rentals	lot	1	$ 5,000	$ 5,000		
			Sub-Total	$ 405,000		
041 Meals & Entertainment						
Meals and expenses	lot	1	$ 1,000	$ 1,000		
OT Meals	lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 2,000		
066 Other Goods & Services						
Contingency	%	10%	$ 828,046	$ 82,805		
			Sub-Total	$ 82,805		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 9,075		
Thermal OT Labour AO				$ 2,165		
Thermal Term Labour AO				$ 2,165		
Thermal / Hydro Contracts AO				$ 43,036		
			Sub-Total	$ 56,441		
			SUB-TOTAL (no AO, AFUDC)	$ 912,851		
			TOTAL (AO, AFUDC included)	$ 969,292		
Original Cost				$ 462,436		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

POT Boiler Refurbishment 2017
Summary of Alternatives

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Point Tupper Generating Station	**CI Number:**	49419
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Refurbish Boiler vs Avoided Fuel & Rep	5.90%	-3,906,802	2,761,101	1	144.13%	1.4 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

This project is recommended to proceed as not doing this project will lead to lessened unit availability.

Notes/Comments :

Refurbish Boiler vs Avoided Fuel & Repair Costs

This option assumes 8 tube failures in year one, increasing as time goes on in the event that this project is not completed.

Test 2

Test 3

Test 4

POT Boiler Refurbishment 2017
Summary of Sensitivities

Nova Scotia POWER An Emera Company

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Point Tupper Generating Station	**CI Number:**	49419
		Project No. :	

	Alternative	**After Tax WACC**	**PV of Revenue Requirement**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Refurbish Boiler vs Avoided Fuel & Repair Costs	5.90%	-3,906,802	2,761,101	1	144.13%	1.4 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	**Variance (%)**	**PV of Revenue Requirement**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Refurbish Boiler vs Avoided Fuel & Repair Costs	10%	-3,814,627	2,690,674	1	120.90%	1.5 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years

Change:	**A**	92,175	-70,427	0	-23.23%	0.2 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	**Variance (%)**	**PV of Revenue Requirement**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Refurbish Boiler vs Avoided Fuel & Repair Costs	-10%	-3,423,947	2,414,564	1	118.77%	1.6 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years

Change:	**A**	482,855	-346,537	0	-25.36%	0.2 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	**PV of Revenue Requirement** 1	**PV of Revenue Requirement** 2	**PV of Revenue Requirement** 3	**Delay?**
	A	584,980	1,216,587	1,982,805	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

POT Boiler Refurbishment 2017
Avoided Cost Calculations

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Point Tupper Generating Station	**CI Number:**	49419
		Project No. :	

Refurbish Boiler vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			52,920	55,040		
Events/Outages (#)	6	7	6	7		
Probability of Occurance (%)	100%	100%	100%	100%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	150.0	150.0				
Duration (Hours or Years)	60	60				
Totals	$354,647	$419,800	$317,520	$385,280	$672,167	$805,080
Total Capital Cost of Alternative						$969,292

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

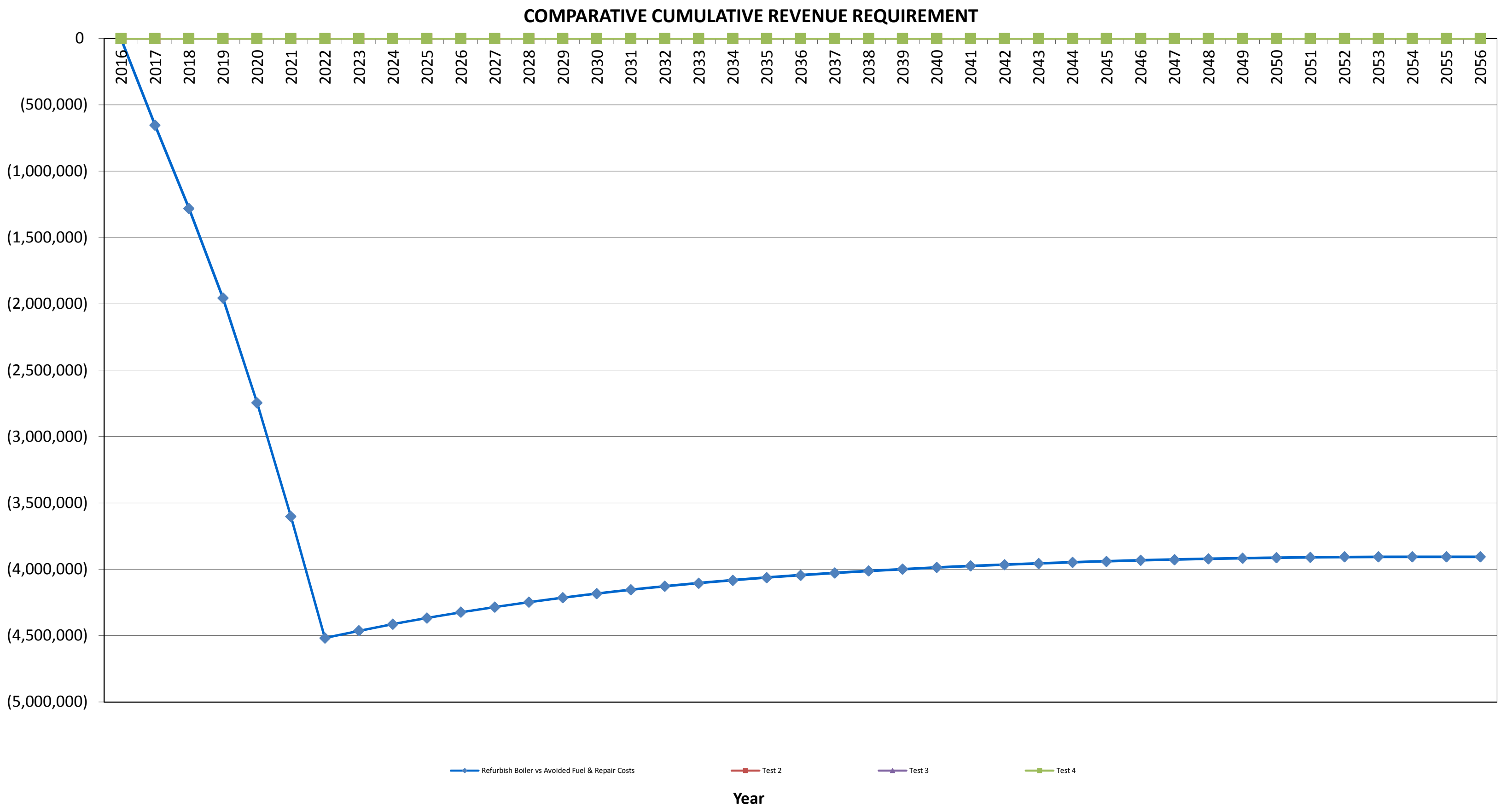
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

POT Boiler Refurbishment 2017
Refurbish Boiler vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	672,167.1	(912,851.1)	36,514.0	891,914.7	(240,684.0)	(197,052.4)	(437,736.4)	(413,348.8)	0.94	(413,348.8)
2018	-	-	805,079.6	-	70,107.0	819,207.0	805,079.6	(227,841.5)	577,238.1	514,710.5	0.89	101,361.7
2019	-	-	914,625.7	-	64,498.4	752,315.8	914,625.7	(263,539.5)	651,086.2	548,214.6	0.84	649,576.3
2020	-	-	1,123,886.5	-	59,338.5	690,776.0	1,123,886.5	(330,009.9)	793,876.6	631,203.2	0.80	1,280,779.5
2021	-	-	1,291,057.2	-	54,591.5	634,159.3	1,291,057.2	(383,304.4)	907,752.8	681,534.4	0.75	1,962,313.9
2022	-	-	1,462,230.1	-	50,224.1	582,072.0	1,462,230.1	(437,721.8)	1,024,508.2	726,339.5	0.71	2,688,653.4
2023	-	-	-	-	46,206.2	534,151.6	-	14,323.9	14,323.9	9,589.4	0.67	2,698,242.8
2024	-	-	-	-	42,509.7	490,064.9	-	13,178.0	13,178.0	8,330.7	0.63	2,706,573.5
2025	-	-	-	-	39,108.9	449,505.2	-	12,123.8	12,123.8	7,237.3	0.60	2,713,810.8
2026	-	-	-	-	35,980.2	412,190.2	-	11,153.9	11,153.9	6,287.3	0.56	2,720,098.1
2027	-	-	-	-	33,101.8	377,860.4	-	10,261.6	10,261.6	5,462.1	0.53	2,725,560.2
2028	-	-	-	-	30,453.7	346,277.0	-	9,440.6	9,440.6	4,745.1	0.50	2,730,305.3
2029	-	-	-	-	28,017.4	317,220.2	-	8,685.4	8,685.4	4,122.3	0.47	2,734,427.7
2030	-	-	-	-	25,776.0	290,488.0	-	7,990.6	7,990.6	3,581.2	0.45	2,738,008.9
2031	-	-	-	-	23,713.9	265,894.4	-	7,351.3	7,351.3	3,111.2	0.42	2,741,120.1
2032	-	-	-	-	21,816.8	243,268.3	-	6,763.2	6,763.2	2,702.8	0.40	2,743,822.9
2033	-	-	-	-	20,071.4	222,452.2	-	6,222.1	6,222.1	2,348.1	0.38	2,746,171.0
2034	-	-	-	-	18,465.7	203,301.5	-	5,724.4	5,724.4	2,039.9	0.36	2,748,210.8
2035	-	-	-	-	16,988.5	185,682.8	-	5,266.4	5,266.4	1,772.1	0.34	2,749,982.9
2036	-	-	-	-	15,629.4	169,473.5	-	4,845.1	4,845.1	1,539.5	0.32	2,751,522.5
2037	-	-	-	-	14,379.0	154,561.1	-	4,457.5	4,457.5	1,337.4	0.30	2,752,859.9
2038	-	-	-	-	13,228.7	140,841.6	-	4,100.9	4,100.9	1,161.9	0.28	2,754,021.8
2039	-	-	-	-	12,170.4	128,219.7	-	3,772.8	3,772.8	1,009.4	0.27	2,755,031.2
2040	-	-	-	-	11,196.8	116,607.5	-	3,471.0	3,471.0	876.9	0.25	2,755,908.1
2041	-	-	-	-	10,301.0	105,924.4	-	3,193.3	3,193.3	761.8	0.24	2,756,669.9
2042	-	-	-	-	9,477.0	96,095.8	-	2,937.9	2,937.9	661.8	0.23	2,757,331.7
2043	-	-	-	-	8,718.8	87,053.6	-	2,702.8	2,702.8	574.9	0.21	2,757,906.7
2044	-	-	-	-	8,021.3	78,734.7	-	2,486.6	2,486.6	499.5	0.20	2,758,406.1
2045	-	-	-	-	7,379.6	71,081.3	-	2,287.7	2,287.7	433.9	0.19	2,758,840.1
2046	-	-	-	-	6,789.2	64,040.3	-	2,104.7	2,104.7	377.0	0.18	2,759,217.0
2047	-	-	-	-	6,246.1	57,562.5	-	1,936.3	1,936.3	327.5	0.17	2,759,544.5
2048	-	-	-	-	5,746.4	51,602.9	-	1,781.4	1,781.4	284.5	0.16	2,759,829.0
2049	-	-	-	-	5,286.7	46,120.1	-	1,638.9	1,638.9	247.2	0.15	2,760,076.2
2050	-	-	-	-	4,863.8	41,075.9	-	1,507.8	1,507.8	214.7	0.14	2,760,290.9
2051	-	-	-	-	4,474.7	36,435.2	-	1,387.1	1,387.1	186.5	0.13	2,760,477.4
2052	-	-	-	-	4,116.7	32,165.8	-	1,276.2	1,276.2	162.1	0.13	2,760,639.5
2053	-	-	-	-	3,787.3	28,238.0	-	1,174.1	1,174.1	140.8	0.12	2,760,780.3
2054	-	-	-	-	3,484.4	24,624.3	-	1,080.2	1,080.2	122.3	0.11	2,760,902.6
2055	-	-	-	-	3,205.6	21,299.8	-	993.7	993.7	106.3	0.11	2,761,008.8
2056	-	-	-	-	2,949.2	18,241.3	-	914.2	914.2	92.3	0.10	2,761,101.1
Total	**-**	**-**	**6,269,046.1**	**(912,851.1)**	**878,935.7**		**5,356,195.0**	**(1,670,934.2)**	**3,685,260.8**	**2,761,101.1**		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Refurbish Boiler vs Avoided Fuel & Repair Costs
Test 2
Test 3
Test 4
Year

CI Number: 49536

Title: TRE5 Boiler Refurbishment 2017

Start Date: 2017/03
In-Service Date: 2017/05
Final Cost Date: 2017/11
Function: Steam
Forecast Amount: $717,589

DESCRIPTION:

The scope of work for this project is to refurbish and replace deteriorated boiler tubes, tube bends and shields on the Trenton Unit 5 boiler as part of the planned outage in 2017. The scope of this project is determined as part of the annual boiler condition data collection and analysis, however it currently is expected to include 8 tube cut-outs along with tube re-alignment efforts. This effort includes evaluation and prioritization of activities to be undertaken during the annual outage. Protective erosion shields identified as missing or degraded will be replaced with new shields. Tubes and bends will be replaced in the areas where the thickness readings are below American Society of Mechanical Engineers (ASME) specifications. This tolerance maximizes the economic tube life while maintaining boiler reliability.

Summary of Related CIs +/- 2 years:
2015 CI 46302 TRE5 Boiler Refurbishment $647,845
2016 CI 47552 TRE5 Boiler Refurbishment $1,204,387
2018 CI TBD TRE5 Boiler Refurbishment $TBD
2019 CI TBD TRE5 Boiler Refurbishment $TBD

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement/Refurbishment

Why do this project?

Ongoing asset management activities have identified the requirement for boiler component replacement to maintain the long term reliability of the boiler and mitigate the risk of unplanned outages due to tube leaks. Boiler Tube failures represent the industry's single largest source of outages for steam-based generation. NS Power has a long history of managing this issue with comprehensive Boiler Inspection and Investment Programs to match the various failure mechanisms.

This project is being undertaken primarily to prevent unit deratings and preserve the unit's availability, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

In order to mitigate the risk of unplanned outages, annual boiler refurbishment activities are required. Some of the tubes to be inspected and replaced are difficult to access and sufficient time during a planned outage is required to complete refurbishment or replacements. The annual planned outage duration will afford the time necessary to assess, locate and repair tubes and shields.

Why do this project this way?

Replacing deteriorated boiler tubes, tube bends and shields will mitigate the risk of tube leaks and minimize the number of unplanned outages. Based on boiler assessments, these upgrades are necessary to maintain reliable operation of the boiler. Refurbishment of these components is not an option once they are outside acceptable tolerances.

CI Number : 49536 - TRE5 Boiler Refurbishments 2017 **Project Number**

Parent CI Number : -

Cost Centre : 340 - 340-Trenton Unit 5 Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		2,122	0	2,122
095		095-Thermal Term Labour AO		1,031	0	1,031
095		095-Thermal Overtime Labour AO		515	0	515
095		095-Thermal & Hydro Contracts AO		49,599	0	49,599
095		095-Thermal Regular Labour AO		3,139	0	3,139
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	14,627	0	14,627
002	013	002 - THERMAL Overtime Labour	013 - SGP - Boiler	4,804	0	4,804
004	013	004 - THERMAL Term Labour	013 - SGP - Boiler	4,804	0	4,804
012	013	012 - Materials	013 - SGP - Boiler	114,931	0	114,931
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	461,000	0	461,000
066	013	066 - Other Goods & Services	013 - SGP - Boiler	60,017	0	60,017
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	1,000	0	1,000
			Total Cost:	717,589	0	717,589
			Original Cost:	155,305		

Capital Project Detailed Estimate

Location: **Trenton Generating Station**
CI# : 49536
Title: TRE5 Boiler Refurbishment 2017
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Engineering	PD	20	$ 405	$ 8,106		
Maintenance Trades	PD	8	$ 365	$ 2,918		
Utility worker	PD	15	$ 240	$ 3,603		
			Sub-Total	$ 14,627		
002 OT Labour						
Utility worker	PD	10	$ 480	$ 4,804		
			Sub-Total	$ 4,804		
004 Term Labour						
Utility worker	PD	20	$ 240	$ 4,804		
				$ -		
			Sub-Total	$ 4,804		
012 Materials						
Boiler Tubes	ea	8	$ 1,500	$ 12,000		
Contractor Materials	lot	1	$ 20,000	$ 20,000		
Shields	ea	200	$ 100	$ 20,000		
Alignment Brackets	ea	66	$ 953	$ 62,931		
			Sub-Total	$ 114,931		
013 Contracts						
Inspection	lot	1	$ 80,000	$ 80,000		
Boiler Repairs	lot	1	$ 256,000	$ 256,000		
Supervision	lot	1	$ 90,000	$ 90,000		
Vacuum Services	lot	1	$ 20,000	$ 20,000		
Refractory	lot	1	$ 15,000	$ 15,000		
			Sub-Total	$ 461,000		
041 Meals & Entertainment						
Meals	lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000		
066 Other Goods & Services						
Contingency	%	10%	$ 600,165	$ 60,017		
			Sub-Total	$ 60,017		
094 Interest Capitalized						
AFUDC				$ 2,122		
			Sub-Total	$ 2,122		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 3,139		
Thermal OT Labour AO				$ 515		
Thermal Term Labour AO				$ 1,031		
Thermal / Hydro Contracts AO				$ 49,599		
			Sub-Total	$ 54,285		
			SUB-TOTAL (no AO, AFUDC)	$ 661,182		
			TOTAL (AO, AFUDC included)	$ 717,589		
Original Cost				$ 155,305		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

TRE5 Boiler Refurbishment 2017
Summary of Alternatives

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Trenton Generating Station	**CI Number:**	49536
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Boiler Refurbishment vs Avoided Fuel &	5.90%	-2,422,397	1,801,982	1	38.61%	3.9 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

It is recommended to complete this project to prevent unit deratings and preserve the unit's availability.

Notes/Comments :

Boiler Refurbishment vs Avoided Fuel & Repair Costs

This model compares the refurbishment costs to the replacement energy costs associated with unplanned outages due to tube leaks in the boiler. Assumptions are that there will be one tube leak in 2016, with increasing likelihood of failure in subsequent years. The unit would be down an average of 120 hours to perform repairs such that the unit could be returned to service. The failure rate considers the age of the boiler (1969).

Test 2

Test 3

Test 4

TRE5 Boiler Refurbishment 2017
Summary of Sensitivities

Nova Scotia POWE An Emera Compa

Division :	Power Production		**Date :**	**28-Oct-16**
Department :	Trenton Generating Station		**CI Number:**	49536
			Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Boiler Refurbishment vs Avoided Fuel & Repair C	5.90%	-2,422,397	1,801,982	1	38.61%	3.9 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Boiler Refurbishment vs Avoided Fuel & Repair C	10%	-2,355,347	1,750,770	1	35.26%	4.2 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years

		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
Change:	A	67,051	-51,211	0	-3.35%	0.3 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Boiler Refurbishment vs Avoided Fuel & Repair C	-10%	-2,113,107	1,570,572	1	34.92%	4.2 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years

		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
Change:	A	309,291	-231,409	0	-3.69%	0.3 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	65,585	223,559	405,945	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

TRE5 Boiler Refurbishment 2017
Avoided Cost Calculations

Nova Scotia POWER An Emera Company

Division :	Power Production	Date :	28-Oct-16
Department :	Trenton Generating Station	CI Number:	49536
		Project No. :	

Boiler Refurbishment vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2017	2018	2017	2018	2017	2018
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			100,000	104,024		
Events/Outages (#)	1	2	1	2		
Probability of Occurance (%)	100%	100%	100%	100%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	160.0	160.0				
Duration (Hours or Years)	120	120				
Totals	$3,775	$6,170	$100,000	$208,048	$103,775	$214,218
Total Capital Cost of Alternative						$717,589

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2017	2018	2017	2018	2017	2018
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

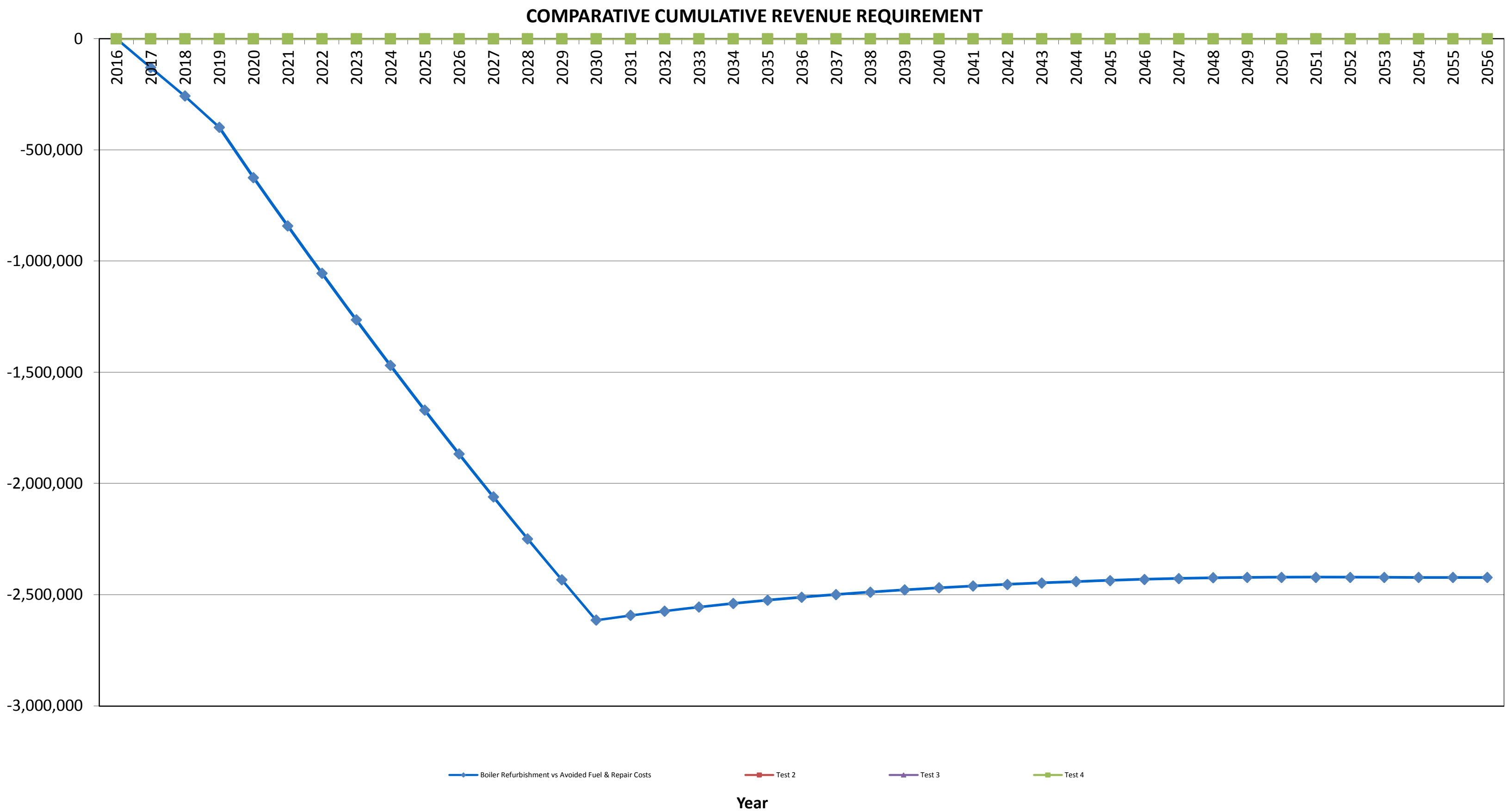
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2017	2018	2017	2018	2017	2018
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2017	2018	2017	2018	2017	2018
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

TRE5 Boiler Refurbishment 2017
Boiler Refurbishment vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	103,775.2	(663,304.0)	26,447.3	649,716.9	(559,528.7)	(23,971.7)	(583,500.4)	(550,991.9)	0.94	(550,991.9)
2018	-	-	214,218.4	-	50,778.7	596,436.8	214,218.4	(50,666.3)	163,552.1	145,835.8	0.89	(405,156.1)
2019	-	-	239,725.1	-	46,716.4	547,419.0	239,725.1	(59,832.7)	179,892.4	151,469.4	0.84	(253,686.7)
2020	-	-	364,225.4	-	42,979.1	502,322.6	364,225.4	(99,586.3)	264,639.1	210,411.8	0.80	(43,274.8)
2021	-	-	372,686.0	-	39,540.8	460,834.0	372,686.0	(103,275.0)	269,411.0	202,271.9	0.75	158,997.0
2022	-	-	387,249.7	-	36,377.5	422,664.4	387,249.7	(108,770.4)	278,479.3	197,431.8	0.71	356,428.9
2023	-	-	402,390.8	-	33,467.3	387,548.4	402,390.8	(114,366.3)	288,024.5	192,822.5	0.67	549,251.4
2024	-	-	418,132.4	-	30,789.9	355,241.7	418,132.4	(120,076.1)	298,056.2	188,421.5	0.63	737,672.9
2025	-	-	434,498.4	-	28,326.8	325,519.6	434,498.4	(125,913.2)	308,585.2	184,209.2	0.60	921,882.1
2026	-	-	451,513.8	-	26,060.6	298,175.2	451,513.8	(131,890.5)	319,623.3	180,168.5	0.56	1,102,050.6
2027	-	-	469,204.5	-	23,975.8	273,018.3	469,204.5	(138,020.9)	331,183.6	176,284.2	0.53	1,278,334.8
2028	-	-	487,597.6	-	22,057.7	249,874.0	487,597.6	(144,317.4)	343,280.2	172,543.0	0.50	1,450,877.8
2029	-	-	506,721.1	-	20,293.1	228,581.3	506,721.1	(150,792.7)	355,928.4	168,933.3	0.47	1,619,811.0
2030	-	-	526,604.2	-	18,669.6	208,991.9	526,604.2	(157,459.7)	369,144.5	165,444.7	0.45	1,785,255.7
2031	-	-	-	-	17,176.1	190,969.7	-	5,324.6	5,324.6	2,253.4	0.42	1,787,509.2
2032	-	-	-	-	15,802.0	174,389.3	-	4,898.6	4,898.6	1,957.7	0.40	1,789,466.8
2033	-	-	-	-	14,537.8	159,135.4	-	4,506.7	4,506.7	1,700.7	0.38	1,791,167.5
2034	-	-	-	-	13,374.8	145,101.7	-	4,146.2	4,146.2	1,477.5	0.36	1,792,645.0
2035	-	-	-	-	12,304.8	132,190.7	-	3,814.5	3,814.5	1,283.6	0.34	1,793,928.6
2036	-	-	-	-	11,320.4	120,312.6	-	3,509.3	3,509.3	1,115.1	0.32	1,795,043.7
2037	-	-	-	-	10,414.8	109,384.8	-	3,228.6	3,228.6	968.7	0.30	1,796,012.4
2038	-	-	-	-	9,581.6	99,331.2	-	2,970.3	2,970.3	841.6	0.28	1,796,853.9
2039	-	-	-	-	8,815.1	90,081.8	-	2,732.7	2,732.7	731.1	0.27	1,797,585.0
2040	-	-	-	-	8,109.9	81,572.5	-	2,514.1	2,514.1	635.1	0.25	1,798,220.2
2041	-	-	-	-	7,461.1	73,743.8	-	2,312.9	2,312.9	551.8	0.24	1,798,772.0
2042	-	-	-	-	6,864.2	66,541.5	-	2,127.9	2,127.9	479.4	0.23	1,799,251.3
2043	-	-	-	-	6,315.1	59,915.3	-	1,957.7	1,957.7	416.4	0.21	1,799,667.8
2044	-	-	-	-	5,809.9	53,819.3	-	1,801.1	1,801.1	361.8	0.20	1,800,029.5
2045	-	-	-	-	5,345.1	48,210.9	-	1,657.0	1,657.0	314.3	0.19	1,800,343.8
2046	-	-	-	-	4,917.5	43,051.2	-	1,524.4	1,524.4	273.0	0.18	1,800,616.9
2047	-	-	-	-	4,524.1	38,304.3	-	1,402.5	1,402.5	237.2	0.17	1,800,854.1
2048	-	-	-	-	4,162.1	33,937.1	-	1,290.3	1,290.3	206.1	0.16	1,801,060.1
2049	-	-	-	-	3,829.2	29,919.3	-	1,187.0	1,187.0	179.0	0.15	1,801,239.2
2050	-	-	-	-	3,522.8	26,222.9	-	1,092.1	1,092.1	155.5	0.14	1,801,394.7
2051	-	-	-	-	3,241.0	22,822.3	-	1,004.7	1,004.7	135.1	0.13	1,801,529.8
2052	-	-	-	-	2,981.7	19,693.6	-	924.3	924.3	117.4	0.13	1,801,647.2
2053	-	-	-	-	2,743.2	16,815.3	-	850.4	850.4	102.0	0.12	1,801,749.1
2054	-	-	-	-	2,523.7	14,167.3	-	782.4	782.4	88.6	0.11	1,801,837.7
2055	-	-	-	-	2,321.8	11,731.0	-	719.8	719.8	77.0	0.11	1,801,914.7
2056	-	-	-	-	2,136.1	9,489.7	-	662.2	662.2	66.9	0.10	1,801,981.5
Total	**-**	**-**	**5,378,542.5**	**(663,304.0)**	**636,616.6**		**4,715,238.5**	**(1,469,997.0)**	**3,245,241.5**	**1,801,981.5**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
-500,000
-1,000,000
-1,500,000
-2,000,000
-2,500,000
-3,000,000
2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056
Boiler Refurbishment vs Avoided Fuel & Repair Costs
Test 2
Test 3
Test 4
Year

CI Number: 41511

Title: TRE6 Condenser Waterbox and CW Piping Refurbishment

Start Date:	2017/09
In-Service Date:	2017/09
Final Cost Date:	2018/04
Function:	Steam
Forecast Amount:	$700,809

DESCRIPTION:

This project includes re-lining of the four condenser waterboxes and the refurbishment of the Cooling Water (CW) inlet and discharge piping. Refurbishment of the CW piping will include replacement of some sections of pipe as well as extending the life of some existing concrete pipe sections through repairs of the internal joints.

The Unit 6 condenser and CW piping were installed in 1991, have reached the end of their useful life, and are original equipment to the Unit. The function of this condenser is to provide the greatest vacuum possible to the turbine exhaust in order to achieve the most generating capacity possible from the steam, and to increase efficiency of the unit. Once the steam from the turbine enters the condenser, it flows around the outside of the condenser tubes and condenses when cooled by river water which flows through the inside of the condenser tubes. The cooling water, taken from the East River, enters the plant through two large CW pumps, and then flows through large-diameter pipes into the waterboxes of the condenser. After passing through the tubes in the waterbox of the condenser, the water is piped back to the river.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 and 2019

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement/Refurbishment

Why do this project?

The CW piping and the waterboxes are made of carbon steel, and experience normal wear and corrosion over time because brackish river water is used as cooling water. These components are lined with a coating in order to protect the steel from premature corrosion. The interior surfaces of the waterboxes are lined with neoprene and the CW piping is lined with an epoxy coating. Due to normal wear over time, these linings have deteriorated, and degradation in the CW piping and waterboxes are now visually evident. As the piping has recently experienced leaks and the neoprene coating has started to separate from the interior surfaces of the waterboxes, this work must be completed to mitigate the risk of further deterioration and unplanned unit outages.

There are safety and environmental implications of a CW leak in the plant. Although this is a low pressure system, the volume of water generated by a leak is a safety concern within the plant and an environmental concern outside of the plant should the resulting failure lead to an uncontrolled release of water.

This project is being undertaken primarily to preserve the unit’s availability, and is secondarily being undertaken to address safety and environmental issues.

Why do this project now?

The sections of CW piping to be replaced are 25 years old, have reached the end of their useful life, and must be replaced. Refurbishment of the CW piping will include replacement of some sections of pipe as well as extending the life of some existing concrete pipe sections through repairs of the internal joints. The 2017 planned outage is of sufficient duration to complete this work. As the piping has experienced leaks, most recently one was repaired during the 2016 outage, and the neoprene coating has started to separate from the interior surfaces of the waterboxes, this work must be completed now to mitigate the risk of further deterioration and unplanned unit outages.

Why do this project this way?

Removal of the remaining neoprene lining and replacing it with an epoxy coating will protect the waterboxes from further degradation. Replacement and repair of the CW piping combined with upgrading the internal and external coatings will ensure the reliability of the system. Refurbishing the waterboxes and CW piping is the most cost-effective option, as the condition of the components allows for refurbishment, thus avoiding a more costly replacement.

CI Number : 41511 - TRE6 - Condenser Waterbox and Cooling Water Piping Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 345 - 345-Trenton unit 6 Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
095		095-Thermal Regular Labour AO		8,499	0	8,499
095		095-Thermal Term Labour AO		5,194	0	5,194
095		095-Thermal & Hydro Contracts AO		36,652	0	36,652
095		095-Thermal Overtime Labour AO		825	0	825
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	39,601	0	39,601
002	014	002 - THERMAL Overtime Labour	014 - SGP - Circ.Water Sys.	7,686	0	7,686
004	014	004 - THERMAL Term Labour	014 - SGP - Circ.Water Sys.	24,199	0	24,199
012	014	012 - Materials	014 - SGP - Circ.Water Sys.	178,113	0	178,113
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.	340,663	0	340,663
033	014	033 - Rental and Maintenance of	014 - SGP - Circ.Water Sys.	5,000	0	5,000
066	014	066 - Other Goods & Services	014 - SGP - Circ.Water Sys.	51,878	0	51,878
011	087	011 - Travel Expense	087 Field Super.& Ops.	1,500	0	1,500
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	1,000	0	1,000
			Total Cost:	700,809	0	700,809
			Original Cost:	437,822		

Capital Project Detailed Estimate

Location: **Trenton Generating Station**
CI# / FP#: 41511
Title: TRE6 - Condenser Waterbox and Cooling Water Piping Refurbishment
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Mech (Millwrights)	PD	40	$ 365	$ 14,592		
Mech (Welders)	PD	20	$ 365	$ 7,296		
Utility	PD	40	$ 240	$ 9,607		
Internal Supervison	PD	20	$ 405	$ 8,106		
			Sub-Total	$ 39,601		
002 OT Labour						
Utility	PD	16	$ 480	$ 7,686		
			Sub-Total	$ 7,686		
004 Term Labour						
Mech (Millwrights)	PD	40	$ 365	$ 14,592		
Utility	PD	40	$ 240	$ 9,607		
			Sub-Total	$ 24,199		
011 Travel Expense						
Travel	lot	1	$ 1,500	$ 1,500		
			Sub-Total	$ 1,500		
012 Materials						
Waterbox reline - material	lot	1	[redacted]	[redacted]	Cost Support Item #1 - 50%	
USD Exchange	%	31%	[redacted]	[redacted]		
Bolting	lot	1	[redacted]	[redacted]		
	lot					
			Sub-Total	$ 178,113		
013 Contracts						
Outside supervision	lot	1	$ 20,000	$ 20,000		
Waterbox reline- labour	lot	1	[redacted]	[redacted]	Cost Support Item #1 - 50%	
USD Exchange	%	31%	[redacted]	[redacted]		
CW pipe supply	lot	1	[redacted]	[redacted]	Cost Support Item #2	
External supervision	lot	1	$ 20,000	$ 20,000		
CW concrete pipe repairs	lot	1	$ 20,000	$ 20,000		
			Sub-Total	$ 340,663		
033 Rental						
Trailer	lot	1	$ 5,000	$ 5,000		
			Sub-Total	$ 5,000		
041 Meals						
Meals	lot	1.00	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000		
066 Other Goods and Services						
Contingency	%	10%	$ 518,776	$ 51,878		
			Sub-Total	$ 51,878		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 8,499		
Thermal OT Labour AO				$ 825		
Thermal Term Labour AO				$ 5,194		
Thermal Contracts AO				$ 36,652		
			Sub-Total	$ 51,169		
			SUB-TOTAL (no AO, AFUDC)	$ 649,639		
			TOTAL (AO, AFUDC included)	$ 700,809		
Original Cost				$ 437,822		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

100 Research Road
Hingham MA 02043
781.749.5050
fax 781.749.5075
www.plastocor.com

September 20, 2016

Nova Scotia Power
Trenton Generating Station

Attention: Frederick Jordan
Sr. Mechanical Engineer
902-755-5811 x4210 (o)
902-396-9182 (cell)
902-755-3722 (fax)
Fredrick.jordan@nspower.ca

Subject: Trenton Unit 6
Waterbox Re-lining
Estimate Q160920-EL-1

Fred,

The scope of this project, in 2017, is to remove the existing neoprene lining and areas coated with Belzona epoxy and neoprene products, and then apply a new lining system. The Belzona systems you describe can be very time consuming to remove, therefore I have used very conservative numbers in estimating removal time.

I am specifying our P-400U/P-2000U/P-400U System to 75 mils minimum, with Duromar SAR on the hot side of the divider plates. This is our most durable system.

SCOPE

1. Remove existing linings with hand and power tools.
2. Perform a first abrasive blast, water wash and follow with Chlor*rid to remove chloride contamination.
3. Perform a second abrasive blast to SSPC-SP-5 White Metal Standard with a 3 mil minimum profile.
4. Prime Coat: Plastocor's 100% Solids P-400U at 5 mils minimum DFT.
5. Build Coat: Plastocor's 100% Solids P-2000U at 60 mils minimum DFT.
6. Top Coat: Plastocor's 100% Solids P-400U at 10 mils minimum DFT.
7. Caulked Joints: Duromar 100% Solids Duro Caulk
8. Hot Side Divider Plates: Duromar 100% Solids SAR at 60 mils minimum DFT.

SCHEDULE

Work can be performed on a two 12 hour shift basis, seven days a week, to the following schedule. Six person crews would be used.

		1st Shift	2nd Shift	Men	Hrs
mo	1	mob	mob	12	10
tu	2	chip, scrape, sand (at 6 sq/hr) is 60 hrs	chip, scrape, sand (at 6 sq/hr) is 60 hrs	12	12
we	3	chip, scrape, sand (at 6 sq/hr) is 60 hrs	chip, scrape, sand (at 6 sq/hr) is 60 hrs	12	12
th	4	chip, scrape, sand (at 6 sq/hr) is 60 hrs	1st blast (at 50/hr is 13.5 hrs)	12	12
fr	5	complete blast /clean/chlor*rid	2nd blast (12 hrs)	12	12
sa	6	clean/inspect/prime	prime & cure	12	12
su	7	build coat	prep and top coat	12	12
mo	8	cure	inspect/touch up/caulk	12	12
tu	9	cure	demob	12	12

COATING APPLICATION RESPONSIBILITIES

Plastocor, Inc., performs all projects on a turnkey, non-union basis, which includes labor, equipment, tools, consumables, and material for all phases of the project including:

Drying the condenser.

Environmental controls, including dehumidification and dust collection.

Surface preparation – abrasive blasting to SSPC-5 or NACE 1 with a 3 mil minimum profile with good angularity and density.

Grit removal from the condenser.

All coating materials, specialty tooling, blast/coating plugs.

Application of waterbox coating materials.

Insure proper curing of materials

Complete quality control.

Compressed air.

Plastocor assumes the following:

The existing coating on the exterior of the waterboxes does not contain lead or asbestos.

There are no union or prevailing wage requirements.

From others we require:

Background screening and badging of Plastocor personnel

Potable or de-mineralized water for waterblasting.

Disposal of waste water from waterblasting

Fork truck assistance

Staging (interior and exterior of waterboxes)

Containers for spent abrasive, tube trimmings, general trash, old coatings

Disposal of all waste

Free and clear access to the condenser

Use of sanitary facilities

Electrical service, 110 volt 100 amps, 480 volt, 3 phase, 200 amps. (Plastocor can provide a step down transformer)

COST ESTIMATE

The estimated cost for the work performed in 2017 is . . . . [redacted]
This estimate excludes Canadian taxes and fees.

WARRANTY

Plastocor, Inc. warrants to supply labor and material for a period of Five (5) years for the waterbox coating in order to bring the coating system up to contract conditions. Providing the condenser is operated under normal design parameters; that is, the system is not subject to workman damage, failure of Station equipment or other intrusions into the circulating water system.

In no event shall Plastocor, Inc. be responsible for consequential damages of any kind, downtime costs, increased expense of operation, or reconstruction of the work beyond the repair of the cladding system.

Please call me with any questions.

Sincerely,

Edward R. Lesko
Project Manager,
Plastocor

I.Matheson
ASME U Stamp Pressure Vessels
Your Guarantee of Quality

327 North Provost Street
New Glasgow, Nova Scotia
Canada, B2H 5E5
P: 902.752.2521
F: 902.752.0558

ATTN: Fred Jordan
RE: T6 Condenser CW Pipe

I. Matheson & Company Ltd. (IMC) is pleased to offer you the following quote for the supply of CW Piping Items as per drawing A050N6242251002 Rev. E

Price for Items 2, 3 and 4 Qty 2 of each = [redacted] + HST Total

- FOB – IMC Shop, New Glasgow, NS
- Includes SA-193-B7 Hardware c/w 2H Nuts
- Coated Internally with Plasite 7122VAR (7122HAR has been renamed by vendor as 7122 VAR, same product low VOC.) 8 – 12 mils total DFT.
- Coated Externally with Carboguard 890, 8 – 16 mils total DFT.

Price for Item 1 Qty 2 = [redacted] + HST Total

- FOB – IMC Shop, New Glasgow, NS
- Includes SA-193-B7 Hardware c/w 2H Nuts
- Coated Internally with Plasite 7122VAR (7122HAR has been renamed by vendor as 7122 VAR, same product low VOC.) 8 – 12 mils total DFT.
- Coated Externally with Carboguard 890, 8 – 16 mils total DFT.

Thank you for the opportunity to quote this project, and if you have any questions, or would like to discuss this in greater detail, please do not hesitate to contact me.

Regards,
David Smith
QCS
I. Matheson & Co. Ltd.
(902) 301-2952

CI Number: 49433

Title: LIN1 SH5 Boiler Tube Replacement

Start Date: 2017/04
In-Service Date: 2017/05
Final Cost Date: 2017/11
Function: Steam
Forecast Amount: $493,396

DESCRIPTION:

The scope of this project includes the replacement of 38 tube cut-outs and 20 tube bends in the Lingan 1 boiler superheater #5 (SH5). During 2015, the Lingan #1 Superheater #5 was inspected as part of the routine boiler inspection. Ultrasonic testing showed thinning of tube wall thickness; tubes were found to be thinning and will require replacement during the next planned outage, which is occurring in 2017.

Summary of Related CIs +/- 2 years:
2017 CI 47761 LIN1 Boiler Refurbishment 2017 $398,673

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

Erosion wear from ash impingement on boiler tubes will lead to leaks, which require the boiler to come offline for repairs. Superheat tubes exhibiting erosion wear with tube wall thickness below the minimum for the boiler pressure and temperature, as per Association of Mechanical Engineeers (ASME) code specifications, should be replaced to mitigate unplanned outages due to tube leaks.

This project is being undertaken primarily to preserve the unit's availability, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

Ultrasonic testing in 2015 showed thinning wall thickness of the SH5 tubes. The project must be completed during the next scheduled extended outage to avoid tube leaks during operation and provide reliable unit operation during high demand periods.

Why do this project this way?

This work is in accordance with maintenance best practices. Replacing the tubes through tube cut-outs is the only feasible way to allow the unit to operate without tube failures in this area.

CI Number : 49433 - LIN1 SH5 Boiler Tube Replacement **Project Numbe**

Parent CI Number : -

Cost Centre : 301 - 301-Lingan Admin./Common Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
095		095-Thermal & Hydro Contracts AO		40,884	0	40,884
095		095-Thermal Term Labour AO		5,366	0	5,366
095		095-Thermal Regular Labour AO		2,146	0	2,146
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	10,000	0	10,000
004	013	004 - THERMAL Term Labour	013 - SGP - Boiler	25,000	0	25,000
012	013	012 - Materials	013 - SGP - Boiler	30,000	0	30,000
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	380,000	0	380,000
			Total Cost:	493,396	0	493,396
			Original Cost:	112,808		

Capital Project Detailed Estimate

Location: Steam
CI# : 49433
Title: LIN1 SH5 Boiler Tube Replacement
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Maintenance Trades	PD	5	$ 358	$ 1,759		
Utility worker	PD	35	$ 235	$ 8,241		
			Sub-Total	$ 10,000		
004 Term Labour						
Utility worker	PD	106	$ 235	$ 25,000		
				$ -		
				$ -		
			Sub-Total	$ 25,000		
012 Materials						
Boiler Tube	ea	1	$ 15,000	$ 15,000		
Boiler Shields	ea	1	$ 10,000	$ 10,000		
Misc. Consumables	ea	1	$ 5,000	$ 5,000		
			Sub-Total	$ 30,000		
013 Contracts						
Boiler Inspection & Refurbishment	ea	1	$ 380,000	$ 380,000		
				$ -		
			Sub-Total	$ 380,000		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 2,146		
Thermal Term Labour AO				$ 5,366		
Thermal / Hydro Contracts AO				$ 40,884		
			Sub-Total	$ 48,396		
			SUB-TOTAL (no AO, AFUDC)	$ 445,000		
			TOTAL (AO, AFUDC included)	$ 493,396		
Original Cost				$ 112,808		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

LIN1 SH5 Boiler Tube Replacement
Summary of Alternatives

Nova Scotia POWER An Emera Company

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Lingan Generating Station	**CI Number:**	49433
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Boiler Tube Replacements vs Avoided	5.90%	-1,371,137	1,005,017	1	42.21%	3.7 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

The plant recommends completing this project to maintain reliability in the SH5 section of the boiler.

Notes/Comments :

Boiler Tube Replacements vs Avoided Fuel & Repair Costs

It is estimated to repair a tube leak in SH5 it will take approximately 80 hours. As time passes the frequency and probability of leaks in this section of the boiler will increase.

Test 2

Test 3

Test 4

LIN1 SH5 Boiler Tube Replacement
Summary of Sensitivities

Nova Scotia POWE An Emera Compa

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Lingan Generating Station	**CI Number:**	49433
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Boiler Tube Replacements vs Avoided Fuel & Rep	5.90%	-1,371,137	1,005,017	1	42.21%	3.7 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Boiler Tube Replacements vs Avoided Fuel & Rep	10%	-1,325,300	970,685	1	38.13%	4.0 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years

Change:		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
	A	45,837	-34,332	0	-4.08%	0.3 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Boiler Tube Replacements vs Avoided Fuel & Rep	-10%	-1,188,186	870,183	1	37.72%	4.0 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years

Change:		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
	A	182,951	-134,834	0	-4.49%	0.4 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	74,412	211,052	361,947	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

LIN1 SH5 Boiler Tube Replacement
Avoided Cost Calculations

Nova Scotia POWER
An Emera Company

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Lingan Generating Station	**CI Number:**	49433
		Project No. :	

Boiler Tube Replacements vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			61,040	63,486		
Events/Outages (#)	1	2	1	2		
Probability of Occurance (%)	100%	100%	100%	100%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	154.0	154.0				
Duration (Hours or Years)	96	96				
Totals	$41,553	$54,137	$61,040	$126,972	$102,593	$181,109
Total Capital Cost of Alternative						$493,396

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

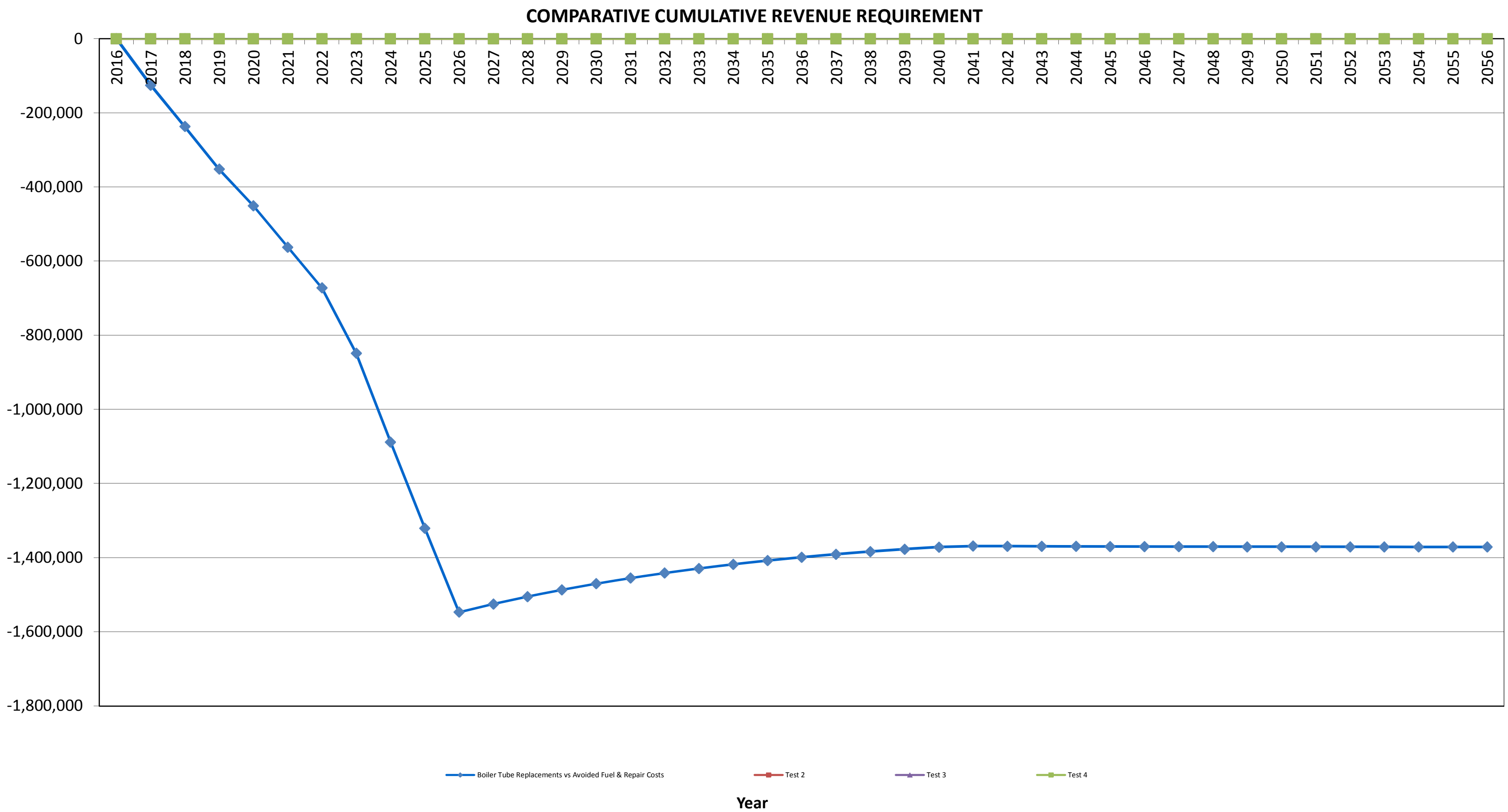
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

LIN1 SH5 Boiler Tube Replacement
Boiler Tube Replacements vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	102,592.7	(445,000.0)	17,800.0	440,557.3	(342,407.3)	(26,285.7)	(368,693.1)	(348,152.1)	0.94	(348,152.1)
2018	-	-	181,109.1	-	34,176.0	404,151.2	181,109.1	(45,549.2)	135,559.8	120,875.7	0.89	(227,276.4)
2019	-	-	194,200.5	-	31,441.9	370,657.6	194,200.5	(50,455.2)	143,745.3	121,033.6	0.84	(106,242.8)
2020	-	-	182,421.6	-	28,926.6	339,843.5	182,421.6	(47,583.5)	134,838.2	107,208.4	0.80	965.6
2021	-	-	208,601.3	-	26,612.4	311,494.5	208,601.3	(56,416.5)	152,184.8	114,259.2	0.75	115,224.9
2022	-	-	215,640.8	-	24,483.4	285,413.4	215,640.8	(59,258.8)	156,382.0	110,869.2	0.71	226,094.1
2023	-	-	334,404.0	-	22,524.8	261,418.9	334,404.0	(96,682.6)	237,721.4	159,146.3	0.67	385,240.4
2024	-	-	460,993.2	-	20,722.8	239,343.9	460,993.2	(136,483.8)	324,509.4	205,144.4	0.63	590,384.8
2025	-	-	476,665.5	-	19,065.0	219,034.8	476,665.5	(141,856.2)	334,809.3	199,863.7	0.60	790,248.5
2026	-	-	492,909.8	-	17,539.8	200,350.6	492,909.8	(147,364.7)	345,545.1	194,780.3	0.56	985,028.8
2027	-	-	-	-	16,136.6	183,161.0	-	5,002.3	5,002.3	2,662.7	0.53	987,691.5
2028	-	-	-	-	14,845.7	167,346.6	-	4,602.2	4,602.2	2,313.2	0.50	990,004.7
2029	-	-	-	-	13,658.0	152,797.4	-	4,234.0	4,234.0	2,009.6	0.47	992,014.2
2030	-	-	-	-	12,565.4	139,412.1	-	3,895.3	3,895.3	1,745.8	0.45	993,760.0
2031	-	-	-	-	11,560.1	127,097.6	-	3,583.6	3,583.6	1,516.6	0.42	995,276.7
2032	-	-	-	-	10,635.3	115,768.3	-	3,297.0	3,297.0	1,317.6	0.40	996,594.3
2033	-	-	-	-	9,784.5	105,345.4	-	3,033.2	3,033.2	1,144.6	0.38	997,738.9
2034	-	-	-	-	9,001.7	95,756.2	-	2,790.5	2,790.5	994.4	0.36	998,733.3
2035	-	-	-	-	8,281.6	86,934.2	-	2,567.3	2,567.3	863.9	0.34	999,597.2
2036	-	-	-	-	7,619.1	78,818.0	-	2,361.9	2,361.9	750.5	0.32	1,000,347.7
2037	-	-	-	-	7,009.5	71,351.0	-	2,173.0	2,173.0	652.0	0.30	1,000,999.7
2038	-	-	-	-	6,448.8	64,481.5	-	1,999.1	1,999.1	566.4	0.28	1,001,566.1
2039	-	-	-	-	5,932.9	58,161.4	-	1,839.2	1,839.2	492.1	0.27	1,002,058.1
2040	-	-	-	-	5,458.3	52,347.0	-	1,692.1	1,692.1	427.5	0.25	1,002,485.6
2041	-	-	-	-	5,021.6	46,997.8	-	1,556.7	1,556.7	371.4	0.24	1,002,857.0
2042	-	-	-	-	4,619.9	42,076.4	-	1,432.2	1,432.2	322.6	0.23	1,003,179.6
2043	-	-	-	-	4,250.3	37,548.8	-	1,317.6	1,317.6	280.3	0.21	1,003,459.9
2044	-	-	-	-	3,910.3	33,383.4	-	1,212.2	1,212.2	243.5	0.20	1,003,703.4
2045	-	-	-	-	3,597.4	29,551.2	-	1,115.2	1,115.2	211.5	0.19	1,003,914.9
2046	-	-	-	-	3,309.6	26,025.6	-	1,026.0	1,026.0	183.8	0.18	1,004,098.7
2047	-	-	-	-	3,044.9	22,782.1	-	943.9	943.9	159.6	0.17	1,004,258.3
2048	-	-	-	-	2,801.3	19,798.0	-	868.4	868.4	138.7	0.16	1,004,397.0
2049	-	-	-	-	2,577.2	17,052.7	-	798.9	798.9	120.5	0.15	1,004,517.5
2050	-	-	-	-	2,371.0	14,527.0	-	735.0	735.0	104.7	0.14	1,004,622.2
2051	-	-	-	-	2,181.3	12,203.3	-	676.2	676.2	90.9	0.13	1,004,713.1
2052	-	-	-	-	2,006.8	10,065.5	-	622.1	622.1	79.0	0.13	1,004,792.1
2053	-	-	-	-	1,846.3	8,098.8	-	572.3	572.3	68.6	0.12	1,004,860.7
2054	-	-	-	-	1,698.6	6,289.4	-	526.6	526.6	59.6	0.11	1,004,920.3
2055	-	-	-	-	1,562.7	4,624.7	-	484.4	484.4	51.8	0.11	1,004,972.1
2056	-	-	-	-	1,437.7	3,093.3	-	445.7	445.7	45.0	0.10	1,005,017.1
Total	**-**	**-**	**2,849,538.4**	**(445,000.0)**	**428,466.8**		**2,404,538.4**	**(750,532.2)**	**1,654,006.2**	**1,005,017.1**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
-200,000
-400,000
-600,000
-800,000
-1,000,000
-1,200,000
-1,400,000
-1,600,000
-1,800,000
2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056
Boiler Tube Replacements vs Avoided Fuel & Repair Costs
Test 2
Test 3
Test 4
Year

Generator

CI Number: 49057

Title: TRE6 Excitation System Replacement

Start Date:	2016/07
In-Service Date:	2017/10
Final Cost Date:	2018/04
Function:	Steam
Forecast Amount:	$904,011

DESCRIPTION:

The excitation system for a synchronous generator provides the DC field current to the generator rotor. The DC field current is derived from rectifying an AC supply. The excitation system includes the thyristor rectifier bridges, Automatic Voltage Regulator (AVR), field circuit breaker, monitoring and control. The AVR automatically controls the generator voltage via field current regulation and is integral to the excitation system.

The purpose of this project is to upgrade the Trenton Unit 6 excitation system as the existing excitation system for Trenton Unit 6 generator is now obsolete. The Original Equipment Manufacturer (OEM) no longer exists, and the manufacturer which acquired the OEM no longer supports this equipment. It is no longer possible to source spare parts, or receive technical service for this equipment. A dependable excitation system is required for reliable operation of Trenton Unit 6.

Summary of Related CIs +/- 2 years:
No other projects 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement/Refurbishment

Why do this project?

The excitation system for Trenton Unit 6 generator is now obsolete. The Original Equipment Manufacturer (OEM) no longer supports this equipment and it is no longer possible to source spare parts or receive technical service. A dependable excitation system is required for operation of Trenton Unit 6.

This project is being undertaken primarily to preserve the unit's availability, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

The spare parts originally supplied with the system have been depleted over the years and replacement parts are no longer available. Replacing the excitation system now will mitigate the risk of a lengthy unplanned outage and associated replacement energy costs. A major outage is planned for 2017; this would be the opportune time to complete this project without incurring replacement energy costs from an unplanned eight week outage.

Why do this project this way?

Replacement of the obsolete excitation system and AVR is the only option, since the OEM no longer supports this equipment and it is no longer possible to source spare parts. This replacement utilizes the same technology and OEM employed at other NS Power stations in recent years thereby improving maintainability and technical serviceability.

CI Number : 49057-SG33 - TRE6 Excitation System Replacement **Project Number** SG33

Parent CI Number : -

Cost Centre : 345 - 345-Trenton unit 6 Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		33,666	0	33,666
095		095-Thermal Term Labour AO		11,534	0	11,534
095		095-Thermal Overtime Labour AO		1,044	0	1,044
095		095-Thermal & Hydro Contracts AO		11,512	0	11,512
095		095-Thermal Regular Labour AO		13,863	0	13,863
001	010	001 - THERMAL Regular Labour	010 - SGP - Turbo Gen.Instal.	64,594	0	64,594
002	010	002 - THERMAL Overtime Labour	010 - SGP - Turbo Gen.Instal.	9,727	0	9,727
004	010	004 - THERMAL Term Labour	010 - SGP - Turbo Gen.Instal.	53,742	0	53,742
012	010	012 - Materials	010 - SGP - Turbo Gen.Instal.	457,633	0	457,633
013	010	013 - POWER PRODUCTION Contracts	010 - SGP - Turbo Gen.Instal.	107,000	0	107,000
066	010	066 - Other Goods & Services	010 - SGP - Turbo Gen.Instal.	84,695	0	84,695
028	085	028 - Consulting	085 Design	40,000	0	40,000
011	087	011 - Travel Expense	087 Field Super.& Ops.	15,000	0	15,000
			Total Cost:	904,011	0	904,011
			Original Cost:			

Capital Project Detailed Estimate

Location: **Trenton Generating Station**
CI# : 49057
Title: TRE6 Excitation System Replacement
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Electrician	PD	80	$ 358	$ 28,663		
Engineering	PD	60	$ 405	$ 24,318		
Supervision	PD	6	$ 405	$ 2,432		
Maintenance Trades	PD	12	$ 365	$ 4,377		
Utility worker	PD	20	$ 240	$ 4,804		
			Sub-Total	$ 64,594		
002 OT Labour						
Engineering	PD	12	$ 811	$ 9,727		
			Sub-Total	$ 9,727		
004 Term Labour						
Electrician	PD	150	$ 358	$ 53,742		
			Sub-Total	$ 53,742		
011 Travel Expense						
Factory Acceptance Test	lot	3	$ 5,000	$ 15,000		
			Sub-Total	$ 15,000		
012 Materials						
Excitation System (USD)	lot	1	[redacted]	[redacted]	Cost Support Item #1	
Currency Exchange	%	0.31	[redacted]	[redacted]		
AVR Commissioning Spares	lot	1	[redacted]	[redacted]		CI43170
Assembly for remoted IDP 1200	lot	1	$ 6,500	$ 6,500		CI43170
Tools and Rigging Misc.	lot	1	$ 10,000	$ 10,000		CI43170
Cable Tray - new wire runs	lot	1	$ 10,000	$ 10,000		CI43170
DC cables	lot	1	$ 10,000	$ 10,000		CI43170
Control, AC Cable and Misc.	lot	1	$ 10,000	$ 10,000		CI43170
			Sub-Total	$ 457,633		
013 Contracts						
Freight/Shipping	lot	1	$ 15,000	$ 15,000		
Concrete Floor Cutting	lot	1	$ 10,000	$ 10,000		
AVR TA Supervision / commission	lot	2	$ 26,000	$ 52,000		
Generator OEM TA Debug	lot	1	$ 20,000	$ 20,000		
Training	lot	1	$ 10,000	$ 10,000		
			Sub-Total	$ 107,000		CI43170
028 Consulting						
Design	lot	1	$ 40,000	$ 40,000		
			Sub-Total	$ 40,000		
066 Other Goods & Services						
Contingency	%	15%	$ 564,633	$ 84,695		
			Sub-Total	$ 84,695		
094 Interest Capitalized						
AFUDC				$ 33,666		
			Sub-Total	$ 33,666		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 13,863		
Thermal OT Labour AO				$ 1,044		
Thermal Term Labour AO				$ 11,534		
Thermal / Hydro Contracts AO				$ 11,512		
			Sub-Total	$ 37,953		
			SUB-TOTAL (no AO, AFUDC)	$ 832,391		
			TOTAL (AO, AFUDC included)	$ 904,011		
Original Cost				$ 472,927.13		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

TRE6 Excitation System Replacement
Summary of Alternatives

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Trenton Generating Station	**CI Number:**	49057
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Replace Excitation System vs Avoided	5.90%	-7,418,317	5,667,791	1	40.90%	3.5 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

It is recommended to replace the excitation system to preserve the unit's availability.
The economics are positive even when conservatively not including the potential for generator damage from the failure of the excitation system.

Notes/Comments :

Replace Excitation System vs Avoided Fuel & Repair Costs

The Excitation System is required to allow the generator to operate. If the excitation system fails, parts have a long lead time delivery if they are available, and the unit would not be able to run until replacement parts are installed. No consideration has been made for damage that is possible to the generator in the case of a failure of the excitation system.

Test 2

Test 3

Test 4

TRE6 Excitation System Replacement
Summary of Sensitivities

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Trenton Generating Station	**CI Number:**	49057
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Excitation System vs Avoided Fuel & Rep	5.90%	-7,418,317	5,667,791	1	40.90%	3.5 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Excitation System vs Avoided Fuel & Rep	10%	-7,332,738	5,597,997	1	38.28%	3.6 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years

		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
Change:	A	85,579	-69,794	0	-2.62%	0.1 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Excitation System vs Avoided Fuel & Rep	-10%	-6,590,906	5,031,218	1	38.02%	3.8 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years

		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
Change:	A	827,411	-636,573	0	-2.88%	0.3 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	193,521	326,408	577,006	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

TRE6 Excitation System Replacement
Avoided Cost Calculations

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Trenton Generating Station	**CI Number:**	49057
		Project No. :	

Replace Excitation System vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			110,000	114,404		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	20%	25%	20%	25%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	160.0	160.0				
Duration (Hours or Years)	1344	1344				
Totals	$227,962	$186,146	$22,000	$28,601	$249,962	$214,747
Total Capital Cost of Alternative						$904,011

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

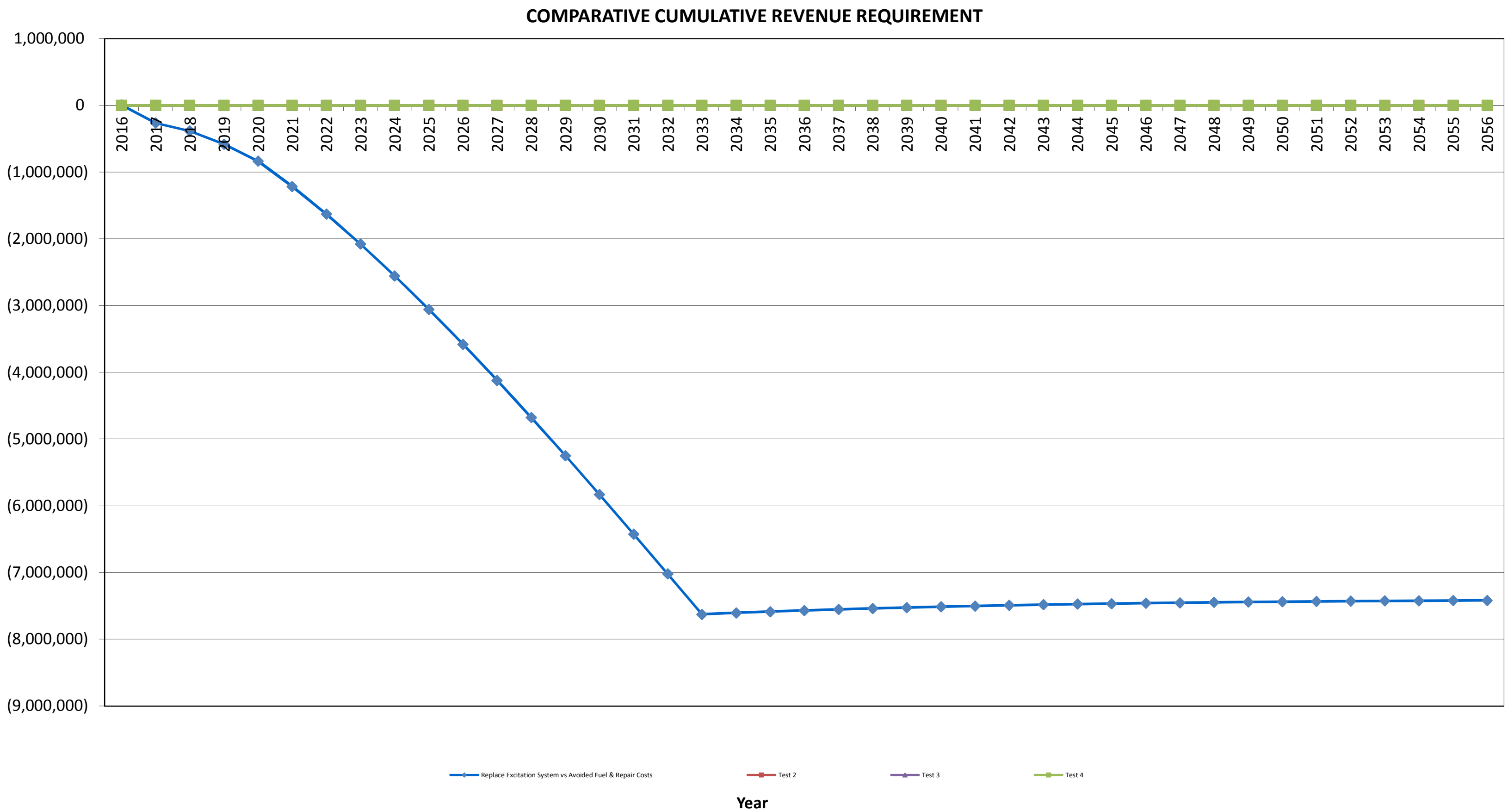
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

TRE6 Excitation System Replacement
Replace Excitation System vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	(429,944.9)	-	-	(429,944.9)	-	(429,944.9)	(429,944.9)	1.00	(429,944.9)
2017	-	-	249,962.0	(436,112.9)	33,295.7	809,570.7	(186,150.9)	(67,166.6)	(253,317.4)	(239,204.4)	0.94	(669,149.3)
2018	-	-	214,746.8	-	63,927.6	743,894.2	214,746.8	(46,753.9)	167,992.9	149,795.6	0.89	(519,353.7)
2019	-	-	321,186.7	-	58,813.4	683,471.8	321,186.7	(81,335.7)	239,851.0	201,954.6	0.84	(317,399.2)
2020	-	-	410,922.7	-	54,108.4	627,883.1	410,922.7	(110,612.4)	300,310.3	238,773.6	0.80	(78,625.5)
2021	-	-	611,511.5	-	49,779.7	576,741.6	611,511.5	(174,136.9)	437,374.7	328,377.8	0.75	249,752.3
2022	-	-	702,869.9	-	45,797.3	529,691.4	702,869.9	(203,692.5)	499,177.4	353,898.9	0.71	603,651.1
2023	-	-	797,926.9	-	42,133.5	486,405.2	797,926.9	(234,295.9)	563,630.9	377,331.5	0.67	980,982.7
2024	-	-	896,808.1	-	38,762.8	446,581.9	896,808.1	(265,994.0)	630,814.1	398,780.3	0.63	1,379,762.9
2025	-	-	999,643.5	-	35,661.8	409,944.5	999,643.5	(298,834.3)	700,809.1	418,346.5	0.60	1,798,109.4
2026	-	-	1,106,567.2	-	32,808.9	376,238.1	1,106,567.2	(332,865.1)	773,702.1	436,128.2	0.56	2,234,237.6
2027	-	-	1,217,718.1	-	30,184.2	345,228.1	1,217,718.1	(368,135.5)	849,582.6	452,220.3	0.53	2,686,457.9
2028	-	-	1,333,239.6	-	27,769.4	316,699.0	1,333,239.6	(404,695.8)	928,543.9	466,714.1	0.50	3,153,172.0
2029	-	-	1,453,280.1	-	25,547.9	290,452.2	1,453,280.1	(442,597.0)	1,010,683.1	479,697.6	0.47	3,632,869.6
2030	-	-	1,577,993.0	-	23,504.0	266,305.2	1,577,993.0	(481,891.6)	1,096,101.4	491,255.4	0.45	4,124,125.0
2031	-	-	1,707,536.8	-	21,623.7	244,089.9	1,707,536.8	(522,633.1)	1,184,903.8	501,468.5	0.42	4,625,593.5
2032	-	-	1,842,075.6	-	19,893.8	223,651.8	1,842,075.6	(564,876.3)	1,277,199.2	510,414.8	0.40	5,136,008.3
2033	-	-	1,981,778.9	-	18,302.3	204,848.8	1,981,778.9	(608,677.7)	1,373,101.1	518,168.7	0.38	5,654,177.0
2034	-	-	-	-	16,838.1	187,550.0	-	5,219.8	5,219.8	1,860.1	0.36	5,656,037.1
2035	-	-	-	-	15,491.1	171,635.1	-	4,802.2	4,802.2	1,615.9	0.34	5,657,653.0
2036	-	-	-	-	14,251.8	156,993.4	-	4,418.1	4,418.1	1,403.8	0.32	5,659,056.9
2037	-	-	-	-	13,111.7	143,523.1	-	4,064.6	4,064.6	1,219.6	0.30	5,660,276.4
2038	-	-	-	-	12,062.7	131,130.4	-	3,739.4	3,739.4	1,059.5	0.28	5,661,335.9
2039	-	-	-	-	11,097.7	119,729.0	-	3,440.3	3,440.3	920.4	0.27	5,662,256.3
2040	-	-	-	-	10,209.9	109,239.8	-	3,165.1	3,165.1	799.6	0.25	5,663,055.9
2041	-	-	-	-	9,393.1	99,589.8	-	2,911.9	2,911.9	694.7	0.24	5,663,750.6
2042	-	-	-	-	8,641.6	90,711.7	-	2,678.9	2,678.9	603.5	0.23	5,664,354.1
2043	-	-	-	-	7,950.3	82,543.9	-	2,464.6	2,464.6	524.3	0.21	5,664,878.3
2044	-	-	-	-	7,314.3	75,029.5	-	2,267.4	2,267.4	455.5	0.20	5,665,333.8
2045	-	-	-	-	6,729.1	68,116.3	-	2,086.0	2,086.0	395.7	0.19	5,665,729.5
2046	-	-	-	-	6,190.8	61,756.1	-	1,919.2	1,919.2	343.7	0.18	5,666,073.2
2047	-	-	-	-	5,695.6	55,904.7	-	1,765.6	1,765.6	298.6	0.17	5,666,371.8
2048	-	-	-	-	5,239.9	50,521.5	-	1,624.4	1,624.4	259.4	0.16	5,666,631.3
2049	-	-	-	-	4,820.7	45,568.9	-	1,494.4	1,494.4	225.4	0.15	5,666,856.6
2050	-	-	-	-	4,435.1	41,012.5	-	1,374.9	1,374.9	195.8	0.14	5,667,052.4
2051	-	-	-	-	4,080.3	36,820.6	-	1,264.9	1,264.9	170.1	0.13	5,667,222.5
2052	-	-	-	-	3,753.8	32,964.1	-	1,163.7	1,163.7	147.8	0.13	5,667,370.3
2053	-	-	-	-	3,453.5	29,416.1	-	1,070.6	1,070.6	128.4	0.12	5,667,498.7
2054	-	-	-	-	3,177.2	26,151.9	-	984.9	984.9	111.5	0.11	5,667,610.2
2055	-	-	-	-	2,923.1	23,148.9	-	906.1	906.1	96.9	0.11	5,667,707.1
2056	-	-	-	-	2,689.2	20,386.1	-	833.7	833.7	84.2	0.10	5,667,791.3
Total	**-**	**-**	**17,425,767.4**	**(866,057.8)**	**801,465.2**		**16,559,709.6**	**(5,153,533.7)**	**11,406,176.0**	**5,667,791.3**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
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Replace Excitation System vs Avoided Fuel & Repair Costs
Test 2
Test 3
Test 4
Year

Basler Electric®

A
PROPOSAL
FOR

Nova Scotia Power Incorporated

Trenton Generating Station
Unit 6

DECS-2100 Static Excitation System
Sales Quotation (SQ) Number: 835686
Revision №: 1
March 9, 2016

Basler Electric®

12570 State Route 143 • Highland IL 62249-1074 U.S.A. • Phone 618/654-2341 • Fax: 618/654-2351 • www.basler.com

March 9, 2016

Dartmouth, Nova Scotia

Dear Mr. Cameron:

We are Basler Electric Company, Power Systems Group, provider of power system control equipment and protection equipment for the electrical power industry. BASLER static exciter systems are custom designed to support a wide range of applications regardless of the prime mover. Our excitation systems will enhance system performance in new and retrofit applications.

We are pleased to present our revised proposal for a DECS-2100 Digital Static Excitation system for the project to replace the static exciter for Unit 6 at the Trenton Generating Station. This proposal is based on your request as forwarded via Roger Labbe and Andrew Branch. The DECS-2100 is an advance into the next generation, building on the ECS2100, a fully tested and customer accepted modern all-digital excitation control system intended for application on the full range of utility power generation applications, well-proven for reliable operation and high performance in the electric utility industry.

The digital static excitation system in our proposal is furnished with a dual-control channel. The term “dual-control channel” is defined as two (2) independent logic schemes with each scheme having both an automatic regulator (terminal voltage regulation) and a manual regulator (field current regulation). Both the main and redundant channels are configured with identical sets of printed circuit modules. Each channel continuously monitors the system and each has the capability of performing the voltage regulation, limiter, protection, sequence control, and firing functions. All limiter and protection functions are available in both automatic and manual modes of operation.

The proposed excitation control logic scheme includes, integrated within the digital excitation controller, the compensators, limiters and protection features that you should expect as available in an advanced excitation control system, for your use to match your application. The completeness of the features is further made useful with BASLER’s configuration software, BESTCOMS™*Pro*.

The digital static excitation system in our proposal is furnished with redundant (*N*+1) draw-out power converter bridges (*i.e.*, power drawers). The system is forced-air cooled with redundant forced-draft fans. Power circuits also include voltage suppression; de-excitation controls with discharge resistor; and field-flashing for build-up support. Power to the rectifiers will be supplied from the owner's re-used existing power potential transformer.

A draw-out power circuit breaker is included as the main disconnect device (41A). It is fully rated and also meets the most stringent operational safety "rack-out/tag-out" requirements.

The excitation control cabinet will have arrangement/layout dimensionally identical to system 9465900101, built for Lingan Unit 4, including external connections to buswork and control cables.

Please do not hesitate to contact Roger Labbe, your Basler Electric representative, or Gene Asbury, BASLER senior application specialist, should you have any questions. We look forward to your purchase order and to working with you on this project. Thank you for considering Basler Electric Company as your supplier for excitation control equipment.

Sincerely,

Roger Labbe
Henery & Sons, Inc.
87 Aurora
Pointe-Claire, Quebec
Canada H9R 3G5
Office: 450-378-5038
FAX: 450-378-8228
E-Mail: rlabbe@henery.ca

Gene P. Asbury
Senior Applications Specialist
Canada & Eastern U.S.A.
Power Systems Group
Basler Electric Company
Office: +1 618 654 2341 Ext. 747
Mobile: +1 618 980-3988
E-Mail: geneasbury@BASLER.com

Lance Bazzell
Market Segment Sales Manager
- Power Generation
Power Systems Group
Basler Electric Company
Office: +1 618 654 2341 Ext. 740
Mobile: +1 618 304 8254
E-Mail: LanceBazzell@BASLER.com

Tom Harnetiaux
Director of Global Sales
Basler Electric Company
Office: 618-654-2341 Ext. 618
Mobile: 618-267-8412
E-Mail: tomharnetiaux@BASLER.com

Revision 1, March 2016

Revision 1 is a price update to an expired quote, without any other changes in scope.

12570 STATE ROUTE 143
HIGHLAND IL 62249-1074 USA
http://www.basler.com, info@basler.com
PHONE 618/654-2341 Operator-assisted Fax 618/654-2341, ext 248 **FAX 618/654-2351**

Power System Control and Protection for the Electric Power Industry

QUOTATION

TO:	**Nova Scotia Power Inc.** **315 Windmill Road** **Dartmouth, Nova Scotia** **Canada B3A 1H3**	**QUOTATION (SQ) No.:** **Revision №:** **DATE of QUOTE:**	**835686** **1** **March 9, 2016**

ATTN: Willard Cameron

REF: request via Roger Labbe and Gene Asbury

Item	Qty	Description	Price Each

DECS-2100 Static Exciter for Trenton G.S. Unit 6

1 **1** **DECS-2100** [redacted]

Supply of a Fully Static Exciter – to be installed by *others.* The fully static exciter, consisting of digital excitation control and rectifier bridge assemblies cooled with redundant fans, complete with accessories listed below, mounted and wired and tested in a NEMA 1 Control/Rectifying cabinet – for use with a brush-type synchronous generator with main field requirements of [redacted] **Amperes at** [redacted] at rated load and power factor. **The static exciter includes a multi-bridge design that provides a minimum of N+1 bridge redundancy,** with

Continuous capacity of [redacted] **Amperes** [redacted], with a 30-second forcing rating of [redacted] **Amperes** [redacted] – for operation in 40°C ambient, at up to 1000 meters above sea level

High Initial Response, with ceiling voltage at [redacted] Volts [redacted], **based on source voltage at rated level and connection to PPT - as follows:**

Excitation Power Potential Transformer (PPT) – re-used existing:

Three-Phase, 60 Hz, [redacted] kVA; 8% Impedance
Primary**: 13800** Volts
Secondary**:** [redacted] Volts (line currents ≈ [redacted] Amperes RMS)

The quoted system includes:

NEMA Type 1 - indoor - Excitation Control/Rectifying Enclosure

Exterior ANSI Gray #61 (light gray)
Cabinet Line-Up,
144″W × 90″/102″H × 60½″D
weighing approximately [redacted] (*avoirdupois*)
Front and Rear Access Required
Cabinet layout – of equipment - will be the same as for the DECS-2100 cabinet *9465900101*, for Lingan Unit 4, especially the heights – from the base of the cabinet – of the busbar connections.

Item	Qty	Description	Price Each

DECS-2100 Excitation Control Features – continued

Dual-Control Channel

With automatic voltage regulator, manual control, excitation limiters and integrated protection systems

Regulation

Automatic Voltage Regulation Mode
Paralleling Compensation
Reactive Current / Line Drop Compensation
Adjuster Follower Circuits for Bumpless Transfer (auto-manual)
Transient Gain Reduction transfer function (*TGR*)
Manual Control, field *current* regulator (*FCR*)
available as field *voltage* regulator (*FVR*) for testing
Auto-Manual Control Transfer – operator action

Sensing

Inputs for two sets of PTs, Regulating and Metering sets
Inputs for three CTs from the machine under control

Power System Stabilizer (PSS),

Type: Two input; utilizing compensated frequency and power
[redacted]

Limiting Functions including:

Under Excitation Limiter (*UEL*)
Over (Maximum) Excitation Limiter (*OEL*)
Instantaneous Field Current Limiter (*INST_CUR*)
separate on-line and off-line pickups
Volts/Hertz Limiter (*HXL*)
Generator Overvoltage Limiter (OVL)

Protective Functions including:

Loss of Field (*40Q*), Alarm/Transfer/Trip with delay
Over Excitation Protection (*OEP*)
Instantaneous Field Over-Current Protection (*INST_CUR*)
separate on-line and off-line pick-ups
Volts/Hertz Protection (*24*)
Loss of PT sensing (*LOS_SENS*)
Loss of Voltage Sensing automatic transfer to metering PTs
Automatic Transfer to Manual – [redacted]
Field Ground Detector (*64F*), integrated in excitation control

Monitoring Functions:

[redacted]

Self-diagnostic documentation functions:

[redacted]

Item	Qty	Description	Price Each

Item 1: DECS-2100 Static Excitation System – continued

Interactive Display Panel (IDP-1201)

high-resolution TFT color LCD touchscreen Human Machine Interface (HMI) capable of displaying generator system parameters.
Generator operation overview screen acts as operator's interface to monitor status and to view metering of excitation inputs to the generator and metering of the outputs of the generator.
[redacted] control screen offers the user access to control operation, to adjust setpoints, etc.
Ethernet, USB and SD interface ports
Please see product bulletin *SVU.*

[redacted] **Analog I/O Modules per channel**

[redacted]

[redacted] **Digital I/O Modules per channel**

[redacted]

Redundant Power Inputs,

Each logic/control module accepts two sources of power, for enhanced fault tolerance.

Redundant Power Supplies,

a paralleled set of dual-sourced power supplies,
to feed the power inputs of the logic/control modules
plus a second set of single-sourced, power supplies
to feed the other power inputs of the logic/control modules

Power Supplies Dual Sources,

Inputs contribute power to the "auctioneering circuit" that provides an interface to accept both AC and DC sources,
both the PPT's secondary
[or, in the special testing mode, accept AC station service]
and the 125-V station battery.

Monitoring and Metering

Status Indicating Lights for exciter breaker (41),
OPEN & CLOSED
Switchboard-Type Analogue Meters, mounted on the front door
Field Volt Meter
Field Current Meter

Lockout (86ET & 86E) Relays, electrically tripping, manually resetting

Additional Auxiliary Relays

supply, mounting, wiring and testing eight (8) auxiliary control relays

Item	Qty	Description	Price Each

Item 1: DECS-2100 Static Excitation System – continued

Excitation PPT Protection

[redacted]

Inputs for discrete contact alarms from the Owner's PPT

Contact for transformer overtemperature
Contact for transformer low oil
Contact for High pressure alarm

Test Switches for the CT and PT Circuits

[redacted]

CTs for differential (87) protection

[redacted]

Terminal Blocks and Test Plugs

With existing points and additional terminal points added, all wired out for customer use:

Add double-screw type terminal blocks
Add [redacted] type test, pluggable, terminal blocks
Add [redacted] type test plug for pluggable terminal blocks
Add sliding link compression terminal blocks

[redacted] (N+1) Power Converters, [redacted]

cooled by forced air – redundant fans
patented active Temperature balancing among parallel bridges

Incoming AC Line surge suppression

Incoming AC Line Voltage Filters

De-Excitation module – for field discharge for shutdown

Rapid de-excitation is accomplished by a combination of electronically inverting the field voltage and triggering the DX module that shorts the field through a discharge resistor. The energy stored in the field is dissipated quickly in the discharge resistor that reduces the field excitation to zero. The ac field breaker is then opened to complete the shutdown.

Item	Qty	Description	Price Each

Item 1: DECS-2100 Static Excitation System – continued

Crowbar module – for protection during pole slip

Field Discharge Resistor (FDR)

Shaft Voltage Suppression Network

Field Build-Up Circuit, flashing from 125 Volt DC source
Field Build-Up Circuit, flashing from 600-Volt AC source

AC Field Breaker – "41A" Device

Drawout Air Circuit Breaker – EATON Magnum DS

DC Field Disconnect – isolating switch (41S)

non-load break, 2-pole, rated [redacted]

Test Transformer & Switching –

means of testing when generator is not available

[redacted]

Cabinet space heater, fed from station's 120-Volt supply

Thermostat for controlling space heater
Two (2) AC receptacles, for 120 V station-fed power
Shorting current transformer (CT) blocks, for CT secondaries

Standard Factory Tests

Witness Testing – at workshop, one workday or two consecutive workdays
Special Excitation System Tests:

[redacted]

Six (6) Sets O&M Instruction Books, Hardcopy
and two CD-ROM copies
Two (2) Sets BESTCOMS™*Pro* Software Level 3 – compatible with Windows™
High-Level Logic for the Digitally-Processed Excitation Controller
Control functions diagrammed in the form of blocks
Inputs and Outputs shown with corresponding variable assignments
Labels and Terms with nomenclature consistent with synchronous machine excitation control

CI Number: 49707

Title: TUC2 Generator Bushing Replacement

Start Date:	2017/06
In-Service Date:	2017/07
Final Cost Date:	2018/01
Function:	Steam
Forecast Amount:	$440,082

DESCRIPTION:

This project is for the replacement of the six generator bushings on the Tufts Cove Unit#2 generator. These bushing are original to the plant (44 years old) and have exceeded their expected useful & design life.

The generator is hydrogen cooled and operates at 13,000 volts. The generator high voltage bushings provide a high current electrical connection from the generator stator winding, leads through the generator casing and connects to the Isolated Phase Bus (IPB) system (main electrical output) external to the generator. The generator bushings are insulated for 13,880 volts and also provide a hydrogen seal to prevent hydrogen from inside the generator leaking through the bushings.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

The six generator bushings on the Tufts Cove Unit #2 generator are 44 years old and beyond their design life. These bushings are almost identical in design to Pt. Tupper and Tufts Cove Unit #3, which both experienced bushing failures at earlier points in their life than those at Tufts Cove Unit #2. Pt. Tupper (2005) and Tufts Cove Unit 3 (2010) bushings were replaced during scheduled outages, which is now the plan for the Tufts Cove Unit #2 replacement in 2017.

Why do this project now?

The six generator bushings on the Tufts Cove Unit 2 generator are 44 years old and beyond their design life. There are no spares and an unexpected bushing failure would result in a significant forced outage of several months as bushing repairs would need to be completed in Europe and delivery on new bushings has a very long lead time. As Tufts Cove Unit #2 ages further and has its utilization changed, the probability of a bushing failure increases. Based on the history and experience of failures on similar bushings, it would be prudent and pro-active to replace the bushings during a regular scheduled major outage.

Although different in design, similar replacement or refurbishment of generator bushings has been completed on all four generators at Lingan and at Pt. Aconi.

Why do this project this way?

There are no spare bushings for Tufts Cove Unit #2, therefore completing this work during a planned outage allows for the ordering of the bushings in advance of this outage.

CI Number : 49707 - TUC2 Generator Bushing Replacement **Project Number**

Parent CI Number : -

Cost Centre : 318 - 318-TC Unit 2 Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
095		095-Thermal Regular Labour AO		5,483	0	5,483
095		095-Thermal & Hydro Contracts AO		12,050	0	12,050
001	010	001 - THERMAL Regular Labour	010 - SGP - Turbo Gen.Instal.	25,549	0	25,549
012	010	012 - Materials	010 - SGP - Turbo Gen.Instal.	275,000	0	275,000
013	010	013 - POWER PRODUCTION Contracts	010 - SGP - Turbo Gen.Instal.	112,000	0	112,000
015	010	015 - Frt, Post & Delivery	010 - SGP - Turbo Gen.Instal.	10,000	0	10,000
			Total Cost:	440,082	0	440,082
			Original Cost:	70,307		

Capital Project Detailed Estimate

Location: TUC
CI# : 49707
Title: TUC2 Generator Bushing Replacement
Execution Year: 2016

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Electrician	PD	40	$ 358	$ 14,331		
Engineering	PD	20	$ 405	$ 8,106		
Power Plant Technician	PD	5	$ 382	$ 1,911		
Utility worker	PD	5	$ 240	$ 1,201		
			Sub-Total	$ 25,549		
012 Materials						
Generator Bushings	ea.	6	$ 45,000	$ 270,000		
Misc. material	lot	1	$ 5,000	$ 5,000		
			Sub-Total	$ 275,000		
013 Contracts						
Scaffolding	lot	1	$ 12,000	$ 12,000		
Siemens Technicians	lot	1	$ 200,000	$ 100,000		
			Sub-Total	$ 112,000		
015 Freight						
Shipping	ea.	1	$ 10,000	$ 10,000		
			Sub-Total	$ 10,000		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 5,483		
Thermal / Hydro Contracts AO				$ 12,050		
			Sub-Total	$ 17,533		
			SUB-TOTAL (no AO, AFUDC)	$ 422,549		
			TOTAL (AO, AFUDC included)	$ 440,082		
Original Cost				$ 70,307		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

Chemical

CI Number: 49537

Title: TRE6 Analytical Panel Upgrade

Start Date:	2017/05
In-Service Date:	2017/10
Final Cost Date:	2018/04
Function:	Steam
Forecast Amount:	$438,216

DESCRIPTION:

This project is for the replacement of the Analytical Panel on Unit 6 of the Trenton Generating Station that monitors the boiler feedwater chemistry.

A modern high-pressure steam generator consists of a boiler, turbine, condenser and feedwater components. High pressure steam is produced in the boiler for the turbine. The steam is then condensed and returned through the feedwater system to the boiler. This is referred to as the steam/water cycle.

The high pressure steam/water must be of high purity and within a certain pH band as it comes in contact with the various metallic surfaces of the steam/water cycle equipment. Proper chemical treatment in fossil fuel fired generating stations is critical for corrosion prevention. The temperatures and pressures which modern steam producing generators operate at require strict chemical regimes and tight control. Proper treatment is dependent on timely and accurate measurement of chemical parameters.

Samples from various points in the steam/water cycle are tubed back to a centralized panel. There, the samples are conditioned (pressure reduction, cooling) and introduced to analyzers which measure various chemical parameters. The results of the analysers are transmitted to the plant Data Acquisition System (DAS) for control room monitoring. Alarm conditions are indicated in the control room.

Summary of Related CIs +/- 2 years:
No other projects 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement/Refurbishment

Why do this project?

The analytical equipment is crucial to the long term life of the boiler. By having accurate knowledge of the water condition at all times, the operations group is able to treat the water appropriately by dosing with the correct chemicals in the right concentrations, and avoid unplanned outages due to water quality. In the event of not upgrading this analytical panel, the likelihood of a chemistry upset with extensive damage to the steam generating equipment would be greatly increased.

Why do this project now?

The analytical equipment and sample cooling is no longer reliable because of its degraded condition and must be replaced.

Why do this project this way?

Replacement of the analytical panel and sample cooling system is the only method to provide reliable analysis of boiler and steam chemistry. New technology for sample analysis will be employed to ensure long term performance of the analytical system for boiler chemistry monitoring.

CI Number : 49537 - TRE6 Analytical Panel Upgrade **Project Number**

Parent CI Number : -

Cost Centre : 345 - 345-Trenton unit 6 Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		10,557	0	10,557
095		095-Thermal Regular Labour AO		5,842	0	5,842
095		095-Thermal Overtime Labour AO		87	0	87
095		095-Thermal Term Labour AO		77	0	77
001	011	001 - THERMAL Regular Labour	011 - SGP - Plant Control and Inst	27,220	0	27,220
002	011	002 - THERMAL Overtime Labour	011 - SGP - Plant Control and Inst	811	0	811
004	011	004 - THERMAL Term Labour	011 - SGP - Plant Control and Inst	358	0	358
011	011	011 - Travel Expense	011 - SGP - Plant Control and Inst	1,000	0	1,000
012	011	012 - Materials	011 - SGP - Plant Control and Inst	349,250	0	349,250
015	011	015 - Frt, Post & Delivery	011 - SGP - Plant Control and Inst	5,000	0	5,000
041	011	041 - Meals & Entertainment	011 - SGP - Plant Control and Inst	250	0	250
066	011	066 - Other Goods & Services	011 - SGP - Plant Control and Inst	37,764	0	37,764
			Total Cost:	438,216	0	438,216
			Original Cost:	278,450		

Capital Project Detailed Estimate

Location: Trenton Generating Station
CI# : 49537
Title: TRE6 Analytical Panel Upgrade
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Electrician	PD	10	$ 358	$ 3,583		
Instrumentation	PD	30	$ 358	$ 10,748		
Engineering	PD	6	$ 405	$ 2,432		
Supervision	PD	6	$ 405	$ 2,432		
Maintenance Trades	PD	22	$ 365	$ 8,025		
			Sub-Total	$ 27,220		
002 OT Labour						
Supervision	PD	1.00	$ 811	$ 811		
			Sub-Total	$ 811		
004 Term Labour						
Instrumentation	PD	1.00	$ 358	$ 358		
			Sub-Total	$ 358		
011 Travel Expense						
	lot	1.00	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000		
012 Materials						
Analytical Panel	lot	1	$ 339,250	$ 339,250		47762
Piping, valves, fittings	lot	1	$ 10,000	$ 10,000		
			Sub-Total	$ 349,250		
015 Freight						
Freight/Shipping	lot	1.00	$ 5,000	$ 5,000		
			Sub-Total	$ 5,000		
041 Meals & Entertainment						
	lot	1.00	$ 250	$ 250		
			Sub-Total	$ 250		
066 Other Goods & Services						
Contingency	%	10%	$ 377,639	$ 37,764		
			Sub-Total	$ 37,764		
094 Interest Capitalized						
AFUDC				$ 10,557		
			Sub-Total	$ 10,557		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 5,842		
Thermal OT Labour AO				$ 87		
Thermal Term Labour AO				$ 77		
			Sub-Total	$ 6,006		
			SUB-TOTAL (no AO, AFUDC)	$ 421,653		
			TOTAL (AO, AFUDC included)	$ 438,216		
Original Cost				$ 278,450		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 47893

Title: TUC3 Hydrogen Panel Replacement

Start Date:	2016/03
In-Service Date:	2017/10
Final Cost Date:	2018/04
Function:	Steam
Forecast Amount:	$423,798

DESCRIPTION:

This project includes the replacement of the Tufts Cove #3 hydrogen panel with new valves, instruments and gauges. This hydrogen panel is original to the Tufts Cove #3 generating station, and is approximately 40 years old and has reached the end of their useful life. As the Hydrogen Cooling System (Hydrogen Panel) has aged, the Plant has experienced failures in components (valves, sensors, piping connections). These failures can lead to unsafe working conditions.

The hydrogen panel is designed to permit hydrogen gas to be admitted to, or expelled from, the generator casing, and to monitor and regulate the purity of hydrogen in the casing. Hydrogen is the Generator cooling medium and the Hydrogen cooling system is essential to Generator operation. Considering the nature of Hydrogen and the importance of Hydrogen to unit performance, the Hydrogen system is a high criticality system.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Thermal

Sub-Criteria: Equipment Replacement / Refurbishment

Why do this project?

As the Hydrogen Cooling System (Hydrogen Panel) has aged, the Plant has experienced failures in components (valves, sensors, piping connections). These failures can lead to Hydrogen gas releases, which can cause unsafe working conditions. When failures such as these occur, the area of the failure is isolated and can cause the unit to be kept offline until the leak is identified and corrected. The condition of the system will continue to deteriorate and therefore needs replacement to ensure reliable generator cooling and to maintain the integrity of the Hydrogen system.

This project is being undertaken primarily to preserve the unit's performance, and is secondarily undertaken to maintain the safe operation of the unit.

Why do this project now?

The system continues to age, and the likelihood of a more significant system failure (larger releases of hydrogen) increases, thereby increasing risk to a level where mitigating actions are required.

Why do this project this way?

To date the method of resolving Hydrogen Panel leaks has been to repair and/or replace valve components, instrument components and piping elements as they fail. As the equipment ages, this approach is less effective, resulting in a greater probability of significant failure (risk). System replacement is now the recommended approach to mitigate the risk.

CI Number : 47893-SG06 - TUC3 PE Generator Hydrogen Panel Replacement **Project Number** SG06

Parent CI Number : -

Cost Centre : 319 - 319-TC Unit 3 Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		4,476	0	4,476
095		095-Thermal Regular Labour AO		10,652	0	10,652
095		095-Thermal & Hydro Contracts AO		3,497	0	3,497
095		095 - Proj Supp Regular Labour AO		5,847	0	5,847
001	010	001 - Proj Supp Regular Labour	010 - SGP - Turbo Gen.Instal.	12,159	0	12,159
001	010	001 - THERMAL Regular Labour	010 - SGP - Turbo Gen.Instal.	49,668	0	49,668
012	010	012 - Materials	010 - SGP - Turbo Gen.Instal.	275,000	0	275,000
013	010	013 - POWER PRODUCTION Contracts	010 - SGP - Turbo Gen.Instal.	32,500	0	32,500
015	010	015 - Frt, Post & Delivery	010 - SGP - Turbo Gen.Instal.	10,000	0	10,000
028	010	028 - Consulting	010 - SGP - Turbo Gen.Instal.	20,000	0	20,000
			Total Cost:	423,798	0	423,798
			Original Cost:	92,408		

Capital Project Detailed Estimate

Location: TUC
CI# : 47893
Title: TUC3 Hydrogen Panel Replacement
Execution Year: 2016

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Electrician	PD	36	$ 358	$ 12,898		
Engineering	PD	30	$ 405	$ 12,159		
Maintenance Trades	PD	83	$ 365	$ 30,277		
Power Plant Technician	PD	10	$ 382	$ 3,821		
Utilityworker	PD	5	$ 240	$ 1,201		
CADD Operators	PD	5	$ 294	$ 1,470		
	PD			$ -		
			Sub-Total	$ 61,827		
012 Materials						
Hydrogen Control Panel	lot	1	$ 250,000	$ 250,000		
Misc Pipe, Cable, Tubing, Instruments	lot	1	$ 25,000	$ 25,000		
				$ -		
			Sub-Total	$ 275,000		
013 Contracts						
Scaffolding	lot	1	$ 17,500	$ 17,500		
Commissioning Representative	lot	1	$ 15,000	$ 15,000		
				$ -		
			Sub-Total	$ 32,500		
028 Consulting						
Engineering / Project Management	lot	1	$ 20,000	$ 20,000		
				$ -		
			Sub-Total	$ 20,000		
015 Freight						
Shipping	ea	1	$ 10,000	$ 10,000		
				$ -		
			Sub-Total	$ 10,000		
094 Interest Capitalized						
AFUDC				$ 4,476		
				$ -		
			Sub-Total	$ 4,476		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 10,652		
Project Support AO				$ 5,847		
Thermal / Hydro Contracts AO				$ 3,497		
			Sub-Total	$ 19,996		
			SUB-TOTAL (no AO, AFUDC)	$ 399,327		
			TOTAL (AO, AFUDC included)	$ 423,798		
Original Cost				$ 92,408		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

Balance of Plant

CI Number: 49535

Title: TRE6 Mills Refurbishment 2017

Start Date: 2017/07
In-Service Date: 2017/10
Final Cost Date: 2018/04
Function: Steam
Forecast Amount: $822,141

DESCRIPTION:

This project is to refurbish the coal mills on Trenton 6, which utilize two Foster Wheeler D-10 Ball Mill Coal Pulverizers (6A & 6B) to size the coal for combustion in the boiler. These mills were originally installed and commissioned in 1991 and have been subjected to continuous use since this time, with the exception of shutdowns.

Refurbishments for these mills are scheduled every two years to coincide with planned unit outages. These mills were last refurbished in 2015. Completing refurbishments during the 2017 planned outage is important with regards to unit reliability.

Scope for this project includes the following:

- Replace raw coal pipes
- Replace trunnion bearings
- Replace trunnion bearing seals
- Replace ribbon conveyors and bearings
- Replace grinding media

Summary of Related CIs +/- 2 years:
2015 CI 46301 TRE6 6A 6B Mills Refurbishment $665,045
2019 CI TBD TRE6 Mills Refurbishments 2019 $TBD

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement/Refurbishment

Why do this project?

Mill maintenance can be a significant cost to the station, and a number of initiatives have been undertaken to extend component life, reduce mill forced outages, maximize mill availability and extend running hours between overhauls in efforts to reduce these costs. This project, similar to previous mill refurbishment projects, focuses on employing optimal maintenance practices in order to improve the performance of the raw coal supply system to each mill and to extend the reliability of mill rotating elements and associated components. In the event of an unplanned failure of these mills, the unit would experience a 70MW derate in generating capacity.

This project is being undertaken primarily to preserve the unit’s performance, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

The 2017 Unit 6 planned outage is a nine-week shutdown, and will provide the ideal timeframe to complete the aforementioned refurbishment of both mills in a planned and cost effective manner. If not completed now, reliability of the mills will be at risk.

Why do this project this way?

Replacement parts are now required due to age and wear on many of the mill components. Refurbishment of these components is not an option due to the age and wear. Re-establishing Original Equipment Manufacturer (OEM) physical specifications and the replacement of worn components will prevent degradation in mill and plant performance.

CI Number : 49535 - TRE6 Mills Refurbishment 2017 **Project Number**

Parent CI Number : -

Cost Centre : 345 - 345-Trenton unit 6 Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		6,511	0	6,511
095		095-Thermal & Hydro Contracts AO		6,993	0	6,993
095		095-Thermal Regular Labour AO		30,343	0	30,343
095		095-Thermal Term Labour AO		21,366	0	21,366
095		095-Thermal Overtime Labour AO		7,790	0	7,790
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	141,380	0	141,380
002	013	002 - THERMAL Overtime Labour	013 - SGP - Boiler	72,596	0	72,596
004	013	004 - THERMAL Term Labour	013 - SGP - Boiler	99,555	0	99,555
012	013	012 - Materials	013 - SGP - Boiler	311,000	0	311,000
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	65,000	0	65,000
033	013	033 - Rental and Maintenance of	013 - SGP - Boiler	500	0	500
066	013	066 - Other Goods & Services	013 - SGP - Boiler	47,605	0	47,605
028	085	028 - Consulting	085 Design	10,000	0	10,000
011	087	011 - Travel Expense	087 Field Super.& Ops.	1,000	0	1,000
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	500	0	500
			Total Cost:	822,141	0	822,141
			Original Cost:	468,474		

Capital Project Detailed Estimate

Location: **Trenton Generating Station**
CI# : 49535
Title: TRE6 Mills Refurbishment 2017
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Electrician	PD	15	$ 358	$ 5,374		CI 46301
Engineering	PD	30	$ 405	$ 12,159		
Maintenance Trades	PD	300	$ 365	$ 109,436		
Utility worker	PD	60	$ 240	$ 14,411		
			Sub-Total	$ 141,380		
002 OT Labour						
Mechanical	PD	60	$ 730	$ 43,774		
Utility	PD	60	$ 480	$ 28,821		
			Sub-Total	$ 72,596		
004 Term Labour						
Mechanical	PD	240	$ 365	$ 87,550		
Utility	PD	50	$ 240	$ 12,005		
			Sub-Total	$ 99,555		
011 Travel Expense						
Travel	lot	1	$ 1,000	$ 1,000		
				$ -		
			Sub-Total	$ 1,000		
012 Materials						
Ribbon Conveyors	ea	4	$ 18,500	$ 74,000		CI 46301
Grinding Media (Balls)	lot	1	$ 60,000	$ 60,000		CI 46301
Trunion Bearing Seals	lot	1	$ 12,000	$ 12,000		CI 46301
Ribbon Conveyor Bearings	lot	1	$ 13,000	$ 13,000		CI 46301
Plate	lot	1	$ 4,000	$ 4,000		CI 46301
Spokes	lot	1	$ 8,000	$ 8,000		CI 46301
Fire Sprinklers	lot	1	$ 5,000	$ 5,000		CI 46301
Consumables	lot	1	$ 20,000	$ 20,000		CI 46301
Trunion Bearing	lot	2	$ 57,500	$ 115,000		
			Sub-Total	$ 311,000		
013 Contracts						
Ball Sorter Rental	lot	1	$ 6,500	$ 6,500		
Forklift Rental	lot	1	$ 7,000	$ 7,000		
Vacuum Services	lot	1	$ 30,000	$ 30,000		
Freight	lot	1	$ 20,000	$ 20,000		
Boom Truck Rental	lot	1	$ 2,000	$ 2,000		
			Sub-Total	$ 65,500		CI 46301
028 Consulting						
Tech Support (Engineering)	lot	1	$ 10,000	$ 10,000		
			Sub-Total	$ 10,000		
041 Meals & Entertainment						
Meals	lot	1	$ 500	$ 500		
			Sub-Total	$ 500		
066 Other Goods & Services						
Contingency	%	10%	$ 476,055	$ 47,605		
			Sub-Total	$ 47,605		
094 Interest Capitalized						
AFUDC				$ 6,511		
			Sub-Total	$ 6,511		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 30,343		
Thermal OT Labour AO				$ 7,790		
Thermal Term Labour AO				$ 21,366		
Thermal / Hydro Contracts AO				$ 6,993		
			Sub-Total	$ 66,493		
			SUB-TOTAL (no AO, AFUDC)	$ 749,136		
			TOTAL (AO, AFUDC included)	$ 822,141		
Original Cost				$ 468,474		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

TRE6 Mills Refurbishments 2017
Summary of Alternatives

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Trenton Generating Station	**CI Number:**	49535
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Mill Refurbishment vs Avoided Fuel & R	5.90%	-5,644,762	3,945,968	1	271.69%	0.7 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

It is recommended to fund this project to perform Unit 6 mills refurbishment. Work can be completed during the planned outage, therefore avoiding unplanned replacement energy costs associated with an unplanned outage.

Notes/Comments :

Mill Refurbishment vs Avoided Fuel & Repair Costs

Avoided replacement energy costs were calculated assuming that there would be a 10% chance of an unplanned outage within 2017 to perform refurbishments if the refurbishments were not completed at this time. The likelihood of failure increases to 50% in 2018 and 100% in 2019. An unavailable Unit 6 pulverizer results in an average 70MW derating of the unit.

Test 2

Test 3

Test 4

TRE6 Mills Refurbishments 2017
Summary of Sensitivities

Division :	Power Production
Department :	Trenton Generating Station
Date :	**28-Oct-16**
CI Number:	49535
Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Mill Refurbishment vs Avoided Fuel & Repair Cos	5.90%	-5,644,762	3,945,968	1	271.69%	0.7 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Mill Refurbishment vs Avoided Fuel & Repair Cos	10%	-5,570,792	3,887,556	1	245.26%	0.8 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years

Change:		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
	A	73,970	-58,411	0	-26.43%	0.1 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Mill Refurbishment vs Avoided Fuel & Repair Cos	-10%	-5,006,315	3,492,959	1	242.61%	0.8 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years

Change:		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
	A	638,447	-453,008	0	-29.07%	0.1 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	66,613	2,004,910	6,915,248	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

TRE6 Mills Refurbishments 2017
Avoided Cost Calculations

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Trenton Generating Station	**CI Number:**	49535
		Project No. :	

Mill Refurbishment vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	2	2	2	2		
Probability of Occurance (%)	10%	50%	10%	50%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	70.0	70.0				
Duration (Hours or Years)	1460	8760				
Totals	$108,341	$2,123,226	$0	$0	$108,341	$2,123,226

Total Capital Cost of Alternative **$822,141**

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative **$0**

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative **$0**

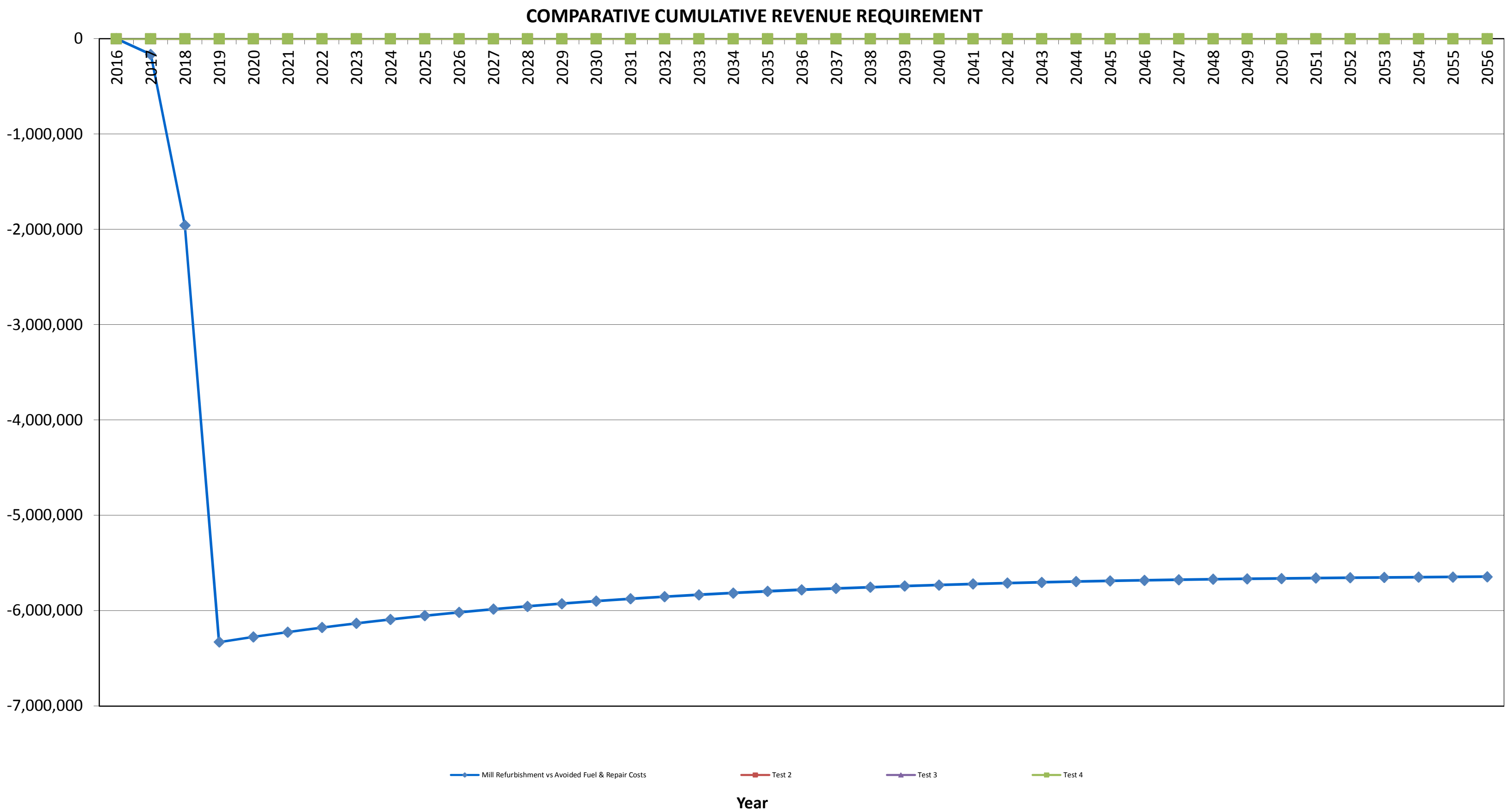
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative **$0**

TRE6 Mills Refurbishments 2017
Mill Refurbishment vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	108,341.3	(755,647.4)	29,965.4	737,522.6	(647,306.1)	(24,296.5)	(671,602.6)	(634,185.7)	0.94	(634,185.7)
2018	-	-	2,123,225.9	-	57,533.6	676,924.9	2,123,225.9	(640,364.6)	1,482,861.3	1,322,234.9	0.89	688,049.2
2019	-	-	5,427,311.1	-	52,930.9	621,175.1	5,427,311.1	(1,666,057.8)	3,761,253.2	3,166,975.4	0.84	3,855,024.7
2020	-	-	-	-	48,696.5	569,885.3	-	15,095.9	15,095.9	12,002.6	0.80	3,867,027.3
2021	-	-	-	-	44,800.8	522,698.6	-	13,888.2	13,888.2	10,427.2	0.75	3,877,454.4
2022	-	-	-	-	41,216.7	479,286.9	-	12,777.2	12,777.2	9,058.6	0.71	3,886,513.0
2023	-	-	-	-	37,919.4	439,348.1	-	11,755.0	11,755.0	7,869.6	0.67	3,894,382.6
2024	-	-	-	-	34,885.8	402,604.4	-	10,814.6	10,814.6	6,836.6	0.63	3,901,219.2
2025	-	-	-	-	32,094.9	368,800.2	-	9,949.4	9,949.4	5,939.3	0.60	3,907,158.5
2026	-	-	-	-	29,527.3	337,700.4	-	9,153.5	9,153.5	5,159.7	0.56	3,912,318.2
2027	-	-	-	-	27,165.2	309,088.5	-	8,421.2	8,421.2	4,482.5	0.53	3,916,800.7
2028	-	-	-	-	24,991.9	282,765.6	-	7,747.5	7,747.5	3,894.1	0.50	3,920,694.8
2029	-	-	-	-	22,992.6	258,548.5	-	7,127.7	7,127.7	3,383.0	0.47	3,924,077.8
2030	-	-	-	-	21,153.2	236,268.8	-	6,557.5	6,557.5	2,939.0	0.45	3,927,016.8
2031	-	-	-	-	19,460.9	215,771.5	-	6,032.9	6,032.9	2,553.2	0.42	3,929,570.0
2032	-	-	-	-	17,904.1	196,913.9	-	5,550.3	5,550.3	2,218.1	0.40	3,931,788.1
2033	-	-	-	-	16,471.7	179,565.0	-	5,106.2	5,106.2	1,926.9	0.38	3,933,715.0
2034	-	-	-	-	15,154.0	163,603.9	-	4,697.7	4,697.7	1,674.0	0.36	3,935,389.1
2035	-	-	-	-	13,941.7	148,919.8	-	4,321.9	4,321.9	1,454.3	0.34	3,936,843.4
2036	-	-	-	-	12,826.3	135,410.4	-	3,976.2	3,976.2	1,263.4	0.32	3,938,106.8
2037	-	-	-	-	11,800.2	122,981.7	-	3,658.1	3,658.1	1,097.6	0.30	3,939,204.4
2038	-	-	-	-	10,856.2	111,547.3	-	3,365.4	3,365.4	953.5	0.28	3,940,157.9
2039	-	-	-	-	9,987.7	101,027.7	-	3,096.2	3,096.2	828.4	0.27	3,940,986.2
2040	-	-	-	-	9,188.7	91,349.7	-	2,848.5	2,848.5	719.6	0.25	3,941,705.9
2041	-	-	-	-	8,453.6	82,445.9	-	2,620.6	2,620.6	625.2	0.24	3,942,331.1
2042	-	-	-	-	7,777.3	74,254.3	-	2,411.0	2,411.0	543.1	0.23	3,942,874.2
2043	-	-	-	-	7,155.1	66,718.2	-	2,218.1	2,218.1	471.8	0.21	3,943,346.0
2044	-	-	-	-	6,582.7	59,784.9	-	2,040.6	2,040.6	409.9	0.20	3,943,755.9
2045	-	-	-	-	6,056.1	53,406.3	-	1,877.4	1,877.4	356.1	0.19	3,944,112.0
2046	-	-	-	-	5,571.6	47,537.9	-	1,727.2	1,727.2	309.4	0.18	3,944,421.4
2047	-	-	-	-	5,125.9	42,139.1	-	1,589.0	1,589.0	268.8	0.17	3,944,690.1
2048	-	-	-	-	4,715.8	37,172.1	-	1,461.9	1,461.9	233.5	0.16	3,944,923.6
2049	-	-	-	-	4,338.5	32,602.5	-	1,345.0	1,345.0	202.8	0.15	3,945,126.4
2050	-	-	-	-	3,991.5	28,398.5	-	1,237.4	1,237.4	176.2	0.14	3,945,302.6
2051	-	-	-	-	3,672.1	24,530.7	-	1,138.4	1,138.4	153.1	0.13	3,945,455.7
2052	-	-	-	-	3,378.4	20,972.5	-	1,047.3	1,047.3	133.0	0.13	3,945,588.7
2053	-	-	-	-	3,108.1	17,698.8	-	963.5	963.5	115.5	0.12	3,945,704.2
2054	-	-	-	-	2,859.5	14,687.1	-	886.4	886.4	100.4	0.11	3,945,804.6
2055	-	-	-	-	2,630.7	11,916.3	-	815.5	815.5	87.2	0.11	3,945,891.8
2056	-	-	-	-	2,420.2	9,367.1	-	750.3	750.3	75.7	0.10	3,945,967.6
Total	**-**	**-**	**7,658,878.3**	**(755,647.4)**	**721,303.1**		**6,903,230.9**	**(2,150,648.3)**	**4,752,582.6**	**3,945,967.6**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
-1,000,000
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2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056
Mill Refurbishment vs Avoided Fuel & Repair Costs
Test 2
Test 3
Test 4
Year

CI Number: 47597

Title: TRE6 Bottom Ash Chain Replacement

Start Date:	2017/08
In-Service Date:	2017/10
Final Cost Date:	2018/04
Function:	Steam
Forecast Amount:	$793,792

DESCRIPTION:

This project includes the replacement of the bar loop chain with a round link style chain, idler wheels, sprockets, flight bars and wear plate of the bottom ash removal system on Trenton Unit 6. In addition to the chain, all of the flight bars (total of 66), idlers and take up pulleys, and head sprockets will be replaced.

The bottom ash removal system is a submerged mechanical drag conveyor (SMDC), which removes bottom ash via two bar loop style chains fitted with 66 flight bars equally spaced along the chains. The operation of the chains is such that there is always relative motion between the chain and the wear resistant surface at the bottom of the SMDC hopper. This relative motion tends to abrade the chain over time, eventually leading to failure.

Summary of Related CIs +/- 2 years:
2015 CI 47411 TRE6 Bottom Ash Refurbishment $172,500

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

The existing chain design on the submerged drag conveyor utilizes a bar loop style chain. This current bar loop chain has been phased out by the drag conveyor vendor and currently Trenton Unit 6 is one of only two units still operating with the bar loop chain.

This project is being undertaken primarily to preserve the unit's availability, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

The current bar loop chain lasts approximately 2 years; and the condition of the bar loop chain has deteriorated to the point where replacement is necessary. The 2017 outage will mark the 2 year point for the next chain replacement. Unit 6 is scheduled for a major planned outage in 2017. The replacement of the existing chain, idler wheels, sprockets, flight bars and wear plate is a labour intensive job and cannot be completed in a 2-3 week outage. The 8 weeks for the 2017 planned major outage will give adequate time to complete this project.

Why do this project this way?

Converting to a round link style chain, from a bar-loop chain will decrease the amount of chain replacements by as much as three times. The current bar loop style chain has required replacement every 2 years and replacement of individual links is labour intensive. As shown in the attached economic analysis, converting to the round link chain (with replacement every five years) is more economical than using the current bar-loop chain (with replacement every two years).

CI Number : 47597 - TRE6 Bottom Ash Chain Replacement **Project Number**

Parent CI Number : -

Cost Centre : 345 - 345-Trenton unit 6 Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		7,400	0	7,400
095		095-Thermal & Hydro Contracts AO		1,883	0	1,883
095		095-Thermal Regular Labour AO		9,208	0	9,208
095		095-Thermal Overtime Labour AO		3,128	0	3,128
095		095-Thermal Term Labour AO		10,941	0	10,941
001	021	001 - THERMAL Regular Labour	021 - SGP - Ash Handling	42,903	0	42,903
002	021	002 - THERMAL Overtime Labour	021 - SGP - Ash Handling	29,147	0	29,147
004	021	004 - THERMAL Term Labour	021 - SGP - Ash Handling	50,980	0	50,980
012	021	012 - Materials	021 - SGP - Ash Handling	[redacted]	0	[redacted]
013	021	013 - POWER PRODUCTION Contracts	021 - SGP - Ash Handling	17,500	0	17,500
066	021	066 - Other Goods & Services	021 - SGP - Ash Handling	12,303	0	12,303
028	085	028 - Consulting	085 Design	[redacted]	0	[redacted]
011	087	011 - Travel Expense	087 Field Super.& Ops.	500	0	500
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	500	0	500
			Total Cost:	793,792	0	793,792
			Original Cost:	491,507		

Capital Project Detailed Estimate

Location: **Trenton Generating Station**
CI# : 47597
Title: TRE6 Bottom Ash Chain Replacement\
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Engineering	PD	10	$ 405	$ 4,053		
Supervision	PD	30	$ 405	$ 12,159		
Maintenance Trades	PD	60	$ 365	$ 21,887		
Utilityworker	PD	20	$ 240	$ 4,804		
			Sub-Total	$ 42,903		
002 OT Labour						
Utility	PD	6	$ 480	$ 2,882		
Maintenance Trades	PD	36	$ 730	$ 26,265		
			Sub-Total	$ 29,147		
004 Term Labour						
Maintenance Trades	PD	120	$ 365	$ 43,774		
Utility	PD	30	$ 240	$ 7,205		
			Sub-Total	$ 50,980		
011 Travel Expense						
Travel	lot	1	$ 500	$ 500		
			Sub-Total	$ 500		
012 Materials						
Round link chain conversion kit	lot	1	[redacted]		Cost Support Item #1	
Wear plate	lot	1	$ 25,000	$ 25,000		
Misc Material	lot	1	$ 5,000	$ 5,000		
Forklift rental	lot	1	$ 4,000	$ 4,000		
Heat trace cable	lot	1	$ 5,000	$ 5,000		
			Sub-Total	[redacted]		
013 Contracts						
Vacuum Services	lot	1	$ 7,500	$ 7,500		
Concrete contractor	lot	1	$ 10,000	$ 10,000		
				$ -		
			Sub-Total	$ 17,500		
028 Consulting						
Service Rep	lot	1	[redacted]		Cost Support Item #1	
			Sub-Total	[redacted]		
041 Meals & Entertainment						
Meals	lot	1	$ 500	$ 500		
			Sub-Total	$ 500		
066 Other Goods & Services						
Contingency	%	10%	$ 123,030	$ 12,303		
				$ -		
			Sub-Total	$ 12,303		
094 Interest Capitalized						
AFUDC				$ 7,400		
			Sub-Total	$ 7,400		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 9,208		
Thermal OT Labour AO				$ 3,128		
Thermal Term Labour AO				$ 10,941		
Thermal / Hydro Contracts AO				$ 1,883		
			Sub-Total	$ 25,160		
			SUB-TOTAL (no AO, AFUDC)	$ 761,232		
			TOTAL (AO, AFUDC included)	$ 793,792		
Original Cost				$ 491,507		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

TRE6 Bottom Ash Chain Refurbishment
Summary of Alternatives

Division :	Power Production	**Date :**	**9-Nov-16**
Department :	Trenton	**CI Number:**	47597
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Chain Replacement vs Replacement En	5.90%	-3,625,762	2,467,156	1	517.63%	0.4 years
B	Bar-Loop Replacement vs Replacement	5.90%	-3,504,809	2,358,087	2	1350.52%	0.4 years
C	Test 3	5.90%	0	0	3	#NUM!	0.0 years
D	Test 4	5.90%	0	0	3	#NUM!	0.0 years

Recommendation :

It is recommended that this project is pursued to maintain the availability of the unit. It is advantageous to perform the refurbishments during the planned outage in 2017. No additional replacement energy costs are incurred, and the system is returned to acceptable level of reliability. This decision is supported by favourable economic anaysis data.

Notes/Comments :

Chain Replacement vs Replacement Energy Costs

This analysis compared the cost of converting to a round link chain on Trenton Unit 6 bottom ash conveyor versus the avoided replacement energy costs associated with unplanned outage due to bottom ash system failure over the next two years. This option also considers the replacement of the round link chain every 5 years.

Bar-Loop Replacement vs Replacement Energy Costs

This analysis compared the cost of replacing with a similar bar-loop chain on Trenton Unit 6 bottom ash conveyor versus the avoided replacement energy costs associated with unplanned outage due to bottom ash system failure over the next two years. This option also considers the replacement of the round link chain every 2 years.

Test 3

Test 4

TRE6 Bottom Ash Chain Refurbishment
Summary of Sensitivities

Nova Scotia POWER An Emera Company

Division :	Power Production	**Date :**	**9-Nov-16**
Department :	Trenton	**CI Number:**	47597
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Chain Replacement vs Replacement Energy Cost	5.90%	-3,625,762	2,467,156	1	517.63%	0.4 years
B	Bar-Loop Replacement vs Replacement Energy C	5.90%	-3,504,809	2,358,087	2	1350.52%	0.4 years
C	Test 3	5.90%	0	0	3	#NUM!	0.0 years
D	Test 4	5.90%	0	0	3	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Chain Replacement vs Replacement Energy Cost	10%	-3,535,603	2,395,113	1	442.61%	0.4 years
B	Bar-Loop Replacement vs Replacement Energy C	10%	-3,402,555	2,275,136	2	1115.46%	0.4 years
C	Test 3	10%	0	0	3	#NUM!	0.0 years
D	Test 4	10%	0	0	3	#NUM!	0.0 years

Change:						
	A	90,159	-72,043	0	-75.02%	0.0 years
	B	102,254	-82,950	0	-235.05%	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Chain Replacement vs Replacement Energy Cost	-10%	-3,173,027	2,148,397	1	435.40%	0.4 years
B	Bar-Loop Replacement vs Replacement Energy C	-10%	-3,052,074	2,039,328	2	1093.94%	0.4 years
C	Test 3	-10%	0	0	3	#NUM!	0.0 years
D	Test 4	-10%	0	0	3	#NUM!	0.0 years

Change:						
	A	452,735	-318,759	0	-82.24%	0.0 years
	B	452,735	-318,759	0	-256.58%	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	247,058	4,705,339	4,369,898	No
	B	241,395	4,694,278	4,353,693	No
	C	0	0	0	No
	D	0	0	0	No

TRE6 Bottom Ash Chain Refurbishment
Avoided Cost Calculations

Division :	Power Production	**Date :**	**9-Nov-16**
Department :	Trenton	**CI Number:**	47597
		Project No. :	

Chain Replacement vs Replacement Energy Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]	[redacted]				
Repair Cost ($)			**0**	**0**		
Events/Outages (#)	**1**	**1**	**1**	**1**		
Probability of Occurance (%)	**25%**	**100%**	**25%**	**100%**		
Capacity Factor (%)	[redacted]	[redacted]				
Energy Replaced (MW)	**160.0**	**160.0**				
Duration (Hours or Years)	**1460**	**8760**				
Totals	**$309,547**	**$4,853,088**	**$0**	**$0**	**$309,547**	**$4,853,088**
Total Capital Cost of Alternative						**$1,043,792**

Bar-Loop Replacement vs Replacement Energy Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]	[redacted]				
Repair Cost ($)			**0**	**0**		
Events/Outages (#)	**1**	**1**	**1**	**1**		
Probability of Occurance (%)	**25%**	**100%**	**25%**	**100%**		
Capacity Factor (%)	[redacted]	[redacted]				
Energy Replaced (MW)	**160.0**	**160.0**				
Duration (Hours or Years)	**1460**	**8760**				
Totals	**$309,547**	**$4,853,088**	**$0**	**$0**	**$309,547**	**$4,853,088**
Total Capital Cost of Alternative						**$1,350,000**

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]	[redacted]				
Repair Cost ($)			**0**	**0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]	[redacted]				
Energy Replaced (MW)	**0.0**	**0.0**				
Duration (Hours or Years)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

Test 4

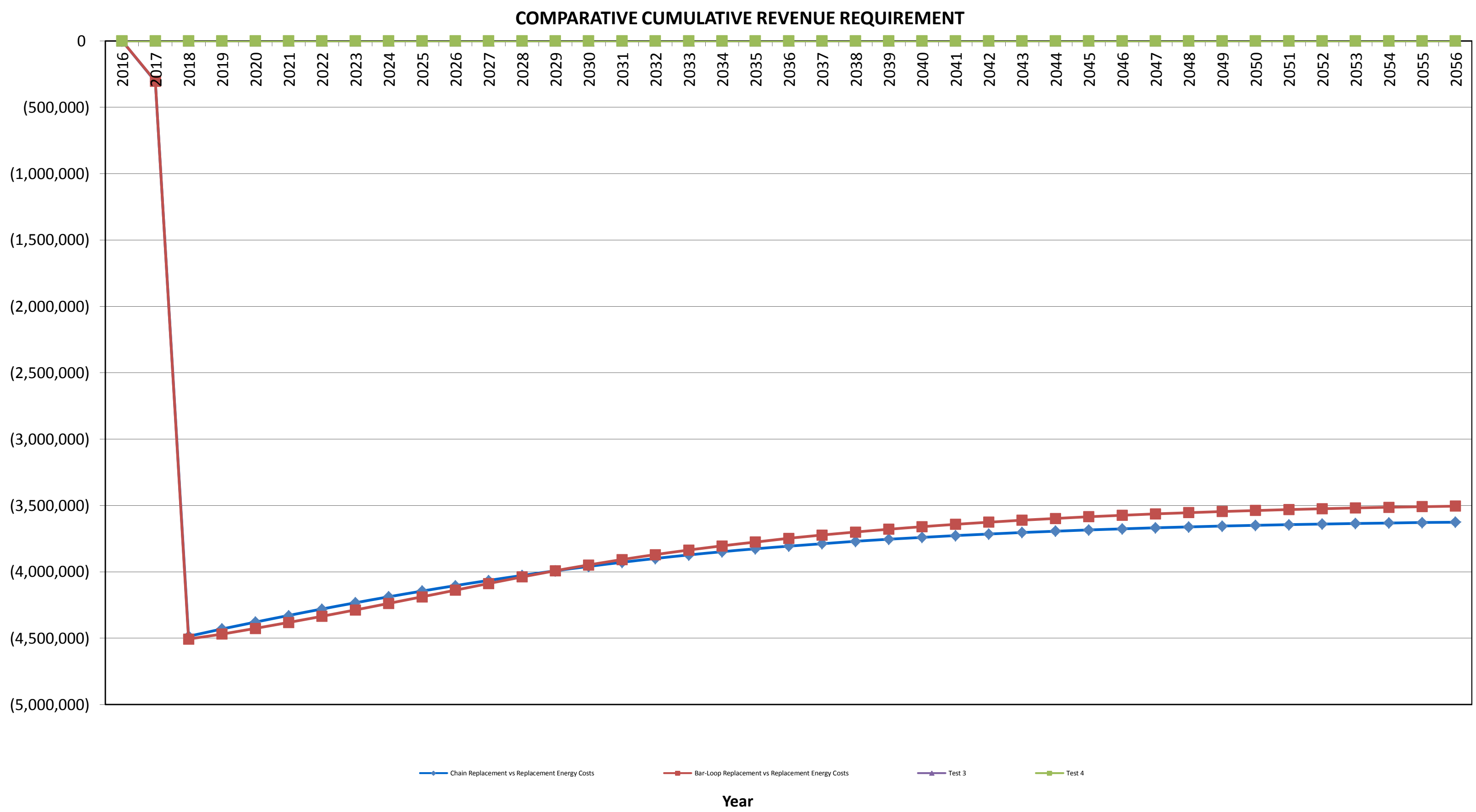
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]	[redacted]				
Repair Cost ($)			**0**	**0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]	[redacted]				
Energy Replaced (MW)	**0.0**	**0.0**				
Duration (Hours or Years)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

TRE6 Bottom Ash Chain Refurbishment
Chain Replacement vs Replacement Energy Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	309,546.6	(768,632.2)	30,449.3	737,727.3	(459,085.7)	(86,520.2)	(545,605.8)	(515,208.5)	0.94	(515,208.5)
2018	-	-	4,853,087.8	-	58,462.7	678,105.2	4,853,087.8	(1,486,333.8)	3,366,754.0	3,002,060.7	0.89	2,486,852.1
2019	-	-	-	-	53,785.6	623,253.0	-	16,673.5	16,673.5	14,039.1	0.84	2,500,891.3
2020	-	-	-	-	49,482.8	572,788.9	-	15,339.7	15,339.7	12,196.4	0.80	2,513,087.7
2021	-	-	-	-	45,524.2	526,362.0	-	14,112.5	14,112.5	10,595.6	0.75	2,523,683.2
2022	-	-	-	(125,000.0)	51,882.2	598,649.2	(125,000.0)	16,083.5	(108,916.5)	(77,217.9)	0.71	2,446,465.3
2023	-	-	-	-	47,731.7	550,153.4	-	14,796.8	14,796.8	9,906.0	0.67	2,456,371.3
2024	-	-	-	-	43,913.1	505,537.3	-	13,613.1	13,613.1	8,605.7	0.63	2,464,977.0
2025	-	-	-	-	40,400.1	464,490.5	-	12,524.0	12,524.0	7,476.2	0.60	2,472,453.2
2026	-	-	-	-	37,168.1	426,727.4	-	11,522.1	11,522.1	6,494.9	0.56	2,478,948.1
2027	-	-	-	(125,000.0)	44,194.6	506,985.4	(125,000.0)	13,700.3	(111,299.7)	(59,243.2)	0.53	2,419,704.9
2028	-	-	-	-	40,659.1	465,822.7	-	12,604.3	12,604.3	6,335.3	0.50	2,426,040.3
2029	-	-	-	-	37,406.3	427,953.1	-	11,596.0	11,596.0	5,503.8	0.47	2,431,544.0
2030	-	-	-	-	34,413.8	393,113.0	-	10,668.3	10,668.3	4,781.4	0.45	2,436,325.4
2031	-	-	-	-	31,660.7	361,060.1	-	9,814.8	9,814.8	4,153.8	0.42	2,440,479.1
2032	-	-	-	-	29,127.9	331,571.5	-	9,029.6	9,029.6	3,608.6	0.40	2,444,087.7
2033	-	-	-	-	26,797.6	304,441.9	-	8,307.3	8,307.3	3,134.9	0.38	2,447,222.6
2034	-	-	-	-	24,653.8	279,482.7	-	7,642.7	7,642.7	2,723.4	0.36	2,449,946.1
2035	-	-	-	-	22,681.5	256,520.3	-	7,031.3	7,031.3	2,366.0	0.34	2,452,312.1
2036	-	-	-	-	20,867.0	235,394.8	-	6,468.8	6,468.8	2,055.4	0.32	2,454,367.5
2037	-	-	-	-	19,197.6	215,959.4	-	5,951.3	5,951.3	1,785.6	0.30	2,456,153.1
2038	-	-	-	-	17,661.8	198,078.8	-	5,475.2	5,475.2	1,551.3	0.28	2,457,704.4
2039	-	-	-	-	16,248.9	181,628.7	-	5,037.2	5,037.2	1,347.7	0.27	2,459,052.0
2040	-	-	-	-	14,949.0	166,494.5	-	4,634.2	4,634.2	1,170.8	0.25	2,460,222.8
2041	-	-	-	-	13,753.0	152,571.1	-	4,263.4	4,263.4	1,017.1	0.24	2,461,239.9
2042	-	-	-	-	12,652.8	139,761.6	-	3,922.4	3,922.4	883.6	0.23	2,462,123.5
2043	-	-	-	-	11,640.6	127,976.9	-	3,608.6	3,608.6	767.6	0.21	2,462,891.1
2044	-	-	-	-	10,709.3	117,134.9	-	3,319.9	3,319.9	666.9	0.20	2,463,558.0
2045	-	-	-	-	9,852.6	107,160.3	-	3,054.3	3,054.3	579.3	0.19	2,464,137.3
2046	-	-	-	-	9,064.4	97,983.6	-	2,810.0	2,810.0	503.3	0.18	2,464,640.6
2047	-	-	-	-	8,339.2	89,541.1	-	2,585.2	2,585.2	437.2	0.17	2,465,077.8
2048	-	-	-	-	7,672.1	81,774.0	-	2,378.3	2,378.3	379.8	0.16	2,465,457.7
2049	-	-	-	-	7,058.3	74,628.2	-	2,188.1	2,188.1	330.0	0.15	2,465,787.7
2050	-	-	-	-	6,493.7	68,054.1	-	2,013.0	2,013.0	286.7	0.14	2,466,074.3
2051	-	-	-	-	5,974.2	62,006.0	-	1,852.0	1,852.0	249.0	0.13	2,466,323.4
2052	-	-	-	-	5,496.2	56,441.6	-	1,703.8	1,703.8	216.4	0.13	2,466,539.8
2053	-	-	-	-	5,056.5	51,322.5	-	1,567.5	1,567.5	188.0	0.12	2,466,727.7
2054	-	-	-	-	4,652.0	46,612.8	-	1,442.1	1,442.1	163.3	0.11	2,466,891.0
2055	-	-	-	-	4,279.9	42,280.0	-	1,326.8	1,326.8	141.9	0.11	2,467,032.9
2056	-	-	-	-	3,937.5	38,293.7	-	1,220.6	1,220.6	123.2	0.10	2,467,156.1
Total	**-**	**-**	**5,162,634.4**	**(1,018,632.2)**	**965,951.6**		**4,144,002.1**	**(1,300,971.6)**	**2,843,030.5**	**2,467,156.1**		

TRE6 Bottom Ash Chain Refurbishment
Bar-Loop Replacement vs Replacement Energy Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	309,546.6	(450,000.0)	18,000.0	457,200.0	(140,453.4)	(90,379.4)	(230,832.9)	(217,972.5)	0.94	(217,972.5)
2018	-	-	4,853,087.8	-	34,560.0	403,188.0	4,853,087.8	(1,493,743.6)	3,359,344.2	2,995,453.5	0.89	2,777,481.0
2019	-	-	-	(175,000.0)	45,795.2	531,333.0	(175,000.0)	14,196.5	(160,803.5)	(135,396.5)	0.84	2,642,084.4
2020	-	-	-	-	42,131.6	488,226.3	-	13,060.8	13,060.8	10,384.5	0.80	2,652,469.0
2021	-	-	-	(175,000.0)	52,761.1	609,568.2	(175,000.0)	16,355.9	(158,644.1)	(119,108.9)	0.75	2,533,360.1
2022	-	-	-	-	48,540.2	560,202.8	-	15,047.5	15,047.5	10,668.1	0.71	2,544,028.2
2023	-	-	-	(175,000.0)	58,657.0	675,786.5	(175,000.0)	18,183.7	(156,816.3)	(104,983.2)	0.67	2,439,045.1
2024	-	-	-	-	53,964.4	621,123.6	-	16,729.0	16,729.0	10,575.5	0.63	2,449,620.6
2025	-	-	-	(175,000.0)	63,647.2	731,833.7	(175,000.0)	19,730.6	(155,269.4)	(92,687.7)	0.60	2,356,932.9
2026	-	-	-	-	58,555.5	672,687.0	-	18,152.2	18,152.2	10,232.2	0.56	2,367,165.1
2027	-	-	-	(175,000.0)	67,871.0	779,272.1	(175,000.0)	21,040.0	(153,960.0)	(81,950.6)	0.53	2,285,214.4
2028	-	-	-	-	62,441.3	716,330.3	-	19,356.8	19,356.8	9,729.3	0.50	2,294,943.8
2029	-	-	-	-	57,446.0	658,423.9	-	17,808.3	17,808.3	8,452.3	0.47	2,303,396.1
2030	-	-	-	-	52,850.4	605,150.0	-	16,383.6	16,383.6	7,342.9	0.45	2,310,738.9
2031	-	-	-	-	48,622.3	556,138.0	-	15,072.9	15,072.9	6,379.1	0.42	2,317,118.0
2032	-	-	-	-	44,732.5	511,046.9	-	13,867.1	13,867.1	5,541.8	0.40	2,322,659.8
2033	-	-	-	-	41,153.9	469,563.2	-	12,757.7	12,757.7	4,814.4	0.38	2,327,474.2
2034	-	-	-	-	37,861.6	431,398.1	-	11,737.1	11,737.1	4,182.5	0.36	2,331,656.7
2035	-	-	-	-	34,832.7	396,286.3	-	10,798.1	10,798.1	3,633.5	0.34	2,335,290.2
2036	-	-	-	-	32,046.1	363,983.4	-	9,934.3	9,934.3	3,156.6	0.32	2,338,446.8
2037	-	-	-	-	29,482.4	334,264.7	-	9,139.5	9,139.5	2,742.3	0.30	2,341,189.0
2038	-	-	-	-	27,123.8	306,923.5	-	8,408.4	8,408.4	2,382.3	0.28	2,343,571.4
2039	-	-	-	-	24,953.9	281,769.6	-	7,735.7	7,735.7	2,069.6	0.27	2,345,641.0
2040	-	-	-	-	22,957.6	258,628.1	-	7,116.9	7,116.9	1,798.0	0.25	2,347,439.0
2041	-	-	-	-	21,121.0	237,337.8	-	6,547.5	6,547.5	1,562.0	0.24	2,349,000.9
2042	-	-	-	-	19,431.3	217,750.8	-	6,023.7	6,023.7	1,357.0	0.23	2,350,357.9
2043	-	-	-	-	17,876.8	199,730.7	-	5,541.8	5,541.8	1,178.9	0.21	2,351,536.8
2044	-	-	-	-	16,446.7	183,152.3	-	5,098.5	5,098.5	1,024.1	0.20	2,352,560.9
2045	-	-	-	-	15,130.9	167,900.1	-	4,690.6	4,690.6	889.7	0.19	2,353,450.6
2046	-	-	-	-	13,920.4	153,868.1	-	4,315.3	4,315.3	772.9	0.18	2,354,223.5
2047	-	-	-	-	12,806.8	140,958.6	-	3,970.1	3,970.1	671.5	0.17	2,354,895.0
2048	-	-	-	-	11,782.3	129,081.9	-	3,652.5	3,652.5	583.3	0.16	2,355,478.3
2049	-	-	-	-	10,839.7	118,155.4	-	3,360.3	3,360.3	506.8	0.15	2,355,985.1
2050	-	-	-	-	9,972.5	108,103.0	-	3,091.5	3,091.5	440.3	0.14	2,356,425.3
2051	-	-	-	-	9,174.7	98,854.7	-	2,844.2	2,844.2	382.5	0.13	2,356,807.8
2052	-	-	-	-	8,440.7	90,346.3	-	2,616.6	2,616.6	332.3	0.13	2,357,140.1
2053	-	-	-	-	7,765.5	82,518.6	-	2,407.3	2,407.3	288.7	0.12	2,357,428.7
2054	-	-	-	-	7,144.2	75,317.1	-	2,214.7	2,214.7	250.8	0.11	2,357,679.5
2055	-	-	-	-	6,572.7	68,691.8	-	2,037.5	2,037.5	217.9	0.11	2,357,897.4
2056	-	-	-	-	6,046.9	62,596.4	-	1,874.5	1,874.5	189.3	0.10	2,358,086.6
	-	**-**	**5,162,634.4**	**(1,325,000.0)**	**1,255,460.9**		**3,837,634.4**	**(1,211,223.8)**	**2,626,410.6**	**2,358,086.6**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
Chain Replacement vs Replacement Energy Costs
Bar-Loop Replacement vs Replacement Energy Costs
Test 3
Test 4
Year

Allen-Sherman-Hoff
a Division of Diamond Power International, Inc.

Trusted for experience. Preferred for performance.

June 12, 2015

Nova Scotia Power Corporation
Trenton Generating Station
Trenton, Nova Scotia
B0K 1X0

Attention: Mr. Jack Lewis

Reference: **Modifications to Existing Submerged Bottom Ash Drag Conveyor**
Trenton Station Unit No. 6
Original A-S-H Contract 5070-02
Our Estimate No.: 2151072

Gentlemen:

In accordance with the recent visit by our Field Engineer, Mr. Skip Calabrese, we are pleased to quote budgetary pricing to supply the new round link ship chain components for one (1) Submerged Bottom Ash Drag Conveyor originally supplied under contract 5070-02

Our proposal will consist of the following:

Allen-Sherman-Hoff
a Division of Diamond Power International, Inc.

Trusted for experience. Preferred for performance.

Please note that any order resulting from this proposal should be placed on Diamond Canapower in Cambridge, Ontario Canada.
Contact information;

Diamond Canapower
75 Savage Drive
Cambridge, Ontario, Canada
N1T 1S5
Phone 1-888-827-4272
Phone 1-519-621-1975
Fax 1-519-621-1277

We wish to thank you for the opportunity to work with you on this project. If you have any questions regarding this quotation or if you require any additional information, please feel free to contact us.

Respectfully submitted,

Allen-Sherman-Hoff

Angelo M. Matrisciano

Angelo Matrisciano
Application Engineer

Allen-Sherman-Hoff

F. A. 'Skip' Calabrese

Frank A. "Skip" Calabrese

:

Sr. Field Evaluation Engineer
Engineered Systems Group

(630) 258-9574 Mobile
(618) 262-8979 Office
(440) 332-1768 Fax
facalabrese@a-s-h.com

cc: David P. Gibbs, Diamond Canapower – Cambridge, ON. dpgibbs@babcock.com
Mike Stubbings, Diamond Canapower – Dartmouth, NS. mstubbings@diamondpower.com
A-S-H file, Exton, PA
file

SYSTEM DESCRIPTION

We propose to furnish the necessary engineering and materials to modify one (1) Existing Submerged Bottom Ash Drag Conveyor (aka SSC). The modifications will include replacing the chain, sprockets, idler wheels and flights using round link type ship chain in place of the existing bar loop type chain.

<u>DETAILS OF CONSTRUCTION</u>

<u>A. Submerged Bottom Ash Drag Conveyor</u>

1. <u>Conveyor Chains</u>

The conveyor chains will be 30 mm diameter x 120mm pitch, round link type chain as manufactured by Rud or equal. The chains will be furnished in matched pairs complete with flat master links. The chain links will be case hardened to a minimum depth of 0.045d of the wire diameter to a nominal hardness of 800 Vickers. The chains will have a breaking strength of 566KN. The chains will be shipped in 5.6m length strands

<u>Note:</u> The conveyor chain size was selected to most closely match that of the existing bar loop type chain.

2. <u>Conveyor Flights and Attachments</u>

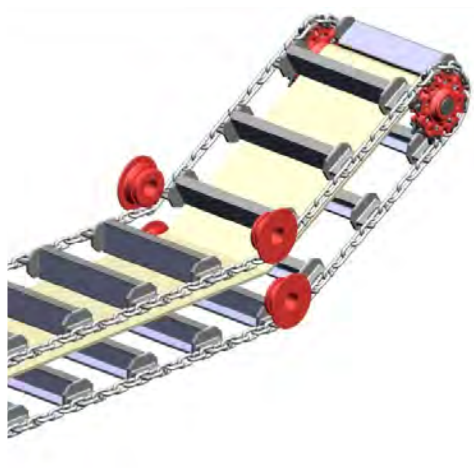
The flights will be 9.5" high attached to the chains at 47.2" (10 pitches) by means of self-locking plug in reversible attachments. The flights will consist of 8" high carbon steel structural tubing with replaceable ¾" thick AR-400 abrasion resistant wear flats on the top and bottom of the tubing.

The flight attachments will be welded to the flights.

3. Conveyor Shafts, Sprockets and Idler Wheels

a. The conveyor drive sprockets will be 9 tooth, 24.17" (690 mm) pitch diameter mounted on a solid shaft supported by two (2) spherical roller bearings. The sprockets will be made of the same material as the chain and will have bolted teeth for easy removal and installation.

b. The four (4) idler assemblies in the submerged upper trough will be of the cantilevered type which will be mounted to an externally removable support plate. The idlers will have internally mounted self aligning, anti-friction bearings which will be re-greaseable from outside the trough.



c. The idlers for the dry return run will be mounted on carbon steel through shafts supported by pillow block or flange block roller bearings mounted to an externally removable support plate. There will be two (2) return run idler assemblies.

d. The two (2) take-up idler assemblies will be of the cantilevered type, supported by a take-up block mounted in center pull type take-up frames. The take-up idlers will have internally mounted self-aligning, anti-friction bearings.

e. One (1) carbon steel frame to be mounted on existing conveyor.

f. Two (2) hydraulic take up cylinders to be used with existing hydraulic power unit. Limit switches are supplied to indicate end of travel take up.

g. Two (2) Zero speed switches for the take up section

Note: All modifications to the conveyor trough (new liners or base metal replacement) or modifications to the existing hydraulic power unit will be by others.

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PRICING SHEET

The lump sum **Budget** price to design and supply round link/ ship chain components for one (1) Submerged Bottom Ash Drag Conveyor described within our proposal, F.O.B. our shops (Lancaster, OHIO)……………. .... [redacted]

The **additional** cost for one (1) five (5) day trip to the jobsite for supervision of installation or startup is [redacted]

Note: All pricing is in Canadian Dollars.
All taxes, duties and customs formalities are extra.

Our pricing is valid for 90 days and is based upon shipment by December 2016.

Terms:
Payment Terms please see below.
All Invoices are due Net 30 Days
Unless otherwise stated this offer may be modified or withdrawn prior to acceptance and expires on September 8, 2015.
Delivery Lead Times are dependent on capacity and work-in progress at time of order placement and shipping date will be set after receipt of formal purchase order.
All other terms as per Diamond Canapower Standard Terms and Conditions of Sale Form DC-1-70P Rev 08/02.

Any Order resulting from this proposal shall be placed on Diamond Canapower, Cambridge. Ontario.

Diamond Canapower
75 Savage Drive
Cambridge, Ontario, Canada
N1T 1S5
Phone 1-888-827-4272
Phone 1-519-621-1975
Fax 1-519-621-1277

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EQUIPMENT AND SERVICES BY OTHERS

Allen-Sherman-Hoff will **not** provide the following materials or services.

- Any major piece of equipment not listed.
- Unloading, storage, erection or supervision of erection.
- Demolition or revisions to existing equipment.
- Foundations and foundation bolts.
- Concrete work that may be required.
- Hydraulic and air piping or installation of same.
- Cutting or patching to concrete walls or floors.
- Insulation and heat tracing or design of same.
- Installation of any insulation or heat tracing.
- Field paint or application of same.
- Field measuring or verification of field dimensions.
- Storage of equipment at the jobsite.
- Motor control centers, control panels or any other electrical equipment.
- Electrical wire, wiring, conduit, layout, testing or design of same.
- Electrical grounding where required.
- Electrical power and control wiring to drives including all necessary conduit, disconnects and motor starters.
- All building enclosures and supports.
- Communications, lighting and lightning protection.
- Conveyor trough modifications or trough carry run liners.
- Walkways and platforms including hand railing and grating, stairs and ladders.
- Modifications to the Hydraulic power unit.
- Any Applicable, federal, provincial, or local use taxes.
- Any permits licenses or other fees which may be required for installation of this equipment.

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Estimate No.: 2151072
Date: June 10, 2015

SUPPLEMENTAL NOTES

PURCHASE ORDERS:	Are to be written to Diamond Canapower forwarded to the address shown herein.
DRAWINGS:	Three (3) sets of drawings for approval will be supplied (4 to 6) weeks after receipt of a written P.O. and complete information. Certified drawings will be provided (2 to 3) weeks after receipt of approval.
MANUALS:	Unless otherwise noted herein, (3) sets of operation and maintenance manuals will be provided. Should additional sets be required, they are available at a cost of [redacted] each.
SHIPMENT:	Shipment of equipment can be made (22 to 26) weeks after receipt of approval and complete release for manufacturing. We can review our schedule to meet your project requirements.
PAYMENT:	Our standard payment terms are: 10% to accompany written P.O. 15% upon submittal of drawings for approval, 25% upon submittal of certified drawings. 50% will be invoiced upon shipment and due Net (30). If desired, special payment terms can be negotiated to meet individual project requirements.
VALIDITY:	This proposal is valid for a period of (90) days from the date of quotation with delivery made by the end of the year 2016
FIELD SERVICE:	Unless otherwise noted herein, services of a factory technician to assist in start-up and operator training are not included. Please contact Diamond Canapower for our Field Service Rates and Terms of Service.

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Diamond Canapower
TERMS AND CONDITIONS OF SALE

This Quotation and any resulting sale is conditional on the terms and conditions set forth below. Any additional or different terms or conditions submitted by Purchaser shall be deemed objected to by Company and shall be of no effect nor in any circumstance binding upon Company unless accepted by Company in writing. If Purchaser objects to any of the terms and conditions, said objection must be specifically brought to the attention of Company by Purchaser by a written instrument separate from any purchase order or other printed form of Purchaser. Said objections shall be deemed proposals for different terms and conditions and may be accepted only by a writing executed by an authorized representative of the Company at its office in Burlington, Ontario.

1. ACCEPTANCE: This Quotation is open for 30 days from the date thereof, and no acceptance of same is binding upon the Company unless and until acknowledged by the Company in writing from its head office in Burlington, Ontario.

2. PRICING: Unless otherwise stated, all prices are in Canadian funds at par, Burlington, Ontario, and do not include present and/or possible future Federal, Provincial or Municipal Sales Taxes, Excise Taxes or other levies. Such prices are subject to increase or decrease to the extent of any change (either before or after acceptance) in transportation rates, import duties, sales taxes (when included), foreign exchange rates, or the imposition of any new form of taxation.

3. TERMS OF PAYMENT: Unless otherwise stated Terms of Payment are net 30 days.

4. WARRANTY: The Company warrants products of its own manufacture to be free from defects in material and workmanship for a period of one year from the date of shipment provided that such products have been stored, installed, operated and maintained in accordance with the Company's recommendations. The Company shall have the option to repair, replace, or refund the purchase price of any such defective part, F.O.B. its Works, provided that the Purchaser has given the Company immediate written notice of any alleged defects and that use of such equipment is promptly discontinued. This warranty shall terminate and the Company shall not be liable if the Purchaser has permitted any modification, adjustment and/or repair to the product without the express written consent of the Company. Warranty on parts and equipment not manufactured by the Company shall be limited to the warranty, if any, of the manufacturer or supplier of such parts and equipment. The Company makes no warranty of merchantability or of fitness for any purpose, and no other express or implied warranties whether statutory or otherwise which extend beyond the warranties set forth in this Paragraph 4. Notwithstanding any breach of contract or negligence on the part of the Company, the foregoing constitutes the sole obligations of the company and the sole remedy of the Purchaser.

5. CONSEQUENTIAL DAMAGES: COMPANY SHALL NOT BE LIABLE FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, UNDER ANY CIRCUMSTANCES, including but not limited to damage or loss resulting from inability to use the equipment, increased operating cost, loss of production, loss of anticipated profits, or other special, incidental or consequential damages whether similar or dissimilar, of any nature arising from any cause whatsoever, including negligence.

6. LIMITATION OF LIABILITY: Seller's maximum liability hereunder arising from any cause whatsoever, whether based in contract, tort (including negligence), strict liability, or any other theory of law, shall not exceed the contract price. Any above mentioned cause of action must be commenced within one (1) year from the date of which that action accrues.

7. NUCLEAR LIMITATION OF USE: The equipment is not for use in or with any nuclear facility unless specifically so stated in Company's Quotation. If Company's Quotation does expressly acknowledge that the equipment is to be used in or with a nuclear facility, Company's Special Nuclear Conditions will be attached hereto and shall control.
Purchaser accepts the responsibility for insuring that the equipment is not used in violation of this limitation and Purchaser shall indemnify and hold Company harmless from any and all liability (including such liability resulting from Company's negligence) arising out of said improper use.

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8. INSURANCE: Company shall maintain Comprehensive General Liability insurance policies to protect Company's legal liability and Workers' Compensation protection for Company's employees. However, Company shall not accept any contractual liability for indemnity.

9. DELIVERY: Delivery of the equipment shall be made F.O.B. shipping point unless otherwise stipulated in a writing signed by the Company. Shipping schedules are the best estimate possible at time of Quotation, but are not guaranteed. Such estimates shall date from the acknowledgement of the order by the Company, or from when all information required for manufacture has been supplied by the Purchaser, whichever is the later, and are contingent upon fires, floods, strikes, lockouts, delays in transportation, or any other cause beyond the control of the Company. If Purchaser delays delivery of any items, Company may invoice Purchaser for said items and hold them at Purchaser's risk and expense pending instructions from Purchaser.

10. PATENTS: Company shall defend at its own expense any suit or action brought against Purchaser based on a claim that the equipment, operating alone and based solely on Company's design or any part thereof, manufactured by the Company constitutes an infringement of any Canadian patent in effect on the date of Company's Quotation, if notified promptly in writing and given authority, information and assistance for the defense of same, and Company shall pay all costs awarded therein against Purchaser. In case the equipment, or any part thereof, is held in such suit to constitute an infringement and its use is enjoined, Company shall, at its own expense, either procure for the Purchaser the right to continue using said equipment; or replace same with non-infringing equipment; or modify it so it becomes non-infringing; or remove said equipment and refund the contract price and the transportation and installation costs thereof.

11. FIELD ADVISORY SERVICES: Field Advisory Services can be supplied for erection or start up and operator training at prevailing daily rates per man including travelling and waiting time based on a normal 8 hour working day plus all travelling and living expenses extra at cost. Overtime and Saturdays will be charged at 1□ times daily rate. Sundays and holidays will be charged at 2 times daily rate.

12. NON-WAIVER: No failure of Company to insist upon strict compliance of Purchaser to any of these Terms and Conditions or to promptly exercise any right accruing from any default of Purchaser shall impair Company's rights in case Purchaser's default continues or in case of any subsequent default by Purchaser.

13. ASSIGNMENT: Neither Company nor Purchaser shall have the right to assign any right or interest in Company's Quotation or any resulting contract, unless such assignment is in connection with the transfer of all or substantially all of the assignor's business.

14. TITLE: Although risk of loss passes to Purchaser upon shipment, title to all products sold shall remain in the Company, which shall have the right of repossession for default, until payment of purchase price has been made in full by the Purchaser.

15. PROPRIETARY INFORMATION: The specifications, drawings, manufacturing data and other information transmitted between Company and Purchaser in connection with Company's Quotation and any resulting sales are the property of the originating party and are disclosed in confidence on the condition that they are not to be reproduced, copied or used for any purpose detrimental to the interest of the other.

16. GOVERNING LAW: The rights and obligations of Company and Purchaser with respect to Company's Quotation and any resulting contract shall be governed by the laws of the Province of Ontario.

17. DISCLAIMER OF DAMAGES: Notwithstanding any other provision of the Contract, in no event shall the Seller or its subcontractors or suppliers be liable, whether arising under Contract, tort (including negligence), strict liability, or otherwise, for loss of anticipated profits, loss by reason of plant shutdown, non-operation or increased expense of operation, service interruptions, cost of purchased or replacement power, claims of customers, cost of money, loss of use of capital or revenue, decontamination expenses, or for any special, incidental, or consequential loss or damage of any nature arising at any time or from any cause whatsoever.

Form DC-1-70, Rev. 4/93

CI Number: 49431

Title: LIN Mill Refurbishment 2017

Start Date: 2017/04
In-Service Date: 2017/10
Final Cost Date: 2018/04
Function: Steam
Forecast Amount: $665,839

DESCRIPTION:

Lingan Generating Station employs sixteen Raymond Bowl style mills to pulverize coal for combustion in the boiler. This project is to replace coal mill components that have reached the end of their useful life on two of the sixteen mills. Based on experienced wear characteristics, component failures will occur if a replacement plan is not performed. The consequence of such a failure could include unplanned unit derating.

This capital item includes the replacement of welded steel rollers and tables with ceramic wear components, worm gear & shaft, vertical shaft and other non-repairable mill components. Components either to be replaced or refurbished will be determined based on the condition assessment when teardown is undertaken as part of the planned outage for each mill in 2017. Going forward continued capital investment of the Lingan mills will still be required to extend asset life and ensure the reliability of this equipment is maintained.

These mills service all units at the Lingan generating station. Current expectation is that this project will not include the refurbishment of any mills on Unit #2. However, if mills on Unit #2 were found to require refurbishment in 2017, investment on Unit #2 could still be the best option. All four units at Lingan are similar and as such, the components refurbished on this coal mill can be transferred to any of the other Lingan coal mills when Lingan Unit #2 is retired. This includes welded steel rollers and tables with ceramic wear components, worm gear and shaft, vertical shaft and other components that will be addressed in this capital item. The useful life of these coal mill components is more than double the payback period shown in the EAM, providing a significant benefit to all of the coal mills at Lingan.

Due to the change in utilization of the Lingan Generating Station, it is anticipated that the requirement to refurbish two of the sixteen mills annually will be reduced to a single mill for 2018.

Summary of Related CIs +/- 2 years:
2015 CI 46055 LIN Mill Refurbishment 2015 $736,546
2016 CI 47505 LIN Mill Refurbishment 2016 $749,183
2018 CI TBD LIN Coal Mill Refurbishment 2018 $TBD
2019 CI TBD LIN Coal Mill Refurbishment 2019 $TBD

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

This project is being completed to mitigate the risk of mill failure. A mill failure could limit the ability of the unit to reach rated generation depending on the fuel blend in service. It is imperative that the mills are available full time between planned outages in order to maintain unit performance at rated capacity. The replacement of mechanical components and the upgrading of the ceramic surfaces are necessary to achieve the most economic operation of the unit.

This project is being undertaken primarily to prevent unit deratings, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

A total of sixteen coal mills are installed on the four units at Lingan. An orderly approach to mill refurbishment manages the availability of the assets and supports the operation of the generating units that they serve. Operating and maintenance experience with the mills has identified several areas of concern that need to be addressed in order for the mills to meet availability targets. Replacement parts are now needed due to age and wear on many of the components. During periods of lower load it is possible to take 1 of 4 mills out of service without affecting generation. Isolated repairs and minor refurbishment are not typically possible for the mills. To access components and complete the required equipment replacement, it is necessary to disassemble the mill and therefore an overall refurbishment versus isolated repairs is more effective.

Why do this project this way?

A phased approach to upgrading the mills allows for scheduled outages of selected mills, reducing the risk of extended unplanned outages. By planning refurbishments in a given year the refurbishment efforts can be made more efficient, with dedicated labour and parts available as required.

CI Number : 49431 - LIN Mill Refurbishment 2017 **Project Number**

Parent CI Number : -

Cost Centre : 301 - 301-Lingan Admin./Common Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		6,223	0	6,223
095		095-Thermal Term Labour AO		12,281	0	12,281
095		095-Thermal Regular Labour AO		28,292	0	28,292
001	018	001 - THERMAL Regular Labour	018 - SGP - Fuel Hndlg.Coal	131,822	0	131,822
004	018	004 - THERMAL Term Labour	018 - SGP - Fuel Hndlg.Coal	57,221	0	57,221
012	018	012 - Materials	018 - SGP - Fuel Hndlg.Coal	430,000	0	430,000
			Total Cost:	665,839	0	665,839
			Original Cost:	514,626		

Capital Project Detailed Estimate

Location: **Lingan Generating Station**
CI# / FP#: 49431
Title: LIN Mill Refurbishment 2017
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Maintenance Trades	PD	306	$ 358	$ 109,490		47505, 44351
Utility worker	PD	95	$ 235	$ 22,332		47505, 44351
			Sub-Total	$ 131,822		
004 Term Labour						
Maintenance Trades	PD	160	$ 358	$ 57,221		47505, 44351
			Sub-Total	$ 57,221		
012 Materials						
OEM and Locally Manufactured Parts	ea	1	$ 430,000	$ 430,000		47505, 44351
			Sub-Total	$ 430,000		
094 Interest Capitalized						
				$ 6,223		
			Sub-Total	$ 6,223		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 28,292		
Thermal Term Labour AO				$ 12,281		
			Sub-Total	$ 40,572		
			SUB-TOTAL (no AO, AFUDC)	$ 619,043		
			TOTAL (AO, AFUDC included)	$ 665,839		
Original Cost				$ 514,626		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

LIN Mill Refurbishment 2017
Summary of Alternatives

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Lingan Generating Station	**CI Number:**	49431
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Mill Refurbishment vs Avoided Fuel & R	5.90%	-1,691,100	1,194,147	1	47.30%	2.7 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

Plant recommends completing this project to help avoid mill related deratings.

Notes/Comments :

Mill Refurbishment vs Avoided Fuel & Repair Costs

Failure scenario is loss of a Mill during peak unit load. With current coal blends (Low sulf., low BTU) , all four Mills are required for peak load. A derate of approx 20 MW is expected if a Mill is not available. A significant Mill repair, incl material lead time is 2 - 4 weeks. This scenario assumes the Mill is unavailable for 4 weeks for teardown and materials lead time.

Test 2

Test 3

Test 4

LIN Mill Refurbishment 2017
Summary of Sensitivities

Nova Scotia POWE
An Emera Compa

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Lingan Generating Station	**CI Number:**	49431
		Project No. :	

	Alternative	**After Tax WACC**	**PV of Revenue Requirement**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Mill Refurbishment vs Avoided Fuel & Repair Cos	5.90%	-1,691,100	1,194,147	1	47.30%	2.7 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	**Variance (%)**	**PV of Revenue Requirement**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Mill Refurbishment vs Avoided Fuel & Repair Cos	10%	-1,630,105	1,145,800	1	42.11%	3.0 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years

Change:	**A**	60,994	-48,347	0	-5.19%	0.3 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	**Variance (%)**	**PV of Revenue Requirement**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Mill Refurbishment vs Avoided Fuel & Repair Cos	-10%	-1,460,995	1,026,385	1	41.60%	3.0 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years

Change:	**A**	230,104	-167,762	0	-5.71%	0.3 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	**PV of Revenue Requirement** 1	**PV of Revenue Requirement** 2	**PV of Revenue Requirement** 3	**Delay?**
	A	142,038	333,723	610,451	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

LIN Mill Refurbishment 2017
Avoided Cost Calculations

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Lingan Generating Station	**CI Number:**	49431
		Project No. :	

Mill Refurbishment vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			161,800	168,287		
Events/Outages (#)	2	2	2	2		
Probability of Occurance (%)	40%	60%	40%	60%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	20.0	20.0				
Duration (Hours or Years)	672	672				
Totals	$53,113	$55,440	$129,440	$201,944	$182,553	$257,384
Total Capital Cost of Alternative						$665,839

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

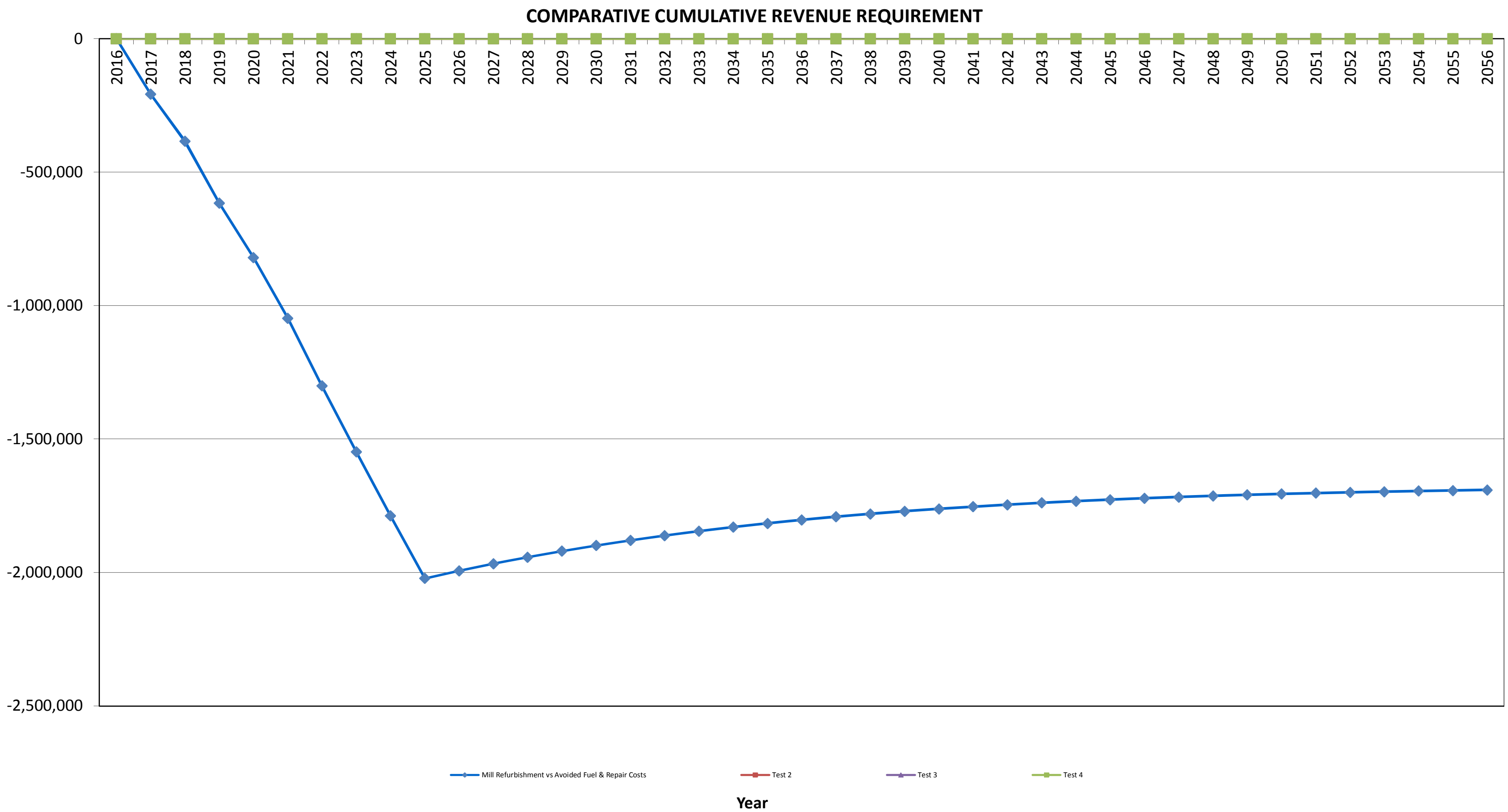
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

LIN Mill Refurbishment 2017
Mill Refurbishment vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	182,553.0	(625,266.5)	24,761.7	605,479.5	(442,713.5)	(48,915.3)	(491,628.8)	(464,238.7)	0.94	(464,238.7)
2018	-	-	257,383.9	-	47,542.5	556,067.4	257,383.9	(65,050.8)	192,333.0	171,499.2	0.89	(292,739.6)
2019	-	-	340,750.6	-	43,739.1	510,608.3	340,750.6	(92,073.5)	248,677.0	209,386.1	0.84	(83,353.5)
2020	-	-	324,575.3	-	40,240.0	468,785.9	324,575.3	(88,143.9)	236,431.4	187,984.1	0.80	104,630.6
2021	-	-	375,637.4	-	37,020.8	430,309.3	375,637.4	(104,971.1)	270,666.2	203,214.3	0.75	307,844.9
2022	-	-	437,891.5	-	34,059.1	394,910.8	437,891.5	(125,188.0)	312,703.5	221,695.5	0.71	529,540.5
2023	-	-	453,771.5	-	31,334.4	362,344.2	453,771.5	(130,955.5)	322,816.0	216,114.2	0.67	745,654.7
2024	-	-	470,254.6	-	28,827.6	332,382.9	470,254.6	(136,842.4)	333,412.3	210,772.5	0.63	956,427.1
2025	-	-	487,364.4	-	26,521.4	304,818.5	487,364.4	(142,861.3)	344,503.1	205,650.4	0.60	1,162,077.5
2026	-	-	-	-	24,399.7	279,459.3	-	7,563.9	7,563.9	4,263.7	0.56	1,166,341.2
2027	-	-	-	-	22,447.7	256,128.8	-	6,958.8	6,958.8	3,704.1	0.53	1,170,045.2
2028	-	-	-	-	20,651.9	234,664.8	-	6,402.1	6,402.1	3,217.9	0.50	1,173,263.1
2029	-	-	-	-	18,999.8	214,917.9	-	5,889.9	5,889.9	2,795.5	0.47	1,176,058.7
2030	-	-	-	-	17,479.8	196,750.7	-	5,418.7	5,418.7	2,428.6	0.45	1,178,487.2
2031	-	-	-	-	16,081.4	180,036.9	-	4,985.2	4,985.2	2,109.8	0.42	1,180,597.1
2032	-	-	-	-	14,794.9	164,660.2	-	4,586.4	4,586.4	1,832.9	0.40	1,182,430.0
2033	-	-	-	-	13,611.3	150,513.7	-	4,219.5	4,219.5	1,592.3	0.38	1,184,022.3
2034	-	-	-	-	12,522.4	137,498.8	-	3,881.9	3,881.9	1,383.3	0.36	1,185,405.6
2035	-	-	-	-	11,520.6	125,525.2	-	3,571.4	3,571.4	1,201.7	0.34	1,186,607.4
2036	-	-	-	-	10,599.0	114,509.4	-	3,285.7	3,285.7	1,044.0	0.32	1,187,651.4
2037	-	-	-	-	9,751.0	104,374.9	-	3,022.8	3,022.8	907.0	0.30	1,188,558.3
2038	-	-	-	-	8,971.0	95,051.2	-	2,781.0	2,781.0	787.9	0.28	1,189,346.3
2039	-	-	-	-	8,253.3	86,473.4	-	2,558.5	2,558.5	684.5	0.27	1,190,030.8
2040	-	-	-	-	7,593.0	78,581.8	-	2,353.8	2,353.8	594.7	0.25	1,190,625.5
2041	-	-	-	-	6,985.6	71,321.5	-	2,165.5	2,165.5	516.6	0.24	1,191,142.1
2042	-	-	-	-	6,426.7	64,642.0	-	1,992.3	1,992.3	448.8	0.23	1,191,590.9
2043	-	-	-	-	5,912.6	58,496.9	-	1,832.9	1,832.9	389.9	0.21	1,191,980.8
2044	-	-	-	-	5,439.6	52,843.4	-	1,686.3	1,686.3	338.7	0.20	1,192,319.5
2045	-	-	-	-	5,004.4	47,642.2	-	1,551.4	1,551.4	294.3	0.19	1,192,613.7
2046	-	-	-	-	4,604.1	42,857.1	-	1,427.3	1,427.3	255.6	0.18	1,192,869.4
2047	-	-	-	-	4,235.7	38,454.8	-	1,313.1	1,313.1	222.1	0.17	1,193,091.5
2048	-	-	-	-	3,896.9	34,404.7	-	1,208.0	1,208.0	192.9	0.16	1,193,284.4
2049	-	-	-	-	3,585.1	30,678.6	-	1,111.4	1,111.4	167.6	0.15	1,193,452.0
2050	-	-	-	-	3,298.3	27,250.5	-	1,022.5	1,022.5	145.6	0.14	1,193,597.6
2051	-	-	-	-	3,034.5	24,096.8	-	940.7	940.7	126.5	0.13	1,193,724.1
2052	-	-	-	-	2,791.7	21,195.3	-	865.4	865.4	109.9	0.13	1,193,834.0
2053	-	-	-	-	2,568.4	18,525.9	-	796.2	796.2	95.5	0.12	1,193,929.5
2054	-	-	-	-	2,362.9	16,070.1	-	732.5	732.5	82.9	0.11	1,194,012.4
2055	-	-	-	-	2,173.9	13,810.8	-	673.9	673.9	72.1	0.11	1,194,084.5
2056	-	-	-	-	2,000.0	11,732.2	-	620.0	620.0	62.6	0.10	1,194,147.1
Total	**-**	**-**	**3,330,182.1**	**(625,266.5)**	**596,043.8**		**2,704,915.5**	**(847,582.9)**	**1,857,332.7**	**1,194,147.1**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
-500,000
-1,000,000
-1,500,000
-2,000,000
-2,500,000
2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056
Mill Refurbishment vs Avoided Fuel & Repair Costs
Test 2
Test 3
Test 4
Year

CI Number: 49675

Title: TUC2 Cooling Water Piping Refurbishment

Start Date:	2017/05
In-Service Date:	2017/06
Final Cost Date:	2017/12
Function:	Steam
Forecast Amount:	$568,673

DESCRIPTION:

This project is for the refurbishment of the Tufts Cove #2 Circulating Water (CW) carbon steel piping. This project will extend the life of the piping, ensuring its structural integrity, and reduce the risk of Unit forced outages resulting from leaks in this system.

Summary of Related CIs +/- 2 years:
2015 CI 47934 TUC3 Cooling Water Piping Refurbishment $584,991

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

Exposure to a harsh environment and many years of operation has degraded the piping. The CW piping system brings seawater from the harbor to the condenser, lube oil coolers, generator seal oil coolers, distilled water coolers, general service cooling water heat exchangers and vacuum pump coolers, etc. The system is critical to plant generation and the development of leaks can put the unit at risk for a forced outage.

Why do this project now?

Several CW piping sections have degraded to the point of requiring refurbishment due to exposure to a harsh operating environment over their 35 year life. This project is required to extend the life and reduce the risk of forced unit outages resulting from further deterioration. Failure to address this issue now will increase the risk of forced outages and lead to more extensive and costly repair in the future.

Why do this project this way?

The scope of refurbishment would include sandblasting, internal plating where required, and application of a protective coating to the internal and external surfaces to prevent future corrosion. It is a proven technique successfully used on CI 47934 in 2015. A complete replacement of this piping is a more costly method and is not required.

CI Number : 49675 - TUC2 Cooling Water Piping Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 318 - 318-TC Unit 2 Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
095		095-Thermal & Hydro Contracts AO		38,958	0	38,958
095		095-Thermal Regular Labour AO		17,196	0	17,196
095		095-Thermal Overtime Labour AO		4,292	0	4,292
095		095 - Proj Supp Regular Labour AO		1,949	0	1,949
001	014	001 - Proj Supp Regular Labour	014 - SGP - Circ.Water Sys.	4,053	0	4,053
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	80,125	0	80,125
002	014	002 - THERMAL Overtime Labour	014 - SGP - Circ.Water Sys.	40,000	0	40,000
012	014	012 - Materials	014 - SGP - Circ.Water Sys.	20,000	0	20,000
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.	362,099	0	362,099
			Total Cost:	568,673	0	568,673
			Original Cost:	43,534		

Capital Project Detailed Estimate

Location: Steam
CI# : 49675
Title: TUC2 Cooling Water Piping Refurbishment
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Engineering	PD	10	$ 405	$ 4,053		47934
Maintenance Trades	PD	165	$ 365	$ 60,190		
Utility worker	PD	83	$ 240	$ 19,935		
	PD			$ -		
			Sub-Total	$ 84,178		
002 OT Labour						
Maintenance Trades	PD	41	$ 730	$ 29,913		
Utility worker	PD	21	$ 480	$ 10,087		
				$ -		
			Sub-Total	$ 40,000		
012 Materials						
Misc. Materials		1	$ 20,000	$ 20,000		
				$ -		
				$ -		
			Sub-Total	$ 20,000		
013 Contracts						
Pipe Internal Cleaning		1	$ 20,000	$ 20,000		
Pipe External Cleaning		1	$ 52,225	$ 52,225		
NDE Inspection		1	$ 8,232	$ 8,232		
Scaffolding		1	$ 43,886	$ 43,886		
Diving		1	$ 7,000	$ 7,000		
Welding		1	$ 19,369	$ 19,369		
Door Watch		1	$ 12,320	$ 12,320		
Crane		1	$ 3,971	$ 3,971		
Fabricate Rolled Steel Plates		1	$ 2,080	$ 2,080		
Engineering Services		1	$ 2,094	$ 2,094		
Platform truck		1	$ 990	$ 990		
Protective Coating Work		1	$ 189,932	$ 189,932		
			Sub-Total	$ 362,099		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 17,196		
Thermal OT Labour AO				$ 4,292		
Thermal Term Labour AO				$ -		
Thermal / Hydro Contracts AO				$ 38,958		
Project Support Regular AO				$ 1,949		
			Sub-Total	$ 62,396		
			SUB-TOTAL (no AO, AFUDC)	$ 506,277		
			TOTAL (AO, AFUDC included)	$ 568,673		
Original Cost				$ 43,534		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 47953

Title: LIN Railcar Positioner Refurbishment

Start Date:	2017/07
In-Service Date:	2017/09
Final Cost Date:	2018/03
Function:	Steam
Forecast Amount:	$566,619

DESCRIPTION:

This project is for the refurbishment of the railcar positioner at the Lingan rotary dumper. This includes the refurbishment of the structure and hydraulic pistons, and the replacement of hydraulic motors, lines and hoses. The positioner is original equipment to the plant and is required to position each railcar to be dumped. The railcar positioner is hydraulically powered; the hydraulic motors are no longer supported and spare parts are no longer available, which was discovered when an RFP was issued in 2016. The refurbishment of the positioner will update no longer supported equipment, thus increasing reliability.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

The railcar positioner is relied on almost daily to position railcars through the railcar dumper. Much of the hydraulic equipment on the positioner is no longer supported and spare parts are not available. Refurbishing the hydraulics will increase reliability and allow spare parts to be available if required.

This project is being undertaken primarily to prevent railcar positioner failure which would lead to costly coal trucking costs, as evident in the attached Economic Analysis.

Why do this project now?

The positioner's hydraulic components are no longer available; this project needs to be completed now before breakdowns occur and parts cannot be sourced. This would significantly extend the repair time of the positioner, impacting plant coal deliveries.

Why do this project this way?

Refurbishment of the coal positioner is a more cost effective solution than replacement as it is estimated that the replacement of the railcar positioner would be approximately $2 million.

CI Number : 47953 - LIN Railcar Positioner Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 301 - 301-Lingan Admin./Common Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		2,282	0	2,282
095		095-Thermal Term Labour AO		1,566	0	1,566
095		095-Thermal Regular Labour AO		3,132	0	3,132
095		095-Thermal & Hydro Contracts AO		17,752	0	17,752
001	018	001 - THERMAL Regular Labour	018 - SGP - Fuel Hndlg.Coal	14,591	0	14,591
004	018	004 - THERMAL Term Labour	018 - SGP - Fuel Hndlg.Coal	7,296	0	7,296
012	018	012 - Materials	018 - SGP - Fuel Hndlg.Coal	[redacted]	0	[redacted]
013	018	013 - POWER PRODUCTION Contracts	018 - SGP - Fuel Hndlg.Coal		0	
015	018	015 - Frt, Post & Delivery	018 - SGP - Fuel Hndlg.Coal	13,000	0	13,000
033	018	033 - Rental and Maintenance of	018 - SGP - Fuel Hndlg.Coal	[redacted]	0	[redacted]
			Total Cost:	566,619	0	566,619
			Original Cost:	118,027		

Capital Project Detailed Estimate

Location: Steam
CI# : 47953
Title: L N Railcar Positioner Refurbishment
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Maintenance Trades	PD	40	$ 364.79	$ 14,591		
			Sub-Total	$ 14,591		
004 Term Labour						
Maintenance Trades	PD	20	$ 364.79	$ 7,296		
			Sub-Total	$ 7,296		
012 Materials						
Positioner Materials	Lot	1	[redacted]		Cost Support Item #1	
			Sub-Total	[redacted]		
013 Contracts						
Positioner Refurbishment	Lot	1	[redacted]		Cost Support Item #1	
			Sub-Total	[redacted]		
015 Freight						
Freight	Ea.	2	$ 6,500	$ 13,000		
			Sub-Total	$ 13,000		
033 Equipment Rental						
Crane Rental	Ea.	2	[redacted]			
			Sub-Total	[redacted]		
094 Interest Capitalized						
AFUDC				$ 2,282		
			Sub-Total	$ 2,282		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 3,132		
Thermal Term Labour AO				$ 1,566		
Thermal / Hydro Contracts AO				$ 17,752		
			Sub-Total	$ 22,450		
			SUB-TOTAL (no AO, AFUDC)	$ 541,887		
			TOTAL (AO, AFUDC included)	$ 591,619		
Original Cost				$ 118,027		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

LIN Railcar Positioner Upgrade
Summary of Alternatives

Division :	Power Production	**Date :**	**9-Nov-16**
Department :	Lingan Generating Station	**CI Number:**	47953
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Upgrade Railcar Positioner vs Avoided	5.90%	-5,370,253	4,105,622	1	62.91%	2.5 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

The plant recommends completing this project to avoid extended railcar positioner breakdowns.

Notes/Comments :

Upgrade Railcar Positioner vs Avoided Fuel & Repair Costs

If coal cannot be delivered by rail and is required to be delivered by truck, the difference in price is assumed to be approximately $5 per metric tonne more, assuming approximately 12,000 metric tons are delivered daily, the difference between rail and trucking is $60,000. If the positioner breaks down it could take as long as 2 to 6 weeks to repair, for this anaylsis 3 (15 days) weeks will be assumed for a total cost of $900,000 per event.

Test 2

Test 3

Test 4

LIN Railcar Positioner Upgrade
Summary of Sensitivities

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Division :	Power Production	**Date :**	**9-Nov-16**
Department :	Lingan Generating Station	**CI Number:**	47953
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Upgrade Railcar Positioner vs Avoided Fuel & Re	5.90%	-5,370,253	4,105,622	1	62.91%	2.5 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Upgrade Railcar Positioner vs Avoided Fuel & Re	10%	-5,314,200	4,063,600	1	57.37%	2.7 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years

Change:						
	A	56,054	-42,023	0	-5.54%	0.2 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Upgrade Railcar Positioner vs Avoided Fuel & Re	-10%	-4,777,175	3,653,037	1	56.83%	2.7 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years

Change:						
	A	593,079	-452,585	0	-6.08%	0.3 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	151,161	334,291	583,162	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

LIN Railcar Positioner Upgrade
Avoided Cost Calculations

Division :	Power Production	**Date :**	**9-Nov-16**
Department :	Lingan Generating Station	**CI Number:**	47953
		Project No. :	

Upgrade Railcar Positioner vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	0.00	0.00				
Repair Cost ($)			949,200	987,172		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	20%	25%	20%	25%		
Capacity Factor (%)	0%	0%				
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$189,840	$246,793	$189,840	$246,793
Total Capital Cost of Alternative						$566,619

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	0.00	0.00				
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	0%	0%				
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	0.00	0.00				
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	0%	0%				
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

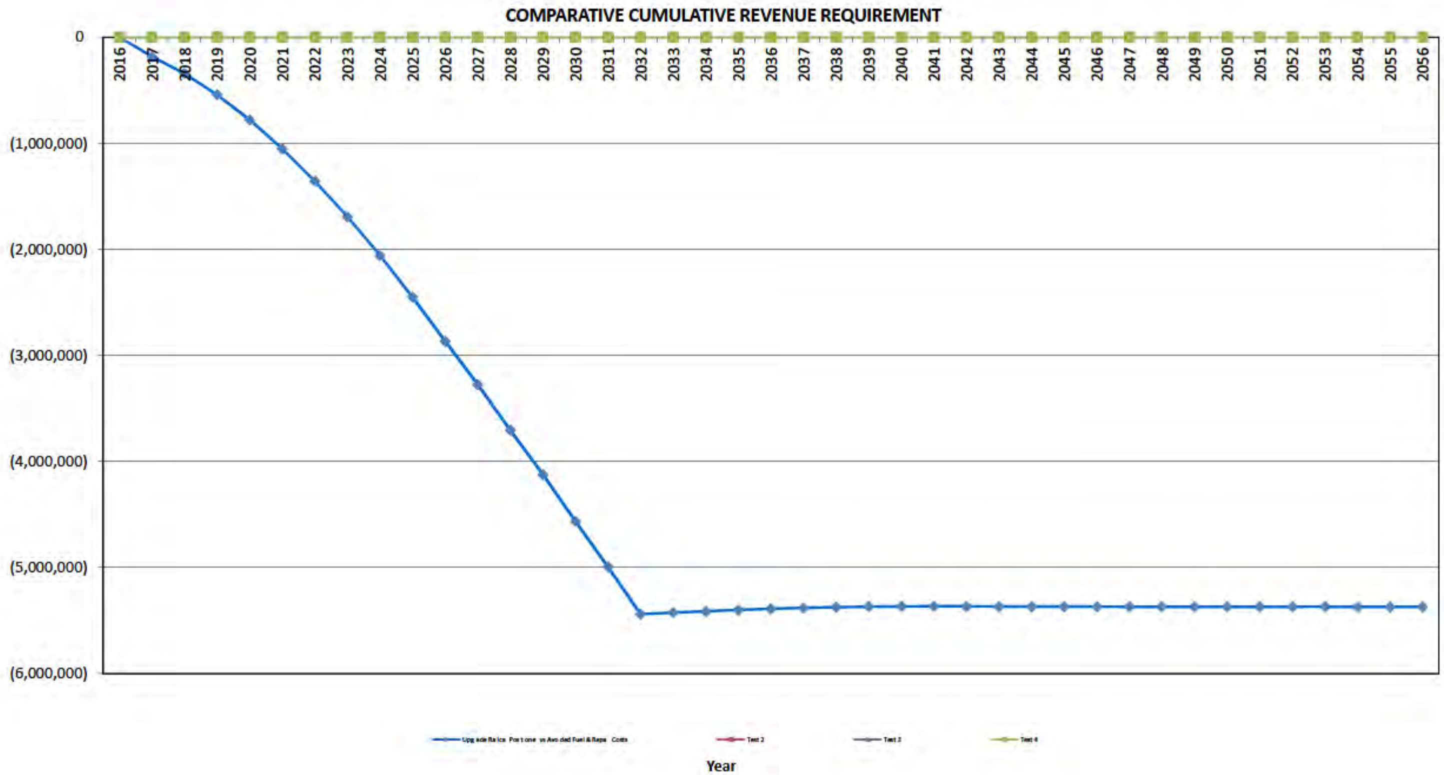
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	0.00	0.00				
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	0%	0%				
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

LIN Railcar Positioner Upgrade

Upgrade Railcar Positioner vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	189,840.0	(544,169.2)	21,675.5	526,407 9	(354,329.2)	(52,131.0)	(406,460.2)	(383,815.1)	0.94	(383,815.1)
2018	-	-	246,792.9	-	41,616.9	483,756.4	246,792.9	(63,604.6)	183,188.4	163,345.0	0.89	(220,470.1)
2019	-	-	307,998.7	-	38,287.6	444,517.1	307,998.7	(83,610.5)	224,388.3	188,934.9	0.84	(31,535.1)
2020	-	-	373,706.5	-	35,224.6	408,417 0	373,706.5	(104,929.4)	268,777.1	213,701.9	0.80	182,166.8
2021	-	-	444,178.5	-	32,406.6	375,204 8	444,178.5	(127,649.3)	316,529.2	237,647.9	0.75	419,814.7
2022	-	-	519,690.8	-	29,814.1	344,649.6	519,690.8	(151,861.8)	367,829.0	260,777.6	0.71	680,592.3
2023	-	-	600,533.9	-	27,429.0	316,538 9	600,533.9	(177,662.5)	422,871.3	283,097.8	0.67	963,690.1
2024	-	-	687,013.3	-	25,234.6	290,677 0	687,013.3	(205,151.4)	481,861.9	304,617.5	0.63	1,268,307.6
2025	-	-	779,450.7	-	23,215.9	266,884 0	779,450.7	(234,432.8)	545,017.9	325,347.2	0.60	1,593,654.9
2026	-	-	878,184.4	-	21,358.6	244,994 5	878,184.4	(265,616.0)	612,568.4	345,298.7	0.56	1,938,953.6
2027	-	-	913,315.2	-	19,649.9	224,856.1	913,315.2	(277,036.2)	636,279.0	338,681.9	0.53	2,277,635.6
2028	-	-	1,022,916.9	-	18,077.9	206,328 9	1,022,916.9	(311,500.1)	711,416.8	357,579.5	0.50	2,635,215.0
2029	-	-	1,063,837.5	-	16,631.7	189,283.7	1,063,837.5	(324,633.8)	739,203.7	350,846.1	0.47	2,986,061.2
2030	-	-	1,185,423.4	-	15,301.1	173,602 3	1,185,423.4	(362,737.9)	822,685.5	368,714.7	0.45	3,354,775.8
2031	-	-	1,232,845.0	-	14,077.1	159,175 3	1,232,845.0	(377,818.1)	855,026.9	361,859.8	0.42	3,716,635.6
2032	-	-	1,367,641.1	-	12,950.9	145,902 5	1,367,641.1	(419,954.0)	947,687.2	378,729.9	0.40	4,095,365.6
2033	-	-	-	-	11,914.8	133,691 5	-	3,693.6	3,693.6	1,393.9	0.38	4,096,759.4
2034	-	-	-	-	10,961.6	122,457.4	-	3,398.1	3,398.1	1,210.9	0.36	4,097,970.3
2035	-	-	-	-	10,084.7	112,122 0	-	3,126.3	3,126.3	1,052.0	0.34	4,099,022.3
2036	-	-	-	-	9,277.9	102,613.4	-	2,876.2	2,876.2	913.9	0.32	4,099,936.2
2037	-	-	-	-	8,535.7	93,865.6	-	2,646.1	2,646.1	793.9	0.30	4,100,730.1
2038	-	-	-	-	7,852.8	85,817.5	-	2,434.4	2,434.4	689.7	0.28	4,101,419.9
2039	-	-	-	-	7,224.6	78,413 3	-	2,239.6	2,239.6	599.2	0.27	4,102,019.1
2040	-	-	-	-	6,646.6	71,601 5	-	2,060.5	2,060.5	520.5	0.25	4,102,539.6
2041	-	-	-	-	6,114.9	65,334 5	-	1,895.6	1,895.6	452.2	0.24	4,102,991.8
2042	-	-	-	-	5,625.7	59,569.0	-	1,744.0	1,744.0	392.9	0.23	4,103,384.7
2043	-	-	-	-	5,175.7	54,264.7	-	1,604.5	1,604.5	341.3	0.21	4,103,726.0
2044	-	-	-	-	4,761.6	49,384.7	-	1,476.1	1,476.1	296.5	0.20	4,104,022.5
2045	-	-	-	-	4,380.7	44,895.1	-	1,358.0	1,358.0	257.6	0.19	4,104,280.1
2046	-	-	-	-	4,030.2	40,764.7	-	1,249.4	1,249.4	223.8	0.18	4,104,503.9
2047	-	-	-	-	3,707.8	36,964.8	-	1,149.4	1,149.4	194.4	0.17	4,104,698.3
2048	-	-	-	-	3,411.2	33,468.8	-	1,057.5	1,057.5	168.9	0.16	4,104,867.1
2049	-	-	-	-	3,138.3	30,252 5	-	972.9	972.9	146.7	0.15	4,105,013.9
2050	-	-	-	-	2,887.2	27,293 5	-	895.0	895.0	127.5	0.14	4,105,141.3
2051	-	-	-	-	2,656.2	24,571 2	-	823.4	823.4	110.7	0.13	4,105,252.1
2052	-	-	-	-	2,443.7	22,066.7	-	757.6	757.6	96.2	0.13	4,105,348.3
2053	-	-	-	-	2,248.2	19,762.6	-	697.0	697.0	83.6	0.12	4,105,431.8
2054	-	-	-	-	2,068.4	17,642 8	-	641.2	641.2	72.6	0.11	4,105,504.4
2055	-	-	-	-	1,902.9	15,692.6	-	589.9	589.9	63.1	0.11	4,105,567.5
2056	-	-	-	-	1,750.7	13,898.4	-	542.7	542.7	54.8	0.10	4,105,622.3
Total	**-**	**-**	**11,813,368.9**	**(544,169.2)**	**521,754.3**		**11,269,199.7**	**(3,500,400.5)**	**7,768,799.2**	**4,105,622.3**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
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Technical Proposal for

Lingan RailCar Positioner Refurbishment

NSPI RFP P-16-097

Submitted to:

Nova Scotia Power Inc.

Submitted by:

Target Hydraulics & Machine Works Ltd.
1615 Grand Lake Road
Sydney, NS B1M 1A3

April 28, 2016

TECHNICAL PROPOSAL INTRODUCTION

Please accept this proposal as a submission from Target Hydraulics and Machine Works Ltd. for the following Request for Proposal:

NSPI RFP P-16-097

Our submission includes this proposal, as well as other required documents, which are included as attachments to the submission email.

Communication Contact

Kenny MacLean

Owner and General Manager, Target Hydraulics and Machine Works

(902) 564-9229

Kenny.target@seaside.ns.ca

TECHNICAL PROPOSAL

11.1 ORGANIZATIONAL CAPABILITIES

a) Provide a brief overview of your company including your company name and headquarters address, the name of any sub-contractors or business partners used as part of this proposal, and length of time in business.

Located in Sydney, N.S , Target Hydraulics & Machine Works Ltd is a very resourceful and experienced service provider in areas provider in all arears pertaining to the. The Lingan Rail Car Positioner Refurbishment project.

Established in 1993, Target continues to grow and succeed in satisfying customer need. Offering a wide range of products and services under one roof, such as industrial mechanics- hydraulics-machining-metal fabrication-welding contribute to the exceptional reputation for quality and service.

Target Hydraulics & Machine Works Ltd., an ISO 9001:2008 standard registered company. The company has been a services provider for approximately 20 years to lingan and point aconi generation station for reverse engineering and deigns of industrial equipment. Our proximity to lingan power site is also a key part of our offering, as it makes us extremely accessible

For some of the most sensitive and critical components of The Lingan Rail Car Positioner Refurbishment, we propose to utilize the expertise of Bosch Rexroth Canada Corp. as a main supplier of components. Bosch Rexroth has much experience in similar rail car positioner drives. They also have proven applications in coal dust environments and in climates similar to what is experienced at the Lingan Power Generating Station. Bosch Rexroth team of support engineers specializing in product applications.

b) Give examples of previous engagements of similar nature/expertise/scale, including contact information for at least three references that are currently using your services that NSPI may contact.

The following are examples of projects we have previously delivered on that are relevant to the present request for proposal:

1. Manufacture of main components of superstructure for Marine Atlantic Loading Dock.
   Marine Atlantic.
   Tom Cholock, (902) 577-3543

2. Installation of hoppers, chutes and major coal handling systems.
   Logistec.
   John Walker, (902) 563 4460

3. On-site Diagnostics and Repair on the Lingan Railcar Positioner over the last 15 years.
   Lingan Power Generating Station, NSPI.
   Donnie MacLennan, (902) 862-6422

c) Identify key personnel within your management structure who will ultimately be accountable to NSPI for your company's performance.

President Kenny MacLean, office manager Michelle mazalin-smith

d) Provide your HST Number (Canadian Vendors) or Federal Tax Number (Non-Canadian Vendors).

HST number is: 136879129RT0001

1.2 TECHNICAL REQUIREMENTS

a) Provide detailed written descriptions of all alternatives/deviations from the specification or the requirements stated in Attachment "A" and why they should be considered as a preferred solution to NSPI's RFP.

The following is a specification alternative we would suggest:

Instead of replacing all the main hydraulic components with exact or close replicas within the same configuration and automation vintage, we are proposing a modernized main hydraulic system purchased from Bosch Rexroth. The simple reason for this being that many of the motors and parts are obsolete, prohibitive to purchase. Engineered and produced to spec by Bosch Rexroth, the new system will integrate with the existing functionality requirements of the "positioner" while implementing modern automation.

We would like to highlight the following within the quote:

- Deliver a complete & tested hydraulic skid
    - Complete piping to common hydraulic manifold
    - Complete skid control wiring to NEMA type 9 junction box
    - Complete replacement of obsolete components
    - No time lost in refurbishment of existing tank manifold and pumps
    - No time lost in fitting and flushing hose and piping
    - Dusty outside air does not get into system
    - Oil cleanliness will improve and system reliability will increase
    - Explosion proof rating
    - C-flange for bell-housed pump mount
    - High-efficiency rating
    - No time lost in "free issuing" and rework of old motors

Deliver new Hagglunds hydraulic motors
- Existing Sundstrand motors are obsolete and costly to repair or replace
- Replacement Sundstrand motors are 2-3x the cost of the proposed Hagglunds motors
- Hagglunds motor deliver smooth rotation and full torque in all required speed ranges

  - Motors come equipped with hydraulic operated parking brake for additional security
  - No time lost in rework of old motors

- Deliver new Hagglunds Spider controller
  - Tank and cooling systems are monitored
  - Drive pump flow and power output controlled
  - Flexible configuration of parameters of drive system
    - power / flow (speed)
    - acceleration / ramp rates
    - alarm / trips
  - Integration within existing control systems

- Bosch Rexroth offers current drive and control technology which will be available and serviceable for years to come

The following is a list of the items on the Scope-of-Work list, which would be incorporated into an updated assembly:

Item 1 Qty. 1 HPU – Reservoir / Pump Skid

• 1x Reservoir Skid – 450L (120GAL), 10% drip tray, carbon steel construction, closed construction with bladder isolator breather
• 1x PMG – 75kW (100HP), 575VAC/3P explosion proof motor with 355cc A4CSG pump (SP 355-SR-V-EP) – variable displacement piston pump, pressure compensated, electrical proportional controlled, 350bar nominal pressure – main drives

BR-I - Main Pump.pdf

• 1x PMG 11kW (15HP), 575VAC/3P explosion proof motor with 28cc A10 DR pump (AA10VSO28DR…) – variable displacement piston pump, pressure compensated, 280bar nominal pressure – auxiliary functions
• Max pumping capacity for drive is 620 LPM which results in max motor speed of ~27 RPM
• Power limiting of main drive by Spider controller - using current monitoring
• Custom control manifold for system pressure control & auxiliary functions – includes solenoid valves, pressure control valves, pressure switches
• Accumulator 20L (5GAL)
• Control electronics and valves terminated to Nema Type 9 enclosure keeping CSA class 2 Div 1 Group F in mind

• Air-Oil cooler with 2.2kW (3HP), 575VAC/3P explosion proof motor and anti-static fan
• Visual drive, boost and auxiliary pressure gauges
• Visual oil temperature and level gauges

BR-F - Rail Car
Positioner GA - 1x10C

• Hagglunds CA140 motors (CA140/120SB0NH0) – 7543cc/Rev – 120Nm/Bar – 350bar max pressure
• Hagglunds multi disk parking brake (BICA 24) – 24,000Nm Static Braking Torque
• Design pressure of 200bar required for 30TON force with three motors
• Optional two motor operation in case of failure with higher system pressure and limited tonnage

BR-B - Motor with
disk brake.pdf

- Shaft support plate / drive shafts/ ring adapter plate

Drive Motor Piping / Hose System

• Prefabricated to required dimensions and design of existing puller
• Pretested and flushed
• Tube-Mac system for piping (main flow – A & B lines) / SS swage type system for tube (flushing & leakage)
• Hose

Arm Head Manifold & Accumulator
• Custom manifold for arm head cylinder – includes PO check valve, pressure safety valve
• Accumulator – 20L (5GAL)
• Tubing/hose to/from arm head manifold
• Tubing/hose to/from accumulator

  - Manufacture new arm cylinder
  - Rebuild rotary actuator

Controller

BR-D - Spider
Controls.pdf

• Spider controller supplied for integration into existing control system by end user; controller takes care of the drive, cooling and tank systems

Spider is loose supply and intended for panel mounting

• Current transducers – loose supplied for main drive
• Basic programming verified an completed in BRCA shop test – custom programming and onsite support extra per Bosch Rexroth posted rates
• Auxiliary controls for arm actuator, arm head cylinder and lubrication pump are not controlled by the Spider and are not in Bosch Rexroth scope
• Motor starters are not controlled by the Spider but require the circuit to pass through the controllers contactor for stopping the drive in case of fault
• Interconnection and installation is not include
• Sample circuit and further detail please see attachment

BR-E - Spider Control
Wring Sample Diagrar

Drive limit control

• Replaces hydro-mechanical pump control
• Utilizing existing control lever and ramps
• 4x loose supply mechanical limit switches for slow and stop in forward and reverse direction
• mount limit switches in adjustable arrangement
• add springs for centering control lever

Engineering Documents & Verification

• Drawings, O&M Manual, Technical Documents, Parts List.
• Supplied after completion of project in “as-commissioned” format

1 Spare Part for Hydraulics

• 1x Hydraulic drive motor
• 1x Main drive pump
• 1x Auxiliary drive pump
• One of each type of solenoid valve
• One of each type of pressure and limit switch
• 4x each filter element

FAT testing with mineral oil

• Commissioning support on site
• Standard crating is included for hydraulic component, not intended for outside storage.
• Includes plastic engraved labels to identify BOM items
• All systems are primed and epoxy painted to customers chosen RAL colour
• System is designed with CSA class 2 Div. 1 Group F in mind for electrical components.
• Hydraulic valves are supplied with equivalent ATEX rating

Quote does not include:

- Any specific certifications by a third party
- Training and programming other then what is noted above
- Outdoor / seaworthy packaging or outdoor / seaworthy crating
- Drawings and procedures do not include P-Eng. Stamp Motor starter or starter related items
- Motor disconnects
- Machine / hydraulics certified to CSA class 2 Div. 1 Group F

11.3 PROJECT PLAN

a) Provide a step-by-step project plan.

