



CENTRE WELLINGTON HYDRO LTD.

Distribution System Plan

Prepared by



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1 Introduction

1.1 Description of the Utility Company

Centre Wellington Hydro's (CWH) service territory is shown in Figure 1 and it covers the town of Fergus and the village of Elora, serving approximately 6,800 Residential and General Service customers in addition to some Unmetered Scattered Load customers as well as Street Light and Sentinel Light connections.

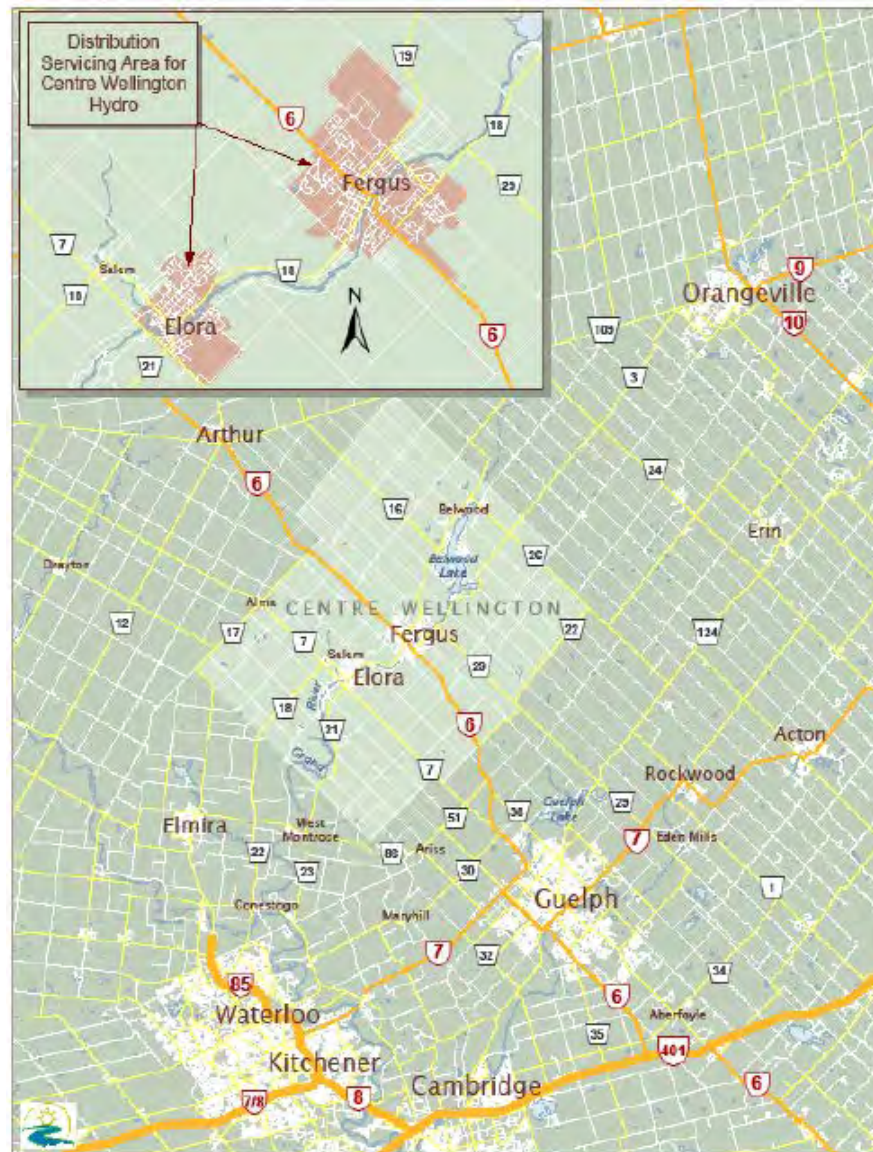


Figure 1: CWH Service Territory

The service territory is comprised of approximately 10 sq. km. of high density urban area, with a customer density of approximately 680 per sq. km. The service areas have a combined population of approximately 19,000. The electric utility customer base is indicated in Figure 2 and Table 1.

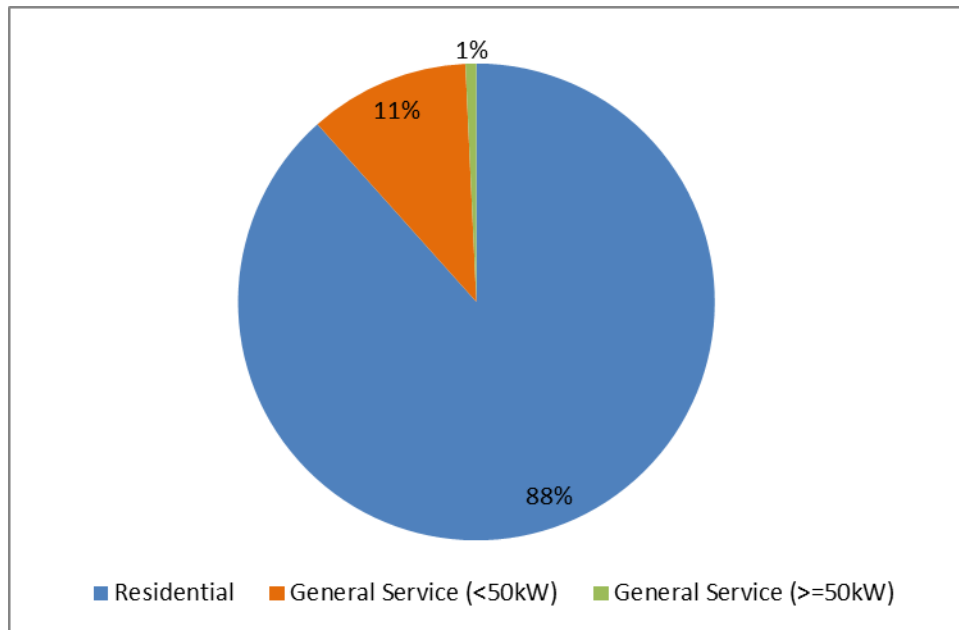


Figure 2: Customer Mix by Type

Table 1: Customer Count by Type

<u>Customers or Connections</u>	
Customer Class Name	2016
Residential	5,987
General Service < 50 kW	743
General Service 50 to 2999 kW	48
General Service 3000-4999 kW	1
Unmetered Scattered Load	13
Sentinel Lighting	29
Street Lighting	1,705
TOTAL	8,524

CWH's distribution system consists of two distinct distribution networks, one in Fergus and a second in Elora. Both distribution networks receive power from Hydro One at 44 kV, which is

stepped down to 4.16 kV at six distribution stations, four of which are located in Fergus with the remaining two located in Elora.

CWH's distribution system consists of approximately 91 km of overhead lines and approximately 70 km of underground lines. The 4.16 kV distribution voltage is further stepped down to utilization voltages of 120/240V, 120/208V or 347/600V through approximately 830 distribution transformers. The distribution system is monitored through a control centre located in its office in Fergus.

CWH actively participates in Ontario's Green Energy program and Table 2 shows the Green Energy generation installations connected to CWH's distribution system pursuant to IESO micro-FIT and FIT contracts. The total connected microFIT installations in kW is 273 and FIT connections are 645 kW for a combined total of 918 kW connected capacity.

Table 2: Micro-Fit and FIT Connections and Ratings

IESO ID	capacity/nameplate rating (kW)	Connected	Fuel Types
MicroFIT			
FIT-MH8KDWN	10	Dec 21/10	Solar Rooftop
FIT-MUJACYX	10	Oct 1/10	Solar Rooftop
FIT-M99ZVMB	10	Aug 5/10	Solar Rooftop
FIT-MHFD989	9.87	Sep 30/10	solar ground mount
FIT-MBTRHE7	10	Mar 30/11	Solar Rooftop
FIT-MFEDAZ6	2.3	Sept 21/11	Solar Rooftop
FIT-MJTDED8	7.5	Dec. 20, 2011	Solar Rooftop
FIT-MMNBHMQ	10	Dec. 6, 2011	Solar Rooftop
FIT-MXV9H38	10	Dec. 20, 2011	Solar Rooftop
FIT-MTYBE6Q	8	Sept 20/11	Solar Rooftop
FIT-M8QDDQD	8	Dec 21/10	Solar Rooftop
FIT-MR8GW29	10	Jan. 19, 2012	Solar Rooftop
FIT-MIRXXM2	10	Apr. 6, 2012	Solar Rooftop
FIT-M2YQYMT	10	Apr. 6, 2012	Solar Rooftop
FIT-MIUZ3JT	10	Apr. 1, 2012	Solar Rooftop
FIT-MX6TPV7	10	Apr. 6, 2012	Solar Rooftop
FIT-MCPIXUN	10	Apr. 27, 2012	Solar Rooftop
FIT-MVCZB7V	5	29-May-12	Solar Rooftop
FIT-MQBQWB8	8	05-Jun-12	Solar Rooftop
FIT-M6WAIXZ	10	02-Jul-12	Solar Rooftop
FIT-M6B4TFQ	10	29-Oct-12	Solar Rooftop
FIT-MNPU6WK	10	Dec. 4, 2012	Solar Rooftop
FIT-MK9E49B	10	Apr. 18, 2013	Solar Rooftop
FIT-MJJE82C	10	14-Jun-13	Solar Rooftop
FIT-M2MYDKF	10	Nov. 18/13	Solar Rooftop
FIT-MK43ZXT	10	01-May-14	Solar Rooftop
FIT-MMWWPFV	10	10-Jul-14	Solar Rooftop
FIT-M9GG79B	10	Dec. 23, 2014	Solar Rooftop
FIT-M396NJA	10	Mar. 19, 2015	Solar Rooftop
FIT-M9VWJXP	4	Aug. 11, 2015	Solar Rooftop
FIT-MUQMY98	10	April 7, 2016	Solar Rooftop
FIT-MHTXBRR	10	April 28, 2018	Solar Rooftop
FIT-MQYW7Z3	10	July 28, 2016	Solar Rooftop
FIT-MGYIGKE	10	December 1, 2016	Solar Rooftop
FIT			
FIT-FFZDCIP	185	09-Jun-12	Solar Rooftop
FIT-F6VP5TR	60	Oct. 5, 2012	Solar Rooftop
FIT-FDBG0VP	250	01-Jun-14	Solar Rooftop
RESOP	150	2006	Hydraulic

1.2 Background & Drivers

The capital investments proposed in this distribution plan include investments into each of the four general categories: a) system access; (b) system renewal; (c) system service; and (d) general plant. The background and drivers for the proposed capital investments over the next five-year period are discussed below under appropriate titles:

1.2.1 System Access

For the proposed investments under the System Access category, the key drivers in the case of CWH include:

- Customer service requests for new customer connections as well as modifications and load expansion at existing commercial and industrial customers
- Third party infrastructure developments requiring system plant relocates; and
- Mandated service obligations, such as revenue metering

There has not been a significant change in the number of customers served during the past several years in CWH service territory. A modest number of requests are received each year for newly constructed homes. Currently there is no backlog at CWH of customers requiring new services and no significant change is anticipated in the number of new services required from CWH from those in the recent previous years.

Similarly, road widening projects in the region require relocation of some power distribution lines each year and such projects requiring capital investments by CWH are anticipated to continue throughout the next five years. All residential and general service customers have been equipped with smart meters and investments into revenue meter calibration and resealing are planned over the next five years.

1.2.2 System Renewal

In order to conduct a comprehensive condition assessment of the distribution system assets, CWH engaged METSCO Energy Solutions Inc. (METSCO), an independent power sector consulting firm, in 2015 to perform an Asset Condition Assessment (ACA) of the fixed assets employed on CWH's distribution system and develop an Asset Management Plan (AMP). A report prepared by METSCO is attached in Appendix B.