Following the delivery of the Positioner to our facility:

1. Disassemble the Positioner completely while identifying and labeling all components.

- Identify and label all components.
- complete disassembly of the Positioner while carefully managing the components.
- Categorization and storage of all components

2. Refurbish the Structural Frame.

- Complete inspection of the main structural frame.
- Contact the NSPI Engineer with report after inspection.
- Repair structural defects on frame as per approval from NSPI Engineer.
- Grit Blast as required to prepare for paint.
- Complete repainting of the frame and tank exterior. Paint to be Ameron “Bar-Rust 235”.

3. Supply all new and refurbished components.

Replace the following components with a built to spec Bosch Rexroth Assembly:

All hydraulic components replaced as noted under / *11.2 TECHNICAL REQUIREMENTS*

Replace the following components as needed:

- Inspect the motor output spur gears. Replace if necessary. Work associated with this detail will not be known until disassembly.
- Replace all hoses.
- Replace the four (4) Support Rollers and four (4) guide rollers.
- Replace the Plexiglas enclosure around the Operator's area.
- Replace fasteners as required.

4. Rebuild the Positioner.

- Completely reassemble Positioner
- Test the Positioner hydraulics in our facility by adding new oil and testing all stroke and rotate motions.
- Drain oil before shipping to LGS.
- Prepare Positioner for transport back to LGS.

5. Re-commission the Positioner at LGS after re-installation by NSPI.

- Assist NSPI in re-commissioning the Positioner.

b) Indicate timeline details with an estimate of how much time each step will require.

Pre-Project Preparation. Order all replacement components in advance.

Estimated Time: Lead time on replacement components is 16 to 18 weeks.

Step 1. Disassemble the Positioner completely while identifying and labeling all components.

Estimated Time: 1-2 weeks

Step 2. Refurbish the Structural Frame

Estimated time: 2 weeks

Step 3. Supply all new and refurbished components

Estimated time: Up to 16 weeks lead time on parts

Step 4. Rebuild the Positioner.

Estimated time: 1.5 weeks with parts on hand

Step 5. Re-commission the Positioner at LGS after re-installation by NSPI.

Estimated time: 1 week

Note: With all components pre-ordered we are confident we can have all work done in a 6 week time frame.

c) Comment on the portion of the work that your company proposes to perform with its own workforce versus work that will be sublet to sub-contractors.

Target Hydraulics & Machine Works propose to purchase the necessary components and perform all of the work necessary in areas of inspection, hydraulics, structural repair and machining. Target hydraulics will be partnering up with Bosch Rexroth Canada Corp. as a main supplier of hydraulic and PLC controls and engineering for design of new components.

11.4 ACCOUNT MANAGEMENT

a) Describe the start-up process for a new account.

The process of starting up a new account:

1. Send out Credit Application
2. Check credit references
3.Accept application and set payment terms

11.5 QUALITY AND MONITORING

a) Provide a brief description of your quality assurance programs and quality management system.

In order to maintain a consistent level of quality for our customers, Target achieved ISO 9001:2008 certification in 2005. As part of this, we have developed and implemented a Quality Management Policy document that details our document management, hiring and training, quality control and other policies

Target has appointed a Quality Management Representative who, irrespective of other responsibilities, has defined authority and responsibility to ensure that the processes needed for the quality management system are established, implemented and maintained in accordance with the needs of Target Hydraulics & Machine Works Ltd. and the requirements of the ISO 9001:2008 standard.

The Quality Management Representative is responsible for reporting the performance of the quality management system and any need for improvement to Management for review, as a basis for improvement of the quality management system. In addition, customers are asked to comment upon project completion, in order to identify any issues with our work, in order to prevent the issue from recurring. Michelle Mazalin-Smith is the appointed Quality Management Representative.

11.6 SPECIALIZED SERVICES

a) Describe any other related services your company supplies.

Target Hydraulics & Machine Works Ltd. offers the following services related to this RFP.

1. CNC Machining capabilities complement our manual machine shop.
2. Stock and quick access via networks to hydraulic components.
3. Possession of large storage and manufacturing facilities at the Phalen Mine site, adjacent to Lingan generating station. This facility is used for larger jobs that exceed the capacity of our Grand Lake Road location.

11.7 PERFORMANCE STANDARDS

a) What are your standards with respect to resolving service issues?

Target Hydraulics & Machine Works, commits to addressing any issues that may arise with an immediate response, resolution to any job site without delay with any of the management team

b) Who is responsible for responding to the customer?

Responding to the customer is a coordinated effort, most often with first point of contact being Office Manager Michelle Mazalin-Smith, with the appropriate employees brought into the conversation as relevant information is needed.
For any customer satisfaction issues, Kenny MacLean will follow up with the customer and ensure that the issue has been resolved to NSPI's satisfaction.

c) Explain any contractual issues with unions or affiliates that may affect service levels to NSPI. Indicate cost that may be incurred.

There are no issues present. Target employees are not unionized, and have enjoyed a long-term, positive relationship with the staff and management at both Lingan and Point Aconi generating stations. To date, we have completed both small and large projects at these facilities with little or no interruptions. Target acknowledges the sensitivity of this venture for NSPI, and that this may impact employee relations for both companies. Therefore, Target is willing to work with NSPI to resolve any issues that may arise in this area.

11.8 WARRANTY

a) Provide your statement of warranty.

Please see attachment;

BR-G - Product Warranty.pdf

Statement of warranty from new components

b) Provide details and cost of extended warranty options.

Extended warranty options may be negotiated during contract talks.

11.9 SAFETY

a) Provide Workers' Compensation Board issued copies of Experience Rating statements for this year and the two previous years.

Please see attached our paper work from The Workers' Compensation Board.

WCB Clearance Letter March 2016.pc

WCB Experience Rating Statement for

b) Provide a detailed safety plan.

Target Hydraulics & Machine Works Ltd. has adopted a safety program in accordance with the Nova Scotia Government Labour regulations. We have taken the extra steps of implementing a more demanding safety program than required of a company of our size.
Our active OH&S committee meets monthly and executes continuously on the recommendations that flow from our safety reps and monthly inspections. Please see attached documents that relate to our Safety Program.

Target Hydraulics and Machine Works S

c) Indicate proponent's understanding and acceptance of the following:
i. The proponents will comply with all safety programs and practices initiated by NSPI from time to time, including, if applicable, those programs

described in Attachment "E". All costs incurred by the proponent in relation to the compliance with NSPI's safety programs will be the responsibility of the proponent.
ii. During the performance of the Goods & Services, if NSPI determines that the proponent's compliance with the applicable safety programs and practices is not satisfactory, NSPI shall have the right to require the proponent to take such additional steps at the proponent's expense as are necessary to ensure compliance.
iii. If, in NSPI's sole determination, the safety performance of proponent is deemed unacceptable to NSPI, NSPI shall have the right to terminate immediately upon notice to the proponent.
iv. The proponent agrees to comply and be responsible for ensuring all employees, sub-suppliers, agents and representatives of the proponent comply with all federal, provincial and municipal health, safety and environmental statutes, regulations, policies, guidelines and all health, safety and environmental rules as prescribed by NSPI.

Target Hydraulics & Machine Works Ltd. understands and accepts the above.

d) For the following questions, regulatory agencies can include but not be limited to, fire safety, occupational health and safety, etc. and can be provincial and/or federal:
v. Has the proponent ever been convicted of any regulatory offences? If yes, please provide specific details, court locations and jurisdictions.
vi. Has your company ever received any regulatory directives/orders? If yes, please provide any and all documentation related to the directives/orders including but not limited to any related inspection reports, directives/orders and compliance notices (within previous 3 years).

Target Hydraulics & Machine Works Ltd. has no history regarding regulatory offences.

ENVIRONMENT

a) Provide the name and qualifications of the individual(s) who will be responsible for monitoring, maintenance and execution of all environmental measures onsite during the project.

Kenny MacLean will be responsible for all environmental measures being maintained while the project is underway in our facility.

b) Provide a detailed plan for the proposed methods and sequence of environmental management control during the project.

All work done prior to re-commissioning will be done inside our facility, which will fall under our daily environmental protocol.
Any assistance in the re-commissioning stages on-site will be done under the guidelines of the Environmental measures and designated supervision of NSPI.
All Target employees working at NSPI facilities will be mindful of any waste generated by our activities, and will be responsible for disposing of this waste as required by each facility. Kenny MacLean will responsible for ensuring that Target employees adhere to this policy.

c) Indicate Proponent's understanding and acceptance of the following:
i. The company shall comply with all applicable environmental legislation, regulations, standards, work practices, and provisions including, but not limited to, NSPI's Contractor Environmental Requirements (Attachment "F"), as may be amended or replaced from time to time.
ii. The company is also responsible for the disposal and/or destruction of all scrap treated wood at an approved facility. All work will be completed using the company's personnel and equipment in accordance with all applicable laws governing the disposal/destruction of treated wood products. A Certificate of Disposal/Destruction shall be provided by the company to NSPI confirming that the scrap treated wood products have been disposed of and/or destroyed in accordance with all applicable laws.

Target Hydraulics & Machine Works Ltd. understands and accepts the above.

d) Has your company ever been convicted of any environmental regulatory offences? If yes, please provide specific details, court locations and jurisdictions.

Target Hydraulics & Machine Works Ltd. has no history regarding environmental regulatory offences.

e) Has your company ever received any environmental regulatory directives/orders? If yes, please provide any and all documentation related to the environmental directives/orders including but not limited to any related inspection reports, directives/orders and compliance notices (within previous 3 years).

Target Hydraulics & Machine Works Ltd. has no history regarding environmental regulatory orders.

11.10 EMPLOYEE REQUIREMENTS

a) Indicate Proponent's understanding and acceptance of the following:
i. Employees must be experienced / qualified to safely perform the work.
ii. Employees must maintain a professional appearance and attitude.
iii. NSPI reserves the right to reject any employees who have been appointed to perform the work where its field personnel determine that the individual

does not meet NSPI safety or performance standards and the company shall be obligated to replace the individuals.

Target Hydraulics & Machine Works Ltd. understands and accepts the above.

11.11 INSURANCE / CERTIFICATIONS
Upon proposal receipt, further review may be performed by NSPI.

a) Indicate compliance and supply the necessary documentation for the following certifications with your proposal. Your proposal should also list all other certifications not listed in this RFP:
i. Contractor must have at least the following insurance coverage:
• $2,000,000 Commercial General
· Including Sudden and Accidental Pollution
• $2,000,000 Automobile Liability
ii. Workers' Compensation Letter of Good Standing
iii. Nova Scotia Construction Safety Association Certificate of Recognition
iv. NSPI site orientation – indicate locations orientated
v. First aid training
vi. All employee certifications necessary to perform work
vii. All other certifications applicable to your business that are not listed

Commercial Insurace Policy 2015-2016.pdf

Please see attached.

11.12 BID AND PERFORMANCE SECURITY

a) Provide a prequalification letter or other evidence satisfactory to NSPI, demonstrating your company's ability to have appropriate bonds issued by a Surety acceptable to NSPI.

- Not included as per Addendum # 1 dated April 14, 2016.

11.13 COMMERCIAL / PRICE PROPOSAL REQUIREMENTS

a) Pricing assumptions should be clearly stated.

- Validity of Quote: 90 days

- Target hydraulics & Machine Works Ltd. and Bosch Rexroth Canada reserves all rights to amend and adjust the pricing based on currency fluctuation, raw material or processing cost between the receipt of order and the delivery. Justification and supporting documentation will be provided.

b) The prices in the pricing proposal shall be the full inclusive value of the work described, including all costs and expenses which may be required for the work described together with all General risks, liabilities and obligations set forth or implied in this RFP. If a price element is Required but has not been specifically requested in this document, proponents are required to Include the element and clearly note it.

c) Specify any additional charges for out-of-scope work.

- Additional charges out of scope work will be at regular shop rates.

d) Costs should be in Canadian dollars.

- All prices are in Canadian dollars.

e) Costs should be FOB the installation site (Lingan, Nova Scotia).

f) GST or HST should not be included in the quoted prices but will be paid in addition to the Contract price.

g) Complete Quantities and Prices (Attachment "G")

QUANTITIES AND PRICES

Total cost Refurbishment as per the Attachment "A" [redacted] FOB lingan N.S CAD funds

COST BREAK DOWN

HPU – reservoir – pumps – motors etc. In attachment "A "

[redacted]

All mechanical work / sand blasting / paint/ refurbishing work / machining / retort fitting/ reverse engineering in attachment "A''

[redacted]

h) Payment Terms – The proposal shall be based on terms net 35 for payment, however, the proponent may offer alternate payment terms should they be in the best interest of both parties.

Commercial Terms & Conditions of Sales:

Delivery:	~4th Quarter 2016 (TB reviewed) 14-16 weeks delivery from drawing approval
Payment Terms:	
	30% upon receipt of order 30% upon drawing submittal 20% prior to delivery of components 20% net 35 days from shipment
Incoterms 2010:	FCA Target Hydraulics - Sydney, NS
Prices:	Are each net, in CAD funds
Warranty:	As per Bosch Rexroth Canada Corp. Standard Warranty Policy Reference appendices: *BR-G - Product Warranty*
Taxes:	Are extra where applicable
Terms & Conditions:	target hydraulics standard conditions
Validity of Quote:	90 days

Yours truly,

Kenneth MacLean.

Owner/operator

CI Number: 49897

Title: POT – Fire System Upgrades 2017

Start Date: 2017/03
In-Service Date: 2017/10
Final Cost Date: 2018/04
Function: Steam
Forecast Amount: $538,437

DESCRIPTION:

This project will address plant fire system deficiencies. This project will modify the fire system, including additional fire pumps and piping, to ensure the reliability and capacity of the fire system.

All fire system capital projects are completed as part of the NS Power Multi-Year Fire Protection Plan. The plan is reviewed on an annual basis with internal Subject Matter Experts (SME) as well as with our current corporate insurance representatives. The annual review, with a fleet wide risk reduction approach, enables a better scheduling of investment priorities and spending.

The increase from the 2015 and 2016 investment is primarily due to the investment in fire pumps, which were not part of the 2015 and 2016 capital projects.

Summary of Related CIs +/- 2 years:
2015 CI 46418 POT - Fire System Upgrades $204,813
2016 CI 47692 POT - Fire system Upgrades 2016 $224,304
2018 CI TBD POT - Fire System Upgrades 2018 $TBD
2019 CI TBD POT - Fire System Upgrades 2019 $TBD

JUSTIFICATION:

Justification Criteria: Health & Safety

Why do this project?

Completion of these upgrades will minimize the risk associated with the fire protection/firefighting systems at the Point Tupper Generating Station. Additionally, completing this work also allows NS Power to meet the insurance requirements related to fire safety.

Why do this project now?

Addressing these deficiencies in timely upgrades will reduce the risk of fire related incidents at the Point Tupper Generating Station.

Why do this project this way?

Completing this work in this manner is the only option in order to meet the safety requirements of the fire system.

CI Number : 49897 - POT - Fire System Upgrades 2017 **Project Number**

Parent CI Number : -

Cost Centre : 351 - 351-Pt.Tupper Admin./Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		3,368	0	3,368
095		095-Thermal Regular Labour AO		1,315	0	1,315
095		095 - Proj Supp Regular Labour AO		975	0	975
095		095-Thermal & Hydro Contracts AO		24,208	0	24,208
095		095-Thermal Term Labour AO		391	0	391
095		095-Thermal Overtime Labour AO		391	0	391
001	003	001 - Proj Supp Regular Labour	003 - SGP - Bldg.,Struct.Grnd.	2,027	0	2,027
001	003	001 - THERMAL Regular Labour	003 - SGP - Bldg.,Struct.Grnd.	6,127	0	6,127
002	003	002 - THERMAL Overtime Labour	003 - SGP - Bldg.,Struct.Grnd.	3,648	0	3,648
004	003	004 - THERMAL Term Labour	003 - SGP - Bldg.,Struct.Grnd.	1,824	0	1,824
012	003	012 - Materials	003 - SGP - Bldg.,Struct.Grnd.	205,000	0	205,000
013	003	013 - POWER PRODUCTION Contracts	003 - SGP - Bldg.,Struct.Grnd.	225,000	0	225,000
066	003	066 - Other Goods & Services	003 - SGP - Bldg.,Struct.Grnd.	46,163	0	46,163
011	085	011 - Travel Expense	085 Design	1,000	0	1,000
028	085	028 - Consulting	085 Design	15,000	0	15,000
041	085	041 - Meals & Entertainment	085 Design	2,000	0	2,000
			Total Cost:	538,437	0	538,437
			Original Cost:	0		

Capital Project Detailed Estimate

Location: **Steam**
CI# : 49897
Title: POT - Fire System Upgrades 2017
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Electrician	PD	10	$ 358	$ 3,583		
Engineering	PD	5	$ 405	$ 2,027		
Maintenance Trades	PD	5	$ 365	$ 1,824		
Utility worker	PD	3	$ 240	$ 721		
			Sub-Total	$ 8,154		
002 OT Labour						
Maintenance Trades	PD	5	$ 730	$ 3,648		
			Sub-Total	$ 3,648		
004 Term Labour						
Maintenance Trades	PD	5	$ 365	$ 1,824		
			Sub-Total	$ 1,824		
011 Travel Expense						
Travel and expenses	lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000		
012 Materials						
Pumps, piping, etc.	lot	1	$ 200,000	$ 200,000		47692
Misc. and consumables	lot	1	$ 5,000	$ 5,000		
			Sub-Total	$ 205,000		
013 Contracts						
Piping modifications and pump installation	lot	1	$ 225,000	$ 225,000		47692
			Sub-Total	$ 225,000		
028 Consulting						
Engineering	lot	1	$ 15,000	$ 15,000		
			Sub-Total	$ 15,000		
041 Meals & Entertainment						
Meals and expenses	lot	1	$ 2,000	$ 2,000		
			Sub-Total	$ 2,000		
066 Other Goods & Services						
Contingency	%	10%	$ 461,626	$ 46,163		
				$ -		
			Sub-Total	$ 46,163		
094 Interest Capitalized						
AFUDC				$ 3,368		
			Sub-Total	$ 3,368		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 1,315		
Thermal OT Labour AO				$ 391		
Thermal Term Labour AO				$ 391		
Thermal / Hydro Contracts AO				$ 24,208		
Project Support Regular AO				$ 975		
			Sub-Total	$ 27,281		
			SUB-TOTAL (no AO, AFUDC)	$ 507,788		
			TOTAL (AO, AFUDC included)	$ 538,437		
Original Cost						

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49430

Title: LIN CW Pump Refurbishment 2017

Start Date:	2017/05
In-Service Date:	2017/06
Final Cost Date:	2017/12
Function:	Steam
Forecast Amount:	$516,270

DESCRIPTION:

The scope of work for this project is the refurbishment of one of eight cooling water (CW) pumps at Lingan Generating Station. As pump performance degrades, the CW water flow is insufficient to maintain cooling in the condenser and the pumps must be refurbished to regain unit performance. The CW pumps are routinely inspected for running shaft misalignment/whipping but all developing failures are not always indicated in advance as monitoring of the submersed lower pump shaft is not feasible while the pump is in service.

The refurbishment includes re-surfacing/re-building and coating of worn, corroded and damaged surfaces and components, a new sleeveless, chromed stainless pump shaft, new marine bearings, and verification of all mating fits and alignments. The refurbishment project includes the installation of an additional bearing on the pump shaft. This bearing will help to maintain alignment and will reduce the movement of the pump shaft if misalignment occurs, protecting related bearings and running surfaces.

Each Generating Unit is equipped with two CW pumps. Current expectation is that this project will not include the refurbishment of the CW pumps on Unit #2. However, if CW pumps on Unit #2 were found to require refurbishment in 2017, investment on Unit #2 could still be the best option. All four units at Lingan are similar and as such, the components refurbished/replaced on the CW pump can be transferred to any of the other Lingan CW pumps when Lingan Unit #2 is retired.

Summary of Related CIs +/- 2 years:
2015 CI 43168 LIN – CW Pump Refurbishment $477,793
2016 CI 47507 LIN – CW Pump Refurbishment $441,560

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement/Refurbishment

Why do this project?

Each Generating Unit is equipped with two CW pumps, which supply cooling water to each unit's condenser as well as to various smaller heat exchangers serving the Unit. Adequate condenser cooling is necessary to ensure proper condenser vacuum, which is a major contributor to unit efficiency. During the cooler months, one CW pump per operating unit is capable of providing adequate condenser cooling. During warmer months, both pumps are required. If one of a unit's two pumps is unavailable during the warmer months, the unit's heat rate and/or ability to generate full load is restricted. The loss of both pumps would lead to an unplanned outage. Therefore, the reliability and availability of these pumps is critical to plant operation. The CW pumps are subject to solid particle erosion and corrosion effects related to their salt water environment (which includes sea water, kelp, eel grass and other sea debris). These deterioration mechanisms are managed through periodic overhauls.

This project is being undertaken primarily to prevent unit deratings and preserve the unit's availability, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

Health assessments are a function of pump performance, condition based assessment and operating hours. A typical operating period between pump refurbishments is several years, partly dependent upon the unit's utilization. Several pumps are approaching actionable risk threshold and preparations should be made to refurbish in order to adequately mitigate the risk. Final determination of which pump to be refurbished will be based on latest performance and condition based monitoring (CBM) results. Additionally, CW Pump refurbishment has a lead time of upwards of six months, therefore proactive planning for these refurbishments is necessary to avoid lengthy unit derates from unplanned failures.

Why do this project this way?

Compared to a full replacement or operate until failure, the most economic and efficient solution is to rebuild deteriorated CW pumps. Because repair and balancing facilities are not available on site or locally, the plant proposes to have restorations done at a reputable repair facility ensuring an effective overhaul. New pumps have an 11 month lead time and cost approximately 50 percent more than refurbishment.

CI Number : 49430 - LIN CW Pump Refurbishment 2017 **Project Number**

Parent CI Number : -

Cost Centre : 301 - 301-Lingan Admin./Common Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
095		095-Thermal Regular Labour AO		8,606	0	8,606
095		095-Thermal & Hydro Contracts AO		1,076	0	1,076
095		095-Thermal Term Labour AO		6,447	0	6,447
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	40,099	0	40,099
004	014	004 - THERMAL Term Labour	014 - SGP - Circ.Water Sys.	30,041	0	30,041
012	014	012 - Materials	014 - SGP - Circ.Water Sys.	400,000	0	400,000
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.	10,000	0	10,000
015	014	015 - Frt, Post & Delivery	014 - SGP - Circ.Water Sys.	20,000	0	20,000
			Total Cost:	516,270	0	516,270
			Original Cost:	401,201		

Capital Project Detailed Estimate

Location: Steam
CI# : 49430
Title: LIN CW Pump Refurbishment 2017
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Electrician	PD	18	$ 351	$ 6,323		
Engineering	PD	4	$ 397	$ 1,589.43		
Maintenance Trades	PD	90	$ 358	$ 32,187		
			Sub-Total	$ 40,099		
004 Term Labour						
Maintenance Trades	PD	84	$ 358	$ 30,041		
			Sub-Total	$ 30,041		
012 Materials						
CW Pump Refurbishment	Lot	1	$ 400,000	$ 400,000		47507
			Sub-Total	$ 400,000		
013 Contracts						
Machining Contractor	Lot	1	$ 10,000	$ 10,000		
			Sub-Total	$ 10,000		
015 Freight						
Transportation & Shipping	Lot	1	$ 20,000	$ 20,000		
			Sub-Total	$ 20,000		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 8,606		
Thermal Term Labour AO				$ 6,447		
Thermal / Hydro Contracts AO				$ 1,076		
			Sub-Total	$ 16,129		
			SUB-TOTAL (no AO, AFUDC)	$ 500,140		
			TOTAL (AO, AFUDC included)	$ 516,270		
Original Cost				$ 401,201		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

LIN CW Pump Refurbishment 2017
Summary of Alternatives

Nova Scotia POWER An Emera Company

Division :	Power Production		**Date :**	**28-Oct-16**
Department :	Lingan Generating Station		**CI Number:**	49430
			Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	CW Pump Refurbishment vs Avoided F	5.90%	-481,067	317,278	1	26.54%	4.1 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

This project is being undertaken primarily to prevent unit deratings and preserve the unit's availability, and is secondarily supported by positive replacement energy cost economics.

Notes/Comments :

CW Pump Refurbishment vs Avoided Fuel & Repair Costs

If the CW pump fails effectively the whole unit will lose approximately 40 MW for approximately 10 weeks depending on the severity of the damage when the pump fails.

Test 2

Test 3

Test 4

LIN CW Pump Refurbishment 2017
Summary of Sensitivities

Nova Scotia POWE An Emera Compa

Division :	Power Production		**Date :**	**28-Oct-16**
Department :	Lingan Generating Station		**CI Number:**	49430
			Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	CW Pump Refurbishment vs Avoided Fuel & Rep	5.90%	-481,067	317,278	1	26.54%	4.1 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	CW Pump Refurbishment vs Avoided Fuel & Rep	10%	-431,495	278,692	1	22.19%	4.5 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years

		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
Change:	A	49,572	-38,586	0	-4.35%	0.4 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	CW Pump Refurbishment vs Avoided Fuel & Rep	-10%	-383,389	246,964	1	21.76%	4.6 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years

		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
Change:	A	97,679	-70,314	0	-4.78%	0.4 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	131,897	219,639	360,583	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

LIN CW Pump Refurbishment 2017
Avoided Cost Calculations

Division :	Power Production	**Date :**	**28-Oct-16**
Department :	Lingan Generating Station	**CI Number:**	49430
		Project No. :	

CW Pump Refurbishment vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2017	2018	2017	2018	2017	2018
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	50%	60%	50%	60%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	40.0	40.0				
Duration (Hours or Years)	1680	1680				
Totals	$165,978	$138,599	$0	$0	$165,978	$138,599

Total Capital Cost of Alternative **$516,270**

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2017	2018	2017	2018	2017	2018
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative **$0**

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	[redacted]		2017	2018	2017	2018
Replacement Energy Cost ($/MWh)						
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative **$0**

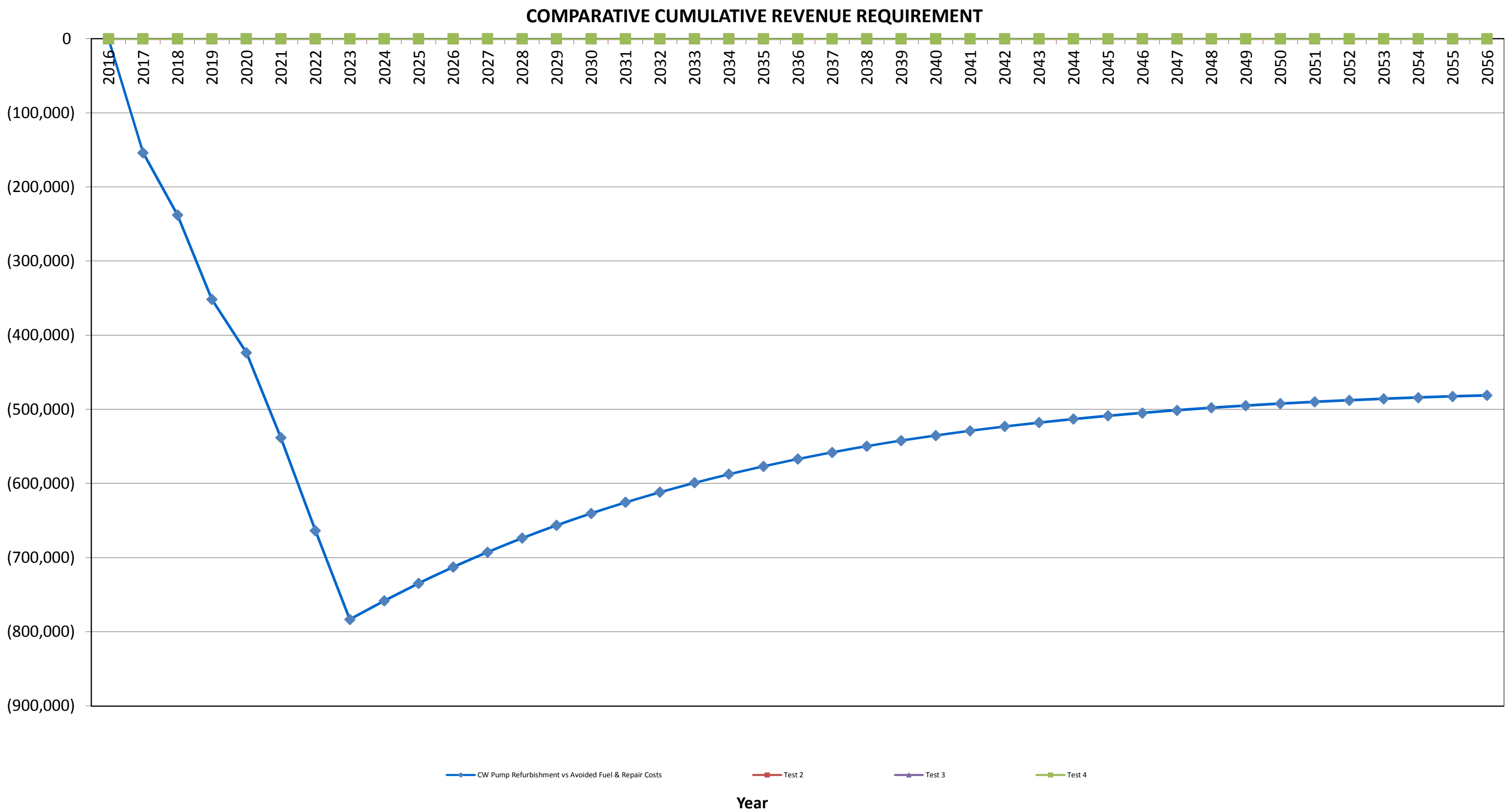
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2017	2018	2017	2018	2017	2018
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative **$0**

LIN CW Pump Refurbishment 2017
CW Pump Refurbishment vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	165,978.2	(500,140.4)	20,005.6	484,586.5	(334,162.2)	(45,251.5)	(379,413.7)	(358,275.4)	0.94	(358,275.4)
2018	-	-	138,599.5	-	38,410.8	445,432.5	138,599.5	(31,058.5)	107,541.0	95,891.9	0.89	(262,383.5)
2019	-	-	182,467.4	-	35,337.9	409,410.8	182,467.4	(45,610.1)	136,857.2	115,233.8	0.84	(147,149.7)
2020	-	-	137,331.0	-	32,510.9	376,270.8	137,331.0	(32,494.2)	104,836.8	83,354.6	0.80	(63,795.1)
2021	-	-	204,407.8	-	29,910.0	345,782.0	204,407.8	(54,094.3)	150,313.5	112,854.3	0.75	49,059.3
2022	-	-	231,662.2	-	27,517.2	317,732.4	231,662.2	(63,284.9)	168,377.3	119,373.4	0.71	168,432.7
2023	-	-	236,295.4	-	25,315.8	291,926.7	236,295.4	(65,403.7)	170,891.8	114,406.2	0.67	282,838.9
2024	-	-	-	-	23,290.6	268,185.4	-	7,220.1	7,220.1	4,564.3	0.63	287,403.2
2025	-	-	-	-	21,427.3	246,343.5	-	6,642.5	6,642.5	3,965.2	0.60	291,368.4
2026	-	-	-	-	19,713.1	226,248.9	-	6,111.1	6,111.1	3,444.8	0.56	294,813.1
2027	-	-	-	-	18,136.1	207,761.9	-	5,622.2	5,622.2	2,992.6	0.53	297,805.7
2028	-	-	-	-	16,685.2	190,753.8	-	5,172.4	5,172.4	2,599.8	0.50	300,405.5
2029	-	-	-	-	15,350.4	175,106.4	-	4,758.6	4,758.6	2,258.6	0.47	302,664.1
2030	-	-	-	-	14,122.4	160,710.8	-	4,377.9	4,377.9	1,962.1	0.45	304,626.2
2031	-	-	-	-	12,992.6	147,466.8	-	4,027.7	4,027.7	1,704.6	0.42	306,330.8
2032	-	-	-	-	11,953.2	135,282.4	-	3,705.5	3,705.5	1,480.8	0.40	307,811.6
2033	-	-	-	-	10,996.9	124,072.7	-	3,409.0	3,409.0	1,286.5	0.38	309,098.1
2034	-	-	-	-	10,117.2	113,759.8	-	3,136.3	3,136.3	1,117.6	0.36	310,215.7
2035	-	-	-	-	9,307.8	104,271.9	-	2,885.4	2,885.4	970.9	0.34	311,186.7
2036	-	-	-	-	8,563.2	95,543.0	-	2,654.6	2,654.6	843.5	0.32	312,030.1
2037	-	-	-	-	7,878.1	87,512.5	-	2,442.2	2,442.2	732.8	0.30	312,762.9
2038	-	-	-	-	7,247.9	80,124.4	-	2,246.8	2,246.8	636.6	0.28	313,399.5
2039	-	-	-	-	6,668.0	73,327.3	-	2,067.1	2,067.1	553.0	0.27	313,952.5
2040	-	-	-	-	6,134.6	67,074.0	-	1,901.7	1,901.7	480.4	0.25	314,433.0
2041	-	-	-	-	5,643.8	61,321.0	-	1,749.6	1,749.6	417.4	0.24	314,850.4
2042	-	-	-	-	5,192.3	56,028.2	-	1,609.6	1,609.6	362.6	0.23	315,213.0
2043	-	-	-	-	4,776.9	51,158.8	-	1,480.8	1,480.8	315.0	0.21	315,528.0
2044	-	-	-	-	4,394.8	46,679.0	-	1,362.4	1,362.4	273.7	0.20	315,801.6
2045	-	-	-	-	4,043.2	42,557.6	-	1,253.4	1,253.4	237.7	0.19	316,039.4
2046	-	-	-	-	3,719.7	38,765.9	-	1,153.1	1,153.1	206.5	0.18	316,245.9
2047	-	-	-	-	3,422.2	35,277.5	-	1,060.9	1,060.9	179.4	0.17	316,425.3
2048	-	-	-	-	3,148.4	32,068.2	-	976.0	976.0	155.9	0.16	316,581.2
2049	-	-	-	-	2,896.5	29,115.6	-	897.9	897.9	135.4	0.15	316,716.6
2050	-	-	-	-	2,664.8	26,399.3	-	826.1	826.1	117.6	0.14	316,834.3
2051	-	-	-	-	2,451.6	23,900.2	-	760.0	760.0	102.2	0.13	316,936.5
2052	-	-	-	-	2,255.5	21,601.1	-	699.2	699.2	88.8	0.13	317,025.3
2053	-	-	-	-	2,075.0	19,485.9	-	643.3	643.3	77.1	0.12	317,102.4
2054	-	-	-	-	1,909.0	17,539.9	-	591.8	591.8	67.0	0.11	317,169.4
2055	-	-	-	-	1,756.3	15,749.6	-	544.5	544.5	58.2	0.11	317,227.6
2056	-	-	-	-	1,615.8	14,102.6	-	500.9	500.9	50.6	0.10	317,278.2
Total	**-**	**-**	**1,296,741.5**	**(500,140.4)**	**481,558.5**		**796,601.1**	**(252,706.7)**	**543,894.4**	**317,278.2**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(100,000)
(200,000)
(300,000)
(400,000)
(500,000)
(600,000)
(700,000)
(800,000)
(900,000)
2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056
CW Pump Refurbishment vs Avoided Fuel & Repair Costs
Test 2
Test 3
Test 4
Year

CI Number: 49466

Title: PTMT – Dock and Inhaul Conveyor Replacement

Start Date:	2017/06
In-Service Date:	2017/07
Final Cost Date:	2018/01
Function:	Steam
Forecast Amount:	$467,607

DESCRIPTION:

This project is for the replacement of the dock belt and the inhaul conveyor belt at the Point Tupper Marine Terminal.

Over the past 12 years, the Point Tupper Marine Terminal belt-lines have transported more than nine million tonnes of coal, supplying the Pt. Tupper and Trenton 5 generation stations. Both belts are now showing excessive wear due to the extreme weather conditions on the Strait of Canso and the tonnages they have handled over the years. The splices on both belts have been temporarily repaired several times due to delamination caused by salt slowly deteriorating the inner core and dissolving the glues used in the laminating process.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Health and Safety

Why do this project?

These belts transport all of the coal for the Point Tupper and Trenton 5 generating units. The belts have deteriorated to the point where replacement is necessary to provide safe reliable operation. There is considerable force released if a conveyor belt were to fail and large amounts of coal also thrown exposing personnel in the area to risk of injury. Additionally, a failed belt could also cause significant damage to equipment and unit downtime.

This project is being undertaken primarily to mitigate the safety risk, and is being undertaken secondarily to maintain the reliability of the conveyor.

Why do this project now?

The project is based on a belt inspection (attached) completed in the summer of 2016, the belts will require replacement in 2017. Both belts are showing wear and have been repaired several times.

Why do this project this way?

Replacement of the belts is the only option to restore the conveyors to safe and reliable operation. Mobilizing marine equipment once to replace both belts is more economic than replacing one belt at a time. By replacing all belts at the same time, it will reduce the costs associated with mobilization, transporting equipment and supplies to and from the dock, as well as splicing (where the ends of the belt are joined together).

CI Number : 49466 - PTMT - Dock and Inhaul Conveyor Replacement **Project Number**

Parent CI Number : -

Cost Centre : 386 - 386-Strait Marine Terminal **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
095		095-Thermal & Hydro Contracts AO		4,862	0	4,862
012	003	012 - Materials	003 - SGP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
013	003	013 - POWER PRODUCTION Contracts	003 - SGP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
033	003	033 - Rental and Maintenance of	003 - SGP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
066	003	066 - Other Goods & Services	003 - SGP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
			Total Cost:	467,607	0	467,607
			Original Cost:	362,490		

Capital Project Detailed Estimate

Location: Steam
CI# : 49466
Title: PTMT – Dock and Inhaul Conveyor Replacement
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
012 Materials						
Conveyor out on Dock - Belting	ea	762	[redacted]	[redacted]	Cost Support Item #1 - Page 1	
Inhaul Conveyor - Belting	ea	3500	[redacted]	[redacted]	Cost Support Item #1 - Page 2	
Misc. and consumables	lot	1	$ 10,000	$ 10,000		
			Sub-Total	[redacted]		
013 Contracts						
Conveyor out on Dock - Contract Labour	lot	1	[redacted]	[redacted]	Cost Support Item #1 - Page 1	
Inhaul Conveyor - Contract Labour	lot	1	[redacted]	[redacted]	Cost Support Item #1 - Page 2	
			Sub-Total	[redacted]		
033 Rentals						
Conveyor out on Dock -	lot	1	[redacted]	[redacted]	Cost Support Item #1 - Page 1	
Inhaul Conveyor - Air Tugger / Crane	lot	1	[redacted]	[redacted]	Cost Support Item #1 - Page 2	
			Sub-Total	[redacted]		
066 Other Goods & Services						
Contingency	%	[redacted]	[redacted]	[redacted]		
			Sub-Total	[redacted]		
095 Administrative Overhead						
Thermal / Hydro Contracts AO				$ 4,862		
			Sub-Total	$ 4,862		
			SUB-TOTAL (no AO, AFUDC)	$ 462,745		
			TOTAL (AO, AFUDC included)	$ 467,607		
Original Cost				$ 362,490		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

ALTERNATIVE BELTING ENTERPRISES LTD.
265 INDUSTRIAL AVENUE, TRURO, NS B2N 6V3
Tel: (902) 897-4736 Fax: (902) 897-4727

QUOTATION

Quotation No:

Date: *11/23/2015*

To: Savage Power Plant Solutions
4137 Port Malcolm Rd
Point Tupper NS B9A 1Z4

Attention: John Jeffery

F.O.B.

Estimated Delivery: stock
Taxes: EXTRA
Duty & Brokerage: N/A
Terms: Net 30

Quote Valid for 15 Days

QUANTITY	DESCRIPTION		PRICE
	Conveyor out on Dock		
762	4 ply 800 1/4 x 1/16 MSHA-K covers 60" wide MSHA- Fire resistant Phoenix belting K- Wear resistant	[redacted]	[redacted]
1	4 men 5 days to remove and install and wind up old belt on site.	[redacted]	[redacted]
1	Meals and lodging for 4 men	[redacted]	[redacted]
1	Barge rentals	[redacted]	[redacted]

Thank you,

Scott Tarrant

SUBTOTAL		[redacted]
HST	**15%**	
TOTAL		

ALTERNATIVE BELTING ENTERPRISES LTD.
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Attention: John Jeffery

F.O.B.

Estimated Delivery: stock
Taxes: EXTRA
Duty & Brokerage: N/A
Terms: Net 30

Quote Valid for 15 Days

QUANTITY	DESCRIPTION		PRICE
	Quote for the Inhaul Conveyor 3500 ft long		
3500	4 ply 800 1/4 x 1/16 MSHA-K covers 60" wide MSHA- Fire resistant Phoenix belting K- Wear resistant	[redacted]	[redacted]
1	4 men 8 days to remove and install and wind up old belt on site.	[redacted]	[redacted]
1	Meals and lodging for 4 men	[redacted]	[redacted]
1	Air tugger rental for 7 days heavy chainfalls rental	[redacted]	[redacted]
1	Crane rental 8 days	[redacted]	[redacted]

Thank you,

Scott Tarrant

SUBTOTAL		[redacted]
HST	**15%**	
TOTAL		

Note Page "2"

ALTERNATIVE BELTING ENTERPRISES LTD.

265 Industrial Ave - Truro NS B2N 6V3
PH (902)897-4736 FX (902)897-4727

INSPECTION REPORT

CUSTOMER:	Savage Canac Corporation
	Port Malcolm Rd
	Point Tupper NS

EQUIPMENT: Inhaul Conveyor

CONCERNS AND/OR PROBLEMS IDENTIFIED:

The conveyor belting on the Inhaul is 4 ply 800 1/4 x 1/8 covers 60" wide.

Belt is showing delamintion on edges and splice area
Severe weather cracking on top cover
Top cover is worn in center down to 1/16"

RECOMMENDATIONS:

Belt should be replace in near future.

ADDITIONAL COMMENTS:

Inhaul should be replaced with Phoenix belting MSHW K covers
MSHA is fire resistant and K is wear resistant no other belt offers the wear resistant covers in a MSHA belt.

Scott Tarrant 5/2/2016

INSPECTION REPORT

265 Industrial Ave - Truro NS B2N 6V3
PH (902)897-4736 FX (902)897-4727

CUSTOMER:	Savage Canac Corporation
	Port Malcolm Rd
	Point Tupper NS

EQUIPMENT: Dock Conveyor

CONCERNS AND/OR PROBLEMS IDENTIFIED:

The conveyor belting on dock is a 4 ply 800 1/4 x 1/8 covers 60" wide

Belt is showing delamintion on edges and splice area
Severe weather cracking on top cover
Top cover is worn to canvas needs attention

RECOMMENDATIONS:

Belt should be replaced very soon could be a potential line down situation.

ADDITIONAL COMMENTS:

Dock should be replaced with Phoenix belting MSHW K covers
MSHA is fire resistant and K is wear resistant no other belt offers the wear resistant
covers in a MSHA belt.

Scott Tarrant 5/2/2016

INSPECTION REPORT

265 Industrial Ave - Truro NS B2N 6V3
PH (902)897-4736 FX (902)897-4727

CUSTOMER:	Savage Canac Corporation
	Port Malcolm Rd
	Point Tupper NS

EQUIPMENT: Shuttle Conveyor

CONCERNS AND/OR PROBLEMS IDENTIFIED:

The conveyor belting on the shuttle is 4 ply 800 1/4 x 1/8 60" wide

Belt is showing delamintion on edges and splice area
Severe weather cracking on top cover

RECOMMENDATIONS:

Belt should be replaced in near future.

ADDITIONAL COMMENTS:

Dock should be replaced with Phoenix belting MSHW K covers
MSHA is fire resistant and K is wear resistant no other belt offers the wear resistant covers in a MSHA belt.

Scott Tarrant 5/2/2016

INSPECTION REPORT

265 Industrial Ave - Truro NS B2N 6V3
PH (902)897-4736 FX (902)897-4727

CUSTOMER:	Savage Canac Corporation
	Port Malcolm Rd
	Point Tupper NS

EQUIPMENT: Hopper Conveyor

CONCERNS AND/OR PROBLEMS IDENTIFIED:

The conveyor belting on the Shuttle is a 2 ply 600 Usflex 96" wide

The belt has edge wear from rubbing on chute belt

RECOMMENDATIONS:

Belt should be aligned and track to stop from rubbing on chute.

Belt should be replaced in Near future

ADDITIONAL COMMENTS:

Scott Tarrant 5/2/2016

CI Number: 49427

Title: LIN Coal Plant Structural Refurbishment Phase 3

Start Date:	2017/04
In-Service Date:	2017/08
Final Cost Date:	2018/02
Function:	Steam
Forecast Amount:	$365,003

DESCRIPTION:

This project is for the refurbishment of the structural system in the Lingan coal reclaim, due to corrosion damage over time and to address associated safety concerns.

Lingan Generating Station has extensive coal handling facilities which move hundreds of thousands tonnes per year. Extending from the rotary rail car dumper though the stacker, coal reclaims, crushers, and conveyor systems, the coal handling system is supported by structural steel components installed in the mid-1970s. This project is part of a program approach, expected over a three year period, to refurbish the coal system structural steel. This system supports production from all four operating units at Lingan.

Phase 1 (completed in 2015) focused on the coal system conveyor support structures mainly in coal reclaim (D belts), and the B belt which travels outside along the coal pile. Phase 2 (completed in 2016), was focused on the refurbishment of the structural system in the coal reclaim and crusher building. Phase 3 of the project will focus primarily on the conveyor structure, roller and roller frame replacements. As work progressed during Phase 2, the condition of the coal plant was further assessed for Phase 3 which will continue in 2017 and likely beyond as the condition of structural components continue to deteriorate.

Summary of Related CIs +/- 2 years:
2015 CI 46058 LIN Coal Plant Structural Refurbishment Phase 1 $516,818
2016 CI 47510 LIN Coal Plant Structural Refurbishment Phase 2 $359,425
2018 CI TBD LIN Coal Plant Structural Refurbishment Phase 4 $TBD

JUSTIFICATION:

Justification Criteria: Health & Safety

Why do this project?

Coal must be delivered into the Lingan Plant through a coal conveyor system. An integral part of the conveyor system is the support structure and roller support system. Due to the corrosive nature of the coal and the high humidity conditions that exist in the conveyor system galleries, the support structure suffers corrosion damage over time causing safety related issues. The conveyor support structure must be maintained in design condition in order to allow safe operation of the coal handling equipment and reliable performance of the generating units at Lingan.

This project is being undertaken primarily to address safety concerns, and is secondarily undertaken to maintain unit availability.

Why do this project now?

The conveyor support structure must be refurbished in order for the coal system to address safety concerns related to the corrosion damage the support structures have suffered over time. This will allow the coal system to meet the coal handling demands of the plant in a safe and reliable manner. In order to maintain safe operation of the coal system and reliable supply of coal to the generating units, this project needs to be undertaken now.

Why do this project this way?

Refurbishment of the support structure is the only option to allow coal supply to the plant to continue. Typically coal is hoisted one shift per day during off-peak season that aligns well with refurbishment work to be conducted on the non-hoisting shifts. Retirement of the structure is not feasible, as the coal system is required to operate all four Lingan units.

CI Number	: 49427	- LIN Coal Plant Structural Refurbishment Phase 3	**Project Number**	
Parent CI Number	:	-		
Cost Centre	: 301	- 301-Lingan Admin./Common Capital	**Budget Version**	2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		2,048	0	2,048
095		095-Thermal Term Labour AO		6,439	0	6,439
095		095-Thermal Regular Labour AO		36,485	0	36,485
001	018	001 - THERMAL Regular Labour	018 - SGP - Fuel Hndlg.Coal	170,000	0	170,000
004	018	004 - THERMAL Term Labour	018 - SGP - Fuel Hndlg.Coal	30,000	0	30,000
012	018	012 - Materials	018 - SGP - Fuel Hndlg.Coal	120,031	0	120,031
			Total Cost:	365,003	0	365,003
			Original Cost:	86,314		

Capital Project Detailed Estimate

Location: **Steam**
CI# : 49427
Title: LIN Coal Plant Structural Refurbishment Phase 3
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Maintenance Trades	PD	387	$ 364.79	$ 141,179		46058
Utility worker	PD	120	$ 240.18	$ 28,821		46058
			Sub-Total	$ 170,000		
004 Term Labour						
Maintenance Trades	PD	82	$ 364.79	$ 30,000		46058
			Sub-Total	$ 30,000		
012 Materials						
Structural Steel	ea.	1	$ 30,000.00	$ 30,000		46058
Troughing Roller	ea.	600	$ 54.40	$ 32,640		
Trough Roller Support	ea.	223	$ 217.00	$ 48,391		
Miscellaneous Consumables	ea.	1.00	$ 9,000.00	$ 9,000		
			Sub-Total	$ 120,031		46058
094 Interest Capitalized						
AFUDC				$ 2,048		
			Sub-Total	$ 2,048		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 36,485		
Thermal Term Labour AO				$ 6,439		
			Sub-Total	$ 42,924		
			SUB-TOTAL (no AO, AFUDC)	$ 320,031		
			TOTAL (AO, AFUDC included)	$ 365,003		
Original Cost				$ 86,314		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49434

Title: LIN CW Screen Refurbishment 2017

Start Date:	2017/04
In-Service Date:	2017/10
Final Cost Date:	2018/04
Function:	Steam
Forecast Amount:	$347,062

DESCRIPTION:

There are eight travelling screens (two per unit) at the Lingan Generating Station. The self-cleaning screens remove debris from the incoming seawater before it enters the cooling water (CW) pump and downstream cooling systems including unit condensers.

The travelling screen assemblies consist of bottom, top and intermediate sections. The bottom section includes the tail sprocket assembly and support structure. The top section is comprised of the drive sprocket assembly and the support structure. The intermediate section spans vertically between the bottom and top sections, and supports the entire structure. The bottom and intermediate sections are submerged in seawater, and the upper sections are wetted components, and in a salt spray environment.

Seasonally, during periods of low seaweed loading in the cooling water intake, screens can be taken out of service with no impact to production and refurbished. Screens are selected for refurbishment based on performance, condition and operational strategy for the unit.

Each Generating Unit is equipped with two CW travelling screens. Current expectation is that this project will not include the refurbishment of the screens on Unit #2. However, if screens on Unit #2 were found to require refurbishment in 2017, investment on Unit #2 could still be the best option. All four units at Lingan are similar and as such, the components refurbished/replaced on the CW travelling screens can be transferred to any of the other Lingan CW travelling screens when Lingan Unit #2 is retired. The useful life of these CW travelling screens will extend beyond the payback period shown in the EAM, providing a significant benefit to all of the CW travelling screens at Lingan.

Summary of Related CIs +/- 2 years:
2015 46057 LIN CW Screen Refurbishment $292,634
2016 47506 LIN CW Screen Refurbishment $349,743

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement/Refurbishment

Why do this project?

Eel grass passing through degraded or non-functioning travelling screen panels results in downstream fouling of strainers at CW and Auxiliary CW locations and increases the risk of unit de-rating or outages due to inadequate cooling capacity, particularly during the late summer and fall. The degree of eel grass fouling also results in high mechanical loading on the screens and drive systems and on the circulating water pumps. This high loading cause's component failure at the screens and CW pumps and increases the risk of unit de-rating or forced outages due to insufficient cooling water flow.

This project is being undertaken primarily to prevent unit deratings and preserve the unit's availability, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

The screens have degraded over time due to wear and corrosion and are in need of refurbishment. Completing this project will reduce existing issues with the circulating water system during periods of heavy seaweed and debris. This will reduce the risk of unit de-ratings and subsequent associated replacement energy costs.

Why do this project this way?

The screens operate in an aggressive seawater environment and have experienced related corrosion and wear. The most cost effective solution is to replace the corroded and worn components as opposed to replacing the complete screen assembly. Primary components to be refurbished include the top drives (sprocket refurbishment, bearing replacement, shaft refurbishment, top boot replacement with stainless steel material), Intermediate Section (guides, supports and screen panels replacement) and Lower Section (sprocket refurbishment, bearing replacement, shaft refurbishment, bottom boot replacement with stainless steel material).

CI Number : 49434 - LIN CW Screen Refurbishment 2017 **Project Number**

Parent CI Number : -

Cost Centre : 301 - 301-Lingan Admin./Common Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		4,066	0	4,066
095		095-Thermal Term Labour AO		12,434	0	12,434
095		095-Thermal & Hydro Contracts AO		2,152	0	2,152
095		095-Thermal Regular Labour AO		19,520	0	19,520
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	90,953	0	90,953
004	014	004 - THERMAL Term Labour	014 - SGP - Circ.Water Sys.	57,937	0	57,937
012	014	012 - Materials	014 - SGP - Circ.Water Sys.	140,000	0	140,000
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.	20,000	0	20,000
			Total Cost:	347,062	0	347,062
			Original Cost:	251,375		

Capital Project Detailed Estimate

Location: **Lingan Generating Station**
CI# / FP#: 49434
Title: LIN CW Screen Refurbishment 2017
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Electrician	PD	8	$ 351	$ 2,810		
Maintenance Trades	PD	230	$ 358	$ 82,256		
Utility worker	PD	25	$ 235	$ 5,887		
			Sub-Total	$ 90,953		47506; 46057
004 Term Labour						
Maintenance Trades	PD	162	$ 358	$ 57,937		
			Sub-Total	$ 57,937		
012 Materials						
Top boot screen components	Lot	2	$ 21,000	$ 42,000		
Screen Section Panels -stainless	Lot	2	$ 30,000	$ 60,000		
Bottom Boot screen components	Lot	2	$ 19,000	$ 38,000		
			Sub-Total	$ 140,000		47506; 46057
013 Contracts						
Machining	Lot	2	$ 10,000	$ 20,000		
			Sub-Total	$ 20,000		
094 Interest Capitalized						
AFUDC				$ 4,066		
			Sub-Total	$ 4,066		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 19,520		
Thermal Term Labour AO				$ 12,434		
Thermal / Hydro Contracts AO				$ 2,152		
			Sub-Total	$ 34,106		
			SUB-TOTAL (no AO, AFUDC)	$ 308,889		
			TOTAL (AO, AFUDC included)	$ 347,062		
Original Cost				$ 251,375		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

LIN CW Screen Refurbishment 2017
Summary of Alternatives

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Lingan Generating Station	**CI Number:**	49434
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	CW Screen Refurbishment vs Avoided	5.90%	-400,062	257,046	1	55.70%	1.8 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

The plant recommends completing this project to prevent unit deratings and preserve the unit's availability.

Notes/Comments :

CW Screen Refurbishment vs Avoided Fuel & Repair Costs

It is assumed if a CW screen fails it can repaired to allow it to operate. If the screen is taken out of service it is assumed that one CW pump may have to come out of service and it is estimated it may cause generation reduction of 20 MW until a repair is made to return the screen to service.

Test 2

Test 3

Test 4

LIN CW Screen Refurbishment 2017
Summary of Sensitivities

Nova Scotia POWE An Emera Compa

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Lingan Generating Station	**CI Number:**	49434
		Project No. :	

	Alternative	**After Tax WACC**	**PV of Revenue Requirement**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	CW Screen Refurbishment vs Avoided Fuel & Re	5.90%	-400,062	257,046	1	55.70%	1.8 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	**Variance (%)**	**PV of Revenue Requirement**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	CW Screen Refurbishment vs Avoided Fuel & Re	10%	-369,744	232,830	1	45.48%	2.0 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years

Change:	**A**	30,318	-24,215	0	-10.22%	0.2 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	**Variance (%)**	**PV of Revenue Requirement**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	CW Screen Refurbishment vs Avoided Fuel & Re	-10%	-329,738	207,126	1	44.49%	2.0 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years

Change:	**A**	70,324	-49,920	0	-11.21%	0.2 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	**PV of Revenue Requirement** 1	**PV of Revenue Requirement** 2	**PV of Revenue Requirement** 3	**Delay?**
	A	128,213	224,423	476,257	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

LIN CW Screen Refurbishment 2017
Avoided Cost Calculations

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Lingan Generating Station	**CI Number:**	49434
		Project No. :	

CW Screen Refurbishment vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			89,160	92,744		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	100%	100%	100%	100%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	20.0	20.0				
Duration (Hours or Years)	640	640				
Totals	$63,230	$44,000	$89,160	$92,744	$152,390	$136,744
Total Capital Cost of Alternative						$347,062

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

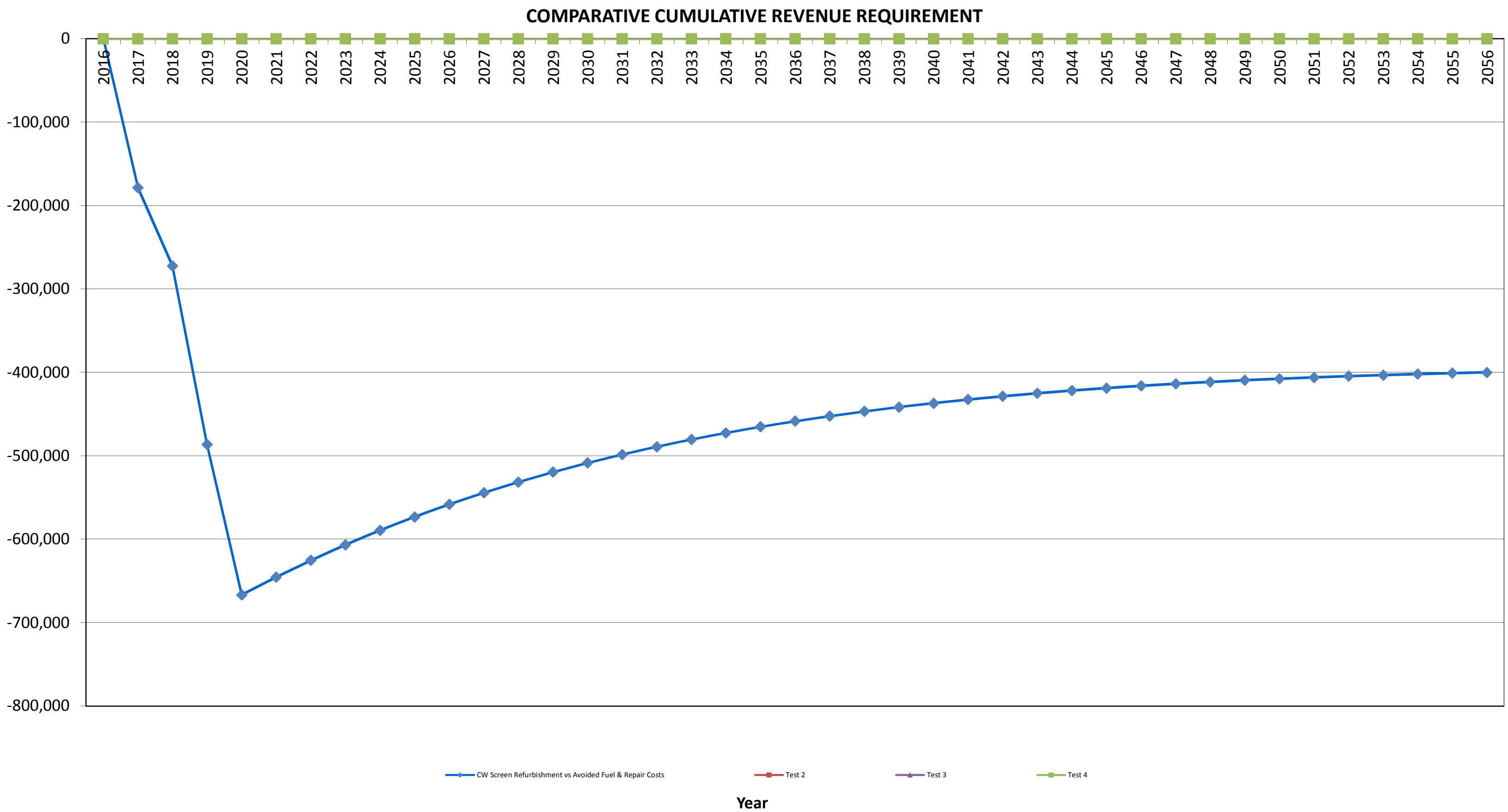
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

LIN CW Screen Refurbishment 2017

CW Screen Refurbishment vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	152,389.8	(312,955.8)	12,355.6	305,947.1	(160,566.0)	(43,410.6)	(203,976.6)	(192,612.5)	0.94	(192,612.5)
2018	-	-	136,743.9	-	23,722.7	280,652.8	136,743.9	(35,036.6)	101,707.3	90,690.2	0.89	(101,922.3)
2019	-	-	292,246.4	-	21,824.9	257,382.0	292,246.4	(83,830.7)	208,415.7	175,486.0	0.84	73,563.8
2020	-	-	266,096.1	-	20,078.9	235,972.9	266,096.1	(76,265.3)	189,830.8	150,932.5	0.80	224,496.3
2021	-	-	-	-	18,472.6	216,276.5	-	5,726.5	5,726.5	4,299.4	0.75	228,795.7
2022	-	-	-	-	16,994.8	198,155.8	-	5,268.4	5,268.4	3,735.1	0.71	232,530.8
2023	-	-	-	-	15,635.2	181,484.8	-	4,846.9	4,846.9	3,244.8	0.67	235,775.6
2024	-	-	-	-	14,384.4	166,147.5	-	4,459.2	4,459.2	2,818.9	0.63	238,594.6
2025	-	-	-	-	13,233.6	152,037.1	-	4,102.4	4,102.4	2,448.9	0.60	241,043.5
2026	-	-	-	-	12,174.9	139,055.6	-	3,774.2	3,774.2	2,127.5	0.56	243,171.0
2027	-	-	-	-	11,200.9	127,112.6	-	3,472.3	3,472.3	1,848.2	0.53	245,019.3
2028	-	-	-	-	10,304.9	116,125.0	-	3,194.5	3,194.5	1,605.7	0.50	246,624.9
2029	-	-	-	-	9,480.5	106,016.5	-	2,938.9	2,938.9	1,394.9	0.47	248,019.8
2030	-	-	-	-	8,722.0	96,716.6	-	2,703.8	2,703.8	1,211.8	0.45	249,231.6
2031	-	-	-	-	8,024.3	88,160.7	-	2,487.5	2,487.5	1,052.8	0.42	250,284.4
2032	-	-	-	-	7,382.3	80,289.3	-	2,288.5	2,288.5	914.6	0.40	251,199.0
2033	-	-	-	-	6,791.7	73,047.6	-	2,105.4	2,105.4	794.5	0.38	251,993.5
2034	-	-	-	-	6,248.4	66,385.2	-	1,937.0	1,937.0	690.2	0.36	252,683.7
2035	-	-	-	-	5,748.5	60,255.9	-	1,782.0	1,782.0	599.6	0.34	253,283.4
2036	-	-	-	-	5,288.7	54,616.8	-	1,639.5	1,639.5	520.9	0.32	253,804.3
2037	-	-	-	-	4,865.6	49,428.9	-	1,508.3	1,508.3	452.6	0.30	254,256.9
2038	-	-	-	-	4,476.3	44,656.1	-	1,387.7	1,387.7	393.2	0.28	254,650.1
2039	-	-	-	-	4,118.2	40,265.0	-	1,276.6	1,276.6	341.6	0.27	254,991.6
2040	-	-	-	-	3,788.8	36,225.3	-	1,174.5	1,174.5	296.7	0.25	255,288.3
2041	-	-	-	-	3,485.7	32,508.7	-	1,080.6	1,080.6	257.8	0.24	255,546.1
2042	-	-	-	-	3,206.8	29,089.5	-	994.1	994.1	223.9	0.23	255,770.1
2043	-	-	-	-	2,950.3	25,943.7	-	914.6	914.6	194.5	0.21	255,964.6
2044	-	-	-	-	2,714.2	23,049.7	-	841.4	841.4	169.0	0.20	256,133.6
2045	-	-	-	-	2,497.1	20,387.2	-	774.1	774.1	146.8	0.19	256,280.5
2046	-	-	-	-	2,297.3	17,937.6	-	712.2	712.2	127.6	0.18	256,408.0
2047	-	-	-	-	2,113.5	15,684.1	-	655.2	655.2	110.8	0.17	256,518.8
2048	-	-	-	-	1,944.5	13,610.8	-	602.8	602.8	96.3	0.16	256,615.1
2049	-	-	-	-	1,788.9	11,703.4	-	554.6	554.6	83.6	0.15	256,698.7
2050	-	-	-	-	1,645.8	9,948.5	-	510.2	510.2	72.7	0.14	256,771.4
2051	-	-	-	-	1,514.1	8,334.1	-	469.4	469.4	63.1	0.13	256,834.5
2052	-	-	-	-	1,393.0	6,848.8	-	431.8	431.8	54.8	0.13	256,889.3
2053	-	-	-	-	1,281.6	5,482.4	-	397.3	397.3	47.6	0.12	256,937.0
2054	-	-	-	-	1,179.0	4,225.2	-	365.5	365.5	41.4	0.11	256,978.4
2055	-	-	-	-	1,084.7	3,068.6	-	336.3	336.3	36.0	0.11	257,014.3
2056	-	-	-	-	997.9	2,004.6	-	309.4	309.4	31.2	0.10	257,045.6
Total	**-**	**-**	**847,476.2**	**(312,955.8)**	**297,413.1**		**534,520.4**	**(170,519.6)**	**364,000.9**	**257,045.6**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
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-200,000
-300,000
-400,000
-500,000
-600,000
-700,000
-800,000
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CW Screen Refurbishment vs Avoided Fuel & Repair Costs
Test 2
Test 3
Test 4
Year

CI Number: 49463

Title: POT Coal Mill Overhauls 2017

Start Date:	2017/04
In-Service Date:	2017/07
Final Cost Date:	2018/01
Function:	Steam
Forecast Amount:	$328,410

DESCRIPTION:

Point Tupper Unit 2 employs four Raymond Bowl style mills to pulverize coal for combustion in the boiler. This project will replace mill components that have reached the end of their useful life on one of the four mills. Based on experienced wear characteristics, component failures will occur if a replacement plan is not performed. The consequence of such a failure could include unplanned unit derating. This capital item includes the replacement of welded steel rollers and tables with ceramic wear components, and other non-repairable mill components.

Components either to be replaced or refurbished will be decided based on the condition assessment when teardown is undertaken as part of the planned outage for the mill in 2017. Going forward, continued capital investment of the mills will still be required to extend asset life and maintain the reliability of this equipment.

Summary of Related CIs +/- 2 years:
2015 CI 46372 POT Coal Mill Overhauls $418,292
2016 CI 47662 POT Coal Mill Overhauls 2016 $324,874
2018 CI TBD POT Coal Mill Overhauls 2018 $TBD
2019 CI TBD POT Coal Mill Overhauls 2019 $TBD

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement/Refurbishment

Why do this project?

This project is being completed to mitigate the risk of mill failure. A mill failure could limit the ability of the unit to generate at full capacity depending on the fuel blend in service. It is imperative that the mills are available full time between planned outages in order to maintain unit performance at rated capacity.

This project is being undertaken primarily to prevent unit deratings, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

Operating and maintenance experience with the mills has identified several areas of concern that need to be addressed in order for the mills to meet availability targets. Replacement parts are now needed due to age and wear on many of the components. During periods of lower load it is possible to take 1 of 4 mills out of service without affecting generation. Isolated repairs and minor refurbishment are not typically possible for the mills. It is often necessary to disassemble major components and therefore an overall refurbishment versus isolated repairs is more effective.

Why do this project this way?

A phased approach to maintaining the mills allows for scheduled outages of selected mills, reducing the risk of extended unplanned outages. By planning refurbishments and replacements in a given year, the refurbishment and replacement efforts can be made more efficient with dedicated labour and parts available as required.

CI Number : 49463 - POT Coal Mill Overhauls 2017 **Project Number**

Parent CI Number : -

Cost Centre : 351 - 351-Pt.Tupper Admin./Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		2,260	0	2,260
095		095-Thermal Term Labour AO		7,676	0	7,676
095		095-Thermal Overtime Labour AO		360	0	360
095		095-Thermal & Hydro Contracts AO		323	0	323
095		095-Thermal Regular Labour AO		6,552	0	6,552
001	018	001 - THERMAL Regular Labour	018 - SGP - Fuel Hndlg.Coal	30,527	0	30,527
002	018	002 - THERMAL Overtime Labour	018 - SGP - Fuel Hndlg.Coal	3,353	0	3,353
004	018	004 - THERMAL Term Labour	018 - SGP - Fuel Hndlg.Coal	35,763	0	35,763
012	018	012 - Materials	018 - SGP - Fuel Hndlg.Coal	189,000	0	189,000
013	018	013 - POWER PRODUCTION Contracts	018 - SGP - Fuel Hndlg.Coal	3,000	0	3,000
014	018	014 - Overtime Meals	018 - SGP - Fuel Hndlg.Coal	1,000	0	1,000
015	018	015 - Frt, Post & Delivery	018 - SGP - Fuel Hndlg.Coal	5,000	0	5,000
033	018	033 - Rental and Maintenance of	018 - SGP - Fuel Hndlg.Coal	1,000	0	1,000
066	018	066 - Other Goods & Services	018 - SGP - Fuel Hndlg.Coal	40,597	0	40,597
011	085	011 - Travel Expense	085 Design	1,000	0	1,000
041	085	041 - Meals & Entertainment	085 Design	1,000	0	1,000
			Total Cost:	328,410	0	328,410
			Original Cost:	295,873		

Capital Project Detailed Estimate

Location: Pt. Tupper
CI# / FP#: 49463
Title: POT Coal Mill Overhauls 2017
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Electrician	PD	2	$ 351	$ 703		
Maintenance Trades	PD	40	$ 358	$ 14,305		
Power Plant Technician	PD	10	$ 375	$ 3,746		
Utilityworker	PD	50	$ 235	$ 11,773		
			Sub-Total	$ 30,527		
002 OT Labour						
Electrician	PD	1	$ 703	$ 703		
Maintenance Trades	PD	2	$ 715	$ 1,431		
Power Plant Technician	PD	1	$ 749	$ 749		
Utilityworker	PD	1	$ 471	$ 471		
			Sub-Total	$ 3,353		
004 Term Labour						
Maintenance Trades	PD	100	$ 358	$ 35,763		
			Sub-Total	$ 35,763		
011 Travel Expense						
Travel	lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000		
012 Materials						
Mill rolls	lot	1	$ 33,000	$ 33,000		
Grinding table	lot	1	$ 33,000	$ 33,000		
Rejects table	lot	1	$ 6,000	$ 6,000		
Roll seals	lot	1	$ 2,000	$ 2,000		
Main table seals	lot	1	$ 2,000	$ 2,000		
Riffle boxes	lot	1	$ 6,000	$ 6,000		
Scraper assemblies	lot	2	$ 2,500	$ 5,000		
Mill side liners	lot	1	$ 10,000	$ 10,000		
Rejects side liners	lot	1	$ 10,000	$ 10,000		
Exhauster periphery liners	lot	1	$ 12,000	$ 12,000		
Door assemblies	lot	3	$ 3,000	$ 9,000		
Trunion bushings	lot	1	$ 3,500	$ 3,500		
Bowl ring extension	lot	1	$ 5,000	$ 5,000		
Exhauster fan	lot	1	$ 5,000	$ 5,000		
Exhauster bearings	lot	1	$ 2,000	$ 2,000		
Feeder parts	lot	1	$ 10,000	$ 10,000		
Transition piece	lot	1	$ 15,000	$ 15,000		
Coal pipe	lot	1	$ 6,000	$ 6,000		
Lubricating oil	lot	1	$ 4,500	$ 4,500		
Misc. and consumables	lot	1	$ 10,000	$ 10,000		
Freight (015)	lot	1	$ 5,000	$ 5,000		
			Sub-Total	$ 194,000		
013 Contracts						
Cranes, etc.	lot	1	$ 3,000	$ 3,000		
			Sub-Total	$ 3,000		
033 Rentals						
Rentals	lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000		
041 Meals & Entertainment						
Meals and expenses	lot	1	$ 1,000	$ 1,000		
Overtime meals	lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 2,000		
066 Other Goods & Services						
Contingency	%	15%	$ 270,644	$ 40,597		
			Sub-Total	$ 40,597		
094 Interest Capitalized						

Capital Project Detailed Estimate

	AFUDC				$ 2,260		
				Sub-Total	$ 2,260		
	095 Administrative Overhead						
	Thermal Reg. Labour AO				$ 6,552		
	Thermal OT Labour AO				$ 360		
	Thermal Term Labour AO				$ 7,676		
	Thermal / Hydro Contracts AO				$ 323		
				Sub-Total	$ 14,910		
				SUB-TOTAL (no AO, AFUDC)	$ 311,241		
				TOTAL (AO, AFUDC included)	$ 328,410		
	Original Cost				$ 295,873		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

POT Coal Mill Overhauls 2017
Summary of Alternatives

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Point Tupper Generating Station	**CI Number:**	49463
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Coal Mill Overhaul vs Avoided Fuel & R	5.90%	-569,670	386,870	1	68.11%	2.1 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

This project is recommended to proceed to prevent unit deratings. The project should not be delayed as that will increase the cost of the repair and increase the number of failures substantially, and mill overhauls must be avoided in winter as available generation must be considered.

Notes/Comments :

Coal Mill Overhaul vs Avoided Fuel & Repair Costs

This option assumes two failures in year one, increasing as time goes on and the components continue to deteriorate. A 3 day derate is assumed in order to complete repairs.

Test 2

Test 3

Test 4

POT Coal Mill Overhauls 2017
Summary of Sensitivities

Nova Scotia POWE An Emera Compa

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Point Tupper Generating Station	**CI Number:**	49463
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Coal Mill Overhaul vs Avoided Fuel & Repair Cost	5.90%	-569,670	386,870	1	68.11%	2.1 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Coal Mill Overhaul vs Avoided Fuel & Repair Cost	10%	-538,245	362,644	1	58.26%	2.2 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
	Change:	A	31,426	-24,226	0	-9.85%	0.1 years
		B	0	0	0	#NUM!	0.0 years
		C	0	0	0	#NUM!	0.0 years
		D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Coal Mill Overhaul vs Avoided Fuel & Repair Cost	-10%	-481,278	323,957	1	57.28%	2.2 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
	Change:	A	88,393	-62,913	0	-10.82%	0.2 years
		B	0	0	0	#NUM!	0.0 years
		C	0	0	0	#NUM!	0.0 years
		D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	80,753	250,974	519,212	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

POT Coal Mill Overhauls 2017
Avoided Cost Calculations

Nova Scotia POWER An Emera Company

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Point Tupper Generating Station	**CI Number:**	49463
		Project No. :	

Coal Mill Overhaul vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			27,436	28,538		
Events/Outages (#)	2	4	2	4		
Probability of Occurance (%)	100%	100%	100%	100%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	50.0	50.0				
Duration (Hours or Years)	72	72				
Totals	$47,286	$95,954	$54,872	$114,153	$102,158	$210,107
Total Capital Cost of Alternative						$328,410

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

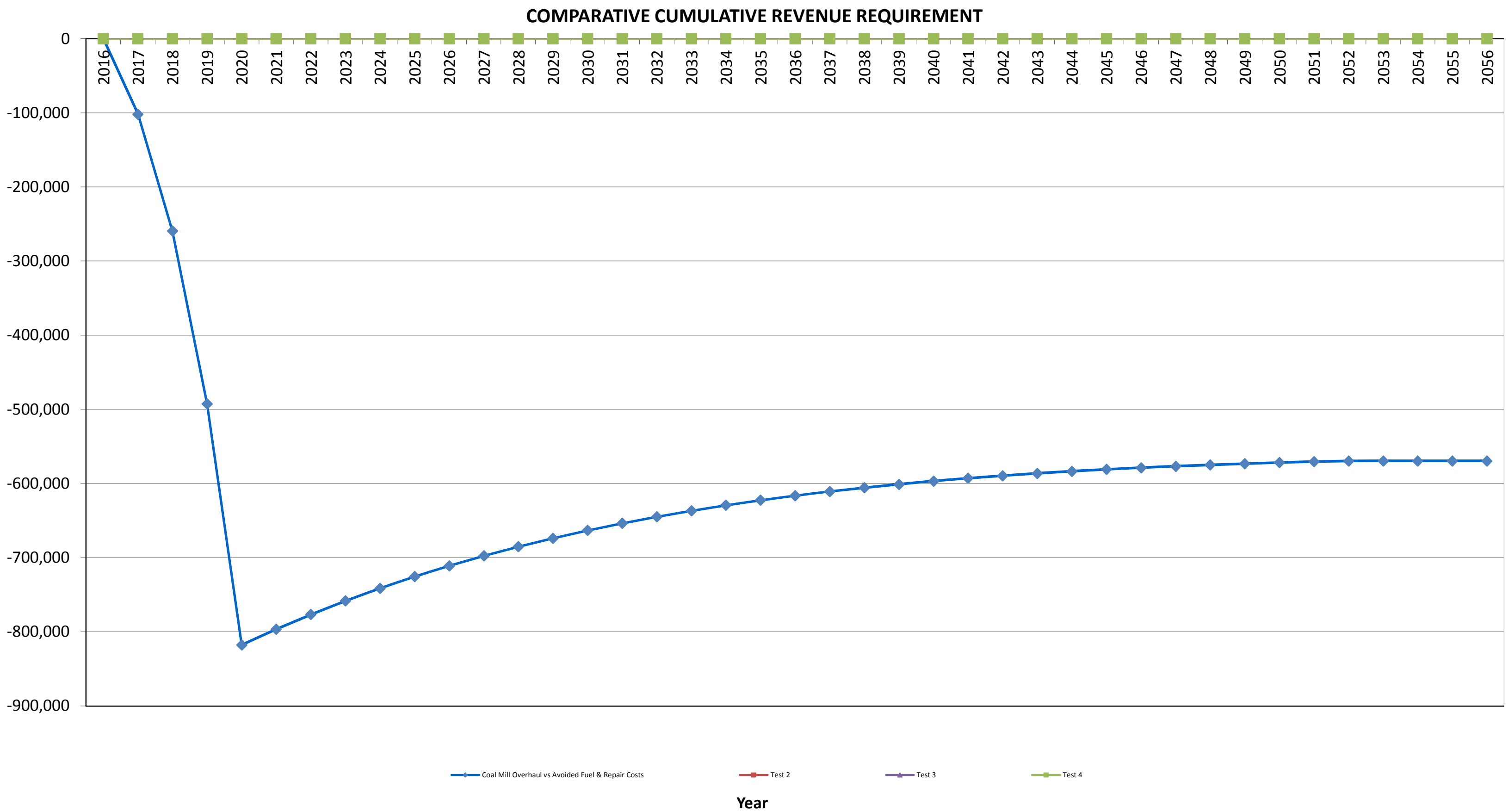
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

POT Coal Mill Overhauls 2017
Coal Mill Overhaul vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	102,158.0	(313,500.5)	12,449.6	302,906.2	(211,342.6)	(27,809.6)	(239,152.2)	(225,828.3)	0.94	(225,828.3)
2018	-	-	210,107.2	-	23,903.3	278,315.8	210,107.2	(57,723.2)	152,384.0	135,877.5	0.89	(89,950.8)
2019	-	-	315,109.8	-	21,991.0	255,692.7	315,109.8	(90,866.8)	224,242.9	188,812.6	0.84	98,861.8
2020	-	-	456,104.1	-	20,231.7	234,879.5	456,104.1	(135,120.4)	320,983.7	255,210.8	0.80	354,072.6
2021	-	-	-	-	18,613.2	215,731.3	-	5,770.1	5,770.1	4,332.1	0.75	358,404.7
2022	-	-	-	-	17,124.1	198,114.9	-	5,308.5	5,308.5	3,763.5	0.71	362,168.3
2023	-	-	-	-	15,754.2	181,907.9	-	4,883.8	4,883.8	3,269.5	0.67	365,437.8
2024	-	-	-	-	14,493.9	166,997.4	-	4,493.1	4,493.1	2,840.4	0.63	368,278.2
2025	-	-	-	-	13,334.4	153,279.8	-	4,133.7	4,133.7	2,467.6	0.60	370,745.8
2026	-	-	-	-	12,267.6	140,659.6	-	3,803.0	3,803.0	2,143.7	0.56	372,889.5
2027	-	-	-	-	11,286.2	129,049.0	-	3,498.7	3,498.7	1,862.3	0.53	374,751.8
2028	-	-	-	-	10,383.3	118,367.2	-	3,218.8	3,218.8	1,617.9	0.50	376,369.7
2029	-	-	-	-	9,552.6	108,540.0	-	2,961.3	2,961.3	1,405.5	0.47	377,775.2
2030	-	-	-	-	8,788.4	99,499.0	-	2,724.4	2,724.4	1,221.0	0.45	378,996.2
2031	-	-	-	-	8,085.4	91,181.2	-	2,506.5	2,506.5	1,060.8	0.42	380,057.0
2032	-	-	-	-	7,438.5	83,528.9	-	2,305.9	2,305.9	921.5	0.40	380,978.5
2033	-	-	-	-	6,843.4	76,488.7	-	2,121.5	2,121.5	800.6	0.38	381,779.1
2034	-	-	-	-	6,296.0	70,011.8	-	1,951.8	1,951.8	695.5	0.36	382,474.6
2035	-	-	-	-	5,792.3	64,053.0	-	1,795.6	1,795.6	604.2	0.34	383,078.8
2036	-	-	-	-	5,328.9	58,570.9	-	1,652.0	1,652.0	524.9	0.32	383,603.7
2037	-	-	-	-	4,902.6	53,527.4	-	1,519.8	1,519.8	456.0	0.30	384,059.7
2038	-	-	-	-	4,510.4	48,887.4	-	1,398.2	1,398.2	396.2	0.28	384,455.9
2039	-	-	-	-	4,149.6	44,618.6	-	1,286.4	1,286.4	344.2	0.27	384,800.0
2040	-	-	-	-	3,817.6	40,691.2	-	1,183.5	1,183.5	299.0	0.25	385,099.0
2041	-	-	-	-	3,512.2	37,078.1	-	1,088.8	1,088.8	259.7	0.24	385,358.8
2042	-	-	-	-	3,231.2	33,754.0	-	1,001.7	1,001.7	225.6	0.23	385,584.4
2043	-	-	-	-	2,972.7	30,695.8	-	921.5	921.5	196.0	0.21	385,780.4
2044	-	-	-	-	2,734.9	27,882.3	-	847.8	847.8	170.3	0.20	385,950.7
2045	-	-	-	-	2,516.1	25,293.9	-	780.0	780.0	147.9	0.19	386,098.7
2046	-	-	-	-	2,314.8	22,912.6	-	717.6	717.6	128.5	0.18	386,227.2
2047	-	-	-	-	2,129.6	20,721.7	-	660.2	660.2	111.7	0.17	386,338.9
2048	-	-	-	-	1,959.3	18,706.1	-	607.4	607.4	97.0	0.16	386,435.9
2049	-	-	-	-	1,802.5	16,851.8	-	558.8	558.8	84.3	0.15	386,520.2
2050	-	-	-	-	1,658.3	15,145.8	-	514.1	514.1	73.2	0.14	386,593.4
2051	-	-	-	-	1,525.7	13,576.3	-	473.0	473.0	63.6	0.13	386,657.0
2052	-	-	-	-	1,403.6	12,132.4	-	435.1	435.1	55.3	0.13	386,712.2
2053	-	-	-	-	1,291.3	10,804.0	-	400.3	400.3	48.0	0.12	386,760.2
2054	-	-	-	-	1,188.0	9,581.8	-	368.3	368.3	41.7	0.11	386,801.9
2055	-	-	-	-	1,093.0	8,457.4	-	338.8	338.8	36.2	0.11	386,838.1
2056	-	-	-	-	1,005.5	7,423.0	-	311.7	311.7	31.5	0.10	386,869.6
Total	-	-	**1,083,479.0**	**(313,500.5)**	**299,677.1**		**769,978.5**	**(242,978.6)**	**526,999.9**	**386,869.6**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
-100,000
-200,000
-300,000
-400,000
-500,000
-600,000
-700,000
-800,000
-900,000
2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056
Coal Mill Overhaul vs Avoided Fuel & Repair Costs
Test 2
Test 3
Test 4
Year

CI Number: 49429

Title: LIN Coal Pile Run Off Pond Expansion

Start Date:	2017/05
In-Service Date:	2017/08
Final Cost Date:	2018/02
Function:	Steam
Forecast Amount:	$311,793

DESCRIPTION:

The coal pile run off pond collects the rain water discharge from the coal storage pile and diverts it to the waste water pump house where it is finally pumped to the waste water settling pond at the ash site.

During a storm run-off study (attached) of the Lingan Generating Station's property, completed in the fall of 2015, it was found that the current coal pile run off pond, adjacent to the ocean, has insufficient capacity in the case of an abnormally severe (1:100 year) storm event. This project is to increase the capacity of the pond to avoid overflowing of untreated wastewater into the ocean in such a storm event.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Environment

Why do this project?

The coal pile run off pond collects water from two coal storage piles; active storage and dead storage (short-term storage). The storm run-off study identified inadequacies in the run off collection pond from the two storage piles in the event of an abnormally severe storm event. Under a severe storm, the run off pond could potentially overflow untreated wastewater into the ocean.

Why do this project now?

The pond capacity issue was only recently discovered and the pond must be addressed now to avoid any potential of overflows during a 1 in 100 year storm. An additional coal laydown pile was constructed approximately 10 years ago that collects additional water and has put more strain on this run off system. NS Power has implemented additional pumping capacity over the years in efforts to mitigate this risk; however the pond is still limiting the surge capacity. Because of this, this extension is now required to mitigate the risk of an overflow.

Why do this project this way?

Increasing the capacity is the most cost effective solution compared to creating a new pond in another location. The underground infrastructure, including the piping and valves necessary to drain the pond to the waste water pump house, already exists at the current site.

CI Number : 49429 - LIN Coal Pile Run Off Pond Expansion **Project Number**

Parent CI Number : -

Cost Centre : 301 - 301-Lingan Admin./Common Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		1,857	0	1,857
095		095-Thermal & Hydro Contracts AO		22,930	0	22,930
095		095-Thermal Regular Labour AO		3,756	0	3,756
001	007	001 - THERMAL Regular Labour	007 - SGP - Environmental	17,500	0	17,500
013	007	013 - POWER PRODUCTION Contracts	007 - SGP - Environmental	[redacted]	0	[redacted]
028	007	028 - Consulting	007 - SGP - Environmental	10,000	0	10,000
066	007	066 - Other Goods & Services	007 - SGP - Environmental	[redacted]	0	[redacted]
			Total Cost:	311,793	0	311,793
			Original Cost:			

Capital Project Detailed Estimate

Location: **Steam**
CI# : 49429
Title: LIN Coal Pile Run Off Pond Expansion
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Engineering	PD	43	$ 405	$ 17,500		
			Sub-Total	$ 17,500		
013 Contracts						
Supply material and Extend Pond	$	1	[redacted]	[redacted]	Cost Support Item #1	
			Sub-Total	[redacted]		
028 Consulting						
Engineering Consulting	lot	1	$ 10,000	$ 10,000		
			Sub-Total	$ 10,000		
066 Other Goods & Services						
Contingency	%	20%	[redacted]	[redacted]		
			Sub-Total	[redacted]		
094 Interest Capitalized						
AFUDC				$ 1,857		
			Sub-Total	$ 1,857		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 3,756		
Thermal / Hydro Contracts AO				$ 22,930		
			Sub-Total	$ 26,686		
			SUB-TOTAL (no AO, AFUDC)	$ 283,250		
			TOTAL (AO, AFUDC included)	$ 311,793		
Original Cost						

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

		Lingan Coal Pond Drainage System Upgrades			
		Opinion of Probable Cost			
			Date:	**January 18, 2016**	
	Item Description	**Unit of Measure**	**Estimated Quantity**	**Estimated Unit Price**	**Estimated Subtotal Price**
-	General Requirements (Mobilization/Demobilization, Bonding, Insurance, etc.)	LS	1	[redacted]	[redacted]
Small Coal Pond Drainage System Upgrades					
1	Mass Excavation @ Ditch	m^3	2000	[redacted]	[redacted]
2	Mass Excavation @ Pond	m^3	2200	[redacted]	[redacted]
3	Supply and Install 750 mm. Dia. HDPE Culvert Piping	m	20	[redacted]	[redacted]
				Subtotal Small Pond Drainage System Upgrades	[redacted]
Large Coal Pond Drainage System Upgrades					
1	Mass Excavation @ Drain Inlet	m^3	350	[redacted]	[redacted]
2	Selected BackFill Material Around Manholes	m^3	600	[redacted]	[redacted]
3	Directionally Drill 200 mm Dia. HDPE Pipe Under Rail Bed	m	35	[redacted]	[redacted]
4	Supply and Install Precast Concrete Manhole	LS	2	[redacted]	[redacted]
5	Supply and Install Valving System in Manhole #1	LS	1	[redacted]	[redacted]
6	Supply and Install 200 mm Dia. Ductile Iron Pipe @ Drain Inlet	m	8	[redacted]	[redacted]
7	Supply and Install 450 mm. Dia. HDPE Culvert Piping # Manhole #2	m	20	[redacted]	[redacted]
8	Supply and Install Rock Lined Spillway @ Existing Culvert End	LS	1	[redacted]	[redacted]
9	Supply and Install Type 1 Gravel on Manhole #1 Roadway	t	75	[redacted]	[redacted]
				Subtotal Large Pond Drainage System Upgrades	[redacted]
				Contingency Allowance (10%)	[redacted]
				TOTAL PRICE (EXCLUDING TAXES)	[redacted]

September 14, 2015 SYD-00222859-A0

Mr. Shawn Lively
Nova Scotia Power Inc.
2599 Hinchey Avenue
Lingan, NS B1H 5E6

Re: Lingan Thermal Generating Station
Hydrological Assessment

Dear Mr. Lively:

Exp Services Inc. (**exp**) is pleased to provide Nova Scotia Power Inc. (NSPI) with a Final Report on the recent Hydrological Assessment at the Lingan Thermal Generating Station. The following sections outline the findings and recommendations of this effort.

Background

Exp was engaged by NSPI to undertake a hydrological assessment of the Lingan Thermal Generating Station in October 2014. This assessment is required for renewal NSPI's Approval to Operate # 2005-044906-A01 from Nova Scotia Environment (NSE) for the Station, which expires on December 31, 2015. The assessment included the raw coal stockpile area, but not the Ash Management Site. In general, it examined the capability of the existing site runoff control features to handle storm water runoff from a major rain event. The approved Scope of Work incorporated the following general tasks:

Task 1- Site Inspection:

This task entailed walking the site to determine the particulars of all pertinent drainage features, including culverts and drainage channels with measurements of slope and cross sections at select points. **Exp** also interviewed NSPI personnel regarding the disposition of any roof, footer and sump drainages.

Task 2- Mapping:

Existing LIDAR imagery for the site was acquired from the Cape Breton Regional Municipality (CBRM) to develop detailed topographic contours of the site based upon 2008 imagery. This formed the basis for delineating watershed contributing areas for selected points in the drainage system.

TASK 3- Obtain Intensity-Duration-Frequency (IDF) Storm Information:

We understand that neither NSPI nor the regulator has specified a “design” storm for this site. However, Intensity-duration-frequency (IDF) curves for precipitation were acquired from Environment Canada’s Sydney Airport station to support determination of 1:25 and 1:100 year – 24 hour duration events. Climate change scenarios would not specifically be incorporated into the analysis, other than looking at a 1.3 times the 1:100 year event.

TASK 4 – Flow:

Discharge calculations were undertaken for selected points over the site to determine the ability of the existing drainage network to handle runoff flows for various design storm scenarios based upon a conceptual/analytical flow model. A detailed numerical flow model was not to be undertaken for this assessment. This approach indicated where flooding could be expected to originate from, but not the extent or depth of flooding surrounding that area. This approach also does not account for enhanced flooding due to ice conditions, or backwater effects from up-gradient restrictions in the drainage network.

TASK 5 – Coal-Impacted Water Storage / Pumping System Capacity Check:

An additional task was added to the scope of this assignment, which involved a review of the coal-impacted water storage / pumping system at the Lingan Facility. There are two storm water storage ponds located adjacent to each of the two coal storage piles at the site. Storm water flow from these coal storage pile areas is diverted to these storage ponds and then to a pumping station located next to the Generating Facility itself. This coal-impacted storm water is then pumped to a storage/treatment lagoon to the west of the Generating Facility.

TASK 6 – Report:

This correspondence provides a brief, stand-alone report with the accompanying drawing depicting the site drainage patterns.

Methodology

A site tour was conducted with Lingan Generating Station’s Chemical - Environmental Supervisor, Mr. Shawn Lively, on November 20, 2014. The intent of this tour was to identify the storm water flow patterns throughout the site, including the overall drainage areas and sub-drainage areas, storm water discharge points, as well as the locations and routings of culverts and drainage channels. The attached drawing depicts the results of this site tour, including a comprehensive account of the storm water drainage areas and infrastructure at the Lingan site.

Culvert Capacity Checks

Exp obtained the most recent rainfall Intensity-Duration-Frequency (IDF) curves from Environment Canada and calculated the rainfall intensity for the site based on the specified design storm duration. There are effectively three design storm scenarios:

1. A storm return frequency of 1:25 years;
2. A storm return frequency of 1:100 years;
3. A storm return frequency of 1:100 years for which the rainfall intensity has been arbitrarily increased by a factor of 1.3 (30%) to account for Climate Change effects.

The diameter, slope and type of material for each critical culvert on the site was obtained and this information was used to calculate a maximum flow capacity for each culvert. The drainage area that is tributary to each culvert was also determined and was used to calculate the theoretical flow that each culvert would be required to accommodate for each storm scenario. This was in an effort to determine whether or not critical culverts are expected to be overloaded during the design storm scenario. The results of these calculations are shown in the **Appendix A** to this letter report.

Coal-Impacted Storm Water Pumping/Storage System Check

For analysis of the coal-impacted storm water storage / pumping system a rainfall distribution hyetograph was developed for a 24 hour duration storm based on the total rainfall to be expected for each of the three design storm scenarios. This hyetograph was developed by using the SCS - 24 (Soil Conservation Service 24 hour Storm) method and assumed a Type III storm event. A Type III storm event is considered to most closely approximate the type of storm that might be experienced in a coastal area such as Nova Scotia. This rainfall distribution resembles a bell-curve whereby the most intense rainfall occurs during the middle period of storm duration. The resulting rainfall hyetographs for the three design storm scenarios are shown in **Appendix B**.

Once a rainfall hyetograph was developed for the Lingan site, a resulting runoff versus duration of storm curve was developed for each of the drainage areas in question.

Next, the storage volume of each coal-impacted stormwater storage pond was computed. For the larger pond to the north of the site, it was assumed that the maximum top water level in this pond would be at the invert elevation of the pipe that connects this storage pond to the emergency oil containment area adjacent to the pond. The volume of this pond was computed with the use of limited LIDAR survey information, which depicts the bottom of the pond and in consideration of surveyed invert elevations of pond inlet and outlet piping. This computation of storage volume also assumes that the pond outfall piping would be reconfigured to provide for a drain pipe at the base of the pond equipped with a valve which would normally be closed. This would enable the pond to be drained on dry days and would enable the pond to retain storm water in anticipation of a large storm water event.

The volume of the smaller storage pond/concrete holding tank to the south of the site was computed based on LIDAR data and "as-built" drawings that were obtained from NSPI showing the existing holding tank setup.

Calculations of the volumes of various storage areas and associated drainage areas are shown in **Appendix B**.

Subsequently, information regarding the existing arrangement for the coal-impacted stormwater pumping station was compiled and used to calculate the station pumping capacity.

Finally, the coal-impacted stormwater storage/pumping system was analyzed in the context of each of the three design storm scenarios in an effort to determine whether or not adequate capacity exists to accommodate the flows it would theoretically be subjected to without overflowing into the adjacent receiving water. Graphs depicting the results of this analysis are provided in **Appendix B**.

Discussion of Results and Findings

In consideration of our conversations with NSPI staff and our calculations of the capacity of the storm water drainage infrastructure relative to the various design storm scenarios, we have the following comments:

1. At the time of writing this report, Culvert Number 1-6 at the east side of the site was severely blocked and needed to be cleaned out. This same culvert would also be overloaded under the 1.3 x 1:100 Year storm scenario. However, we understand that this culvert was recently cleaned out by NSPI's forces.
2. Culvert Number 1-3 which is a small diameter (75 mm or 3") drain pipe from the large coal-impacted storm water storage pond is undersized for the flows it could be subjected to under all three storm scenarios. Reportedly, this pipe is also frequently blocked and is a maintenance liability for NSPI.
3. Culvert Number 1-10 which is a 300 mm (12") diameter, PVC is undersized for the flows it could be subjected to under all three storm scenarios.
4. While analysis indicates that Culvert 1-5 which drains the Oil Tank Emergency Containment Basin would be overloaded for the two 1:100 year storm scenarios, there appears to be ample storage capacity in this basin to retain water during heavy rainfall events.
5. While analysis indicates that Culvert 1-6 would be overloaded during the 1.3 x 1:100 year storm scenario, there appears to be ample storage capacity in the large coal-impacted storage pond to retain water during heavy rainfall events.
6. While analysis indicates that Culvert 1-11 would be overloaded during all three design storm scenarios, this is not a concern because this pipe is only required to carry the maximum pumping capacity of the storm water pumping station at the site. In that regard, this pipe is adequately sized.
7. The upper portion of the culvert system that carries Laffin's Brook through the Lingan site, which is understood to be 914 mm (36") in diameter appears to be undersized for all three

storm scenarios. This section of culvert was installed in two stages. Based on a review of record drawings for this culvert system, the first section was installed at a slope of 4.0% and the second section was installed at a slope of 1.0%. The lower portion of this culvert system which is understood to be 1,370 mm (54") in diameter is undersized for the 1.3 x 1:100 Year storm scenario, but is adequate for the other two storm scenarios. While this area would be impacted by flooding during a large storm event, NSPI indicates that there is no critical plant infrastructure in the area that would be flooded during a heavy rainfall event.

8. The approximate storage volume of the large coal-impacted storage pond is 8,000 m^3. Runoff calculations indicate that this pond has adequate capacity to retain all runoff from each of the three design storm scenarios.
9. The approximate storage volume of the oil tank emergency containment basin is 3,000 m^3 and runoff calculations indicate that this basin has adequate capacity to retain all runoff from each of the three design storm scenarios.
10. A large portion of flow reports to the existing small coal-impacted storm water storage pond and holding tank, and ultimately to the existing wastewater pumping station at the east side of the site. This storm water runoff is pumped up to a storage/treatment lagoon to the west of the Lingan Generating Station. Our analysis has revealed that based on the maximum discharge pumping capacity of the pumping station (5860 USGPM with all 5 possible pumps running and discharging in parallel into both the 20" and 10" Basalt lined pipes), the present storage volume of 3500 m^3 in the small storage pond/holding tank is insufficient to prevent overflow of the system. Operating on the assumption that all 5 pumps and both the 20" and 10" Basalt lined pipes would be available, storage capacity of the small storage pond/holding tank would need to increase to 4818, 6100 or 8877m^3 depending on the rainfall event chosen (i.e. 25 year, 100 year or 100 year + 30% storm) in order to prevent overflow.

    In the case that only the 4 Cornelll Pumps were operational, the maximum flow rate achievable would reduce to 5425 USGPM with corresponding storage capacity requirements of 5011 m^3, 6294 m^3 or 9272 m^3. In the case of the 1 in 100 Year + 30% event, the above noted storage volumes would prevent overflow, but the sump would not be completely pumped out at the end of the event.

    If looked at from the perspective of maintaining the existing storage volume of 3500 m^3, the existing pumping capacity is insufficient. In order to prevent an overflow of the current system, pumping capacity would need to increase to 8752 USGPM, 11575 USGPM or 17247 USGPM depending on whether the governing rainfall event was the 25 year, 100 year or 100 year + 30% storm. Ideally, pumping capacity and storage should be matched to each other so that the storage system does not overflow during the heaviest rainfall and is completely pumped out when the storm ends. Analysis shows that for the 25 year, 100 year and 100 year +30% events, the pumping capacity and storage combinations would be: 4094 USGPM and 5660 m^3, 4747 USGPM and 6690 m^3 and 6059 USGPM and 8697m^3, respectively.

Recommendations

Based on our analysis, we have the following recommendations at this time:

1. Consideration should be given to replacement of Culvert Number 1-6 at the east side of the site to accommodate the 1.3 x 1:100 Year storm scenario. If this culvert is replaced, a 760 mm (30") diameter pipe should be installed in this location.
2. The small diameter 75 mm (3") drain pipe from the coal-impacted dead storage area, Culvert Number 1-3 is undersized for the flows it could be subjected to and should be replaced. We suggest that a 600 mm (24") diameter pipe or two 300 mm diameter (12) pipes should be installed in this location and at such an elevation to provide overflow from the pond and to establish the maximum allowable water level. We also recommend that a drain pipe of a minimum diameter of 200 mm (8") be installed at the base of the pond and equipped with a valve that can be closed to retain storm water in the pond. This would enable the pond to be drained on dry days and in anticipation of large storm events.
3. Culvert Number 1-10 which is 300 mm (12") diameter, PVC should be replaced with a 600 mm (24") diameter pipe.
4. NSE should be asked to specify a design storm event to be used for analysis of the capacity of critical storm water infrastructure on the site.
5. During replacement of culverts, the composition of the replacement pipe should be selected to give consideration to the pH of the water they will be in contact with, especially the low pHs In Laffin's Brook.
6. It is recommended that NSPI give consideration to increasing the storage volume of the small coal-impacted storage pond/holding tank to mitigate the risk of overflow of coal-impacted storm water into the adjacent receiving waters during a heavy rainfall event.

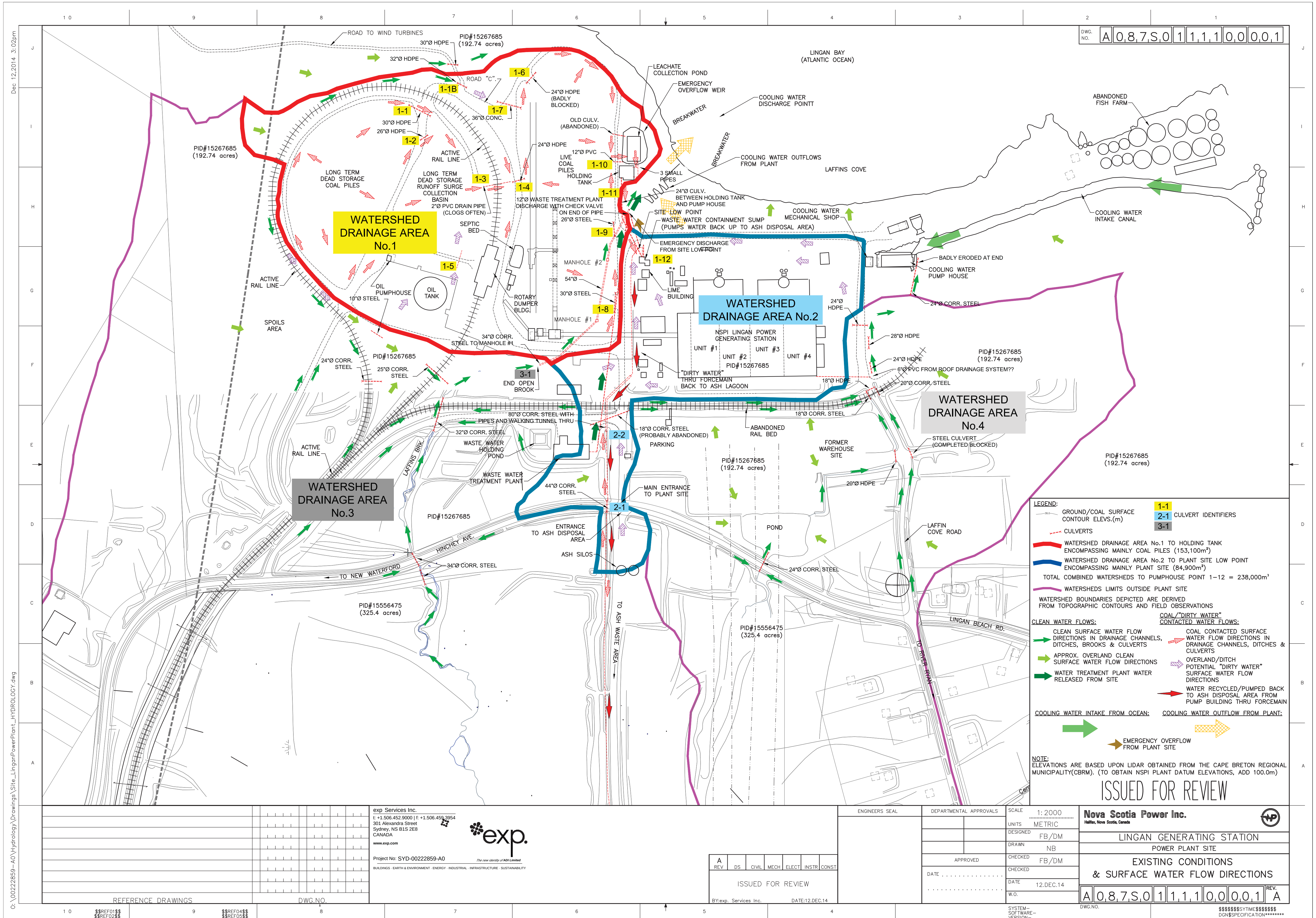
We thank you for the opportunity to provide this report. If you have any questions, please contact the undersigned at your convenience.

Sincerely,

Darrin McLean, P.Eng., MBA
Project Management - Municipal Infrastructure

exp Services Inc.

Appendix A – Culvert Capacity Check


WATERSHED DRAINAGE AREA No.1
WATERSHED DRAINAGE AREA No.2
WATERSHED DRAINAGE AREA No.3
WATERSHED DRAINAGE AREA No.4
LINGAN BAY (ATLANTIC OCEAN)
LAFFINS COVE
ABANDONED FISH FARM
COOLING WATER INTAKE CANAL
COOLING WATER PUMP HOUSE
COOLING WATER OUTFLOWS FROM PLANT
COOLING WATER DISCHARGE POINT
LEACHATE COLLECTION POND
EMERGENCY OVERFLOW WEIR
BREAKWATER
ROAD TO WIND TURBINES
LONG TERM DEAD STORAGE COAL PILES
LONG TERM DEAD STORAGE RUNOFF SURGE COLLECTION BASIN
LIVE COAL PILES
HOLDING TANK
OIL PUMPHOUSE
OIL TANK
ROTARY DUMPER BLDG.
SPOILS AREA
ACTIVE RAIL LINE
NSPI LINGAN POWER GENERATING STATION
UNIT #1
UNIT #2
UNIT #3
UNIT #4
PID#15267685 (192.74 acres)
PID#15556475 (325.4 acres)
LIME BUILDING
WASTE WATER HOLDING POND
WASTE WATER TREATMENT PLANT
MAIN ENTRANCE TO PLANT SITE
ENTRANCE TO ASH DISPOSAL AREA
ASH SILOS
TO ASH WASTE AREA
PARKING
FORMER WAREHOUSE SITE
POND
ABANDONED RAIL BED
HINCHEY AVE.
TO NEW WATERFORD
LINGAN BEACH RD.
LAFFIN COVE ROAD
LAFFINS BRK.
TO RIVER RYAN
LEGEND:
GROUND/COAL SURFACE CONTOUR ELEVS.(m)
CULVERTS
1-1 2-1 3-1 CULVERT IDENTIFIERS
WATERSHED DRAINAGE AREA No.1 TO HOLDING TANK ENCOMPASSING MAINLY COAL PILES (153,100m²)
WATERSHED DRAINAGE AREA No.2 TO PLANT SITE LOW POINT ENCOMPASSING MAINLY PLANT SITE (84,900m²)
TOTAL COMBINED WATERSHEDS TO PUMPHOUSE POINT 1-12 = 238,000m²
WATERSHEDS LIMITS OUTSIDE PLANT SITE
WATERSHED BOUNDARIES DEPICTED ARE DERIVED FROM TOPOGRAPHIC CONTOURS AND FIELD OBSERVATIONS
CLEAN WATER FLOWS:
CLEAN SURFACE WATER FLOW DIRECTIONS IN DRAINAGE CHANNELS, DITCHES, BROOKS & CULVERTS
APPROX. OVERLAND CLEAN SURFACE WATER FLOW DIRECTIONS
WATER TREATMENT PLANT WATER RELEASED FROM SITE
COAL/"DIRTY WATER" CONTACTED WATER FLOWS:
COAL CONTACTED SURFACE WATER FLOW DIRECTIONS IN DRAINAGE CHANNELS, DITCHES & CULVERTS
OVERLAND/DITCH POTENTIAL "DIRTY WATER" SURFACE WATER FLOW DIRECTIONS
WATER RECYCLED/PUMPED BACK TO ASH DISPOSAL AREA FROM PUMP BUILDING THRU FORCEMAIN
COOLING WATER INTAKE FROM OCEAN:
COOLING WATER OUTFLOW FROM PLANT:
EMERGENCY OVERFLOW FROM PLANT SITE
NOTE:
ELEVATIONS ARE BASED UPON LIDAR OBTAINED FROM THE CAPE BRETON REGIONAL MUNICIPALITY(CBRM). (TO OBTAIN NSPI PLANT DATUM ELEVATIONS, ADD 100.0m)
ISSUED FOR REVIEW
exp Services Inc.
301 Alexandra Street
Sydney, NS B1S 2E8
CANADA
www.exp.com
Project No: SYD-00222859-A0
exp.
REFERENCE DRAWINGS
DWG.NO.
ISSUED FOR REVIEW
ENGINEERS SEAL
DEPARTMENTAL APPROVALS
APPROVED
SCALE 1:2000
UNITS METRIC
DESIGNED FB/DM
DRAWN NB
CHECKED FB/DM
DATE 12.DEC.14
Nova Scotia Power Inc.
LINGAN GENERATING STATION
POWER PLANT SITE
EXISTING CONDITIONS & SURFACE WATER FLOW DIRECTIONS
DWG. NO. A087S0 1 111 00 001
REV. A

NSPI Lingan Hydrological Review - Culvert Capacity Check

Storm Frequency:	**1:25**		**Comments**				
Drainage Area 1							
Assumed Runoff Coefficent (C):	0.8		Assumes winter runoff coefficient				
Time of Concentration (t)(minutes):	30						
Rainfall Intensity (I) (mm/hr):	47		Assumes Sydney IDF curve - 1:25 year storm at above noted Time of Concentration				
Total Drainage Area Size (A) (m^2)	153100						
Total Flow (Q)	***56***	ft^3/s	21110	igpm			

Mannings Coefficient (n) Lookup Table	
Pipe Material	***n***
HDPE	0.010
PVC	0.009
STEEL	0.012
CONC	0.013

Drainage Area	**Culvert Pipe #**	**Pipe Diameter (in)**	**Pipe Material**	Mannings Coefficient (n)	Pipe Slope (%)	**Pipe Capacity (Ft^3/s)**	**Culvert Sub-Drainage Area Size (m^2)**	Assumed Runoff Coefficent (C):	Rainfall Intensity (mm/hr):	**Flow Rate Under Design Storm (ft^3/s)**	**Overloaded During Storm?**	**Comments**
1	1	30	HDPE	0.010	3.4%	***98.5***	12130	0.8	47	**4.5**	**NO**	
1	2	26	HDPE	0.010	2.8%	**61.1**	15290	0.8	47	**5.6**	**NO**	
1	3	3	PVC	0.009	6.3%	**0.3**	63030	0.8	47	**23.3**	**YES**	Drain for dead storage collection basin
1	4	24	HDPE	0.010	2.6%	**47.5**	71155	0.8	47	**26.3**	**NO**	
1	5	12	PVC	0.009	1.3%	**5.9**	14520	0.8	47	**5.4**	**NO**	Pipe between Oil Tank Basin and Large Storage Pond. Pipe contains a valve which is normally closed.
1	6	24	HDPE	0.010	2.3%	**44.7**	96197	0.8	47	**35.5**	**NO**	Badly blocked culvert
1	7	36	CONC	0.013	2.2%	**99.1**	11610	0.8	47	**4.3**	**NO**	
1	8	30	STEEL	0.012	1.4%	**52.7**	15895	0.8	47	**5.9**	**NO**	
1	9	26	STEEL	0.012	5.2%	**69.3**	27910	0.8	47	**10.3**	**NO**	
1	10	12	PVC	0.009	11.8%	**17.7**	147170	0.8	47	**54.3**	**YES**	This culvert would still be overloaded if drainage area associated with Large Coal-Impacted Storage Pond was removed
1	11	30	CONC	0.013	0.9%	**39.0**	153100	0.8	47	**56.5**	**YES**	Culvert between holding tank and WW Pump House. This culvert would still be overloaded if drainage area associated with Large Coal-Impacted Storage Pond was removed.

NSPI Lingan Hydrological Review - Culvert Capacity Check

Storm Frequency:	1:100		Comments				
Drainage Area 1							
Assumed Runoff Coefficent (C):	0.8		Assumes winter runoff coefficient				
Time of Concentration (t)(minutes):	30						
Rainfall Intensity (I) (mm/hr):	57		Assumes Sydney IDF curve - 1:100 year storm at above noted Time of Concentration				
Total Drainage Area Size (A) (m^2)	153100						
Total Flow (Q)	***69***	ft^3/s	25601	igpm			

Mannings Coefficient (n) Lookup Table	
Pipe Material	***n***
HDPE	0.010
PVC	0.009
STEEL	0.012
CONC	0.013

Drainage Area	Culvert Pipe #	Pipe Diameter (in)	Pipe Material	Mannings Coefficient (n)	Pipe Slope (%)	Pipe Capacity (Ft^3/s)	Culvert Sub-Drainage Area Size (m^2)	Assumed Runoff Coefficent (C):	Rainfall Intensity (mm/hr):	Flow Rate Under Design Storm (ft^3/s)	Overloaded During Storm?	Comments
1	1	30	HDPE	0.010	3.4%	***98.5***	12130	0.8	57	**5.4**	**NO**	
1	2	26	HDPE	0.010	2.8%	**61.1**	15290	0.8	57	**6.8**	**NO**	
1	3	3	PVC	0.009	6.3%	**0.3**	63030	0.8	57	**28.2**	**YES**	Drain for dead storage collection basin
1	4	24	HDPE	0.010	2.6%	**47.5**	71155	0.8	57	**31.8**	**NO**	
1	5	12	PVC	0.009	1.3%	**5.9**	14520	0.8	57	**6.5**	**YES**	Pipe between Oil Tank Basin and Large Storage Pond. Pipe contains a valve which is normally closed.
1	6	24	HDPE	0.010	2.3%	**44.7**	96197	0.8	57	**43.0**	**NO**	Badly blocked culvert
1	7	36	CONC	0.013	2.2%	**99.1**	11610	0.8	57	**5.2**	**NO**	
1	8	30	STEEL	0.012	1.4%	**52.7**	15895	0.8	57	**7.1**	**NO**	
1	9	26	STEEL	0.012	5.2%	**69.3**	27910	0.8	57	**12.5**	**NO**	
1	10	12	PVC	0.009	11.8%	**17.7**	147170	0.8	57	**65.9**	**YES**	This culvert would still be overloaded if drainage area associated with Large Coal-Impacted Storage Pond was removed
1	11	30	CONC	0.013	0.9%	**39.0**	153100	0.8	57	**68.5**	**YES**	Culvert between holding tank and WW Pump House. This culvert would still be overloaded if drainage area associated with Large Coal-Impacted Storage Pond was removed.

NSPI Lingan Hydrological Review - Culvert Capacity Check

Storm Frequency:	**1:100**	**x 1.3**	**Comments**				
Drainage Area 1							
Assumed Runoff Coefficent (C):	0.8		Assumes winter runoff coefficient				
Time of Concentration (t)(minutes):	30						
Rainfall Intensity (I) (mm/hr):	74.1		Assumes Sydney IDF curve - 1:100 year storm at above noted Time of Concentration				
Total Drainage Area Size (A) (m^2)	153100						
Total Flow (Q)	***89***	ft^3/s	33281	igpm			

Mannings Coefficient (n) Lookup Table	
Pipe Material	***n***
HDPE	0.010
PVC	0.009
STEEL	0.012
CONC	0.013

Drainage Area	**Culvert Pipe #**	**Pipe Diameter (in)**	**Pipe Material**	Mannings Coefficient (n)	Pipe Slope (%)	**Pipe Capacity (Ft^3/s)**	**Culvert Sub-Drainage Area Size (m^2)**	Assumed Runoff Coefficent (C):	Rainfall Intensity (mm/hr):	**Flow Rate Under Design Storm (ft^3/s)**	**Overloaded During Storm?**	**Comments**
1	1	30	HDPE	0.010	3.4%	***98.5***	12130	0.8	74.1	**7.1**	**NO**	
1	2	26	HDPE	0.010	2.8%	**61.1**	15290	0.8	74.1	**8.9**	**NO**	
1	3	3	PVC	0.009	6.3%	**0.3**	63030	0.8	74.1	**36.7**	**YES**	Drain for dead storage collection basin
1	4	24	HDPE	0.010	2.6%	**47.5**	71155	0.8	74.1	**41.4**	**NO**	
1	5	12	PVC	0.009	1.3%	**5.9**	14520	0.8	74.1	**8.4**	**YES**	Pipe between Oil Tank Basin and Large Storage Pond. Pipe contains a valve which is normally closed.
1	6	24	HDPE	0.010	2.3%	**44.7**	96197	0.8	74.1	**56.0**	**YES**	Badly blocked culvert
1	7	36	CONC	0.013	2.2%	**99.1**	11610	0.8	74.1	**6.8**	**NO**	
1	8	30	STEEL	0.012	1.4%	**52.7**	15895	0.8	74.1	**9.2**	**NO**	
1	9	26	STEEL	0.012	5.2%	**69.3**	27910	0.8	74.1	**16.2**	**NO**	
1	10	12	PVC	0.009	11.8%	**17.7**	147170	0.8	74.1	**85.6**	**YES**	This culvert would still be overloaded if drainage area associated with Large Coal-Impacted Storage Pond was removed
1	11	30	CONC	0.013	0.9%	**39.0**	153100	0.8	74.1	**89.1**	**YES**	Culvert between holding tank and WW Pump House. This culvert would still be overloaded if drainage area associated with Large Coal-Impacted Storage Pond was removed.

NSPI Lingan Hydrological Review - Culvert Capacity Check

Storm Frequency:	1:25		Comments				
Drainage Area 2							
Assumed Runoff Coefficent (C):	0.8		Assumes winter runoff coefficient				
Time of Concentration (t)(minutes):	30						
Rainfall Intensity (I) (mm/hr):	47		Assumes Sydney IDF curve - 1:25 year storm at above noted Time of Concentration				
Total Drainage Area Size (A) (m^2)	84865						
Total Flow (Q)	***31***	ft^3/s	11701	igpm			

Mannings Coefficient (n) Lookup Table	
Pipe Material	***n***
HDPE	0.010
PVC	0.009
STEEL	0.012
CONC	0.013

Drainage Area	Culvert Pipe #	Pipe Diameter (in)	Pipe Material	Mannings Coefficient (n)	Pipe Slope (%)	Pipe Capacity (Ft^3/s)	Culvert Sub-Drainage Area Size (m^2)	Assumed Runoff Coefficent (C):	Rainfall Intensity (mm/hr):	Flow Rate Under Design Storm (ft^3/s)	Overloaded During Storm?	Comments
2	1	44	STEEL	0.012	0.6%	***95.8***	3630	0.8	47	**1.3**	**NO**	
2	2	80	STEEL	0.012	1.3%	**694.3**	13365	0.8	47	**4.9**	**NO**	

NSPI Lingan Hydrological Review - Culvert Capacity Check

Storm Frequency:	1:100		Comments				
Drainage Area 2							
Assumed Runoff Coefficent (C):	0.8		Assumes winter runoff coefficient				
Time of Concentration (t)(minutes):	30						
Rainfall Intensity (I) (mm/hr):	57		Assumes Sydney IDF curve - 1:100 year storm at above noted Time of Concentration				
Total Drainage Area Size (A) (m^2)	84865						
Total Flow (Q)	***38***	ft^3/s	14191	igpm			

Mannings Coefficient (n) Lookup Table	
Pipe Material	***n***
HDPE	0.010
PVC	0.009
STEEL	0.012
CONC	0.013

Drainage Area	Culvert Pipe #	Pipe Diameter (in)	Pipe Material	Mannings Coefficient (n)	Pipe Slope (%)	Pipe Capacity (Ft^3/s)	Culvert Sub-Drainage Area Size (m^2)	Assumed Runoff Coefficent (C):	Rainfall Intensity (mm/hr):	Flow Rate Under Design Storm (ft^3/s)	Overloaded During Storm?	Comments
2	1	44	STEEL	0.012	0.6%	***95.8***	3630	0.8	57	**1.6**	**NO**	
2	2	80	STEEL	0.012	1.3%	**694.3**	13365	0.8	57	**6.0**	**NO**	

NSPI Lingan Hydrological Review - Culvert Capacity Check

Storm Frequency:	1:100	x 1.3	Comments				
Drainage Area 2							
Assumed Runoff Coefficent (C):	0.8		Assumes winter runoff coefficient				
Time of Concentration (t)(minutes):	30						
Rainfall Intensity (I) (mm/hr):	74.1		Assumes Sydney IDF curve - 1:100 year storm at above noted Time of Concentration				
Total Drainage Area Size (A) (m^2)	84865						
Total Flow (Q)	***49***	ft^3/s	18448	igpm			

Mannings Coefficient (n) Lookup Table	
Pipe Material	***n***
HDPE	0.010
PVC	0.009
STEEL	0.012
CONC	0.013

Drainage Area	**Culvert Pipe #**	**Pipe Diameter (in)**	**Pipe Material**	Mannings Coefficient (n)	Pipe Slope (%)	**Pipe Capacity (Ft^3/s)**	**Culvert Sub-Drainage Area Size (m^2)**	Assumed Runoff Coefficent (C):	Rainfall Intensity (mm/hr):	**Flow Rate Under Design Storm (ft^3/s)**	**Overloaded During Storm?**	**Comments**
2	1	44	STEEL	0.012	0.6%	***95.8***	3630	0.8	74.1	**2.1**	**NO**	
2	2	80	STEEL	0.012	1.3%	**694.3**	13365	0.8	74.1	**7.8**	**NO**	

NSPI Lingan Hydrological Review - Culvert Capacity Check

Storm Frequency:	**1:25**		**Comments**				
Drainage Area 3							
Assumed Runoff Coefficent (C):	0.8		Assumes winter runoff coefficient				
Time of Concentration (t)(minutes):	30						
Rainfall Intensity (I) (mm/hr):	47		Assumes Sydney IDF curve - 1:25 year storm at above noted Time of Concentration				
Total Drainage Area Size (A) (m^2)	785910						
Total Flow (Q)	***290***	ft^3/s	108363	igpm			

Mannings Coefficient (n) Lookup Table	
Pipe Material	***n***
HDPE	0.010
PVC	0.009
STEEL	0.012
CONC	0.013

Drainage Area	**Culvert Pipe #**	**Pipe Diameter (in)**	**Pipe Material**	Mannings Coefficient (n)	Pipe Slope (%)	**Pipe Capacity (Ft^3/s)**	**Culvert Sub-Drainage Area Size (m^2)**	Assumed Runoff Coefficent (C):	Rainfall Intensity (mm/hr):	**Flow Rate Under Design Storm (ft^3/s)**	**Overloaded During Storm?**	**Comments**
3	1A-1	36	STEEL	0.012	4.0%	***144.8***	785910	0.8	47	**290**	**YES**	First section of Laffin's Brook culvert to 1st MH. Pipe slope shown on record drawing
3	1A-2	36	STEEL	0.012	1.0%	***72.4***	785910	0.8	47	**290**	**YES**	Second section of Laffin's Brook culvert to 1st MH. Pipe slope shown on record drawing
3	1B	54	STEEL	0.012	3.2%	***381.9***	785910	0.8	47	**290**	**NO**	Laffin's Brook - 1st MH to Outfall. Pipe slope to be confirmed

NSPI Lingan Hydrological Review - Culvert Capacity Check

Storm Frequency:	**1:100**		**Comments**				
Drainage Area 3							
Assumed Runoff Coefficent (C):	0.8		Assumes winter runoff coefficient				
Time of Concentration (t)(minutes):	30						
Rainfall Intensity (I) (mm/hr):	57		Assumes Sydney IDF curve - 1:100 year storm at above noted Time of Concentration				
Total Drainage Area Size (A) (m^2)	785910						
Total Flow (Q)	***352***	ft^3/s	131419	igpm			

Mannings Coefficient (n) Lookup Table	
Pipe Material	***n***
HDPE	0.010
PVC	0.009
STEEL	0.012
CONC	0.013

Drainage Area	**Culvert Pipe #**	**Pipe Diameter (in)**	**Pipe Material**	Mannings Coefficient (n)	Pipe Slope (%)	**Pipe Capacity (Ft^3/s)**	**Culvert Sub-Drainage Area Size (m^2)**	Assumed Runoff Coefficent (C):	Rainfall Intensity (mm/hr):	**Flow Rate Under Design Storm (ft^3/s)**	**Overloaded During Storm?**	**Comments**
3	1A-1	36	STEEL	0.012	4.0%	***144.8***	785910	0.8	57	**352**	**YES**	First section of Laffin's Brook culvert to 1st MH. Pipe slope shown on record drawing
3	1A-2	36	STEEL	0.012	1.0%	***72.4***	785910	0.8	57	**352**	**YES**	Second section of Laffin's Brook culvert to 1st MH. Pipe slope shown on record drawing
3	1B	54	STEEL	0.012	3.2%	***381.9***	785910	0.8	57	**352**	**NO**	Laffin's Brook - 1st MH to Outfall. Pipe slope to be confirmed

NSPI Lingan Hydrological Review - Culvert Capacity Check

Storm Frequency:	**1:100**	**x 1.3**	**Comments**				
Drainage Area 3							
Assumed Runoff Coefficent (C):	0.8		Assumes winter runoff coefficient				
Time of Concentration (t)(minutes):	30						
Rainfall Intensity (I) (mm/hr):	74.1		Assumes Sydney IDF curve - 1:100 year storm at above noted Time of Concentration				
Total Drainage Area Size (A) (m^2)	785910						
Total Flow (Q)	***457***	ft^3/s	170844	igpm			

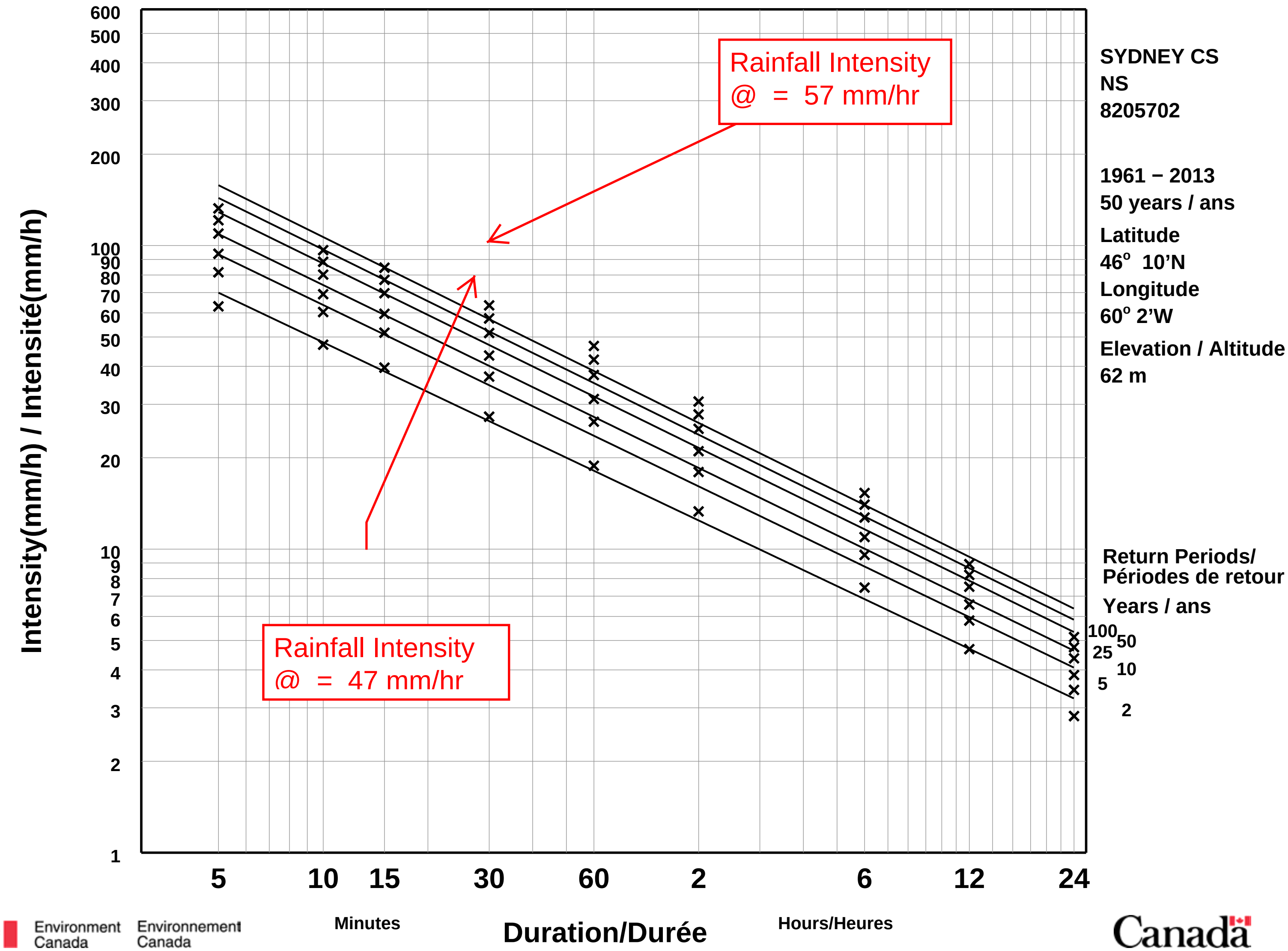
Mannings Coefficient (n) Lookup Table	
Pipe Material	***n***
HDPE	0.010
PVC	0.009
STEEL	0.012
CONC	0.013

Drainage Area	**Culvert Pipe #**	**Pipe Diameter (in)**	**Pipe Material**	Mannings Coefficient (n)	Pipe Slope (%)	**Pipe Capacity (Ft^3/s)**	**Culvert Sub-Drainage Area Size (m^2)**	Assumed Runoff Coefficent (C):	Rainfall Intensity (mm/hr):	**Flow Rate Under Design Storm (ft^3/s)**	**Overloaded During Storm?**	**Comments**
3	1A-1	36	STEEL	0.012	4.0%	***144.8***	785910	0.8	74.1	**457**	**YES**	First section of Laffin's Brook culvert to 1st MH. Pipe slope shown on record drawing
3	1A-2	36	STEEL	0.012	1.0%	***72.4***	785910	0.8	74.1	**457**	**YES**	Second section of Laffin's Brook culvert to 1st MH. Pipe slope shown on record drawing
3	1B	54	STEEL	0.012	3.2%	***381.9***	785910	0.8	74.1	**457**	**YES**	Laffin's Brook - 1st MH to Outfall. Pipe slope to be confirmed

Short Duration Rainfall Intensity−Duration−Frequency Data

2014/12/21

Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée



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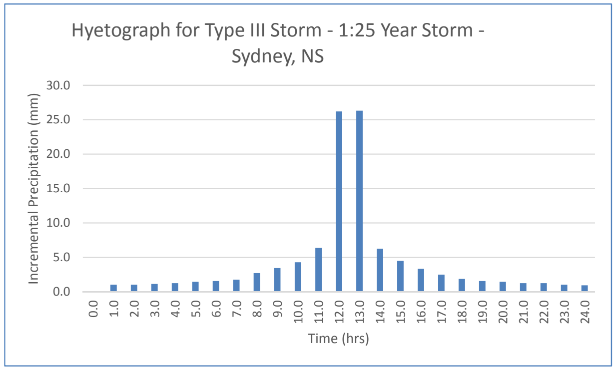
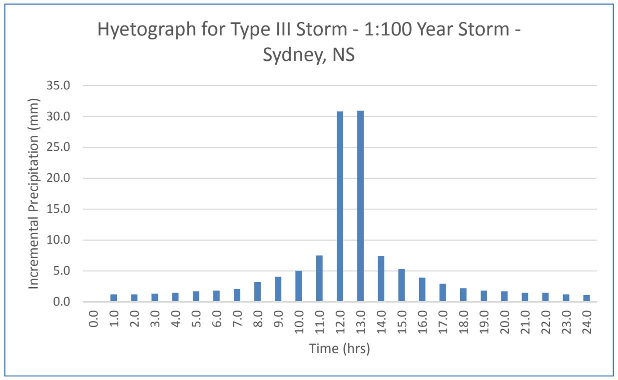
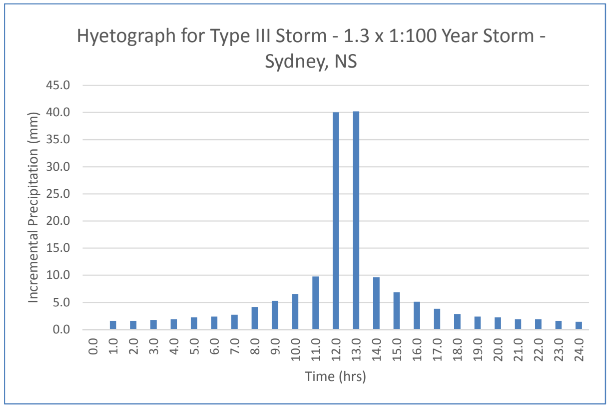
Appendix B – Coal-Impacted Storm Water Storage / Pumping System Check

SCS Curve for Type III Storm

Time (hrs)	Fraction of 24 hour Rainfall	1:25 Year Storm		1:100 Year Storm		1.3 x 1:100 Year Storm	
		Cumulative Precipitation (mm)	*Incremental Precipitation (mm)*	*Cumulative Precipitation (mm)*	*Incremental Precipitation (mm)*	*Cumulative Precipitation (mm)*	*Incremental Precipitation (mm)*
0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0
1.0	0.010	1.0	1.0	1.2	1.2	1.6	1.6
2.0	0.020	2.1	1.0	2.5	1.2	3.2	1.6
3.0	0.031	3.2	1.2	3.8	1.4	5.0	1.8
4.0	0.043	4.5	1.3	5.3	1.5	6.9	1.9
5.0	0.057	6.0	1.5	7.0	1.7	9.1	2.2
6.0	0.072	7.5	1.6	8.9	1.8	11.5	2.4
7.0	0.089	9.3	1.8	11.0	2.1	14.3	2.7
8.0	0.115	12.1	2.7	14.2	3.2	18.4	4.2
9.0	0.148	15.5	3.5	18.2	4.1	23.7	5.3
10.0	0.189	19.8	4.3	23.3	5.1	30.3	6.6
11.0	0.250	26.2	6.4	30.8	7.5	40.0	9.8
12.0	0.500	52.4	26.2	61.6	30.8	80.1	40.0
13.0	0.751	78.7	26.3	92.5	30.9	120.3	40.2
14.0	0.811	85.0	6.3	99.9	7.4	129.9	9.6
15.0	0.854	89.5	4.5	105.2	5.3	136.8	6.9
16.0	0.886	92.9	3.4	109.2	3.9	141.9	5.1
17.0	0.910	95.4	2.5	112.1	3.0	145.7	3.8
18.0	0.928	97.3	1.9	114.3	2.2	148.6	2.9
19.0	0.943	98.8	1.6	116.2	1.8	151.0	2.4
20.0	0.957	100.3	1.5	117.9	1.7	153.3	2.2
21.0	0.969	101.6	1.3	119.4	1.5	155.2	1.9
22.0	0.981	102.8	1.3	120.9	1.5	157.1	1.9
23.0	0.991	103.9	1.0	122.1	1.2	158.7	1.6
24.0	1.000	104.8	0.9	123.2	1.1	160.2	1.4
Totals:			**104.8**		**123.2**		**160.2**







NSPI Lingan Hydrological Assessment - Storage/Pumping System Capacity Check

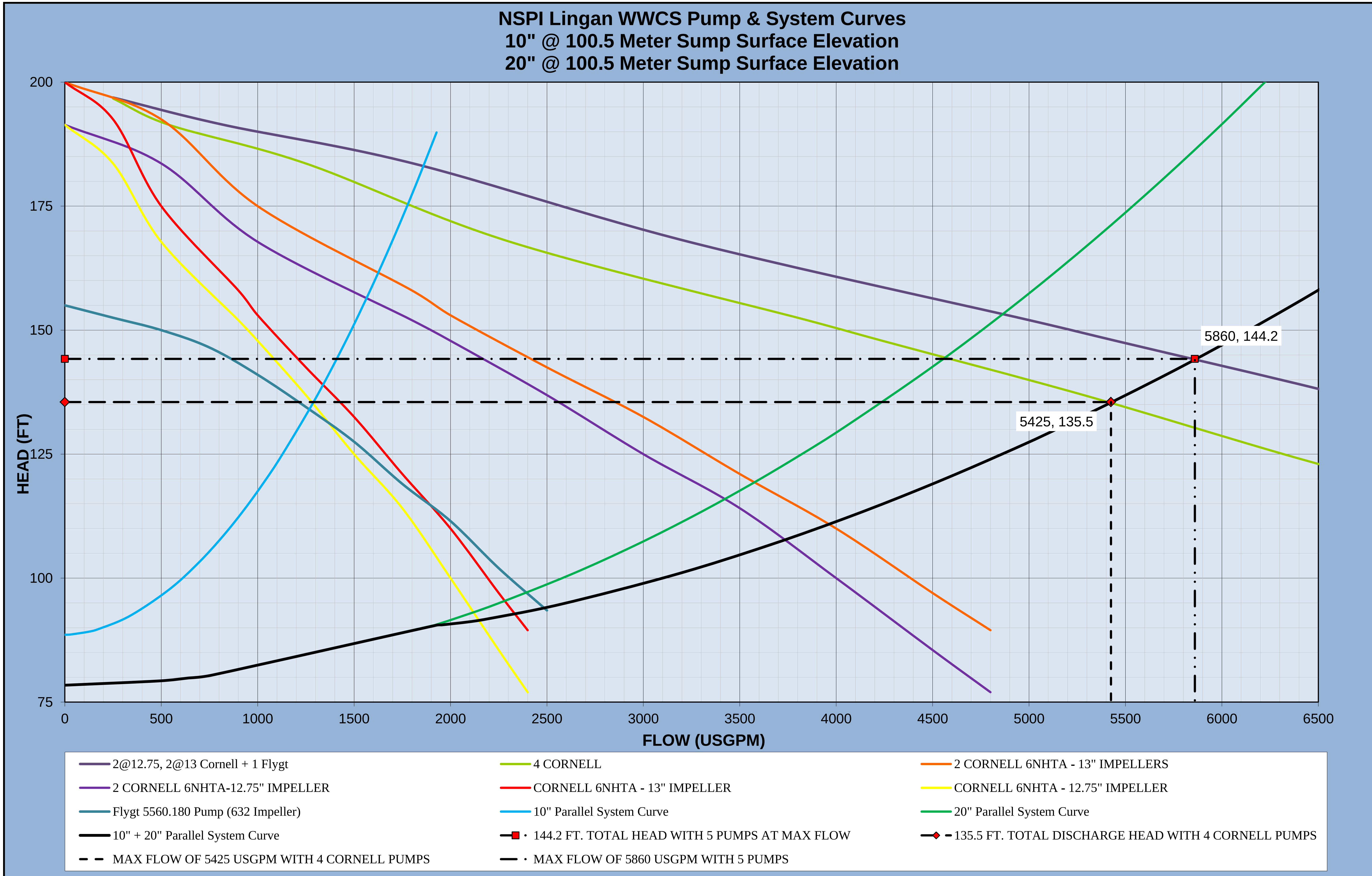
Area Draining to Large Coal-Impacted Water Storage Pond				
Drainage Area		Area (m^2)	Comments	
1	A	13741		
1	B	15609		
1	C	15563	Oil Tank Basin Area - Not included in area draining to Large Storage Pond	
Large Storage Pond		18577		
Total Area Draining to Large Storage Pond:			*47927*	*m^2*
Area Draining to Small Coal-Impacted Water Storage Pond/Holding Tank				
Drainage Area		Area (m^2)	Comments	
1	D	12783		
1	E	7676		
1	F	11449		
1	G	24002		
1	H	11936		
1	I	16580		
Small Storage Pond/Holding Tank		4617		
Total Area Draining to Small Storage Pond/Holding TankStorage Pond:			89043	*m^2*
Area Draining Directly to Pumping Station				
2	A	71500		
2	B	13364		
Total Sub-Area Draining Directly to Pumping Station:			84864	*m^2*

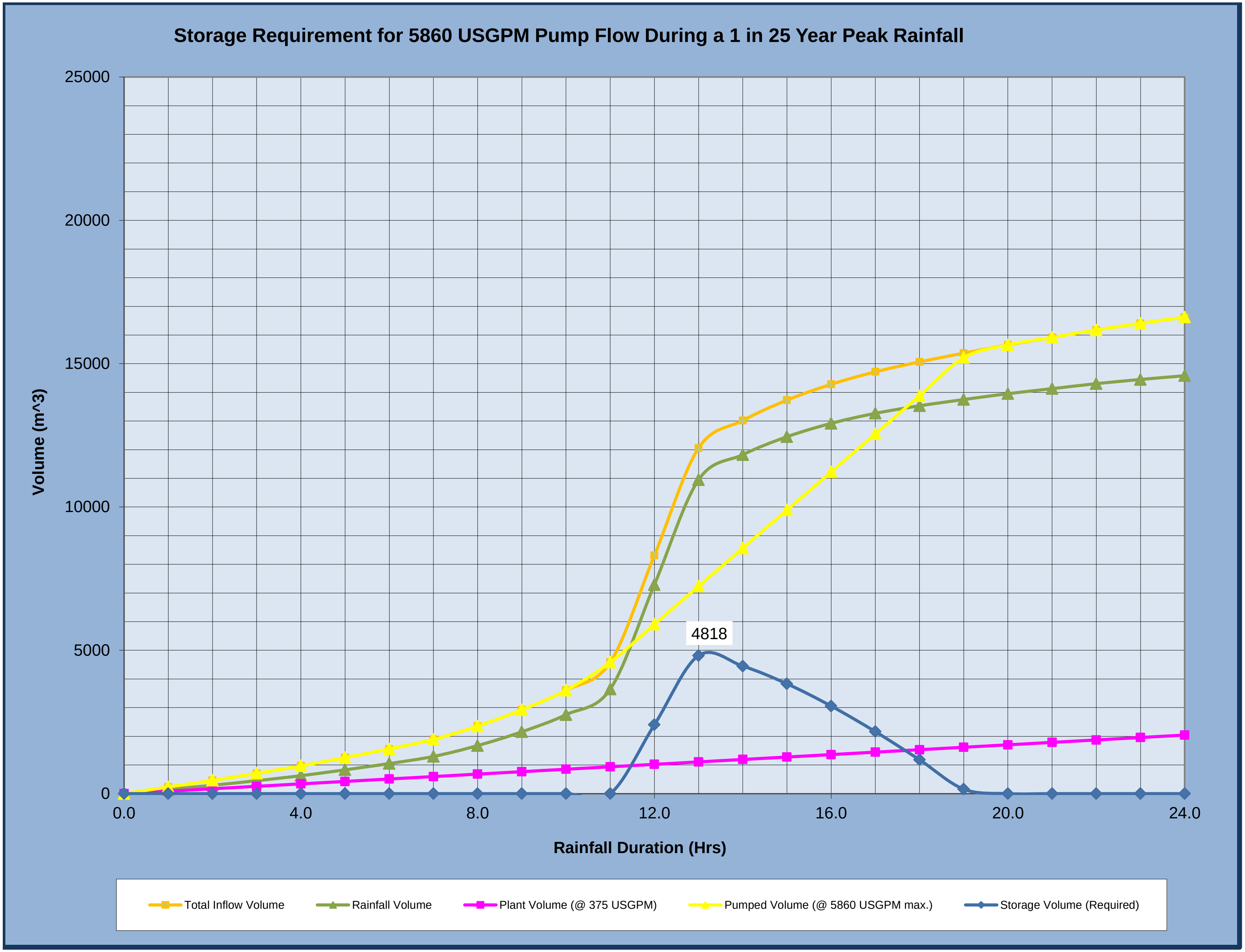
Volume of Large Coal-Impacted Water Storage Pond			
Approximate surface area of large pond:	8000	*m^2*	**Comments**
Existing pond outlet elevation (3" dia):	110.74	m	
Inlet elevation of pipe to Large Pond from Oil Tank Basin (12" dia):	111.74	m	
Outlet elevation of pipe to Large Pond from Oil Tank Basin (12" dia):	111.48	m	
Assumed depth of large pond:	1	m	
Approximate Volume of large pond:	**8000**	**m^3**	
Volume of Small Coal-Impacted Water Storage Pond/Holding Tank			
Elevation of overflow spillway	104.02	*m*	
Approximate Bottom of Pond	102.5	m	
Assumed depth of small pond:	1.52	m	
Approximate Square Area of Small Pond	1645	m^2	
Approximate Volume of Small Pond:	2500	m^3	
Approximate Volume of Holding Tank:	500	m^3	
Approximate Volume of Piping:	500	m^3	
Total Approximate Volume of Small Pond, Holding Tank and Piping:	**3500**	m^3	
Volume of Oil Tank Basin			
Approximate Square Area of Oil Tank Basin	5000	m^2	
Approximate Depth of Oil Tank Basin	0.6	m	
Approximate Volume of Oil Tank Basin	3000	m^3	Q (m^3) 1994

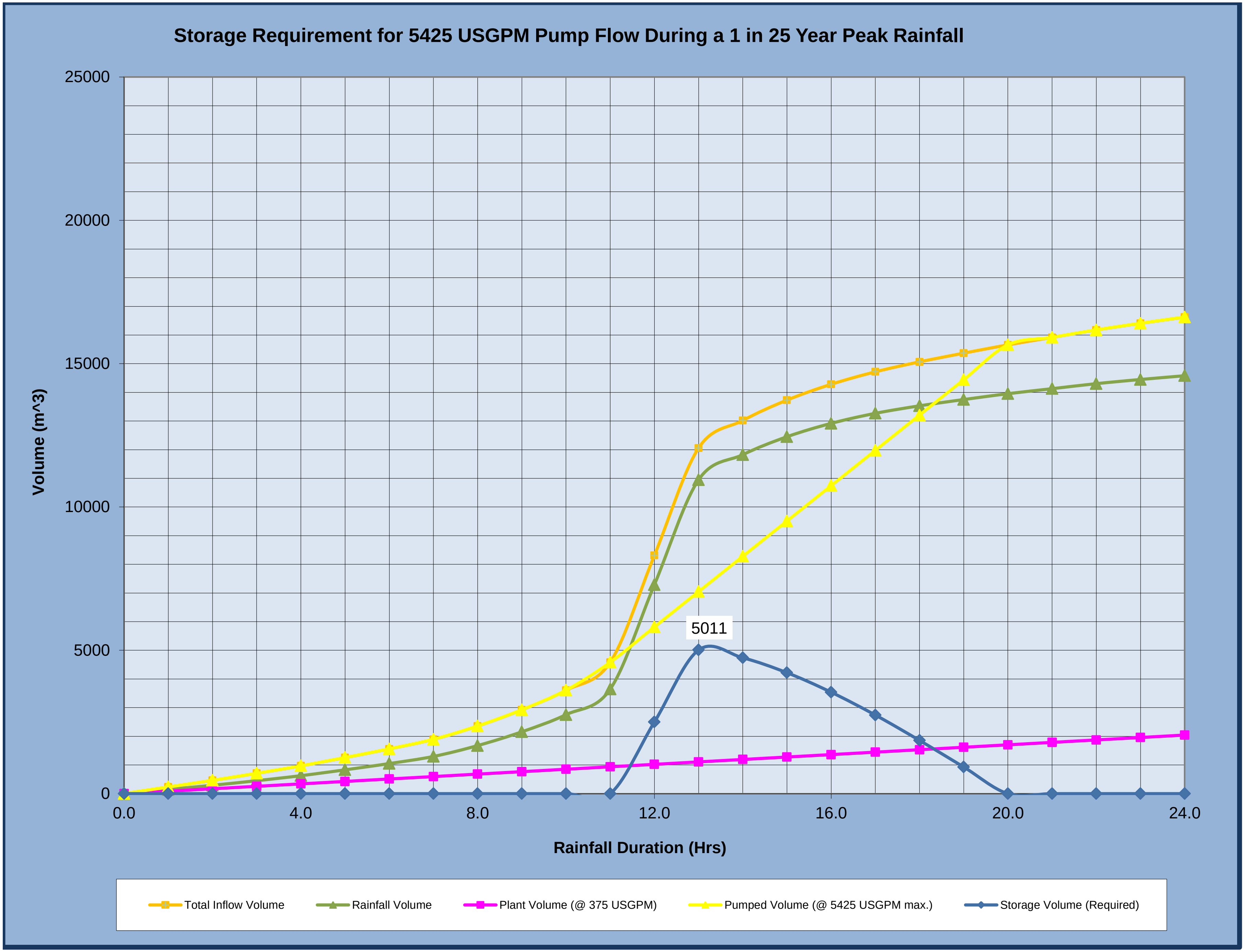
Runoff Volume Calculations

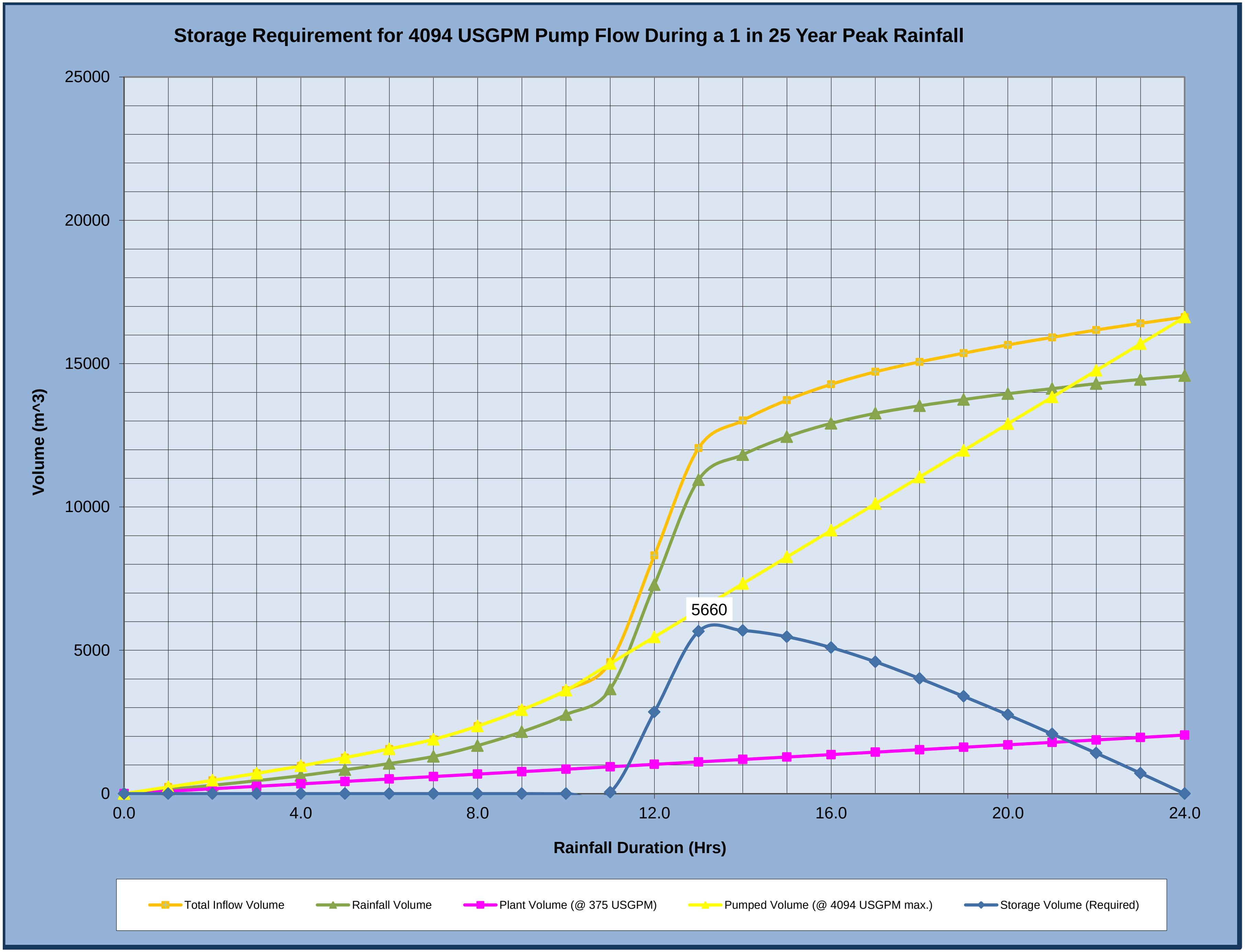
Assumed 'C' Factor: *0.8*

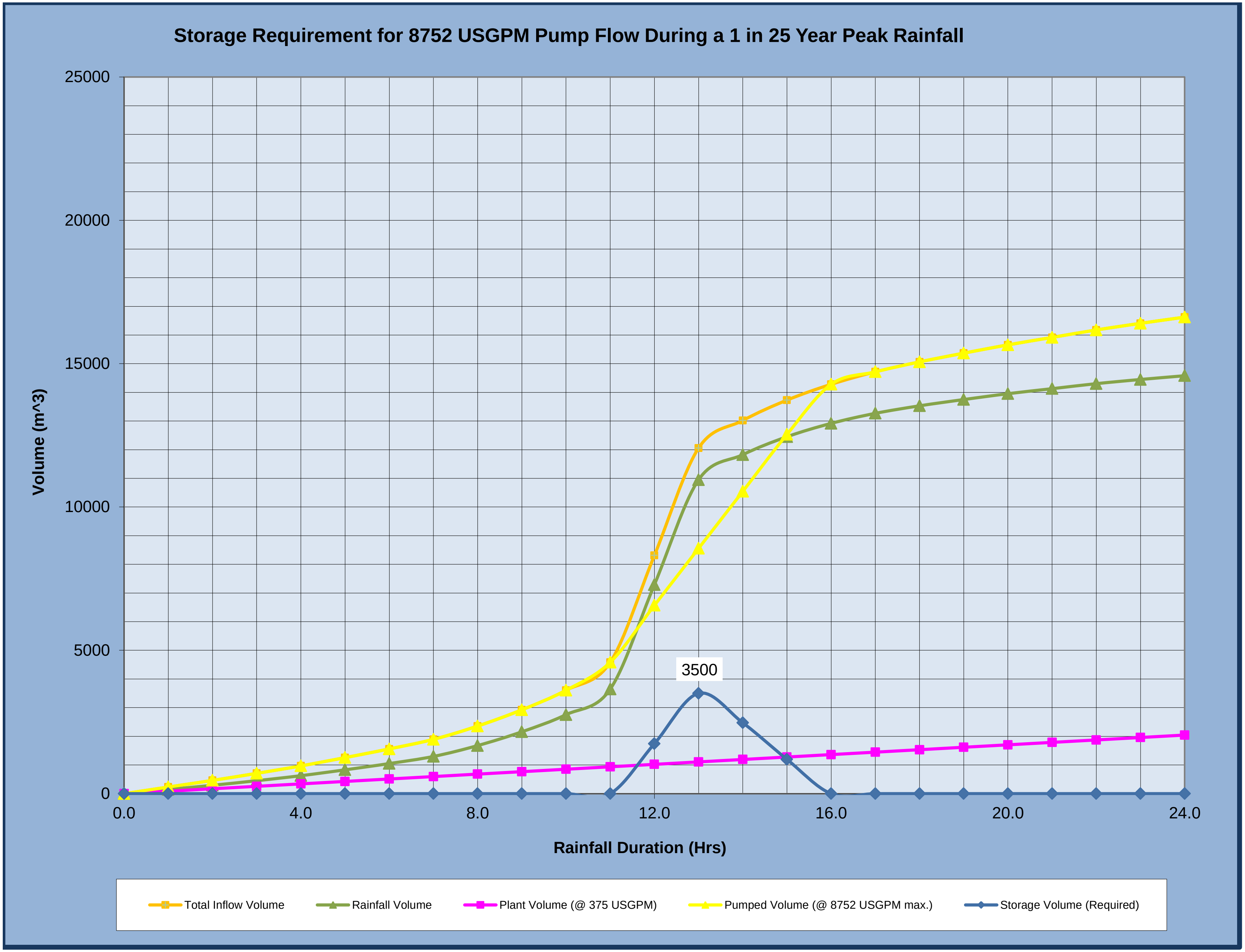
Time (hrs)	Runoff to Large Coal-Impacted Water Storage Pond				Runoff to Small Coal-Impacted Water Storage Pond/Holding Tank				Runoff Direct to Pumping Station				Total Runoff to Pumping Station Neglecting Available On-Site Storage Capacity	
	1:100 Year Storm		1.3 x 1:100 Year Storm		1:100 Year Storm		1.3 x 1:100 Year Storm		1:100 Year Storm		1.3 x 1:100 Year Storm		1:100 Year Storm	1.3 x 1:100 Year Storm
	Incremental Precipitation (mm)	*Q (Runoff) = CIA (m^3)*	*Incremental Precipitation (mm)*	*Q (Runoff) = CIA (m^3)*	*Incremental Precipitation (mm)*	*Q (Runoff) = CIA (m^3)*	*Incremental Precipitation (mm)*	*Q (Runoff) = CIA (m^3)*	*Incremental Precipitation (mm)*	*Q (Runoff) = CIA (m^3)*	*Incremental Precipitation (mm)*	*Q (Runoff) = CIA (m^3)*	*Q (Runoff) = CIA (m^3)*	*Q (Runoff) = CIA (m^3)*
0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0
1.0	1.2	47	1.6	61	1.2	88	1.6	114	1.2	84	1.6	109	219	284
2.0	1.2	47	1.6	61	1.2	88	1.6	114	1.2	84	1.6	109	219	284
3.0	1.4	52	1.8	68	1.4	97	1.8	125	1.4	92	1.8	120	241	313
4.0	1.5	57	1.9	74	1.5	105	1.9	137	1.5	100	1.9	130	262	341
5.0	1.7	66	2.2	86	1.7	123	2.2	160	1.7	117	2.2	152	306	398
6.0	1.8	71	2.4	92	1.8	132	2.4	171	1.8	125	2.4	163	328	426
7.0	2.1	80	2.7	104	2.1	149	2.7	194	2.1	142	2.7	185	372	483
8.0	3.2	123	4.2	160	3.2	228	4.2	297	3.2	217	4.2	283	568	739
9.0	4.1	156	5.3	203	4.1	290	5.3	376	4.1	276	5.3	359	722	938
10.0	5.1	194	6.6	252	5.1	360	6.6	468	5.1	343	6.6	446	896	1165
11.0	7.5	288	9.8	375	7.5	535	9.8	696	7.5	510	9.8	663	1334	1734
12.0	30.8	1181	40.0	1535	30.8	2194	40.0	2852	30.8	2091	40.0	2718	5466	7106
13.0	30.9	1186	40.2	1541	30.9	2203	40.2	2864	30.9	2099	40.2	2729	5488	7134
14.0	7.4	283	9.6	368	7.4	527	9.6	685	7.4	502	9.6	652	1312	1705
15.0	5.3	203	6.9	264	5.3	377	6.9	491	5.3	360	6.9	468	940	1222
16.0	3.9	151	5.1	197	3.9	281	5.1	365	3.9	268	5.1	348	700	910
17.0	3.0	113	3.8	147	3.0	211	3.8	274	3.0	201	3.8	261	525	682
18.0	2.2	85	2.9	111	2.2	158	2.9	205	2.2	151	2.9	196	394	512
19.0	1.8	71	2.4	92	1.8	132	2.4	171	1.8	125	2.4	163	328	426
20.0	1.7	66	2.2	86	1.7	123	2.2	160	1.7	117	2.2	152	306	398
21.0	1.5	57	1.9	74	1.5	105	1.9	137	1.5	100	1.9	130	262	341
22.0	1.5	57	1.9	74	1.5	105	1.9	137	1.5	100	1.9	130	262	341
23.0	1.2	47	1.6	61	1.2	88	1.6	114	1.2	84	1.6	109	219	284
24.0	1.1	43	1.4	55	1.1	79	1.4	103	1.1	75	1.4	98	197	256
TOTALS:	**123.2**	**4724**	***160.16***	**6141**	**123.2**	**8776**	***160.16***	**11409**	**123.2**	**8364**	***160.16***	**10873**	**21864**	**28423**


NSPI Lingan WWCS Pump & System Curves
10" @ 100.5 Meter Sump Surface Elevation
20" @ 100.5 Meter Sump Surface Elevation
HEAD (FT)
200
175
150
125
100
75
FLOW (USGPM)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
5860, 144.2
5425, 135.5
2@12.75, 2@13 Cornell + 1 Flygt
4 CORNELL
2 CORNELL 6NHTA - 13" IMPELLERS
2 CORNELL 6NHTA-12.75" IMPELLER
CORNELL 6NHTA - 13" IMPELLER
CORNELL 6NHTA - 12.75" IMPELLER
Flygt 5560.180 Pump (632 Impeller)
10" Parallel System Curve
20" Parallel System Curve
10" + 20" Parallel System Curve
144.2 FT. TOTAL HEAD WITH 5 PUMPS AT MAX FLOW
135.5 FT. TOTAL DISCHARGE HEAD WITH 4 CORNELL PUMPS
MAX FLOW OF 5425 USGPM WITH 4 CORNELL PUMPS
MAX FLOW OF 5860 USGPM WITH 5 PUMPS

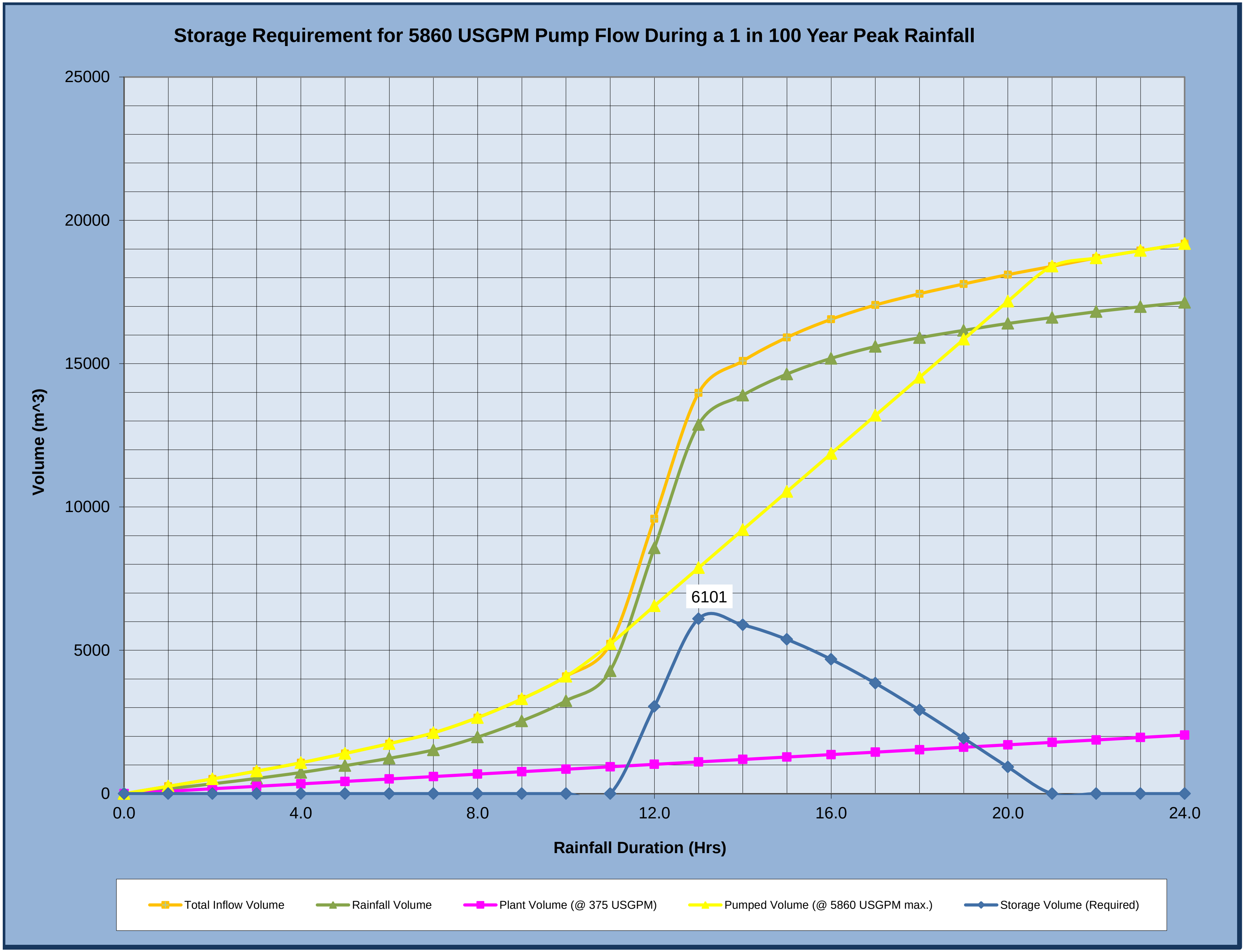

Storage Requirement for 5860 USGPM Pump Flow During a 1 in 25 Year Peak Rainfall
Volume (m^3)
25000
20000
15000
10000
5000
0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Rainfall Duration (Hrs)
4818
Total Inflow Volume
Rainfall Volume
Plant Volume (@ 375 USGPM)
Pumped Volume (@ 5860 USGPM max.)
Storage Volume (Required)

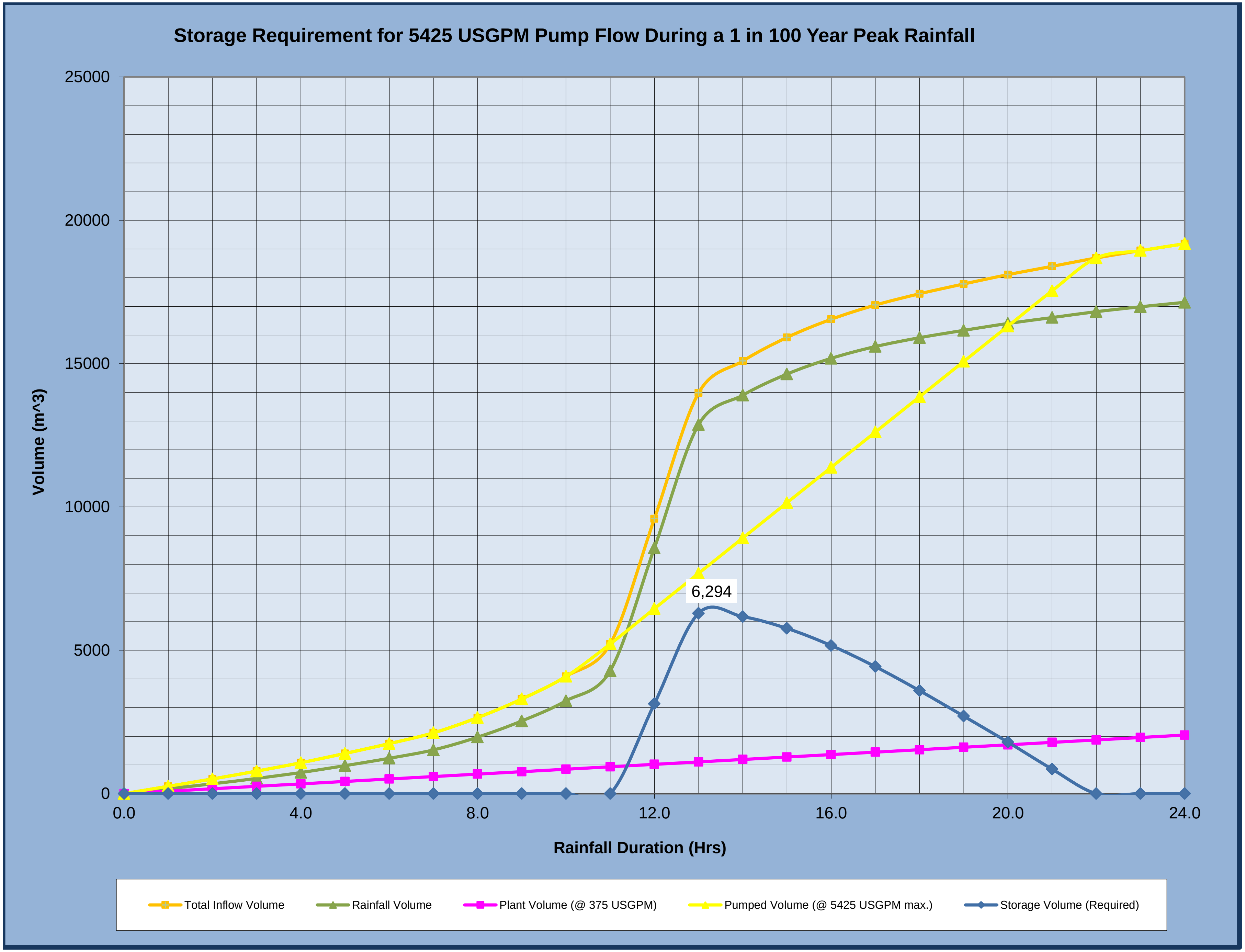

Storage Requirement for 5425 USGPM Pump Flow During a 1 in 25 Year Peak Rainfall
Volume (m^3)
25000
20000
15000
10000
5000
0
5011
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Rainfall Duration (Hrs)
Total Inflow Volume
Rainfall Volume
Plant Volume (@ 375 USGPM)
Pumped Volume (@ 5425 USGPM max.)
Storage Volume (Required)


Storage Requirement for 4094 USGPM Pump Flow During a 1 in 25 Year Peak Rainfall
Volume (m^3)
25000
20000
15000
10000
5000
0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Rainfall Duration (Hrs)
5660
Total Inflow Volume
Rainfall Volume
Plant Volume (@ 375 USGPM)
Pumped Volume (@ 4094 USGPM max.)
Storage Volume (Required)

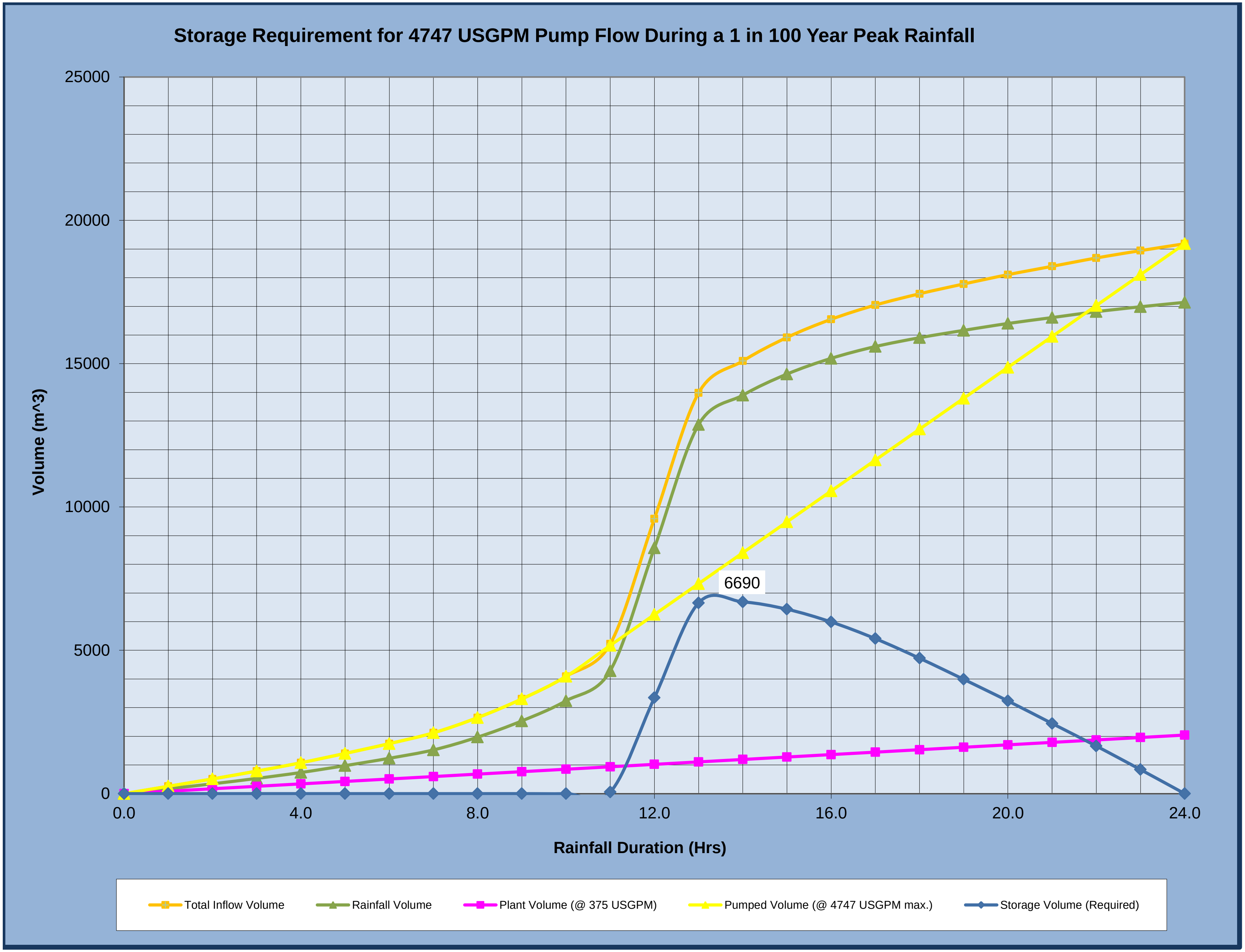


Storage Requirement for 8752 USGPM Pump Flow During a 1 in 25 Year Peak Rainfall
Volume (m^3)
25000
20000
15000
10000
5000
0
3500
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Rainfall Duration (Hrs)
Total Inflow Volume
Rainfall Volume
Plant Volume (@ 375 USGPM)
Pumped Volume (@ 8752 USGPM max.)
Storage Volume (Required)

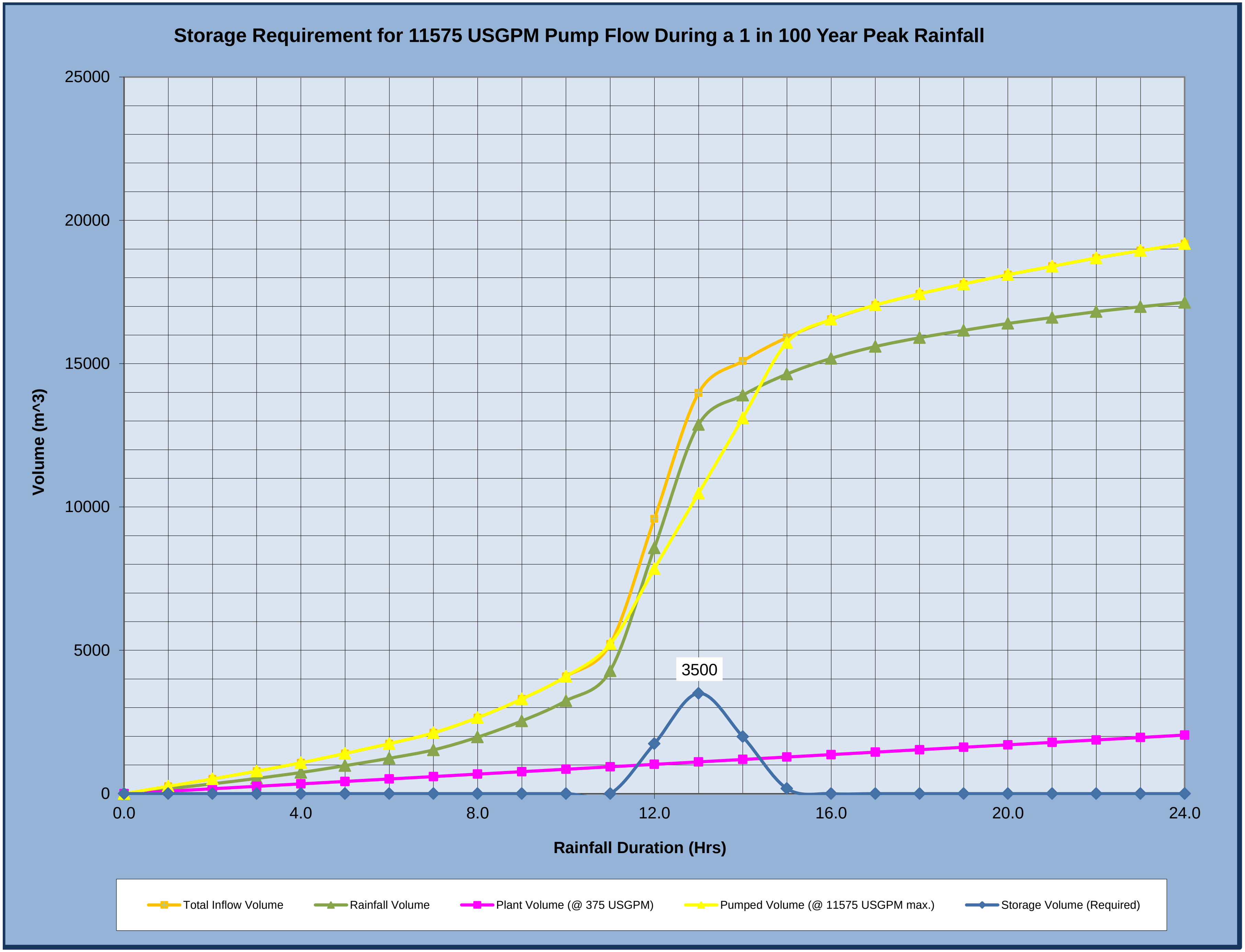

Storage Requirement for 5860 USGPM Pump Flow During a 1 in 100 Year Peak Rainfall
Volume (m^3)
25000
20000
15000
10000
5000
0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Rainfall Duration (Hrs)
6101
Total Inflow Volume
Rainfall Volume
Plant Volume (@ 375 USGPM)
Pumped Volume (@ 5860 USGPM max.)
Storage Volume (Required)

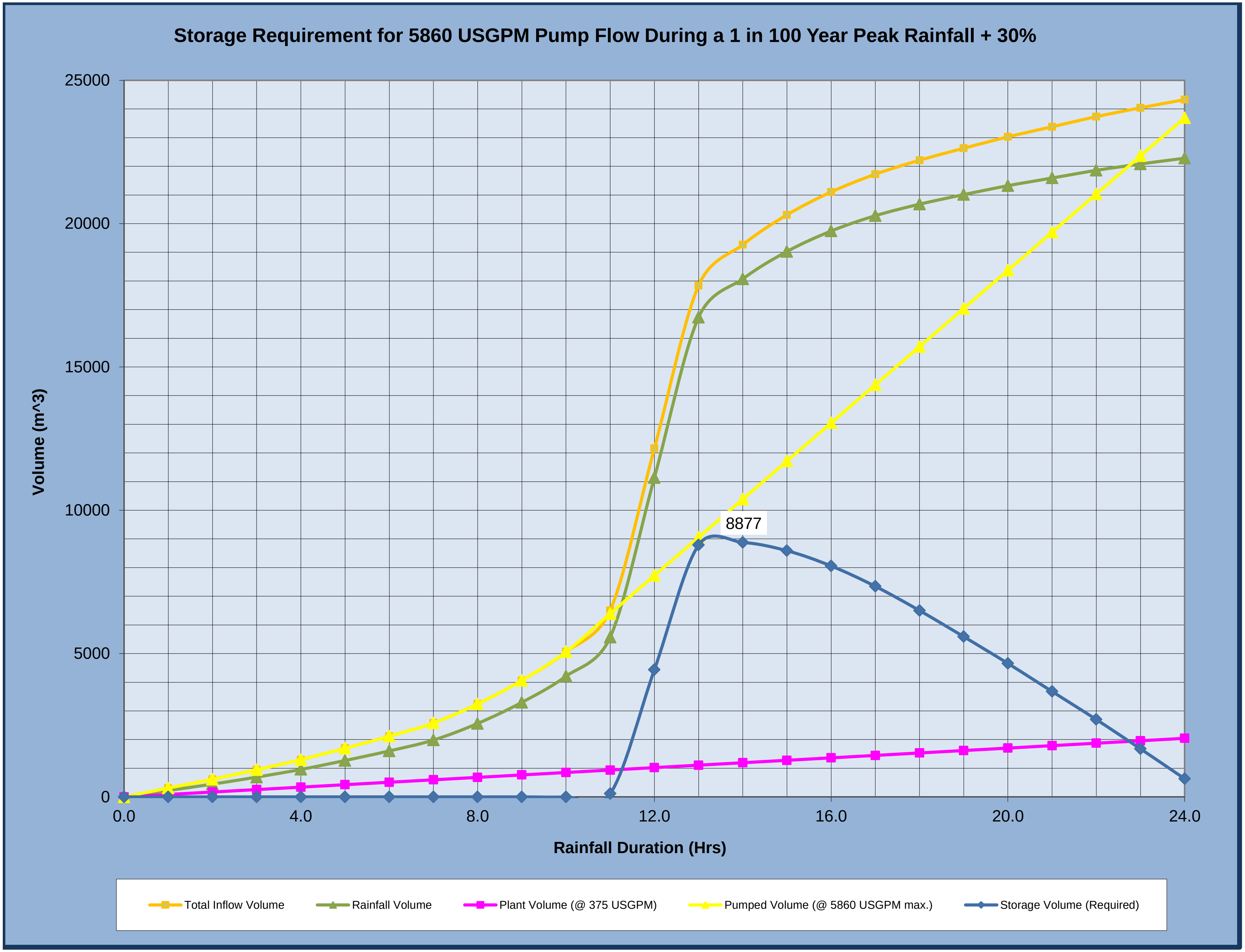


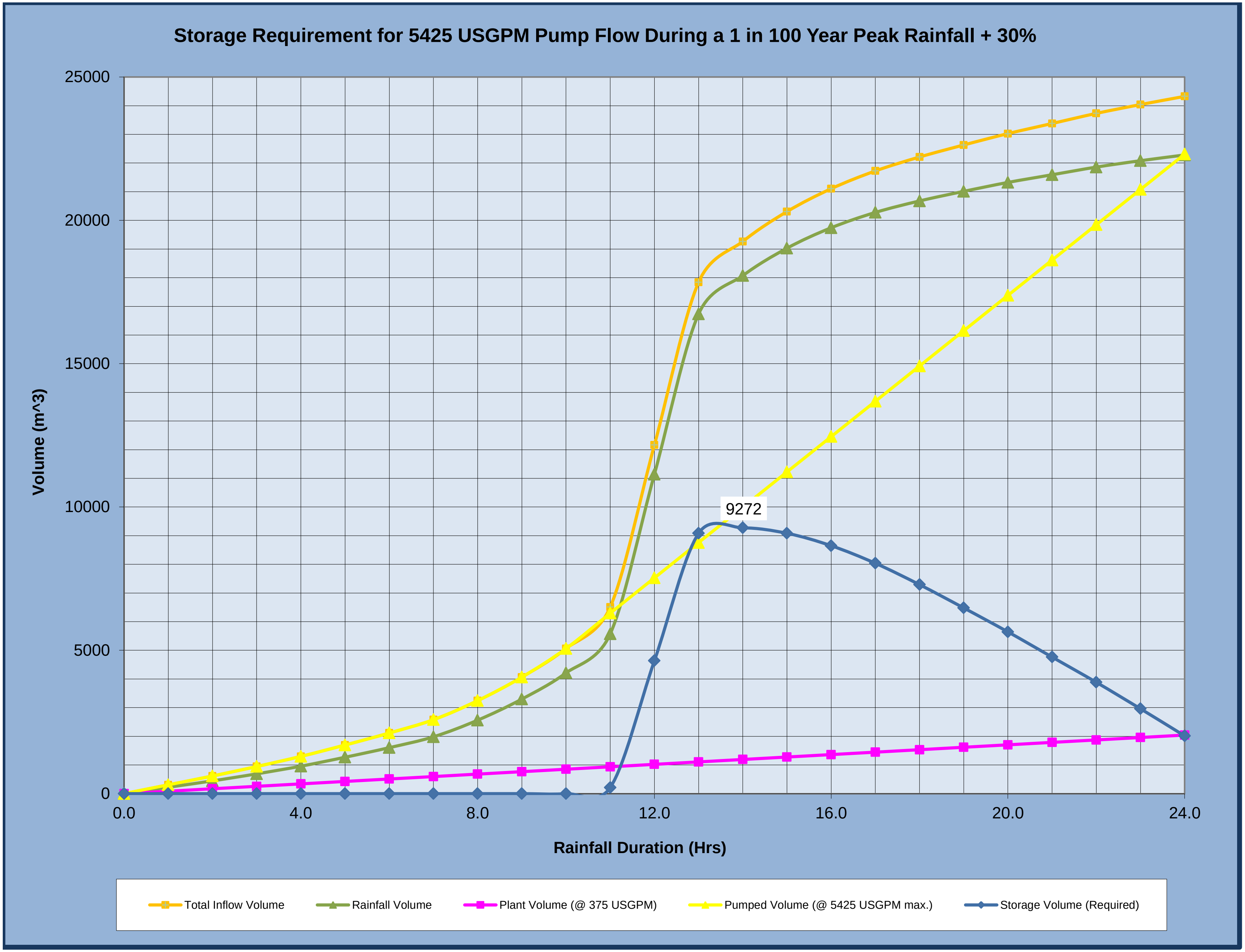
Storage Requirement for 5425 USGPM Pump Flow During a 1 in 100 Year Peak Rainfall
Volume (m^3)
25000
20000
15000
10000
5000
0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
6,294
Rainfall Duration (Hrs)
Total Inflow Volume
Rainfall Volume
Plant Volume (@ 375 USGPM)
Pumped Volume (@ 5425 USGPM max.)
Storage Volume (Required)

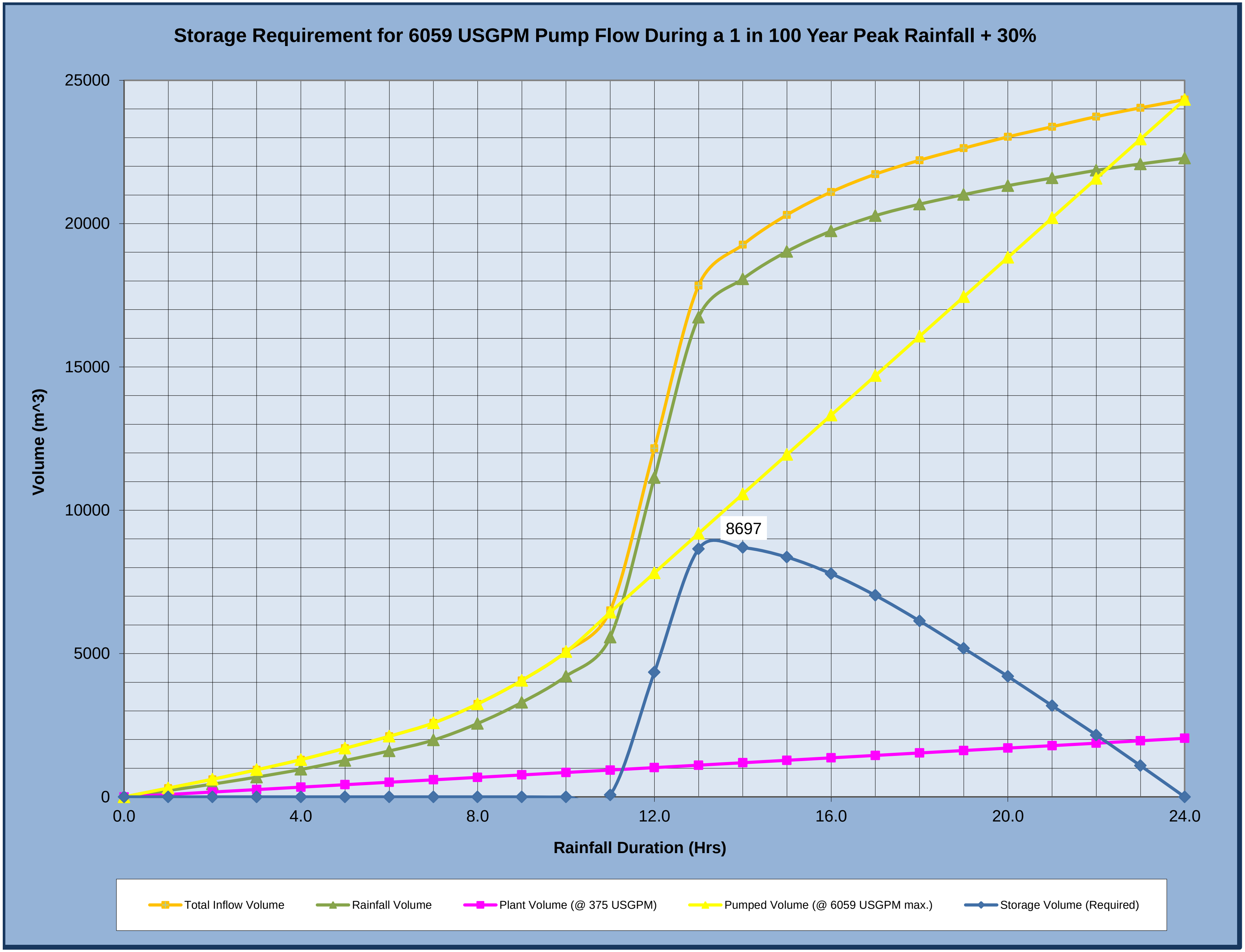


Storage Requirement for 4747 USGPM Pump Flow During a 1 in 100 Year Peak Rainfall
Volume (m^3)
25000
20000
15000
10000
5000
0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Rainfall Duration (Hrs)
6690
Total Inflow Volume
Rainfall Volume
Plant Volume (@ 375 USGPM)
Pumped Volume (@ 4747 USGPM max.)
Storage Volume (Required)

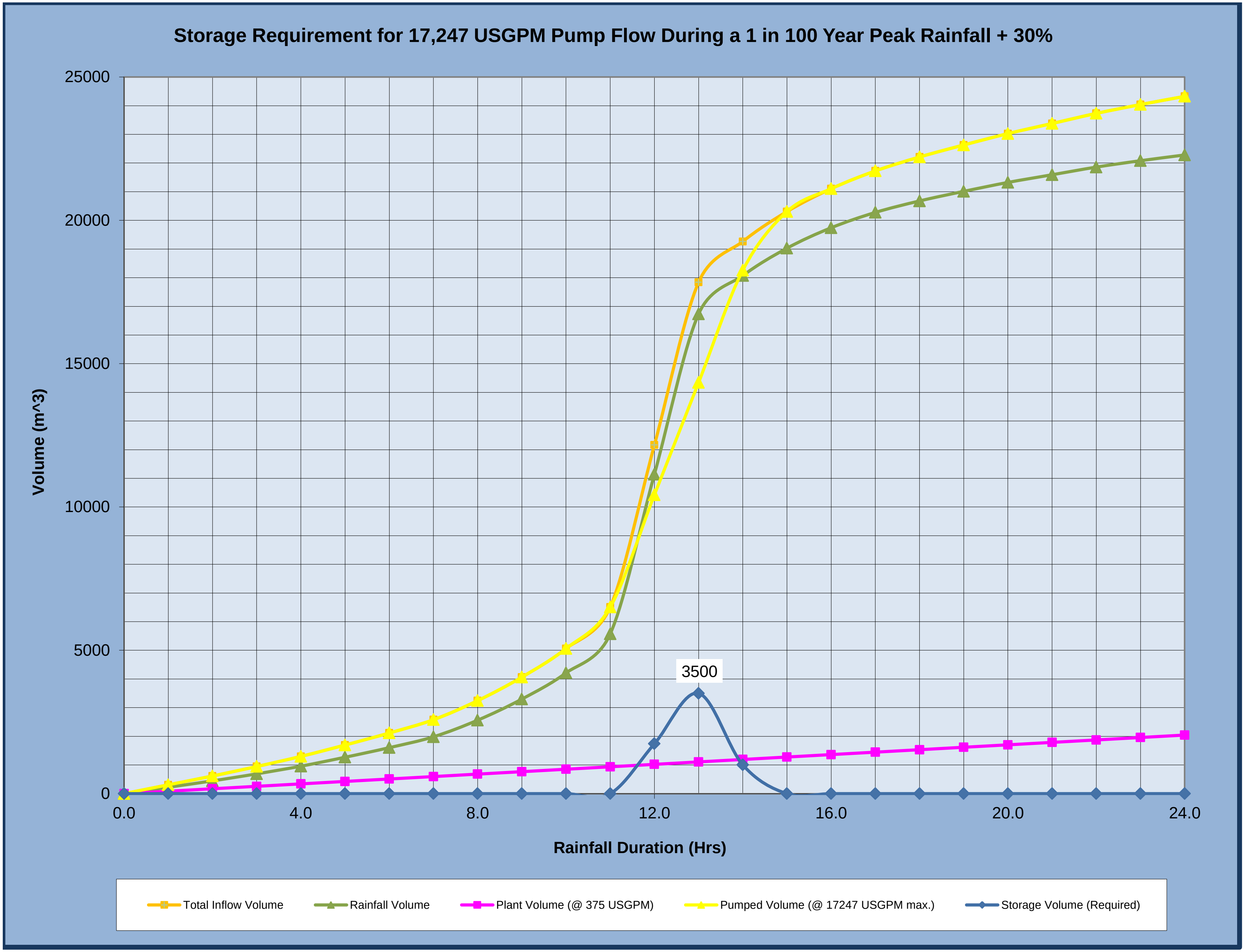

Storage Requirement for 11575 USGPM Pump Flow During a 1 in 100 Year Peak Rainfall
25000
20000
15000
10000
5000
0
Volume (m^3)
3500
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Rainfall Duration (Hrs)
Total Inflow Volume
Rainfall Volume
Plant Volume (@ 375 USGPM)
Pumped Volume (@ 11575 USGPM max.)
Storage Volume (Required)


Storage Requirement for 5860 USGPM Pump Flow During a 1 in 100 Year Peak Rainfall + 30%
Volume (m^3)
25000
20000
15000
10000
5000
0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
8877
Rainfall Duration (Hrs)
Total Inflow Volume
Rainfall Volume
Plant Volume (@ 375 USGPM)
Pumped Volume (@ 5860 USGPM max.)
Storage Volume (Required)


Storage Requirement for 5425 USGPM Pump Flow During a 1 in 100 Year Peak Rainfall + 30%
Volume (m^3)
25000
20000
15000
10000
5000
0
9272
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Rainfall Duration (Hrs)
Total Inflow Volume
Rainfall Volume
Plant Volume (@ 375 USGPM)
Pumped Volume (@ 5425 USGPM max.)
Storage Volume (Required)



Storage Requirement for 6059 USGPM Pump Flow During a 1 in 100 Year Peak Rainfall + 30%
Volume (m^3)
25000
20000
15000
10000
5000
0
8697
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Rainfall Duration (Hrs)
Total Inflow Volume
Rainfall Volume
Plant Volume (@ 375 USGPM)
Pumped Volume (@ 6059 USGPM max.)
Storage Volume (Required)


Storage Requirement for 17,247 USGPM Pump Flow During a 1 in 100 Year Peak Rainfall + 30%
Volume (m^3)
25000
20000
15000
10000
5000
0
3500
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Rainfall Duration (Hrs)
Total Inflow Volume
Rainfall Volume
Plant Volume (@ 375 USGPM)
Pumped Volume (@ 17247 USGPM max.)
Storage Volume (Required)

CI Number: 49437

Title: LIN Vacuum Pump Cooler Refurbishment

Start Date: 2017/04
In-Service Date: 2017/09
Final Cost Date: 2018/03
Function: Steam
Forecast Amount: $282,034

DESCRIPTION:

The scope of this project includes the refurbishment of six coolers on the Condenser Vacuum Pumps (CVPs). The condenser vacuum pump is required to create a vacuum in the condenser to remove air and any non-condensing gases. It also assists in drawing steam through the condenser as it exits the last stage of the low pressure section of the turbine. If the pump fails or is not working properly, the loss of vacuum in the condenser affects the heat rate of the unit, as steam does not exit the turbine at the required rate. There are two pumps per unit. Each pump in good working order is sufficient to operate the unit at full load. In order for the pump to work properly, the cooler must be in good working order. If both pumps fail, the unit will not be able to operate. The coolers are original to each unit (31-36 years old) and are corroded, impeding their ability to cool the pumps properly.

One cooler refurbishment was completed in 2016 on Lingan Unit #3 (under CI 48772), and this project will complete the refurbishment of six of the remaining seven coolers. Due to the continued low utilization of Lingan Unit #2, only one of the coolers on that unit is being replaced. The investment in Unit #2 is still a low-risk investment at this time. This project has a payback period within the expected operational life of Lingan Unit #2, and additionally the cooler will be able to be utilized as a spare on any of the other Lingan units in the event Lingan Unit #2 is retired.

Summary of Related CIs +/- 2 years:
2016 CI 48772 LIN3 U&U 3B Condenser Vacuum Pump Replacement $147,050

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

The pumps are critical pieces of equipment and are required to allow the unit to operate. These pumps are necessary to support the proper operation of the vacuum pumps. If the vacuum pumps are not working properly there is a loss of efficiency as the steam will not exhaust from the turbine at the required rate. This prevents the unit from operating. If one pump fails, and the opposite pump fails in the same timeframe, the unit cannot operate until one pump is returned to service. This project must be completed to ensure enough cooling is provided to allow the vacuum pumps to operate properly.

This project is being undertaken primarily to preserve the unit’s availability, and is secondarily supported by positive replacement energy cost economics.

Why do this project now?

The Condenser Vacuum Pump coolers are corroded, have reached the end of their useful life, and can no longer reliably provide enough cooling to the vacuum pumps to operate properly in the long term.

Why do this project this way?

Refurbishment of the coolers through re-tubing is the most cost effective option as a full replacement is more costly and not necessary at this time. This will bring the coolers back to like-new condition without the extra installation costs of redirecting pipes.

CI Number : 49437 - LIN Vacuum Pump Cooler Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 301 - 301-Lingan Admin./Common Capital **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		2,289	0	2,289
095		095-Thermal Regular Labour AO		6,284	0	6,284
095		095-Thermal Term Labour AO		4,605	0	4,605
095		095-Thermal & Hydro Contracts AO		18,721	0	18,721
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	29,278	0	29,278
004	014	004 - THERMAL Term Labour	014 - SGP - Circ.Water Sys.	21,458	0	21,458
012	014	012 - Materials	014 - SGP - Circ.Water Sys.	8,000	0	8,000
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.	174,000	0	174,000
066	014	066 - Other Goods & Services	014 - SGP - Circ.Water Sys.	17,400	0	17,400
			Total Cost:	282,034	0	282,034
			Original Cost:	93,747		

Capital Project Detailed Estimate

Location: **Steam**
CI# : 49437
Title: LIN Vacuum Pump Cooler Refurbishment
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Electrician	PD	20	$ 351	$ 7,025		
Engineering	PD	2	$ 397	$ 795		
Maintenance Trades	PD	60	$ 358	$ 21,458		
			Sub-Total	$ 29,278		
004 Term Labour						
Electrician	PD	0	$ 351	$ -		
Maintenance Trades	PD	60	$ 358	$ 21,458		
				$ -		
			Sub-Total	$ 21,458		
012 Materials						
Misc Consumable	Lot	1	$ 8,000	$ 8,000		
			Sub-Total	$ 8,000		
013 Contracts						
Condenser Vacuum Pump Cooler Rebuild	Ea	6	$ 29,000	$ 174,000		48772
			Sub-Total	$ 174,000		
066 Other Goods & Services						
Contingency	%	10%	$ 174,000	$ 17,400		
			Sub-Total	$ 17,400		
094 Interest Capitalized						
				$ 2,289		
			Sub-Total	$ 2,289		
095 Administrative Overhead						
Thermal Reg. Labour AO				$ 6,284		
Thermal Term Labour AO				$ 4,605		
Thermal / Hydro Contracts AO				$ 18,721		
			Sub-Total	$ 29,610		
			SUB-TOTAL (no AO, AFUDC)	$ 250,136		
			TOTAL (AO, AFUDC included)	$ 282,034		
Original Cost				$ 93,747		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

LIN Vacuum Pump Cooler Refurbishment
Summary of Alternatives

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Lingan Generating Station	**CI Number:**	49437
		Project No. :	

	Alternative	**After Tax WACC**	**PV of Revenue Requirement**	**PV of EVA / NPV**	**Rank (based on PV of RR)**	**IRR**	**Disc Pay**
A	Vaccum Pump Cooler Refurb vs Avoide	5.90%	-931,774	672,680	1	66.96%	1.9 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

The plant recommends refurbishing the vacuum pump cooler to ensure reliability of the operating unit.