The AMP report evaluates the risk of assets' failure in service by taking into account all available information, including age, operating conditions, results of visual inspections and non-destructive testing and identifies the assets in very poor and poor condition that present unacceptably high risk of failure in service. The report also identifies the level of investments considered economically efficient.

Over the past five years CWH has been systematically planning and implementing investments into asset renewal projects to replace the assets that have reached the end of their useful service life, by prioritizing investments into those assets with the highest impact on reliability and safety when they fail in service. Since the in-service failure of substation assets has the highest impact on reliability and safety, a majority of the asset renewal investments during the past five years have focussed on renewal of substation equipment. The 4 kV and 44 kV switchgear at each of the six stations have been replaced with new switchgear, employing modern protection and control designs.

It is noteworthy that the power transformers at stations have not been replaced during the station renewal initiative undertaken during the past five years; all have been repainted, and 3 of the heavier loaded transformers have been equipped with forced air cooling to extend their life. During the condition assessment of stations, the power transformer at Fergus MS-2 was determined to have the lowest health index score such that it presents an elevated risk of failure in service. Therefore, the power transformer at Fergus MS-2 is recommended to be replaced in 2022.

Distribution system renewal projects during the next five years also include renewal of high risk assets on both the overhead and underground distribution system. By taking into account the service age of overhead lines, results of pole testing and the extent of small conductors (#4 and #6 copper) employed on overhead lines, the line sections in poor and very poor condition as of the end of 2015 were identified and are included in this distribution plan for renewal.

On the underground distribution system, with the exception of a very small length of cable section, the vast majority of cables are well below their typical useful service life, with low probability of failure in service such that only a modest level of investment is proposed for renewal of those underground assets determined to be in poor and very poor condition.

CWH has not had extensive failure issues with distribution transformers, and like most distribution utilities, CWH manages this asset category using a reactive replacement strategy, i.e. replacement of transformers upon failure, unless inspections identify transformers that present safety risks. However, pad mounted distribution transformers installed along some main regional streets, where different types of road salts, including liquids that "spray" have

been used for snow melting, have experienced excessive corrosion of the enclosures which require rehabilitation during the next five years.

1.2.3 System Service

Projects in the System Service category are driven by the need to alleviate capacity constraints due to load growth. The projects in this category also include capital investments aimed at improving system operations, reliability and efficiencies through voltage upgrades, distribution automation and intelligent devices or equipment, all aimed at enhancing customer value and operational effectiveness.

During the next five years, no capacity constraints are anticipated on the distribution system requiring investments into capacity upgrades. CWH's smart grid development initiative, involving equipping all the distribution stations with automated feeder reclosers and supervisory control and data acquisition (SCADA) system, has already been completed and all of the stations are now equipped with automated and remote controlled reclosers, protected through SEL relays, allowing full features of the SCADA system to be fully utilized. Smart grid development initiative also includes upgrade and renewal of revenue meters to comply with the regulations.

1.2.4 General Plant

The capital investments under this category include investments into motor vehicle fleet, equipment and tools, buildings and facilities, computer hardware, software systems and system supervisory equipment. These investments are driven by the objectives to improve employee safety, worker productivity and operating efficiency.

1.3 Objectives & Scope of Work

The key objectives of the capital investment program proposed by CWH for the next five years include:

- ✓ Ensuring customer needs for supply system security and reliability are met through implementation of cost effective solutions, by mitigating the risk of asset failures in service, through economically efficient investments;
- ✓ Mitigating and reducing the public safety risks from distribution system operations;

- ✓ Meeting CWH's regulatory obligations with respect to customer service, including the obligation to serve customers within the service territory and the obligation to relocate lines when requested by the Regional and Municipal Governments, in conjunction with road widening programs and compliance with Measurement Canada regulations related retail revenue metering;
- ✓ Providing access to connect green energy generation to distribution system through Smart grid development initiatives, improving protection, controls and monitoring of distribution stations and effective use of data provided by smart meters for energy conservation and demand management; and
- ✓ Improving worker safety and productivity and enhancing operating efficiency.

The requests for new customer connections, load increase from existing customers and line relocations from the municipal government are commonly received on relatively short notice throughout the year. Therefore, the proposed investments into the "System Access" category, to meet CWH's regulatory obligations are based on the historic investment levels.

The level of investments and prioritization of the investments into system renewal, aimed at improving supply system reliability and public safety have been determined through an evaluation of the risk as described in detail in the AMP report, attached in Appendix B.

1.4 Outline of Report

The report is organized using the Ontario Energy Board's *Chapter 5 - Consolidated Distribution System Plan Filing Requirements* dated March 28, 2013, included in the Filing Requirements for Electricity Transmission and Distribution Applications (the "Filing Requirements"). The report is organized into four sections, including this introductory section. Section 2 provides an overview of the Distribution System Plan and describes the process employed in its development, i.e. stakeholder consultations, collaboration with municipal/regional governments and transmitters, performance measurements and monitoring metrics. Section 3 describes in detail the asset management process employed to determine the scope of capital investments into asset sustainment and prioritize these investments into various assets. Section 4 documents the overall capital expenditure plan covering system access, system renewal, system service, as well as capital investments into general plant upkeep and investments into provincially mandated programs to facilitate smart grid, CDM and Green Energy connections during the next five

years. Cross references to the Filing Requirements are included in brackets () at all headings/subheadings within this report for ease of reference.

2 Distribution System Plan (5.2)

2.1 Distribution System Plan Overview (5.2.1)

Key elements of the DS Plan that affect its rates proposal, especially prospective business conditions driving the size and mix of capital investments needed to achieve planning objectives (5.2.1 a):

As described previously in Section 1, the capital investments proposed in this distribution plan include investments into each of the four standardized categories: (1) system access; (2) system renewal; (3) system service and (4) general plant. The scope and timing of the investments in each category has been determined by taking into account all information available at the time of preparation of the distribution plan.

System Access:

The proposed investments in the “System Access” category include expenditure required by CWH to meet its regulatory obligations. These investments consist of three main components:

- (i) line extensions to permit new customer connections;
- (ii) line relocations required in conjunction with municipal road widening programs; and
- (iii) investments to maintain revenue meters compliant with regulations.

Although it is difficult to accurately estimate in advance the level of investments needed over the next five years in this category, CWH has used all available information obtained through consultations with the municipal government, local developers and major customers to estimate the required expenditure as accurately as possible. The capital investment level for this category also takes into account the average expenditure in this category during the last five years.

There has not been a significant change in the number of customers served by CWH during the past several years and at the present time, there is no backlog of customers requiring new services within CWH service areas and no significant change is anticipated in the number of new services required from those in the recent previous years. CWH receives only a modest number of requests each year for new services and service upgrades, a trend that is not expected to change in the near term.

Road widening projects undertaken in the municipality occasionally require relocation of some power distribution lines, necessitating capital investments by CWH. There are no known projects requiring line relocations at the present time, but such projects are anticipated to be performed throughout the next five years, when requested by the municipal authorities. Such requests are often received with relatively short notice.

CWH owns approximately 6,800 revenue meters, all of which were changed with smart meters in 2009 and will require resealing in 2019. CWH plans to sample 100 meters in each year of 2016 and 2017 to determine accuracy, and will sample 250 meters in 2018 under Measurement Canada Regulation S-S-05 to acquire an 8-year seal extension. In addition, revenue meters will also be required to replace meters that have failed in service; CWH's historical failure rate of smart meters (revenue meters) is approximately 2% per year.

System Renewal:

CWH engaged METSCO Energy Solutions in 2015 to perform a comprehensive condition assessment of all distribution system assets and develop an asset management plan to mitigate risks associated with in-service failure of assets. The AMP, included in Appendix B, provides detailed results of the asset condition assessment initiative completed in 2015. The scope of capital investments proposed in the "System Renewal" category has been determined with the objective of keeping power supply reliability from deteriorating.

Over the past five years CWH has been systematically planning and implementing investments into asset renewal projects to replace the assets that have reached the end of their useful service life, by prioritizing investments into those assets with the highest impact on reliability and safety when they fail in service. Since the in-service failure of substation assets has the highest impact on reliability and safety, as shown in Table 3, a majority of the asset renewal investments during the past five years have focussed on renewal of substation equipment. The 4 kV and 44 kV switchgear in all of the six stations have been replaced with new switchgear, employing modern protection and control designs.

The power transformers at stations have not been replaced during the station renewal initiative undertaken during the past five years but have all been repainted, with 3 of the heavier loaded transformers equipped with forced air cooling to extend their life. During the condition assessment of stations, the power transformer at Fergus MS-2 was determined to have the lowest health index score. Although the original manufacture date for this transformer is not known with certainty, visual inspections indicate it is one of the oldest transformers on CWH's supply system and presents an elevated risk of failure in service. Therefore, the power transformer at Fergus MS-2 is recommended to be replaced in 2022.

Table 3: Status of Station Renewal Projects

Station ID	Transformer In Service/ Rebuilt Date	Installed Capacity	44 kV Switchgear	4 kV Switchgear with Automatic Reclosers
Fergus MS1	Not Known	5 MVA	Upgraded During past five years	Upgraded During past five years
Fergus MS2	Not Known	5 MVA	Upgraded During past five years	Upgraded During past five years
Fergus MS3	1992	5 MVA	Upgraded During past five years	Upgraded During past five years
Fergus MS4	1989	5 MVA	Upgraded During past five years	Upgraded During past five years
Elora MS1	2014	6/8 MVA	Upgraded During past five years	Upgraded During past five years
Elora MS2	1997	5 MVA	Upgraded During past five years	Upgraded During past five years

Distribution system renewal program also includes replacement of high risk assets on overhead and underground distribution system. By taking into account the service age of overhead lines, results of pole testing and the extent of small conductors (#4 and #6 copper) employed on overhead lines, condition assessment of overhead lines indicates approximately 25% of the lines to be in poor and very poor condition, as detailed in the AMP in Appendix B. On the underground distribution system, with the exception of a small length of cable section, the vast majority of cables are well below their typical useful service life, and only a modest level of investment is required for renewal of underground cables determined to be in poor and very poor condition.

CWH has not had extensive failure issues with distribution transformers, and like most distribution utilities, CWH manages this asset category in form of reactive replacement strategy, i.e. replace transformers upon failure, unless the inspections identify transformers that present safety risks. However, pad mounted distribution transformers installed along some main regional streets, where different types of road salts including liquids that “spray” have been used for snow melting, have experienced excessive corrosion of the metal enclosures of the transformers necessitating rehabilitation or replacement during the next five years. In those cases where the transformer enclosure has experienced excessive corrosion, it is more economical to replace the pad mounted transformer with a new one, rather changing the enclosure.

System Service:

As described previously, for substations, replacing old vintage switchgear with modern SCADA controlled switchgear is proposed under asset renewal. Implementation of the smart grid initiative can be considered a secondary driver for this work. This category also includes investments into replacement and renewal of smart meters (revenue meters) to remain compliant with the regulatory requirements for Measurement Canada.

General Plant:

Capital investments under the “General Plant” category include investments into replacement of components in buildings and facilities and renewal of motor vehicle fleet, tools and equipment and IT hardware and software as they reach the end of their useful service life. These investments are aimed at improving worker productivity, operating efficiency and employee safety.

2.2 Key Benefits of Investments:

The capital investments proposed for the 2017 to 2022 period are expected to yield the following benefits:

- i. The investments into system access category would allow CWH to meet its obligations to serve new customers and relocate lines in public rights-of-way to comply with the requirements of the Distribution Code.
- ii. The investments into system renewal are aimed at reducing the risk of critical assets’ failure in service and help sustain the reliability and safety at acceptable levels. These investments will also help avoid an increase in operating costs by eliminating the increase in extent of emergency repairs upon asset failures.
- iii. The investments into system service are aimed at developing and maintaining smart grid features of the distribution grid, with adequate supply of smart meters compliant with Measurement Canada regulations.
- iv. Investments into General Plant are aimed at improving employee safety and worker productivity by providing safe work environment and modern tools and equipment, as well as maintaining fast response times and high customer service levels.