Notes/Comments :

Vaccum Pump Cooler Refurb vs Avoided Fuel & Repair Costs

There are two vacuum pumps on each unit. If one pump overheats and cannot operate, and the operating pump fails which is likely because the cooler are in similar condition, the unit would have to come offline for an extended period of time, a minimum of 72 hours to replace the pump cooler if one can be removed from another unit however it will put that unit at risk as well.

Test 2

Test 3

Test 4

LIN Vacuum Pump Cooler Refurbishment
Summary of Sensitivities

Nova Scotia POWE An Emera Compa

Division :	Power Production	**Date :**	**29-Oct-16**
Department :	Lingan Generating Station	**CI Number:**	49437
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Vaccum Pump Cooler Refurb vs Avoided Fuel & F	5.90%	-931,774	672,680	1	66.96%	1.9 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Vaccum Pump Cooler Refurb vs Avoided Fuel & F	10%	-907,210	653,166	1	57.21%	2.2 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years

Change:		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
	A	24,563	-19,514	0	-9.75%	0.3 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Vaccum Pump Cooler Refurb vs Avoided Fuel & F	-10%	-814,033	585,898	1	56.30%	2.2 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years

Change:		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
	A	117,741	-86,782	0	-10.66%	0.3 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	135,725	224,009	334,774	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

LIN Vacuum Pump Cooler Refurbishment
Avoided Cost Calculations

Nova Scotia POWER An Emera Company

Division :	Power Production		**Date :**	**29-Oct-16**
Department :	Lingan Generating Station		**CI Number:**	49437
			Project No. :	

Vaccum Pump Cooler Refurb vs Avoided Fuel & Repair Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**24,000**	**24,969**		
Events/Outages (#)	**2**	**2**	**2**	**2**		
Probability of Occurance (%)	**100%**	**100%**	**100%**	**100%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**154.0**	**154.0**				
Duration (Hours or Years)	**72**	**72**				
Totals	**$109,546**	**$76,230**	**$48,000**	**$49,938**	**$157,546**	**$126,168**
Total Capital Cost of Alternative						**$282,034**

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**0**	**0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0.0**	**0.0**				
Duration (Hours or Years)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**0**	**0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0.0**	**0.0**				
Duration (Hours or Years)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

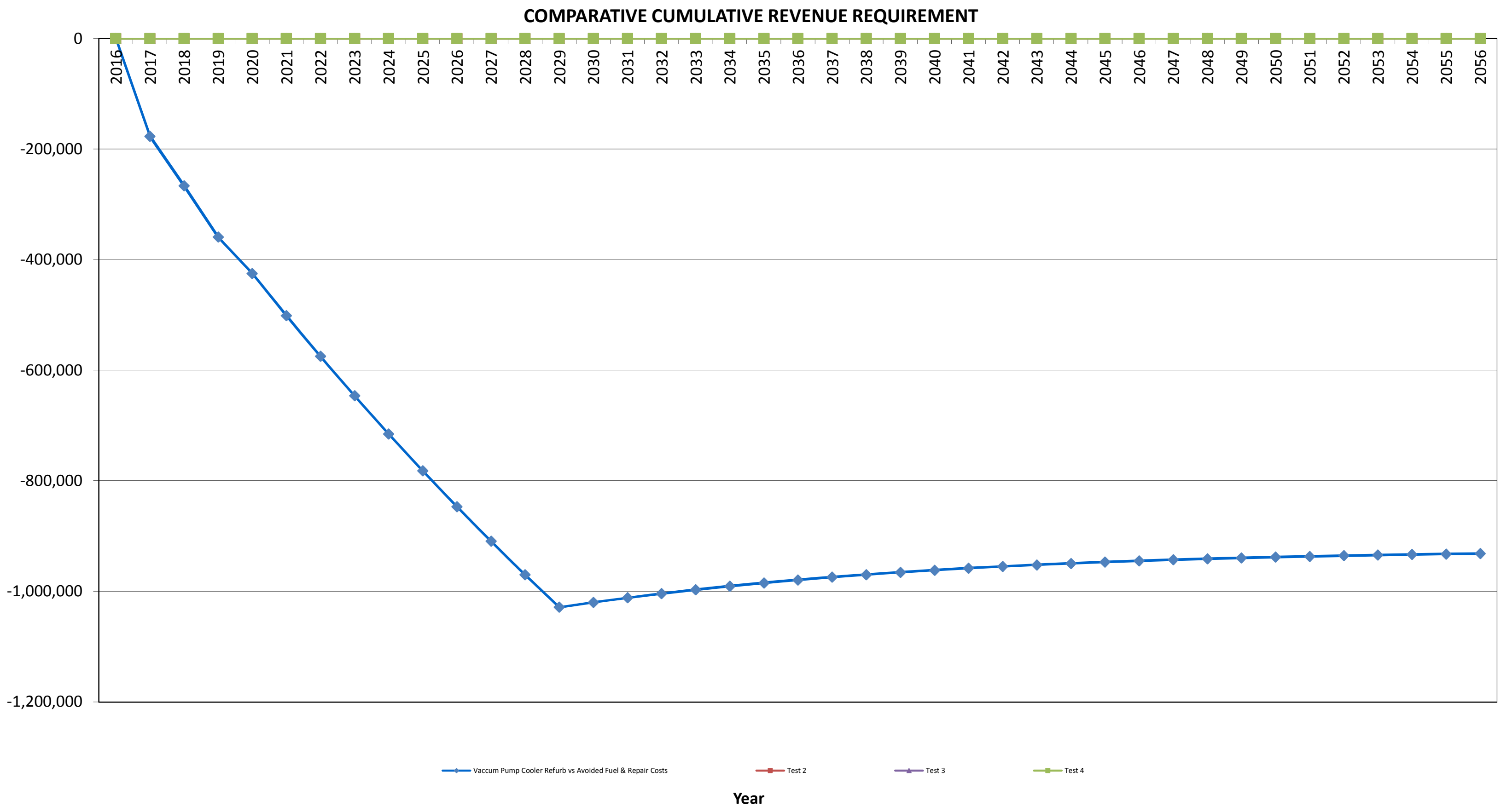
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**0**	**0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0.0**	**0.0**				
Duration (Hours or Years)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

LIN Vacuum Pump Cooler Refurbishment

Vaccum Pump Cooler Refurb vs Avoided Fuel & Repair Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	157,545.6	(252,424.7)	10,005.4	248,302.7	(94,879.1)	(45,737.5)	(140,616.5)	(132,782.4)	0.94	(132,782.4)
2018	-	-	126,168.1	-	19,210.4	227,727.9	126,168.1	(33,156.9)	93,011.2	82,936.1	0.89	(49,846.3)
2019	-	-	137,975.4	-	17,673.6	208,799.0	137,975.4	(37,293.6)	100,681.8	84,774.1	0.84	34,927.8
2020	-	-	110,702.2	-	16,259.7	191,384.5	110,702.2	(29,277.2)	81,425.1	64,740.2	0.80	99,668.0
2021	-	-	131,185.6	-	14,958.9	175,363.1	131,185.6	(36,030.3)	95,155.3	71,441.9	0.75	171,110.0
2022	-	-	134,955.6	-	13,762.2	160,623.4	134,955.6	(37,569.9)	97,385.6	69,042.9	0.71	240,152.9
2023	-	-	138,847.3	-	12,661.2	147,062.9	138,847.3	(39,117.7)	99,729.6	66,765.5	0.67	306,918.5
2024	-	-	142,864.9	-	11,648.3	134,587.2	142,864.9	(40,677.1)	102,187.8	64,599.8	0.63	371,518.3
2025	-	-	147,013.1	-	10,716.5	123,109.6	147,013.1	(42,251.9)	104,761.1	62,536.9	0.60	434,055.2
2026	-	-	151,296.3	-	9,859.2	112,550.2	151,296.3	(43,845.5)	107,450.8	60,568.9	0.56	494,624.1
2027	-	-	155,719.4	-	9,070.4	102,835.6	155,719.4	(45,461.2)	110,258.2	58,688.8	0.53	553,313.0
2028	-	-	160,287.4	-	8,344.8	93,898.1	160,287.4	(47,102.2)	113,185.2	56,890.3	0.50	610,203.3
2029	-	-	165,005.5	-	7,677.2	85,675.6	165,005.5	(48,771.8)	116,233.7	55,167.7	0.47	665,370.9
2030	-	-	-	-	7,063.0	78,110.9	-	2,189.5	2,189.5	981.3	0.45	666,352.3
2031	-	-	-	-	6,498.0	71,151.4	-	2,014.4	2,014.4	852.5	0.42	667,204.8
2032	-	-	-	-	5,978.2	64,748.7	-	1,853.2	1,853.2	740.6	0.40	667,945.4
2033	-	-	-	-	5,499.9	58,858.2	-	1,705.0	1,705.0	643.4	0.38	668,588.8
2034	-	-	-	-	5,059.9	53,438.9	-	1,568.6	1,568.6	559.0	0.36	669,147.8
2035	-	-	-	-	4,655.1	48,453.1	-	1,443.1	1,443.1	485.6	0.34	669,633.3
2036	-	-	-	-	4,282.7	43,866.3	-	1,327.6	1,327.6	421.9	0.32	670,055.2
2037	-	-	-	-	3,940.1	39,646.3	-	1,221.4	1,221.4	366.5	0.30	670,421.7
2038	-	-	-	-	3,624.9	35,764.0	-	1,123.7	1,123.7	318.4	0.28	670,740.1
2039	-	-	-	-	3,334.9	32,192.2	-	1,033.8	1,033.8	276.6	0.27	671,016.6
2040	-	-	-	-	3,068.1	28,906.2	-	951.1	951.1	240.3	0.25	671,256.9
2041	-	-	-	-	2,822.7	25,883.1	-	875.0	875.0	208.7	0.24	671,465.7
2042	-	-	-	-	2,596.8	23,101.8	-	805.0	805.0	181.3	0.23	671,647.0
2043	-	-	-	-	2,389.1	20,543.1	-	740.6	740.6	157.5	0.21	671,804.6
2044	-	-	-	-	2,198.0	18,189.0	-	681.4	681.4	136.9	0.20	671,941.4
2045	-	-	-	-	2,022.1	16,023.2	-	626.9	626.9	118.9	0.19	672,060.3
2046	-	-	-	-	1,860.4	14,030.7	-	576.7	576.7	103.3	0.18	672,163.6
2047	-	-	-	-	1,711.5	12,197.6	-	530.6	530.6	89.7	0.17	672,253.4
2048	-	-	-	-	1,574.6	10,511.2	-	488.1	488.1	78.0	0.16	672,331.3
2049	-	-	-	-	1,448.6	8,959.7	-	449.1	449.1	67.7	0.15	672,399.1
2050	-	-	-	-	1,332.7	7,532.3	-	413.2	413.2	58.8	0.14	672,457.9
2051	-	-	-	-	1,226.1	6,219.1	-	380.1	380.1	51.1	0.13	672,509.0
2052	-	-	-	-	1,128.0	5,010.9	-	349.7	349.7	44.4	0.13	672,553.4
2053	-	-	-	-	1,037.8	3,899.4	-	321.7	321.7	38.6	0.12	672,592.0
2054	-	-	-	-	954.8	2,876.8	-	296.0	296.0	33.5	0.11	672,625.5
2055	-	-	-	-	878.4	1,936.0	-	272.3	272.3	29.1	0.11	672,654.6
2056	-	-	-	-	808.1	1,070.5	-	250.5	250.5	25.3	0.10	672,679.9
Total	**-**	**-**	**1,859,566.4**	**(252,424.7)**	**240,842.6**		**1,607,141.7**	**(501,804.4)**	**1,105,337.3**	**672,679.9**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
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-600,000
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Vaccum Pump Cooler Refurb vs Avoided Fuel & Repair Costs
Test 2
Test 3
Test 4
Year

Transmission

CI Number: 49992

Title: 2017 Transmission Right-of-Way Widening 69kV

Start Date:	2017/01
In-Service Date:	2017/12
Final Cost Date:	2018/06
Function Class:	Transmission
Forecast Amount:	$5,400,855

INTRODUCTION:

The Board's 2016 ACE Plan Order provided the following directive:

> The Board directs that the Routine for Transmission widening be treated as a separate project, and not a routine, in future ACE Plan Applications. NSPI is to provide an annual progress report on the expenditure, works undertaken, results achieved and future plans as part of the annual ACE Plan submissions.[1]

This capital application is submitted in compliance with the Board's directive. With the addition of this capital work order, the transmission vegetation management program will be carried-out under three broad initiatives:

(1) Operating activities for transmission vegetation management
(2) Capital Routine T010 - Transmission Right-of-Way Widening (for 138kV, 230kV and 345kV RoWs)
(3) Transmission Rights-of-Way Widening individual capital projects (i.e. CI 49992 for 69kV RoWs and subsequent phases)

Capital routine T010 remains for the widening of 138kV, 230kV and 345kV RoWs. This is the traditional scope of T010. CI 49992 and subsequent phases represent the 69kV Widening Plan. This was the scope of work included in the $36M eight-year program ($4.5M per year, increased to $5.0M per year due to AO), which the UARB approved in principle and directed NS Power to include in ACE Plan filings for final approval.[2]

DESCRIPTION:

The vegetation management practices performed under NS Power's maintenance program target vegetation within the rights-of-way and maintain existing, sustainable rights-of-way. These activities prevent tree growth from causing outages, but do not address edge or off right-of-way trees. Widening rights-of-way will reduce the occurrence of edge and off right-of-way tree contacts by increasing the separation between trees and transmission lines.

This is year two of the eight year 69 kV Transmission Right-of-Way Widening Plan accepted by the UARB through the Post Tropical Storm Arthur review process. Increasing the right-of-way width for 69 kV transmission lines to 30-40 meters, where possible, will significantly reduce the risk of trees contacting the power line during storms. The 69 kV transmission lines and the length of line planned for widening in 2017 are as follows:

[1] 2016 ACE Plan, UARB Order, Matter Number M07176, June 8, 2016, page 2. NS Power's annual progress report on the expenditure, works undertaken, results achieved and future plans can be found in the 2017 ACE Plan Reliability Directive.
[2] Review of Nova Scotia Power Inc.'s (NSPI) state of preparedness and response to Post-Tropical Storm Arthur, UARB Supplemental Decision, Matter Number M06321, September 21, 2015, page 16. 2016 ACE Plan, UARB Decision, Matter Number M07176, June 8, 2016, pages 26-28.

Line #	Length of Line to be Widened (km)	Total Cost ($)
L-5502	1.1	24,652
L-5521	1.3	76,737
L-5510	3.0	58,586
L-5025	4.9	201,611
L-5037	7.1	153,347
L-5040	8.0	150,127
L-5039	9.2	176,166
L-5555	22.2	600,425
L-5055	34.0	617,550
L-5550	37.9	842,202
L-5524	58.0	1,050,151
L-5559	65.6	1,449,300
TOTAL	**254.3**	**5,400,855**

Summary of Related CIs +/- 2 years:
2015 T010 Provincial Transmission Right of Way Widening $600,000
2016 T010 Provincial Transmission Right of Way Widening $5,999,956
2018 CI TBD 2018 Transmission Right of Way Widening 69kV $TBD
2019 CI TBD 2019 Transmission Right of Way Widening 69kV $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Why do this project?

NS Power's standard right-of-way width for a 69 kV transmission line was 20 meters. Given the power line structure is usually in the centre of the right-of-way, it results in a cleared area of 10m on each side of the centre line; however, the distance between the forest edge and conductors varies depending on structure type. While this distance provides ample clearance for the safe maintenance and operation of all types of structures, it is not wide enough to prevent many tree species that are tall enough to span the entire right-of-way width from making contact with the power lines when they fall. Increasing the right-of-way width for 69 kV transmission lines to 30-40 meters, where possible, will significantly reduce the risk of trees contacting the power lines during storms.

Why do this project now?

This is year two of the eight year 69 kV Transmission Right-of-Way Widening Plan. The transmission lines targeted for widening in 2017 are based on the prioritization outlined in the Widening Plan.

Why do this project this way?

Prioritizing the widening of the 69 kV transmission rights-of-way based on customer count and redundancy will provide the largest reliability benefit.

CI Number : 49992 - 2017 Transmission Right of Way Widening **Project Number**

Parent CI Number : -

Cost Centre : 840 - 840-Forestry **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
095		095-COPS Contracts AO		900,855	0	900,855
013	002	013 - COPS Contracts	002 - TP - Land Rights	4,500,000	0	4,500,000
			Total Cost:	5,400,855	0	5,400,855
			Original Cost:			

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 49992
Title: 2017 Transmission Right-of-Way Widening 69kV
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
013 Contracts						
L-5502 Widening	Lot	1	$ 20,540	$ 20,540		
L-5521 Widening	Lot	1	$ 63,938	$ 63,938		
L-5510 Widening	Lot	1	$ 48,814	$ 48,814		
L-5025 Widening	Lot	1	$ 167,983	$ 167,983		
L-5037 Widening	Lot	1	$ 127,769	$ 127,769		
L-5040 Widening	Lot	1	$ 125,086	$ 125,086		
L-5039 Widening	Lot	1	$ 146,782	$ 146,782		
L-5555 Widening	Lot	1	$ 500,275	$ 500,275		
L-5055 Widening	Lot	1	$ 514,543	$ 514,543		
L-5550 Widening	Lot	1	$ 701,724	$ 701,724		
L-5524 Widening	Lot	1	$ 874,987	$ 874,987		
L-5559 Widening	Lot	1	$ 1,207,559	$ 1,207,559		
			Sub-Total	$ 4,500,000		
095 Administrative Overhead						
COPS Contract AO				$ 900,855		
			Sub-Total	$ 900,855		
			SUB-TOTAL (no AO, AFUDC)	$ 4,500,000		
			TOTAL (AO, AFUDC included)	$ 5,400,855		
Original Cost				$ -		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 47954

Title: L7012 Replacements and Upgrades

Start Date:	2017/07
In-Service Date:	2017/09
Final Cost Date:	2018/11
Function Class:	Transmission
Forecast Amount:	$4,428,520

DESCRIPTION:

L7012 is a 139.02 kilometer (673 Structures) 230kV transmission line that connects 3C Port Hastings to 88S Lingan substations. This line was built in 1982. This project is required to replace deteriorated assets that have been identified through NS Power's inspection program. This project includes the replacement of deteriorated assets on approximately 270 structures, over a two year period.

The project scope includes:

- Structure Replacements: 23 Structures
- Spar Arm Replacements and Insulator Replacements: 174 Structures
- Pole Replacements: 10 Structures
- Pole and Insulator Replacements: 18 Structures
- Insulator Replacement: 39 Structures
- Other Deteriorated Assets: 6 Structures

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

Depreciation Class: Transmission Plant

Estimated Life of the Asset: 45 years

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

The transmission inspection program identified deteriorated assets that require replacement to avoid transmission interruptions. Not completing this project would compromise the reliable operation of this line.

Why do this project now?

This work has been prioritized based on transmission inspection results. This project is required to support the reliable operation of the transmission line.

Why do this project this way?

Replacing the existing deteriorated assets is more cost effective than rebuilding the entire line.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 47954 - L7012 Replacements and Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		46,919	0	46,919
094		094 - Interest Capitalized		11,636	0	11,636
095		095-COPS Contracts AO		585,259	0	585,259
095		095-COPS Regular Labour AO		69,505	0	69,505
013	007	013 - COPS Contracts	007 - TP - Environmental	321,703	0	321,703
012	035	012 - Materials	035 - TP - Wood Poles	256,875	0	256,875
013	035	013 - COPS Contracts	035 - TP - Wood Poles	1,541,424	0	1,541,424
012	038	012 - Materials	038 - TP - Insulators	143,574	0	143,574
013	038	013 - COPS Contracts	038 - TP - Insulators	543,118	0	543,118
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	1,288	0	1,288
012	039	012 - Materials	039 - TP - O/H Cond.	10	0	10
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	517,271	0	517,271
001	085	001 - Regular Labour (No AO)	085 Design	8,009	0	8,009
066	085	066 - Other Goods & Services	085 Design	292,352	0	292,352
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	89,579	0	89,579
			Total Cost:	4,428,520	0	4,428,520
			Original Cost:	1,476,448		

Capital Project Detailed Estimate

Location: **Transmission**
CI# / FP#: 47954
Title: L7012 Replacements and Upgrades
Execution Year: 2017 / 2018

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	4	$ 360	$ 1,288		
T&D Labour - Site Supervision	PD	233	$ 385	$ 89,579		
Procurement / Financial Support	Lot	1	$ 8,009	$ 8,009		
			Sub-Total	$ 98,875		
012 Materials						
Poles, Anchors, and Guys	Lot	1	$ 256,875	$ 256,875		
Insulators and Conductors	Lot	1	$ 143,584	$ 143,584		
			Sub-Total	$ 400,459		
013 Contracts						
Contract Line Work	Hrs	[redacted]		$ 2,483,013		
Environmental Bridges and Mats	Lot	1	$ 321,703	$ 321,703		
Flagging	Lot	1	$ 20,000	$ 20,000		
Pole-Haulage	Lot	1	$ 67,800	$ 67,800		
Waste Disposal	Lot	1	$ 25,000	$ 25,000		
Miscellaneous costs for ground excavation	Lot	1	$ 6,000	$ 6,000		
			Sub-Total	$ 2,923,516		
066 Other Goods & Services						
Contingency	%	10%	$ 2,923,516	$ 292,352		
			Sub-Total	$ 292,352		
094 Interest Capitalized						
Interest				$ 11,636		
			Sub-Total	$ 11,636		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 46,919		
			Sub-Total	$ 46,919		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 69,505		
COPS Contract AO				$ 585,259		
			Sub-Total	$ 654,763		
			SUB-TOTAL (no AO, AFUDC)	$ 3,715,202		
			TOTAL (AO, AFUDC included)	$ 4,428,520		
Original Cost				$ 1,476,448		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49838

Title: 2017/2018 Substation Polychlorinated Biphenyl (PCB) Equipment Removal Program

Start Date: 2017/03
In-Service Date: 2017/03
Final Cost Date: 2019/06
Function Class: Transmission
Amount: $4,127,023

DESCRIPTION:

This project provides for the costs associated with the polychlorinated biphenyl (PCB) sampling of all substation oil-filled equipment and the removal of substation devices with 50 mg/kg or more of PCBs, to be in compliance with 2008 Federal Environmental PCB Regulations.

The annual investment on this asset has increased from 2015 and 2016 as the regulations around the removal of substation devices went from 500 mg/kg to 50 mg/kg.

Summary of Related CIs +/- 2 years:
2015 CI 46586 2015 Substation PCB Equipment Removal $1,262,087
2016 CI 48066 2016/2017 Substation PCB Equipment Removal $ $3,500,427
2018 CI TBD 2018/2019 Substation PCB Equipment Removal $TBD
2019 CI TBD 2019/2020 Substation PCB Equipment Removal $TBD

Depreciation Class: Transmission Plant

Estimated Useful Life: 40 Years

JUSTIFICATION:

Justification Criteria: Environment

Sub Criteria: Environmental Permit, License, Regulation Criteria

Why do this project?

This project is required to ensure NS Power is compliant with the revised 2008 Federal PCB Regulations as set by the Federal Government, which set the deadline of 2025 for ending the use of all equipment containing PCBs in concentrations at or above 50 mg/kg.

Why do this project now?

This project needs to be completed now to ensure replacement of all applicable PCB contaminated substation equipment before the 2025 deadline.

Why do this project this way?

The sampling and replacement of equipment containing greater than 50 mg/kg concentration of PCBs must be planned over a period of several years to ensure outages are effectively managed and the 2008 Federal PCB Regulations are met.

CI Number : 49838 - 2017/2018 Substation Polychlorinated Biphenyl (PCB) Equipment Removal Program **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		39,053	0	39,053
095		095-COPS Contracts AO		177,427	0	177,427
095		095 - Proj Supp Regular Labour AO		165,380	0	165,380
095		095-COPS Regular Labour AO		57,852	0	57,852
012	003	012 - Materials	003 - TP - Bldg.,Struct.Grnd.	840	0	840
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	72,176	0	72,176
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	75,632	0	75,632
012	022	012 - Materials	022 - TP - Elec Contr.Equip.	61,180	0	61,180
013	022	013 - COPS Contracts	022 - TP - Elec Contr.Equip.	42,000	0	42,000
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	42,000	0	42,000
012	043	012 - Materials	043 - TP - Substn Dev.	1,177,697	0	1,177,697
013	043	013 - COPS Contracts	043 - TP - Substn Dev.	618,119	0	618,119
012	044	012 - Materials	044 - TP - Substn.Transf.	800,000	0	800,000
013	044	013 - COPS Contracts	044 - TP - Substn.Transf.	112,000	0	112,000
001	085	001 - Regular Labour (No AO)	085 Design	6,560	0	6,560
001	085	001 - Proj Supp Regular Labour	085 Design	343,897	0	343,897
066	085	066 - Other Goods & Services	085 Design	335,210	0	335,210
			Total Cost:	4,127,023	0	4,127,023
			Original Cost:	1,211,908		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 49838
Title: 2017/2018 Substation Polychlorinated Biphenyl (PCB) Equipment Removal Program
Execution Year: 2017-2018

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	210	$ 360	$ 75,632		
Procurement / Financial Support	Lot	1	$ 6,560	$ 6,560		
Project Support AO - Engineering Design	PD	900	$ 382	$ 343,897		
			Sub-Total	$ 426,089		
012 Materials						
Ground Connectors	Lot	1	$ 840	$ 840		
Control Cables, Junction Boxes & Grounding	Lot	1	$ 61,180	$ 61,180		
138kv Circuit Breakers, 138kv Post PTs	Ea	5	$ 111,445	$ 557,225		
69kv Circuit Breakers, 69 kv Posts PTs	Ea	8	$ 74,823	$ 598,587		
Coils, Connectors, Jumpers	lot	1	$ 21,885	$ 21,885		
HV Bushings	Ea	80	$ 10,000	$ 800,000		
			Sub-Total	$ 2,039,717		
013 Contracts						
Civil Work - Foundations	Lot	1	$ 72,175	$ 72,175		
Installation and Removal of Equipment	Ea	13	$ 60,308	$ 784,000		
Crane Services	Lot	1	$ 18,000	$ 18,000		
Mobile Transport	Lot	1	$ 6,000	$ 6,000		
Boom Truck	Lot	1	$ 6,120	$ 6,120		
			Sub-Total	$ 886,295		
066 Other Goods & Services						
Contingency	%	10%	$ 3,352,101	$ 335,210		
			Sub-Total	$ 335,210		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 39,053		
			Sub-Total	$ 39,053		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 57,852		
COPS Contract AO				$ 177,427		
Project Support Regular AO				$ 165,380		
			Sub-Total	$ 400,659		
			SUB-TOTAL (no AO, AFUDC)	$ 3,687,311		
			TOTAL (AO, AFUDC included)	$ 4,127,023		
Original Cost				$ 1,211,907.11		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49948

Title: 2017/2018 Isolated Transmission Structure Replacements

Start Date: 2017/06
In-Service Date: 2017/10
Final Cost Date: 2019/04
Function Class: Transmission
Forecast Amount: $3,822,487

DESCRIPTION:

This is a multi-year project with work planned to be completed in 2017 and 2018. This program is designed to use helicopters to conduct maintenance work on transmission structures located in isolated or environmentally sensitive areas that are very difficult to access using traditional construction methods. Utilizing helicopters to complete this work will reduce environmental impact and permitting times, reduce equipment and material mobilization challenges, lessen the costs of site access, reduce the planned outage time required to complete maintenance work, and reduce land access challenges. To complete the maintenance work on these isolated structures using traditional construction methods requires significant resources to build bridges and lay environmental matting to access the structures, adding to project time and costs. Photos showing the difficult and environmentally sensitive locations of some structures in these isolated areas are below.

The project scope includes:

L6021 (77 structures):
- Structure Replacements: 29 structures
- Timber/Arm & Insulator Replacements: 40 structures
- Insulator Replacement: 8 structures

L6024 (18 structures):
- Structure Replacements: 18 Structures

Summary of Related CIs +/- 2 years:
2018 CI TBD 2018/2019 Isolated Structure Replacements $TBD
2019 CI TBD 2019/2020 Isolated Structure Replacements $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Why do this project?

The transmission inspection program identified deteriorated assets that require replacement to avoid transmission interruptions. Not completing this project would compromise the reliable operation of these lines. Access to these isolated structures is very difficult and the cost to build the required environmental bridges and lay environmental matting for site access is prohibitive. Therefore, past work has been completed using only small off-road vehicles. As a result, it has not been possible to use standard materials and equipment to complete the repairs and temporary repairs have been completed on multiple structures in these areas (please refer to the photo below).

Why do this project now?

This project is required to ensure the reliable operation of the transmission line. The temporary repairs that have been made need to be replaced with permanent standard construction structures.

Why do this project this way?

This program targets isolated structure refurbishment and replacements on L6021 and L6024. L6021 and L6024 are 138kV transmission lines that connect the 50W Milton, 30W Souriquois and 9W Tusket substations in the Western part of the province. These lines require a large quantity of environmental matting and bridges for structure access. The cost of these traditional access methods exceeds the cost of completing the work from a helicopter. The following table compares the contract costs for performing the work with a helicopter and using traditional methods.

Line (# Structures)	Contract Cost Comparison ($000s)		
	Helicopter Costs	**Traditional Methods Environmental Matting Costs**	**Variance**
L6021 (24 structures)	$364	$592	$(228)
L6021 (27 structures)	$473	$583	$(110)
L6021 (26 structures)	$460	$702	$(242)
L6024 (18 structures)	$413	$611	$(198)
TOTAL	**$1,710**	**$2,488**	**$(778)**

Note: L6021 is being completed in three sections, therefore was broken out separately in the table above.

This comparison demonstrates the benefit of using helicopters to complete the maintenance work on the isolated structures. In addition, once this program is established, the method of conducting work from a helicopter will be available for use for reactive outage restoration, resulting in decreased outage times.

Replacing the existing deteriorated assets is more cost effective than rebuilding the entire line. Gaining access and completing the work from a helicopter for the identified structures on L6021 and L6024 will result in lower costs than traditional work methods and will reduce permitting times, reduce equipment and material mobilization challenges, lessen the costs of site access, allow for faster completion of the work, and reduce land access challenges.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services, and through subcontractors the helicopter work. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

The pictures below show areas where large tracked equipment would do significant damage if used in the execution of this work.

Temporary Structure Repairs:

CI Number : 49948 - 2017/2018 Isolated Transmission Structure Replacements **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		24,281	0	24,281
095		095-COPS Contracts AO		529,075	0	529,075
095		095-COPS Regular Labour AO		35,969	0	35,969
012	035	012 - Materials	035 - TP - Wood Poles	240,876	0	240,876
013	035	013 - COPS Contracts	035 - TP - Wood Poles	2,264,606	0	2,264,606
012	038	012 - Materials	038 - TP - Insulators	22,543	0	22,543
013	038	013 - COPS Contracts	038 - TP - Insulators	113,209	0	113,209
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	3,756	0	3,756
012	039	012 - Materials	039 - TP - O/H Cond.	10,095	0	10,095
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	265,051	0	265,051
001	085	001 - Regular Labour (No AO)	085 Design	5,470	0	5,470
066	085	066 - Other Goods & Services	085 Design	264,287	0	264,287
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	43,268	0	43,268
			Total Cost:	3,822,487	0	3,822,487
			Original Cost:	1,176,822		

Capital Project Detailed Estimate

Location: **Transmission**
CI# / FP#: 49948
Title: 2017/2018 Isolated Transmission Structure Replacements
Execution Year: 2017-2018

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	10	$ 360	3,756		
T&D Labour - Site Supervision	PD	112	$ 385	43,268		
Procurement / Financial Support	Lot	1	$ 5,470	5,470		
			Sub-Total	52,495		
012 Materials						
Conductors	Lot	1	$ 10,095	$ 10,095		
Anchors, Guys, and Poles	Lot	1	$ 240,876	$ 240,876		
Insulators	Lot	1	$ 22,543	$ 22,543		
			Sub-Total	$ 273,514		
013 Contracts						
Contract Line Work	Hrs	[redacted]	[redacted]	$ 868,090		
Flagging	Lot	1	$ 12,000	$ 12,000		
Pole-Haulage	Lot	1	$ 32,600	$ 32,600		
Waste Disposal	Lot	1	$ 20,000	$ 20,000		
Helicopter Services - L6024 (18 Structures)	Lot	1	$ 413,600	$ 413,600		
Helicopter Services - L6021 (24 Structures)	Lot	1	$ 363,688	$ 363,688		
Helicopter Services - L6021 (27 Structures)	Lot	1	$ 473,160	$ 473,160		
Helicopter Services - L6021 (26 Structures)	Lot	1	$ 459,728	$ 459,728		
			Sub-Total	$ 2,642,866		
066 Other Goods & Services						
Contingency	%	10%	$ 2,642,866	$ 264,287		
			Sub-Total	$ 264,287		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 24,281		
			Sub-Total	$ 24,281		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 35,969		
COPS Contract AO				$ 529,075		
			Sub-Total	$ 565,045		
			SUB-TOTAL (no AO, AFUDC)	$ 3,233,161		
			TOTAL (AO, AFUDC included)	$ 3,822,487		
Original Cost				$ 1,184,352		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49793

Title: L7011 Replacements and Upgrades

Start Date: 2017/04
In-Service Date: 2017/06
Final Cost Date: 2019/06
Function Class: Transmission
Forecast Amount: $3,343,484

DESCRIPTION:

L7011 is a 139.98 kilometer (578 Structures) 230kV transmission line that connects 3C Port Hastings to 88S Lingan substations. This line was built in 1972. This project is required to replace deteriorated assets that have been identified through Nova Scotia Power's inspection program. This project includes the replacement of deteriorated assets on approximately 170 structures. The insulators targeted for replacement have a known failure mechanism resulting from cement growth.

The project scope includes:

- Structure Replacements: 29 Structures
- Spar Arm Replacements and Insulator Replacements: 52 Structures
- Spar Arm Replacements: 19 Structures
- Pole Replacements: 6 Structures
- Pole and Insulator Replacements: 5 Structures
- Insulator Replacement: 13 Structures
- Other Deteriorated Assets: 45 Structures

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

The transmission inspection program identified deteriorated assets that require replacement to avoid transmission interruptions. Not completing this project would compromise the reliable operation of this line.

Why do this project now?

This work has been prioritized based on transmission inspection results. This project is required to support the reliable operation of the transmission line.

Why do this project this way?

Replacing the existing deteriorated assets is more cost effective than rebuilding the entire line.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 49793 - L7011 Replacements and Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		42,603	0	42,603
094		094 - Interest Capitalized		7,647	0	7,647
095		095-COPS Contracts AO		413,906	0	413,906
095		095-COPS Regular Labour AO		63,112	0	63,112
013	007	013 - COPS Contracts	007 - TP - Environmental	349,108	0	349,108
012	035	012 - Materials	035 - TP - Wood Poles	385,582	0	385,582
013	035	013 - COPS Contracts	035 - TP - Wood Poles	1,069,011	0	1,069,011
012	037	012 - Materials	037 - TP - Steel Towers	690	0	690
013	037	013 - COPS Contracts	037 - TP - Steel Towers	5,352	0	5,352
012	038	012 - Materials	038 - TP - Insulators	57,338	0	57,338
013	038	013 - COPS Contracts	038 - TP - Insulators	210,477	0	210,477
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	2,736	0	2,736
012	039	012 - Materials	039 - TP - O/H Cond.	6,766	0	6,766
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	414,618	0	414,618
001	085	001 - Regular Labour (No AO)	085 Design	9,008	0	9,008
066	085	066 - Other Goods & Services	085 Design	206,757	0	206,757
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	79,773	0	79,773
013	088	013 - COPS Contracts	088 Survey/Mapping	19,000	0	19,000
			Total Cost:	3,343,484	0	3,343,484
			Original Cost:	406,904		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 49793
Title: L7011 Replacements and Upgrades
Execution Year: 2017 / 2018

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	8	$ 360	$ 2,736		
T&D Labour - Site Supervision	PD	207	$ 385	$ 79,773		
Procurement / Financial Support	Lot	1	$ 9,008	$ 9,008		
			Sub-Total	$ 91,516		
012 Materials						
Poles, Anchors, and Guys	Lot	1	$ 385,582	$ 385,582		
Insulators	Lot	1	$ 57,338	$ 57,338		
Conductor	Lot	1	$ 6,766	$ 6,766		
Steel	Lot	1	$ 690	$ 690		
			Sub-Total	$ 450,377		
013 Contracts						
Contract Line Work	Hrs	[redacted]		$ 1,630,758		
Environmental Bridges and Mats	Lot	1	$ 349,108	$ 349,108		
Flagging	Lot	1	$ 17,500	$ 17,500		
Rock breaking	Lot	1	$ 10,000	$ 10,000		
Pole-Haulage	Lot	1	$ 16,200	$ 16,200		
Waste Disposal	Lot	1	$ 25,000	$ 25,000		
Survey	Lot	1	$ 19,000	$ 19,000		
			Sub-Total	$ 2,067,566		
066 Other Goods & Services						
Contingency	%	10%	$ 2,067,566	$ 206,757		
			Sub-Total	$ 206,757		
094 Interest Capitalized						
AFUDC				$ 7,647		
			Sub-Total	$ 7,647		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 42,603		
			Sub-Total	$ 42,603		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 63,112		
COPS Contract AO				$ 413,906		
			Sub-Total	$ 477,018		
			SUB-TOTAL (no AO, AFUDC)	$ 2,816,216		
			TOTAL (AO, AFUDC included)	$ 3,343,484		
Original Cost				$ 406,904		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49789

Title: L6515 Replacements and Upgrades

Start Date:	2017/07
In-Service Date:	2017/09
Final Cost Date:	2018/12
Function Class:	Transmission
Forecast Amount:	$2,340,989

DESCRIPTION:

L6515 is a 49.25 kilometer 138kV transmission line that connects 4C Lochaber Road to 100C Cape Porcupine substations. This line was built in 1959. This project is required to replace deteriorated assets and ground clearance violations that have been identified through NS Power's inspection program. This project includes the replacement of assets and addressing of ground clearance violations on approximately 161 structures over a two year period.

The project scope includes:

- Structure Replacements: 17 Structures
- Timber Arm Replacements: 8 Structures
- Pole and Insulator Replacements: 22 Structures
- Insulator Replacement: 113 Structures
- Other Deteriorated Assets: 1 Structures

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

Depreciation Class: Transmission Plant

Estimated Life of the Asset: 45 years

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

The transmission inspection program identified deteriorated assets that require replacement to avoid transmission interruptions. Not completing this project would compromise the reliable operation of this line.

Why do this project now?

This work has been prioritized based on transmission inspection results. This project is required to support the reliable operation of the transmission line.

Why do this project this way?

Replacing the existing deteriorated assets is more cost effective than rebuilding the entire line.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 49789 - L6515 Replacements and Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		35,260	0	35,260
094		094 - Interest Capitalized		7,489	0	7,489
095		095-COPS Contracts AO		306,164	0	306,164
095		095-COPS Regular Labour AO		52,233	0	52,233
013	007	013 - COPS Contracts	007 - TP - Environmental	123,327	0	123,327
012	035	012 - Materials	035 - TP - Wood Poles	115,664	0	115,664
013	035	013 - COPS Contracts	035 - TP - Wood Poles	285,956	0	285,956
012	038	012 - Materials	038 - TP - Insulators	62,130	0	62,130
013	038	013 - COPS Contracts	038 - TP - Insulators	283,649	0	283,649
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	1,288	0	1,288
012	039	012 - Materials	039 - TP - O/H Cond.	7,747	0	7,747
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	831,436	0	831,436
001	085	001 - Regular Labour (No AO)	085 Design	3,711	0	3,711
066	085	066 - Other Goods & Services	085 Design	152,937	0	152,937
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	66,999	0	66,999
013	088	013 - COPS Contracts	088 Survey/Mapping	5,000	0	5,000
			Total Cost:	2,340,989	0	2,340,989
			Original Cost:	232,028		

Capital Project Detailed Estimate

Location: **Transmission**
CI# / FP#: 49789
Title: L6515 Replacements and Upgrades
Execution Year: 2017 / 2018

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	4	$ 360	$ 1,288		
T&D Labour - Site Supervision	PD	174	$ 385	$ 66,999		
Procurement / Financial Support	Lot	1	$ 3,711	$ 3,711		
			Sub-Total	$ 71,998		
012 Materials						
Poles, Anchors and Guys	Lot	1	$ 115,664	$ 115,664		
Insulators	Lot	1	$ 62,130	$ 62,130		
Conductors	Lot	1	$ 7,747	$ 7,747		
			Sub-Total	$ 185,541		
013 Contracts						
Contract Line Work	Hrs.	[redacted]		$ 1,369,640		
Environmental Bridges and Mats	Lot	1	$ 123,327	$ 123,327		
Flagging	Lot	1	$ 10,000	$ 10,000		
Pole-Haulage	Lot	1	$ 11,400	$ 11,400		
Waste Disposal	Lot	1	$ 10,000	$ 10,000		
Survey	Lot	1	$ 5,000	$ 5,000		
			Sub-Total	$ 1,529,368		
066 Other Goods & Services						
Contingency	%	10%	$ 1,529,368	$ 152,937		
			Sub-Total	$ 152,937		
094 Interest Capitalized						
AFUDC				$ 7,489		
			Sub-Total	$ 7,489		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 35,260		
			Sub-Total	$ 35,260		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 52,233		
COPS Contract AO				$ 306,164		
			Sub-Total	$ 358,397		
			SUB-TOTAL (no AO, AFUDC)	$ 1,939,843		
			TOTAL (AO, AFUDC included)	$ 2,340,989		
Original Cost				$ 232,028		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49815

Title: 2017/2018 Steel Tower Refurbishment

Start Date: 2017/01
In-Service Date: 2017/02
Final Cost Date: 2019/06
Function Class: Transmission
Amount: $2,003,317

DESCRIPTION:

This project is required to replace deteriorated steel tower components. NS Power has approximately 2,000 Steel Towers installed on the transmission system. These deteriorated steel tower components are identified through the NS Power transmission inspection program. Components that will be replaced include hardware, guys, tower legs and grillages, footings and steel members. The age profile of the steel tower fleet is illustrated in the table below.

Age Range	Kilometers of Steel Structures	% of Steel Structures
0-10	0	0%
11-20	10	1%
21-30	334	47%
31-40	209	29%
41-50	44	6%
51-55	0	0%
55+	120	17%

Summary of Related CIs +/- 2 years:
2015 CI 43490 2015 Steel Tower Life Extension $1,441,709
2016 CI 48113 2016 Steel Tower Refurbishment $1,032,578
2018 CI TBD 2018 Steel Tower Refurbishment $TBD
2019 CI TBD 2019 Steel Tower Refurbishment $TBD

Depreciation Class: Transmission Equipment – Towers and Fixtures

Estimated Useful Life: 50 - 55 Years

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

NS Power's inspection program has identified deteriorated steel tower components that require replacement. Deteriorated steel tower components have been identified on 17 transmission lines throughout the province. These lines are critical to the reliable operation of the transmission system. Work on these deficiencies will be prioritized based on inspection results and engineering assessments, consistent with how work has been completed under this program in the past. The exact towers that will be refurbished will be determined throughout the prioritization process.

Why do this project now?

This work has been prioritized based on transmission inspection results. Many of these steel tower components have reached or are approaching the end of their estimated useful lives and if replacements are not completed, the reliability of the lines will be compromised.

Why do this project this way?

Replacing the existing deteriorated steel tower components is more cost effective than entire steel tower replacements.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 49815 - 2017 / 2018 Steel Tower Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		25,247	0	25,247
095		095-COPS Regular Labour AO		37,400	0	37,400
095		095 - Proj Supp Regular Labour AO		12,859	0	12,859
095		095-COPS Contracts AO		263,716	0	263,716
012	037	012 - Materials	037 - TP - Steel Towers	120,000	0	120,000
013	037	013 - COPS Contracts	037 - TP - Steel Towers	1,242,327	0	1,242,327
001	085	001 - Proj Supp Regular Labour	085 Design	26,740	0	26,740
001	085	001 - Regular Labour (No AO)	085 Design	2,400	0	2,400
028	085	028 - Consulting	085 Design	3,000	0	3,000
041	085	041 - Meals & Entertainment	085 Design	2,000	0	2,000
066	085	066 - Other Goods & Services	085 Design	143,733	0	143,733
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	48,895	0	48,895
013	087	013 - COPS Contracts	087 Field Super.& Ops.	75,000	0	75,000
			Total Cost:	2,003,317	0	2,003,317
			Original Cost:	306,816		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 49815
Title: 2017 / 2018 Steel Tower Refurbishment
Execution Year: 2017-2018

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Site Supervision	PD	$ 127	$ 385	$ 48,895		
Procurement / Financial Support	Lot	$ 1	$ 2,400	$ 2,400		
Project Support AO - Engineering Design	PD	$ 70	$ 382	$ 26,740		
			Sub-Total	$ 78,035		
012 Materials						
Steel Tower Components	Lot	$ 1	$ 120,000	$ 120,000		
			Sub-Total	$ 120,000		
013 Contracts						
Contract Line Work	Hrs	[redacted]		$ 1,242,327		
Site Supervision	Lot	$ 1	$ 75,000	$ 75,000		
			Sub-Total	$ 1,317,327		
028 Consulting						
Consulting	Lot	$ 1	$ 3,000	$ 3,000		
			Sub-Total	$ 3,000		
041 Meals & Entertainment						
Meals	Lot	$ 1	$ 2,000	$ 2,000		
			Sub-Total	$ 2,000		
066 Other Goods & Services						
Contingency	%	10%	$ 1,437,327	$ 143,733		
			Sub-Total	$ 143,733		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 25,247		
			Sub-Total	$ 25,247		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 37,400		
COPS Contract AO				$ 263,716		
Project Support Regular AO				$ 12,859		
			Sub-Total	$ 313,975		
			SUB-TOTAL (no AO, AFUDC)	$ 1,664,095		
			TOTAL (AO, AFUDC included)	$ 2,003,317		
Original Cost				$ 306,816		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49774

Title: L5527 Replacements and Upgrades

Start Date:	2017/04
In-Service Date:	2017/06
Final Cost Date:	2018/12
Function Class:	Transmission
Forecast Amount:	$1,537,852

DESCRIPTION:

L5527 is a 57.01 kilometer radial 69kV transmission line that connects 57C Salmon River Lake to 19C Canso substations. This line was built in 1966. This project is required to replace deteriorated assets that have been identified through NS Power's inspection program. This project includes the replacement of assets on approximately 151 structures over a two year period.

The project scope includes:

- Structure Replacements: 66 Structures
- Timber Arm Replacements: 59 Structures
- Insulator Replacement: 9 Structures
- Other Deteriorated Assets: 17 Structures

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

Depreciation Class: Transmission Plant

Estimated Life of the Asset: 45 years

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

The transmission inspection program identified deteriorated assets that require replacement to avoid transmission interruptions. Not completing this project would compromise the reliable operation of this line.

Why do this project now?

This work has been prioritized based on transmission inspection results. This project is required to support the reliable operation of the transmission line.

Why do this project this way?

Replacing the existing deteriorated assets is more cost effective than rebuilding the entire line.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 49774 - L5527 Replacements and Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		20,747	0	20,747
094		094 - Interest Capitalized		4,329	0	4,329
095		095-COPS Regular Labour AO		30,735	0	30,735
095		095-COPS Contracts AO		192,986	0	192,986
013	007	013 - COPS Contracts	007 - TP - Environmental	95,294	0	95,294
012	035	012 - Materials	035 - TP - Wood Poles	176,912	0	176,912
013	035	013 - COPS Contracts	035 - TP - Wood Poles	432,883	0	432,883
012	038	012 - Materials	038 - TP - Insulators	7,110	0	7,110
013	038	013 - COPS Contracts	038 - TP - Insulators	40,686	0	40,686
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	1,931	0	1,931
012	039	012 - Materials	039 - TP - O/H Cond.	740	0	740
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	393,152	0	393,152
001	085	001 - Regular Labour (No AO)	085 Design	3,695	0	3,695
066	085	066 - Other Goods & Services	085 Design	96,402	0	96,402
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	38,250	0	38,250
013	088	013 - COPS Contracts	088 Survey/Mapping	2,000	0	2,000
			Total Cost:	1,537,852	0	1,537,852
			Original Cost:	171,174		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 49774
Title: L5527 Replacements and Upgrades
Execution Year: 2017-2018

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	5	$ 360	$ 1,931		
T&D Labour - Site Supervision	PD	99	$ 385	$ 38,250		
Procurement / Financial Support	Lot	1	$ 3,695	$ 3,695		
				$ -		
			Sub-Total	$ 43,876.15		
012 Materials						
Poles, Anchors, and Guys	Lot	1	$ 176,914	$ 176,914		
Insulators and Conductors	Lot	1	$ 7,849	$ 7,849		
			Sub-Total	$ 184,762		
013 Contracts						
Contract Line Work	Hrs	[redacted]	[redacted]	$ 781,921		
Environmental Bridges and Mats	Lot	1	$ 95,294	$ 95,294		
Flagging	Lot	1	$ 10,000	$ 10,000		
Rock breaking	Lot	1	$ 50,000	$ 50,000		
Pole-Haulage	Lot	1	$ 19,800	$ 19,800		
Waste Disposal	Lot	1	$ 5,000	$ 5,000		
Survey	Lot	1	$ 2,000	$ 2,000		
				$ -		
			Sub-Total	$ 964,014.93		
066 Other Goods & Services						
Contingency	%	10%	$ 964,015	$ 96,401		
			Sub-Total	$ 96,401		
094 Interest Capitalized						
AFDUC				$ 4,329		
			Sub-Total	$ 4,329		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 20,747		
				$ -		
			Sub-Total	$ 20,747		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 30,735		
COPS Contract AO				$ 192,986		
			Sub-Total	$ 223,721		
			SUB-TOTAL (no AO, AFUDC)	$ 1,289,055		
			TOTAL (AO, AFUDC included)	$ 1,537,852		
Original Cost				$ 171,174		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49813

Title: 2017 Sacrificial Anode Installation Program

Start Date: 2017/01
In-Service Date: 2017/01
Final Cost Date: 2018/06
Function Class: Transmission
Amount: $1,532,340

DESCRIPTION:

Sacrificial anodes are highly active metals that are used for cathodic protection to prevent a less active material surface from corroding. This project will systematically install sacrificial anodes on steel transmission structures and key tower anchors identified as corroding or at a high risk for corrosion. This program, along with a specialized transmission steel towers inspection and the steel tower refurbishment will identify and address corrosion issues on steel assets throughout the province.

Summary of Related CIs +/- 2 years:
2015 CI 46356 2015 Sacrificial Anode Installation Program $2,133,377
2016 CI 48116 2016 Sacrificial Anode Installation Program $970,909
2018 CI TBD 2018 Sacrificial Anode Installation Program $TBD
2019 CI TBD 2019 Sacrificial Anode Installation Program $TBD

Depreciation Class: Transmission Equipment – Towers and Fixtures

Estimated Useful Life: 15-20 years

JUSTIFICATION:

Justification Criteria: Transmission Plant

Why do this project?

Based on transmission line inspections, the age of NS Power infrastructure and the corrosion rate of steel once galvanization is breached, sacrificial anodes have been recommended by the T&D Engineering group and have been proven effective in other jurisdictions to protect steel transmission structure assets and slow the rate of corrosion.

Why do this project now?

Due to the age of NS Power steel transmission structure assets, the galvanization is at or near the end of the anticipated life. The cathodic protection provided by the installation of sacrificial anodes will effectively extend the life of the steel structure.

Why do this project this way?

The installation of sacrificial anodes protects the existing assets once the galvanization is ineffective, deferring costly replacement.

This project is expected to be completed by external resources.

CI Number : 49813 - 2017 Sacrificial Anode Installation Program **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		12,723	0	12,723
095		095-COPS Regular Labour AO		18,847	0	18,847
095		095 - Proj Supp Regular Labour AO		11,941	0	11,941
095		095-COPS Contracts AO		210,200	0	210,200
012	037	012 - Materials	037 - TP - Steel Towers	71,725	0	71,725
013	037	013 - COPS Contracts	037 - TP - Steel Towers	1,000,000	0	1,000,000
001	085	001 - Proj Supp Regular Labour	085 Design	24,830	0	24,830
001	085	001 - Regular Labour (No AO)	085 Design	1,435	0	1,435
041	085	041 - Meals & Entertainment	085 Design	1,000	0	1,000
066	085	066 - Other Goods & Services	085 Design	105,000	0	105,000
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	24,640	0	24,640
013	087	013 - COPS Contracts	087 Field Super.& Ops.	50,000	0	50,000
			Total Cost:	1,532,340	0	1,532,340
			Original Cost:			

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 49813
Title: 2017 Sacrificial Anode Installation Program
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Site Supervision	PD	$ 64	$ 385	$ 24,640		
Procurement / Financial Support	Lot	$ 1	$ 1,435	$ 1,435		
Project Support AO - Engineering Design	PD	$ 65	$ 382	$ 24,830		
			Sub-Total	$ 50,905		
012 Materials						
Anodes & Test Stations	EA	$ 475	$ 151	$ 71,725		
			Sub-Total	$ 71,725		
013 Contracts						
Contract Line Work	EA	$ 1	$ 1,000,000	$ 1,000,000		
Contract Supervision	EA	$ 1	$ 50,000	$ 50,000		
			Sub-Total	$ 1,050,000		
041 Meals & Entertainment						
Meals	Lot	$ 1	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000		
066 Other Goods & Services						
Contingency	$ 1	$ 0	$ 1,050,000	$ 105,000		
			Sub-Total	$ 105,000		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 12,723		
			Sub-Total	$ 12,723		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 18,847		
COPS Contract AO				$ 210,200		
Project Support Regular AO				$ 11,941		
			Sub-Total	$ 240,988		
			SUB-TOTAL (no AO, AFUDC)	$ 1,278,630		
			TOTAL (AO, AFUDC included)	$ 1,532,340		
Original Cost				$ -		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49814

Title: 2017/2018 Steel Tower Life Extension

Start Date: 2017/01
In-Service Date: 2017/06
Final Cost Date: 2018/12
Function Class: Transmission
Amount: $1,462,100

DESCRIPTION:

This project is to apply protective coating to 19 lattice steel towers around the Halifax Peninsula and the Canso Causeway to extend the life of the structures. The towers to be coated will be prioritized based on the latest inspection data. Current inspection results indicate that the towers on L6033/6035 should continue to be targeted, along with several towers located near the Canso Causeway based on the deteriorated state of the steel. The cost includes the removal, collection, and disposal of lead paint where required, working at heights in proximity to energized lines and material costs. Applying protective coatings on steel transmission structures is a common and accepted form of corrosion control used in the utility industry. Please refer to Attachment 1.

Summary of Related CIs +/- 2 years:
2015 CI 43490 Steel Tower Life Extension – Halifax Harbour $1,441,709
2016 CI 48114 2016 Steel Tower Life Extension – HRM $1,477,739
2018 CI TBD 2018/2019 Steel Tower Life Extension $TBD
2019 CI TBD 2019/2020 Steel Tower Life Extension $TBD

Depreciation Class: Transmission Equipment – Towers and Fixtures

Estimated Useful Life: 60 – 65 years

JUSTIFICATION:

Justification Criteria: Transmission Plant

Why do this project?

The environmental conditions that these towers are exposed to have led to the deterioration of the protective coating on the structures. These structures are showing signs of steel structure corrosion.

Why do this project now?

Current inspection results indicate that the towers on L6033/6035 should continue to be targeted, along with several towers located near the Canso Causeway based on the deteriorated state of the steel. These towers require recoating to be completed in order to reduce the loss of metal, which will extend the life of the towers beyond their originally estimated useful life of 50-55 years. A conservative estimate for the life extension from coating the tower is 10 years, resulting in a revised useful life of 60-65 years. The towers will be selected based on the age and condition of the structures. Restoration of protective coating before failure of the coating system prevents corrosion damage to structural steel tower components.

Why do this project this way?

The most cost effective approach is to recoat the steel towers prior to the failure of the protective coating which would lead to corrosion damage to the structural steel. If corrosion damage occurs in the structural steel components of a transmission tower, costly replacement of steel members may be necessary to preserve the integrity of the tower. The average cost of a tower replacement is $500,000 and protective coating costs approximately $50,000. The protective coasting extends the expected useful life of the steel tower from 55 years to 65 years. The average cost per year of service for a steel tower without protective coating is $9,090 ($500,000 / 55 years); with the protective coating applied, the average cost per year of service is reduced to $8,461 ($550,000 / 65 years).

This work is being completed by an external contractor.

CI Number : 49814 - 2017 / 2018 Steel Tower Life Extension **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D OT Labour AO		11,363	0	11,363
092		092-Vehicle T&D Reg. Labour AO		13,821	0	13,821
095		095-COPS Overtime Labour AO		16,832	0	16,832
095		095-COPS Contracts AO		184,175	0	184,175
095		095 - Proj Supp Regular Labour AO		1,837	0	1,837
095		095-COPS Regular Labour AO		20,475	0	20,475
001	037	001 - T&D Regular Labour	037 - TP - Steel Towers	3,668	0	3,668
002	037	002 - T&D Overtime Labour	037 - TP - Steel Towers	44,010	0	44,010
011	037	011 - Travel Expense	037 - TP - Steel Towers	2,500	0	2,500
012	037	012 - Materials	037 - TP - Steel Towers	110,000	0	110,000
013	037	013 - COPS Contracts	037 - TP - Steel Towers	920,000	0	920,000
001	085	001 - Proj Supp Regular Labour	085 Design	3,820	0	3,820
001	085	001 - Regular Labour (No AO)	085 Design	2,500	0	2,500
041	085	041 - Meals & Entertainment	085 Design	1,000	0	1,000
066	085	066 - Other Goods & Services	085 Design	103,000	0	103,000
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	23,100	0	23,100
			Total Cost:	1,462,100	0	1,462,100
			Original Cost:			

Capital Project Detailed Estimate

Location: **Transmission**
CI# / FP#: 49814
Title: 2017 / 2018 Steel Tower Life Extension
Execution Year: 2017 / 2018

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - PLT	PD	10	$ 367	$ 3,668		
T&D Labour - Site Supervision	PD	60	$ 385	$ 23,100		
Procurement / Financial Support	Lot	1	$ 2,500	$ 2,500		
Project Support AO - Engineering Design	PD	10	$ 382	$ 3,820		
			Sub-Total	$ 33,088		
002 OT Labour						
T&D Labour - PLT	PD	60	$ 734	$ 44,010		
			Sub-Total	$ 44,010		
011 Travel Expense						
Site Supervision Travel	Lot	1	$ 2,500	$ 2,500		
			Sub-Total	$ 2,500		
012 Materials						
Coating for Towers <100 ft	EA	16	$ 5,000	$ 80,000		
Coating for Towers >160 ft	EA	3	$ 10,000	$ 30,000		
			Sub-Total	$ 110,000		
013 Contracts						
Coating of Towers <100 ft	EA	16	$ 30,000	$ 480,000		
Coating of Towers >160 ft (lead abatement)	EA	3	$ 115,000	$ 345,000		
Grounding & Permit Holding	EA	19	$ 5,000	$ 95,000		
			Sub-Total	$ 920,000		
041 Meals & Entertainment						
Meals	Lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000.00		
066 Other Goods & Services						
Contingency	%	10%	$ 1,030,000	$ 103,000		
			Sub-Total	$ 103,000		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 13,821		
Vehicle T&D Labour Overtime AO				$ 11,363		
			Sub-Total	$ 25,184		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 20,475		
COPS T&D Labour Overtime AO				$ 16,832		
COPS Contract AO				$ 184,175		
Project Support Regular AO				$ 1,837		
			Sub-Total	$ 223,318		
			SUB-TOTAL (no AO, AFUDC)	$ 1,213,598		
			TOTAL (AO, AFUDC included)	$ 1,462,100		
Original Cost				$ -		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

2017 ACE CI 49814 Attachment 1 has been removed due to confidentiality.

CI Number: 49778

Title: L5535 Replacements and Upgrades

Start Date:	2017/10
In-Service Date:	2017/12
Final Cost Date:	2018/06
Function Class:	Transmission
Forecast Amount:	$1,261,920

DESCRIPTION:

L5535 is a 64.14 kilometer 69kV transmission line that connects 15V Sissiboo to 19W Tusket substations. This line was built in 1958. This project is required to replace deteriorated assets and ground clearance violations (due to changes in surrounding environment) that have been identified through NS Power's inspection program. This project includes the replacement of assets and addressing of ground clearance violations on approximately 146 structures.

The project scope includes:

- Structure Replacements: 84 Structures
- Timber Arm Replacements: 12 Structures
- Insulator Replacement: 2 Structures
- Other Deteriorated Assets: 48 Structures

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

Depreciation Class: Transmission Plant

Estimated Life of the Asset: 45 years

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

The transmission inspection program identified deteriorated assets that require replacement to avoid transmission interruptions. Not completing this project would compromise the reliable operation of this line.

Why do this project now?

This work has been prioritized based on transmission inspection results. This project is required to support the reliable operation of the transmission line.

Why do this project this way?

Replacing the existing deteriorated assets is more cost effective than rebuilding the entire line.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 49778 - L5535 Replacements and Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		18,564	0	18,564
094		094 - Interest Capitalized		7,212	0	7,212
095		095-COPS Regular Labour AO		27,500	0	27,500
095		095-COPS Contracts AO		158,671	0	158,671
013	007	013 - COPS Contracts	007 - TP - Environmental	45,378	0	45,378
012	035	012 - Materials	035 - TP - Wood Poles	136,334	0	136,334
013	035	013 - COPS Contracts	035 - TP - Wood Poles	337,925	0	337,925
013	037	013 - COPS Contracts	037 - TP - Steel Towers	122,842	0	122,842
012	038	012 - Materials	038 - TP - Insulators	888	0	888
013	038	013 - COPS Contracts	038 - TP - Insulators	18,176	0	18,176
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	1,424	0	1,424
012	039	012 - Materials	039 - TP - O/H Cond.	2,148	0	2,148
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	263,283	0	263,283
001	085	001 - Regular Labour (No AO)	085 Design	2,787	0	2,787
066	085	066 - Other Goods & Services	085 Design	79,260	0	79,260
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	34,527	0	34,527
013	088	013 - COPS Contracts	088 Survey/Mapping	5,000	0	5,000
			Total Cost:	1,261,920	0	1,261,920
			Original Cost:	106,689		

Capital Project Detailed Estimate

Location: **Transmission**
CI# / FP#: 49778
Title: L5535 Replacements and Upgrades
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	4	$ 360	$ 1,424		
T&D Labour - Site Supervision	PD	90	$ 385	$ 34,527		
Procurement / Financial Support	Lot	1	$ 2,787	$ 2,787		
			Sub-Total	$ 38,739		
012 Materials						
Poles, Anchors, and Guys	Lot	1	$ 136,334	$ 136,334		
Insulators	Lot	1	$ 888	$ 888		
Conductor	Lot	1	$ 2,148	$ 2,148		
			Sub-Total	$ 139,370		
013 Contracts						
Contract Line Work	Hrs.	[redacted]		$ 705,826		
Environmental Bridges and Mats	Lot	1	$ 45,378	$ 45,378		
Flagging	Lot	1	$ 8,000	$ 8,000		
Pole-Haulage	Lot	1	$ 19,400	$ 19,400		
Waste Disposal and other misc.-costs	Lot	1	$ 9,000	$ 9,000		
Survey	Lot	1	$ 5,000	$ 5,000		
			Sub-Total	$ 792,604		
066 Other Goods & Services						
Contingency	%	10%	$ 792,604	$ 79,260		
			Sub-Total	$ 79,260		
094 Interest Capitalized						
AFUDC				$ 7,212		
			Sub-Total	$ 7,212		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 18,564		
			Sub-Total	$ 18,564		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 27,500		
COPS Contract AO				$ 158,671		
			Sub-Total	$ 186,171		
			SUB-TOTAL (no AO, AFUDC)	$ 1,049,974		
			TOTAL (AO, AFUDC included)	$ 1,261,920		
Original Cost				$ 106,689		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49790

Title: L5505 Replacements and Upgrades

Start Date: 2017/01
In-Service Date: 2017/03
Final Cost Date: 2018/09
Function Class: Transmission
Forecast Amount: $1,223,571

DESCRIPTION:

L5505 is a 11.10 kilometer radial 69kV transmission line that connects 67C Whycocomagh to 9C Aberdeen substations. This line was built in 1958. This project is required to replace deteriorated assets and ground clearance violations that have been identified through NS Power's inspection program. This project includes the replacement of deteriorated assets on approximately 70 structures over a two year period.

The project scope includes:

- Structure Replacements: 33 Structures
- Timber Arm Replacements: 31 Structures
- Other Deteriorated Assets: 6 Structures

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

Depreciation Class: Transmission Plant

Estimated Life of the Asset: 45 years

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

The transmission inspection program identified deteriorated assets that require replacement to avoid transmission interruptions. Not completing this project would compromise the reliable operation of this line.

Why do this project now?

This work has been prioritized based on transmission inspection results. This project is required to support the reliable operation of the transmission line.

Why do this project this way?

Replacing the existing deteriorated assets is more cost effective than rebuilding the entire line.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 49790 - L5505 Replacements and Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		15,908	0	15,908
094		094 - Interest Capitalized		3,484	0	3,484
095		095-COPS Contracts AO		150,976	0	150,976
095		095-COPS Regular Labour AO		23,565	0	23,565
013	007	013 - COPS Contracts	007 - TP - Environmental	73,513	0	73,513
012	035	012 - Materials	035 - TP - Wood Poles	153,173	0	153,173
013	035	013 - COPS Contracts	035 - TP - Wood Poles	399,308	0	399,308
012	038	012 - Materials	038 - TP - Insulators	12,332	0	12,332
013	038	013 - COPS Contracts	038 - TP - Insulators	39,354	0	39,354
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	936	0	936
012	039	012 - Materials	039 - TP - O/H Cond.	425	0	425
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	233,991	0	233,991
001	085	001 - Regular Labour (No AO)	085 Design	3,318	0	3,318
066	085	066 - Other Goods & Services	085 Design	75,417	0	75,417
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	29,872	0	29,872
013	088	013 - COPS Contracts	088 Survey/Mapping	8,000	0	8,000
			Total Cost:	1,223,571	0	1,223,571
			Original Cost:	295,563		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 49790
Title: L5505 Replacements and Upgrades
Execution Year: 2017-2018

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	3	$ 360	$ 936		
T&D Labour - Site Supervision	PD	78	$ 385	$ 29,872		
Procurement / Financial Support	Lot	1	$ 3,318	$ 3,318		
			Sub-Total	$ 34,126		
012 Materials						
Poles, Guys and Anchors	Lot	1	$ 153,173	$ 153,173		
Insulators	Lot	1	$ 12,332	$ 12,332		
Conductors	Lot	1	$ 425	$ 425		
			Sub-Total	$ 165,929		
013 Contracts						
Contract Line Work	Hrs	[redacted]		$ 610,654		
Environmental Bridges and Mats	Lot	1	$ 73,512	$ 73,512		
Flagging	Lot	1	$ 5,000	$ 5,000		
Pole-Haulage	Lot	1	$ 17,000	$ 17,000		
Waste Disposal	Lot	1	$ 10,000	$ 10,000		
Mobile	Lot	1	$ 30,000	$ 30,000		
Survey	Lot	1	$ 8,000	$ 8,000		
			Sub-Total	$ 754,165.89		
066 Other Goods & Services						
Contingency	%	10%	$ 754,166	$ 75,416.59		
			Sub-Total	$ 75,417		
094 Interest Capitalized						
AFUDC				$ 3,484		
			Sub-Total	$ 3,484		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 15,908		
			Sub-Total	$ 15,908		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 23,565		
COPS Contract AO				$ 150,976		
			Sub-Total	$ 174,542		
			SUB-TOTAL (no AO, AFUDC)	$ 1,029,638		
			TOTAL (AO, AFUDC included)	$ 1,223,571		
Original Cost				$ 295,563		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49782

Title: L5027B Replacements and Upgrades

Start Date: 2017/03
In-Service Date: 2017/04
Final Cost Date: 2017/10
Function Class: Transmission
Forecast Amount: $1,093,542

DESCRIPTION:

L5027 is a 103.08 kilometer 69kV transmission line that connects 9W Tusket to 30W Souriquois substations. This work will be specifically on L5027B section of the line which runs from 21W Lower Woods Harbour to 30W Souriquois Substations. This section of line is 52.67 kilometers in length and was built in 1966. This project is required to replace deteriorated assets that have been identified through NS Power's inspection program. This project includes the replacement of assets on approximately 103 structures.

The project scope includes:

- Structure Replacements: 19 Structures
- Timber Arm Replacements and Insulator Replacements: 63 Structures
- Insulator Replacement: 9 Structures
- Other Deteriorated Assets: 12 Structures

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

Depreciation Class: Transmission Plant

Estimated Life of the Asset: 45 years

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

The transmission inspection program identified deteriorated assets that require replacement to avoid transmission interruptions. Not completing this project would compromise the reliable operation of this line.

Why do this project now?

This work has been prioritized based on transmission inspection results. This project is required to support the reliable operation of the transmission line.

Why do this project this way?

Replacing the existing deteriorated assets is more cost effective than rebuilding the entire line.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 49782 - L5027B Replacements and Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		17,113	0	17,113
095		095-COPS Contracts AO		149,596	0	149,596
095		095-COPS Regular Labour AO		25,351	0	25,351
013	007	013 - COPS Contracts	007 - TP - Environmental	95,625	0	95,625
012	035	012 - Materials	035 - TP - Wood Poles	42,795	0	42,795
013	035	013 - COPS Contracts	035 - TP - Wood Poles	148,993	0	148,993
012	038	012 - Materials	038 - TP - Insulators	2,535	0	2,535
013	038	013 - COPS Contracts	038 - TP - Insulators	11,339	0	11,339
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	1,931	0	1,931
012	039	012 - Materials	039 - TP - O/H Cond.	101	0	101
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	491,313	0	491,313
001	085	001 - Regular Labour (No AO)	085 Design	909	0	909
066	085	066 - Other Goods & Services	085 Design	74,727	0	74,727
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	31,212	0	31,212
			Total Cost:	1,093,542	0	1,093,542
			Original Cost:	122,912		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 49782
Title: L5027B Replacements and Upgrades
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	5	$ 360	$ 1,931		
T&D Labour - Site Supervision	PD	81	$ 385	$ 31,212		
Procurement / Financial Support	Lot	1	$ 909	$ 909		
			Sub-Total	$ 34,051		
012 Materials						
Poles, Anchors and Guys	Lot	1	$ 42,795	$ 42,795		
Insulators	Lot	1	$ 2,535	$ 2,535		
Conductors	Lot	1	$ 101	$ 101		
			Sub-Total	$ 45,431		
013 Contracts						
Contract Line Work	Hrs.	[redacted]		$ 638,046		
Environmental Bridges and Mats	Lot	1	$ 95,625	$ 95,625		
Flagging	Lot	1	$ 5,000	$ 5,000		
Pole-Haulage	Lot	1	$ 4,600	$ 4,600		
Waste Disposal	Lot	1	$ 4,000	$ 4,000		
			Sub-Total	$ 747,271		
066 Other Goods & Services						
Contingency	%	10%	$ 747,271	$ 74,727		
			Sub-Total	$ 74,727		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 17,113		
Vehicle T&D Labour Overtime AO						
			Sub-Total	$ 17,113		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 25,351		
COPS Contract AO				$ 149,596		
				$ -		
			Sub-Total	$ 174,948		
			SUB-TOTAL (no AO, AFUDC)	$ 901,481		
			TOTAL (AO, AFUDC included)	$ 1,093,542		
Original Cost				$ 122,912		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49818

Title: 2017/2018 Transmission Switch & Breaker Replacement

Start Date:	2017/04
In-Service Date:	2017/04
Final Cost Date:	2019/06
Function Class:	Transmission
Forecast Amount:	$1,074,472

DESCRIPTION:

This project provides for replacement of deteriorated circuit breakers and switches on the NS Power transmission system. The project estimate includes the retirement and replacement of 3 x 69kV breakers, 1 x 138kV breaker, 4 x 69kV switches and 4 x 138kV switches. The breakers and switches being replaced will be prioritized based on the Asset Management Program health & criticality parameters: maintenance history, age, number of operations, electrical test results, design or manufacturing issues, inspection results, customers supplied, system redundancy, and safety and environmental issues.

Summary of Related CIs +/- 2 years:
2015 CI 46340 2015 Transmission Switch and Breaker Replacement $1,581,599
2016 CI 48059 2016/2017 Transmission Switch and Breaker Replacement $980,999
2018 CI TBD 2018/2019 Transmission Switch and Breaker Replacement $TBD
2019 CI TBD 20192020 Transmission Switch and Breaker Replacement $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Why do this project?

This project will replace circuit breakers and switches that are deteriorated. The 69kV circuit breakers evaluated for replacement have an average age of greater than 50 years and over 440 operations, and the 138kV circuit breakers considered for replacement have an average age of greater than 43 years and over 1,130 operations. The expected useful life of a breaker is 40 years.

This project is being undertaken primarily to replace end-of-life assets, and is secondarily being undertaken to reduce environmental liability as a result of removing oil filled equipment.

Why do this project now?

Completing this project now will result in mitigating transmission supply interruptions and maintaining reliable operation of the transmission system for customers.

Why do this project this way?

In the majority of cases, spare parts are no longer available for the circuit breakers that are being replaced due to the age of the devices. The breakers being replaced are often oil filled so this project also serves to remove oil filled equipment from the fleet, reducing the environmental liability.

CI Number : 49818 - 2017/2018 Transmission Switch & Breaker Replacement **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		23,310	0	23,310
095		095 - Proj Supp Regular Labour AO		58,307	0	58,307
095		095-COPS Contracts AO		58,588	0	58,588
095		095-COPS Regular Labour AO		34,531	0	34,531
012	003	012 - Materials	003 - TP - Bldg.,Struct.Grnd.	280	0	280
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	27,624	0	27,624
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	25,211	0	25,211
012	022	012 - Materials	022 - TP - Elec Contr.Equip.	50,460	0	50,460
013	022	013 - COPS Contracts	022 - TP - Elec Contr.Equip.	1,000	0	1,000
012	023	012 - Materials	023 - TP - Power Equip.-Station S	5,000	0	5,000
012	039	012 - Materials	039 - TP - O/H Cond.	840	0	840
012	043	012 - Materials	043 - TP - Substn Dev.	295,270	0	295,270
013	043	013 - COPS Contracts	043 - TP - Substn Dev.	264,040	0	264,040
001	085	001 - Proj Supp Regular Labour	085 Design	121,246	0	121,246
001	085	001 - Regular Labour (No AO)	085 Design	7,037	0	7,037
066	085	066 - Other Goods & Services	085 Design	81,794	0	81,794
001	086	001 - T&D Regular Labour	086 Commissioning	18,008	0	18,008
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	1,925	0	1,925
			Total Cost:	1,074,472	0	1,074,472
			Original Cost:	151,961		

Capital Project Detailed Estimate

Location: **Transmission**
CI# / FP#: 49818
Title: 2017 / 2018 Transmission Switch & Breaker Replacement
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	120	$ 360	$ 43,219		
T&D Labour - Site Supervision	PD	5	$ 385	$ 1,925		
Procurement / Financial Support	Lot	1	$ 7,037	$ 7,037		
Project Support AO - Engineering Design	PD	317	$ 382	$ 121,246		
			Sub-Total	$ 173,427		
012 Materials						
Ground Connectors	ea	8	$ 35	$ 280		
Control Cables,		4840	$ 10	$ 48,400		
J Boxes, misc. conduit, cord grip connectors, etc.	lot	1	$ 2,060	$ 2,060		
Conductor		84	$ 10	$ 840		
138 kV Surge Arrester	ea	3	$ 9,000	$ 27,000		
138 kV Circuit Breaker	ea	1	$ 85,000	$ 85,000		
138 kV Switch w/ high velocity whips	ea	4	$ 1,500	$ 6,000		
misc. connectors, coil,	lot	1	$ 6,870	$ 6,870		
69 kV Surge Arrester	ea	12	$ 1,200	$ 14,400		
69 kV Circuit Breaker	ea	3	$ 50,000	$ 150,000		
69 kV Switch w/ high velocity whips	ea	4	$ 1,500	$ 6,000		
Secondary Dist. Panel	lot	1	$ 2,000	$ 2,000		
Secondary Cable		300	$ 10	$ 3,000		
			Sub-Total	$ 351,850		
013 Contracts						
Concrete Foundations for Circuit Breakers	lot	1	$ 27,624	$ 27,624		
Labour for install/remove Circuit Breakers	lot	1	$ 252,040	$ 252,040		
Boom Truck	lot	1	$ 12,000	$ 12,000		
Remove Cable	lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 292,664		
066 Other Goods & Services						
Contingency	%	10%	$ 817,941	$ 81,794		
			Sub-Total	$ 81,794		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 23,310		
			Sub-Total	$ 23,310		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 34,531		
COPS Contract AO				$ 58,588		
Project Support Regular AO				$ 58,307		
			Sub-Total	$ 151,427		
			SUB-TOTAL (no AO, AFUDC)	$ 899,735		
			TOTAL (AO, AFUDC included)	$ 1,074,472		
Original Cost				$ 151,961		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49775

Title: L5004 Replacements and Upgrades

Start Date:	2017/01
In-Service Date:	2017/03
Final Cost Date:	2017/09
Function Class:	Transmission
Forecast Amount:	$995,712

DESCRIPTION:

L5004 is a 13.06 kilometer 69kV transmission line that connects 90H Sackville to 34H Geizer Hill substations. This line was built in 1966. This project is required to replace deteriorated assets and ground clearance violations that have been identified through NS Power's inspection program. This project includes the replacement of assets and addressing of ground clearance violations on approximately 34 structures.

The project scope includes:

- Structure Replacements: 25 Structures
- Timber Arm Replacements: 2 Structures
- Insulator Replacement: 3 Structures
- Other Deteriorated Assets: 4 Structures

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

The transmission inspection program identified deteriorated assets that require replacement to avoid transmission interruptions. Not completing this project would compromise the reliable operation of this line.

Why do this project now?

This work has been prioritized based on transmission inspection results. This project is required to support the reliable operation of the transmission line.

Why do this project this way?

Replacing the existing deteriorated assets is more cost effective than rebuilding the entire line.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 49775 - L5004 Replacements and Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		12,790	0	12,790
094		094 - Interest Capitalized		5,756	0	5,756
095		095-COPS Regular Labour AO		18,948	0	18,948
095		095-COPS Contracts AO		128,028	0	128,028
020	002	020 - Royalties, Easements, App	002 - TP - Land Rights	10,000	0	10,000
013	007	013 - COPS Contracts	007 - TP - Environmental	22,689	0	22,689
012	035	012 - Materials	035 - TP - Wood Poles	80,370	0	80,370
013	035	013 - COPS Contracts	035 - TP - Wood Poles	318,262	0	318,262
012	038	012 - Materials	038 - TP - Insulators	972	0	972
013	038	013 - COPS Contracts	038 - TP - Insulators	10,537	0	10,537
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	2,012	0	2,012
012	039	012 - Materials	039 - TP - O/H Cond.	8,788	0	8,788
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	278,046	0	278,046
001	085	001 - Regular Labour (No AO)	085 Design	1,803	0	1,803
066	085	066 - Other Goods & Services	085 Design	63,953	0	63,953
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	22,759	0	22,759
013	088	013 - COPS Contracts	088 Survey/Mapping	10,000	0	10,000
			Total Cost:	995,712	0	995,712
			Original Cost:	116,236		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 49775
Title: L5004 Replacements and Upgrades
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	6	$ 360	$ 2,012		
T&D Labour - Site Supervision	PD	59	$ 385	$ 22,759		
Procurement / Financial Support	Lot	1	$ 1,803	$ 1,803		
			Sub-Total	$ 26,574		
012 Materials						
Poles, Anchors, and Guys	Lot	1	$ 80,370	$ 80,370		
Insulators	Lot	1	$ 972	$ 972		
Conductor	Lot	1	$ 8,788	$ 8,788		
			Sub-Total	$ 90,129		
013 Contracts						
Contract Line Work	Hrs.	[redacted]		$ 465,245		
Environmental Bridges and Mats	Lot	1	$ 22,689	$ 22,689		
Flagging	Lot	1	$ 25,000	$ 25,000		
Rock break	Lot	1	$ 25,000	$ 25,000		
Pole-Haulage	Lot	1	$ 11,600	$ 11,600		
Waste Disposal	Lot	1	$ 15,000	$ 15,000		
Barge Services	Lot	1	$ 65,000	$ 65,000		
Survey	Lot	1	$ 10,000	$ 10,000		
			Sub-Total	$ 639,534		
020 Easements						
Easements	Lot	1	$ 10,000	$ 10,000		
			Sub-Total	$ 10,000		
066 Other Goods & Services						
Contingency	%	10%	$ 639,534	$ 63,953		
			Sub-Total	$ 63,953		
092 Vehicle Overhead						
Vehicle Regular Labour AO				$ 12,790		
			Sub-Total	$ 12,790		
094 Interest Capitalized						
AFUDC				$ 5,756		
			Sub-Total	$ 5,756		
095 Administrative Overhead						
COPS Contract AO				$ 128,028		
COPS Regular Labour AO				$ 18,948		
			Sub-Total	$ 146,976		
			SUB-TOTAL (no AO, AFUDC)	$ 830,190		
			TOTAL (AO, AFUDC included)	$ 995,712		
Original Cost				$ 116,236		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49776

Title: L7008 Replacements and Upgrades

Start Date: 2017/08
In-Service Date: 2017/09
Final Cost Date: 2018/03
Function Class: Transmission
Forecast Amount: $876,277

DESCRIPTION:

L7008 is an 88.5 kilometer 230kV transmission line that connects 120H Brushy Hill to 99W Bridgewater substations. This line was built in 1984. This project is required to replace deteriorated assets and ground clearance violations that have been identified through NS Power's inspection program. This project includes the replacement of assets and addressing of ground clearance violations on approximately 53 structures.

The project scope includes:

- Structure Replacements: 22 Structures
- Timber Arm Replacements: 16 Structures
- Pole Replacements: 2 Structures
- Pole and Insulator Replacements: 2 Structures
- Insulator Replacement: 1 Structures
- Other Deteriorated Assets: 10 Structures

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

The transmission inspection program identified deteriorated assets that require replacement to avoid transmission interruptions. Not completing this project would compromise the reliable operation of this line.

Why do this project now?

This work has been prioritized based on transmission inspection results. This project is required to support the reliable operation of the transmission line.

Why do this project this way?

Replacing the existing deteriorated assets is more cost effective than rebuilding the entire line.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 49776 - L7008 Replacements and Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		11,920	0	11,920
095		095-COPS Contracts AO		101,152	0	101,152
095		095-COPS Regular Labour AO		17,659	0	17,659
012	035	012 - Materials	035 - TP - Wood Poles	163,091	0	163,091
013	035	013 - COPS Contracts	035 - TP - Wood Poles	398,111	0	398,111
012	038	012 - Materials	038 - TP - Insulators	292	0	292
013	038	013 - COPS Contracts	038 - TP - Insulators	2,107	0	2,107
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	805	0	805
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	95,063	0	95,063
001	085	001 - Regular Labour (No AO)	085 Design	3,268	0	3,268
066	085	066 - Other Goods & Services	085 Design	50,528	0	50,528
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	22,281	0	22,281
013	088	013 - COPS Contracts	088 Survey/Mapping	10,000	0	10,000
			Total Cost:	876,277	0	876,277
			Original Cost:	316,879		

Capital Project Detailed Estimate

Location: **Transmission**
CI# / FP#: 49776
Title: L7008 Replacements and Upgrades
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	2	$ 360	$ 805		
T&D Labour - Site Supervision	PD	58	$ 385	$ 22,281		
Procurement / Financial Support	Lot	1	$ 3,268	$ 3,268		
			Sub-Total	$ 26,354		
012 Materials						
Poles, Anchor, and Guys	Lot	1	$ 163,091	$ 163,091		
Insulators	Lot	1	$ 292	$ 292		
			Sub-Total	$ 163,383		
013 Contracts						
Contract Line Work	Hrs.	[redacted]		$ 455,481		
Flagging	Lot	1	$ 5,000	$ 5,000		
Rockbreak	Lot	1	$ 20,000	$ 20,000		
Pole-Haulage	Lot	1	$ 9,800	$ 9,800		
Waste Disposal	Lot	1	$ 5,000	$ 5,000		
Survey	Lot	1	$ 10,000	$ 10,000		
			Sub-Total	$ 505,281		
066 Other Goods & Services						
Contingency	%	10%	$ 505,281	$ 50,528		
			Sub-Total	$ 50,528		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 11,920		
			Sub-Total	$ 11,920		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 17,659		
COPS Contract AO				$ 101,152		
			Sub-Total	$ 118,811		
			SUB-TOTAL (no AO, AFUDC)	$ 745,546		
			TOTAL (AO, AFUDC included)	$ 876,277		
Original Cost				$ 316,879		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 43200

Title: 2017 Wood Pole Retreatment Program

Start Date: 2017/04
In-Service Date: 2017/11
Final Cost Date: 2018/05
Function Class: Transmission
Amount: $841,821

DESCRIPTION:

This project provides for the cost of re-treatment of approximately 4,900 transmission poles in 2017. This project is the first CI of a multi-year program that will continue beyond 2017.

NS Power carries out a pole retreatment program on transmission class poles. Wood poles originally treated with pentachlorophenol and creosote preservatives are retreated with wood preservatives to reinforce the preservative retention levels in the ground line area to maintain protection against fungal and insect damage.

Summary of Related CIs +/- 2 years:
2018 CI TBD 2018 Wood Pole Retreatment Program $TBD
2019 CI TBD 2019 Wood Pole Retreatment Program $TBD

JUSTIFICATION:

Justification Criteria: Pole Retreatment

Why do this project?

This project is being completed in order to extend the expected life of these 4,900 transmission poles from 35 to 55 years, thus delaying the full replacement of these poles by approximately 20 years.

Why do this project now?

This project should be completed now to ensure the reliable operation of the transmission system.

Why do this project this way?

Pole re-treatment is a proven and accepted cost effective approach to extend the life of the pole. This method is supported by the electric utility industry as demonstrated in research as shown in Attachment 1. The average cost of a pole installation is $4,500 and a retreatment would cost approximately $175. Four retreatments (at 15, 25, 35 and 45 years of service) would extend the expected useful life of the pole from 35 years to 55 years. The average cost per year of service for a pole without retreatment is $129 ($4,500 / 35 years); with a retreatment program the average cost per year of service is reduced to $94.55 ($5,200/ 55 years). Cycle based pole re-treatment is a cost effective way to extend the life of treated wood poles and to defer the replacement of the pole by approximately 20 years.

CI Number : 43200 - 2017 Wood Pole Retreatment Program **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		8,946	0	8,946
095		095 - Proj Supp Regular Labour AO		1,837	0	1,837
095		095-COPS Contracts AO		121,966	0	121,966
095		095-COPS Regular Labour AO		13,252	0	13,252
013	035	013 - COPS Contracts	035 - TP - Wood Poles	609,250	0	609,250
001	085	001 - Proj Supp Regular Labour	085 Design	3,820	0	3,820
001	085	001 - Regular Labour (No AO)	085 Design	2,500	0	2,500
066	085	066 - Other Goods & Services	085 Design	60,925	0	60,925
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	17,325	0	17,325
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
011	087	011 - Travel Expense	087 Field Super.& Ops.	1,000	0	1,000
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	1,000	0	1,000
			Total Cost:	841,821	0	841,821
			Original Cost:			

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 43200
Title: 2017 Wood Pole Retreatment Program
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Site Supervision	PD	45	$ 385	$ 17,325		
Procurement / Financial Support	Lot	1	$ 2,500	$ 2,500		
Project Support AO - Engineering Design	PD	10	$ 382	$ 3,820		
			Sub-Total	$ 23,645		
011 Travel Expense						
Travel - Site Supervisor	Lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000		
013 Contracts						
Pole Retreatment	EA	4874	$ 125	$ 609,250		
			Sub-Total	$ 609,250		
041 Meals & Entertainment						
Meals - Site Supervisor	Lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000		
066 Other Goods & Services						
Contingency				$ 60,925		
			Sub-Total	$ 60,925		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 8,946		
			Sub-Total	$ 8,946		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 13,252		
COPS Contract AO				$ 121,966		
Project Support Regular AO				$ 1,837		
			Sub-Total	$ 137,055		
			SUB-TOTAL (no AO, AFUDC)	$ 695,820		
			TOTAL (AO, AFUDC included)	$ 841,821		
Original Cost				$ -		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 47915

Title: L5053 Replacements and Upgrades

Start Date: 2017/05
In-Service Date: 2017/06
Final Cost Date: 2017/12
Function Class: Transmission
Forecast Amount: $692,706

DESCRIPTION:

L5053 is a 25.38 kilometer 69kV transmission line that connects 92V Michelin to 51V Tremont substations. The majority of this line was built in 1951 with a small portion rebuilt in 1980. This project is required to replace deteriorated assets and ground clearance violations that have been identified through NS Power's inspection program. This project includes the replacement of assets and addressing of ground clearance violations on approximately 30 structures.

The project scope includes:

- Structure Replacements: 14 Structures
- Timber Arm Replacements: 10 Structures
- Insulator Replacement: 1 Structures
- Other Deteriorated Assets: 5 Structures

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

The transmission inspection program identified deteriorated assets that require replacement to avoid transmission interruptions. Not completing this project would compromise the reliable operation of this line.

Why do this project now?

This work has been prioritized based on transmission inspection results. This project is required to support the reliable operation of the transmission line.

Why do this project this way?

Replacing the existing deteriorated assets is more cost effective than rebuilding the entire line.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 47915 - L5053 Replacements and Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		8,413	0	8,413
095		095-COPS Contracts AO		89,386	0	89,386
095		095-COPS Regular Labour AO		12,463	0	12,463
013	007	013 - COPS Contracts	007 - TP - Environmental	18,756	0	18,756
012	035	012 - Materials	035 - TP - Wood Poles	71,153	0	71,153
013	035	013 - COPS Contracts	035 - TP - Wood Poles	175,238	0	175,238
012	038	012 - Materials	038 - TP - Insulators	81	0	81
013	038	013 - COPS Contracts	038 - TP - Insulators	16,800	0	16,800
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	1,342	0	1,342
012	039	012 - Materials	039 - TP - O/H Cond.	2,286	0	2,286
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	221,348	0	221,348
013	040	013 - COPS Contracts	040 - TP - O/H Cond.Devices	9,366	0	9,366
001	085	001 - Regular Labour (No AO)	085 Design	1,470	0	1,470
066	085	066 - Other Goods & Services	085 Design	44,651	0	44,651
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	14,952	0	14,952
013	088	013 - COPS Contracts	088 Survey/Mapping	5,000	0	5,000
			Total Cost:	692,706	0	692,706
			Original Cost:	59,630		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 47915
Title: L5053 Replacements and Upgrades
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	4	$ 360	$ 1,342		
T&D Labour - Site Supervision	PD	39	$ 385	$ 14,952		
Procurement / Financial Support	Lot	1	$ 1,470	$ 1,470		
			Sub-Total	$ 17,764		
012 Materials						
Poles, Anchors, and Guys	Lot	1	$ 71,153	$ 71,153		
Insulators	Lot	1	$ 81	$ 81		
Conductors	Lot	1	$ 2,286	$ 2,286		
			Sub-Total	$ 73,520		
013 Contracts						
Contract Line Work	Hrs	[redacted]		$ 407,552		
Environmental Bridges and Mats	Lot	1	$ 18,756	$ 18,756		
Flagging	Lot	1	$ 4,000	$ 4,000		
Pole-Haulage	Lot	1	$ 8,200	$ 8,200		
Waste Disposal	Lot	1	$ 3,000	$ 3,000		
Survey	Lot	1	$ 5,000	$ 5,000		
			Sub-Total	$ 446,508		
066 Other Goods & Services						
Contingency	%	10%	$ 446,508	$ 44,651		
			Sub-Total	$ 44,651		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 8,413		
			Sub-Total	$ 8,413		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 12,463		
COPS Contract AO				$ 89,386		
			Sub-Total	$ 101,850		
			SUB-TOTAL (no AO, AFUDC)	$ 582,443		
			TOTAL (AO, AFUDC included)	$ 692,706		
Original Cost				$ 59,630		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 47956

Title: L7004 Replacements and Upgrades

Start Date: 2017/07
In-Service Date: 2017/09
Final Cost Date: 2018/03
Function Class: Transmission
Forecast Amount: $672,131

DESCRIPTION:

L7004 is a 131 kilometer (632 Structures) 230 kV transmission line that connects 3C Port Hastings to 91N Dalhousie Mountain Wind Farm substations. A 36 kilometer section was built in 1968-1970; the remaining 95 kilometer section was built in 1979. This project is required to replace deteriorated assets that have been identified through NS Power's inspection program. This project includes the replacement of deteriorated assets on approximately 71 structures.

The project scope includes:

- Structure Replacements: 4 Structures
- Timber Arm Replacements: 14 Structures
- Pole Replacements: 3 Structures
- Pole and Insulator Replacements: 1 Structures
- Insulator Replacement: 45 Structures
- Other Deteriorated Assets: 4 Structures

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

The transmission inspection program identified deteriorated assets that require replacement to avoid transmission interruptions. Not completing this project would compromise the reliable operation of this line.

Why do this project now?

This work has been prioritized based on transmission inspection results. This project is required to support the reliable operation of the transmission line.

Why do this project this way?

Replacing the existing deteriorated assets is more cost effective than rebuilding the entire line.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 47956 - L7004 Replacements and Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		10,303	0	10,303
094		094 - Interest Capitalized		3,647	0	3,647
095		095-COPS Regular Labour AO		15,262	0	15,262
095		095-COPS Contracts AO		85,826	0	85,826
013	007	013 - COPS Contracts	007 - TP - Environmental	33,056	0	33,056
012	035	012 - Materials	035 - TP - Wood Poles	44,568	0	44,568
013	035	013 - COPS Contracts	035 - TP - Wood Poles	141,146	0	141,146
012	038	012 - Materials	038 - TP - Insulators	19,693	0	19,693
013	038	013 - COPS Contracts	038 - TP - Insulators	103,554	0	103,554
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	1,288	0	1,288
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	146,966	0	146,966
001	085	001 - Regular Labour (No AO)	085 Design	1,285	0	1,285
066	085	066 - Other Goods & Services	085 Design	42,872	0	42,872
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	18,665	0	18,665
013	088	013 - COPS Contracts	088 Survey/Mapping	4,000	0	4,000
			Total Cost:	672,131	0	672,131
			Original Cost:	173,262		

Capital Project Detailed Estimate

Location: **Transmission**
CI# / FP#: 47956
Title: L7004 Replacements and Upgrades
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	4	$ 360	$ 1,288		
T&D Labour - Site Supervision	PD	48	$ 385	$ 18,665		
Procurement / Financial Support	Lot	1	$ 1,285	$ 1,285		
			Sub-Total	$ 21,238		
012 Materials						
Poles, Anchors, and Guys	Lot	1	$ 44,568	$ 44,568		
Insulators	Lot	1	$ 19,693	$ 19,693		
			Sub-Total	$ 64,261		
013 Contracts						
Contract Line Work	Hrs	[redacted]		$ 381,567		
Environmental Bridges and Mats	Lot	1	$ 33,056	$ 33,056		
Flagging	Lot	1	$ 6,000	$ 6,000		
Pole-Haulage	Lot	1	$ 2,600	$ 2,600		
Waste Disposal	Lot	1	$ 1,500	$ 1,500		
Survey	Lot	1	$ 4,000	$ 4,000		
			Sub-Total	$ 428,722		
066 Other Goods & Services						
Contingency	%	10%	$ 428,722	$ 42,872		
			Sub-Total	$ 42,872		
094 Interest Capitalized						
AFUDC				$ 3,647		
			Sub-Total	$ 3,647		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 10,303		
			Sub-Total	$ 10,303		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 15,262		
COPS Contract AO				$ 85,826		
			Sub-Total	$ 101,088		
			SUB-TOTAL (no AO, AFUDC)	$ 557,094		
			TOTAL (AO, AFUDC included)	$ 672,131		
Original Cost				$ 173,262		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49792

Title: 2017 Line Retirement Program

Start Date: 2017/01
In-Service Date: 2017/03
Final Cost Date: 2017/09
Function Class: Transmission
Forecast Amount: $526,064

DESCRIPTION:

This project includes the removal of poles, conductor and anchors from decommissioned transmission lines.

L-5503 is a 12.72km 69kV transmission line from 2C Port Hastings to 22C Cleveland substations. This line was decommissioned in 2012 when 22C Cleveland was upgraded from 69kV to 138kV.

L-5536C is a 1km 69kV transmission line from 88W Pleasant Street to 11W King Street substations. This line is no longer required since the 11W King Street Substation was decommissioned in 2016. A large portion of L-5536C has distribution underbuild; those structures will remain. NS Power will be removing approximately 8 structures.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Health & Safety

Why do this project?

These assets will no longer be maintained as they are no longer in service; therefore they must be removed and retired before they become a safety hazard.

Why do this project now?

These 69kV transmission lines are no longer required; therefore, the assets must be removed and retired.

Why do this project this way?

Removal of the line mitigates the liability associated with de-energized and abandoned lines.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 49792 - 2017 Transmission Line Retirement Program **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		8,241	0	8,241
095		095-COPS Regular Labour AO		12,207	0	12,207
095		095-COPS Contracts AO		75,392	0	75,392
013	007	013 - COPS Contracts	007 - TP - Environmental	34,356	0	34,356
013	035	013 - COPS Contracts	035 - TP - Wood Poles	109,065	0	109,065
013	038	013 - COPS Contracts	038 - TP - Insulators	562	0	562
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	232,621	0	232,621
066	085	066 - Other Goods & Services	085 Design	37,660	0	37,660
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	15,959	0	15,959
			Total Cost:	526,064	0	526,064
			Original Cost:	155,410		

Capital Project Detailed Estimate

Location: **Transmission**
CI# / FP#: 49792
Title: 2017 Transmission Line Retirement Program
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Site Supervision	PD	41	$ 385	$ 15,959		
			Sub-Total	$ 15,959		
013 Contracts						
Contract Line Labour	HR	[redacted]		$ 326,248		
Environmental Bridges and Bog Mats	Lot	1	$ 34,356	$ 34,356		
Traffic Control	Lot	1	$ 5,500	$ 5,500		
Waste Disposal	Lot	1	$ 10,500	$ 10,500		
			Sub-Total	$ 376,604		
066 Other Goods & Services						
Contingency	%	10%	$ 376,604	$ 37,660		
			Sub-Total	$ 37,660		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 8,241		
			Sub-Total	$ 8,241		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 12,207		
COPS Contract AO				$ 75,392		
			Sub-Total	$ 87,600		
			SUB-TOTAL (no AO, AFUDC)	$ 430,224		
			TOTAL (AO, AFUDC included)	$ 526,064		
Original Cost				$ 155,410		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49821

Title: Mersey River Hydro Spare Transformer

Start Date:	2017/01
In-Service Date:	2018/03
Final Cost Date:	2018/09
Function Class:	Transmission
Amount:	$519,994

DESCRIPTION:

This project is required to purchase a spare 7.5/10 MVA transformer that can be deployed in the event of a transformer failure on the Mersey River hydro system. A failure of a transformer on the Mersey River hydro system would lead to a loss of Hydro production.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Transmission Plant

Why do this project?

Three transformers (1W-GT1, 2W-GT1, 4W-GT1) on the Mersey River hydro system are over 50 years old and are exhibiting high levels of furan in insulating oil indicating degradation of paper insulation (please refer to Attachment 1 for test results). NS Power does not currently have a spare transformer available for these transformers These Mersey River hydro units generate 88,000 MWh of renewable energy annually. In the case of a failure of one of these three transformers, it could take between six to twelve months to install a replacement transformer, resulting in lost low-cost hydro production. As shown in the attached economic analysis, the purchase of this spare transformer is a more cost effective alternative than the risk of an unplanned transformer failure.

Furthermore, NS Power's Power Transformer Spares Inventory Study recommends that a system with 3-24 transformers in-service have one spare available to achieve the required reliability.

Why do this project now?

These three Mersey River hydro system transformers have all exceeded the estimated useful life of 45 years and test data taken in June 2016 show high levels of furan in the transformer oil. This data indicate a deterioration in the health of these transformers and therefore an increase in the probability of failure.

Why do this project this way?

In the event of a Mersey River hydro transformer failure, the 3P mobile transformer could be deployed. However, with a lead time of 6 to 12 months for a replacement transformer, this would tie up an important asset for an extended period of time. Furthermore, as the 3P mobile has 6 MVA of capacity, it does not have the capability to completely replace 2W-GT1 on the Mersey system.

CI Number : 49821 - Mersey River Hydro Spare Transformer **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		2,854	0	2,854
094		094 - Interest Capitalized		7,491	0	7,491
095		095-COPS Contracts AO		17,316	0	17,316
095		095 - Proj Supp Regular Labour AO		4,041	0	4,041
095		095-COPS Regular Labour AO		4,228	0	4,228
012	007	012 - Materials	007 - TP - Environmental	28,000	0	28,000
013	007	013 - COPS Contracts	007 - TP - Environmental	18,000	0	18,000
012	044	012 - Materials	044 - TP - Substn.Transf.	285,360	0	285,360
013	044	013 - COPS Contracts	044 - TP - Substn.Transf.	68,500	0	68,500
001	085	001 - Proj Supp Regular Labour	085 Design	8,404	0	8,404
001	085	001 - Regular Labour (No AO)	085 Design	6,267	0	6,267
028	085	028 - Consulting	085 Design	20,000	0	20,000
066	085	066 - Other Goods & Services	085 Design	44,006	0	44,006
001	086	001 - T&D Regular Labour	086 Commissioning	3,602	0	3,602
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	1,925	0	1,925
			Total Cost:	519,994	0	519,994
			Original Cost:			

Capital Project Detailed Estimate

Location: **Transmission**
CI# / FP#: 49821
Title: Mersey Hydro System Spare Transformer
Execution Year: 2017 - 2018

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	10	$ 360	$ 3,602		
T&D Labour - Site Supervision	PD	5	$ 385	$ 1,925		
Procurement / Financial Support	Lot	1	$ 6,267	$ 6,267		
Project Support AO - Engineering Design	PD	22	$ 382	$ 8,404		
			Sub-Total	$ 20,198		
012 Materials						
PVC oil containment	lot	1	$ 28,000	$ 28,000		
69-6.9 kV Hydro GT (4-10 MVA ONAN)	ea	1	$ 270,000	$ 270,000		
LV and HV Bushings	ea	6	$ 2,560	$ 15,360		
			Sub-Total	$ 313,360		
013 Contracts						
Oil/Water Separator Installment	lot	1	$ 18,000	$ 18,000		
Transformer Transport and Placement	lot	1	$ 41,000	$ 41,000		
Transformer Assembly	lot	1	$ 27,500	$ 27,500		
			Sub-Total	$ 86,500		
028 Consulting						
Transformer Inspections & Witnessing of Tests	lot	1	$ 20,000	$ 20,000		
			Sub-Total	$ 20,000		
066 Other Goods & Services						
Contingency	%	10%	$ 440,058	$ 44,006		
			Sub-Total	$ 44,006		
094 Interest Capitalized						
AFUDC				$ 7,491		
			Sub-Total	$ 7,491		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 2,854		
			Sub-Total	$ 2,854		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 4,228		
COPS Contract AO				$ 17,316		
Project Support Regular AO				$ 4,041		
			Sub-Total	$ 25,586		
			SUB-TOTAL (no AO, AFUDC)	$ 484,063		
			TOTAL (AO, AFUDC included)	$ 519,994		
Original Cost				$ -		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

Mersey River Hydro Spare Transformer
Summary of Alternatives

Nova Scotia POWER An Emera Company

Division :	Transmission	**Date :**	**28-Oct-16**
Department :		**CI Number:**	49821
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Purchase Spare Transformer vs Avoid	5.90%	-1,977,991	1,432,862	1	55.24%	3.1 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

Recommendation :

It is recommended to purchase this spare transformer in order to mitigate the risk of losing valuable renewable generation that would have to be replaced with more costly generation.

Notes/Comments :

Purchase Spare Transformer vs Avoided Fuel Costs

This alternative assumes in the event of a failure of one of the three transformers, NS Power will be able to install a mobile substation as a spare for 6 months of the 12 months it would take to procure and install a new or refurbished transformer into the site. The average annual generation from the three hydro plants served by these transformers is 88,000 MWH. The average of the three plants is 29,333 MWH, and six months of generation is then 14,667 MWH

Test 2

Test 3

Test 4

Mersey River Hydro Spare Transformer
Summary of Sensitivities

Nova Scotia POWE
An Emera Compa

Division :	Transmission	**Date :**	**28-Oct-16**
Department :		**CI Number:**	49821
		Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Purchase Spare Transformer vs Avoided Fuel Co	5.90%	-1,977,991	1,432,862	1	55.24%	3.1 years
B	Test 2	5.90%	0	0	2	#NUM!	0.0 years
C	Test 3	5.90%	0	0	2	#NUM!	0.0 years
D	Test 4	5.90%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Purchase Spare Transformer vs Avoided Fuel Co	10%	-1,933,070	1,396,411	1	49.98%	3.4 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years

Change:		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
	A	44,921	-36,450	0	-5.26%	0.2 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Purchase Spare Transformer vs Avoided Fuel Co	-10%	-1,735,271	1,253,125	1	49.46%	3.4 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years

Change:		PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
	A	242,720	-179,737	0	-5.78%	0.3 years
	B	0	0	0	#NUM!	0.0 years
	C	0	0	0	#NUM!	0.0 years
	D	0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	36,147	118,264	268,745	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

Mersey River Hydro Spare Transformer
Avoided Cost Calculations

Division :	Transmission	**Date :**	**28-Oct-16**
Department :		**CI Number:**	49821
		Project No. :	

Purchase Spare Transformer vs Avoided Fuel Costs

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	10%	20%	10%	20%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	14667.0	14667.0				
Duration (Hours or Years)	1	1				
Totals	$61,186	$117,079	$0	$0	$61,186	$117,079

Total Capital Cost of Alternative **$519,994**

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative **$0**

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative **$0**

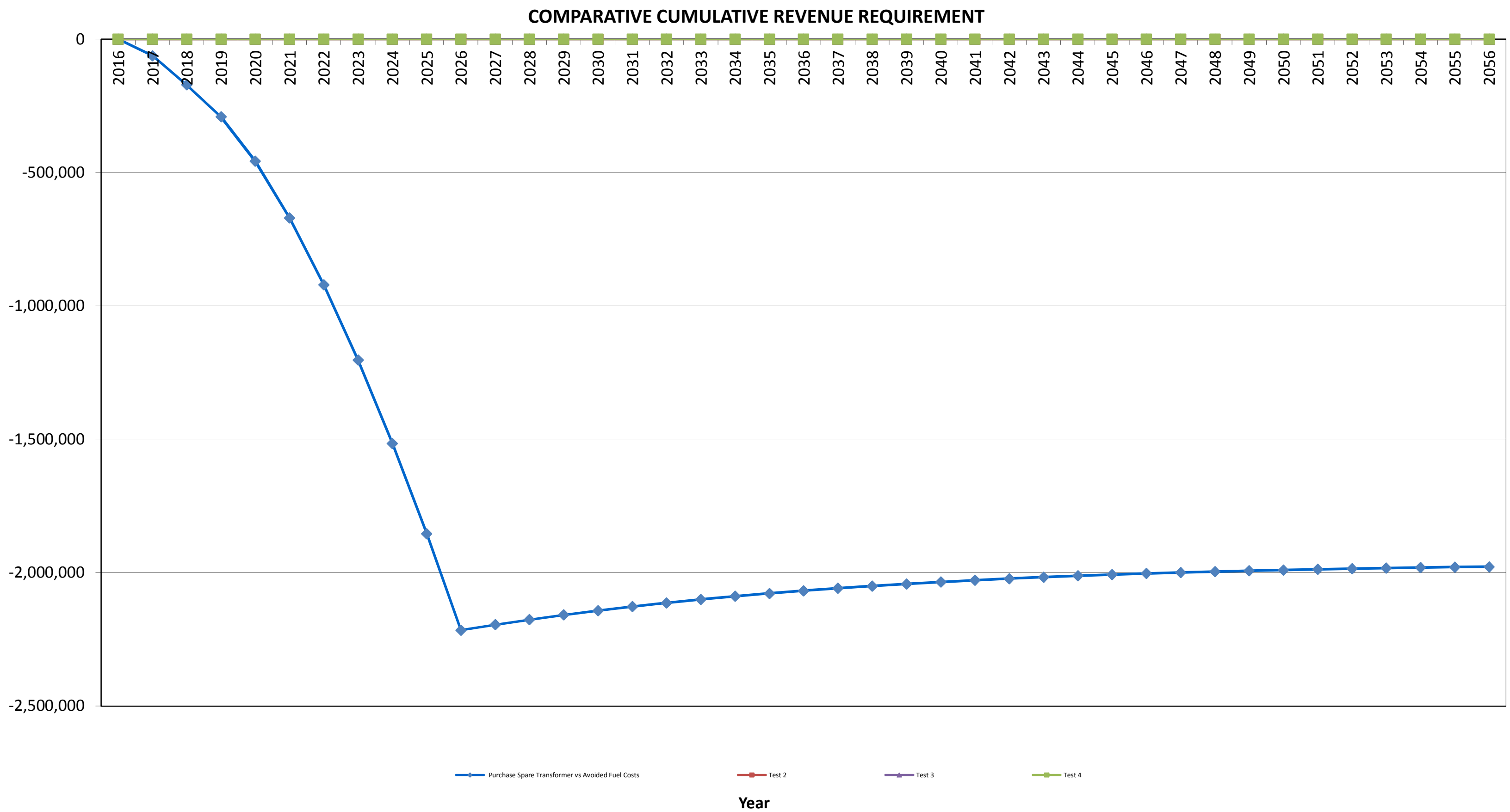
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0.0	0.0				
Duration (Hours or Years)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative **$0**

Mersey River Hydro Spare Transformer
Purchase Spare Transformer vs Avoided Fuel Costs

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2016	-	-	-	-	-	-	-	-	-	-	1.00	-
2017	-	-	61,186.4	(97,415.7)	-	-	(36,229.3)	(18,967.8)	(55,197.1)	(52,121.9)	0.94	(52,121.9)
2018	-	-	117,078.7	(394,139.1)	19,362.5	472,550.5	(277,060.4)	(30,292.0)	(307,352.4)	(274,059.4)	0.89	(326,181.3)
2019	-	-	189,147.0	-	37,176.1	434,063.9	189,147.0	(47,111.0)	142,036.0	119,594.3	0.84	(206,587.0)
2020	-	-	261,130.1	-	34,202.0	398,656.2	261,130.1	(70,347.7)	190,782.4	151,689.1	0.80	(54,897.8)
2021	-	-	341,706.7	-	31,465.8	366,081.2	341,706.7	(96,174.7)	245,532.0	184,343.7	0.75	129,445.9
2022	-	-	418,249.0	-	28,948.6	336,112.1	418,249.0	(120,683.1)	297,565.9	210,963.5	0.71	340,409.4
2023	-	-	497,716.3	-	26,632.7	308,540.6	497,716.3	(146,035.9)	351,680.4	235,437.9	0.67	575,847.3
2024	-	-	580,195.0	-	24,502.1	283,174.8	580,195.0	(172,264.8)	407,930.2	257,880.3	0.63	833,727.6
2025	-	-	665,773.7	-	22,541.9	259,838.3	665,773.7	(199,401.9)	466,371.9	278,399.7	0.60	1,112,127.3
2026	-	-	754,543.6	-	20,738.6	238,368.7	754,543.6	(227,479.6)	527,064.0	297,100.8	0.56	1,409,228.0
2027	-	-	-	-	19,079.5	218,616.6	-	5,914.6	5,914.6	3,148.3	0.53	1,412,376.3
2028	-	-	-	-	17,553.1	200,444.8	-	5,441.5	5,441.5	2,735.0	0.50	1,415,111.4
2029	-	-	-	-	16,148.9	183,726.6	-	5,006.1	5,006.1	2,376.1	0.47	1,417,487.4
2030	-	-	-	-	14,857.0	168,346.0	-	4,605.7	4,605.7	2,064.2	0.45	1,419,551.6
2031	-	-	-	-	13,668.4	154,195.7	-	4,237.2	4,237.2	1,793.2	0.42	1,421,344.8
2032	-	-	-	-	12,574.9	141,177.5	-	3,898.2	3,898.2	1,557.9	0.40	1,422,902.7
2033	-	-	-	-	11,568.9	129,200.8	-	3,586.4	3,586.4	1,353.4	0.38	1,424,256.1
2034	-	-	-	-	10,643.4	118,182.2	-	3,299.5	3,299.5	1,175.8	0.36	1,425,431.9
2035	-	-	-	-	9,791.9	108,045.1	-	3,035.5	3,035.5	1,021.4	0.34	1,426,453.3
2036	-	-	-	-	9,008.6	98,718.9	-	2,792.7	2,792.7	887.4	0.32	1,427,340.6
2037	-	-	-	-	8,287.9	90,138.8	-	2,569.2	2,569.2	770.9	0.30	1,428,111.5
2038	-	-	-	-	7,624.9	82,245.2	-	2,363.7	2,363.7	669.7	0.28	1,428,781.2
2039	-	-	-	-	7,014.9	74,983.0	-	2,174.6	2,174.6	581.8	0.27	1,429,363.0
2040	-	-	-	-	6,453.7	68,301.8	-	2,000.6	2,000.6	505.4	0.25	1,429,868.5
2041	-	-	-	-	5,937.4	62,155.1	-	1,840.6	1,840.6	439.1	0.24	1,430,307.6
2042	-	-	-	-	5,462.4	56,500.2	-	1,693.3	1,693.3	381.5	0.23	1,430,689.0
2043	-	-	-	-	5,025.4	51,297.6	-	1,557.9	1,557.9	331.4	0.21	1,431,020.4
2044	-	-	-	-	4,623.4	46,511.3	-	1,433.2	1,433.2	287.9	0.20	1,431,308.3
2045	-	-	-	-	4,253.5	42,107.8	-	1,318.6	1,318.6	250.1	0.19	1,431,558.4
2046	-	-	-	-	3,913.2	38,056.7	-	1,213.1	1,213.1	217.3	0.18	1,431,775.7
2047	-	-	-	-	3,600.2	34,329.6	-	1,116.1	1,116.1	188.8	0.17	1,431,964.5
2048	-	-	-	-	3,312.2	30,900.7	-	1,026.8	1,026.8	164.0	0.16	1,432,128.4
2049	-	-	-	-	3,047.2	27,746.1	-	944.6	944.6	142.5	0.15	1,432,270.9
2050	-	-	-	-	2,803.4	24,843.8	-	869.1	869.1	123.8	0.14	1,432,394.7
2051	-	-	-	-	2,579.1	22,173.8	-	799.5	799.5	107.5	0.13	1,432,502.2
2052	-	-	-	-	2,372.8	19,717.3	-	735.6	735.6	93.4	0.13	1,432,595.6
2053	-	-	-	-	2,183.0	17,457.4	-	676.7	676.7	81.1	0.12	1,432,676.7
2054	-	-	-	-	2,008.3	15,378.3	-	622.6	622.6	70.5	0.11	1,432,747.2
2055	-	-	-	-	1,847.7	13,465.5	-	572.8	572.8	61.2	0.11	1,432,808.5
2056	-	-	-	-	1,699.9	11,705.7	-	527.0	527.0	53.2	0.10	1,432,861.7
Total	**-**	**-**	**3,886,726.5**	**(491,554.8)**	**464,515.3**		**3,395,171.7**	**(1,060,885.5)**	**2,334,286.2**	**1,432,861.7**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
-500,000
-1,000,000
-1,500,000
-2,000,000
-2,500,000
2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056
Purchase Spare Transformer vs Avoided Fuel Costs
Test 2
Test 3
Test 4
Year

1W-GT1 Fluid Report (1 of 3)

Fluid Analysis Report

Serial No.	188701	*Tank*	MAIN
Apparatus type	TRN	*Norms used*	TRN_IEEE_69_288KV
Owner	CNS15	*DGA result*	1/1
Substation	Upper Lake Falls No.1 Hydro	*Fluid condition*	1/2
Designation	1W-GT1	*Moisture code*	2/2
Norms	TRN_IEEE_69_288KV	*PCB result code*	0/0
Fluid type	oil	*Oil test status*	UNREVIEWED

Remarks

1W-GT1 MAIN TANK

Gas Analysis

Lab Report Number	N/A	N/A	N/A	N/A	
Sample date	2015-05-04 00:00:00	2015-05-04 00:00:00	2013-04-16 00:00:00	2011-11-01 07:20:00	2011-06-0
Fluid temp	24	24	40	30	
Hydrogen (H2)	0	0	0	15	
Methane (CH4)	0	0	0	0	
Ethane (C2H6)	0.0	2.0	3.0	0.0	
Ethylene (C2H4)	0.0	8.0	8.0	6.0	
Acetylene (C2H2)	0.0	0.0	0.0	0.0	
Carbon Monoxide (CO)	0	316	242	491	
Propylene (C3H6)	0	0	0	0	
Carbon Dioxide (CO2)	0	5110	4280	6540	
Oxygen (O2)	0	27500	26500	22800	
Nitrogen (N2)	0	68900	62000	62200	
Total heat gas	0	10			
TDCG	0	326			
Equivalent TCG		0.271			
Total partial press		95.5			
Est. safe handling limit		12.4			
Calculated monitor ppm	0	57			
CO2/CO		16.171			
Oxygen/Nitrogen (O2/N2)		0.399			
Normalized Energy Intensity	0.00	0.05			
DGA retest days	365	365			
DGA retest date	2016-05-03	2016-05-03			2
DGA reference days	0.0	748.0			
DGA result	1	1			

Gas Analysis Remarks

(Initial sample). No anomalies.

1W-GT1 Fluid Report (2 of 3)

Fluid Quality

Lab Report Number	N/A
Sample date	2015-05-04 00:00:00
Fluid temp	30
Dielectric breakdown D1816 (2 mm)	26.0
Acid number	0.140
Interfacial tension	17.6
Specific Gravity	0.883
Color	3.5
Oil quality index	8.0
Visual	CLEAR
Fluid condition	2
Fluid diagnosis	CONTAMINATED

Fluid Quality Analysis Remarks

Low breakdown kV. There may be polar contaminants or excessive moisture. Consider reclaiming the oil.

Fluid Quality Summary

Variable name	Value	Units	Description
Dielectric breakdown D1816 (2 mm)	26.0	kV	Level alert (low 45.0).
Interfacial tension	17.6	mN/m	Level alert (low 26.0, 16.0).

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d1816_2* ift*
```

Moisture Analysis

Lab Report Number	N/A	N/A	N/A	N/A	I080-6
Sample date	2015-05-04 00:00:00	2013-04-16 00:00:00	2011-07-08 14:57:00	2009-05-25 10:00:00	2006-02-22
Fluid temp	30	37	43	38	30
Moisture	20	15	20	27	12
Relative saturation	24				14
Dew point	-1				-11
Moisture code	1				1

Moisture Remarks

The water content of the oil is acceptable.

1W-GT1 Fluid Report (3 of 3)

Furans

Lab Report Number	N/A
Sample date	2015-05-04 00:00:00
Fluid temp	30
2-furfural (2FAL)	796
5-methyl-2-furfural (5M2F)	18
5-hydroxymethyl-2-furfural (5H2F)	0
Furfuryl alcohol (2FOL)	0
2-acetylfuran (2ACF)	0
Estimated degree of polymerization	460
Furan result code	3

Furan Analysis Remarks

High 2FAL. There may be significant paper deterioration. Watch for any signs that total furan may be increasing.

Furan Analysis Summary

Variable name	Value	Units	Description
2-furfural (2FAL)	796	ppb	Level warn (high 100, 250, 1000).

`furfural**`

2W-GT1 Fluid Report (1 of 3)

Fluid Analysis Report

Serial No.	285580	*Tank*	MAIN
Apparatus type	TRN	*Norms used*	TRN_IEEE_69_288KV
Owner	CNS15	*DGA result*	1/1
Substation	Lower Lake Falls No. 2 Hydro	*Fluid condition*	0/2
Designation	2W-GT1	*Moisture code*	1/1
Norms	TRN_IEEE_69_288KV	*PCB result code*	0/0
Fluid type	oil	*Oil test status*	UNREVIEWED

Remarks

2W-GT1 MAIN TANK

Gas Analysis

Lab Report Number	N/A	N/A	N/A	N/A	
Sample date	2015-05-04 00:00:00	2015-05-04 00:00:00	2013-04-16 00:00:00	2011-07-08 14:57:00	2009-05-
Fluid temp	30	30	37	43	
Hydrogen (H2)	0	20	20	50	
Methane (CH4)	0	0	0	0	
Ethane (C2H6)	0.0	0.0	0.0	0.0	
Ethylene (C2H4)	0.0	0.0	0.0	0.0	
Acetylene (C2H2)	0.0	0.0	0.0	0.0	
Carbon Monoxide (CO)	0	303	262	429	
Propylene (C3H6)	0	0	0	0	
Carbon Dioxide (CO2)	0	2600	2310	3110	
Oxygen (O2)	0	24300	26300	20400	
Nitrogen (N2)	0	61600	67000	64400	
Total heat gas	0	0			
TDCG	0	323			
Equivalent TCG		0.338			
Total partial press		83.0			
Est. safe handling limit		9.7			
Calculated monitor ppm	0	75			
CO2/CO		8.581			
Oxygen/Nitrogen (O2/N2)		0.394			
Normalized Energy Intensity	0.00	0.00			
DGA retest days	365	365			
DGA retest date	2016-05-03	2016-05-03			
DGA reference days	0.0	748.0			
DGA result	1	1			

Gas Analysis Remarks

(Initial sample). No anomalies.

2W-GT1 Fluid Report (2 of 3)

Fluid Quality

Lab Report Number	N/A
Sample date	2015-05-04 00:00:00
Fluid temp	30
Dielectric breakdown D1816 (2 mm)	26.0
Acid number	0.140
Interfacial tension	17.6
Specific Gravity	0.883
Color	3.5
Oil quality index	8.0
Visual	CLEAR
Fluid condition	2
Fluid diagnosis	CONTAMINATED

Fluid Quality Analysis Remarks

Low breakdown kV. There may be polar contaminants or excessive moisture. Consider reclaiming the oil.

Fluid Quality Summary

Variable name	Value	Units	Description
Dielectric breakdown D1816 (2 mm)	26.0	kV	Level alert (low 45.0).
Interfacial tension	17.6	mN/m	Level alert (low 26.0, 16.0).

d1816_2* ift*

Moisture Analysis

Lab Report Number	N/A	N/A	N/A	N/A	I080-6
Sample date	2015-05-04 00:00:00	2013-04-16 00:00:00	2011-07-08 14:57:00	2009-05-25 10:00:00	2006-02-22
Fluid temp	30	37	43	38	30
Moisture	20	15	20	27	12
Relative saturation	24				14
Dew point	-1				-11
Moisture code	1				1

Moisture Remarks

The water content of the oil is acceptable.

2W-GT1 Fluid Report (3 of 3)

Furans

Lab Report Number	N/A
Sample date	2015-05-04 00:00:00
Fluid temp	30
2-furfural (2FAL)	796
5-methyl-2-furfural (5M2F)	18
5-hydroxymethyl-2-furfural (5H2F)	0
Furfuryl alcohol (2FOL)	0
2-acetylfuran (2ACF)	0
Estimated degree of polymerization	460
Furan result code	3

Furan Analysis Remarks

High 2FAL. There may be significant paper deterioration. Watch for any signs that total furan may be increasing.

Furan Analysis Summary

Variable name	Value	Units	Description
2-furfural (2FAL)	796	ppb	Level warn (high 100, 250, 1000).

`furfural**`

4W-GT1 Fluid Report (1 of 3)

Fluid Analysis Report

Serial No.	197961	*Tank*	MAIN
Apparatus type	TRN	*Norms used*	TRN_IEEE_69_288KV
Owner	CNS15	*DGA result*	1/1
Substation	Lower Great Brook No. 4 Hydro	*Fluid condition*	0/2
Designation	4W-GT1	*Moisture code*	2/1
Norms	TRN_IEEE_69_288KV	*PCB result code*	0/0
Fluid type	oil	*Oil test status*	UNREVIEWED

Remarks

4W-GT1 MAIN TANK

Gas Analysis

Lab Report Number	N/A	N/A	N/A	N/A	
Sample date	2015-05-04 00:00:00	2015-05-04 00:00:00	2013-04-16 00:00:00	2011-06-06 12:24:00	2009-05-:
Fluid temp	30	30	35	57	
Hydrogen (H2)	0	30	30	55	
Methane (CH4)	0	0	0	0	
Ethane (C2H6)	0.0	4.0	3.0	4.0	
Ethylene (C2H4)	0.0	8.0	6.0	11.0	
Acetylene (C2H2)	0.0	0.0	0.0	0.0	
Carbon Monoxide (CO)	0	378	347	398	
Propylene (C3H6)	0	0	0	0	
Carbon Dioxide (CO2)	0	4610	5070	4980	
Oxygen (O2)	0	21700	23000	21100	
Nitrogen (N2)	0	68300	65700	77100	
Total heat gas	0	12			
TDCG	0	420			
Equivalent TCG		0.405			
Total partial press		89.1			
Est. safe handling limit		9.3			
Calculated monitor ppm	0	98			
CO2/CO		12.196			
Oxygen/Nitrogen (O2/N2)		0.318			
Normalized Energy Intensity	0.00	0.05			
DGA retest days	365	365			
DGA retest date	2016-05-03	2016-05-03			
DGA reference days	0.0	748.0			
DGA result	1	1			

Gas Analysis Remarks

(Initial sample). No anomalies.

4W-GT1 Fluid Report (2 of 3)

Fluid Quality

Lab Report Number	N/A
Sample date	2015-05-04 00:00:00
Fluid temp	30
Dielectric breakdown D1816 (2 mm)	31.0
Acid number	0.270
Interfacial tension	17.8
Specific Gravity	0.867
Color	2.5
Oil quality index	15.2
Visual	CLEAR
Fluid condition	2
Fluid diagnosis	OXIDIZED

Fluid Quality Analysis Remarks

High oil acidity. Low IFT. Low breakdown kV. Consider reclaiming the oil.

Fluid Quality Summary

Variable name	Value	Units	Description
Dielectric breakdown D1816 (2 mm)	31.0	kV	Level alert (low 45.0).
Acid number	0.270	mg KOH/g	Level alert (high 0.200, 0.500).
Interfacial tension	17.8	mN/m	Level alert (low 26.0, 16.0).

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d1816_2* acidnum* ift*
```

Moisture Analysis

Lab Report Number	N/A	N/A	N/A	N/A	L181-5
Sample date	2015-05-04 00:00:00	2013-04-16 00:00:00	2011-06-06 12:24:00	2009-05-25 09:37:00	2007-05-10
Fluid temp	30	35	57	36	
Moisture	21	18	32	24	30
Relative saturation	25				
Dew point	-0				7
Moisture code	1				2
Moisture diagnosis					WET-OIL

Moisture Remarks

The water content of the oil is acceptable.

4W-GT1 Fluid Report (3 of 3)

Furans

Lab Report Number	N/A
Sample date	2015-05-04 00:00:00
Fluid temp	30
2-furfural (2FAL)	796
5-methyl-2-furfural (5M2F)	81
5-hydroxymethyl-2-furfural (5H2F)	0
Furfuryl alcohol (2FOL)	0
2-acetylfuran (2ACF)	20
Estimated degree of polymerization	460
Furan result code	3

Furan Analysis Remarks

High 2FAL. There may be significant paper deterioration. Watch for any signs that total furan may be increasing.

Furan Analysis Summary

Variable name	Value	Units	Description
2-furfural (2FAL)	796	ppb	Level warn (high 100, 250, 1000).

furfural**

CI Number: 49878

Title: 2017 Substation Insulator Replacement Program

Start Date:	2017/02
In-Service Date:	2017/02
Final Cost Date:	2018/05
Function Class:	Transmission
Forecast Amount:	$508,893

DESCRIPTION:

The aim of this project is to identify the remaining installations of these insulators at substations, and remove them from service, replacing them with new insulators. This budget is based on replacing 973 substation insulators.

The increase in investment from 2016 to 2017 is due to identification of additional Canadian Porcelain and Canadian Ohio Brass Insulators during substation inspections throughout 2016.

Summary of Related CIs +/- 2 years:
2016 CI 48151 2016 Substation Insulator Replacement Program $244,828
2018 CI TBD 2018 Substation Insulator Replacement Program $TBD
2019 CI TBD 2019 Substation Insulator Replacement Program $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Why do this project?

In past years, NS Power has experienced reliability issues with strain insulators manufactured by Canadian Porcelain and Canadian Ohio Brass. These insulators are vulnerable to cement growth, an issue in which the cement used to seal the insulator begins to absorb moisture and swell, eventually leading to electrical and mechanical failure. These insulators can be found inside substations and on transmission lines, where failure can lead to lines being dropped to the ground, or on energized equipment, potentially leading to extensive outages and/or damage to equipment.

These insulators are well known in the industry for being prone to failure. Replacing them proactively will prevent unnecessary outages and damage to equipment.

Why do this project now?

These insulators have been known to be an issue within the utility industry for several years. There have been similar programs in the past aimed at identifying and removing insulators of this type, however several installations at substations have been identified and should be replaced as soon as possible to avoid unnecessary outages.

Why do this project this way?

Replacing the existing defective insulators with the new insulators is the only option.

The contracts portion of this project will be sourced through NS Power’s existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power’s workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 49878 - 2017 Substation Insulator Replacement Program **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D OT Labour AO		7,313	0	7,313
092		092-Vehicle T&D Reg. Labour AO		38,268	0	38,268
095		095-COPS Regular Labour AO		56,690	0	56,690
095		095-COPS Contracts AO		11,111	0	11,111
095		095-COPS Overtime Labour AO		10,833	0	10,833
001	038	001 - T&D Regular Labour	038 - TP - Insulators	25,673	0	25,673
002	038	002 - T&D Overtime Labour	038 - TP - Insulators	12,837	0	12,837
011	038	011 - Travel Expense	038 - TP - Insulators	2,550	0	2,550
012	038	012 - Materials	038 - TP - Insulators	13,696	0	13,696
014	038	014 - Overtime Meals	038 - TP - Insulators	1,050	0	1,050
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	48,440	0	48,440
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	15,487	0	15,487
011	043	011 - Travel Expense	043 - TP - Substn Dev.	5,100	0	5,100
012	043	012 - Materials	043 - TP - Substn Dev.	162,060	0	162,060
013	043	013 - COPS Contracts	043 - TP - Substn Dev.	55,500	0	55,500
014	043	014 - Overtime Meals	043 - TP - Substn Dev.	2,100	0	2,100
041	043	041 - Meals & Entertainment	043 - TP - Substn Dev.	1,700	0	1,700
001	085	001 - Regular Labour (No AO)	085 Design	3,515	0	3,515
066	085	066 - Other Goods & Services	085 Design	34,971	0	34,971
			Total Cost:	508,893	0	508,893
			Original Cost:	51,924		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 49878
Title: 2017 Substation Insulator Replacement Program
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	206	$ 360	$ 74,113		
Procurement / Financial Support	Lot	1	$ 3,515	$ 3,515		
			Sub-Total	$ 77,628		
002 OT Labour						
T&D Labour - Electrician/Technician	PD	39	$ 720	$ 28,324		
			Sub-Total	$ 28,324		
011 Travel Expense						
Travel	Lot	1	$ 7,650	$ 7,650		
			Sub-Total	$ 7,650		
012 Materials						
Insulators	Lot	1	$ 82,068	$ 82,068		
Connectors	Lot	1	$ 68,688	$ 68,688		
Jumper Wire	Lot	1	$ 25,000	$ 25,000		
			Sub-Total	$ 175,756		
013 Contracts						
Contract Line Labour	HR	168	$ 197	$ 33,100		
Boom Truck	Lot	1	$ 22,400	$ 22,400		
			Sub-Total	$ 55,500		
014 Overtime Meals						
Overtime Meals	Lot	1	$ 3,150	$ 3,150		
			Sub-Total	$ 3,150		
041 Meals & Entertainment						
Meals	Lot	1	$ 1,700	$ 1,700		
			Sub-Total	$ 1,700		
066 Other Goods & Services						
Contingency	%	10%	$ 349,708	$ 34,971		
			Sub-Total	$ 34,971		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 38,268		
Vehicle T&D Labour Overtime AO				$ 7,313		
			Sub-Total	$ 45,581		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 56,690		
COPS T&D Labour Overtime AO				$ 10,833		
COPS Contract AO				$ 11,111		
			Sub-Total	$ 78,633		
			SUB-TOTAL (no AO, AFUDC)	$ 384,679		
			TOTAL (AO, AFUDC included)	$ 508,893		
Original Cost				$ 51,924		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 48057

Title: Replace 69kV cables between 2S and 83S

Start Date:	2017/01
In-Service Date:	2017/10
Final Cost Date:	2018/04
Function Class:	Transmission
Amount:	$459,931

DESCRIPTION:

This project involves replacement of the 69 kV power cables which connect the 83S Victoria Junction Gas Turbines to the 2S Victoria Junction substation. The cables are required to supply power to the 2S substation when the Gas Turbines are required to operate. The expected useful life of these cables is 30 years and the existing cables are approximately 40 years old and are showing signs of deterioration. There are two circuits that need to be replaced, one for each of the two Gas Turbines located at Victoria Junction. The Victoria Junctions Gas Turbines are rated at 30MW each and serve the system with peaking capacity and black start capability. The total length of conductor that needs to be replaced is approximately 1,800 metres.

Summary of Related CIs +/- 2 years:
No other projects 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Deteriorated Conductor

Why do this project?

This project should be completed to ensure a reliable connection between the Gas Turbines and the substation. The existing cables are 40 years old and showing signs of deterioration. Not completing this work could result in a cable failure which would lead to the Gas Turbines being unavailable.

Why do this project now?

This project should be completed now because the cables have exceeded their expected useful life of 30 years by 10 years. These cables are not subjected to a harsh environment or operation and therefore remained in acceptable condition past their expected useful life. However, the cables are now showing signs of deterioration and replacing them now reduces the likelihood of an unplanned failure and improves reliability, ensuring that the gas turbines will be available when required.

Why do this project this way?

Direct cable replacement is the best option because the existing infrastructure (cable trenches and tray) are still in good condition and can be utilized. Using this route will minimize engineering effort, as the design and cable pathway are already established and proven.

CI Number : 48057 - Replace 69kV cables between 2S and 83S **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		18,966	0	18,966
094		094 - Interest Capitalized		4,504	0	4,504
095		095 - Proj Supp Regular Labour AO		4,206	0	4,206
095		095-COPS Contracts AO		1,722	0	1,722
095		095-COPS Regular Labour AO		28,095	0	28,095
001	046	001 - T&D Regular Labour	046 - TP - U/G Conductor	21,609	0	21,609
012	046	012 - Materials	046 - TP - U/G Conductor	300,300	0	300,300
013	046	013 - COPS Contracts	046 - TP - U/G Conductor	2,000	0	2,000
001	085	001 - Proj Supp Regular Labour	085 Design	8,747	0	8,747
001	085	001 - Regular Labour (No AO)	085 Design	6,006	0	6,006
011	085	011 - Travel Expense	085 Design	370	0	370
041	085	041 - Meals & Entertainment	085 Design	100	0	100
066	085	066 - Other Goods & Services	085 Design	36,585	0	36,585
001	086	001 - T&D Regular Labour	086 Commissioning	15,121	0	15,121
012	086	012 - Materials	086 Commissioning	5,000	0	5,000
013	087	013 - COPS Contracts	087 Field Super.& Ops.	6,600	0	6,600
			Total Cost:	459,931	0	459,931
			Original Cost:	95,606		

Capital Project Detailed Estimate

Location: **Transmission**
CI# / FP#: 48057
Title: Replace 69kV Cables Between 2S and 83S
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - PLT	PD	88	$ 367	$ 32,408		
T&D Labour - Electrician/Technician	PD	12	$ 360	$ 4,322		
Procurement / Financial Support	lot	1	$ 6,006	$ 6,006		
Project Support AO - Engineering Design	PD	23	$ 382	$ 8,747		
			Sub-Total	$ 51,483		
011 Travel Expense						
Engineering Design		1	$ 370	$ 370		
			Sub-Total	$ 370		
012 Materials						
69 kV Terminators	ea	12	$ 2,000	$ 24,000		
69 kV Cable	m	1830	$ 150	$ 274,500		
Support Brackets etc..	lot	12	$ 150	$ 1,800		
Miscellaneous Materials	lot	1	$ 5,000	$ 5,000		
			Sub-Total	$ 305,300		
013 Contracts						
Rental of Pulley and Misc. Equipment	lot	1	$ 2,000	$ 2,000		
Field Supervision	lot	1	$ 6,600	$ 6,600		
			Sub-Total	$ 8,600		
041 Meals & Entertainment						
Meals		1	$ 100	$ 100		
			Sub-Total	$ 100		
066 Other Goods & Services						
Contingency	%	10%	$ 365,853	$ 36,585		
			Sub-Total	$ 36,585		
094 Interest Capitalized						
AFUDC				$ 4,504		
			Sub-Total	$ 4,504		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 18,966		
				$ -		
			Sub-Total	$ 18,966		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 28,095		
COPS Contract AO				$ 1,722		
Project Support Regular AO				$ 4,206		
				$ -		
			Sub-Total	$ 34,023		
			SUB-TOTAL (no AO, AFUDC)	$ 402,438		
			TOTAL (AO, AFUDC included)	$ 459,931		
Original Cost				$ 95,606		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49833

Title: 2017 Oil Containment Program

Start Date:	2017/03
In-Service Date:	2017/11
Final Cost Date:	2018/05
Function Class:	Transmission
Amount:	$432,518

DESCRIPTION:

This project includes the installation of oil containment systems for substation main power transformers. NS Power completed a survey of the main power transformers without an oil containment system. The sites were also reviewed to determine their proximity to sensitive environmental sites, such as watercourses and wetlands along with the presence of pathways for contaminants to reach the receptors. From these assessments of environmental risk, a prioritized list of substation sites has been developed for retrofitting oil containment systems, thereby reducing the environmental risk. This program began in 2016, and the 2017 project, which will install oil containment at four sites, is a continuation of this program, which is planned to be complete by 2021.

Summary of Related CIs +/- 2 years:
2016 CI 48067 2016 Oil Containment Program $468,963
2018 CI TBD 2018 Oil Containment Program $TBD
2019 CI TBD 2019 Oil Containment Program $TBD

JUSTIFICATION:

Justification Criteria: Environment

Why do this project?

NS Power has identified that there is risk of oil from substation transformers being released to a nearby sensitive environmental area at locations that currently do not have oil containment systems. Installation of oil containment systems will reduce the risk to the environment and public safety surrounding substations.

Why do this project now?

In 2013, *Nova Scotia Environment* released the *Contaminated Sites Regulations* which outlines new clean-up criteria for spills, increasing clean-up and assessment costs. Clean-ups and ongoing assessment costs for oil releases from substation transformers can account for a significant cost to NS Power. These regulations can be found at the following link: https://www.novascotia.ca/just/regulations/regs/envcontsite.htm.

Proactively adding oil containment systems to the highest environmental risk sites will reduce long-term costs associated with clean-ups and will protect these sensitive areas from possible contamination.

Why do this project this way?

A total of 303 sites were evaluated for this project. Approximately 76 of these have known sensitive areas in the immediate vicinity that are at risk for possible contamination should an oil release occur. NS Power then identified the 30 sites, which will be addressed in this program, that had the highest risk for those pathways to be created between the potential contamination and the receptors. Installation of oil containment at five sites will be completed in the 2016/2017 Oil Containment Program (CI# 48067). Installing oil containment in these highest sensitive sites in a prioritized approach will reduce the environmental risk of oil being released from our substation operations to nearby sensitive areas.

CI Number : 49833 - 2017 Oil Containment Program **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		5,378	0	5,378
094		094 - Interest Capitalized		6,227	0	6,227
095		095-COPS Contracts AO		24,938	0	24,938
095		095-COPS Regular Labour AO		7,967	0	7,967
095		095 - Proj Supp Regular Labour AO		8,235	0	8,235
001	007	001 - T&D Regular Labour	007 - TP - Environmental	2,835	0	2,835
012	007	012 - Materials	007 - TP - Environmental	189,351	0	189,351
013	007	013 - COPS Contracts	007 - TP - Environmental	124,573	0	124,573
001	085	001 - Regular Labour (No AO)	085 Design	3,787	0	3,787
001	085	001 - Proj Supp Regular Labour	085 Design	17,123	0	17,123
066	085	066 - Other Goods & Services	085 Design	34,525	0	34,525
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	7,580	0	7,580
			Total Cost:	432,518	0	432,518
			Original Cost:			

Capital Project Detailed Estimate

Location: **Transmission**
CI# / FP#: 49833
Title: 2017 Oil Containment Program
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Site Supervision	PD	20	$ 385	$ 7,580		
T&D Labour - Project Support	PD	7	$ 382	$ 2,835		
Procurement / Financial Support	lot	1	$ 3,787	$ 3,787		
Project Support AO - Engineering Design	PD	45	$ 382	$ 17,123		
				$ -		
			Sub-Total	$ 31,325		
012 Materials						
PVC Oil Containment Materials - Site 1	ea	1	$ 64,954	$ 64,954		
PVC Oil Containment Materials - Site 2	ea	1	$ 33,866	$ 33,866		
PVC Oil Containment Materials - Site 3	ea	1	$ 50,692	$ 50,692		
PVC Oil Containment Materials - Site 4	ea	1	$ 39,839	$ 39,839		
			Sub-Total	$ 189,351		
013 Contracts						
PVC Oil Containment Installation - Site 1	ea	1	$ 42,733	$ 42,733		
PVC Oil Containment Installation - Site 2	ea	1	$ 22,280	$ 22,280		
PVC Oil Containment Installation - Site 3	ea	1	$ 33,350	$ 33,350		
PVC Oil Containment Installation - Site 4	ea	1	$ 26,210	$ 26,210		
			Sub-Total	$ 124,573		
066 Other Goods & Services						
Contingency	%	10%	$ 345,249	$ 34,525		
			Sub-Total	$ 34,525		
094 Interest Capitalized						
AFUDC				$ 6,227		
			Sub-Total	$ 6,227		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 5,378		
			Sub-Total	$ 5,378		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 7,967		
COPS Contract AO				$ 24,938		
Project Support Regular AO				$ 8,235		
			Sub-Total	$ 41,139		
			SUB-TOTAL (no AO, AFUDC)	$ 379,774		
			TOTAL (AO, AFUDC included)	$ 432,518		
Original Cost						

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49798

Title: 2017/2018 Capacitor Bank Breaker Replacements

Start Date:	2017/06
In-Service Date:	2018/04
Final Cost Date:	2018/12
Function Class:	Transmission
Amount:	$378,150

DESCRIPTION:

This project is required for the retirement and replacement of three capacitor bank breakers.

- 82V-409 (Valley): 33 years old
- 101H-419 (Halifax): 33 years old
- 1H-417 (Halifax): 56 years old

Breaker replacements will be prioritized based on age, number of operations, maintenance history and criticality to the transmission system. Capacitor Bank Breakers are utilized by system operators to control voltage on the transmission system. Engineering, design and procurement will occur throughout 2017 with replacement scheduled for 2018.

Summary of Related CIs +/- 2 years:
2015 CI 47631 U&U Capacitor Bank Breaker Replacements $411,871
2016 CI 48063 2016/2017 Capacitor Bank Breaker Replacements $385,850
2018 CI TBD 2018/2019 Capacitor Bank Breaker Replacements $TBD
2019 CI TBD 2019/2020 Capacitor Bank Breaker Replacements $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement / Refurbishment

Why do this project?

There are currently 23 Capacitor Bank Breakers on the transmission system. These breakers are critical to the operation of the transmission system as they are utilized to control the system voltage. These breakers are operated frequently and as a result see higher duty cycles compared to our line breakers. This higher duty cycle increases the probability of failure in these devices. The replacement of these breakers, on a priority basis as part of this replacement program, will mitigate the risk of voltage issues on the transmission system in the event of a failure.

Why do this project now?

To support the reliable operation of the transmission system, a Capacitor Bank Breaker replacement program is required.

In late 2014 issues on capacitor bank breakers in the Halifax area were discovered as a result of NS Power’s preventative maintenance inspection cycle on these capacitor bank breakers. In these instances, there was high contact resistance and subsequent thermal imaging showed elevated temperatures on the affected breaker poles. As these breakers are operated multiple times per day in some cases, replacing three breakers at this time will reduce the risk of failure. Failure of these devices could result in voltage issues on the transmission system.

Why do this project this way?

Due to the age of the breakers being replaced in this program, refurbishment is not an option and sourcing spare parts is becoming more challenging. As a result, replacement is the recommended option.

CI Number : 49798 - 2017 / 2018 Capacitor Bank Breaker Replacements **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		19,292	0	19,292
094		094 - Interest Capitalized		8,299	0	8,299
095		095-COPS Contracts AO		6,165	0	6,165
095		095-COPS Regular Labour AO		28,579	0	28,579
095		095 - Proj Supp Regular Labour AO		19,660	0	19,660
012	003	012 - Materials	003 - TP - Bldg.,Struct.Grnd.	210	0	210
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	23,318	0	23,318
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	20,258	0	20,258
012	022	012 - Materials	022 - TP - Elec Contr.Equip.	8,946	0	8,946
012	039	012 - Materials	039 - TP - O/H Cond.	630	0	630
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	3,600	0	3,600
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	11,702	0	11,702
012	043	012 - Materials	043 - TP - Substn Dev.	147,262	0	147,262
013	043	013 - COPS Contracts	043 - TP - Substn Dev.	3,880	0	3,880
001	085	001 - Proj Supp Regular Labour	085 Design	40,882	0	40,882
001	085	001 - Regular Labour (No AO)	085 Design	3,142	0	3,142
066	085	066 - Other Goods & Services	085 Design	26,923	0	26,923
001	086	001 - T&D Regular Labour	086 Commissioning	5,402	0	5,402
			Total Cost:	378,150	0	378,150
			Original Cost:	117,816		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 49798
Title: 2017/2018 Capacitor Bank Breaker Replacement
Execution Year: 2017 / 2018

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	104	$ 360	$ 37,363		
Procurement / Financial Support	Lot	1	$ 3,141	$ 3,141		
Project Support AO - Engineering Design	PD	107	$ 382	$ 40,882		
			Sub-Total	$ 81,386		
012 Materials						
Ground Connectors	Lot	1	$ 210	$ 210		
Control Cables	Lot	1	$ 8,945	$ 8,945		
Conductor	MR	63	$ 10	$ 630		
Arrestor	Lot	9	$ 2,000	$ 18,000		
Breakers	ea	3	$ 43,088	$ 129,263		
			Sub-Total	$ 157,048		
013 Contracts						
Concrete Foundations	ea	3	$ 7,773	$ 23,318		
Installation of Conductor	Lot	1	$ 3,600	$ 3,600		
Boom Truck Services	Lot	1	$ 3,880	$ 3,880		
			Sub-Total	$ 30,798		
066 Other Goods & Services						
Contingency	%	10%	$ 269,232	$ 26,923		
			Sub-Total	$ 26,923		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 19,292		
			Sub-Total	$ 19,292		
094 Interest Capitalized						
AFUDC				$ 8,299		
			Sub-Total	$ 8,299		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 28,579		
COPS Contract AO				$ 6,165		
Project Support Regular AO				$ 19,660		
				$ -		
			Sub-Total	$ 54,404		
			SUB-TOTAL (no AO, AFUDC)	$ 296,155		
			TOTAL (AO, AFUDC included)	$ 378,150		
Original Cost				$ 117,816		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

Distribution

CI Number: 49919

Title: 2017 PCB Pole Top Transformer Replacements

Start Date):	2017/01
In-Service Date:	2017/01
Final Cost Date:	2018/03
Function Class:	Distribution
Amount:	$2,446,051

DESCRIPTION:

This project provides for the systematic removal of potentially Polychlorinated biphenyl (PCB) contaminated material in accordance with federal guidelines. Regulations state that all pole top equipment containing PCBs in a concentration greater than 50 mg/kg must be removed from service by December 31, 2025. Based on the results of feeder inspections, NS Power estimates there are approximately 45,000 pole top transformers on the distribution system that may contain PCBs. Feeder inspectors identified potential PCB transformers based on the apparent age of the equipment and visual inspection of bushings, connections, color, etc.

In 2017, NS Power will test approximately 7,000 pole top transformers that have been identified as potentially PCB contaminated and change out approximately 100 of these transformers. The 2017 project will complete the sampling of all road-side accessible transformers that began in 2015. Once completed, this program will primarily consist of changing out PCB contaminated transformers. The amount of testing as part of the 2017 program has been accelerated in order to take advantage of approximately 15% savings in the cost of testing due to the bulk purchase of patented rivets used in testing as well as efficiencies in large volume of targeted sampling.

The 2016 project was a larger investment as it included the sampling of 10,000 pole top transformers, compared to 7,000 in this year's project.

Summary of Related CIs +/- 2 years:
2015 CI 46576 2015 PCB Pole Top Transformer Replacements $733,503
2016 CI 47721 2016 PCB Pole Top Transformer Replacements $4,409,579
2018 CI TBD 2018 PCB Pole Top Transformer Replacements $TBD
2019 CI TBD 2019 PCB Pole Top Transformer Replacements $TBD

JUSTIFICATION:

Justification Criteria: Environment

Why do this project?

The Canadian Council of Ministers of the Environment (CCME) has committed to a policy of phasing out the use of all PCBs in Canada. In support of this policy, NS Power will be focusing on eliminating all pole-top electrical transformers and related pole-top auxiliary electrical equipment containing PCBs in a concentration of 50 mg/kg or more before December 31, 2025.

Why do this project now?

The volume of potentially PCB contaminated pole top transformers in NS Power's system is estimated at approximately 45,000 units. Proceeding with this work over a multi-year timeframe will allow the work to be incorporated into NS Power's existing work plan and resources.

Why do this project this way?

An inventory of pole top assets will be completed to identify the location and number of potentially contaminated transformers. NS Power will engage a contractor to obtain oil samples of these units. All units that test greater than the 50mg/kg limit will be changed out. This project provides for testing and destruction of materials, as required. Based on pole top transformer disposal data from 2004 to 2013, approximately 5 percent of the pole-top transformers replaced contain PCB concentration equal to or above 50 mg/kg. Based on that percentage, NS Power anticipates 3,825 transformers of the 45,000 will be replaced throughout the multiple annual projects. The 2017 project is focused on continuing the identification of PCB containing transformers through sampling, enabling the development of a strategic replacement plan that will be executed in future year ACE Plan projects. This work will be completed by an external contractor.

CI Number : 49919 - 2017 PCB Pole Top Transformer Replacement **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		27,468	0	27,468
095		095-COPS Regular Labour AO		40,691	0	40,691
095		095 - Proj Supp Regular Labour AO		4,005	0	4,005
095		095-COPS Contracts AO		219,672	0	219,672
001	041	001 - T&D Regular Labour	041 - DP - O/H Line Transf.	49,000	0	49,000
012	041	012 - Materials	041 - DP - O/H Line Transf.	787,167	0	787,167
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	1,097,320	0	1,097,320
001	085	001 - Proj Supp Regular Labour	085 Design	8,328	0	8,328
001	085	001 - Regular Labour (No AO)	085 Design	19,754	0	19,754
066	085	066 - Other Goods & Services	085 Design	188,449	0	188,449
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	4,197	0	4,197
			Total Cost:	2,446,051	0	2,446,051
			Original Cost:	826,374		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 49919
Title: 2017 Pole Top Transformer Replacements
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - PLT	PD	134	$ 367	$ 49,000		
T&D Labour - Site Supervision	PD	11	$ 385	$ 4,197		
Procurement / Financial Support	Lot	1	$ 19,754	$ 19,754		
Project Support AO - Engineering Design	PD	22	$ 382	$ 8,328		
			Sub-Total	$ 81,279		
012 Materials						
Pole Top Transformers	ea	100	$ 1,921.67	$ 192,167		
Field Testing Costs - Oil sampling - Mat'l	ea	7000	$ 85.00	$ 595,000		
			Sub-Total	$ 787,167		
013 Contracts						
Field Testing Costs - Oil sampling - Contract	ea	7000	$ 120.00	$ 840,000		
Lab Testing Costs	ea	7000	$ 31.50	$ 220,500		
Environmental Disposal Fee	ea	7000	$ 1.75	$ 12,250		
Traffic Control	ea	100	$ 163.80	$ 16,380		
TC for Non Sampled ID	ea	200	$ 40.95	$ 8,190		
			Sub-Total	$ 1,097,320		
Contingency	%	10%	$ 1,884,487.00	$ 188,449		
			Sub-Total	$ 188,449		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 27,468		
			Sub-Total	$ 27,468		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 40,691		
COPS Contract AO				$ 219,672		
Project Support Regular AO				$ 4,005		
			Sub-Total	$ 264,368		
			SUB-TOTAL (no AO, AFUDC)	$ 2,154,215		
			TOTAL (AO, AFUDC included)	$ 2,446,051		
Original Cost				$ 826,374		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49806

Title: 2017 Padmount Replacement Program

Start Date:	2017/01
In-Service Date:	2017/01
Final Cost Date:	2018/06
Function Class:	Distribution
Forecast Amount:	$1,703,774

DESCRIPTION:

This project will provide for costs associated with the replacement of 80 padmount transformers identified through the padmount inspection program. NS Power has 4,058 padmount transformers across its fleet which are inspected every year through the padmount inspection program. The expected useful life of these assets is between 35-45 years. This will be an ongoing program as part of lifecycle andcondition management of the in-service distribution padmount transformer inventory.

Summary of Related CIs +/- 2 years:
2015 CI 46292 2015 Padmount Replacement Program $1,536,110
2016 CI 48093 2016 Padmount Replacement Program $1,911,470
2018 CI TBD 2018 Padmount Replacement Program $TBD
2019 CI TBD 2019 Padmount Replacement Program $TBD

Depreciation Class: Distribution Equipment, Underground Line Transformers

Estimated Useful Life: 40 years

JUSTIFICATION:

Justification Criteria: Distribution System

Why do this project?

Padmount transformer inspections have identified transformers that need to be replaced next year due to deterioration. Proactive, planned replacement of end of life padmount transformers mitigates the potential for prolonged, unplanned customer outages from transformer failure.

A secondary important driver for this project is the prevention of environmental incidents, as padmount transformer failures can potentially result in signification oil release, which is prohibited by environmental regulations.

Why do this project now?

At or near end of life padmount transformers were identified through the padmount inspection process, and prioritized for replacement. They will be replaced in a planned manner as part of NS Power's environmental due diligence.

Why do this project this way?

Padmount transformers are typically associated with commercial customers. Planned replacement of end of life padmount transformers is conducted during an outage coordinated at the convenience of the customer. The replacement of these transformers will minimize unplanned customer outages and mitigate potential environmental impact.

CI Number : 49806 - 2017 Padmount Replacement Program **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		52,070	0	52,070
095		095-COPS Contracts AO		21,861	0	21,861
095		095 - Proj Supp Regular Labour AO		5,879	0	5,879
095		095-COPS Regular Labour AO		77,136	0	77,136
012	004	012 - Materials	004 - DP - Misc.Equipment	0	0	0
001	048	001 - T&D Regular Labour	048 - DP - U/G Line Transf.	100,843	0	100,843
012	048	012 - Materials	048 - DP - U/G Line Transf.	1,190,400	0	1,190,400
013	048	013 - COPS Contracts	048 - DP - U/G Line Transf.	109,203	0	109,203
001	085	001 - Proj Supp Regular Labour	085 Design	12,224	0	12,224
001	085	001 - Regular Labour (No AO)	085 Design	4,198	0	4,198
066	085	066 - Other Goods & Services	085 Design	129,960	0	129,960
			Total Cost:	1,703,774	0	1,703,774
			Original Cost:	870,590		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 49806
Title: 2017 Padmount Replacement Program
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	280	$ 360	$ 100,843		
Procurement / Financial Support	Lot	1	$ 4,198	$ 4,198		
Project Support AO - Engineering Design	PD	32	$ 382	$ 12,224		
			Sub-Total	$ 117,265		
012 Materials						
Padmount Transformers	Ea	80	$ 13,880	$ 1,110,400		
Small Components for Padmount Transformers	Ea	80	$ 1,000	$ 80,000		
			Sub-Total	$ 1,190,400		
013 Contracts						
Contract Line Work	Hrs	[redacted]		$ 109,203		
			Sub-Total	$ 109,203		
066 Other Goods & Contingency						
Contingency	%	10%	$ 1,299,603.20	$ 129,960		
			Sub-Total	$ 129,960		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 52,070		
			Sub-Total	$ 52,070		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 77,136		
COPS Contract AO				$ 21,861		
Project Support Regular AO				$ 5,879		
			Sub-Total	$ 104,876		
			SUB-TOTAL (no AO, AFUDC)	$ 1,546,829		
			TOTAL (AO, AFUDC included)	$ 1,703,774		
Original Cost				$ 870,590		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 41350

Title: 16W-301G Hebron Rebuild Phase 2

Start Date: 2017/05
In-Service Date: 2018/09
Final Cost Date: 2019/03
Function Class: Distribution
Forecast Amount: $904,732

DESCRIPTION:

This project provides for the costs associated with rebuilding a 4.2 kilometer section of primary feeder 16W-301G, from R311-058 to E311-060, over a two year period. The existing mixture of #4 and #2 conductors, and mixture of #6, #4 and #2 neutral, will be replaced with 336ASC conductor and 4/0 neutral. 61 poles will be replaced with 82 poles, in order to reduce spans to standard length. Additional replacements include downline recloser R311-058, insulators, cut-outs, pole-top transformers and services. The targeted section of line will also be relocated closer to Highway 1 to improve accessibility.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Deteriorated Conductor

Why do this project?

The existing #4 and #2 conductor, poles and recloser are deteriorated and at risk of failure due to their age and condition. The conductor can no longer be worked on under live conditions. Some of the existing spans are beyond current standard for span lengths. In addition, the majority of the targeted section is not accessible from the road making access for repairs difficult and extending outage times as a result.

This project is being undertaking primarily to replace deteriorated conductor and maintain reliability, and is secondarily undertaken to comply with current standards.

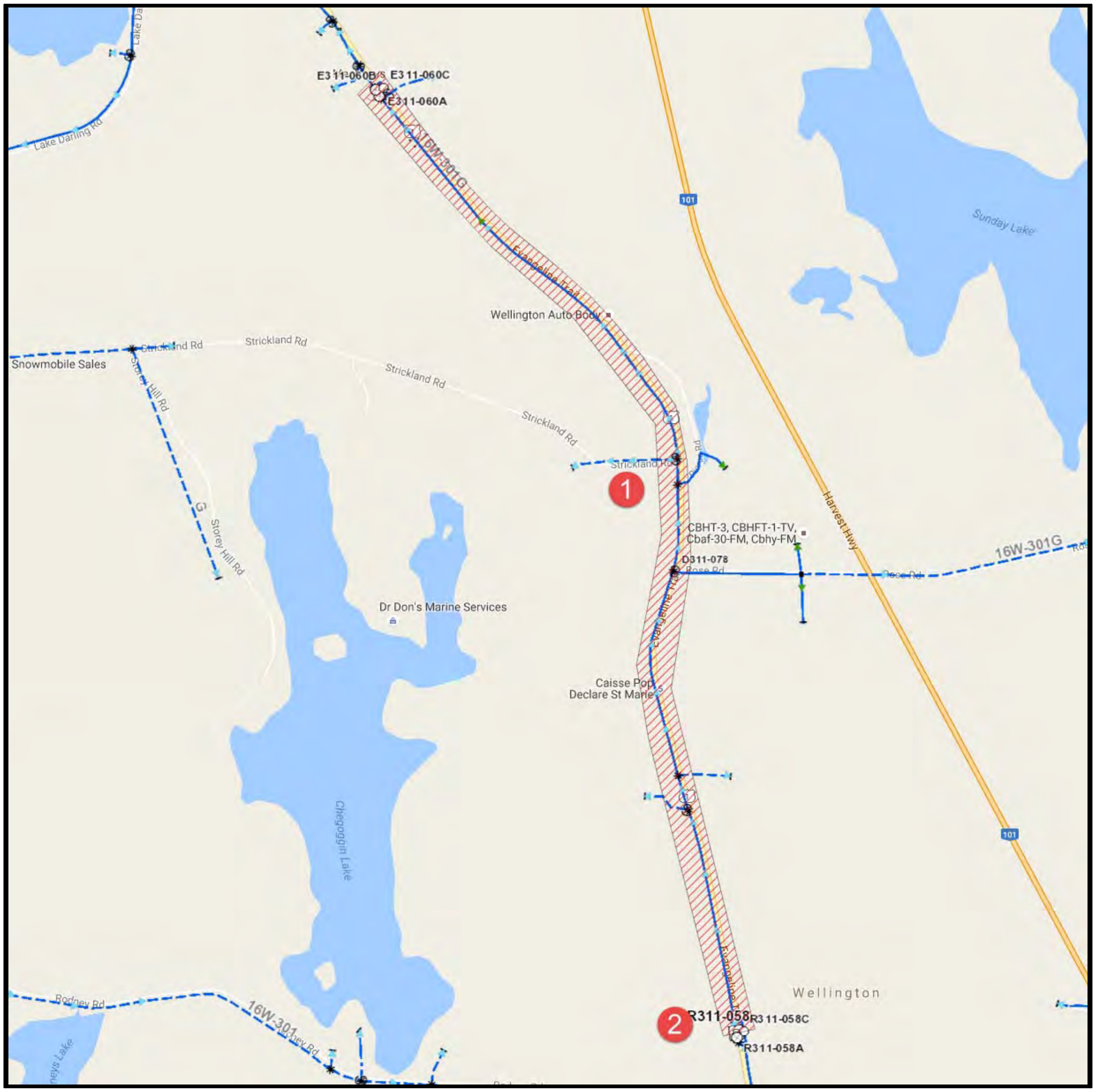
Why do this project now?

The existing #4 and #2 conductor is more than 45 years old and has reached the end of its expected service life. The existing R311-058 recloser is approximately 30 years old and has reached the end of its expected service life. Inspections of the targeted devices and assessment based on age, condition and risk of failure has determined that replacements are required.

Why do this project this way?

There is no alternative source of supply for the 745 customers currently on this targeted feeder section. Replacing the targeted assets is a more cost effective solution than rebuilding the entire line. Conductor and poles will be upgraded in accordance with current NS Power standards. Rebuilding the line closer to the roadside will allow for improved accessibility.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.



(1) Rebuild approximately 4.2kms of distribution line
(2) Replace existing hydraulic recloser R311-058 with an electronic recloser

CI Number : 41350 - 16W-301 Hebron Rebuild Phase 2 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		31,073	0	31,073
094		094 - Interest Capitalized		41,345	0	41,345
095		095-COPS Contracts AO		79,465	0	79,465
095		095-COPS Regular Labour AO		46,030	0	46,030
013	002	013 - COPS Contracts	002 - DP - Land Rights	52,000	0	52,000
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	28,000	0	28,000
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	26,069	0	26,069
012	035	012 - Materials	035 - DP - Wood Poles	82,287	0	82,287
013	035	013 - COPS Contracts	035 - DP - Wood Poles	211,182	0	211,182
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	26,656	0	26,656
012	039	012 - Materials	039 - DP - O/H Cond.	43,854	0	43,854
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	120,378	0	120,378
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	1,475	0	1,475
012	040	012 - Materials	040 - DP - O/H Cond.Devices	24,954	0	24,954
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	5,789	0	5,789
001	041	001 - T&D Regular Labour	041 - DP - O/H Line Transf.	3,278	0	3,278
012	041	012 - Materials	041 - DP - O/H Line Transf.	25,276	0	25,276
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	3,588	0	3,588
001	052	001 - T&D Regular Labour	052 - DP - Services	2,700	0	2,700
012	052	012 - Materials	052 - DP - Services	1,042	0	1,042
013	052	013 - COPS Contracts	052 - DP - Services	4,012	0	4,012
001	085	001 - Regular Labour (No AO)	085 Design	14,793	0	14,793
066	085	066 - Other Goods & Services	085 Design	29,486	0	29,486
			Total Cost:	904,732	0	904,732
			Original Cost:	81,050		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 41350
Title: 16W-301 Hebron Rebuild Phase 2
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - PLT	PD	164	$ 367	$ 60,178		
Procurement / Financial Support	Lot	1	$ 14,793	$ 14,793		
			Sub-Total	$ 74,970		
012 Materials						
Poles, Anchors, and Guys	Lot	1	$ 44,337	$ 44,337		
Aliant Sacrificial Pole	Lot	1	$ 37,950	$ 37,950		
Conductors	Lot	1	$ 43,854	$ 43,854		
Overhead Conductor Devices	Lot	1	$ 24,954	$ 24,954		
Overhead Line Transformer	Lot	1	$ 25,276	$ 25,276		
Services	Lot	1	$ 1,042	$ 1,042		
			Sub-Total	$ 177,413		
013 Contracts						
Contract Line Work	Hrs.	[redacted]	[redacted]	$ 191,277		
Tree Trimming	Lot	1	$ 52,000	$ 52,000		
Backhoe	Lot	1	$ 69,000	$ 69,000		
Flagging	Lot	1	$ 84,672	$ 84,672		
			Sub-Total	$ 396,949		
020 Easements						
Easements	Lot	1	$ 28,000	$ 28,000		
			Sub-Total	$ 28,000		
066 Other Goods & Services						
Contingency	$	1	$ 29,486	$ 29,486		
			Sub-Total	$ 29,486		
094 Interest Capitalized						
AFUDC				$ 41,345		
			Sub-Total	$ 41,345		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 31,073		
			Sub-Total	$ 31,073		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 46,030		
COPS Contract AO				$ 79,465		
			Sub-Total	$ 125,496		
			SUB-TOTAL (no AO, AFUDC)	$ 706,818		
			TOTAL (AO, AFUDC included)	$ 904,732		
Original Cost				$ 81,050		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49836

Title: 11S-411 11S-302 Rebuild Coxheath Road Phase 2

Start Date: 2017/01
In-Service Date: 2017/04
Final Cost Date: 2018/11
Function Class: Distribution
Amount: $807,456

DESCRIPTION:

This project provides for the costs associated with rebuilding approximately 1.8kms of the 11S-411 and 11S-302 double circuit line along Coxheath Road, from Mackillop Avenue to Pringle Street Road. Approximately 70 existing poles will be replaced with larger, higher class poles in order to provide the spacing and strength required by the current double-circuit standard. This project will be completed throughout 2017 and 2018. Additional replacements include insulators, cut-outs and transformers.

Summary of Related CIs +/- 2 years:
2016 CI 49173 11S-411 11S-302 Re-Build Coxheath Road Phase 1 $178,552
2018 CI TBD 11S Re-build Coxheath Road Phase 3 $TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Outage Performance

Why do this project?

The existing poles are deteriorated and at risk of failure due to their age and condition. Additionally, the existing double circuit line along Coxheath Road does not meet the current NS Power standard for double-circuit construction. Outage response is complicated by the limited spacing on the poles between the existing circuits. A fault on this double circuit line can affect up to 4,300 customers. The limited spacing often requires an outage to both feeders in order for repair work to occur. Rebuilding this line will improve reliability by improving the ability of crews to work on the circuits, and by improving outage response time.

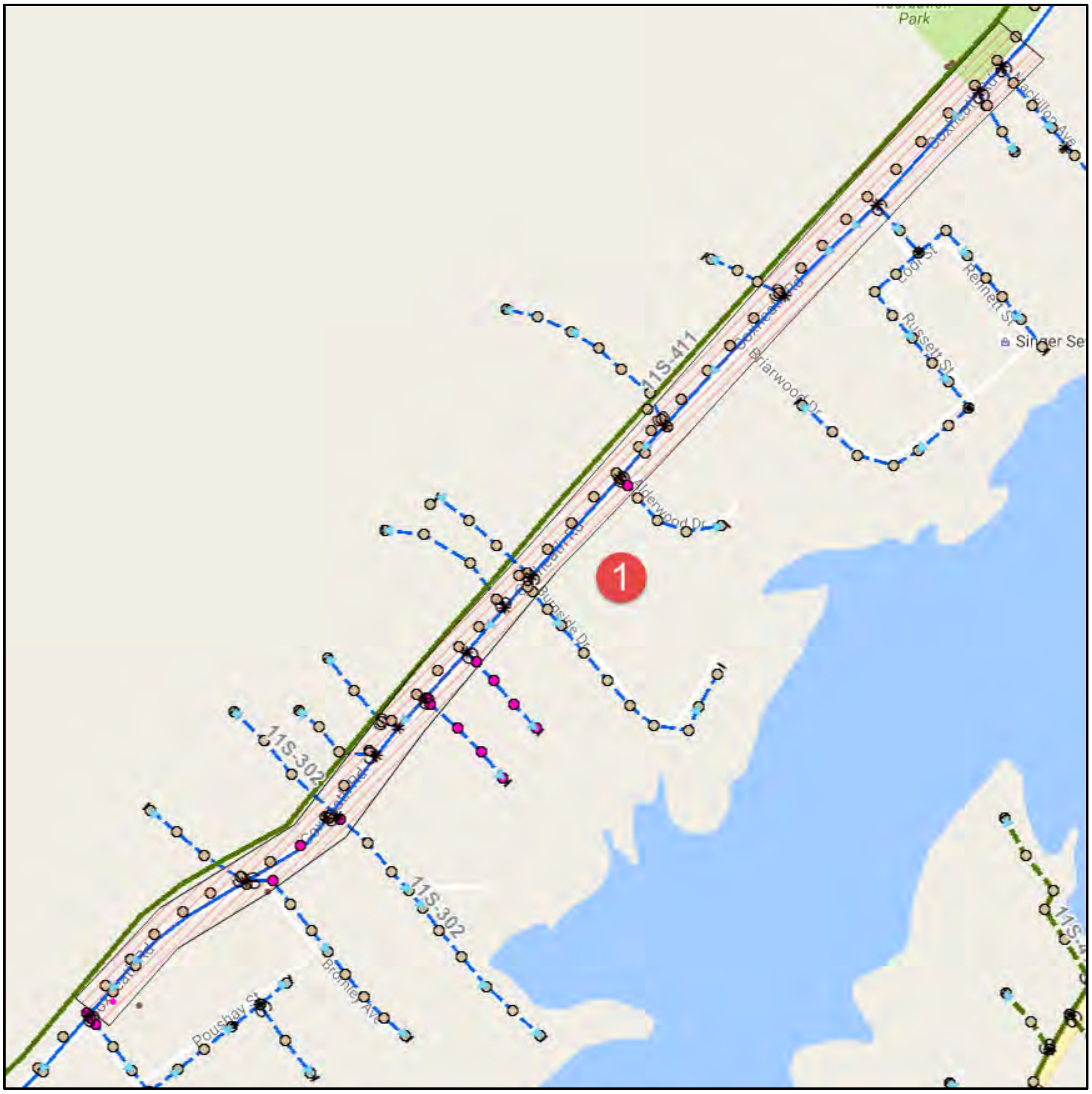
Why do this project now?

The existing poles are approximately 45 years old and have reached the end of their expected useful life. Inspections of the targeted devices and assessment based on age, condition and risk of failure has determined that replacements are required. Additionally, the non-standard design of the existing line limits NS Power's ability to maintain it and respond to outages. In 2014 and 2015, there were 20 outage events on both circuits, impacting more than 500 customers per event.

Why do this project this way?

There is no alternative source of supply for customers. Rebuilding the existing line to the current double-circuit standard is a more cost effective solution than splitting the two circuits, because it would require a similar rebuild of the existing line and also acquisition of a new right-of-way, and construction of a second, new line.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.



(1) Rebuild approximately 1.8kms of 11S-411 and 11S-302 double-circuit line

CI Number : 49836 - 11S-302 11S-401 Rebuild Coxheath Phase 2 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		1,935	0	1,935
095		095-COPS Contracts AO		107,203	0	107,203
013	002	013 - COPS Contracts	002 - DP - Land Rights	8,000	0	8,000
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	2,000	0	2,000
012	035	012 - Materials	035 - DP - Wood Poles	63,773	0	63,773
013	035	013 - COPS Contracts	035 - DP - Wood Poles	304,369	0	304,369
012	039	012 - Materials	039 - DP - O/H Cond.	8,907	0	8,907
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	193,494	0	193,494
012	040	012 - Materials	040 - DP - O/H Cond.Devices	1,603	0	1,603
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	5,912	0	5,912
012	041	012 - Materials	041 - DP - O/H Line Transf.	20,136	0	20,136
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	13,046	0	13,046
013	050	013 - COPS Contracts	050 - DP - Street Lights	4,077	0	4,077
012	052	012 - Materials	052 - DP - Services	34	0	34
013	052	013 - COPS Contracts	052 - DP - Services	6,605	0	6,605
001	085	001 - Regular Labour (No AO)	085 Design	12,811	0	12,811
066	085	066 - Other Goods & Services	085 Design	53,550	0	53,550
			Total Cost:	807,456	0	807,456
			Original Cost:	118,331		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 49836
Title: 11S-411 11S-302 Rebuild Coxheath Phase 2
Execution Year: 2017 / 2018

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Procurement / Financial Support	Lot	1	$ 12,811	$ 12,811		
			Sub-Total	$ 12,811		
012 Materials						
Poles	Lot	1	$ 63,773	$ 63,773		
Overhead Conductor	Lot	1	$ 8,907	$ 8,907		
Cutouts	Lot	1	$ 1,603	$ 1,603		
Overhead Line Transformer	Lot	1	$ 20,136	$ 20,136		
Services	Lot	1	$ 34	$ 34		
			Sub-Total	$ 94,453		
013 Contracts						
Contract Line Work	Hrs	[redacted]		$ 380,498		
Tree Trimming	Lot	1	$ 8,000	$ 8,000		
Backhoe	Lot	1	$ 59,700	$ 59,700		
Flagging	Lot	1	$ 87,305	$ 87,305		
			Sub-Total	$ 535,504		
020 Easements						
Permit	$	1	$ 2,000	$ 2,000		
			Sub-Total	$ 2,000		
066 Other Goods & Services						
Contingency				$ 53,550		
			Sub-Total	$ 53,550		
094 Interest Capitalized						
Interest				$ 1,935		
			Sub-Total	$ 1,935.13		
095 Administrative Overhead						
COPS Contract AO				$ 107,203		
			Sub-Total	$ 107,203		
			SUB-TOTAL (no AO, AFUDC)	$ 698,318		
			TOTAL (AO, AFUDC included)	$ 807,456		
Original Cost				$ 118,331		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49841

Title: 23H Rockingham Voltage Conversion Phase 2

Start Date:	2017/03
In-Service Date:	2017/06
Final Cost Date:	2018/09
Function Class:	Distribution
Forecast Amount:	$743,213

DESCRIPTION:

This project provides for the costs associated with implementing recommendation 6.1.3.6 of the Peninsular Halifax and Area Distribution Planning Study (342-1113-H50). Section 6.1.3.6 recommends converting a targeted section of 23H-303G from 12kV to 25kV. This conversion will be completed by opening D331-068, creating a new open point at the intersection of Birch Hill Drive and Upper Prince Street, and converting Main Avenue, including side streets, from D331-068 to D331-078 to 25kV. Approximately 2.3 kilometers of existing mixture of #6, #2, 2/0 and 336 primary and neutral will be replaced with 2/0, 4/0 and 336 primary and neutral. Additional replacements include approximately 56 poles, insulators, cut-outs, lightning arrestors, switches and the replacement of all existing single-tap transformers with dual-tap transformers. This work will be completed throughout 2017 and 2018.

Summary of Related CIs +/- 2 years:
2015 CI 46651 23H Rockingham Voltage Conversion Phase 1 $566,694
2018 CI TBD 23H Rockingham Voltage Conversion Phase 3 $TBD
2019 CI TBD 23H Rockingham Voltage Conversion Phase 4 $TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Why do this project?

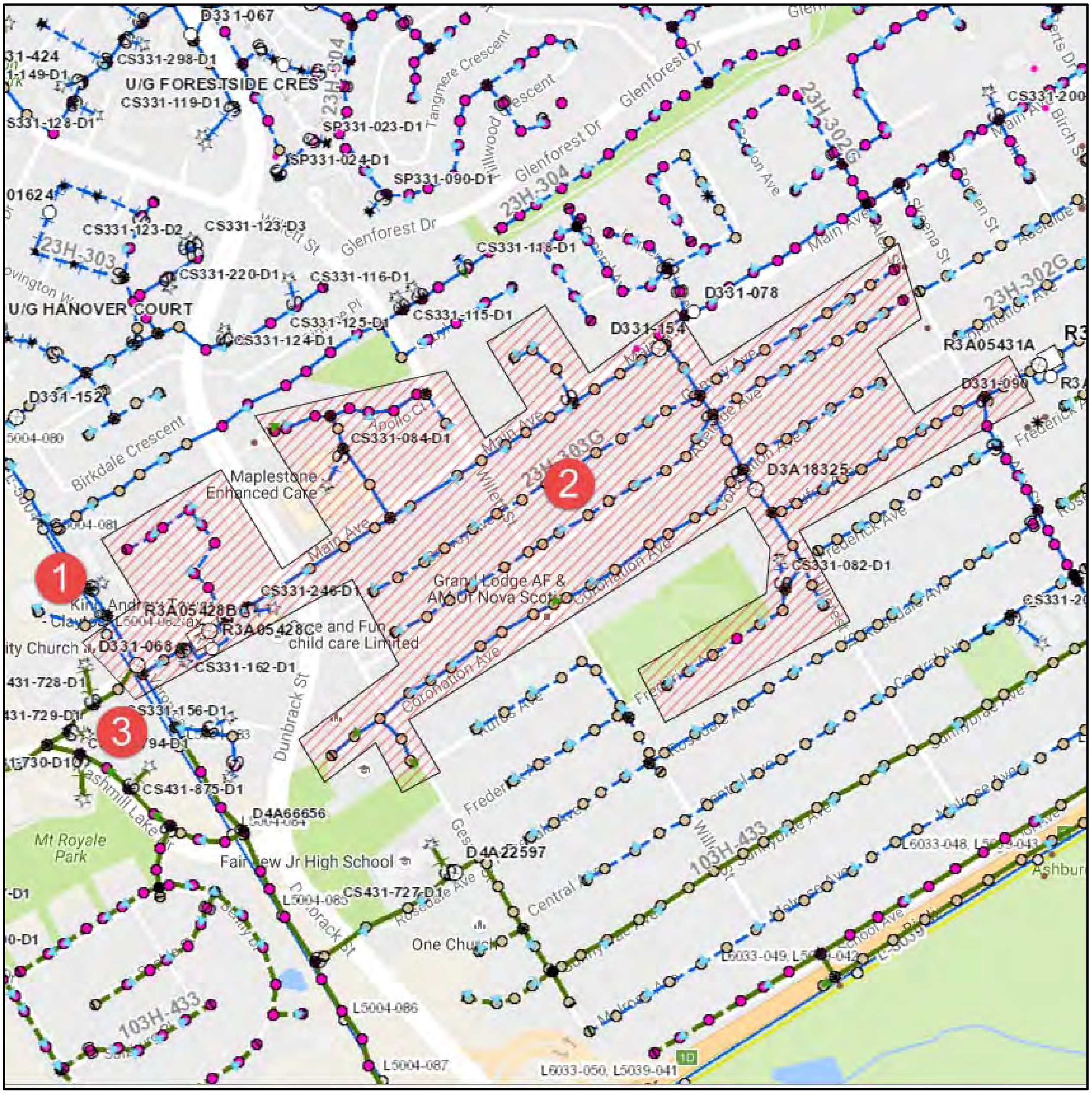
The load from 23H-Rockingham needs to be transferred in order to accommodate the retirement of the 23H substation by 2025, as outlined in section 6.1.11.1 of planning study 342-1113-H50. The 23H 12kV system is islanded, with no contingency opportunity other than the mobile transformer. Converting 23H feeders will result in the ability to transfer load to adjacent feeders from other sources, including 103H and 104H, which will improve reliability for these customers.

Why do this project now?

The conversion of the 23H 12kV distribution systems needs to be completed in approximately 10 phases. These conversions require significant logistics, including rear-lot construction, commercial customers, and high-traffic areas. Phase 1 was completed in 2015, which implemented recommendation 6.1.2.4. It is anticipated that the remaining conversions will take approximately 8 years to complete. The multiple phases of conversion required are outlined in section 6.1.

Why do this project this way?

Alternatives and recommendation are outlined in section 5.4 of the attached planning study. This alternative was chosen as it will reduce the 12kV load at 23H-Rockingham near the anticipated load growth rate, to ensure the peak loading on 23H-T51 does not exceed its nameplate rating.



(1) Create new open point at D331-068

(2) Upgrade approximately 2.3kms of conductor. Replace targeted poles, insulators, cut-outs, lightning arrestors, switches and all existing single-tap transformers with dual-tap transformers

(3) Convert targeted section of 23H-303G to 25kV and transfer load to 103H-433

CI Number : 49841 - 23H-Rockingham Voltage Conversion-Phase 2 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		71,347	0	71,347
094		094 - Interest Capitalized		4,127	0	4,127
095		095-COPS Regular Labour AO		105,692	0	105,692
095		095-COPS Contracts AO		34,931	0	34,931
013	002	013 - COPS Contracts	002 - DP - Land Rights	11,550	0	11,550
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	1,000	0	1,000
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	34,507	0	34,507
012	035	012 - Materials	035 - DP - Wood Poles	27,355	0	27,355
013	035	013 - COPS Contracts	035 - DP - Wood Poles	162,941	0	162,941
001	038	001 - T&D Regular Labour	038 - DP - Insulators	1,788	0	1,788
012	038	012 - Materials	038 - DP - Insulators	392	0	392
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	51,406	0	51,406
012	039	012 - Materials	039 - DP - O/H Cond.	12,992	0	12,992
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	4,753	0	4,753
012	040	012 - Materials	040 - DP - O/H Cond.Devices	13,640	0	13,640
001	041	001 - T&D Regular Labour	041 - DP - O/H Line Transf.	19,607	0	19,607
012	041	012 - Materials	041 - DP - O/H Line Transf.	129,142	0	129,142
001	046	001 - T&D Regular Labour	046 - DP - U/G Conductor	9,325	0	9,325
012	046	012 - Materials	046 - DP - U/G Conductor	11,065	0	11,065
001	052	001 - T&D Regular Labour	052 - DP - Services	16,790	0	16,790
012	052	012 - Materials	052 - DP - Services	835	0	835
001	085	001 - Regular Labour (No AO)	085 Design	18,030	0	18,030
			Total Cost:	743,213	0	743,213
			Original Cost:	103,086		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 49841
Title: 23H Rockingham Voltage Conversion Phase 2
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - PLT	PD	377	$ 367	$ 138,176		
T&D Labour - Project Support	PD	1	$ 18,030	$ 18,030		
			Sub-Total	$ 156,205		
012 Materials						
Wood Poles, Anchors, Guys	Lot	1	$ 27,355	$ 27,355		
Insulators	Lot	1	$ 392	$ 392		
Overhead Conductor	Lot	1	$ 12,992	$ 12,992		
Cutouts, Switches and Regulators	Lot	1	$ 13,640	$ 13,640		
Overhead Transformers and Transformer Cutouts	Lot	1	$ 129,142	$ 129,142		
Underground Conductor	Lot	1	$ 11,065	$ 11,065		
Services	Lot	1	$ 835	$ 835		
			Sub-Total	$ 195,420		
013 Contracts						
Tree Trimming	Lot	1	$ 11,550	$ 11,550		
Backhoe	Lot	1	$ 47,550	$ 47,550		
Traffic Control	Lot	1	$ 100,391	$ 100,391		
Site Restoration	Lot	1	$ 15,000	$ 15,000		
			Sub-Total	$ 174,491		
020 Easements						
Permit/Easement	ea	1	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000		
094 Interest Capitalized						
Interest				$ 4,127		
			Sub-Total	$ 4,127		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 71,347		
			Sub-Total	$ 71,347		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 105,692		
COPS Contract AO				$ 34,931		
			Sub-Total	$ 140,623		
			SUB-TOTAL (no AO, AFUDC)	$ 527,116		
			TOTAL (AO, AFUDC included)	$ 743,213		
Original Cost				$ 103,086		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

Nova Scotia POWER An Emera Company

Peninsular Halifax and Area
DISTRIBUTION PLANNING STUDY

Report number 342-1113-H50

Revision		Date	Drafted By	Reviewed by	Approved By
0	Issued for Study	29-Nov-13	JMQ		
1	Issued for Release	30-Jan-15	JMQ	DK	
2	Issued for Release	15-Feb-15	JMQ	DK	

EXECUTIVE SUMMARY

This study was initiated by Central Regional Engineering to examine the loading on the Halifax Peninsula and surrounding areas, with consideration of the continued anticipated load growth within the area. This study considers the ongoing recommendations of the Halifax 4kV Conversion study (303-0612-H49).

Given the significant growth, both commencing and anticipated, within the Halifax Peninsula and surrounding areas, a review of the current and future capacity requirements is required. This study will review the existing capacity at the substations indicated below, as well as the future capacity requirements in these areas, to meet the anticipated load growth. Some of the large developments announced within the study area are:

- The Nova Centre (under construction)
- Brunello Estates (under construction)
- Lovett Lake (under construction)
- Larry Uteck area (under expansion)
- The Mother House Lands (before HRM council)

The study has been bounded by the following substations:

- 1H-Water Street
- 2H-Armdale
- 103H-Lakeside
- 104H-Kempt Road
- 129H-Kearney Lake
- 20H-Spryfield
- 23H-Rockingham

The outcome of the Economic Analysis to the alternatives, outlined in Section 5 of this study, indicates the completion of the following:

1. Add an additional 138-26.4kV transformer at 2H-Armdale, in 2015
2. Add an additional 138-26.4kV transformer at 103H-Lakeside, in 2018
3. Replace 103H-T63, in 2015 and reduce loading at 20H-Spryfield through conversions to 25kV
4. Retire 23H-Rockingham in 2026, through planned conversions to 25kV

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1.0 SCOPE

This study was initiated by Central Regional Engineering to examine the loading on the Halifax Peninsula and surrounding areas, with consideration of the continued anticipated load growth within the area. With the current and proposed load developments on the Halifax Peninsula and adjacent areas, it is imperative to investigate the overall load in the area, to determine the future capacity requirements of both the Halifax Peninsula and the adjacent areas.

This study will recommend general feeder reconfigurations, as new feeders are added, but the final determination of these configurations will be at the discretion of Central Regional Engineering.

Given the significant growth, both commencing and anticipated, within the Halifax Peninsula and surrounding areas, a review of the current and future capacity requirements is required. This study will review the existing capacity at the substations indicated below, as well as the future capacity requirements in these areas, to meet the anticipated load growth.

The study has been bounded by the following substations:

- 1H-Water Street
- 2H-Armdale
- 103H-Lakeside
- 104H-Kempt Road
- 129H-Kearney Lake
- 20H-Spryfield
- 23H-Rockingham

This study considers the ongoing recommendations of the Halifax 4kV Conversion study (303-0612-H49).

2.0 EXISTING SYSTEMS

2.1 Transmission

Presently, the substations within the scope of this study are supplied from the bulk power systems at 103H-Lakeside and 91H-Tufts Cove. An overview of the substations within the scope of this study can be found in Figure 1 below. The System Operating Diagrams can be found in Appendix A.

Table 1 Transmission Line Ratings

Transmission Line	Substation		MVA Rating	
	From	To	Summer	Winter
L-8002	67N-Onslow	103H-Lakeside	554	554
L-6008	90H-Sackville	103H-Lakeside	215	231
L-6014	91H-Tufts Cove	104H-Kempt Road	268	287
L-6016	120H-Brushy Hill	103H-Lakeside	231	231
L-6033	103H-Lakeside	1H-Water Street 2H-Armdale	230	230
L-6035	104H-Kempt Road	1H-Water Street 2H-Armdale	230	230
L-6038	103H-Lakeside	129H-Kearney Lake	95	95
L-5004	90H-Sackville	34H-Geizer's Hill	55	72
L-5032	22H-Rockingham Tap	23H-Rockingham	31	45
L-5039	103H-Lakeside	20H-Spryfield	41	60

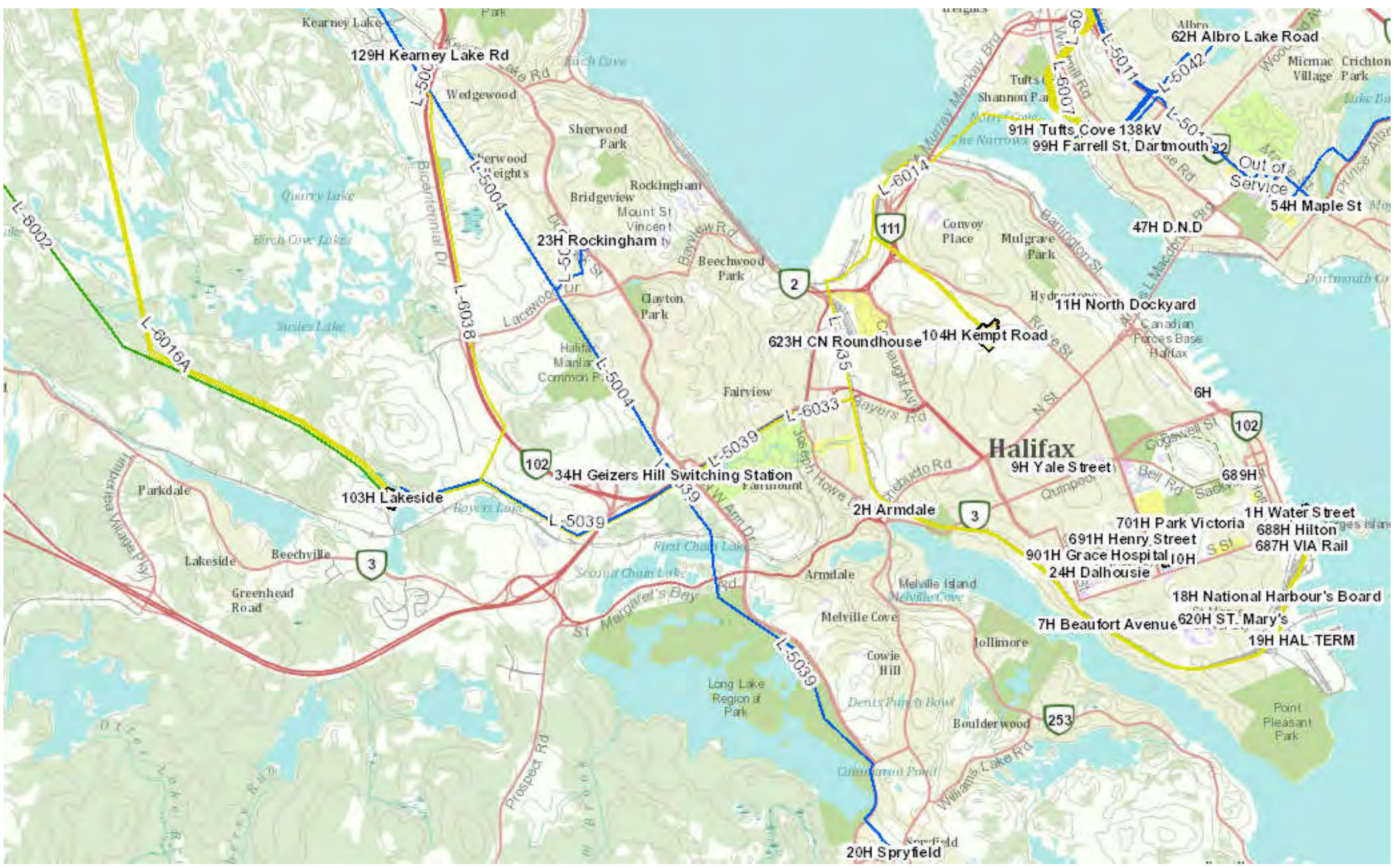


Figure 1 Peninsular Halifax Transmission

2.2 Distribution

The distribution system being studied in this report includes the 25kV feeders supplied from the substations located on/ or adjacent to Peninsular Halifax. All of these substations are capable of providing transfer capacity to adjacent substations, when required.

With this in mind the 12kV and 25kV substations adjacent to the Halifax Peninsula are also being considered, with respect of potential transfer capacity and additional load that may be added to the 25kV distribution system bounded by the scope of this study, in the future.

Table 2 provides the transformer data for the substations that are directly impacted by the scope of this study.

Table 2 Substation Transformers, within Scope of Study

Substation	Transformer Data				
	ID	MAN	kV	Rating (in MVA)	In Service
1H-Water Street	T61	ASEA	138-25kV	40/53	1979
1H-Water Street	T62	ASEA	138-25kV	40/53	1979
1H-Water Street	T63	Shihlin	138-25kV	40/53	2014
2H-Armdale	T61	ABB	138-25kV	//25/35/42	2000
103H-Lakeside	T61	Federal Pioneer	138-26.4kV	25/33.3/41.6//46.6	1978
103H-Lakeside	T63	CGE	138-69kV	20/26.7//29.9	1971
104H-Kempt Road	T61	Siemens	138-25kV	25/33.3/41.7	2009
104H-Kempt Road	T62	CGE	138-25kV	25/33.3/41.7	2009
104H-Kempt Road	T63	CGE	138-25kV	25/37/46.7	1996 (rebuilt 2002)
129H-Kearney Lake	T61	Ferranti Packard	138-26.4kV	25/33.3//41.5	1988
20H-Spryfield	T1	CGE	69-13.2kV	15/20//22.4	1987 (rebuilt)
20H-Spryfield	T2	Ferranti Packard	69-13.2kV	15/20/25//28	1977
23H-Rockingham	T51	ABB	69-13.2kV	15/20//25	1991

2.2.1 Halifax 4kV Conversions

Presently, recommendations from the Halifax 4kV Conversions Distribution Planning Study (303-0612-H49) are being completed with an anticipated completion of conversions in 2018. The extents of the remaining Halifax 4kV can be found in Figure 2. It is worth noting that the two remaining 4kV substations, 9H-Yale Street and 10H-VG Hospital are supplied by 25kV distribution feeders supplied by the Peninsular Halifax substations.

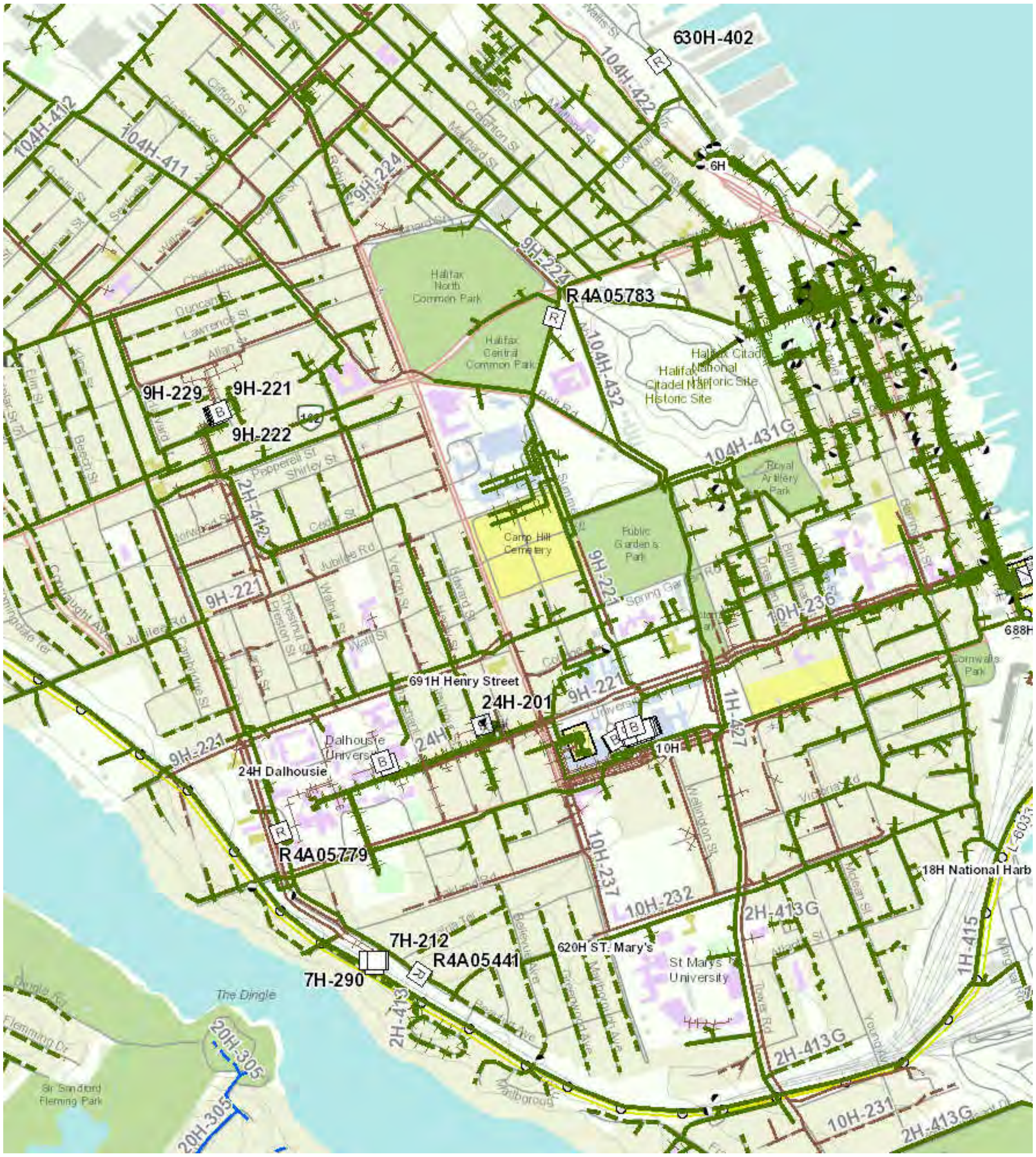


Figure 2 **Halifax 4kV Overview (brown)**

3.0 LOAD HISTORY AND FORECAST

The majority of the load being considered within this study is residential, with a number of commercial and industrial customers. As illustrated in the load history (Appendix B) for the substation transformers and feeders, the load being considered, within this study, continues to have a larger winter peak than summer. Historical load data for the feeders and transformers was collected from the Distribution Load Check Database and archived PI data and is presented below.

3.1 Load Forecast

Overall customer load has been increasing in substations that service the Halifax Peninsula, as well as the adjacent areas. The overall load growth is anticipated to continue for the next several years, due to the proposed developments outlined in subsequent sections of this study.

Due to the ability to reconfigure feeders on the Halifax Peninsula, the utilization of the 90th percentile forecast is difficult to compile, on a feeder basis. With this in mind, the overall load growth has been calculated utilizing the 90th percentile calculations, for each substation examined within this study. Refer to Table 10 and Table 11 below.

An overview of the peak loading of the individual feeders, organized by substation, is contained within the tables below.

Table 3 1H-WaterStreet peak 2013/2014 feeder loading, in Amps

	1H-403	1H-405	1H-415	1H-419	1H-424	1H-429	1H-431
2013/2014 Peak	186	213	222	263*	212	220*	197

Table 4 2H-Armdale and 103H-Lakeside peak 2013/2014 feeder loading, in Amps

	2H-411	2H-412	2H-413	103H-431	103H-432	103H-433	103H-434
2013/2014 Peak	206	284	272	160	331	332	327

Table 5 104H-Kempt Road 2014 peak 2013/2014 feeder loading, in Amps

	104H-411	104H-412	104H-413	104H-421*	104H-422*	104H-423*	104H-431	104H-432	104H-433*	104H-441	104H-442
2013/ 2014 Peak	139	209	280	208	239	232	385	146		217	

Note:

- * indicates feeders with gaps in telemetry data.

Table 6 129H-Kearney Lake 2014 peak 2013/2014 feeder loading, in Amps

	129H-411	129H-412	129H-413
2013/2014 Peak	175	226	354

Table 7 20H-Spryfield and 23H-Rockingham 2014 peak 2013/2014 feeder loading, in Amps

	20H-301	20H-302	20H-303	20H-304	20H-305	20H-306	23H-301	23H-302	23H-303	23H-304	23H-301
2014 Peak	357	288	318	237	475	372	105	207	318	288	105

Table 8 **90th Percentile Load Forecast for Halifax Peninsula Transformers, in MVA**

Year / Load Growth	1H-T61	1H-T62	2H-T61	104H-T61	104H-T62	104H-T63	Peninsula Total
Rating	**40/53**	**40/53**	**//25/32/42**	**25/33.3/41.7**	**25/33.3/41.7**	**25/37/46.7**	
Load Growth	**-0.8%**	**1.4%**	**0.24%**	**0.6%**	**0.2%**	**-0.1%**	**0.7%**
2013/2014 Peak	**42**	**36**	**38**	**46**	**49**	**41**	**205**
2014 / 2015	43	37	40	47	46	44	219
2015 / 2016	43	38	40	48	46	44	220
2016 / 2017	43	38	40	48	46	44	222
2017 / 2018	42	39	40	48	47	44	224
2018 / 2019	42	40	40	49	47	43	225
2019 / 2020	42	40	40	49	47	43	227
2020 / 2021	41	41	41	49	47	43	229
2021 / 2022	41	42	41	50	47	43	230
2022 / 2023	41	42	41	50	47	43	232
2023 / 2024	40	43	41	50	47	43	234
2024 / 2025	40	43	41	51	47	43	235
2025 / 2026	40	44	41	51	47	43	237
2026 / 2027	39	45	41	51	47	43	239
2027 / 2028	39	45	41	52	47	43	240
2028 / 2029	39	46	41	52	47	43	242

Table 9 **90th Percentile Load Forecast for adjacent substation Transformers, in MVA**

Year / Load Growth	20H-T1	20H-T2	23H-T51	103H-T61	129H-T61	Study Total
Rating	**15/20//22.4**	**15/20/25//28**	**15/20//25**	**25/33.3/41.6//46.6**	**25/33.3//41.5**	
Load Growth	**0.4%**	**0.1%**	**0.4%**	**0.2%**	**1.1%**	**0.9%**
2013/2014 Peak	**21**	**22**	**25**	**51**	**42**	**375**
2014 / 2015	21	20	24	51	40	383
2015 / 2016	21	20	24	51	40	387
2016 / 2017	21	20	24	51	40	390
2017 / 2018	21	20	24	51	41	394
2018 / 2019	21	20	24	51	41	398
2019 / 2020	21	21	24	52	42	402
2020 / 2021	21	21	24	52	42	406
2021 / 2022	21	21	24	52	43	409
2022 / 2023	22	21	25	52	43	413
2023 / 2024	22	21	25	52	44	417
2024 / 2025	22	21	25	52	44	421
2025 / 2026	22	21	25	52	45	425
2026 / 2027	22	21	25	52	45	428
2027 / 2028	22	21	25	53	46	432
2028 / 2029	22	21	25	53	46	436

Note:

- The load forecast for the individual 20H-Spryfield transformers utilizes both the monthly distribution load check values, as well as the recent PI archive values.

4.0 OVERLOADS AND OTHER CONSIDERATIONS

The following section identifies issues that warrant correction based on NSPI's *Capital Expenditure Justification Criteria*.

4.1 Feeder Overloads

In consideration of the variety of feeder reconfigurations available within the study area, the indication of feeders of exceeding 325A will be indicated, for reference only. The load histories for the feeders can be found in Appendix B. The loading on the following feeders was above 325A, during the 2013/2014 peak loading period.

- 103H-Lakeside   103H-432, 103H-433, 103H-434
- 104H-Kempt Road   104H-431
- 129H-Kearney Lake   129H-413
- 20H-Spryfield   20H-301, 20H-305, 20H-306

4.2 Contingency Loss of Supply

In the event of a single transformer failure at any of the substations on the Halifax Peninsula, it is possible to transfer load to the remaining substation transformers on the Peninsula. As the load on the Peninsula continues to grow, the ability to accomplish this will require more extensive switching than presently required.

4.3 Age of Plant

The age of the distribution plant on the Halifax Peninsula ranges from relatively new (<10years), due to load growth and Hurricane Juan (South End), to more than 40years old, in mature communities.

A large portion of the older overhead distribution plant on the Peninsula is supplied via the 4kV system. Given the recommendations of the Halifax 4kV Distribution Planning Study (303-0612-H49), significant portions of this older infrastructure will be replaced, as part of the conversion work that will take place. The conversion of the remaining 4kV distribution on the Halifax Peninsula has been recommended to be completed prior to 2018.

4.4 Proposed Load Growth

There are several areas of load growth in Halifax Peninsula and adjacent areas. An overview of these areas can be found below, with discussions relating to the recommendations and overall impacts on the overall distribution system in subsequent sections.

4.4.1 Halifax Peninsula Load Growth

Peninsular Halifax is in the midst of a large scale redevelopment plan, ranging from redevelopment of existing buildings through to new developments and the repurposing of existing lands. While there have been a variety of developments before HRM council, for the last several years, a significant number of these developments have been approved to proceed, since the last municipal election (Oct. 2012). Some of the significant developments that have been approved include:

- New convention centre (under construction)
- Redevelopment of TD Bank block (under construction)
- New Halifax Regional Library (under construction)
- Port of Halifax Shore Power Project (under construction)

While individually these developments do not represent significant load growth (with the exception of the Convention Centre and Shore Power), the cumulative load of these developments represents significant growth in the area (above the forecasted rate of 0.7%). Consideration for these developments is required, for the planning of the transformation capacity on the Halifax Peninsula.

4.4.2 103H-Lakeside and 129H-Kearney Lake Load Growth

103H-Lakeside currently provides additional transfer capacity to the Halifax Peninsula via feeder ties with 2H-Armdale and also to the Kearney Lake area via feeder ties with 129H-Kearney Lake. Continued load growth at 103H-Lakeside and 129H-Kearney Lake will see reductions in this transfer capacity.

Currently, there are several projects in various stages of construction and approvals, within the 103H-Lakeside service area. The larger projects include new housing developments, as well as increases in commercial and industrial load, within the service area. The list below is a sample of these projects:

- Brunello Estates 530 Acre development
- Lovett Lake Estates 49.5 Acre development

Continued growth in the Larry Uteck area and development west of Highway 102, in the area will provide significant growth in the 129H-Kearney Lake service area. There is also a variety of new anticipated growth in the 129H-Kearney Lake service area, in addition to projects currently under construction.

Given these increases in load growth, the requirement to address both the substation capacity, as well as the transfer capacity available to adjacent substations is required.

4.4.3 20H-Spryfield Load Growth

20H-Spryfield is an islanded12kV distribution, with no ability to transfer, to adjacent substations, only between transformers within the substation (20H-T1 and 20H-T2). As the load in the service area continues to grow, the ability to transfer load to other feeders supplied by the substation decrease. Presently, the load is nearing the contingency capacity. Given the overall growth rate of 20H-Spryfield has been calculated to be 1.06%, it is projected that the contingency capacity (54.7MVA) will be exceeded prior to 2024. The 12kV service area supplied by 20H-Spryfield is highlighted in Figure 3 and Figure 4.

Currently, there are a number of projects in construction, as well as others that have been approved by HRM council. The list below is a sample of these projects:

- Kidston Estates 900 Acre development
- Governor's Brook 351 Acre development

Figure 3 20H-Spryfield Service Area Part 1

Figure 4 20H-Spryfield Service Area Part 2

With consideration of the continued forecasted load growth in the area, and the inability to transfer load to another 12kV source, a solution to address these requirements needs to be determined.

4.4.4 23H-Rockingham Load Growth

23H-Rockingham is another area of islanded 12kV distribution, with no ability to transfer to any adjacent substations. While the load at this substation has been relatively small in recent years, new anticipated load growth will exceed the capacity of the 5P-MS (25MVA), in the near term, under peak loading conditions. Presently, there are a variety of development applications that have been approved by HRM council. Some of these developments have begun or are preparing to begin construction. These developments include:

- Halifax West High School Redevelopment
- Rockingham South 55 Acre Development
- The Motherhouse Lands 63 Acre Development

Figure 5 23H-Rockingham Service Area

With consideration of the proposed future growth within the service area, the requirement to address substation and contingency capacities are required, both in the near and long terms.

5.0 SOLUTIONS AND EVALUATION

Peninsular Halifax is in the beginning stages of large redevelopment. Within this redevelopment, a great deal of new load will be added to the existing 25kV distribution system in the coming years. Due to this growth, this study will investigate the need for additional transformation and feeders within the peninsula.

In addition to the load growth on the peninsula, the areas adjacent to the peninsula are also experiencing significant growth. As a result of this growth, the initial scope of this study has expanded to include the islanded 12kV systems at 20H-Spryfield and 23H-Rockingham as well as the 25kV distribution at 103H-Lakeside and 129H-Kearney Lake.

In consideration of the large area being considered within the scope of this study, the study will be separated by the following areas:

- Halifax Peninsula
- 103H-Lakeside and 129H-Kearney Lake
- 20H-Spryfield
- 23H-Rockingham

The discussions for each of these areas are outlined below:

5.1 Halifax Peninsula

The Halifax Peninsula area is on the cusp of large scale load growth **(0.7%)**, that hasn't been seen in Halifax for a number of years. The proposed redevelopment of the downtown core will increase the population density in the downtown core, as well as create more retail and office space, than ever before.

While there is a resurgence in the downtown core, the remainder of the peninsula is also in the midst of significant growth, both residentially and industrial (Halifax Ship Yards, CFB Halifax and Shore Power). With this in mind, there is a renewed requirement to review the substation transformer and feeder loading to ensure enough capacity is available, when required, to meet this growth.

With the introduction of Shore Power, a new type of load will be introduced into Nova Scotia for cruise ships visiting the Port of Halifax. This seasonal load will require one entire feeder (with prospects for a second), to enable a cruise ship to be supplied via a dedicated source, rather than utilize on-board generation, while in port. This will reduce the ship's fuel consumption, as well as lower emissions, while in port.

Additionally, as part of the National Shipbuilding Procurement Strategy, The Halifax Shipyards are in the process of designing and constructing a new fabrication facility to construct the new Arctic Offshore Patrol Ships (AOPS) and Canadian Surface Combatant (CSC) vessels over the next 25-30 years. This additional load is anticipated to require a reconfiguration of the feeders supplying the area.

A new transformer, 1H-T63, was procured for 1H-Water Street in 2012. This transformer (138kV-26.4kV 40/53MVA) was initially to be utilized as spare capacity at 1H-Water Street to accommodate increases in load. As a result, additional transfer capacity will not be required at 1H-Water Street despite the load increase due to Shore Power under both normal and contingency conditions for the foreseeable future.

Additionally, another transformer will be available to be installed within the peninsula in 2015. This transformer will provide additional capacity on the Halifax Peninsula, when installed. The location of this transformer is the basis of the alternatives presented below.

Alternative New Transformer- A would see the new transformer placed at 104H-Kempt Road. This alternative would add a fourth transformer to the 104H-Kempt Road substation, as per its current design configuration. The placement of this transformer would be difficult, by way of the existing infrastructure within the substation. The installation of a new transformer would require the relocation of 104H-T63 to the new location, prior to the installation of the fourth transformer (in the current location of 104H-T64). An additional challenge would be adding new feeders to this substation, given the congestion and ability to secure easements for any new feeders. Further to this, in the event of a 104H-T63 failure, the process for removing the unit is the reverse of the installation, in that the new transformer would need to be removed to access the third unit. This would potentially create additional outages and/or extensive switching with two units de-energized at one time, due to one unit failure.

Alternative New Transformer – B would see the new transformer installed at 2H-Armdale. Utilizing this location would require significant work, on both the high and low side buses. Unlike, Alternative New Transformer – A, the ability to add additional feeders to the substation is less complicated, in that the substation is constructed roadside near the Armdale rotary. This location would allow for additional feeders to be added and provide the widest array of transfer capacity to both the substations on the Halifax Peninsula (1H-Water Street and 104H-Kempt Road), as well as 103H-Lakeside. In the event of a transformer failure at 2H-Armdale, either unit would be readily accessible unlike the process of outlined in the previous alternative.

Further detail of each alternative can be found below.

5.1.1 Alternative New Transformer-A Place Transformer at 104H-Kempt Road

This alternative (New Transformer-A) would see the installation of a fourth transformer at 104H-Kempt Road. This substation had been originally designed as a four transformer substation. With the addition of a fourth transformer, an additional three feeders would be added to the substation.

The first new feeder would supply the North Street area, near the MacDonald Bridge. This new feeder would utilize the feeder exits on Young Street and require a new double circuit to Robie Street. The new double circuit would continue on Robie Street to Almon Street, where advancement of the 4kV conversions would be required. The de-energized 4kV along Robie Street would then be reconductored, from Almon Street to North Street, continuing on North Street to Creighton Street. New open points and feeder configurations would reduce the loading on the feeders in the area. Refer to Figure 6 below for a general outline of this new feeder.

Figure 6 **Alternative A; 104H-Kempt Road New Feeder-A**

The second new feeder would supply the Duffus Street, north Barrington Street area. This would be accomplished through extending the duct containing 104H-433 along Stairs Street, to Massachusetts Avenue. Transitioning to overhead configuration, the new feeder would continue along Stairs Street to Isleville Street, rebuilding the single phase portions to three phase. Isleville Street would then be rebuilt from Livingstone Place to Duffus Street, with this portion of Isleville Street being supplied via Stairs Street. A new open point would be installed on Duffus Street on the opposite side of the Robie Street intersection, than D431-431. Additionally, an open point would be installed on Barrington Street, near North Marginal Road. Refer to Figure 7 below for a general outline of this new feeder.

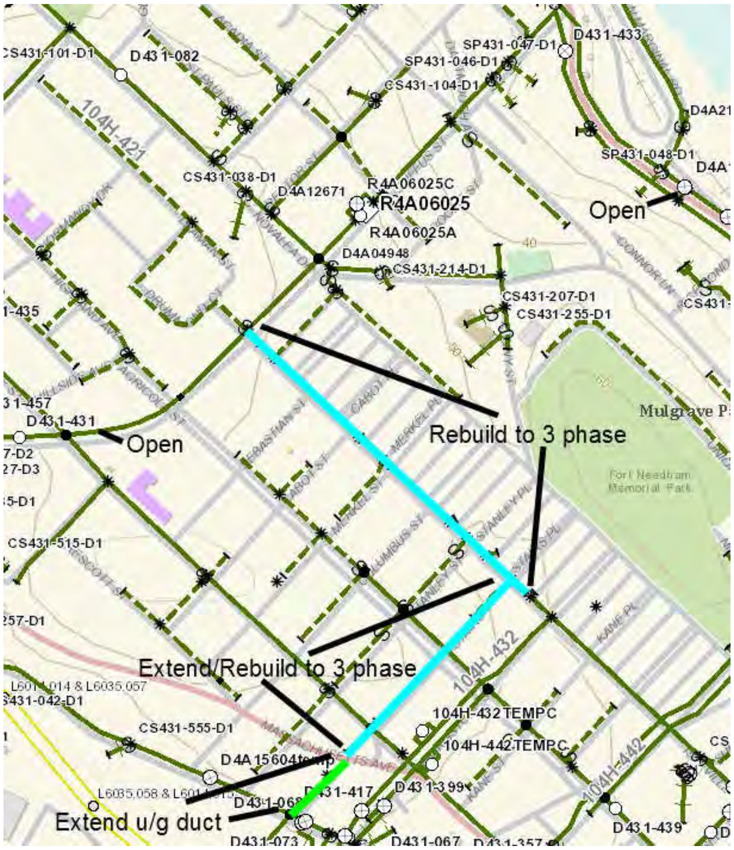


Figure 7 **Alternative A; 104H-Kempt Road New Feeder-B**

The third new feeder would provide an additional supply to Joseph Howe Drive, via Lady Hammond Road. This would be accomplished by utilizing the feeder exit ducts to Kempt Road and double circuiting Kempt Road to Hood Street, as well as Commission Street to Lady Hammond Road. Lady Hammond Road already has a double circuit configuration from Commission Street to McKintosh Street. Reconfiguration in this area would require the relocation of open points, to enable the use of the new feeder. Refer to Figure 8 below for a general outline of this new feeder.

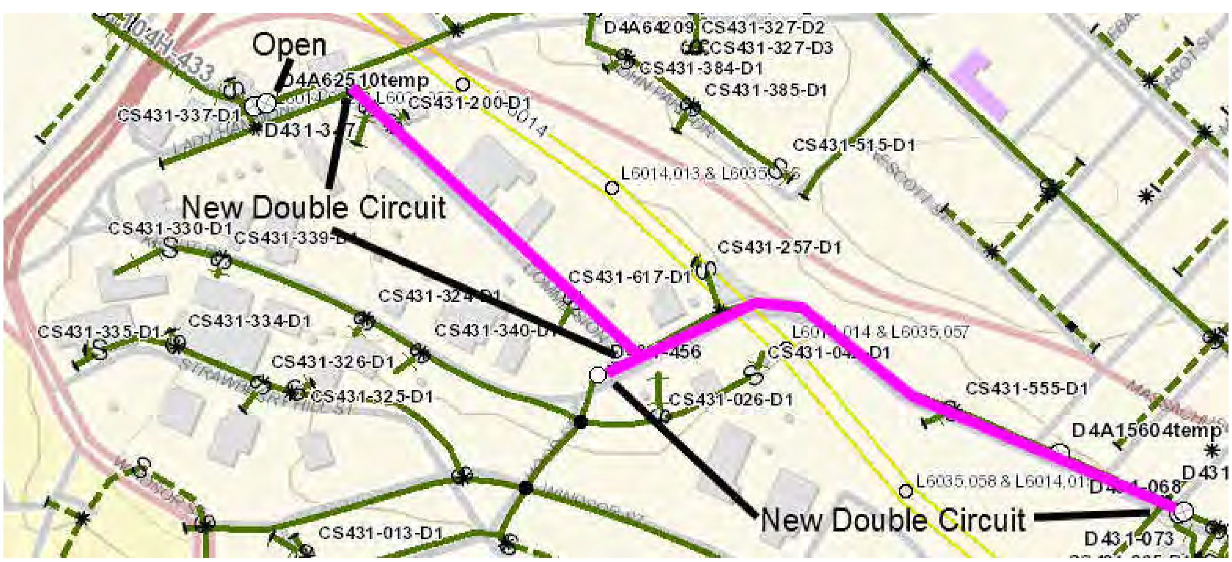


Figure 8 **Alternative A; 104H-Kempt Road New Feeder-C**

Due to growth in the area, the installation of a fourth transformer would be difficult to implement. Installation of a fourth transformer at 104H-Kempt Road would require that the third transformer (104H-T63) be moved into the empty transformer location and the fourth transformer installed. Due to congestion in the substation, 104H-T63 would not be able to be hoisted into position.

Additionally, in the event of a failure of 104H-T63, the process of installation would need to be reversed. The new transformer would need to be removed from service to enable the removal of 104H-T63. If this failure occurred under peak loading conditions, extensive switching and/or longer duration of outages would occur because of the affected buses,.

5.1.2 Alternative New Transformer-B Place Transformer at 2H-Armdale

This alternative (New Transformer-B) would see the addition of the new 138-25kV 25/33/42MVA transformer at the 2H-Armdale substation. The location of the 2H-Armdale substation enables the ability to transfer load between adjacent substations, both on and off of the peninsula. With the installation of this new transformer, four additional feeders would be added to the substation.

The first feeder, Feeder-A, would be utilized to reduce load on 104H-423, along Joseph Howe Drive. This would be accomplished through the construction of a double circuit along Clinton Avenue to Joseph Howe Drive. The Joseph Howe Drive tap would be moved from 2H-411 to the new feeder. D431-190 would close and recloser R4A05791 would open. Refer to Figure 9 below for a general outline of this new feeder.

Figure 9 **Alternative B; 2H-Armdale New Feeder-A**

The second and third feeders, Feeder B & C, would supply St, Margaret's Bay Road and Purcell's Cove Road via the Armdale Rotary. This would be accomplished through extending the feeders down Chebucto Road to the Armdale Rotary to Purcell's Cove Road. One feeder would supply the upper circuit (currently 2H-411) and the other the lower circuit (currently 20H-302, prior to conversion). A new open point would then be installed, on 2H-411, between the current supply and the new supply. Additionally, the Regency Park area would be transferred from 103H-433 to 2H-411 through shifting the open point on St. Margaret's Bay Road, through Opening D431-309 and closing D431-310. Refer to Figure 10 below for a general outline of this new feeder.

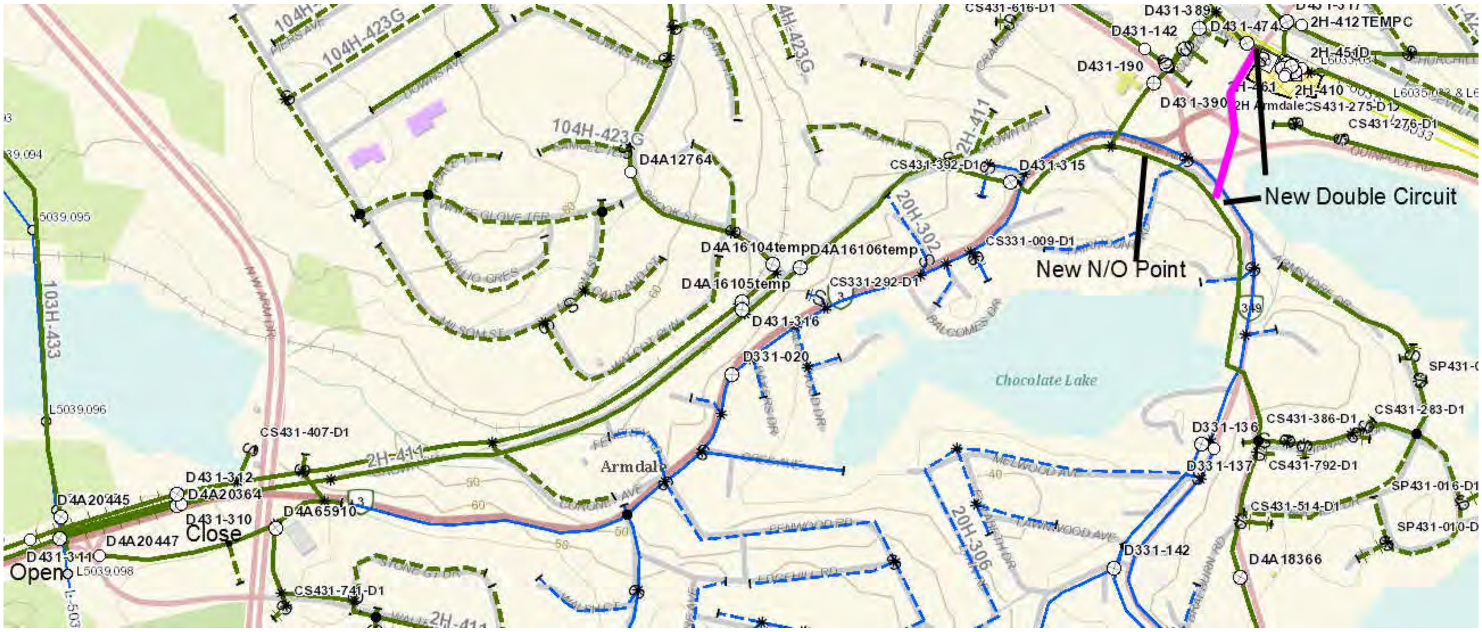


Figure 10 Alternative B; 2H-Armdale New Feeders B&C

The fourth feeder, Feeder D, would add an additional supply into the Quinpool Road area. This would be accomplished by utilizing the same routing as Feeders B&C down Chebucto Road. Extending the existing feeder on Quinpool Road towards the Armdale Rotary would meet the routing on Chebucto Road. The tap from 2H-413, where it crosses Quinpool Road, would need to be removed. A new open point on MacDonald Street, near Quinpool Road, as well as closing D431-492, will enable the feeder to extend along Quinpool Road. This new feeder would reduce loading to 2H-412, as well as 2H-413. Refer to Figure 11 below for a general outline of this new feeder.

Figure 11 Alternative B; 2H-Armdale New Feeder-D

In addition to providing additional feeders to the peninsula and adjacent areas, the feeders would provide the greatest capability to supply large portions of the forthcoming conversions at both 20H-Spryfield and 23H-Rockingham (as outlined in subsequent sections).

5.1.3 Recommend Alternative Install New Transformer at 2H-Armdale

The recommended alternative for the Halifax Peninsula is to install a new 138-25kV 25/33/42MVA transformer at 2H-Armdale. The installation of additional transformation at 2H-Armdale enables a greater amount of feeder configurations both on and off of the Halifax Peninsula. This alternative will also provide the capacity required to supply the 20H-Spryfield conversions, as well as a significant portion of the 23H-Rockingham conversions, as described later in this study.

The results of the Economic Analysis Model (EAM) indicated that the installation of the new transformer at 2H-Armdale is the least cost alternative, of those presented.

5.2 103H-Lakeside and 129H-Kearney Lake

The area supplied by 103H-Lakeside is currently experiencing noticeable growth through new residential developments. There are also industrial development applications before HRM council. The combined effect of these new developments will load 103H-T61 beyond its nameplate rating. This transformer is the lone distribution transformer at 103H-Lakeside.

The areas supplied by the 129H-Kearney Lake substation are continuing to see considerable residential and commercial growth. Presently the substation supplies a large portion of the 25kV in Clayton Park, as well as the Larry Uteck Boulevard area. The anticipated growth within the Larry Uteck Boulevard area, in particular is projected to continue for the next several years, with an increase in the population density in the area continuing to grow. With this projected continued growth, opportunities to transfer load to adjacent substations need to be considered.

The 129H-Kearney Lake substation is supplied via a radial 138kV transmission line, L-6038. The lone transformer at this substation is 138-26.4kV 25/33.3/41.5MVA unit (55MVA at 133% of nameplate rating). In consideration of the limited capacity available, prior to requiring a second transmission supply into the substation, an investigation into load transfers between 129H-Kearney Lake and adjacent substations is required. The scope of this study bounds these potential load transfers to the substations within and adjacent to the Halifax Peninsula (presently 103H-Lakeside and 104H-Kempt Road for 129H-Kearney Lake).

Alternative 103H/129H-A would see the replacement of 103H-T61 with a larger unit, to meet the anticipated near term load growth. Currently, the largest 138-26.4kV transformer in the NSPI fleet is a 40/53MVA, located at 1H-Water Street. A transformer, of this size, would be capable of supplying the existing four feeders, with the ability to add one additional feeder. Given that the majority of the 103H-Lakeside distribution is mostly radial, outside of Lakeside and Bayers Lake area, the ability to transfer load between feeders would require the construction of double circuits to balance load across feeders. Additionally, a new feeder could be created at 129H-Kearney Lake to reduce load on 129H-413, through reconfiguring existing feeders. In consideration of the anticipated load growth in the area, a second transformer would need to be installed at 103H-Lakeside in 2023.

Alternative 103H/129H-B would see an additional distribution transformer added to 103H-Lakeside. This alternative would allow for three additional feeders to be added to the substation initially, with provisions for a fourth, as demanded by load growth. These new feeders would reduce loading at 129H-Keaney Lake via load transfers to 103H-Lakeside. Similarly to Alternative 103H/129H-A, a new feeder could be created at 129H-Kearney Lake to further reduce loading on 129H-413.

Alternative 103H/129H-C would see the installation of a new 69-25kV 25/33/42MVA transformer at 129H-Kearney Lake. This new transformer would add an additional three feeders initially, with the ability to add a fourth feeder, when required. The existing 129H-Kearney Lake feeders, as well as those adjacent, would see reductions, through transfers to the new feeders created. These load reductions would then be cascaded to the other feeders, of the adjacent substations, where possible.

Further detail of each alternative can be found below.

5.2.1 Alternative 103H/129H-A Replace 103H-T61

This alternative (103H/129H-A) would see the replacement of the 103H-T61 (138–26.4kV 25/33.3/41.6//46.6 MVA) with a larger (53MVA) unit. The additional capacity created by this replacement will allow for one additional feeder to be created. Additional feeder reconfigurations would be required to reduce loading on the feeders where growth is anticipated. A second transformer would be installed in 2023, utilizing similar feeder configurations, as outlined in Alternative 103H/129H-B.

The new feeder would exit the 103H-Lakeside substation along the transmission corridor to Horseshoe Lake Drive. A new open point would be created on 103H-433, south of the transmission corridor crossing, as well as on Chain Lake Drive, south of Susie Crescent. The existing open point on Hobson Lake Drive (D4A11144) and Chain Lake Drive (D431-299) would be closed. D431-296 (along the Salt Marsh Trail) would be opened. This would allow the new feeder to supply the northern portion of the Bayers Lake Industrial Park, while 103H-422 would supply the southern portion of the business park. A general outline of this new feeder and reconfigurations within the Bayers Lake Industrial Park can be found in Figure 12 below.

Figure 12 **Alternative 103H/129H-A; New 103H-Lakeside Feeder**

With the reduction in load on 103H-431, a reduction of load on 103H-432 can be accomplished by extending the double circuit on St. Margaret's Bay Road to Greenhead Road. This would enable the transfer of load from 103H-432 to 103H-431, to this point. Refer to Figure 13 below for a general outline of this feeder reconfiguration.

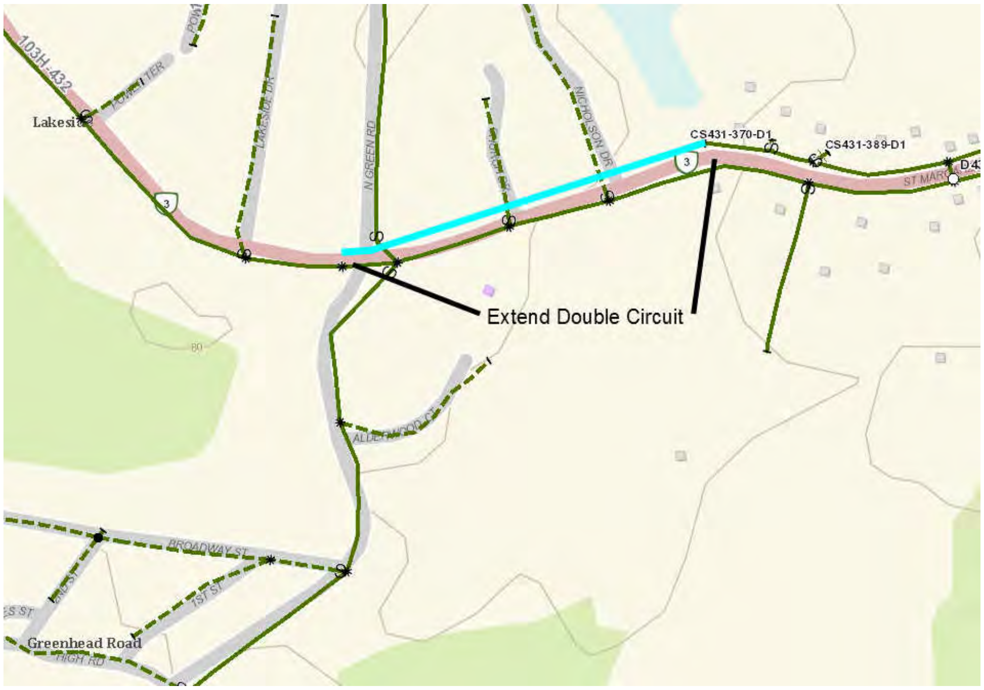


Figure 13 **Alternative 103H/129H-A; 103H-432 Load Reduction**

Further feeder reconfigurations of 103H-Lakeside feeders would see an extension of the double circuit along Prospect Road, reducing load on 103H-434. Given that the existing load on this feeder is primarily radial, load reductions can only be achieved through extending the existing double circuit. Given that Prospect Road is capable of being supplied by three feeders (103H-431, 103H-433 and 103H-434), extending the double circuit beyond Ragged Lake Boulevard will enable the transfer of load from 103H-434 to another feeder.

The initial extension of this double circuit would extend from Ragged Lake Boulevard to Mills Drive and supplied by 103H-431, via Ragged Lake Boulevard. Further extension of this double circuit would be dependent on the rate of load growth, in the future. Refer to Figure 14 below for a general outline of the double circuit extension.

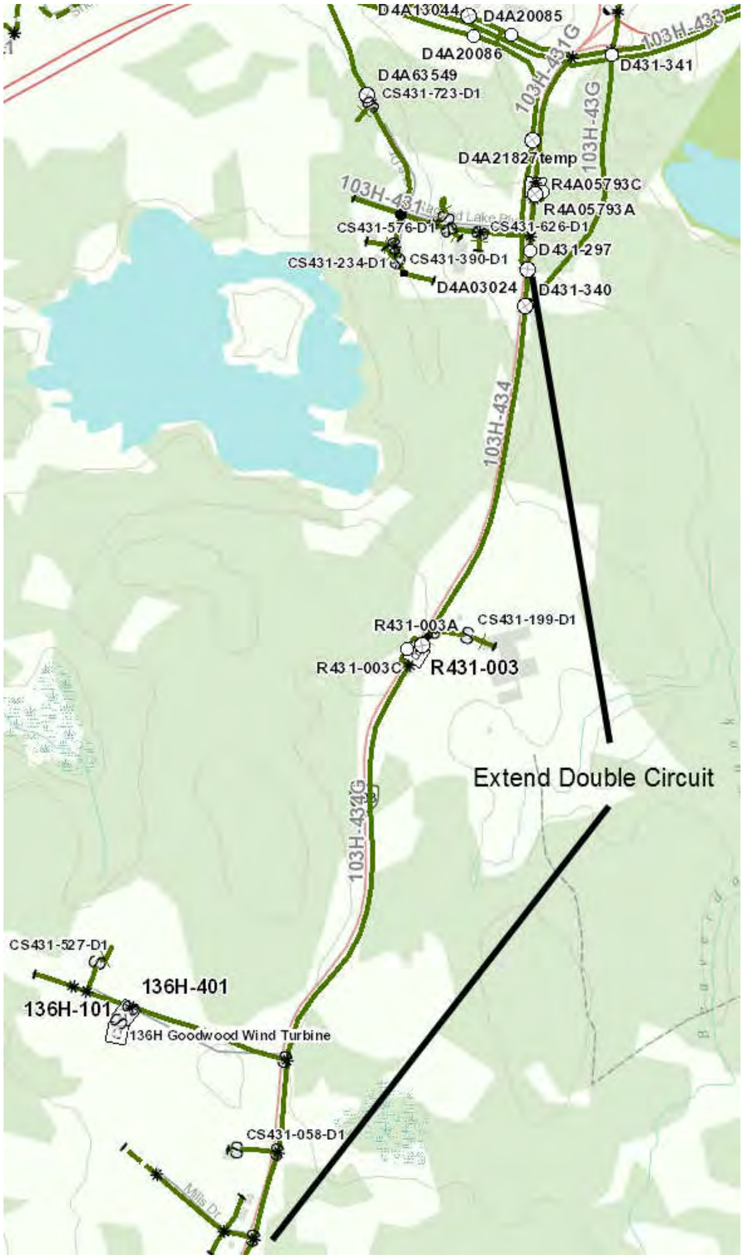


Figure 14 **Alternative 103H/129H-A; Prospect Road Double Circuit Extension**

Additionally, a fourth feeder would be created at 129H-Kearney Lake, to reduce the overall loading on 129H-413. This feeder would exit the substation and cross Highway 102, in a double circuit configuration with 129H-413. The feeder would then continue along Kearney Lake Road, to Castle Hill Drive. The supply to Castle Hill Drive would be changed to the new feeder. A new open point would also be added on Kearney Lake Road, where 129H-412 currently crosses the road, near the Dunbrack Street intersection. Refer to Figure 15 below for a general outline of this new feeder.

Figure 15 Alternative 103H/129H-A; New 129H-Keaney Lake Feeder

With the introduction of this new feeder, further load reductions can be realized through the reconfiguration of 129H-413. Utilizing the new feeder's supply along the Bedford Highway, load could be transferred to this feeder, through operating existing switches. An overview of these feeder reconfigurations can be seen in Figure 16 below.

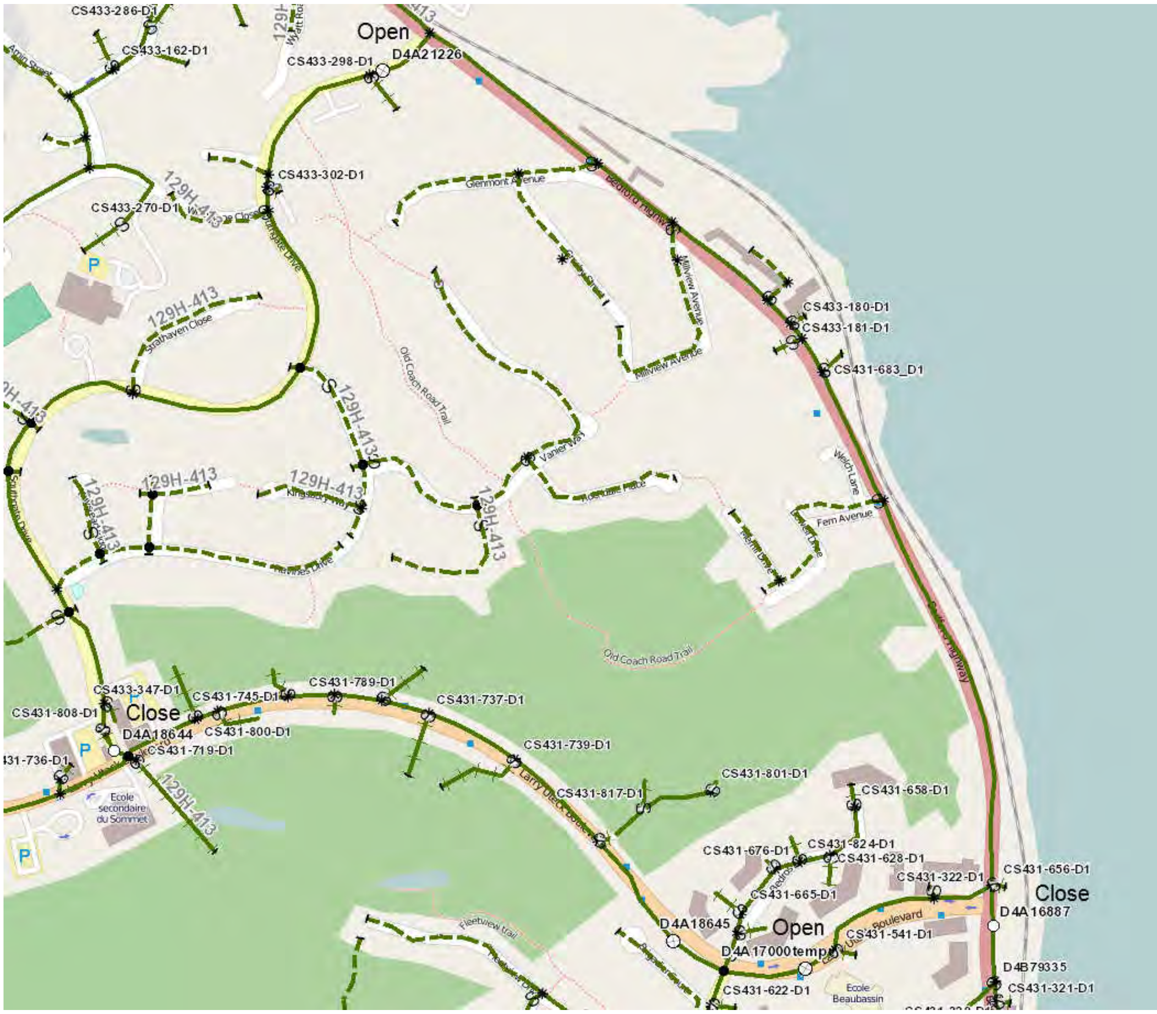


Figure 16 Alternative 103H/129H-A; 129H-Kearney Lake Reconfiguration

5.2.2 Alternative 103H/129H-B Additional 103H-Lakeside Transformer

Alternative 103H/129H-B would see the addition of a 138kV-26kV 25/33/42MVA transformer installed at the 103H-Lakeside substation. This new transformer would initially provide three new feeders to the 103H-Lakeside substation and reduce loading at 129H-Kearney Lake via load transfers to these new feeders. Provisions for a fourth feeder would be considered, in the future, as required.

The three new feeders would be routed via the transmission corridor from 103H-Lakeside into the Bayers Lake Industrial Park. Two of the new feeders would supply the area north of the transmission corridor on Horseshoe Lake Drive, extending to Chain Lake Drive. The third feeder, would supply the southern portion of the Bayers Lake Industrial Park. Refer to Figure 17 below for a general outline of these new feeders.

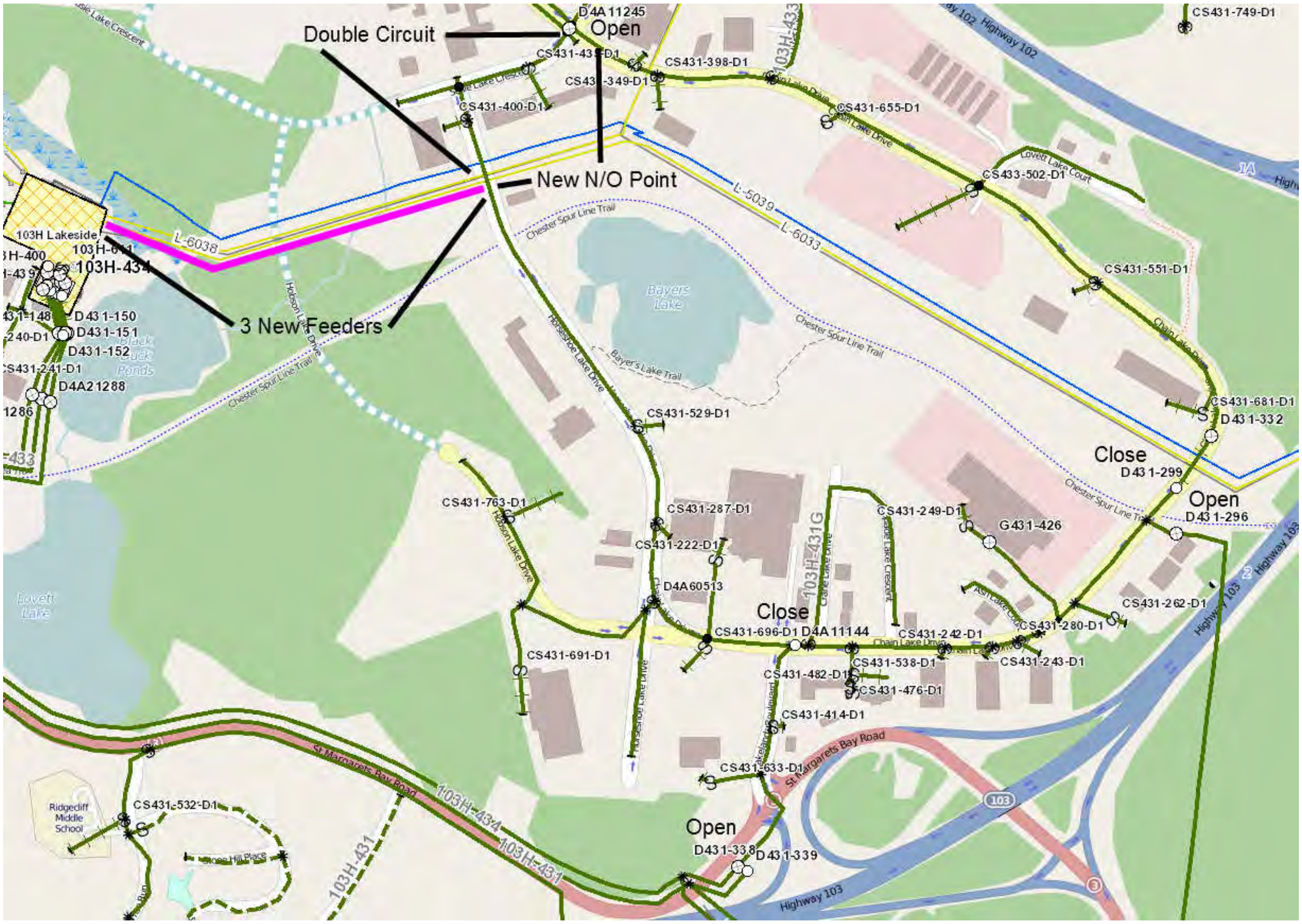


Figure 17 **Alternative 103H/129H-B; New 103H-Lakeside Feeders**

With the reduction in load on 103H-431, a reduction of load on 103H-432 can be accomplished by extending the double circuit on St. Margaret's Bay Road to Greenhead Road. This would enable the transfer of load from 103H-432 to 103H-431, to this point. Refer to Figure 18 below for a general outline of this feeder reconfiguration.

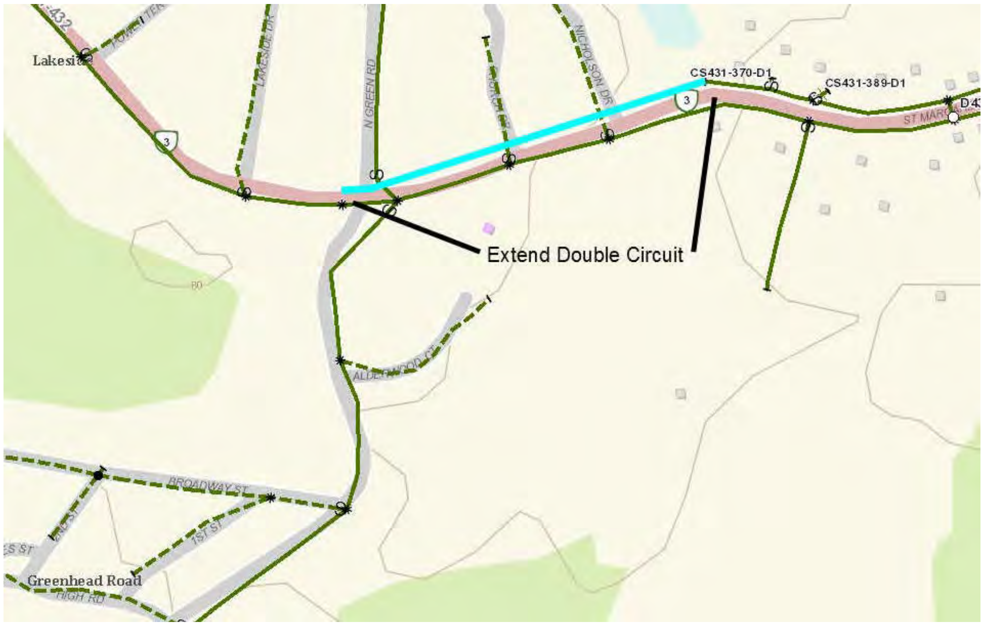


Figure 18 **Alternative 103H/129H-B; 103H-432 Load Reduction**

As outlined in the previous alternative, further feeder reconfigurations of 103H-Lakeside feeders would see an extension of the double circuit along Prospect Road, reducing load on 103H-434. Given that the existing load on this feeder is primarily radial, load reductions can only be achieved through extending the existing double circuit. Given that Prospect Road is capable of being supplied by three feeders (103H-431, 103H-433 and 103H-434), extending the double circuit beyond Ragged Lake Boulevard will enable the transfer of load from 103H-434 to another feeder.

The initial extension of this double circuit would extend from Ragged Lake Boulevard to Mills Drive and supplied by 103H-431, via Ragged Lake Boulevard. Further extension of this double circuit would be dependent on the rate of load growth, in the future. Refer to Figure 19 below for a general outline of the double circuit extension.

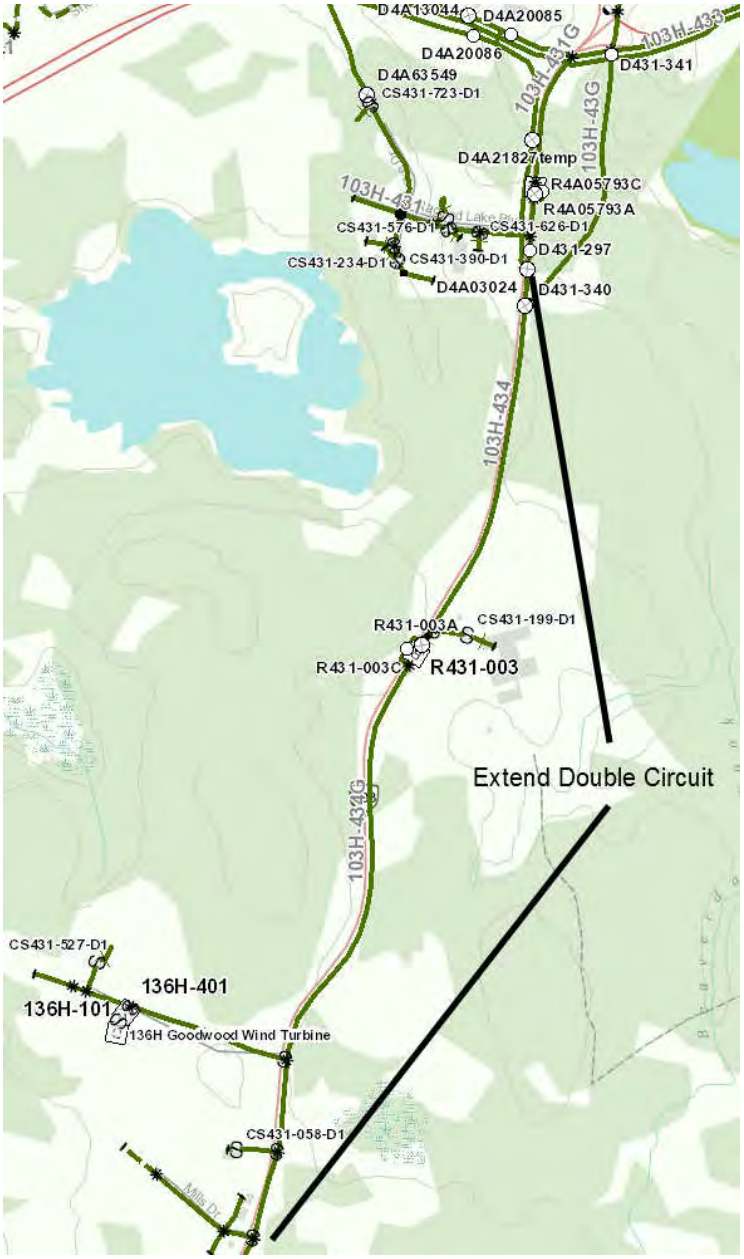


Figure 19 **Alternative 103H/129H-B; Prospect Road Double Circuit Extension**

Load reductions at 129H-Kearney Lake would be realized through transferring load to the Chain Lake Drive feeders. Initially, these new feeders would have sections of both 129H-411 and 129H-412 transferred to them, utilizing the existing feeder tie points, on Lacewood Drive. Refer to Figure 20 below for a general outline of this feeder reconfiguration.

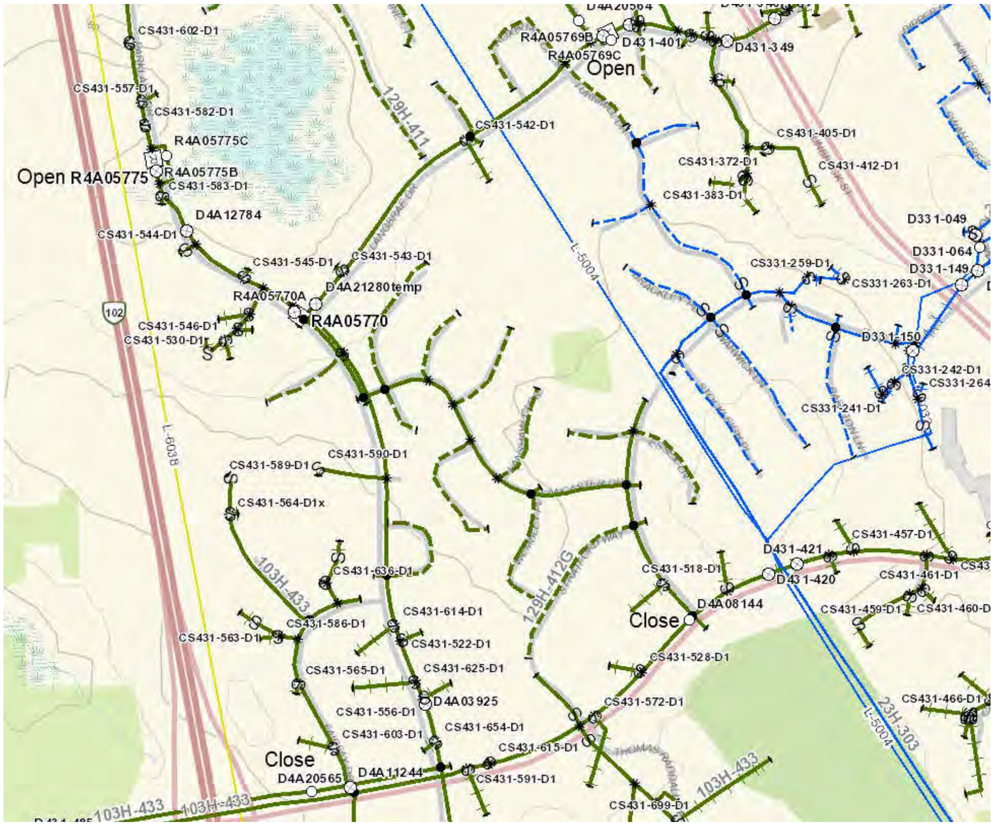


Figure 20 Alternative 103H/129H-B; 129H-Kearney Lake Load Transfer

Similar to Alternative 103H/129H-A, a fourth feeder would be created at 129H-Kearney Lake, to reduce the overall load on 129H-413. This feeder would exit the substation and cross Highway 102, in a double circuit configuration with 129H-413. The feeder would then continue along Kearney Lake Road, to Castle Hill Drive. The supply to Castle Hill Drive would be changed to the new feeder. A new open point would also be added on Kearney Lake Road, where 129H-412 currently crosses the road, near the Dunbrack Street intersection. Refer to Figure 21 below for a general outline of this new feeder.

Figure 21 **Alternative 103H/129H-B; New 129H-Keaney Lake Feeder**

With the introduction of this new feeder, further load reductions can be realized through the reconfiguration of 129H-413. Utilizing the new feeder's supply along the Bedford Highway, load could be transferred to this feeder, through operating existing switches. An overview of these feeder reconfigurations can be seen in Figure 22 below.

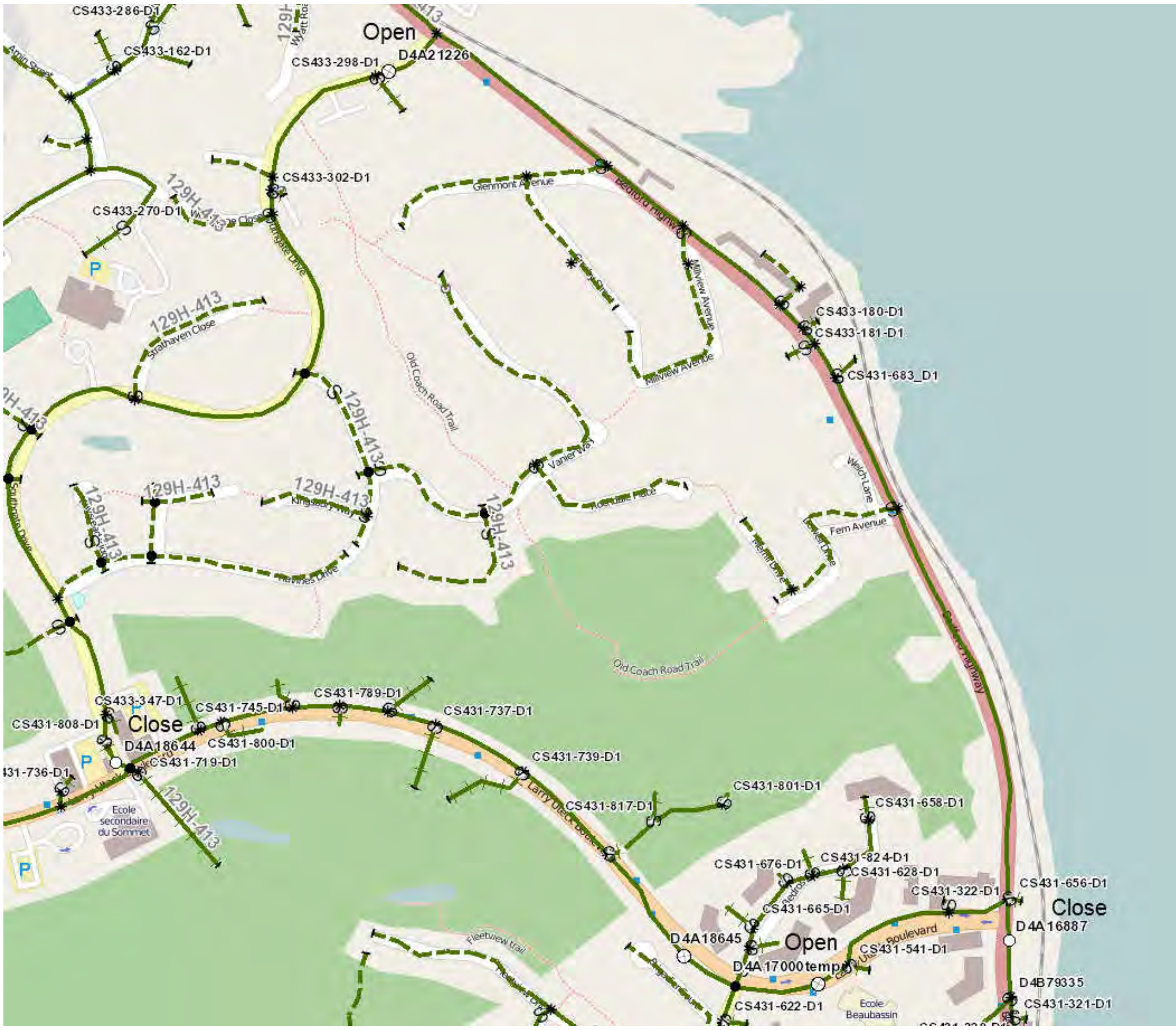


Figure 22 Alternative 103H/129H-B; 129H-Kearney Lake Reconfiguration

5.2.3 Alternative 103H/129H-C 129H-Kearney Lake Transformer Addition

Alternative 103H/129H-C would see the addition of a 69-25kV 25/33/42MVA transformer at 129H-Kearney Lake. This new transformer would initially supply three feeders to reduce loading on the current 129H-Kearney Lake feeders and meet the anticipated load growth in the surrounding areas. Additionally, feeder reconfigurations would be required at 103H-Lakeside to reduce loading on heavily loaded feeders.

The first of these feeders would exit the substation, similarly to the new 129H-Kearney Lake feeder outlined in the previous alternatives. This feeder would utilize the existing pole line, in a new double circuit configuration to Castle Hill Drive. The supply to Castle Hill Drive would then change from 129H-412, to this new feeder. A new open point would also be added on Kearney Lake Road, where 129H-412 currently crosses the road, near the Dunbrack Street intersection. Refer to Figure 23 below for a general outline of this new feeder.

Figure 23 **Alternative 103H/129H-C; New 129H-Keaney Lake Feeder-A**

With the introduction of this new feeder, further load reductions can be realized through the reconfiguration of 129H-413. Utilizing the new feeder's supply along the Bedford Highway, load could be transferred to this feeder, through operating existing switches. An overview of these feeder reconfigurations can be seen in Figure 24 below.

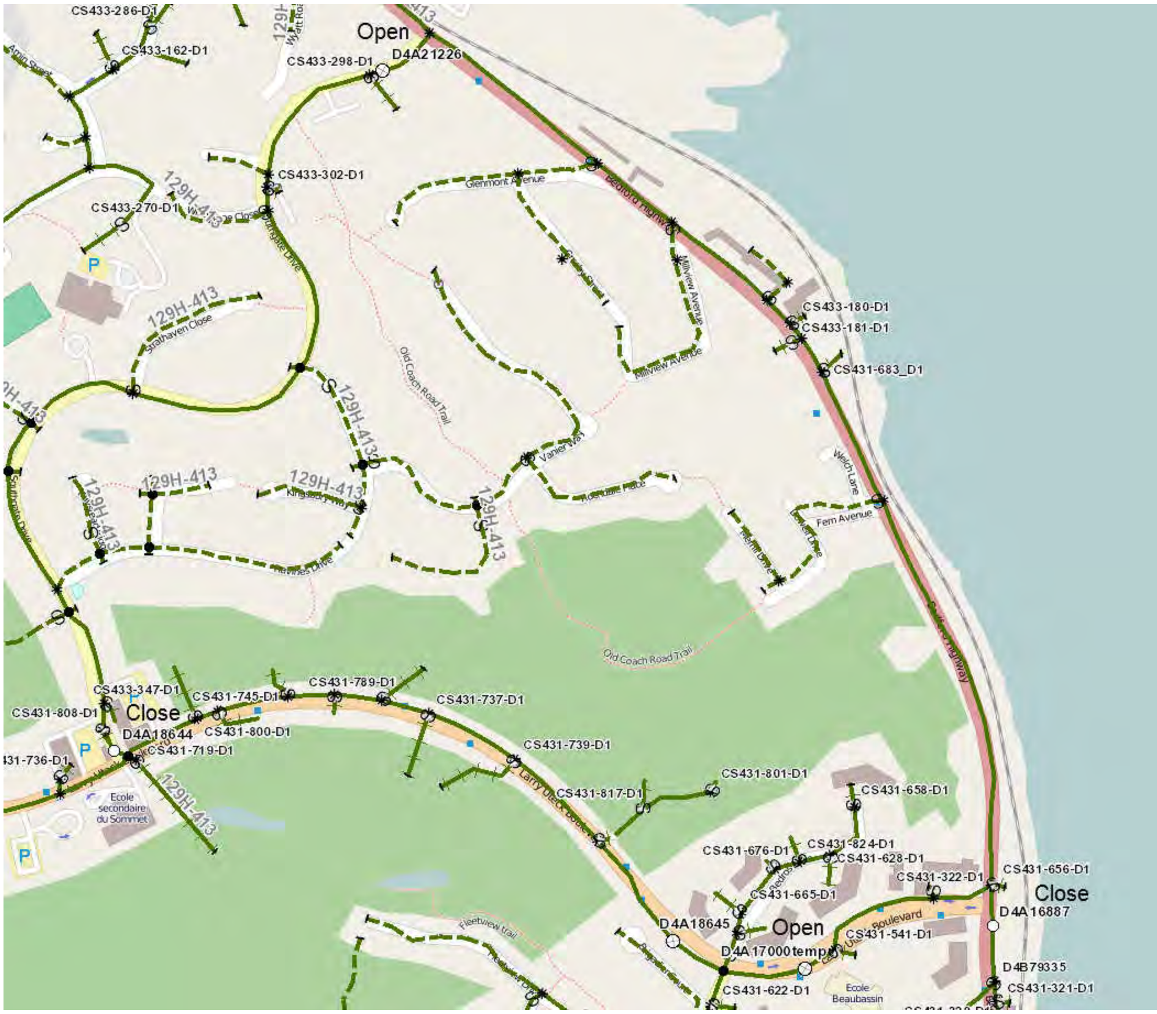


Figure 24 **Alternative 103H/129H-C; 129H-Kearney Lake Reconfiguration -A**

The second new feeder to be created at 129H-Kearney Lake would utilize the existing 129H-413 feeder tap that extends south of the substation, parallel to Highway 103. This feeder would initially remove a small portion of load from 129H-413, but in combination with the proposed reconfiguration (next portion) would provide an additional feeder into the Clayton Park area. Refer to Figure 25 below for a general outline of this new feeder.

Figure 25 **Alternative 103H/129H-C; New 129H-Kearney Lake Feeder-B**

The initial feeder reconfigurations associated with the second new 129H-Kearney Lake feeder would create an additional feeder supplying the Clayton Park area, via Farnham Gate Road. This new feeder would be capable of reducing load on both 129H-411 and 129H-412, as well as enable the transfer of load from 103H-433 (via Lacewood Drive). An overview of these feeder reconfigurations can be seen in Figure 26 below.

Figure 26 **Alternative 103H/129H-C; 129H-Kearney Lake Reconfiguration -B**

The third new feeder created with the addition of the new transformer at 129H-Kearney Lake would be utilized for the future growth of the Larry Uteck Boulevard area. This feeder would exit the substation and end adjacent to the existing 137H-414, on Kearney Lake Road. As the anticipated development of the Larry Uteck Boulevard area continues on the western side of Highway 103, this new feeder would be used to supply this new load. Refer to Figure 27 below for a general outline of this new feeder.

Figure 27 **Alternative 103H/129H-C; New 129H-Kearney Lake Feeder-C**

As outlined in the previous alternatives, a reconfiguration of 103H-Lakeside feeders would see an extension of the double circuit along Prospect Road, reducing load on 103H-434. Given that the existing load on this feeder is primarily radial, load reductions can only be achieved through extending the existing double circuit. Given that Prospect Road is capable of being supplied by three feeders (103H-431, 103H-433 and 103H-434), extending the double circuit beyond Ragged Lake Boulevard will enable the transfer of load from 103H-434 to another feeder.

The initial extension of this double circuit would extend from Ragged Lake Boulevard to Mills Drive and supplied by 103H-433, via St. Margaret's Bay Road. Further extension of this double circuit would be dependent on the rate of load growth, in the future. Refer to Figure 28 below for a general outline of the double circuit extension.

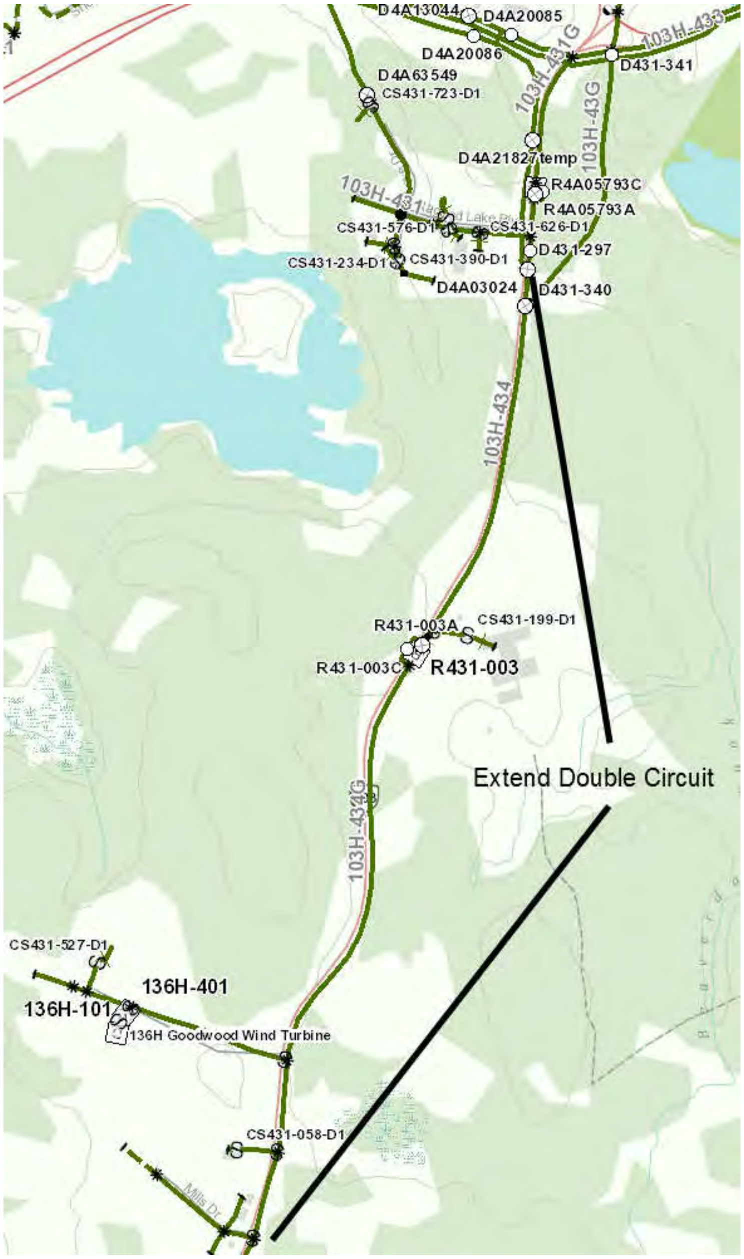


Figure 28 **Alternative 103H/129H-C; Prospect Road Double Circuit Extension**

A reduction of load on 103H-432 would be accomplished through the initial extension of the double circuit on St. Margaret's Bay Road to Greenhead Road. This would enable the transfer of load from 103H-432 to 103H-431. Future extensions of this double circuit will be required, as load continues to develop. Refer to Figure 29 below for a general outline of this feeder reconfiguration.

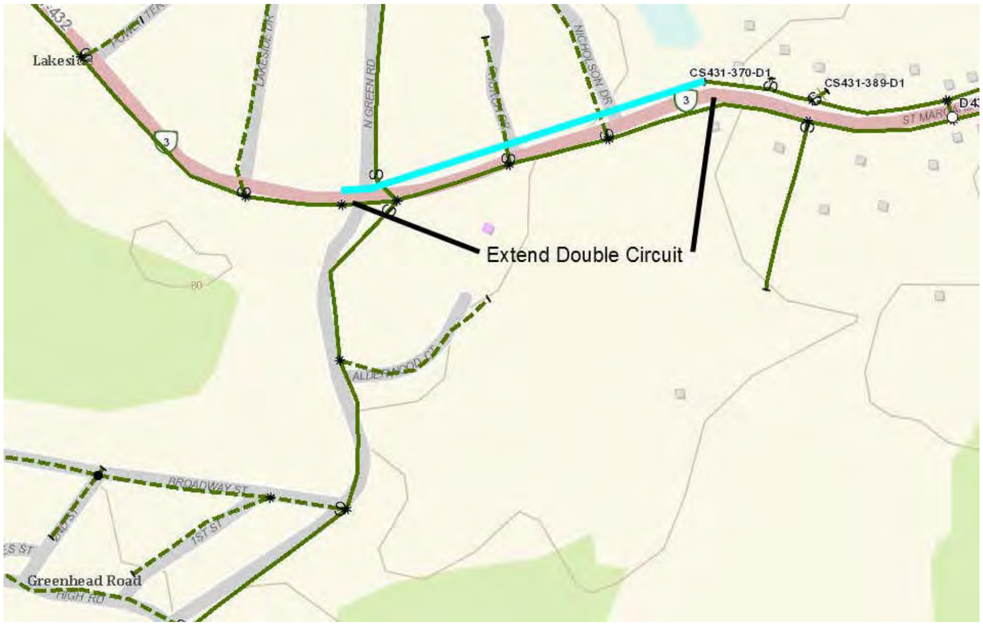


Figure 29 **Alternative 103H/129H-C; 103H-432 Load Reduction**

5.2.4 Recommend Alternative New 103H-Lakeside Transformer

The recommended alternative for this portion of the study is the implementation of a new 138-25kV 25/33/42MVA transformer at 103H-Lakeside, for the 2017/2018 peak loading period. The installation of a transformer at this location will provide the capacity for the anticipated load growth in the Lakeside/Timberlea area, as well as being able to supply a portion of the future conversions of 23H-Rockingham.

It is also recommended that a fourth feeder be created at 129H-Kearney Lake, in 2016, to reduce load on 129H-413, in anticipation of continued development in the area.

5.3 20H-Spryfield Load Growth

The 20H-Spryfield service area is in the midst of continued residential growth. Given the close proximity to the downtown Halifax core, as well as the nearby industrial parks (Bayers Lake and Ragged Lake), residential development has seen a significant increase in the last several years. This growth is projected to continue in the near future. This continued growth, of the islanded 12kV at 20H-Spryfield, needs to be addressed.

An examination of the loading at 103H-T63, which supplies 69kV to 20H-Spryfield via L-5039, indicates that the transformer has exceeded 133% of its nameplate rating, under peak loading conditions. Given the continued growth in Spryfield, the continued exceeding of the transformer's rating (103H-T63) is inevitable. A plan to mitigate this overload is required.

For the 2014 capital year, 12kV load reductions (through conversion to 25kV), at 20H-Spryfield have been recommended to reduce the total loading on 103H-T63, for the 2014/2015 winter peak. These conversions are required for all of the alternatives outlined below, in order to reduce the overall peak load at 20H-Spryfield below the 2013/2014 peak.

Alternative 20H-A would see the replacement of 103H-T63 with a transformer with a 60MVA rating. In replacing this transformer with one of a larger rating, the current overload condition (on 103H-T63) would be removed for the foreseeable future. This alternative would also allow for the continued load growth in the 20H-Spryfield service area to continue for the next several years, until the cumulative load at the substation approaches 54MVA. Loading beyond this level represents a contingency violation, in that there would not be enough capacity available in the event of a failure of 20H-T2 and the installation of a mobile substation.

Alternative 20H-B would see the replacement of 103H-T63 with a transformer with a 50MVA rating. In addition to the replacement of 103H-T63, conversions of some of the 12kV load to 25kV would also occur. The conversions would continue to ensure the peak loading of 20H-Spyrfield remains below 54MVA. This alternative would allow for the continued development on the 12kV system, while at the same time ensuring the peak loading does not exceed the contingency violation at 54MVA.

Alternative 20H-C would see the complete conversion of the 12kV at 20H-Spryfield over a 15 year period. The conversion of this 12kV load to 25kV would remove a large islanded load that has no transfer capabilities with any of the adjacent substations. A new 69-25kV source would also be added to the 20H-Spryfield substation, as 12kV load is reduced. These conversions would require significant investment in both capital and resources to ensure completion.

Alternative 20H-D would see the resupply of 20H-Spryfield at 138kV. This alternative would require the temporary installation of a new 138-69kV transformer at 103H-Lakeside. This alternative would also require the installation of a new tap off of the L-6033 and rebuilding of L-5039 from 34H-Geizers Hill to 20H-Spryfield to a 138kV standard. Two new 138-12kV 15/20/25MVA transformers would need to be installed. This alternative would require significant capital investment, through the construction of line tap and rebuilding of the L-5039 to 138kV. Additional significant investments would be required to rebuild the existing 20H-Spryfield substation to 138kV, while minimizing the duration of outages for the 20H-Spryfield customers.

Further detail of each alternative can be found below.

5.3.1 Alternative 20H-A Replace 103H-T63

This alternative would see the replacement of 103H-T63 (20/26.7//29.9MVA) with a larger 60MVA unit. This larger unit will provide additional capacity to the area for the foreseeable future, without consideration of the 12kV contingency capacity at 20H-Spryfield.

The replacement of 103H-T63 with a 60MVA unit would provide the additional capacity on the 69kV system that supplies 20H-Spryfield. This increase in size would also allow for a longer duration outage, for maintenance purposes of L-5004, from 90H-Sackville. This increased capacity will support load growth within the 20H-Spryfield area for the foreseeable future, given the current growth rate in the 20H-Spryfield (0.9%).

Currently, the contingency capacity at the substation is 54MVA. This value was determined through the potential loss of the largest transformer (20H-T2 15/20/25//28MVA) and the installation of a 25MVA mobile transformer. In consideration of the replacement of 103H-T63 with a 60MVA unit, it would also be recommended that 20H-T1 (currently 15/20//22.4MVA) be replaced with a 15/20/25MVA unit, as the load approaches 54MVA, in 2022. This increase in capacity of 20H-T1 would raise the contingency capacity of the 20H-Spryfield distribution to 58MVA, which is closer to the rating of the new 103H-T63.

This alternative would also include additional costs, when the load on L-5039 exceeds 60MVA. At this point of loading, the construction costs of double circuiting the current 69kV transmission line (L-5039) would be required, as per the existing looping policy. While this would not be anticipated until 2032/2033 timeframe, the significant cost in line design, construction and land make this alternative cost prohibitive.

Figure 30 Alternative 20H-A; Replace 103H-T63

5.3.2 Alternative 20H-B 20H-Spryfield Load Reduction

Alternative 533S-B would see the replacement of 103H-T63 with a 30/40/50MVA unit. The selection of this size transformer ensures that the 60MVA looping criteria will not be violated, as well as ensuring that the loading at 20H-Spryfield does not enter into a contingency violation.

In addition to replacing 103H-T63, a reduction of the 12kV load supplied by 20H-Spryfield through conversions to 25kV would take place. The initial conversions would reduce the 20H-Spryfield load by 3MVA. Conversions would commence at the northern end of the 20H-Spryfield service area utilizing the existing 25kV feeders, to minimize outages. Subsequent conversions would convert the eastern portions of the 20H-Spryfield load to 25kV, beginning in 2018. An overview of these conversions is outlined below in Figure 31.

The initial conversion will create additional feeder ties between 2H-Armdale and 103H-Lakeside. The overall benefit of these conversions will localize the 12kV around the 20H-Spryfield substation, while enabling greater diversity of configurations of the 25kV feeders.

Figure 31 Alternative 20H-B; 20H-Spryfield Load Reduction

5.3.3 Alternative 20H-C 20H-Spryfield Conversions

Alternative 20H-C would see the complete conversion of the 20H-Spryfield substation from 12kV to 25kV. This would be accomplished through an initial conversion of the 20H-T1 load and replacing 20H-T1 with a 69kV-25kV 25/33/42MVA unit. Upon installation of the new 25kV source, conversions would be continued until the eventual removal of 20H-T2.

The initial conversions of this alternative would be supplied via 2H-Armdale, until the installation of the new 25kV source at 20H-Spryfield.

This alternative would require significant capital investment not only in through the conversion of the 12kV load to 25kV, but also in the substantial upgrades required to the 20H-Spryfield substation. This alternative would require the removal of a portion of the 12kV bus and switchgear, to enable the installation of the 25kV equipment, all while serving the remaining 12kV customers.

This alternative would add an additional 25kV source adjacent to the Halifax Peninsula, adding more transfer capacity to the peninsula and to 103H-Lakeside.

5.3.4 Alternative 20H-D Resupply 20H-Spryfield at 138kV

Alternative 20H-D would see the supply of 20H-Spryfield changed from 69kV to 138kV. This would be accomplished by rebuilding the existing 69kV structures between 34H-Geizer's Hill and 20H-Spryfield to a 138kV standard. This would include the off road structures, as well as the roadside structures within the existing routing.

A temporary replacement of 103H-T63 would be required until the L-5039 between 34H-Geizer's Hill and 20H-Spryfield is completed. At that point in time, the 138-69kV transformer could be utilized in another application. Additionally, the two substation transformers at 20H-Spryfield would need to be replaced. It is recommended that the transformers be replaced with two 15/20/25MVA 138kV-13.2kV units. In ensuring that both units are similarly sized, the primary contingency for the substations would increase from 54MVA to 58MVA.

5.3.5 Recommended Alternative Replace 103H-T63

Alternative 20H-B 20H-Spryfield load reduction has been chosen of the selected alternative. This alternative enables the creation of additional feeder ties between 2H-Armdale and 103H-Lakeside, while reducing the present and future loading at 20H-Spryfield through planned conversions.

This alternative will also see the replacement of 103H-T63 with a 138kV-69kV 30/40/50MVA unit, in 2015. In an effort to reduce overloading of the existing 103H-T63, it is further recommended that the initial conversions be completed prior to the 2014/2015 winter peak.

This alternative will allow for continued load growth to occur for the foreseeable future, without the need for the implementation of the more costly alternatives outlined above.

A detailed outline of the 20H-Spryfield load reduction is outlined in the recommendations section of this study.

5.4 23H-Rockingham Load Growth

The area supplied by 23H-Rockingham is seeing continued growth. This growth is occurring in Clayton Park, as well as in Fairview. Considering that 23H-Rockingham is islanded 12kV, similar to 20H-Spryfield, there is a need to monitor the load growth within the area, so as to no overload the existing transformer 23H-T51, to a point of failure.

Similar to 20H-Spryfield, the alternatives to avoid prolonged overloading of 23H-T51 are limited to load reductions (through conversions to 25kV) or increasing the capacity at 23H-Rockingham.

Alternative 23H-A would see the replacement of 23H-T51 with a larger unit (30MVA). This additional capacity would be capable of supplying the 23H-Rockingham growth for the foreseeable future. Given the size of the substation property, the replacement of the existing transformer is possible with minor substation alterations.

Increasing the capacity of this islanded 12kV substation beyond the rating of the largest mobile substation (25MVA) would require additional contingency capacity be available in the event of a failure of the substation transformer. This additional capacity would be located at the 8H-Fairview substation and supplied via the 25kV from 104H-Kempt Road (104H-433). This 5MVA stepdown transformer would ensure enough capacity is available, in the event of a failure of 23H-T51.

Alternative 23H-B would see the placement of an additional 69kV-12kV transformer at the 23H-Rockingham substation. This additional transformer would be capable of providing enough capacity for the foreseeable future.

Alternative 23H-C would see the conversion of 12kV to 25kV, as new load develops, maintaining the current level of loading at 23H-Rockingham. These conversions can occur in a planned manor so as to not exceed the nameplate rating of 23H-T51.

Alternative 23H-D would see the total conversion of 23H-Rockingham to 25kV over a number of years. These conversions would enable the retirement of 23H-Rockingham, a section islanded 12kV.

Further details of each alternative can be found below.

5.4.1 Alternative 23H-A Replace 23H-T51

Alternative 23H-A considers the anticipated load growth in the area supplied by 23H-Rockingham. This alternative would increase the size of the existing transformer (15/20/25MVA) to a larger unit (30MVA), providing enough capacity for the foreseeable future. This replacement would coincide with the next significant development to commence in the 23H-Rockingham service area.

With the additional capacity add to the substation, an additional feeder would be added. This new feeder would be routed along the existing 23H-302 from the 23H-Rockingham substation to the Bedford Highway. This new feeder would assume the loading along this routing. Additionally, a small portion of the Bedford Highway would be rebuilt in a double circuit configuration, to reduce load on 23H-301. An overview of this new feeder can be seen in Figure 32 below.

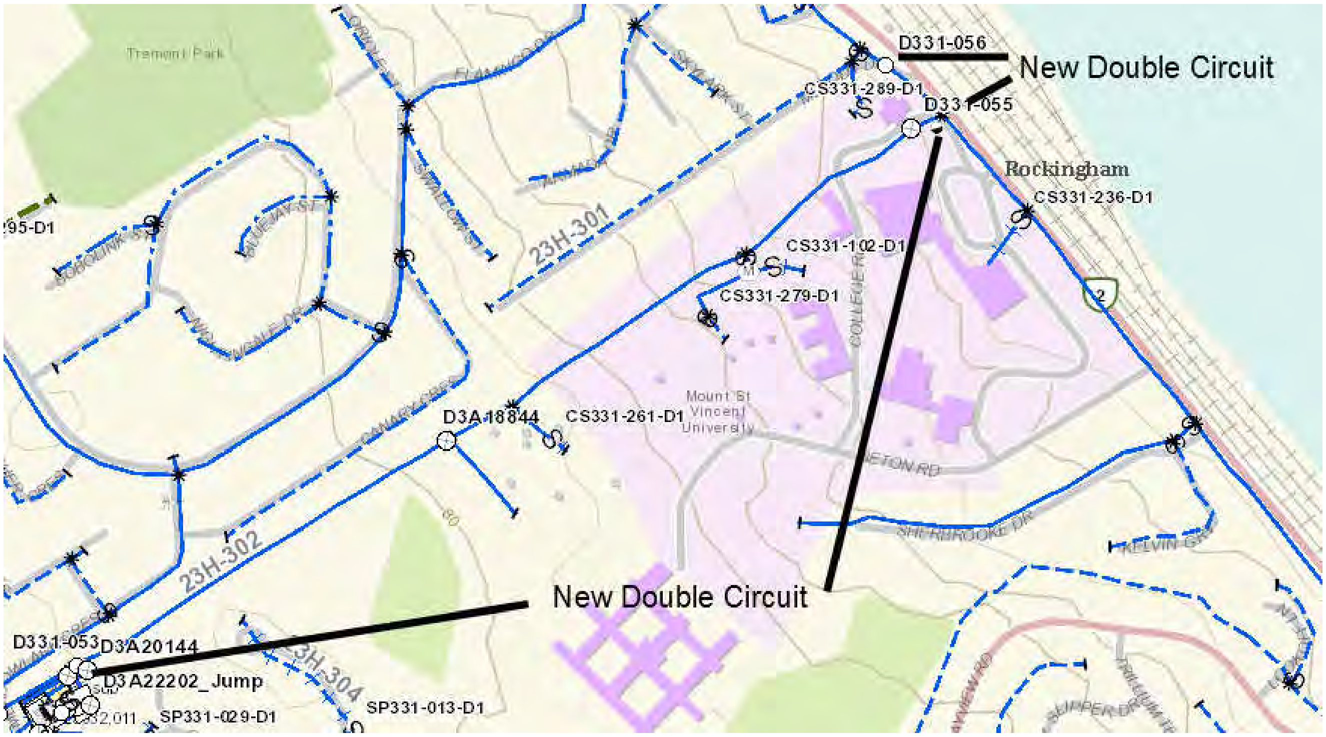


Figure 32 **Alternative 23H-A; New 23H-Rockingham Feeder**

While this alternative would offer enough capacity to meet the anticipated growth, there is potential that the anticipated growth exceeds these expectations and the new transformer enters into an overload state under peak loading conditions. To offset this potential overload, conversions to 25kV would also need to be considered in the future.

Given that the 12kV load supplied by 23H-Rockingham is islanded, there are no other 12kV supplies adjacent to 23H-Rockingham to transfer load in the event of a transformer failure. In replacing the existing 23H-T51 with a larger unit, consideration of the existing mobile transformer fleet needs to be considered. Currently the largest mobile transformer is 25MVA. Replacement of 23H-T51 with a larger unit would exceed the available capacity of the largest mobile transformers (5P and 6P) in the mobile substation fleet.

Alternatively, a 25-12kV 5MVA stepdown transformer could be installed at the 8H-Fairview substation to provide additional capacity, in the event of a failure of 23H-T51, under peak loading conditions. This transformer would be supplied by 103H-433, in a similar configuration to the previous 25-4kV transformer that was in-service, at this substation. The lone 12kV feeder would be capable of supplying 23H-302, via Deal Street. A general overview of this new stepdown placement can be seen in Figure 33 below.

Figure 33 **Alternative 23H-A; 25-12kV Stepdown at 8H-Fairview**

5.4.2 Alternative 23H-B Additional Transformer at 23H-Rockingham

Alternative 23H-B would see a 15/20/25MVA 69kV-13.2kV transformer added to the 23H-Rockingham substation. This additional capacity would be capable of meeting the anticipated load growth in the 23H-Rockingham service area for the foreseeable future. Each of these transformers would be capable of providing the contingency capacity for the other, in the event of a transformer failure. This second transformer would not be required until the peak load at 23H-Rockingham exceeds 25MVA. It is anticipated that this will occur during the 2015/2016 loading peak.

With the additional capacity added to the 23H-Rockingham substation, an additional three feeders would be added to the substation. Two of these feeders, would be routed along the existing 23H-302. Similar to Alternative 23H-A, one of these feeders would assume the 23H-302 load along this routing and continue north on the Bedford Highway. The second feeder would extend south on the Bedford Highway to Bayview Drive. This section of feeder would assume the existing load along 23H-302 and also be available to meet the forthcoming load developments in the area. An overview of these two feeders can be seen in Figure 34 below.

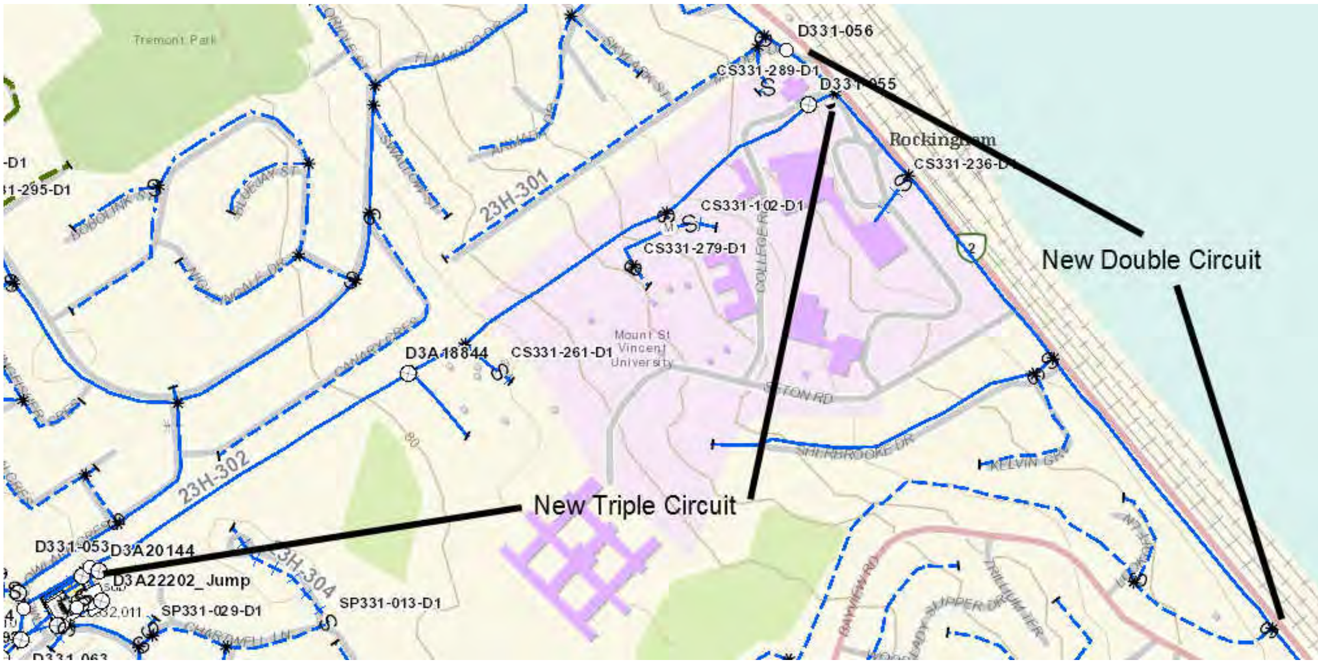


Figure 34 **Alternative 23H-B; Two New 23H-Rockingham Feeders**

The third new feeder to be created would extend in a double circuit configuration along Radcliffe Drive, to the transmission ROW. This new double circuit would then extend to just beyond the tap after D331-065, as indicated in Figure 35 below. This new feeder would enable the load transfers from either 23H-303 or 23H-304, as required.

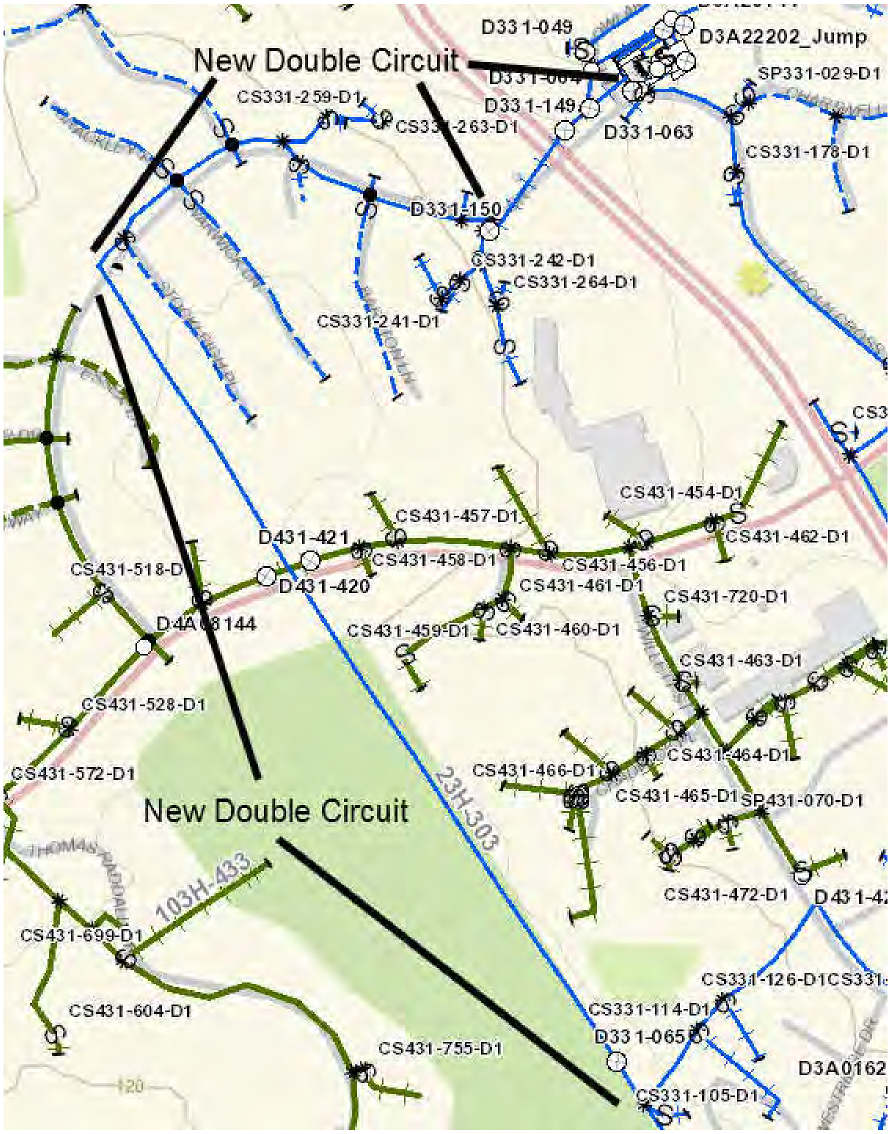


Figure 35 Alternative 23H-B; Third New 23H-Rockingham Feeder

The additional capacity would allow for maintenance to be completed on 23H-T51, during low load periods, without the need for the mobile substation. The additional capacity would be largely unused capacity, until the bulk of the anticipated load materializes.

Unfortunately, given the size of existing 23H-Rockingham substation property, the ability to add an additional transformer would be very difficult and make for a congested area within the substation. In consideration of the above, the installation of an additional transformer at 23H-Rockingham would be difficult to implement and would also create a stranded asset for the foreseeable future.

5.4.3 Alternative 23H-C Retire 23H-Rockingham

Alternative 23H-C would see the planned reduction of 12kV load through conversion to 25kV. These conversions would commence as the forecasted peak loading at 23H-Rockingham exceeds the nameplate rating of 23H-T51 (25MVA) in 2015. Conversions would continue on a planned basis over an 8 year period, with the 23H-Rockingham substation decommissioned and retired in 2025.

These conversions will initially be supplied by the current Halifax Peninsula feeders and create a variety of new feeder ties, as the progress of conversions continue. With this in mind, it is recommended that these conversions commence in Fairview, as indicated in Figure 36.

The conversion of 23H-Rockingham, similar to the 20H-Spryfield conversions would see portions of the existing 12kV infrastructure rebuilt to 25kV standards. This would include pole and transformer replacements, as well as reconductoring, as the future feeder configurations would dictate.

While this alternative requires significant capital investment, it enhances the reliability in the 23H-Rockingham service area, through these conversions and the increased ability to reconfigure the feeders, from different 25kV sources.

Upon completion of the conversions and the retirement of 23H-Rockingham substation, L-5032 could be retired, as there is no requirement for 69kV into the Rockingham area. This alternative could also enable the upgrade of L-5004 from 90H-Sackville to 34H-Geizer's Hill, from 69kV to 138kV when required, as there would be no other substations. This future requirement of L-5004 would need to be fully studied, prior to implementation.

Figure 36 Alternative 23H-C; 23H-Rockingham Initial Load Reduction

5.4.4 Alternative 23H-D Convert 23H-Rockingham to 25kV

Alternative 23H-D would see the retirement of the existing 12kV equipment at 23H-Rockingham and the installation of a new 69-25kV 25/33/42MVA transformer at the 23H-Rockingham substation. This would be accomplished through the conversion of the existing 12kV distribution load to 25kV over a four year period.

The conversions would be accelerated, in comparison to those outlined in Alternative 23H-C, to add additional capacity to the area, to enable load transfers between 23H-Rockingham and 129H-Kearney Lake. Unlike Alternative 23H-C the conversion of the existing 12kV load to 25kV would only be supplied by adjacent 25kV sources, for a short period of time, prior to the installation of the new 25kV source at 23H-Rockingham.

Similar to Alternative 23H-C, this alternative would require significant capital investment, albeit in a shorter timeframe than alternative 23H-C. Additional capital investment would be required through the retirement of the 12kV substation equipment and the installation of 25kV equipment.

While costly to implement, over a four year period, the enhanced configurability of the 25kV load, not only in the 23H-Rockingham area, but also the adjacent areas, would enhance reliability to all customers within the area.

5.4.5 Recommended Alternative Retire 23H-Rockingham

While this alternative, Alternative 23H-C, does not add the configurability that one of the other alternatives, nor does it add additional capacity to the 23H-Rockingham substation, it will reduce the 12kV load at 23H-Rockingham near the anticipated load growth rate, to ensure the peak loading on 23H-T51 does not exceed its nameplate rating.

It is recommended that the initial conversions commence in 2015, as previously indicated. Subsequent conversions will be determined through an examination of the peak loading data, as well as load forecasts.

6.0 RECOMMENDATIONS

In summary, the following provide the impetus for the recommendations contained herein:

- The forecasted load growth in Peninsular Halifax and adjacent areas is anticipated to continue growing at a rate of 0.87% per year for the foreseeable future. Consideration of the proposed developments before HRM council and those that are in various stages of construction may cause a slight increase to the calculated growth rate.
- Additional capacity on the Halifax Peninsula will enable the ability to supply the transfer load and avoid the installation of a mobile substation on the Peninsula for the foreseeable future.
- The loading on 103H-T63 has peaked above 133% of its nameplate rating.
- The loading at 20H-Spryfield is approaching its contingency capacity with limited ability to add additional capacity to the 12kV system in the area.
- The load at 23H-Rockingham is approaching the limits of the largest mobile substation in the NSPI fleet.

Accordingly, this study recommends several large capital investments beginning in 2014 through to 2028. These recommendations include the installation of new substation transformers, as well as the reduction of 12kV load through conversions to 25kV. The recommendations of this study will also yield the creation of new feeder ties, which will enable greater feeder flexibility in the future. The justification for these capital investments can be found in section 5 of this report, as well as in the Economic Assessment Models (EAM) found in Appendices C through F.

The Economic Assessment Model in reference to the increased Halifax Peninsula loading can be found in Appendix C. The results of this EAM indicate the need for additional transformation at 2H-Armdale, in 2015. The EAM also coincides with the recommendation to add four new feeders to the 2H-Armdale substation. The details of the new substation transformer and feeders are indicated in the following sections of this report.

The Economic Assessment Model in reference to the increased load growth in the 103H-Lakeside and 129H-Kearney Lake area can be found in Appendix D. The results of this EAM indicate the need for additional transformation at 103H-Lakeside, prior to the 2018/2019 peak loading period. The EAM also recommends the initial addition of three new feeders at 103H-Lakeside, with the potential to add another if required. This will enable load transfers from 129H-Kearney Lake. The details of the new substation transformer and feeders are indicated in the following sections of this report.

The Economic Assessment Model in reference to the replacement of 103H-T63 and 20H-Spryfield load reductions can be found in Appendix E. The results of this EAM indicate that the 103H-T63 be replaced in 2015 and initial 20H-Spryfield load reductions be completed in 2014. These initial load reductions are required to offset the continued load growth on the 20H-Spryfield 12kV system, while reducing the potential 2014/2015 winter peak below the 2013/2014 level. The 20H-Load reductions and 103H-T63 transformer replacement are further outlined in the following sections of this report.

The Economic Assessment Model in reference to the retirement of 23H-Rockingham can be found in Appendix F. The results of this EAM indicate that the conversion of 23H-Rockingham load to 25kV should commence in 2015 and continue until the retirement of the substation in 2025. The details and scope of each section of conversion are further outlined in the following sections of this report.

A detailed outline of the components of each of these alternatives is outlined below, organized by capital year completion. The advancement or deferment of these projects may be influenced by factors including; residential/commercial development, feeder reconfigurations and/or ranking of capital projects within the ACE plan.

Feeder reconfigurations will be at the discretion of Central Regional Engineering, to enable accommodation of any unforeseen circumstances outside of the scope of this study.

6.1 Recommendations by Capital Year

6.1.1 2014 Capital Year

The capital items recommended to be completed in 2014 include are required to reduce the overall loading on 103H-T63, prior to the 2014/2015 winter peak. Additionally, the preliminary engineering and design for the replacement of 103H-T63 and the new transformer to be installed at 2H-Armdale will occur.

6.1.1.1 20H-Spryfield Load Reduction Part-1

This portion of the project will reduce the load at 20H-Spryfield through conversion of a large section of 20H-302. This newly converted load will be initially supplied via 2H-411. Refer to Figure 37 below. The details of this work are as follows:

- Convert St. Margaret's Bay Road from the end of the 12kV to Chocolate Lake Road, including takeoffs

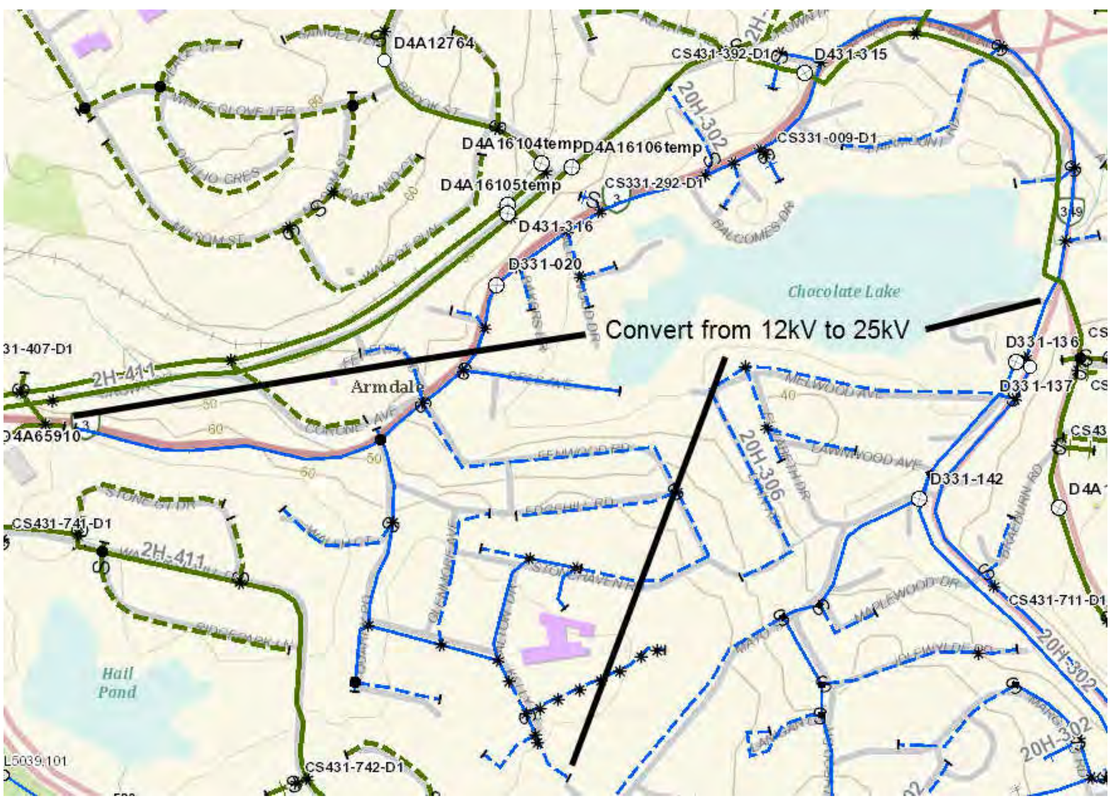


Figure 37 2014 20H-Spryfield Load Reduction, Part-1

6.1.1.2 20H-Spryfield Load Reduction Part-2

This portion of the project will continue to reduce the loading on 20H-Spryfield, through continued conversions to 25kV. This section of conversion will be supplied via the conversions in Part-1 and/or Tamarack Drive (2H-411). Refer to Figure 38 below. The details are as follows;

- Convert Mountain Road and Withrod Drive
- Convert Herring Cove Road, from Chocolate Lake Road to Winchester Avenue

Figure 38 2014 20H-Spryfield Load Reduction, Part-2

6.1.2 2015 Capital Year

The 2015 capital year will see the installation of a new transformer at 2H-Armdale with four new feeder exits. This new added capacity will allow for the reconfiguration of the Spryfield and Regency Park supplies. This new added capacity will also enable feeder reconfigurations at 103H-Lakeside, reducing the overall load between feeders.

Additionally, in 2015 the 23H-Rockingham conversions to 25kV will commence. The initial conversions will see the conversion of the southern portion of Fairview. The converted area will also create an additional feeder tie between Dutch Village Road and Northwest Arm Drive.

6.1.2.1 103H-T63 Replacement

This portion of the project will see the replacement of 103H-T63, to meet the load requirements at 20H-Spryfield.The current load on 103H-T63 (20H-Spryfield) will need to be transferred to L-5004, from L-5039 for the duration of this portion of the project. Refer to Figure 39 below. The details are as follows:

- Switch 20H-Spryfield supply to L-5004 at 34H-Geizer's Hill.
- Remove 103H-T63.
- Prepare location for the installation of new unit.
- Install new 138-69kV 30/40/50MVA transformer.

Figure 39 103H-T63 Replacement

6.1.2.2 New 2H-Armdale Transformer

This portion of the project will see the addition of a new 138-25kV 25/33/42MVA transformer at 2H-Armdale. The addition of this transformer to the 2H-Armdale substation will require additional work to both the existing 138kV and 25kV buses. Additionally, four new feeder exits will be created. The routing of these new feeders will be outlined in the next portion of this project. The details are as follows:

- Prepare 2H-Armdale substation for the addition of a new transformer, including pad and buswork installation
- Install new 138-25kV 25/33/42MVA transformer
- Create four new feeder exits, with terminations outside of the 2H-Armdale substation

6.1.2.3 2H-Armdale New Feeders

This portion of the project will create four new feeders, as outlined in the previous section of work. These new feeders will provide additional capacity to both the area and reduce load on adjacent feeders. The balancing of the new feeders will be completed by Central Regional Engineering. The details are as follows:

6.1.2.3.1 2H-Armdale –New Feeder A

This first new feeder will reduce loading on 104H-423, through initially transferring the 104H-423G section to the new feeder. Refer to Figure 40 below. The creation of this new feeder will be accomplished by the following:

- Double circuit existing feeder to the northwest of the substation along the transmission ROW, to the first tap.
- Extend Double circuit along Clinton Avenue, to Joseph Howe Drive
- Change Joseph Howe Drive tap to new feeder and close D431-190 (on Joseph Howe Drive)
- Open R4A05791 recloser on Mumford Road

Figure 40 2H-Armdale -New Feeder A

6.1.2.3.2 2H-Armdale –New Feeder B&C

These two new feeders will provide additional supplies to the St. Margaret's Bay Road and Herring Cove Road area via the Armdale Rotary. These feeders will supply the converted 20H-Spryfield 25kV load, a portion of 2H-411, as well as provide an additional feeder tie along St. Margaret's Bay Road. The supply to the Regency Park area will be changed from 103H-Lakeside to 2H-Armdale through changing the open points on St. Margaret's Bay Road. Refer to Figure 41 below. The creation of this new feeder will be accomplished by the following:

- Construct new feeder ducts along Chebucto Road to the Armdale Rotary and utilize the existing ducts around the rotary, to route feeders.
- Install a new N/O point on the upper circuit (currently 2H-411), on St. Margaret's Bay Road between existing 2H-411 supply and new.
  - o Close D4A20364 and open D431-309 on St. Margaret's Bay Road.

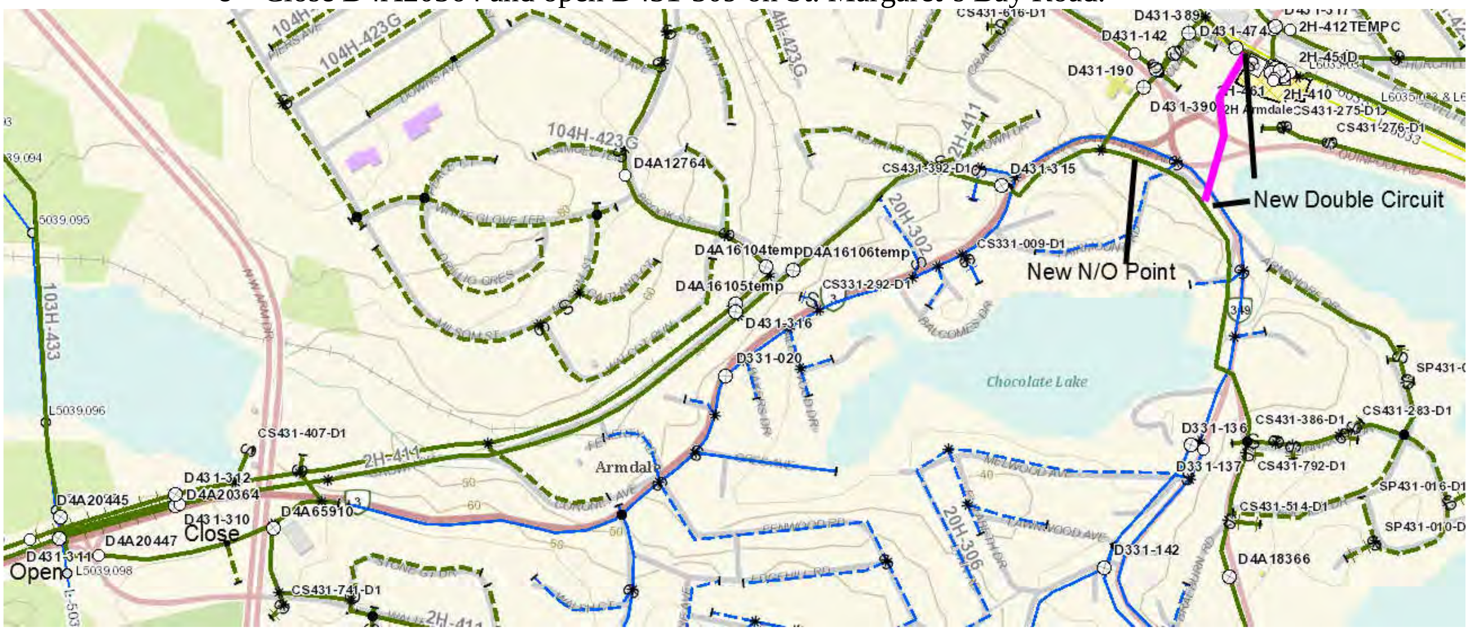


Figure 41 2H-Armdale -New Feeders B&C

6.1.2.3.3 2H-Armdale –New Feeder D

This new feeders will provide an additional feeder along Quinpool Road. This new feeder will be capable of reducing load on existing 2H-Armdale feeders, as well as 104H-Kempt Road feeders in the area. Refer to Figure 42 below. The creation of this new feeder will be accomplished by the following:

- Utilizing the ducts installed in 6.1.2.3.2, install new feeder to the Quinpool Road and Chebucto Road intersection.
- Extend new feeder to the end of Quinpool Road feeder.
- Remove tap from 2H-413, on the transmission structures, where it crosses Quinpool Road.
- Create a new N/O point on MacDonald Street, at the Quinpool Road intersection.

Figure 42 **2H-Armdale -New Feeder D**

6.1.2.4 23H-Rockingham Conversions Part-1

This portion of the project will reduce the 12kV loading at 23H-Rockingham, through initial conversions to 25kV. These initial conversions will create a new feeder tie between Dutch Village Road and Northwest Arm Drive. Refer to Figure 43 below. This will be accomplished by:

- Rebuild Rosedale Avenue, from Dutch Village Road to North West Arm Drive, with three phase 336, to a 25kV standard.
- Replace all transformers downline of D331-090, with 25kV units, as required.
- Open D331-090 and convert area downline.

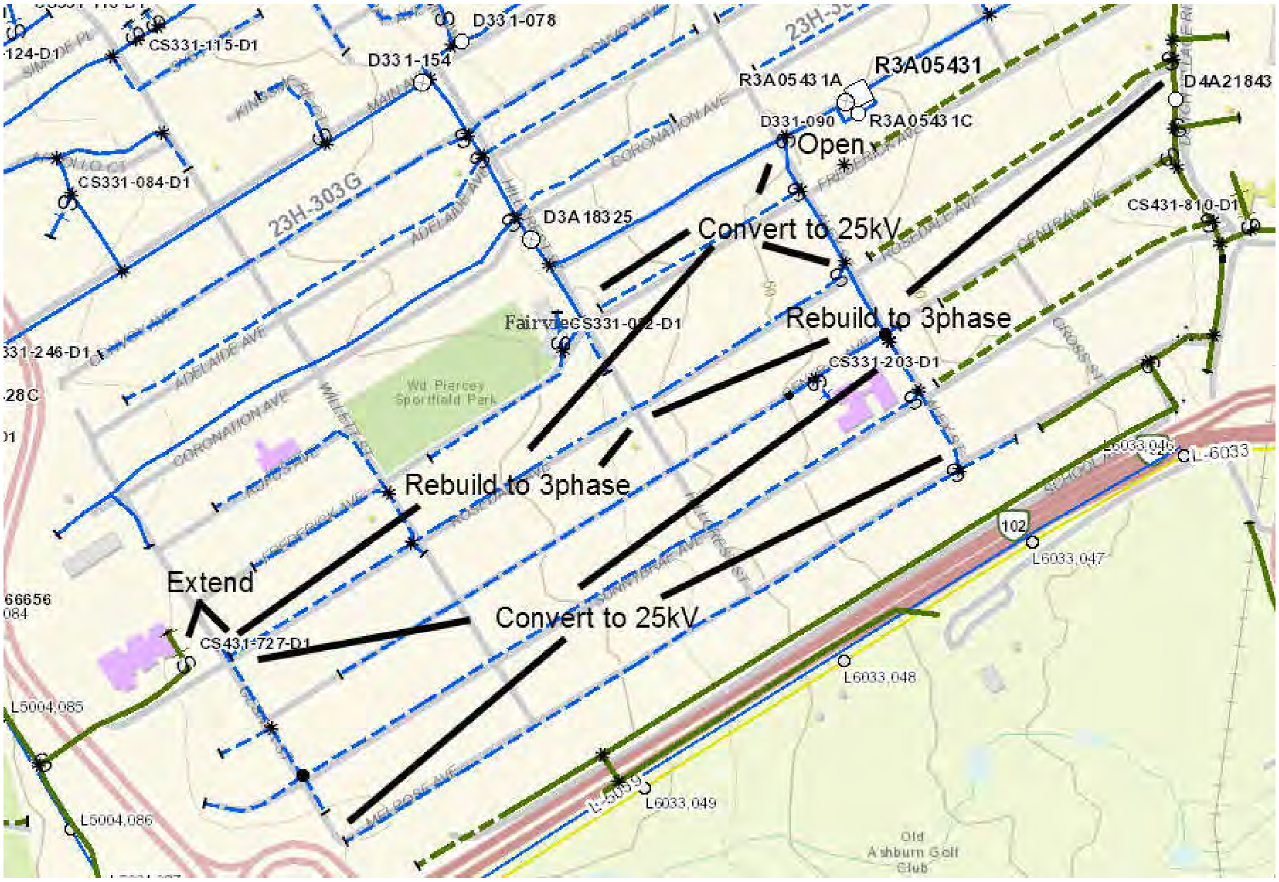


Figure 43 23H-Rockingham Conversions Part-1

6.1.3 2016 Capital Year

For 2016, the capital work includes feeder reconfigurations at 103H-Lakeside and 129H-Kearney Lake reducing the loading on heavily loaded feeders, through load transfers to other feeders.

Additionally, the second portion of 23H-Rockingham 12kV load conversions will occur. This portion of conversion will see the conversion of 23H-303G. This newly converted section will be supplied via Regency Park

6.1.3.1 103H-Lakeside Feeder Reconfiguration Part-1

This portion of the project will reduce loading on a heavily loaded radial 103H-Lakeside feeder through an extension of the existing double circuit on St. Margaret's Bay Road. This extension will transfer load from 103H-432 to 103H-431. Refer to Figure 44 below. This will be accomplished by:

- Extend 103H-431 in a double circuit configuration along St. Margarets Bay Road, to Greenhead Road.
- Transfer taps to new feeder.

Figure 44 103H-Lakeside Feeder Reconfigurations Part-1

6.1.3.2 103H-Lakeside Feeder Reconfiguration Part-2

This portion of the project will continue to cascade the feeder load reductions realized with the transfer of Regency Park to one of the new 2H-Armdale Feeders. With consideration of the load reduction on 103H-433, a portion of 129H-412 along Lacewood Drive can now be transferred to 103H-433.
Refer to Figure 45 below. This will be accomplished by:

- Install new N/O point on Rackcliffe Drive, at the intersection with Lacewood Drive.
- Close D4A08144.

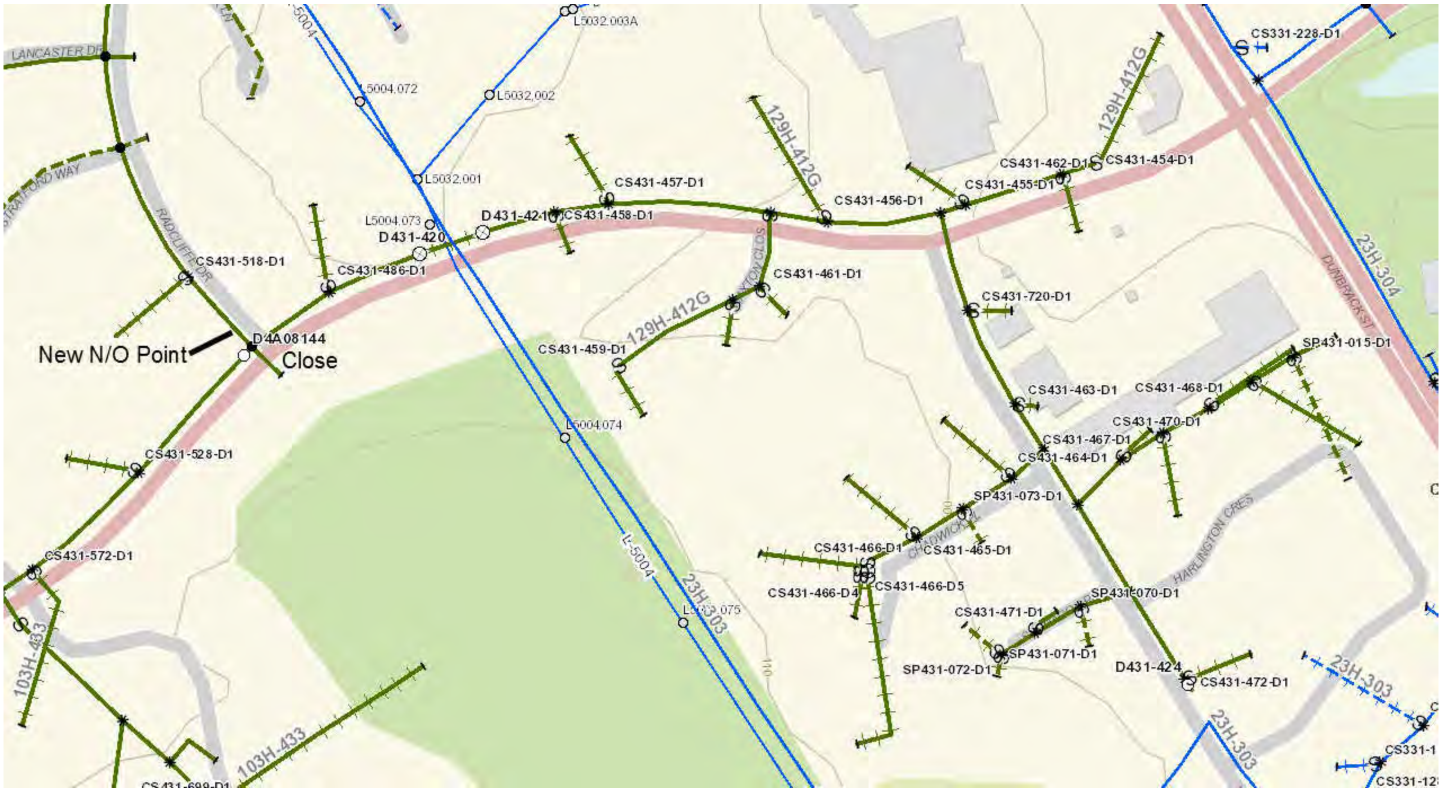


Figure 45 103H-Lakeside Feeder Reconfigurations Part-2

6.1.3.3 103H-Lakeside Feeder Reconfiguration Part-3

This portion of the project will reduce loading on 103H-434, through extending the double circuit along Prospect Road, from Ragged Lake Boulevard to Mills Drive. The new circuit in the double circuit will be supplied from 103H-431 (Ragged Lake Boulevard) initially. Refer to Figure 46 below. This will be accomplished by:

- Construct double circuit on Prospect Road, from Ragged Lake Boulevard to Mills Road.
- Transfer load along routing from 103H-434 to new feeder.

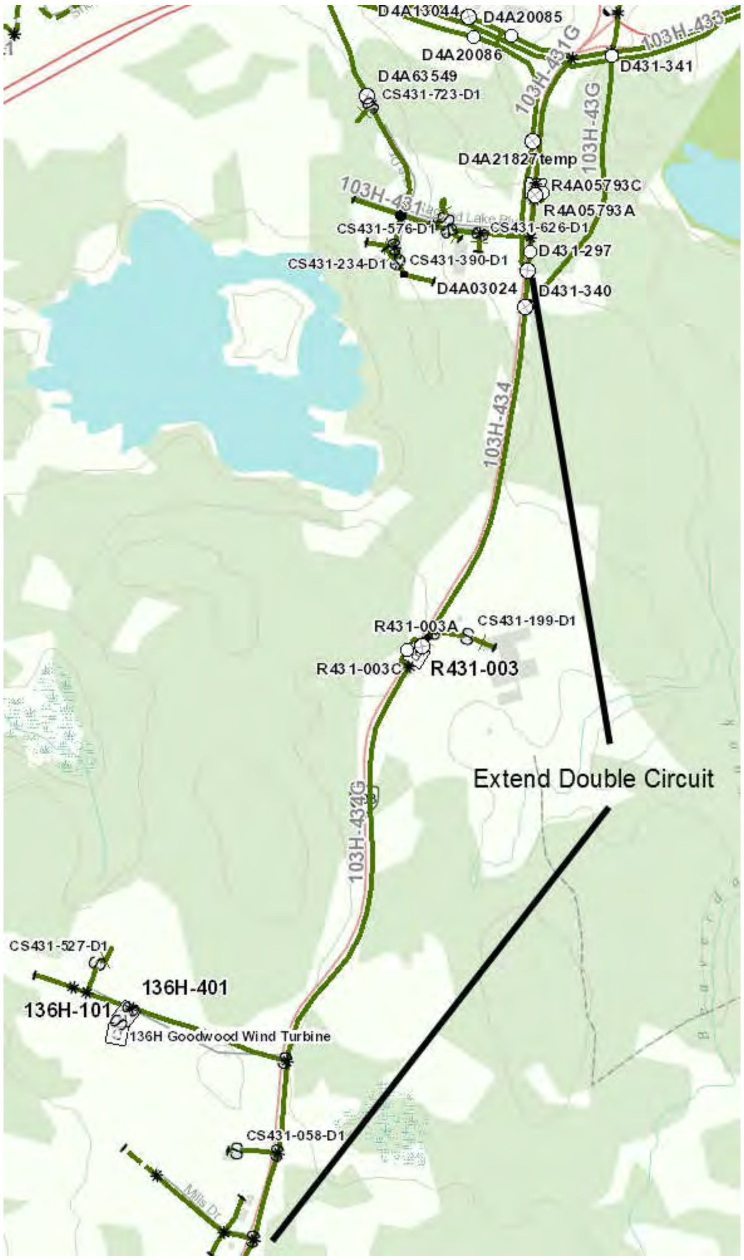


Figure 46 **103H-Lakeside Feeder Reconfigurations Part-3**

6.1.3.4 129H-Kearney Lake New Feeder

This portion of the project will create a new feeder at 129H-Kearney Lake. This new feeder will provide a feeder tie to 129H-413 and provide the necessary capacity to meet the anticipated load growth in the area. Refer to Figure 47 and below. This will be accomplished by:

- Add a new feeder and exit to the 129H-Kearney Lake substation.
- Extend the new feeder to Kearney Lake Road and continue down Kearney Lake Road to Castle Hill Drive, in a double circuit configuration with 129H-413.
- Supply Castle Hill Drive via the new feeder, installing a new N/O point with 129H-412.
- Install new N/O point at the Kearney Lake Road and Dunbrack Street intersection.

Figure 47 **129H-Kearney Lake; New Feeder**

6.1.3.5 129H-Kearney Lake Feeder Reconfiguration

This portion of the project will reconfigure 129H-413 and the new feeder, reducing load on 129H-413. This new will assume the load along the Bedford Highway, from Kearney Lake Road to Hammonds Plains Road. Refer to Figure 48 and below. This will be accomplished by:

- Open D4A16887 on the Bedford Highway, near the intersection with Larry Uteck Boulevard.
- Open D4A17000 on Larry Uteck Boulevard.
- Close D4A18644 on Southgate Drive, near the intersection with Larry Uteck Boulevard.
- Open D4A21226 on Southgate Drive, near the intersection with the Bedford Highway.

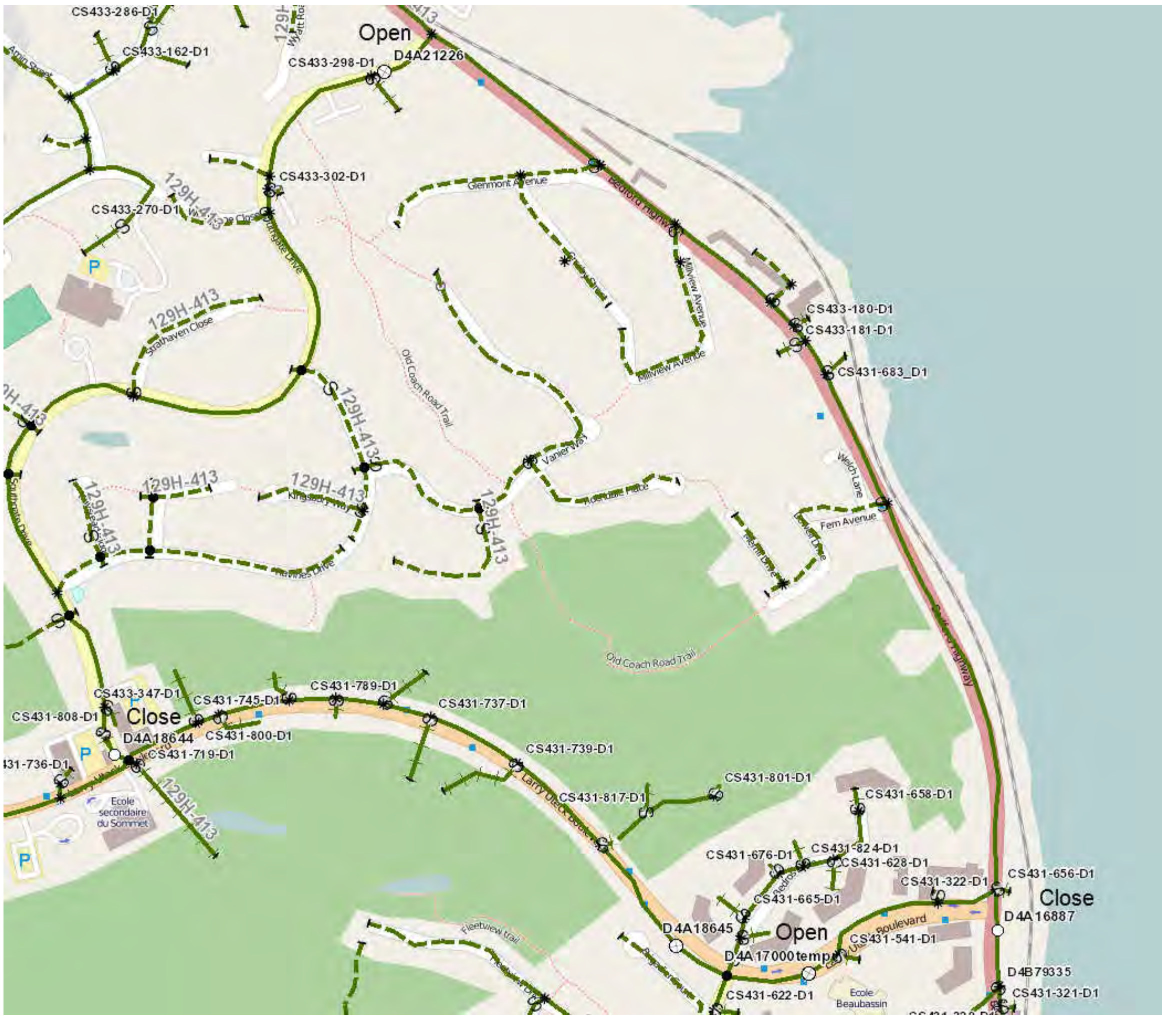


Figure 48 **129H-Kearney Lake Feeder Reconfigurations**

6.1.3.6 23H-Rockingham Conversions Part-2

This portion of the project will convert 23H-303G from 12kV to 25kV. This newly converted section will be supplied via Regency Park. Refer to Figure 49 below. This will be accomplished by:

- Open D221-068 along the L-5004 ROW.
- Create new N/C open point at the intersection of Birch Hill Drive and Upper Prince Street.
- Convert Main Avenue (from D331-068 to D331-078), including side streets, from 12kV to 25kV and supply via Washmill Lake Drive.

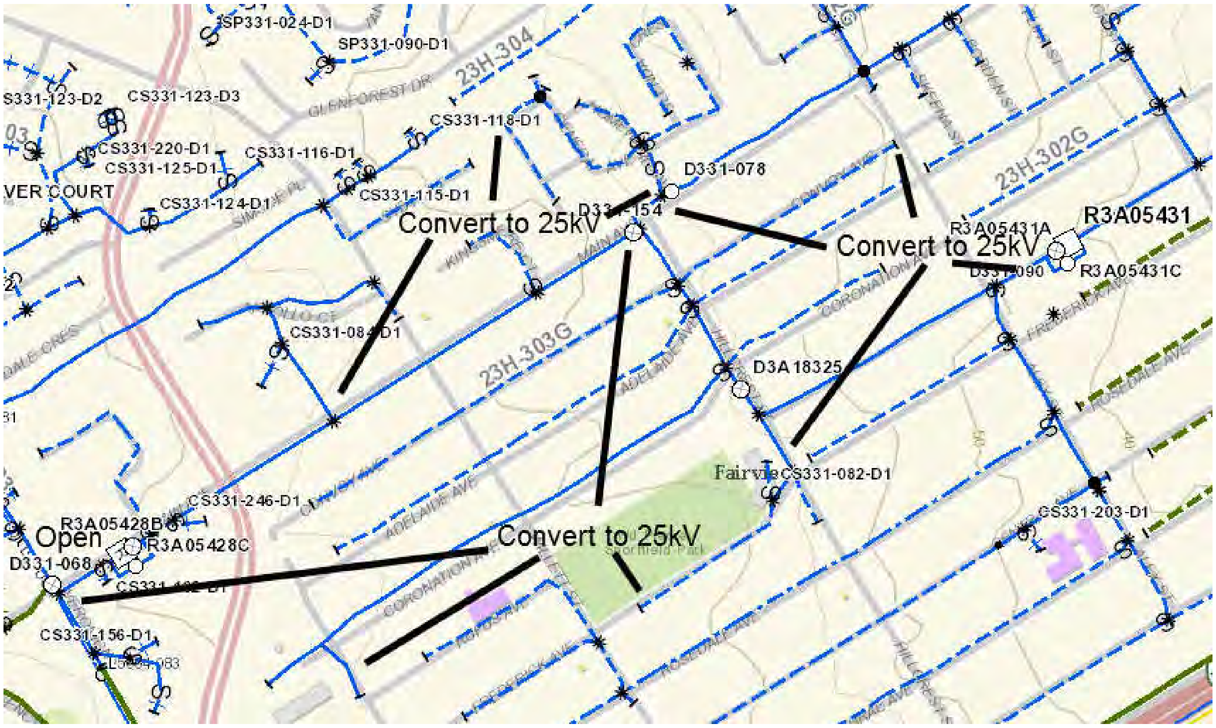


Figure 49 **23H-Rockingham Conversions Part-2**

6.1.4 2017 Capital Year

For 2017, the capital work includes the continuation of load reduction at 23H-Rockingham through conversion of 23H-302G to 25kV. These conversions will be supplied via Regency Park.

In addition to the conversion work, preparation for the installation of a new transformer at 103H-Lakeside will commence.

6.1.4.1 23H-Rockingham Conversions Part-3

This portion of the project will convert 23H-302G, around the former Halifax West School site. The area will be supplied via Dutch Village Road (currently 104H-433). Refer to Figure 50 below. This will be accomplished by:

- Open R3A0543.
- Ensure D331-078 is open on Main Avenue.
- Convert 23H-302G, from R3A0543 to the end of the feeder, as indicated below.

Figure 50 **23H-Rockingham Conversions Part-3**

6.1.5 2018 Capital Year

For 2018, the capital work includes the installation of a new 138-25kV transformer at 103H-Lakeside, with three additional feeders.

In addition to the new transformer installation, the continuation of the 12kV load reductions at 23H-Rockingham continue with the conversion of 23H-302, along the Bedford Highway, to 25kV.

6.1.5.1 Installation of New 138-25kV Transformer at 103H-Lakeside

This portion of the project will see the installation of an additional 138-26.4kV 25/33/42MVA transformer at 103H-Lakeside. Four new feeder exits will be created, with three being utilized initially. This will be accomplished by:

- Extend the current 25kV bus to accommodate the new feeders.
- Prepare new pad for transformer and install.
- Create four new feeder exits, with reclosers.

6.1.5.2 Installation of New 103H-Lakeside Feeders

This portion of the project will see the creation of three new feeders to supply the Bayers Lake and Clayton Park area, utilizing the existing transmission corridor to extend the feeders into Bayers Lake. Two of the feeders will continue on Horseshoe Lake Drive to Chain Lake Drive, via double circuit. The third feeder will supply the remaining portion of the Bayers Lake Industrial Park. Refer to Figure 51 below. This will be accomplished by:

- Construct three new feeders along the transmission corridor to Bayer's Lake Industrial Park.
- Construct a double circuit along Horseshoe Lake Drive, from where the new feeders exit the transmission corridor, to Chain Lake Drive via Susie Lake Crescent.
- Install a new N/O point on Chain Horseshoe Lake Drive, where feeders exit transmission corridor.
- Open D4A11245 on Chain Lake Drive, at the intersection with Susie Lake Crescent.
- Install new N/O Point on Chain Lake Drive, on the single feeder section after the Susie Lake Crescent intersection.
- Close D431-299 (Chain Lake Drive) and D4A111444 (Hobson Lake Drive). Open D431-296 (off of Chain Lake Drive, near the Chester Spur Line Trail).

Figure 51 **103H-Lakeside New Feeders**

6.1.5.3 103H-Lakeside Feeders Reconfiguration Part-3

This portion of the project will reconfigure two of the new 103H-Lakeside feeders through transferring load from two 129H-Kearney Lake Feeder (129-411 and 129H-412). This load reduction will modify a previous recommendation, as outlined in 103H-Lakeside Feeder Reconfiguration Part-2, through closing the new N/O point previously recommended. The reduction in load on these 129H-Kearney Lake feeders will enable a future reconfiguration of the 129H-Kearney Lake feeders. Refer to Figure 52 below. This will be accomplished by:

- Open R4A05775 on Parkland Drive.
- Open R4A05769 on Langbrae Drive.
- Close the N/O Point that was installed as part of recommendation 103H-Feeder Reconfiguration Part-2.
- Close D4A20565 on Lacewood Drive.

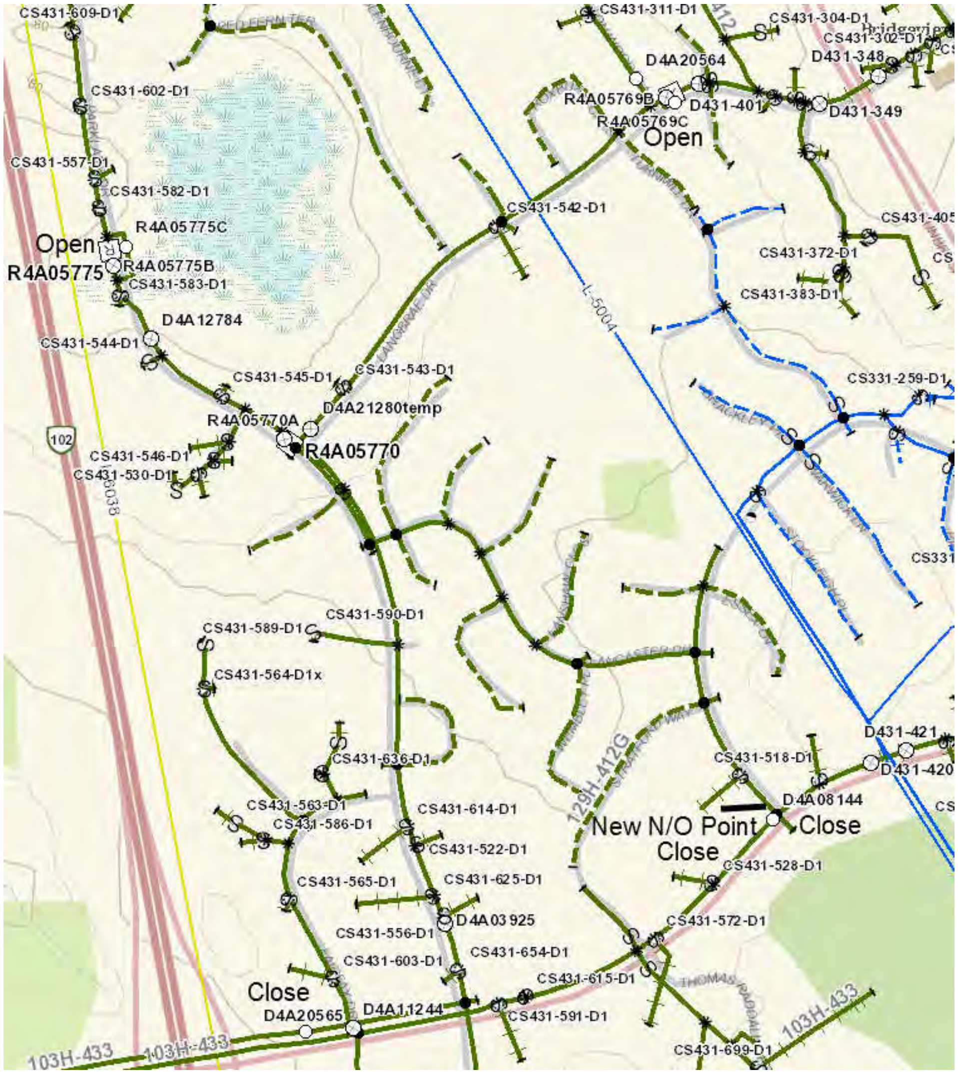


Figure 52 103H-Lakeside Feeder Reconfigurations Part-3

6.1.5.4 23H-Rockingham Conversions Part-4

This portion of the project will convert the remaining portion of 23H-302, along the Bedford Highway. The area will be supplied via the previous conversions along the Bedford Highway. Refer to Figure 53 below. This will be accomplished by:

- Open D3A18844, as well as the 23H-302 breaker.
- Ensure D331-056 (on the Bedford Highway) and D331-163 (off of Bedford Highway) are both open.
- Convert the areas, as indicated below.

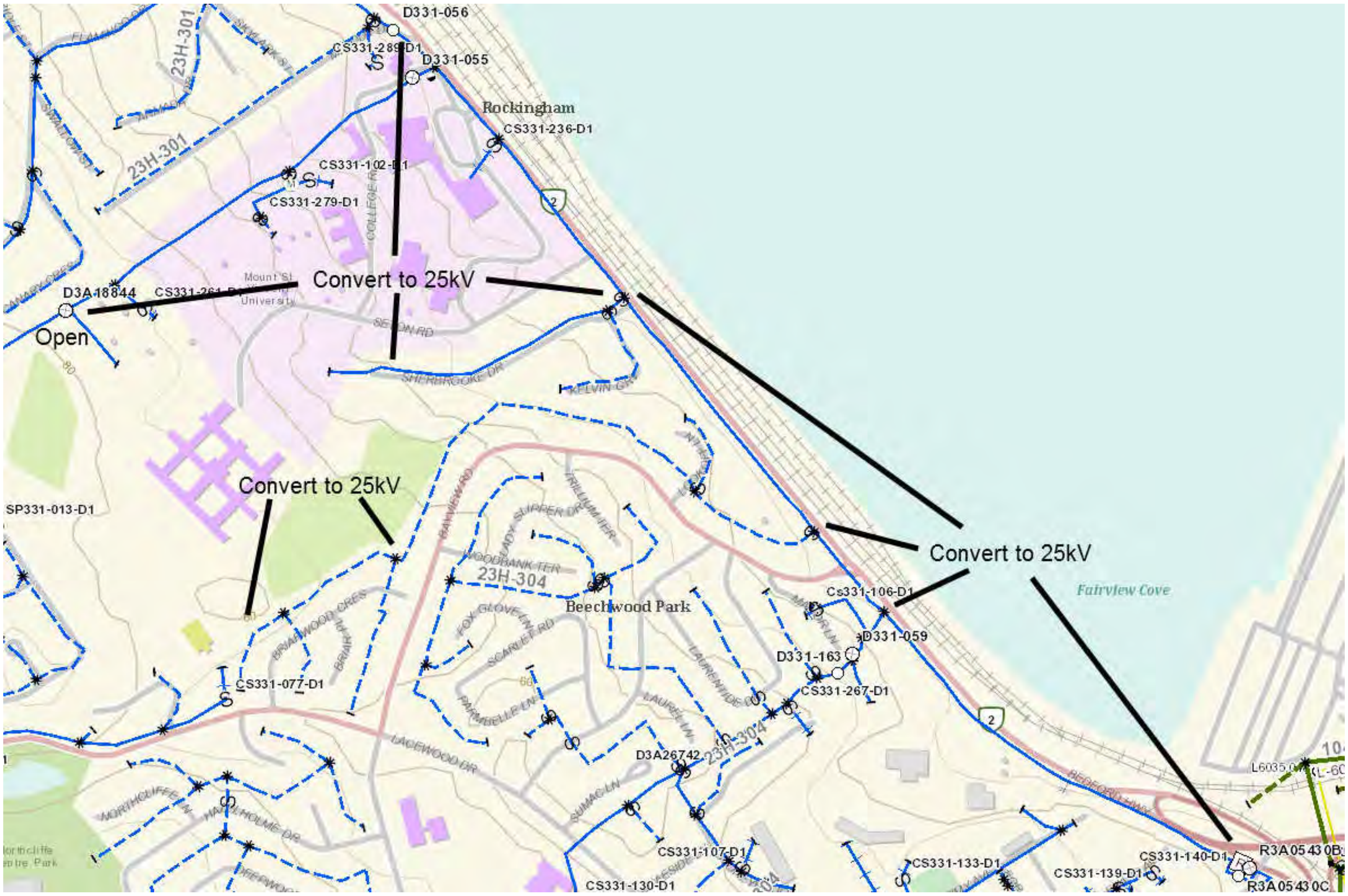


Figure 53 23H-Rockingham Conversions Part-4

6.1.6 2019 Capital Year

For the 2019 capital year, load reductions continue at both 20H-Spryfield, as well as 23H-Rockingham. The 23H-Rockingham service area will be further reduced with the conversion of the remaining 12kV section along the Bedford Highway. Due to the size of this portion of the project, work will be completed over a two year period.

The conversions at 20H-Spryfield include the conversion of the Cowie Hill area.

6.1.6.1 23H-Rockingham Conversions Part-5

This portion of the project will convert 23H-301, along the Bedford Highway. The area will initially be supplied via 129H-412. Refer to Figure 54 below. This will be accomplished by:

- Close D4A11704, on the Bedford Highway.
- Open Breaker 23H-301, at the 23H-Rockingham substation.
- Open D331-123 on the Bedford Highway.
- Convert 23H-301 as indicated below, along the Bedford Highway.

Figure 54 **23H-Rockingham Conversions Part-5**

6.1.6.2 20H-Spryfield Conversions Part-3

This portion of the project will further reduce the loading at 20H-Spryfield through the conversion of the Cowie Hill area. These conversions will commence from the end point of the conversions outlined in 20H-Spryfield Conversions Part-2 above. These conversions will be supplied via the Herring Cove Road feeders. Refer to Figure 55 below. This will be accomplished by:

- Convert Herring Cove Road to 25kV, from Winchester Avenue to Mont Street.
- Convert Cowie Hill Road to 25kV.
- Convert Highfield Street to 25kV.

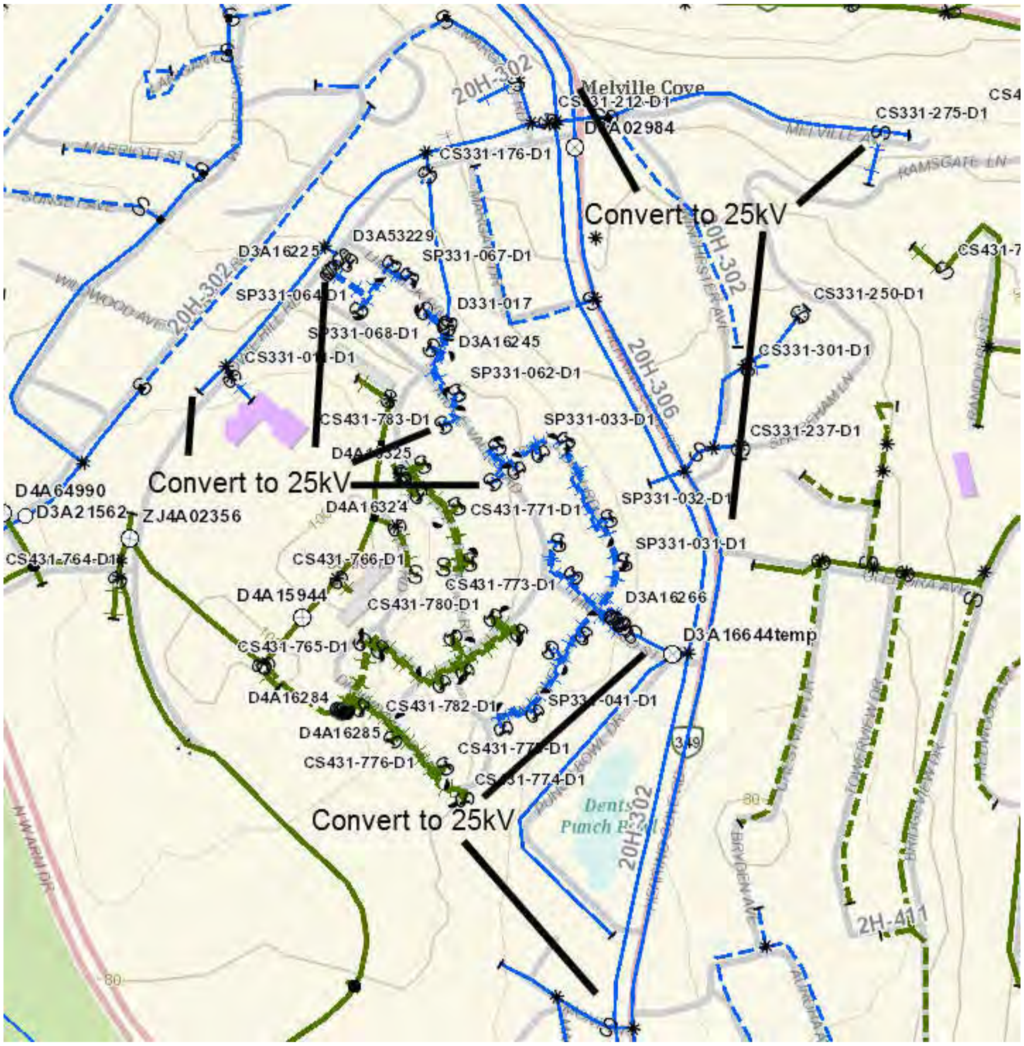


Figure 55 20H-Spryfield Conversions Part-3

6.1.7 2021 Capital Year

For the 2021 capital year, the 23H-Rockingham load reductions continue with the conversion of a portion of 23H-304, from the Bedford Highway to Dunbrack Street.

6.1.7.1 23H-Rockingham Conversions Part-6

This portion of the project will convert a portion of 23H-304, from the Bedford Highway to Dunbrack Street. This section of conversion has a significant portion of rear lot distribution, requiring conversion. The area will initially be supplied via the Bedford Highway (converted in the 23H-Rockingham Conversions Part-4). Refer to Figure 56 below. This will be accomplished by:

- Close D4A11704, on the Bedford Highway.
- Open Breaker 23H-301, at the 23H-Rockingham substation.
- Open D331-123 on the Bedford Highway.
- Convert 23H-301 as indicated below, along the Bedford Highway.

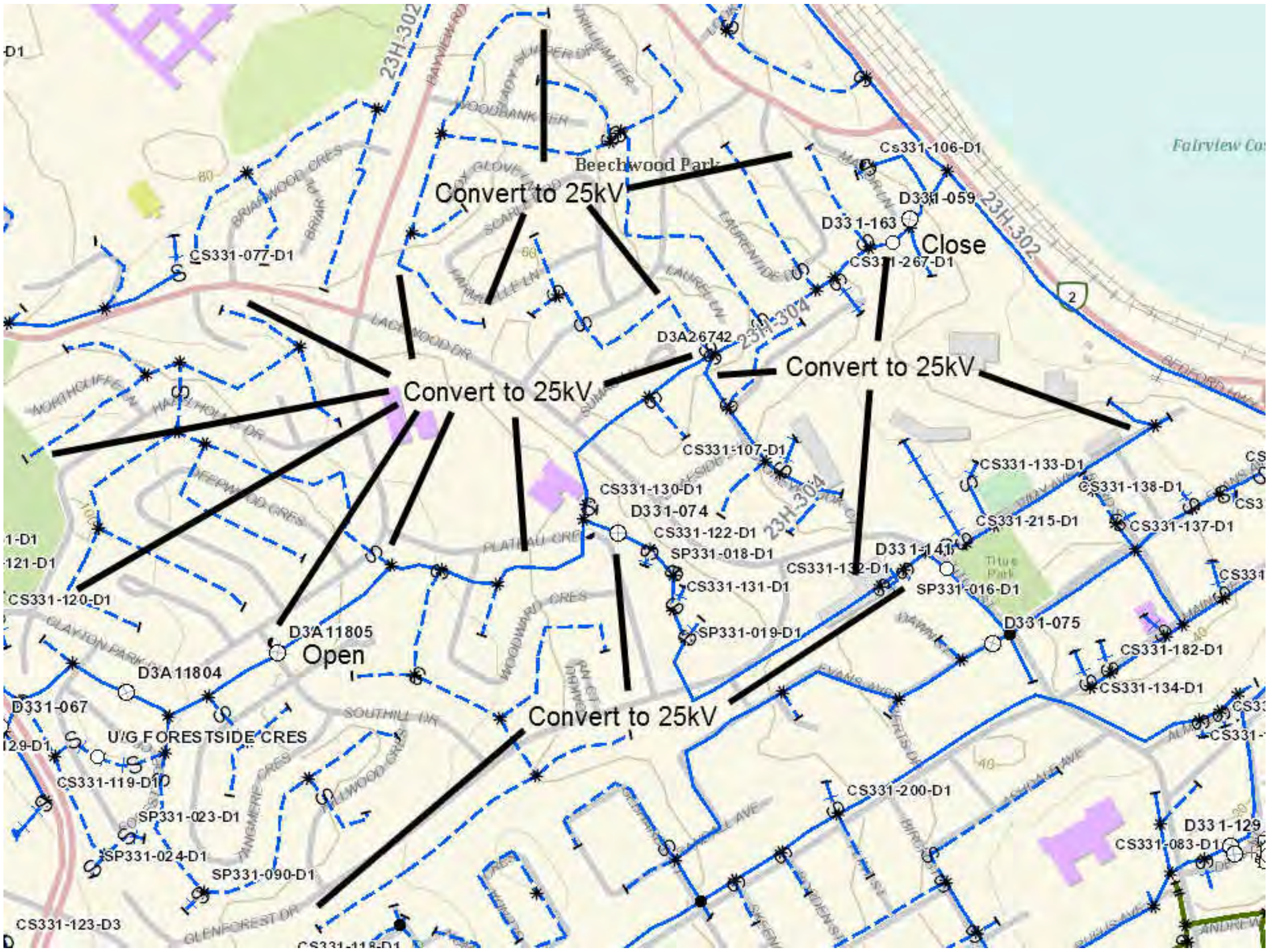


Figure 56 23H-Rockingham Conversions Part-6

6.1.8 2022 Capital Year

In the 2022 capital year, the 23H-Rockingham load reductions continue with the conversion of the remaining 12kV south of Lacewood Drive. Due to the size of this portion of the project, work will be completed over a two year period.

Additionally, further 12kV load reductions at 20H-Spryfield will be completed through commencing part 1 of the conversions on Purcell's Cove Road. The remaining conversions along Purcell's Cove Road will be completed in 2023.

6.1.8.1 23H-Rockingham Conversions Part-7

This portion of the project will convert 23H-301, along the Bedford Highway. The area will initially be supplied via 129H-412. Refer to Figure 57 below. This will be accomplished by:

- Close D4A11704, on the Bedford Highway.
- Open Breaker 23H-301, at the 23H-Rockingham substation.
- Open D331-123 on the Bedford Highway.
- Convert 23H-301 as indicated below, along the Bedford Highway.

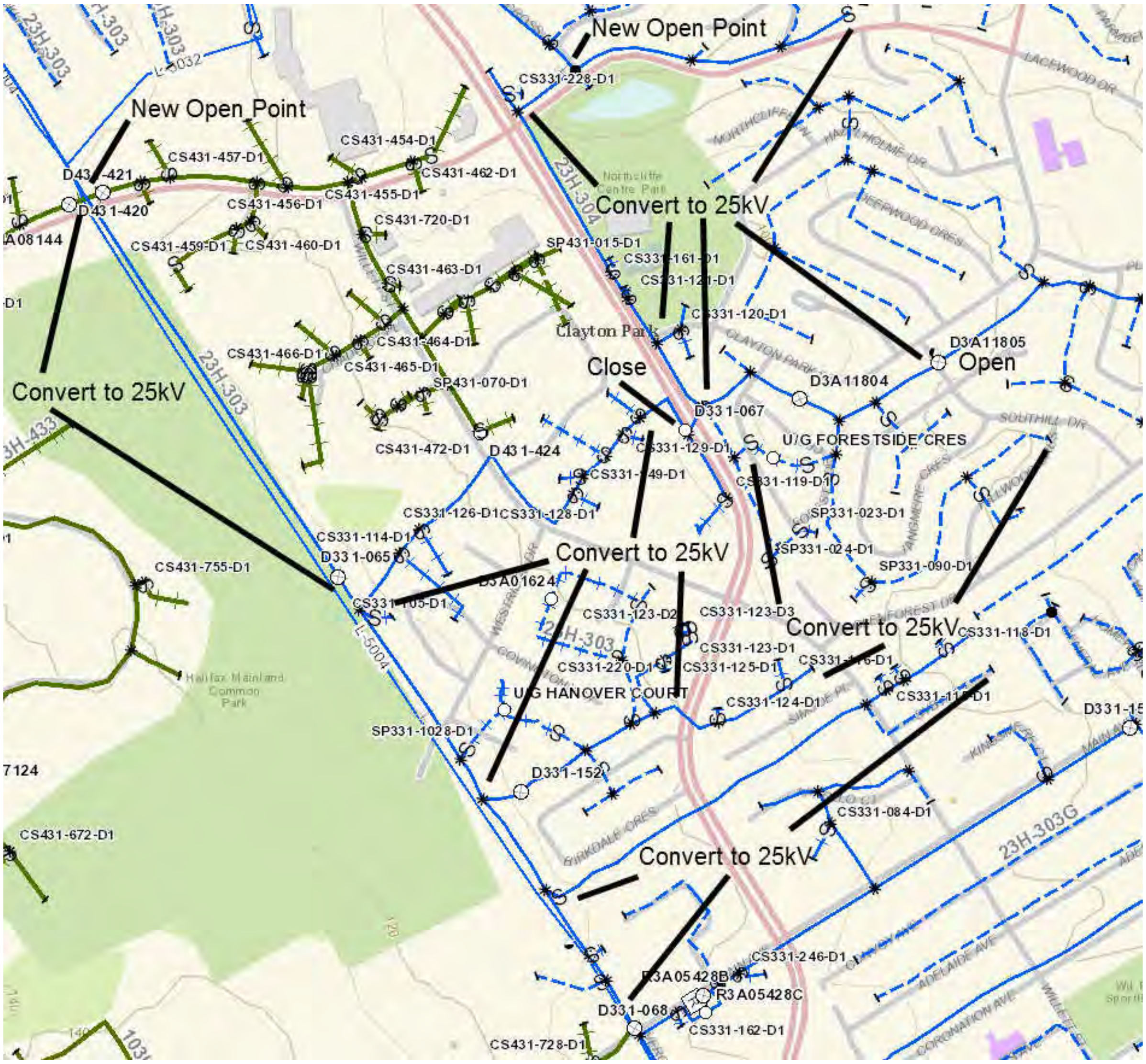


Figure 57 23H-Rockingham Conversions Part-7

6.1.8.2 20H-Spryfield Conversions Part-4

This portion of the project will further reduce the loading at 20H-Spryfield through the conversion of a portion of Purcell's Cove, from the current end point to D331-046. These conversions will be supplied via the 25kV feeder currently on Purcell's Cove Road (presently 2H-411). The remaining portion of Purcell's Cove Road, south of D331-046 will be supplied via 20H-303 (John Brackett Drive). Refer to Figure 58 and Figure 59 below. This will be accomplished by:

- Install new open point on Williams Lake Road, prior to Purcell's Cove Road.
- Open D331-046 on Purcell's Cove Road and close D331-028 on John Brackett Drive.
- Extend 25kV on Purcell's Cove Road and convert area, as indicated below.

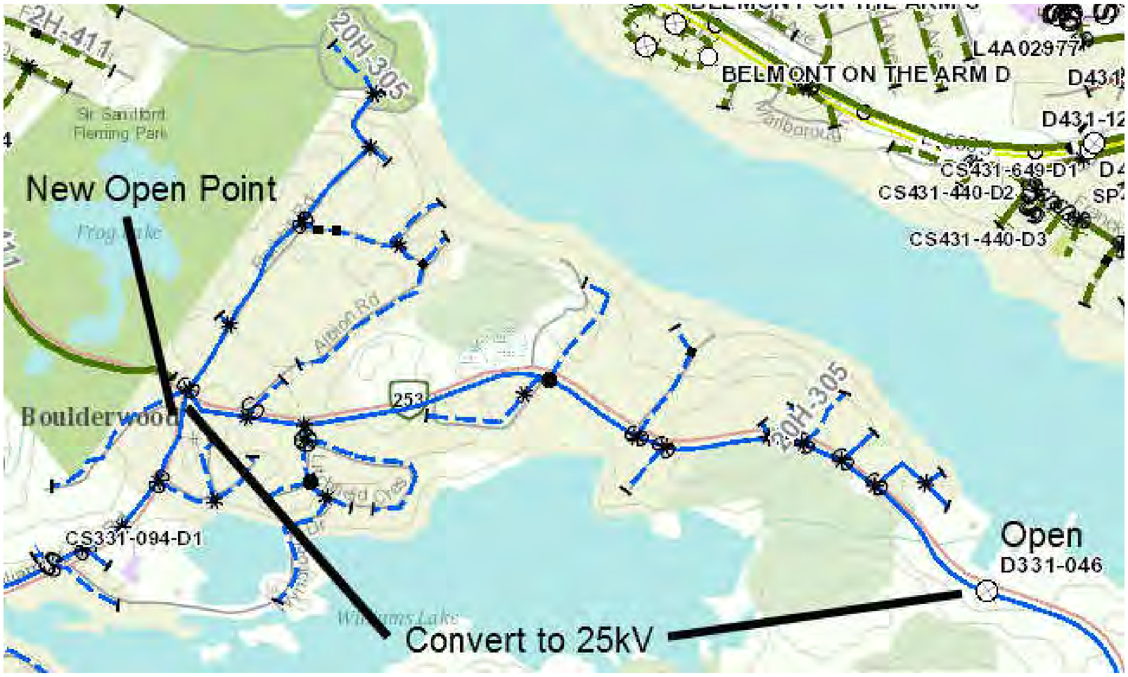


Figure 58 20H-Spryfield Conversions Part-4

Figure 59 20H-Spryfield Conversions Part-4

6.1.9 2023 Capital Year

Additionally, further 12kV load reductions at 20H-Spryfield will be completed through completing the conversions on Purcell's Cove Road that were started during the 2021 capital year.

6.1.9.1 20H-Spryfield Conversions Part-5

This portion of the project will further reduce the loading at 20H-Spryfield through the conversion of a portion of Purcell's Cove, from D331-046 to D331-028. These conversions will be supplied via the 25kV feeder currently on Purcell's Cove Road (presently 2H-411). Refer to Figure 60 and Figure 61 below. This will be accomplished by:

- Close D331-028 on John Brackett Drive and open D331-046 on Purcell's Cove Road.
- Extend 25kV on Purcell's Cove Road and convert area, as indicated below.

Figure 60 20H-Spryfield Conversions Part-5

Figure 61 20H-Spryfield Conversions Part-5

6.1.10 2024 Capital Year

2024 will see the last portion of 23H-Rockingham 12kV load converted to 25kV.

6.1.10.1 23H-Rockingham Conversions Part-8

This portion of the project will convert the remaining two portions of 12kV supplied by 23H-Rockingham. This includes the Radcliffe Drive area and Lincoln Cross, near the substation. The Radcliffe Drive area will be supplied via the distribution along L-5004 (near Lacewood Drive crossing), while the Lincoln Cross area will be supplied via Lacewood Drive. Refer to Figure 62 below. This will be accomplished by:

- Open D331-063 on Lincoln Cross, prior to Dunbrack Street intersection.
- Close Open Point installed as part of 23H-Rockingham Conversions Part-7, at the intersection of the 69kV transmission ROW and Lacewood Drive.
- Convert the remaining 12kV in 23H-303 on the Radcliffe Drive area, as indicated below.
- Open D331-071 on Lincoln Cross, near Meadowlark Crescent.
- Close Open Point installed as part of 23H-Rockingham Conversions Part-7, on Lincoln Cross and Lacewood Drive.
- Convert the remaining 12kV on 23H-304 in the Lincoln Cross area, as indicated below.

Figure 62 **23H-Rockingham Conversions Part-8**

6.1.11 2025 Capital Year

For the 2025 capital year, the 23H-Rockingham substation will be decommissioned and the substation equipment removed, including the underground feeder exits. The 69kV transmission line supplying the substation, L-5032, will also be removed from the L-5004 tap.

6.1.11.1 23H-Rockingham Conversions Part-9

This portion of the project will see the decommissioning of the 23H-Rockingham substation, including all equipment. This portion of the project will maintain the feeder ties, around the 23H-Rockingham substation, as well as decommission and remove L-5032 (the 69kV tap) from L-5004 to the substation. Refer to Figure 63 below. This will be accomplished by:

- Remove L-5032, from L-5004 tap to 23H-Rockingham substation.
- Remove 23H-Rockingham substation equipment, including underground feeder exits.
- Prepare lot for potential sale.

Figure 63 **23H-Rockingham Conversions Part-9**

6.1.12 2026 Capital Year

For the 2026 capital year, further 12kV load reductions at 20H-Spryfield will be realized with the conversion of the Williams Lake Road area.

6.1.12.1 20H-Spryfield Conversions Part-6

This portion of the project will convert the Williams Lake Road portion of the 12kV supplied by 20H-Spryfield. This portion of the project will create a new feeder tie between Purcell's Cove Road and Herring Cove Road. The top circuit of the Herring Cove Road (currently 20H-302), from Mont Street St. Michaels Avenue, will be converted to 25kV and supplied via the upper circuit prior to Mont Street. A new open point on the top circuit will be installed near the Williams Lake Road tap. Refer to Figure 64 below. This will be accomplished by:

- Change tap to Williams Lake Road from lower to top feeder.
- Install new N/O point on top feeder of Herring Cove Road, between Williams Lake Road and Lois Lane.
- Open Circle Drive tap from Herring Cove Road.
- Convert Williams Lake Road including Ravenscraig area, as outlined below.

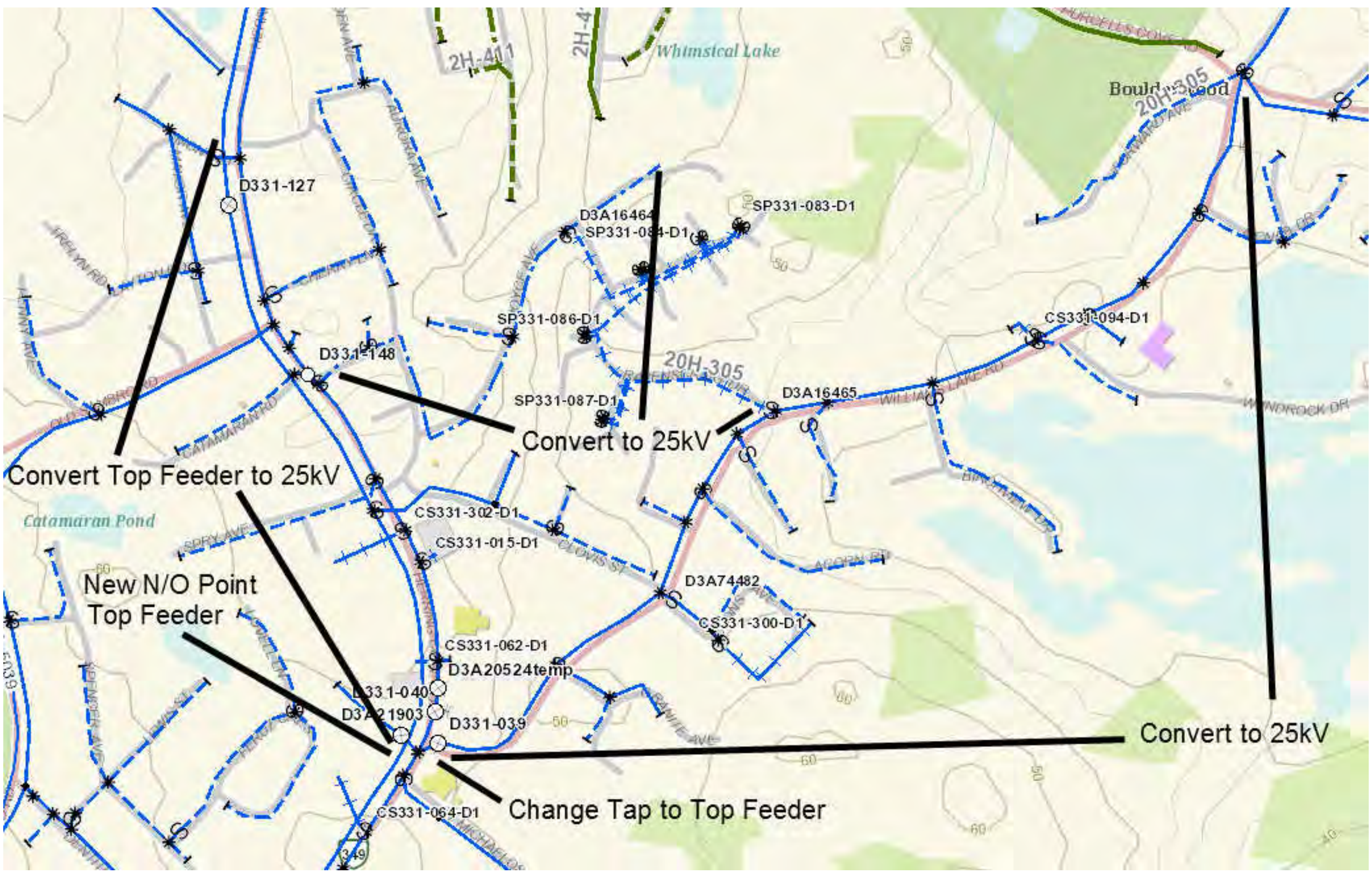


Figure 64 **20H-Spryfield Conversions Part-6**

APPENDIX A

System Operating Diagrams

Pages 86-94 have been removed due to confidentiality.

APPENDIX B

Load History and Forecast

Note:

- Due to the variety of changes in feeder configurations, feeder load forecasts will not be presented in this report.
- Please refer to section 3.2 Load Forecast for the 90th Percentile Data values