Sources of cost savings expected to be achieved over the forecast period through good planning and DS Plan execution (5.2.1 b):

The following cost savings have been achieved through good planning and will be achieved through execution of this distribution plan:

- (a) Through careful evaluation of the risks, projects are prioritized to mitigate higher level risks, while deferring the projects with lower level risks. For example, investments into station renewal do not include replacement of power transformers but instead involve life extension of power transformers.
- (b) Investments into system renewal will reduce the number of in-service failure of assets and thus reduce the risk of emergency repair costs from going up.

- (c) Proposed investments into renewal of motor vehicles will help reduce the maintenance and repair costs from rising to uneconomically high levels.
- (d) Proposed investments into renewal of buildings and facilities and IT systems will ensure efficiency of operations and reduce the risk of operating costs from going up.

Period covered by the DS Plan (historical and forecast (5.2.1 c):

This DSP covers the historical period of 2012 to 2016, the current year of 2017 and future investment period from 2018 to 2022.

Vintage of information on investment drivers used to justify investments identified in the application (5.2.1 d):

The plan employs data as of the last quarter of 2016 to support the proposed investment decisions. Asset condition assessment was performed in 2015, using data obtained during September 2015 to December 2015.

Indication of important changes to the distributor's asset management processes (e.g. enhanced asset data quality or scope; improved analytic tools, process refinements; etc.) since the last DS Plan filing (5.2.1 e):

This is the first DSP being submitted by CWH under OEB's new filing requirements and as such line by line comparison of this plan with previous submissions is difficult. The methodology employed to support the level of investments and prioritize the investments into specific project categories represents an improvement from the methodology used in CWH's previous submission to OEB, in the following ways:

- The AMP employs data related to health and condition of assets as of September, 2015, including asset age, results of testing and visual inspections.

Aspects of the DS Plan that relate to or are contingent upon the outcome of ongoing activities or future events, the nature of the activity (e.g. Regional planning process) or event (Board decision, LTLT) and the expected dates by which such outcomes are expected or will be known (5.2.1 f):

None of the investments proposed in the DSP are contingent upon the outcome of ongoing activities or future events. The level of actual investments for system access may slightly deviate year-to-year from the proposed investment levels, depending upon the number of customer requests for new services and line relocates, but such deviations are expected to be minor and the overall expenditure level during the next five years is not expected to be

significantly different from the previous five years, when adjusted for inflation. Since none of the investments involve addressing constraints in the transmission system or upstream distribution system, regional planning process is expected to have no material impacts on this distribution plan and proposed investments.

2.3 Coordinated Planning with Third Parties (5.2.2)

The results of coordinated planning with third parties are documented in this section, by addressing the following questions for each consultation:

- ✓ the purpose of the consultation;
- ✓ whether the distributor initiated the consultation or was invited to participate in it;
- ✓ the other participants in the consultation process;
- ✓ the nature and prospective timing of the final deliverables, that are expected to result from or otherwise be informed by the consultation; and
- ✓ an indication of whether the consultation has or is expected to affect the distributor's DSP as filed and if so, a brief explanation as to how.

2.3.1 Stakeholders Involved

This DSP has been prepared through a coordinated planning process with all major stakeholders. The stakeholders consulted by CWH during preparation of the DSP include:

- customers;
- the regional and municipal governments;
- CDM program partners;
- Ontario Power Authority/IESO;
- the transmission company – Hydro One; and
- the upstream distributor – Hydro One.

2.3.2 Collaboration Process and Conclusions

Description of consultations (5.2.2 a):

i. Customer Engagement

CWH is a member of the Cornerstone Hydro Electric Concepts group (the “CHEC” group). In 2013 and 2014 the LDC members of the CHEC group, including CWH, collectively funded a telephone customer satisfaction survey conducted by a respected 3rd party survey company UtilityPULSE. The survey covered topics in line with customer satisfaction, engagement and loyalty. The CHEC LDC’s collectively achieved an “A” satisfaction score from customer responses.

In February of 2015, CWH conducted information sessions in both Fergus and Elora with afternoon and evening timeslots to accommodate customer’s busy schedules. These sessions were advertised on the local radio and newspaper but unfortunately, they were very poorly attended. The few customers that did attend were not interested in completing a short questionnaire /survey.

CWH also attended the Centre Wellington Spring Home show for 3 days in May of 2016 and enjoyed some attention at its booth. At this event staff successfully signed customers up for the Peak Saver Plus Program, assisted customers to set up a user account for Customer Connect (CWH’s web based meter data presentment and reporting tool) and educated the public about CDM programs and safety topics.

CWH held a residential and small commercial customer open house in Oct 2016 at its Gartshore Street administration and service centre. The purpose of this event was to invite customers to our work centre for them to see firsthand our operations both in the office and shop and to interact first hand with employees and to present them with information in regards to our upcoming Cost of Service application. Attendees were given a lot of attention in whichever area they were interested i.e. electricity usage presentment (customer connect), Conservation programs, safety and outside operations (bucket rides were available), and rates and rate setting. A report of the event can be found in CWH’s 2018 CoS, Exhibit 1 within the section Customer Engagement.

CWH conducted a customer satisfaction survey in 2017 through an independent survey company, Redhead Media Solutions (Redhead), in compliance with the 2016 reporting requirements; the survey results are in CWH’s 2018 CoS, Exhibit 1 within the section Customer Engagement.