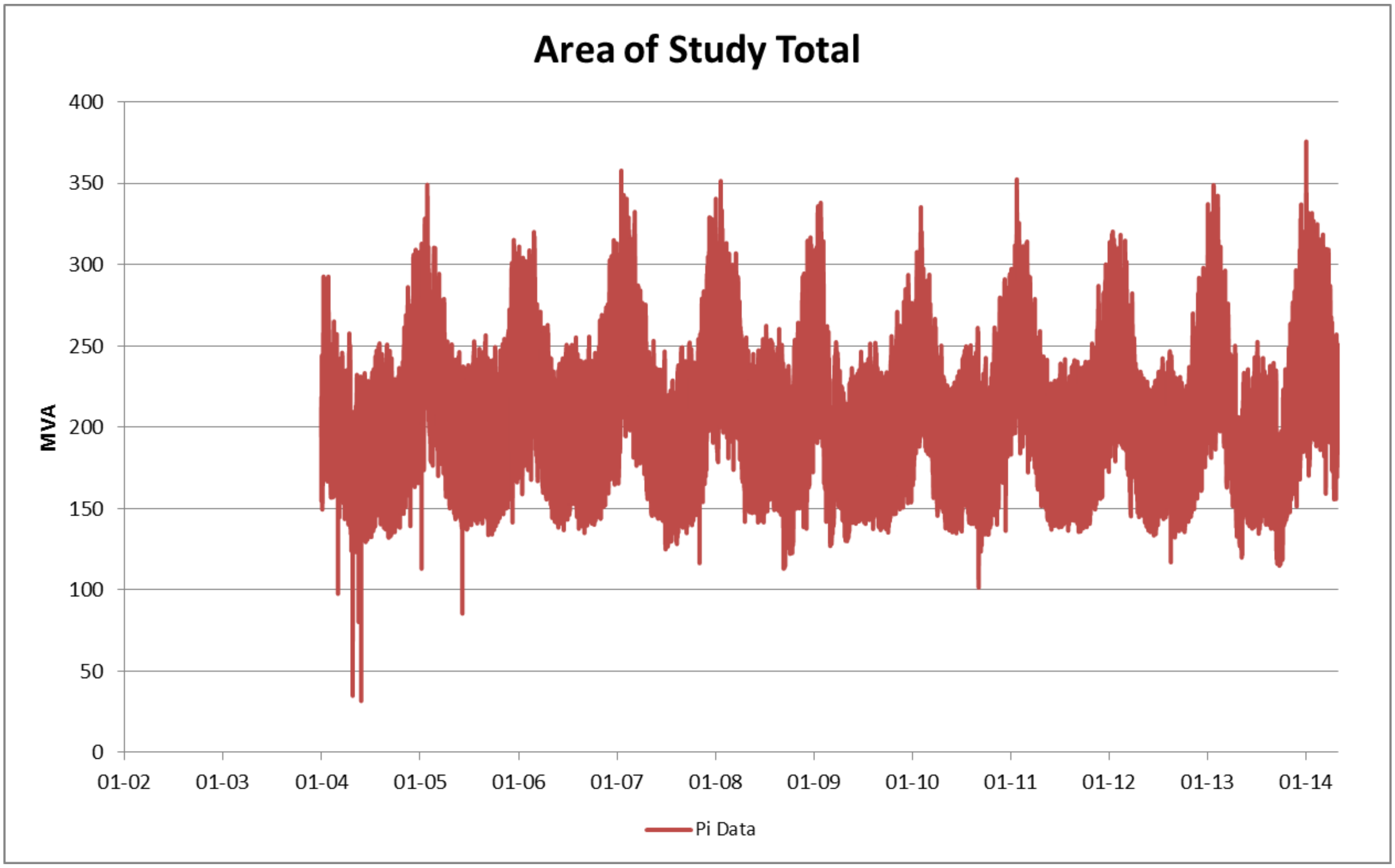


Figure 74 Area of Study Load History

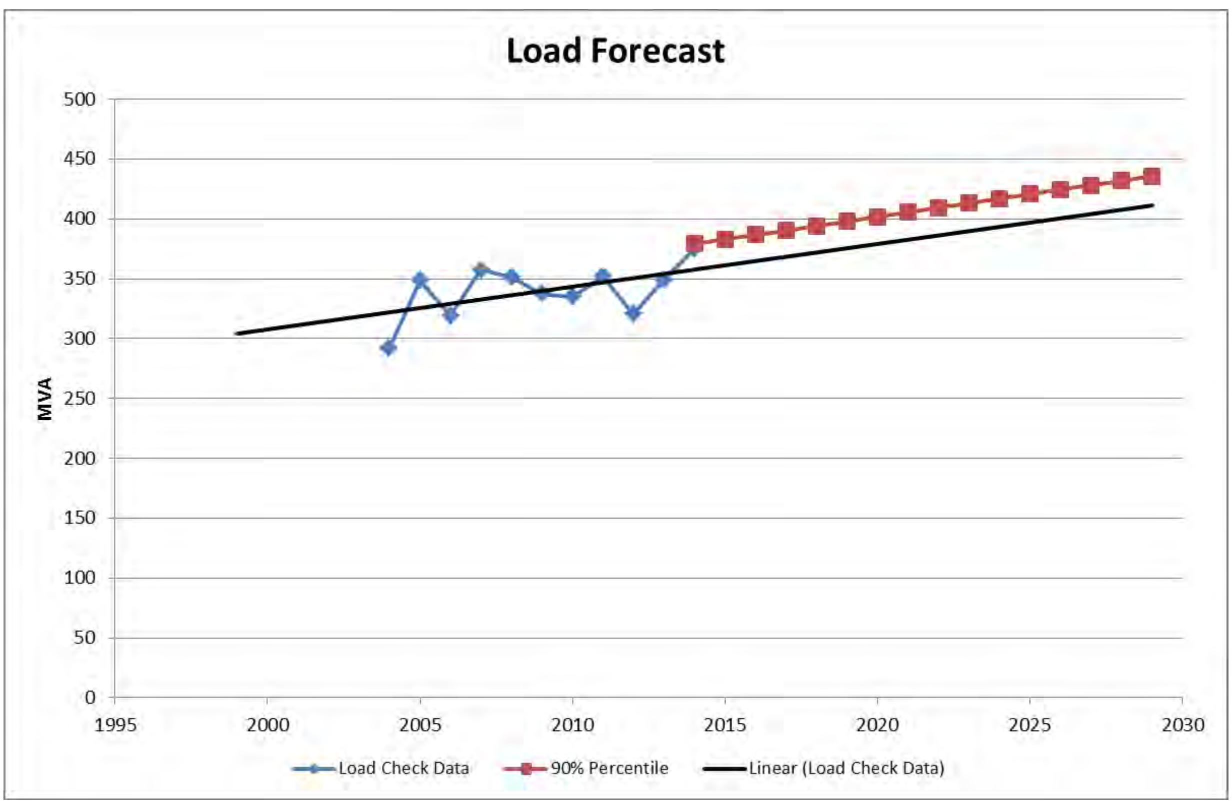


Figure 75 Area of Study Load Forecast

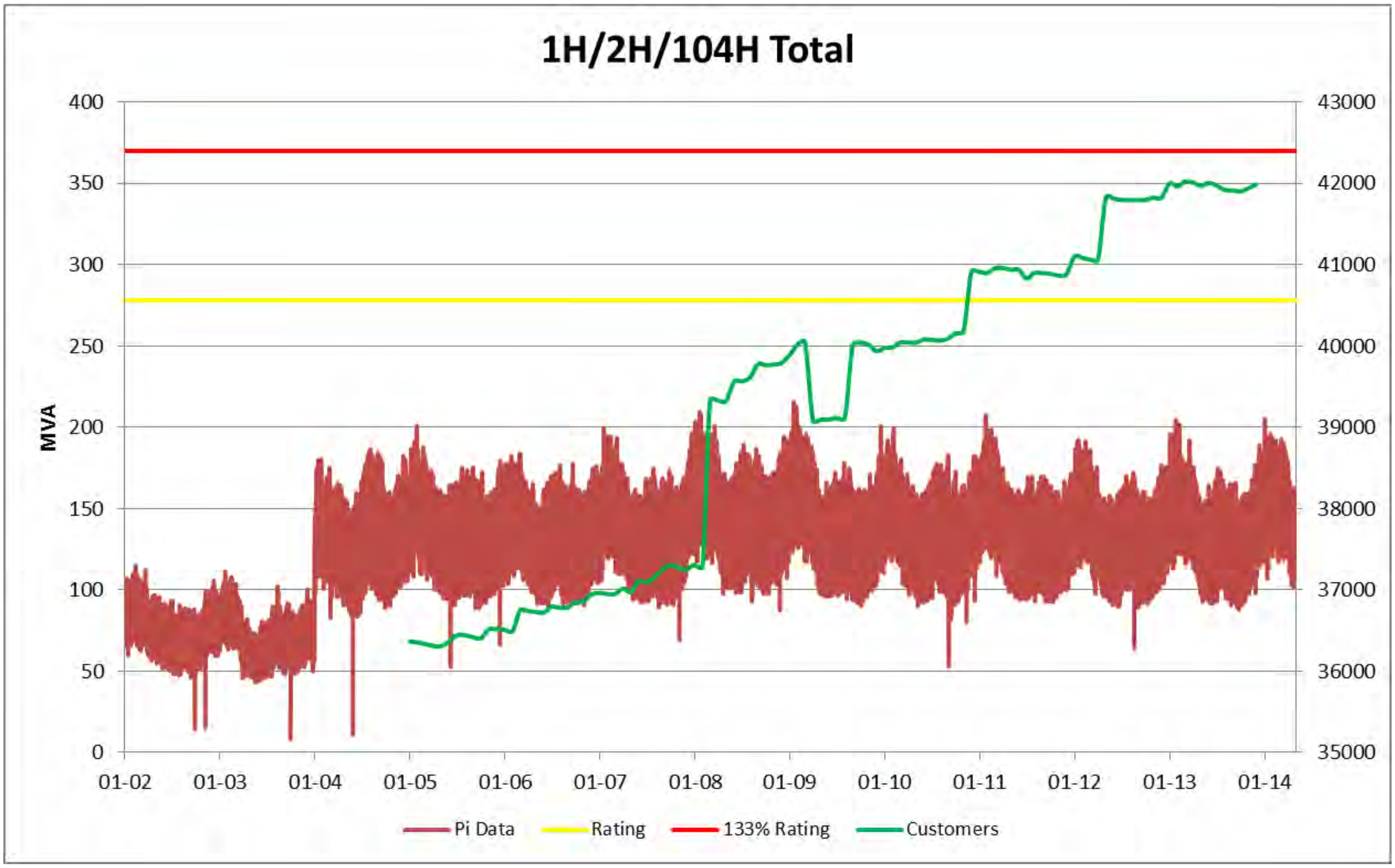


Figure 76 **1H / 2H / 104H Load History**

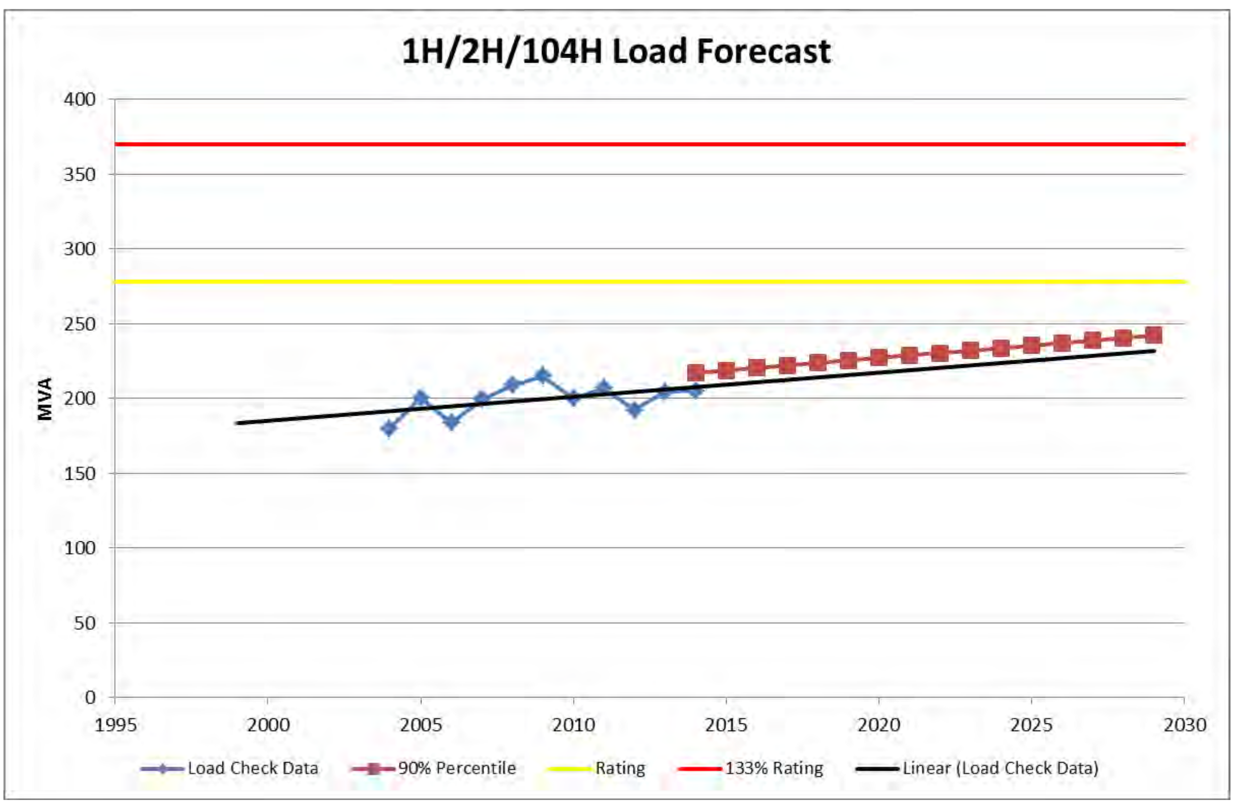


Figure 77 **1H / 2H / 104H Load Forecast**

Appendix B: Load History and Forecast

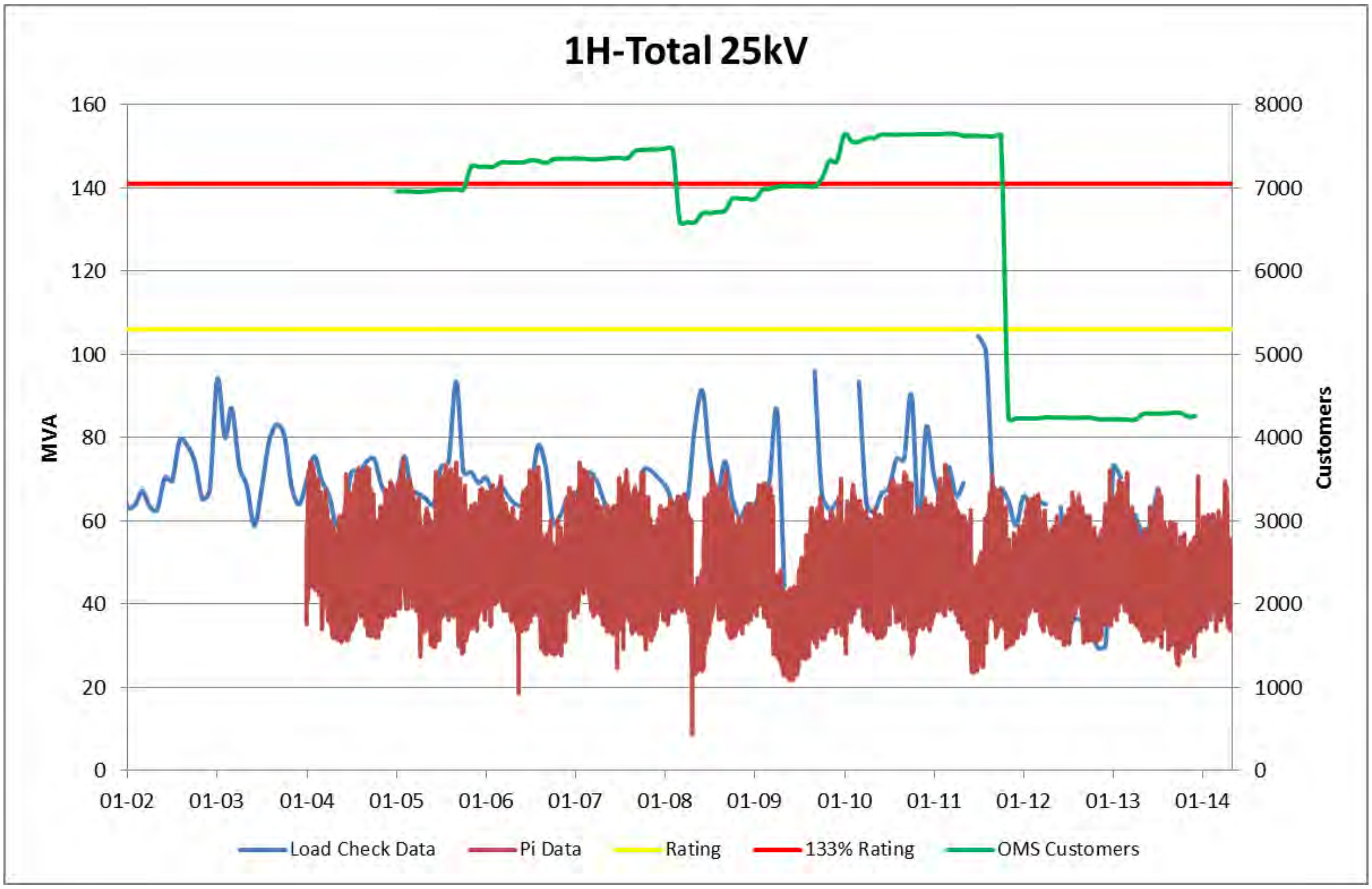


Figure 78 **1H-Water Street 25kV Load History**

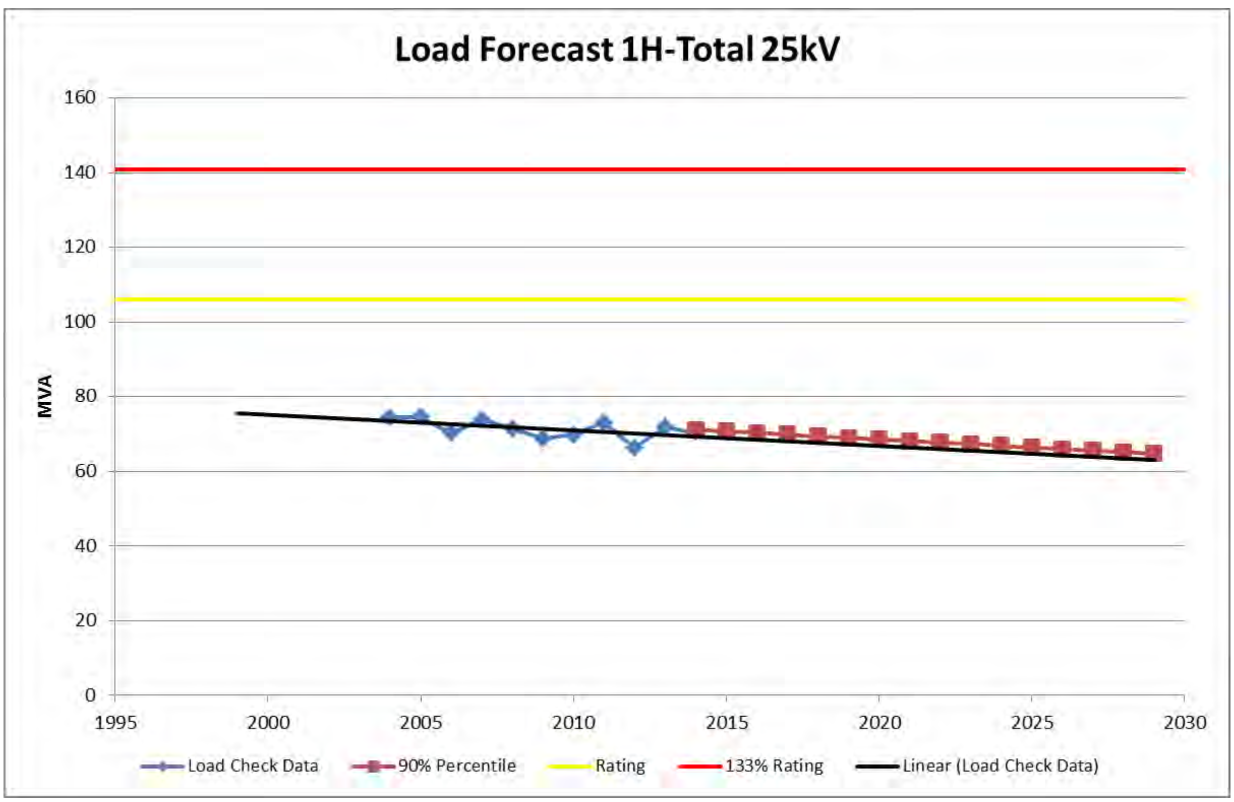


Figure 79 **1H-Water Street 25kV Load Forecast**

Appendix B: Load History and Forecast

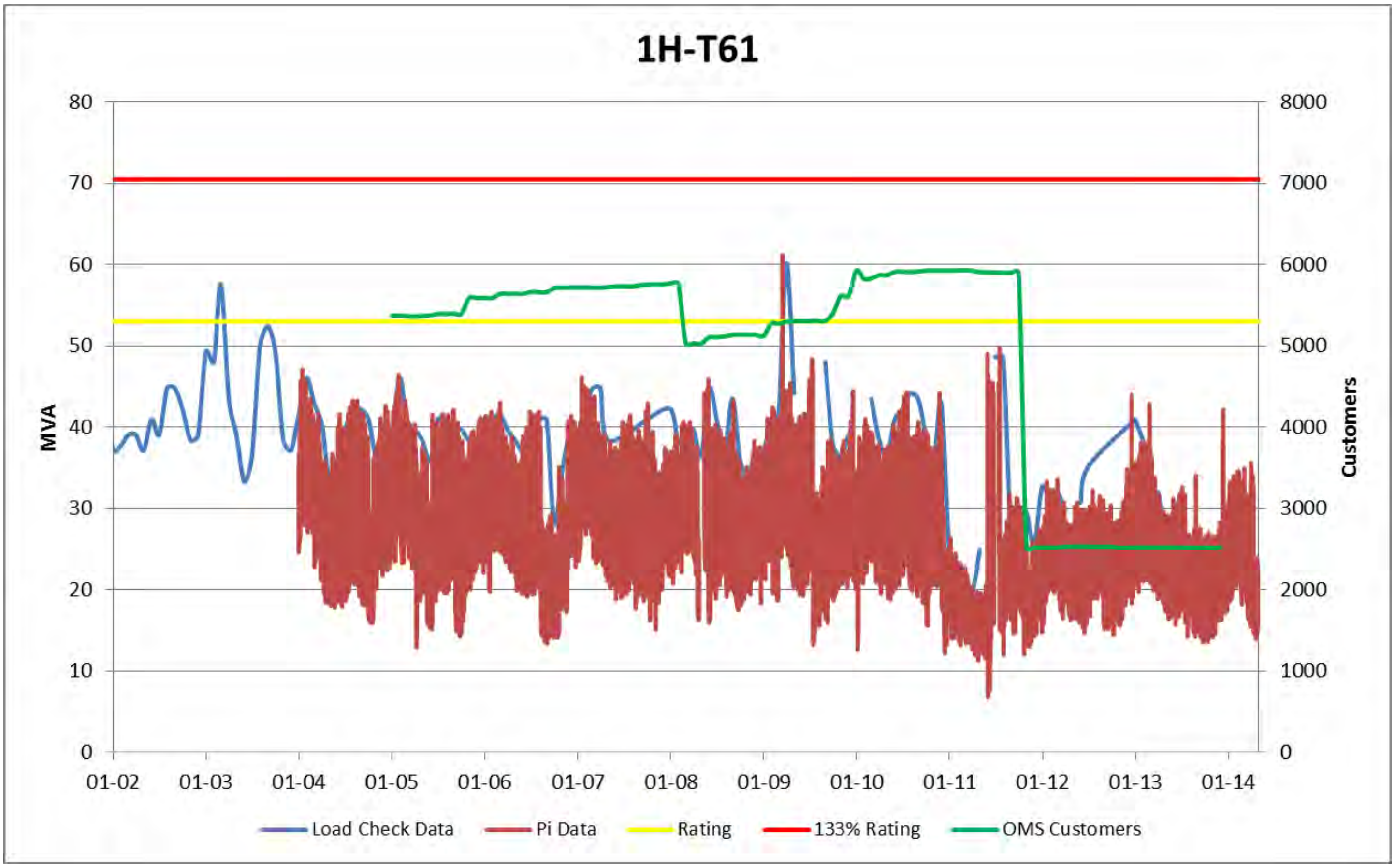


Figure 80 1H-T61 Load History

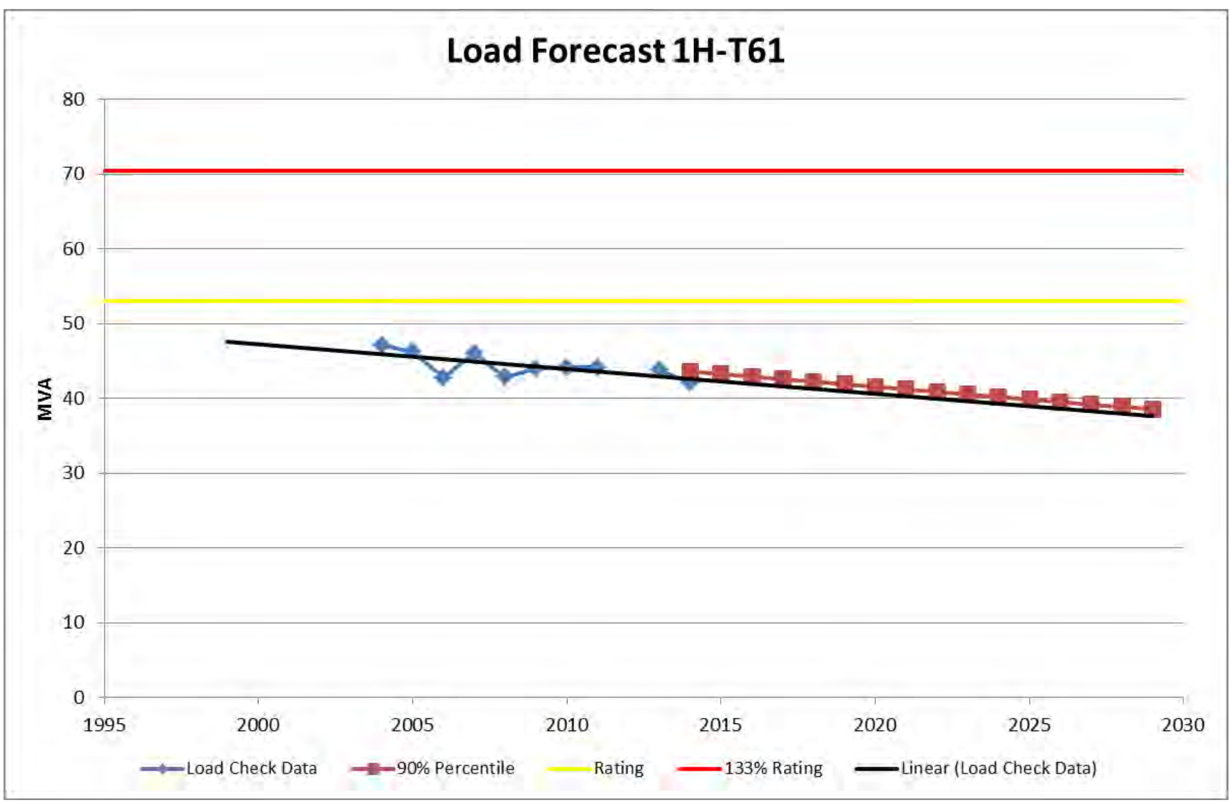


Figure 81 1H-T61 Load Forecast

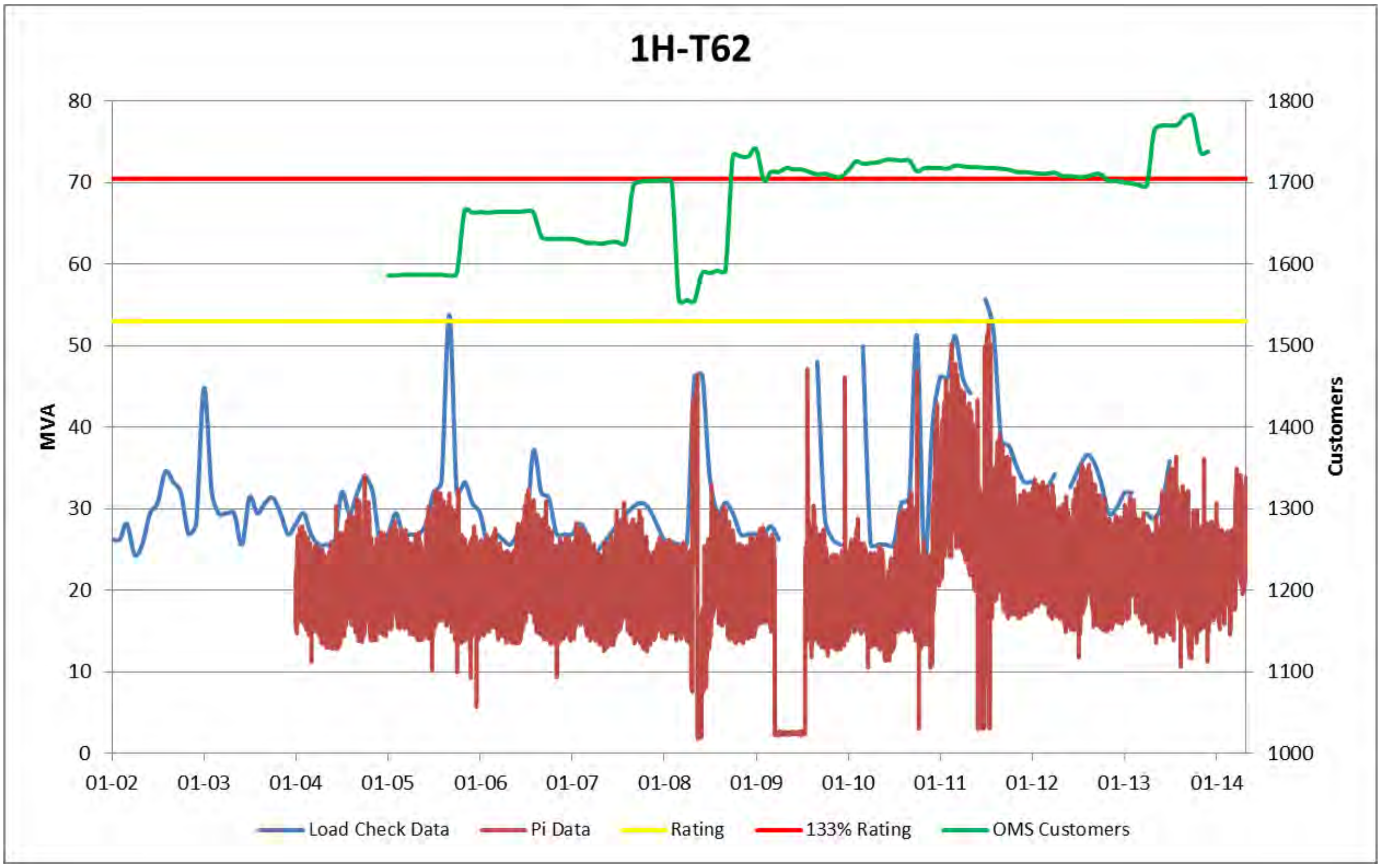


Figure 82 1H-T62 Load History

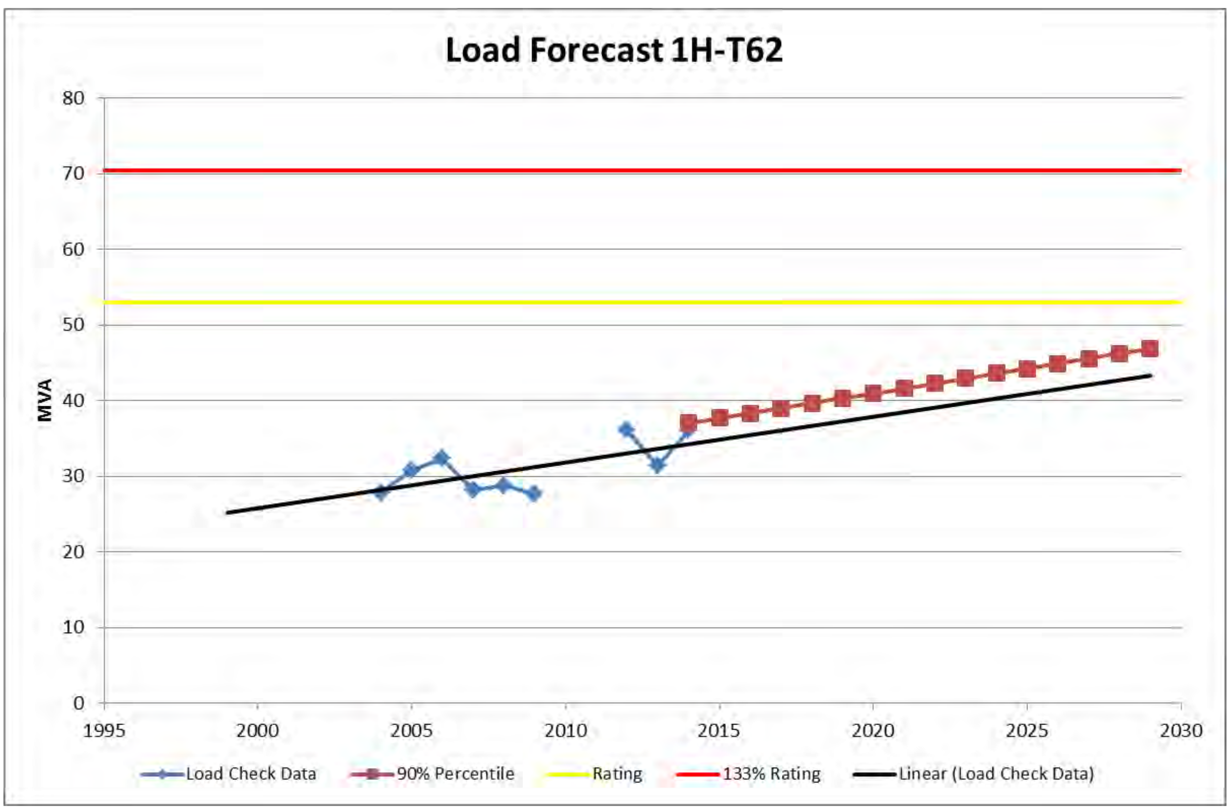


Figure 83 1H-T62 Load Forecast

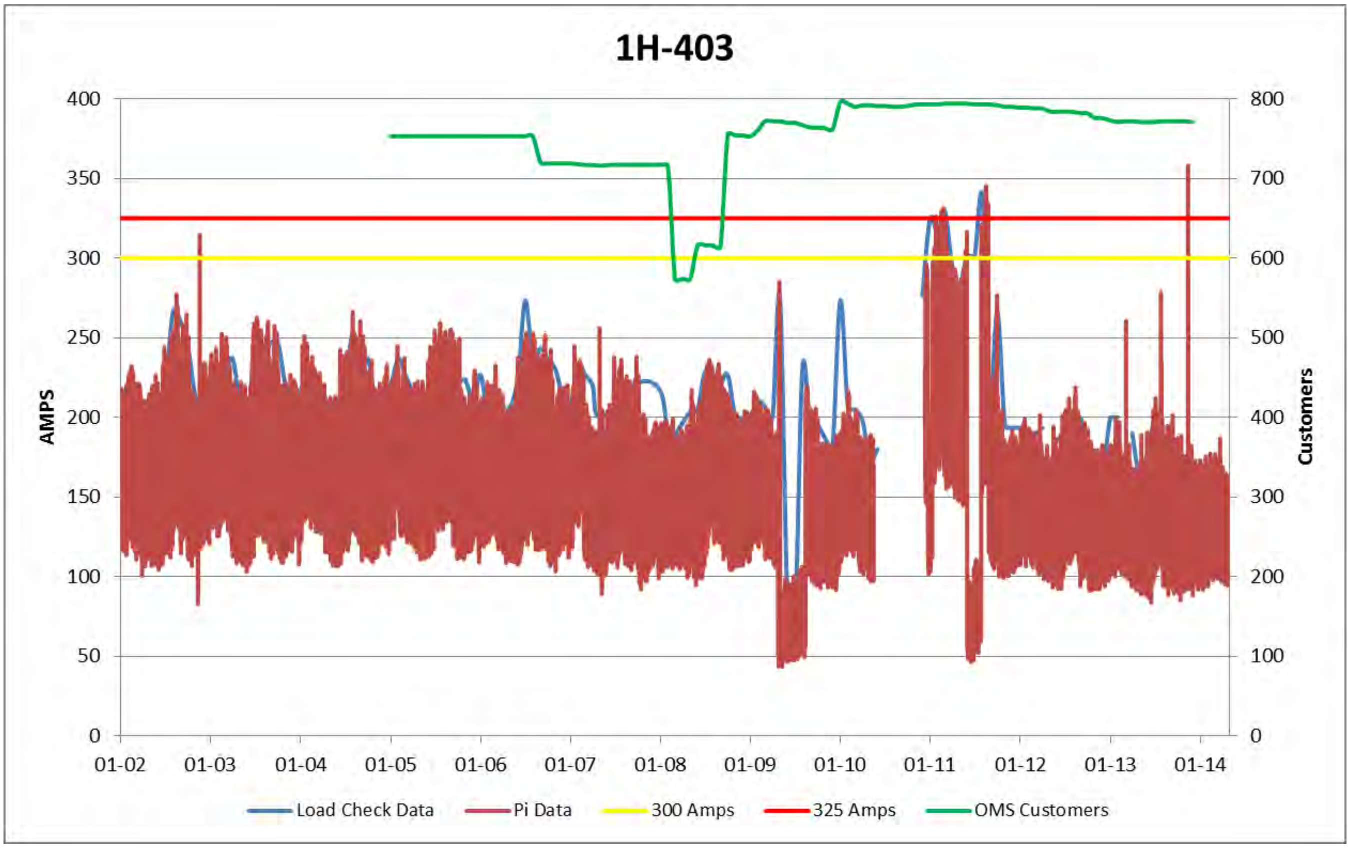


Figure 84 **1H-403 Load History**

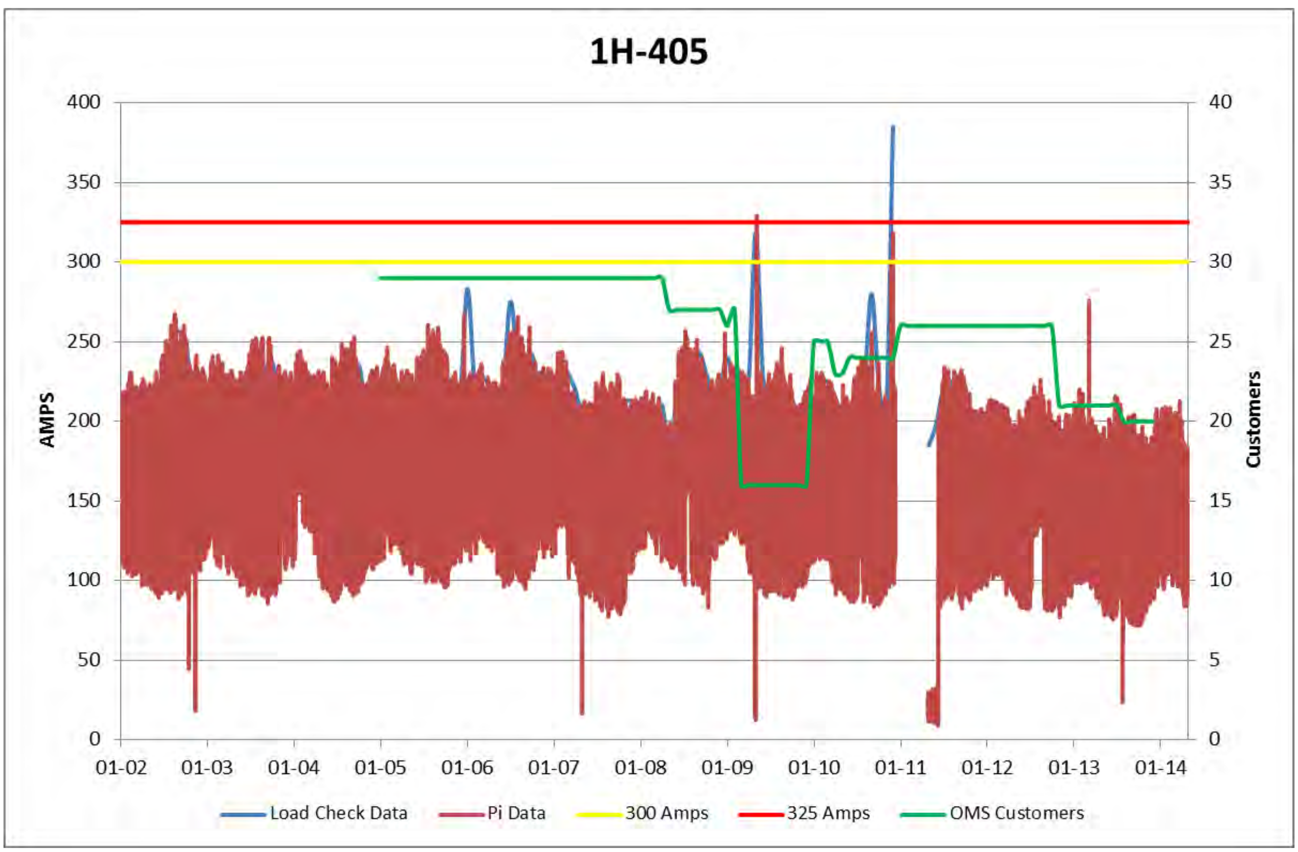


Figure 85 **1H-405 Load History**

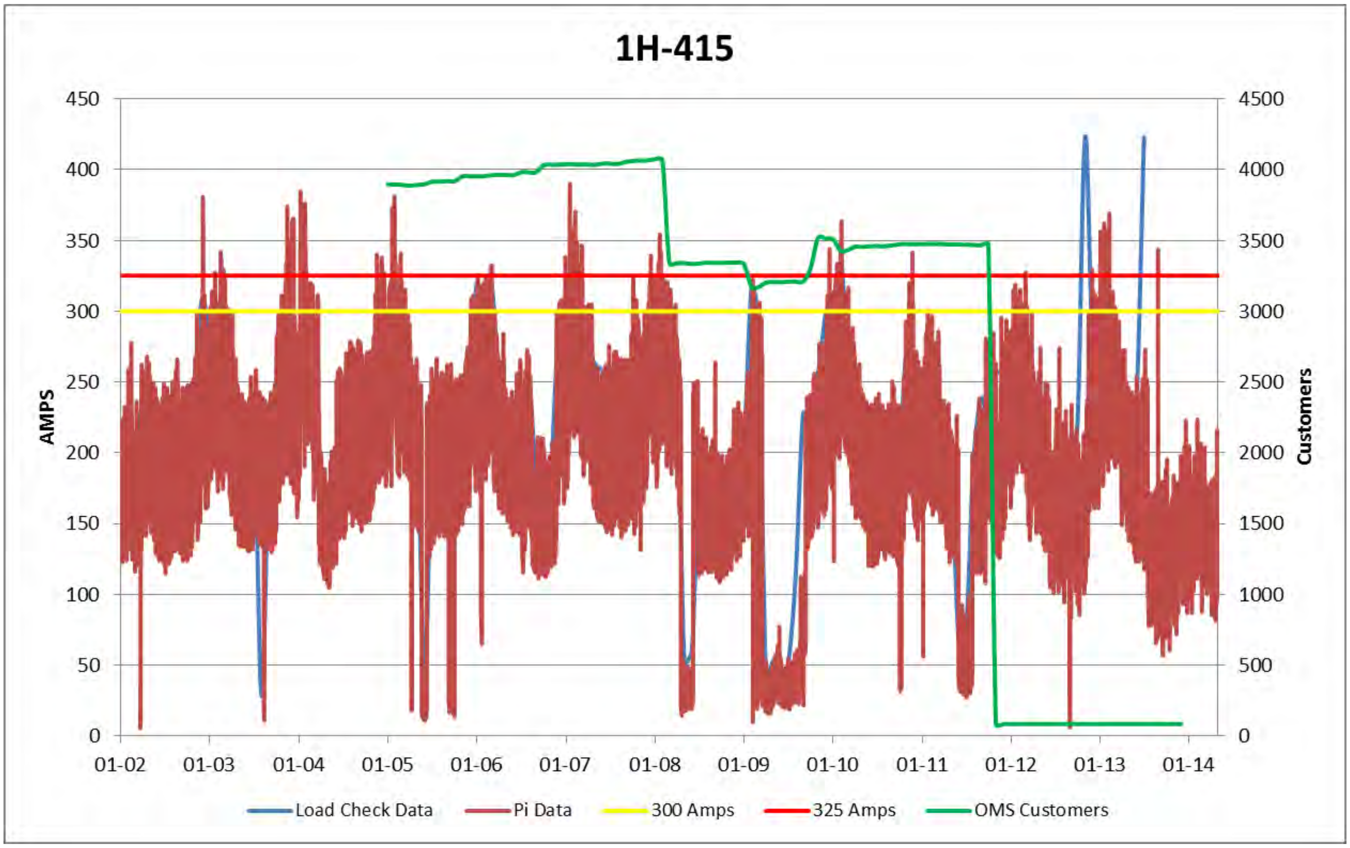


Figure 86 1H-415 Load History

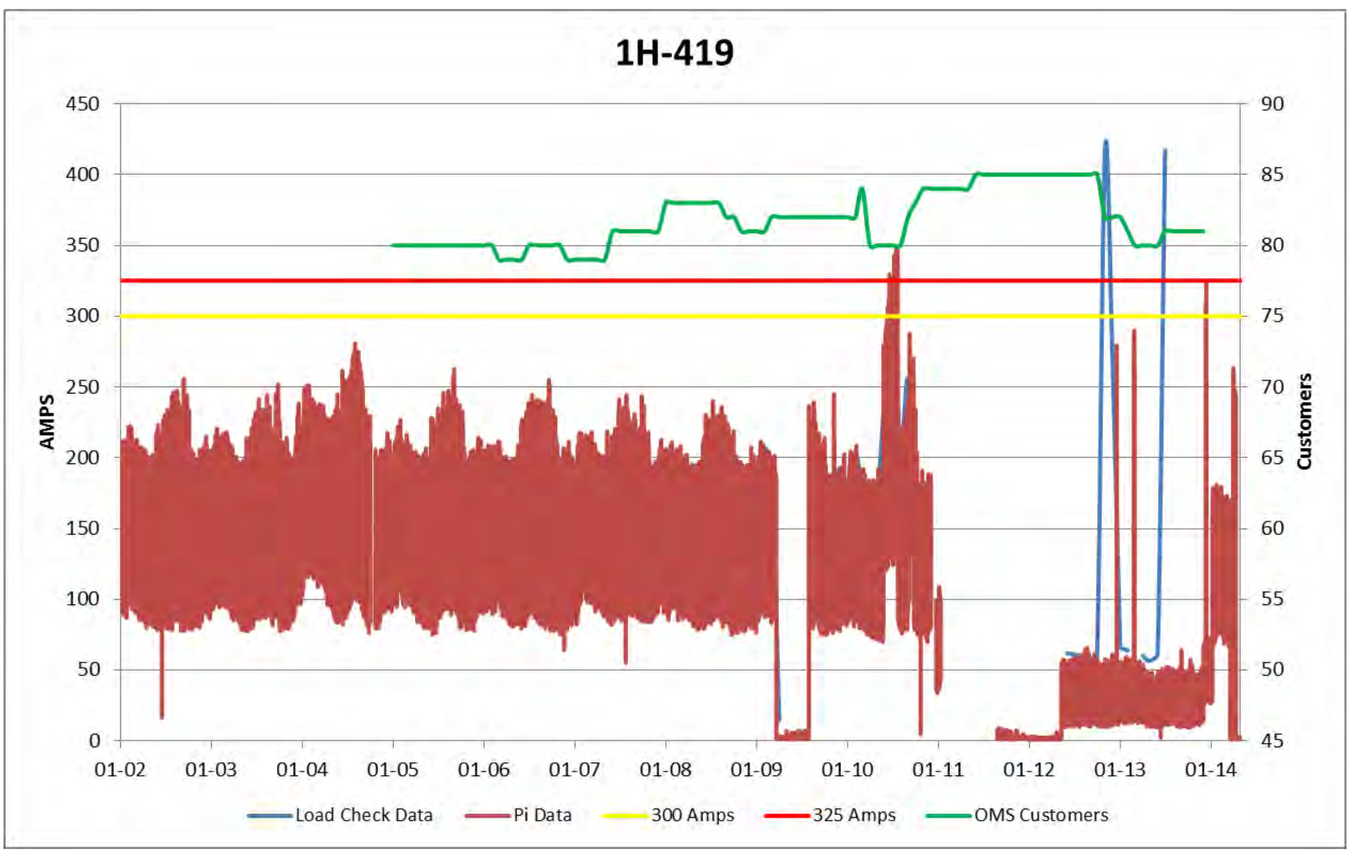


Figure 87 1H-419 Load History

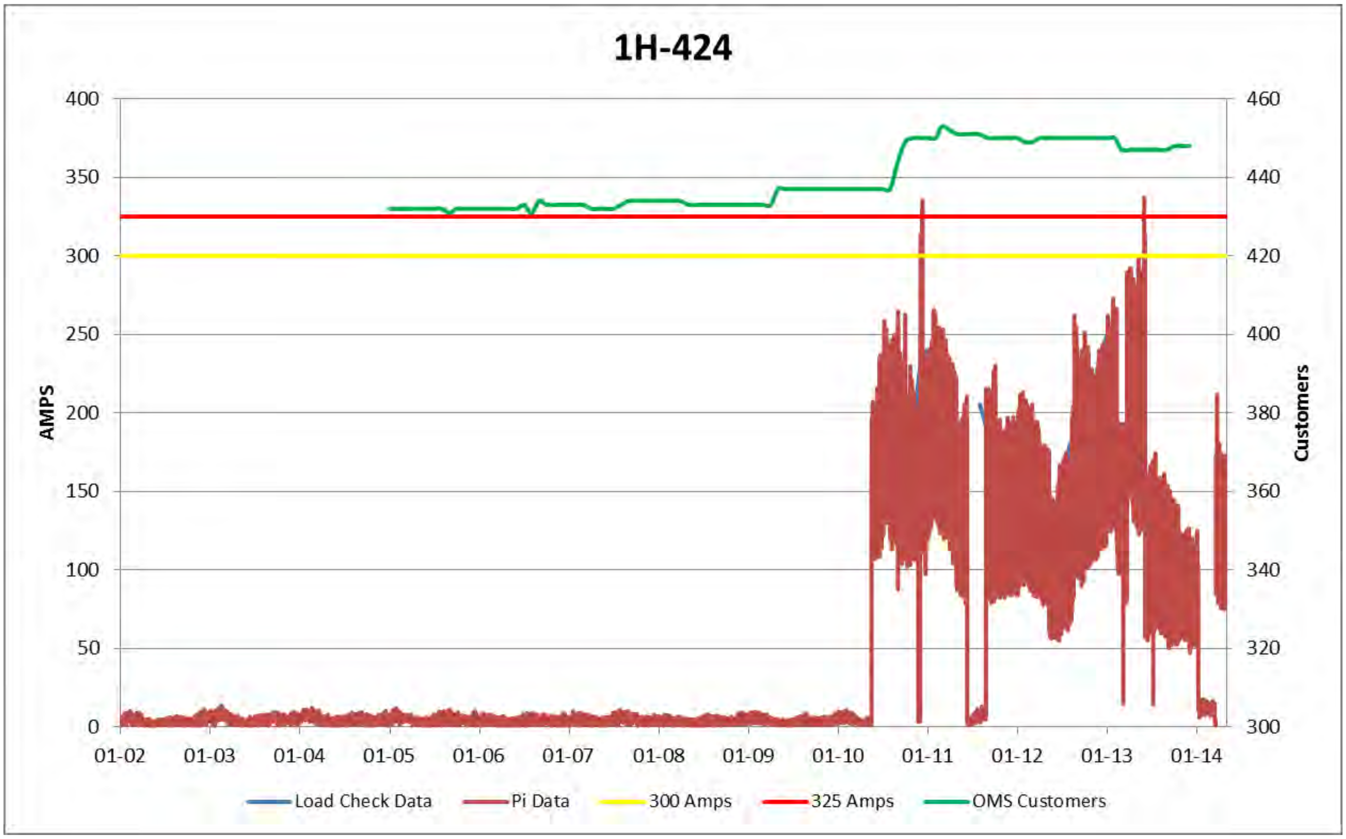


Figure 88 **1H-424 Load History**

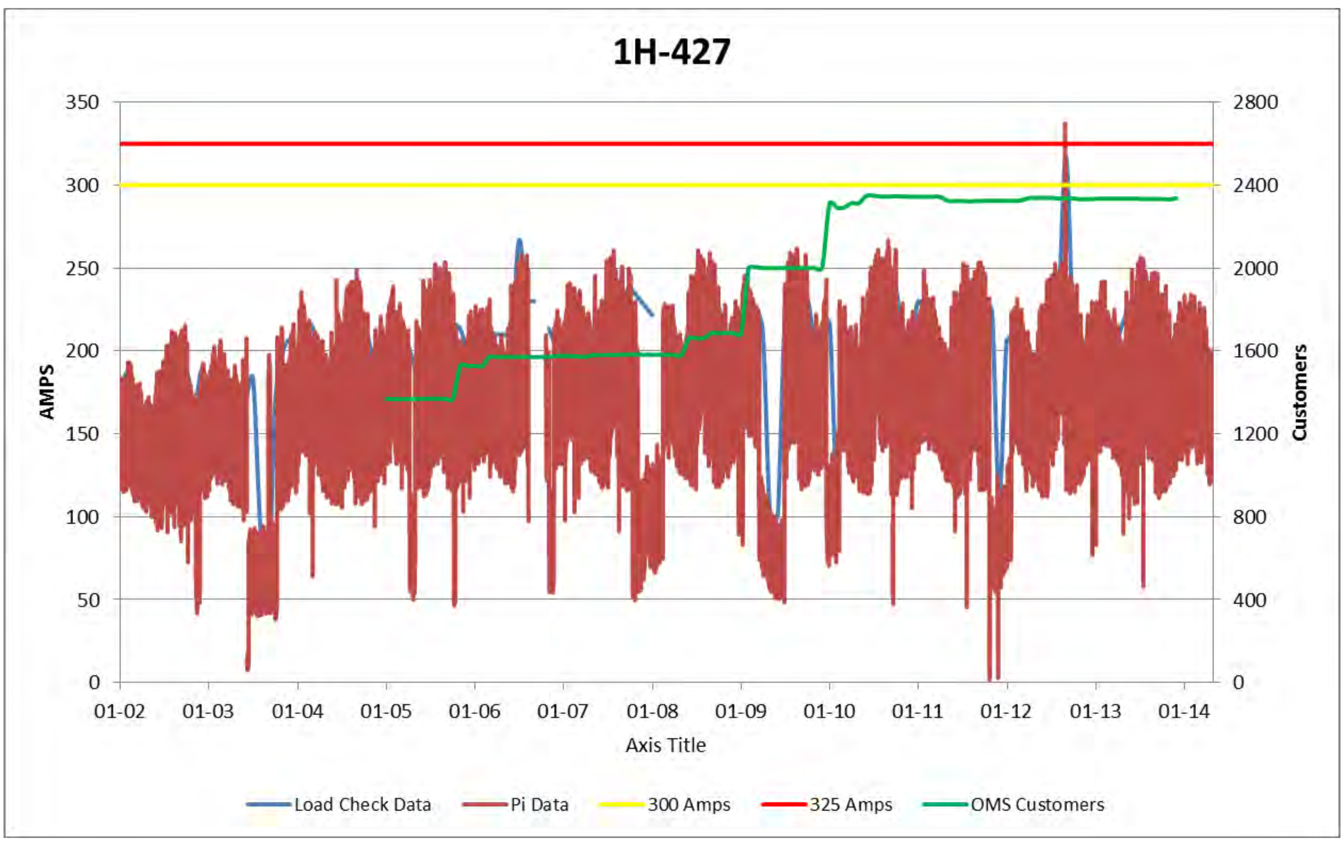


Figure 89 **1H-427 Load History**

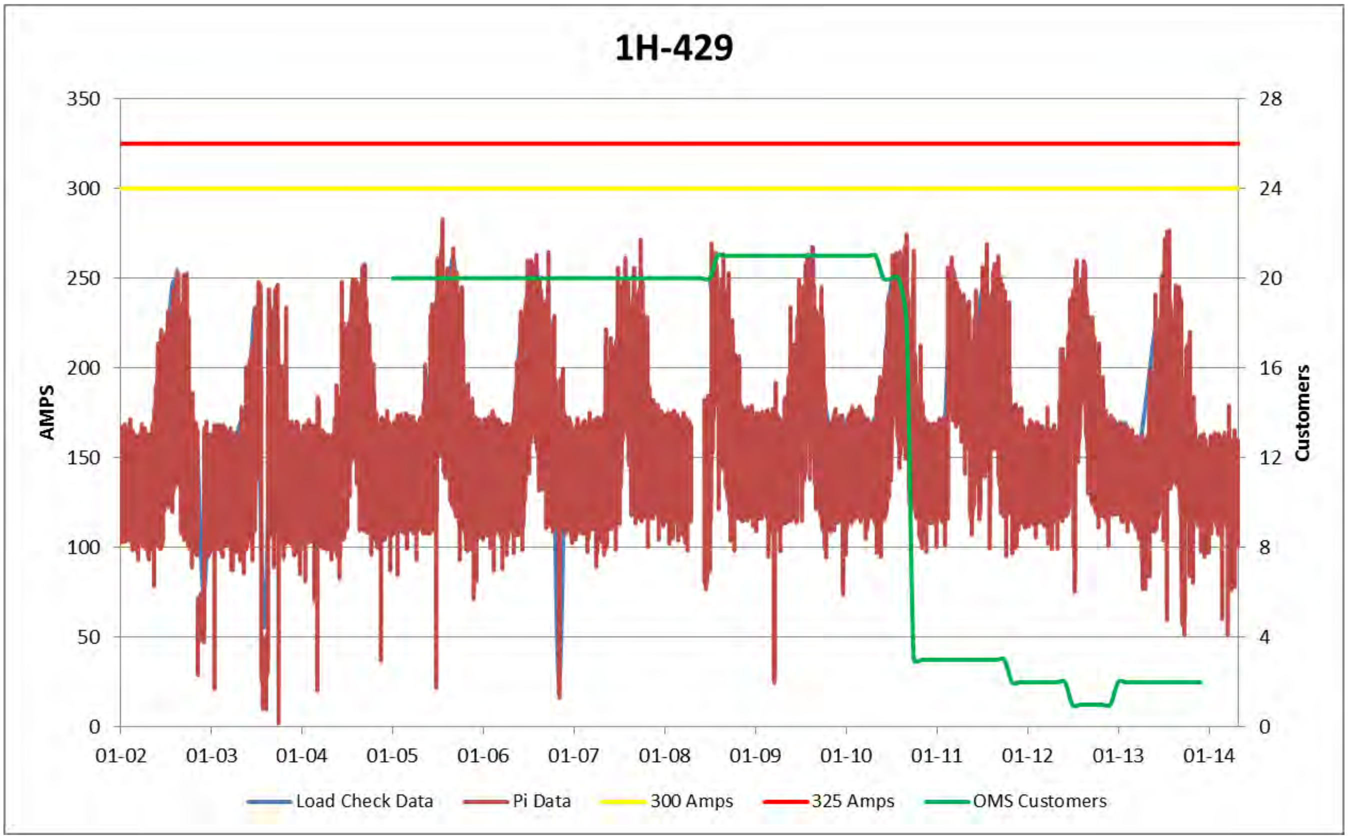


Figure 90 **1H-429 Load History**

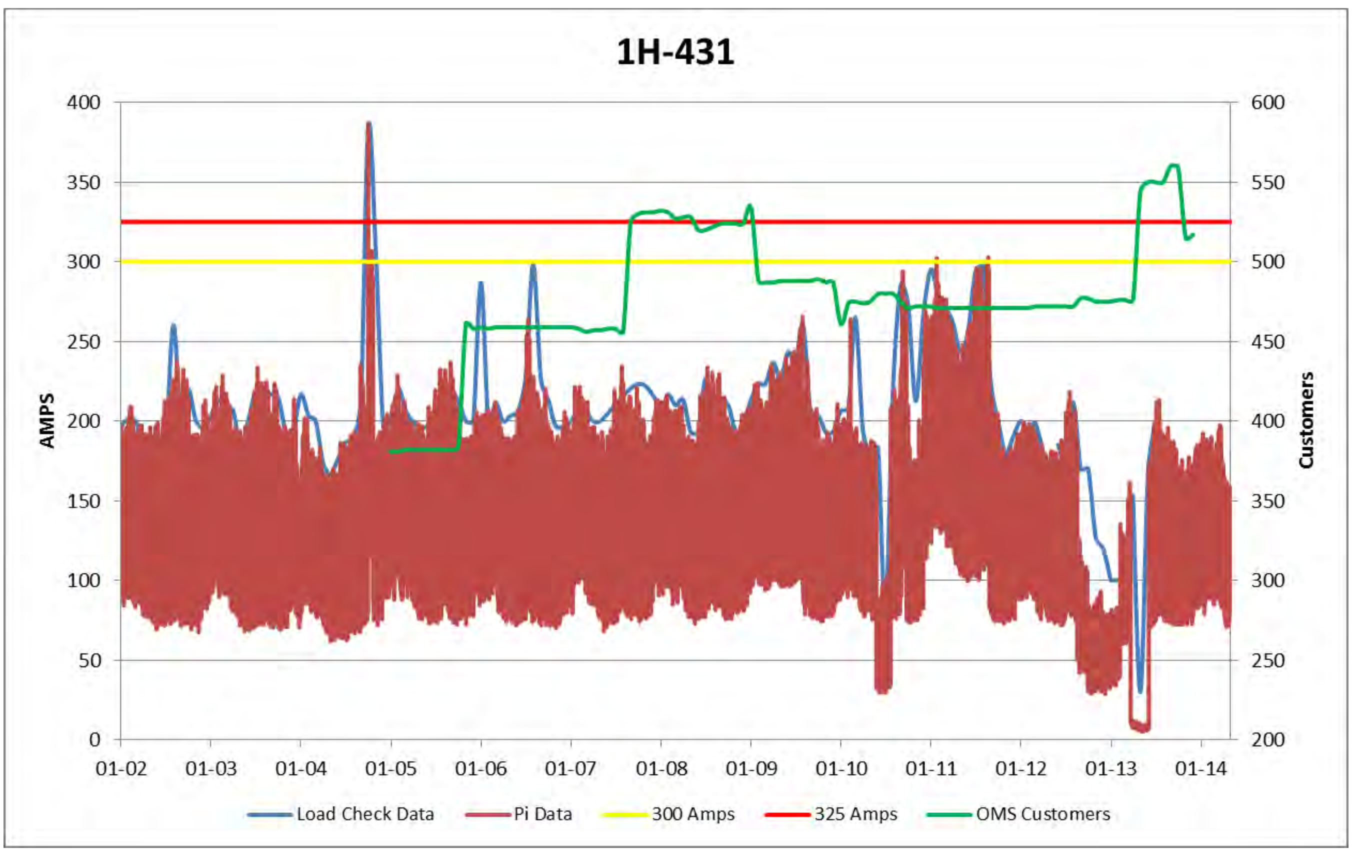


Figure 91 **1H-431 Load History**

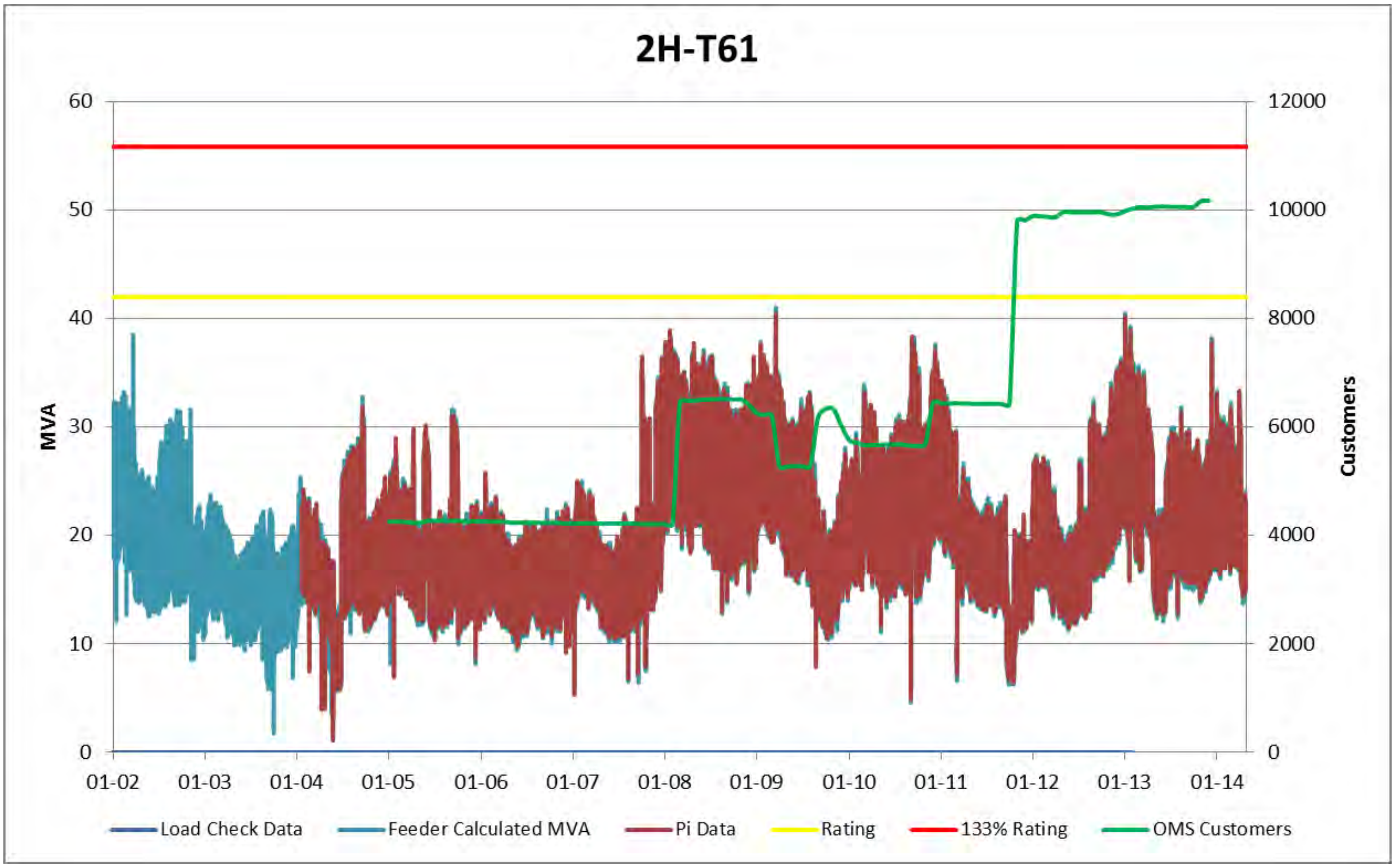


Figure 92 2H-T61 Load History

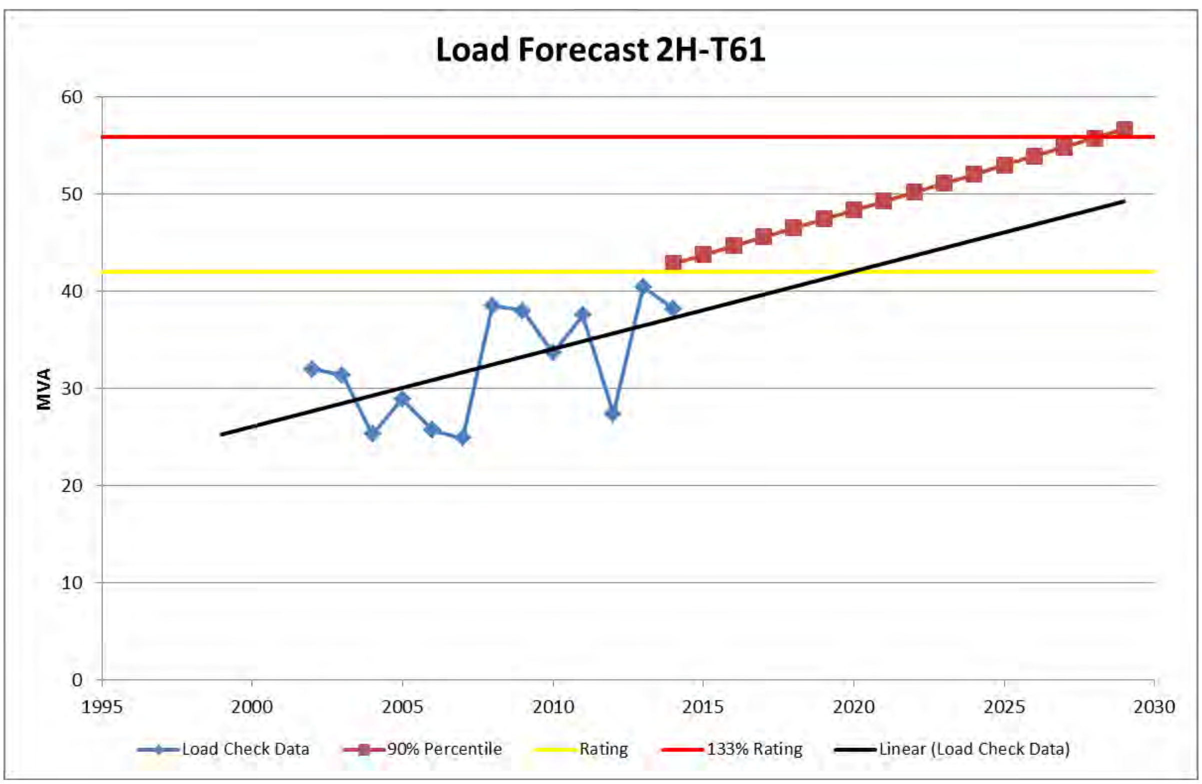


Figure 93 2H-T61 Load Forecast

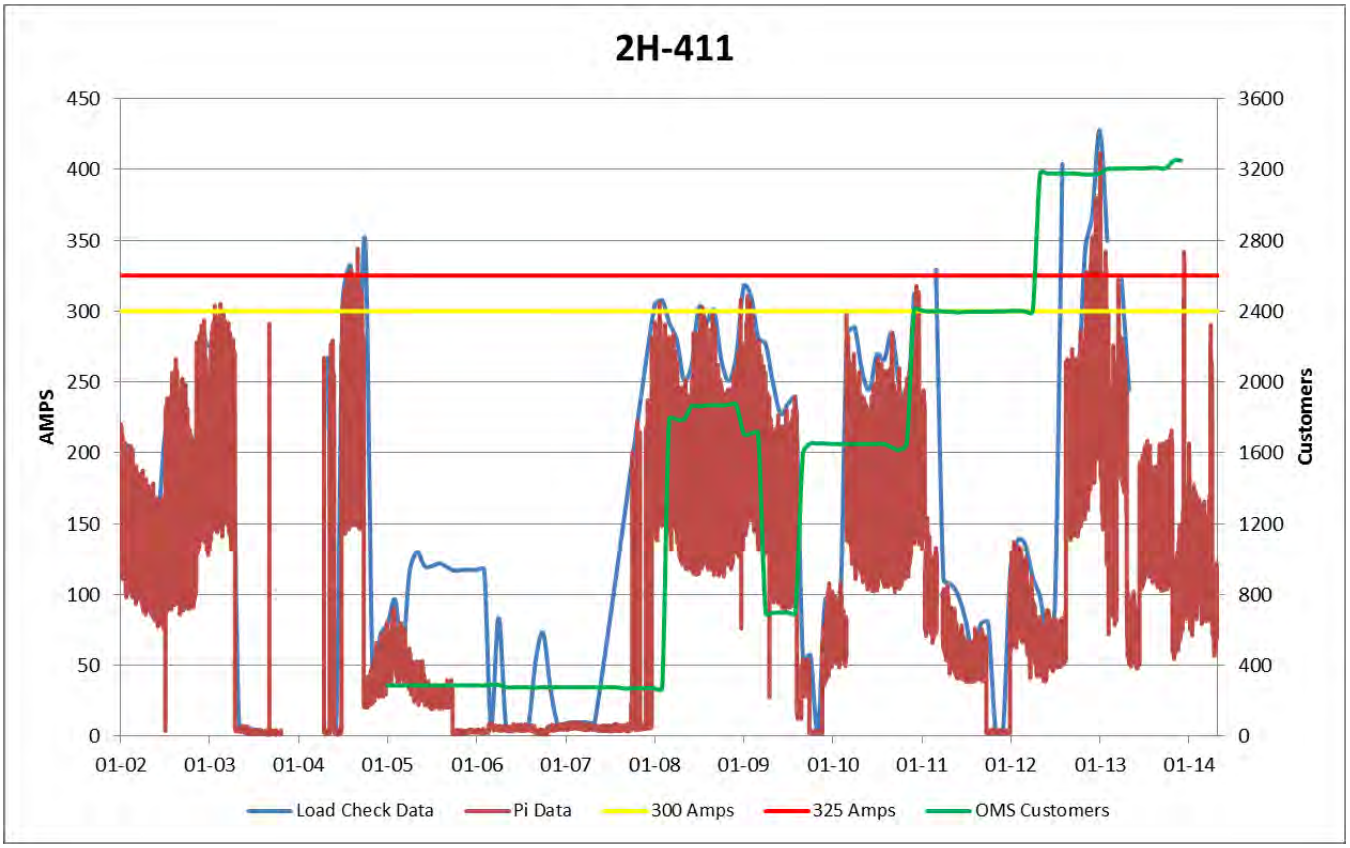


Figure 94 2H-411 Load History

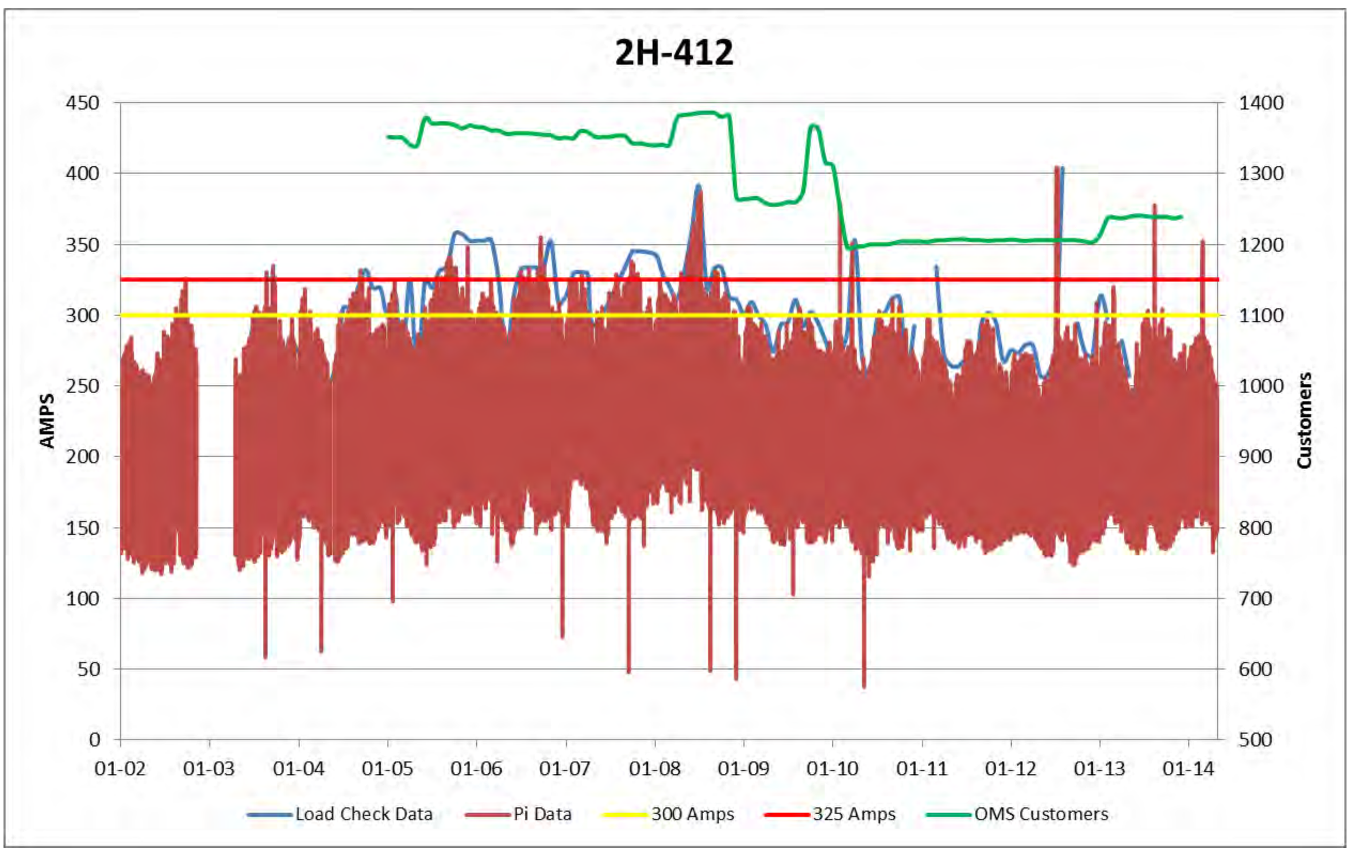


Figure 95 2H-412 Load History

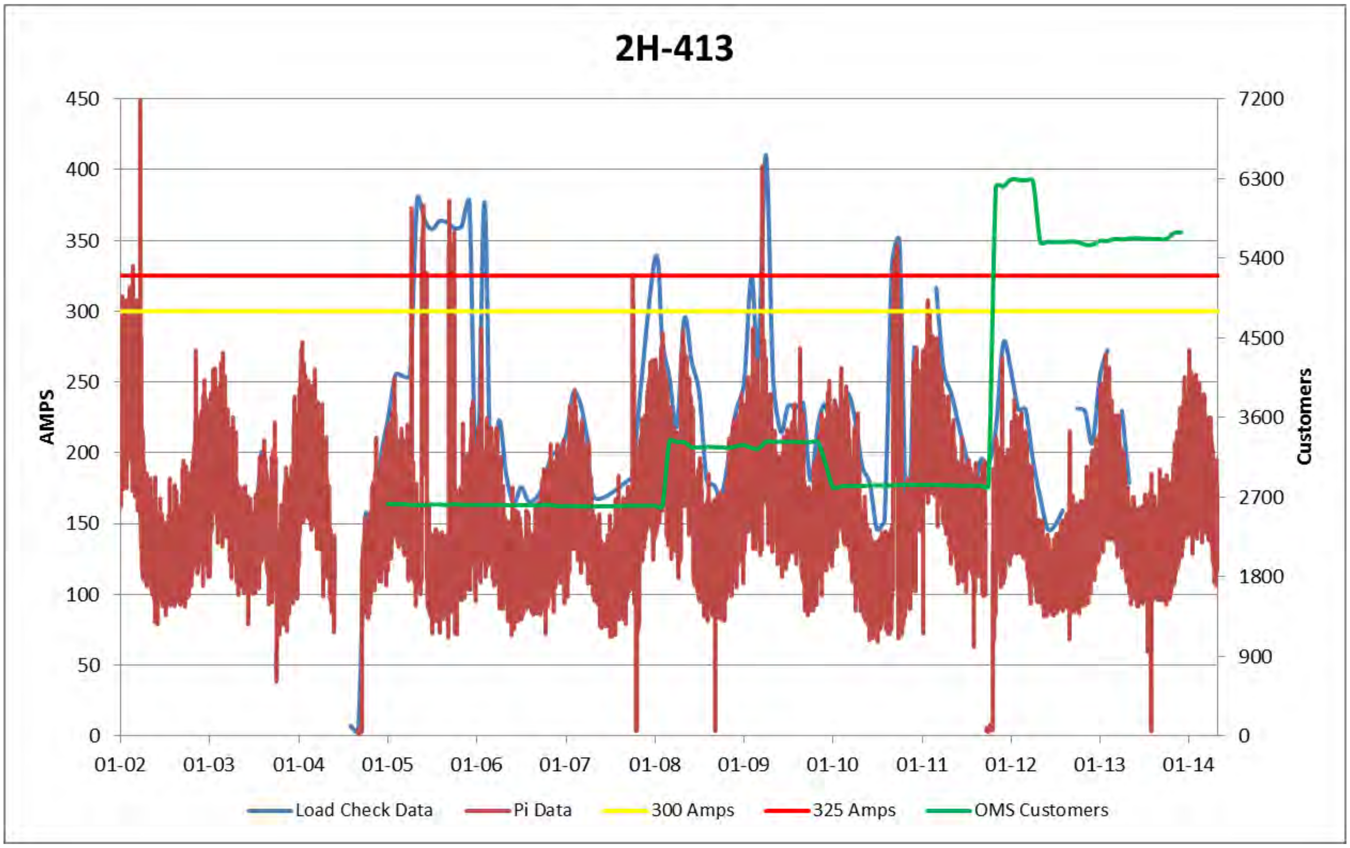


Figure 96 **2H-413 Load History**

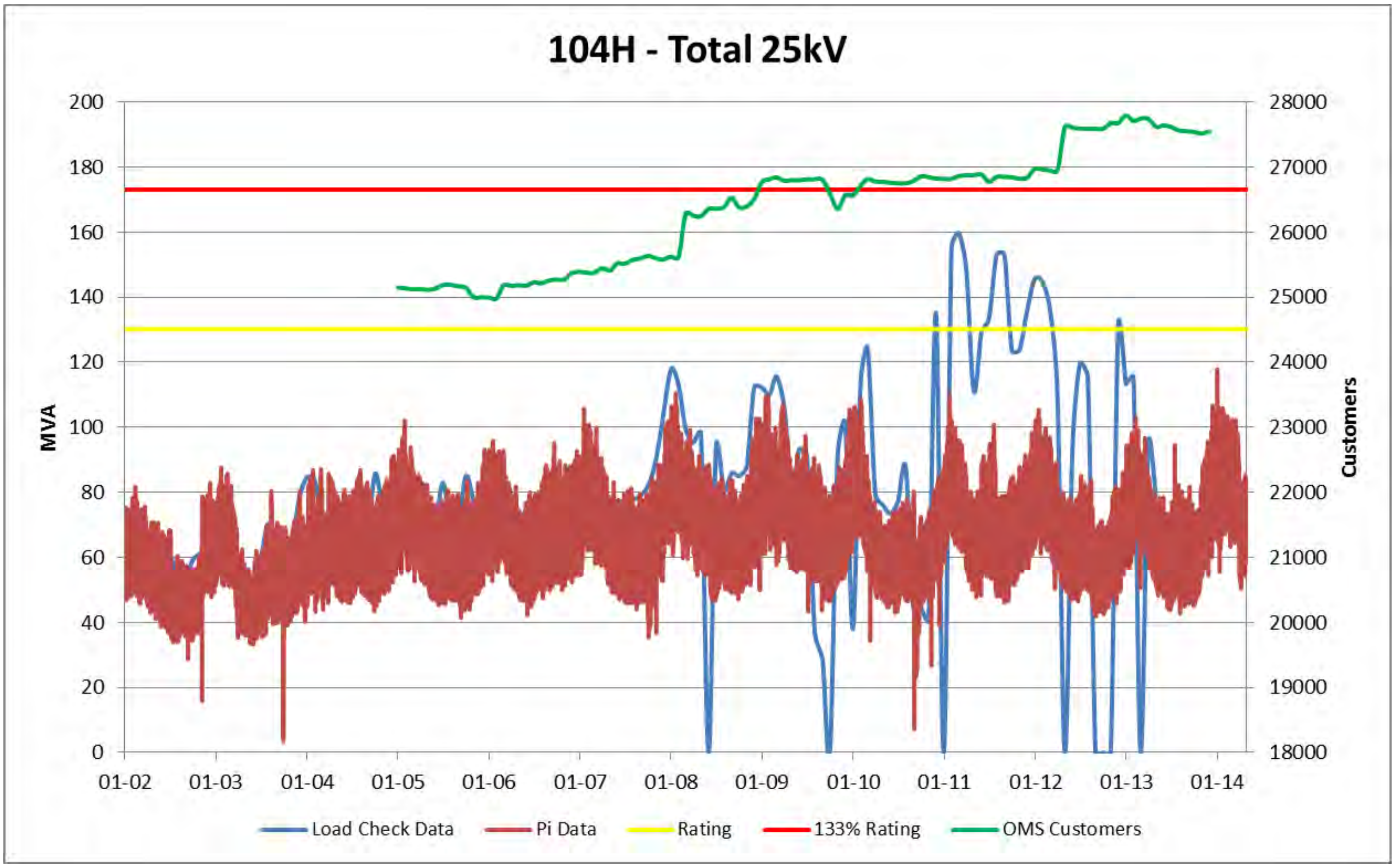


Figure 97 **104H-Kempt Road Total 25kV**

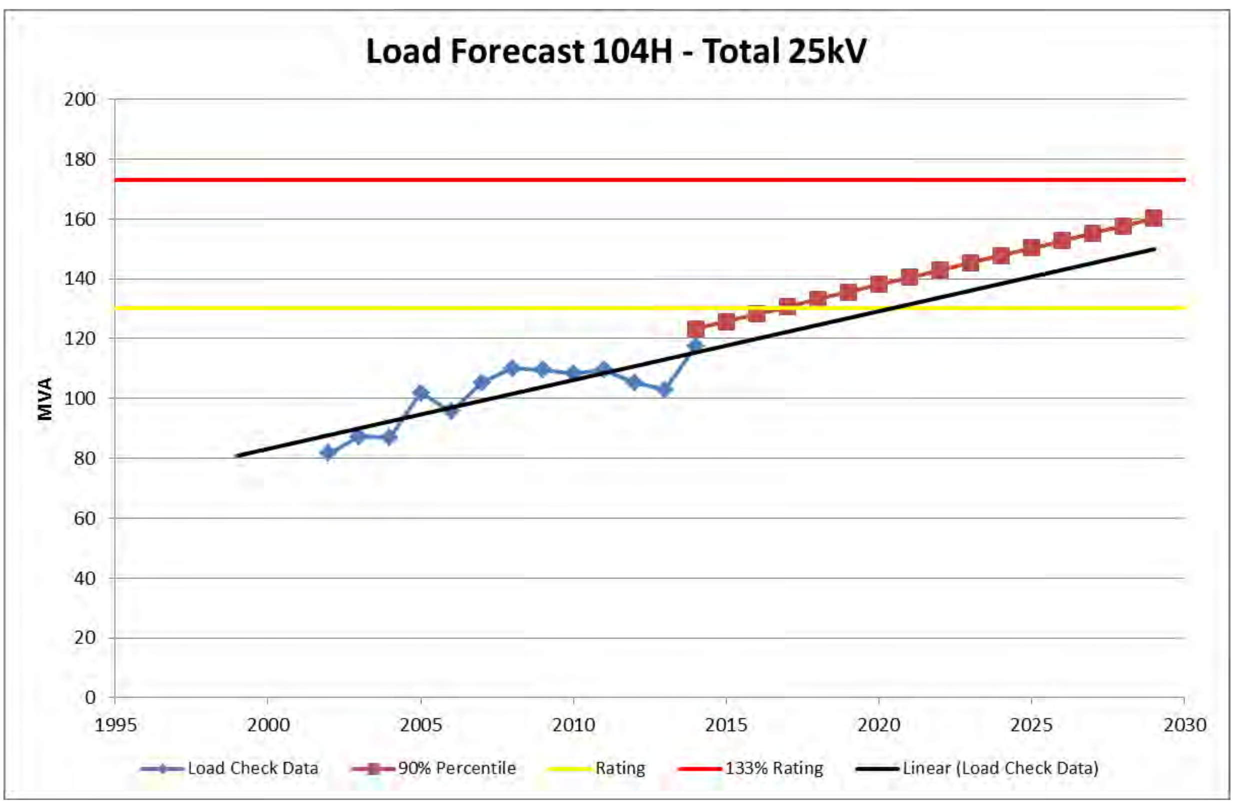


Figure 98 **104H-Kempt Road Load Forecast**

Appendix B: Load History and Forecast

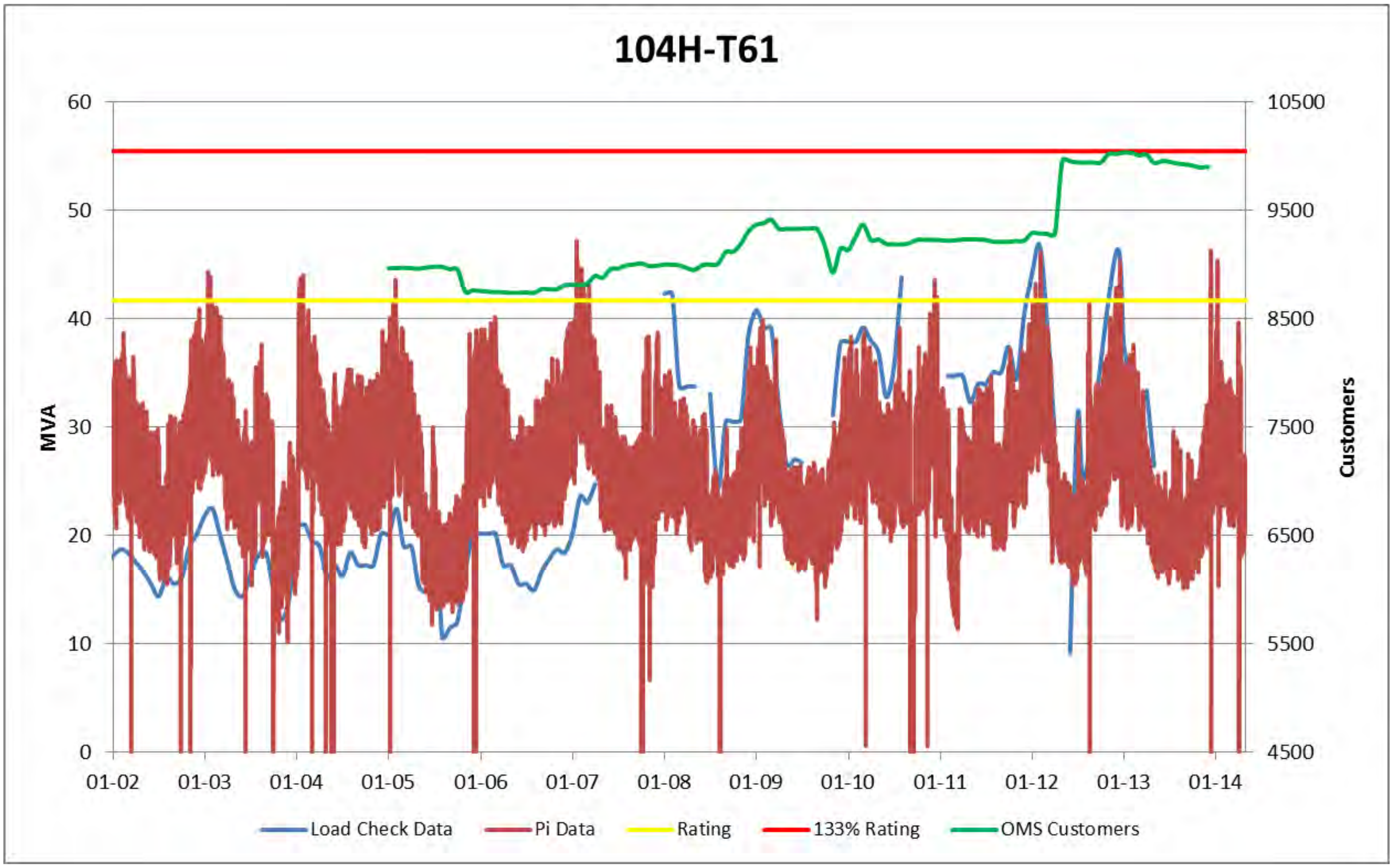


Figure 99 **104H-T61 Load History**

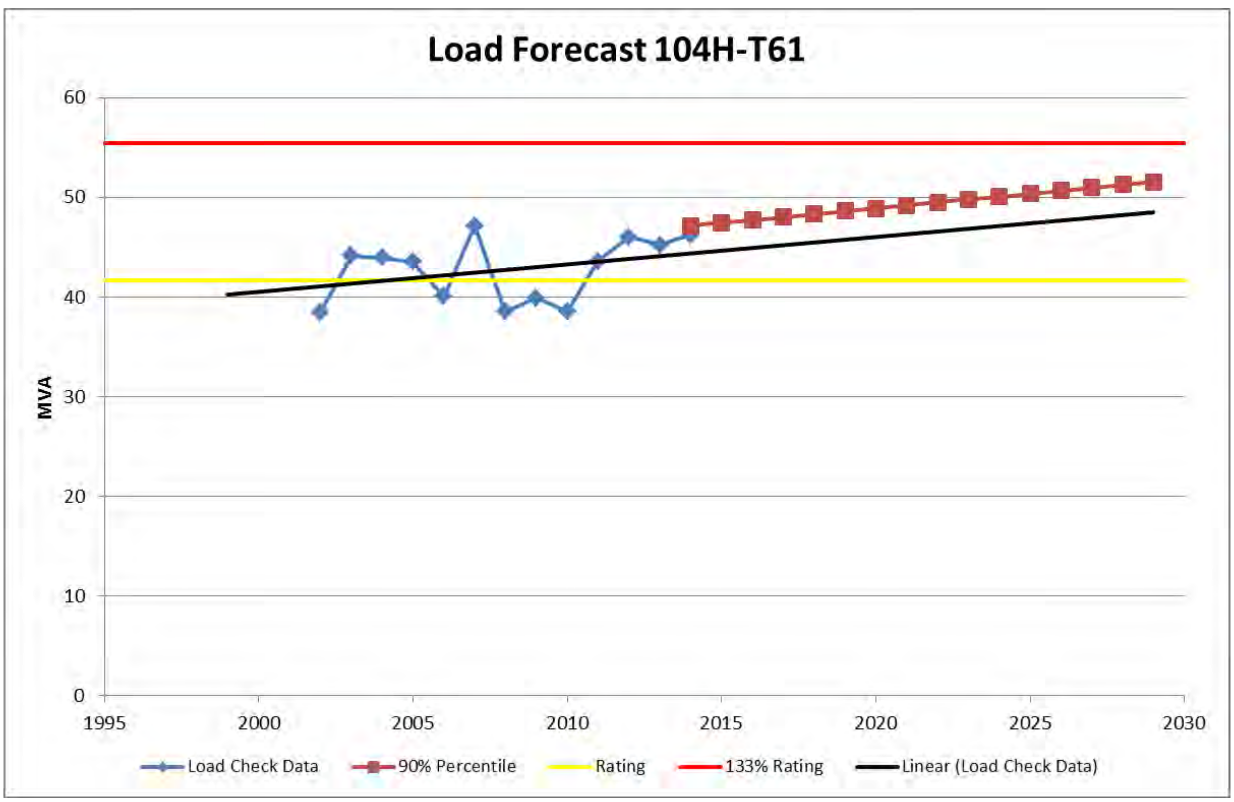


Figure 100 **104H-T61 Load Forecast**

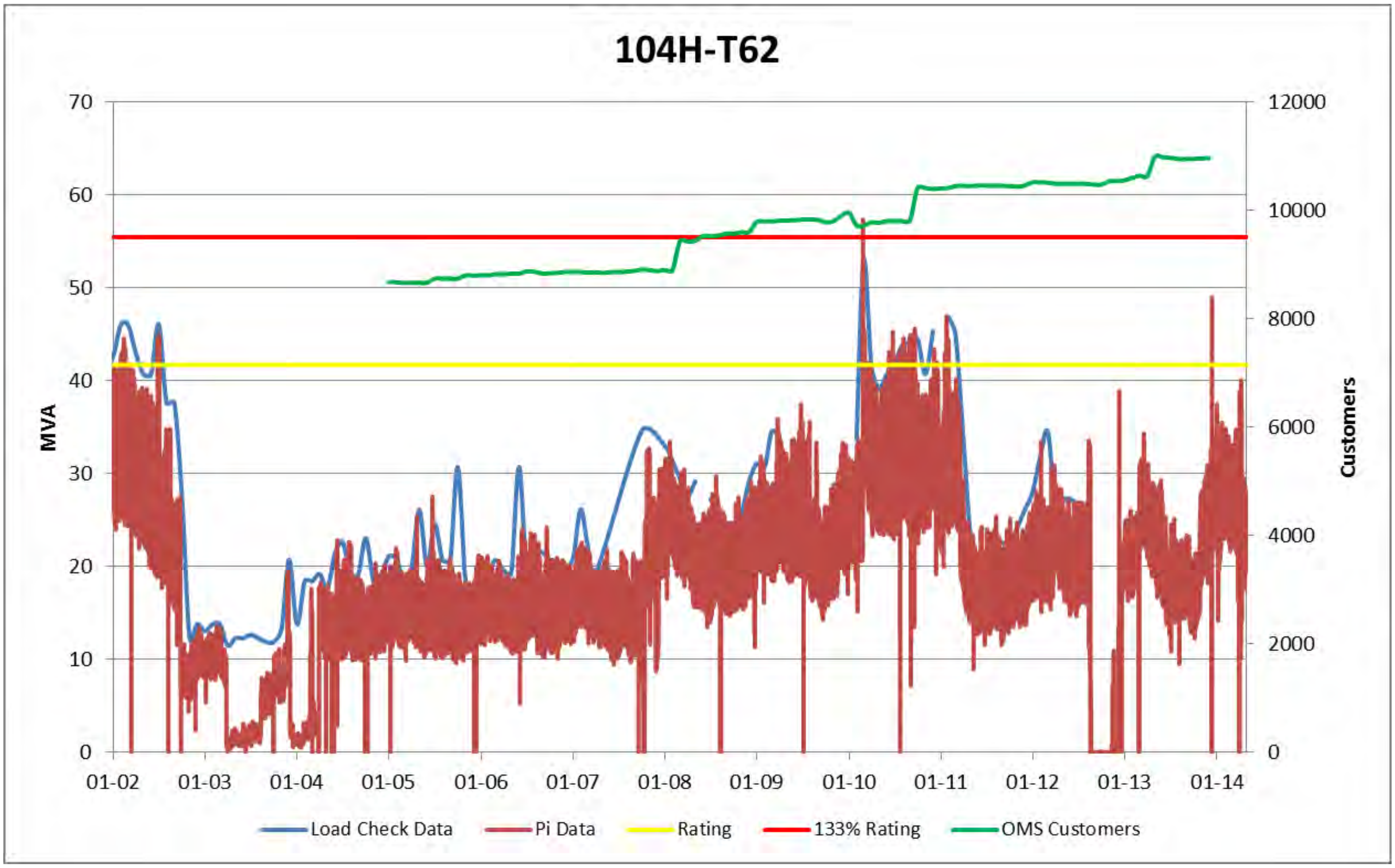


Figure 101 **104H-T62 Load History**

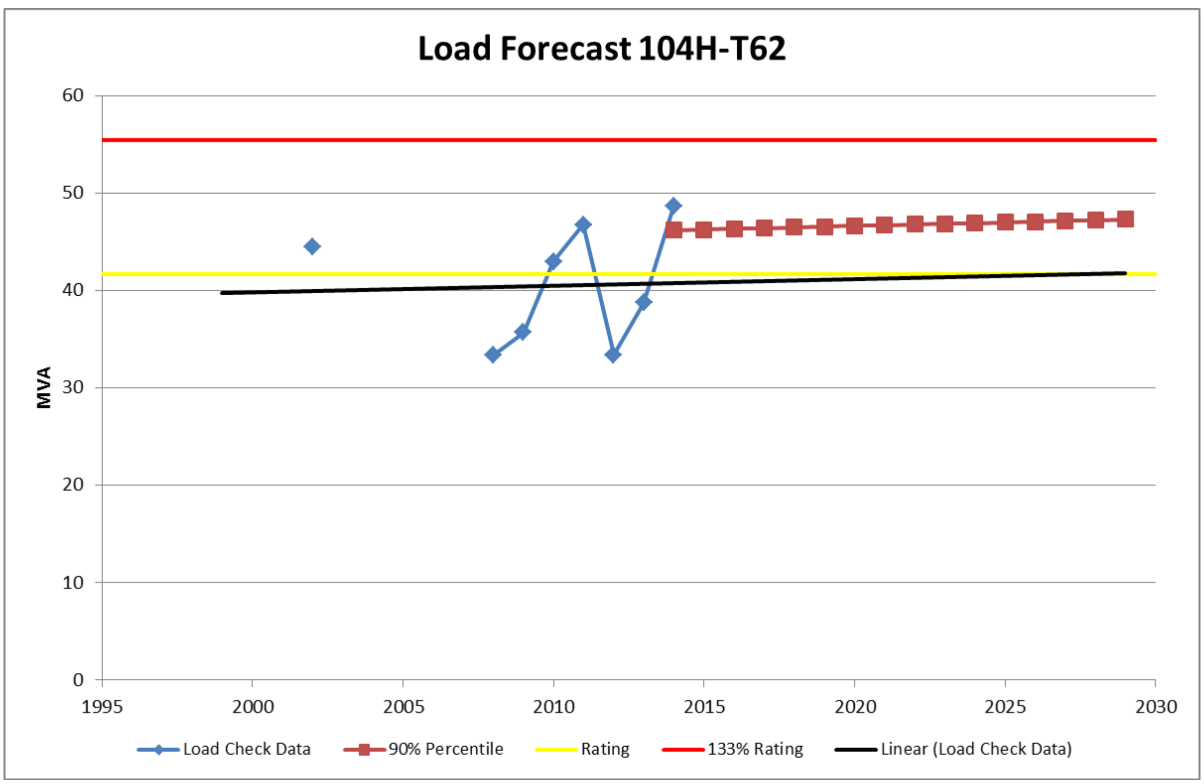


Figure 102 **104H-T62 Load Forecast**

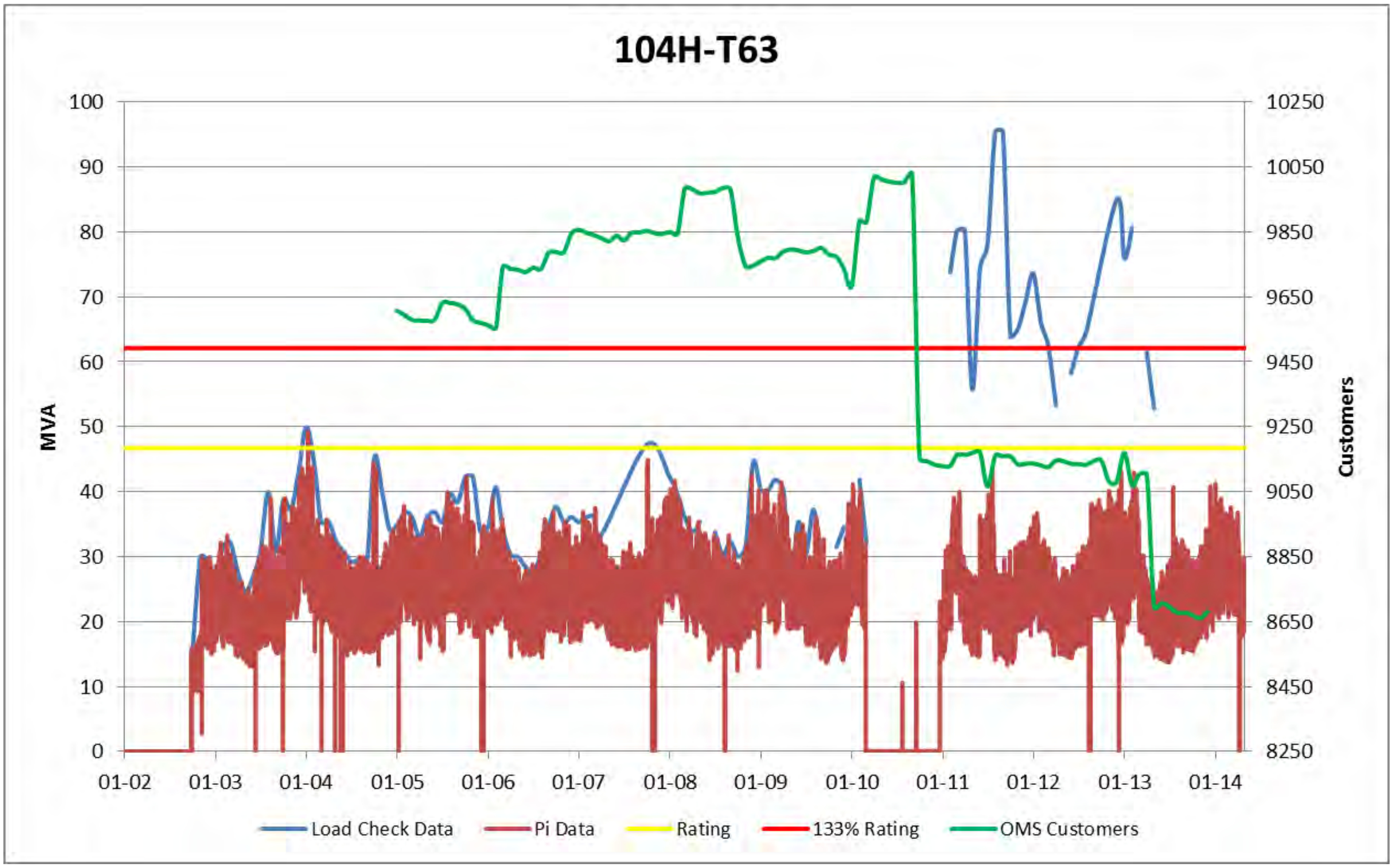


Figure 103 104H-T63 Load History

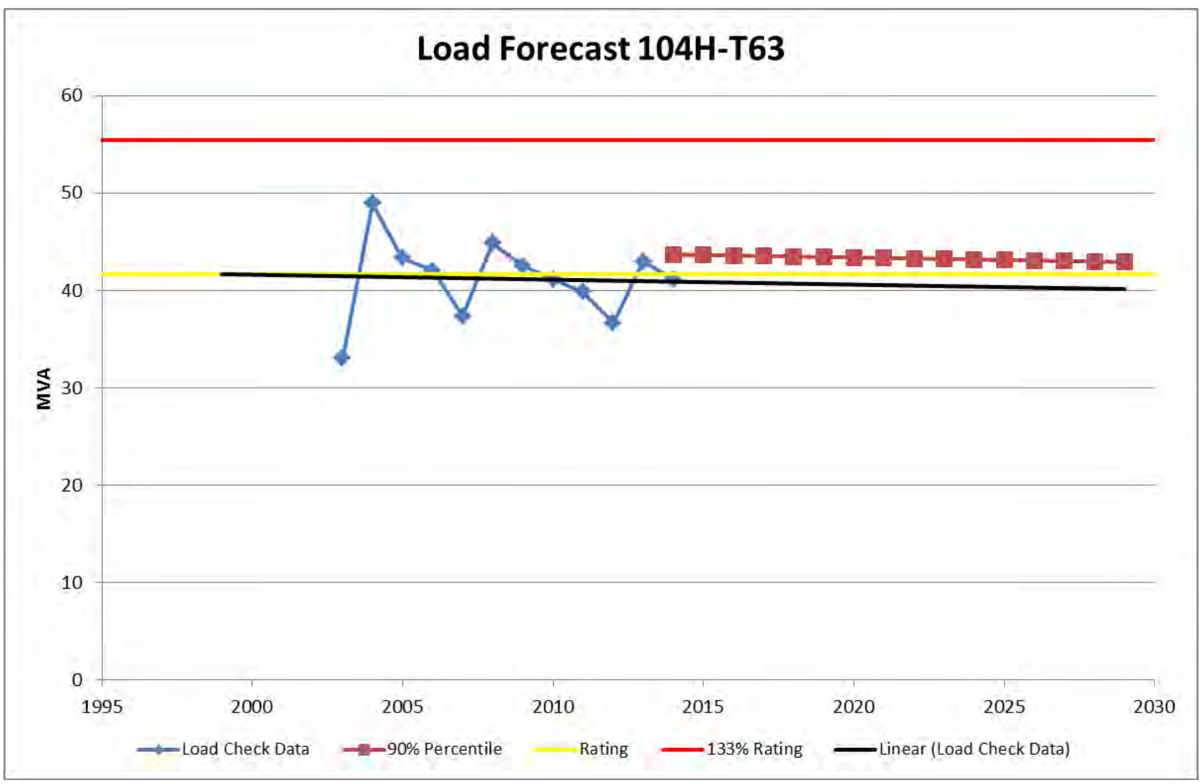


Figure 104 104H-T63 Load Forecast

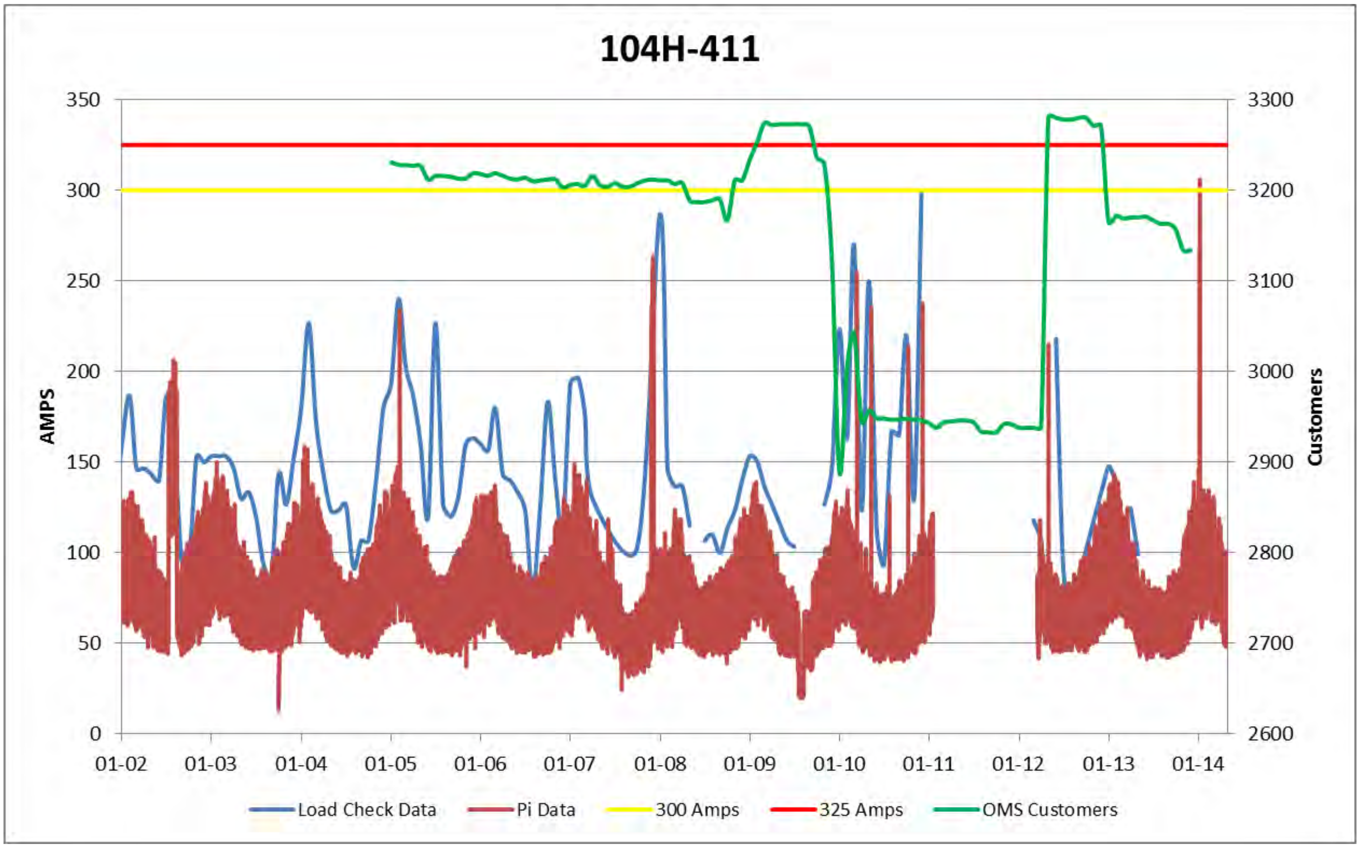


Figure 105 **104H-411 Load History**

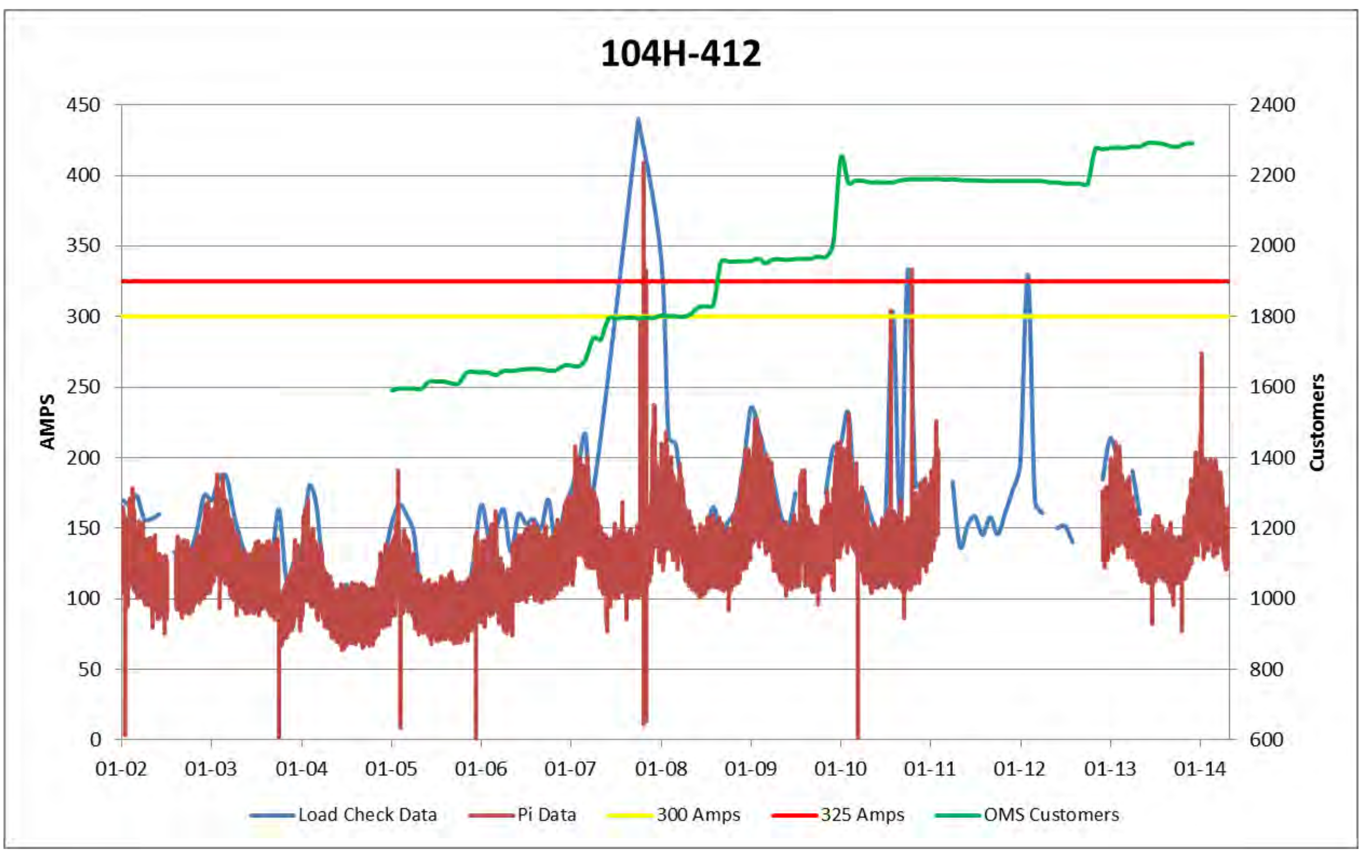


Figure 106 **104H-412 Load History**

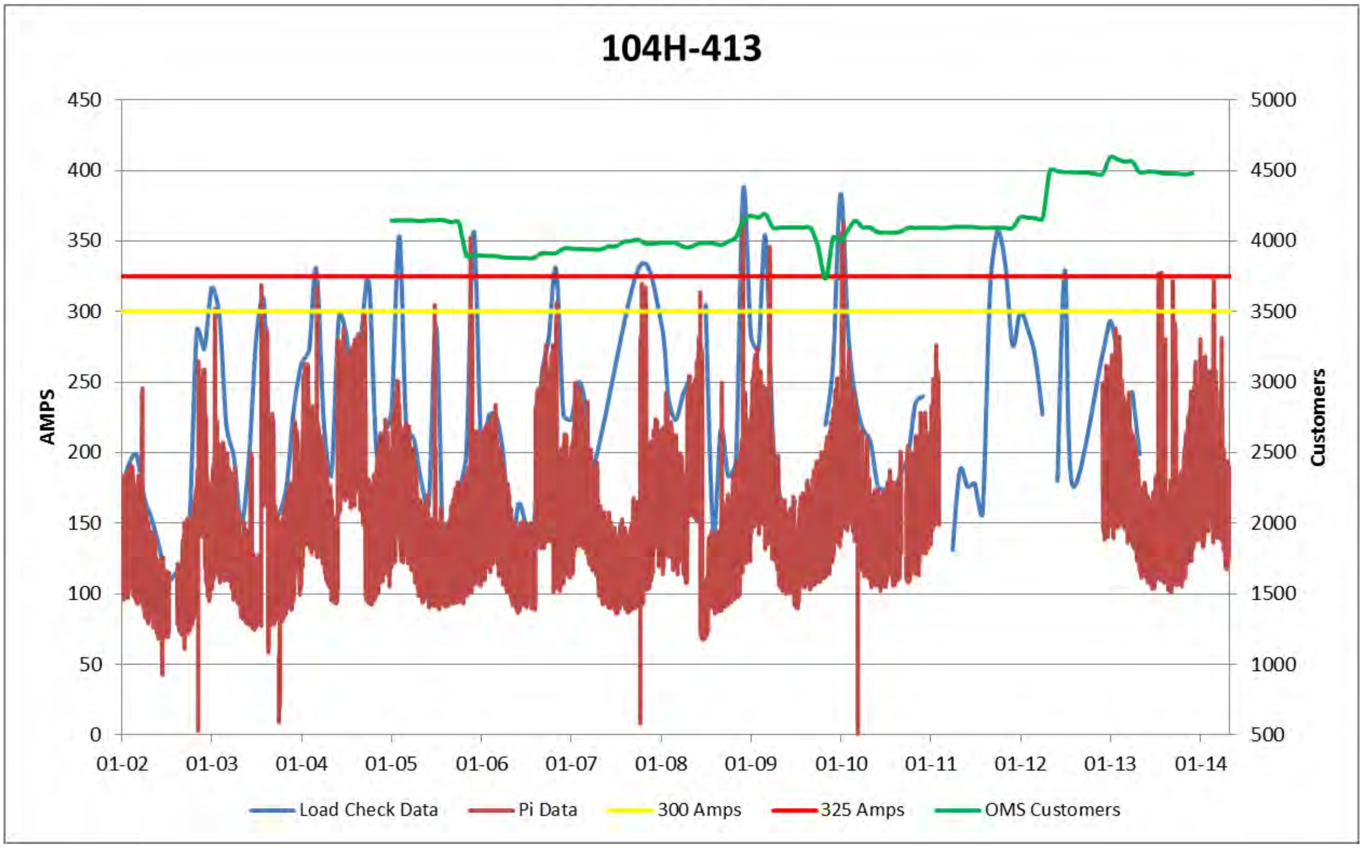


Figure 107 **104H-413 Load History**

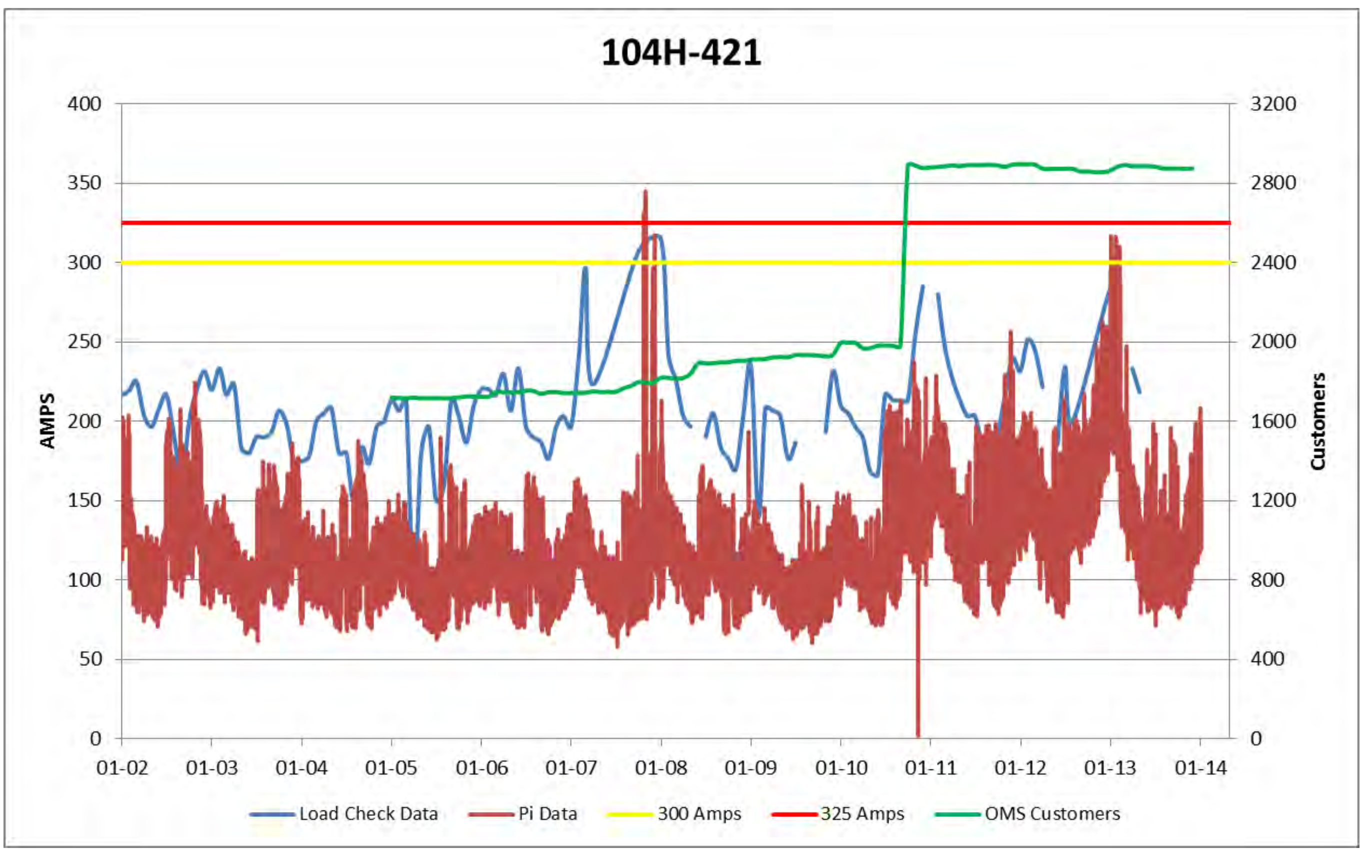


Figure 108 **104H-421 Load History**

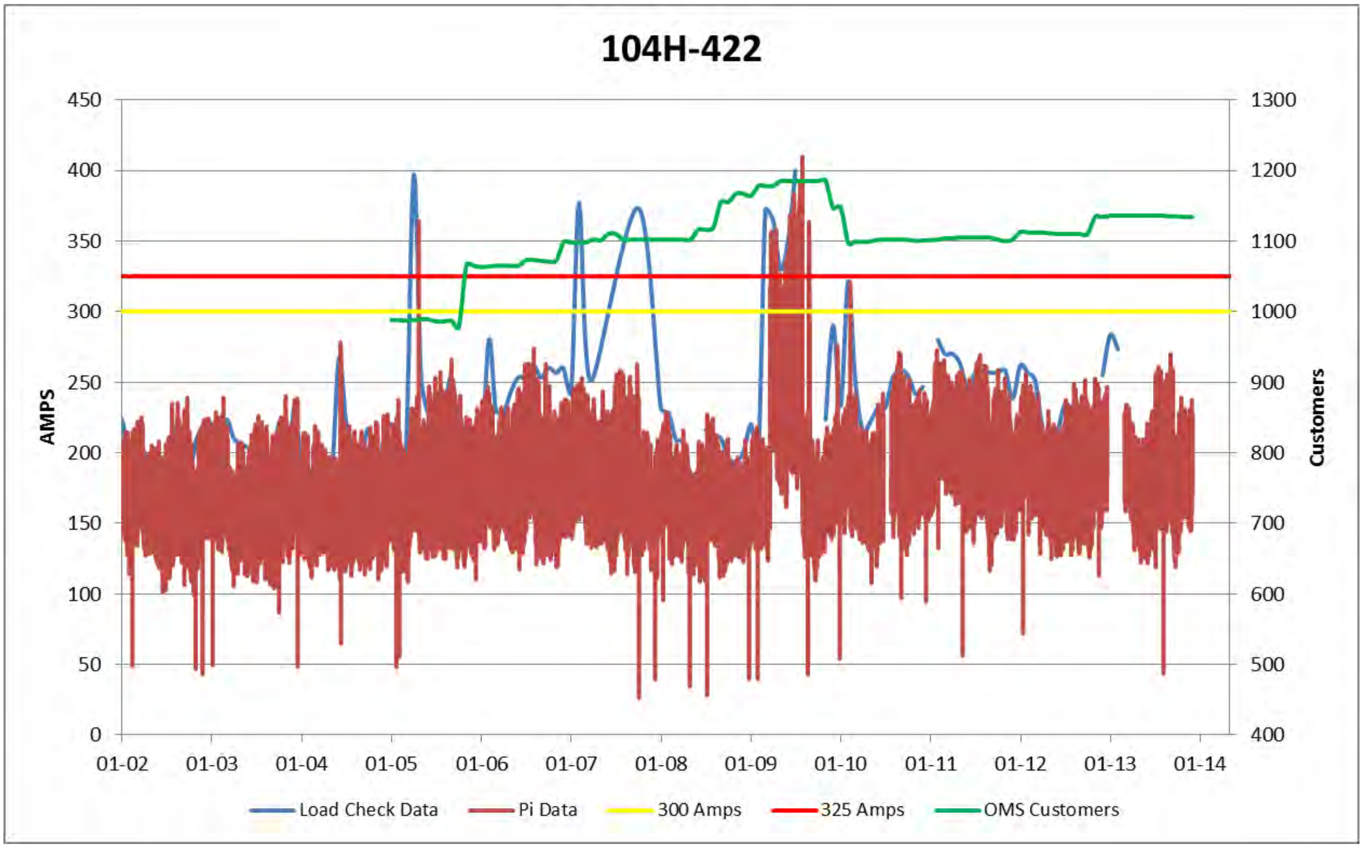


Figure 109 **104H-422 Load History**

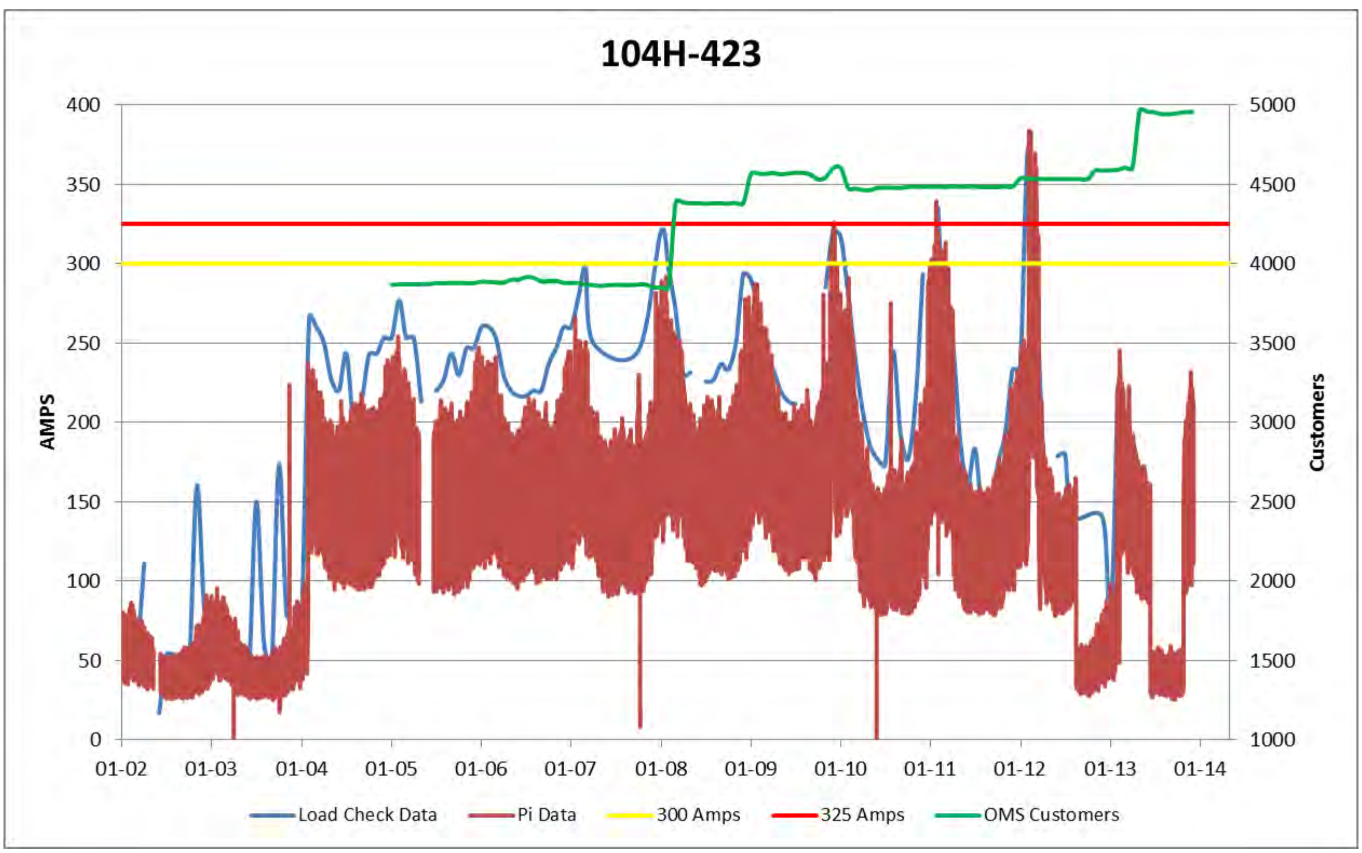


Figure 110 **104H-423 Load History**

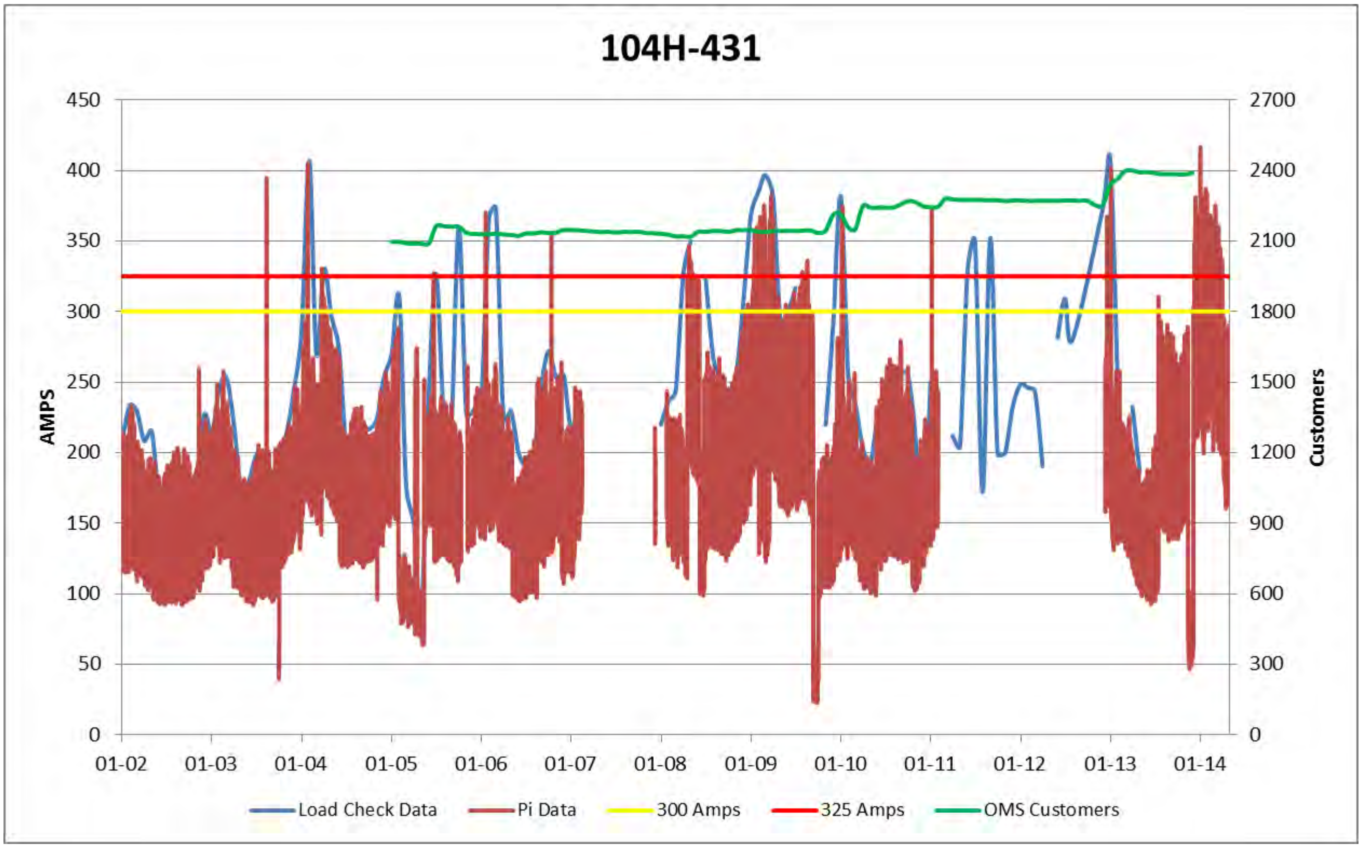


Figure 111 **104H-431 Load History**

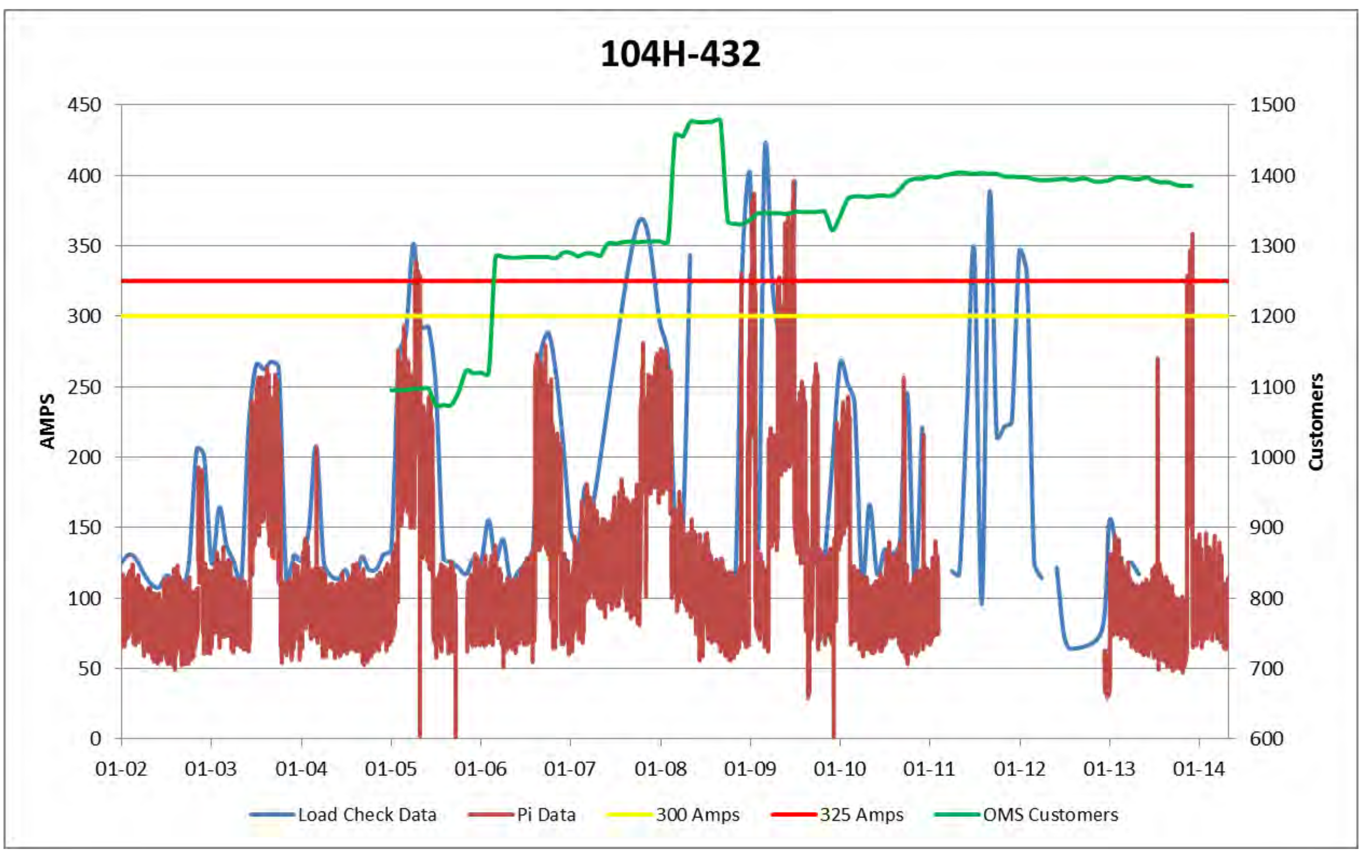


Figure 112 **104H-432 Load History**

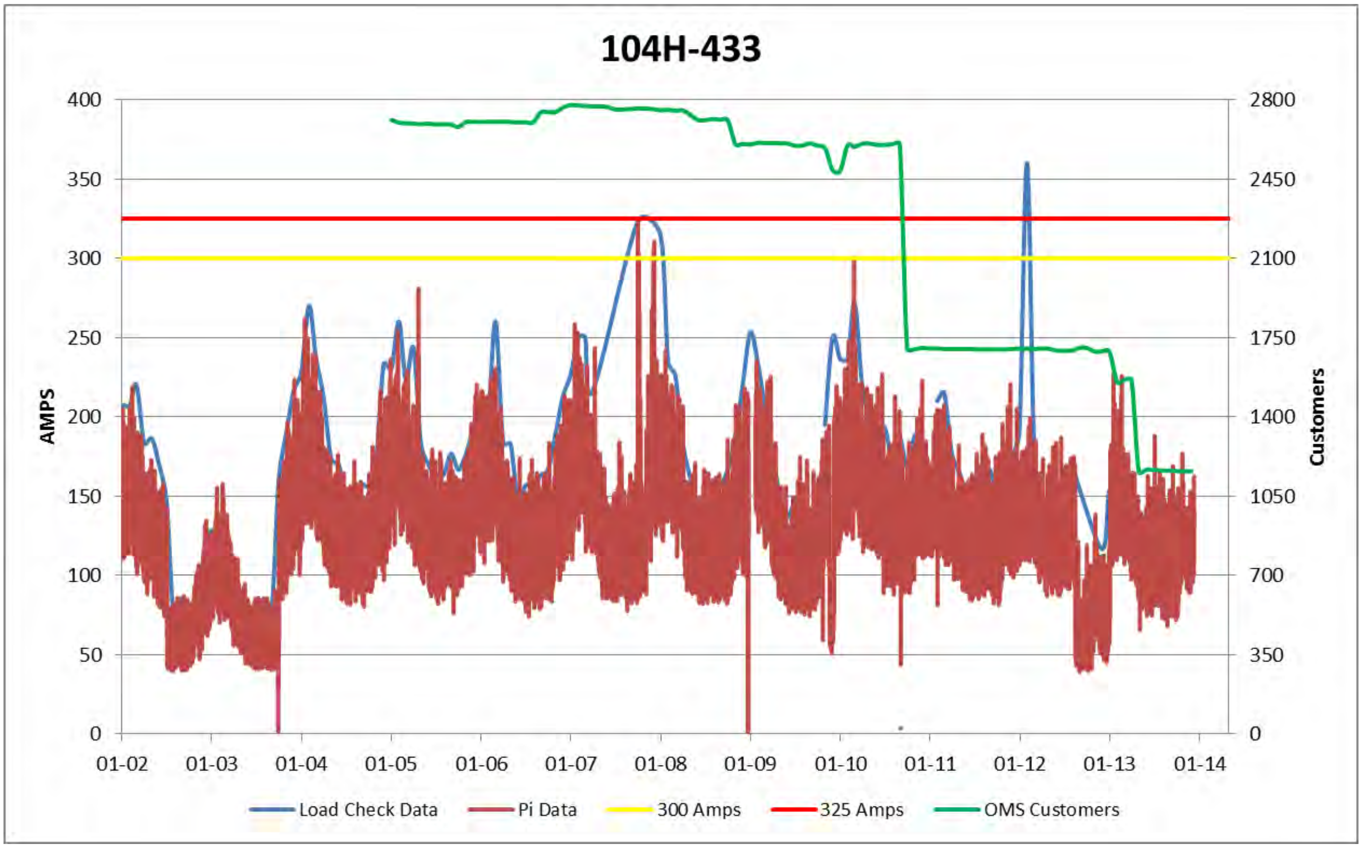


Figure 113 **104H-433 Load History**

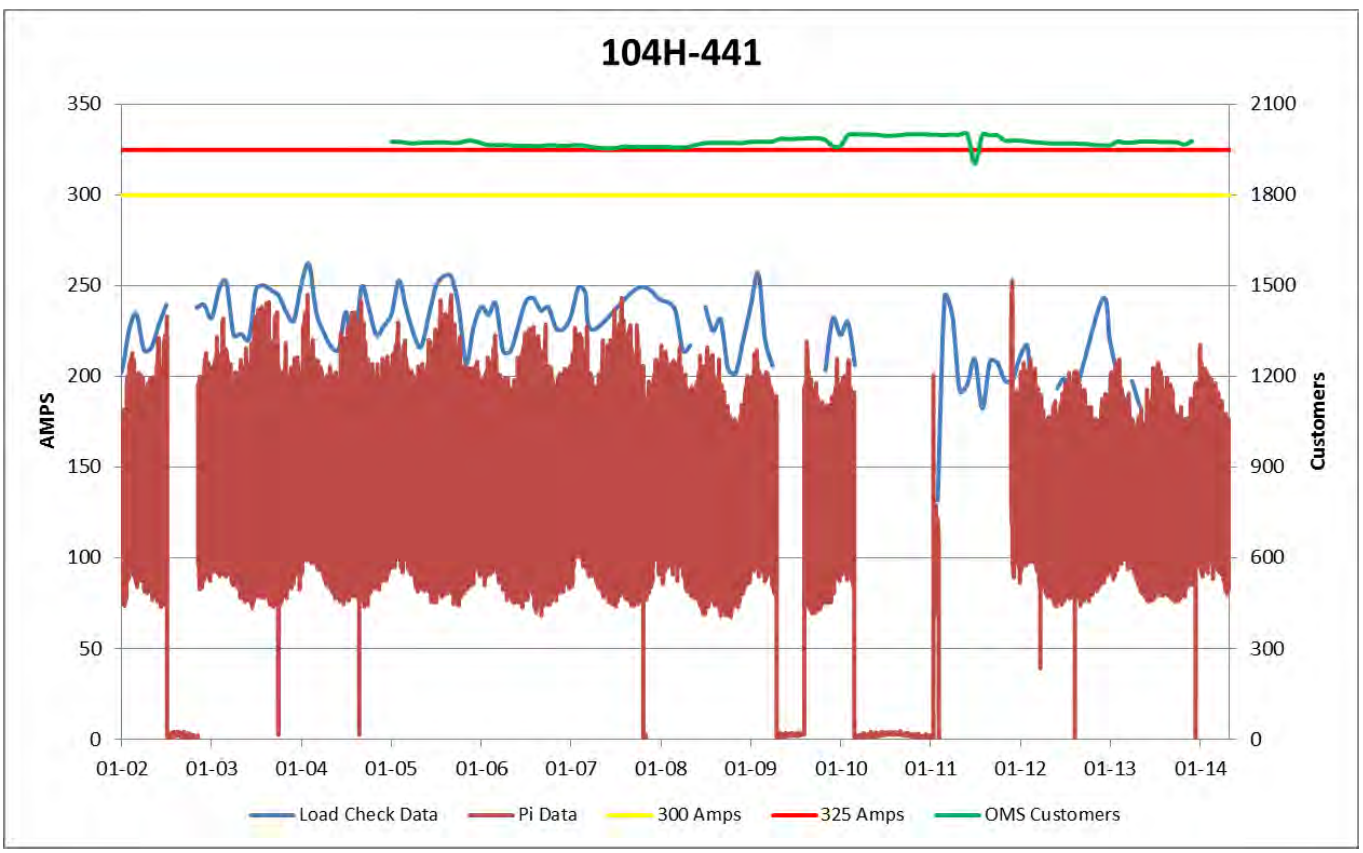


Figure 114 **104H-441 Load History**

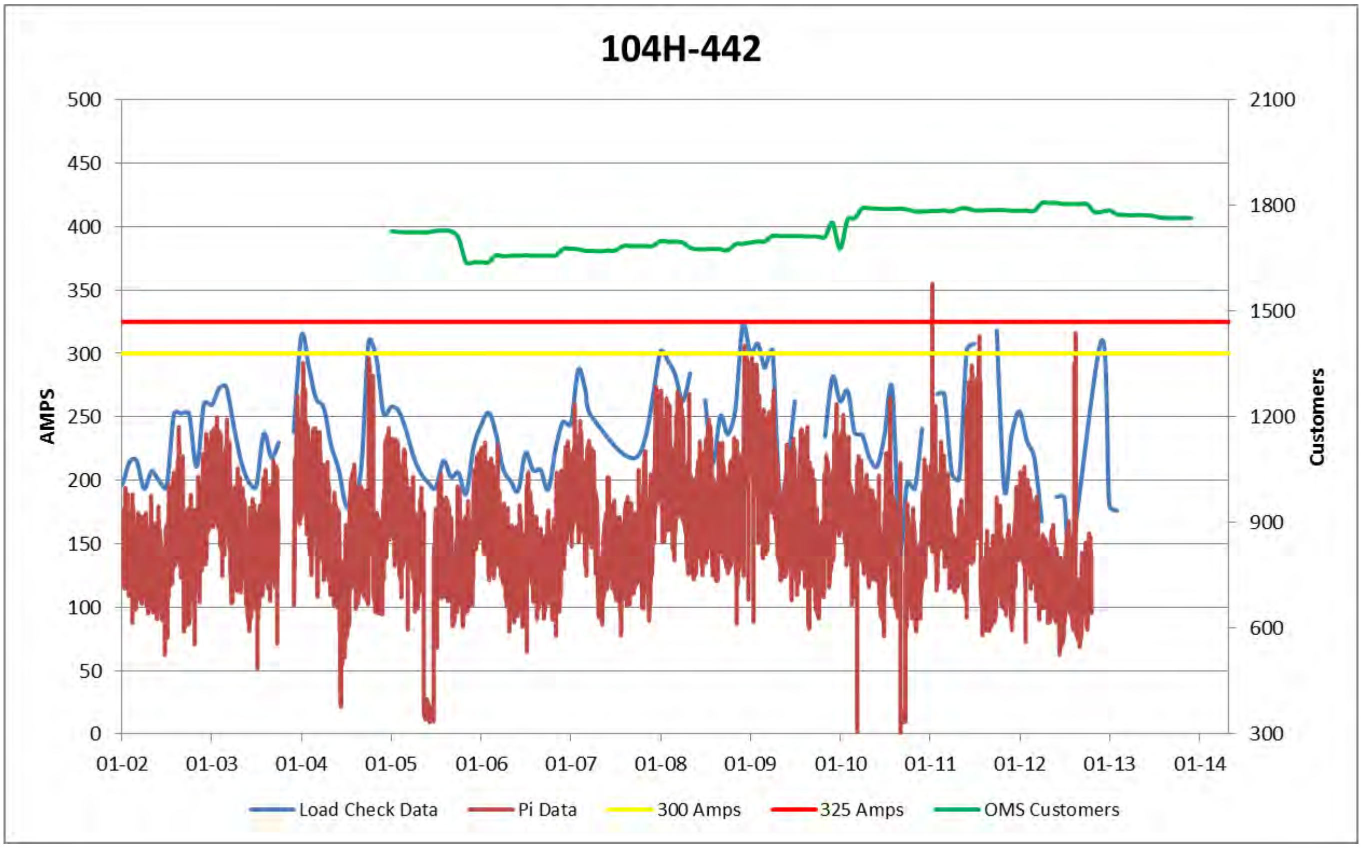


Figure 115 **104H-442 Load History**

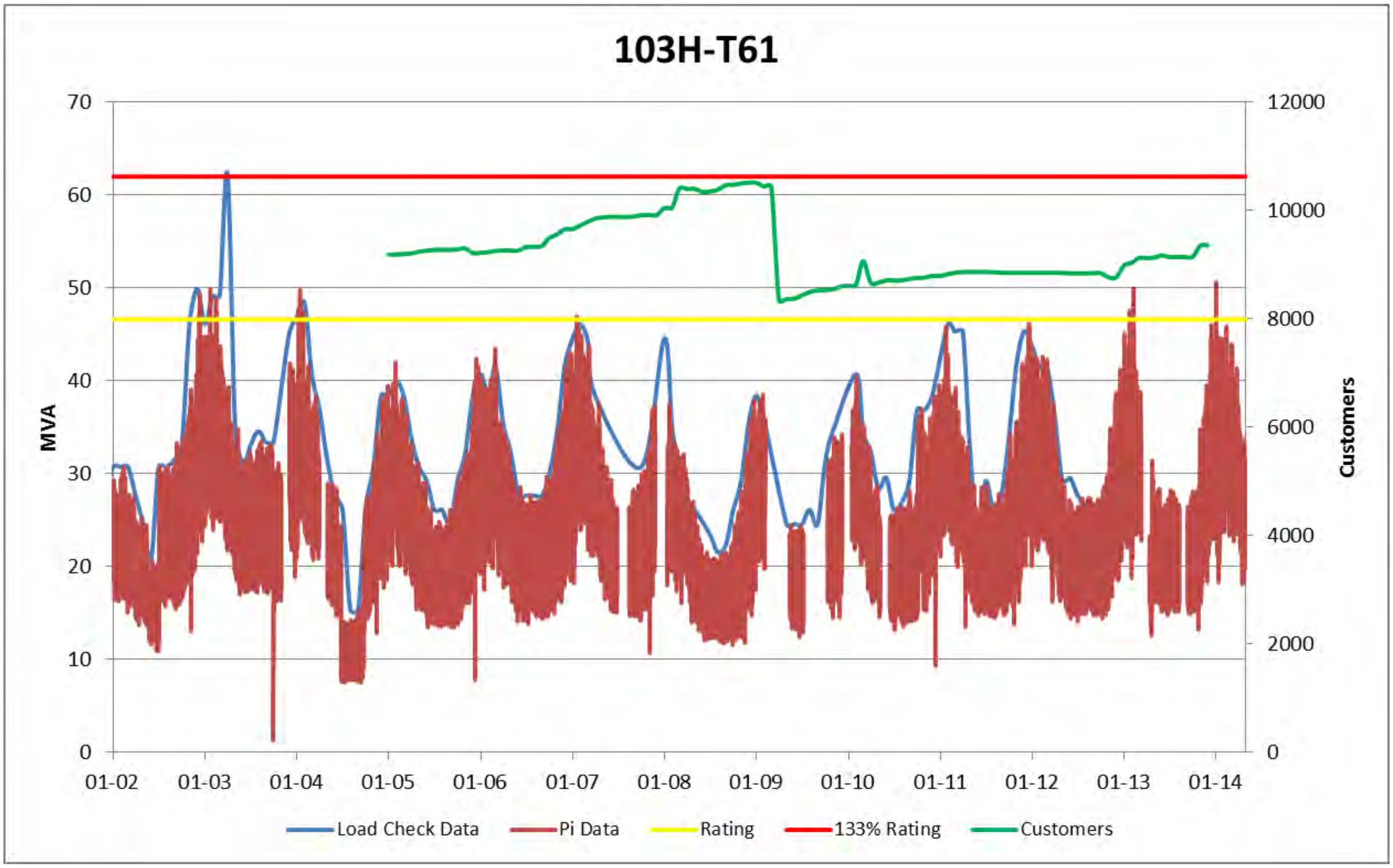


Figure 116 **103H-T61 Load History**

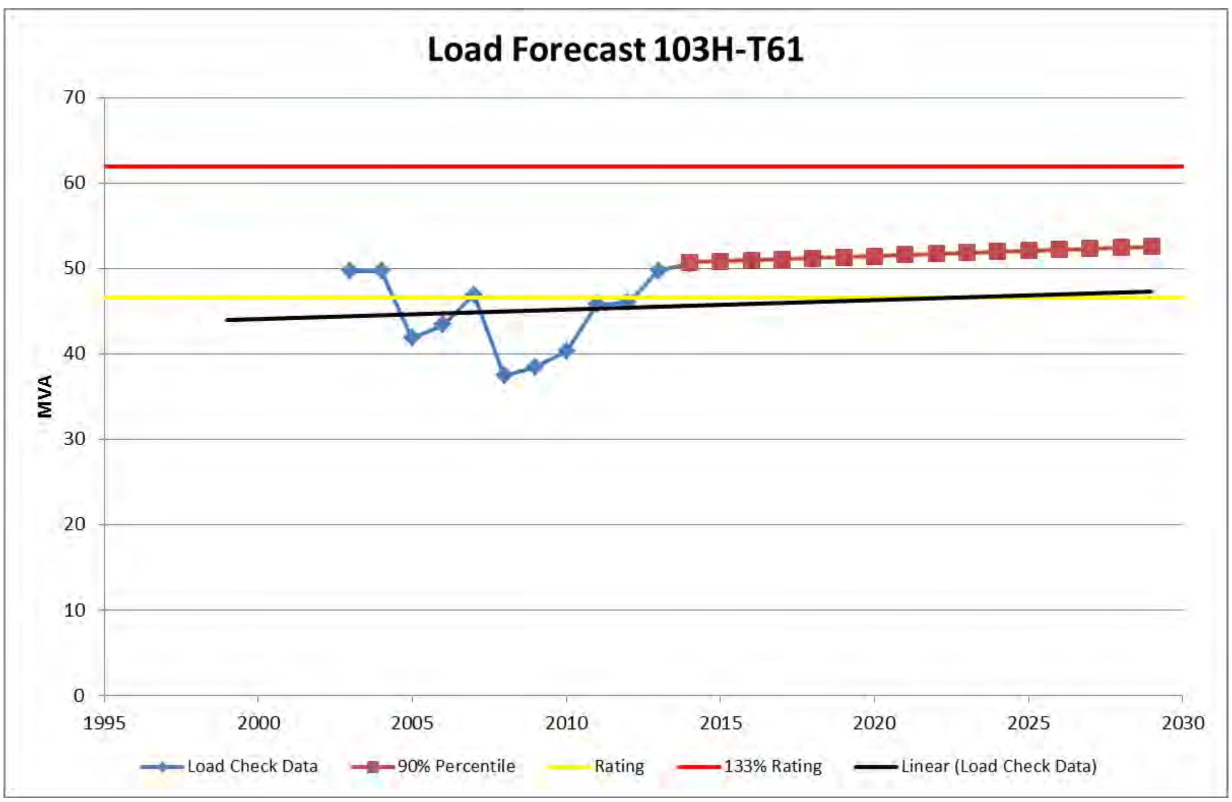


Figure 117 **103H-T61 Load Forecast**

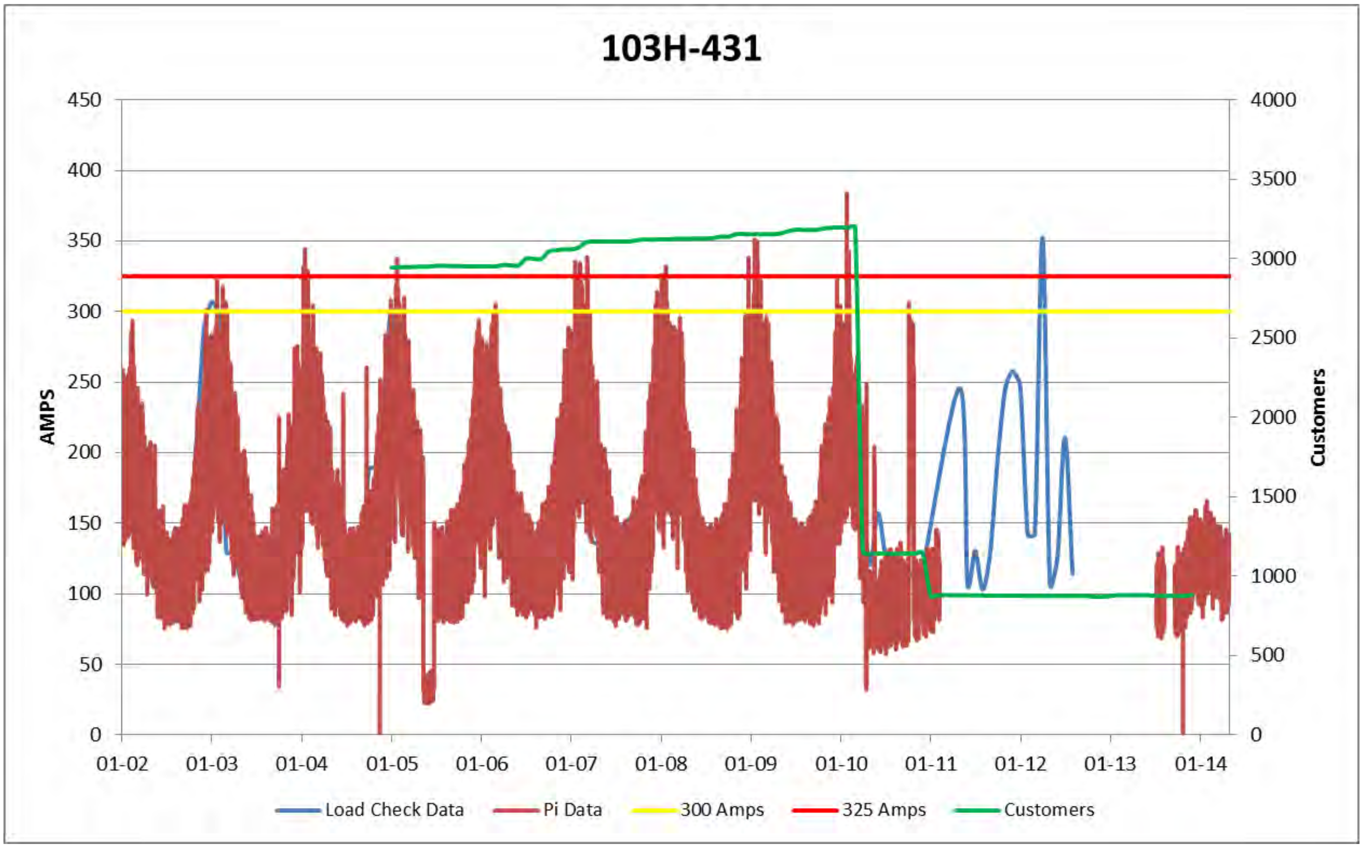


Figure 118 **103H-431 Load History**

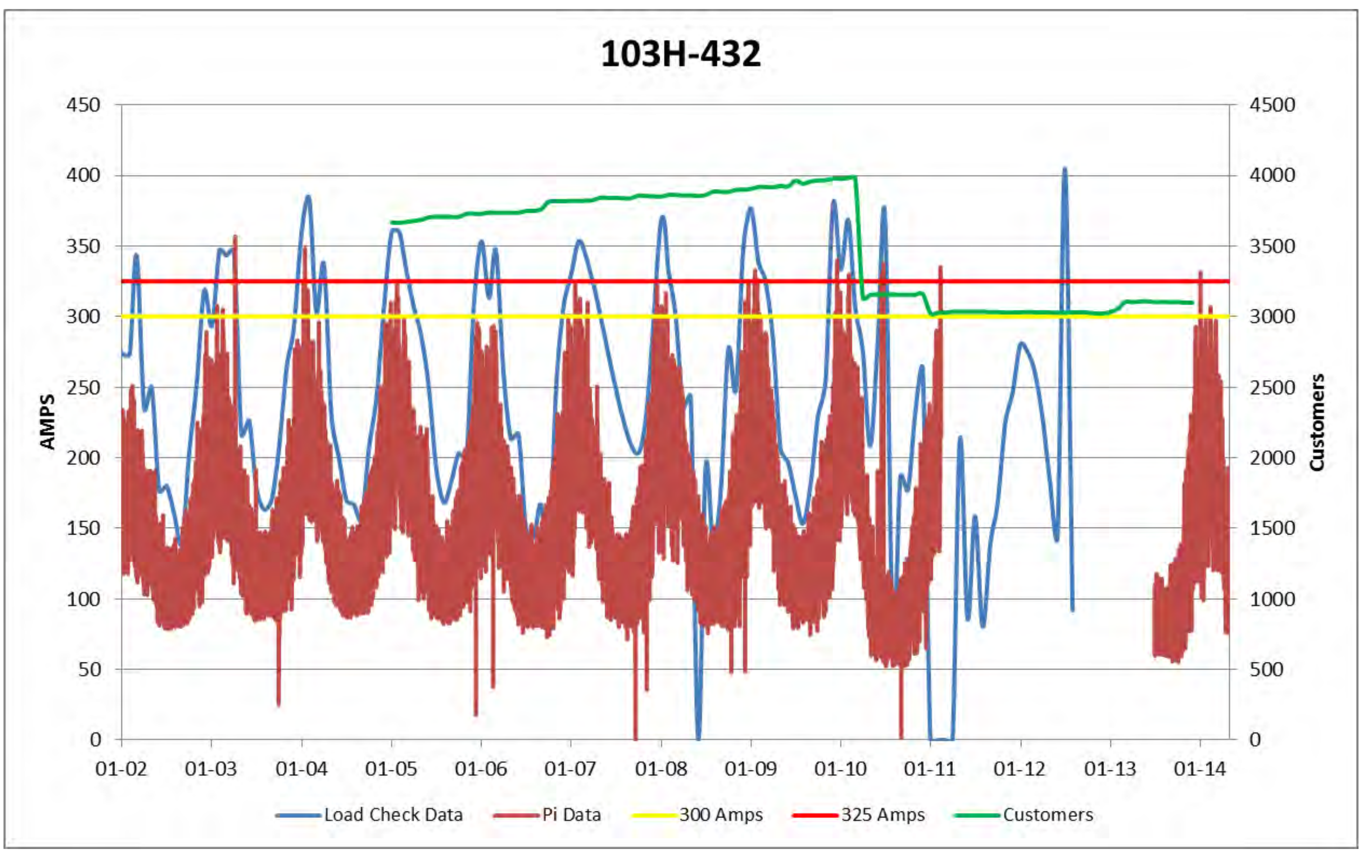


Figure 119 **103H-432 Load History**

Appendix B: Load History and Forecast

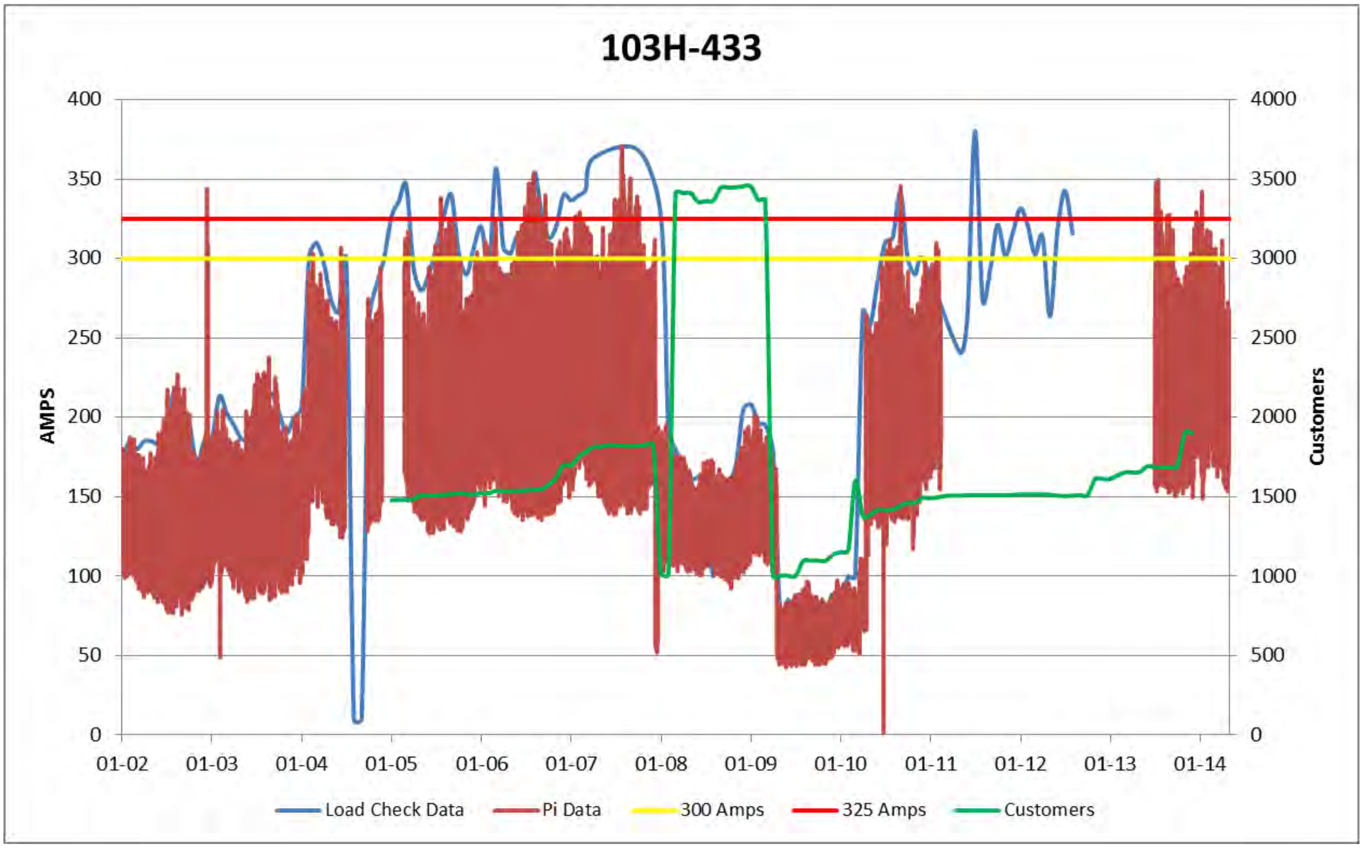


Figure 120 103H-433 Load History

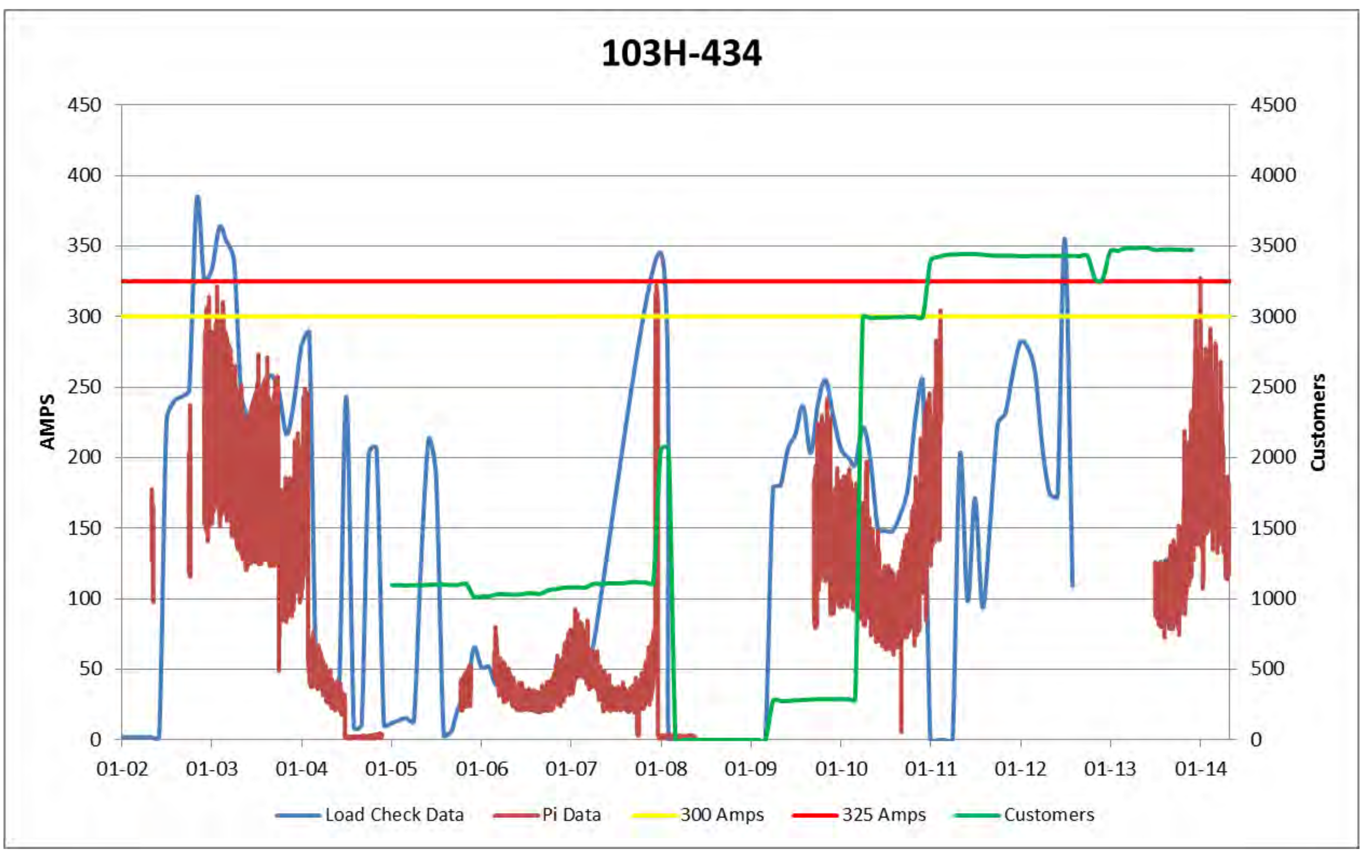


Figure 121 103H-434 Load History

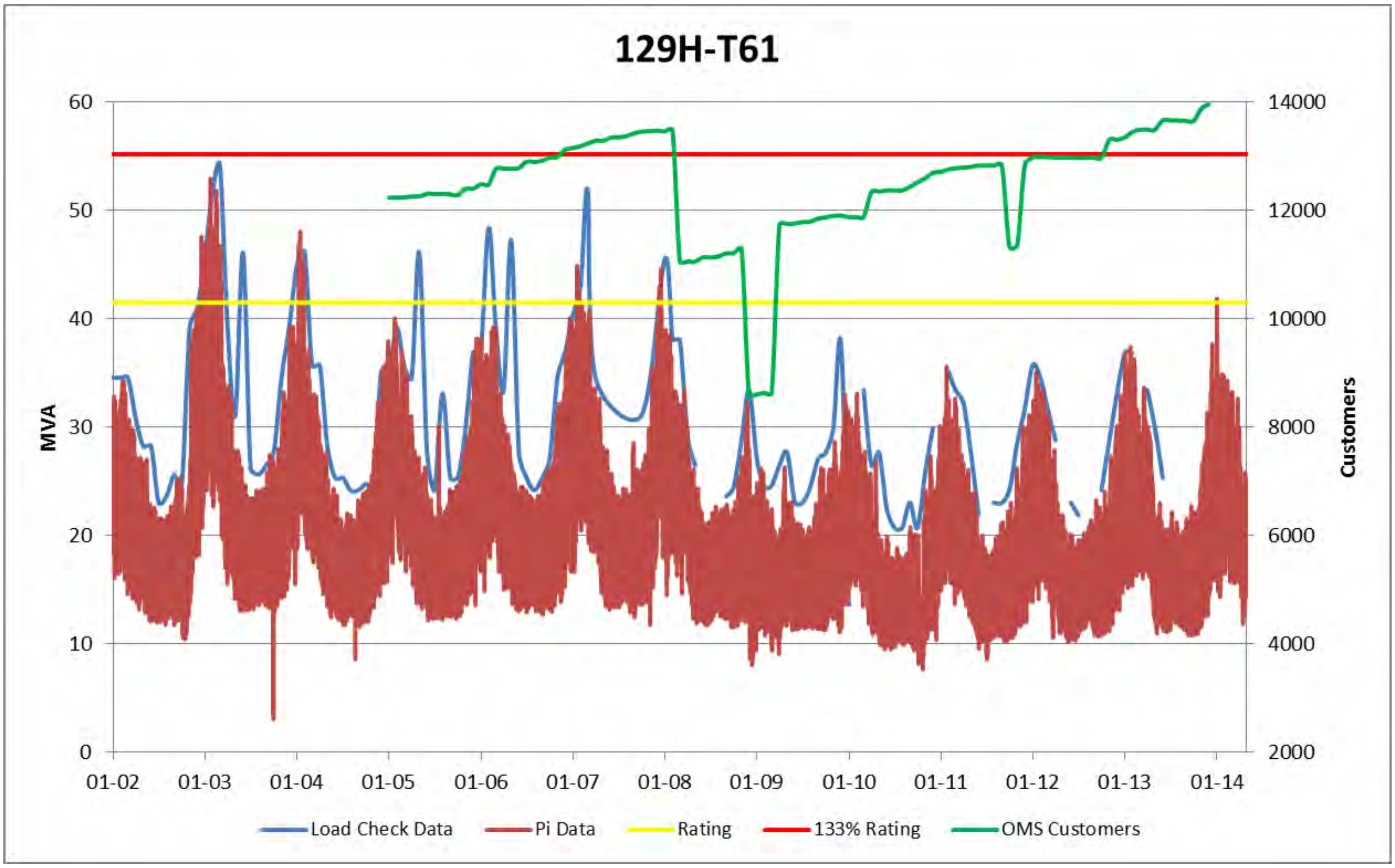


Figure 122 129H-T61 Load History

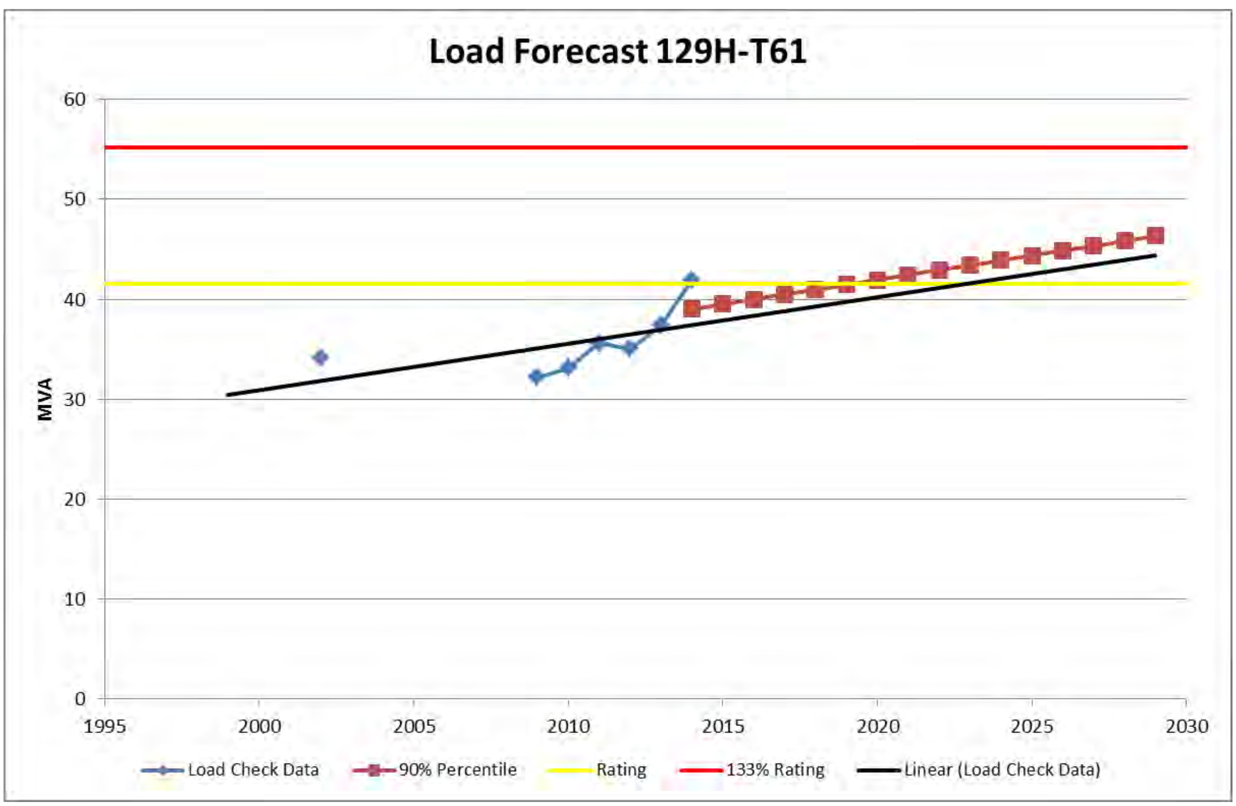


Figure 123 129H-T61 Load Forecast

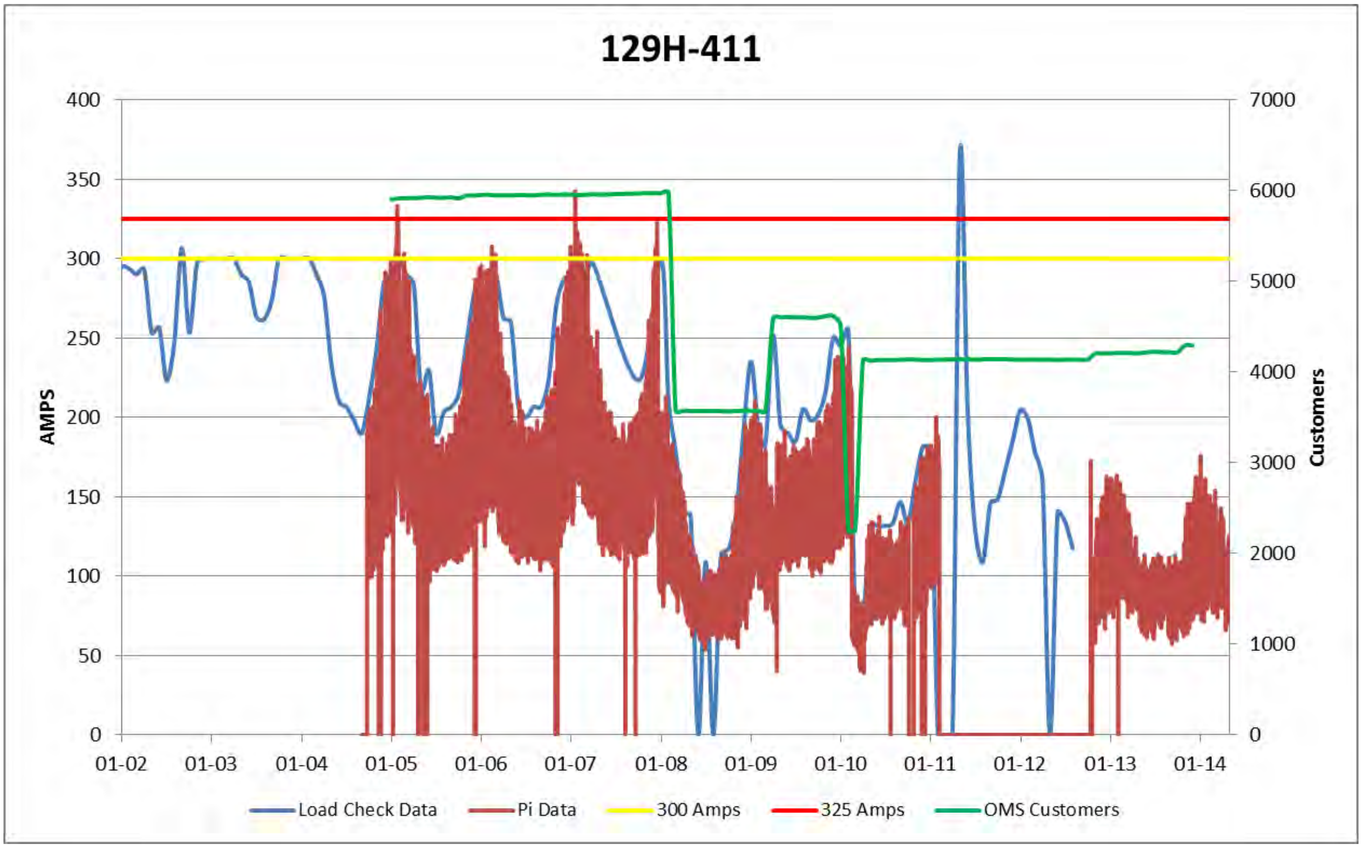


Figure 124 129H-411 Load History

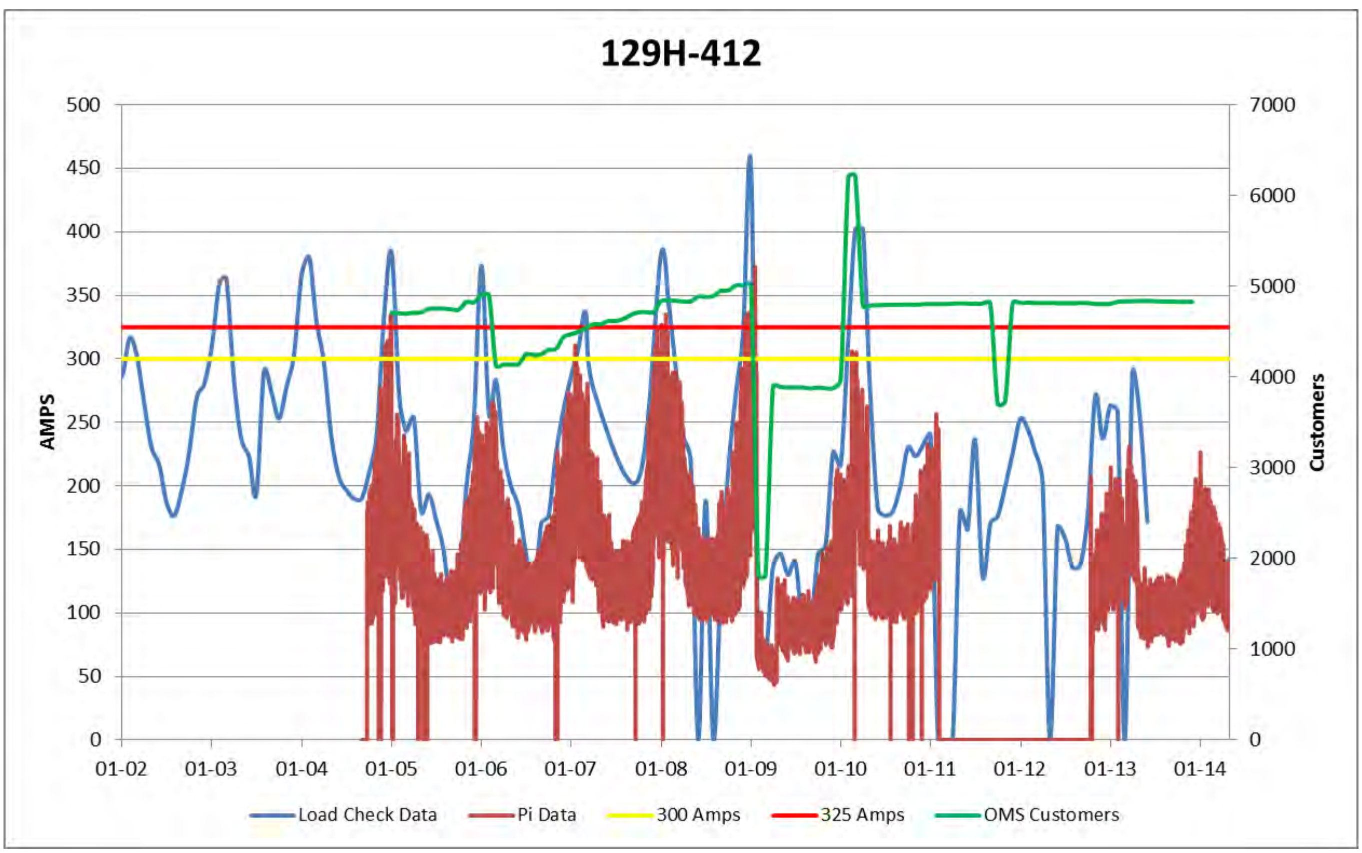


Figure 125 129H-412 Load History

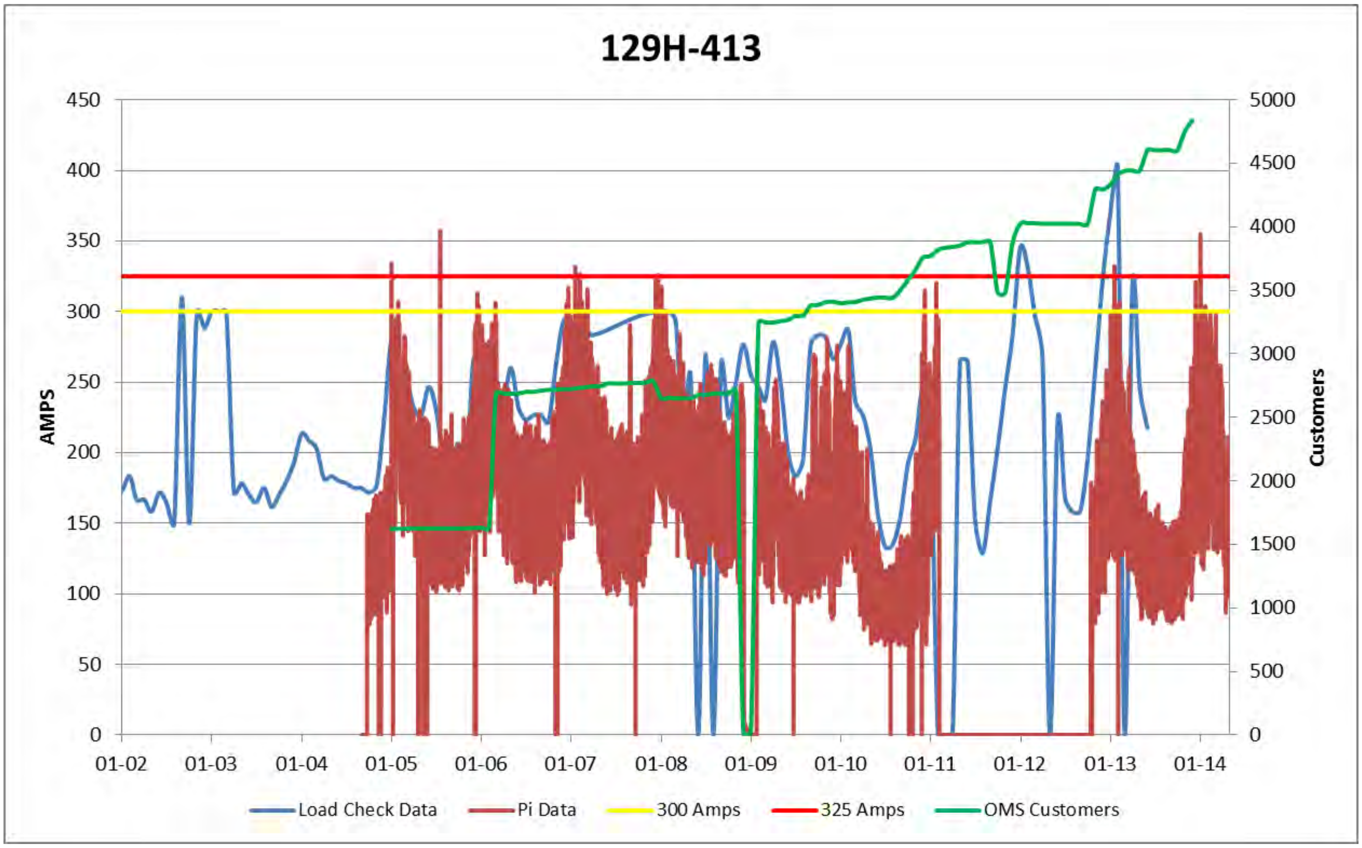


Figure 126 **129H-413 Load History**

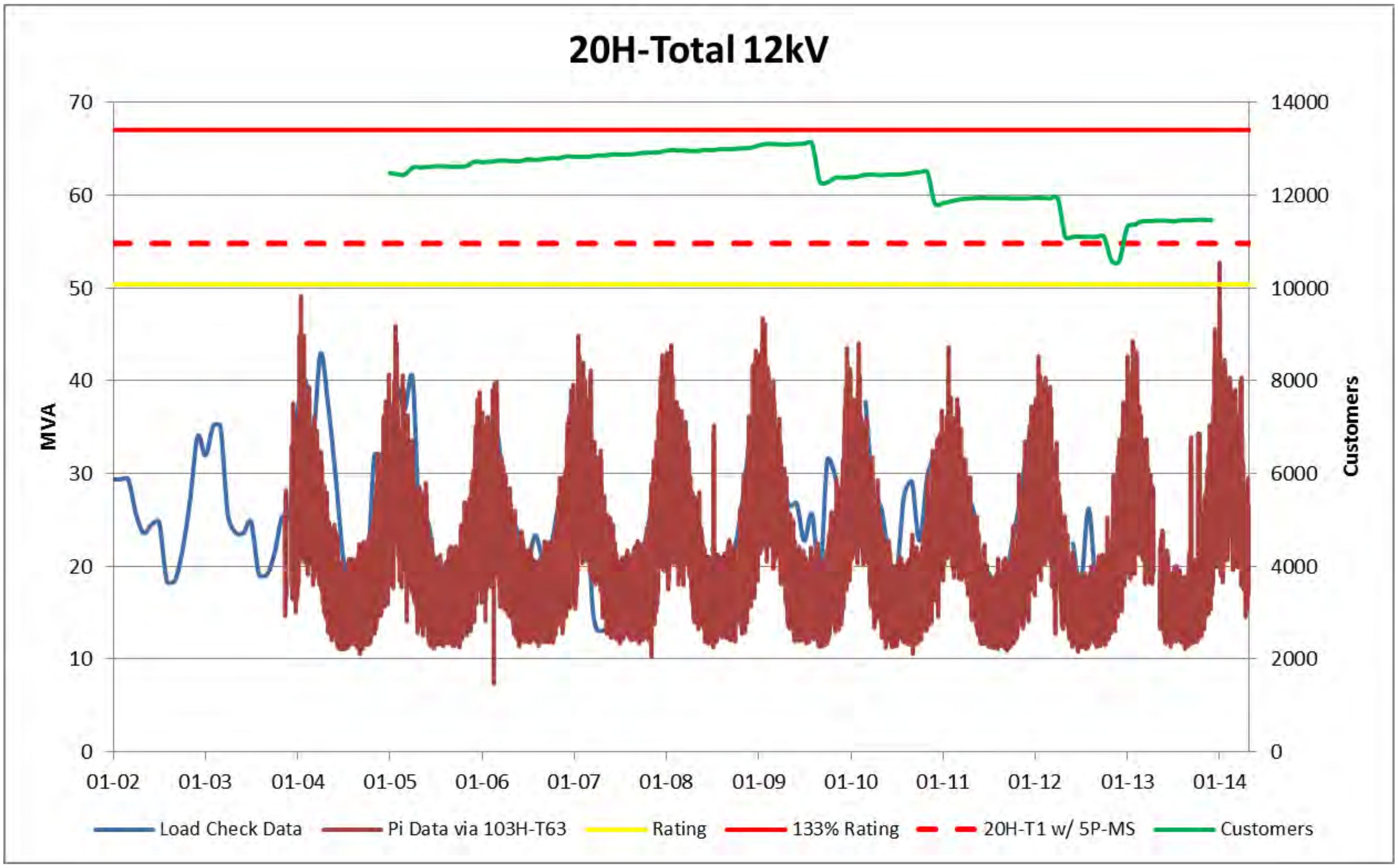


Figure 127 **20H-Spryfield Load History**

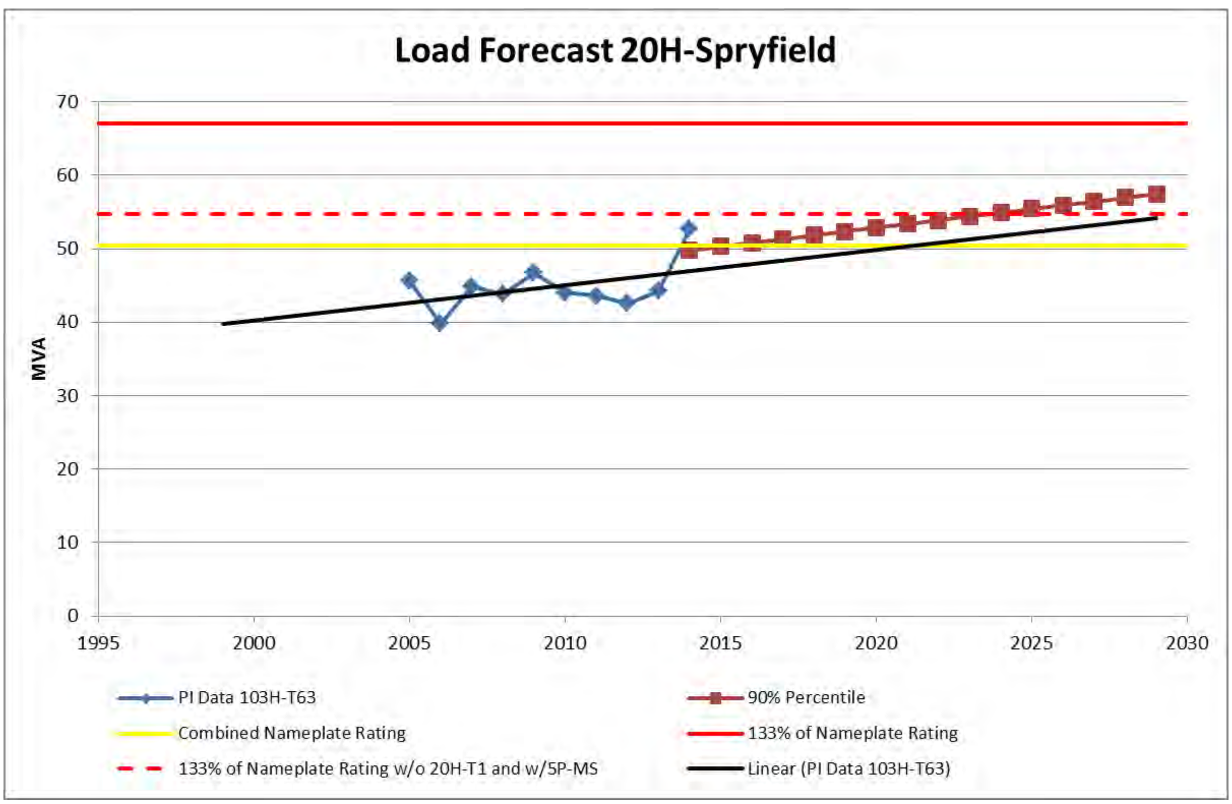


Figure 128 **20H-Spryfield Load Forecast**

Appendix B: Load History and Forecast

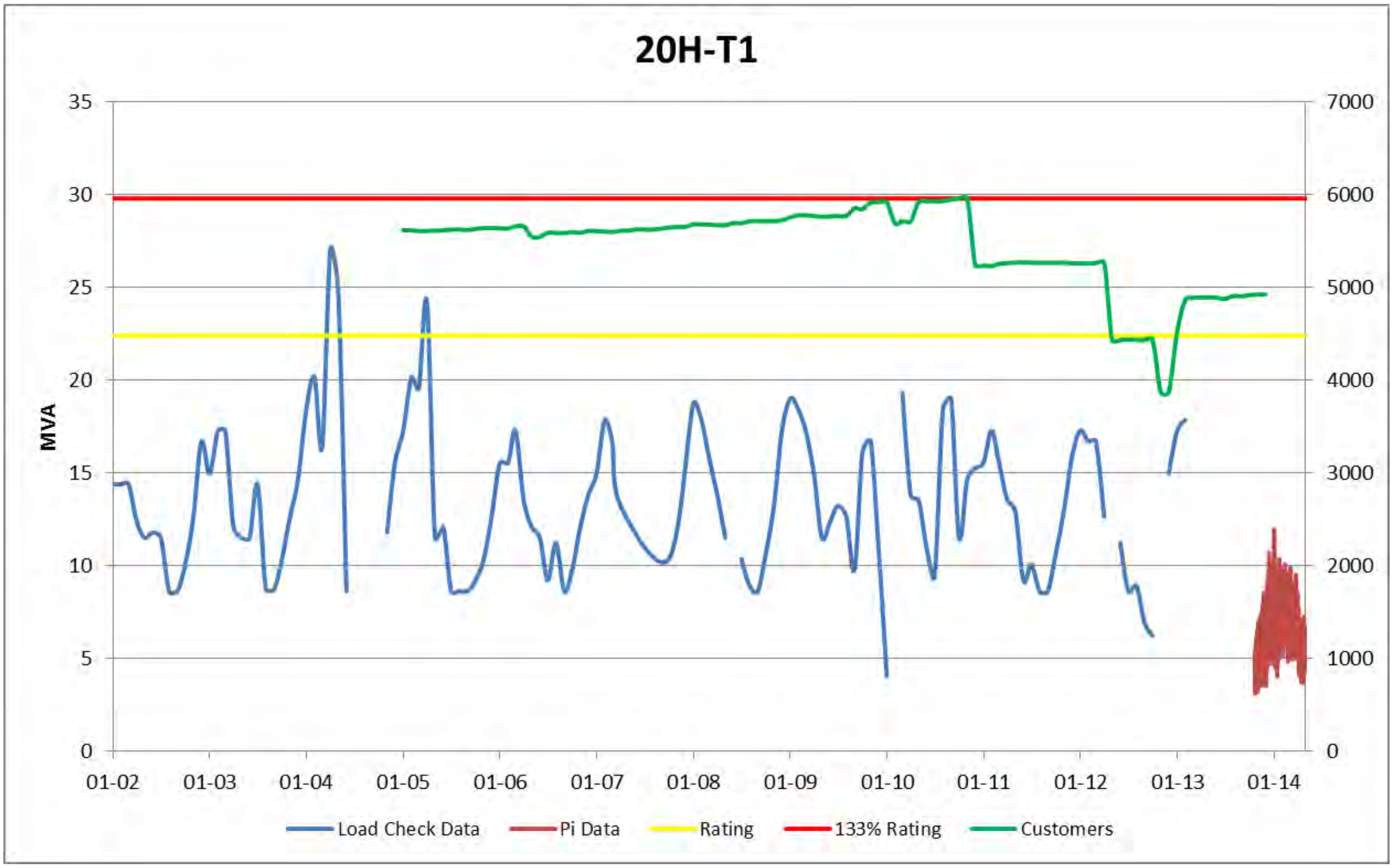


Figure 129 20H-T1 Load History

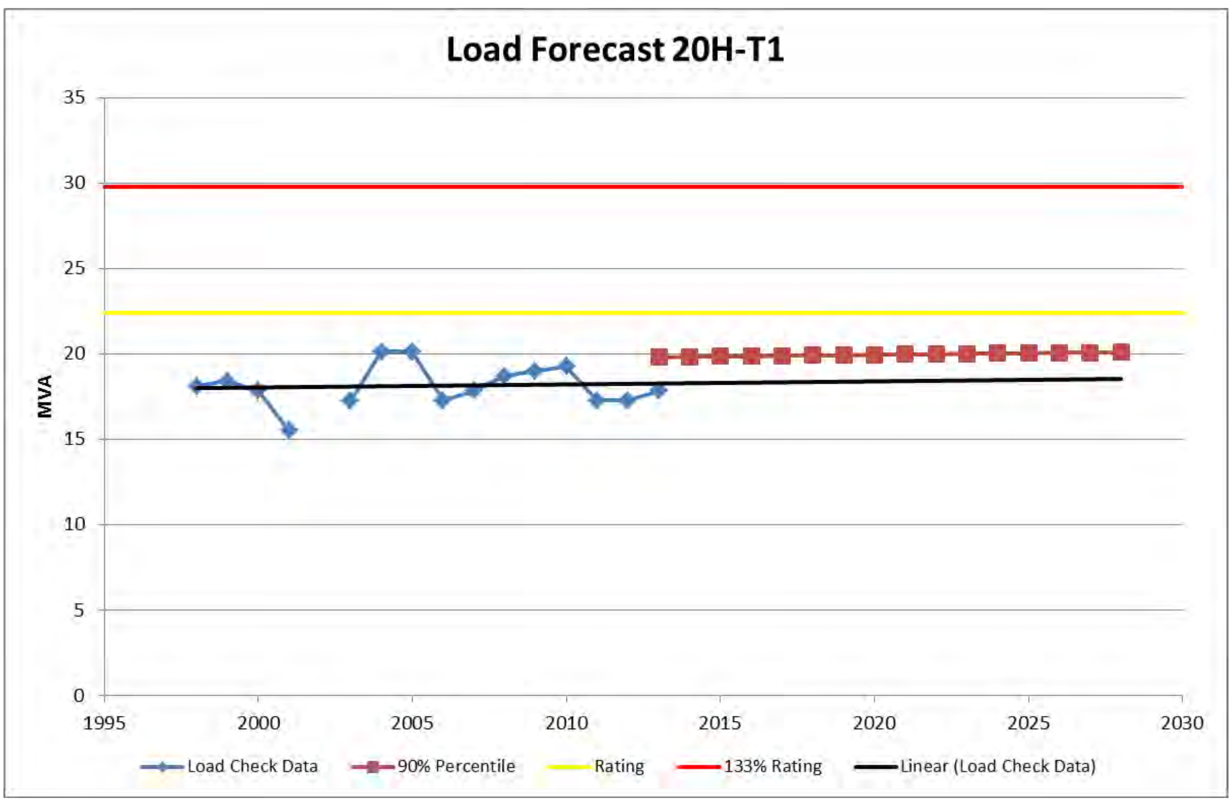


Figure 130 20H-T1 Load Forecast

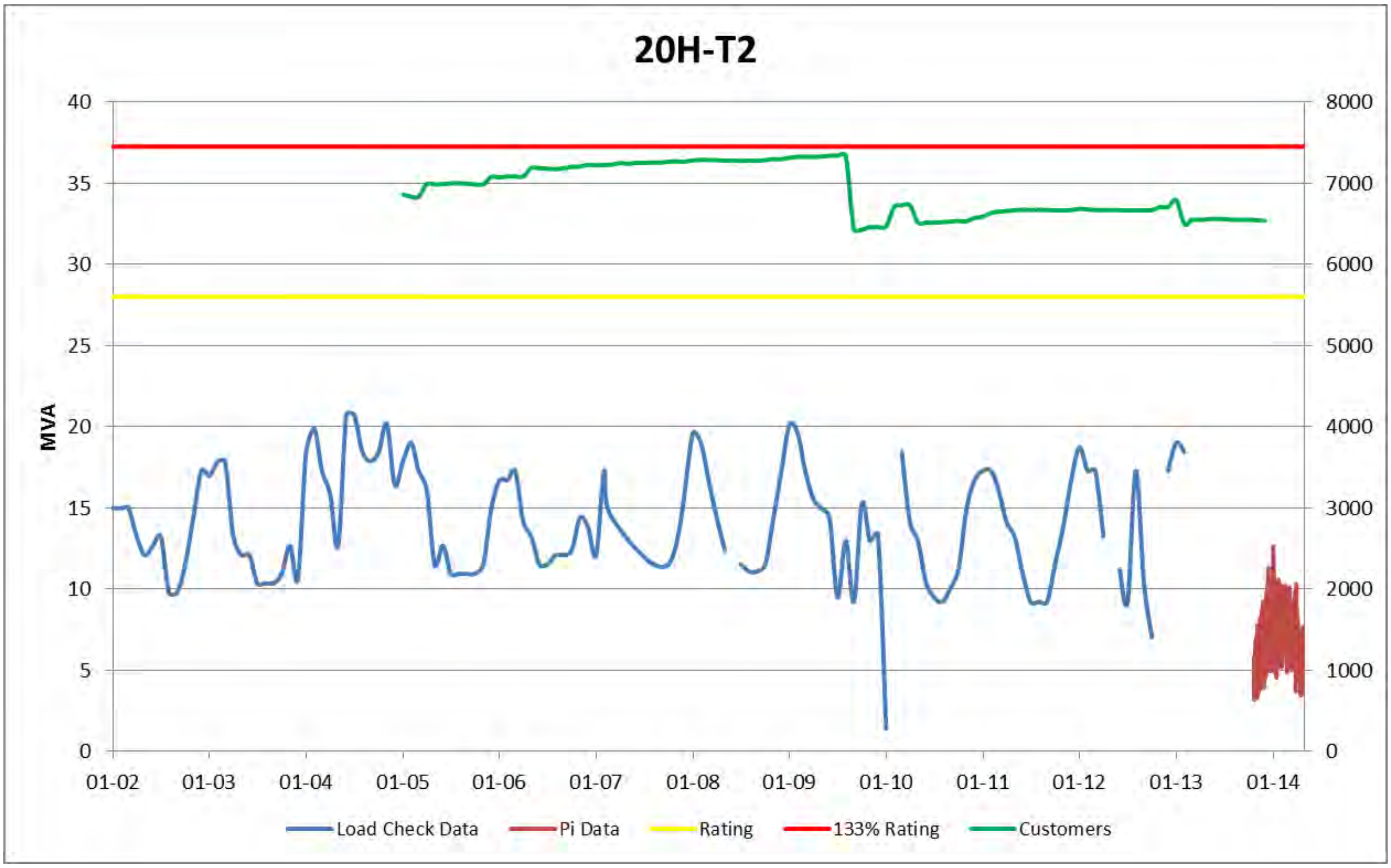


Figure 131 **20H-T2 Load History**

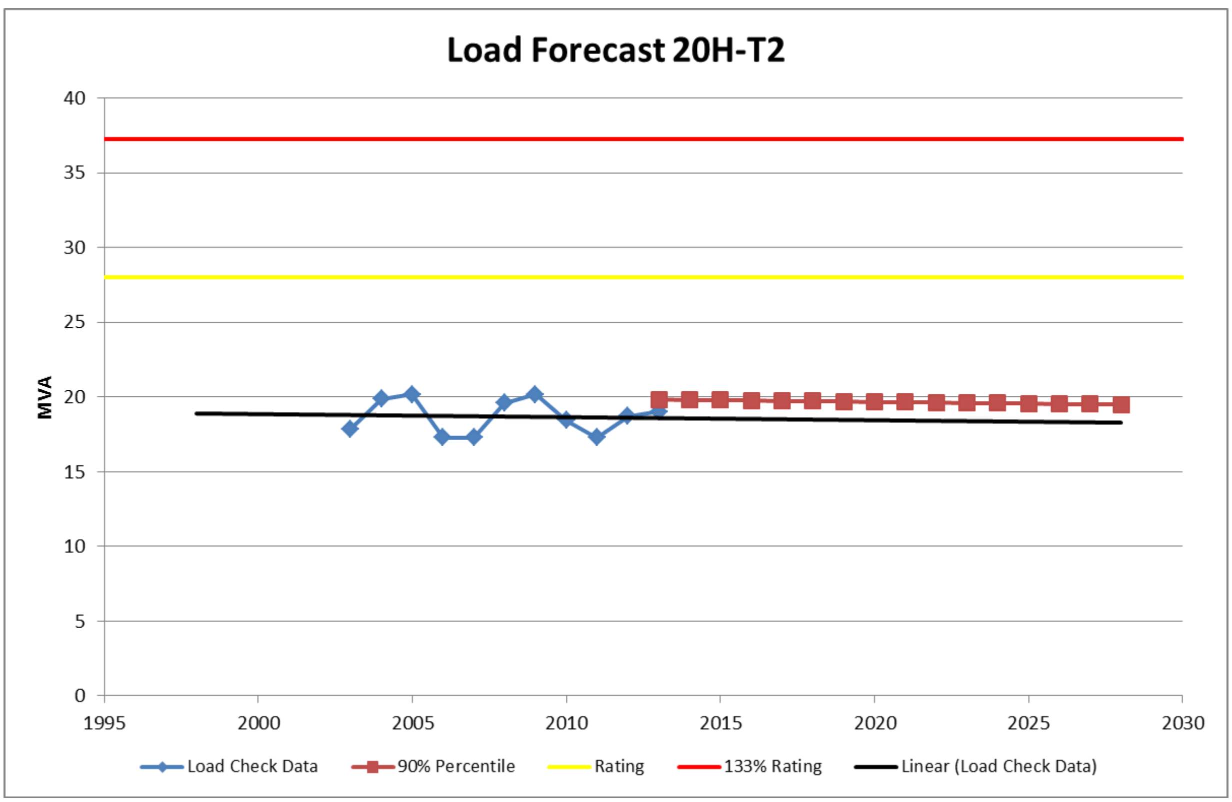


Figure 132 **20H-T2 Load Forecast**

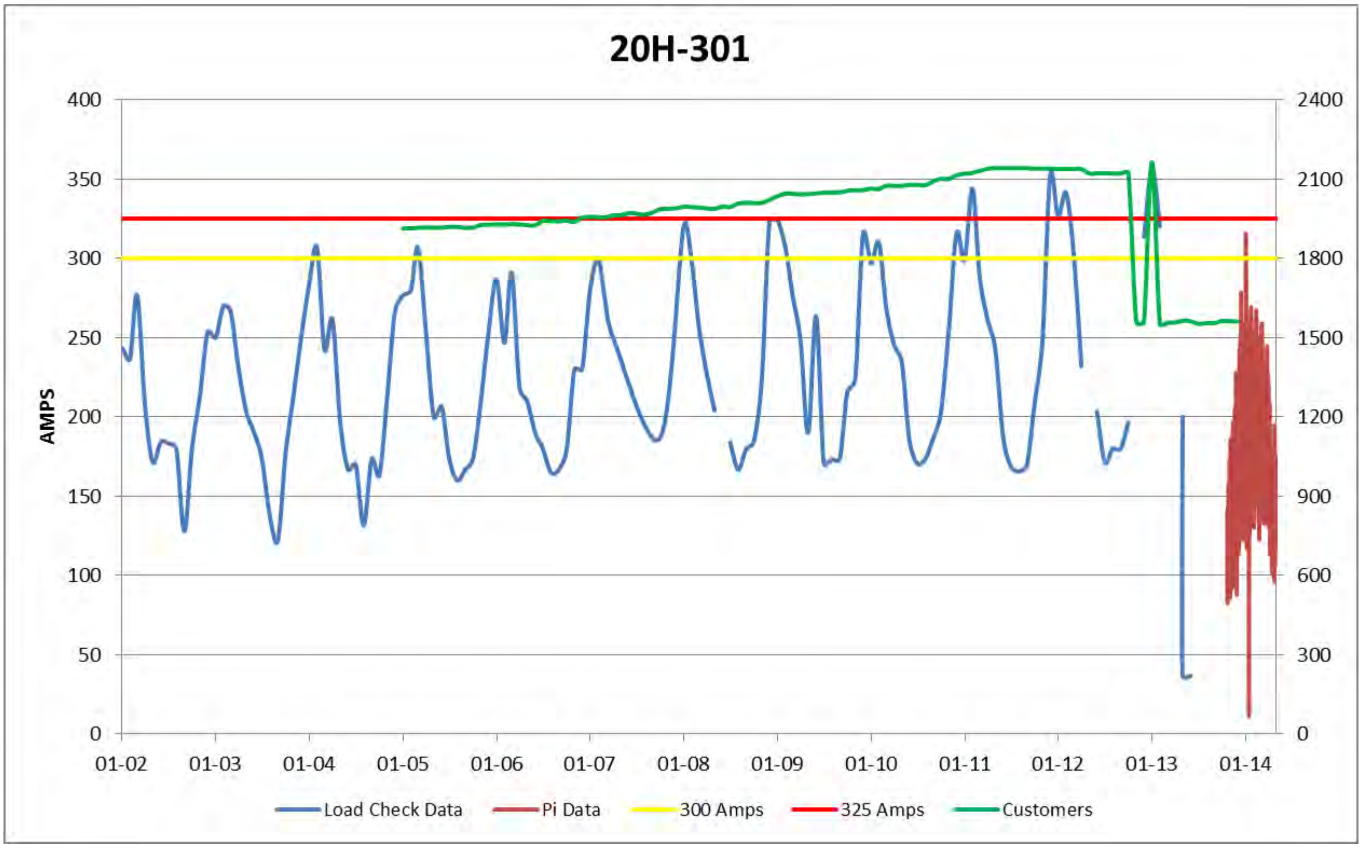


Figure 133 20H-301 Load History

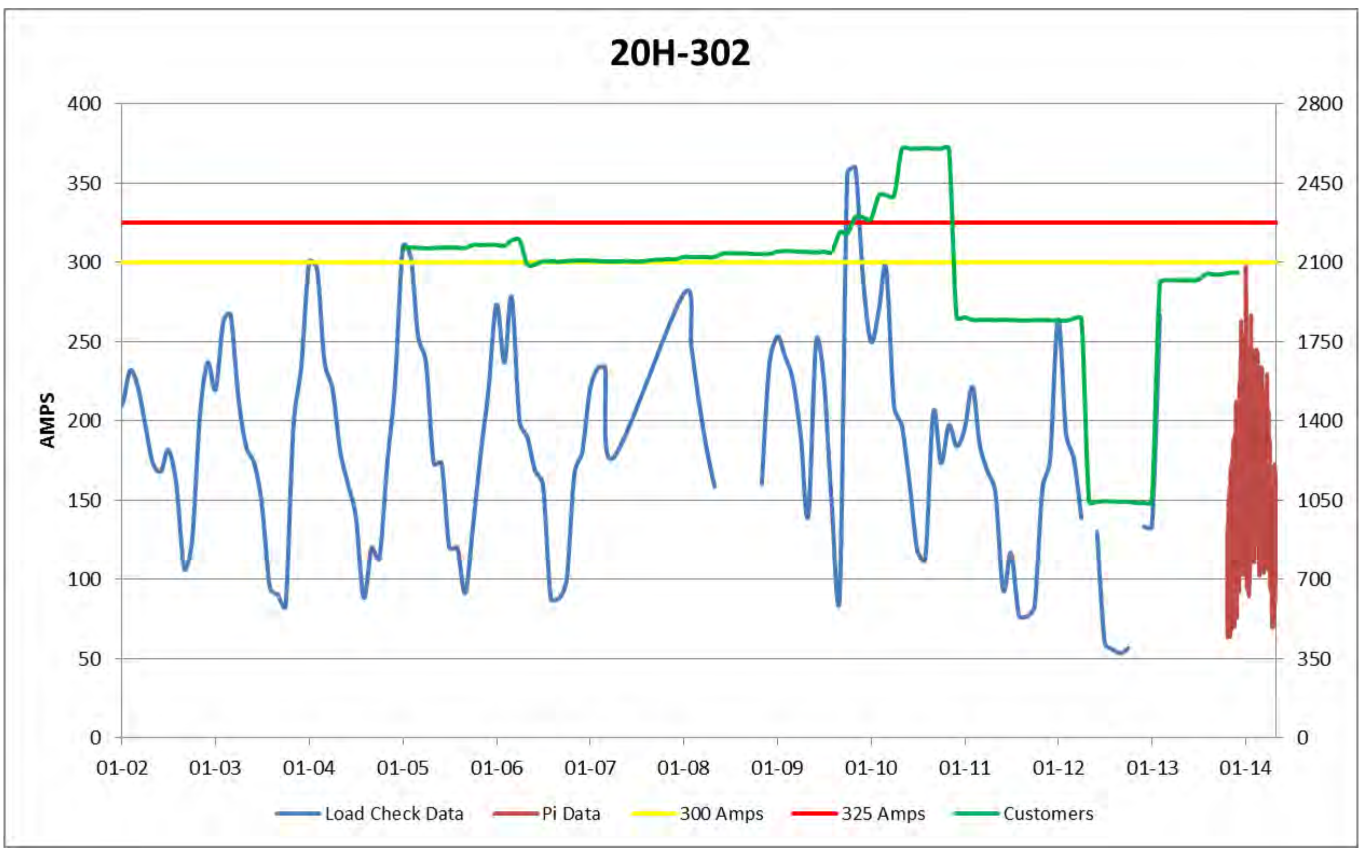


Figure 134 20H-302 Load History

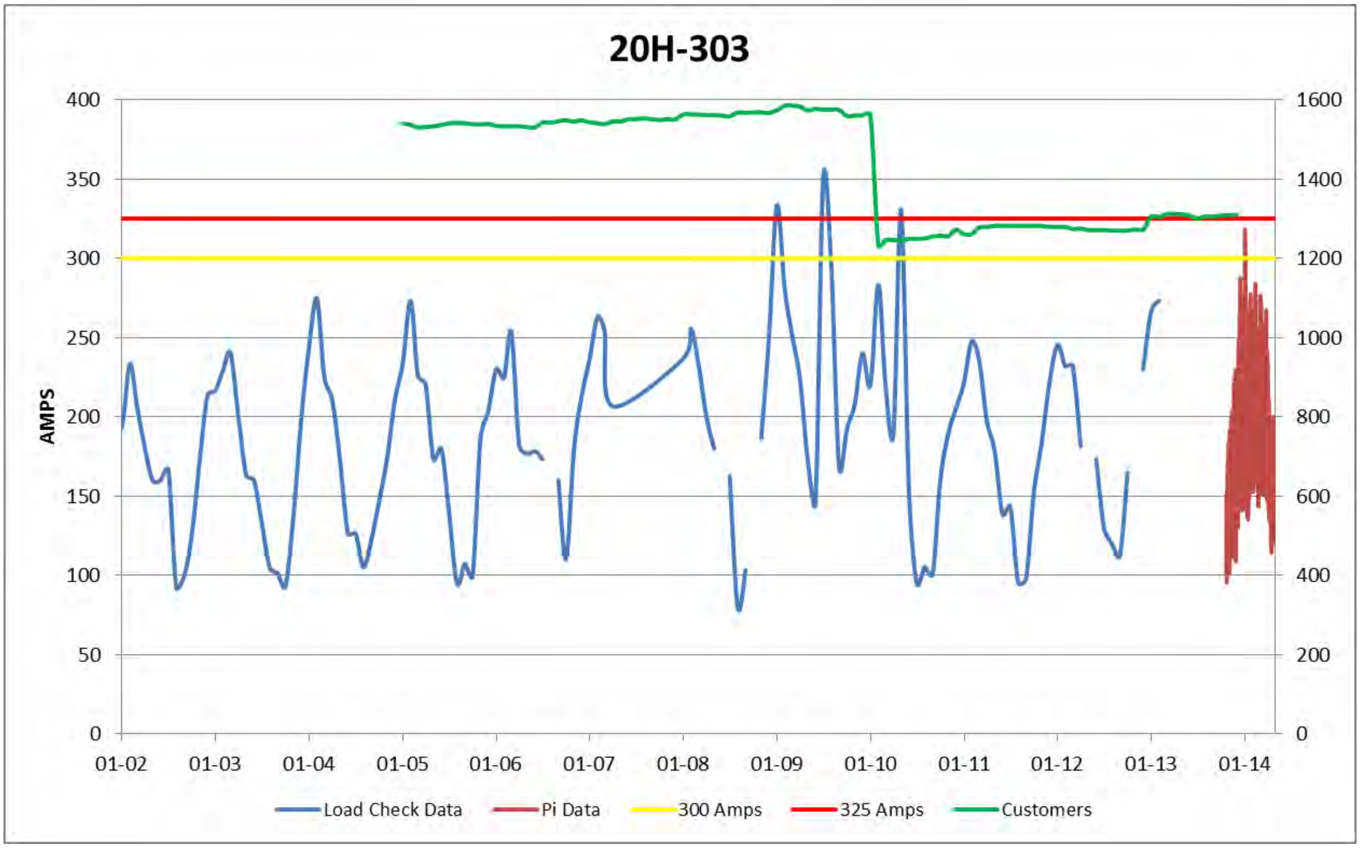


Figure 135 20H-303 Load History

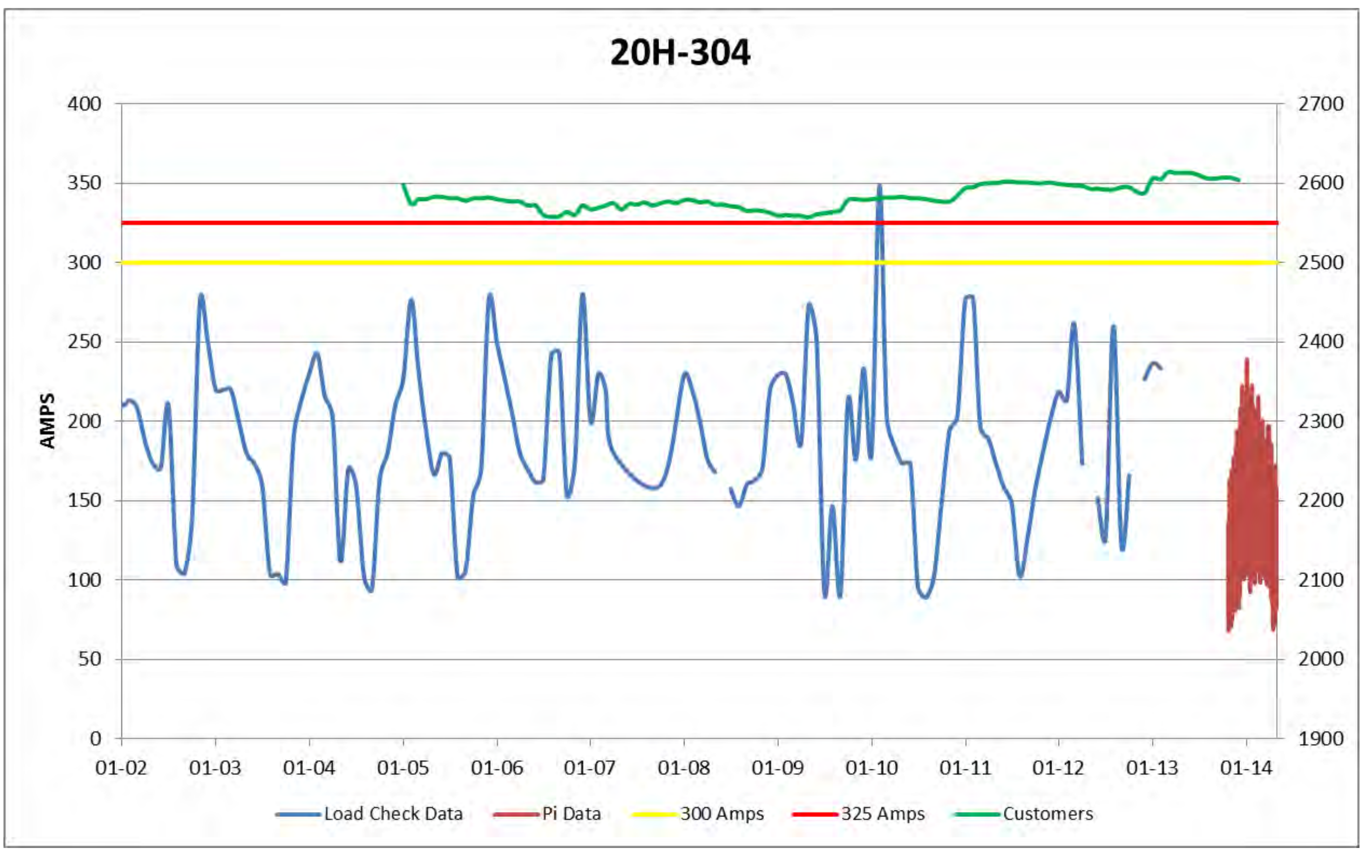


Figure 136 20H-304 Load History

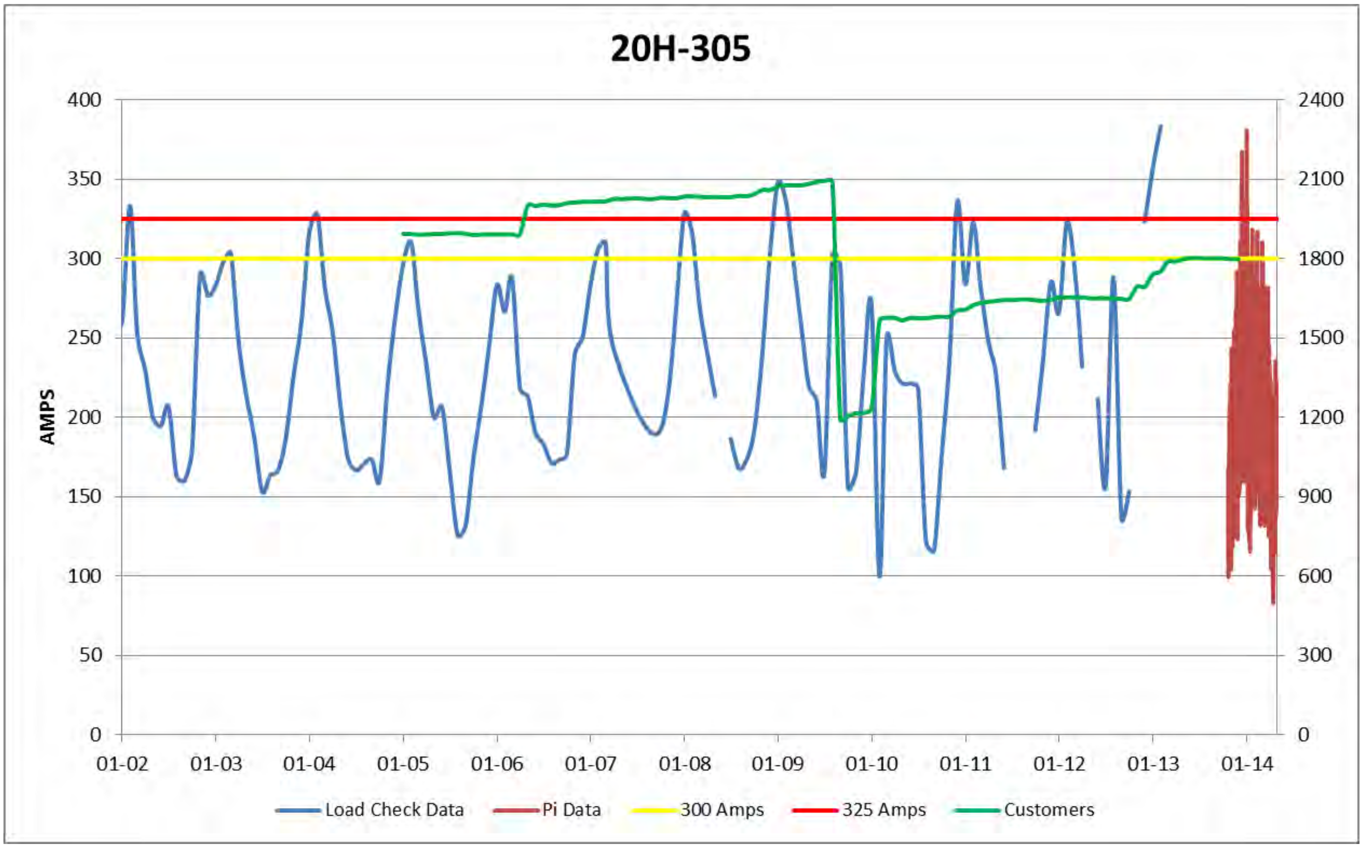


Figure 137 20H-305 Load History

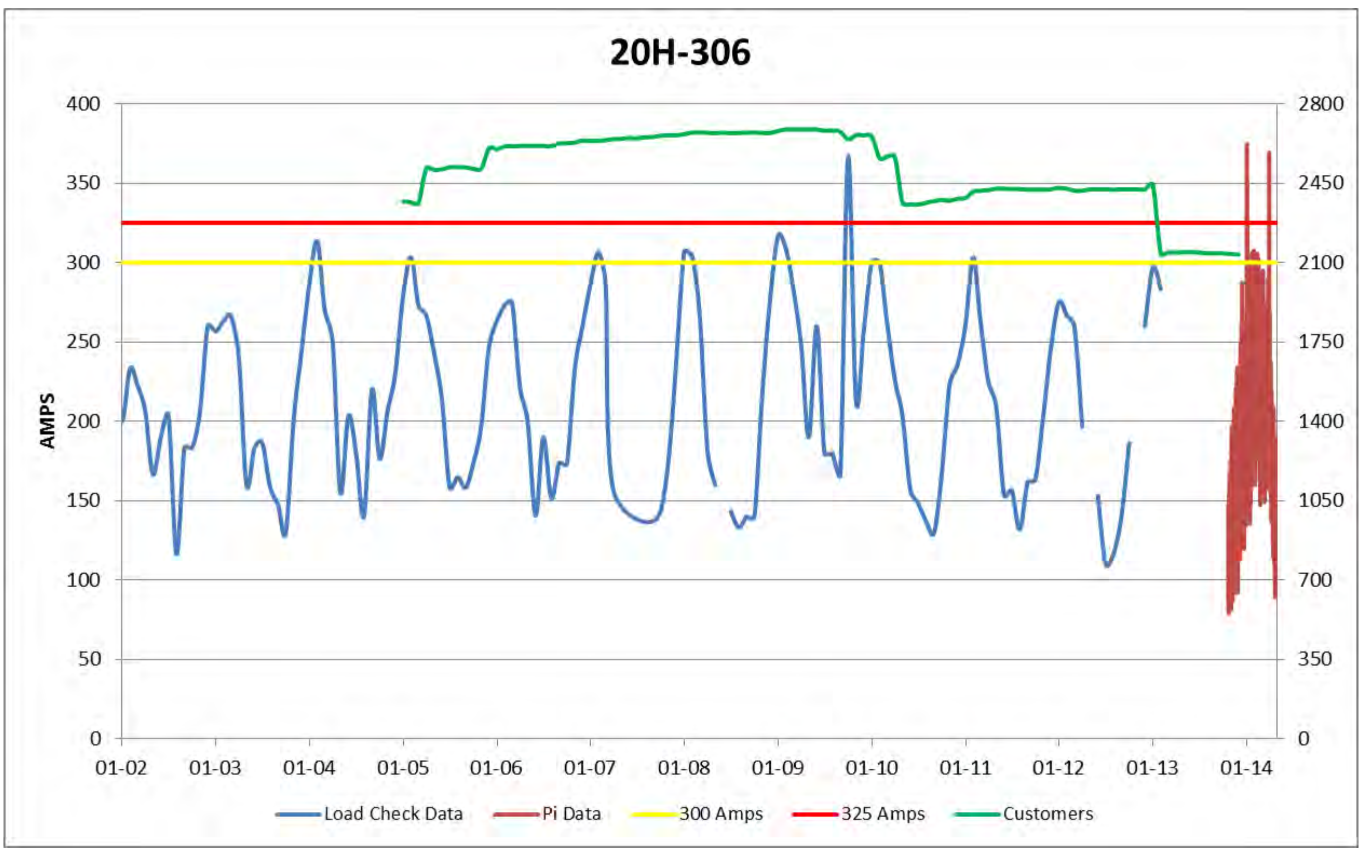


Figure 138 20H-306 Load History

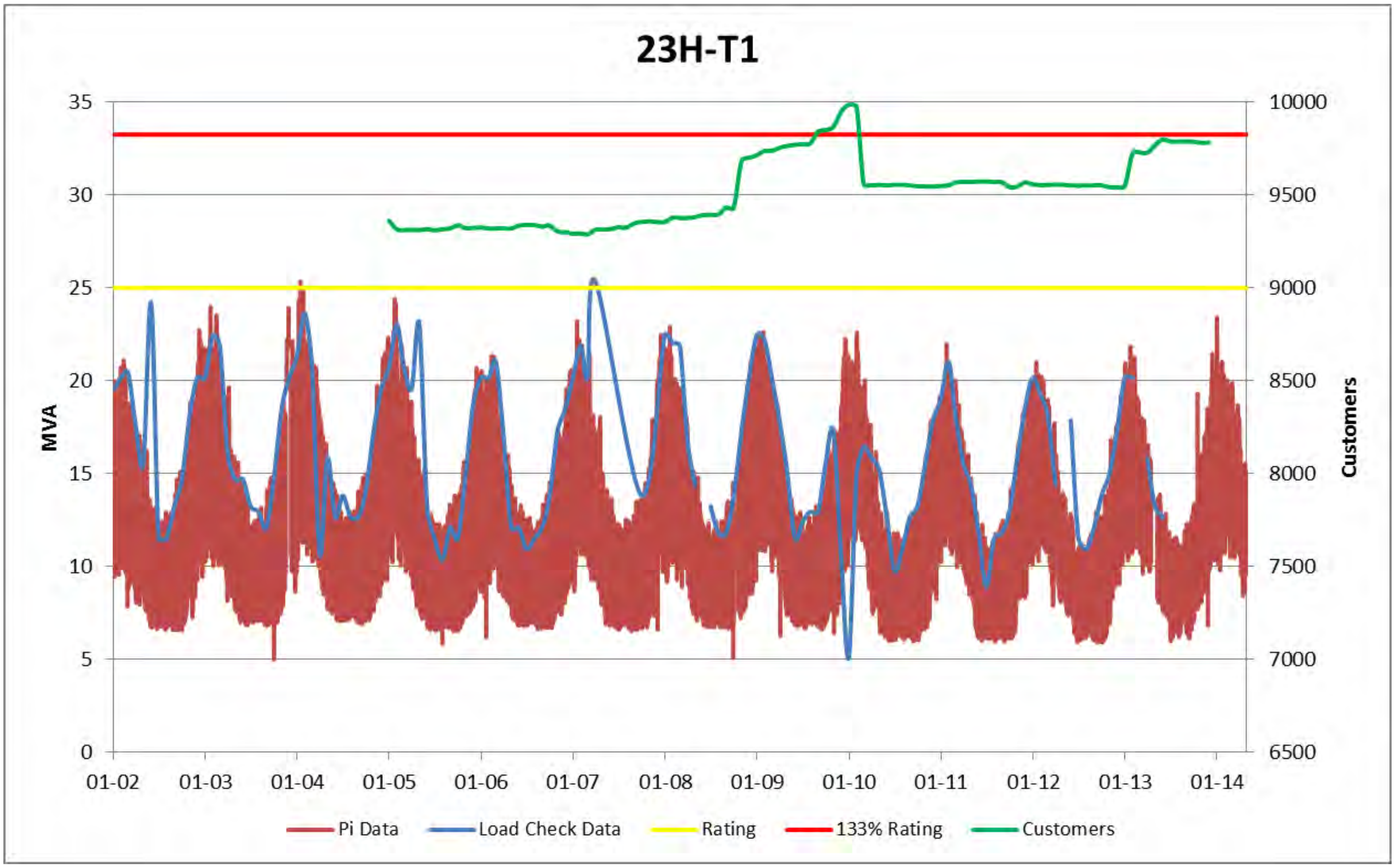


Figure 139 23H-Rockingham Load History

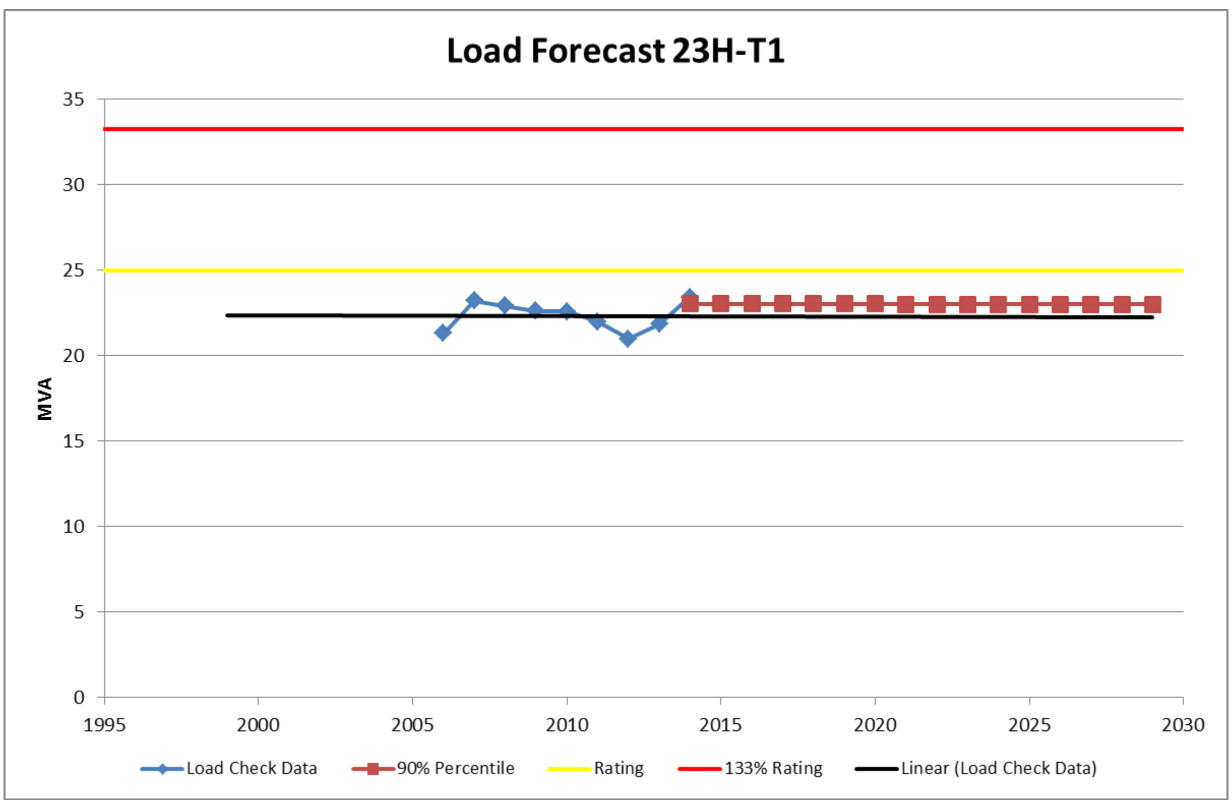


Figure 140 23H-Rockingham Load Forecast

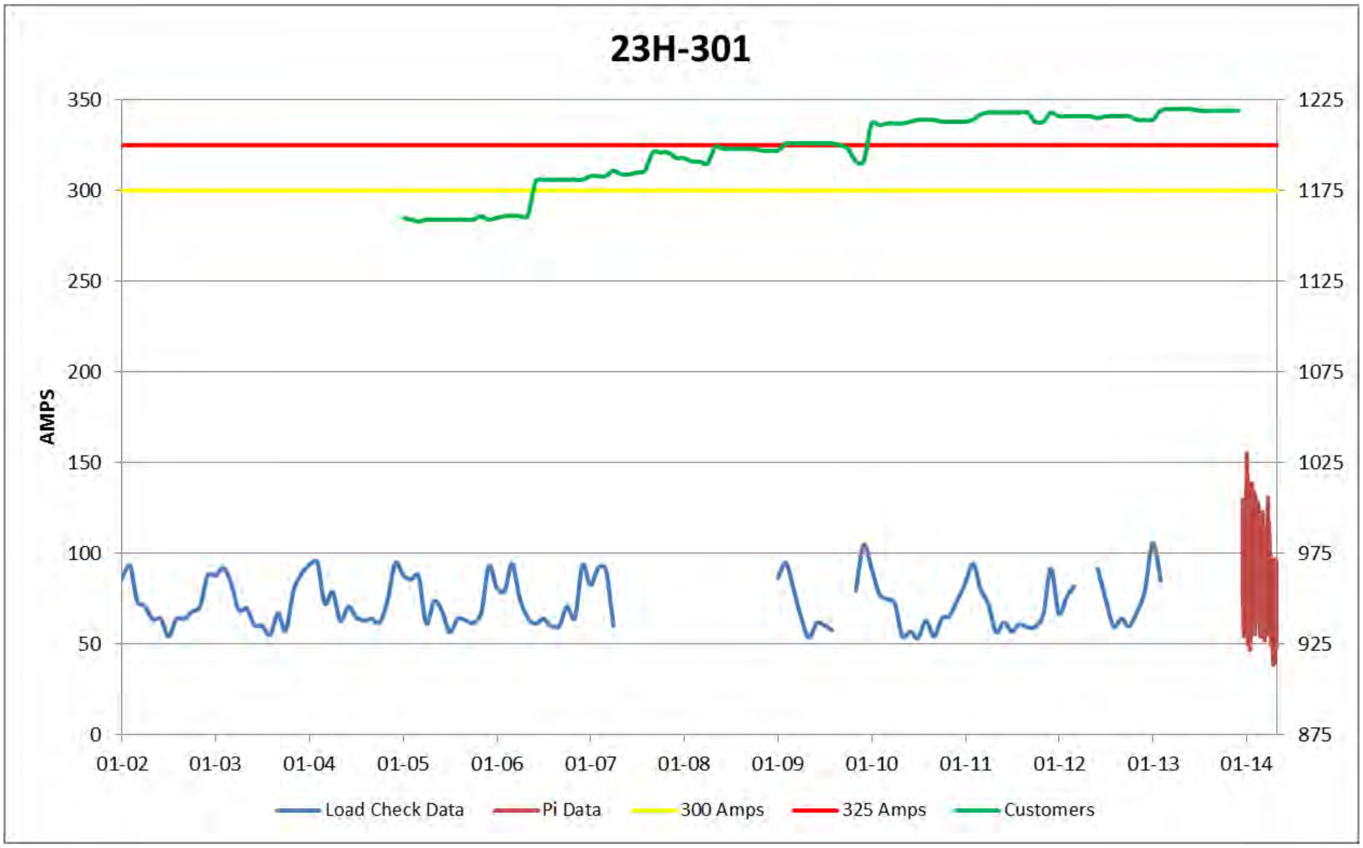


Figure 141 23H-301 Load History

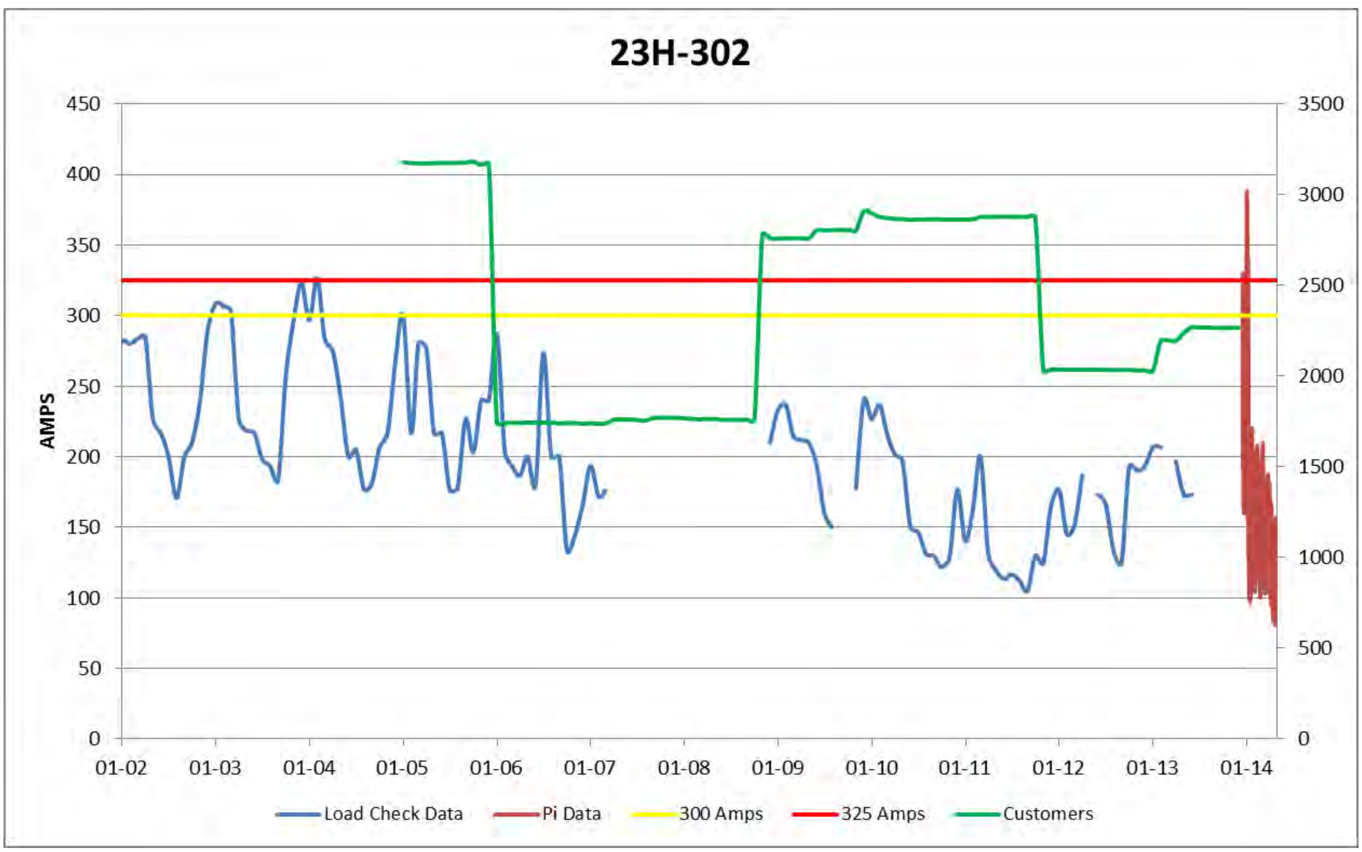


Figure 142 23H-302 Load History

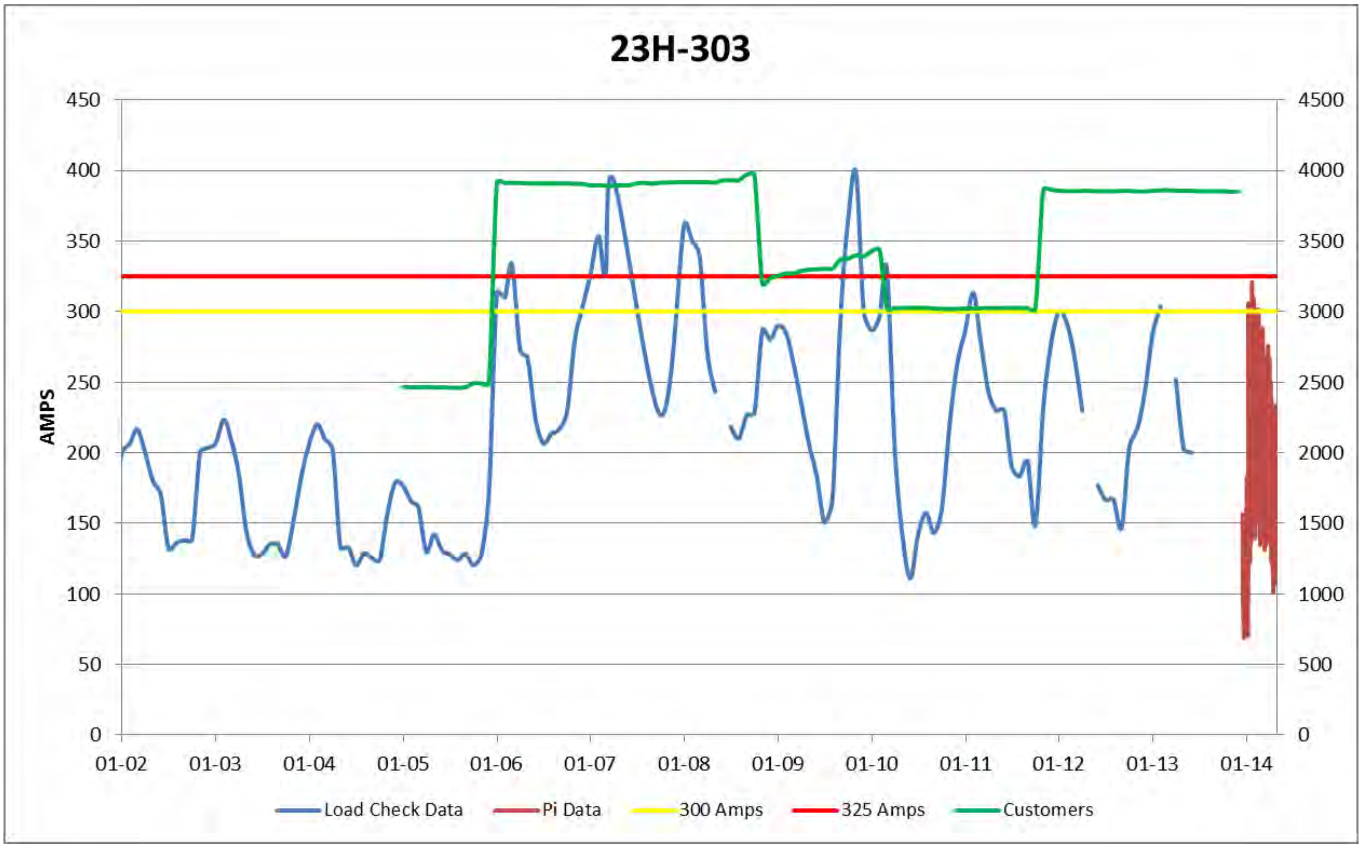


Figure 143 23H-303 Load History

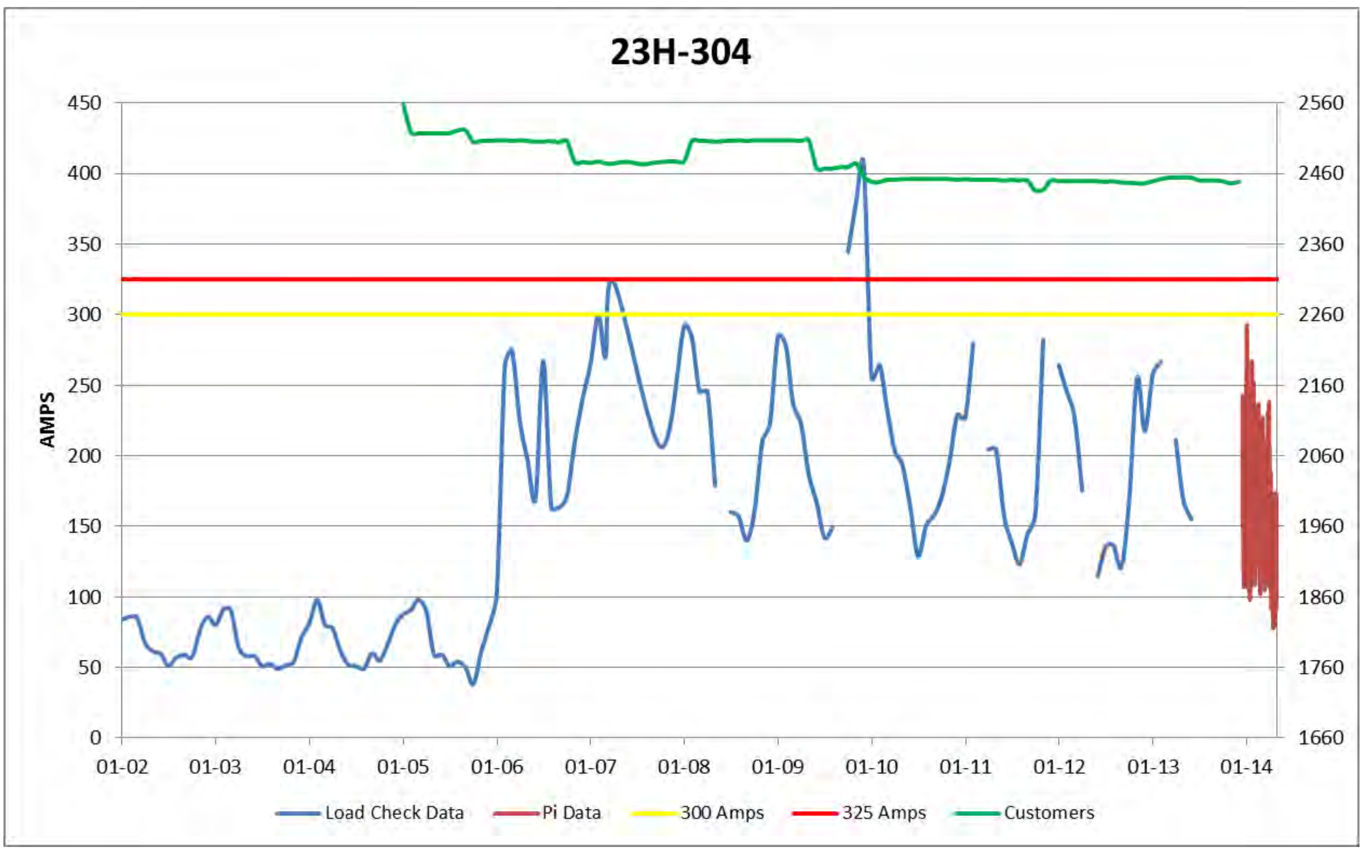


Figure 144 23H-304 Load History

APPENDIX C

Economic Analysis

New Substation Transformer on the Halifax Peninsula

Summary of Alternatives

Halifax Peninsula Alternatives
Summary of Alternatives

Division :		**Date :**	30-Sep-14
Department :	Distribution Planning	**CI Number:**	
Originator :	James MacQueen	**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	New Transformer at 104H-Kempt Road	6.49%	3,665,855	-2,862,439	2	-7.90%	0.0 years
B	New Transformer at 2H-Armdale	6.49%	3,561,509	-2,804,417	1	-7.90%	0.0 years
	0	NA	NA	NA	NA	#NUM!	0.0 years
	0	NA	NA	NA	NA	#NUM!	0.0 years

Recommendation :

This EAM concludes that the installation of the new transformer at 2H-Armdale is the least cost alternative.