CWH held a Commercial and Industrial consultation meeting for GS>50 class customers, to discuss CWH’s rate application and plans as well as CDM offerings for Customers on February 22, 2017. This meeting was well attended with 25% of the customers in this class being represented. The agenda included such topics as future projects, rates and rate planning and

conservation programs and education. Redhead was present to record the meetings events including questions and answers and conducted a short survey. Redhead's report is in CWH's 2018 CoS, Exhibit 1, within the section Customer Engagement.

ii. Municipal Government Consultations

CWH interacts with the Townships' planning departments in its service territory to coordinate infrastructure planning and the connection of customers in a timely fashion. The coordination meetings are generally initiated by Township administration and CWH along with other utilities participate in them. A list of the Townships 10-Year Capital Forecast projects are provided however specific details about these projects are rarely available and therefore scheduling and/or budgeting the projects is not a feasible deliverable from the coordination meetings. The awareness of what projects are on the 10-Year Capital horizon provides the opportunity to familiarize with the project area and coordinate preliminary infrastructure plans.

The meetings with municipal government do not generally have a direct effect on the DSP investment level as a historical average is used to calculate the expenditure level for system access. Within the current 5 year forecast nothing arose out of the meetings that would have a direct effect on projected investment levels.

iii. Consultations with CDM Program Partners

On the CDM Portfolio a long history exists of CWH working in collaboration with local distribution companies (LDCs) that are members of the CHEC. The CHEC LDCs recognized that working together would expedite program delivery and assist to maintain cost effective delivery of programs.

Over the most recent CDM Framework – 2011 to 2014 CWH worked closely with CHEC to obtain service providers and support for program delivery. Group RFP's were utilized along with project management support to support CWH's staff efforts with CDM. Further, as a collaborative effort, a Roving Energy Manager was obtained to support customers of CHEC LDCs on the more involved conservation initiatives. Both the peak and energy targets for this framework were exceeded over the course of the program delivery.

In addition to collaborating with CHEC and the Member LDCs, the combined effort of the Association ensured consistent dialogue with the Ontario Power Association (now the Independent Electricity System Operator (IESO)) in program development, monitoring and reporting. CWH's ability to provide input to the IESO and confer with LDCs with regards to program delivery assisted in the continued development of the CDM portfolio.

Within the Conservation First Framework (CFF) CWH continues to work closely with CHEC. CWH along with 6 other LDCs has filed a combined CDM Plan for the CFF. The CDM Plan development was a result of consultation with CHEC Members, review of historical performance and consideration of the IESO Achievable Potential Study. In addition, CWH's close relationship with customers within the service territory informed the on-going opportunities for conservation over the 2015 to 2020 period. These informal consultations extend across the scope of customers including; local government, institution, retail, residential and large and small commercial/industrial customers. The programs continue to be supported by the CHEC Roving Energy Manager.

In preparation of the CFF, request for proposals were prepared in late 2015 for application evaluation and program delivery support. One combined contract has been awarded with two others to follow later in 2016. Over 2015 CWH reached 15% of the energy targets set for the CFF. This is an excellent start to the new framework and customer contact and interest in further involvement in the programs appears high.

The collaborative approach demonstrated by CWH extends to neighbouring LDCs which may not be in the CHEC. Opportunities to participate and share with other LDCs are pursued where they are seen as being beneficial.

CDM, while seen as a separate portfolio, impacts on planning at the LDC and local level. The results achieved within the CDM portfolio along with the anticipated results are provided for future planning on load growth and customer impacts.

CWH will offer a full range of provincial programs in the service territory and continue collaboratively both with CHEC and other LDCs in an effort to develop new programs at the LDC and/or regional level.

CWH has a close relationship with its customers, has been active in community events and networking opportunities within the community. These activities provide excellent vehicles to share program information, obtain input from the customers and tailor delivery methods to meet local needs.

iv. IESO Consultations

In addition to the consultations with IESO related to Ontario CDM program, CWH is also in communication with IESO in relation to Micro-FIT and FIT connection applications from developers of renewable generation wishing to connect to CWH's distribution system. A copy of this DSP has been provided to IESO.

v. Consultations with the Transmitter (Hydro One)

In the context of Regional Infrastructure Planning CWH belongs to the “Kitchener-Waterloo-Cambridge-Guelph Region”, which covers the cities of Kitchener, Waterloo, Cambridge and Guelph, portions of Oxford and Wellington counties and the townships of North Dumfries, Puslinch, Woolwich, Wellesley and Wilmot. Hydro One Networks Inc. (HONI) is the lead transmitter and primarily responsible for steering the planning in this region.

In response to the Ontario Energy Board's (OEB) Regional Infrastructure Planning process approved in August 2013, regional infrastructure planning was completed by HONI in 2015 with input of all stakeholders on March 20, 2015. CWH participated in the planning process and provided required data to HONI. A copy of the Regional Infrastructure Planning report is attached in Appendix D.

The near-term and mid-term investment needs for the region, identified in the regional planning report are summarized below in Table 4.

Table 4: KWCG Region Near and Mid-term Investment Needs

No.	Project	In-Service Date	Cost
1	Guelph Area Transmission Reinforcement	May 2016	\$95 M
2	Arlen MTS: Install Series reactors	May 2016	\$0.95 M
3	M20D/M21D – Install 230 kV In-line Switches	May 2017	\$6 M
4	Waterloo North Hydro: MTS #4	2024	TBD

None of the investments indicated in Table 4 are related to the transmission system supplying the CWH service territory. The regional planning report concludes the existing infrastructure adequately meets the needs of CWH's service territory in the short term and in the medium term.

vi. **Consultations with the Upstream Distributor (Hydro One)**

CWH regularly communicates with the upstream distributor HONI, into whose 44 kV network, CWH's 44 kV feeders are embedded. Table 5 summarizes the load forecast information for CWH service territory which has been provided to HONI during recent consultations.

Table 5: Load Forecast for CWH Service Territory Provided to Hydro One

[illegible]

Regional Planning Process (5.2.2 b):

As noted above, the regional planning process was successfully completed in 2015. CWH participated in the process. The system planning concluded that the existing transmission infrastructure supplying CWH service territory will adequately meet the needs of CWH service territory for the next 10 years.

IESO Comment Letter (5.2.2 c):

A copy of this DSP has been submitted to the IESO and the comment letter is attached as Appendix C.

2.4 Performance Measurement for Continuous Improvement (5.2.3)

In order to continually improve its operating performance, CWH continually measures and monitors its performance through the following performance indicators:

- (a) Supply system reliability indicators;
- (b) Customer service quality indicators;
- (c) Planning quality indicators;
- (d) Operating efficiency indicators;
- (e) Financial performance indicators; and
- (f) CDM program targets and performance.

The metrics and methods for measurement of each of the above indicated performance indicators are described below, along with CWH's actual performance during the recent past years and how the performance trend has affected this distribution plan.

2.4.1 Supply System Reliability Indicators

For supply system reliability, the key performance indicators include System Average Interruption Duration Index ("SAIDI") and System Average Interruption Frequency Index ("SAIFI").

(a) System Average Interruption Duration Index ("SAIDI")

SAIDI is an index of system reliability that expresses the average duration, per reporting period, over which supply to a customer is interrupted. It is determined by dividing the total customer hours of interruptions into average number of customers served.

In Figure 3:, SAIDI values are shown, by excluding the interruptions caused by the loss of incoming power supply from HONI transmission system, during the past five years. With the exception of a sharp increase in SAIDI in 2013 (which was the result of a major ice storm in 2013); there has been a steady and continuous improvement in SAIDI in CWH's service territory, largely as a result of investments in substation automation.

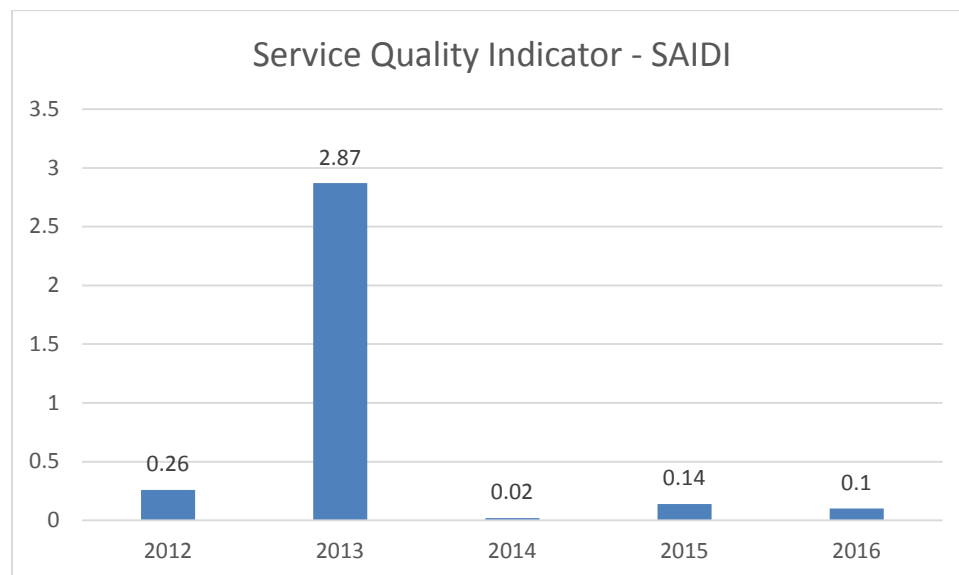


Figure 3: Historic SAIDI Performance

(b) System Average Interruption Frequency Index ("SAIFI")

SAIFI is an index of the distribution system reliability that expresses the number of times per reporting period that the supply to an average customer is interrupted. It is determined by dividing the total number of customer interruptions over a year into the average number of customers served. Figure 4: shows the SAIFI performance for CWH during the past five years, by excluding the power interruptions caused by the loss of incoming power supply from HONI transmission system. The chart indicates steady improvements in SAIFI resulting from investments into automation.

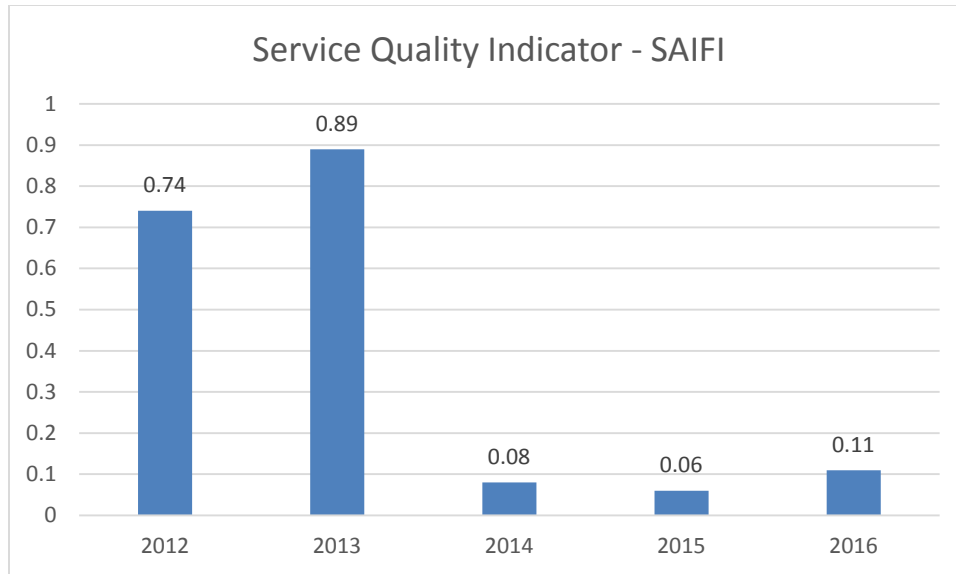


Figure 4: Historic SAIFI Performance

CWH's target is to maintain SAIDI (by excluding incoming supply failure events) below 1.5 and SAIFI (by excluding incoming supply failure events) below 1.0. To achieve this goal this DSP includes investments into system renewal, which are targeted into assets determined to be in "poor" or "very poor" condition during condition assessment of the assets; as well as investments into preventative maintenance to reduce the risk of assets failing in service. The DSP also includes investments for renewal of motor vehicles and equipment as well as hardware and software to improve the response time to power interruptions, when they do occur.