Notes/Comments :

New Transformer at 104H-Kempt Road

This alternative includes the following:
Install a new 25/33/42MVA 138-25kV transformer at 104H-Kempt Road
Install three new feeders at 104H-Kempt Road

New Transformer at 2H-Armdale

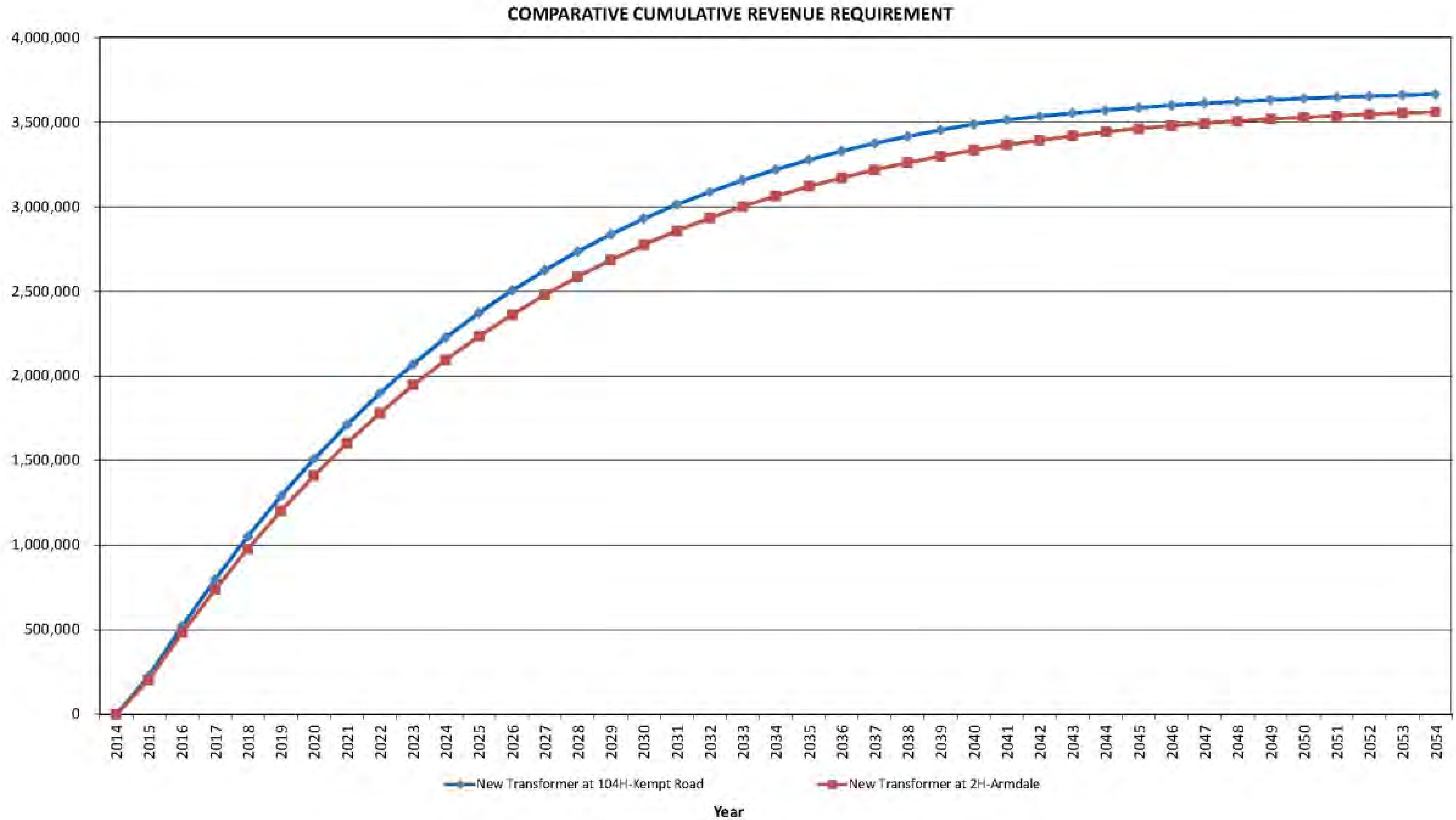
This alternative includes the following:
Install a new 25/33/42MVA 138-25kV transformer at 2H-Armdale
Install four new feeders at 2H-Armdale

0

0

Peninsula EAM -2015 9/30/2014

NPV Comparison



Alternative New Transformer A; Install New Transformer at 104H-Kempt Road

Halifax Peninsula Alternati
New Transformer at 104H-Kempt Road

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item

Project Description

Select:
In-Service Month: January
In-Service Year: 2015

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Capital Invested														
1. New 25/33/42MVA 138-25kV transformer		750,000												
2. Site preparations at 104H-Kempt Road		1,225,000												
3. Installation of new Transformer		500,000												
4. Feeder Exits and Reclosers		300,000												
5. Distribution Upgrades		925,000												
6.														
7.														
8.														
9.														
10.														
11.														
12.														
13.														
14.														
15.														
16.														
17.														
18.														
19.														
20.														
Total Direct Capital Invested by Year		3,700,000												
AFUDC (entered as a positive value)														
AO (entered as a positive value)														
Total Indirect Capital Invested by Year														
Total Capital Invested by Year		**3,700,000**												

Alternative New Transformer B; Install New Transformer at 2H-Armdale

Halifax Peninsula Alternati
New Transformer at 2H-Armdale

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item

Project Description

Select:
In-Service Month: January
In-Service Year: 2015

Capital Invested	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
1. New 25/33/42MVA 138-25kV transformer		750,000												
2. Site preparation and new unit install		2,350,000												
3. Feeder Exits		350,000												
4. Distribution Upgrades		175,000												
5.														
6.														
7.														
8.														
9.														
10.														
11.														
12.														
13.														
14.														
15.														
16.														
17.														
18.														
19.														
20.														
Total Direct Capital Invested by Year		3,625,000												
AFUDC (entered as a positive value)														
AO (entered as a positive value)														
Total Indirect Capital Invested by Year														
Total Capital Invested by Year		**3,625,000**												

APPENDIX D

Economic Analysis

103H-Lakeside and 129H-Kearney Lake Alternatives

Summary of Alternatives

103H-Lakeside and 129H-Kearney Lake Alternatives
Summary of Alternatives

Nova Scotia POWER An Emera Company

Division :		**Date :**	3-Oct-14
Department :	Distribution Planning	**CI Number:**	
Originator :	James MacQueen	**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Replace 103H-T61	6.49%	2,504,136	-2,120,289	3	-8.99%	0.0 years
B	New 103H-Lakeside Transformer	6.49%	1,740,578	-1,411,446	1	-8.40%	0.0 years
C	New 129H-Kearney Lake Transformer	6.49%	1,784,473	-1,447,934	2	-8.40%	0.0 years
	0	NA	NA	NA	NA	#NUM!	0.0 years

Recommendation :

Alternative B: New 103H-Lakeside Transformer has been identified as the least cost alternative.

Notes/Comments :

Replace 103H-T61

This alternative includes the following:
- Replace 103H-T61 (25/33/42MVA) transformer with a 53MVA, similar to the 1H-Water Street Units, in 2015
- Create one new feeder from 103H-Lakeside, in 2015
- Create one new feeder at 129H-Kearney Lake, in 2016
- Install additional transformer at 103H-Lakeside, in 2023

New 103H-Lakeside Transformer

This alternative includes the following:
- Install additional 25/33/42MVA 138-25kV transformer at 103H-Lakeside, in 2018
- Install three new feeders, with provision for a fourth in the future, at 103H-Lakeside, in 2018
- Install new feeder at 129H-Kearney Lake, in 2016

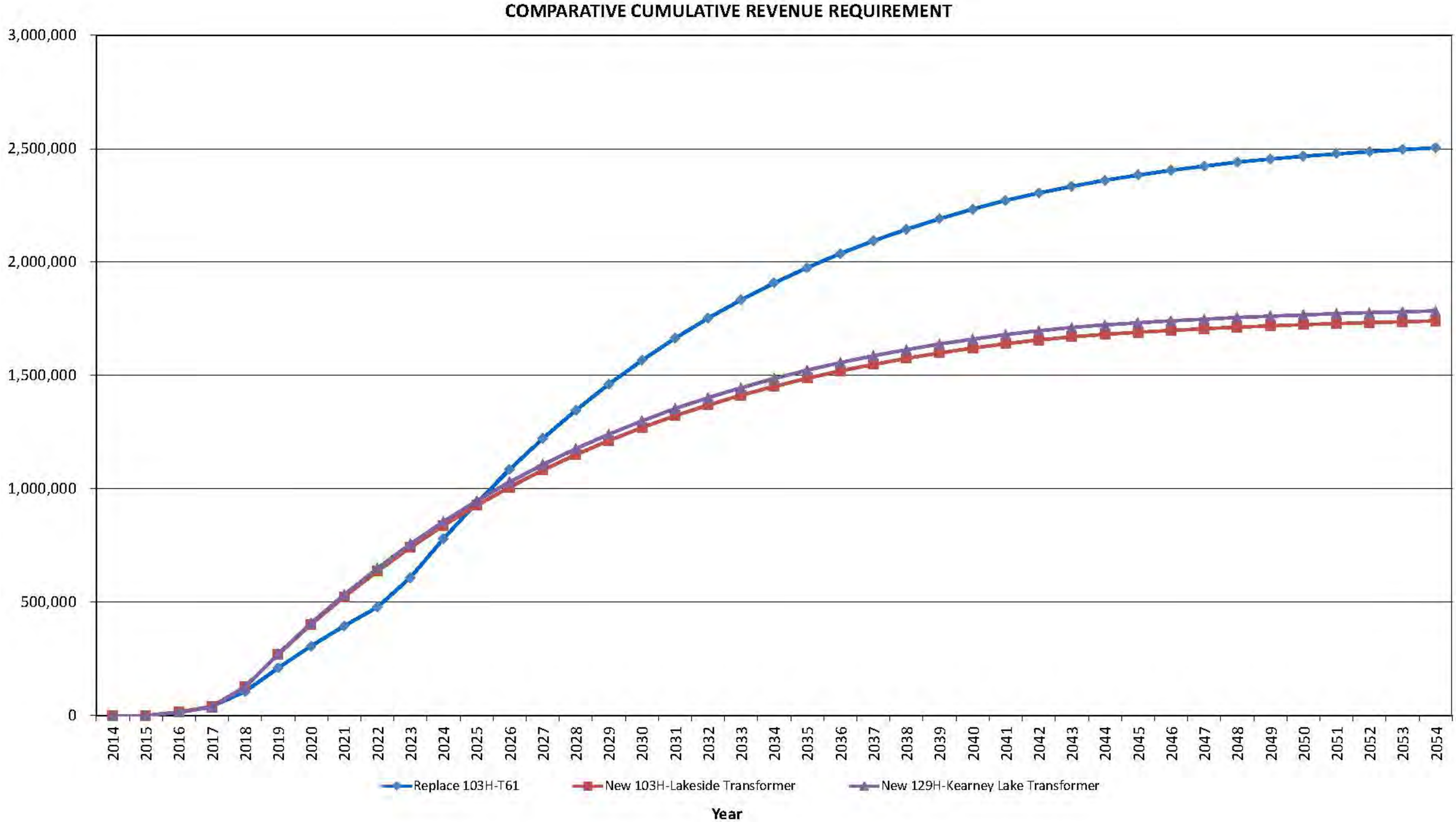
New 129H-Kearney Lake Transformer

This alternative includes the following:
- Install new feeder at 129H-Kearney Lake substation, in 2016
- Install a new 25/33/42MVA 69-25kV transformer at the 129H-Kearney Lake substation, in 2018
- Install three new feeders to the 129H-Kearney Lake substation, in 2018

0

103H-129H EAM Rev-1 10/3/2014

NPV Comparison



Alternative 103H/129HA; Replace 103H-T61

103H-Lakeside and 129H-K
Replace 103H-T61

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item

Project Description

Select:
In-Service Month: January
In-Service Year: 2015

Capital Invested	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
1. 103H-432 Load Reduction			60,000											
2. Load Transfer; 129H-412 to 103H-433			20,000											
3. 129H-Kearney Lake; New Feeder			200,000											
4. New 53MVA 138-25kV transformer					750,000									
5. Installation of new unit					375,000									
6. 103H-Lakeside; New Feeder					200,000									
7. Purchase new 25/33/42MVA 138-25kV transformer										900,000				
8. Installation of new transformer										900,000				
9. Installation of three new feeders										510,000				
10.														
11.														
12.														
13.														
14.														
15.														
16.														
17.														
18.														
19.														
20.														
Total Direct Capital Invested by Year			280,000		1,325,000					2,310,000				
AFUDC (entered as a positive value)														
AO (entered as a positive value)														
Total Indirect Capital Invested by Year														
Total Capital Invested by Year			**280,000**		**1,325,000**					**2,310,000**				

Alternative 103H-/129H-B; New 103H-Lakeside Transformer

103H-Lakeside and 129H-K
Replace 103H-T61

Nova Scotia POWER An Emera Company

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item

Project Description

Select:
In-Service Month: January
In-Service Year: 2015

		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Capital Invested															
1.	103H-432 Load Reduction			60,000											
2.	Load Transfer; 129H-412 to 103H-433			20,000											
3.	129H-Kearney Lake; New Feeder			200,000											
4.	New 53MVA 138-25kV transformer					750,000									
5.	Installation of new unit					375,000									
6.	103H-Lakeside; New Feeder					200,000									
7.	Purchase new 25/33/42MVA 138-25kV transformer										900,000				
8.	Installation of new transformer										900,000				
9.	Installation of three new feeders										510,000				
10.															
11.															
12.															
13.															
14.															
15.															
16.															
17.															
18.															
19.															
20.															
	Total Direct Capital Invested by Year			280,000		1,325,000					2,310,000				
	AFUDC (entered as a positive value)														
	AO (entered as a positive value)														
	Total Indirect Capital Invested by Year														
	Total Capital Invested by Year			**280,000**		**1,325,000**					**2,310,000**				

Alternative 103H/129H-C; New 129H-Kearney Lake Transformer

103H-Lakeside and 129H-K
New 129H-Kearney Lake Transformer

Nova Scotia POWER
An Emera Company

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item

Project Description

Select:
In-Service Month: January
In-Service Year: 2015

Capital Invested	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
1. 103H-432 Load Reduction			60,000											
2. 129H-Kearney Lake; New Feeder			200,000											
3. New 25/33/42MVA 69-25kV Transformer					700,000									
4. Installation of new transformer and buswork					800,000									
5. 129H-Kearney Lakes; New Feeders					480,000									
6.														
7.														
8.														
9.														
10.														
11.														
12.														
13.														
14.														
15.														
16.														
17.														
18.														
19.														
20.														
Total Direct Capital Invested by Year			260,000		1,980,000									
AFUDC (entered as a positive value)														
AO (entered as a positive value)														
Total Indirect Capital Invested by Year														
Total Capital Invested by Year			**260,000**		**1,980,000**									

APPENDIX E

Economic Analysis

20H-Spryfield Alternatives

Summary of Alternatives

20H-Spryfield Alternatives
Summary of Alternatives

Division :		**Date :**	**30-Sep-14**
Department :	Distribution Planning	**CI Number:**	
Originator :	James MacQueen	**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Replace 103H-T63 with 60MVA unit	6.49%	4,708,030	-3,745,113	2	-8.68%	0.0 years
B	Replace 103H-T63 with 50MVA unit and	6.49%	4,505,195	-3,551,705	1	-8.71%	0.0 years
C	20H-Spryfield Conversions to 25kV	6.49%	13,319,494	-10,942,287	4	-9.32%	0.0 years
D	Resupply 20H-Spryfield at 138kV	6.49%	7,255,504	-5,775,897	3	-8.47%	0.0 years

Recommendation :

Alternative B: Replace 103H-T63 and reduce the 12kV load at 20H-Spryfield has been identified as the least cost alternative. The converted 12kV will be supplied by 2H-Armdale.

Notes/Comments :

Replace 103H-T63 with 60MVA unit

This alternative includes the following:
- Replace 103H-T63 with a 60MVA 138-69kV transformer
- Reduce the loading on overloaded feeders through conversion of load to 25kV and reconfiguration of feeders

Replace 103H-T63 with 50MVA unit and Reduce 12kV Load

This alternative includes the following:
- Replace 103H-T63 with a 30/40/50MVA 138-69kV transformer
- Reduce the loading on overloaded feeders through conversion of load to 25kV and reconfiguration of feeders

20H-Spryfield Conversions to 25kV

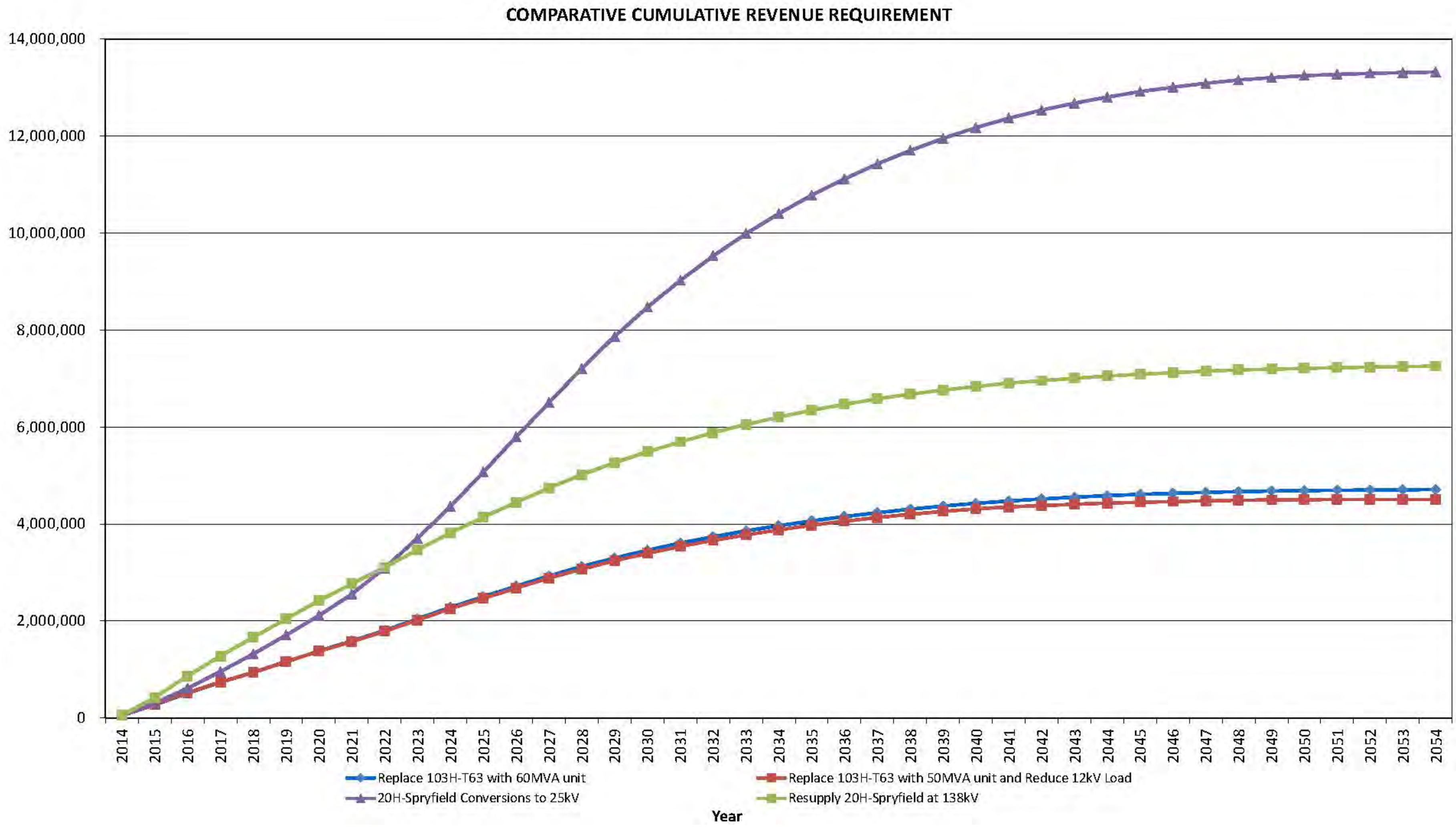
This alternative includes the following:
- Conversion of the 12kV load supplied by 20H-Spryfield to 25kV, by 2028.
- Installation of a new 25/33/42MVA 69-25kV transformer, in 2022.

Resupply 20H-Spryfield at 138kV

This alternative includes the following:
- Construction of a new 138kV tap at 34H-Geizer's Hill
- Construction of a new 138kV transmission line from 34H-Geizer's Hill to 20H-Spryfield
- Replacing the existing 69-12kV transformers with two 15/20/25MVA 138-12kV transformers
- Retimrement of L-5039, from 34H-Geizer's Hill to 20H-Spryfield

20H-Spryfield EAM 9/30/2014

NPV Comparison



Alternative 20H-A; Replace 103H-T63 with 60MVA Unit

20H-Spryfield Alternatives
Replace 103H-T63 with 60MVA unit

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item

Project Description

Select:
In-Service Month: January
In-Service Year: 2015

		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Capital Invested																
1.	Conversions Part 1	650,000														
2.	Conversions Part 2	345,000														
3.	Purchase new 138-69kV 60MVA transformer		1,250,000													
4.	Installation of new transformer		700,000													
5.	Conversions Part 3						680,000									
6.	Conversions Part 4									690,000						
7.	Conversions Part 5										850,000					
8.	Conversions Part 6													680,000		
9.																
10.																
11.																
12.																
13.																
14.																
15.																
16.																
17.																
18.																
19.																
20.																
	Total Direct Capital Invested by Year	995,000	1,950,000				680,000			690,000	850,000			680,000		
	AFUDC (entered as a positive value)															
	AO (entered as a positive value)															
	Total Indirect Capital Invested by Year															
	Total Capital Invested by Year	**995,000**	**1,950,000**				**680,000**			**690,000**	**850,000**			**680,000**		

Alternative 20H-B; Replace 103H-T63 with 50MVA Unit

20H-Spryfield Alternatives

Replace 103H-T63 with 50MVA unit and Red(

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item

Project Description

Select:
In-Service Month: January
In-Service Year: 2015

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Capital Invested															
1. Conversions Part 1	650,000														
2. Conversions Part 2	345,000														
3. Purchase new 138-69kV 30/40/50MVA transformer		1,000,000													
4. Installation of new transformer		700,000													
5. Conversions Part 3						680,000									
6. Conversions Part 4									690,000						
7. Conversions Part 5										850,000					
8. Conversions Part 6													680,000		
9.															
10.															
11.															
12.															
13.															
14.															
15.															
16.															
17.															
18.															
19.															
20.															
Total Direct Capital Invested by Year	995,000	1,700,000				680,000			690,000	850,000			680,000		
AFUDC (entered as a positive value)															
AO (entered as a positive value)															
Total Indirect Capital Invested by Year															
Total Capital Invested by Year	**995,000**	**1,700,000**				**680,000**			**690,000**	**850,000**			**680,000**		

Alternative 20H-C; 20H-Spryfield Conversions to 25kV

20H-Spryfield Alternatives
20H-Spryfield Conversions to 25kV

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item
Project Description

Select:
In-Service Month: January
In-Service Year: 2015

Capital Invested	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
1. Conversions Part 1	650,000															
2. Conversions Part 2	345,000															
3. Purchase new 138-69kV 30/40/50MVA transformer		1,000,000														
4. Installation of new transformer		700,000														
5. Conversions Part 3		600,000														
6. Conversions Part 4			575,000													
7. Conversions Part 5				715,000												
8. Conversions Part 6					540,000											
9. Conversions Part 7						710,000	730,000									
10. Conversions Part 8								1,375,000								
11. Conversions Part 9									1,240,000	1,280,000						
12. Retire 20H-T1 and site preparations for new transformer									600,000							
13. Purchase new 69-25kV 25/33/42MVA transformer									750,000							
14. Install new transformer and switchgear									800,000							
15. Conversions Part 10											2,135,000	2,200,000				
16. Conversions Part 11													1,320,000			
17. Conversions Part 12														1,140,000	1,175,000	
18. Retire 20H-T2 and remove remaining 12kV equipment																300,000
19.																
20.																
Total Direct Capital Invested by Year	995,000	2,300,000	575,000	715,000	540,000	710,000	730,000	1,375,000	3,390,000	1,280,000	2,135,000	2,200,000	1,320,000	1,140,000	1,175,000	300,000
AFUDC (entered as a positive value)																
AO (entered as a positive value)																
Total Indirect Capital Invested by Year																
Total Capital Invested by Year	995,000	2,300,000	575,000	715,000	540,000	710,000	730,000	1,375,000	3,390,000	1,280,000	2,135,000	2,200,000	1,320,000	1,140,000	1,175,000	300,000

Alternative 20H-D; Resupply 20H-Spryfield at 138kV

20H-Spryfield Alternatives
Resupply 20H-Spryfield at 138kV

Nova Scotia POWER
An Emera Company

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item

Project Description

Select:
In-Service Month: January
In-Service Year: 2015

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Capital Invested															
1. Conversions Part 1	650,000														
2. Conversions Part 2	345,000														
3. 138kV tap; 34H-Geizer's Hill		1,500,000													
4. Rebuild L-5039 off road structures to 138kV		625,000													
5. Rebuild L-5039 roadside structures to 138kV		300,000													
6. Purchase two 138-12kV 15/20/25MVA transformers		1,250,000													
7. 20H-Spryfield substation upgrades and install new transformers		900,000													
8. Conversions Part 3						680,000									
9. Conversions Part 4									690,000						
10. Conversions Part 5										850,000					
11. Conversions Part 6													680,000		
12.															
13.															
14.															
15.															
16.															
17.															
18.															
19.															
20.															
Total Direct Capital Invested by Year	995,000	4,575,000				680,000			690,000	850,000			680,000		
AFUDC (entered as a positive value)															
AO (entered as a positive value)															
Total Indirect Capital Invested by Year															
Total Capital Invested by Year	**995,000**	**4,575,000**				**680,000**			**690,000**	**850,000**			**680,000**		

APPENDIX F

Economic Analysis

23H-Rockingham Alternatives

Summary of Alternatives

23H-Rockingham Alternatives
Summary of Alternatives

Division :		Date :	30-Sep-14
Department :	Distribution Planning	CI Number:	
Originator :	James MacQueen	Project No. :	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Replace 23H-T51	6.49%	4,869,086	-3,940,250	2	-9.08%	0.0 years
B	Add additional 15/20/25MVA transforme	6.49%	2,504,992	-1,984,506	1	-8.16%	0.0 years
C	Convert and Retire 23H-Rockingham	6.49%	6,962,144	-5,594,671	3	-8.91%	0.0 years
D	Convert 23H-Rockingham and resupply	6.49%	7,809,124	-6,382,268	4	-9.07%	0.0 years

Recommendation :

Alternative C is the recommended alternative. While this is not the least cost alternative, Alternative A would see the 23H-T51 replacement's rating exceed the largest mobile in the NSPI fleet. Alternative B would provide the capacity and contingency requirements for the forseeable future. Unfortunately, there is limited space within the 23H-Rockingham substation, as well as limited ability to install any new feeders, to be supplied by the substation.

Notes/Comments :

Replace 23H-T51

This alternative would see the following:
- Replace 23H-T51 (15/20/25MVA) with a larger unit
- Install fourth feeder at 23H-Rockingham
- Conversion of 12kV load to 25kV as load increase
- Install 5MVA 25-12kV padmount stepdown at 8H-Fairview

Add additional 15/20/25MVA transformer at 23H-Rockingham

This alternative would see the following:
- Install additional 15/20/25MVA 69-12kV transformer at 23H-Rockingham
- Install 3 new feeders at 23H-Rockingham

Convert and Retire 23H-Rockingham

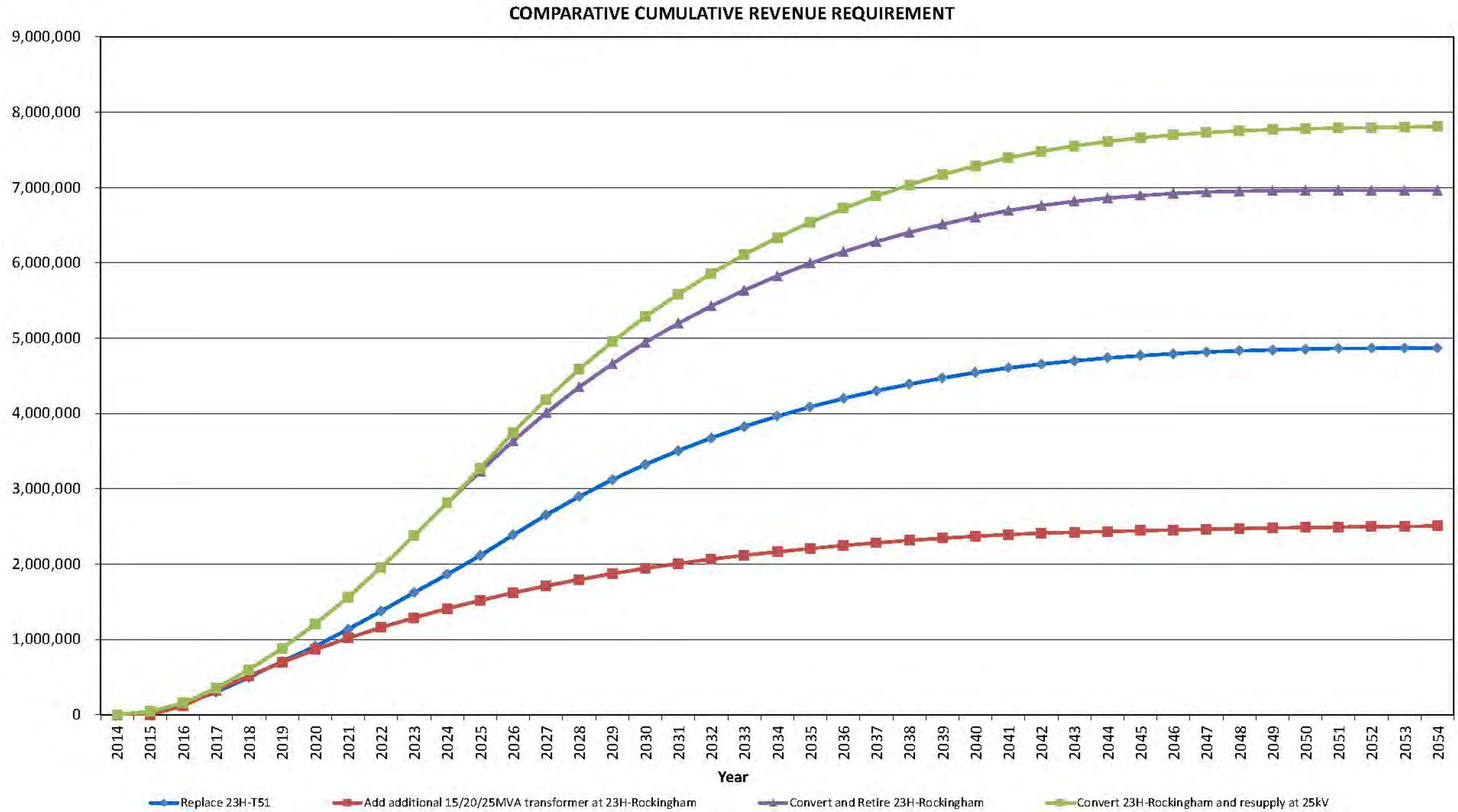
This alternative would see the following:
- Conversion of the existing 12kV load to 25kV, by 2025
- Retire 23H-Rockingham substation in 2026
- Retire L-5032 from L-5004 to 23H-Rockingham

Convert 23H-Rockingham and resupply at 25kV

This alternative would see the following:
- Conversion of the existing 12kV load to 25kV, by 2025
- Remove existing 12kV equipment and install 25kV equipment, in 2025
- Install new 25/33/42MVA 69-25kV transformer at 23H-Rockingham

23H-Rockingham EAM 9/30/2014

NPV Comparison



Alternative 23H-A; Replace 23H-T51

23H-Rockingham Alternati
Replace 23H-T51

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item

Project Description

Select:
In-Service Month: January
In-Service Year: 2015

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Capital Invested															
1. Conversions Part 1		570,000													
2. New 69-12kV 30MVA transformer			650,000												
3. Installation of new transformer			350,000												
4. Conversions Part-2					1,010,000										
5. Conversions Part-3								1,255,000							
6. Conversions Part-4										730,000					
7. Conversions Part 5												995,000	1,025,000		
8. New 23H-Rockingham Feeder			245,000												
9. Install 5MVA 25-12kV stepdown at 8H-Fairview				225,000											
10.															
11.															
12.															
13.															
14.															
15.															
16.															
17.															
18.															
19.															
20.															
Total Direct Capital Invested by Year		570,000	1,245,000	225,000	1,010,000			1,255,000		730,000		995,000	1,025,000		
AFUDC (entered as a positive value)															
AO (entered as a positive value)															
Total Indirect Capital Invested by Year															
Total Capital Invested by Year		**570,000**	**1,245,000**	**225,000**	**1,010,000**			**1,255,000**		**730,000**		**995,000**	**1,025,000**		

Alternative 23H-B; Add Additional Transformer at 23H-Rockingham

23H-Rockingham Alternati Go to: Working Capital
Add additional 15/20/25MVA transformer at Capital
Expenses
Revenue

Nova Scotia POWER An Emera Company

Add Operating Item

Project Description

Select:
In-Service Month: January
In-Service Year: 2015

Capital Invested	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
1. Purchase new 69-12kV 15/20/25MVA transformer			650,000												
2. New 12kV switchgear			800,000												
3. Installation of new transformer			400,000												
4. 1x New 23H-Rockingham Feeder			450,000												
5. 2x New Rockingham Feeders			450,000												
6.															
7.															
8.															
9.															
10.															
11.															
12.															
13.															
14.															
15.															
16.															
17.															
18.															
19.															
20.															
Total Direct Capital Invested by Year			2,750,000												
AFUDC (entered as a positive value)															
AO (entered as a positive value)															
Total Indirect Capital Invested by Year															
Total Capital Invested by Year			**2,750,000**												

Alternative 23H-C; Convert and Retire 23H-Rockingham

23H-Rockingham Alternati
Convert and Retire 23H-Rockingham

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item
Project Description

Select:
In-Service Month: January
In-Service Year: 2015

Capital Invested	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
1. Conversions Part 1		570,000													
2. Conversions Part 2			1,030,000												
3. Conversions Part 3				1,115,000											
4. Conversions Part 4					630,000										
5. Conversions Part 5a						835,000									
6. Conversions Part 5b							860,000								
7. Conversions Part 6								1,080,000							
8. Conversions Part 7a									1,090,000						
9. Conversions Part 7b										1,120,000					
10. Conversions Part 8a											610,000				
11. Conversion Part 8b												630,000			
12. Retire 23H-Rockingham													300,000		
13.															
14.															
15.															
16.															
17.															
18.															
19.															
20.															
Total Direct Capital Invested by Year		570,000	1,030,000	1,115,000	630,000	835,000	860,000	1,080,000	1,090,000	1,120,000	610,000	630,000	300,000		
AFUDC (entered as a positive value)															
AO (entered as a positive value)															
Total Indirect Capital Invested by Year															
Total Capital Invested by Year		**570,000**	**1,030,000**	**1,115,000**	**630,000**	**835,000**	**860,000**	**1,080,000**	**1,090,000**	**1,120,000**	**610,000**	**630,000**	**300,000**		

Alternative 23H-D; Convert 23H-Rockingham and Resupply at 25kV

23H-Rockingham Alternati Go to: Working Capital
Convert 23H-Rockingham and resupply at 25I Capital
Expenses
Revenue

Nova Scotia POWER An Emera Company

Add Operating Item

Project Description

Select:
In-Service Month: January
In-Service Year: 2015

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Capital Invested															
1. Conversions Part 1		570,000													
2. Conversions Part 2			1,030,000												
3. Conversions Part 3				1,115,000											
4. Conversions Part 4					630,000										
5. Conversions Part 5a						835,000									
6. Conversions Part 5b							860,000								
7. Conversions Part 6								1,080,000							
8. Conversions Part 7a									1,090,000						
9. Conversions Part 7b										1,120,000					
10. Conversions Part 8a											610,000				
11. Conversions Part 8b												630,000			
12. Retirement of 23H-Rockingham 12kV												300,000			
13. Purchase new 69-25kV 25/33/42MVA transformer												750,000			
14. Purchase new 25kV Switchgear												650,000			
15. Installation of new equipment												500,000			
16.															
17.															
18.															
19.															
20.															
Total Direct Capital Invested by Year		570,000	1,030,000	1,115,000	630,000	835,000	860,000	1,080,000	1,090,000	1,120,000	610,000	2,830,000			
AFUDC (entered as a positive value)															
AO (entered as a positive value)															
Total Indirect Capital Invested by Year															
Total Capital Invested by Year		**570,000**	**1,030,000**	**1,115,000**	**630,000**	**835,000**	**860,000**	**1,080,000**	**1,090,000**	**1,120,000**	**610,000**	**2,830,000**			

CI Number: 49799

Title: 532N Elm Street Conversion Phase 1

Start Date:	2017/03
In-Service Date:	2017/06
Final Cost Date:	2017/12
Function Class:	Distribution
Forecast Amount:	$548,688

DESCRIPTION:

This project provides for costs associated with implementing recommendation 6.1.1 of the New Glasgow/Stellarton 4kV Distribution Planning Study (362-0615-E30). Section 6.1.1 recommends converting the existing 4kV line on Terrace Street and Elm Street, east of Abercrombie Road, to 25kV. In order to complete this conversion, a new 0.2 kilometer, 3-phase, 25kV line extension from primary distribution feeder 50N-411G will be constructed along Terrace Street from Cameron Avenue. This construction will enable the conversion of the entire 532N-201G feeder section. Additional replacements include upgrading the existing conductor to 336 ASC, approximately 30 poles, framing, insulators, and the replacement of all existing single-tap transformers with dual-tap transformers.

Summary of Related CIs +/- 2 years:
2018 CI TBD 64N Lourdes Phase 1 $TBD
2018 CI TBD 532N Elm Street Conversion Phase 2 $TBD
2019 CI TBD 532N Elm Street Conversion Phase 3 $TBD
2019 CI TBD 64N Lourdes Phase 2 $TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Why do this project?

The existing 532N-Elm Street step-down substation equipment, infrastructure and associated 4kV distribution system are deteriorated. The condition of the targeted assets is further described in section 2.4.3 of planning study 362-0615-E30. If the 532N-T1 transformer failed there would be an extended outage to approximately 500 customers as outlined in the contingency analysis in section 4.2.1.

Why do this project now?

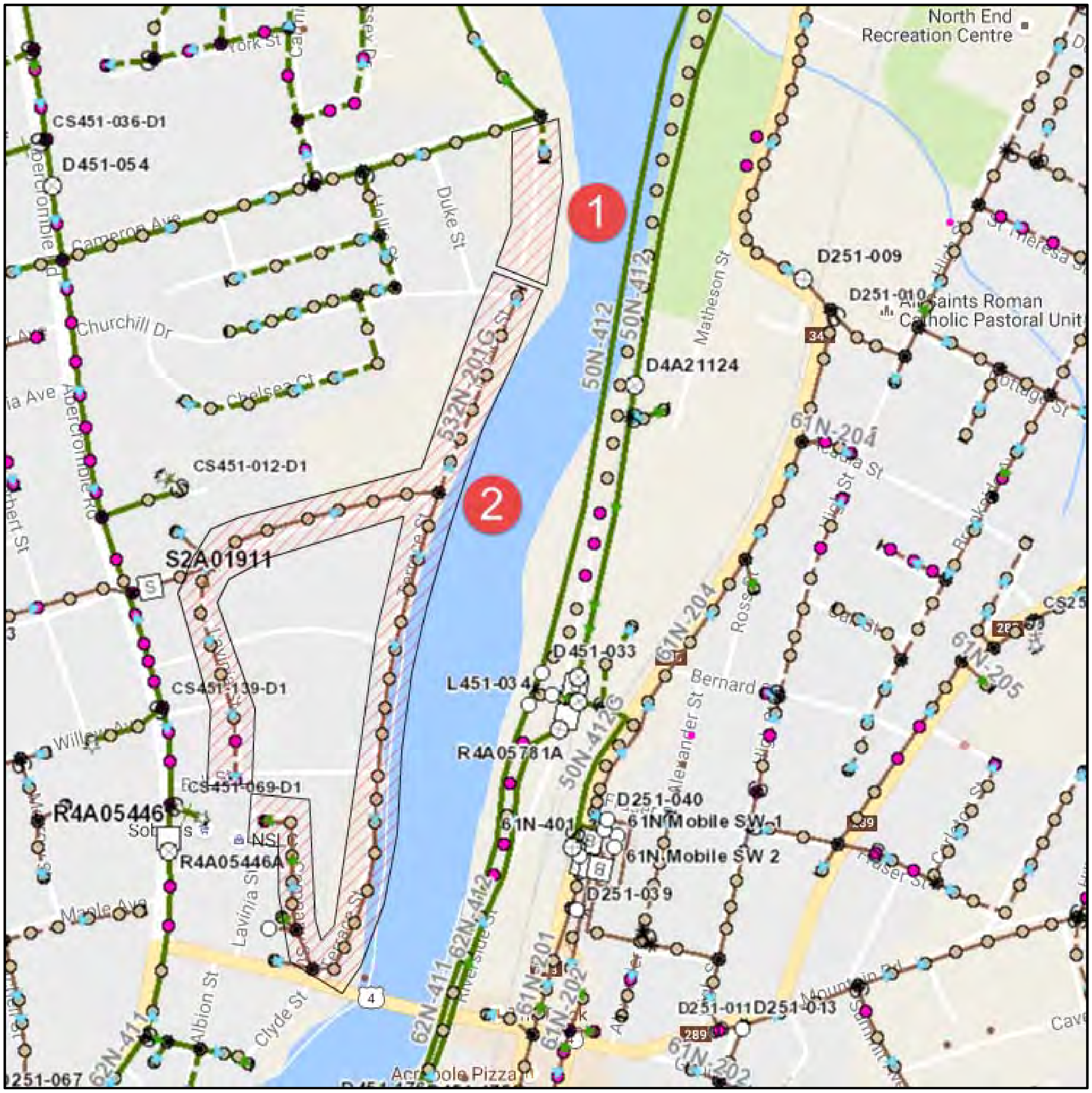
The 532N step-down substation equipment and 4kV distribution plant are up to 60 years old and have reached the end of their expected useful life, as outlined in section 4.3. Two phases of conversion and load transfer need to be completed before 532N can be retired, as outlined in Sections 6.0 and 6.1 of the planning study, with this project recommended for 2016 in Section 6.1.1. This project was not initiated in 2016 due to the ongoing, detailed assessment of all of the 4kV systems included in the study area. The recommendation to complete all 4kV conversions in the study by 2023 will be achieved retiming the plans for conversions in future years.

Why do this project this way?

Alternatives are outlined in Section 5.1 of the planning study, including voltage conversion to decommission the 532N substation, replacing the substation with step-down transformers, and replacing the substation with padmount transformers. The voltage conversion alternative was determined to be the most economical solution, as outlined in Section 5.1.4.

Whereas the recommendation in Section 6.1.1 suggests a line extension from Abercrombie Rd along George St, detailed scoping determined that sufficient anchoring would not be possible due to the location of existing parking lots. A line extension, of similar length, will therefore be constructed along Terrace St from Cameron Ave.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.



(1) Construct a new 0.2 kilometer, 3-phase, 25kV line extension from 50N-411G along Terrace St from Cameron Ave.

(2) Upgrade the existing conductor to 336 ASC. Replacement of poles, framing, insulators, and the replacement of all existing single-tap transformers with dual-tap transformers. Voltage conversion to 25kV.

CI Number : 49799 - 532N Elm Street Conversion Phase 1 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		5,045	0	5,045
095		095-COPS Contracts AO		56,266	0	56,266
012	035	012 - Materials	035 - DP - Wood Poles	39,531	0	39,531
013	035	013 - COPS Contracts	035 - DP - Wood Poles	112,913	0	112,913
012	038	012 - Materials	038 - DP - Insulators	847	0	847
013	038	013 - COPS Contracts	038 - DP - Insulators	11,619	0	11,619
012	039	012 - Materials	039 - DP - O/H Cond.	16,935	0	16,935
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	111,479	0	111,479
012	041	012 - Materials	041 - DP - O/H Line Transf.	16,773	0	16,773
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	5,912	0	5,912
012	048	012 - Materials	048 - DP - U/G Line Transf.	95,210	0	95,210
013	048	013 - COPS Contracts	048 - DP - U/G Line Transf.	39,139	0	39,139
001	085	001 - Regular Labour (No AO)	085 Design	8,912	0	8,912
066	085	066 - Other Goods & Services	085 Design	28,106	0	28,106
			Total Cost:	548,688	0	548,688
			Original Cost:	18,507		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 49799
Title: 532N Elm Street Conversion Phase 1
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Procurement / Financial Support	Lot	1	$ 8,912	$ 8,912		
			Sub-Total	$ 8,912		
012 Materials						
Poles	Lot	1	$ 39,531	$ 39,531		
Insulator	Lot	1	$ 847	$ 847		
Overhead Conductor	Lot	1	$ 16,935	$ 16,935		
Overhead Line Transformer	Lot	1	$ 16,773	$ 16,773		
Underground Line Transformer	Lot	1	$ 95,210	$ 95,210		
			Sub-Total	$ 169,296		
013 Contracts						
Contract Line Work	Hrs	[redacted]		$ 206,473		
Flagging	Lot	1	$ 46,689	$ 46,689		
Backhoe	Lot	1	$ 27,900	$ 27,900		
			Sub-Total	$ 281,063		
066 Other Goods & Services						
Contingency				$ 28,106		
			Sub-Total	$ 28,106		
094 Interest Capitalized						
AFUDC				$ 5,045		
			Sub-Total	$ 5,045		
095 Administrative Overhead						
COPS Contract AO				$ 56,266		
			Sub-Total	$ 56,266		
			SUB-TOTAL (no AO, AFUDC)	$ 487,378		
			TOTAL (AO, AFUDC included)	$ 548,688		
Original Cost				$ 18,507		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

New Glasgow/Stellarton 4kV
DISTRIBUTION PLANNING STUDY

Report number 362-0615-E30

Revision		Date	Drafted By	Reviewed by	Approved By
0	Issued for Study	25-June-2015	BH		
1	Issued for Release	5-Jan-2016	BH	AB	

EXECUTIVE SUMMARY

This study was initiated by the Eastern Territory, to determine solutions for aging/defective 4kV stepdown transformers in New Glasgow. The scope of this study encompasses the solutions to correct high priority issues in New Glasgow and the future of the 4kV system.

It was determined that conversion to 25kV is the best solution for all 4kV distribution remaining in the Stellarton area. Priority of conversions was determined through discussion with representatives from distribution planning, regional engineering, capital engineering, system maintenance and environmental services. Some temporary measures were identified, and assuming their completion, the following priority was agreed upon:

1. 532N-Elm St
2. 64N-Lourdes
3. 61N-Provost St
4. 528N-Granville St

This study makes recommendations by capital year for the phased conversion of these 4kV systems. There are currently no recommendations for capital work on the 25kV systems in this area; however, they should be studied again by 2020. To enable this study, communication work needs to be completed to enable the collection of interval data at 50N-Trenton and all interconnected distribution generation sites in the Stellarton area. This will allow for peak feeder loads to be determined annually.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 SCOPE

This study was initiated by the Eastern Territory, to determine solutions for aging/defective 4kV stepdown transformers in New Glasgow. The scope of this study includes the solutions to correct high priority issues in New Glasgow as well as a longer term plan for the remaining 4kV distribution.

The 4kV step-downs under study are fed from 50N-Trenton and 62N-Bridge Ave. The state of these substations will be considered within this study, although there are no imminent issues with either of these 25kV distribution networks. Timing for a future study will be recommended.

The focus of this study will be on the 4kV step-down sites in New Glasgow: 61N-Provost, 528N-Granville, 532N-Elm and 64N-Lourdes. There have been a variety of issues identified at these sites which pose risks to the environment as well as the reliability of the 4kV distribution in this area.

2.0 EXISTING SYSTEMS

2.1 Transmission

The 50N-Trenton substation serves as the connection point for Trenton Thermal Generating Station and is along the route of a major transmission corridor spanning from Cape Breton to the hub in Truro. The 230kV transmission passes by this station as the 138kV system supplies sub-transmission in the area via lines: L-6503, L-6507, L-6508 and L-6511. The transmission system will not be affected within the scope of this study.

2.2 Sub-Transmission

The sub-transmission system within the Stellarton area operates at 69kV. It is supplied by two 138-69kV auto-transformers located at 50N-Trenton. From there, a 69kV N.O. loop is made with 62N-Bridge Ave (L-5500 and L-5501) as well as a radial feed to 54N-Abercrombie (L-5502). From 62N-Bridge Ave another radial feed (L5510) goes to 89H-Trafalgar. The sub-transmission system will not be affected within the scope of this study.

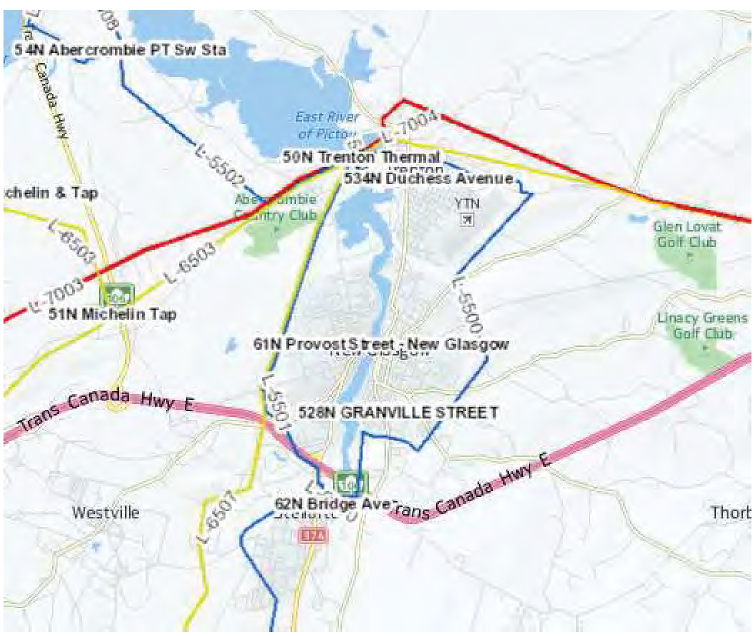


Figure 1 **Stellarton Area Transmission**

2.3 Distribution (25kV)

The 25kV distribution is not the area of focus for this planning study; however 25kV circuits from 50N-Trenton and 62N-Bridge Ave feed the 4kV distribution that is under study. There are no current or imminent issues with the 25kV distribution system that would justify capital expenditure, however the timing for a future study will be recommended.

2.3.1 50N-Trenton

The 50N-Trenton substation has two power transformers, T51 and T13. Transformer T51 has one 13.8kV feeder which supplies industrial customers along the East River of Pictou in Trenton. Transformer T13 has four feeders which cover a large area including: Trenton, Abercrombie, Pictou Landing, the north half of New Glasgow and the eastern extents of the Stellarton depot.

2.3.2 62N-Bridge Ave

The 62N-Bridge Ave substation in Stellarton has a unique configuration that is not standard for NS Power. There are two power transformers (T1/T2) which are connected in parallel to service six feeders. These feeders cover a large area including: Stellarton, Westville, the south half of New Glasgow and the southern extents of the Stellarton depot.

2.4 Distribution (4kV)

The 4kV distribution, stepped-down from 25kV circuits of 50N-Trenton and 62N-Bridge Ave, will be the focus of this study.

Error! Reference source not found.1 provides the transformer data for the 4kV step-downs that are directly impacted by the scope of this study. The stepdown substations will be looked at in greater detail. The phasing out of 4kV single phase pole or platform mounted transformers will be recommended as part of this study, but studied in less detail.

Table 1 Stellarton 4kV Step-down Transformers

Substation	25kV Source	Transformer Data				
		ID	MAN	kV	Rating kVA	Year
61N-Provost	50N-412	T1	Pioneer Electric	24-4.16	5000/6667	1968
528N-Granville	62N-412	T1	General Electric	22-4	5000/5600	1967
532N-Elm St	50N-411G	T41	Brown Boveri	23.9-4.16	2000	1956
64N-Lourdes	62N-411	T1	Packard Electric	22.55-4	1000	1956
534N-Duchess	50N-412	T1	General Electric	24.94-4.16	1000	1958
519N-Drummond	62N-416	T1	N/A	24.94-4.16	1500	1970
658N-Pictou Landing (platform)	50N-415	T41	N/A	14.4-2.4	333x1ph	N/A
536N-Woodburn (platform)	50N-410	T1	N/A	14.4-2.4	500x1ph	N/A
664N-Claremont (platform)	62N-415	T1	N/A	14.4-2.4	167x2ph	N/A
530N-Thorburn (pole)	62N-413	T1	N/A	14.4-2.4	100x1ph	N/A

2.4.1 61N-Provost Street

The 24-4.16kV 5MVA power transformer T1 at 61N-Provost Street was commissioned in 1968. It is fed from 50N-Trenton Thermal feeder 412. The feeders from 61N-Provost supply most of downtown New Glasgow, east of the river, as shown in Figure 2. There are approximately 1600 customers fed from this stepdown, mostly residential with some commercial.

This stepdown transformer has 4 feeders: 61N-201, 202, 203 and 204. Two of these 4kV feeders are tied to feeders from a nearby stepdown transformer at 528N-Granville Street:

- 61N-201 ties to 528N-201 on Stewart Street
- 61N-202 ties to 528N-202 on Marsh Street

This transformer is not overloaded and growth has been relatively flat in the area. The main area of concern in this location is the risk of environmental contamination. There are visible signs oil leakages and the oil level is intentionally left low to prevent excessive leakage.

Running this transformer below recommended oil levels also puts it at greater risk of failure. In the event of failure, this substation has the space and cable runs required to accommodate a mobile transformer.

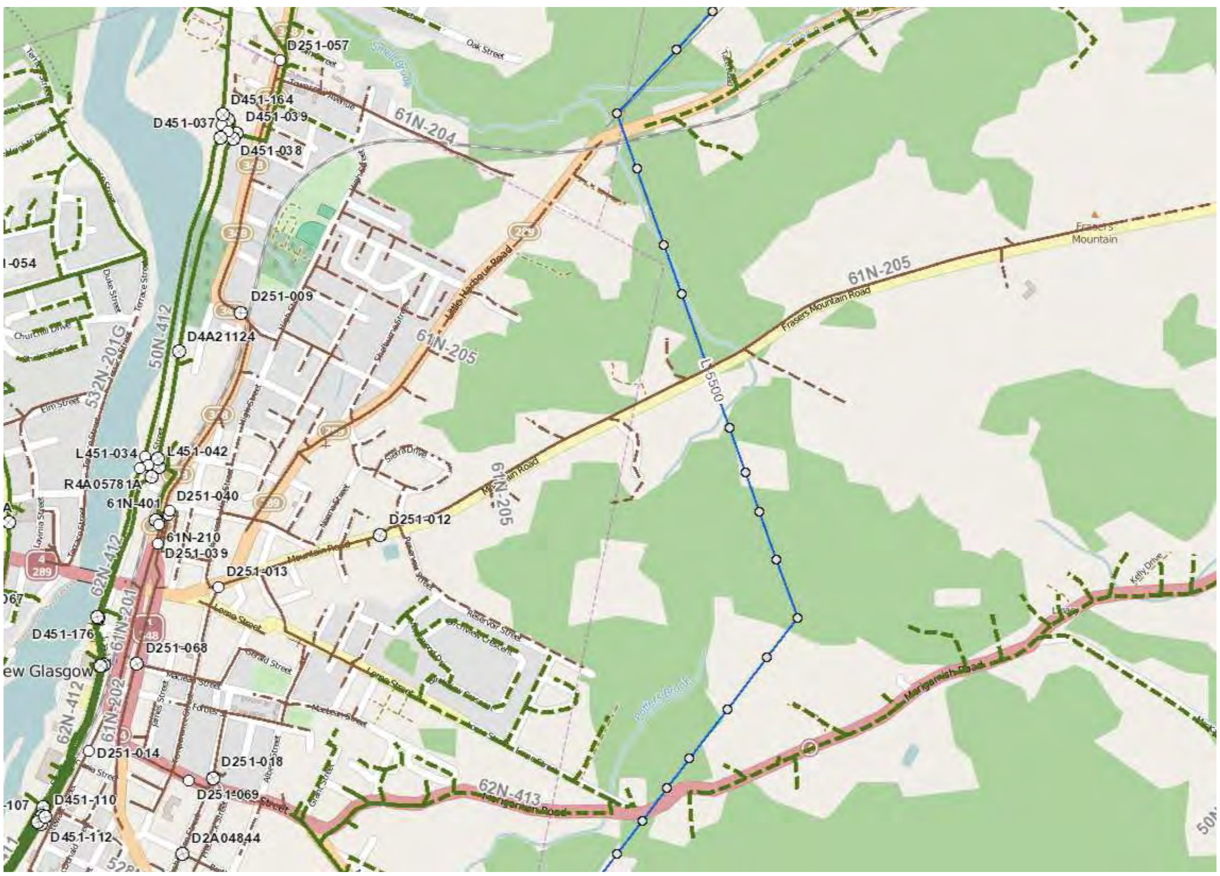


Figure 2 61N-Provost Street Extents

Figure 3 Photos of 61N-Provost St

2.4.2 528N-Granville Street

The 22-4kV 5MVA power transformer T1 at 528N-Granville Street was commissioned in 1967. A voltage regulator was installed to buck the voltage on the high side and allow this transformer to operate as a 25-4kV stepdown. This substation supplies load to southeast New Glasgow as shown in Figure 4.

The original voltage regulator is out of service but was not removed because it sits on the same set of support rails as the transformer and acts as a counter-weight. Engineering of a solution to allow for its removal is underway. This voltage regulator introduces environmental risk to the site as it is an oil filled container and its failure could go unnoticed for some time since it is out of service. There are also visible signs of oil leakages and the oil level is intentionally left low to prevent excessive leakage.

The stepdown transformer has 2 feeder exits: 528N-201 and 202. They are tied to 61N-201 and 202 as mentioned above. There is no space for a mobile transformer at this location.

This transformer is lightly loaded in an area with little growth.

Figure 4 528N-Granville St Extents

Figure 5 Photos of 528N-Granville St

2.4.3 532N-Elm Street

The 23.9-4.16kV 2MVA power transformer T41 at 532N-Elm Street was commissioned in 1956. To operate as a 25-4kV stepdown, three pole top transformers were installed in reverse polarity to buck the voltage to 2400V. The cases of the pole top transformers are painted red and are considered to be live as they are mounted on insulators. These transformers are suspected to be PCB contaminated, since they are of a pre-1982 vintage.

There are visible signs of oil leakages on this power transformer and the oil level is intentionally left low to prevent excessive leakage. There would be risk in maintaining this unit, as there are no spare parts available for it.

The 25kV underground cables appear weathered and the potheads are at about 7 feet above the ground. Due to this, any work on this transformer would likely be within the limits of approach specified in our safety standards.

This stepdown transformer has 1 feeder exit, 532N-201. It is tied to adjacent 4kV feeder 64N-201. There is no space for a mobile transformer at this location.

Overall, this is an unsightly substation in an established residential neighbourhood without readily available contingency. The load growth is flat in this area and has not reached the nameplate capacity of this transformer.

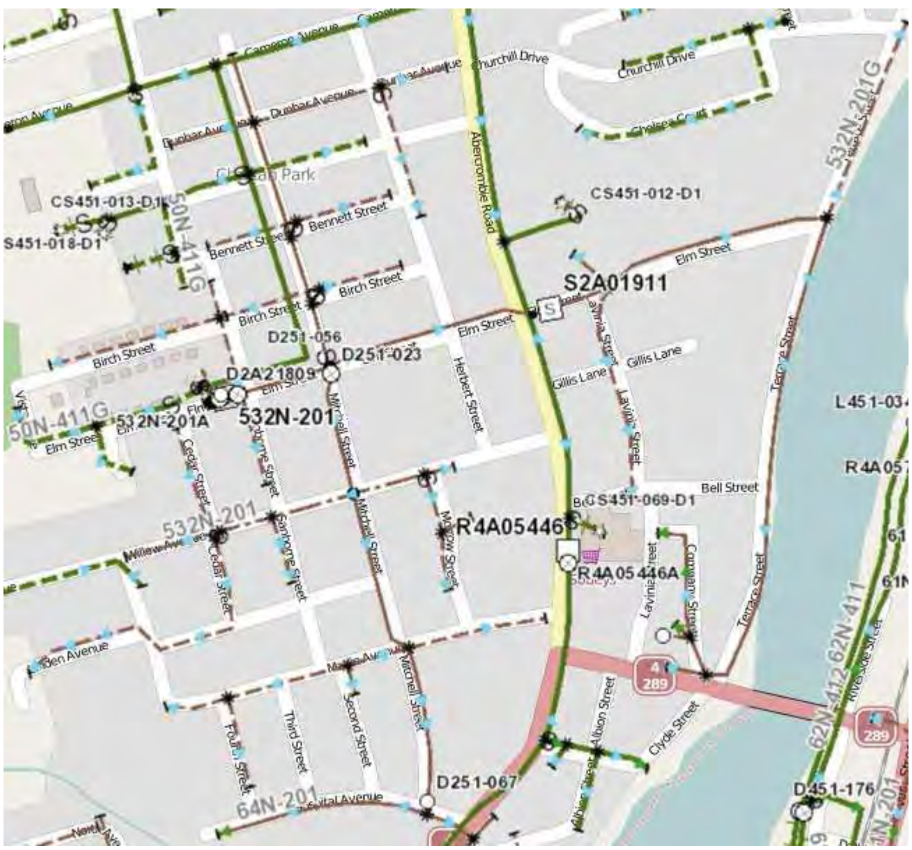


Figure 4 **532N-Elm St Extents**

Figure 6 **Photos of 532N-Elm St**

2.4.4 64N-Lourdes

The 22.55-4kV 5MVA power transformer T1 at 64N-Lourdes was commissioned in 1956. It is the most visually appealing of the four stepdown substations in New Glasgow, but also the most heavily loaded.

There are visible signs of oil leakages on this power transformer and the oil level is intentionally left low to prevent excessive leakage.

This stepdown transformer has 1 feeder exit, 64N-201. It is tied to adjacent 4kV feeder 532N-201. There is space on this site for a mobile transformer, although there are no existing provisions for one to be installed.

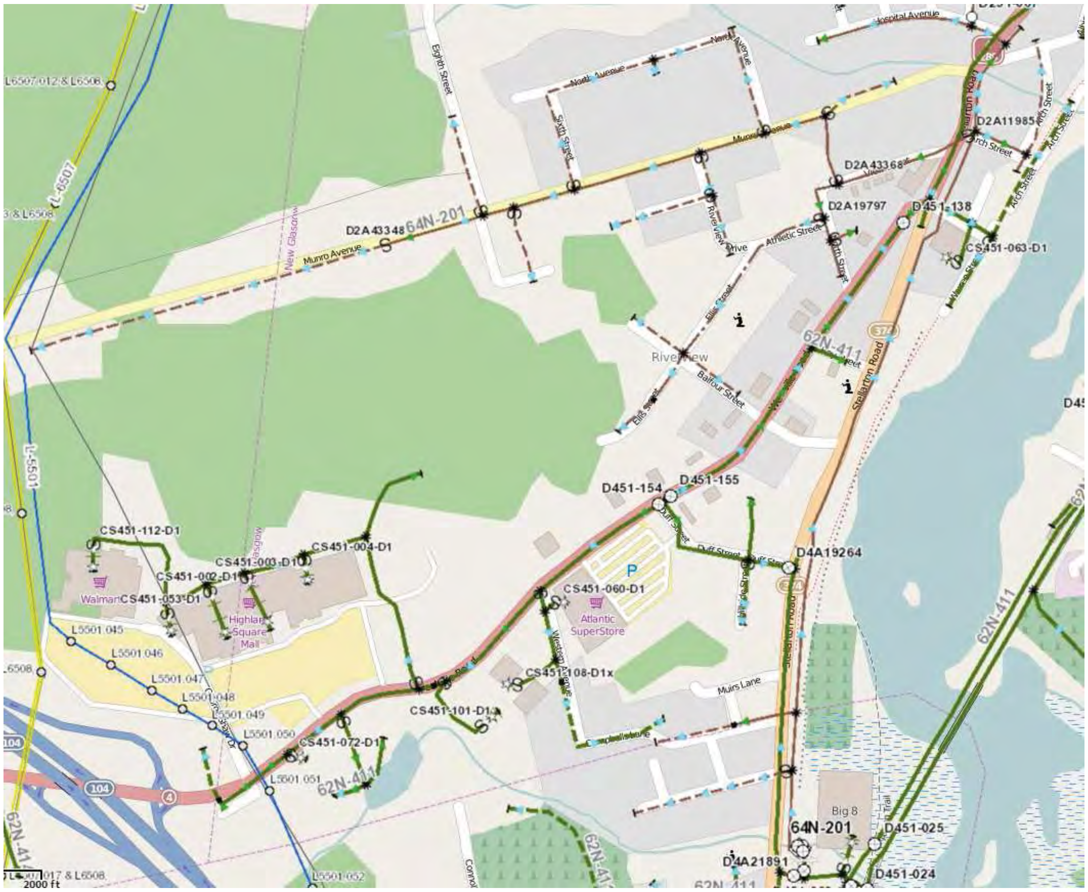


Figure 7 **64N-Lourdes Extents**

Figure 8 **Photos of 64N-Lourdes**

2.4.5 534N-Duchess Avenue

The 24.94-4.16kV 1MVA power transformer at 534N-Duchess was commissioned in 1958.

Due to heavy overload of this transformer, a large section of its load was converted to 25kV in 2014 (see Figure 10). Based on the reduction from 2990 to 2135kVA (connected) and 60 to 327 customers, it is estimated that the load on this transformer was reduced by 30%.

There are visible signs of oil leakages on this power transformer and the oil level is intentionally left low to prevent excessive leakage.

This stepdown transformer has one feeder exit, 534N-201, which is isolated from other 4kV feeders. In the event of failure, there is space for a mobile transformer.

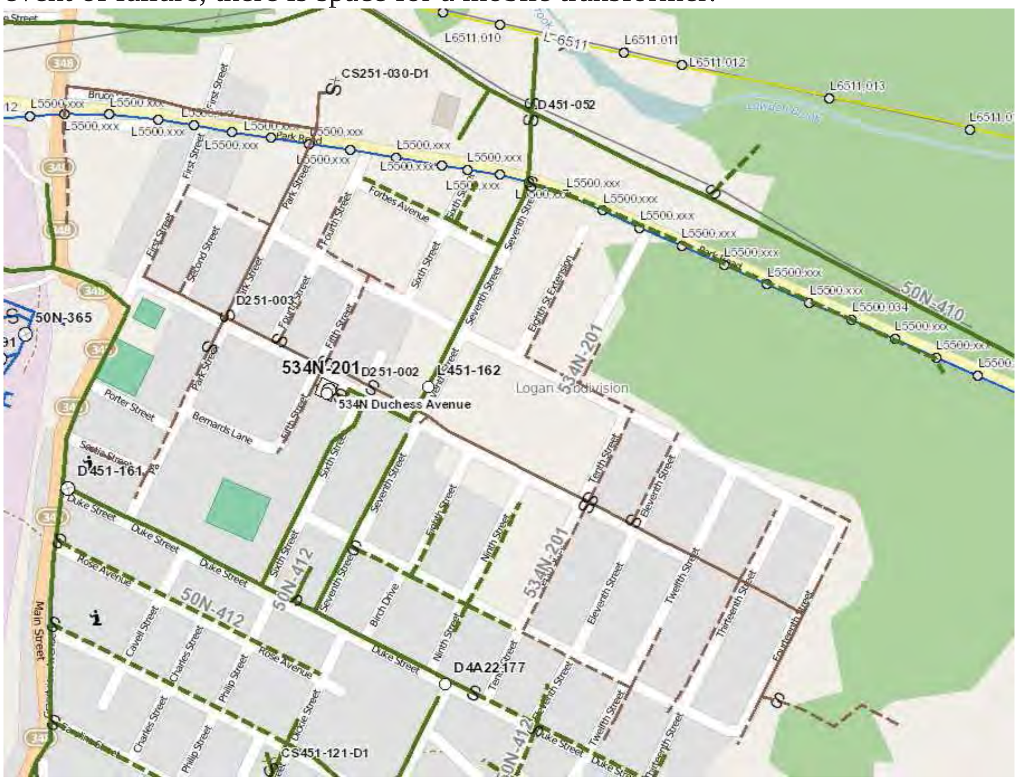


Figure 9 **534N-Duchess Extents (2015)**

Figure 10 534N-Duchess Conversion (2014)

Figure 11 Photo of 534N-Duchess Ave

2.4.6 519N-Drummond Road

The 24.94-4.16kV 1.5MVA power transformer at 519N-Drummond was commissioned in 1970.

In 2012, a partial conversion to 25kV was completed in this area (See Figure 13). Based on the reduction from 674 to 484 customers, it is estimated that the load on this transformer was reduced by 30%.

This stepdown transformer has one feeder exit, 519N-201, which is isolated from other 4kV feeders. In the event of failure, there is minimal to no space for a mobile transformer.

Figure 12 **519N-Drummond Extents**

Figure 13 519N-Drummond Conversion (2012)

Figure 14 Photo of 519N-Drummond

2.5 Distributed Generation

There are currently three distributed generation sites in service and two more planned for the Stellarton area on 25kV distribution from 50N and 62N.

Table 2 Stellarton Distributed Generation

IR#	Site#	Name	Feeder	Size	In Service Date
IR312	717N	Auld's Mountain	50N-410	4.6MW	April 2015
IR257	82N	Irish Mountain	62N-413	1.99MW	November 2013
IR388/464	718N	Forbes Lake	62N-413	6.4MW	April 2015
IR308	724N	Avondale	50N-410	1.6MW	Future (Oct 2015)
IR333	722N	Limerock	62N-414	4.8MW	Future (Aug 2015)

The distributed generation does not affect the peak data or recommendations for the 4kV distribution. For the 25kV distribution, 82N Irish Mountain may have distorted peak feeder readings for 62N-413 for 2014 and 2015 peaks. Unfortunately there is no interval (PI) data available for this feeder during these peaks, however there is interval (MV90) data available for 82N itself.

3.0 LOAD HISTORY AND FORECAST

The 25kV distribution is comprised of long rural feeders and small towns. The 4kV distribution under study is mostly residential with a small number for commercial customers. As illustrated in the load history for these feeders, Appendix B, the feeders being studied have had a larger winter peak than summer. Historical load data for the feeders and transformers being studied was collected from the Distribution Load Check Database and PI data where available. Historical data was used to determine load growth rate and forecast future peak loads. Peak loads should be compared against the rated load and the Capital Expenditure Justification Criteria (CEJC).

3.1 Load Forecast

Customer load has grown at a modest pace in the Stellarton area. There is insufficient data for a load history/forecast for 534N, 519N, 658N, 536N, 664N and 530N. Clip data recorded in the Eastern Region Load Protection Report was used to determine if overloads exist on these stepdown transformers.

Table 3 Load Protection Report Clip Data

Transformer	Customers (#)	Rating (kVA)	2014 Clip (kVA)	2015 Clip (kVA)	% Loading (max)
519N-T1	484	1500	1236	1145	82%
534N-T1	327	1000	1308	NA	131%
530N-T1	41	100	130	89	130%
536N-T1	108	500	283	NA	57%
658N-T41	186	333	300	NA	90%
664N-T1 Ph A	101	167	220	218	132%
664N-T1 Ph C	108	167	182	200	120%

The growth rates indicated in following tables were determined through examination of the peak load check data over the past 15 years. The forecasted load growth was then calculated using the 90th percentile of a linear fit, to determine potential peak load growth in the area. In **bold** are actual recorded values, other values have been estimated from historical data. The 25kV feeders have not been included in these tables, but plots can be found in Appendix B.

Table 4 90th Percentile Load Forecast 25kV

Year / Peak MVA	50N-T13	62N-T1/T2
Rating/CEJC	**28/37.2 MVA**	**40/53.2 MVA**
Current Customers	**5015**	**9735**
Load Growth	**1.13%**	**1.10%**
2014	**24**	**44.1**
2015	**28.5**	46.5
2016	29.0	47.0
2017	29.3	47.6
2018	29.7	48.1
2019	30.0	48.7
2020	30.4	49.2
2021	30.7	49.8
2022	31.1	50.3
2023	31.4	50.9
2024	31.8	51.4
2025	32.1	52.0
2026	32.5	52.5
2027	32.8	53.1
2028	33.2	53.6
2029	33.5	54.2
2030	33.9	54.7

Table 5 90th Percentile Load Forecast 61N-Provost

Year / Peak MVA	61N-T1	61N-201	61N-202	61N-204	61N-205
Rating/CEJC	**6.67/8.87 MVA**	**300/325 A**	**300/325 A**	**300/325 A**	**300/325 A**
Current Customers	**1604**	**132**	**332**	**559**	**581**
Load Growth	**0.55%**	**0.32%**	**-1.16%**	**0.70%**	**1.92%**
2014	**5.0**	**72**	**234**	**222**	**290**
2015	**5.1**	**70**	**212**	**236**	**306**
2016	5.4	73	222	238	313
2017	5.4	73	220	239	320
2018	5.4	73	218	241	326
2019	5.5	73	215	243	333
2020	5.5	74	213	245	340
2021	5.5	74	210	246	347
2022	5.6	74	208	248	353
2023	5.6	74	206	250	360
2024	5.6	75	203	251	367
2025	5.7	75	201	253	374
2026	5.7	75	199	255	380
2027	5.7	75	196	257	387
2028	5.7	76	194	258	394
2029	5.8	76	192	260	401
2030	5.8	76	189	262	407

Table 6 90th Percentile Load Forecast 528N-Granville, 532N-Elm, 64N-Lourdes

Year / Peak MVA	528N-T1	528N-201	528N-202	532N-T41	64N-T1	532N/64N
Rating/CEJC	**5.6/7.45 MVA**	**300/325 A**	**300/325 A**	**2/2.66 MVA**	**1/1.33 MVA**	**Coincidence Factor**
Current Customers	**802**	**395**	**407**	**494**	**374**	
Load Growth	**0.62%**	**-0.76%**	**0.77%**	**-1.16%**	**1.24%**	**90%**
2014	1.91*	**170**	115*	**1.44**	**1.22**	**2.39**
2015	2.02*	**142.0**	148*	**1.44**	**1.21**	**2.39**
2016	2.13	166.7	150.5	1.58	1.40	2.68
2017	2.15	165.4	151.7	1.56	1.42	2.69
2018	2.16	164.2	152.9	1.54	1.44	2.69
2019	2.18	163.0	154.1	1.53	1.46	2.69
2020	2.19	161.8	155.3	1.51	1.48	2.69
2021	2.20	160.6	156.5	1.49	1.50	2.69
2022	2.22	159.4	157.7	1.48	1.52	2.69
2023	2.23	158.2	158.9	1.46	1.53	2.69
2024	2.24	157.0	160.1	1.44	1.55	2.70
2025	2.26	155.7	161.3	1.42	1.57	2.70
2026	2.27	154.5	162.5	1.41	1.59	2.70
2027	2.29	153.3	163.8	1.39	1.61	2.70
2028	2.30	152.1	165.0	1.37	1.63	2.70
2029	2.31	150.9	166.2	1.36	1.65	2.70
2030	2.33	149.7	167.4	1.34	1.67	2.70

***Data not available, values approximated using scaled clip measurements.**

4.0 JUSTIFICATION FOR EXPENDITURE

The following section identifies issues that warrant correction based on NSPI's *Capital Expenditure Justification Criteria*.

4.1 Overloads

There is only one overload condition that is expected within the study period for 25kV distribution: 62N-T1/T2 transformer is expected to peak above 133% of rating in 2028, based on load history

There are two overload conditions expected within the study period for 4kV distribution:

- 61N-205 feeder is expected to peak above 325A in 2018, unless load is transferred
- 64N-T1 transformer peaked above 133% of rating in 2012 and 2013 and is expected to reach similar peak values in the coming years.

An overload condition was present on 534N-T1 in 2013 and 2014 above 133% of rating. Data is not available for 2015 winter peak. In 2014, approximately 30% of the connected kVA was removed from this stepdown through conversion to 25kV. Based on this, the 2015 winter peak is estimated at 100% of rating. The peak winter load is not expected to exceed 133% of rating within the study period.

There are single phase stepdown transformers that are at or approaching overload. Based on 2014 clip data in the Eastern Region Load Protection Report, it is very likely that 530N-Thorburn and 664N-Claremont have exceeded 133% of rating during winter peak.

4.2 Contingency Loss of Supply

The 4kV distribution in New Glasgow is divided by the East River of Pictou. There are two stepdown substations on each side, but they are unable to provide full contingency on either side. The conclusions within this section were determined through modeling single contingency situations during 2015 winter peak loading. Other 4kV in the Stellarton area is completely isolated from alternate supplies.

4.2.1 532N-Elm St and 64N-Lourdes

These two substations supply similar loads. They are tied by a long run of #2 bare copper conductor, which causes voltage drop well below acceptable limits in a situation where 64N provides contingency for 532N. Peak load would greatly exceed 133% of the rating of 64N-T1. There is no room for a mobile transformer near the 532N-Elm St substation. There would be an extended outage to approximately 500 customers if 532N-T41 were to fail.

In the event of 64N-T1 failure, it is possible that Elm St could pick up the load, however voltage drop would be a concern in some areas during peak load. The 2015 peak load for 532N and 64N is just under 133% of 532N-T41 rating, however based on forecasted load, this would be exceeded in 2016. There is space for a mobile transformer at the 64N-Lourdes site, however there is nothing currently in place to facilitate installation. The outage duration would be the length of time required to transfer load in most cases, and the time required to install a mobile transformer during peak load. There are approximately 375 customers supplied by 64N.

4.2.2 61N-Provost and 528N-Granville

There are feeder ties between 61N-201/528N-201 as well as 61N-202/528N-202. These feeder ties cannot be used for contingency during winter peak conditions due to voltage drop below acceptable limits. In an off-peak situation, load could be transferred between these feeders for contingency. For feeders 61N-204 and 205 the load cannot be picked up by 528N-Granville, even off-peak.

In the event of 61N-T1 failure during peak load, customers would experience outages until the mobile transformer could be installed at the 61N-Provost site. The site has been built to accommodate a mobile transformer. There are approximately 1600 customers supplied from this substation.

In the event of 528N-T1 failure during peak load, outage duration would be dependent on the installation of an available replacement transformer. There is no space for a mobile unit at the 528N-Granville site. There are approximately 800 customers supplied from this substation.

4.2.3 534N-Duchess

There are no other 4kV feeders near 534N-Duchess. In the event of 534N-T1 failure, outage duration would be dependent on the installation of an available replacement transformer or mobile transformer. The site has not been built to accommodate a mobile transformer, but there is some space available. There are approximately 330 customers supplied from this substation.

4.2.4 519N-Drummond

There are no other 4kV feeders near 519N-Drummond. In the event of 519N-T1 failure, outage duration would be dependent on the installation of an available replacement transformer. There is no space for a mobile unit at the 519N-Drummond site. There are approximately 485 customers supplied from this substation.

4.2.5 Single Phase Stepdowns

The four other small pockets of 4kV in the Stellarton area: 658N-Pictou Landing, 536N-Woodburn, 664N-Claremont and 530N-Thorburn have similar deteriorated plant.

There are no other 4kV feeders near any of these platform or pole mounted stepdowns. In the event of failure, the outage duration would be dependent on the installation of an available replacement transformer. For 530N-Thorburn, replacement from stores should be very straight forward as it is only a 100kVA pole mounted transformer. Spares should also be available for the platform mounted transformers, however outage impact would be greater.

4.3 Deteriorated Plant

The majority of 4kV distribution plant in Stellarton is greater than 50 years old. There are many safety, environmental and reliability concerns due to the age of this equipment:

- Deteriorated #4 copper conductor has decreased tensile strength and presents a greater hazard for live line work.
- Chronically weeping transformers are left running on low oil to prevent excessive leakage. Lids can be tightened, however tightening of leaking gaskets could cause more harm than good. There are signs of oil leakage around the base of transformers. This condition is present at all 4kV substations in the Stellarton area: 532N, 64N, 61N, 528N, 534N and 519N.
- Historically, equipment failure has caused 4kV conversion to 25kV to proceed unplanned. This results in a much higher cost and customer impact than a planned approach.
- The 4kV voltage level is no longer one of the standard voltages for distribution at NSPI – in service and spare equipment will be phased out when possible.

Unique conditions exist at certain substations as explained in the Existing Systems section. These conditions provide additional justification for expenditure:

- 532N-Elm St
  - Using pole top transformers with possible PCBs to buck voltage and allow a 23.9-4.16kV transformer to be used to step down 25kV.
  - Unsightly equipment and graffiti, in an established residential neighbourhood.
  - 25kV potheads are only 7 feet above ground, so it is easy to be within the limits of approach
  - Center phase pothead has been replaced; failure of other two phases may be imminent.
- 528N-Granville St
  - Out-of-service, oil-filled regulator is sitting on the same rails as power transformer, acting as a counter weight. This presents an unnecessary environmental risk.
  - Sagging timbers support switches (A, B, C)

5.0 SOLUTIONS AND EVALUATION

There is significant justification to correct the deficiencies present in the 4kV distribution in Stellarton. The alternative to "Do Nothing" has not been considered as this would certainly result in environmental incidents, extended customer outages and economic loss for NSPI.

Deteriorated plant conditions and loss of supply contingency requirements have been used to prioritize the areas to correct. Top priorities were agreed upon by key stakeholders from System Maintenance, Regional Engineering, Capital Engineering, Environmental Services and Distribution Planning:

1. 532N-Elm Street
2. 528N-Granville Street
3. 61N-Provost Street
4. 64N-Lourdes

System Maintenance and Environmental Services will be performing work to alleviate certain issues in the short term:

- Install mobile transformer at 61N-Provost to allow: site clean-up and soil testing, transformer maintenance to potentially slow leaking of oil
- Engage a Civil Engineer to design a solution for the removal of the out of service regulator at 528N-Granville

This study recommends the phased conversion of 532N-Elm St and 64N-Lourdes proceeds immediately, followed by the phased conversion of 61N-Provost and 528N-Granville. All other conversions should follow based on observed conditions.

Within the scope of conversion to 25kV is the replacement of all distribution transformers, along with a percentage of conductor, poles, insulators and anchoring. The estimates are based on the scoping of one section of the 4kV distribution from 532N-Elm St. The rest of the 4kV distribution in New Glasgow is of approximately the same age and condition.

5.1 532N-Elm and 64N-Lourdes (New Glasgow East)

To resolve the issues at 532N-Elm Street and 64N-Lourdes, three options were considered:

- Convert the area to 25kV and decommission both substations
- Install 3 platform mounted stepdown locations and decommission both substations
- Replace both transformers with new padmounts and maintain 4kV distribution

Each alternative is proposed in phases and completed in 2017.

5.1.1 Alternative NG East-A, Convert to 25kV

This alternative is a phased approach to converting all of 532N and 64N load to 25kV. The conversion of this area would be completed in three phases for 532N-Elm St and two phases for 64N-Lourdes. The conversions should overlap, with both substations being decommissioned in 2017.

This conversion strategy allows both existing substations to remain in service and provide contingency for each other during conversion. Once the first phase of each conversion is complete, either substation could handle the remaining 4kV winter peak. Once conversion is complete, contingency is handled within the 25kV system. Recommendations for specific conversion steps by capital year can be found in Section 6.

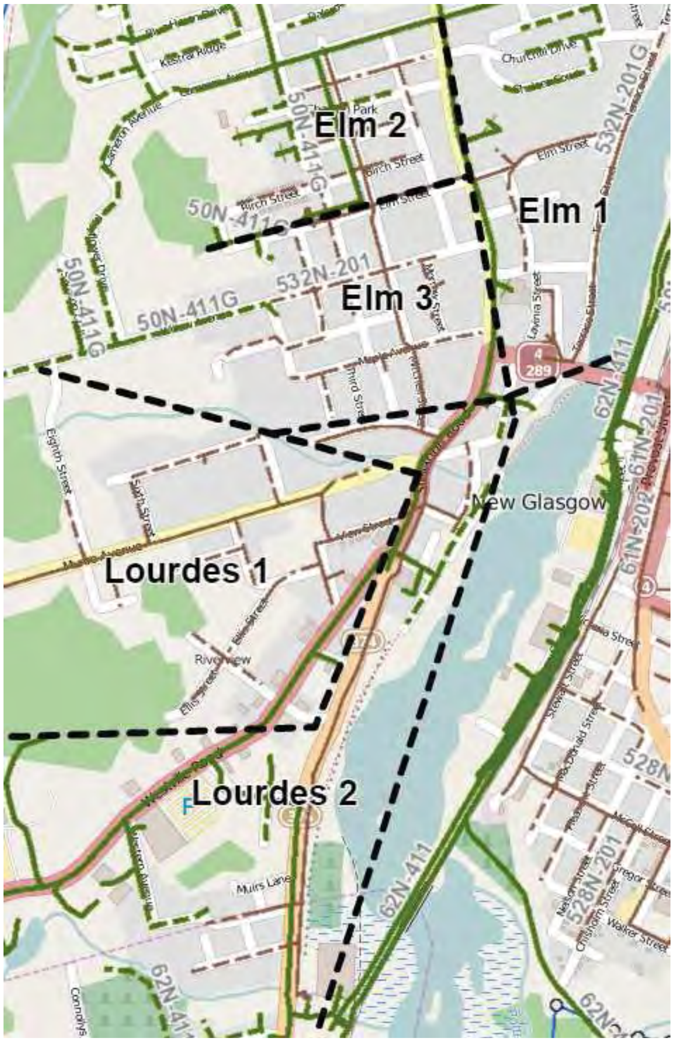


Figure 15 **Geographic Overview of NG East-A Phases**

5.1.2 Alternative NG East-B, Three Stepdown Locations

This alternative replaces the existing 4kV substations at 532N-Elm and 64N-Lourdes with three new 500kVA/phase stepdown transformers. There are very few appropriate locations for these platform-mounted transformers and there could be push back from the town of New Glasgow if this alternative were to go ahead. For the purpose of this study, suggested stepdown locations were assumed to be allowable:

1. Terrace Street near 25kV source 50N-411G
2. Elm St at or near existing substation location
3. N Foord Street at existing 64N substation location

This approach allows for the 4kV load in East New Glasgow to be shared by three stepdown locations and provides contingency for the loss of one stepdown. It also facilitates a phased conversion in the future, as its intent is to defer the eventual conversion to 25kV (complete by 2030). Within the scope of this alternative is the installation of one stepdown location per year, including any required conductor replacement – most notably, a long section of #2 Copper on Stellarton Avenue.

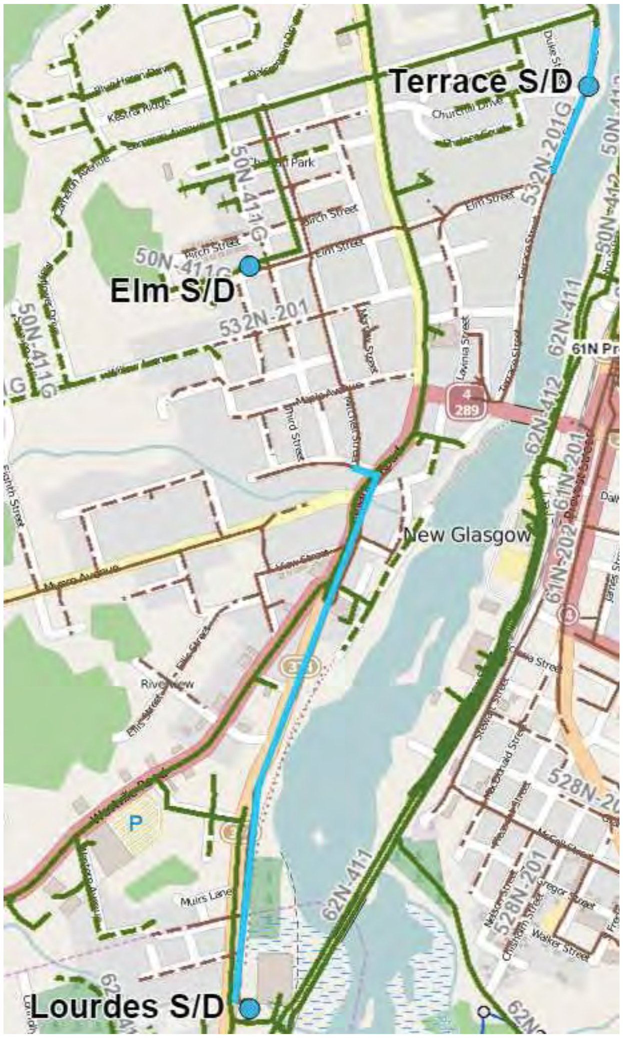


Figure 16 **Geographic Overview of NG East-B Stepdowns**

5.1.3 Alternative NG East-C, Replace Substations with Padmounts

This alternative replaces the existing transformers at 532N-Elm St and 64N-Lourdes with new 3MVA padmount transformers. Unlike alternative B, these substation locations are established and cleaning the sites up with new padmounts would be well received. These padmounts would provide contingency for each other. Unfortunately, this alternative does not facilitate the eventual conversion to 25kV (complete by 2030).

Within the scope of this alternative is the installation of new padmounts, site work, protection equipment, temporary transformers during removal of existing units and reconductoring of #2 Copper on Stellarton Avenue.

5.1.4 532N-Elm and 64N-Lourdes Recommendation

Based on the Economic Analysis Model (EAM) in Appendix C, Alternative NG East-A, Convert to 25kV is the most economical solution. Conversion to 25kV is also the preferred method to correct issues with deteriorated 4kV plant for a variety of reasons. Below is a summary of advantages/disadvantages for each alternative. This will give context for why these solutions were explored.

Alternative NG East-A, Convert to 25kV

- Most economical solution, based on alternatives deferring this eventuality by 15 years
- Results in the most old conductor and equipment being replaced – reliability improvements not considered in EAM
- Most visually appealing alternative
- Reduced cost of losses due to conversion (Appendix D) – considered in EAM as operating expense
- Historically, conversion to 25kV has been performed whenever possible throughout NSPI
- 25kV feeders are very accessible, which facilitates the conversion

Alternative NG East-B, Three Stepdown Locations

- Much less demanding on capital resources
- Configuration facilitates future conversion
- Unsightly platforms in residential neighbourhoods may have strong opposition
- NSPI has committed to phase out 4kV as a standard voltage level for distribution
- Spare units are available in stores

Alternative NG East-C, Replace Substations with Padmounts

- Less demanding on capital resources
- Does not facilitate future conversion
- Clean up of existing substation sites would be well received
- NSPI has committed to phase out 4kV as a standard voltage level for distribution
- A spare padmount would need to be purchased for stores

5.2 61N-Provost and 528N-Granville (New Glasgow West)

The 4kV distribution in the west of New Glasgow is very similar to the east. With the results of the previous economic analysis, it is apparent that alternatives to conversion would not provide economic benefit for the west side of New Glasgow. Further benefits of conversion over other alternatives:

- 61N-Provost St is a large substation with 4 feeder exits, a padmount replacement would not be practical in this situation
- There is four times more load in west New Glasgow compared to the east. To replace the substations with platform-mounted stepdowns, more units would be required and locations for them would be very difficult to find

A strategy for conversion to 25kV can be found in the Recommendations section. Timing is based on the priority discussed previously and predicted resource availability.

5.3 534N-Duchess and 519N-Drummond

The first phase of conversion to 25kV has been completed for each of these islands of 4kV. Based on this precedence and the analysis in Section 5.1, conversion is the preferred alternative for these locations. Phased conversions should proceed as resources are available.

5.4 Single Phase Stepdowns

Conversion is the preferred alternative for the other four small pockets of 4kV in the Stellarton area: 658N-Pictou Landing, 536N-Woodburn, 664N-Claremont and 530N-Thorburn. Phased conversions should proceed as resources are available. These locations should be addressed when overloaded, but not given priority over the 4kV substations.

6.0 RECOMMENDATIONS

This section will outline recommendations for the conversion to 25kV of 532N-Elm, 64N-Lourdes, 61N-Provost and 528N-Granville. These 4kV substations were identified as the highest priority and some strategy is required to complete conversion, based on priority of work, maintaining contingency and minimizing customer outages. Deteriorated 4kV plant should be replaced as required during conversion. Open points should be created as required to maintain the load between 50N and 62N.

Other pockets of 4kV should be converted to 25kV whenever possible. These include: 534N-Duchess, 519N-Drummond, 658N-Pictou Landing, 536N-Woodburn, 664N-Claremont and 530N-Thorburn. These conversions are quite linear, so different strategies for conversion have not been considered. These stations are lower priority in the big picture; in the event of imminent failure, measures should be taken to correct, but also to avoid deferral of recommended timeline below.

There are currently no capital recommendations for the 25kV substations, 50N-Trenton Thermal and 62N-Bridge Avenue. Based on projected load growth, these 25kV systems should be studied again by 2020. To enable this study, communication work needs to be completed to enable the collection of feeder load data in PI for 50N, which is currently not functional. Also, interval data at all distribution generation sites needs to be made available so that the peak feeder load can be determined annually. This study will be advanced or deferred based on new developments and requests from regional engineering.

6.1 2016 Capital Year

It is recommended that conversions to 25kV begin immediately, given the large scope of work required to relieve the issues identified. Since resources will not be available for 2015, the first phases of conversion should proceed in 2016. With the first phase of each conversion completed, the two 4kV substations will be able to provide contingency for each other. At this point, it would be possible to decommission one of these substations if required.

6.1.1 Terrace Street Conversion (532N-Elm Phase 1)

The first phase of conversion for 532N-Elm St covers Terrace St and Elm St east of Abercrombie. Extend a new 25kV branch onto George St from Abercrombie Rd to be used as a source for converting the 4kV in sections back to Elm St through Terrace St.

Figure 17 **Terrace Street Conversion (532N-Elm Phase 1)**

6.1.2 View Street Conversion (64N-Lourdes Phase 1)

The first phase of conversion for 64N-Lourdes covers the 4kV branch from Stellarton Rd on View St.

- Extend a new 25kV branch onto North St from Westville Rd
- Convert North St up to and including the Ellis St branch
- Rebuild Athletic St and Riverview Dr to 3 phase to Monroe Ave and convert
- Convert Monroe Ave east of Riverview Dr and 8th St
- Convert 6th St and North Ave
- Convert the rest of Monroe Ave and remove off-road section
- Finish conversion on View St

Figure 18 View Street Conversion (64N-Lourdes Phase 1)

6.2 2017 Capital Year

In 2016, the phased conversion of 532N should be completed.

6.2.1 North Mitchell Street Conversion (532N-Elm Phase 2)

The second phase of conversion for 532N-Elm St covers Mitchell Street north of Elm Street. There is an existing 25kV supply on north Mitchell St. so each branch can be converted independently.

Figure 19 North Mitchell Street Conversion (532N-Elm Phase 2)

6.2.2 South Mitchell Street Conversion (532N-Elm Phase 3)

The final phase of conversion for 532N-Elm St covers Mitchell Street south of Elm Street.

- Extend a new 25kV branch from Stellarton Ave onto Hospital Ave and convert
- Convert sections of Mitchell St and branches until Elm St
- Convert the remaining 4kV on Elm St and decommission the 532N site

Figure 20 South Mitchell Street Conversion (532N-Elm Phase 3)

6.3 2018 Capital Year

The final phase of 64N-Lourdes conversion should be completed in 2017. Once this is complete, both 532N-Elm and 64N-Lourdes sites can be retired. With the top priority 4kV plant dealt with, the phased conversion of 61N-Provost should begin. The conversion strategy for Provost will start with 204 and 205 feeders which are not tied to adjacent 4kV substation 528N-Granville.

6.3.1 Stellarton Road Conversion (64N-Lourdes Phase 2)

The final phase of conversion for 64N-Lourdes covers the remaining 4kV along Stellarton Rd from Hospital Ave to the 64N-Lourdes site.

- Convert sections of Stellarton Rd back to the intersection of Westville Rd
- Extend 25kV on Stellarton Rd from Westville Rd to Duff St
- Convert the remaining 4kV and decommission the 64N site

Figure 21 Stellarton Road Conversion (64N-Lourdes Phase 2)

6.3.2 Townsend Avenue Conversion (61N-Provost Phase 1)

The first phase of conversion for 61N-Provost covers Townsend Avenue and back to D251-009 on Trenton Road.

Figure 22 Townsend Avenue Conversion (61N-Provost Phase 1)

6.3.3 664N-Claremont Avenue Conversion

The two 167kVA single phase transformers (664N-T1) on Claremont Avenue are suspected to be at or near capacity. This small pocket of 4kV should be converted when resources are available. The conversion has no sequential effect on other conversions, so it can be advanced or deferred as required or broken down into small phases.

Figure 23 **664N-Claremont Avenue Conversion**

6.4 2019 Capital Year

In 2019, the phased conversion of 61N-Provost should continue.

6.4.1 High Street Conversion (61N-Provost Phase 2)

The second phase of conversion for 61N-Provost covers High Street and completes the conversion of 61N-204.

- Rebuild to 3 phase and extend 25kV from Townsend Street (rail crossing will need to be obtained in advance)
- Convert High Street and branches back to D251-010
- Create new open point at D251-010
- Convert Trenton Road back to 61N to retire 61N-204

Figure 24 High Street Conversion (61N-Provost Phase 2)

6.4.2 Little Harbour Road Conversion (61N-Provost Phase 3)

The third phase of conversion for 61N-Provost begins to remove load from 61N-205 on Little Harbour Road.

- Rebuild Dover Avenue to 3 phase and move roadside
- Rebuild Little Harbour Road to 3 phase back to existing 3 phase
- Convert sections of Little Harbour Road, Almont Avenue and Fraser Street back to High Street
- Finish conversion of High Street

Figure 25 Little Harbour Road Conversion (61N-Provost Phase 3)

6.4.3 530N-MacLellan Mountain Road Conversion (Thorburn)

The 100kVA single phase transformer (530N-T1) on MacLellan Mountain Road is suspected to be at or near capacity. This small pocket of 4kV should be converted when resources are available. The conversion has no sequential effect on other conversions, so it can be advanced or deferred as required.

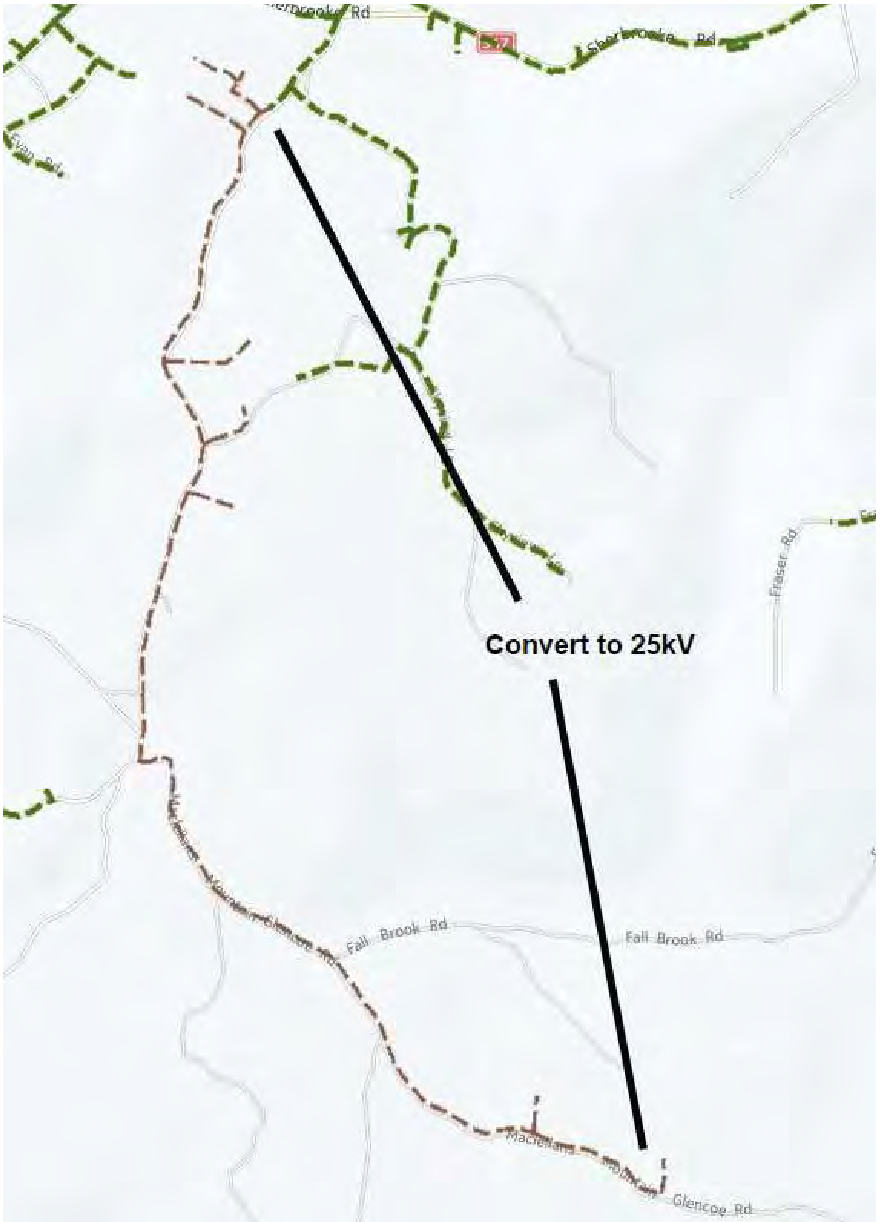


Figure 26 530N-MacLellan Mountain Road Conversion (Thorburn)

6.5 2020 Capital Year

In 2020, the conversion of 61N-205 should be mostly completed and the phased conversion of 528N should begin.

6.5.1 Frasers Mountain Road Conversion (61N-Provost Phase 4)

The fourth phase of conversion for 61N-Provost will cover Fraser Mountain Road.

- Rebuild and convert three phase from Little Harbour Road to Fraser Mountain Road
- Convert the long rural northwest extent of Fraser Mountain Road, dual voltage transformers could be used to limit outage time
- Convert Mountain Road in sections back to D251-013

Figure 27 Frasers Mountain Road Conversion (61N-Provost Phase 4)

6.5.2 Albert Street Conversion (528N-Granville Phase 1)

The first phase of conversion for 528N-Granville extends 25kV from Lorne Street onto Albert St and back to D251-018 on Washington Street.

Figure 28 **Albert Street Conversion (528N-Granville Phase 1)**

6.6 2021 Capital Year

In 2021, the conversion of 61N-205 and 528N-202 should be completed.

6.6.1 528N-202 Conversion (528N-Granville Phase 2)

The second phase of conversion for 528N-Granville completes the conversion of 528N-202. This conversion will break the tie between 528N-202 and 61N-202.

- Extend 25kV three phase on Marsh Street
- Convert feeder 528N-202 in sections back from

Figure 29 528N-202 Conversion (528N-Granville Phase 2)

6.6.2 Temperance Conversion (528N-Granville Phase 3)

The third phase of conversion for 528N-Granville (and 61N-Provost) covers Temperance Street, from Marsh Street back to 61N-Provost Street substation.

Figure 30 **Temperance Conversion (528N-Granville Phase 3)**

6.7 2022 Capital Year

In 2022, the conversion of 61N and 528N should be completed.

6.7.1 Archimedes Street Conversion (61N-Provost Phase 5)

The fifth phase of conversion for 61N-Provost covers Archimedes Street back to 61N substation.

- Extend 25kV three phase from Donald Street to Archimedes
- Convert Archimedes to 25kV in sections from Donald Street to 61N substation

Figure 31 Archimedes Street Conversion (61N-Provost Phase 5)

6.7.2 61N-201/528N-201 Conversions (528N-Granville Phase 4)

This final phase will complete the conversion of 61N and 528N to 25kV. Use the 61N-201 feeder to provide a 4kV source while the conversion is completed in sections back from 528N-Granville.

Figure 32 61N-201/528N-201 Conversions (528N-Granville Phase 4)

6.8 2023 Capital Year

The remainder of the 4kV conversions have been included in the 2023 capital year to maintain visibility. These areas are pockets of 4kV and have no impact on other conversions. They should be advanced or deferred as required.

6.8.1 534N-Duchess Avenue Conversion

This will complete the conversion of Duchess Avenue which began in 2014. It is unlikely this transformer will be overloaded, but deterioration issues will be present. This conversion could be divided into two phases.

Figure 33 534N-Duchess Avenue Conversion

6.8.2 519N-Drummond Road Conversion

This will complete the conversion of Drummond Road which began in 2012. It is unlikely this transformer will be overloaded, but deterioration issues will be present. This conversion could be divided into two phases.

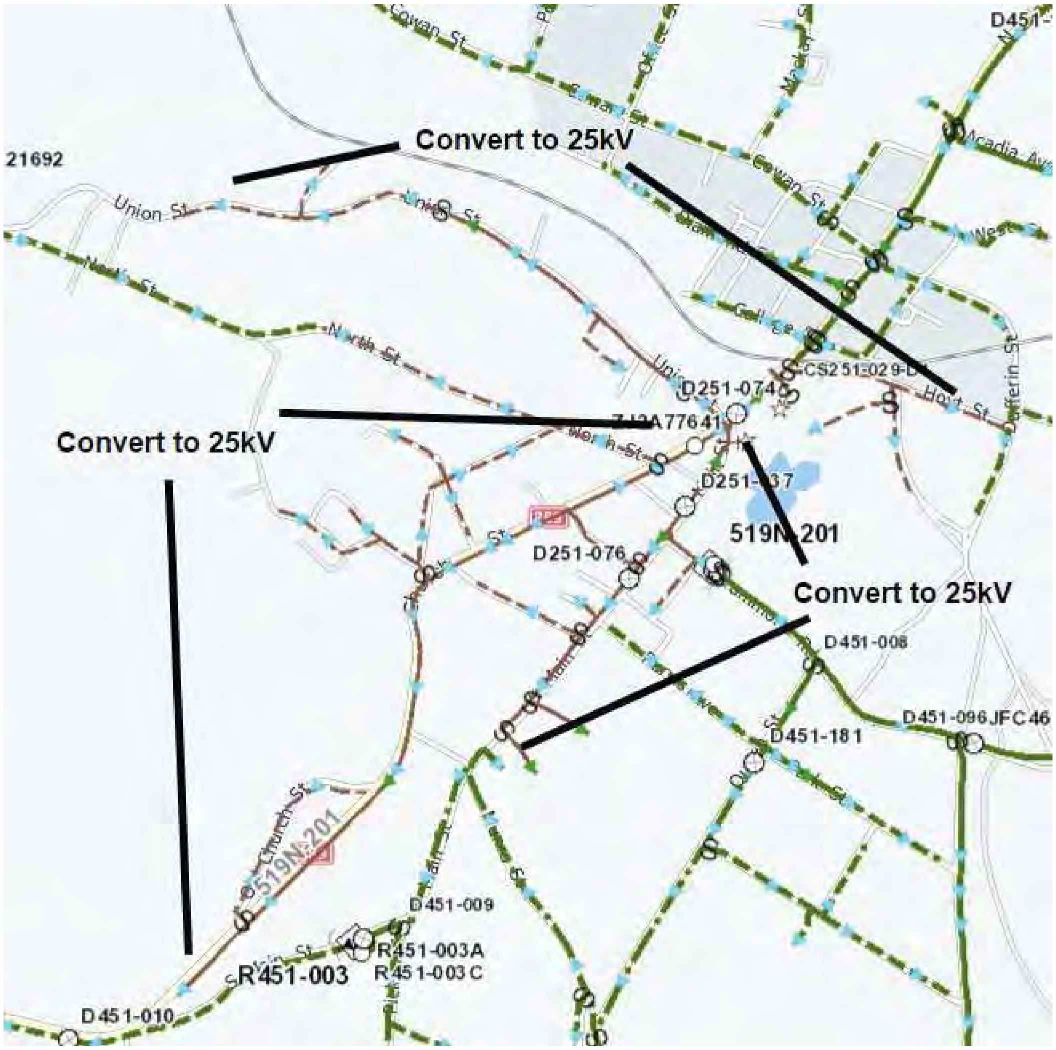


Figure 34 **519N-Drummond Road Conversion**

6.8.3 658N-Pictou Landing Conversion

This will complete the conversion of Pictou Landing 4kV. It is unlikely this transformer will be overloaded, but deterioration issues will be present.

Figure 35 658N-Pictou Landing Conversion

6.8.4 536N-Woodburn Conversion

This will complete the conversion of Pictou Landing 4kV. It is unlikely this transformer will be overloaded, but deterioration issues will be present. With this conversion, the voltage regulator E2A01301 and step up transformer 547N-T1 can be removed.

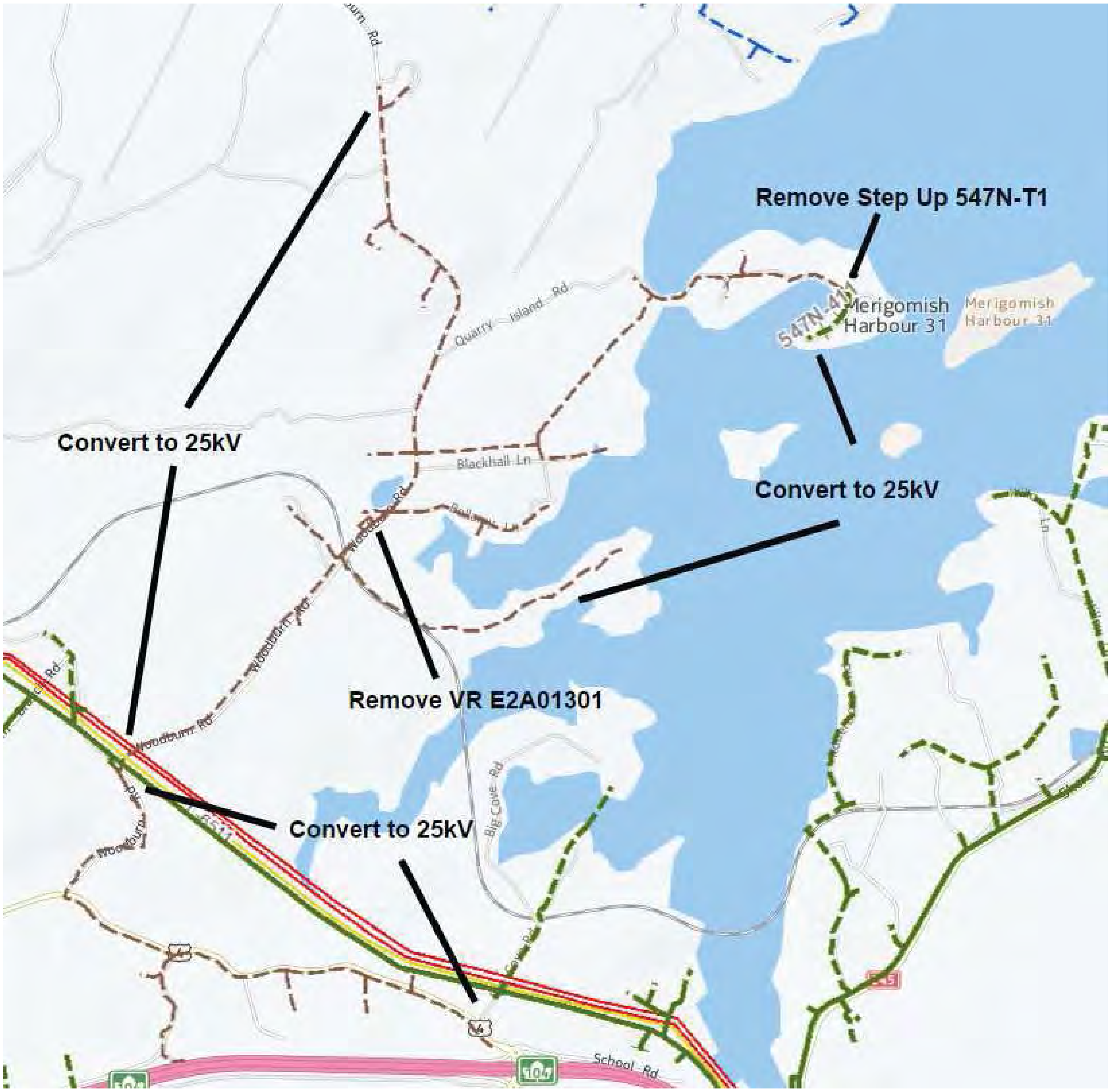


Figure 36 **536N-Woodburn Conversion**

APPENDIX A

System Operating Diagrams

Pages 53-54 have been removed due to confidentiality.

APPENDIX B

Load History and Forecast

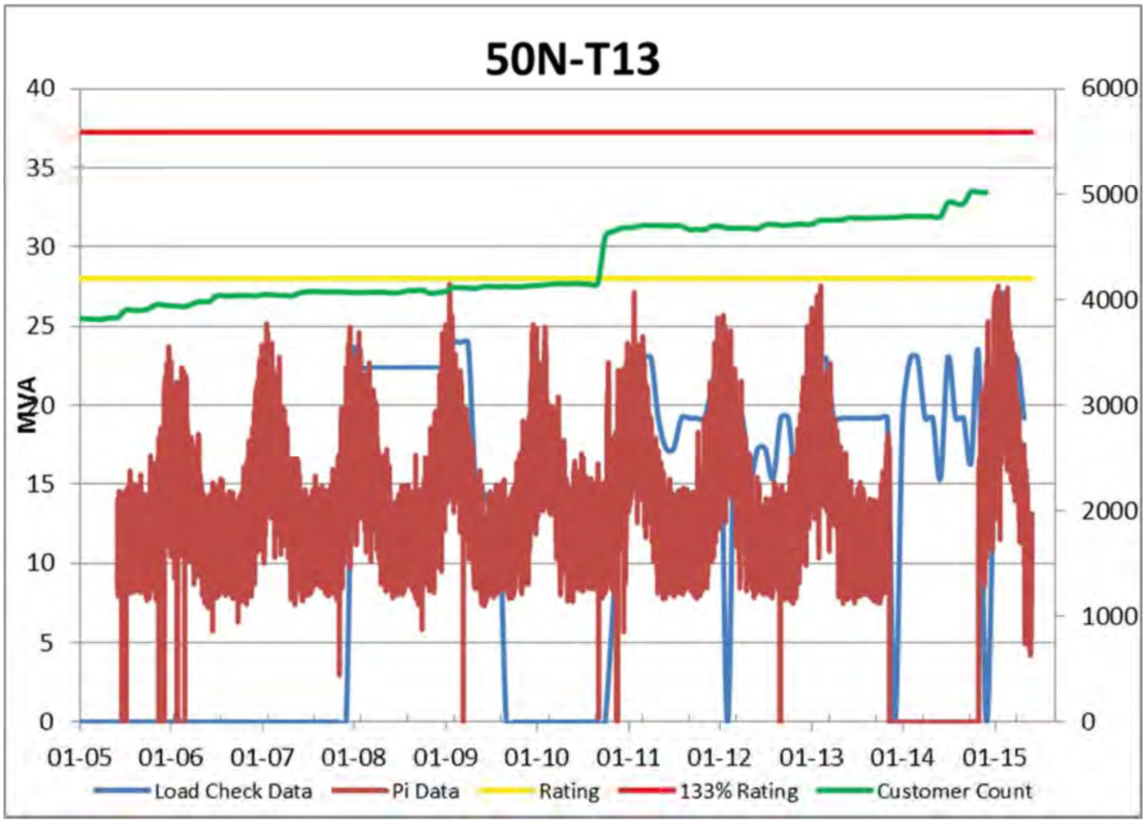


Figure 39 **50N-T13 Load History**

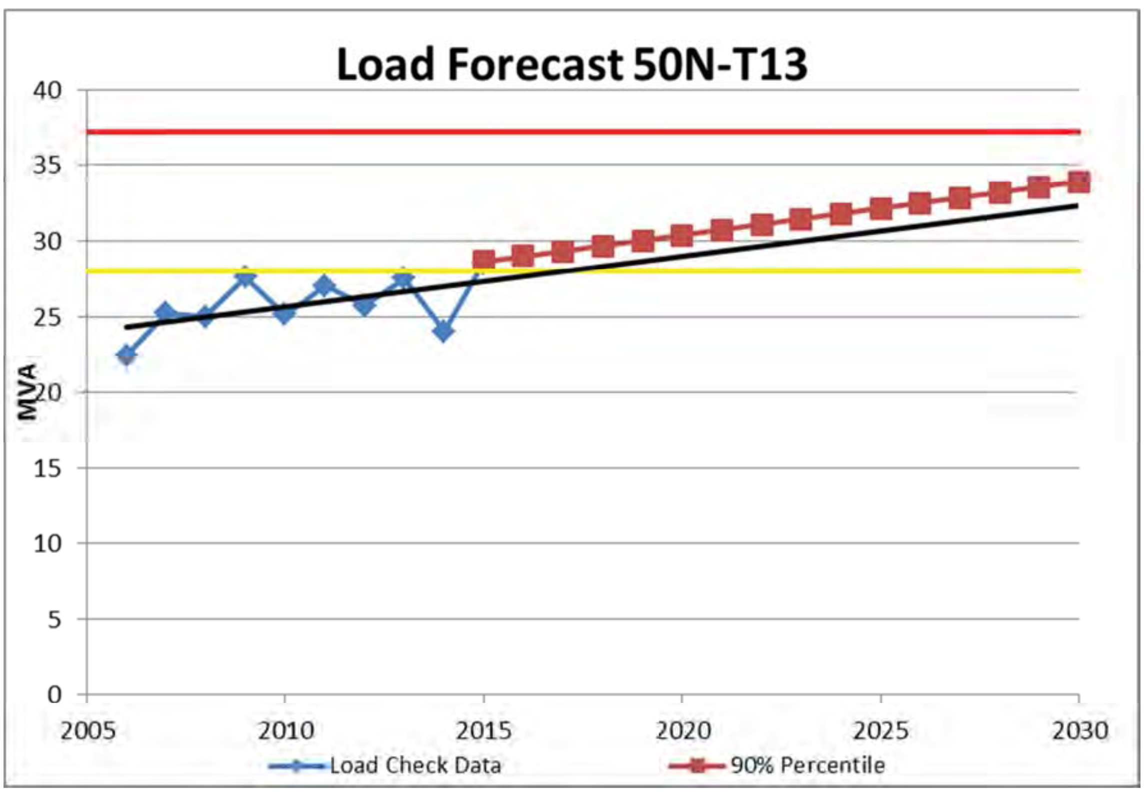


Figure 40 **50N-T13 Load Forecast**

Appendix B: Load History and Forecast

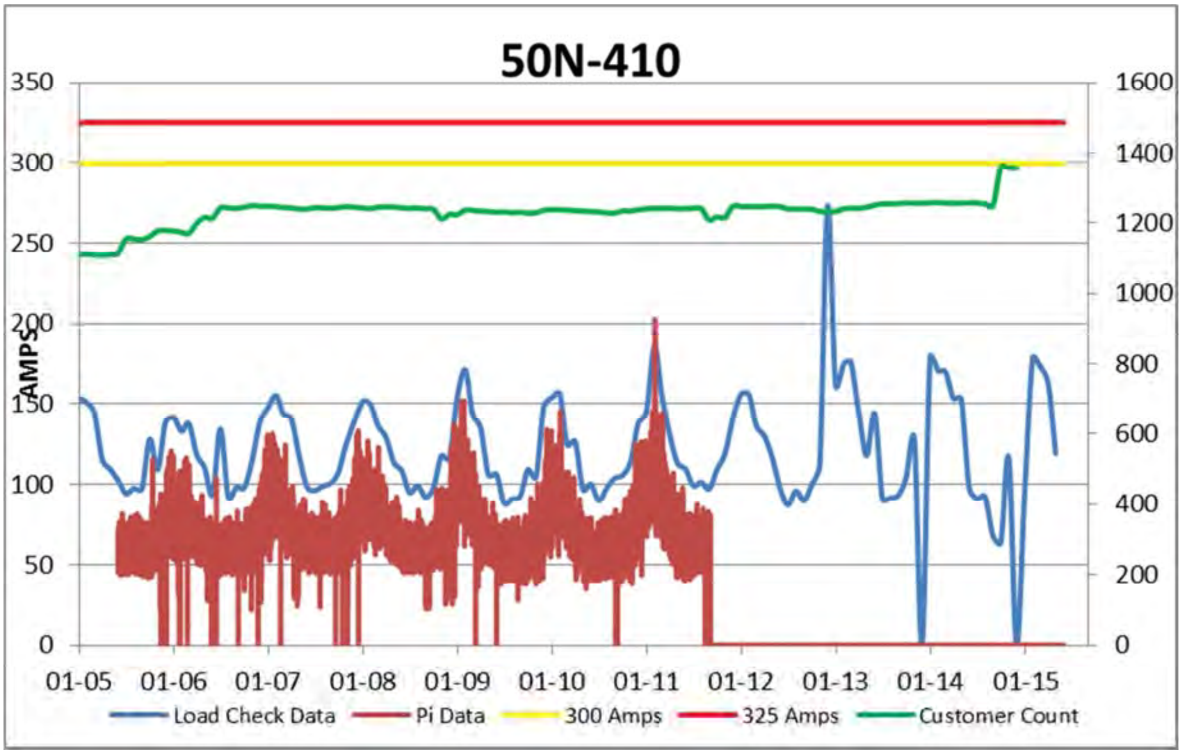


Figure 41 **50N-410 Load History**

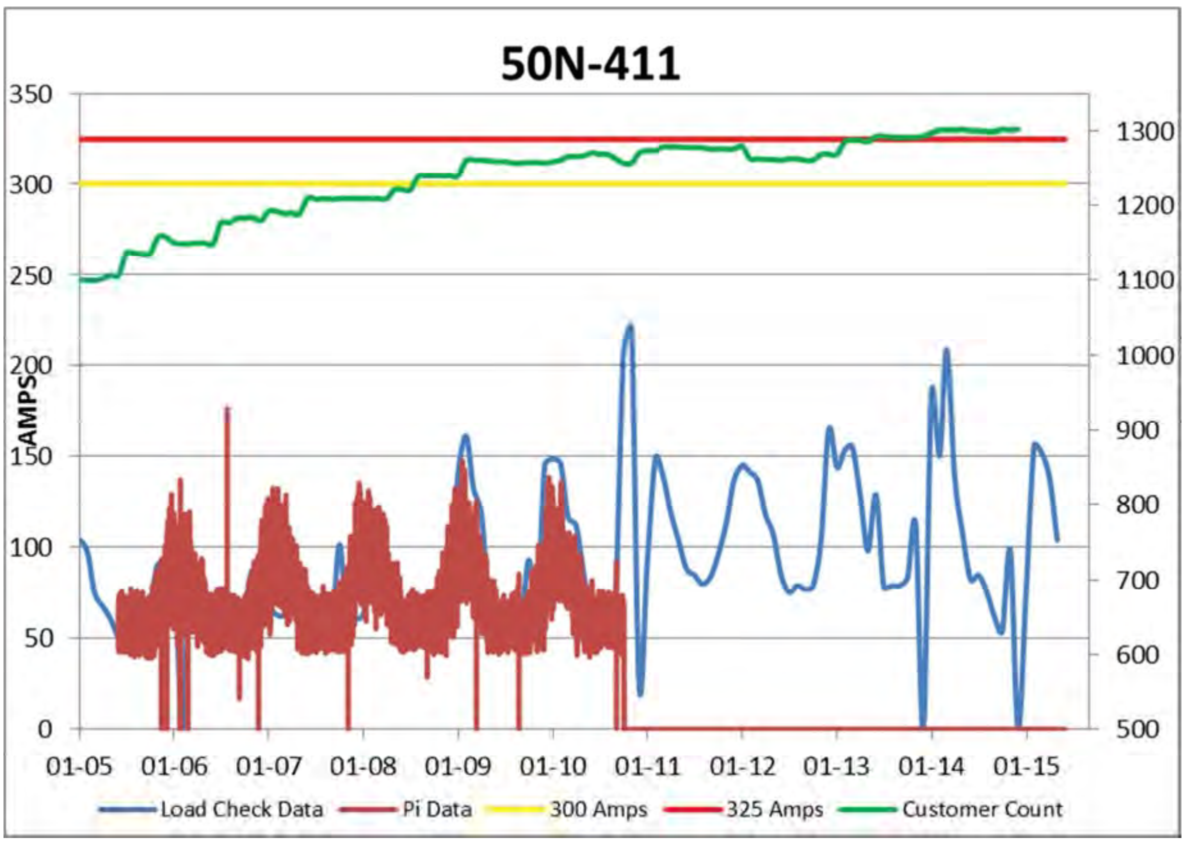


Figure 42 **50N-411 Load History**

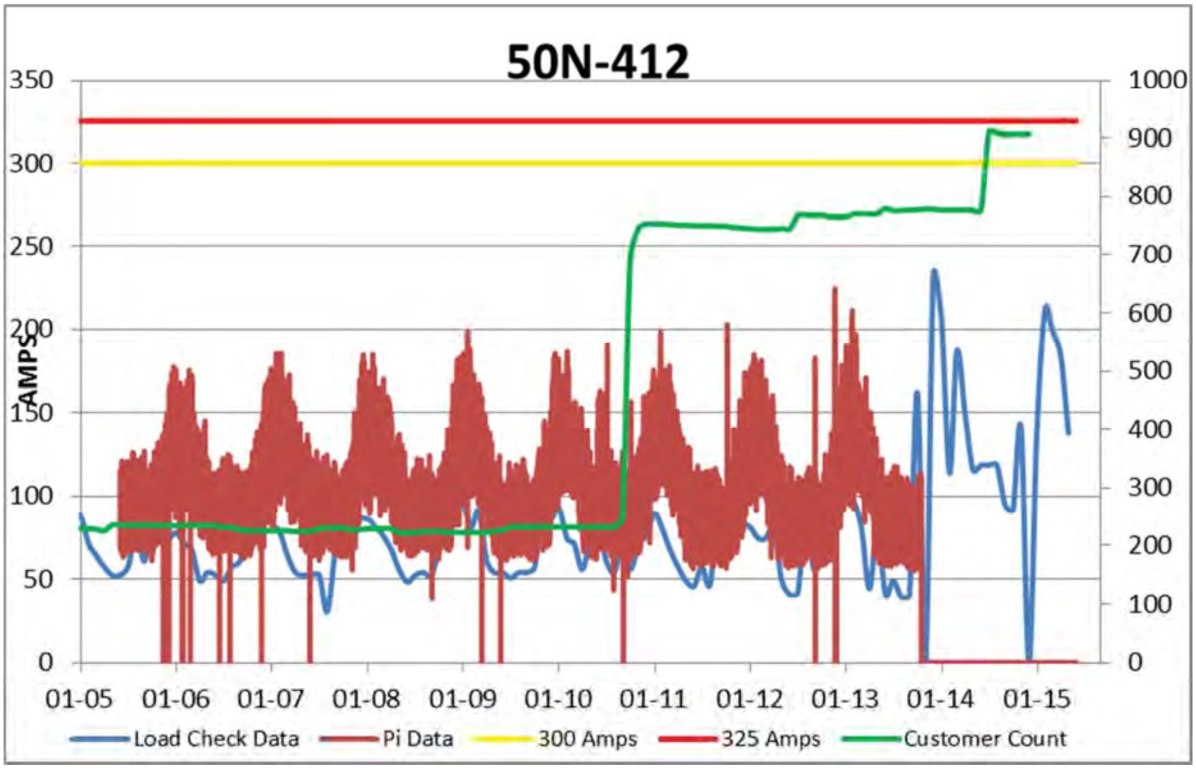


Figure 43 50N-412 Load History

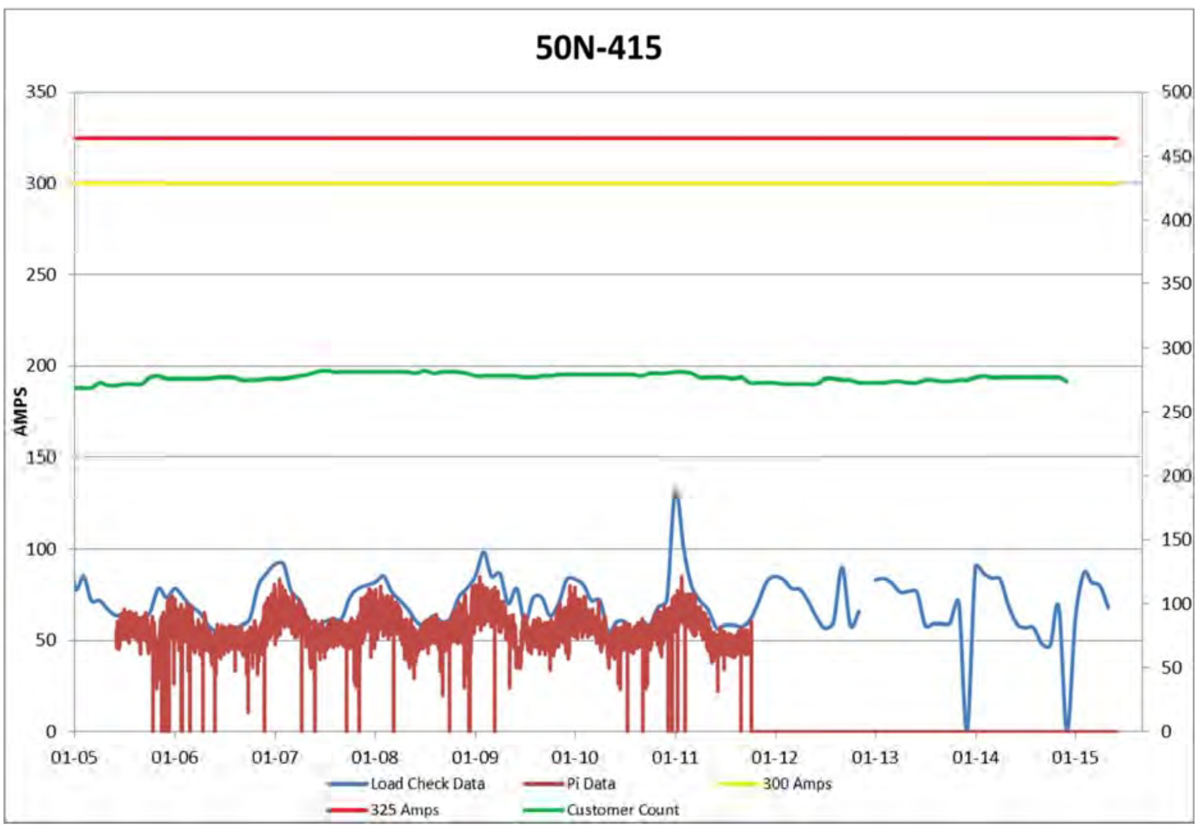


Figure 44 50N-415 Load History

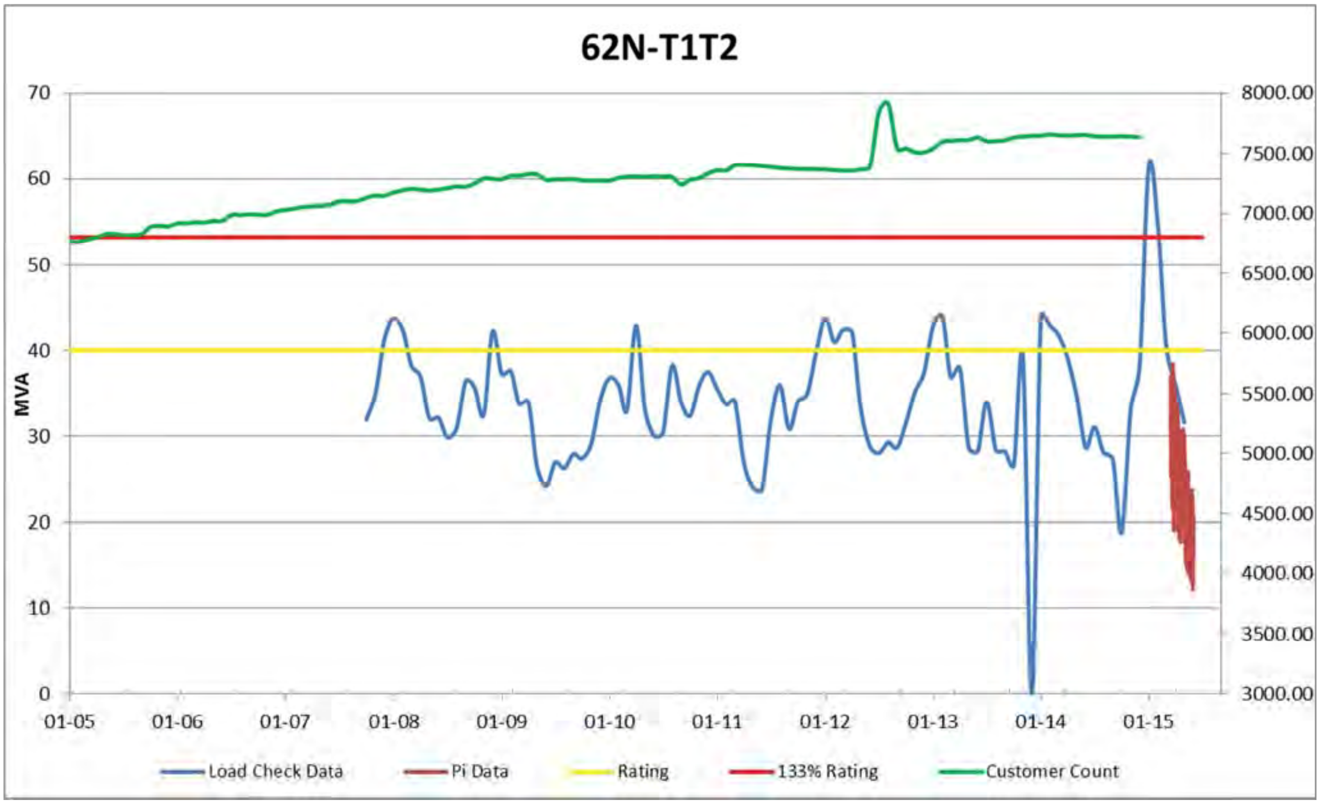


Figure 45 **62N-T1T2 Load History**

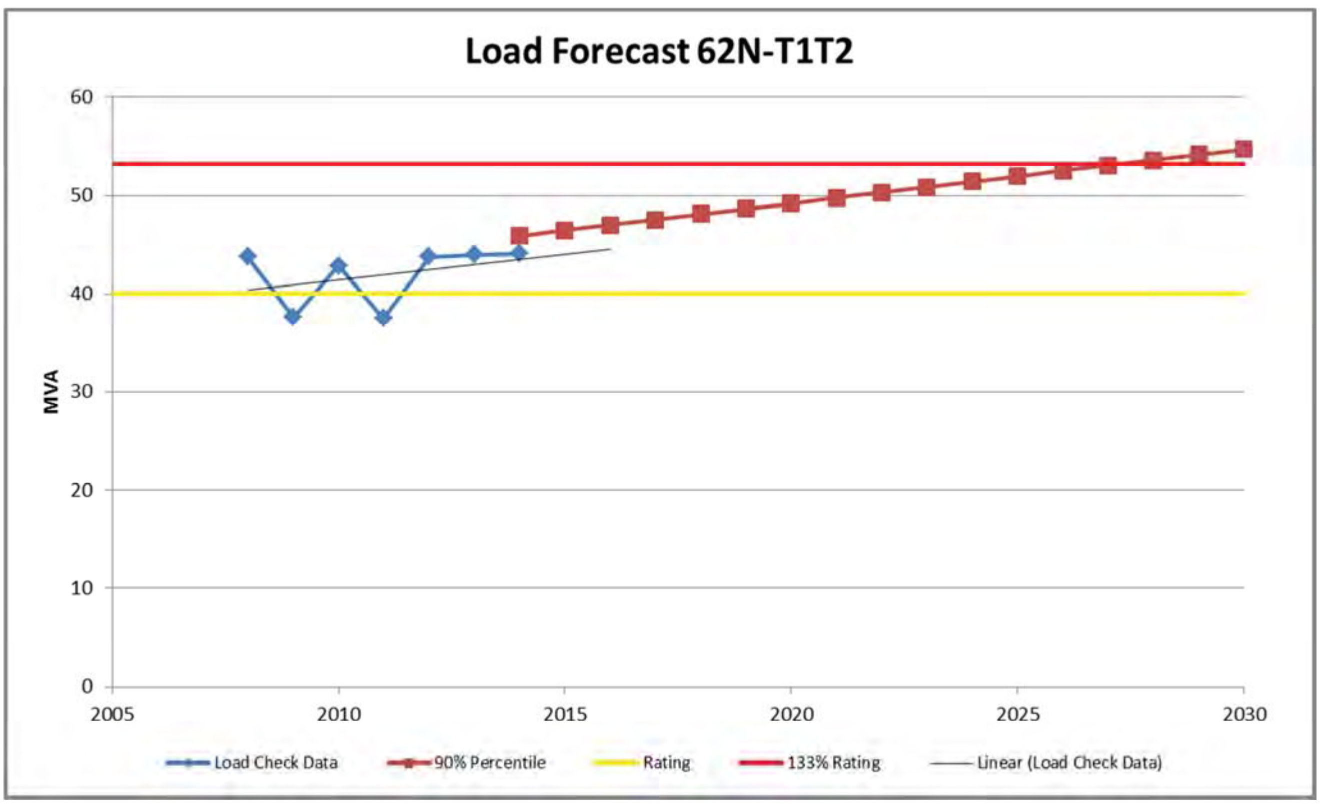


Figure 46 **62N-T1T2 Load Forecast**

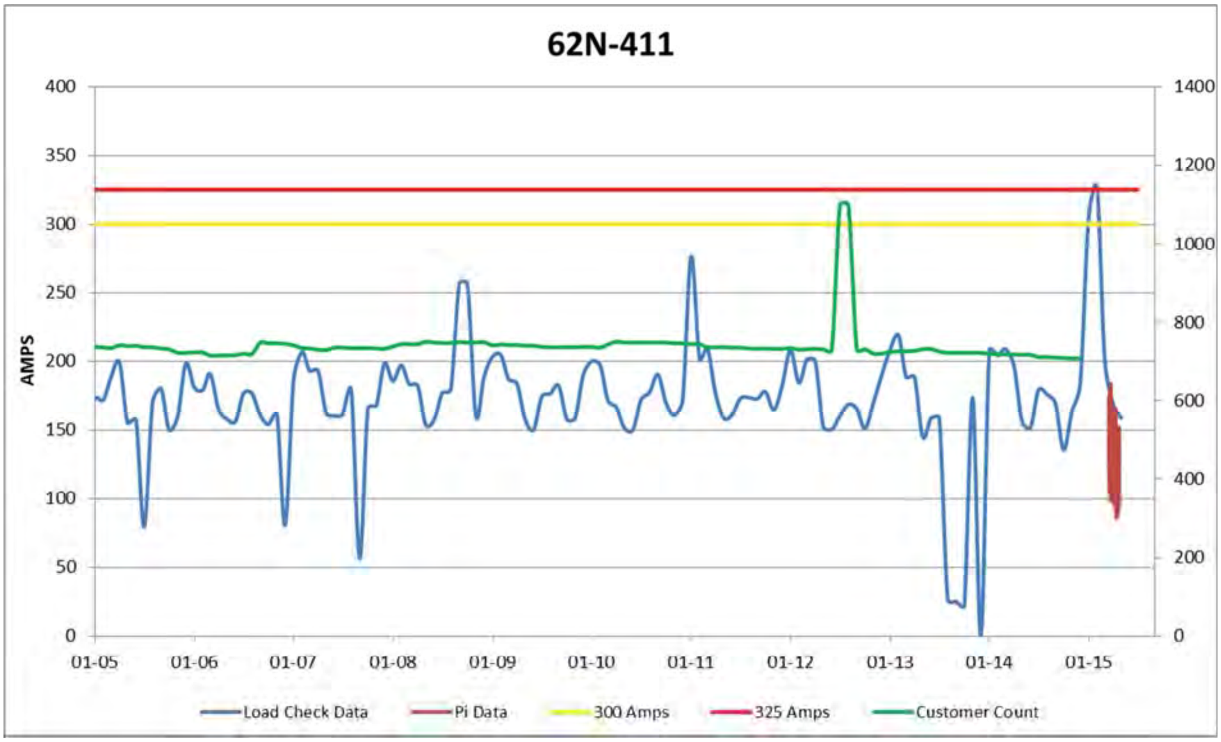


Figure 47 **62N-411 Load History**

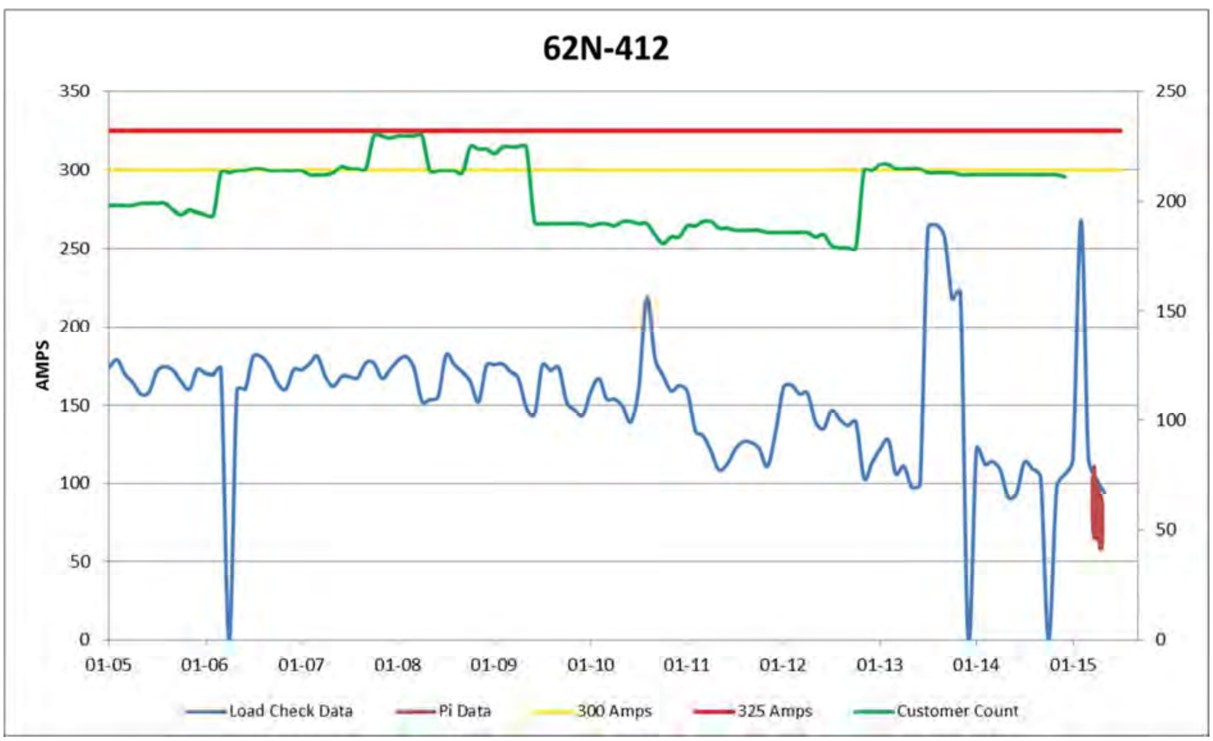


Figure 48 **62N-412 Load History**

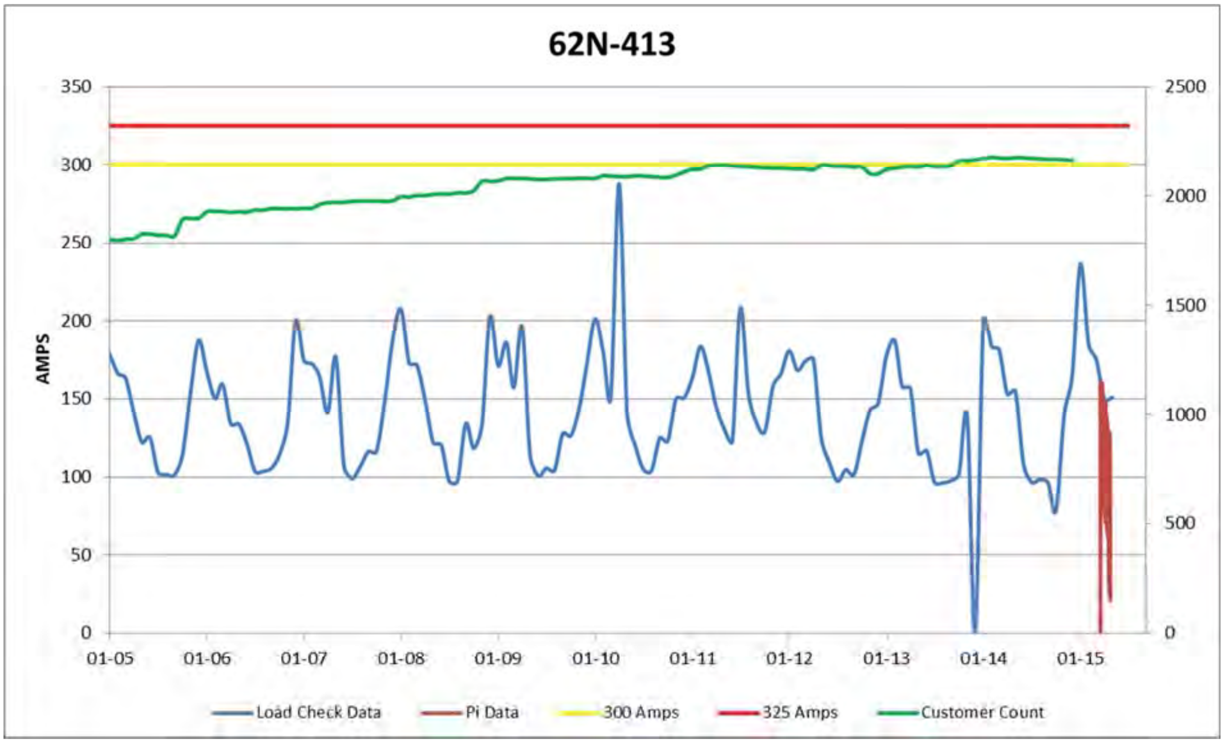


Figure 49 **62N-411 Load History**

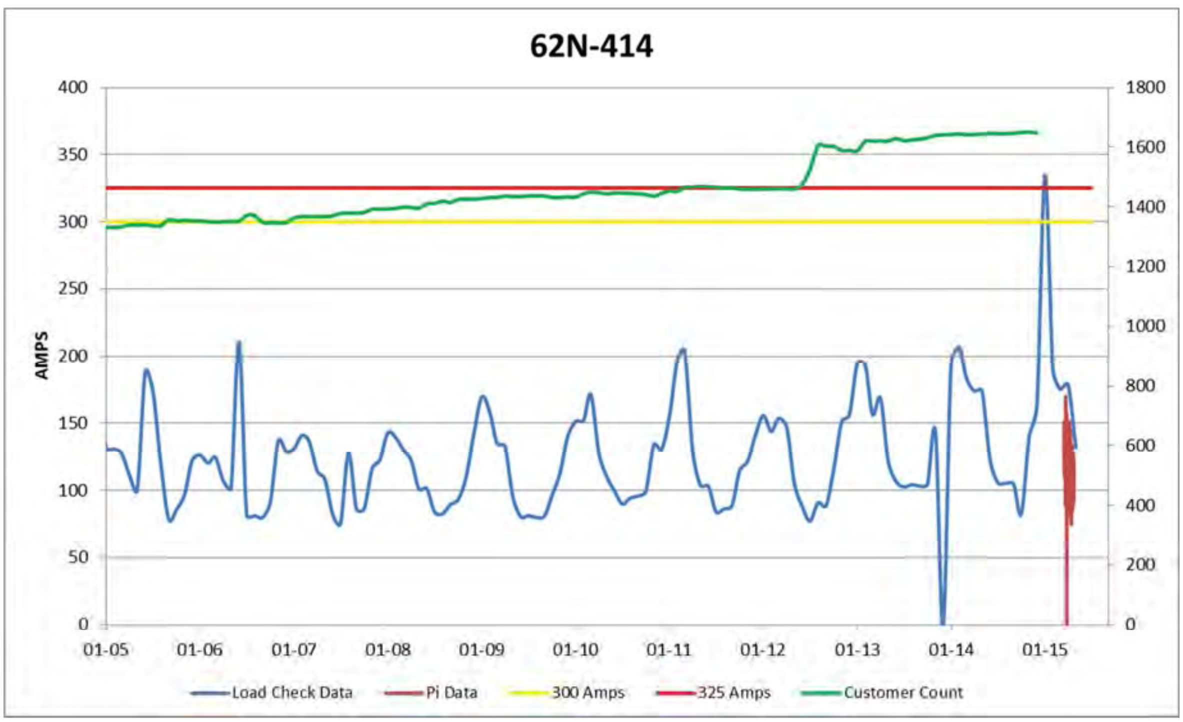


Figure 50 **62N-411 Load History**

Appendix B: Load History and Forecast

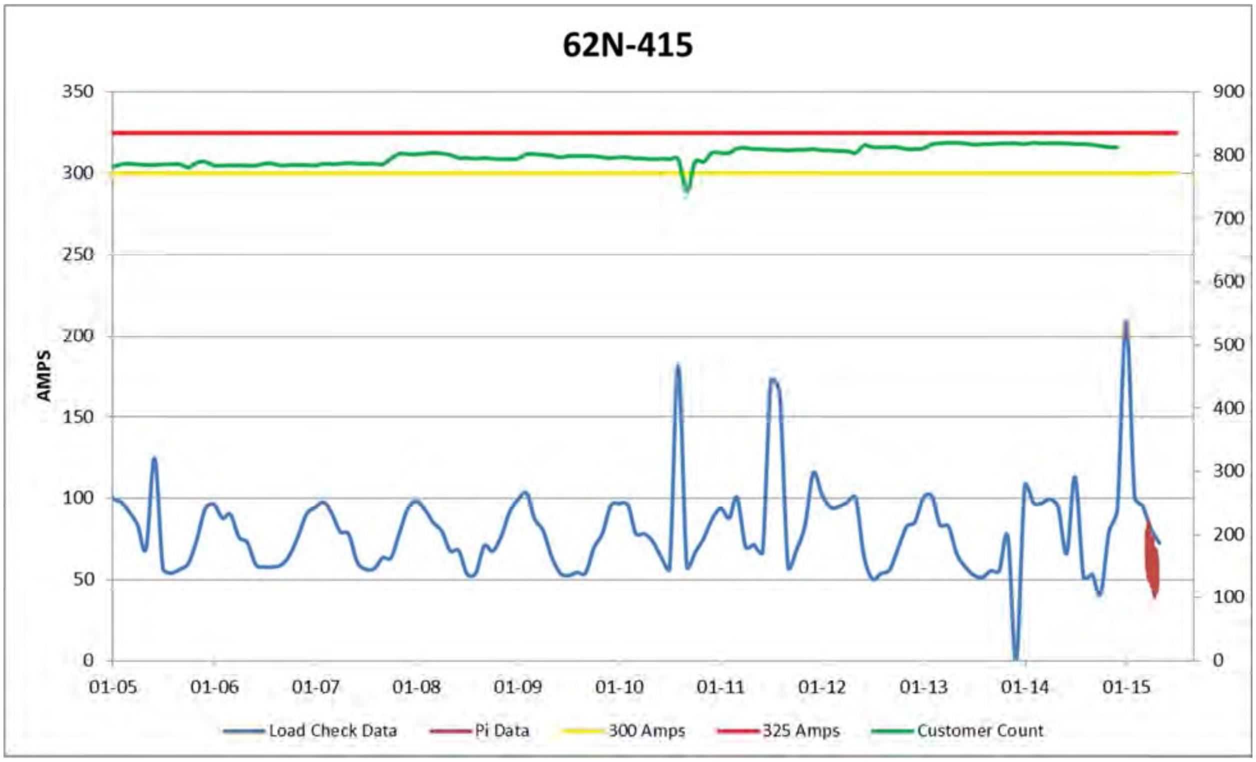


Figure 51 **62N-411 Load History**

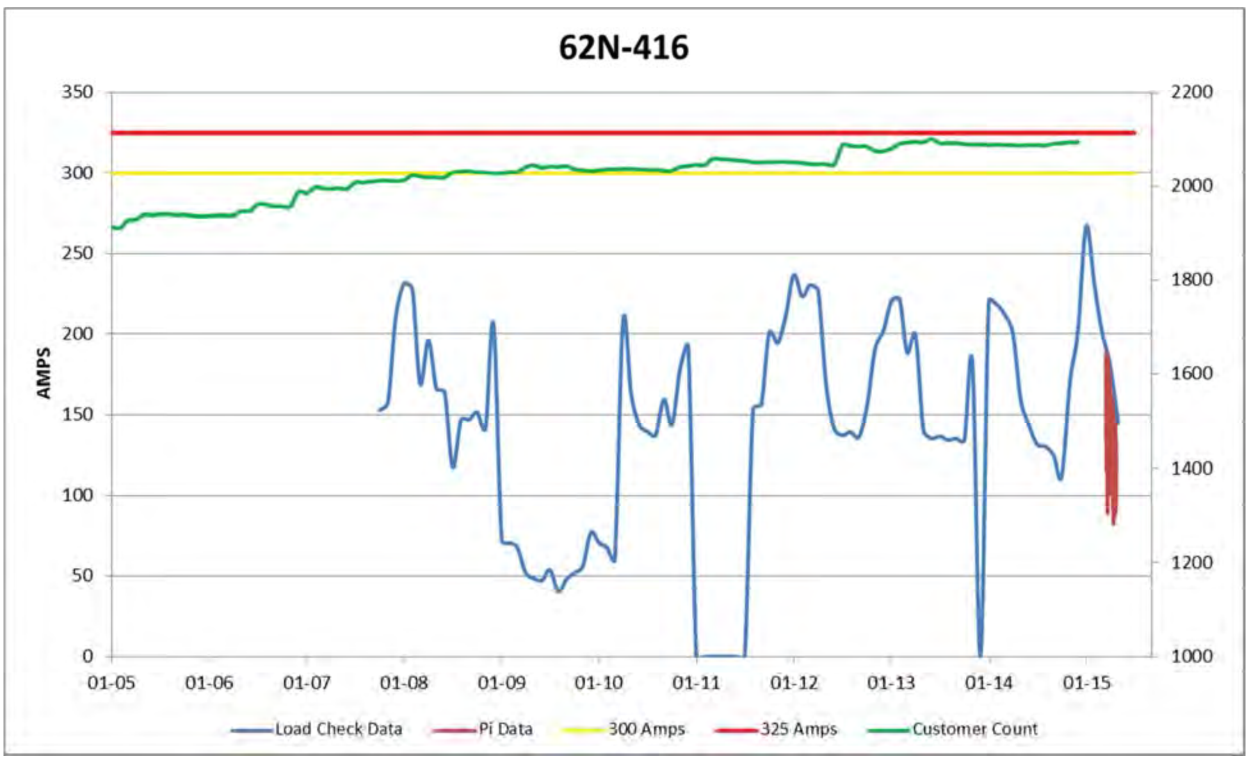


Figure 52 **62N-411 Load History**

APPENDIX C

Economic Analysis

532N-Elm St and 64N-Lourdes Alternatives

Summary of Alternatives

Stellarton 4kV
Summary of Alternatives

Nova Scotia POWER An Emera Company

Division :		**Date :**	**13-Aug-15**
Department :	Distribution Planning	**CI Number:**	
Originator :	Brendon Henderson	**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Convert to 25kV	6.07%	1,672,608	-1,275,336	1	-8.03%	0.0 years
B	Three Stepdown Locations	6.07%	1,768,459	-1,465,093	2	-11.17%	0.0 years
C	Two Padmounts	6.07%	1,924,374	-1,823,638	3	#NUM!	0.0 years
	0	NA	NA	NA	NA	#NUM!	0.0 years

Recommendation :

The conversion to 25kV has a greater up front cost, but is the most economical choice in the long term. Further intangible benefits for converting are explained in full planning study. This analysis is valid for all 4kV pockets in Stellarton area, given their similarities.

Notes/Comments :

Convert to 25kV

Complete a phased conversion of all 4kV plant to 25kV. Retire 532N-Elm and 64N-Lourdes in 2018.

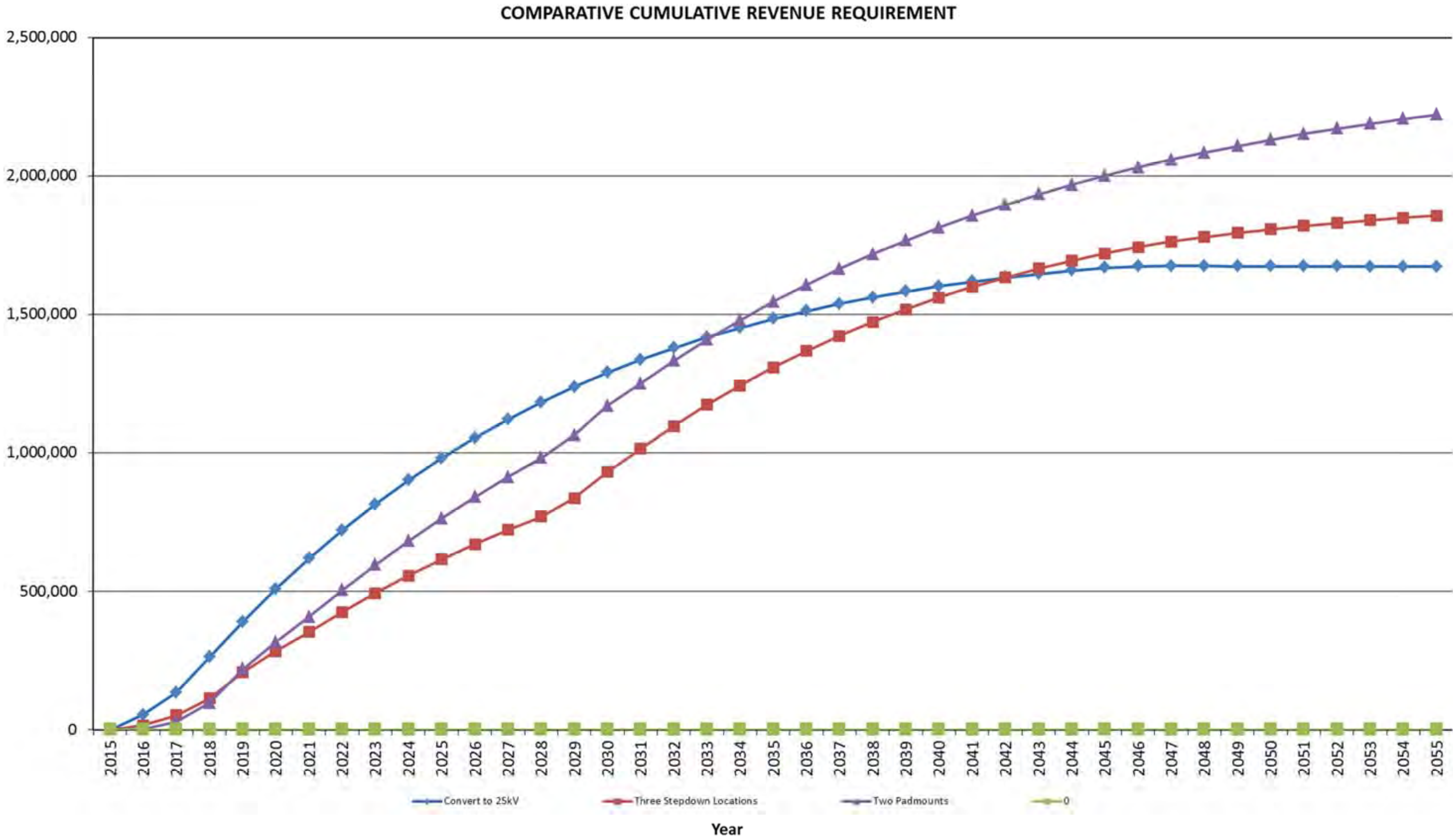
Three Stepdown Locations

Install new platform mounted stepdown transformers to remove load from 4kV substations to allow retirement of 532N-Elm and 64N-Lourdes in 2018. This delays the conversion to 25kV by 15 years.

Two Padmounts

Replace existing 4kV substations with padmount transformers. Both 532N-Elm and 64N-Lourdes replaced by 2018. This delays the conversion to 25kV by 15 years.

NPV Comparison



Alternative A- Convert to 25kV

Stellarton 4kV
Convert to 25kV

Nova Scotia POWER An Emera Company

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item | Add Capital
Project Description | Delete Item

Select:
In-Service Month: January
In-Service Year: 2016

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Capital Invested																	
1. Elm St - Terrace		293,760															
2. Elm St - North Mitchell			262,181														
3. Elm St - South Mitchell			374,544														
4. Lourdes - View St		512,448															
5. Lourdes - Stellarton Rd				299,897													
6.																	
7.																	
8.																	
9.																	
10.																	
11.																	
12.																	
13.																	
14.																	
15.																	
16.																	
17.																	
18.																	
19.																	
20.																	
Total Direct Capital Invested by Year		806,208	636,725	299,897													
AFUDC (entered as a positive value)																	
AO (entered as a positive value)																	
Total Indirect Capital Invested by Year																	
Total Capital Invested by Year		**806,208**	**636,725**	**299,897**													

*This alternative was used as the baseline for operating costs, additional cost is shown for other alternatives.

Alternative B- Three Stepdown Locations

Stellarton 4kV
Three Stepdown Locations

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item | Add Capital
Project Description | Delete Item

Select:
In-Service Month: January
In-Service Year: 2016

Capital Invested	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
1. Terrace St Stepdown		163,200															
2. Elm St Stepdown			166,464														
3. Lourdes Stepdown				275,914													
4. Terrace Conversion															380,010		
5. North Mitchell Conversion																339,159	
6. South Mitchell Conversion																484,513	
7. View St Conversion															662,906		
8. Stellarton Rd Coversion																	387,950
9.																	
10.																	
11.																	
12.																	
13.																	
14.																	
15.																	
16.																	
17.																	
18.																	
19.																	
20.																	
Total Direct Capital Invested by Year	-	163,200	166,464	275,914	-	-	-	-	-	-	-	-	-	-	1,042,916	823,672	387,950
AFUDC (entered as a positive value)																	
AO (entered as a positive value)																	
Total Indirect Capital Invested by Year	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital Invested by Year		**163,200**	**166,464**	**275,914**											**1,042,916**	**823,672**	**387,950**

Expense

Description		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Stepdown Transformation Losses	Cost	1,310	1,241	1,226	1,174	2,827	2,027	1,981	2,571	2,623	2,621	2,716	2,705	2,765	2,848	2,888	2,975	3,072
	$/Unit		3	6	9	9	9	9	9	9	9	9	9	9	9	9	9	
	Expense-Subtotal		3,722	7,354	10,570	25,441	18,240	17,829	23,139	23,611	23,592	24,448	24,345	24,889	25,632	25,993	26,773	
2. 532N 4kV Distribution Tx Losses (less 25kV	Cost	5,244	4,985	4,933	4,743	9,949	7,487	7,364	9,589	9,750	9,764	10,095	10,092	10,339	10,668	10,827	11,169	11,556
	$/Unit		0.33	0.66	1	1	1	1	1	1	1	1	1	1	1	1	1	
	Expense-Subtotal		1,645	3,256	4,743	9,949	7,487	7,364	9,589	9,750	9,764	10,095	10,092	10,339	10,668	10,827	11,169	
3. 64N 4kV Distribution Tx Losses (less 25kV Distribution losses)	Cost	4,899	4,654	4,605	4,425	9,162	6,930	6,820	8,908	9,052	9,067	9,373	9,374	9,607	9,916	10,065	10,387	10,751
	$/Unit			0.5	1	1	1	1	1	1	1	1	1	1	1	1	1	
	Expense-Subtotal			2,302	4,425	9,162	6,930	6,820	8,908	9,052	9,067	9,373	9,374	9,607	9,916	10,065	10,387	
4. 532N 4kV Conductor Losses	Cost	1,624	1,544	1,528	1,469	4,232	2,858	2,773	3,494	3,591	3,578	3,720	3,683	3,749	3,842	3,892	3,992	4,101
	$/Unit		0.33	0.66	1	1	1	1	1	1	1	1	1	1	1	1	1	
	Expense-Subtotal		509	1,008	1,469	4,232	2,858	2,773	3,494	3,591	3,578	3,720	3,683	3,749	3,842	3,892	3,992	
5. 64N 4kV Conductor Losses	Cost	6,829	6,490	6,422	6,174	17,790	12,016	11,658	14,689	15,095	15,044	15,638	15,483	15,759	16,153	16,361	16,784	17,242
	$/Unit			0.5	1	1	1	1	1	1	1	1	1	1	1	1	1	
	Expense-Subtotal			3,211	6,174	17,790	12,016	11,658	14,689	15,095	15,044	15,638	15,483	15,759	16,153	16,361	16,784	

Alternative C- Two Padmounts

Stellarton 4kV
Two Padmounts

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item | Add Capital
Project Description | Delete Item

Select:
In-Service Month: January
In-Service Year: 2016

Capital Invested	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
1. Elm St Padmount			436,968														
2. Lourdes Stepdown				445,707													
3. Terrace Conversion															380,010		
4. North Mitchell Conversion																339,159	
5. South Mitchell Conversion																484,513	
6. View St Conversion															662,906		
7. Stellarton Rd Coversion																	387,950
8.																	
9.																	
10.																	
11.																	
12.																	
13.																	
14.																	
15.																	
16.																	
17.																	
18.																	
19.																	
20.																	
Total Direct Capital Invested by Year	-	-	436,968	445,707	-	-	-	-	-	-	-	-	-	-	1,042,916	823,672	387,950
AFUDC (entered as a positive value)																	
AO (entered as a positive value)																	
Total Indirect Capital Invested by Year	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital Invested by Year			**436,968**	**445,707**											**1,042,916**	**823,672**	**387,950**

Expense

	Description		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Stepdown Transformation Losses	Cost	10,456	9,904	9,784	9,377	22,770	16,274	15,902	20,607	21,035	21,016	21,781	21,684	22,164	22,820	23,140	23,829	24,600
		$/Unit			1.0	2	2	2	2	2	2	2	2	2	2	2	2	2	
		Expense-Subtotal			9,784	18,755	45,540	32,549	31,804	41,215	42,070	42,032	43,563	43,368	44,327	45,639	46,280	47,659	
2.	532N 4kV Distribution Tx Losses (less 25kV Distribution Losses)	Cost	5,244	4,985	4,933	4,743	9,949	7,487	7,364	9,589	9,750	9,764	10,095	10,092	10,339	10,668	10,827	11,169	11,556
		$/Unit		0.33	0.66	1	1	1	1	1	1	1	1	1	1	1	1	1	
		Expense-Subtotal		1,645	3,256	4,743	9,949	7,487	7,364	9,589	9,750	9,764	10,095	10,092	10,339	10,668	10,827	11,169	
3.	64N 4kV Distribution Tx Losses (less 25kV Distribution losses)	Cost	4,899	4,654	4,605	4,425	9,162	6,930	6,820	8,908	9,052	9,067	9,373	9,374	9,607	9,916	10,065	10,387	10,751
		$/Unit			0.5	1	1	1	1	1	1	1	1	1	1	1	1	1	
		Expense-Subtotal			2,302	4,425	9,162	6,930	6,820	8,908	9,052	9,067	9,373	9,374	9,607	9,916	10,065	10,387	
4.	532N 4kV Conductor Losses	Cost	1,624	1,544	1,528	1,469	4,232	2,858	2,773	3,494	3,591	3,578	3,720	3,683	3,749	3,842	3,892	3,992	4,101
		$/Unit		0.33	0.66	1	1	1	1	1	1	1	1	1	1	1	1	1	
		Expense-Subtotal		509	1,008	1,469	4,232	2,858	2,773	3,494	3,591	3,578	3,720	3,683	3,749	3,842	3,892	3,992	
5.	64N 4kV Conductor Losses	Cost	6,829	6,490	6,422	$6,173.71	$17,789.85	$12,015.86	$11,657.93	$14,689.29	$15,095.17	$15,043.77	$15,637.66	$15,483.20	$15,759.03	$16,153.20	$16,360.88	$16,783.88	$17,242.04
		$/Unit			0.5	1	1	1	1	1	1	1	1	1	1	1	1	1	
		Expense-Subtotal			3,211	6,174	17,790	12,016	11,658	14,689	15,095	15,044	15,638	15,483	15,759	16,153	16,361	16,784	
6.	Monthly Subchecks	Cost				1,146	1,169	1,192	1,216	1,241	1,265	1,291	1,317	1,343	1,370	1,397	1,425	1,454	
		$/Unit				1	2	2	2	2	2	2	2	2	2	2	2	2	
		Expense-Subtotal				1,146	2,338	2,384	2,432	2,482	2,530	2,582	2,634	2,686	2,740	2,794	2,850	2,908	
7.	B Maintenance	Cost				637	649	662	676	689	703	717	731	746	761	776	792	808	
		$/Unit				1	2	2	2	2	2	2	2	2	2	2	2	2	
		Expense-Subtotal				637	1,298	1,324	1,352	1,378	1,406	1,434	1,462	1,492	1,522	1,552	1,584	1,616	
8.	C Maintenance (annualized)	Cost				1,327	1,353	1,380	1,408	1,436	1,465	1,494	1,524	1,554	1,585	1,617	1,649	1,682	
		$/Unit				1	2	2	2	2	2	2	2	2	2	2	2	2	
		Expense-Subtotal				1,327	2,706	2,760	2,816	2,872	2,930	2,988	3,048	3,108	3,170	3,234	3,298	3,364	
9.	Grounds upkeep	Cost				2,653	2,706	2,760	2,815	2,872	2,929	2,988	3,047	3,108	3,171	3,234	3,299	3,365	
		$/Unit				1	2	2	2	2	2	2	2	2	2	2	2	2	
		Expense-Subtotal				2,653	5,412	5,520	5,630	5,744	5,858	5,976	6,094	6,216	6,342	6,468	6,598	6,730	

APPENDIX D

Cost of Losses

D1. Station Transformer Losses

The losses of existing substation stepdown transformers were estimated using similar transformer test data as shown below. Note that the loss values of these transformers were not used in the EAM, since they do not remain in service for any of the alternatives.

Table 7 4kV Substation Transformer Loss Approximation

Station Transformers					
Station	**Man**	**Size (MVA)**	**Load (MVA)**	**LL (kW)**	**NLL (kW)**
61N-T1	Pioneer	5	4.16	30.45	10.715
528N-T1	GE	5	1.62	30.45	10.715
532N-T41	Brown Boveri	1	0.99	6.83	3.4
64N-T1	Packard	1	0.98	6.83	3.4

Table 8 Comparable 4kV Transformer Loss Data

Similar Transformers Test Data							
Location	**Station**	**Man**	**MVA**	**HV (kV)**	**LV (kV)**	**LL (kW)**	**NLL (kW)**
Tufts	36D-T1	Ferranti	0.9	22	4	6.83	3.4
HRM	1H-T51	Moloney	2	22.8	4	9.46	7.14
HRM	1H-T13/14	Brown Boveri	5	23	4	36.6	7.93
HRM	1H-T71	Bonar Long	5	22.8	4	24.3	13.5

D2. Stepdown Transformer Losses

The losses of the platform mounted stepdown transformers proposed in Alternative B were estimated using the document 'Old Transformer Losses' which is available on the Distribution Planning SharePoint under COST ESTIMATES.

Table 9 500kVA Stepdown Transformer Loss Approximation

Stepdown Transformers (500kVA)		
Station	**LL (kW)**	**NLL (kW)**
500kVA S.D.	3.57	0.96

D3. Padmount Transformer Losses

The losses of the padmount transformers proposed in Alternative C was estimated using the datasheet from a similar transformer installed on NSPI's system, 700S-T31.

Table 10 700S-T31 Padmount Loss Data

Padmount Transformers				
Station	**Man**	**Size (MVA)**	**LL (kW)**	**NLL (kW)**
700S	CARTE	5	29.488	7.32

D4. Distribution Transformer Losses

The difference in losses between existing 4kV and new 25kV distribution transformers was determined. This information was obtained from the document 'Historical Losses of Standard Design' and '2015 NSPI CARTE Transformers Data', both available on the Distribution Planning SharePoint site under COST ESTIMATES. In the tables below, 'New' refers to the CARTE 25kV transformers we would buy today and 'Old' refers to 4kV transformers bought circa 1960. The number of distribution transformers currently fed from 532N-Elm and 64N-Lourdes was used to estimate the loss savings resulting from conversion.

Table 11 Distribution Transformer Loss Data

Dist. Transformer Test Data			
	Size (kVA)	LL (W)	NLL (W)
New	25	368	56
	50	569	94.5
Old	25	505	130
	50	819	187

Table 12 Distribution Transformer Loss Savings from Conversion

Distribution Transformers									
			Old 4kV Tx		New 25kV Tx		Load Loss Savings		
Station	# of 50kVA	# of 25kVA	LL (W)	NLL (W)	LL (W)	NLL (W)	LL (kW)	NLL (kW)	Total (kW)
532N	51	18	50859	11877	35643	5827.5	15.22	6.05	21.27
64N	28	44	45152	10956	32124	5110	13.03	5.85	18.87

D5. Conductor Losses

The difference in conductor losses, before and after conversion to 25kV, was determined using CYME software. The existing system configurations for 532N-Elm and 64N-Lourdes were modelled at 4kV as well as 25kV. The built-in tool was used to calculate conductor losses. The following table summarizes the results.

Table 13 Line Losses Before and After Conversion

Line Losses from CYME after Conversions				
		Before (kW)	After (kW)	Savings (kW)
64N-Lourdes	201	34	0.83	33.17
532N-Elm	201	8.1	0.21	7.89

D6. The Cost of Losses

Alternative A was used as the baseline for losses in the EAM. The additional losses that would result from selecting Alternative B and Alternative C were determined in kilowatts. These values were converted to dollars using the tables found in '2015 Cost of Losses', available on the Distribution Planning SharePoint site under COST ESTIMATES. The future cost of losses at 31% loss factor was used for stepdown transformation and conductor losses. The future cost of losses at 12% loss factor was used for distribution transformers servicing customers. For background information, see report '254-0807-A48 Cost of NSPI Distribution System Losses'.

Table 14 Future Cost of Distribution Losses – 12% Loss Factor

	Future Cost of Distribution Losses - 12%					
YEAR	Load Losses			No Load Losses		
	Demand $/kW	Energy $/kW	Total	Demand $/kW	Energy $/kW	Total
2015	$33.54	$67.28	$100.81	$52.72	$560.64	$613.36
2016	$34.21	$63.07	$97.28	$53.78	$525.60	$579.38
2017	$34.89	$62.02	$96.91	$54.85	$516.84	$571.69
2018	$35.59	$58.87	$94.46	$55.95	$490.56	$546.51
2019	$211.06	$58.87	$269.93	$475.07	$490.56	$965.63
2020	$118.97	$63.07	$182.04	$254.21	$525.60	$779.81
2021	$112.60	$64.12	$176.73	$238.37	$534.36	$772.73
2022	$117.96	$95.66	$213.62	$250.56	$797.16	$1,047.72
2023	$125.84	$94.61	$220.44	$268.77	$788.40	$1,057.17
2024	$124.11	$95.66	$219.77	$264.01	$797.16	$1,061.17
2025	$130.77	$97.76	$228.53	$279.27	$814.68	$1,093.95
2026	$126.15	$99.86	$226.01	$267.55	$832.20	$1,099.75
2027	$125.31	$104.07	$229.38	$264.86	$867.24	$1,132.10
2028	$124.91	$109.32	$234.23	$263.20	$911.04	$1,174.24
2029	$125.78	$111.43	$237.20	$264.57	$928.56	$1,193.13
2030	$125.83	$116.68	$242.51	$263.96	$972.36	$1,236.32
2031	$125.06	$122.99	$248.05	$261.38	$1,024.92	$1,286.30
2032	$117.61	$132.45	$250.07	$242.82	$1,103.76	$1,346.58
2033	$122.73	$120.89	$243.62	$254.30	$1,007.40	$1,261.70
2034	$123.69	$144.01	$267.71	$255.81	$1,200.12	$1,455.93
2035	$124.25	$159.78	$284.03	$256.34	$1,331.52	$1,587.86
2036	$125.67	$168.19	$293.86	$258.91	$1,401.60	$1,660.51
2037	$128.77	$174.50	$303.27	$265.51	$1,454.16	$1,719.67
2038	$131.35	$177.99	$309.34	$270.82	$1,483.24	$1,754.06
2039	$133.98	$181.55	$315.52	$276.23	$1,512.91	$1,789.14
2040	$136.66	$185.18	$321.84	$281.76	$1,543.17	$1,824.92
2041	$139.39	$188.88	$328.27	$287.39	$1,574.03	$1,861.42
2042	$142.18	$192.66	$334.84	$293.14	$1,605.51	$1,898.65
2043	$145.02	$196.51	$341.53	$299.00	$1,637.62	$1,936.62
2044	$147.92	$200.44	$348.36	$304.98	$1,670.37	$1,975.36
2045	$150.88	$204.45	$355.33	$311.08	$1,703.78	$2,014.86
2046	$153.90	$208.54	$362.44	$317.31	$1,737.86	$2,055.16
2047	$156.97	$212.71	$369.69	$323.65	$1,772.61	$2,096.26
2048	$160.11	$216.97	$377.08	$330.12	$1,808.07	$2,138.19
2049	$163.32	$221.31	$384.62	$336.73	$1,844.23	$2,180.95
2050	$166.58	$225.73	$392.32	$343.46	$1,881.11	$2,224.57
2051	$169.91	$230.25	$400.16	$350.33	$1,918.73	$2,269.06

Table 15 Future Cost of Distribution Losses – 31% Loss Factor

	Future Cost of Distribution Losses - 31%					
YEAR	Load Losses			No Load Losses		
	Demand $/kW	Energy $/kW	Total	Demand $/kW	Energy $/kW	Total
2015	$32.09	$173.80	$205.88	$38.37	$560.64	$599.01
2016	$32.73	$162.94	$195.66	$39.14	$525.60	$564.74
2017	$33.38	$160.22	$193.60	$39.92	$516.84	$556.76
2018	$34.05	$152.07	$186.12	$40.72	$490.56	$531.28
2019	$384.25	$152.07	$536.32	$459.54	$490.56	$950.10
2020	$199.31	$162.94	$362.25	$238.37	$525.60	$763.97
2021	$185.81	$165.65	$351.46	$222.21	$534.36	$756.57
2022	$195.73	$247.12	$442.85	$234.08	$797.16	$1,031.24
2023	$210.68	$244.40	$455.08	$251.96	$788.40	$1,040.36
2024	$206.42	$247.12	$453.54	$246.86	$797.16	$1,044.02
2025	$218.89	$252.55	$471.44	$261.78	$814.68	$1,076.46
2026	$208.80	$257.98	$466.78	$249.71	$832.20	$1,081.91
2027	$206.25	$268.84	$475.10	$246.67	$867.24	$1,113.91
2028	$204.56	$282.42	$486.98	$244.64	$911.04	$1,155.68
2029	$205.39	$287.85	$493.24	$245.63	$928.56	$1,174.19
2030	$204.56	$301.43	$506.00	$244.64	$972.36	$1,217.00
2031	$202.08	$317.73	$519.81	$241.68	$1,024.92	$1,266.60
2032	$186.24	$342.17	$528.41	$222.73	$1,103.76	$1,326.49
2033	$195.50	$312.29	$507.79	$233.81	$1,007.40	$1,241.21
2034	$196.42	$372.04	$568.45	$234.90	$1,200.12	$1,435.02
2035	$196.52	$412.77	$609.29	$235.02	$1,331.52	$1,566.54
2036	$198.31	$434.50	$632.80	$237.16	$1,401.60	$1,638.76
2037	$203.46	$450.79	$654.25	$243.32	$1,454.16	$1,697.48
2038	$207.53	$459.81	$667.33	$248.19	$1,483.24	$1,731.43
2039	$211.68	$469.00	$680.68	$253.15	$1,512.91	$1,766.06
2040	$215.91	$478.38	$694.29	$258.22	$1,543.17	$1,801.38
2041	$220.23	$487.95	$708.18	$263.38	$1,574.03	$1,837.41
2042	$224.64	$497.71	$722.34	$268.65	$1,605.51	$1,874.16
2043	$229.13	$507.66	$736.79	$274.02	$1,637.62	$1,911.64
2044	$233.71	$517.82	$751.53	$279.50	$1,670.37	$1,949.87
2045	$238.39	$528.17	$766.56	$285.09	$1,703.78	$1,988.87
2046	$243.15	$538.74	$781.89	$290.79	$1,737.86	$2,028.65
2047	$248.02	$549.51	$797.53	$296.61	$1,772.61	$2,069.22
2048	$252.98	$560.50	$813.48	$302.54	$1,808.07	$2,110.61
2049	$258.04	$571.71	$829.75	$308.59	$1,844.23	$2,152.82
2050	$263.20	$583.14	$846.34	$314.76	$1,881.11	$2,195.88
2051	$268.46	$594.81	$863.27	$321.06	$1,918.73	$2,239.79

CI Number: 49918

Title: 54H-303 Underground Device Replacements Phase 1

Start Date: 2017/05
In-Service Date: 2017/12
Final Cost Date: 2018/06
Function Class: Distribution
Forecast Amount: $469,604

DESCRIPTION:

This project provides for costs associated with replacing approximately 0.3 kilometers of deteriorated underground cables and various underground devices on primary distribution feeder 54H-303. The targeted equipment is part of the Dartmouth underground system, and is located in six vaults in the downtown area. Replacements include underground cables, submersible transformers, VACpac switchgear, fault indicators and related hardware.

Summary of Related CIs +/- 2 years:
2018 CI TBD 54H-303 Underground Device Replacements Phase 2 $TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Deteriorated Conductor

Why do this project?

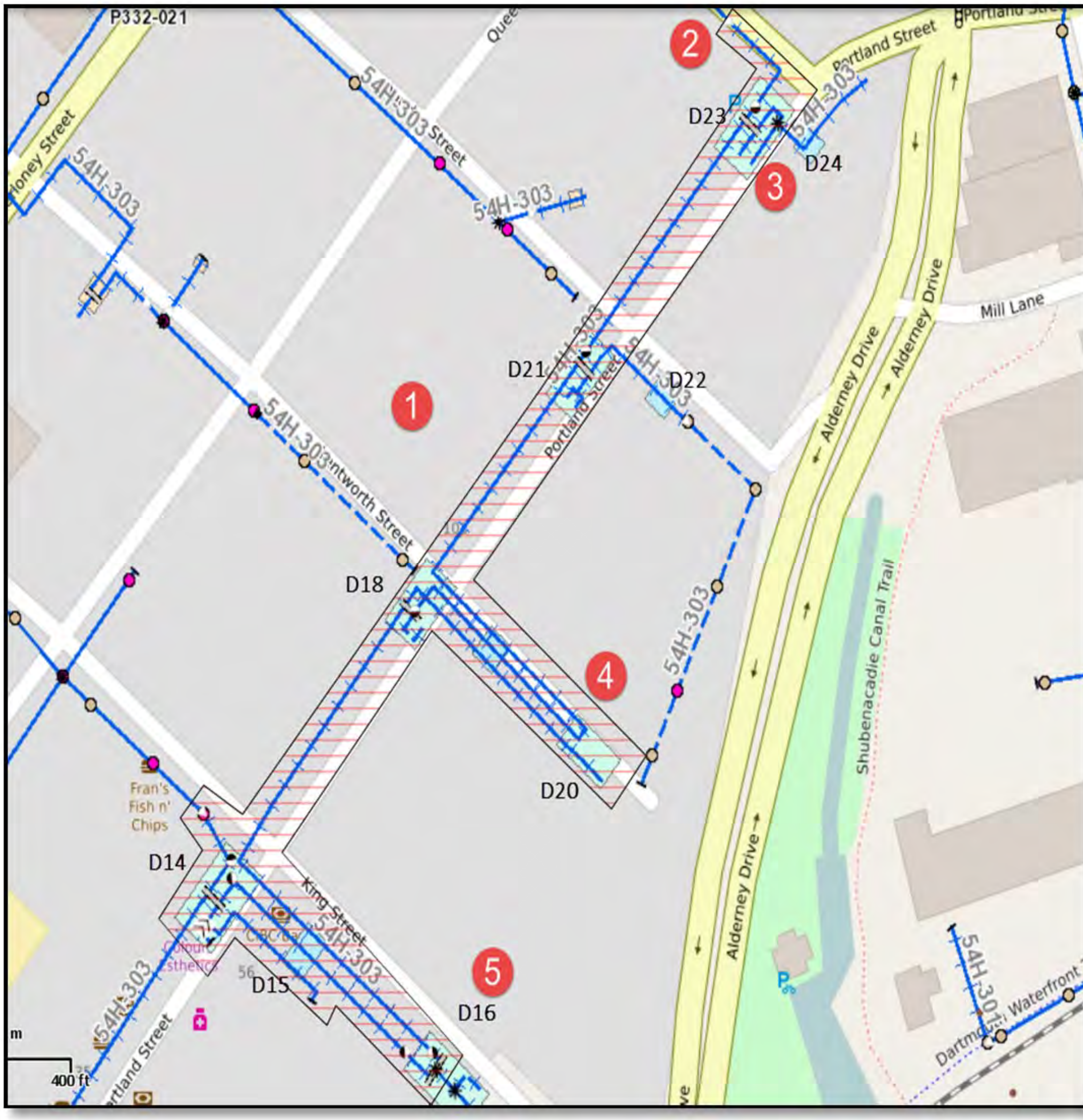
The existing cables and related equipment are deteriorated and at risk of failure due to their age and condition. Failure of this equipment would result in outages to Downtown Dartmouth (1260 customers) including multiple commercial customers.

Why do this project now?

The targeted cables, transformers, switchgear and related equipment are approximately 35 years old, and have reached the end of their expected useful life. Inspections of the targeted devices and assessments based on age, condition, and risk of failure have determined that replacements are required. There have been eight failures in the last three years on the targeted underground feeder due to the age and condition of the assets. These events resulted in lengthy outages to customers due to the time required to isolate the faulted section and the time required to make repairs.

Why do this project this way?

There is no alternate source of supply for customers served by the targeted underground equipment. Replacing the targeted assets is a more cost effective solution than rebuilding the entire underground line, or building new overhead lines. Planned cable replacements can be performed with little to no customer interruptions, as switching can be performed between vaults to supply customers.



(1) Replace approximately 0.6kms of 3-phase underground distribution line between the underground dip pole and D14. Install/replace fault indicators in vaults. Replace cables trays and cable brackets.

(2) Replace pole framing hardware.

(3) Replace submersible switch with operators. Replace submersible transformer.

(4) Re-route feeder from D20 to D18. Replace transformers in D20.

(5) Replace submersible switch and operators.

CI Number : 49918 - 54H-303 Underground Device Replacements Phase I **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		32,589	0	32,589
094		094 - Interest Capitalized		9,898	0	9,898
095		095-COPS Regular Labour AO		48,277	0	48,277
095		095 - Proj Supp Regular Labour AO		6,544	0	6,544
095		095-COPS Contracts AO		10,264	0	10,264
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	2,107	0	2,107
001	041	001 - T&D Regular Labour	041 - DP - O/H Line Transf.	536	0	536
012	041	012 - Materials	041 - DP - O/H Line Transf.	6,346	0	6,346
001	046	001 - T&D Regular Labour	046 - DP - U/G Conductor	30,990	0	30,990
012	046	012 - Materials	046 - DP - U/G Conductor	45,539	0	45,539
013	046	013 - COPS Contracts	046 - DP - U/G Conductor	51,271	0	51,271
001	047	001 - T&D Regular Labour	047 - DP - U/G Conductor Devices	5,721	0	5,721
001	048	001 - T&D Regular Labour	048 - DP - U/G Line Transf.	17,760	0	17,760
012	048	012 - Materials	048 - DP - U/G Line Transf.	171,845	0	171,845
001	085	001 - Regular Labour (No AO)	085 Design	10,310	0	10,310
001	085	001 - Proj Supp Regular Labour	085 Design	13,607	0	13,607
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	6,000	0	6,000
			Total Cost:	469,604	0	469,604
			Original Cost:	110,120		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 49918
Title: 54H-303 Underground Device Replacements Phase I
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - PLT	PD	156	$ 367	57,115		
T&D Labour - Site Supervision	PD	16	$ 385	6,000		
Procurement / Financial Support	Lot	1	$ 10,310	$ 10,310		
Project Support AO - Engineering Design	PD	36	$ 382	$ 13,607		
			Sub-Total	$ 87,032		
012 Materials						
Overhead Transformers	Lot	1	$ 6,346	$ 6,346		
Underground Conductor	Lot	1	$ 45,539	$ 45,539		
Padmount Transformers	Lot	1	$ 171,845	$ 171,845		
			Sub-Total	$ 223,730		
013 Contracts						
Traffic Control	Lot	1	$ 39,271	$ 39,271		
Cable Relocation and Pulling Contractor	Lot	1	$ 6,000	$ 6,000		
Hydro Vac	Lot	1	$ 6,000	$ 6,000		
			Sub-Total	$ 51,271		
094 Interest Capitalized						
AFUDC				$ 9,898		
			Sub-Total	$ 9,898		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 32,589		
			Sub-Total	$ 32,589		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 48,277		
COPS Contract AO				$ 10,264		
Project Support Regular AO				$ 6,544		
			Sub-Total	$ 65,084		
			SUB-TOTAL (no AO, AFUDC)	$ 362,033		
			TOTAL (AO, AFUDC included)	$ 469,604		
Original Cost				$ 110,120		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 47769

Title: 509V-301 Over Cove Rd Replacements

Start Date: 2017/03
In-Service Date: 2017/05
Final Cost Date: 2017/11
Function Class: Distribution
Amount: $402,493

DESCRIPTION:

This project provides for the costs associated with rebuilding approximately 3.5kms of 509V-301 along Over Cove Rd on Long Island, near Freeport. The existing #6 and #4 Cu primary, and #4 neutral will be replaced with 2/0 primary and 2/0 neutral. Approximately 70 structures will be rebuilt through a combination of framing or pole replacements. Additional replacememts include insulators, anchors and guys.

Summary of Related CIs +/- 2 years:
2017 CI 49891 509V Recloser and Voltage Regulator Replacement $319,649

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Deteriorated Conductor

Why do this project?

The existing #6 and #4 conductor, poles and other targeted distribution plant are deteriorated and at risk of failure due to their age and condition. The conductor can no longer be worked on under live conditions.

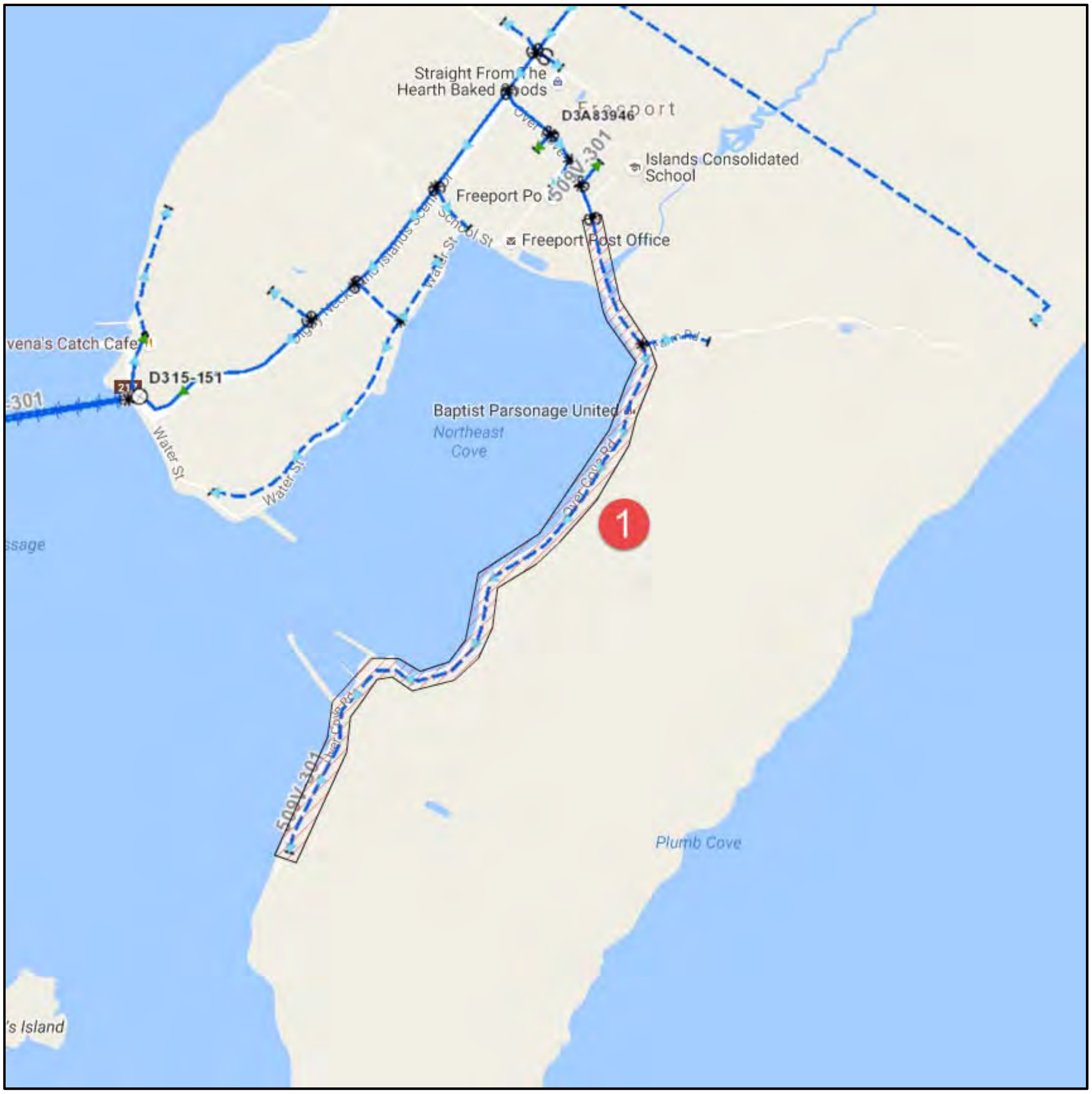
Why do this project now?

The existing #6 and #4 conductor is more than 60 years old and has reached the end of its expected service life. Inspections of the the targeted devices and assessment based on age, condition and risk of failure has determined that replacements are required.

Why do this project this way?

There is no alternative source of supply for customers. Replacing the targeted assets is a more cost effective solution than rebuilding the entire line. Conductor and poles will be upgraded in accordance with current NS Power standards.

The contracts portion of this project will be sourced through NS Power’s existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power’s workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.



1. Rebuild approximately 3.5kms of 509V-301 along Over Cove Rd

CI Number : 47769 - 509V-301 Overcove Rd Replacements **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		2,062	0	2,062
095		095-COPS Contracts AO		56,653	0	56,653
013	002	013 - COPS Contracts	002 - DP - Land Rights	10,000	0	10,000
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	3,000	0	3,000
012	035	012 - Materials	035 - DP - Wood Poles	11,586	0	11,586
013	035	013 - COPS Contracts	035 - DP - Wood Poles	171,808	0	171,808
012	039	012 - Materials	039 - DP - O/H Cond.	12,503	0	12,503
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	93,296	0	93,296
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	7,893	0	7,893
001	085	001 - Regular Labour (No AO)	085 Design	5,393	0	5,393
066	085	066 - Other Goods & Services	085 Design	28,300	0	28,300
			Total Cost:	402,493	0	402,493
			Original Cost:	66,549		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 47769
Title: 509V-301 Overcove Rd Replacements
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Procurement / Financial Support	Lot	1	$ 5,393	$ 5,393		
			Sub-Total	$ 5,393		
012 Materials						
Poles, Anchors, and Guys	Lot	1	$ 11,586	$ 11,586		
Overhead Conductor	Lot	1	$ 12,503	$ 12,503		
			Sub-Total	$ 24,089		
013 Contracts						
Contract Line Work	Hrs	[redacted]		$ 185,037		
Tree Trimming	Lot	1	$ 10,000	$ 10,000		
Flagging	Lot	1	$ 42,961	$ 42,961		
Backhoe	Lot	1	$ 45,000	$ 45,000		
			Sub-Total	$ 282,998		
020 Easements						
Easement	Lot	1	$ 3,000	$ 3,000		
			Sub-Total	$ 3,000		
066 Other Goods & Services						
Contingency	%	10%	$ 282,998	$ 28,300		
			Sub-Total	$ 28,300		
094 Interest Capitalized						
Interest				$ 2,062		
			Sub-Total	$ 2,062		
095 Administrative Overhead						
COPS Contract AO				$ 56,653		
			Sub-Total	$ 56,653		
			SUB-TOTAL (no AO, AFUDC)	$ 343,779		
			TOTAL (AO, AFUDC included)	$ 402,493		
Original Cost				$ 66,549		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49791

Title: 3N - Oxford Conversion Phase 3

Start Date:	2017/01
In-Service Date:	2017/03
Final Cost Date:	2017/09
Function Class:	Distribution
Forecast Amount:	$358,369

DESCRIPTION:

This project provides for costs associated with completing the partial conversion primary feeder 3N-303 from the 3N-Oxford substation. Replacements include approximately 50 poles, insulators, cut-outs, and the replacement of 65 existing single-tap transformers with dual-tap transformers. The targeted section of 3N-303 will be converted to 25kV, and transferred to a new recloser on the 25kV bus from transformer 3N-T51. Two new 500kVA step-down transformers will be installed to maintain the existing feeder sections 3N-303G and 303H at 12kV. Following completion of the conversion, the existing 3N-T42 (4.5MVA, 25kV to 12kV) transformer, 3 voltage regulators and 2 substation reclosers will be decommissioned.

Summary of Related CIs +/- 2 years:
2015 CI 45031 3N Oxford Conversion Phase 1 $716,167
2016 CI 47773 3N Oxford Conversion Phase 2 $631,686

JUSTIFICATION:

Justification Criteria: Distribution System

Why do this project?

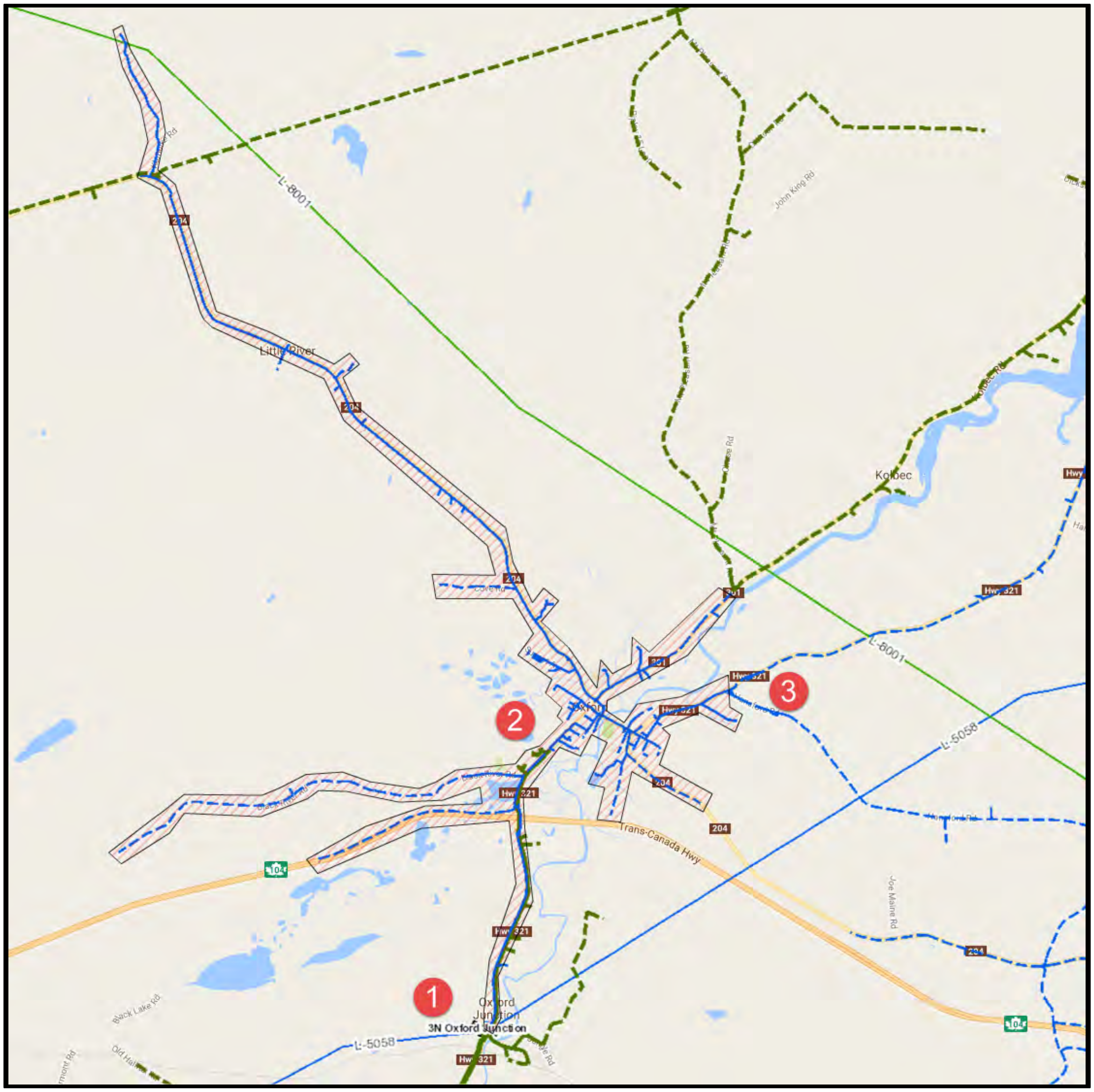
The existing 3N-T42 transformer, 12kV substation equipment, and 12kV distribution system are deteriorated. The load from 3N-T42 needs to be transferred in order to accommodate the retirement of the transformer. In addition, the existing 12kV distribution system, which includes the town of Oxford, is islanded with limited service contingency opportunities. Converting 3N-303 will result in the ability to transfer load with adjacent feeders, including 22N-403.

Why do this project now?

The 3N-T42 transformer and 12kV distribution system are 49 and 42 years old, respectively, and have reached the end of their expected useful life. Three phases of conversion and load transfer need to be completed before 3N-T42 can be retired. Phases 1 and 2 of the 3N-Oxford 12kV conversion will be completed by the end of 2016. Phase 3 is required in order to complete the targeted conversions and allow for the retirement of 3N-T42.

Why do this project this way?

Alternatives considered include partial and full conversion of 3N-303. Full conversion would require converting an additional 50kms of rural, single-phase distribution line and the associated replacements. Partial conversion of the targeted sections, along with installing step-down transformers to service 3N-303G and 303H, is a more economical solution than complete conversion, which isn't necessary at this time.



(1) At 3N Sub - Decommission 3N-T42 4.5MVA transformer, two 12kV reclosers and three voltage regulators. Install new 25kV recloser.

(2) Replace approximately 49 Poles and 63 transformers in the highlighted area prior to converting 3N-303 from 12kV to 25kV

(3) Install two 500 stepdown transformers, one along Highway 321 and one along Hansford Rd.

CI Number : 49791 - 3N Oxford Conversion Phase 3 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		23,170	0	23,170
094		094 - Interest Capitalized		2,594	0	2,594
095		095-COPS Contracts AO		8,157	0	8,157
095		095-COPS Regular Labour AO		34,323	0	34,323
095		095 - Proj Supp Regular Labour AO		2,405	0	2,405
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	3,933	0	3,933
012	035	012 - Materials	035 - DP - Wood Poles	3,002	0	3,002
013	035	013 - COPS Contracts	035 - DP - Wood Poles	34,744	0	34,744
001	038	001 - T&D Regular Labour	038 - DP - Insulators	492	0	492
012	038	012 - Materials	038 - DP - Insulators	71	0	71
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	6,153	0	6,153
012	039	012 - Materials	039 - DP - O/H Cond.	46	0	46
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	4,385	0	4,385
012	040	012 - Materials	040 - DP - O/H Cond.Devices	50,991	0	50,991
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	6,000	0	6,000
001	041	001 - T&D Regular Labour	041 - DP - O/H Line Transf.	29,178	0	29,178
012	041	012 - Materials	041 - DP - O/H Line Transf.	135,379	0	135,379
001	048	001 - T&D Regular Labour	048 - DP - U/G Line Transf.	432	0	432
001	052	001 - T&D Regular Labour	052 - DP - Services	298	0	298
001	085	001 - Proj Supp Regular Labour	085 Design	5,000	0	5,000
001	085	001 - Regular Labour (No AO)	085 Design	7,616	0	7,616
			Total Cost:	358,369	0	358,369
			Original Cost:	62,229		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 49791
Title: 3N Oxford Conversion Phase 3
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - PLT	PD	110	$ 367	$ 40,496		
T&D Labour - Elec/Tech	PD	12	$ 360	$ 4,376		
Project Support AO - Engineering Design	PD	13	$ 382	$ 5,000		
Procurement / Financial Support	Lot	1	$ 7,616	$ 7,616		
			Sub-Total	$ 57,488		
012 Materials						
Guys and Framing	Lot	1	$ 3,048.64	$ 3,049		
Insulators	Lot	1	$ 71.29	$ 71		
Cutouts	Lot	1	$ 20,991.11	$ 20,991		
Recloser	Lot	1	$ 30,000.00	$ 30,000		
Overhead Transformers	Lot	1	$ 135,378.94	$ 135,379		
			Sub-Total	$ 189,490		
013 Contracts						
Traffic Control	Lot	1	$ 34,744.03	$ 34,744		
Boom Truck	Lot	1	$ 6,000.00	$ 6,000		
			Sub-Total	$ 40,744		
094 Interest Capitalized						
Interest				$ 2,594		
			Sub-Total	$ 2,594		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 23,170		
			Sub-Total	$ 23,170		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 34,323		
COPS Contract AO				$ 8,157		
Project Support Regular AO				$ 2,405		
			Sub-Total	$ 44,884		
			SUB-TOTAL (no AO, AFUDC)	$ 287,722		
			TOTAL (AO, AFUDC included)	$ 358,369		
Original Cost				$ 62,229		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49867

Title: 55V-313-Berwick North Replacements

Start Date:	2017/06
In-Service Date:	2017/10
Final Cost Date:	2018/04
Function Class:	Distribution
Forecast Amount:	$345,565

DESCRIPTION:

This project provides for the costs associated with replacing approximately 1km of conductor on 55V-313J along Shaw Road from West Steadman Road to Pleasant Valley Road, and upgrading approximately 2.0kms of conductor on 55V-313 along West Steadman Road from single phase to three phase. The existing #6 primary and #6 neutral will be replaced with 2/0 primary and 2/0 neutral. The load currently on 55V-313J from Shaw Rd and commercial load on Pleasant Valley Road will be transferred to 55V-313 via West Steadman Road. Additional replacements include poles, insulators, cut-outs and transformers.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Deteriorated Conductor

Why do this project?

The existing #6 Cu conductor, poles and other targeted distribution plant are deteriorated and at risk of failure due to their age and condition. The existing conductor can no longer be worked on under live conditions. In addition, the length of the feeder and losses due to the deteriorated conductor is resulting in power quality issues on 55V-313J.

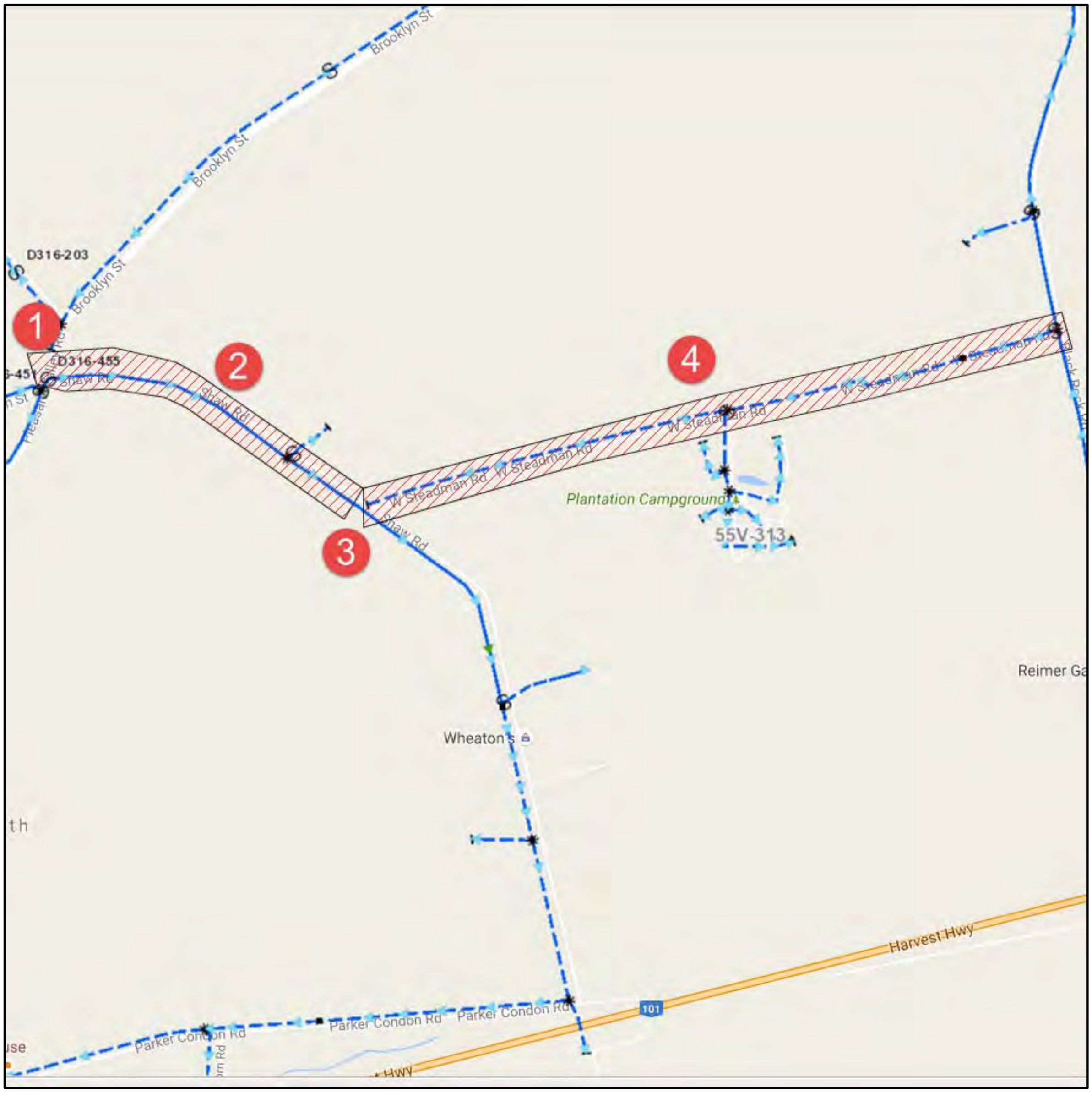
Why do this project now?

The existing #6 Cu conductor is more than 30 years old, has a high splice count, and is approaching the end of its expected service life. Inspections of the targeted devices and assessment based on age, condition and risk of failure has determined that replacements are required. A secondary benefit of the conductor replacements and load transfer is improved voltage levels for commercial customers currently on the end of 55V-313J.

Why do this project this way?

Replacing the targeted section of conductor and transferring load from 55V-313J to 55V-313 is a more cost effective solution than replacing the majority of conductor on 55V-313J. The proposed solution addresses the power quality issues on the end of 55V-313J and allows conductor replacements on 55V-313J to be deferred to future years.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.



(1) Create new open point
(2) Replace existing conductor
(3) Reconfigure load from Shaw Rd to West Steadman Rd
(4) Upgrade to 3-phase and replace existing conductor

CI Number : 49867 - 55V-313-Berwick North Replacements **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		9,270	0	9,270
094		094 - Interest Capitalized		3,841	0	3,841
095		095-COPS Regular Labour AO		13,733	0	13,733
095		095-COPS Contracts AO		39,854	0	39,854
013	002	013 - COPS Contracts	002 - DP - Land Rights	20,700	0	20,700
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	5,400	0	5,400
012	004	012 - Materials	004 - DP - Misc.Equipment	0	0	0
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	5,021	0	5,021
012	035	012 - Materials	035 - DP - Wood Poles	15,435	0	15,435
013	035	013 - COPS Contracts	035 - DP - Wood Poles	87,781	0	87,781
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	10,817	0	10,817
012	039	012 - Materials	039 - DP - O/H Cond.	13,125	0	13,125
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	79,469	0	79,469
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	596	0	596
012	040	012 - Materials	040 - DP - O/H Cond.Devices	927	0	927
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	122	0	122
001	041	001 - T&D Regular Labour	041 - DP - O/H Line Transf.	656	0	656
012	041	012 - Materials	041 - DP - O/H Line Transf.	4,129	0	4,129
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	7,909	0	7,909
013	050	013 - COPS Contracts	050 - DP - Street Lights	326	0	326
001	052	001 - T&D Regular Labour	052 - DP - Services	864	0	864
013	052	013 - COPS Contracts	052 - DP - Services	2,772	0	2,772
001	085	001 - Regular Labour (No AO)	085 Design	5,934	0	5,934
066	085	066 - Other Goods & Services	085 Design	16,882	0	16,882
			Total Cost:	345,565	0	345,565
			Original Cost:	108,014		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 49867
Title: 55V-313 Berwick North Replacements
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - PLT	PD	49	$ 367	$ 17,954		
Procurement / Financial Support	Lot	1	$ 5,934	$ 5,934		
			Sub-Total	$ 23,888.00		
012 Materials						
Poles and Anchors	Lot	1	$ 15,435	$ 15,435		
Conductors	Lot	1	$ 13,125	$ 13,125		
Cutouts	Lot	1	$ 927	$ 927		
Overhead Line Transformer	Lot	1	$ 4,129	$ 4,129		
			Sub-Total	$ 33,617		
013 Contracts						
Contract Line Work	Hrs	[redacted]		$ 119,456		
Tree Trimming	Lot	1	$ 20,700	$ 20,700		
Flagging	Lot	1	$ 37,774	$ 37,774		
Backhoe	Lot	1	$ 21,150	$ 21,150		
			Sub-Total	$ 199,080		
020 Easements						
Easements	Lot	1	$ 5,400	$ 5,400		
			Sub-Total	$ 5,400		
066 Other Goods & Services						
Contingency				$ 16,882		
			Sub-Total	$ 16,882		
094 Interest Capitalized						
Interest				$ 3,841		
			Sub-Total	$ 3,841		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 9,270		
			Sub-Total	$ 9,270		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 13,733		
COPS Contract AO				$ 39,854		
			Sub-Total	$ 53,587		
			SUB-TOTAL (no AO, AFUDC)	$ 278,867		
			TOTAL (AO, AFUDC included)	$ 345,565		
Original Cost				$ 108,014		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49591

Title: 3S Feeder Exit Cable Replacement

Start Date:	2016/08
In-Service Date:	2017/09
Final Cost Date:	2018/03
Function:	Distribution
Amount:	$335,842

DESCRIPTION:

This project provides for costs associated with replacing four sets of deteriorated feeder exit cables at the 3S Gannon Rd substation. The existing feeder exit cables are direct buried, but will be replaced with feeder exit cables in a duct system. The feeder exit cables at the 3S Gannon Road Substation are deteriorated and have reached end of life. Feeder exit cables prevent overhead congestion in the area of a substation by routing feeders underground from the breakers located in the substation to the adjacent poles. Feeder exit cable failures result in lengthy customer outages, especially in cases similar to 3S Gannon Rd where the cables are direct buried and not installed in a duct system.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Deteriorated Conductor

Why do this project?

The feeder exit cables at 3S Gannon Rd substation are deteriorated, and have reached end of life. Cable failures at 3S will result in lengthy customer outages, affecting up to 2,000 customers. In addition, the underground cables at 3S Gannon Road substation are direct buried installations, which cannot be easily accessed, replaced or repaired.

Why do this project now?

The 3S feeder exit cables are approximately 45 years old and have reached the end of their expected useful life. Cables have previously failed at 3S in 2014 and 2015. Assessment of the cable that failed in 2015 indicated that the cables are deteriorated to the point where replacement is required to maintain a reliable supply to the customers supplied by 3S Gannon Rd substation.

Why do this project this way?

Planned replacements of the feeder exit cables can be done without customer interruptions by transferring load to other feeders. The new cables will be installed in a duct system, as per current NS Power standards, to allow for improved access, maintainability and reliability.

CI Number : 49591-D763 - 3S Feeder Exit Cable Replacement **Project Number** D763

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		20,822	0	20,822
094		094 - Interest Capitalized		4,887	0	4,887
095		095 - Proj Supp Regular Labour AO		3,009	0	3,009
095		095-COPS Contracts AO		30,829	0	30,829
095		095-COPS Regular Labour AO		30,845	0	30,845
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	2,029	0	2,029
012	035	012 - Materials	035 - DP - Wood Poles	5,537	0	5,537
013	035	013 - COPS Contracts	035 - DP - Wood Poles	23,893	0	23,893
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	6,640	0	6,640
012	039	012 - Materials	039 - DP - O/H Cond.	1,758	0	1,758
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	2,665	0	2,665
012	040	012 - Materials	040 - DP - O/H Cond.Devices	8,093	0	8,093
001	046	001 - T&D Regular Labour	046 - DP - U/G Conductor	18,200	0	18,200
012	046	012 - Materials	046 - DP - U/G Conductor	26,751	0	26,751
013	046	013 - COPS Contracts	046 - DP - U/G Conductor	122,000	0	122,000
001	085	001 - Proj Supp Regular Labour	085 Design	6,257	0	6,257
001	085	001 - Regular Labour (No AO)	085 Design	1,446	0	1,446
001	085	001 - T&D Regular Labour	085 Design	5,750	0	5,750
011	085	011 - Travel Expense	085 Design	445	0	445
013	085	013 - COPS Contracts	085 Design	8,000	0	8,000
041	085	041 - Meals & Entertainment	085 Design	450	0	450
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	5,537	0	5,537
			Total Cost:	335,842	0	335,842
			Original Cost:	50,379		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 49591
Title: 3S Feeder Exit Cable Replacement
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - PLT	PD	81	$ 367	$ 29,533		
T&D Labour - Site Supervision	PD	14	$ 385	$ 5,537		
T&D Labour - Design	PD	15	$ 382	$ 5,750		
Procurement / Financial Support	Lot	1	$ 1,446	$ 1,446		
Project Support AO - Engineering Design	PD	16	$ 382	$ 6,257		
			Sub-Total	$ 48,523		
011 Travel Expense						
Travel - Design	Lot	1	$ 445	$ 445		
			Sub-Total	$ 445		
012 Materials						
Underground Conductor	Lot	1	$ 26,751	$ 26,751		
Wood Poles	Lot	1	$ 5,537	$ 5,537		
Overhead Conductor	Lot	1	$ 1,758	$ 1,758		
Switches	Lot	1	$ 8,093	$ 8,093		
			Sub-Total	$ 42,140		
013 Contracts						
Drawing fees	Lot	1	$ 8,000	$ 8,000		
Civil Work	Lot	1	$ 122,000	$ 122,000		
Traffic Control	Lot	1	$ 20,293	$ 20,293		
Backhoe	Lot	1	$ 3,600	$ 3,600		
			Sub-Total	$ 153,893		
041 Meals & Entertainment						
Meals - Design	Lot	1	$ 450	$ 450		
			Sub-Total	$ 450		
094 Interest Capitalized						
AFUDC				$ 4,887		
			Sub-Total	$ 4,887		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 20,822		
			Sub-Total	$ 20,822		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 30,845		
COPS Contract AO				$ 30,829		
Project Support Regular AO				$ 3,009		
			Sub-Total	$ 64,683		
			SUB-TOTAL (no AO, AFUDC)	$ 245,451		
			TOTAL (AO, AFUDC included)	$ 335,842		
Original Cost				$ 50,379		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 49891

Title: 509V Recloser and Voltage Regulator Replacement

Start Date: 2017/08
In-Service Date: 2017/11
Final Cost Date: 2018/05
Function Class: Distribution
Forecast Amount: $319,649

DESCRIPTION:

This project provides for the costs associated with replacing the recloser and voltage regulator in the 509V-East Ferry step-down substation. The existing 509V-301 hydraulic recloser will be replaced with an electronic recloser and the existing 509V-VR1 will be replaced with a new 100A voltage regulator. Additional replacements include 2 poles and a gang switch. The new recloser will be connected to NS Power's SCADA system to allow for remote indication and control. Installations associated with connecting to SCADA include conduit and teleprotection equipment.

Summary of Related CIs +/- 2 years:
2017 CI 44769 509V-301 Over Cove Rd Rebuild $402,493

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Equipment Replacement

Why do this project?

The existing recloser and voltage regulator are deteriorated and at risk of failure due to their age and condition. These are both critical pieces of equipment, particularly for a remote step-down substation like 509V. There is no alternative source of supply for 509V customer, and therefore failure of the targeted equipment would result in an extended outage or power quality issues for customers.

A secondary driver for this project is outage performance. The 509V step-down substation supplies Long Island and Brier Island, which can only be accessed via ferry in calm weather. Its remote location results in increased time to repair and restore outages. Connecting the new recloser to the SCADA network will improve outage response by providing remote restoration.

Why do this project now?

The existing recloser and voltage regulator are approximately 49 years old and have reached the end of their expected service life. Inspections of the targeted devices and assessment based on age, condition and risk of failure has determined that replacements are required.

Why do this project this way?

There is no alternative source of supply for customers. Replacement of the recloser is required in order to provide dynamic protection to momentary faults, and replacing the voltage regulator is required in order to maintain power quality. Connecting the recloser to NS Power's SCADA system allows for greater visibility and faster restoration times once the line is repaired, as the recloser can be closed-in remotely and monitored by the Distribution Control Center.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

(1) Replace recloser 509V-301 and connect to SCADA network
(2) Replace voltage regulator 509V-VR1

CI Number : 49891 - 509V Recloser and Voltage Regulator Replacement **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D OT Labour AO		744	0	744
092		092-Vehicle T&D Reg. Labour AO		4,311	0	4,311
094		094 - Interest Capitalized		2,691	0	2,691
095		095-COPS Overtime Labour AO		1,102	0	1,102
095		095 - Proj Supp Regular Labour AO		5,879	0	5,879
095		095-COPS Contracts AO		15,846	0	15,846
095		095-COPS Regular Labour AO		6,386	0	6,386
012	035	012 - Materials	035 - DP - Wood Poles	27,090	0	27,090
013	035	013 - COPS Contracts	035 - DP - Wood Poles	15,885	0	15,885
012	040	012 - Materials	040 - DP - O/H Cond.Devices	107,451	0	107,451
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	42,270	0	42,270
001	043	001 - T&D Regular Labour	043 - DP - Substn Dev.	2,881	0	2,881
002	043	002 - T&D Overtime Labour	043 - DP - Substn Dev.	1,441	0	1,441
013	045	013 - COPS Contracts	045 - DP - U/G Conduit	11,000	0	11,000
001	054	001 - T&D Regular Labour	054 - DP - Remote Monitoring	4,322	0	4,322
002	054	002 - T&D Overtime Labour	054 - DP - Remote Monitoring	1,441	0	1,441
012	054	012 - Materials	054 - DP - Remote Monitoring	16,750	0	16,750
013	054	013 - COPS Contracts	054 - DP - Remote Monitoring	10,000	0	10,000
001	085	001 - Proj Supp Regular Labour	085 Design	12,224	0	12,224
001	085	001 - Regular Labour (No AO)	085 Design	4,298	0	4,298
001	085	001 - T&D Regular Labour	085 Design	1,146	0	1,146
011	085	011 - Travel Expense	085 Design	900	0	900
028	085	028 - Consulting	085 Design	11,500	0	11,500
066	085	066 - Other Goods & Services	085 Design	12,091	0	12,091
			Total Cost:	319,649	0	319,649
			Original Cost:	10,315		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 49891
Title: 509V Recloser and Voltage Regulator Replacement
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - PLT	PD	23	$ 367	$ 8,349		
Procurement / Financial Support	Lot	1	$ 4,298	$ 4,298		
Project Support AO - Engineering Design	PD	32	$ 382	$ 12,224		
			Sub-Total	$ 24,871		
002 OT Labour						
T&D Labour - PLT	PD	4	$ 734	$ 2,881		
			Sub-Total	$ 2,881		
011 Travel Expense						
Travel	Lot	1	$ 900	$ 900		
			Sub-Total	$ 900		
012 Materials						
Poles	Lot	1	$ 27,090	$ 27,090		
Teleprotection	Lot	1	$ 16,750	$ 16,750		
Overhead Conductor Devices	Lot	1	$ 107,451	$ 107,451		
			Sub-Total	$ 151,292		
013 Contracts						
Contract Line Work	Hrs	[redacted]		$ 44,325		
Flagging	Lot	1	$ 11,130	$ 11,130		
Backhoe	Lot	1	$ 2,700	$ 2,700		
Teleprotection	Lot	1	$ 10,000	$ 10,000		
Underground Conduit	Lot	1	$ 11,000	$ 11,000		
			Sub-Total	$ 79,155		
028 Consulting						
Consulting	$	1	$ 11,500	$ 11,500		
			Sub-Total	$ 11,500		
066 Other Goods & Services						
Contingency				$ 12,091		
			Sub-Total	$ 12,091		
094 Interest Capitalized						
Interest				$ 2,691		
			Sub-Total	$ 2,691		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 4,311		
Vehicle T&D Labour Overtime AO				$ 744		
			Sub-Total	$ 5,055		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 6,386		
COPS T&D Labour Overtime AO				$ 1,102		
COPS Contract AO				$ 15,846		
Project Support Regular AO				$ 5,879		
			Sub-Total	$ 29,213		
			SUB-TOTAL (no AO, AFUDC)	$ 282,690		
			TOTAL (AO, AFUDC included)	$ 319,649		
Original Cost				$ 10,315		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

CI Number: 50073

Title: 4S-332 Bernard Lind Drive Conversion

Start Date:	2017/05
In-Service Date:	2017/07
Final Cost Date:	2018/01
Function Class:	Distribution
Amount:	$302,893

DESCRIPTION:

This project provides for costs associated with implementing recommendation 6.1.5.2 of the Sydney 4kV Conversion and Membertou Load Growth Planning Study (283-0212-E27). Section 6.1.5.2 recommends upgrading the circuit on Bernard Lind Drive, and converting a portion of the circuit on Terrace Street and surrounding streets, from 4kV to 12kV, which will facilitate the retirement of the 6S substation. In order to complete this conversion, a new, 0.3 kilometer, 3-phase 12kV line extension from primary distribution feeder 4S-332 will be constructed along Bernard Lind Drive. This construction will enable the conversion of feeder 6S-224, east of the 6S-Terrace Street substation. Additional replacements include upgrading the existing conductor to 4/0 ASC, poles, framing, insulators, cut-outs, and the replacement of all existing single-tap transformers with dual-tap transformers.

Summary of Related CIs +/- 2 years:
2016 CI 45306 111S Prime Brook Substation $3,442,582
2016 CI 47776 111S Prime Brook Feeders $1,504,630
2016 CI 47752 4S-333 Bentinck Street Rebuild $575,357
2018 CI TBD Harold Street Conversion $TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Deteriorated Conductor

Why do this project?

The existing 6S-Terrace Street substation equipment, infrastructure and associated 4kV distribution plant are deteriorated due to their age and condition. The condition of the targeted assets is further described in Sections 2.3.2 and 4.3 of planning study 283-0212-E27. The load from 6S-Terrace Street needs to be transferred in order to accommodate the planned retirement of the 6S substation.

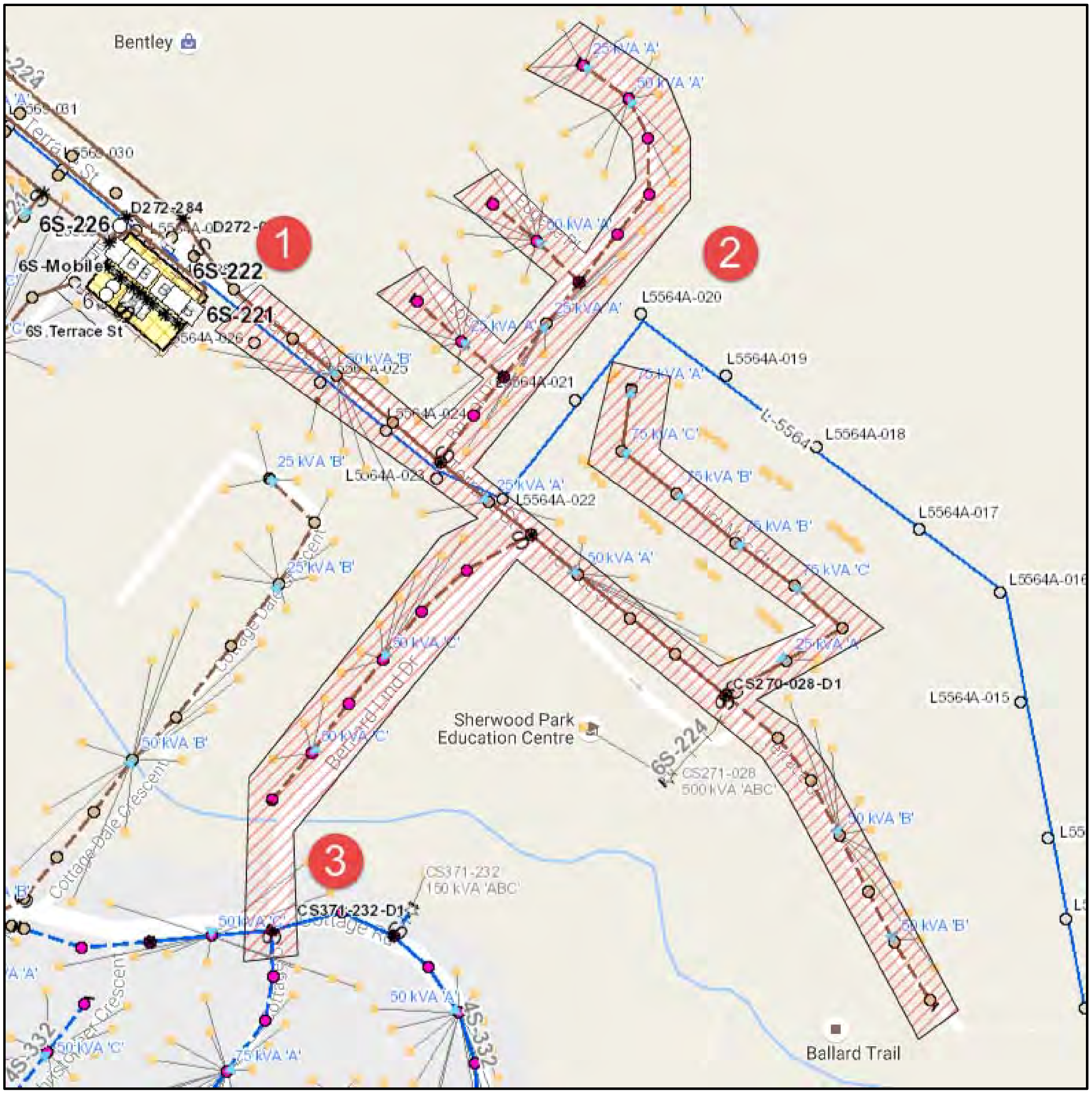
Why do this project now?

The 6S substation equipment and 4kV distribution plant are over 40 years old and are at or nearing their end of service life, as outlined in section 4.3. Multiple phases of conversion and load transfer need to be completed over multiple years before 6S can be retired, as outlined in Section 6.0 and sequentially under Section 6.1, with this project recommended for 2017 in Section 6.1.5.2.

Why do this project this way?

Alternatives are outlined in Section 5.2, including three variations on timing of conversions and one on rebuilding the 6S substation. 4kV systems are no longer built to an NS Power standard and are being phased out. Conversion of the existing 4kV feeders from 6S-Terrace Street is therefore the only feasible solution to accommodate the retirement of the 6S substation.

The contracts portion of this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with Emera Utility Services. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.



Project Scope:

(1) Create new open point
(2) Various replacements and voltage conversion
(3) 0.3kms, 3-phase line extension

CI Number : 50073 - 4S-332 Bernard Lind Drive Conversion **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		2,020	0	2,020
095		095-COPS Contracts AO		30,597	0	30,597
013	002	013 - COPS Contracts	002 - DP - Land Rights	10,000	0	10,000
012	035	012 - Materials	035 - DP - Wood Poles	8,403	0	8,403
013	035	013 - COPS Contracts	035 - DP - Wood Poles	46,246	0	46,246
012	038	012 - Materials	038 - DP - Insulators	180	0	180
013	038	013 - COPS Contracts	038 - DP - Insulators	2,972	0	2,972
012	039	012 - Materials	039 - DP - O/H Cond.	7,543	0	7,543
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	32,901	0	32,901
012	040	012 - Materials	040 - DP - O/H Cond.Devices	301	0	301
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	660	0	660
012	041	012 - Materials	041 - DP - O/H Line Transf.	63,591	0	63,591
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	57,058	0	57,058
012	048	012 - Materials	048 - DP - U/G Line Transf.	17,000	0	17,000
013	048	013 - COPS Contracts	048 - DP - U/G Line Transf.	3,000	0	3,000
001	085	001 - Regular Labour (No AO)	085 Design	5,136	0	5,136
066	085	066 - Other Goods & Services	085 Design	15,284	0	15,284
			Total Cost:	302,893	0	302,893
			Original Cost:	28,594		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 50073
Title: 4S-332 Bernard Lind Drive Conversion
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Procurement / Financial Support	Lot	1	$ 5,136	$ 5,136		
			Sub-Total	$ 5,136		
012 Materials						
Poles	Lot	1	$ 8,403	$ 8,403		
Insulators	Lot	1	$ 180	$ 180		
Conductors	Lot	1	$ 7,543	$ 7,543		
Cutouts	Lot	1	$ 301	$ 301		
Overhead Line Transformer	Lot	1	$ 63,591	$ 63,591		
Padmount	Lot	1	$ 17,000	$ 17,000		
			Sub-Total	$ 97,018		
013 Contracts						
Contract Line Work	Hrs	[redacted]		$ 114,314		
Tree Trimming	Lot	1	$ 10,000	$ 10,000		
Flagging	Lot	1	$ 22,674	$ 22,674		
Backhoe	Lot	1	$ 5,850	$ 5,850		
			Sub-Total	$ 152,838		
066 Other Goods & Services						
Contingency				$ 15,284		
			Sub-Total	$ 15,284		
094 Interest Capitalized						
Interest				$ 2,020		
			Sub-Total	$ 2,020		
095 Administrative Overhead						
COPS Contract AO				$ 30,597		
			Sub-Total	$ 30,597		
			SUB-TOTAL (no AO, AFUDC)	$ 270,276		
			TOTAL (AO, AFUDC included)	$ 302,893		
Original Cost				$ 28,594		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

Sydney 4kV Conversion and Membertou Load Growth
DISTRIBUTION PLANNING STUDY

Report number 283-0212-E27

Revision		Date	Drafted By	Reviewed by	Approved By
0	Issued for Study	16-Feb-2012	JMQ		
1	Issued for Release	16-Aug-2013	JMQ	MGS PZ	
2	Issued for Release	7-Apr-2014	JMQ	JC	JC
3	Issued for Release	5-June-2015	BH	YL/MD	

EXECUTIVE SUMMARY

This study was initiated by the Eastern Territory, in order to determine solutions to the anticipated large load growth in the Membertou area, of Sydney. Solutions were studied and recommendations made to address near and long term load growth in previous revisions. This revision was initiated to address two changes since the last revision:

- Additional reduction of 69kV load required as per transmission planning study, 049-2013-TSMG
- Unable to procure land for proposed substation location

Sydney 4kV to 12kV conversions are underway: Mason St, Cabot St and Rockdale Ave conversions are complete. Further conversion projects will continue until the eventual retirement of 6S-Terrace Street. The advancement or deferral of the 6S-Terrace Street conversion projects will be influenced by factors including residential/commercial development, feeder reconfigurations and/or ranking of capital projects within the ACE plan.

Creation of another supply into Membertou is partially completed. This will enable the transfer of load from the existing feeders, to a feeder that is more lightly loaded. The long term solution for the growth in Membertou is a new substation, which will now be located on Gabarus Hwy in Prime Brook, rather than on George St. This substation will be NSPI standard construction with a capacity of 15/20/25MVA rather than the initially recommended 15MVA pad-mounted option.

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1.0 SCOPE

This study was initiated by the Eastern Territory and undertaken by the Distribution Planning Department to identify solutions to meet the anticipated load growth in the Membertou area. Membertou is currently one of the fastest growing areas in the province. With the amount of development that has been announced for the area, there is a need to ensure enough capacity is available to meet this anticipated growth. This study outlined near and long term solutions to meet the growth in the Membertou area. This current revision (Rev 3), will address changes since the last revision:

- Additional reduction of 69kV load required as per transmission planning study, 049-2013-TSMG
- Unable to procure land for proposed substation location on George Street

Capital work for the recommended short term solution is underway. This solution eliminated an island of 4kV distribution and retired the 533S-Mason Street step-down. Reconfiguration of the feeders on Kings Road will allow the removal of a deteriorated off-road section of feeder 4S-333. A new feeder tie on Alexandra Street will create an additional 12kV supply into Membertou, which will allow balancing between existing feeders. These recommendations are unchanged in revision 3.

This study outlines the conversion of load from 6S-T1, in preparation for retirement of this substation. The first phases of conversions have been completed. The current 4kV breakers are being replaced with reclosers in 2015 to allow the substation to operate until its retirement. These recommendations are unchanged in revision 3.

The construction of a new 15/20/25MVA substation at the intersection of the transmission corridor and Gabarus Hwy will provide the long term solution for Membertou. This replaces the original recommendation for a 15MVA 138-12kV pad-mounted substation, as it does not meet the required capacity. Transmission planning study, 049-2013-TSMG, specified a 20MVA reduction of the 69kV load forecast in 2018, contingent on a new 138-12kV substation near Membertou. The release of this transmission study was the driver for revision 3 of this study.

A Distribution Automation study will be completed to outline future development of automatic transfer schemes in the Sydney area.

2.0 EXISTING SYSTEMS

2.1 Transmission

Presently, a transmission corridor exists from 2S-Victoria Junction to 101S-Woodbine. Prior to the corridor crossing the Louisburg Highway (Highway 22), one of the 138kV transmission lines, L-6539, separates from this corridor to join L-5564, which extends to 3S-Gannon Road. The System Operating Diagrams are attached, in Appendix A.

Table 1 Transmission Line Ratings

Transmission Line	Substation		MVA Rating	
	From	To	Summer	Winter
L-7011	88S-Lingan	3C-Port Hastings	298	383
L-7012	88S-Lingan	3C-Port Hastings	398	398
L-7014	88S-Lingan	101S-Woodbine	404	462
L-6516	2S-Victoria Junction	2C-Port Hastings	110	115
L-6539	2S-Victoria Junction	3S-Gannon Road	115	115
L-5564	2S-Victoria Junction	3S-Gannon Road	55	72
L-5563	2S-Victoria Junction	4S-Townsend Street	31	45
L-5560	2S-Victoria Junction	4S-Townsend Street	29	42
L-5569	4S-Townsend Street	6S-Terrace Street	43	43

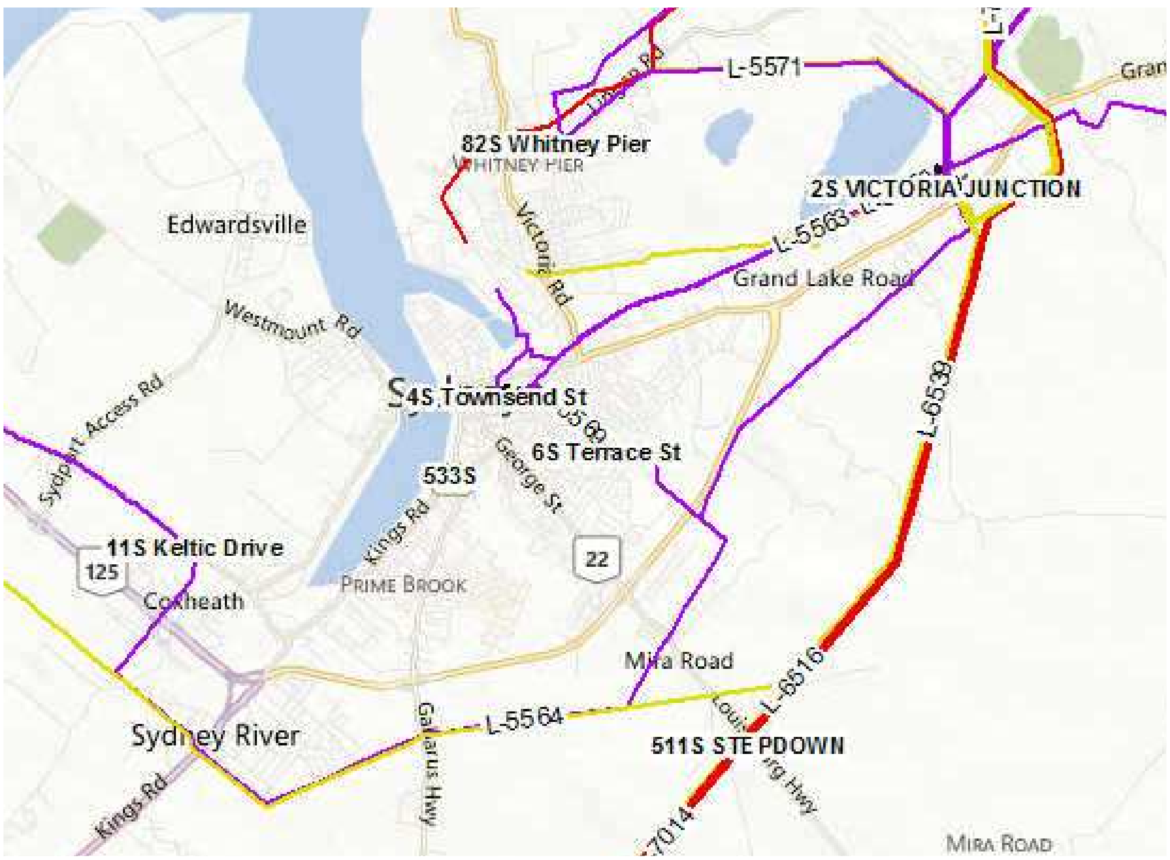


Figure 1 Industrial Cape Breton Transmission

2.2 Sub-Transmission

The sub-transmission system within the Sydney area operates at 69kV. It is supplied by three 138-72kV auto-transformers, two located at 2S-Victoria Junction and one located at 3S-Gannon Road. The System Operating Diagrams are attached, in Appendix A.

Table 2 Sydney Area Sub-Transmission

Substation	Auto-Transformer Data				
	ID	MAN	kV	Rating	Age
2S-Victoria Junction	T1	CGE.	138-72	60/80/100//112	1973
2S-Victoria Junction	T2	CGE.	138-72	60/80/100//112	1972
3S-Gannon Road	T1	CGE	138-72	30/40/50//56	1972

2.3 Distribution

The distribution system being studied in this report includes the 12kV feeders supplied from 4S-Townsend Street and 11S-Keltic Drive substation. The 4kV feeders supplied by the 6S-Terrace Street substation are also considered. The 25kV feeders from 11S-Keltic Dive have not been considered in this study.

Table 3 provides the transformer data for the substations that are directly impacted by the scope of this study.

Table 3 Sydney Area Distribution Transformers

Substation	Transformer Data				
	ID	MAN	kV	Rating	Age
4S-Townsend Street	T52	Federal Pioneer	69-12.47	15/20//24.6	1972
4S-Townsend Street	T53	Federal Pioneer	69-12.47	15/20//22.4	1973
6S-Terrace Street	T1	Moloney Electric	69-4.16	7.5/10	1969
11S-Keltic Drive	T51	Federal Pioneer	69-12.47	10/13.3//14.9	1972
11S-Keltic Drive	T52	Federal Pioneer	69-12.47	10/13//14.8	1972
11S-Keltic Drive	T53	Virginia Transformer	69-26.4	15/20/25	1999

2.3.1 533S-Mason Street

This area has been converted to 12kV as recommended in revision 2 of this study.

2.3.2 6S-Terrace Street

The lone transformer at the 6S-Terrace Street substation (6S-T1) was placed into service in 1969. This 69-4kV transformer is rated at 7.5/10MVA. The transformer annually peaks above 6MVA, with a recent maximum winter peak of 6.7MVA, recorded in the winter 2010 / 2011.The only suitable mobile transformer, in the NSPI fleet, is 3P-MS, which is rated at 6MVA, at 4kV. Given this, the mobile transformer is unable to assume the peak load on 6S-T1 without transferring a portion of customer load to 534S; the lone neighbouring 4kV stepdown transformer (near 4S-Townsend Street). While this response to a loss of 6S-T1 is feasible, it would extend the duration of the outage experienced by customers due to the failure of 6S-T1. The 4kV area covered by Terrace Street, as of 2014, can be found below in Figure 2. As per revision 2 of this study, this area has been partially converted as a short term solution. This reduces the load at 6S and allow mobile to be used in contingency situations. The remainder of the 4kV conversions will be planned for the future. See further details in the recommendations section.

The average age of the distribution plant in the area is greater than 40 years. At the present time, there is difficulty with maintaining the substation breakers due to the age and condition of the building structure. There is also an inability to source replacement components for the breakers themselves, representing a significant reliability concern. Replacement of these breakers is underway and will be completed in 2015. See further details in the recommendations section.

Figure 2 6S-Terrace Street extents as of 2014

3.0 LOAD HISTORY AND FORECAST

The loading for those feeders being studied is largely residential, with a small number of commercial customers. As illustrated in the load history for these feeders, Appendix B, the feeders being studied have had a larger winter peak than summer. Historical load data for the feeders and transformers studied in revision 2 was collected from the Distribution Load Check Database and presented in the tables below.

3.1 Load Forecast

Customer load has been generally consistent in the Sydney area, demonstrating a slight overall growth in recent years. That being stated, the community of Membertou has seen the largest growth in Sydney in recent years. This load growth is anticipated to continue for the next several years, due to the proposed developments outlined in subsequent sections of this study.

The growth rates indicated in following tables were determined through examination of the peak load check data over the past 15 years. The forecasted load growth was then calculated using the 90th percentile, to determine potential peak load growth in the area. The forecasted loading of the substation transformers are indicated in Table 7.

Table 4 90th Percentile Load Forecast for 4S-Townsend Street, in Amps (2014)

Year / Load Growth	4S-321	4S-322	4S-323	4S-324	4S-331	4S-332	4S-333	4S-334
Load Growth	**2.64%**	**-0.97%**	**1.48%**	**0.03%**	**2.76%**	**-0.05%**	**1.53%**	**2.72%**
2014 Peak	**234**	**188**	**256**	**290**	**118**	**279**	**244**	**67**
2014 / 2015	236	226	269	289	190	297	283	129
2015 / 2016	244	223	274	289	197	297	288	134
2016 / 2017	252	221	278	289	204	297	294	139
2017 / 2018	261	219	283	289	211	297	299	144
2018 / 2019	269	217	288	289	218	296	304	148
2019 / 2020	277	215	293	289	226	296	310	153
2020 / 2021	285	213	298	289	233	296	315	158
2021 / 2022	294	210	303	289	240	296	320	163
2022 / 2023	302	208	307	289	247	296	325	167
2023 / 2024	310	206	312	290	254	296	331	172
2024 / 2025	319	204	317	290	261	296	336	177
2025 / 2026	327	202	322	290	268	295	341	182
2026 / 2027	335	199	327	290	275	295	346	186
2027 / 2028	344	197	332	290	283	295	352	191
2028 / 2029	352	195	336	290	290	295	357	196
2029 / 2030	360	193	341	290	297	295	362	201

Note:

- 4S-331 supplies the 534S-Stepdown transformer, near 4S-Townsend Street.
- 4S-333 current supply to Membertou area and 533S-Mason Street.

Table 5 90th Percentile Load Forecast for 6S-Terrace Street, in Amps (2014)

Year / Load Growth	6S-221	6S-223	6S-224	6S-225
2014 Load Clip	**54**	**163**	**153**	**263**

Note:

- Load Clip measurements are presented for the 6S-Terrace Street feeders, as there isn't enough data to accurately forecast the load.
- These clip measurements were taken on a day with ambient temperature of -12^{o}C.

Table 6 **90th Percentile Load Forecast for 11S-Keltic Drive, in Amps (2014)**

Year / Load Growth	11S-301	11S-302	11S-303	11S-304	11S-305	11S-306
Load Growth	**0.83%**	**0.52%**	**0.57%**	**-0.53%**	**0.21%**	**0.61%**
2014 Peak	**190**	**240**	**240**	**210**	**300**	**244**
2013 / 2014	197	237	307	151	307	246
2014 / 2015	199	238	309	150	307	248
2015 / 2016	201	239	311	149	308	250
2016 / 2017	202	241	313	148	309	251
2017 / 2018	204	242	315	147	309	253
2018 / 2019	206	243	317	146	310	255
2019 / 2020	208	245	319	146	311	256
2020 / 2021	210	246	321	145	311	258
2021 / 2022	212	248	323	144	312	260
2022 / 2023	214	249	325	143	313	261
2023 / 2024	215	250	327	142	313	263
2024 / 2025	217	252	329	142	314	265
2025 / 2026	219	253	331	141	314	266
2026 / 2027	221	255	333	140	315	268
2027 / 2028	223	256	334	139	316	270
2028 / 2029	225	257	336	138	316	271

Note:

- 11S-305 is the alternate supply to the Membertou area.

Table 7 **90th Percentile Load Forecast for Sydney Transformers, in MVA (2014)**

Year / Load Growth	4S-T52	4S-T53	6S-T1	11S-T51	11S-T52
Load Growth	**0.42%**	**1.77%**	**-0.02%**	**0.51%**	**0.49%**
2014 Peak	**20.9**	**14.4**	**4.6***	**13.4**	**13.4**
2013 / 2014	20.8	19.3	6.5	15.4	15.2
2014 / 2015	20.9	19.7	6.5	15.5	15.2
2015 / 2016	21.0	20.2	6.5	15.6	15.3
2016 / 2017	21.0	20.6	6.5	15.7	15.4
2017 / 2018	21.1	21.0	6.5	15.8	15.5
2018 / 2019	21.2	21.4	6.5	15.9	15.6
2019 / 2020	21.3	21.9	6.5	16.0	15.6
2020 / 2021	21.4	22.3	6.5	16.1	15.7
2021 / 2022	21.5	22.7	6.5	16.1	15.8
2022 / 2023	21.6	23.1	6.5	16.2	15.9
2023 / 2024	21.7	23.6	6.5	16.3	16.0
2024 / 2025	21.8	24.0	6.5	16.4	16.1
2025 / 2026	21.9	24.4	6.5	16.5	16.1
2026 / 2027	22.0	24.8	6.5	16.6	16.2
2027 / 2028	22.1	25.3	6.5	16.7	16.3
2028 / 2029	22.2	25.7	6.5	16.8	16.4

Note:

- No Peak load data for 2014 available for 6S-T1, 2014 peak values have been indicated (*****).

4.0 OVERLOADS AND OTHER CONSIDERATIONS

The following section identifies issues that warrant correction based on NSPI's *Capital Expenditure Justification Criteria*.

4.1 Feeder Overloads

There are several feeders whose peak loading is approaching 325A. These peak values can be seen in the feeder histories, located in Appendix B. These feeders include

- 6S-224 consistently peaked above 300A,with a peak above 325A in 2010
- 6S-225 peaked above 300A, in 2003 and 2004
- 4S-321 peaked above 325A, in 2007

4.2 Contingency Loss of Supply

4.2.1 6S-T1

The lone transformer at 6S-Terrace Street, 6S-T1, has not exceeded its nameplate rating, in recent years; however the peak winter loading was exceeding the capacity of the mobile substation, 3P-MS, as of 2014. Conversions have been completed which should allow the mobile transformer to be used under peak loading conditions.

4.2.2 533S-Mason Street

This area was converted to 12kV and 533S transformer retired as per revision 2 of this study.

4.3 Age of Plant

The average age of poles and equipment in the Hardwood Hill area of Sydney is greater than 40 years old. Inspections have confirmed this equipment is at or is nearing full service life.

The current breakers at 6S-Terrace Street are obsolete. The breaker manufacturer is no longer in business. The sourcing of replacement components is nearly impossible. Added to this is the deteriorated condition of the breaker house. In the event of a breaker failure, the duration of an outage would be significant in length.

Replacement of deteriorated plant is underway, including the replacement of 6S breakers which will be completed in 2015. The remainder will be budgeted and completed in phases.

4.4 Proposed Load Growth

There are several areas of load growth in the Sydney area impacting this study. The two largest developments are detailed below.

4.4.1 Membertou Load Growth

The community of Membertou is in the midst of large growth, through commercial and residential developments within the community. The anticipated increase in load has been considered throughout this study. Future development plans in the community include:

- Multi-surface ice rink (construction commencing summer 2013)
- New School
- New overpass across Highway 125 related to a new multi-unit Business Park,
- Expanding residential housing areas

Currently there are three supplies into the area, via Churchill Drive and Membertou Street, as seen in Figure 3 and Figure 4. The two feeders capable of supplying the area from the Kings Road side of the development, 11S-305 and 4S-333, do not have excess capacity to serve this proposed growth. The third feeder, 4S-332, has less capacity than those feeders capable supplying from the other side of the development. From the 2011/2012 winter load checks these feeders were measured at 249amps, 269amps, and 292amps respectively. Accordingly, a prolonged outage of one of these feeders could result in an extended customer outage, as the remaining feeders cannot support the peak winter load.

Figure 3 **Feeders Currently Serving Membertou from Kings Road area**

Figure 4 Feeder Currently Serving Membertou from George Street area

4.4.2 Cossitt Heights New Housing Development

A new housing development is planned for the Cossitt Heights area. This new subdivision is approximately 114 Acres and is slated to have both detached homes and multi-unit dwellings. This load will be added to one of the following feeders; 4S-324 or 4S-331. The area of this proposed development is shown below, in Figure 5.

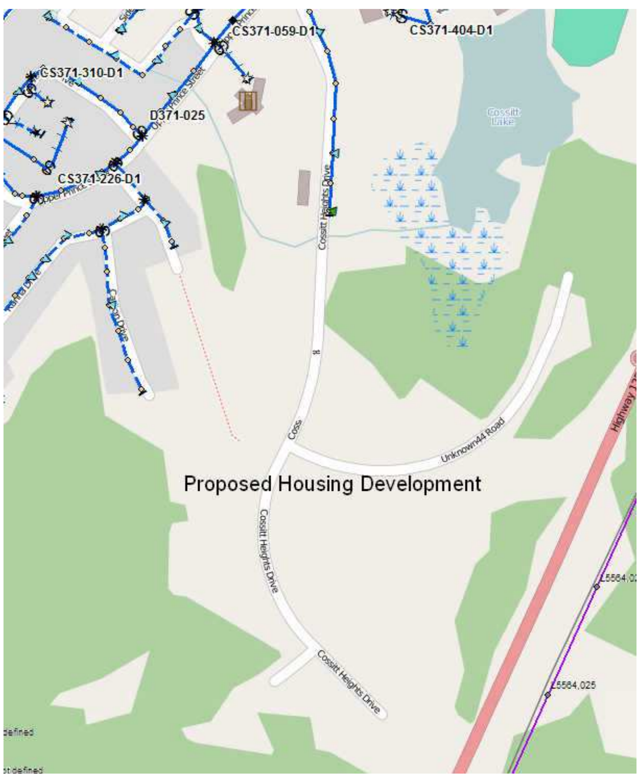


Figure 5 Cossitt Heights Residential Development

5.0 SOLUTIONS AND EVALUATION

Membertou is in the midst of large growth, in both residential and commercial developments. Due to the proposed and developing construction, the amount of expected load will exceed the existing capacity available. NSPI is obligated to accommodate this increased load growth, both in the short and long term.

The short term solution to meet this load growth is to create an additional supply into Membertou via existing distribution feeders. This is underway and the additional feeder, 4S-334, will pick up load from Membertou in 2015. Remainder of work will be completed in 2016, which will remove deteriorated off-road sections of 4S-333.

The longer term solution is to construct a new substation to supply this growing load and provide additional contingency to the distribution system in Sydney.

5.1 Mason Street

Currently, there are three feeders capable of supplying the Membertou area: 11S-305, 4S-333 and 4S-332. Two of these feeders, 11S-305 and 4S-333 supply Membertou from the Alexandra Street. 4S-332 enters from the George Street side of the community, but does not supply load in Membertou. Presently, these three feeders are heavily loaded, with 4S-332 serving as the primary supply for the Cape Breton Regional Hospital. Reducing the load on the existing feeder supplying Membertou or the extension of another feeder into Membertou is required to meet the forthcoming load, currently in the early project stages.

There were four alternatives outlined in revision 2 of this study. Alternative 533S-B was selected and capital work is in progress. The Mason Street area has been converted to 12kV and the step-down transformer (533S) has been retired. An additional feeder, 4S-334, will pick up Membertou load in 2015. Work will be completed in 2016 which will allow remaining deteriorated off-road sections of feeder 4S-333 to be removed. Full details of Alternative 533S-B are outlined below. Other alternatives have been removed in this revision.

5.1.1 Alternative 533S-B Convert 533S-Mason Street, via Bentinck Street

Alternative 533S-B would see the supply on Kings Road between School Street and Churchill Drive change from 4S-333 to 4S-334. This alternative would also see the conversion to 12kV of the islanded 4kV supplied by 533S-Mason Street to 12kV. Also included in this alternative would be the creation of another supply into Membertou via Towerview Place. Refer to Figure 6 for an overview of this proposed work.

Currently, Kings Road is supplied by 4S-333 which has a large off-road section, between Townsend Street and Kings Road. This off-road section is along the existing railway tracks, limiting access and prolonging response time to faults on this section of line. This off-road section is deteriorated and approaching its end of service life. Feeder 4S-334 currently supplies a portion of Kings Road from Falmouth Street to just prior to School Street; extending 4S-334 along Kings Road would be accomplished through the reconfiguration of the distribution at the Kings Road and School Street intersection. This reconfiguration would enable the use of a lightly loaded feeder, 4S-334, to supply Kings Road and Membertou.

In addition to resupplying a portion of Kings Road, the removal of the islanded 4kV supplied by 533S-Mason Street would also be addressed. The conversion, as outlined in Alternative 533S-A would entail the conversion of the lone 4kV feeder, 533S-211, to 12kV. Supplying this new section of 12kV would be accomplished through the rebuilding of Bentinck Street and supplying Argyle Street via 4S-333.

With the newly converted section of 4S-333 along Alexandra Street, the opportunity exists to create an additional supply into Membertou, as outlined in Alternative 533S-A, through the extension and rebuilding of Alexandra Street from Xavier Drive to Castle Drive. Extending the 3 phase circuit along Towerview Place to the Millard Street intersection would bring a second lightly loaded feeder into Membertou, 4S-333.

The detailed outline of this conversion and feeder tie creation is outlined in the recommendations section of this study.

Figure 6 **Alternative 533S-B** **Reconfigure Shipyard Supply**

5.2 6S-Terrace Street

The substation infrastructure at the 6S-Terrace Street substation is approaching its end of service life. In order to extend the service life of the substation, the replacement of the existing breakers with reclosers is required. In order to facilitate the replacement of these breakers, an overall reduction of load on 6S-T1 is necessary. Additionally, the 4kV distribution plant supplied by 6S-Terrace Street is approaching end of service life. This eventually leads to the planned retirement of 6S-T1 upon completion of the 4kV conversion.

There were three alternatives outlined in revision 2 of this study. These alternatives explored the timing conversions and retirement date for 6S. The fourth alternative to rebuild 6S with a new 69-4kV transformer was not considered since the 4kV voltage level is being phase out in Nova Scotia. The sections on each alternative have been removed in this revision as they only spoke to the timing of the recommended work.

The recommended solution would see retirement of 6S-Terrace Street by 2021. Capital work is in progress: initial 4kV to 12kV conversions are complete, which allow the mobile transformer to be installed under peak conditions, without the need to transfer a portion of the load to 534S. Upgrades to 6S will be completed in 2015, as outlined in recommendations section. The retirement of 6S-Terrace Street is planned for 2021, but this will depend on completion of remaining conversions which are dependent on the progress of other capital work outlined in this study.

5.3 Sydney Transformation

To meet the anticipated load growth in the Membertou area, a new source in Sydney will be required. Given the layouts at both 4S-Townsend Street and 11S-Keltic Drive, the ability to install additional feeders to supply developing load would be quite difficult. It makes sense to have a new source close to developing load.

Revision 2 of this study recommended Alternative Sub-D, the installation of a 15MVA 138-12kV pad-mounted substation at the intersection of existing 138kV transmission corridor and George Street. This recommendation has been re-evaluated since the release of transmission study, 049-2013-TSMG, which indicated a 20MVA reduction on the 69kV load forecast in 2018. The location of this substation was also revised due to issues with the purchase of land at this location. The new proposed location for alternatives Sub-A and Sub-D will be at intersection of Gabarus Hwy and existing 138kV transmission corridor – in Prime Brook. The construction year for all options was also revised to 2016.

The details of the four alternative solutions are outlined in further detail below.

5.3.1 Alternative Sub-A New Substation in Prime Brook

This alternative would address growth in Membertou with construction of a new 15/20/25MVA substation near the transmission right-of-way. This new 138-12kV substation would need to be in service prior to the end of 2016 to meet the developing load in the area. This substation would allow for the offloading of the the 69kV system. The location of this new substation would be near the intersection of existing transmission corridor and Gabarus Hwy. In constructing this substation, an additional 12kV supply would be added to the Sydney area for additional contingency to meet the load growth in the Membertou area. Creating a tap off of L-6539 would remove load from the existing 69kV loop that feeds 4S-Townsend Street, 6S-Terrace Street and 11S-Keltic Drive via 2S-Victoria Junction or 3S-Ganon Road.

Initially 4 new 12kV feeders would be able to provide new feeds to the Membertou community, as well as George Street and Alexandra Street. Additional feeders could be used to reduce loading or for contingency purposes for both 4S-Townsend Street and 11S-Keltic Drive feeders, further reducing loading on the 69kV.

In order for this alternative to proceed, land would need to be acquired and a new tap off of L-6539 would need to be engineered. In addition to this preliminary work, further investigation into the substation design would need to be considered. Refer to Figure 7 below for a proposed location.

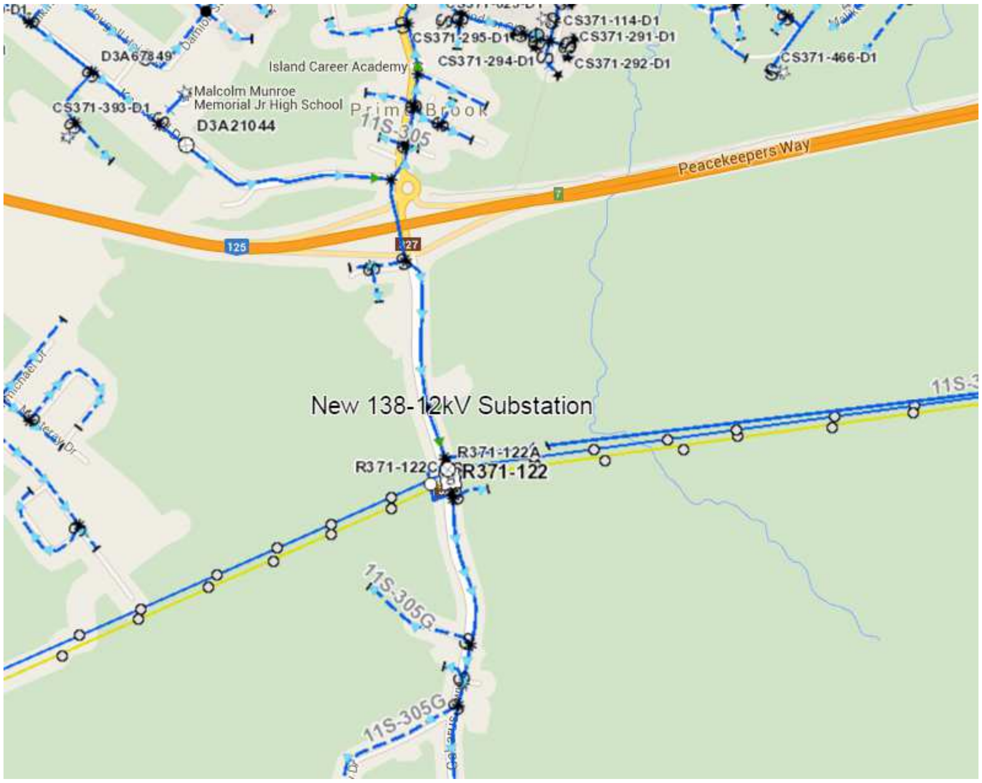


Figure 7Alternative Sub-A Construct New Substation in Prime Brook

5.3.2 Alternative Sub-B New 138-25kV Substation in Prime Brook

Similarly to Alternative Sub-A, the construction of a new substation near the transmission right-of-way would be capable of supplying the newly developing load in the Membertou area. Construction of the new 15/20/25MVA 138-25kV substation would be off of the Highway 327, near the transmission corridor and within close proximity to the existing 25kV distribution feeders in Sydney River. In constructing this substation, an additional 15/20/25MVA 25kV supply would be added to the Sydney area for additional contingency of 11S-Keltic Drive and to meet the load growth in the Membertou area. Creating a tap off of L-6539 would transfer existing load from the 69kV loop that supplies 4S-Townsend Street, 6S-Terrace Street and 11S-Keltic Drive, via 2S-Victoria Junction or 3S-Ganon Road. The loading on the 69kV loop would be further reduced with future customer conversions from 12kV to 25kV, in Sydney River and on Alexandra Street.

These new 25kV feeders would be able to provide feeders directly to the new growth in Membertou. Conversion of portions of Sydney River would enable the creation of new feeder ties between the new feeders and 11S-Keltic Drive 25kV feeders.

In order for this alternative to proceed land would need to be acquired and a new tap off of L-6539 would need to be engineered. In addition to this preliminary work, further investigation into the substation design would need to be considered. Refer to below Figure 8 for a proposed location.

Figure 8Alternative Sub-B Construct New Substation on Alexandra Street

5.3.3 Alternative Sub-C New 69-12kV transformer at 6S-Terrace Street

To meet the planned growth in Membertou, a new 69-12kV 7.5/10/12.5MVA power transformer would be installed, at the 6S-Terrace Street property, in 2015. This new transformer would initially be limited to loading, as the existing 4kV load is reduced. The new transformer would assume the load of the current 4kV transformer, upon load conversions to 12kV.This new transformer would also provide an alternate supply to the George Street area.

Another substation, possibly a padmount design would be required to further supply the Membertou load as it continues to materialize. The padmount substation would require a smaller footprint and be able to supply an additional two feeders to the developing load. It is estimated that this substation would be required in 2017, as the load growth continues, in Membertou. Annual monitoring of the load growth in the Sydney area would be required to ensure that the installation of additional transformation in the area coincides with the continued load growth in the area.
Refer to Figure 9 for an overview of the area.

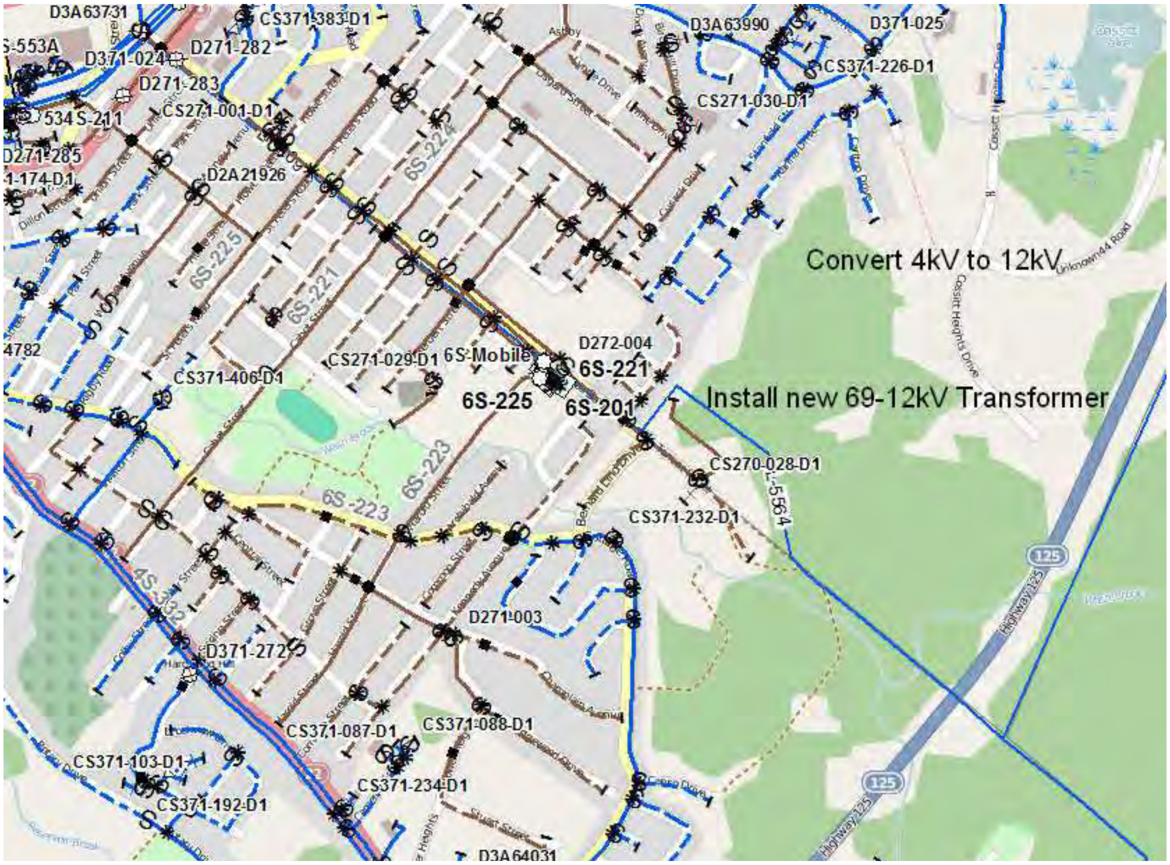


Figure 9 **Alternative Sub-C** **Install New 69-12kV Transformer**

5.3.4 Alternative Sub-D New 138-12kV Pad-Mounted Substation

This alternative is similar to Alternative Sub-A, in that a new 15MVA 12kV source would be constructed near the 138kV transmission corridor and George Street. Refer to Figure 10 below. The alternatives differ, in that this substation will have less capacity and be pad-mounted in design. The new 15MVA transformer would be supplied via a new tap off of L-6539, one of the 138kV transmission lines in the area. This substation would require less space than a traditional substation and does not require a substation fence, as all of the equipment is dead-front.

Unlike Alternative Sub-A, only three feeders would be supplied via this substation. One of these feeders would supply Membertou via a new highway crossing. This feeder will reduce the loading on the existing Membertou supply (4S-333). The second feeder will continue along the transmission Right of Way (ROW) to Alexandra Street. Load from 11S-305 will be transferred to this new feeder, allowing for a load reduction on 11S-305. The third feeder will extend to George Street and assume a portion of the loading along George Street.

As the load continues to grow, in both the Sydney and Membertou area, continual monitoring will indicate the need for any future additional transformation in the area. Given the modularity of the pad-mounted substation, future installations could occur near the 138kV transmission line, closer to the developing load center, when required. Initially, it was thought that expansion would not be required until 2027, but due to transmission planning requirements, an additional transformer would be required in 2018.

As with the introduction of any new equipment, spare components will be required with the initial purchase, but not necessarily for subsequent applications.

Figure 10 **Alternative Sub-D** **New 138-12kV Pad-Mounted Substation**

5.3.5 Sydney Transformation Recommendation

Alternative Sub-D was the least cost option when the Economic Assessment was completed in revision 2 (see Appendix C). With the requirement to remove 20MVA from the 69kV forecast by 2018, an additional pad-mounted transformer must be planned in the short term, rather than 2027. By moving the second pad-mount expansion to 2018, the cost of alternative Sub-D does not offer economic advantage over alternative Sub-A. The additional advantages to alternative Sub-A make it the best choice:

- Less risk due to standard substation construction
- No new spare equipment required
- Standard substation can accommodate mobile transformer, whereas pad-mounted option cannot

A detailed outline of conversions and substation construction is outlined in the recommendations section of this study.

6.0 RECOMMENDATIONS

In summary, the following provide the impetus for the recommendations contained herein:

- The existing feeders supplying the Membertou area are at or near their criteria limits and cannot be utilized to supply the long term capacity needs of Membertou.
- Membertou load growth is forecasted to continue as there are plans for a retail centre adjacent to Hwy125 at the site of the new highway interchange presently under construction
- The 4kV distribution facilities at 6S-Terrace Street are nearing their end of life and key components are obsolete, exposing customers to prolonged outages.
- The 4kV distribution facilities at 533S-Mason Street and 6S-Terrace Street are islanded 4kV that are susceptible to prolonged outages as load cannot be transferred to an adjacent feeder.
- Transmission study has indicated the need to remove 20MVA from 69kV system peak

This study revision does not recommend any change to the capital work underway for the conversion of 533S-Mason Street, as outlined in Alternative 533-B, section 5.1.1.

The recommendation for 4kV conversion and retirement of 6S-Terrace Street is unchanged in this revision. The Economic Assessment Model, refer to Appendix C, recommends the conversions of the 4kV distribution supplied by 6S-Terrace Street be converted to 12kV by 2020, as outlined in Alternative 6S-C, in section 5.2.3. Upon completion of these conversions, the 6S-Terrace Street substation will be retired. The advancement or deferment of these projects may be influenced by factors including: residential/commercial development, feeder reconfigurations and/or ranking of capital projects within the ACE plan.

The second Economic Assessment Model, refer to Appendix D, recommends the installation of a pad-mounted substation, with three feeders prior to the 2015/2016 winter peak. This has been re-evaluated in revision 3 of this study, as outlined in section 5.3. The new recommendation will be for a standard 15/20/25MVA substation constructed in 2016. This added transformation in the Sydney area will meet the area load growth for the next several years and allow for 20MVA reduction of forecasted peak load on 69kV system.

A detailed outline of the components of each of these alternatives is outlined below, organized by capital year completion. The originally recommended capital years were left intact for items that were not modified within this revision of the study. Comments were added to indicate the progress of each recommendation.

6.1 Recommendations by Capital Year

6.1.1 2013 Capital Year

The capital items to be completed in 2013 include the work associated with the conversion of 533S-Mason Street, as well as the work associated with the reduction of 4kV load at 6S-Terrace Street, to enable the retirement of the existing breakers at the substation.

The Shipyard Area Reconfigure and Mason Street Conversion were grouped as one capital item that is well underway. Full completion expected in summer 2015.

The Cabot Street and Rockdale Avenue conversions are complete and the 6S-Terrace Street substation upgrades are in their final stages.

6.1.1.1 Shipyard Area Reconfigure

This portion of the project outlines the change of supply within the Shipyard area, of Sydney. The supply for Kings Road will be changed from 4S-333 to 4S-334.The supply for Argyle Street will also be changed from 4S-321 to 4S-333. Refer to Figure 11 below. The details of this work are as follows:

- Dead-end 4S-333 adjacent to railway tracks, at Bentinck Street and open.
- Jumper 4S-334, to the existing 4S-333, on Kings Road.
- Remove the de-energized section of 4S-333, adjacent to the railway tracks, from Kings Road to Bentinck Street.
- Rebuild Bentinck Street, from Crescent Street to Argyle Street, to 3 phases.
- Open Argyle Street at George Street.

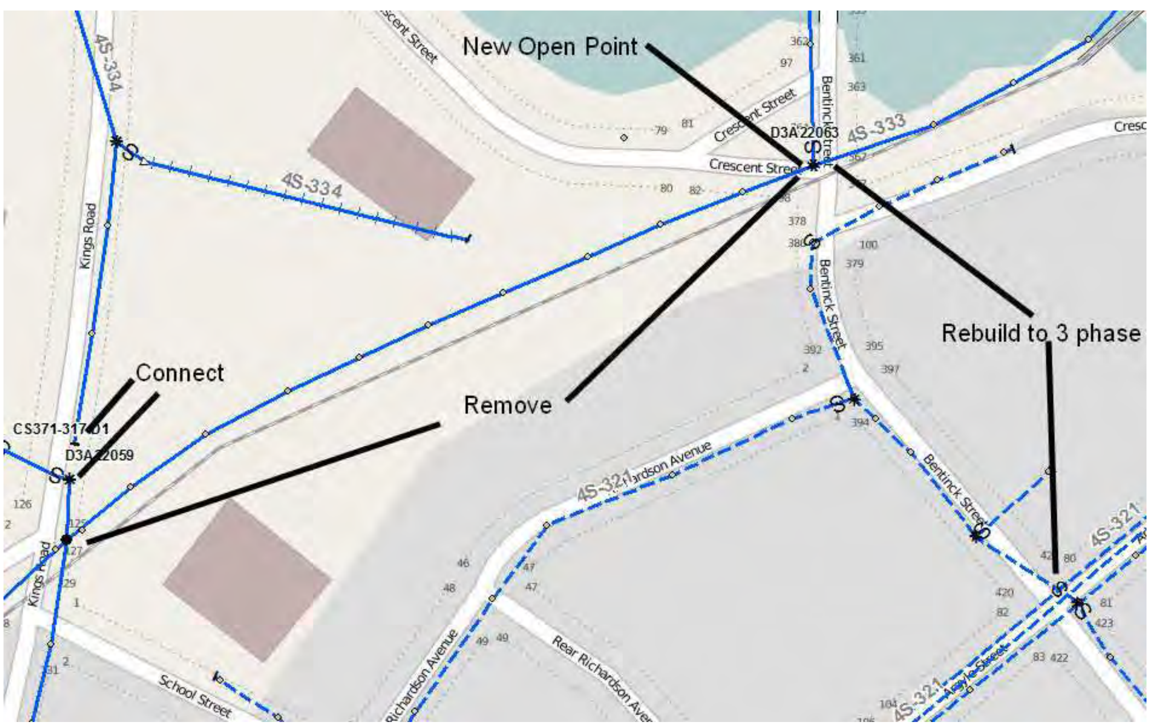


Figure 11 **2013 Reconfigure Supply to Shipyard Area**

6.1.1.2 533S- Mason Street Conversion

This portion of the project will convert 533S-Mason Street changing the supply to the area from Kings Road to Argyle Street. This portion of the project will also see the removal of the 533S-Mason Street stepdown, upon completion of the conversion to 12kV. Upon completion of this portion of the project, Alexandra Street will be supplied by 4S-333 from Yendys Street to Harbourview Drive. Refer to Figure 12 below. The details are as follows;

- Reconductor Mason Street to 336.
- Open Mason Street, at Kings Road
- Close D3A19725 on Argyle Street, at Kent Street
- Replace neutral on Argyle Street and Yendys Streets to 4/0.
- Reconductor primary and neutral on Xavier Drive to 2/0ACSR.
- Remove single phase primary on Xavier Drive.
- Convert area from 4kV to 12kV.

Figure 12 2013 533S-Mason Street Conversion

6.1.1.3 Cabot Street Conversion

This portion of the project will convert Cabot Street, north of Terrace Street. This conversion, along with the Rockdale Avenue conversion, will reduce the load on 6S-T1, to enable the installation of the mobile substation, minimizing the requirement to transfer load to 534S. Refer to Figure 13 below. This will be accomplished by:

- Fill in the gap on Cabot Street and Upper Prince Street
- Create open point at Cabot and Terrace.
- Install open point on Cornwallis Street at McConnell Drive.
- Convert shaded areas, including side streets.

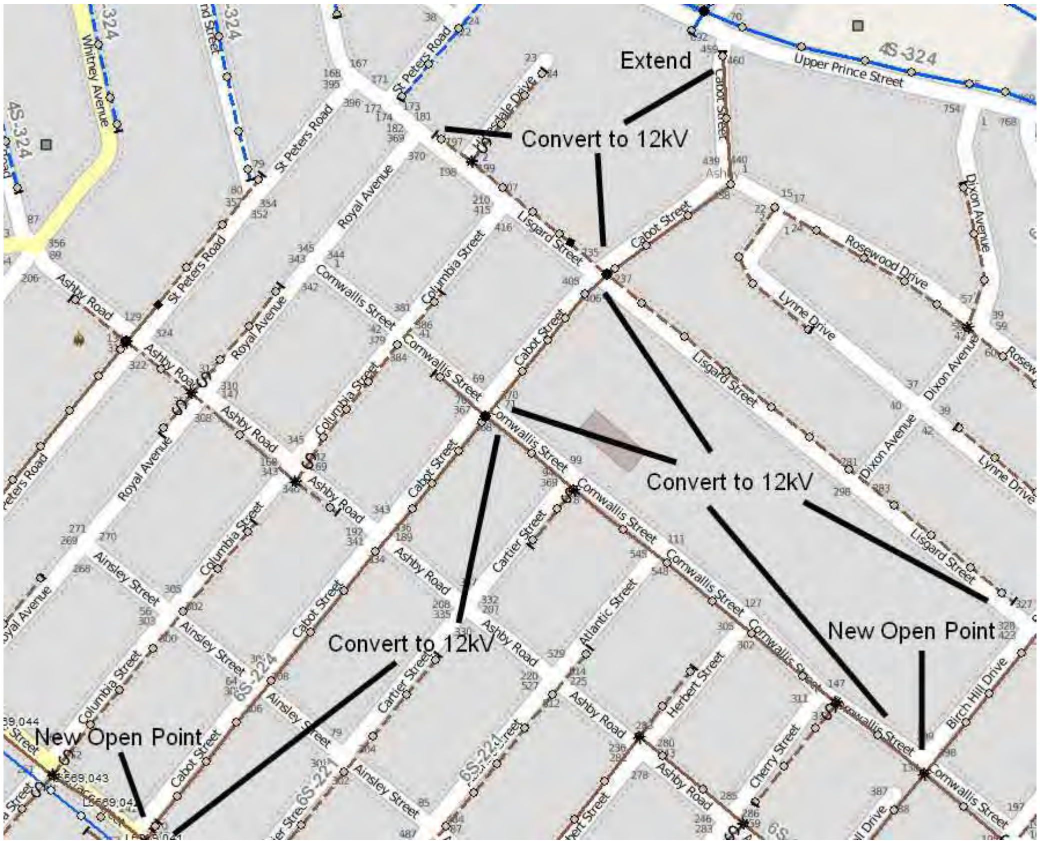


Figure 13 2013 Cabot Street Conversion

6.1.1.4 Rockdale Avenue Conversion

This portion of the project will convert Rockdale Avenue and Cottage Road to Harold Street. This phase of the project will further reduce the overall load on 6S-T1, reducing the need to transfer customer load to 534S, when the mobile substation is installed. Refer to Figure 14 below. This will be accomplished by:

- Close switch at Oxford Street onto George Street.
- Install cutout, on single phase along Cottage Road, at the intersection with Oxford Street.
- Open Harold and Cottage Road.
- Convert Oxford Street, to open point on Cottage Road, from 4kV to 12kV.
- Convert Rockdale Avenue, Champlain Avenue and Cottage Road, to Harold Street, including all side streets and branch lines, as indicated in Figure 14.

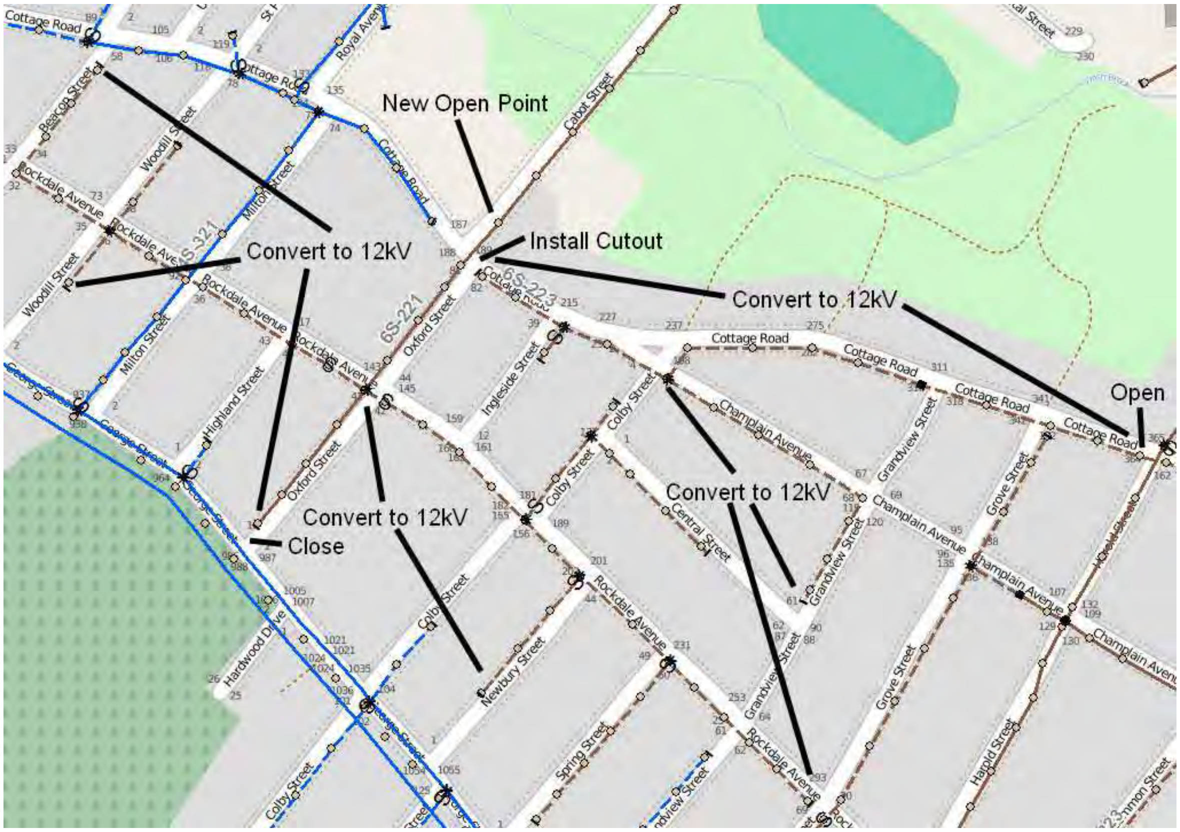


Figure 14 2013 Rockdale Conversion

6.1.1.5 6S-Terrace Street Substation Upgrades

This portion of the project will see the removal of the existing switchgear building, as well as the installation of pole mounted reclosers. This will be accomplished by:

- Installation of three dedicated power cables and buried ducts.
- The installation of three temporary pole mounted reclosers, to be supplied from new power cables.
- Removal of existing 4kV switchgear and building.

6.1.2 2014 Capital Year

The 2014 capital year includes completion of the reconfiguration of the Shipyard area supply, as well as the construction of a new feeder tie into Membertou. This continuation of work will increase the reliability and contingency within the Shipyard and Membertou areas.

The Membertou feeder tie has been completed and the new open point on Kings Road will be done in the summer of 2015. The Bentinck Street upgrades have been deferred until 2016.

New George Street pad-mounted substation preliminary engineering work has been removed.

6.1.2.1 Bentinck Street Upgrades

This portion of the project will upgrade the remaining conductor on Bentinck Street, to enable the removal of the remaining off-road section of feeder, along the railway tracks. This feeder 4S-333, is deteriorated and approaching its end of life. Rebuilding Bentinck Street and reconductoring the previously retired 4kV conductor on Townsend Street will enable 4S-333 to be adjacent to the road, from the substation to the majority of the load it supplies. Refer to Figure 15 below. The details are as follows:

- Reconductor Bentinck Street, from Crescent Street to Townsend Street.
- Reconductor lower circuit on Townsend Street, from 4S-Townsend Street to Bentinck Street, with 336.
- Remove 4S-333, adjacent to the railway tracks, from Bentinck Street to Townsend Street, except for the first two spans from George Street towards Townsend Street.
- Install new 3 phase tap from the remaining portion of 4S-333 to the top circuit along George Street, to supply the customers at the start of Glenwood Street.

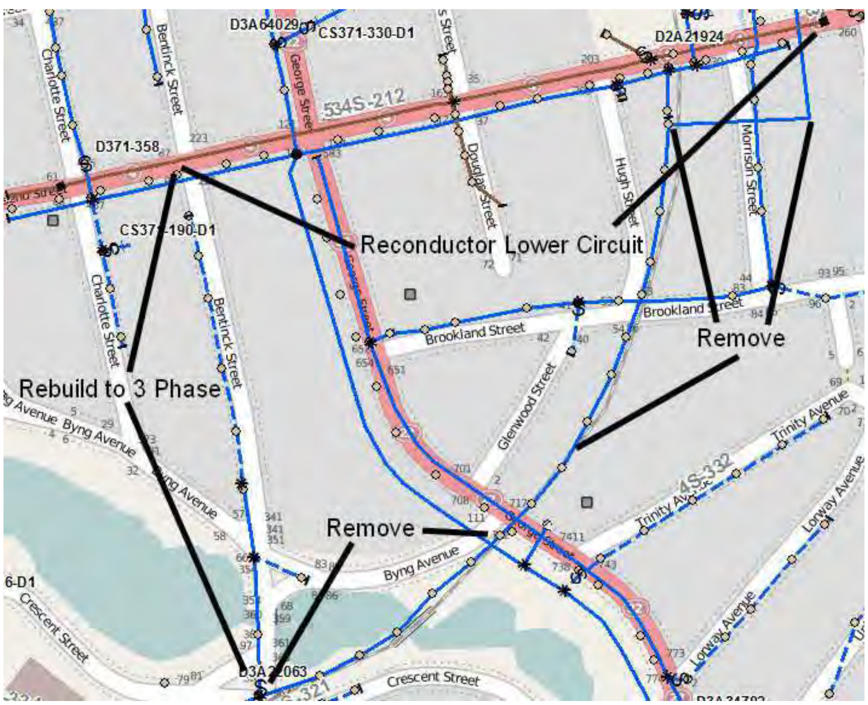


Figure 15 2014 Bentinck Street Upgrades

6.1.2.2 Membertou Feeder Tie

This portion of the project will see the creation of a feeder tie between the recently converted portion of Alexandra Street and the existing feeder on Alexandra Street. Also included in this portion of work is the construction of an additional feeder tie with the primary Membertou supply, on Maillard Street. Refer to Figure 16 below. The details are as follows:

- Extend newly converted 12kV (4S-333) along Alexandra Street to St. Anthony Drive, reconductoring from St Anthony Drive to the new open point with 336.
- Create new, normally closed, solid blade, sectionalizing point on Alexandra Street, at Xavier Drive.
- Create new open point on Alexandra Street, between Castle Drive and Harbourview Drive.
- Reconductor Towerview Place and extend to Maillard Street.
- Create new open point, on Maillard Street, on the north side of the intersection of Churchill Drive and Maillard Street.

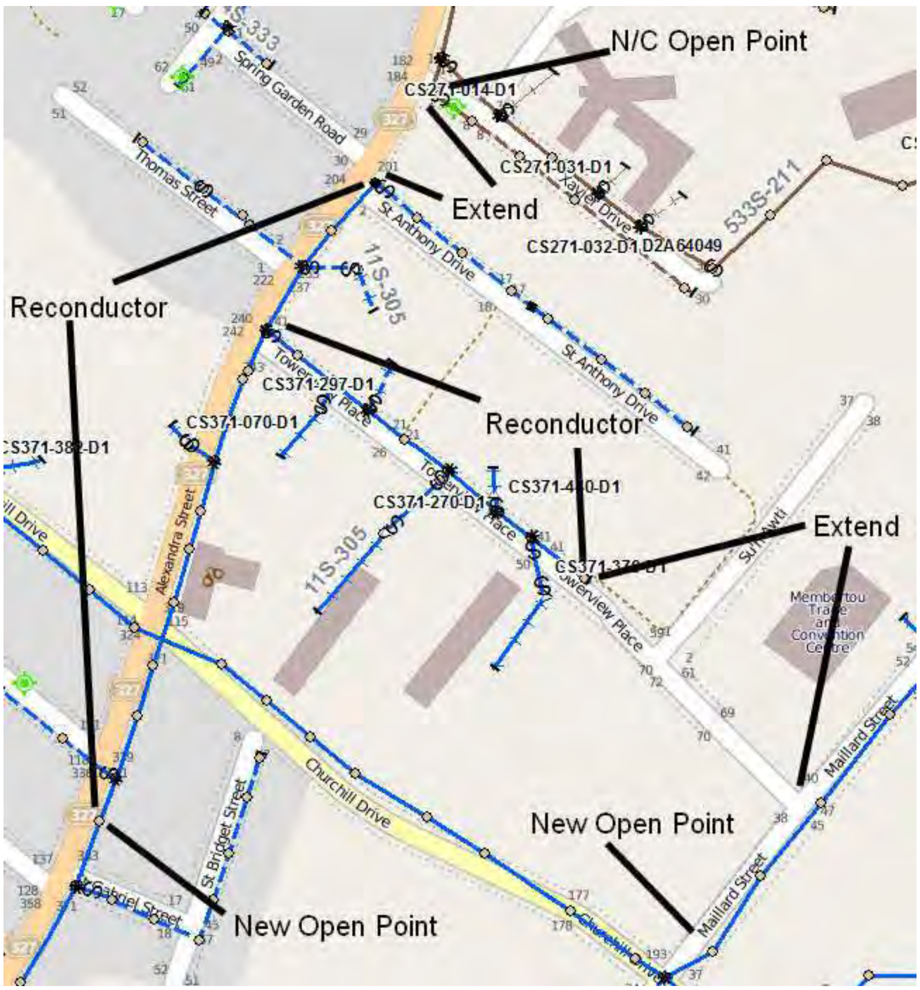


Figure 16 2014 Membertou Feeder Tie

6.1.2.3 New Kings Road Open Point

This portion of the project will enable the transfer of a portion of load from 4S-Townsend Street to 11S-Keltic Drive. This load transfer will reduce the overall loading on 4S-334 that will be supplying Membertou via Churchill Drive. Refer to Figure 17 below. The details are as follows:

- Install new open point on Kings Road, between Harbourview Drive and Churchill Drive.

Figure 17 2014 Kings Road Open Point

6.1.3 2015 Capital Year

The capital 2015 work includes the completion of items noted above in 2013 and 2014 Capital Year sections, as well as the preliminary engineering of the new Prime Brook substation. Further 4kV to 12kV conversions at 6S-Terrace Street will be deferred until after substation construction.

6.1.3.1 New Prime Brook Substation Preliminary Work

This portion of the project will detail the preliminary work required with the construction of the new 15/20/25MVA 138-12kV substation on Gabarus Hwy, near the intersection of the 138kV and 69kV transmission lines, L-6539 and L-5564. Refer to Figure 18 below. This will be accomplished by:

- Secure land rights to new substation location.
- Completion of the substation engineering and sourcing of long lead items.

6.1.4 2016 Capital Year

6.1.4.1 New Prime Brook Substation Construction

This portion of the project will detail the construction of the new 15/20/25MVA 138-12kV substation in Prime Brook. Refer to Figure 18 below. This will be accomplished by:

- Construction of a new tap off of L-6539 and the installation of associated equipment.
- Construction of 15/20/25MVA 138-12kV substation and associated equipment.

6.1.4.2 New Prime Brook Substation Feeders

This portion of the project will construct the new feeders, from the new Prime Brook substation. Refer to Figure 18 below. This will be accomplished by:

- Four new feeder exits will be created.
- The first feeder will connect to existing 11S-305 feeder on Gabarus Hwy.
- Existing 11S-305 feeder along transmission ROW will be rebuilt to double circuit which will extend from the substation to George Street and toward Highway 125 up to existing highway crossing. One feeder will tie to existing 4S-321 feeder at highway crossing. The other feeder will extend beyond existing highway crossing and tie to existing 4S-332 feeder. The location of R371-103 will be determined in a subsequent distribution protection study.
- The fourth feeder will extend north of the substation and use existing ducting to cross Highway 125 and tie to existing 4S-333 feeder on Tupsi Drive.

Figure 18 **2016 New Prime Brook Substation**

6.1.5 2017 Capital Year

Remaining 4kV to 12kV conversions will be dependent on the completion of Prime Brook substation. These conversions have been redistributed based on the new timeline for substation construction. The 2021 retirement of 6S-Terrace Street substation has been maintained.

6.1.5.1 Harold Street Conversion

This portion of the project will see the conversion of the Harold Street area, south of the 6S-Terrace Street substation. This will also include the conversion of the remaining sections of Champlain Avenue, Cottage Road and adjacent streets. This new conversion will be supplied via one of the 12kV feeders, on George Street. The off-road section of the existing 4kV feeder will be removed, between Harold Street and Holly Street. Holly Street will remain at 4kV. Refer to Figure 19below. This will be accomplished through the following:

- Create new N/C open point on Harold Street at George Street.
- Rebuild Cottage Road to Bernard Lind Drive with 3phase, 336ACSR.
- Create a new open point on Cottage Road, at Bernard Lind.
- Convert east of Harold Street to 12kV, as well as Grove Street.
- Remove off-road portion of feeder between Harold Street and Holy Street.
- Extend one phase on Holly Street to Terrace Street and remove the remaining two phases.
- Remove 2 phases from Harold Street, from Cottage Road towards Holly Street.

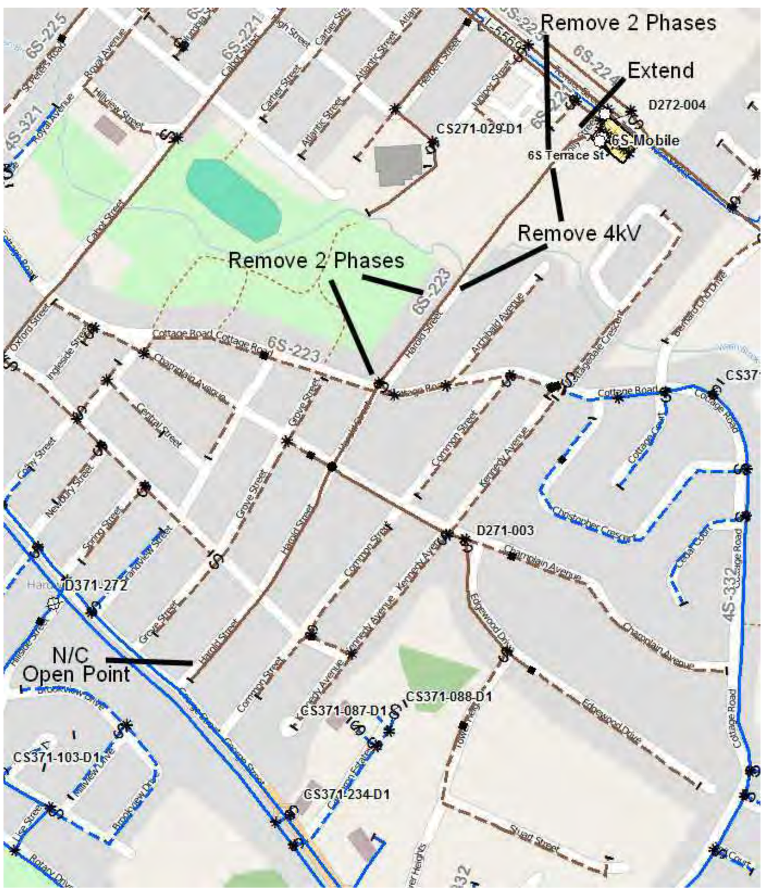


Figure 19 **2015 Harold Street Conversion**

6.1.5.2 Bernard Lind Drive Rebuild

This portion of the project will convert Terrace Street, east of the 6S-Terrace Street substation. This portion of the project will also see the addition of two phases along Bernard Lind Drive, supplying the area via Cottage Road. Refer to Figure 20 below. This will be accomplished by:

- Rebuild Bernard Lind Drive with three phase 4/0 primary and 4/0 neutral, from Cottage Road to Terrace Street.
- Install a new open point east of the 6S-Terrace Street substation.
- Convert Terrace Street east of the 6S-Terrace Street substation.
- Create new Open Point at the end of Bernard Lind Drive and Cottage Road.

Figure 20 **2016 Bernard Lind Rebuild**

6.1.6 2018 Capital Year

6.1.6.1 Birch Hill Drive Conversion

This portion of the project will convert Birch Hill Drive and its side streets from 4kV to 12kV. This newly converted section will be supplied via 4S-324. Refer to Figure 21 below. The details are as follows;

- Extend 3phase on Birch Hill Drive to Upper Prince Street.
- Create new N/C open point at the intersection of Birch Hill Drive and Upper Prince Street.
- Convert Birch Hill Drive, McConnell Drive, Ashby Road and Herbert Street to Terrace Street, including side streets, from 4kV to 12kV.
- Change supply of Herbert Street, south of Terrace Street, to 6S-221. This portion of the street will be converted in a following portion of work.

Figure 21 2017 Birch Hill Drive Conversion

6.1.6.2 Townsend Street Conversion

This portion of the project will convert the 4kV customer load on Terrace Street, from St. Peters Road to Townsend Street. The load will be supplied via 4S-324, until the remaining section of Terrace Street is converted. High Street, from St. Peters Road to Townsend Street will continue to be supplied via 6S-225. Refer to Figure 22 below. The details are as follows;

- Install open point on Terrace Street, between Howe Street and St. Peters Road.
- Open Howe Street, between High Street and Terrace Street.
- Install new open point on the north side of the Howe Street and High Street intersection.
- Install new tap on south Howe Street, to High Street.
- Open D271-283.
- Extend High Street to St Peters Road.
- Install new open point on Park Street, at Terrace Street.
- Convert Terrace Street, from St. Peters Road to Townsend Street, as well as the side streets indicated in Figure 22.

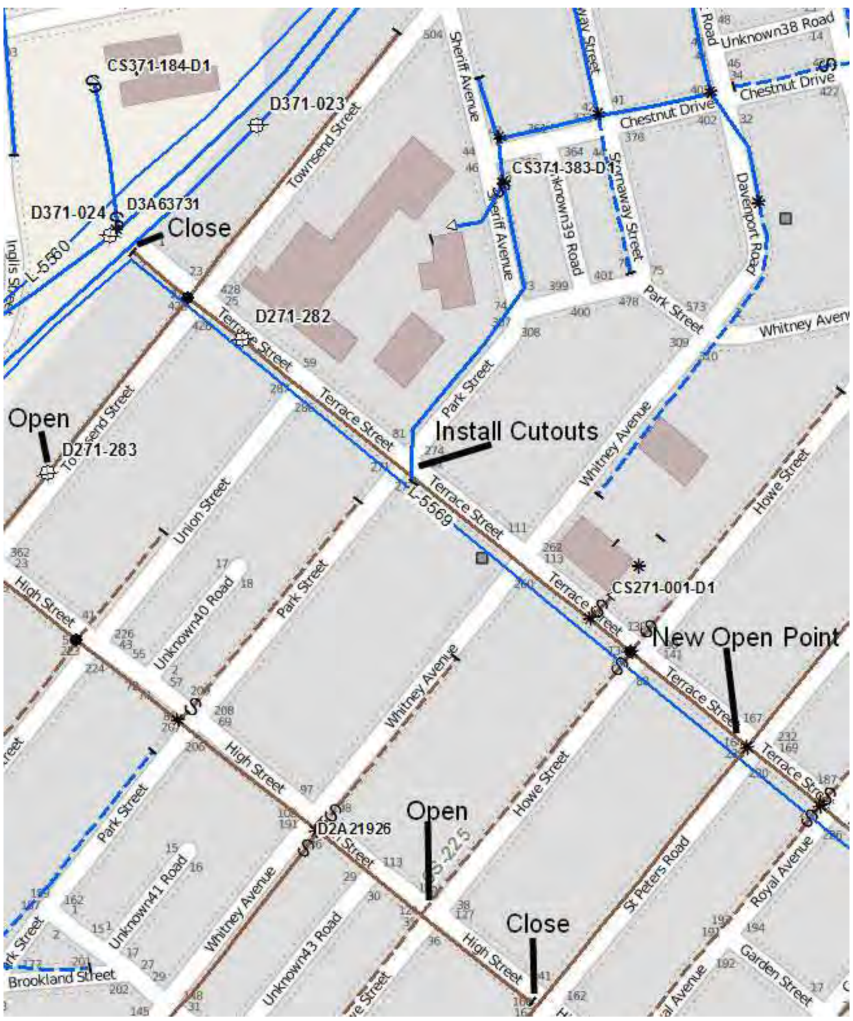


Figure 22 2018 Townsend Street Conversion

6.1.7 2019 Capital Year

6.1.7.1 High Street Conversion

This portion of the project will convert the High Street area, from 4kV to 12kV. The load will be supplied by 4S-324, via the open point on Townsend Street. Upon completion of this portion of work, the 534S stepdown will be removed from service, as there will be no load able to be transferred to it. Refer to Figure 23 below. The details are as follows;

- Close D271-283, on Townsend Street.
- Install new Open Point on Terrace Street, between St. Peters Road and Royal Avenue.
- Convert High Street, from Styles Lane (534S stepdown) to St. Peters Road, including all side streets.
- Convert St. Peters Road, including all side streets.
- Remove 534S stepdown.

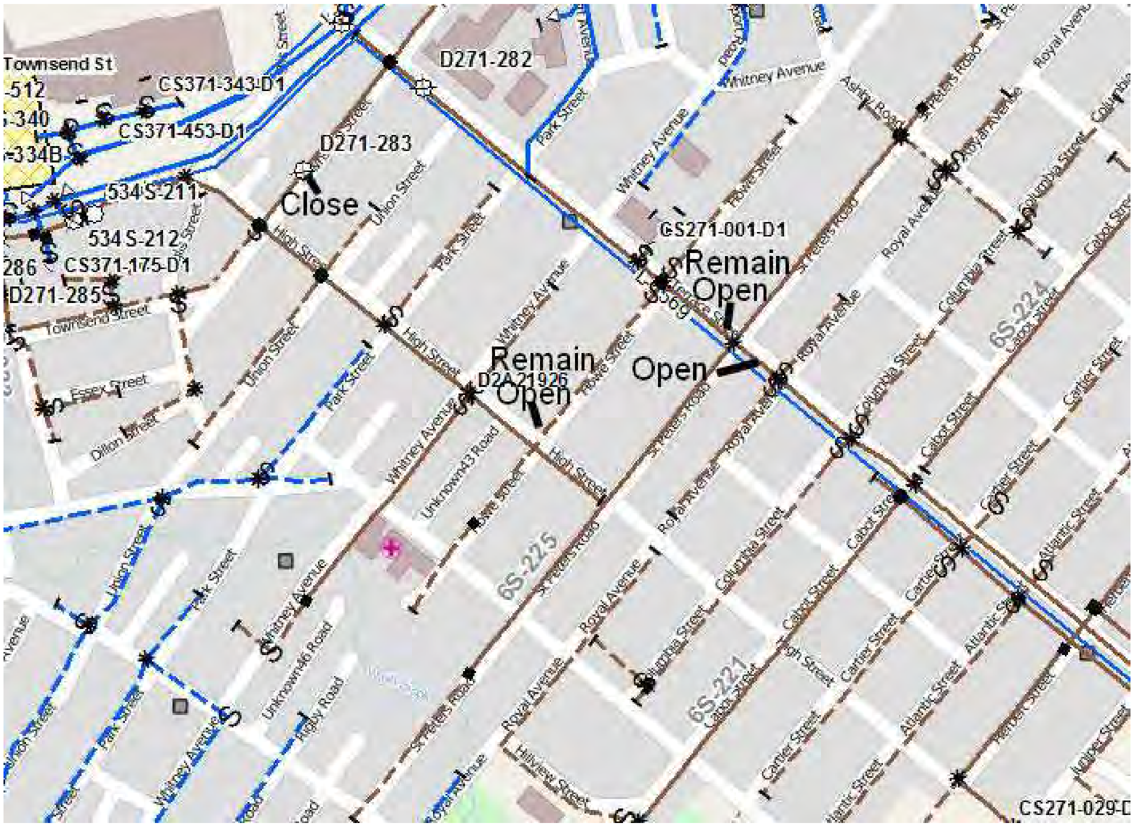


Figure 23 **2019 High Street Conversion**

6.1.8 2020 Capital Year

6.1.8.1 Terrace Street

This portion of the project will see the conversion of the remaining 4kV, east of the 6S-Terrace Street substation. This conversion will include rebuild of a section of Terrace Street, from the substation to Cabot Street. This rebuild will reduce the feeders along Terrace Street from a maximum of three to one. Refer to Figure 24 below. The details are as follows;

- Convert Terrace Street, from the 6S-Terrace Street substation to St. Peters Road, from 4kV to 12kV, including all side streets that have not been previously converted.
- Rebuild Terrace Street, from the 6S-Terrace Street substation, to St. Peters Road with one, 3-phase 336, circuit.

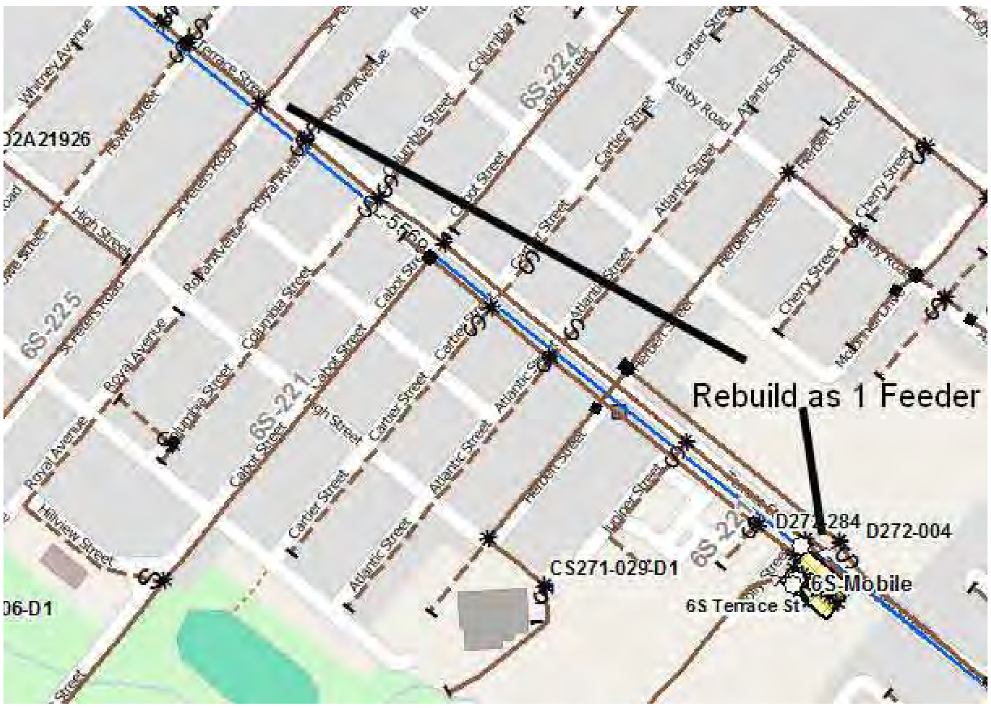


Figure 24 **2020 Terrace Street**

6.1.9 2021 Capital Year

6.1.9.1 6S-Terrace Street Retirement

This portion of the project will see the retirement of the 6S-Terrace Street substation. This will include the decommissioning of 6S-T1, as well as the removal of most substation equipment. A requirement to modify the 69kV transmission will be necessary, to facilitate the removal of the substation buswork. Refer to Figure 25 below. This will be accomplished by:

- Decommission 6S-T1.
- Reconfigure L-5564, in front of the 6S-Terrace Street substation, to bypass the substation.
- Remove buswork and all NSPI owned equipment.

Figure 25 2021 6S-Terrace Street Retirement

APPENDIX A

System Operating Diagrams

Pages 41-46 have been removed due to confidentiality.

APPENDIX B

Load History and Forecast

Please refer to section 3.2 Load Forecast for the 90^{th} Percentile Data values

Figure 32 4S-T52 Load History

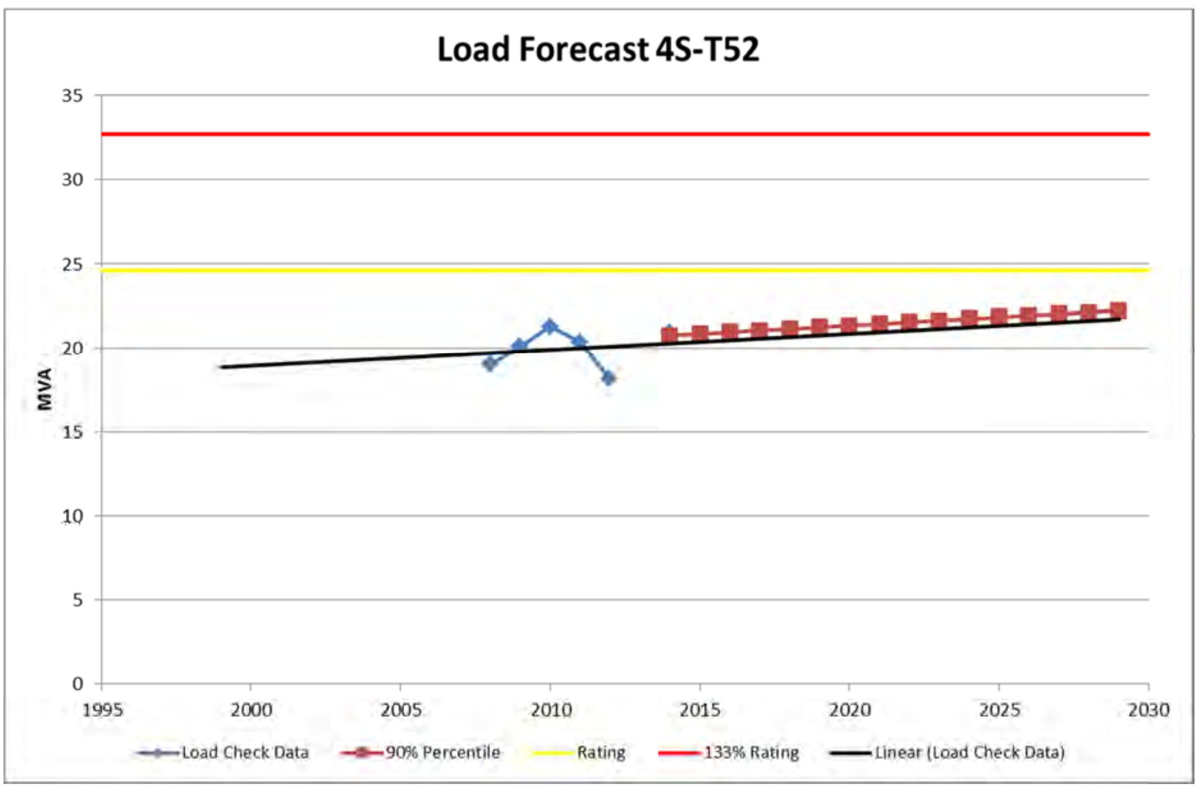


Figure 33 4S-T52 Load Forecast

Load Growth **0.42%****

Figure 34 **4S-T53 Load History**

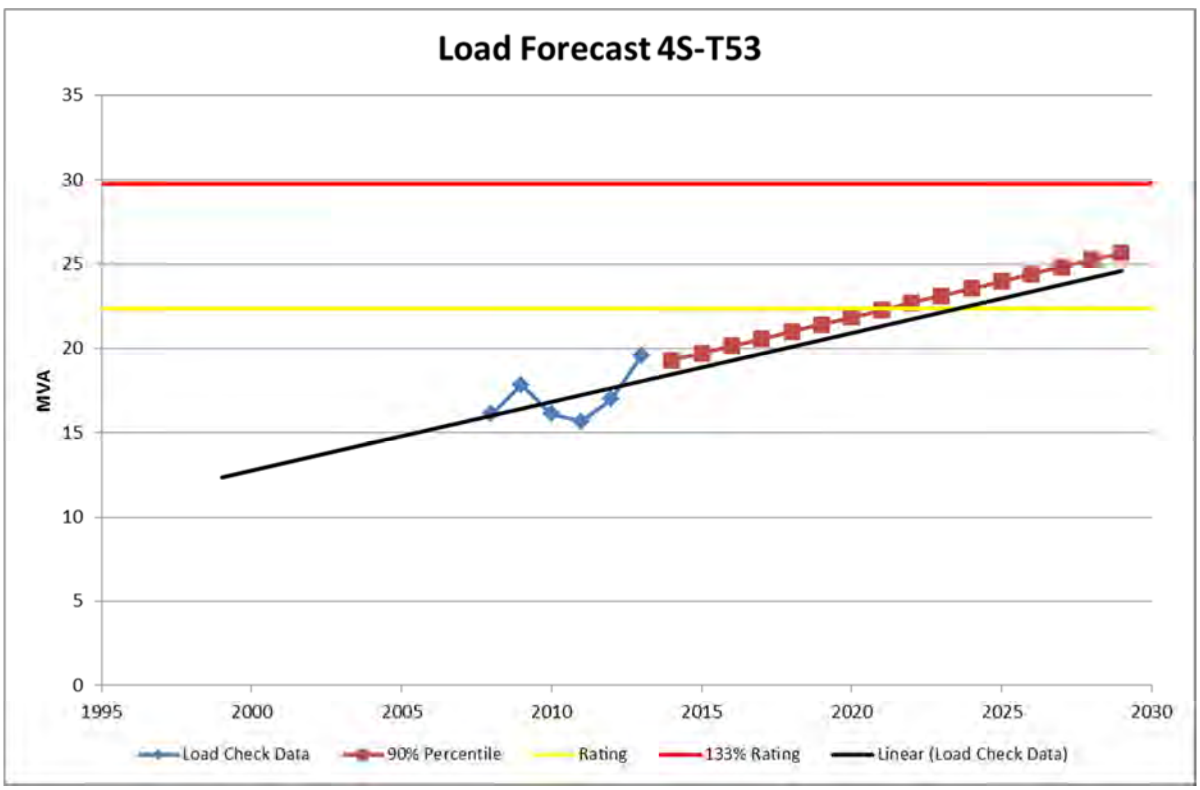


Figure 35 **4S-T53 Load Forecast**

Load Growth **1.77%**

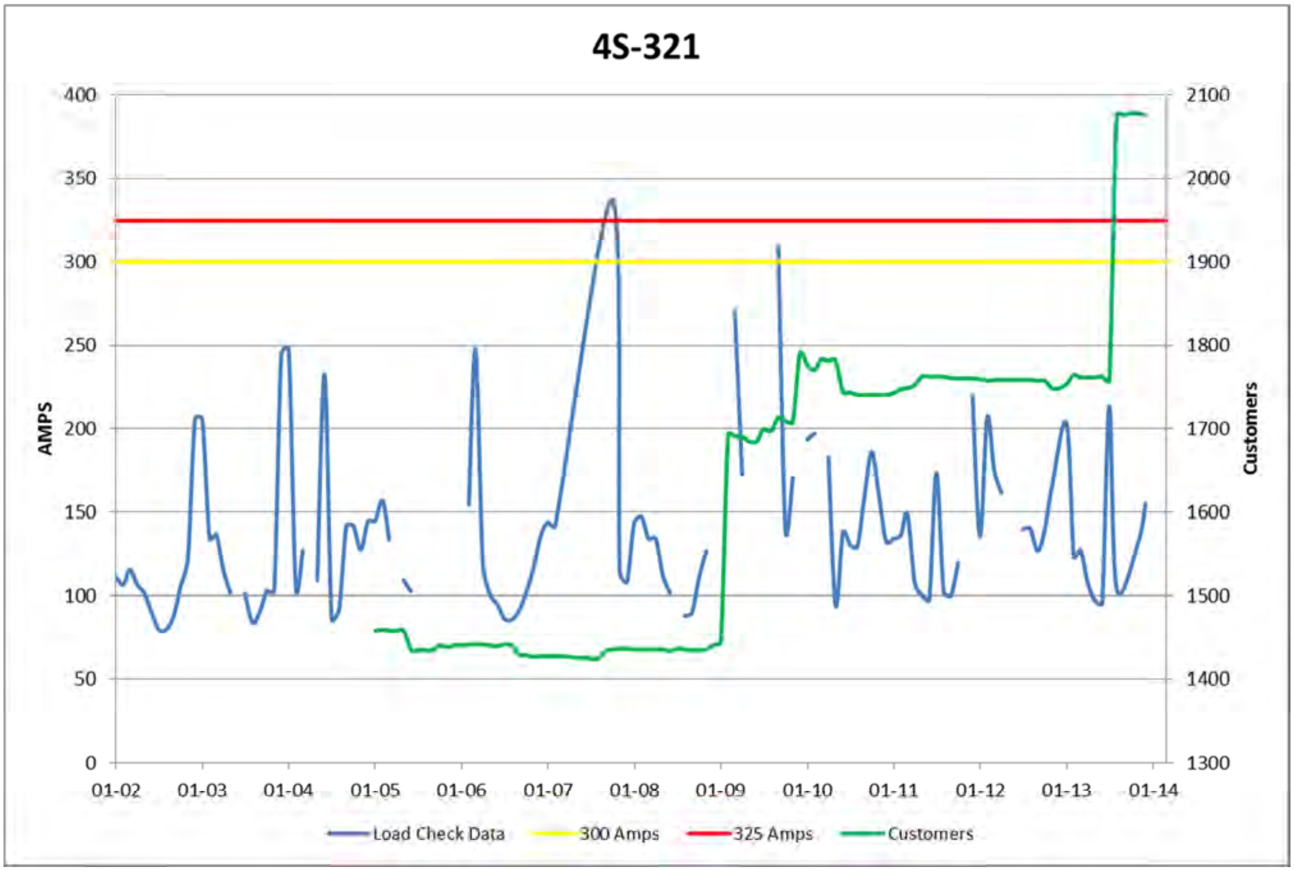


Figure 36 4S-321 Load History

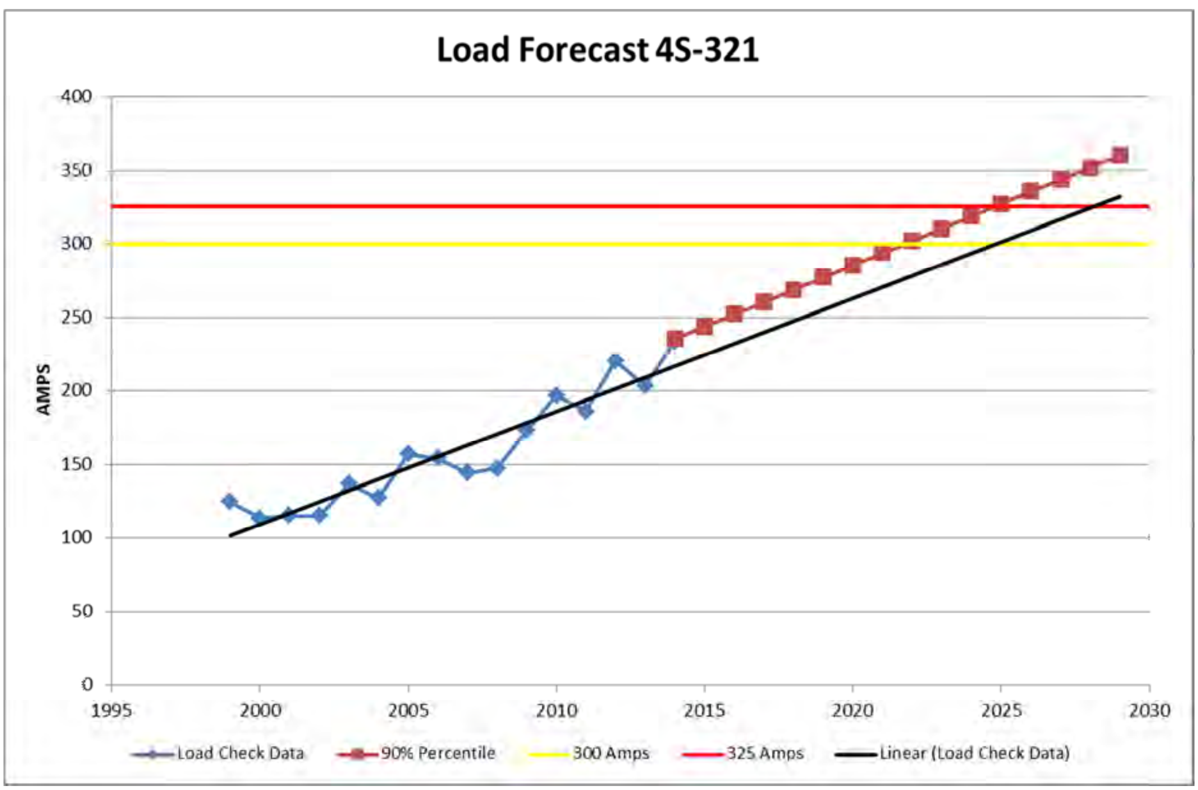


Figure 37 4S-321 Load Forecast

Load Growth	**2.64%**

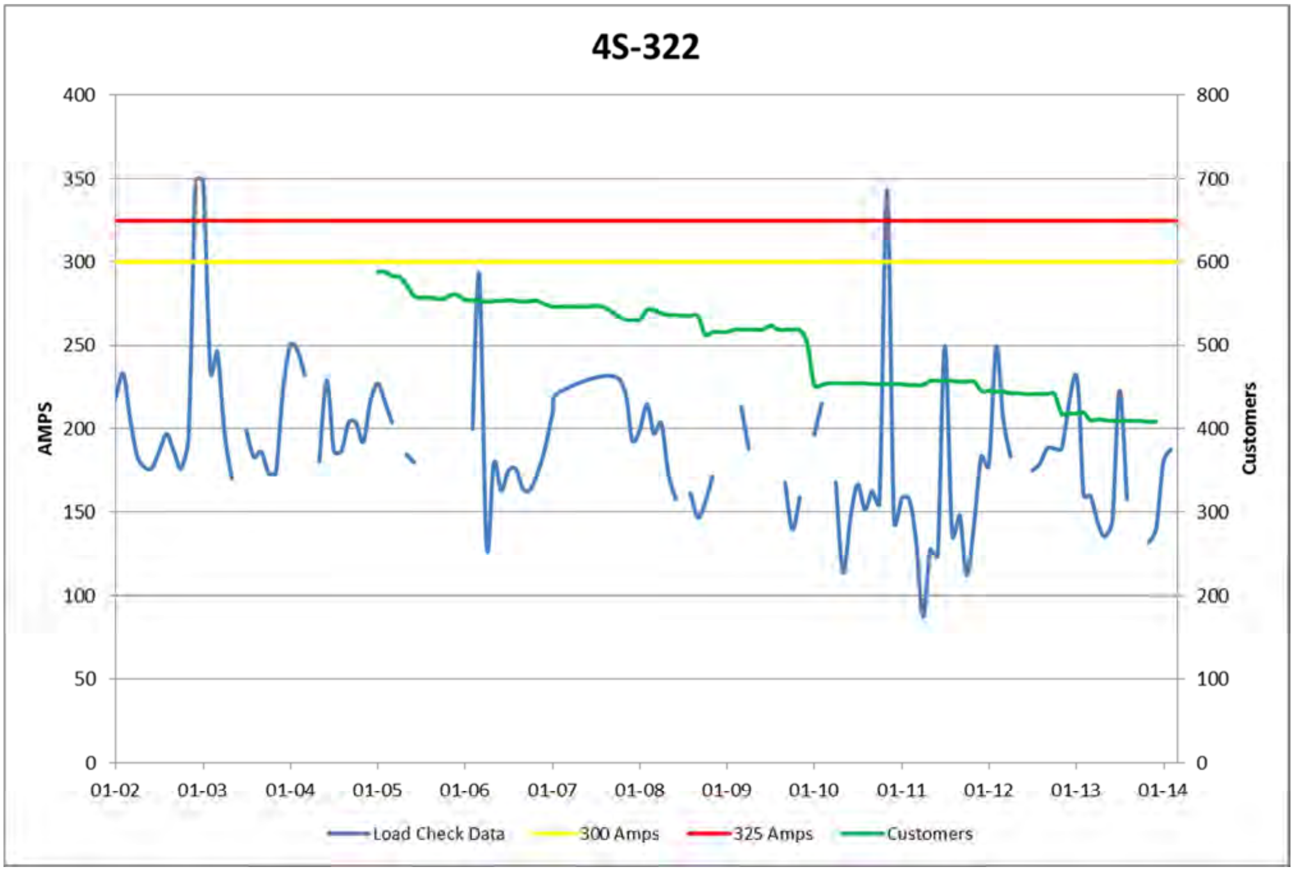


Figure 38 4S-322 Load History

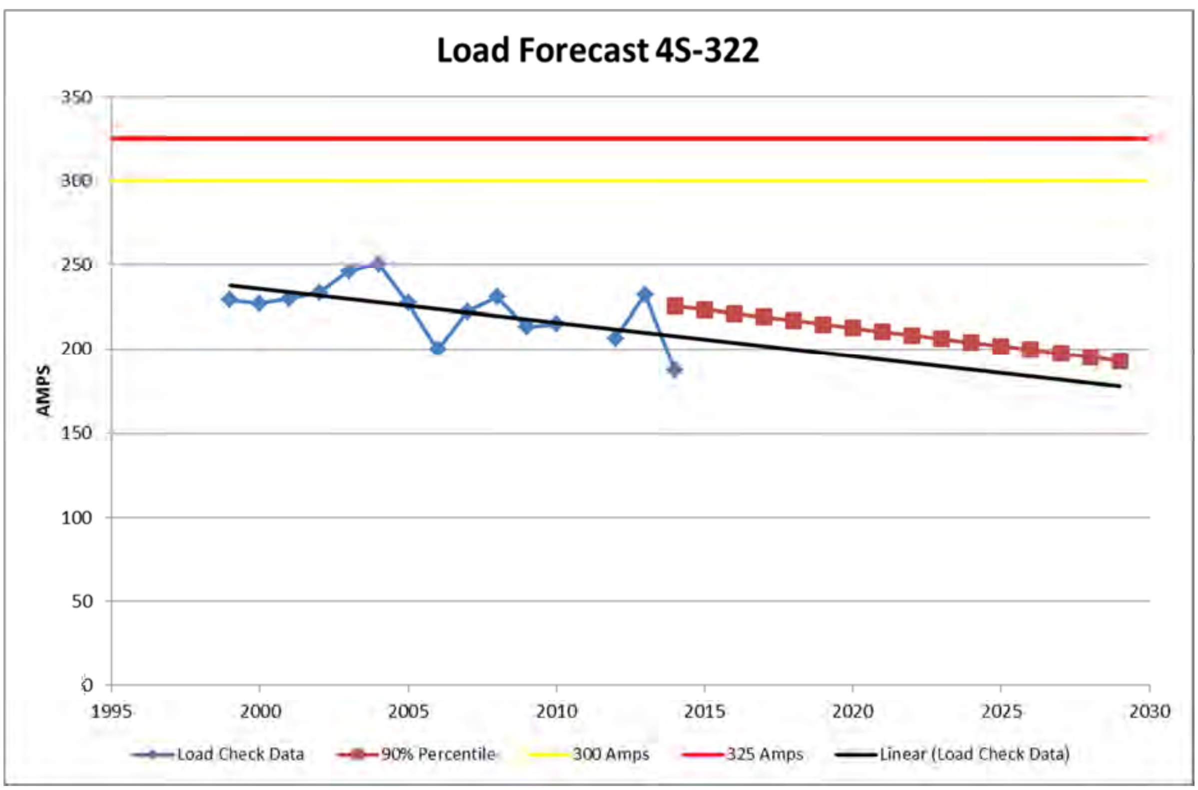


Figure 39 4S-322 Load Forecast

Load Growth **-0.97%**

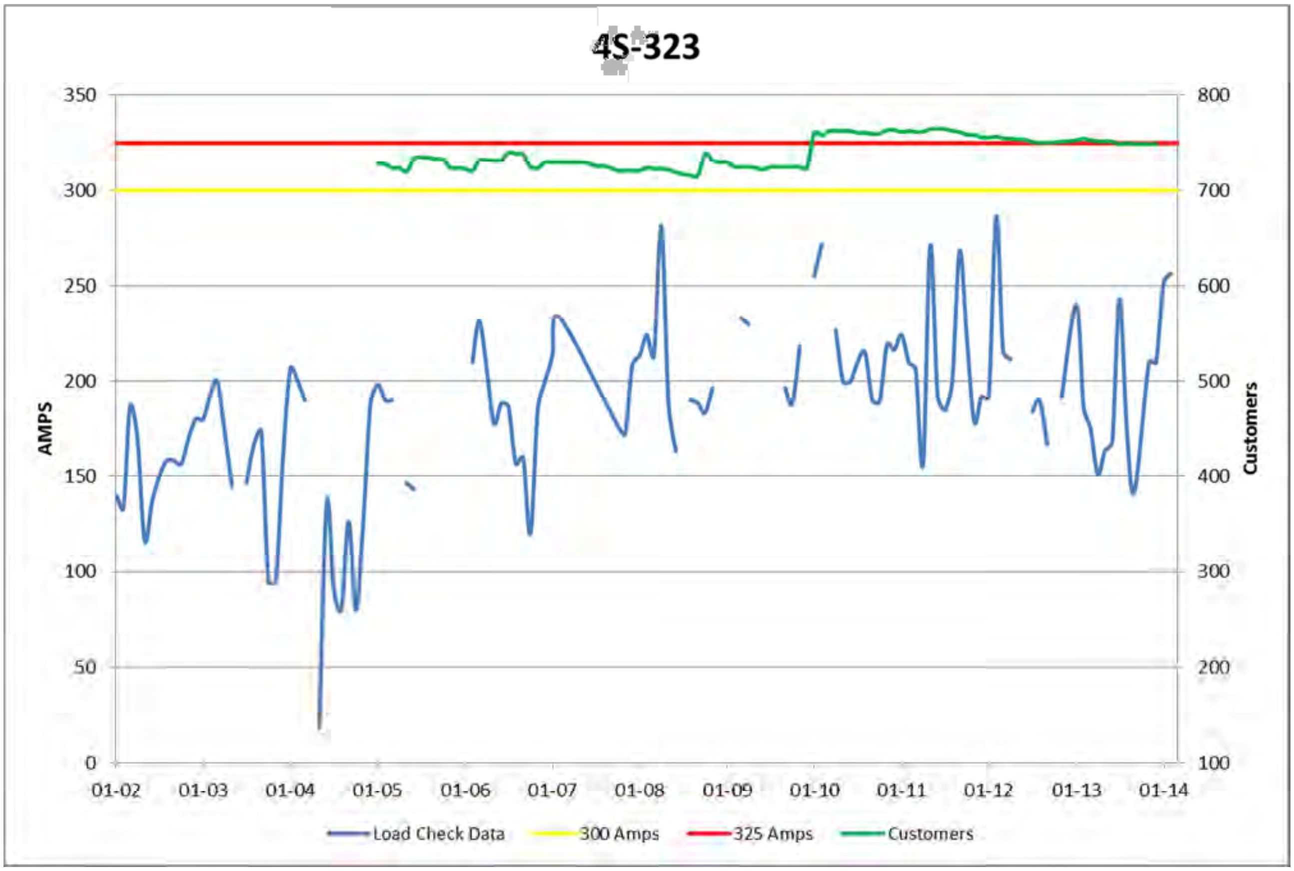


Figure 40 4S-323 Load History

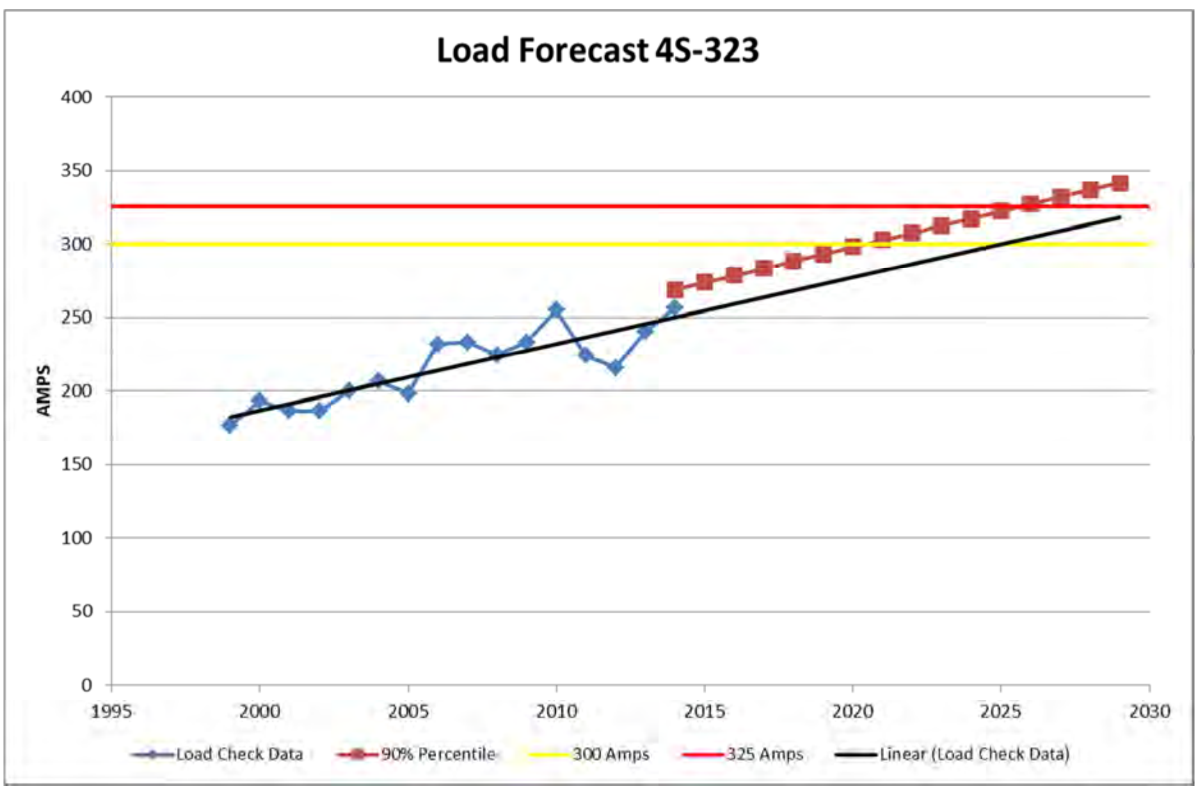


Figure 41 4S-323 Load Forecast

Load Growth **1.48%**

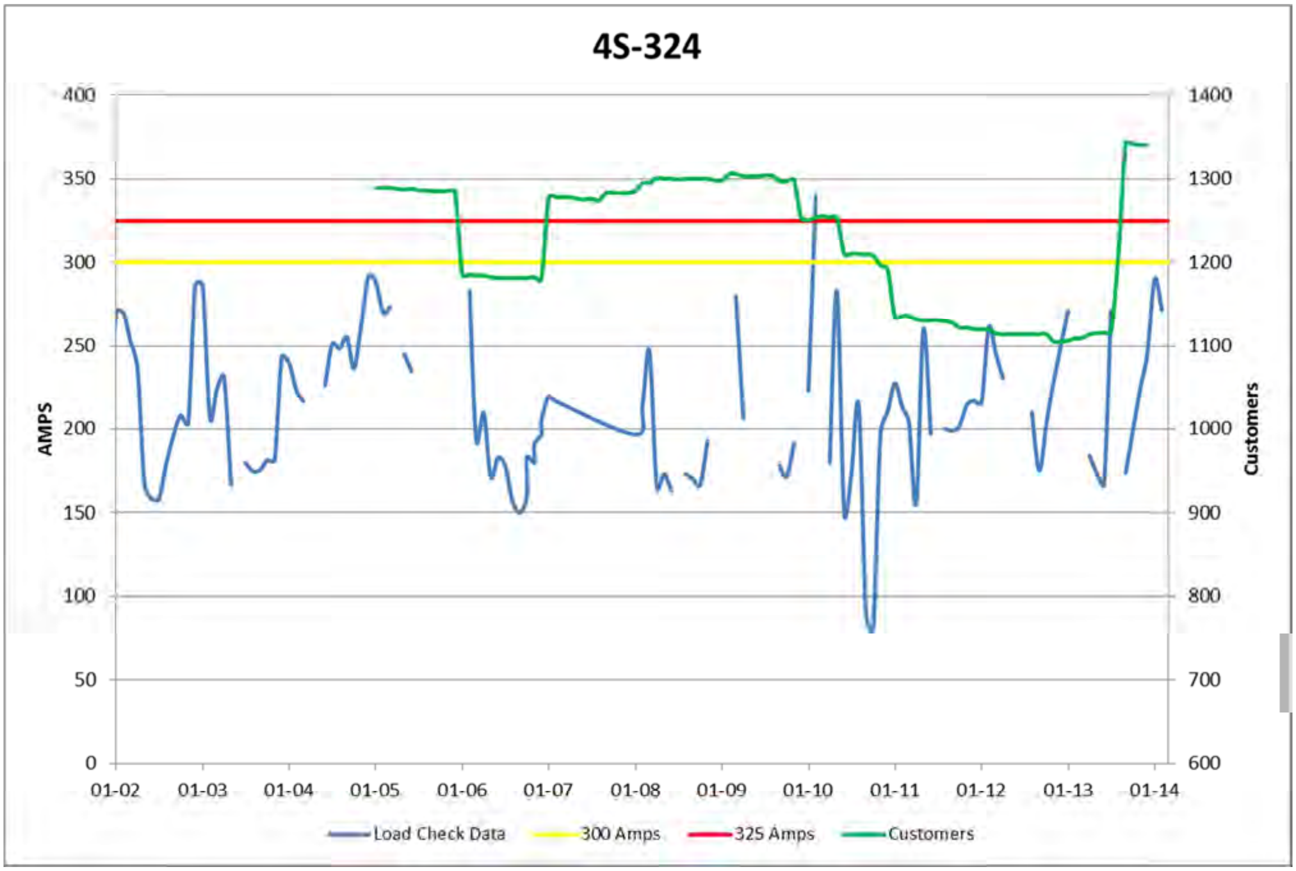


Figure 42 4S-324 Load History

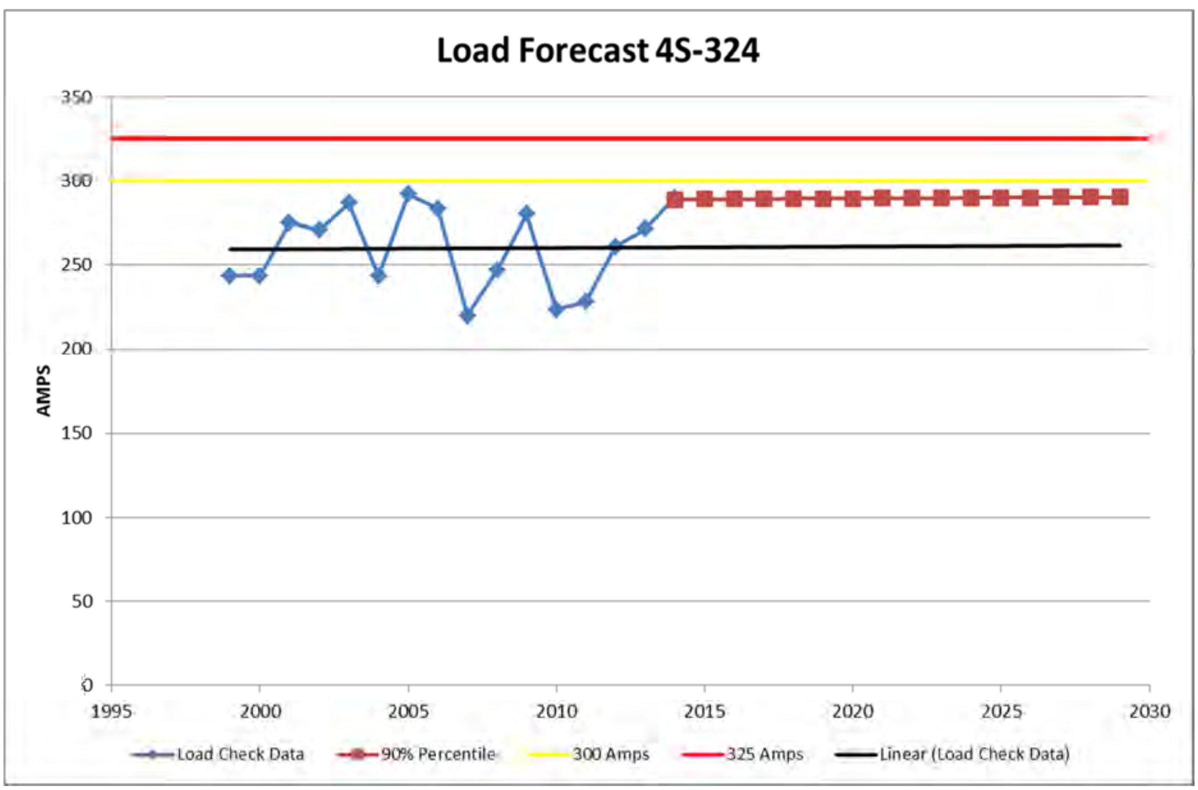


Figure 43 4S-324 Load Forecast

Load Growth	**0.03%**

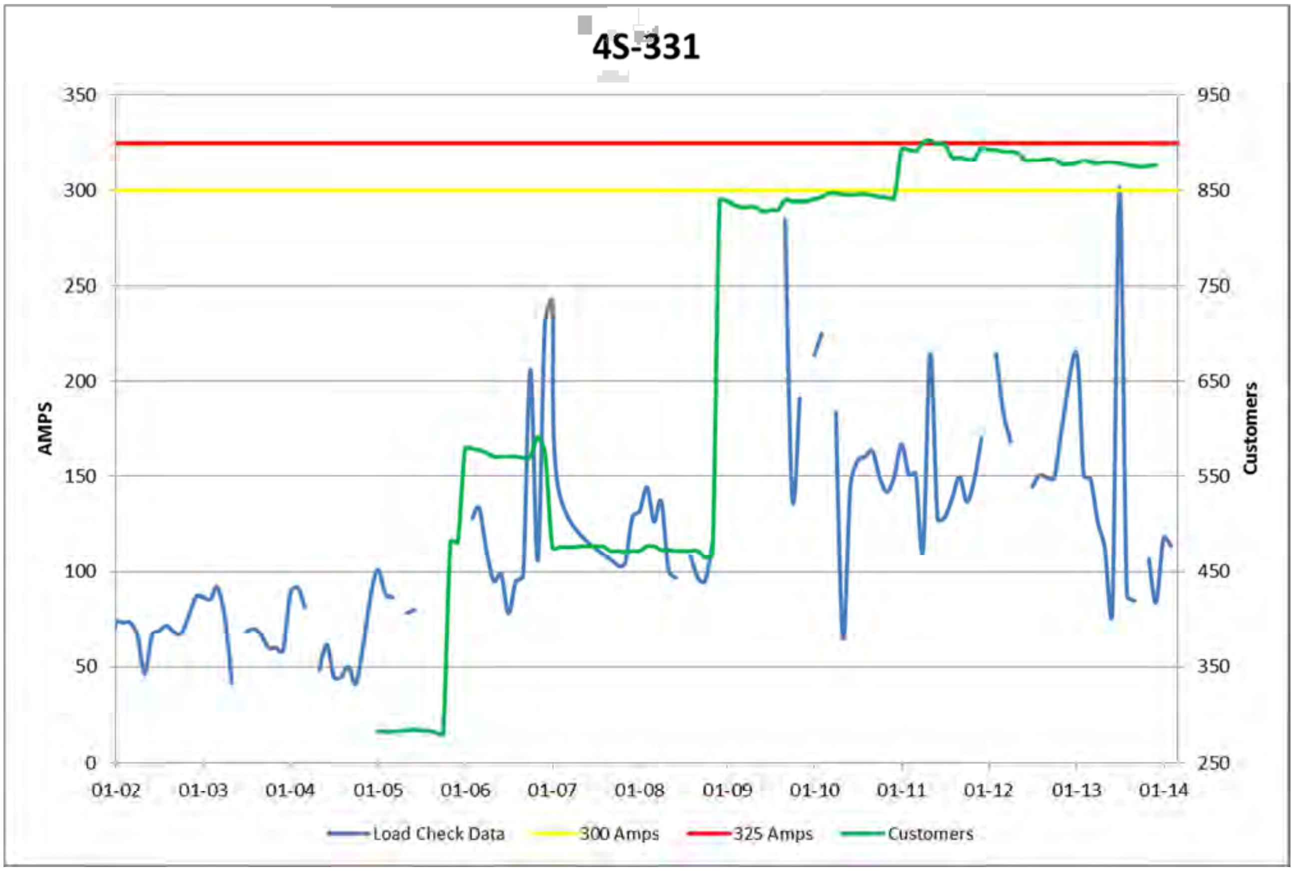


Figure 44 4S-331 Load History

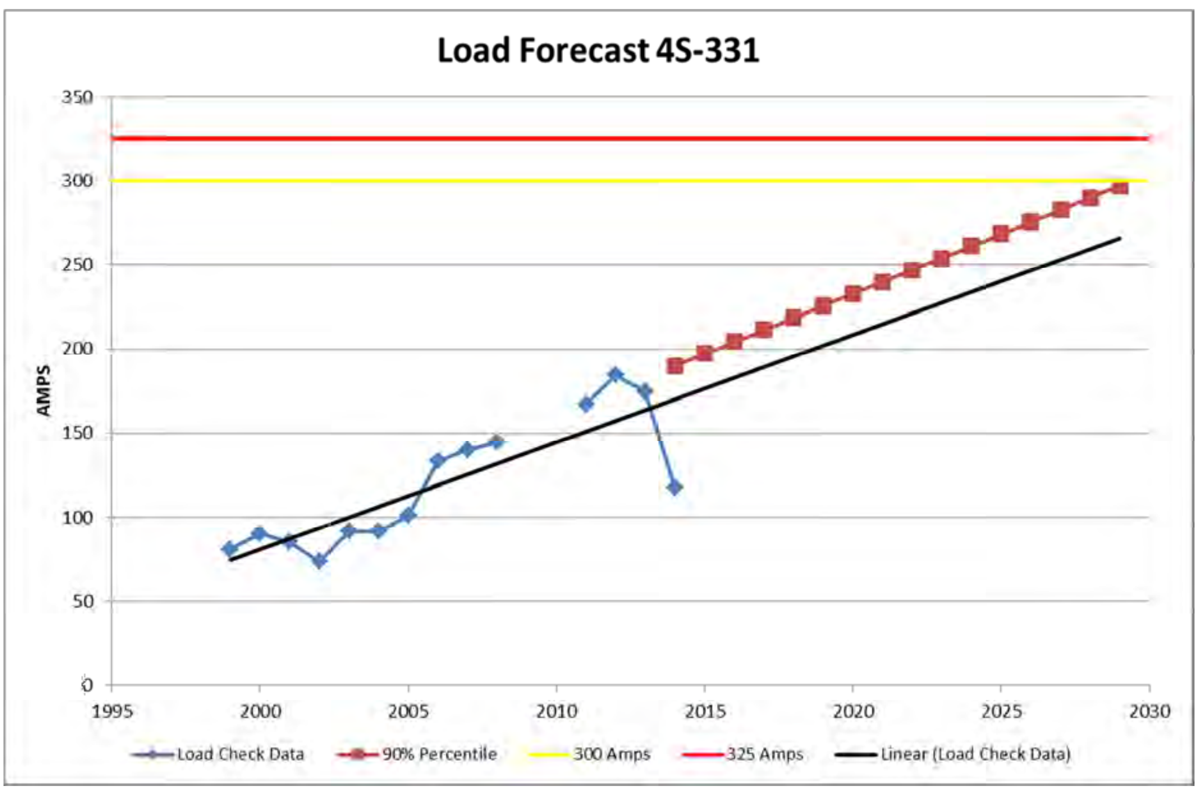


Figure 45 4S-331 Load Forecast

Load Growth **2.76%**

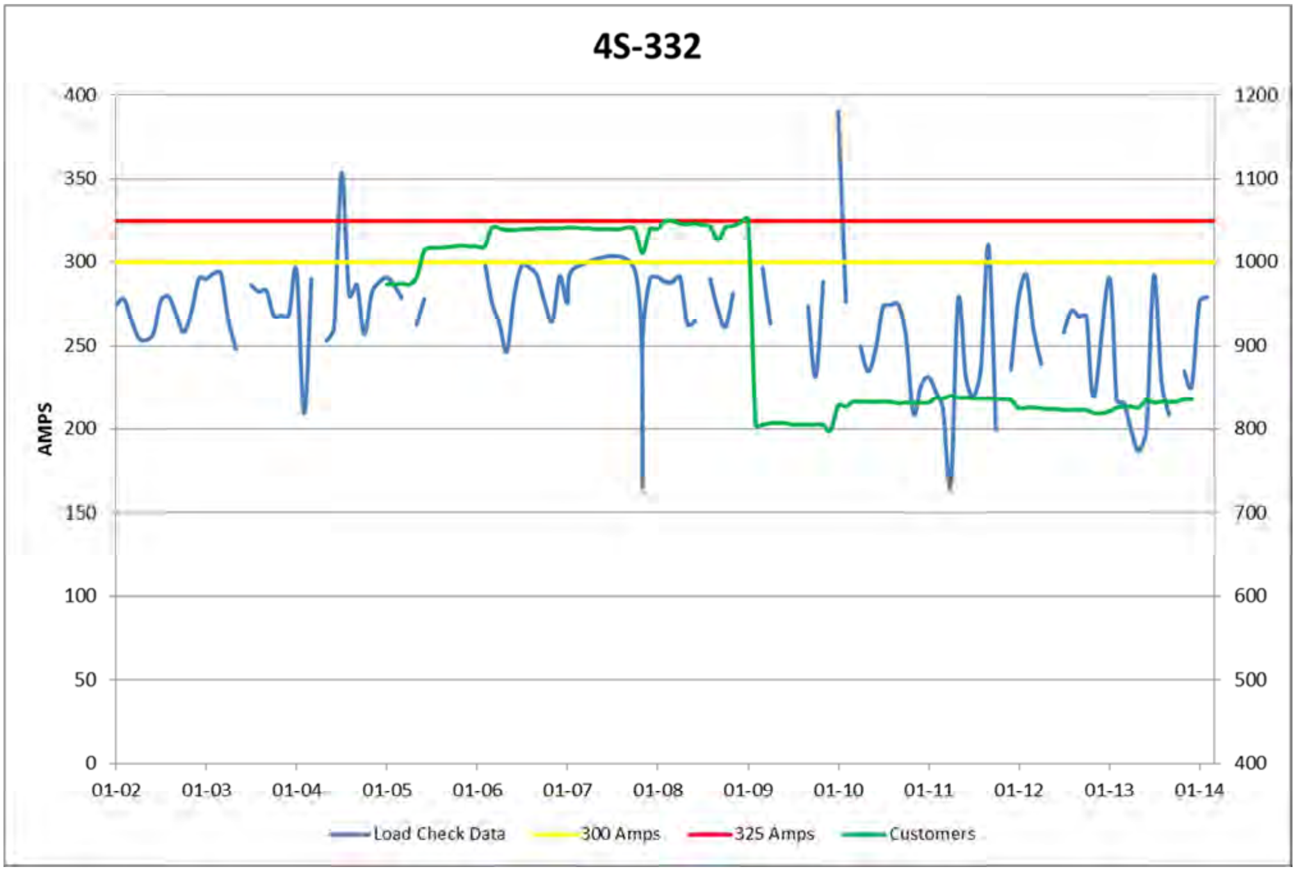


Figure 46 4S-332 Load History

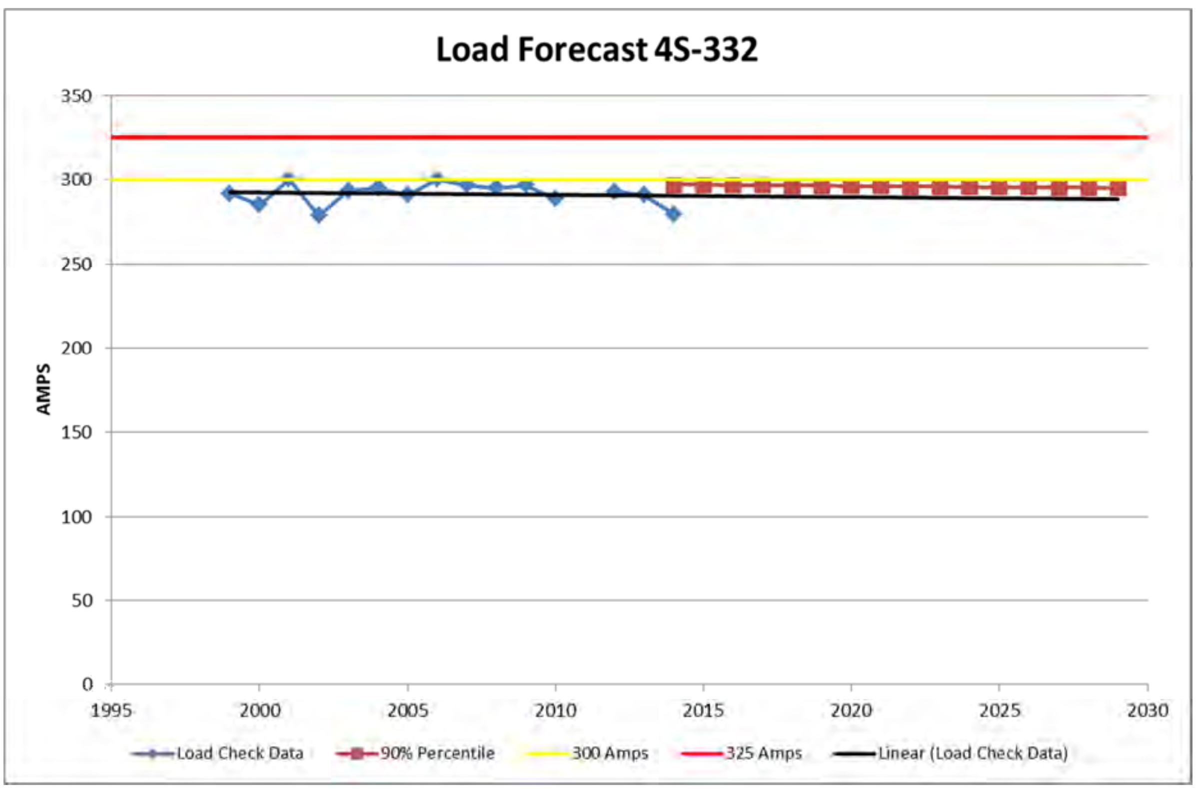


Figure 47 4S-332 Load Forecast

Load Growth **-0.05%**

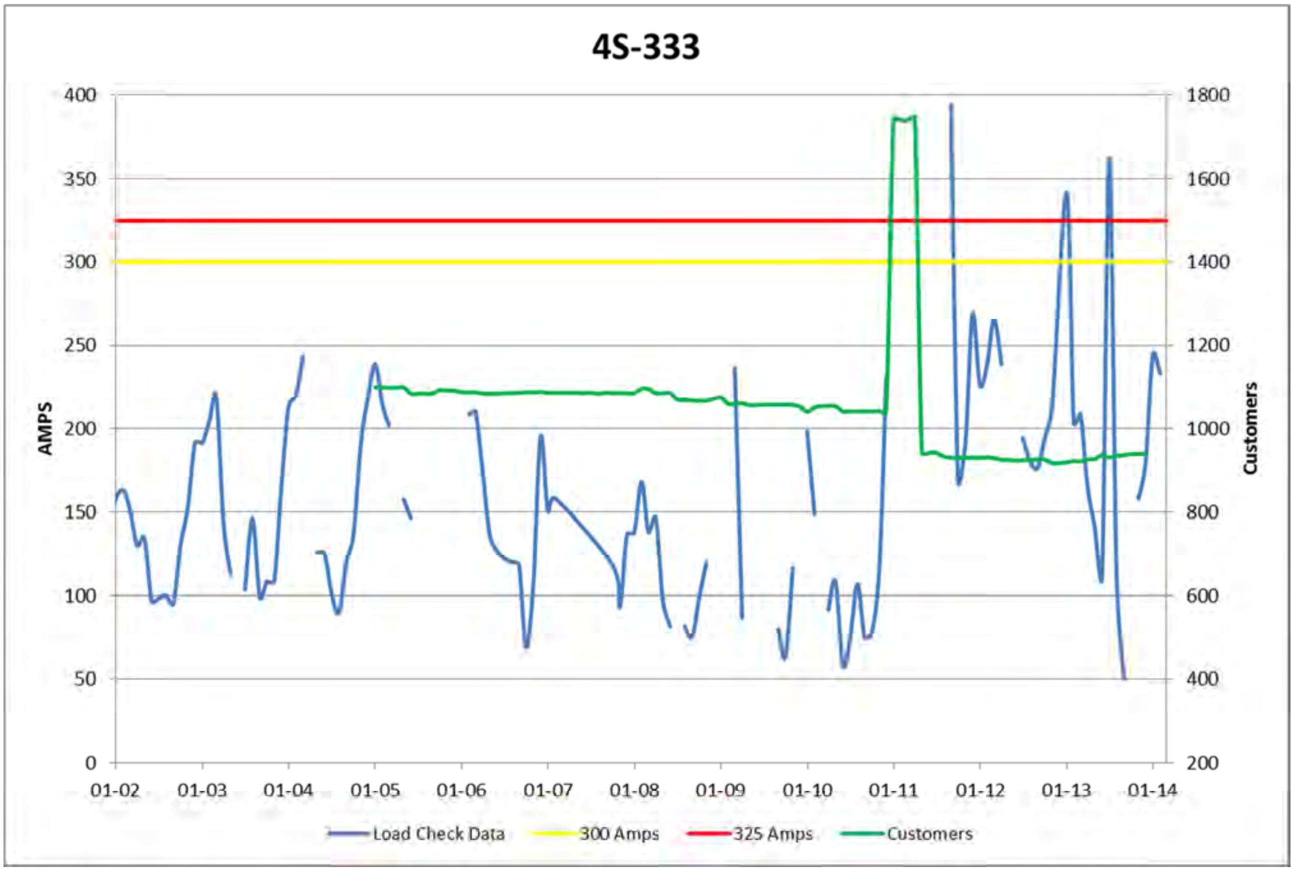


Figure 48 **4S-333 Load History**

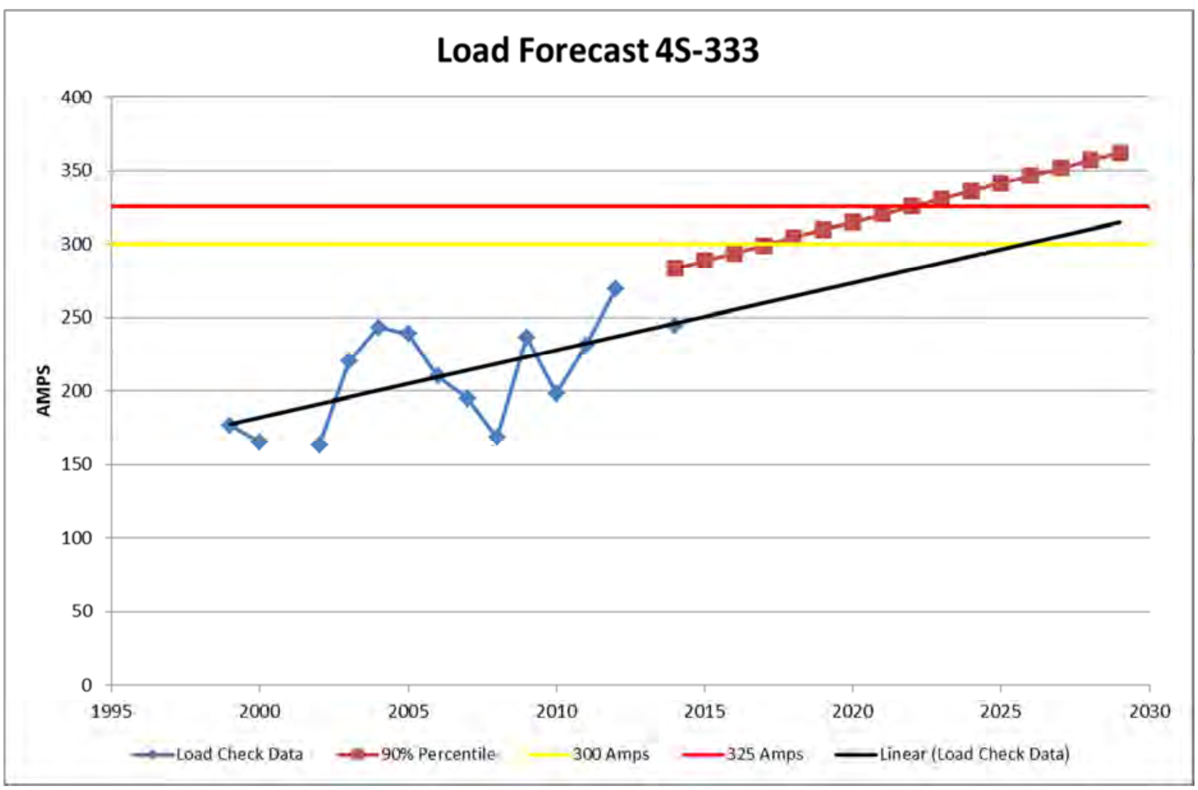


Figure 49 **4S-333 Load Forecast**

Load Growth **1.53%**

Appendix B: Load History and Forecast

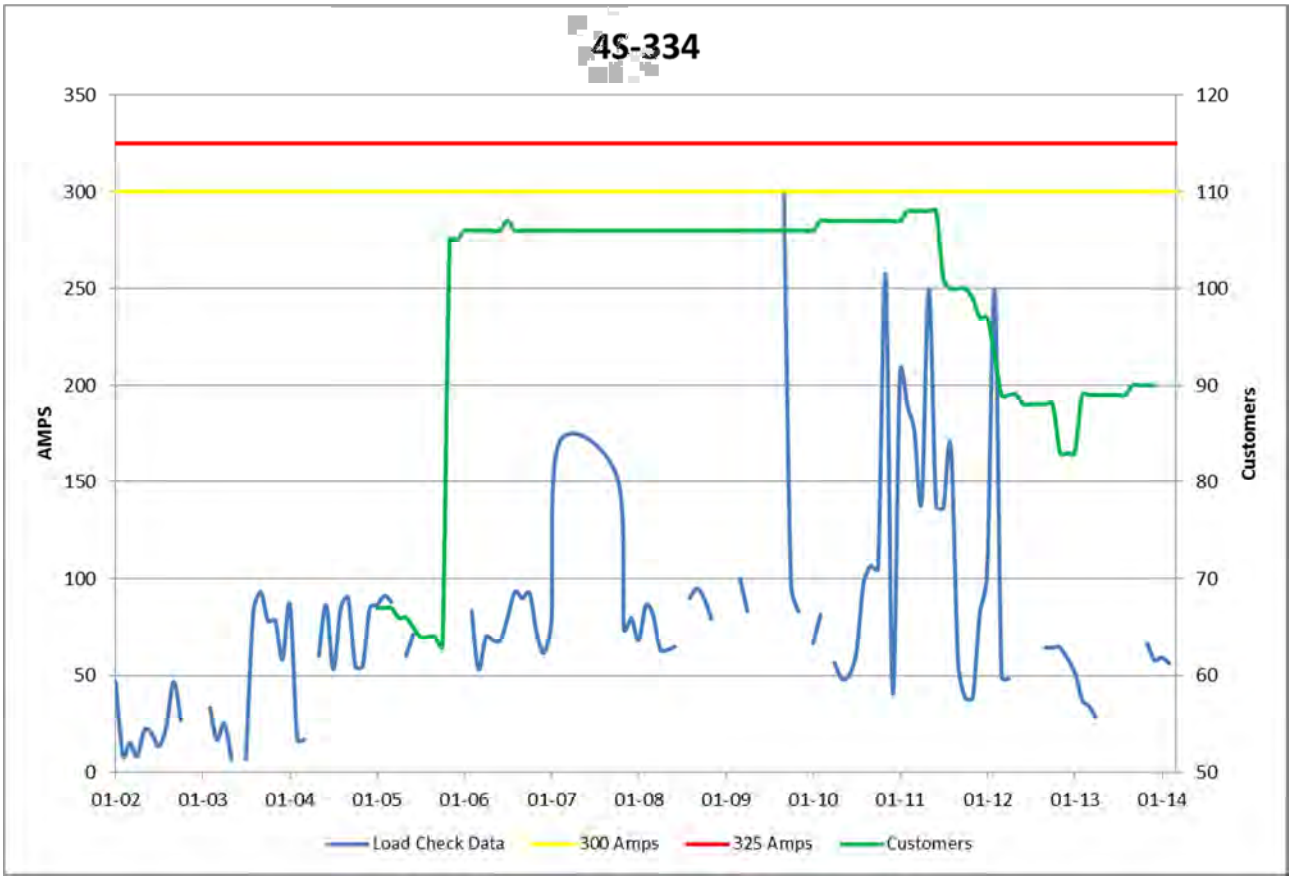


Figure 50 **4S-334 Load History**

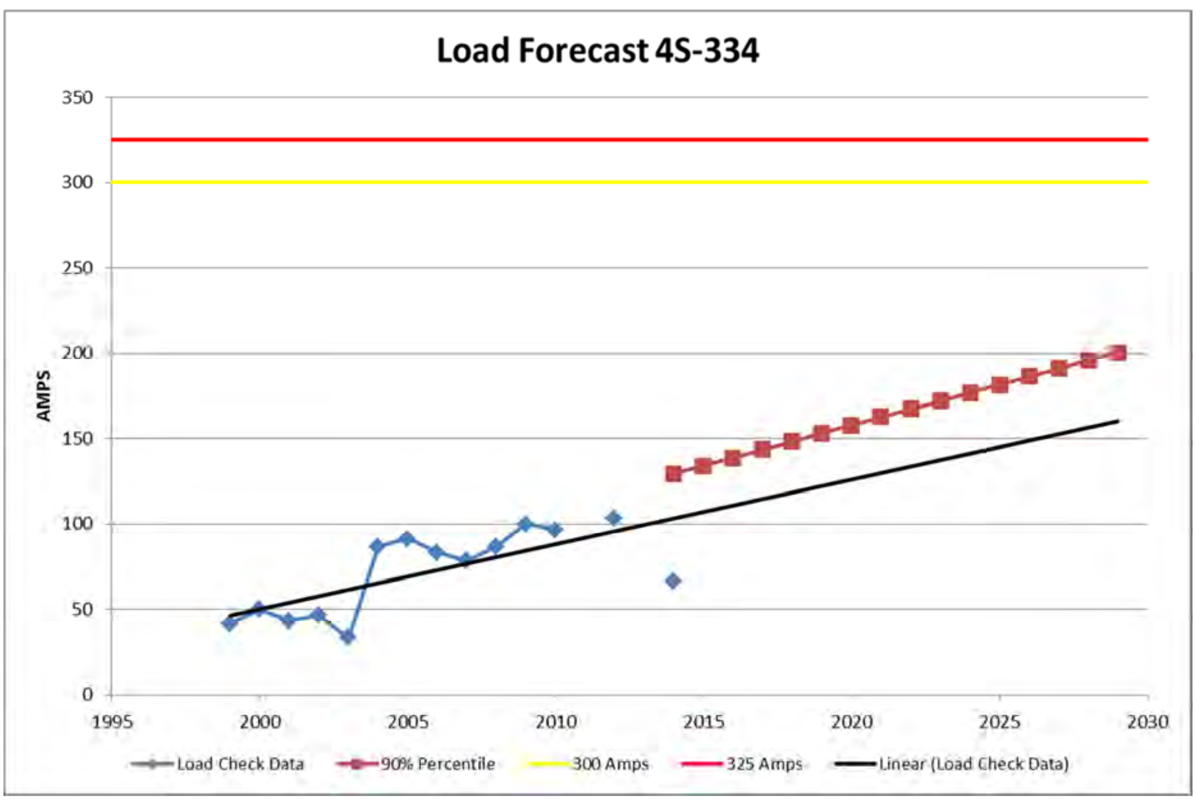


Figure 51 **4S-334 Load Forecast**

Load Growth	**2.72%**

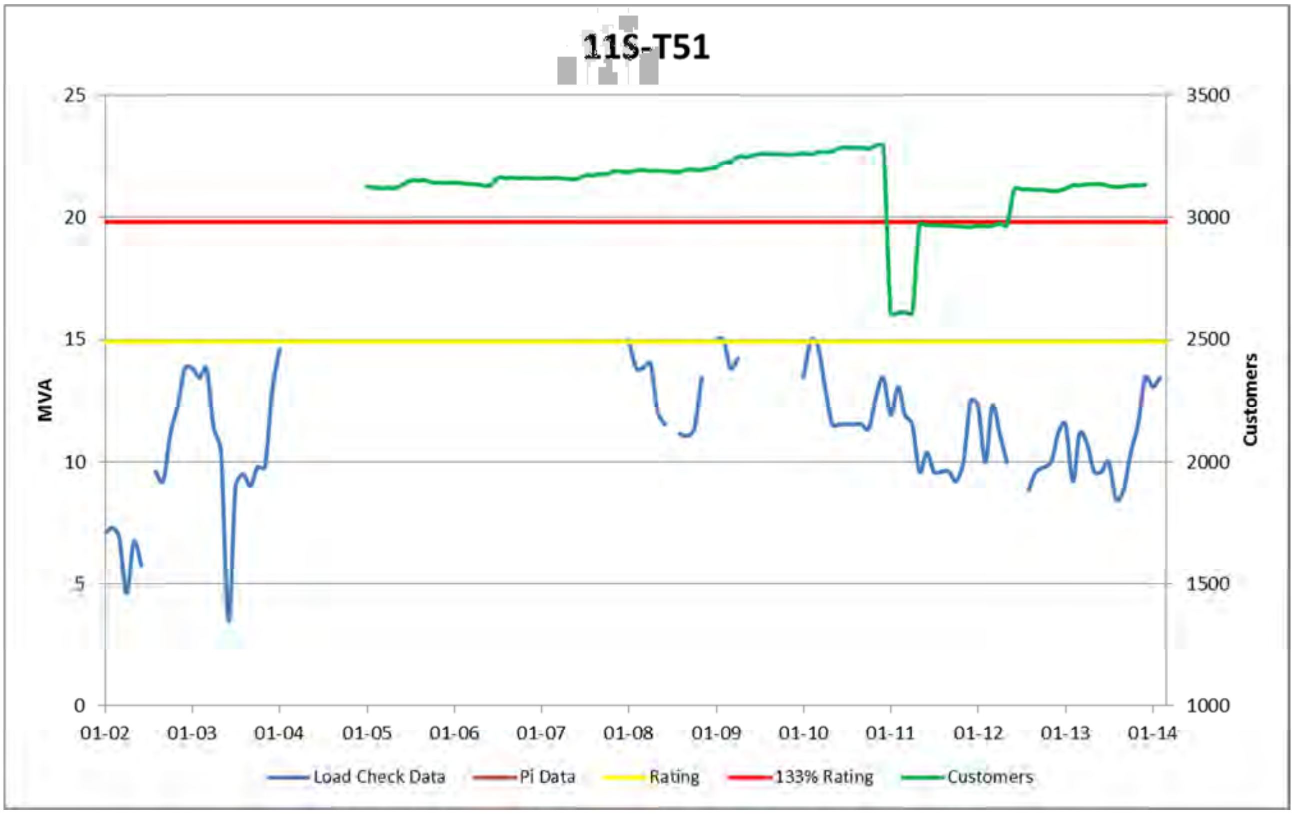


Figure 52 **11S-T51 Load History**

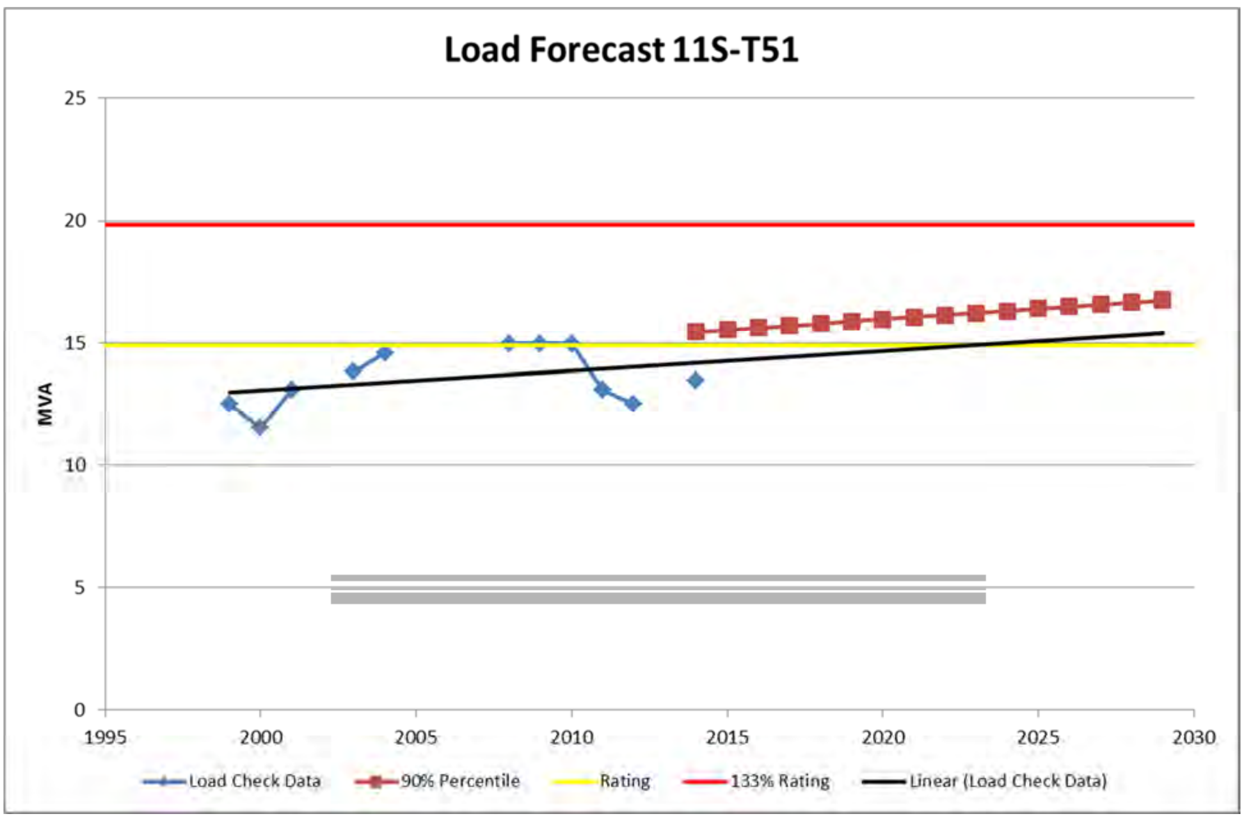


Figure 53 **11S-T51 Load History**

Load Growth **0.51%**

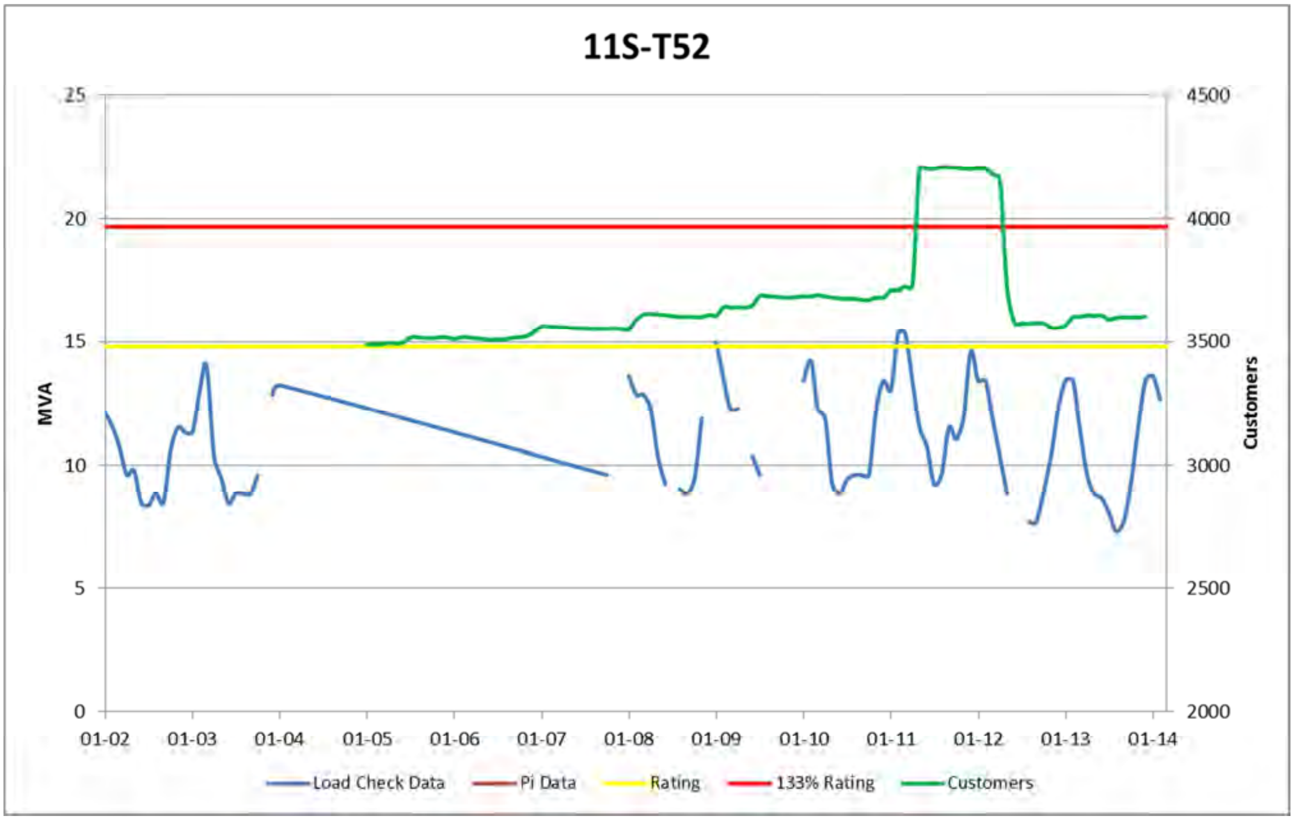


Figure 54 **11S-T52 Load History**

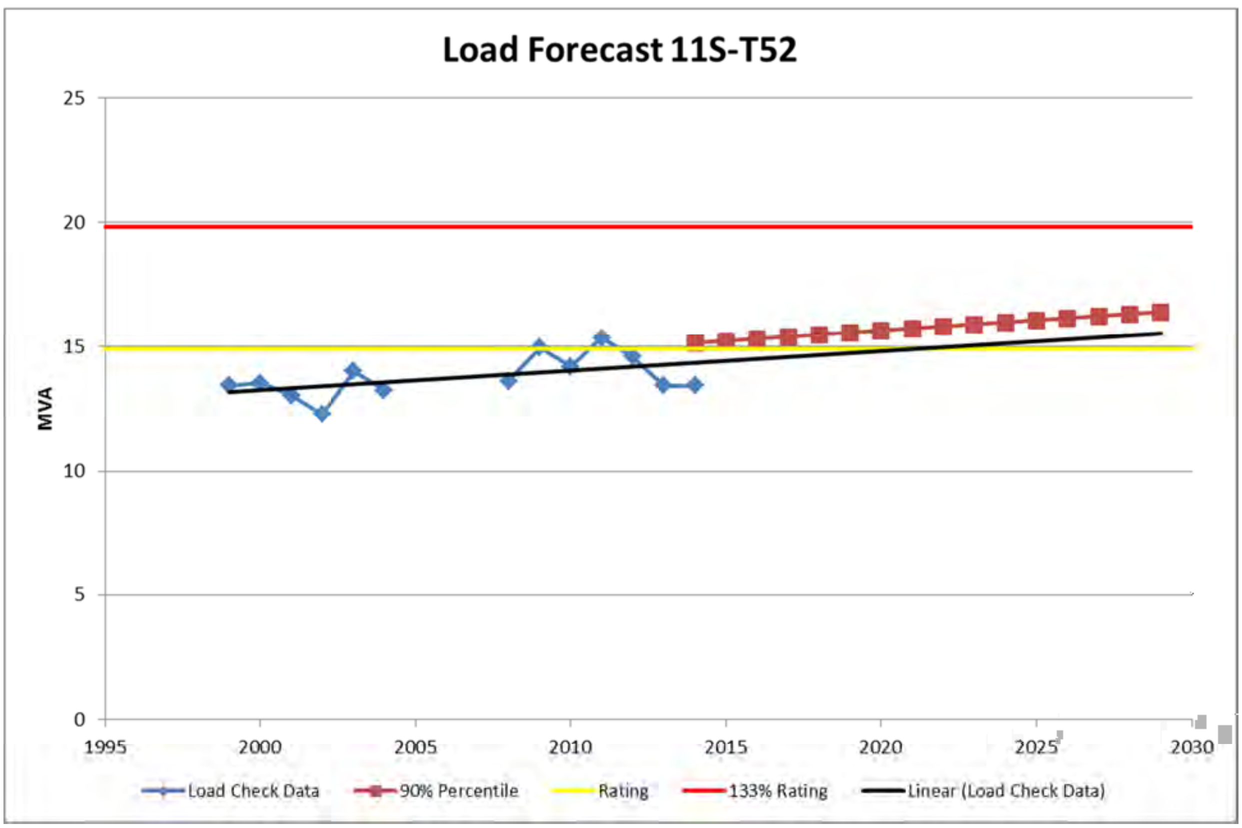


Figure 55 **11S-T52 Load Forecast**

Load Growth **0.49%**

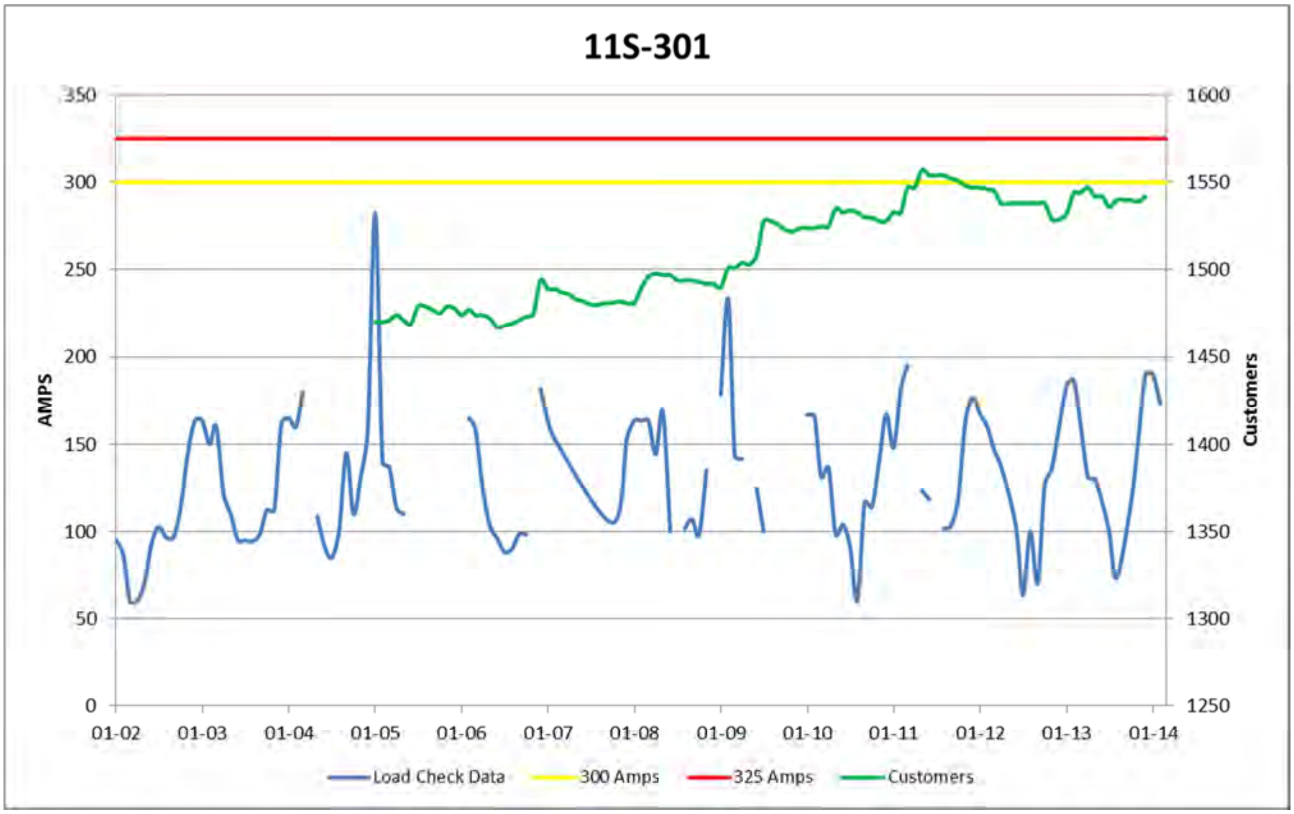


Figure 56 **11S-301 Load History**

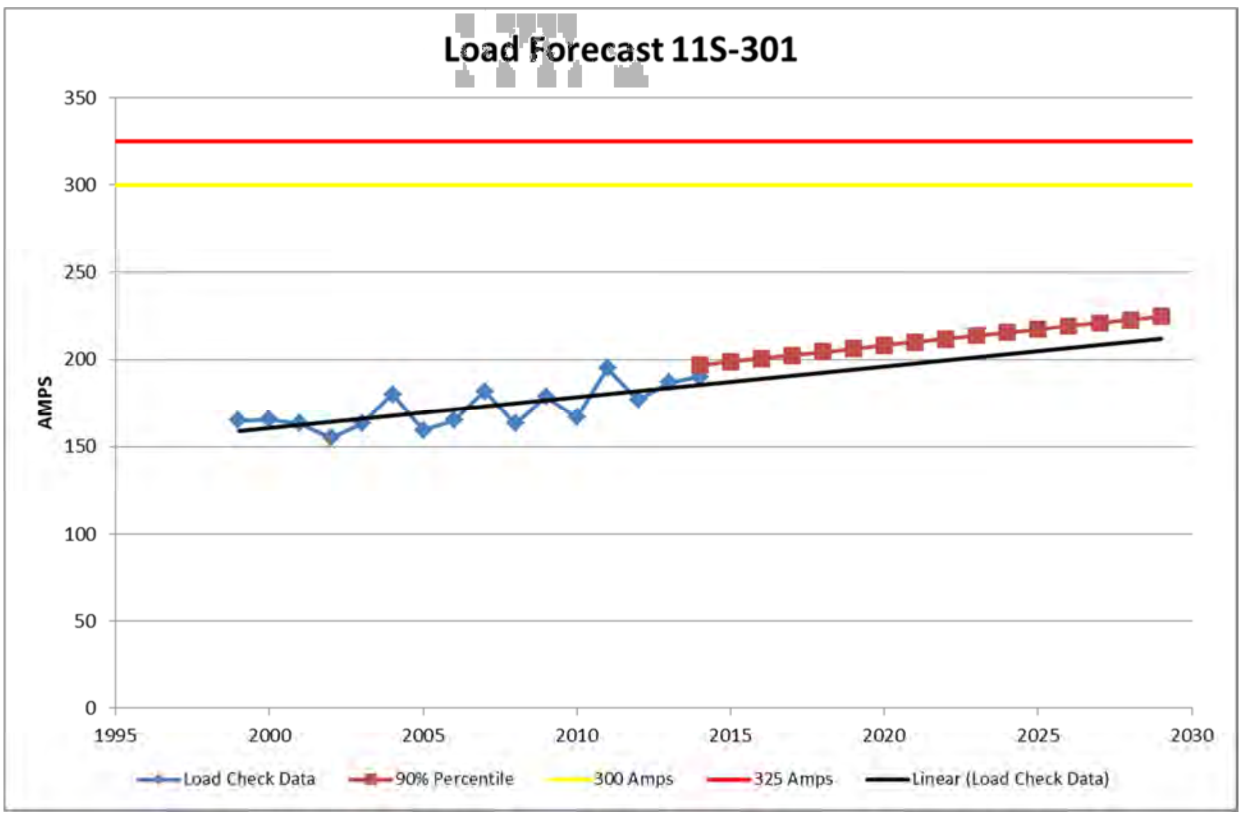


Figure 57 **11S-301 Load Forecast**

Load Growth **0.83%**

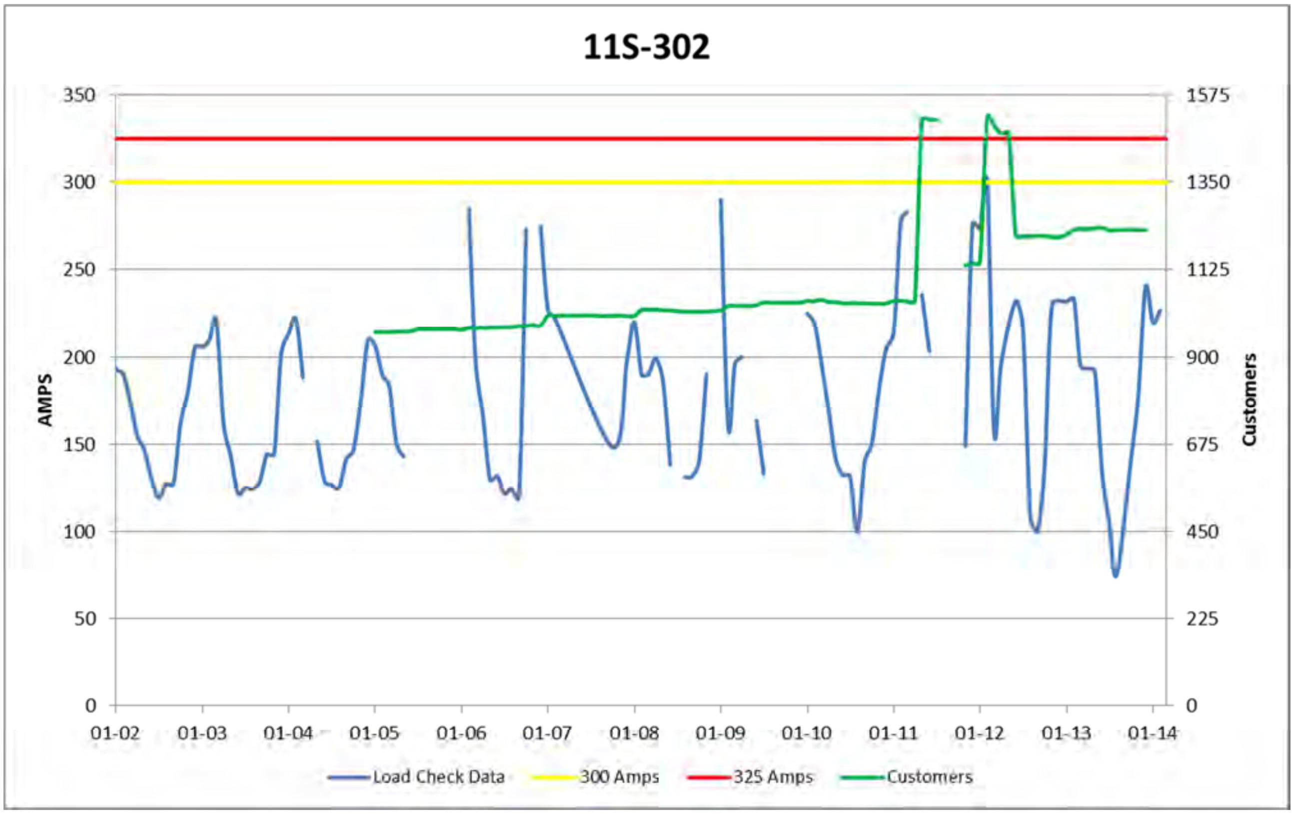


Figure 58 **11S-302 Load History**

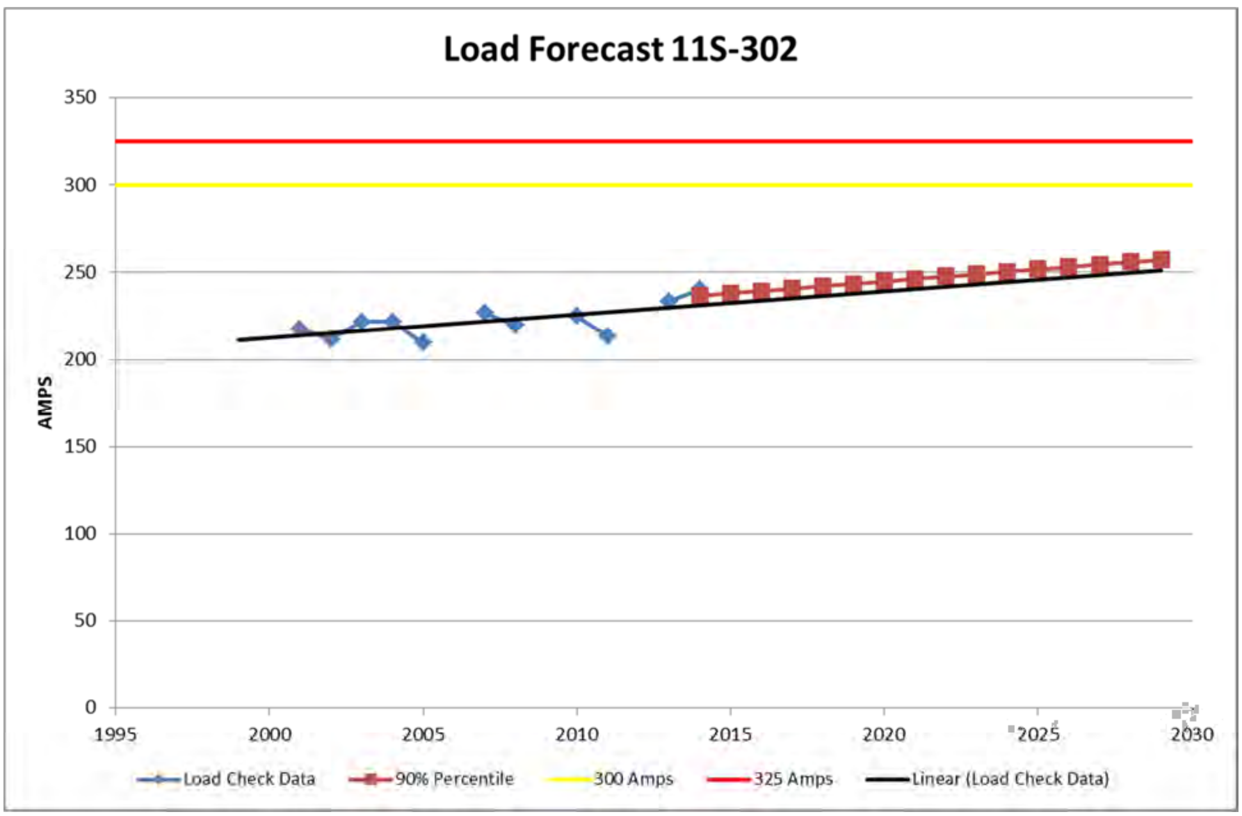


Figure 59 **11S-302 Load Forecast**

Load Growth **0.52%**

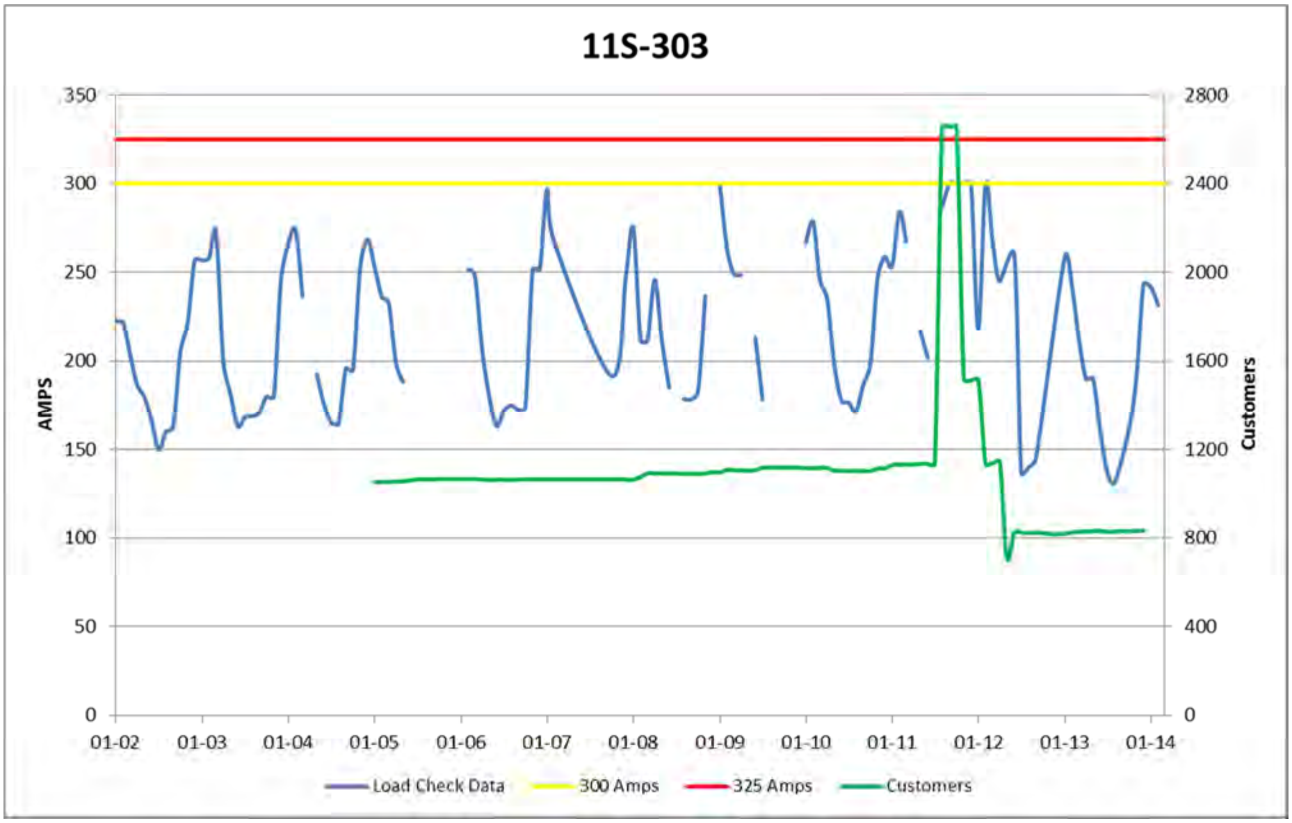


Figure 60 11S-303 Load History

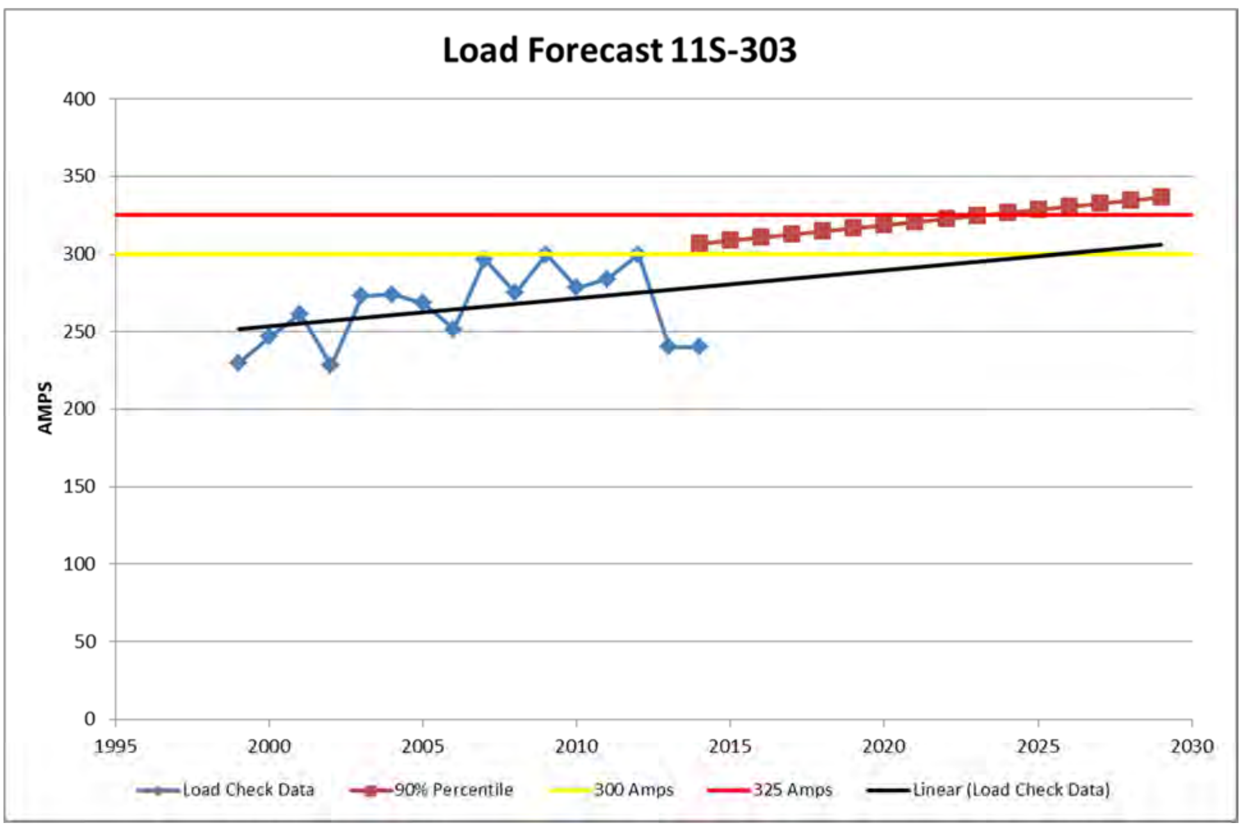


Figure 61 11S-303 Load Forecast

Load Growth **0.57%**

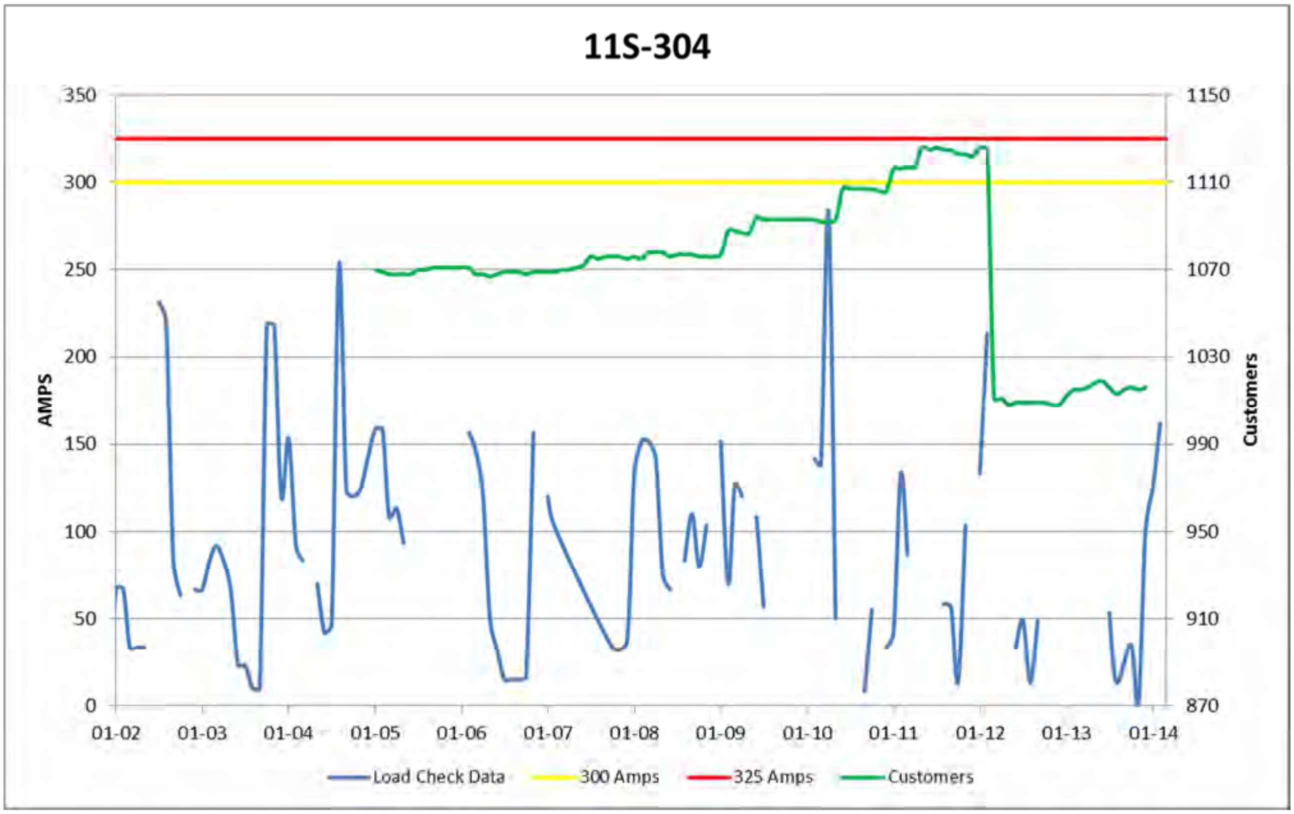


Figure 62 **11S-304 Load History**

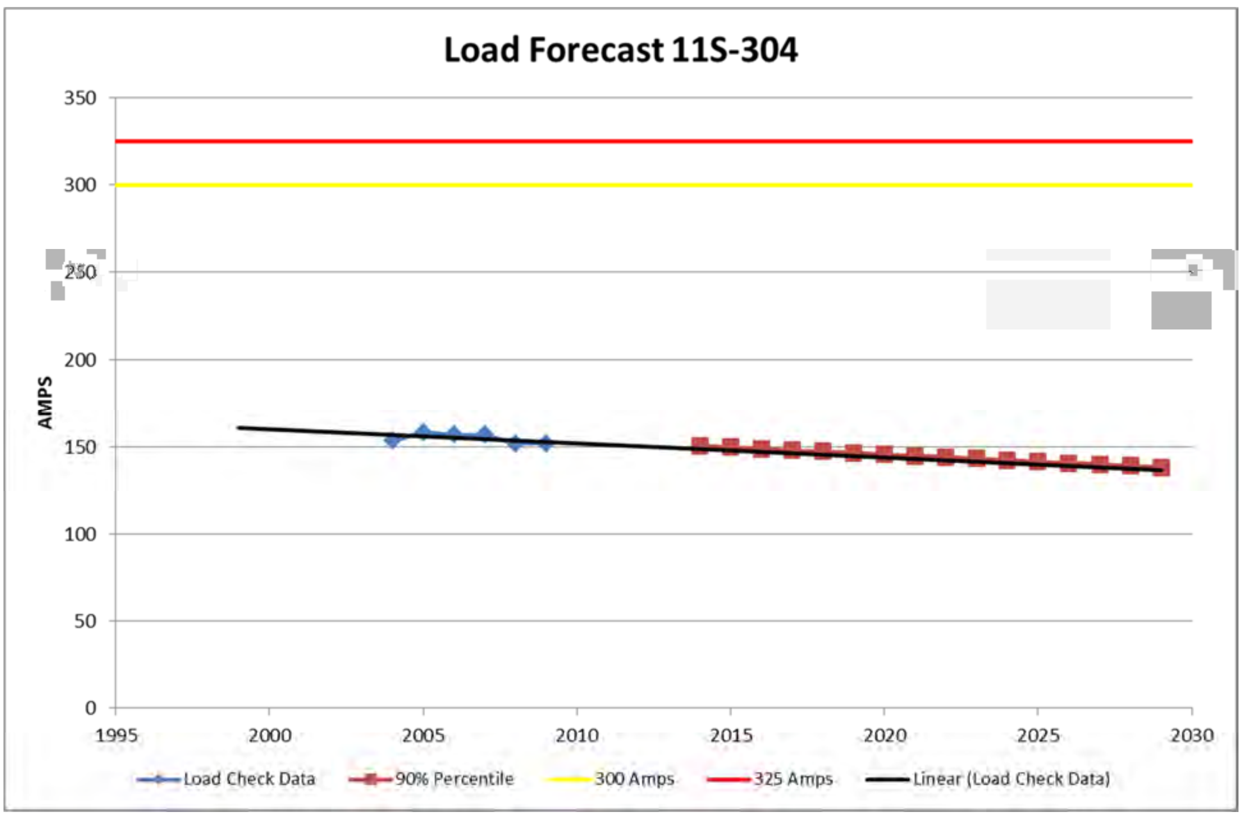


Figure 63 **11S-304 Load Forecast**

Load Growth **-0.53%**

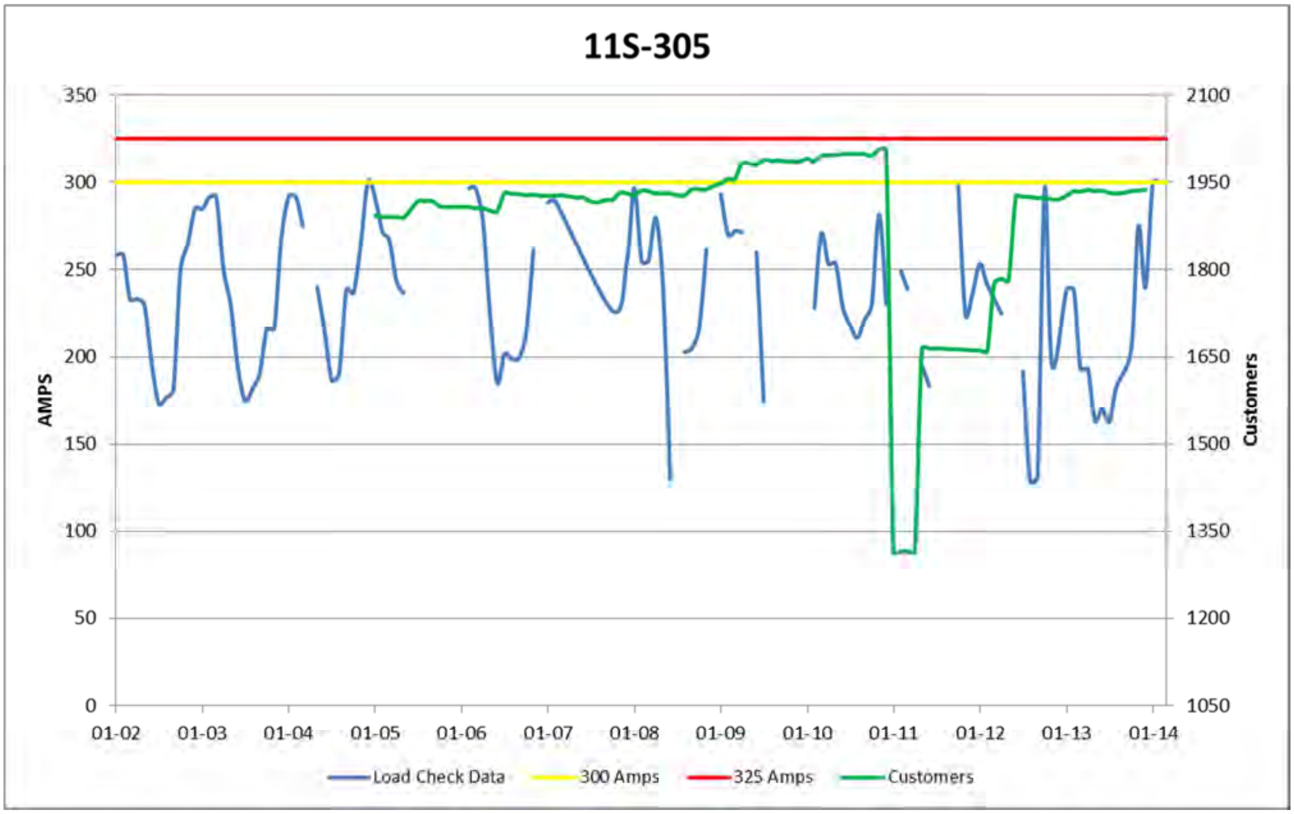


Figure 64 **11S-305 Load History**

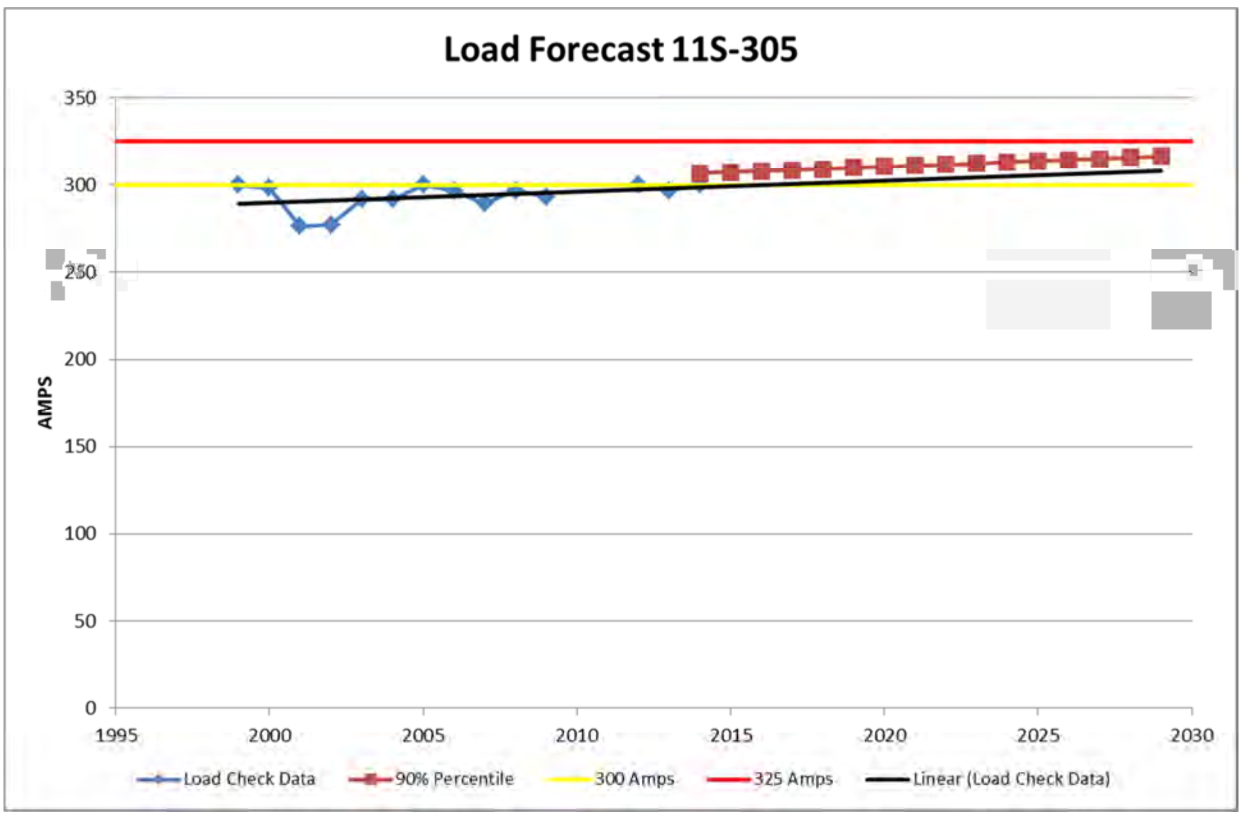


Figure 65 **11S-305 Load Forecast**

Load Growth	**0.21%**

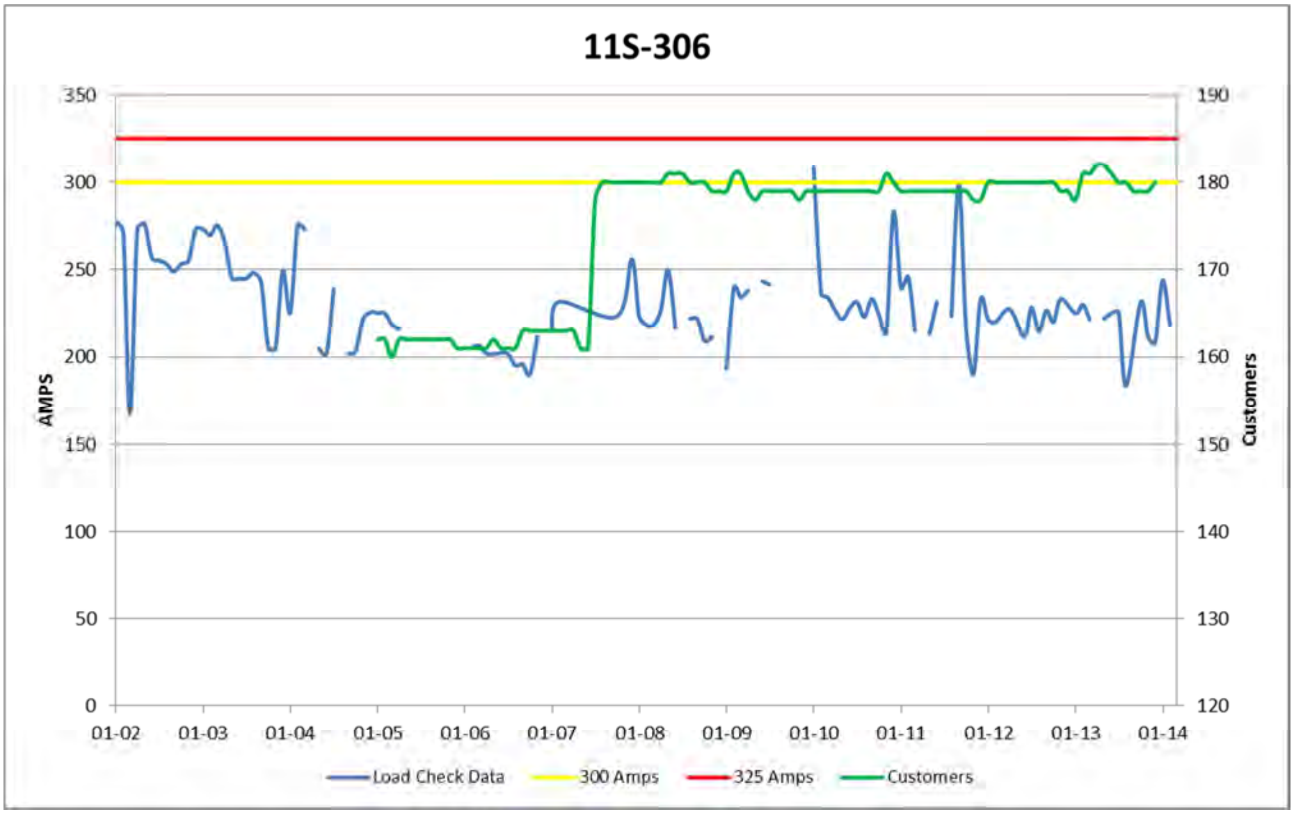


Figure 66 **11S-306 Load History**

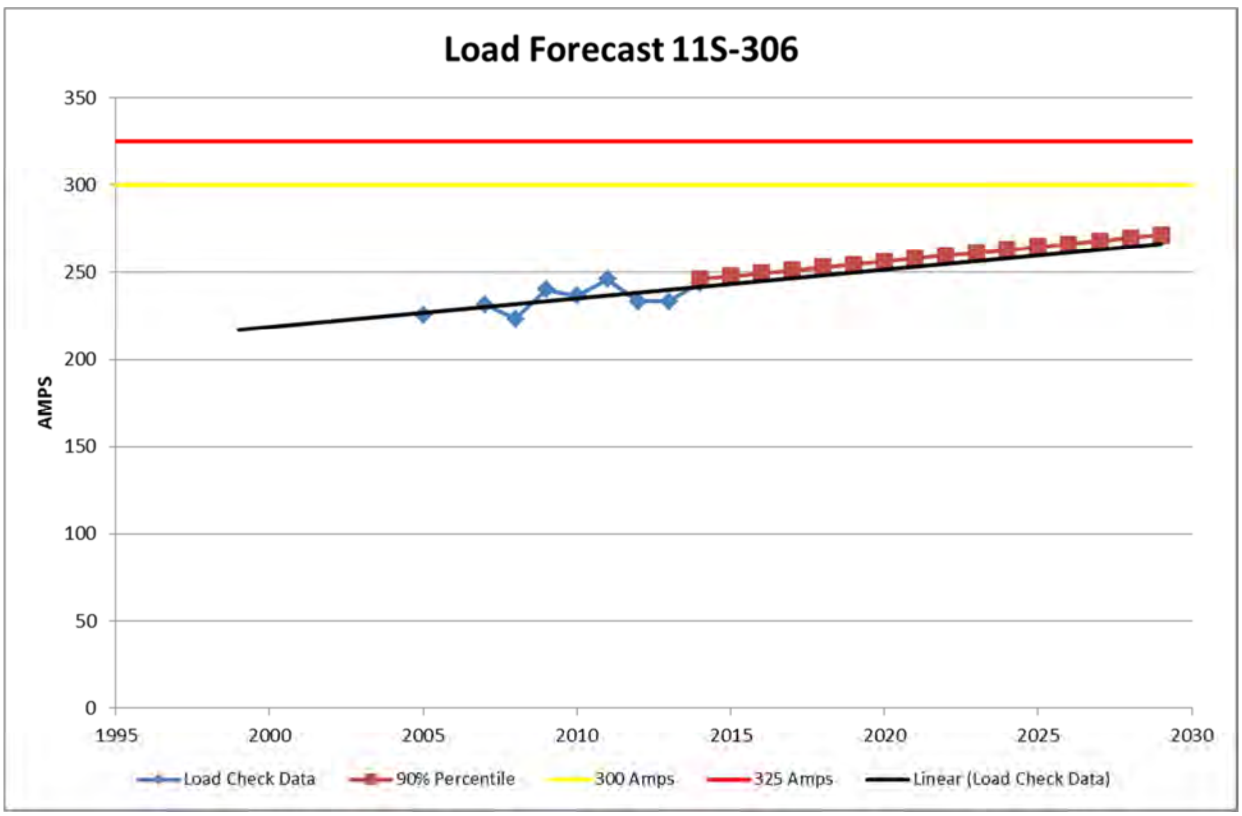


Figure 67 **11S-306 Load Forecast**

Load Growth **0.61%**

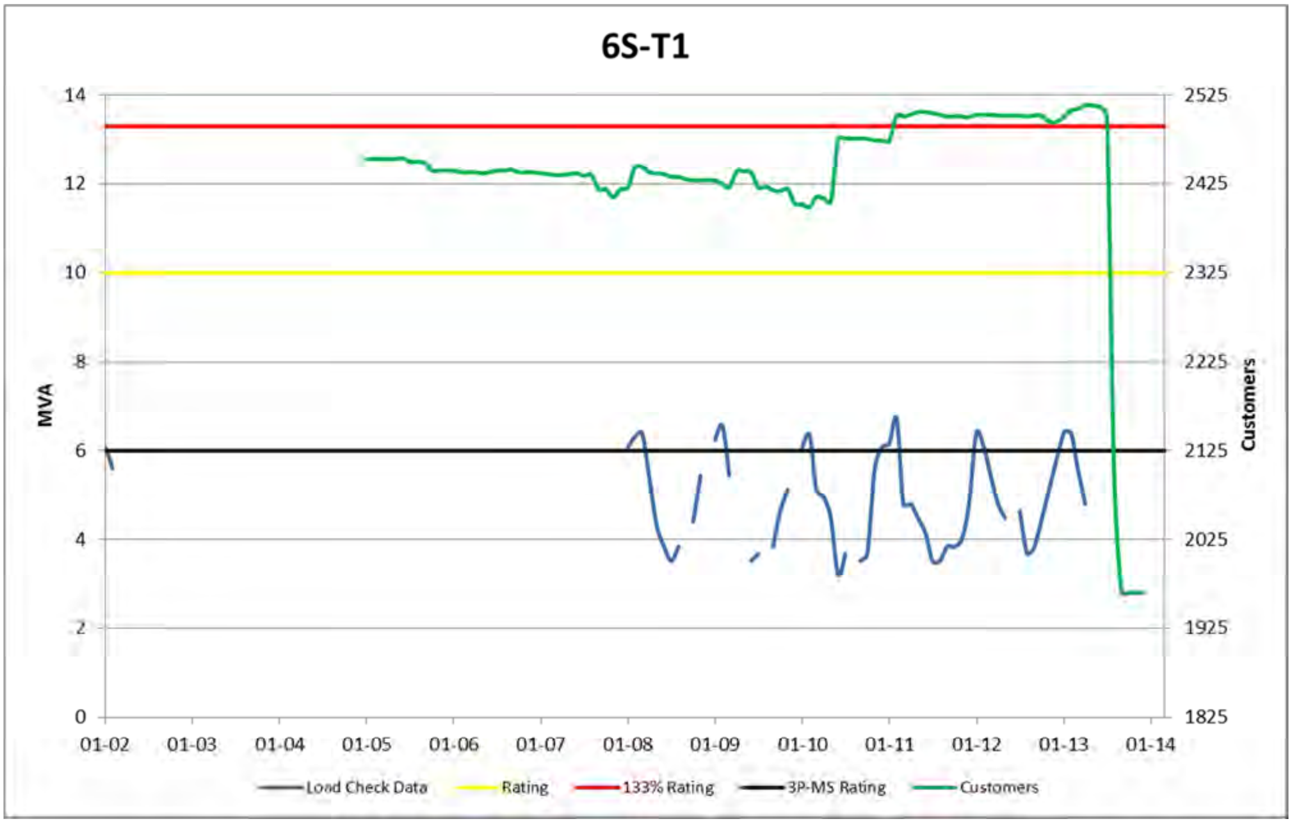


Figure 68 **6S-T1 Load History**

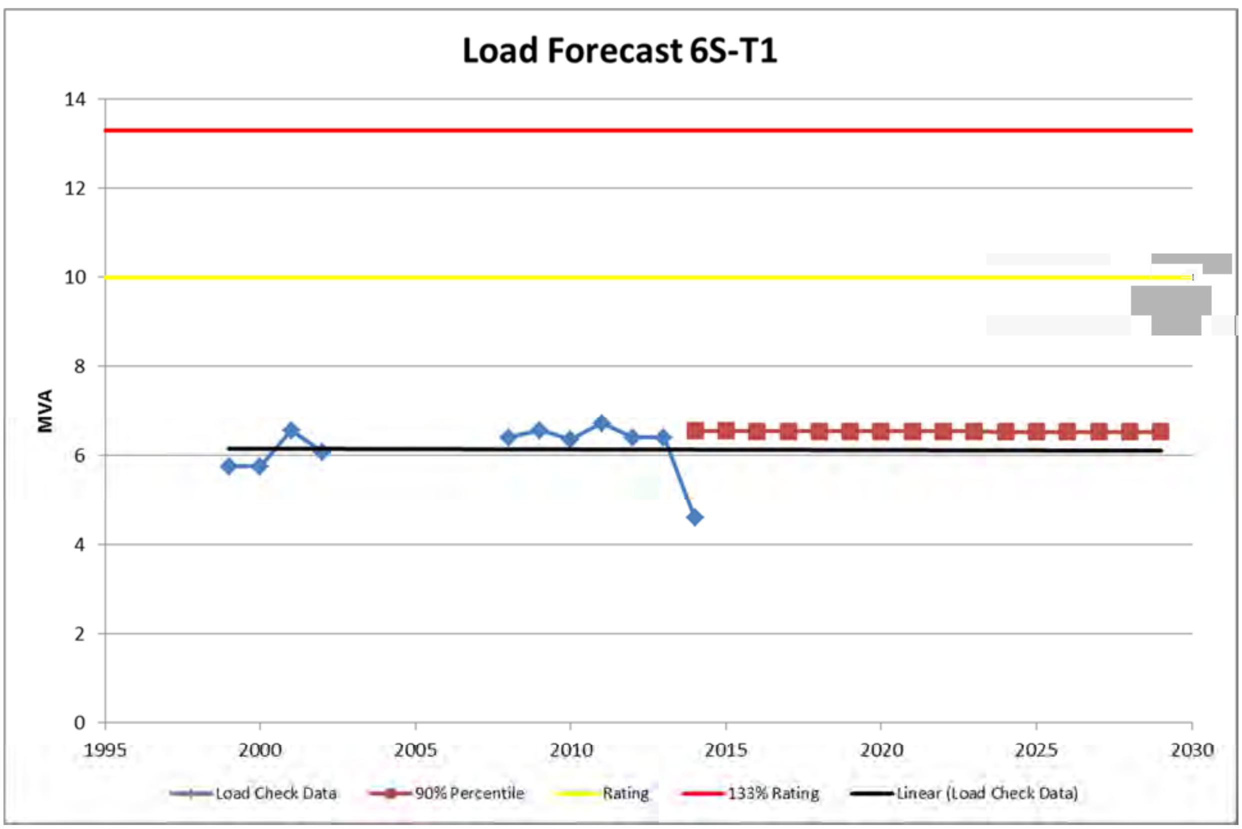


Figure 69 **6S-T1 Load Forecast**

Load Growth **0.02%**

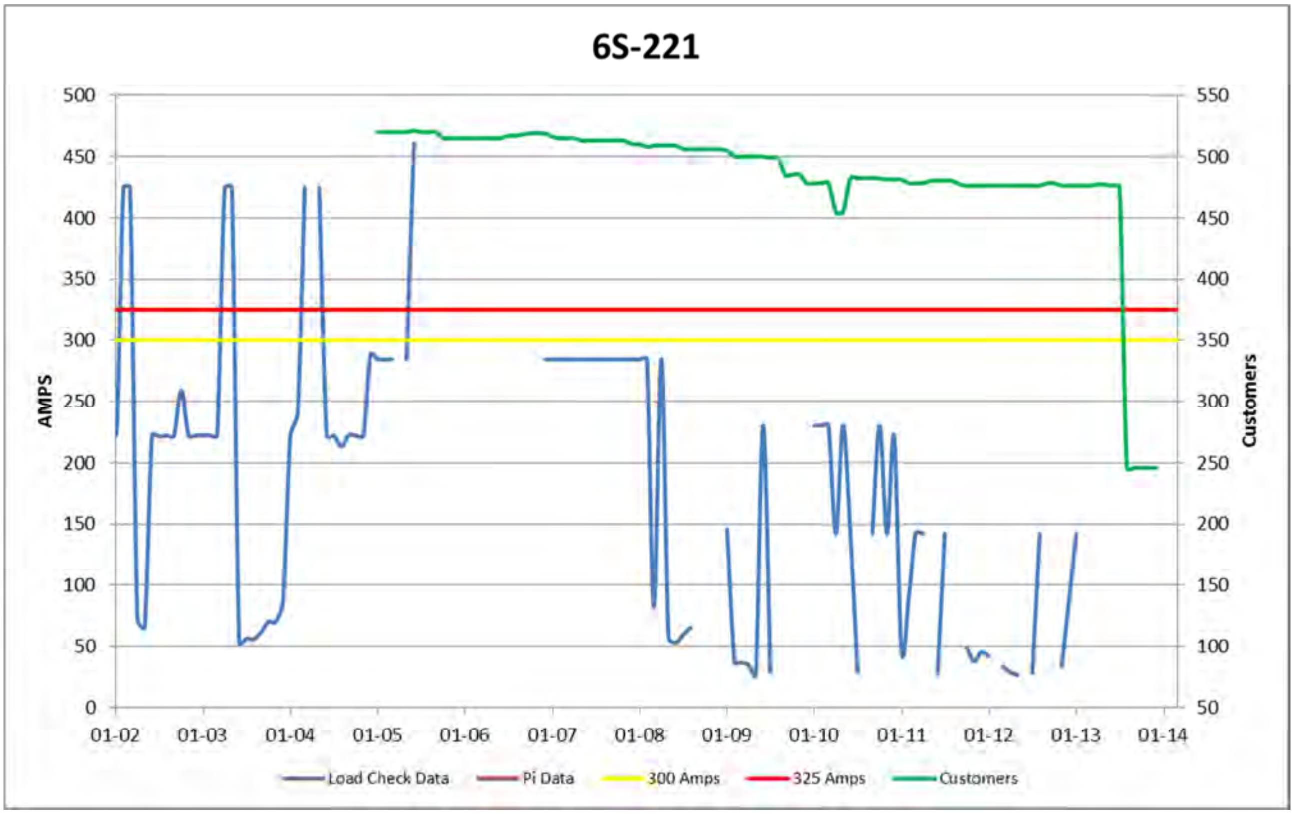


Figure 70 **6S-221 Load History**

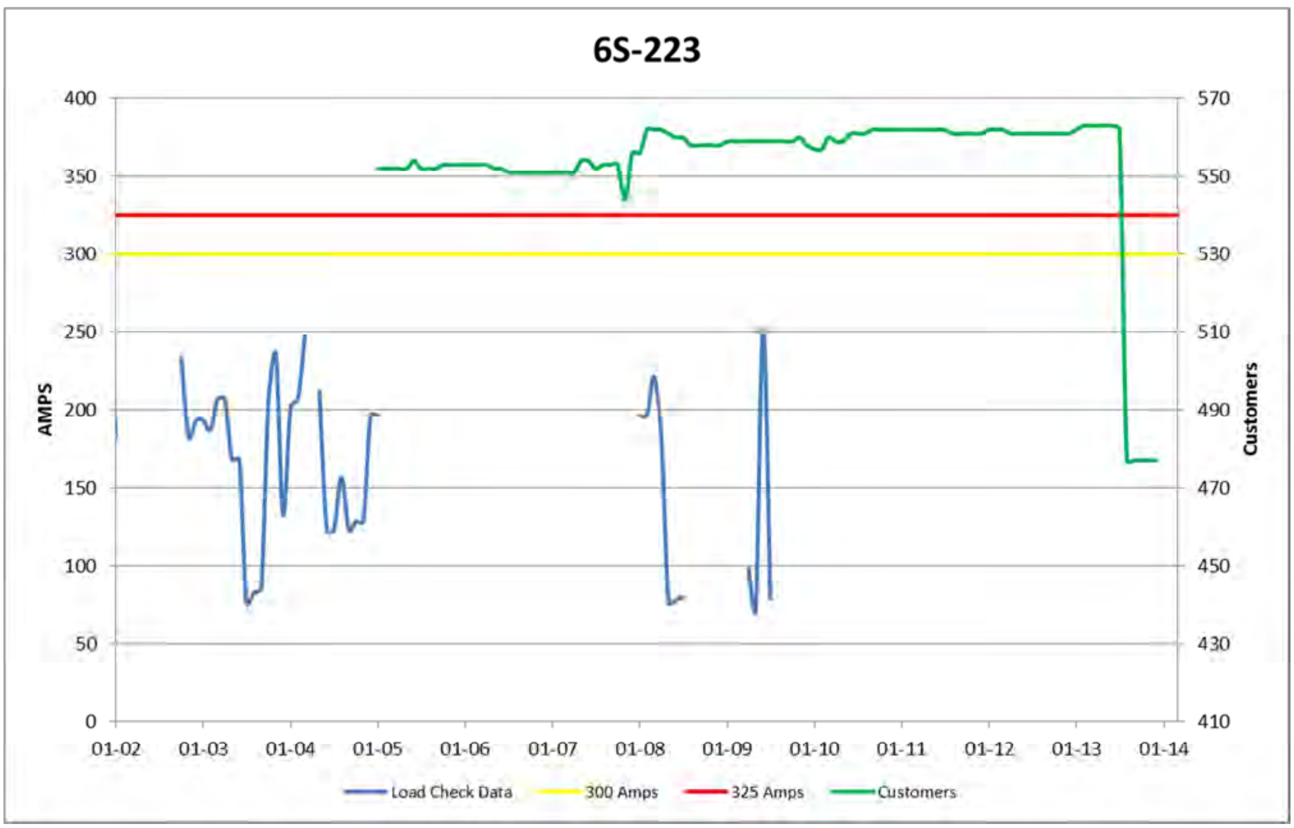


Figure 71 **6S-223 Load History**

Due to the ability to transfer 4kV load at 6S-Terrace Street, only the transformer forecast (6S-T1) will be presented.

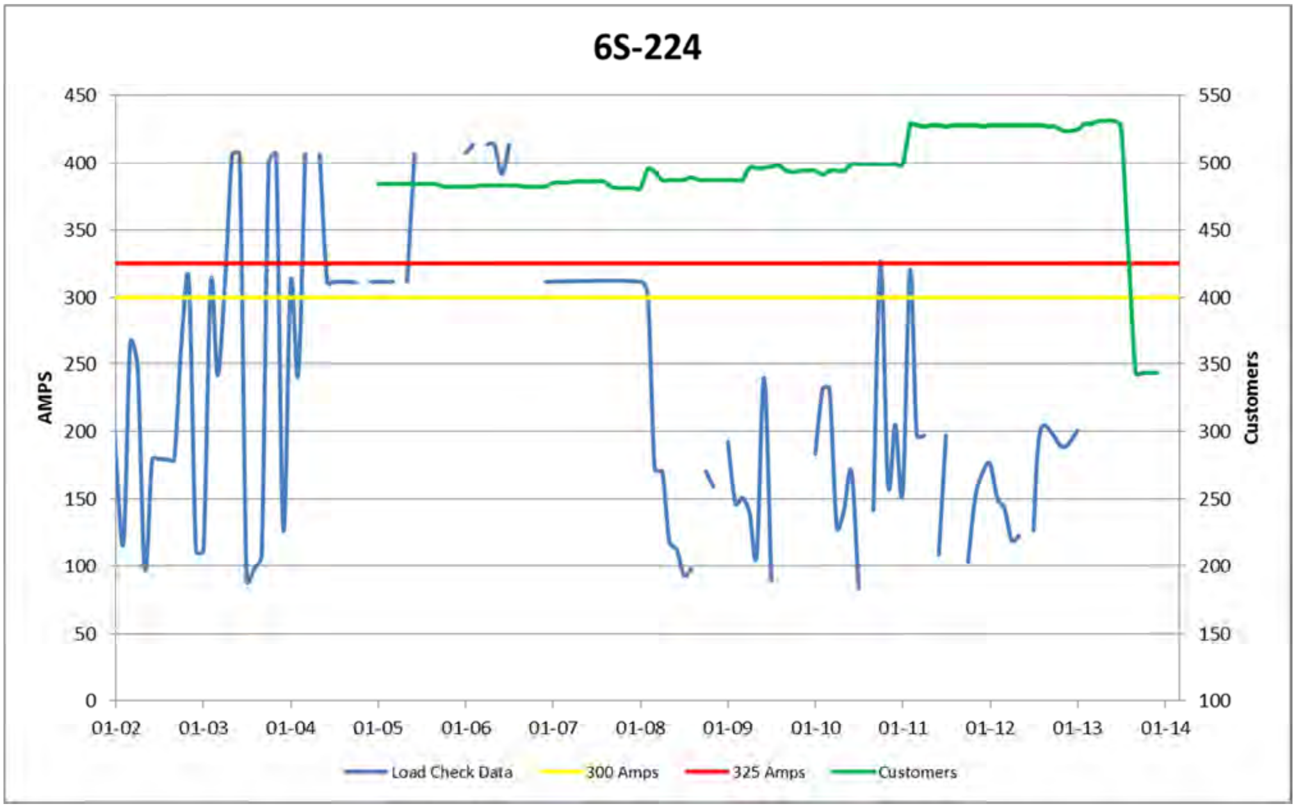


Figure 72 6S-224 Load History

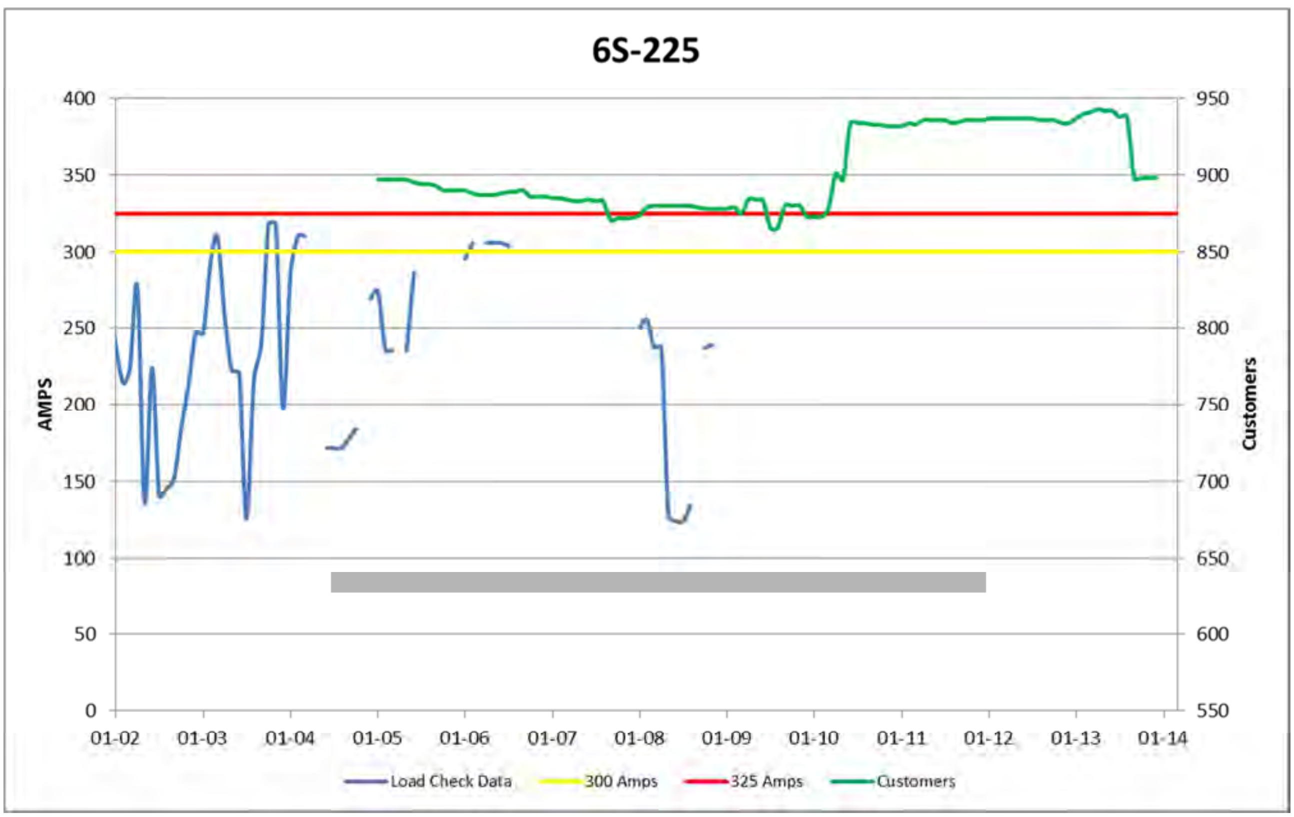


Figure 73 6S-225 Load History

APPENDIX C

Economic Analysis

533S-Mason Street Conversion and 6S-Terrace Street Retirement

Summary of Alternatives

Sydney 4kV Conversions
Summary of Alternatives

Division :		Date :	23-Jul-13
Department :	Distribution Planning	CI Number:	
Originator :	James MacQueen	Project No. :	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	533S-B 6S-A; Convert and Retire 6S-Terrace Street by 2016	6.48%	-2,074,838	3	-7.86%	0.0 years
B	533S-B 6S-B; Convert and Retire 6S-Terrace Street by 2018	6.48%	-2,029,860	2	-7.97%	0.0 years
C	533S-B 6S-C; Convert and Retire 6S-Terrace Streert by 2021	6.48%	-2,010,029	1	-8.28%	0.0 years
	0	NA	NA	NA	#NUM!	0.0 years

Recommendation :

This Economic Assessment recommends the following:
1. Conversion of 533S-Mason Street, from 4 to 12kV, supplied via Bentinck Street
2. Conversion of 4kV load supplied by 6S-Terrace Street to 12kV, over an 8 year period
3. Retirement of 6S-Terrace Street substation in 2021

Notes/Comments :

533S-B 6S-A; Convert and Retire 6S-Terrace Street by 2016

2013: Conversion of 533S-Mason Street stepdown
Conversion at 6S-Terrace Street to reduce overall loading for the installation of mobile substation
Replacement of 4kV breakers and related equipment at 6S-Terrace Street
2014-2015: Continued conversion of 6S-Terrace Street load to 12kV
2016: Retirement of 6S-Terrace Street substation

533S-B 6S-B; Convert and Retire 6S-Terrace Street by 2018

2013: Conversion of 533S-Mason Street stepdown
Conversion at 6S-Terrace Street to reduce overall loading for the installation of mobile substation
Replacement of 4kV breakers and related equipment at 6S-Terrace Street
2014-2017: Continued conversion of 6S-Terrace Street load to 12kV
2018: Retirement of 6S-Terrace Street substation

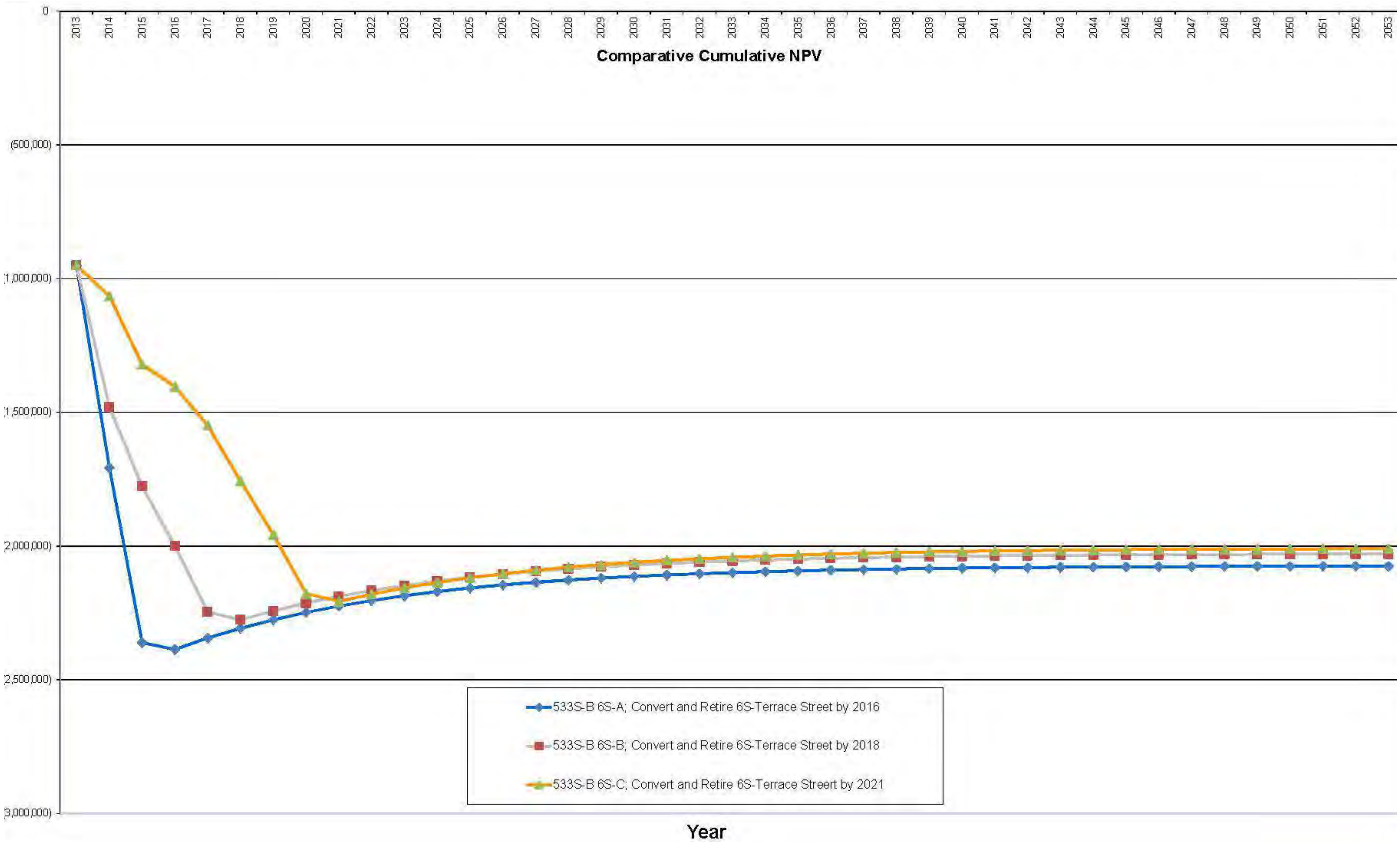
533S-B 6S-C; Convert and Retire 6S-Terrace Streert by 2021

2013: Conversion of 533S-Mason Street stepdown
Conversion at 6S-Terrace Street to reduce overall loading for the installation of mobile substation
Replacement of 4kV breakers and related equipment at 6S-Terrace Street
2014-2020: Continued conversion of 6S-Terrace Street load to 12kV
2018: Maintain 6S-T1, as part of maintenance cycle
2021: Retirement of 6S-Terrace Street substation

0

2013 Sydney 4kV Conversion EAM 7/23/2013

NPV Comparison



Alternative A- 533S-B and 6S-A: Convert and Retire 6S-Terrace Street by 2016

Sydney 4kV Conversions

533S-B 6S-A; Convert and Retire 6S-Terrace Street by

Go to: Working Capital Capital Expenses Revenue

Add Operating Item

Project Description

Nova Scotia POWER An Emera Company

Select:

In-Service Month: January

In-Service Year: 2014

Capital Invested

	Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1.	Shipyard Reconfigure	35,042									
2.	533S-Msaon Street Conversion	274,188									
3.	Bentinck Street Reconfigure		102,510								
4.	Membertou Feeder Tie		35,228								
5.	Cabot Street Conversion	104,080									
6.	Rockdale Avenue Conversion	134,835									
7.	6S-Terrace Street Upgrade	401,500									
8.	Birch Hill Drive Conversion		211,271								
9.	Harold Street Conversion		315,355								
10.	Townsend Street Conversion		164,201								
11.	High Street Conversion			313,381							
12.	Terrace Street Conversion			358,471							
13.	Bernard Lind Conversion			132,214							
14.	6S-Terrace Street Retirement				90,203						
15.											
16.											
17.											
18.											
19.											
20.											
	Total Direct Capital Invested by Year	949,645	828,564	804,066	90,203						
	AFUDC (entered as a positive value)										
	AO (entered as a positive value)										
	Total Indirect Capital Invested by Year										
	Total Capital Invested by Year	**949,645**	**828,564**	**804,066**	**90,203**						

Alternative B- 533S-B and 6S-B: Convert and Retire 6S-Terrace Street by 2018

Sydney 4kV Conversions
533S-B 6S-B; Convert and Retire 6S-Terrace Street by

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item
Project Description

Select:
In-Service Month: January
In-Service Year: 2014

Capital Invested

	Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1.	Shipyard Reconfigure	35,042									
2.	533S-Mason Street Conversion	274,188									
3.	Bentinck Street Reconfigure		102,510								
4.	Membertou Feeder Tie		35,228								
5.	Caobt Street Conversion	104,080									
6.	Rockdale Avenue Conversion	134,835									
7.	6S-Terrace Street Upgrades	401,500									
8.	Birch Hill Drive Conversion			215,496							
9.	Harold Street Conversion		315,355								
10.	Townsend Street Conversion			167,485							
11.	High Street Conversion				319,649						
12.	Terrace Street Conversion					372,953					
13.	Bernard Lind Conversion		129,622								
14.	6S-Terrace Street Retirement						93,847				
15.											
16.											
17.											
18.											
19.											
20.											
	Total Direct Capital Invested by Year	949,645	582,715	382,981	319,649	372,953	93,847				
	AFUDC (entered as a positive value)										
	AO (entered as a positive value)										
	Total Indirect Capital Invested by Year										
	Total Capital Invested by Year	949,645	582,715	382,981	319,649	372,953	93,847				

Alternative C- 533S-B and 6S-C: Convert and Retire 6S-Terrace Street, by 2021

Sydney 4kV Conversions
533S-B 6S-C; Convert and Retire 6S-Terrace Street t

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item
Project Description

Select:
In-Service Month: January
In-Service Year: 2014

Capital Invested

	Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1.	Shipyard Reconfigure	35,042									
2.	533S-Mason Street Conversion	274,188									
3.	Bentinck Street Reconfigure		102,510								
4.	Membertou Feeder Tie		35,228								
5.	Cabot Street Conversion	104,080									
6.	Rockdale Avenue Conversion	134,835									
7.	6S-Terrace Street Upgrades	401,500									
8.	Birch Hill Drive Conversion					224,202					
9.	Harold Street Conversion			321,663							
10.	Townsend Street Conversion						177,736				
11.	High Street Conversion							339,214			
12.	Terrace Street Conversion								395,781		
13.	Bernard Lind Conversion				134,858						
14.	Maintain 6S-T1						150,000				
15.	6S-Terrace Street Retirement									99,591	
16.											
17.											
18.											
19.											
20.											
	Total Direct Capital Invested by Year	949,645	137,738	321,663	134,858	224,202	327,736	339,214	395,781	99,591	
	AFUDC (entered as a positive value)										
	AO (entered as a positive value)										
	Total Indirect Capital Invested by Year										
	Total Capital Invested by Year	**949,645**	**137,738**	**321,663**	**134,858**	**224,202**	**327,736**	**339,214**	**395,781**	**99,591**	

APPENDIX D

Economic Analysis

Membertou Load Growth

Summary of Alternatives

Membertou Load Growth
Summary of Alternatives

Nova Scotia POWER An Emera Company

Division :		**Date :**	25-Mar-14
Department :	Distribution Planning	**CI Number:**	
Originator :	James MacQueen	**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	New George Street Substation, 138kV-12kV	6.48%	-3,585,299	2	-8.15%	0.0 years
B	New Alexandra Street Substation, 138kV-25kV	6.48%	-4,175,037	4	-8.17%	0.0 years
C	6S-Terrace Street Replacement, 69kV - 12kV	6.48%	-3,920,697	3	-8.25%	0.0 years
D	George Street Pad-Mounted Substation 138kV - 12kV	6.48%	-3,098,378	1	-9.04%	0.0 years

Recommendation :

This economic assessment recommends the construction of a pad-mounted substation, near George Street, as outlined in the Distribution Planning Study.

An expansion of the pad-mounted substation will be required, as load materializes and has been accounted for in this EAM.

Notes/Comments :

New George Street Substation, 138kV-12kV

2014-2015: Construction of new 138-12kV sustation off of George Street

New Alexandra Street Substation, 138kV-25kV

2014-2015: Construction of new 138-25kV sustation off of Alexandra Street, with 15/20/25MVA initial transformation
2015: Conversion of 11S-305G from 12 to 25kV
2015: Conversion of Membertou from 12 to 25kV
2016: Conversion of remaining 12kV in Sydney River to 25kV

6S-Terrace Street Replacement, 69kV - 12kV

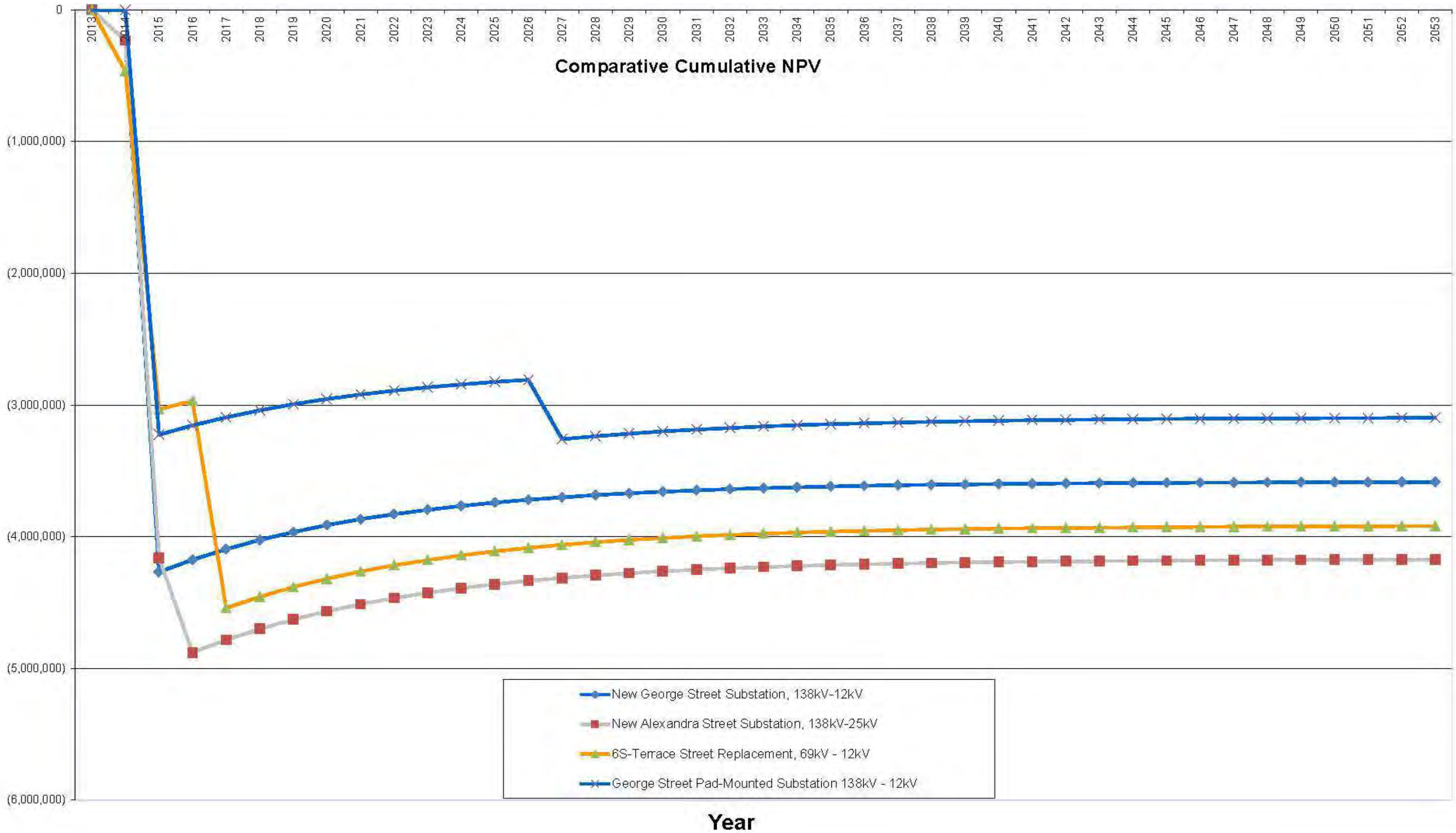
2014-2015: Installation of new 10/12/15MVA 69-12kV transformer at 6S-Terrace Street
2017: Installation of new pad-mounted substation to supply Membertou area

George Street Pad-Mounted Substation 138kV - 12kV

2015: Installation of new 15MVA 138-12kV pad-mounted substation near George Street
2027: Expansion of pad-mounted substation

2013 Membertou Load Growth EAM Rev 9 3/25/2014

NPV Comparison



Alternative Sub-A- New George Street Substation

Membertou Load Growth
New George Street Substation, 138kV-12kV

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item

Project Description

Select:
In-Service Month: January
In-Service Year: 2014

Capital Invested

	Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
1.	New George Street Substation, Part 1		250,000													
2.	New George Street Substation, Part 2			3,500,000												
3.	New George Street Substation Distribution Upgardes			1,200,000												
4.																
5.																
6.																
7.																
8.																
9.																
10.																
11.																
12.																
13.																
14.																
15.																
16.																
17.																
18.																
19.																
20.																
	Total Direct Capital Invested by Year		250,000	4,700,000												
	AFUDC (entered as a positive value)															
	AO (entered as a positive value)															
	Total Indirect Capital Invested by Year															
	Total Capital Invested by Year		**250,000**	**4,700,000**												

Alternative Sub-B- New Alexandra Street Substation

Membertou Load Growth
New Alexandra Street Substation, 138kV-25kV

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item
Project Description

Select:
In-Service Month: January
In-Service Year: 2014

Capital Invested

	Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
1.	New Alexandra Street Substation, Part 1		250,000													
2.	New Alexandra Substation, Part 2			3,500,000												
3.	11S-305G Conversion from 12-25kV			425,000												
4.	Membertou Conversion from 12 to 25kV			650,250												
5.	Sydney River Conversion from 12-25kV				1,002,842											
6.																
7.																
8.																
9.																
10.																
11.																
12.																
13.																
14.																
15.																
16.																
17.																
18.																
19.																
20.																
	Total Direct Capital Invested by Year		250,000	4,575,250	1,002,842											
	AFUDC (entered as a positive value)															
	AO (entered as a positive value)															
	Total Indirect Capital Invested by Year															
	Total Capital Invested by Year		250,000	4,575,250	1,002,842											

Alternative Sub-C- 6S-Terrace Street Replacement, 69kV-12kV

Membertou Load Growth
6S-Terrace Street Replacement, 69kV - 12kV

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item
Project Description

Select:
In-Service Month: January
In-Service Year: 2014

Capital Invested

Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
1. 6S-Terrace Street 69-12kV Preparation		500,000													
2. 6S-Terrace Street 69-12kV Completion			3,000,000												
3. Pad-Mounted Substation, George Street					1,900,000										
4. Pad-Mounted Substation Distribution Upgrades					250,000										
5.															
6.															
7.															
8.															
9.															
10.															
11.															
12.															
13.															
14.															
15.															
16.															
17.															
18.															
19.															
20.															
Total Direct Capital Invested by Year		500,000	3,000,000		2,150,000										
AFUDC (entered as a positive value)															
AO (entered as a positive value)															
Total Indirect Capital Invested by Year															
Total Capital Invested by Year		500,000	3,000,000		2,150,000										

Alternative D- Sub-D George Street Pad-Mounted Substation, 138kV-12kV

Membertou Load Growth

George Street Pad-Mounted Substation 138kV - 12kV

Go to: Working Capital
Capital
Expenses
Revenue

Add Operating Item

Project Description

Select:
In-Service Month: January
In-Service Year: 2014

Capital Invested

	Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
1.	Pad-Mounted Substation, George Street			1,900,000												
2.	Pad-Mounted Substation Expansion															900,000
3.	New George Street Substation Distribution Upgrades			1,000,000												
4.	Spare Pad-Mounted substation equipment			850,000												
5.	Distribution Upgrades for Substation Expansion															250,000
6.																
7.																
8.																
9.																
10.																
11.																
12.																
13.																
14.																
15.																
16.																
17.																
18.																
19.																
20.																
	Total Direct Capital Invested by Year			3,750,000												1,150,000
	AFUDC (entered as a positive value)															
	AO (entered as a positive value)															
	Total Indirect Capital Invested by Year															
	Total Capital Invested by Year			**3,750,000**												**1,150,000**

CI Number: 49866

Title: 512N Toney River Replacements

Start Date: 2017/09
In-Service Date: 2017/11
Final Cost Date: 2018/05
Function Class: Distribution
Forecast Amount: $285,219

DESCRIPTION:

This project provides for costs associated with replacing the stepdown transformers at 512N-Toney River. The existing 333kVA transformers will be replaced with 500kVA transformers. Three 100A voltage regulators will also be installed in conjunction with the stepdown transformers to maintain voltage levels within CSA standards. Additional replacements include three single-phase reclosers and approximately 1 kilometer of conductor and 9 poles.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Distribution System

Why do this project?

The existing 512N-Toney River stepdown transformers and reclosers are deteriorated and at risk of failure. Failure of these transformers would result in extended customer outages of approximately 8-12 hours.

The secondary driver for this project is that the existing 512N-T1 has exceeded its nameplate capacity by 27% and customers on this transformer are experiencing power quality issues (low voltage) due to loading and the length of the feeder.

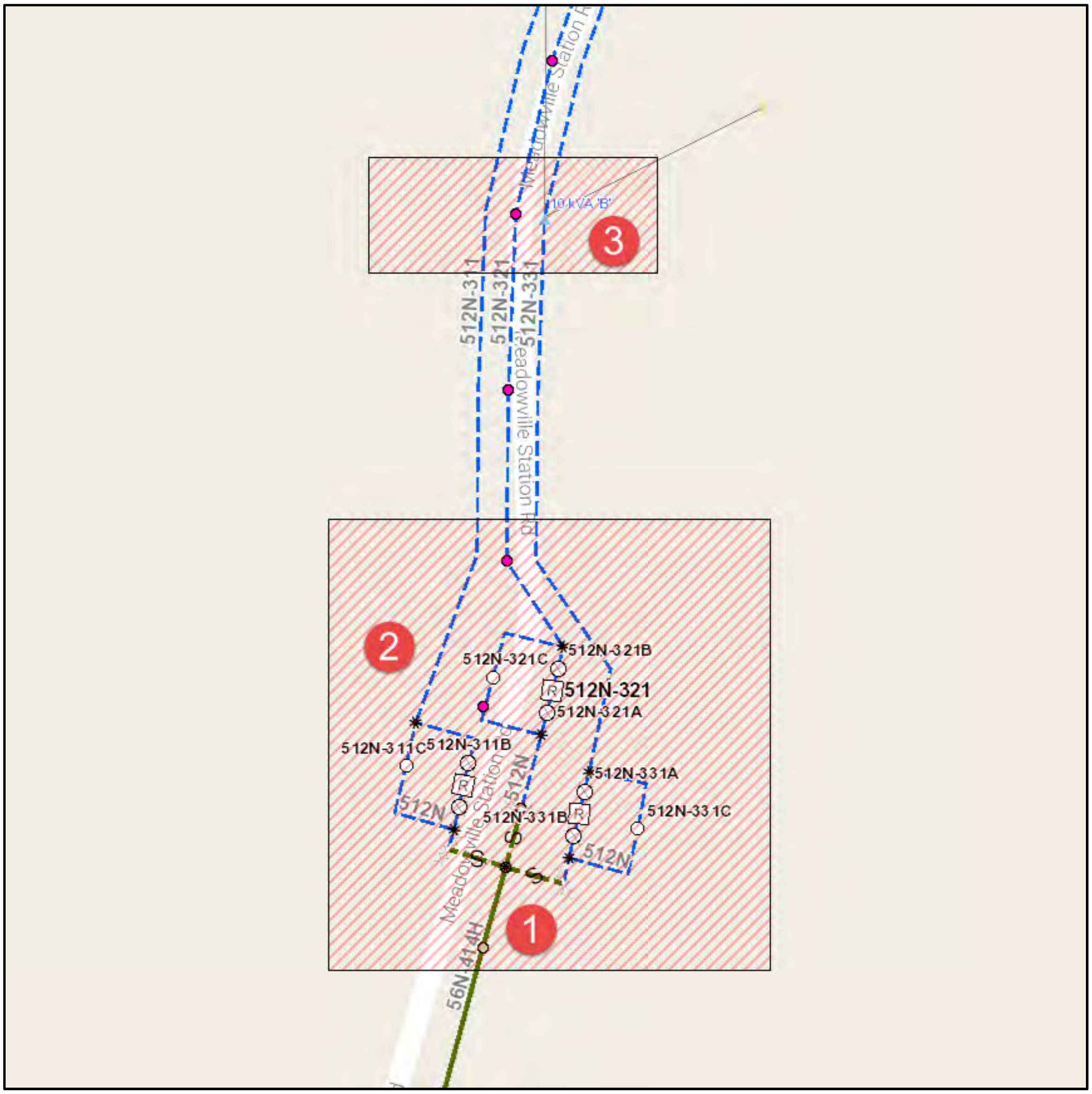
In addition, the existing three stepdown transformers (T1, T2 and T3) are connected in a delta wye configuration, which is no longer an NS Power distribution standard.

Why do this project now?

The existing 512N stepdown transformers and reclosers are approximately 60 and 40 years old, respectively, and have reached the end of their expected useful life. Inspection of the targeted devices and assessment based on age, condition and risk of failure has determined that replacement is required.

Why do this project this way?

Alternatives considered include upgrading the stepdown transformers and voltage conversion. The proposed solution to upgrade the stepdown transformers is more cost effective than voltage conversion, which would be at minimum twice as costly, which would require significant rebuild of the existing distribution system.



(1) Replace existing 333kVA stepdown transformers with 500kVA stepdown transformers
(2) Replace existing single-phase reclosers
(3) Install 3 100A voltage regulators

CI Number : 49866 - 512N-Toney River Replacements **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		15,695	0	15,695
094		094 - Interest Capitalized		2,654	0	2,654
095		095-COPS Regular Labour AO		23,250	0	23,250
095		095-COPS Contracts AO		5,447	0	5,447
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	2,145	0	2,145
012	035	012 - Materials	035 - DP - Wood Poles	5,894	0	5,894
013	035	013 - COPS Contracts	035 - DP - Wood Poles	27,211	0	27,211
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	15,272	0	15,272
012	039	012 - Materials	039 - DP - O/H Cond.	12,100	0	12,100
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	12,978	0	12,978
012	040	012 - Materials	040 - DP - O/H Cond.Devices	157,246	0	157,246
001	085	001 - Regular Labour (No AO)	085 Design	5,327	0	5,327
			Total Cost:	285,219	0	285,219
			Original Cost:	12,971		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 49866
Title: 512N Toney River Replacements
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - PLT	PD	83	$ 367	$ 30,395		
Procurement / Financial Support	Lot	1	$ 5,327	$ 5,327		
			Sub-Total	$ 35,723		
012 Materials						
Poles	Lot	1	$ 5,894	$ 5,894		
Conductors	Lot	1	$ 12,100	$ 12,100		
Voltage Regulator	ea	3	$ 20,000	$ 60,000		
Stepdown and Platform	Lot	1	$ 72,246	$ 72,246		
Reclosers	ea	3	$ 8,333	$ 25,000		
			Sub-Total	$ 175,240		
013 Contracts						
Flagging	Lot	1	$ 19,111	$ 19,111		
Backhoe	Lot	1	$ 8,100	$ 8,100		
			Sub-Total	$ 27,211		
094 Interest Capitalized						
AFUDC				$ 2,654		
			Sub-Total	$ 2,654		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 15,695		
			Sub-Total	$ 15,695		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 23,250		
COPS Contract AO				$ 5,447		
			Sub-Total	$ 28,697		
			SUB-TOTAL (no AO, AFUDC)	$ 238,174		
			TOTAL (AO, AFUDC included)	$ 285,219		
Original Cost				$ 12,971		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

General Plant

CI Number: 49861

Title: IT – PI System Upgrade

Start Date:	2017/02
In-Service Date:	2017/12
Final Cost Date:	2018/06
Function:	General Plant
Forecast Amount:	$779,253

DESCRIPTION:

This project is to upgrade NS Power's Operating Data Historian application system (PI), and to merge the two existing PI servers (Thermal production and ECC Hydro) into a single master server for NS Power.

PI is a data storage system that is used to hold readings from thousands of instruments and numerous data entry systems across NS Power, largely within the power production generating stations. The PI software has a proprietary storage system that allows compression of thousands of readings (temperatures, pressures, vibration level) at very short intervals into a highly functional data system. This system is essential to numerous Asset Management systems and processes, including Predictive Analytics, Operator Rounds and Testing, Equipment Performance Monitoring, Equipment Reporting, Historical Analysis for Plant and Engineering Personnel, Environmental Reporting as well as Alerting Systems. The PI system is a critical business system.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Work Support Facilities

Sub Criteria: Information Technology Application and Hardware System

Why do this project?

The present version of PI is aging (8 years old) and requires an upgrade in order to mitigate the risk of server failure and to meet the needs of the asset management processes within NS Power. NS Power's processes and systems relying on PI have evolved dramatically. PI readings are now being used in proactive and predictive analysis, as opposed to the retroactive analysis of instrument readings that do not proactively (through predictive analytics) mitigate equipment breakdowns. PI has become central to key operational and asset management systems and therefore its reliability and performance are more critical.

This upgrade provides opportunity to merge the existing two independent PI systems into a single, more manageable and maintainable system, providing a central data warehouse as NS Power continuous to advance Asset Management Processes and share best practice across divisions.

This project will enhance PI reliability as redundancy will be built in. This is becoming necessary as NS Power's level of automation and sophistication in its Asset Management processes evolves, as discussed above with the proactive and predictive analysis.

In addition, the latest version of PI provides important functional advancements including enhanced auto alerting capabilities which will enable NS Power's fleet monitoring capability to grow and support Plant and Field Operations.

Why do this project now?

The version of PI used by NS Power is four major revisions old (equating to eight calendar years). PI is an important part of our Operations IT infrastructure. It houses thousands of readings from instruments in the field and is used to provide alerts and do diagnostics that can prevent costly equipment failures. PI has evolved from a diagnostic tool to an integral element in Asset Management including real time monitoring, analytics and auto reporting. As a critical operational tool, PI requires an upgrade to provide more functionality and redundancy. If this upgrade is not completed, a failure of the hardware (servers) could occur. If a failure in the hardware were to occur, NS Power would lose the ability to complete the proactive and predictive analysis discussed above and could lose information related to its equipment.

Why do this project this way?

This project will integrate previous PI systems into a single platform, enabling more effective management of the system. This integration will also enable the sharing of best practice across the organization (Key Performance Indicators, Dashboards, Performance Monitoring).

With respect to project execution, NS Power will optimize implementation utilizing industry experts in support of NS Power technical staff employing a well-established implementation approach.

CI Number : 49861 - IT - PI System Upgrade **Project Number**

Parent CI Number : -

Cost Centre : 027 - 027-Administration **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		23,308	0	23,308
095		095-IT Regular Labour AO		20,886	0	20,886
095		095-COPS Regular Labour AO		29,358	0	29,358
035	072	035 - Comp.Hrdwr & Op.Sftwr	072 - GP - Computer Equipment	70,000	0	70,000
001	078	001 - T&D Regular Labour	078 - GP - Comp. Appl. Software	38,381	0	38,381
001	078	001 - IT Regular Labour	078 - GP - Comp. Appl. Software	62,896	0	62,896
028	078	028 - Consulting	078 - GP - Comp. Appl. Software	[redacted]	0	[redacted]
034	078	034 - Appl. Software	078 - GP - Comp. Appl. Software		0	
066	078	066 - Other Goods & Services	078 - GP - Comp. Appl. Software	64,155	0	64,155
			Total Cost:	779,253	0	779,253
			Original Cost:			

Capital Project Detailed Estimate

Location: General Plant
CI# / FP#: 49861
Title: IT - PI Upgrade
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Engineering	PD	100.00	$ 383.81	$ 38,381		
Technologists	PD	200.00	$ 314.48	$ 62,896		
			Sub-Total	$ 101,277		
028 Consulting						
Technical PM Lead	Lot	100	$ 1,000	$ 100,000		
ADM Resources	Lot	1	[redacted]		Cost Support Item #1	
Test Lead	Lot	60				
			Sub-Total	[redacted]		
034 Computer Software						
PI Visualization Suite / Components	Lot	1	[redacted]		Cost Support Item #2	
Software Reliance Program	Lot	1			Cost Support Item #2	
USD Exchange	%	0.31				
			Sub-Total			
035 Computer Hardware						
3 Environments (prod, Dev, Test)	Lot	1	$ 70,000	$ 70,000		
			Sub-Total	$ 70,000		
066 Other Goods & Services						
Contingency	%	10%	$ 641,547	$ 64,155		
				$ -		
			Sub-Total	$ 64,155		
094 Interest Capitalized - Calculated						
AFUDC				$ 23,308		
				$ -		
			Sub-Total	$ 23,308		
095 Administrative Overhead - Calculated						
COPS Regular Labour AO				$ 29,358		
IT Regular Labour AO				$ 20,886		
				$ -		
			Sub-Total	$ 50,244		
			SUB-TOTAL (no AO, AFUDC)	$ 705,701		
			TOTAL (AO, AFUDC included)	$ 779,253		
Original Cost				$ -		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

SYSTEMS ENGINEERING LTD.
AUTOMATION, DATA MANAGEMENT & MECHANICAL DESIGN

Proposal for

Nova Scotia Power
PI Server Upgrade

ADM Project No. 6110

Revision R1

Submitted to:

Mike Greene
Asset Management Specialist
Nova Scotia Power
1223 Lower Water St
Halifax, NS
B3J 3S8

Prepared by:

Alain Charpentier
ADM Systems Engineering Ltd.
30 Damascus Drive, Suite 208,
Bedford, Nova Scotia, B2Y 4M9

July 6, 2016

TABLE OF CONTENTS

REVISION NOTES

Revision No.	Description	Reviewed by
A	Initial version for internal review	AC
0	Issued to client	JG
1	Modifications made as per request of NSP. Cost increase due to adding development environment.	

July 6, 2016

Nova Scotia Power
1223 Lower Water St
Halifax, NS
B3J 3S8

Attention: **Mike Greene, Asset Management Specialist**
Reference: **PI Server Upgrade**

Dear Mr. Greene,

ADM is pleased to submit this proposal to replace Nova Scotia Power's (NSP) two (2) existing PI servers with a high-availability PI system to be located at their Ragged Lake facility. Our proposal is based on the meeting with Mike Green and Rob McNeil on June 17, 2016 and the draft project schedule provided by NSP.

1 INTRODUCTION

ADM Systems Engineering Ltd. (ADM) is a multi-disciplined engineering and software services firm specializing in automation, data management, mechanical design and industrial energy management. ADM's mission is to provide integrated solutions using the best technology to improve our client's operational performance, productivity and efficiency while reducing costs, material inputs and energy consumption.

2 BACKGROUND

NSP has two existing PI servers. One server, located at their Ragged Lake facility, is dedicated to their Transmission & Distribution (T&D) division. The second PI server, located at NSP's Head Office, is dedicated to their Power Production (PP) division. NSP would like to replace these antiquated servers with a new, virtual high-availability (HA) Production PI system. The HA Production PI system will include both primary and secondary PI servers, which will be replicated in development and test environments.

The existing servers are installed with different versions of PI software. Prior to installing any PI software on the new virtual PI server environments, the PP server will require upgrade to the same PI software version as the T&D server.

3 Objectives

The objective of this proposed scope of work is to develop the preliminary design, detailed design, software configuration and commissioning/testing required to replace NSP's two (2) existing PI servers with a new, virtual, HA Production PI system. The Production PI system, to be located at NSP's Ragged Lake facility, will include both primary and secondary PI servers. These servers will be replicated in development and test environments.

This proposal details this scope of work and provides a fixed cost for the preliminary design, detailed design, software configuration and commissioning/testing.

4 Scope of Work

ADM will be responsible for replacing NSP's two (2) existing PI servers with a new virtual HA Production PI system. This work will include:

4.1 Project Management

In addition to the coordination of internal resources and frequent communication with the project sponsor, ADM will review with the project sponsor the project objectives and present the project execution plan. ADM will also arrange:

- One (1) project kickoff meeting at site.
- Bi-weekly review meetings.
- Bi-weekly project status reports and showing percentage complete.
- One (1) project closeout meeting via web conference.

4.2 Preliminary Design

ADM will review the software specification provided by OSIsoft to NSP to confirm that all PI system components are compatible and that all system prerequisites are met. ADM will also check the compatibility of any existing applications/script for writing to/from the new HA Production PI system.

4.3 Detailed Design

As part of the detailed design, ADM will develop a technical specification for a new virtual HA Production PI system. Based on this specification, NSP will build both primary and secondary virtual Production PI servers, which will be replicated in development and test environments.

ADM will review the PI interface inventory provided by NSP and check for compatibility with the new PI servers. Following this review, ADM will develop a PI network architecture drawing.

Other detailed design activities will include:

- Developing the security for Active Directory.
- Developing backup and disaster recovery plans.
- Developing the site acceptance test (SAT).
- Revising NSP's draft project schedule.

Upon completion, ADM will consolidate the detailed design output into an implementation plan.

4.4 SOFTWARE CONFIGURATION

The software configuration steps will be as follows:

- Confirm that installation prerequisites are met.
- Download OSIsoft required components.
- Backup PP PI server (installed with oldest version of PI software).
- Upgrade PP server to same PI software version as T&D server.
- Back up both the T&D and PP PI servers.
- Install existing PI software version on new virtual PI server.
- Migrate the PP server to the new virtual PI server.
- Migrate the T&D server to the new virtual PI server.
- Upgrade the new virtual Production PI server to the software version specified by OSIsoft.
- Configure the security for Active Directory on the Production server environment.
- Install PI Server Software on Secondary PI Server.
- Synchronize the Primary and Secondary PI Servers.
- Install PI server software on the Development server
- Configure the security for Active Directory on the Development server environment.
- Install PI server software on the Test server.
- Configure the security for Active Directory on the Test server environment.
- Restore backup from the Production server to the Development server.
- Restore backup from the Production server to the Test server.
- Upon finishing all the software configuration steps, ADM will complete an upgrade summary.

4.5 COMMISSIONING

Commissioning by ADM will include:

- Testing the new server configuration and connections.
- Testing the high availability Production system redundancy.
- Testing the Development server.
- Testing the Test server.

4.6 SITE ACCEPTANCE TESTING

ADM will use the checklists developed as part of the detailed design to execute a Site Acceptance Test for the development, test and production server environments.

4.7 CLIENT TRAINING

ADM will develop a training manual and conduct a one day course on security for Active Directory.

4.8 POST PROJECT SUPPORT

ADM will dedicate 16 hours towards post project telephone and VPN query support.

PLEASE NOTE:

The above scope of work is a proposed plan of activities to accomplish the desired outcomes of this project. The specific tasks may change during the execution of this project at the discretion of the project manager to facilitate the development of the deliverables specified.

5 Deliverables

- Specification for new virtual HA PI system.
- PI network architecture drawing.
- Backup and disaster recovery plan.
- Commissioning
- SAT results.
- Project implementation plan / revised project schedule.
- New virtual HA Production PI system, replicated in development and test environments.
- Upgrade summary.
- Training session for Active Directory security.
- Project closeout form.

6 Provided by the Client

- Project charter.
- Complete list of PI interfaces / specifications (spreadsheet)
- Access to site and technical personnel for inquiries, commissioning and training.
- HA PI server software BOM.
- New virtual primary/secondary production PI servers, development server, test server, with Windows Server 2008 R2 SP1 or greater, installed and joined to the NSP network.
- SQL Server for PI AF installation.
- Remote administrative access to PI Servers.

7 Exclusions, Risks And Constraints

The following items are specifically excluded from this proposal:

- Time for PI Visualizations (e.g. PI ProcessBook, CoreSight) or AF.
- Licensed software - purchase orders for the procurement of OSIsoft software licenses are to be addressed directly to OSIsoft. ADM will provide assistance for requesting quotations.
- Virtual PI server hardware platforms.

8 Schedule

ADM is prepared to begin work upon authorization to proceed with purchase order to follow. We anticipate the work will take 10-12 weeks to complete.

9 Project Costs, Specific Terms & Conditions

9.1 Project Costs

Based on the above scope of work our estimate of professional fees is [redacted], excluding all applicable taxes. This can be broken out into the following categories.

Item	Description	Cost
1	PM	[redacted]
2	Preliminary Design	
3	Detailed Design	
4	Software Configuration	
5	Commissioning	
6	SAT	
7	Client Training	
8	Travel Time	
9	Post Project Support	
10	Subtotal	
11	Travel Expenses	
12	Total	

Please note that the cost of our engineering service is based on the scope of services described above. There is potential for changes in scope of work with any project and an important element in cost control is the proper management of those changes. As a matter of practice, we do not undertake additional scope of services without prior written approval from the client. If changes in scope occur, ADM will submit Scope Change Requests (SCR) to the Client for notification of the changes and approval of them prior to proceeding with the additional services. Details of our scope change control system are available on request.

9.2 Specific Terms & Conditions

- ADM proposes to complete this scope of work on a fixed fee basis in accordance with our Standard Terms & Conditions attached in Appendix A.
- All amounts are due thirty (30) days on approved credit. All payments thirty (30) days in arrears are subject to a finance charge of 2% per month on the outstanding balance.
- All taxes extra.
- Quotation is valid for 30 days.

9.3 Payment Terms

- Monthly progress billings based on percentage complete.

9.4 Invoice Payments

Please Remit All Payments To:

ADM Systems Engineering Ltd.
2 Clarwood Drive
Quispamsis, NB E2E 4K1

10 ADM Commitment

ADM project solutions are a managed synergy of best practices and technology developed from the integration of our team within your plant processes.

The decision to include ADM's resources in projects provides peace of mind that the best possible effort has been made to ensure the project will:

- Meet mutually agreed upon budget and time goals
- Have access to a resource of broad talents and experience directly related to the assignment
- Be optimally designed for the intended purpose
- Be undertaken by a team who share goals and responsibility
- Be thoroughly understood and maintainable
- Have reliable and prompt access to future support

If you have any questions, concerns or we have misinterpreted your requirements, please contact me at your convenience to discuss.

Yours truly,

Alain Charpentier
Business Development Manager
ADM Systems Engineering Ltd.
Tel: 902-223-6073
Email: charpentiera@admse.com

11 APPENDIX A – ADM TERMS AND CONDITIONS

ADM Standard Terms and Conditions

1.1 Terms of Payment

Unless otherwise stated in the Specific Terms and Conditions above, percent complete progress will be billed each month. All amounts are in Canadian dollars and are due thirty (30) days on approved credit. Credit application form is included below. All taxes are extra. All payments thirty (30) days in arrears are subject to finance charge of 2% per month on the outstanding balance.

1.2 Escalation

If the contract extends beyond one year or beyond the agreed contract term, then the remaining work rates will be adjusted accordingly to labor and/or material costs escalation.

1.3 Warranty

Services

Services performed by ADM Systems Engineering Ltd. will be conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty, either expressed or implied, is made or intended by our proposal, contracts, reports, or design documents.

Buy-out Items

ADM Systems Engineering Ltd. shall pass through the manufacturer's warranties it receives with the purchase of hardware or software. No other warranties either written or implied shall apply.

ADM is not responsible for travel and expenses to the Client's location.

For purposes of this warranty, start-up will be deemed to be completed when either the Engineered System is partially or completely put into use, or when ADM has met the specifications, whichever is sooner.

1.4 Insurance

The responsibility for loss or damage of the equipment herein specified shall be Purchaser's from the time of shipment. Purchaser is responsible for providing and maintaining adequate insurance for the machinery and equipment herein specified against loss or damage by fire or other causes during the time between time of shipment and final payment

ADM shall arrange for, pay for and maintain in full force and effect, at all times during the performance of supervisory or field engineering work and until final acceptance of that work, policies of insurance issued by carriers acceptable to the Purchaser which afford the following coverage.

(a) Worker's Compensation including employers liability

(b) General Liability

(c) Professional Liability

1.5 Non Solicitation of Employees

The Client specifically agrees that the Client, on its own behalf or on behalf of any other company, will not solicit any employee of ADM for employment with its corporation, or company, without the express written consent of ADM during the time of any active contracts between Client and ADM and for a period of one (1) year after conclusion of all contracts. In addition, should the client or its affiliates hire an ADM engineer during this period, a fee of 50% of the yearly salary they are hired for will be paid, net 30 days after starting, to ADM Systems Engineering Ltd.

1.6 Intellectual Property

ADM shall retain all rights, title and interest in and to all drawings, specifications and software prepared by ADM, including but not limited to all copyrights, patents and other intellectual property rights. The Client shall not use any drawings or specifications prepared by ADM, except for the purpose of confirming the quality of design and manufacturing of the products set forth in the proposal. The Client shall not sell, license, assign or transfer the software or any interest therein to anyone. Subject to the other terms and conditions set forth herein, ADM grants to the Client a non-transferable, non-exclusive right and license to use the software set forth in the Proposal for Client's internal purposes only. In cases in which intellectual property is developed for the client under the terms of the contract, all such property shall remain the property of ADM until all amounts due are paid in full.

1.7 Ownership of Software

All ADM software provided by ADM is covered under our standard license agreement.

1.8 Limits of Liability

In no event, regardless of cause, shall ADM assume responsibility for or be liable (a) for penalties or penalty clause of any description, or (b) for indemnification of Client or others for costs, damages, or expenses each arising out of or related to the goods or services of this order or for certification unless otherwise specifically provided herein or (c) for indirect, incidental, special, or consequential damages under any circumstances including any loss, injury or damages. ADM's maximum liability, including direct damages, shall not exceed the amount of the purchase order. This limitation of ADM's liability will apply regardless of the form of action, whether in contract or tort, including negligence.

1.9 Termination of Contract

Cancellations or stop work requests by the Client on any order or part thereof, must be made in writing. The Client agrees to pay ADM standard contract labor rate for all labor incurred, ADM net material costs for all materials purchased for that order, including any restocking charges incurred.

1.10 Delays & Demobilization

Delays caused by the Client, its agents or subcontractors that impact the productivity of ADM will be considered a reimbursable claim. The cost impact will be negotiated with the Client. The time and material rate in effect for the project will be utilized to calculate the value of time lost and reimbursable costs. ADM's representative is to submit by way of written notice of impacts due to delays on a Change Order Request Form.

1.11 Changes in Scope

The Client may request changes in or additions to the goods and/or licensed programs to the extent consistent with ADM specifications and design criteria. In the event such changes or additions are accepted by ADM, it will advise the Client, in writing, of any revisions in the price, license fees, and/or delivery schedule. No verbal change orders will be accepted. No written change orders will be accepted unless approved by the ADM Project Manager.

1.12 Confidentiality

Any information, suggestions, or ideas transmitted by the Client to ADM in connection with performance hereunder are not to be regarded as secret or submitted in confidence except as may be otherwise provided in writing signed by a duly authorized representative of ADM.

1.13 Dispute Resolution

In the case of a legal dispute between the Client and ADM, and Alternative Dispute Resolution (ADR) system shall be devised and enacted prior to litigation in a court of law, but only after a period of negotiation, with ADM represented by the president and vice-president and the Client represented by two persons with authority to make legally binding decisions for the Client, in which an attempt shall be made to settle the dispute. This negotiation shall begin with one month of the initial Notice of Legal Dispute. All settlements agreed upon in the negotiations shall be final and binding.

If a settlement cannot be reached in the aforementioned negotiation within two months, a neutral third-party shall be appointed by ADM and agreed to by the client to assist the Client and ADM in planning the actual ADR system. The neutral third-party shall be private and confidential and used for no other purpose but to settle the dispute.

The neutral third-party may be involved in the ADR proceedings, if agreed to by the Client and ADM.

All settlements whether partial or full, between the Client and ADM agreed upon in the ADR proceedings shall be final and binding. If the ADR proceedings fail to settle the dispute within one year from the date of the initial Notice of a Legal Dispute, the Client or ADM may initiate litigation in a Court of Law. The costs of the neutral third-party shall be shared equally by both the Client and ADM.

1.14 Venue and Jurisdiction

These Terms and Conditions shall be construed in accordance with the law of the Province of New Brunswick.

1.15 Returns

All products and services described herein are sufficiently unique to prohibit any return for full or partial credit, other than warranty, unless specifically stated otherwise in the proposal. ADM is not responsible for loss of or damage to products returned to it, unless notified on advance of the return and the Client is given a Return Authorization Number which is prominently placed upon the shipping documents and packing container.

1.16 Force Majeure

If ADM is unable to perform the obligations of this agreement due to wars, acts of terrorism, riots, acts of governmental authorities, acts of God, civil disturbances, explosions, ADM may terminate and have no liability under the terms of this agreement.

Quote

Date: 09 September 2016
Quote No: 4000036159
Seller: OSIsoft, LLC
Account Manager: Rheal Benoit
Tel:
Email: RBENOIT@OSISOFT.COM

Requestor: Mike Greene
Tel: + 1(902)428-6485
Email: mike.greene@nspower.ca
Sold to: Nova Scotia Power Incorporated
1223 Lower Water Street
Halifax NS B3J 3S8 Canada

Ship to: Nova Scotia Power Incorporated
1223 Lower Water Street
Halifax NS B3J 3S8 Canada

SLA Number: 1012687
Licensee Name: NOVA SCOTIA POWER INCORPORATED

Bill to: Nova Scotia Power Inc.
PO Box 910
Halifax NS B3J 2W5 Canada

Quote Valid from: 26 February 2015
Valid to: 31 December 2016
Quote type: Final

Terms: Net due in 30 days
Delivery: Download

Introduction

Quote Number: 4000036159
Requestor: Mike Greene
Site: Nova Scotia Power Incorporated [Power Production Site]
Description of Quote:
PI Visualization Suite for server #[4887]. A onetime credit is being applied towards the decommission of some PI-Client licenses. Upon acceptance and by submitting a Purchase Order referencing proposal No. [4000036159], Customer acknowledges and agrees to irrevocably relinquish all rights to use the OSIsoft software products that will be decommissioned, listed below:

PI ComboPack, serial#1053037, Qty 80
PI ProcessBook, serial#1061409, Qty 110
PI ProfessionalPack, serial#1061410, Qty 1
PI Datalink, serial#2005284, Qty 40

Please submit your PO via email to orders@osisoft.com and reference proposal No. [4000036159].

Pricing

Total Price (excluding Taxes and Shipping & Handling): [redacted] USD
Total Estimated Taxes: [redacted] USD
Total Price * : [redacted] USD

* Final invoiced price is subject to the following conditions:
- Software provided by download. If physical media shipment is requested, additional charges will apply.
- Projected Prorated SRP price is an estimate based on the dates indicated. Final SRP price will be prorated according to the date the order is processed.

Organization: Nova Scotia Power Incorporated
End User Site: Nova Scotia Power Incorporated [Power Production Site]
Site No: 5004627
Site SLA Number: 1012687

OSIsoft.

Quote

Site Licensee Name: Nova Scotia Power Incorporated

Software Components				
Quantity	**Unit**	**Description**	**List Price (Unit)**	**Total Price (USD)**
		PI Server Components Expansion of Serial #4887		[redacted]
1	EA	OPC DA and HDA Server		
50,000-	EA	Data Access Pack		
50,000	EA	Additional HA Nodes		
50,000	EA	PI System Access (Server)		
50,000	EA	PI Visualization Suite		
		Subtotal		[redacted]
		Other Discount		[redacted]
		Subtotal - Software		[redacted]

Software Reliance Program			
Start Date	**End Date**	**Product**	**Total Price (USD)**
01 OCT 2016	31 MAR 2017	PI Server Components	[redacted]
		SRP List Price	[redacted]
		Other Discount	[redacted]
		Estimated Taxes	[redacted]
		Subtotal - SRP	[redacted]

Recommended Hardware and System Requirements

The recommended system requirements for PI System software are detailed on our website: https://techsupport.osisoft.com/Troubleshooting/System-Manager-Resources
You may also obtain this information by contacting OSIsoft Technical Support by calling + 1 (510) 297-5828 or by emailing techsupport@osisoft.com
These should be used as guidelines. A validation of these requirements is required prior to the acceptance of the Terms and Conditions.

Terms and Conditions:

Any order submitted to OSIsoft, LLC ("OSIsoft") by or on behalf of NOVA SCOTIA POWER INCORPORATED ("Customer") will be governed by the Software License and Services Agreement by and between OSIsoft and NOVA SCOTIA POWER INCORPORATED dated: 16 June 2000 (Agreement # 1012687) and any corresponding pricing agreements, the terms of which are incorporated herein by this reference to form a separate agreement by and between Customer and OSIsoft ("SLA"). Customer and any party submitting such order(s) agree to be bound by the SLA, and Customer agrees that it will be responsible for any such third parties acting on its behalf.

1. Note that the terms and conditions of the SLA or other agreements executed by OSIsoft and Customer will be the sole and exclusive terms and conditions governing Customer's purchase and license of Products and Services from OSIsoft.
2. The prices quoted herein are in US $, delivered DAP Licensee location and are valid for a period of 90 days.
3. This Quote does not include hardware, cables, generic or third-party software, or any other such supplies required to use the licensed software.

4. Except for taxes quoted and paid by OSIsoft on its net income, all amounts due pursuant to OSIsoft's invoices are net of, and Licensee will be solely responsible for, any shipping charges and withholding, use, sales, value-added, import, and any other taxes, fees, tariffs, or duties associated with this Quote or Licensee's use of the OSIsoft products and technical support services.
5. OSIsoft reserves the right to change our price list as we deem necessary.
6. OSIsoft's standard annual SRP subscription renewal rate is 15% of current list price.

Purchase Order (PO) Requirements

Please meet the following PO requirements:

☑ Provide complete **Bill-To** and **Ship-To** (destination of software, download, or service) information:
(Full Company legal name and address)

☑ Provide complete Licensee (**End-User**) information:
(Full Company legal name, address, and phone number)

☑ Ensure Licensee (End-User) has an executed Software License and Services Agreement (**SLA**) with OSIsoft.

☑ Reference "OSIsoft Quote:**4000036159**".

☑ **Issue PO** to "OSIsoft, LLC"

Please submit your Purchase Order using one of the following methods:

Email (preferred):
orders@osisoft.com

Fax:
+ 1 514-221-4116

Mail:
OSIsoft, LLC
Attn: Order Processing
Creekside Plaza Bldg A
1100 San Leandro Blvd, Suite 200
San Leandro, CA 94577
USA

CI Number: 46572

Title: 2017 RTU Replacement Program

Start Date:	2017/01
In-Service Date:	2017/10
Final Cost Date:	2018/10
Function:	General Plant
Forecast Amount:	$693,354

DESCRIPTION:

Remote Terminal Units (RTUs) are deployed in substations and generating stations to allow for communications of data and control signals to enable the operation of NS Power's SCADA system. This project provides for the replacement of four existing RTUs over two years (2017 and 2018), associated telecommunications equipment, and the connection of Intelligent Electronic Devices, such as recloser controllers, transformer meters and relays. The RTU equipment removed will enable NS Power to redeploy the equipment as spare parts for other similar RTUs in service that are not yet being replaced.

Summary of Related CIs +/- 2 years:
2018 CI TBD 2018 RTU Replacement Program $TBD
2019 CI TBD 2019 RTU Replacement Program $TBD

JUSTIFICATION:

Justification Criteria: Work Support Facilities

Sub Criteria: Telecontrol & Telecommunications

Why do this project?

Due to evolving industry standards, technology and product lifespans, approximately 87 of the 153 RTUs that are currently in service have been deemed obsolete by their manufacturers (please refer to Attachment 1). The commercial availability of spare parts is becoming difficult to manage effectively. Equipment removed from service under this project can be harvested for spare parts which will support other existing RTUs until such time that they are also replaced.

Why do this project now?

The inventory of the RTU spare parts has become sparse. The RTUs being replaced by this project have been deemed obsolete as discussed above. RTU installations require extensive time and effort (approximately 12 weeks) to complete and having an effective RTU management plan is critical for the orderly replacement of units that are experiencing reliability issues and to gradually modernize the fleet.

Why do this project this way?

RTU replacement is the only alternative as the RTUs are now considered obsolete. The technology - both hardware and software - is familiar to field and engineering personnel through regular training and exposure. Additionally, standardizing on the equipment will lead to a more sustainable spare parts inventory.

CI Number : 46572 - 2017 RTU Replacement Program **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		44,166	0	44,166
092		092-Vehicle T&D OT Labour AO		372	0	372
094		094 - Interest Capitalized		6,778	0	6,778
095		095-COPS Overtime Labour AO		551	0	551
095		095-COPS Regular Labour AO		65,427	0	65,427
095		095-COPS Contracts AO		9,609	0	9,609
095		095 - Proj Supp Regular Labour AO		38,631	0	38,631
013	003	013 - COPS Contracts	003 - GP - Bldg.,Struct.Grnd.	22,000	0	22,000
001	061	001 - T&D Regular Labour	061 - GP - Switched Telecomm. Sys	9,004	0	9,004
002	061	002 - T&D Overtime Labour	061 - GP - Switched Telecomm. Sys	1,441	0	1,441
012	061	012 - Materials	061 - GP - Switched Telecomm. Sys	28,560	0	28,560
013	061	013 - COPS Contracts	061 - GP - Switched Telecomm. Sys	26,000	0	26,000
001	064	001 - T&D Regular Labour	064 - GP - Sup. Control and DA	76,532	0	76,532
012	064	012 - Materials	064 - GP - Sup. Control and DA	186,960	0	186,960
001	085	001 - Regular Labour (No AO)	085 Design	4,310	0	4,310
001	085	001 - Proj Supp Regular Labour	085 Design	80,330	0	80,330
011	085	011 - Travel Expense	085 Design	6,750	0	6,750
028	085	028 - Consulting	085 Design	33,000	0	33,000
041	085	041 - Meals & Entertainment	085 Design	4,950	0	4,950
066	085	066 - Other Goods & Services	085 Design	47,984	0	47,984
			Total Cost:	693,354	0	693,354
			Original Cost:	391,314		

Capital Project Detailed Estimate

Location: General Plant
CI# / FP#: 46572
Title: 2017 RTU Replacement Program
Execution Year: 2017-2018

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	238	$ 360	$ 85,536		
Procurement / Financial Support		1	$ 4,310	$ 4,310		
Project Support AO - Engineering Design	PD	197	$ 382	$ 75,254		
Project Support AO - CADD	PD	18	$ 282	$ 5,076		
			Sub-Total	$ 170,176		
002 OT Labour						
T&D Labour - Electrician/Technician	PD	2	$ 720	$ 1,441		
			Sub-Total	$ 1,441		
011 Travel Expense						
Engineering	Lot	1	$ 6,750	$ 6,750		
			Sub-Total	$ 6,750		
012 Materials						
RTUs	ea	4	$ 41,250	$ 165,000		
Cable/Wiring, Serial Equipment/Cable, Fiber Equipment/Cable, Accys	ea	4	$ 5,490	$ 21,960		
Radios	ea	4	$ 2,000	$ 8,000.00		
Antennae and Poles	ea	2	$ 6,100	$ 12,200.00		
Feedlines, Accys	ea	3	$ 2,787	$ 8,360.01		
			Sub-Total	$ 215,520		
013 Contracts						
Conduit, Concrete, Grounding	Lot	1	$ 22,000	$ 22,000		
Antenna Monopole, Antenna Install/Pan	Lot	1	$ 26,000	$ 26,000		
			Sub-Total	$ 48,000		
028 Consulting						
Engineering Design	Lot	1	$ 33,000	$ 33,000		
			Sub-Total	$ 33,000		
041 Meals & Entertainment						
Engineering	Lot	1	$ 4,950	$ 4,950		
			Sub-Total	$ 4,950		
066 Other Goods & Services						
Contingency	%	10%	$ 479,837	$ 47,984		
			Sub-Total	$ 47,984		
094 Interest Capitalized						
AFUDC				$ 6,778		
			Sub-Total	$ 6,778		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 44,166		
Vehicle T&D Labour Overtime AO				$ 372		
			Sub-Total	$ 44,538		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 65,427		
COPS T&D Labour Overtime AO				$ 551		
COPS Contract AO				$ 9,609		
Project Support Regular AO				$ 38,631		
			Sub-Total	$ 114,218		
			SUB-TOTAL (no AO, AFUDC)	$ 527,820		
			TOTAL (AO, AFUDC included)	$ 693,354		
Original Cost				$ 391,314		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

GE Energy Services

Product Bulletin

Bulletin Number		**Rev**		**Date**	Jan 30, 2003
Product	D20M++ / D20ME			**Distribution**	General
Part Number				**Classification**	Information
Summary	D20M++ Discontinuance				
Originator	Daryl Cowie			**Title**	

GE SAS will be discontinuing all models of D20M++ Main Board by the end of calendar year 2003. These models will be replaced with our D20ME Main Board models 526-2004 (non-VME) and 526-2005 (VME). The D20ME Main Boards will become the only models of D20 Main Board available. The D20ME Main Board is a mature product, and is expected to be available for more than 5 years.

The following tables outline product comparison, compatibility issues, and time line of events.

D20M++ v.s. D20ME Comparison

	D20M++	**D20ME**
Processing Power	100% (Benchmark)	250% compared to D20M++
Serial Communications	Single Port Max: 38.4bps Aggregate Max: 38.4kbps	Single Port Max: 110kbps Aggregate Max: 500kbps
Memory Models	Multiple Models. Largest Mem Model: • 1MB EPROM • 2MB SRAM • 512kB NVRAM • 128kB BootROM	One Memory Model for improved inventory mgmt • 2MB FLASH • 1.5MB SRAM • 512kB NVRAM • 1MB BootROM
TCXO	Optional	Standard
Firmware Storage	EPROM	FLASH

D20ME Compatibility

	D20ME Compatibility
D20/D200 Chassis	Compatible with all chassis. When adding Ethernet to D20, the MX Chassis is required for proper cable routing. The Ethernet MIC interconnect cable can physically be routed out the back of an older chassis, but this invalidates emissions compliance statements.
D20/D200 Backplane	D20 minimum backplane revision requirements apply (included in upgrade kit) D200 Backplanes are all compatible with the D20ME
D20 Peripherals	Compatible with old and new style peripherals (same as D20M++)
D20M++ Compatibility	Limited compatibility with D20M++ in a D200 multi-node environment. Only systems with 3 nodes or less may mix D20M++ and D20ME boards.
Base System	CCU Base Single Node System: 1.88 & greater CCU Base Multi Node System: 2.03 & greater D20 Base: 3.51 & greater Note: D20 Base only sees 1Mb of code space
Configuration System	ConfigPro 4.00 or greater required (previous versions do not list D20ME)
Application Software	All D20 software applications are compatible with the D20ME

D20M++ Discontinuance Time Line

Stage	Description	Actions Required	Duration / Milestones
PRODUCT MATURITY	Product is mature and quality is very high.	• Orders and shipments permitted.	5 years (since 1994)
PRODUCT DECLINE	Product no longer meets industry expectations for new projects.	• Orders and shipments permitted. • Decision to discontinue the product must be made • Product alternative must be identified and recommended for new designs.	3 years Product Decline Stage ends with Discontinuance Notice: Aug 2002
PRODUCT PHASE OUT	Product alternative identified. Product alternative is field proven.	• Limitations on shipments can occur. • Product should no longer be considered for new designs. • Formal discontinuance notice must be given. • Formal upgrade plan and incentives must be established. • Product last buy date must be established.	17 months Phase Out Stage ends with Last Buy: Dec 2003
PRODUCT NOT AVAILABLE	Product is no longer available. Inventory is removed.	• New orders are limited to existing or residual inventory. • Repairs / replacements may be done with refurbished parts. • Product support from Customer Service continues. • Product support cut-off date must be established	24 months Not Available Stage ends when Product Support ends: Dec 2005
PRODUCT NOT SUPPORTED	Product is no longer supported.	• No new orders, no shipments, and no inventory exist. • Customer Service stops supporting the product. • All internal supporting hardware, software, and documentation are removed from active systems.	

The following supporting documents are available to guide you through the upgrade process:

- TSFM-010 D20M++ to D20ME Upgrade Checklist
  This checklist guides the customer through gathering all information required by GE SAS to identify potential issues with the standard upgrade. The process is designed to identify problems during the quotation stage.

- TSPD-003 Guide to Upgrading D20M++ to D20ME
  This comprehensive, step-by-step guide illustrates how to perform a D20M++ to D20ME upgrade.

TINGLEY, SARA

From:	Van Wyk, Johann <Johann.vanWyk@landisgyr.com>
Sent:	November 3, 2013 5:48 PM
To:	PENNEY, ERIC
Cc:	OAKLEY, BILL; VICTOR, CHUCK
Subject:	RE: Product Life Cycle Inquiry

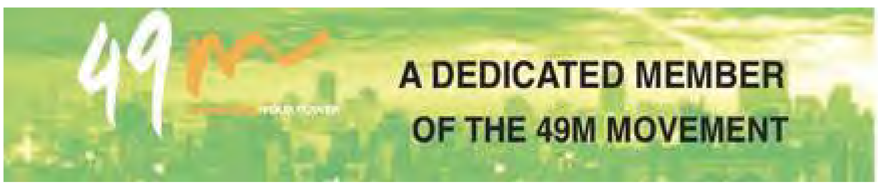
Dear sir, thank you for contacting us.

Unfortunately all the equipment mentioned below are:

End-of-Service (EOS) products are not being manufactured or supported any longer.

Freundliche Grüsse / Kind regards / Beste Wense / Asante Sana / Viele Grüße / مع اطيـب التحيـــــات

Johann van Wyk
Smart\Credit Meter Support



Landis+Gyr manage energy better

From: PENNEY, ERIC [mailto:Eric.Penney@nspower.ca]
Sent: 29 October 2013 21:51
To: ZA JNB Support
Cc: OAKLEY, BILL; VICTOR, CHUCK
Subject: Product Life Cycle Inquiry
Importance: High

Good day,

My name is Eric Penney and I work at Nova Scotia Power. We have several Landis & Gyr RTUs, installed between 1988 and 1995, in our substations and we need to know their Life Cycle status. The table below may help you answer my inquiry.

Current products would be those that are still being manufactured and are fully supported (technical & repair).
Retiring products are approaching or are currently in their last year of manufacturing but are still fully supported.
End-of-Build (EOB) products are not being manufactured but full support is available.
End-of-Service (EOS) products are not being manufactured or supported any longer.

Indicate the column that applies for each model.

	Current Products	Retiring Products	End-of-Build	End-of-Service
MPS-9000S				
Telegyr 0500				
Telegyr 5200				
Telegyr 5300				
Telegyr 5320				

Telegyr 5500				
Telegyr 5520				
Telegyr 8500				

Any additional information you have about these models would be appreciated as well.
--

Eric Penney | TeleControl Engineer | **Nova Scotia Power**
T: 902-428-7706 | C: 902-221-5855 | F: 902-428-7715
E: eric.penney@nspower.ca
www.nspower.ca
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CI Number: 48774

Title: HYD Milton Shop HVAC Upgrade

Start Date:	2016/09
In-Service Date:	2017/10
Final Cost Date:	2018/04
Function:	General Plant
Forecast Amount:	$564,347

DESCRIPTION:

This project includes the installation of Heating, Ventilation and Cooling (HVAC) system at the Milton Hydro Maintenance shop in Queens County.

The Milton Shop is a maintenance shop that supports welding and machining capabilities within the Hydro & Wind Department. The shop is a registered Division 2 fabrication shop capable of refurbishments for most generating assets within Hydro and is fully utilized throughout the year. The shop currently has no mechanical air ventilation, a deficiency in compliance with the National Building Code of Canada. Existing ventilation schemes simply open the truck bay doors for natural air flow. This is impractical and detrimental to the machining process in the winter months and a system is required to meet the National Building Code requirements and the Industrial Ventilation Manual published by the American Conference of Governmental Industrial Hygienists. The project will provide area specific ventilation schemes based on the intended use of the space and equipment used in the space.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Health & Safety

Why do this project?

The Milton Shop has shown elevated levels of Manganese due to a ventilation deficiency according to the National Building Code Division B 6.2.2.1 Required Ventilation. This project is being completed in order to provide a safe working environment for indoor air quality and to meet building code requirements for ventilation.

Why do this project now?

Air Testing has indicated that there are elevated levels of Manganese present in the shop air, highlighting the building code deficiencies. This is not considered an isolated test result and due to the conditions is considered a low concentration within the shop on average; it affects air quality for the entire machine shop of which there is no ventilation system.

This is an occupational health & safety and code compliance issue and needs to be addressed.

Why do this project this way?

The project includes putting in a zoned ventilation system including numerous smaller units each sized for the specific areas it will serve. The alternative approach is to have one large ventilation unit supply multiple zones, which is considered inefficient and results in higher energy usage. Different work areas (storage, welding, machining) require specific air exchange rates per American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) Standard 62-2001, Ventilation for Acceptable Indoor Air Quality and it is more economic to use units sized for those requirements as opposed to a large unit with dampers. Multiple units also allow NS Power to achieve National Fire Protection Association (NFPA) standards for fire separation at the lowest cost. It is estimated to be 20% more costly to go with single large unit supplying multiple zones.

CI Number : 48774-H764 - HYD - Milton Shop HVAC Upgrade **Project Number** H764

Parent CI Number : -

Cost Centre : 490 - 490-Mersey Heavy Maintenance **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		2,790	0	2,790
095		095-Thermal & Hydro Contracts AO		16,311	0	16,311
095		095-Hydro Regular Labour AO		18,090	0	18,090
001	003	001 - HYDRO Regular Labour	003 - HGP - Bldg.,Struct.Grnd.	34,857	0	34,857
011	003	011 - Travel Expense	003 - HGP - Bldg.,Struct.Grnd.	750	0	750
012	003	012 - Materials	003 - HGP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
013	003	013 - POWER PRODUCTION Contracts	003 - HGP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
028	003	028 - Consulting	003 - HGP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
041	003	041 - Meals & Entertainment	003 - HGP - Bldg.,Struct.Grnd.	350	0	350
066	003	066 - Other Goods & Services	003 - HGP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
			Total Cost:	564,347	0	564,347
			Original Cost:			

Capital Project Detailed Estimate

Location: Hydro
CI# / FP#: 48774
Title: HYD - Milton Shop HVAC Upgrade
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Hydro River Staff - Construction	day	50	$ 365	$ 18,239		
Engineering Staff	day	41	$ 405	$ 16,618		
			Sub-Total	$ 34,857		
011 Travel Expenses						
Site Visits	Lot	1	$ 750	$ 750		
			Sub-Total	$ 750		
012 Materials						
Zone 1- Office Area System	Lot	1	[redacted]		Cost Support Item #1 - Material portion of Zone 1 + AHU-1	
Zone 2 - Maintenance Shop System	Lot	1			Cost Support Item #1 - Material portion of Zone 2 + AHU-2	
Zone 3 - Wood Shop System	Lot	1			Cost Support Item #1 - Material portion of Zone 3 + AHU-3	
Zone 4 - Welding Shop System	Lot	1			Cost Support Item #1 - Material portion of Zone 4 + AHU4 + ESP 1&2	
Zone 5 - Store Room System	Lot	1			Cost Support Item #1 - Material portion of Zone 3 + AHU-5	
			Sub-Total	[redacted]		
013 Power Production Contracts						
Zone 1- Office Area System	Lot	1	[redacted]		Cost Support Item #1 - Contract portion of Zone 1 + AHU-1	
Zone 2 - Maintenance Shop System	Lot	1			Cost Support Item #1 - Contract portion of Zone 2 + AHU-2	
Zone 3 - Wood Shop System	Lot	1			Cost Support Item #1 - Contract portion of Zone 3 + AHU-3	
Zone 4 - Welding Shop System	Lot	1			Cost Support Item #1 - Contract portion of Zone 4 + AHU4 + ESP 1&2	
Zone 5 - Store Room System	Lot	1			Cost Support Item #1 - Contract portion of Zone 3 + AHU-5	
			Sub-Total	[redacted]		
028 Consulting						
Detailed Engineering	Lot	1	[redacted]		Cost Support Item #1 - Indirects - Phase 1,2 & 3	
Construction Review	Lot	1			Cost Support Item #1 - Indirects - Phase 1,2 & 3	
Commissioning / Testing & Balancing	Lot	1			Cost Support Item #1 - Indirects - Phase 1,2 & 3	
Project Management	Lot	1			Cost Support Item #1 - Indirects - Phase 1,2 & 3	
			Sub-Total	[redacted]		
041 Meals and Entertainment						
Site Visits		1	$ 350	$ 350		
			Sub-Total	$ 350		
066- Other Goods and Services						
contingency 25%	%	[redacted]				
			Sub-Total	[redacted]		
094 Interest Capitalized						
AFUDC				$ 2,790		
			Sub-Total	$ 2,790		
095 Administrative Overhead						
Hydro Regular Labour AO				$ 18,090		
Thermal & Hydro Contracts AO				$ 16,311		
			Sub-Total	$ 34,401		
			Sub-Total (no AO, AFUDC)	$ 527,157		
			TOTAL (AO, AFUDC included)	$ 564,347		
Original Cost						

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

PROJECT REPORT

PRELIMINARY ENGINEERING AND CAPITAL COST ESTIMATE

Milton Office and Shop Ventilation

CLIENT:	Nova Scotia Power
PROJECT:	Milton Office and Shop Ventilation
SITE:	Milton Maintenance Shop
ISSUED FOR:	FINAL REPORT

1.0 PROJECT DESCRIPTION

The Milton Maintenance Facility is made up of an office area at the front of the building and shops and storerooms to the rear. Each area of the facility has heating and there is also air conditioning from window units in the office area. All areas of the Milton Facility do not have controlled make-up air systems to ensure that they meet the minimum requirements by code as is typical of building of its age.

The single-level facility has been divided into five zones to assess the varying requirements. The zones are as follows:

1. Office area including reception, kitchen, break-rooms and washrooms.
2. Maintenance Shop
3. Wood Shop
4. Welding Shop
5. and the Storage Area

The zones were reviewed and this report presents a recommended solution for the facility to meet the required ventilation rates and provided a safer and more comfortable area for all personnel to work. The fresh air rates are provided by ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. ASHRAE does not publish air circulation rates (usually listed as air changes per hour), so industry standards are used. Both values are tabulated follows:

VENTILATION RATES		
	Fresh Air Required	Ventilation Required
	CFM	CFM
Office Area	1000	5000
Maintenance Shop	1100	7200
Wood Shop	200	2500
Welding Shop	400	6000
Storage Area	250	2000

The ventilation rates were taken at the lower end of the recommended ranges as the shops would have a lower occupancy and less machines operating than in some shops where all machines are being operated continually. The ventilation rate determines the size of the air handling unit which is then matched to the heat pump.

The shops presently rely on opening a window or an exterior door for ventilation. The Welding Shop has a large general exhaust fan but no source capture of the welding fumes.

Heat is presently provided by electric baseboard heaters in the office area and electric unit heaters mounted on the walls and ceiling in the shops. It is proposed that air handling units will be provided for each zone. The existing heaters would remain in place for back-up or removed if no longer serviceable. Air conditioning would be provided in the office area only but it is not recommended for the shops due to a potential for condensation on the steel when an exterior door is opened.

For conservation of power, the heating of all areas and the cooling of the office area, will be provided by heat pumps built in to the air handling units for each zone. The thermostats will control the temperature in each zone and will turn on the baseboard or unit heaters as required if the outside temperature falls below approximately -20C at which point the heat pump loses efficiency.

The use of electrically heated air handling units was reviewed as opposed to the heat pump units included in the estimate. There would be a savings of approximately twenty percent on the initial cost of the electrically heated air handling unit for the Maintenance Shop. This is the larger 20-ton unit. The mid-sized unit for the Welding Shop is much the same initial cost and electrically heated air handling units for the Wood Shop and Store Room are actually more expensive. The supplier states that these units are more expensive as the Reznor units are a make-up air unit with mixing box/economizer capability, with double wall construction and a remote operator’s panel. Installation costs are expected to be much the same for each unit. As the heat pumps are two to three times more efficient than electric heating, it is recommended that the heat pump units be installed.

It should be noted that all heat pump units can be used for air conditioning as well as heating. The air conditioning option needs to be locked out on the units for the shop areas otherwise any savings in electricity in the winter will be quickly lost with high power usage in the summer months.

All areas will have programmable thermostats such that in the winter the temperature will drop down a few degrees at night when the space is unoccupied but will remain at a comfortable setting throughout the working day. Weekends can also be set to match unoccupied hours. The cooling in the office area can also be set back at night in the summer.

The circulating and ventilation air can be shut off at night and only come on if the thermostat calls for heating and cooling in the office area.

NS Power intends to complete the construction in three phases:
Phase 1 – The welding shop
Phase 2 - The Maintenance Area including the Wood Shop and Storage Room,
Phase 3 - The Office Area.

The engineering will be completed all at once with the phases outlined on the drawings. The phases will be tendered and constructed separately with Phase 1 expected to start this spring.

For Phases 2 and 3, the engineering will have to be quickly checked to ensure there were no changes to the building that will affect the design or installation then each phase will be tendered with the construction reviewed then the equipment commissioned.

2.0 RECOMMENDATIONS BY ZONE

2.1 Office Area

The office area will be heated and air conditioned using a new air handling unit, AHU-1 mounted on the roof above the washroom and main hallway to limit noise in the offices and common areas. Some mechanical noise may penetrate the roof from the AHU which will be less intrusive in the washroom and hallway verses office or meeting room areas. The main supply duct will be routed along the hallways to limit disturbances during construction in the offices.

Some walls extend to just above the suspended ceiling throughout the office area so this area will be utilized as a return plenum. Some of the concrete walls extend to within 50mm of the roof so may have been intended as firewalls although they do not provide a firebreak from floor to roof. The ductwork penetrating these walls will be provided with fire dampers to maintain the integrity of the wall section being removed. However, the assessment of the walls for fire integrity and any repairs to meet fire codes is not provided in the scope of this work.

The office area is further divided into six independent zones based on the type of room use and by similar heating and cooling requirements. Each of these zones will be provided with a thermostat and a VAV (Variable Air Volume) box to control the temperature within the space. The air flow will be controlled from 40 to 100% flow with the AHU providing heating or cooling, averaged for all areas. The VAV boxes will be positioned centrally in each area to reduce the use of ductwork which takes time to install verses flexible ducting for the short runs from the VAV box to each supply louver.

The existing baseboard heaters will remain and will be controlled by the thermostat for when the outside temperature drops below the efficient point for the heat pump (approximately -20C).

Exhaust fans will be provided in the Women's and Men's Washrooms with flowrates based on ASHRAE recommendations. The exhausts will be ducted together to the existing outlet through the roof where and new backflow valve and a gooseneck will be provided. This will limit air and water ingress. No ventilation air is provided to the washrooms as it would mix with the other office area ventilation air.

The kitchen will be provided with a two-speed, range hood (exhaust fan) ducted to the west side of the building. The low speed would be for general cooking smells or excessive cooking heat and the high speed for burning smells for material on burners and such. Ventilation air will be provided to the kitchen and will be exhausted through a diffuser in the hallway outside of the kitchen.

The existing wall-mounted air conditioners will be removed and the opening in the windows will be temporarily sealed. It is understood that the windows will be replaced with more energy efficient window units. If the new window type is known, the AHU could be sized based this new requirement which may reduce costs. The heating and cooling loads will be more accurately determined during the detail engineering phase, however the current estimates are based on conservative numbers and with present window and door trims.

Access to the roof-mounted AHU will be provided by a ladder. The proposed ladder location is on the south wall of the office near the east wall of the Maintenance Shop.

2.2 Maintenance Shop Area

The maintenance shop was reviewed in detail. It was first thought that hoods would be provided for all equipment that release fumes while operating. However, it is not possible by NFPA Standards to have one low-flow system and open dampers at just the machine(s) that are operating although this tends to be common practice for woodshops. Having one large system running all the time or having an independent system with ductwork for each machine is not cost effective. It is proposed that the recommended amount of ventilation air with fresh air be supplied from a central supply duct with fully adjustable louvers. The airflow from the louvers can be controlled and directed at the machines that produce the fumes and can be adjusted if machines are relocated. The exhaust air will be removed from the outside walls of the rooms.

If any welding needs to be done throughout the Maintenance Shop, a portable electrostatic precipitator (ESP) air filtration unit would be used. This will keep the air clean from the welding fume and extend the filter life on the AHU.

An AHU to control the ventilation and fresh air requirements will be installed on the roof near the central crane rail. The main supply duct will run just west of the central crane rail and air flow will be directed to all areas of the shop. The last length of duct will run above the crane rail near the south end and supply air to the south overhead door area.

The return air will be along the inside wall and will exit the shop such that it does not need to be ducted between the crane rail and the ceiling trusses. The return duct will run along the roof to the AHU. Return air will also be collect along the outside wall of the shop. Standard air filters will be on the units which will protect the AHU. Metal shop smells will be evident but should be mush better than the current situation due to the fresh air being provided on a continuous basis.

In the winter, the overhead doors would be expected to remain closed as much as possible. The AHU could be manually shutdown temporarily if a door has to remain open for an extended period. A procedure must be put in place to have the AHU turned back on as soon as the door is closed. Door switches could also be installed that would be interlocked to the AHU.

Access to the roof-mounted AHU will be provided by a short ladder from the roof of the Office Area. Its proposed location is on the north wall of the Maintenance Shop near the AHU. This ladder will also provide access to the Storeroom AHU.

A secondary means of egress will be by the ladder for the Welding and Wood Shops on the south wall of the shop building.

2.3 Wood Shop Area

The wood shop is mainly used for storage of materials along the east wall shelving and on pallets throughout the shop. Woodworking machines are available for use in the shop but need to be pulled out in to the central area. Some manual painting of the metal parts machined in the Maintenance Shop is completed in this area to limit the painting smells in the main area.

It is proposed that a portable woodworking dust collector be provided and connected to the machine being used and disconnected and emptied when the work is finished or the end of each shift. The small dust collectors work well at removing the dust from the air and keeping it off the stored materials. Due to there small size, any possible fire or explosion concerns are minimized and there is no need for elaborate explosion suppression system. Although, care must be taken with flammable or explosive substances. The unit proposed is 2000cfm which would provide enough flow for one woodworking machine with multiple connections. Vacuum hoses and an allowance for reducers to match equipment connections have been estimated.

The fresh and ventilation air is provided by a new air handling unit on the roof of the Wood Shop. Supply air is provided to the wall by the overhead door and the south exterior wall which are the areas of greatest heat loss and cooling load. The return air is taken from the back of the shop.

It is understood that metal parts machined in the Maintenance Shop are epoxy painted by brush or roller in the Wood Shop. No spray painting is done in the shop and all parts are small enough to fit on a standard pallet.

Atlantic Air Cleaning Specialist proposed a system similar to the Lingan Mill Roller Repair Shop but sized for painting smells verses welding fume. The location of the hood would be limited by the radius of the swinging support arm and the height would be fixed but for screening material hanging from the sides of the hood. The hood would have a face velocity of 100 fpm which will remove any smells that get to the hood but if a door is open or if there is any draft the smell would not be captured.

The preferred option as discussed on site, is to use a welding type extension arm that can be placed much closer to the workface to capture more of the odor. This would exhaust through a spark-proof fan to the exterior along the south wall. Make-up air would be provided from the Maintenance Shop through the access door between the shops. The fan and arm would be mounted on a column provided by the same supplier to permit placement anywhere along the exterior, south wall.

Access to the roof-mounted AHU's for the Wood Shop and the Welding Shop will be provided by a ladder on the south side of the shop building.

2.4 Welding Shop Area

The welding shop currently has a large exhaust fan centrally located along the south wall. This fan would draw air from the Maintenance Shop and from leakage around the many doors. It is proposed that a new air handling unit be installed on the roof of the Welding Shop. Supply air is provided to the exterior walls and doors which are the areas of greatest heat loss and cooling load. The return air is taken from the back of the shop.

Welding arms are provided for the two floor areas that are commonly used for welding work and directed by the shop welder. The portable unit supplied for the Maintenance Shop could be used if welding needs to be done outside of the reach of these two arms. The arms are connected to a Smog Hog electrostatic precipitator type (ESP) fume collector and returned to the shop area.

A fabricated hood is provided on the back of the welding bench. The bench is 3m long and the hood will provide fume collection from welding or grinding in the center half of the bench. Air is drawn from behind the welder to keep the welder supplied with clean air and exhausted from the back of the bench. The hood is ducted to a Smog Hog (ESP) fume collector and returned to the shop area. Both Smog Hog units are suspended from the ceiling of the weld shop to maintain the same floor space.

2.5 Storeroom Area

The initial thought for the Storeroom was to combine it with the Maintenance Shop and share an air handling unit. It was determined that the flow would be too high and much of the ductwork would have to be on the roof as it is not possible to route ductwork past the two crane rails that run the length of the Shop.

It is proposed that a new air handling unit be installed on the roof of the Storeroom. Supply air is provided to the exterior walls, to the overhead and man doors and in the central area where some work is performed. The return air is taken from near the entrance to the Storeroom from the Shop.

A plastic curtain wall should be installed between the Storeroom and the Maintenance shop to keep the zones separate. As they are similar areas the screen could stop about seven feet (2.3m) above the floor so it is easy for personnel to walk through.

3.0 CIVIL / STRUCTURAL SCOPE

The civil/structural scope would include the following:

- supporting of the air handling units on the roof,
- supporting of the Smog Hog units in the welding shop,
- and roof access to the air handling units.

This scope has not been reviewed by a structural engineer. An allowance for this scope has been provided in the estimate although the extent of the steelwork required to support the units has not been determined.

Roofing repairs and any exterior wall penetrations will be completed by, or subcontracted by, the Mechanical contractor and is included in the estimate.

4.0 ELECTRICAL AND INSTRUMENTATION SCOPE

The electrical and instrumentation (controls) scope would include the following:

- power cabling to the five air handling units
- power cabling to the two electrostatic precipitators in the Welding Shop
- Control cabling and installation of thermostats for the air handling units and the existing base board heaters or unit heaters
- And on/off Control cabling to the two electrostatic precipitators in the Welding Shop.
- Rework or replace the three unit heaters in the Welding Shop.

The electrical and instrumentation scope was reviewed and estimated by Stefan Richards of ASAP Electrical and included in the estimate from Sea Coast HVAC. During the Detail Engineering phase, a proper design should be completed and all tie-ins for the new equipment documented.

There may be situations when some areas of the office may need cooling while others may need heating. This will be reviewed during the detail engineering phase.

A Building Automation System could be installed so that all zone systems can be monitored and controlled on site or remotely. Approximate cost would be [redacted]

The Air Handling Units and Smog Hogs are all 600V, three-phase units.

5.0 ESTIMATES

See attached spreadsheet in Appendix B.

See quotations obtained in Appendix C. All quotations should be reviewed by NSP to ensure that they meet their requirements.

The accuracy of an estimate is expected to be +/-25% at the end of preliminary engineering. As much of the scope has been defined and quotations received for the major equipment, it is expected that this estimate should be well within this limit.

The source of the equipment is noted on the estimate spreadsheet. Only one source was used for this estimate and a budget quote was requested. Ten percent was added to most quotes for prices changing over time, material cost changes, addition of options not considered, or other miscellaneous changes in pricing. It is expected that the equipment and installation will be tendered at the end of the detailed engineering phase.

A quotation for the equipment installation including electrical, instrumentation, cranage and roofing scope was provided by Seacoast HVAC. They are part of the Nodding Group of Bridgewater and have completed projects at other NSP sites.

The Electrical work is based on new cabling for the equipment and some new panels. Note that no engineering has been done for the electrical / instrumentation scope.

All other costs are based on the estimated fabrication costs and time to install. Labor costs are based on $65.00/hour which includes supervision, mobilization, hand tools, PPE and orientations.

Detail engineering to confirm the design and to provide construction drawings for contractors and construction review will be required and has been estimated. A proposal for the detailed engineering from M&R Engineering was not available in time for the draft report. A proposal for the first phase of engineering has been prepared and is reflected in the estimate provided. The engineering will be briefly reviewed prior to the Phase 2 and 3 packages being issued to ensure that no other changes have been made affecting the design.

The estimate has been revised to reflect Nova Scotia Power's plan to implement the construction of the project in three phases. The engineering for phase 2 and 3 is estimated for this report.

No in-plant costs for contractor supervision, insurance, accounting, project support, etc., has been included in the estimate.

A twenty-five percent contingency has been added which is standard practice for a preliminary engineering estimate.

6.0 GO FORWARD

It is proposed that the Detailed Engineering scope be completed by M&R Engineering Limited of Halifax as they are a specialist consulting firm for HVAC and Building Services. They briefly reviewed the preliminary drawings and had some good recommendations to improve the air quality and distribution while reducing costs. Conrose Engineering specializes in industrial dust control and ventilation and would not be effective providing the engineering services required to complete this job. Conrose Engineering will provide project management and the engineering of the dust and fume exhaust systems for the Welding and Wood Shops.

We would be pleased to answer any questions or provide clarification for any information presented within this report.

Submitted by;

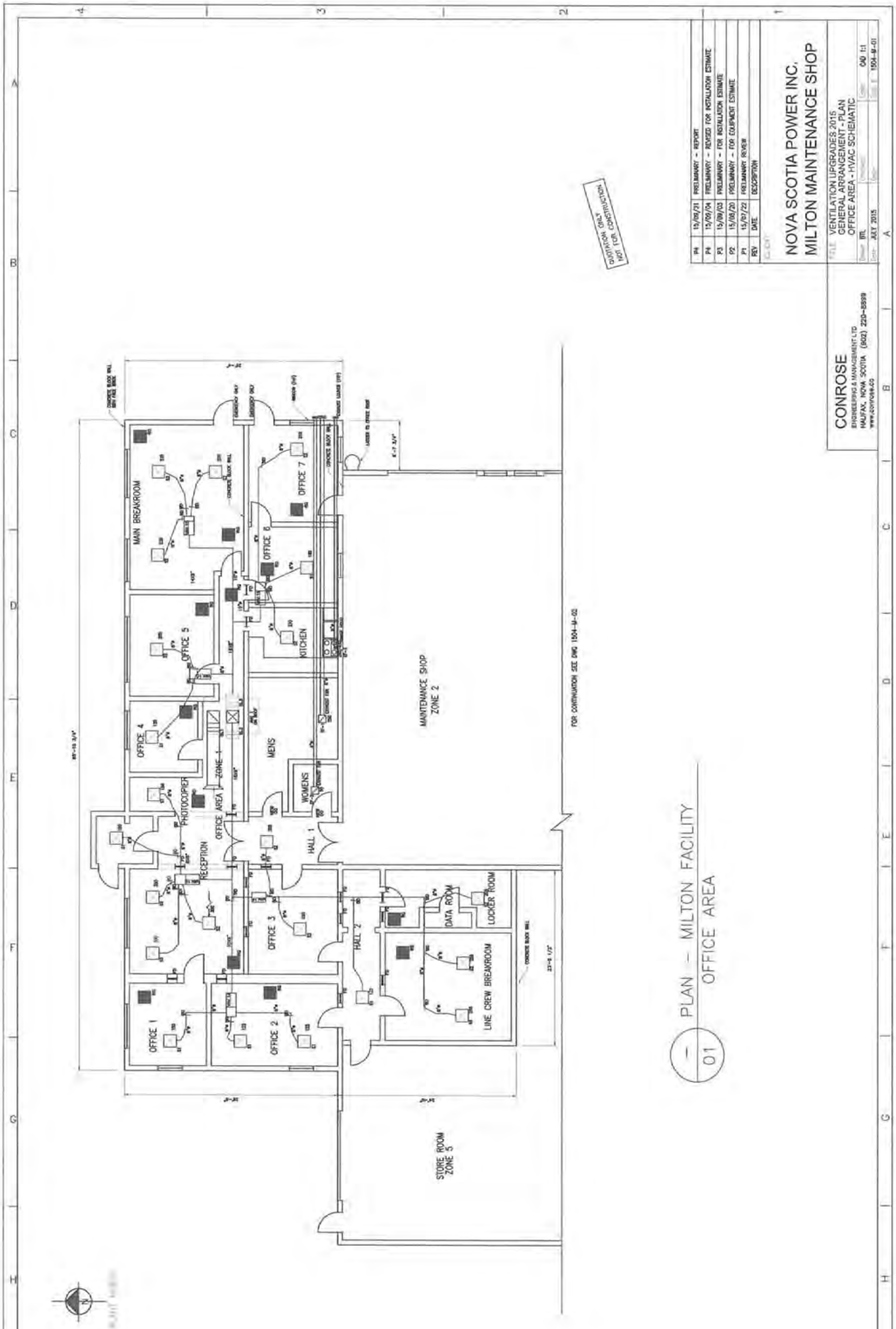
Conrose Engineering & Management Ltd
Brian Layton, P.Eng.

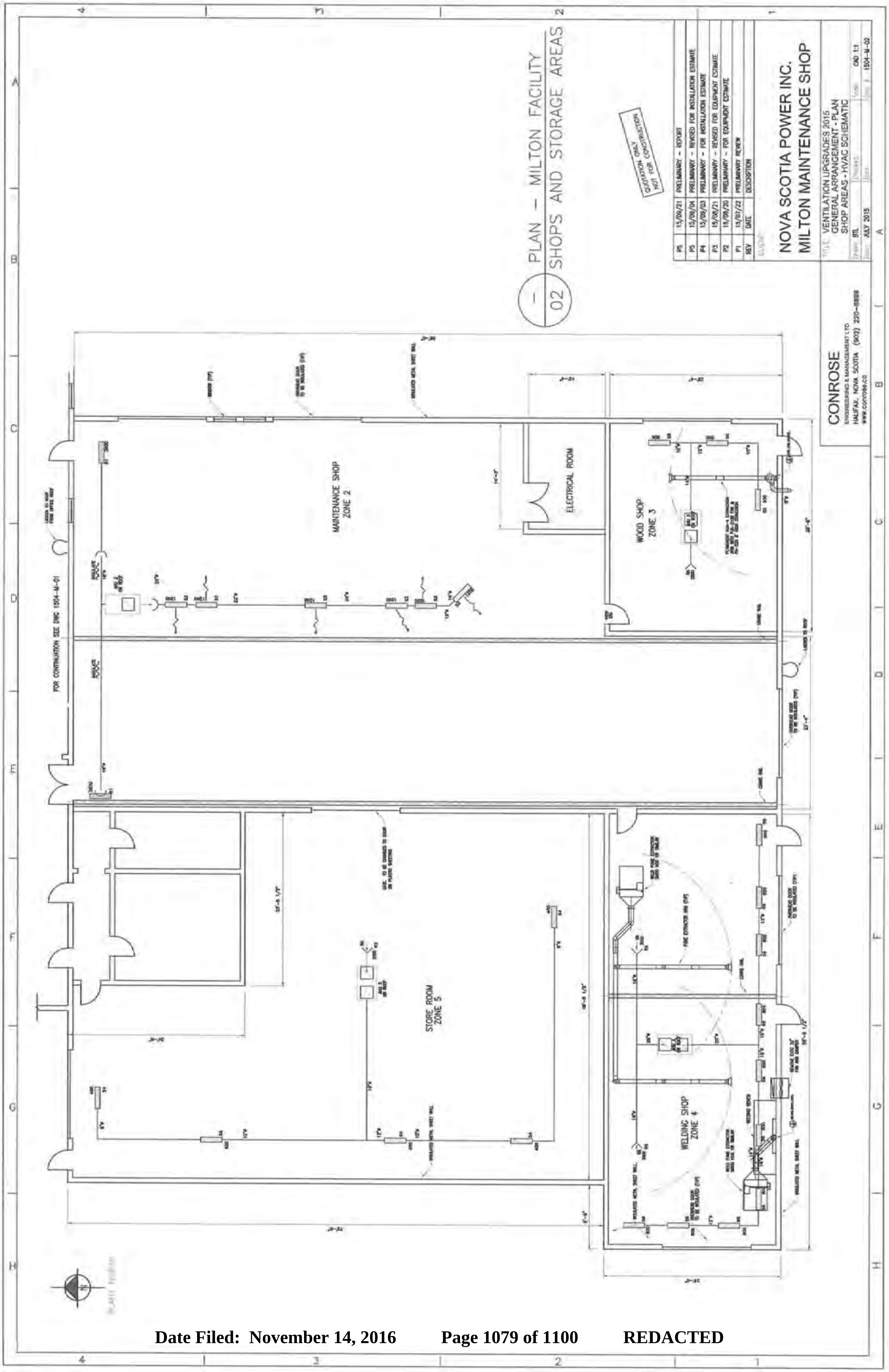
Email: brian.layton@conrose.ca
Phone: 902-220-8899

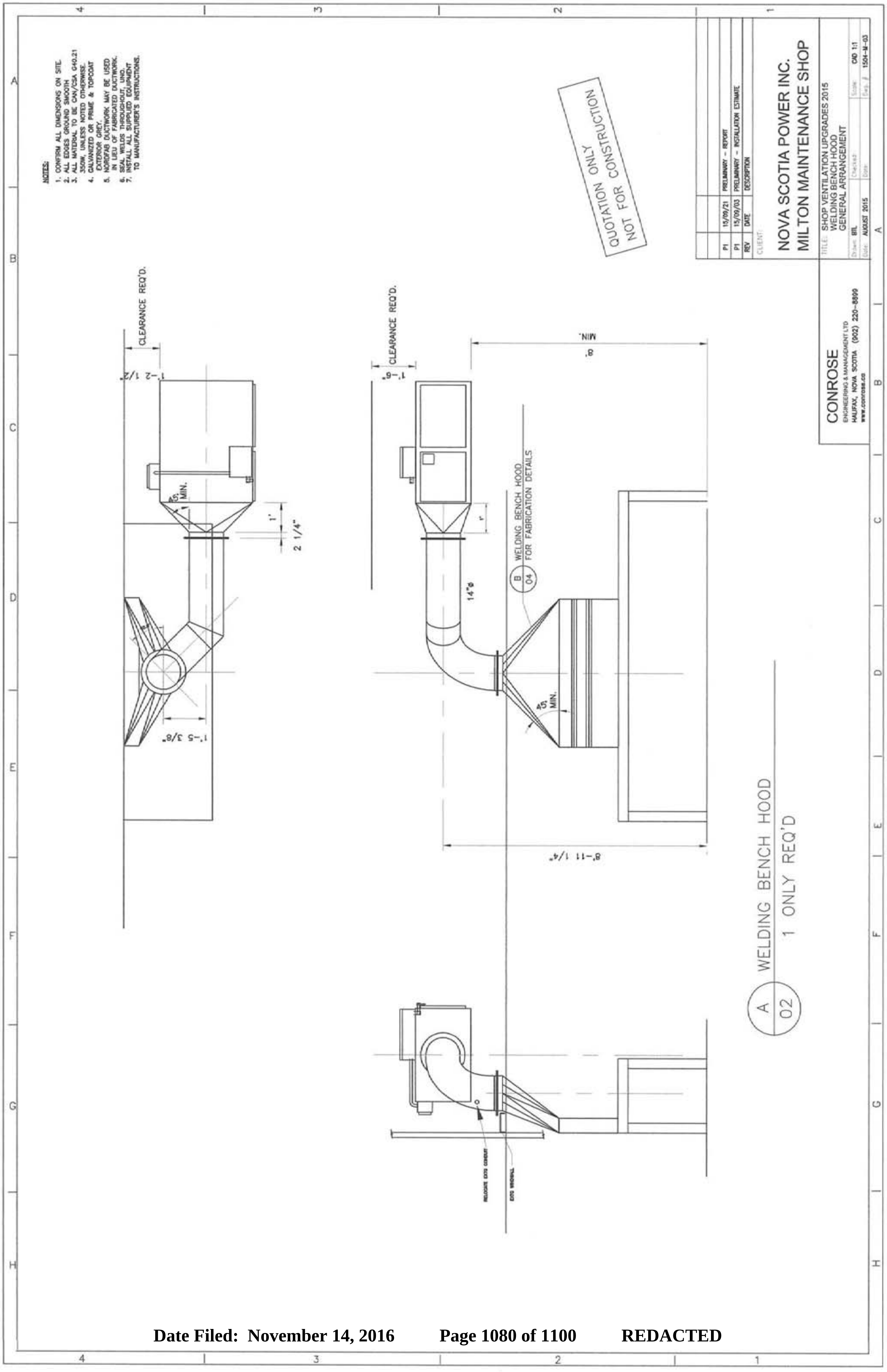
APPENDIX A

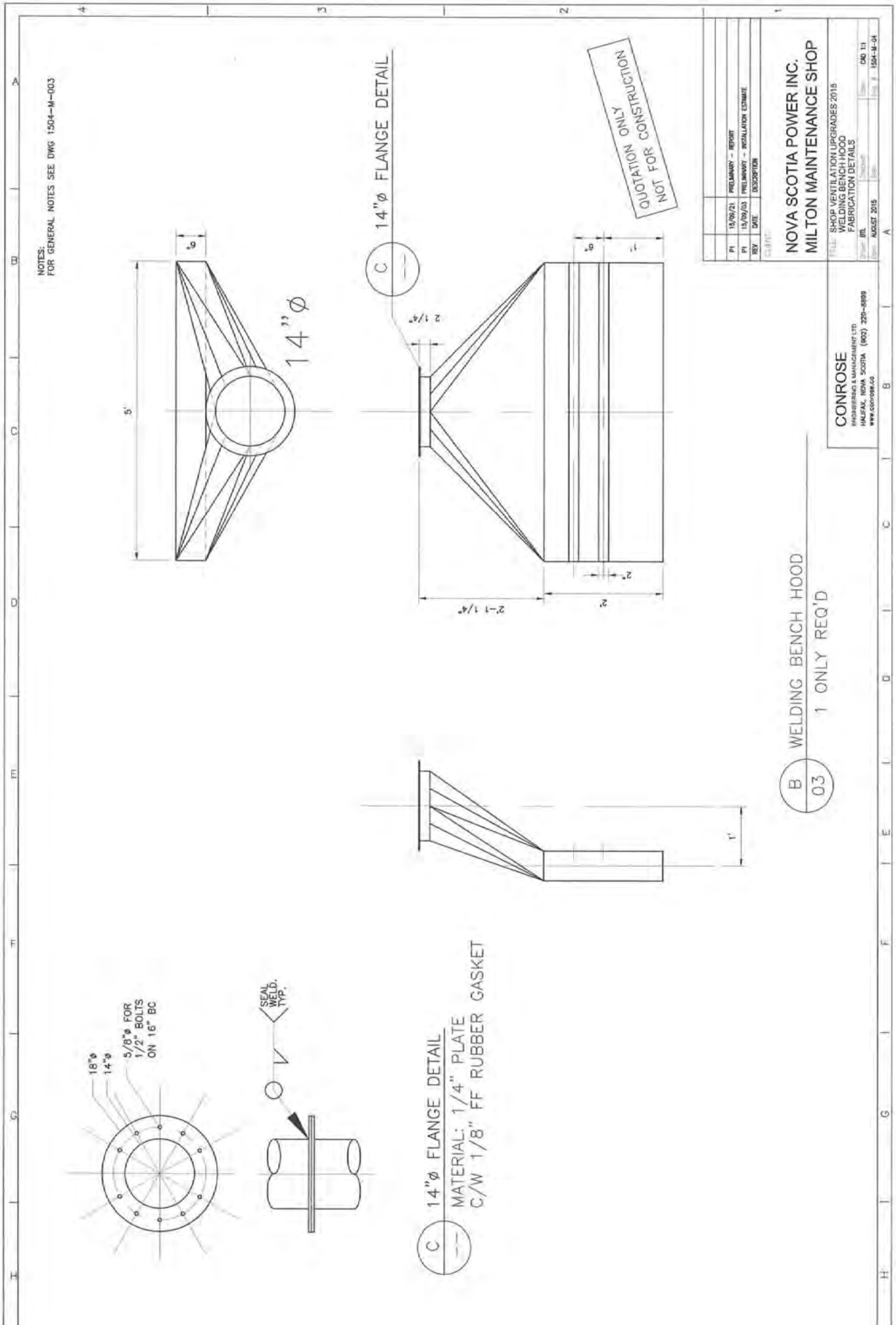
DRAWINGS

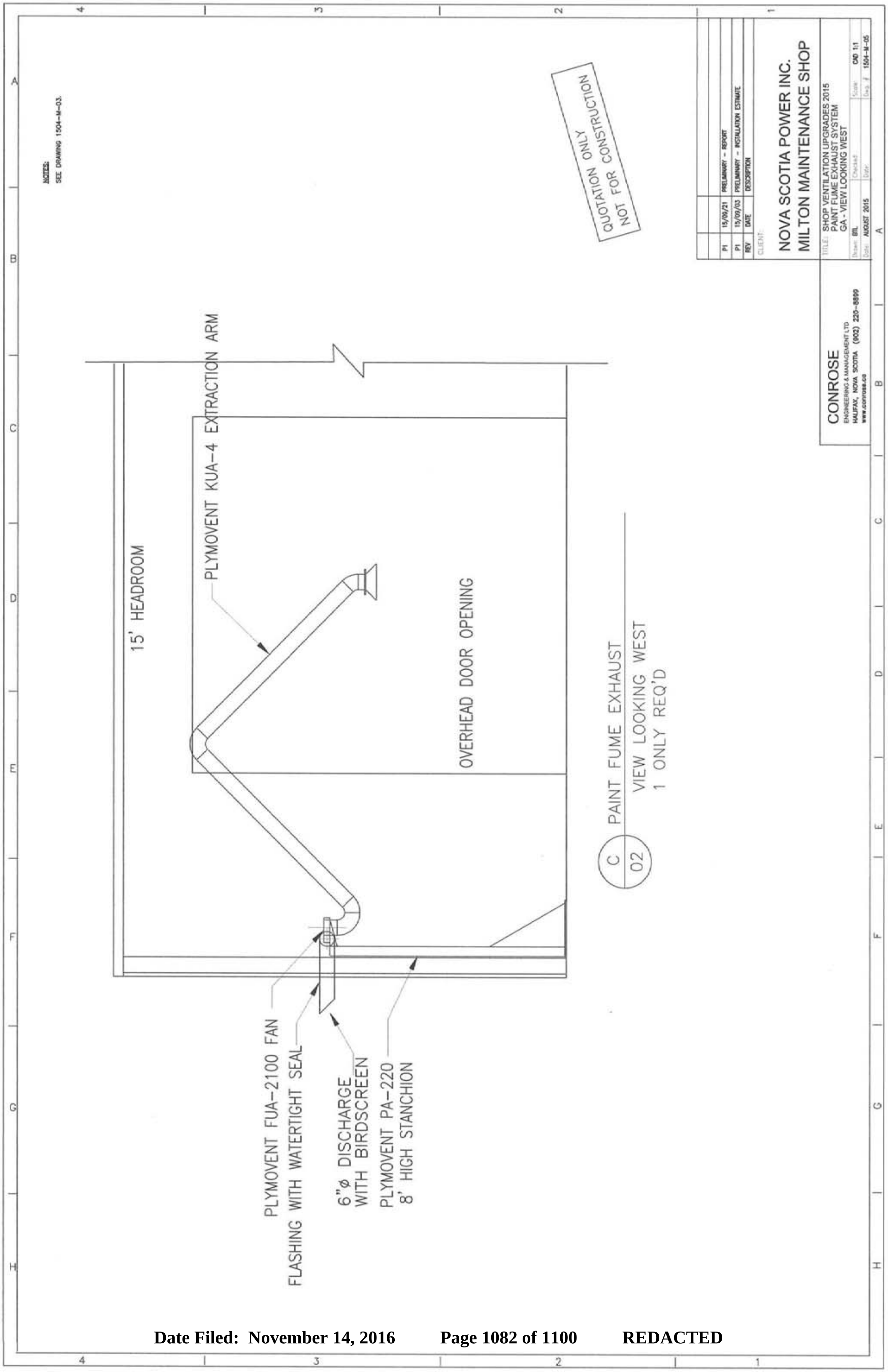
1504-M-01	Office Area – HVAC Schematic
1504-M-02	Shop Area – HVAC Schematic
1504-M-03	Welding Shop Hood - General Arrangement
1504-M-04	Welding Shop Hood - Details
1504-M-05	Paint Fume Exhaust System - General Arrangement


NOVA SCOTIA POWER INC.
MILTON MAINTENANCE SHOP
VENTILATION UPGRADES 2015
GENERAL ARRANGEMENT - PLAN
OFFICE AREA - HVAC SCHEMATIC
CONROSE
QUOTATION ONLY
NOT FOR CONSTRUCTION
PLAN - MILTON FACILITY
OFFICE AREA
01
MAINTENANCE SHOP
ZONE 2
STORE ROOM
ZONE 5
MAIN BREAKROOM
OFFICE 7
OFFICE 6
OFFICE 5
OFFICE 4
KITCHEN
MENS
WOMENS
PHOTOCOPIER
OFFICE AREA
ZONE 1
RECEPTION
HALL 1
HALL 2
OFFICE 3
OFFICE 2
OFFICE 1
DATA ROOM
LOCKER ROOM
LINE CREW BREAKROOM


PLAN – MILTON FACILITY
SHOPS AND STORAGE AREAS
02
QUOTATION ONLY
NOT FOR CONSTRUCTION
NOVA SCOTIA POWER INC.
MILTON MAINTENANCE SHOP
VENTILATION UPGRADES 2015
GENERAL ARRANGEMENT - PLAN
SHOP AREAS - HVAC SCHEMATIC
CONROSE
MAINTENANCE SHOP
ZONE 2
ELECTRICAL ROOM
WOOD SHOP
ZONE 3
STORE ROOM
ZONE 5
WELDING SHOP
ZONE 4
FOR CONTINUATION SEE DWG 1504-M-01


NOTES:
1. CONFIRM ALL DIMENSIONS ON SITE.
2. ALL EDGES GROUND SMOOTH
3. ALL MATERIAL TO BE CAN/CSA G40.21 350W, UNLESS NOTED OTHERWISE.
4. GALVANIZED OR PRIME & TOPCOAT EXTERIOR GREY.
5. NORDFAB DUCTWORK MAY BE USED IN LIEU OF FABRICATED DUCTWORK.
6. SEAL WELDS THROUGHOUT, UNO.
7. INSTALL ALL SUPPLIED EQUIPMENT TO MANUFACTURER'S INSTRUCTIONS.
QUOTATION ONLY
NOT FOR CONSTRUCTION
P1 15/09/21 PRELIMINARY - REPORT
P1 15/09/03 PRELIMINARY - INSTALLATION ESTIMATE
REV DATE DESCRIPTION
CLIENT:
NOVA SCOTIA POWER INC.
MILTON MAINTENANCE SHOP
TITLE: SHOP VENTILATION UPGRADES 2015
WELDING BENCH HOOD
GENERAL ARRANGEMENT
Drawn: BTL
Date: AUGUST 2015
CAD 1:1
1504-M-03
CONROSE
HALIFAX, NOVA SCOTIA (902) 220-8899
www.conrose.ca
CLEARANCE REQ'D.
1'-2 1/2"
1'-6"
8' MIN.
45° MIN.
1'
2 1/4"
14"ø
B
04
WELDING BENCH HOOD
FOR FABRICATION DETAILS
1'-5 3/8"
8'-11 1/4"
A
02
WELDING BENCH HOOD
1 ONLY REQ'D


NOTES:
FOR GENERAL NOTES SEE DWG 1504-M-003
14"ø FLANGE DETAIL
QUOTATION ONLY
NOT FOR CONSTRUCTION
NOVA SCOTIA POWER INC.
MILTON MAINTENANCE SHOP
SHOP VENTILATION UPGRADES 2015
WELDING BENCH HOOD
FABRICATION DETAILS
AUGUST 2015
CONROSE
14"ø
5'
6"
2 1/4"
2'-1 1/4"
2'
1'
WELDING BENCH HOOD
1 ONLY REQ'D
B
03
18"ø
14"ø
5/8"ø FOR
1/2" BOLTS
ON 16" BC
SEAL
WELD.
TYP.
C
14"ø FLANGE DETAIL
MATERIAL: 1/4" PLATE
C/W 1/8" FF RUBBER GASKET


NOTES:
SEE DRAWING 1504-M-03.
QUOTATION ONLY
NOT FOR CONSTRUCTION
15' HEADROOM
PLYMOVENT KUA-4 EXTRACTION ARM
OVERHEAD DOOR OPENING
C
02
PAINT FUME EXHAUST
VIEW LOOKING WEST
1 ONLY REQ'D
PLYMOVENT FUA-2100 FAN
FLASHING WITH WATERTIGHT SEAL
6"ø DISCHARGE
WITH BIRDSCREEN
PLYMOVENT PA-220
8' HIGH STANCHION
PI 15/09/21 PRELIMINARY - REPORT
PI 15/09/03 PRELIMINARY - INSTALLATION ESTIMATE
REV DATE DESCRIPTION
CLIENT:
NOVA SCOTIA POWER INC.
MILTON MAINTENANCE SHOP
TITLE: SHOP VENTILATION UPGRADES 2015
PAINT FUME EXHAUST SYSTEM
GA - VIEW LOOKING WEST
Drawn: BTL
Date: AUGUST 2015
Scale: CAD 1:1
Dwg #: 1504-M-05
CONROSE
ENGINEERING & MANAGEMENT LTD
HALIFAX, NOVA SCOTIA (902) 220-8899
www.conrose.ca

APPENDIX B

CAPITAL COST ESTIMATE

Nova Scotia Power | BTL
Milton Office and Shop Ventilation Upgrades | Project # 1504 | January 11, 2016
Capital Cost Estimate

Description	Qty	Unit	Material	Labor	Cost	Quoted by or *Estimated
ZONE 1 - OFFICE AREA						
AHU-1 10ton, Heating and Air Conditioning	1	ea	[redacted]		[redacted]	Master Group
VAV Boxes and Louvers/Diffusers	1	lot	[redacted]		[redacted]	Master Group
AHU Installation					[redacted]	Sea Coast HVAC
Roofing and siding removal/replacement					Inc	
Electrical supply to AHU					Inc	
Controls wiring					Inc	
Programmable Thermostat			[redacted]		[redacted]	
Ceiling modifications, ductwork, Louver installation					Inc	
Exhaust fans	2	ea	[redacted]	Inc	[redacted]	*
Range Hood, two-speed	1	ea	[redacted]	Inc	[redacted]	Home Depot
Exhaust ductwork, gooseneck, roofing, electrical					Inc	
Ductwork, VAV Boxes, Silencers, Fire Damper, Louvers					Inc	
Access ladder to Office Roof	1	ea	[redacted]			
Sub-total Zone 1					[redacted]	
ZONE 2 - MAINTENANCE SHOP						
AHU-2 20ton, Heating Only	1	ea	[redacted]		[redacted]	Master Group
Supply Louvers and Return grills	1	lot	[redacted]		[redacted]	Master Group
AHU Installation					[redacted]	Sea Coast HVAC
Roofing					Inc	
Electrical supply to AHU					Inc	
Controls wiring					Inc	
Programmable Thermostat			[redacted]		[redacted]	
Ceiling modifications, ductwork, Louver installation					Inc	
Set-up Portable Welding Fume Collector	1	ea	[redacted]			
Access ladder from Office to Shop Roof	1	ea				
Sub-total Zone 2					[redacted]	
ZONE 3 - WOOD SHOP						
AHU-3 6.5ton, Heating Only	1	ea	[redacted]		[redacted]	Master Group
Supply Louvers and Return grills	1	lot	[redacted]		[redacted]	Master Group
AHU Installation					[redacted]	Sea Coast HVAC
Roofing/Siding repair					Inc	
Electrical supply to AHU and Fume Arm Fan					Inc	
Controls wiring					Inc	
Programmable Thermostat			[redacted]		[redacted]	
Ceiling modifications, ductwork, Louver installation					Inc	
Install Paint Fume Extraction Arm, Column, fan, ductwor	1	lot	[redacted]	inc	[redacted]	
Set-up Wood Dust Collector	1	ea	[redacted]	inc	[redacted]	Busy Bee Tools
Install ductwork, hoses, adapters to equipment	1	lot	[redacted]	inc	[redacted]	Estimate
Access ladder to Shop Roof	1	ea	[redacted]	[redacted]		
Sub-total Zone 3					[redacted]	
ZONE 4 - WELDING SHOP						
AHU-4 15ton, Heating Only	1	ea	[redacted]		[redacted]	Master Group
Supply Louvers and Return grills	1	lot	[redacted]		[redacted]	Master Group
AHU Installation					[redacted]	Sea Coast HVAC
Roofing					Inc	
Electrical supply to AHU					Inc	
Controls wiring					Inc	
Programmable Thermostat			[redacted]		[redacted]	
Ceiling modifications, ductwork, Louver installation					Inc	
Fume Extraction Arms with wall suport & ESP	1	lot	[redacted]	Inc	[redacted]	
Install ductwork for Fume Extraction Arms					Inc	
Fabricate and Install Welding Bench Hood & ductwork					Inc	
Install ESP for Welding Bench Hood	1	ea	[redacted]	inc	[redacted]	
Relocate lighting at welding bench					Inc	
Fill masonary hole in Storeroom wall					[redacted]	
Replace Unit Heaters if required	3	ea	[redacted]			Ouillet
Sub-total Zone 4					[redacted]	

Nova Scotia Power BTL
Milton Office and Shop Ventilation Upgrades Project # 1504 January 11, 2016
Capital Cost Estimate

Description	Qty	Unit	Material	Labor	Cost	Quoted by or *Estimated
ZONE 5 - STORE ROOM						
AHU-5 5ton, Heating Only	1	ea	[redacted]		[redacted]	Master Group
Supply Louvers and Return grills	1	lot	[redacted]		[redacted]	Master Group
AHU Installation					[redacted]	Sea Coast HVAC
Roofing					Inc	
Electrical supply to AHU					Inc	
Controls wiring					Inc	
Programmable Thermostat			[redacted]	Inc	[redacted]	
Ceiling modifications, ductwork, Louver installation					Inc	
Sub-total Zone 5					[redacted]	
CIVIL/STRUCTURAL DEMOLITION AND INSTALLATION						
Additional support steel for AHU-1 if required	1	lot	[redacted]	[redacted]	[redacted]	Estimate
Additional support steel for AHU-2 if required	1	lot	[redacted]	[redacted]	[redacted]	Estimate
Additional support steel for AHU-3 if required	1	lot	[redacted]	[redacted]	[redacted]	Estimate
Additional support steel for AHU-4 if required	1	lot	[redacted]	[redacted]	[redacted]	Estimate
Additional support steel for AHU-5 if required	1	lot	[redacted]	[redacted]	[redacted]	Estimate
Additional support steel for ESP-1 if required	1	lot	[redacted]	[redacted]	[redacted]	Estimate
Additional support steel for ESP-2 if required	1	lot	[redacted]	[redacted]	[redacted]	Estimate
Sub-total Civil/Structural Demolition and Installation					[redacted]	
ELECTRICAL DEMOLITION AND INSTALLATION	1	lot			Inc	Sea Coast HVAC
CRANAGE	1	lot			Inc	Sea Coast HVAC
TOTAL Direct Costs					[redacted]	
INDIRECTS						
Phase 1 - All detail engineering and Weld Shop Construction						
Detail Engineering - HVAC - All phases	1	lot			[redacted]	M&R Engineering Ltd
Detail Engineering - Dust & Fume Control - All phases	1	lot			[redacted]	Conrose Engineering
Construction Review	1	lot			[redacted]	M&R Engineering Ltd
Commissioning	1	lot			[redacted]	M&R Engineering Ltd
Project Management	1	lot			[redacted]	Conrose Engineering
Phase 1 Subtotal					[redacted]	
Phase 2 - Review detail engineering and Shops Construction						
Detail Engineering review	1	lot			[redacted]	M&R / Conrose
Construction Review	1	lot			[redacted]	M&R Engineering Ltd
Commissioning	1	lot			[redacted]	M&R Engineering Ltd
Project Management	1	lot			[redacted]	Conrose Engineering
Phase 2 Subtotal					[redacted]	
Phase 3 - Review detail engineering and Office HVAC Construction						
Detail Engineering review	1	lot			[redacted]	M&R / Conrose
Construction Review	1	lot			[redacted]	M&R Engineering Ltd
Commissioning	1	lot			[redacted]	M&R Engineering Ltd
Testing and Air Balancing	1	lot			[redacted]	ICC
Project Management	1	lot			[redacted]	Conrose Engineering
Phase 3 Subtotal					[redacted]	
Phase 1 - All detail engineering and Weld Shop Construction total					[redacted]	
25% Contingency					[redacted]	
TOTAL PHASE 1					[redacted]	
Phase 2 - Review detail engineering and Shops Construction total					[redacted]	
25% Contingency					[redacted]	
TOTAL PHASE 2					[redacted]	
Phase 3 - Review detail engineering and Office HVAC Construction total					[redacted]	
25% Contingency					[redacted]	
TOTAL PHASE 3					[redacted]	
TOTAL ALL PHASES					[redacted]	

Assumptions: The system decription and assumptions are included in the report.

Memo

To: Becky MacDonald, Milton

From: Helen Mersereau, Occupational Hygienist

CC: Stewart Whynot

Date: 02 Dec 2014

Re: Air sampling for Welding at Milton

Air sampling was conducted on December 2, 2014 to determine welding fume exposure to welders working in the Milton heavy duty shop. One personal sample and one area sample were taken by affixing an air sampling pump and filter to one welder, and by having one air sampling pump in the centre of the room. Jim was doing some MIG welding and using carbon steel. The samples were then sent to Maxxam for analysis of all metals by NIOSH method 7300. The pumps were calibrated before and after sampling. The results were compared to the ACGIH[1] 2014 TLVs. A dust trak was also set up to measure total dust. A Q-Trak was set up to measure carbon monoxide and dioxide. The results from 2012 are also included for the sake of comparison. Only one welder was working for the entire day, with one that had meetings offsite for part of the day.

Results

A total of 2 samples were taken for welding fume. A Q-trak was used to assess concentrations of carbon monoxide and carbon dioxide. A Dust-trak was used to assess concentrations of total dust. The results are presented in Table 1. Only the metals that were at detectable levels are reported. All others were below the limit of detection. As can be seen from both table 1 and 2, manganese was the only metal that was at or above the TLV. Carbon monoxide concentrations ranged from 0 ppm to 52ppm, with an average of 2 ppm. Carbon dioxide concentrations ranged from 434 ppm to 1207 ppm, with an average of 878 ppm.

Discussion

All metals were present in acceptable amounts except for manganese. Manganese is a metal used for hardness, and it is put into many welding products. Recent changes to the TLV have lowered it from 0.2 mg/m3 to 0.1 mg/m3. Carbon monoxide and carbon dioxide were present in acceptable concentrations.

Manganese is a metal that is often found in welding, and can cause some unpleasant symptoms such as irritation and mucous production. Respiratory protection would need to be provided to the welders for use when welding. Consideration can also be given to the ventilation system to try and capture the local fumes given off when welding, and pulling it away from the welder's breathing zone. Based on sampling of 2 years ago, it appears that the MIG process on carbon steel might be responsible for the manganese

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[1] The Department of Labour adopts the most up to date version of the ACGIH TLVs (American Conference of Governmental Industrial Hygienists, 2014 Threshold Limit Values).

concentrations. This welding was in progress during the 2014 and 2012 surveys. It appears that respiratory protection is necessary for work during MIG activities[2].

Given the air sampling results, I would recommend Jim continue to wear his respirator when doing MIG or stainless. When the other workers are doing stainless, they must also wear their fit tested respirators with HEPA filters. Fit testing should be repeated on a regular basis to ensure the welder still has a good fit with his respirator. Manganese health effects are uncomfortable, so care should be taken to ensure no overexposure occurs. If possible, a ventilation system should be considered to alleviate the possible manganese fume. Other welding shops have either smoke eaters (which filter out particulate) or a bell shaped local capture system to exhaust the particles outside the shop. Either one would be appropriate for your shop. The local capture device should be purchased with consideration for its reach and its capture velocity (how far away it can capture the welding fume[3]).

In the meantime, welders should wear at least a half face disposable P100 for welding fume. They can also wear PAPR, full face, or half face HEPA cartridge style respirator. A safety factor of 10 would be needed.

Conclusion

The sampling showed overexposure to manganese. Carbon monoxide and dioxide concentrations were acceptable. Future MIG and stainless welding require the use of respiratory protection. Fit tests should be conducted. Consideration should be given to ventilation for welding operations.

Please do not hesitate to call me if you have any further questions or concerns at 563 1206 or 565 1570.

Regards,

Helen

Helen Mersereau, MHSc, CIH, ROH, CRSP
Occupational Hygienist

[2] Additional respirator information is available at: http://multimedia.3m.com/mws/media/850502O/tdb-211-manganese-update-feb-2013.pdf?fn=TDB%20211%20-%20Manganese%20Update%20-%20Feb

[3] Additional information on welding extraction systems is available at: http://www.lincolnelectric.com/en-ca/equipment/weld-fume-control/Pages/weld-fume-control.aspx

Table 1: Milton Welding Shop, December 2, 2014

ELEMENTS BY ICP/MS (FILTER)

Metals	Personal mg/m^3	Area mg/m^3	TLV-TWA Mg/m3
Aluminum (Al)	0.02	Nd	1
Arsenic (As)	0.006	0.006	0.01
Barium (Ba)	0.01	0.004	0.5
Chromium (Cr)	0.005	0.003	0.01
Cobalt (Co)	0.001	Nd	0.02
Copper (Cu)	0.02	0.02	0.2
Iron (Fe)	3.26	2.15	5
Lead (Pb)	0.001	0.001	0.05
Manganese (Mn)	**0.25**	**0.27**	0.1
Nickel (Ni)	0.004	0.002	0.2
Tin (Sn)	0.002	Nd	2
Zinc (Zn)	0.012	0.005	2

Table 2: Milton Welding Shop December 3, 2012

Analyte	Welder 1 **mg/m^3**	**Welder 2 mg/m^3**	**Welder 3 mg/m^3**	TLV **mg/m^3**
Barium	0.002	0.002	Nd	0.5
Chromium	0.003	Nd	0.003	0.01
Copper	0.01	0.009	0.02	0.2
Iron	1.07	0.76	1.9	5
Manganese	0.11	0.07	**0.30**	0.1

nd indicates that the sample fell below the detection limit for the method used (<0.0006). All other metals were at undetectable levels.

Table 3: Datalogging concentrations, Milton Welding Shop, December 3, 2012

Analyte	2012	2014	TLV
Total dust	2.42 **mg/m^3**	2.02	10 **mg/m^3**
Carbon monoxide	1.1 ppm	2	25 ppm
Carbon dioxide	1155 ppm	878	5000 ppm

CI Number: 50071

Title: T&D Inspection Application Upgrade Phase 1

Start Date: 2016/10
In-Service Date: 2017/09
Final Cost Date: 2018/03
Function Class: General Plant
Forecast Amount: $411,191

DESCRIPTION:

This project includes the transition from ArcGIS Mobile (an approaching end-of-life application) to ArcGIS Collector to support the transmission and distribution inspection programs. This will enable the development of the new detailed distribution feeder inspection tools, underground device inspection tools and Polychlorinated Biphenyl (PCB) potential device inspection tools. The existing transmission & distribution inspection programs, currently under the Mobile Application, will be transitioned to the Collector application. The information derived from these applications will be used to inform the Transmission & Distribution (T&D) Asset Management program.

Summary of Related CIs +/- 2 years:
2015 CI 46691 2015 U&U T&D Inspection Infrastructure Additions $239,336
2018 CI TBD 2018 T&D Inspection Application Upgrade Phase 2 $TBD

JUSTIFICATION:

Justification Criteria: Work Support Facilities

Why do this project?

This project will transition existing inspection infrastructure to a more reliable application, as ArcGIS Mobile is approaching end-of-life (please refer to Attachment 1). Additionally, new inspection applications are required to allow for underground and PCB potential devices to transition from a paper-based inspection, and will allow for more comprehensive data collection and analysis.

Why do this project now?

The application currently used for some of the existing inspection infrastructure is approaching end of life, and will no longer be supported after July 2017. In addition, new tools are required for detailed distribution feeder inspection, underground inspections, and PCB potential device inspections.

Why do this project this way?

The existing inspection infrastructure is approaching end-of-life and must be transitioned to a new application to ensure ongoing support. The new inspection tools within the scope of this project will be developed with the new application. This will ensure a common platform for all T&D inspection infrastructure.

CI Number : 50071 - T&D Inspection Application Upgrade Phase 1 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		15,149	0	15,149
095		095-COPS Regular Labour AO		128,192	0	128,192
095		095-IT Regular Labour AO		1,976	0	1,976
001	072	001 - T&D Regular Labour	072 - GP - Computer Equipment	174,104	0	174,104
001	072	001 - IT Regular Labour	072 - GP - Computer Equipment	6,000	0	6,000
011	072	011 - Travel Expense	072 - GP - Computer Equipment	1,000	0	1,000
012	072	012 - Materials	072 - GP - Computer Equipment	500	0	500
028	072	028 - Consulting	072 - GP - Computer Equipment	32,000	0	32,000
035	072	035 - Comp.Hrdwr & Op.Sftwr	072 - GP - Computer Equipment	17,000	0	17,000
041	072	041 - Meals & Entertainment	072 - GP - Computer Equipment	1,000	0	1,000
056	072	056 - Training & Development	072 - GP - Computer Equipment	10,100	0	10,100
066	085	066 - Other Goods & Services	085 Design	24,170	0	24,170
			Total Cost:	411,191	0	411,191
			Original Cost:			

Capital Project Detailed Estimate

Location: General Plant
CI# / FP#: 50071
Title: T&D Inspection Application Upgrade Phase 1
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Project Manager	PD	30	$ 400	$ 12,000		
T&D Labour - Business Lead	PD	49	$ 400	$ 19,600		
T&D Labour - GIS Analyst	PD	360	$ 300	$ 108,000		
T&D Labour - Subject Matter Expert - Distribution	PD	72	$ 382	$ 27,504		
T&D Labour - ESRI Analyst	PD	3	$ 1,000	$ 3,000		
T&D Labour - ESRI Analyst Project Manager	Lot	4	$ 1,000	$ 4,000		
IT Labour	PD	15	$ 400	$ 6,000		
			Sub-Total	$ 180,104		
011 Travel Expense						
Travel	Lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000		
012 Materials						
Project Materials	Lot	1	$ 500	$ 500		
			Sub-Total	$ 500		
028 Consulting						
Consulting	Lot	1	$ 32,000	$ 32,000		
			Sub-Total	$ 32,000		
035 Hardware						
Servers, Routers Tough Pads and Workstations	Lot	5	$ 3,400	$ 17,000		
			Sub-Total	$ 17,000		
041 Meals & Entertainment						
Meals	Lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000		
056 Training						
Training	Hr	101	$ 100	$ 10,100		
			Sub-Total	$ 10,100		
066 Other Goods & Services						
Contingency	%	10%	$ 241,704	$ 24,170		
			Sub-Total	$ 24,170		
094 Interest Capitalized						
AFUDC				$ 15,149		
			Sub-Total	$ 15,149		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 128,192		
IT Regular AO				$ 1,976		
			Sub-Total	$ 130,168		
			SUB-TOTAL (no AO, AFUDC)	$ 265,874		
			TOTAL (AO, AFUDC included)	$ 411,191		
Original Cost				$ -		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

ArcGIS for Windows Mobile Product Life Cycle Support Status

The Product Life Cycle Support Policy is designed to help communicate to ESRI users the technical support resources available during a product's life span and to provide advanced notification of planned changes to available support options. Read more about this in our Product Life Cycle Support Policy.

Notes:

- **April 11, 2016: ArcGIS 10.2.1 for Windows Mobile is the last release of ArcGIS for Windows Mobile.** It is no longer part of our development strategy and no additional features, functionality or performance/stability updates will be released. Esri recommends customers consider migration to new mobile applications such as Collector for ArcGIS, Survey123 for ArcGIS, Workforce for ArcGIS, and Explorer for ArcGIS now. If building and deploying custom mobile solutions, please refer to Building Apps on the Developers site for your development path forward.
- ArcGIS for Windows Mobile includes the following: ArcGIS Applications (Windows Desktop & Windows Mobile), ArcGIS Runtime SDK for Windows Mobile, ArcGIS for Windows Mobile Project Center, Mobile GP Tools.
- Dates listed in a support column provide the date on which the product entered that support level.

Version	Release Date	General Availability	Mature Support	Retired	Notes
10.2.1	**Feb 13, 2015**	**Feb 2015 – June 2015**	**July 2015 – June 2017**	**July 1, 2017**	**April 11, 2016: ArcGIS 10.2.1 for Windows Mobile (compatible with ArcGIS 10.3x is the last release of ArcGIS for Windows Mobile.** **StreetMap Data currently accompanying the release of ArcGIS for Windows Mobile will be retired on December 31, 2016 (and no longer be available).**
10.2	October 2013	October 2013 - June 2015	July 2015 – June 2017	July 1, 2017	
10.1.1	January 2013	January 2013 – Dec 2013	In Mature support until December 31, 2016	Jan 1, 2017	The version of ArcGIS for Windows Mobile has been changed from 3.x to 10.1.1. This is a version change only to conform to an overall strategy to standardize version numbering across Esri products.
3.1	Sept 2012	Sep 2012 – Dec 2013	In Mature support until December 31, 2016	Jan 1, 2017	
3.0	June 2012	Jun 2012 – Dec 2013	In Mature support until December 31, 2016	Jan 1, 2017	
10 build 2550	Jan 2012	Jun 2010 – Jun 2012	Jan 2014 – Dec 2015	Jan 1, 2016	Retired.
10 build 2525	Sept 2011	Jun 2010 – Jun 2012	Jan 2014 – Dec 2015	Jan 1, 2016	Retired.
10 build 2500	June 2011	Jun 2010 – Jun 2012	Jan 2014 – Dec 2015	Jan 1, 2016	Retired.
10 build 2475	Aug 2010	Jun 2010 – Jun 2012	Jan 2014 – Dec 2015	Jan 1, 2016	Retired.
10	June 2010	Jun 2010 – Jun 2012	Jan 2014 – Dec 2015	Jan 1, 2016	Retired.
9.3.1	April 2009			X	Retired.
9.3	June 2008			X	Retired.
9.2	Nov 2006			X	Retired.

CI Number: 49880

Title: Meter Shop Test Console Replacement

Start Date:	2017/02
In-Service Date:	2017/02
Final Cost Date:	2017/12
Function:	General Plant
Forecast Amount:	$410,457

DESCRIPTION:

This project includes the procurement of two test consoles (one in 2017 and one in 2018) for testing energy only meters to replace the current consoles currently in use. NS Power's meter shop tests approximately 6,000 meters as part of the annual sampling program, re-certifies approximately 10,000 older meters to be reused, test approximately 400-500 meters that are disputed by customers, and provide meter testing services for approximately 1,200 meters per year from various municipal utilities in Nova Scotia. NS Power currently has two test consoles for testing energy only meters that are both past their useful life (both are approximately 25 years old) and run on software that is no longer supported (the supplier went bankrupt several years ago) and cannot be replaced. Should a failure occur with these consoles, NS Power would be unable to test meters.

Summary of Related CIs +/- 2 years:
No other projects in 2015, 2016, 2017, 2018 or 2019

JUSTIFICATION:

Justification Criteria: Work Support Facilities

Sub Criteria: Equipment Replacement

Why do this project?

The existing consoles are 25 years old and run on software that is no longer supported. Should a failure occur to the consoles (software crash, part failure, physical damage), NS Power would be unable to carry out sample testing and re-certification activities as prescribed by Measurement Canada.

This would lead to increased expenditures related to maintaining inventory levels (older meters would not be able to be re-certified, therefore more new meters would need to be maintained in inventory) and related to testing of meters (for customer dispute investigations or sample testing). The cost to test and re-certify meters is approximately $15 per meter (this is what NS Power charges external customers for testing; other utilities have confirmed slightly more expensive rates). Assuming another facility could accommodate NS Power's meter testing requirements; NS Power would need to send 5,000-6,000 meters out for testing which would cost approximately $75,000-$90,000 per year (not including shipping costs). NS Power would also incur delays related to providing meter testing results to customers.

Why do this project now?

The current consoles have reached end-of-life, and new test consoles have a lead time of 9-12 months. If a console were to fail unexpectedly, it would be difficult to arrange for testing of the quantity of meters required within the timelines as prescribed by Measurement Canada (expired meters must be removed by the end of the year). For example, if NS Power was unable to complete the sample testing program, there is a risk that the larger population of meters would have to be replaced. Samples typically represent a population of 40,000-60,000 meters per year.

Why do this project this way?

The only alternative would be to send the meters for testing at another Measurement Canada certified facility (another utility). This option, in addition to being difficult to find a facility with capacity to complete this work, would also cost at minimum $15 per meter (not including shipping costs).

CI Number : 49880-P112 - Meter Shop Test Console Replacement **Project Number** P112

Parent CI Number : -

Cost Centre : 571 - 571-Meter Serv.-Meter Shop **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle Cust. Serv. Reg. Labour		3,430	0	3,430
095		095-COPS Regular Labour AO		5,080	0	5,080
001	051	001 - CUST. SERV. Regular Labour	051 - GP - Meters	6,642	0	6,642
012	051	012 - Materials	051 - GP - Meters	394,305	0	394,305
013	051	013 - OTHER Contracts	051 - GP - Meters	1,000	0	1,000
			Total Cost:	410,457	0	410,457
			Original Cost:	254,508		

Capital Project Detailed Estimate

Location: **General Plant**
CI# : 49880
Title: Meter Shop Test Console Replacement
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
Cust Service Labour	PD	20	$ 332	$ 6,642		
			Sub-Total	$ 6,642		
012 Materials						
Energy only test board		2	[redacted]		Cost Support Item #1	
Service Upgrade		1				
Service Disconnect		1				
			Sub-Total	$ 394,305		
013 Contracts						
Certification by Measurement Canada		2	$ 500	$ 1,000		
				$ -		
			Sub-Total	$ 1,000		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 3,430		
Vehicle T&D Labour Overtime AO				$ -		
			Sub-Total	$ 3,430		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 5,081		
			Sub-Total	$ 5,081		
			SUB-TOTAL (no AO, AFUDC)	$ 401,947		
			TOTAL (AO, AFUDC included)	$ 410,457		
Original Cost				$ 254,508		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.

Power Measurement Technologies Inc.
43 Riviera Drive Unit #7, Markham, Ontario, Canada L3R 5J6
Telephone: (905) 944-1551 Fax: (905) 944-9629

Quotation No.: 2015013A-1
Page 1 of 1

QUOTATION

Sold To:	Ship To:
Nova Scotia Power 1223 Lower Water Street Halifax Nova Scotia B3J 3S8	Nova Scotia Power 1223 Lower Water Street Halifax Nova Scotia B3J 3S8

Cust. Inq. No	Quotation Date 2016-04-28	Valid Until 2016-07-28	GST 89481-4573	PST 4248-0116
Contact Robert Dunne			F.O.B. Origin	Terms Net 30 Days

Item No	QTY	Description	Delivery	Unit Price	Extension
1	1	**PMT40600-000-10** Fully Automatic, Measurement Canada EL-ENG-12-01 / S-E-01 Compliant, Single Phase, Ten Position Meter Calibration Console. Each console includes...	TBD	[redacted]	[redacted]
	1	**PMT40600-009-00** Two isolation current transformers per station supporting testing of meters exhibiting potential burden up to 120VA.			
	1	**PMT40000-002-03** 'A' Base Adaptor for 2 element meters.			
	1	**PMT40000-003-02** 'P' Base Adaptor for 3 element meters.			
	1	**PMT40000-004-02** 'P' Base Adaptor for 3 element Sangamo 'K' – Line meters.			
	1	**PMT40600-002-00** Bar Code Scanner supporting keyless entry of Meter Nameplate Information.			
	10	**PMT003066** Polyphase Meter Socket Jumper Covers.			
	1	**Cable and Lead Set** comprised of… • Current Bottom Connect Lead Set • Potential Bottom Connect Lead Set • Three Phase 12' Power Cord • Single Phase 12' Power Cord			
	1	**Meter Hanging Pin Set** comprised of… • Qty 10 Short Shaft Aluminum Pins • Qty 10 Long Shaft Aluminum Pins			
	1	**Console Installation Kit** comprised of … • Qty 8 Console Cabinet levelling Feet • Qty 1 Compressed Air Hose and Fittings			
	1	**PMT40600-008-00** Measurement Canada EL-ENG-12-01 / S-E-01 Pre-Test Report			
	1	**PMT90020-000-00** On-site commissioning and 1 day of operator training.			

PRICES ARE IN CDN DOLLARS	Sub Total	[redacted]
Warranty: 3 years labour and material.	Shipping	Included
	Insurance	Included
PER	Handling	Included
Robert Dunne	H.S.T.	[redacted]
Power Measurement Technologies	Total	[redacted]

CI Number: 49902

Title: 2017 Telecom Building Replacement - Wittenburg

Start Date: 2017/04
In-Service Date: 2017/12
Final Cost Date: 2018/06
Function Class: General Plant
Amount: $294,000

DESCRIPTION:

This project is for the replacement of the Wittenburg radio building with a new telecommunications building. The Wittenburg radio site is an important site for the existing mobile radio system as it contains a Very High Frequency (VHF) repeater which provides mobile radio coverage for the Upper Musquodoboit area for Power Line Technicians, System Maintenance and other field crews in the area. This site also provides a critical radio links to 82V Elmsdale Substation, 440H Chaplin Radio Site and 704V Hardwood Lands COMFIT site.

Included in this project are the costs of the electrical wiring and controls for the heating, ventilation and air conditioning (HVAC) system in the new building, and the installation of a backup generator and automatic transfer switch to provide emergency backup power for this radio site.

This is the fourth year of a multi-year project to replace and upgrade NS Power's radio site buildings and the associated back-up generators. These buildings were installed in the late 1970s and are now over 30 years old and contain asbestos wallboard. Priority for replacement will be given to the buildings that contain asbestos and show the highest degree of deterioration.

Summary of Related CIs +/- 2 years:
2015 CI 46306 2015 Telecom Building Replacement – Maple Ridge $251,727
2018 CI TBD 2018 Telecom Building Replacement $TBD
2019 CI TBD 2019 Telecom Building Replacement $TBD

JUSTIFICATION:

Justification Criteria: Work Support Facilities

Sub Criteria: Building Replacement/Modifications

Why do this project?

This project will replace the Wittenburg telecommunications building which was installed around 1978. The building is deteriorated and replacement of the entire building is required. The building contains asbestos wallboard which is a safety hazard if disturbed in any way.

This project is being undertaken primarily to replace the deteriorated building structure, and is secondarily being undertaken for safety.

Why do this project now?

The Wittenburg telecommunication building must be replaced to provide proper shelter and backup power for the critical equipment at this site. The back-up generator equipment within the building must also be replaced as it is over thirty years old and difficult to maintain due to a lack of availability of spare parts.

Why do this project this way?

Replacing the existing telecom building and generator at Wittenburg is the most cost effective option to provide proper shelter and backup power available for the critical equipment at this site. Further maintenance and/or modifications to the building risks the disturbance of the asbestos contained within the wallboard of the building which would be a significant safety concern.

CI Number : 49902 - 2017 Telecom Building Replacement - Wittenburg **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2017 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		5,707	0	5,707
092		092-Vehicle T&D OT Labour AO		744	0	744
094		094 - Interest Capitalized		5,280	0	5,280
095		095 - Proj Supp Regular Labour AO		7,716	0	7,716
095		095-COPS Contracts AO		9,509	0	9,509
095		095-COPS Overtime Labour AO		1,102	0	1,102
095		095-COPS Regular Labour AO		8,455	0	8,455
001	003	001 - T&D Regular Labour	003 - GP - Bldg.,Struct.Grnd.	7,203	0	7,203
002	003	002 - T&D Overtime Labour	003 - GP - Bldg.,Struct.Grnd.	2,881	0	2,881
012	003	012 - Materials	003 - GP - Bldg.,Struct.Grnd.	110,000	0	110,000
013	003	013 - COPS Contracts	003 - GP - Bldg.,Struct.Grnd.	40,000	0	40,000
012	055	012 - Materials	055 - GP - Teleprotection	28,000	0	28,000
013	055	013 - COPS Contracts	055 - GP - Teleprotection	7,500	0	7,500
001	085	001 - Proj Supp Regular Labour	085 Design	16,044	0	16,044
001	085	001 - Regular Labour (No AO)	085 Design	2,760	0	2,760
011	085	011 - Travel Expense	085 Design	1,200	0	1,200
028	085	028 - Consulting	085 Design	15,000	0	15,000
041	085	041 - Meals & Entertainment	085 Design	1,000	0	1,000
066	085	066 - Other Goods & Services	085 Design	18,550	0	18,550
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	3,850	0	3,850
011	087	011 - Travel Expense	087 Field Super.& Ops.	1,500	0	1,500
			Total Cost:	294,000	0	294,000
			Original Cost:	66,759		

Capital Project Detailed Estimate

Location: **General Plant**
CI# / FP#: 49902
Title: 2017 Telecom Building Replacement - Whittenburg
Execution Year: 2017

Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
001 Regular Labour						
T&D Labour - Electrician/Technician	PD	20	$ 360	$ 7,203		
T&D Labour - Site Supervision	PD	10	$ 385	$ 3,850		
Procurement / Financial Support		1	$ 2,760	$ 2,760		
Project Support AO - Engineering Design	PD	42	$ 382	$ 16,044		
			Sub-Total	$ 29,857		
002 OT Labour						
T&D Labour - Electrician/Technician	PD	4	$ 720	$ 2,881		
			Sub-Total	$ 2,881		
011 Travel Expense						
Engineering	lot	1	$ 1,200	$ 1,200		
Site Supervisor	lot	1	$ 1,500	$ 1,500		
				$ -		
			Sub-Total	$ 2,700		
012 Materials						
New Building materials	Lot	1	$ 110,000	$ 110,000		
Backup Generator	Lot	1	$ 28,000	$ 28,000		
			Sub-Total	$ 138,000		
013 Contracts						
Install new building and site upgrades	Lot	1	$ 40,000	$ 40,000		
Install new generator	Lot	1	$ 7,500	$ 7,500		
			Sub-Total	$ 47,500		
028 Consulting						
Electrical and Mechanical drawings	Lot	1	$ 15,000	$ 15,000		
			Sub-Total	$ 15,000		
041 Meals & Entertainment						
Meals	Lot	1	$ 1,000	$ 1,000		
			Sub-Total	$ 1,000		
066 Other Goods & Services						
Contingency	%	10%	$ 185,500	$ 18,550		
			Sub-Total	$ 18,550		
094 Interest Capitalized						
AFUDC				$ 5,280		
			Sub-Total	$ 5,280		
092 Vehicle Overhead						
Vehicle T&D Labour Regular AO				$ 5,707		
Vehicle T&D Labour Overtime AO				$ 744		
			Sub-Total	$ 6,451		
095 Administrative Overhead						
COPS T&D Labour Regular AO				$ 8,455		
COPS T&D Labour Overtime AO				$ 1,102		
COPS Contract AO				$ 9,509		
Project Support Regular AO				$ 7,716		
			Sub-Total	$ 26,781		
			SUB-TOTAL (no AO, AFUDC)	$ 255,488		
			TOTAL (AO, AFUDC included)	$ 294,000		
Original Cost				$ 66,759		

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