2.4.2 Customer Service Quality Measures

The Distribution System Code sets the minimum service quality requirements that a distributor must meet in carrying out its obligations to distribute electricity under its license and the Energy Competition Act, 1998. As required by OEB, CWH records and submits performance measures which are compared with OEB established levels to evaluate CWH's performance in appointment scheduling, service accessibility, emergency response, etc.

✓ Telephone Accessibility

The OEB requires that qualified incoming calls to the distributor's customer care telephone number must be answered within the 30-seconds time period established as below:

- For qualified incoming calls that are transferred from the distributor's IVR system, the 30 seconds shall be counted from the time the customer selects to speak to a customer service representative.
- In all other cases, the 30 seconds shall be counted from the first ring.

Mandated by OEB, this service quality requirement must be met at least 65 percent of the time on a yearly basis.

✓ **Response Time To Emergencies**

The OEB requires that emergency calls must be responded to within 120 minutes in rural areas and within 60 minutes in urban areas. This service quality requirement must be met at least 80 percent of the time on a yearly basis.

✓ **Connection of New Services**

The OEB sets out the following requirements on connection of new services in the DSC:

- A connection for a new service request for a low voltage (<750 volts) service must be completed within 5 business days from the day on which all applicable service conditions are satisfied, or at such later date as agreed to by the customer and distributor.
- A connection for a new service request for a high voltage (>750 volts) service must be completed within 10 business days from the day on which all applicable service conditions are satisfied, or at such later date as agreed to by the customer and distributor.

Mandated by OEB, this service quality requirement must be met at least 90 percent of the time on a yearly basis.

CWH's historic performance on service quality measures from 2011 to 2015 is summarized in Table 6.

Table 6: Service Quality Indicators - Historic Performance

Metric	Target	2012	2013	2014	2015	2016
New connections connected on time	90%	100.0%	100.0%	96.6%	97.9%	99.3%
Appointment Scheduling	90%	99.1%	98.3%	94.6%	98.9%	99.0%
Scheduled appointments met on time	90%	97.6%	99.4%	91.7%	97.6%	98.9%
Telephone calls answered on time	65%	99.8%	99.9%	99.7%	99.6%	98.6%
On time written response	80%	100.0%	100.0%	99.6%	100.0%	100.0%
On time response to emergencies	80%	97.1%	100.0%	100.0%	100.0%	100.0%
On time response for Reconnections	85%	100.0%	100.0%	100.0%	100.0%	97.5%
Billing accuracy	98%	NA	NA	99.99%	99.98%	99.99%

During each of the last five years, CWH has met or exceeded the requirements prescribed by OEB for each of the customer service quality indicator listed in Table 6 and no investments are proposed in the DSP to further improve these service quality indicators.

2.4.3 Planning Quality Indicators

Table 7 shows the program level variance in CWH's actual expenditure from its planned expenditure. As indicated for both the capital expenditure (CAPEX) as well as the operating, maintenance and administrative expenditure (OM&A), the mean variance over the past five years is approximately 2%. The actual level of OM&A expenditure is impacted to some degree by unplanned expenditure to replace asset failures due to inclement weather, so there would always be some variance in actual expenditure from planned, however on an annual basis the variance level in OM&A expenditure during any of the past five years was 7% or less.

Table 7: Planning Quality Indicators - Historic Performance

		2012	2013	2014	2015	2016	5-year Average
Capital Expenditure	Budget	\$ 2,173,500	\$ 1,876,400	\$ 2,346,500	\$ 2,034,700	\$ 2,050,700	\$ 2,096,360
	Actual	\$ 2,009,227	\$ 3,563,699	\$ 2,398,195	\$ 1,870,376	\$ 2,132,797	\$ 2,394,858.79
	% Variation	-8%	90%	2%	-8%	4%	14%
OM&A Expenditure	Budget	\$ 2,022,400	\$ 2,077,580	\$ 2,121,965	\$ 2,073,300	\$ 2,131,600	\$ 2,085,369
	Actual	\$ 2,157,178	\$ 2,018,522	\$ 1,991,553	\$ 2,026,375	\$ 2,075,153	\$ 2,053,756
	% Variation	7%	-3%	-6%	-2%	-2%	-2%

In the case of CAPEX, during one of the past five years, the variance has exceeded the target level of 10% during 2013. The capital budget spending for 2013 was projected to be \$1,876,400, and the actual capital expenditures for that year was a total of \$3,563,699 or a difference of \$1,687,299. The overspending for the budget year of 2013 was primarily due to

the transfer of capital costs associated with the Smart Meter deployment from 1555-Smart Meter Capital and Recovery Offset variance account into capital in that year.

Moving forward, CWH is in the process of implementing two new initiatives that will allow for more effective planning and continuous improvement in relation to estimate creation and resource availability on all construction jobs. The first initiative will involve annual review and updating of the implementation of projects included in the DSP to help ensure that the projects included in the DSP are being implemented in accordance with the schedule. The second initiative will involve a detailed review of all budgeted projects above the materiality threshold of \$50K. For each project, an accurate estimate will be prepared prior to the work order being written to issue the project for construction and compared against the estimate approved as part of the budget. Variances, if any, will be thoroughly examined. Upon construction completion a second variance analysis will be conducted to compare the work order estimate against actual costs including labour hours, materials and contracted services used. This step will not only improve accuracy of future work orders, but it will also bring attention to any productivity related issues. This variance analysis process will result in improved project planning and project management.

2.4.4 Operating Efficiency Indicators

As part of the OEB scorecard, CWH records the following metrics to measure and monitor the efficiency of its operations:

- ✓ Operating efficiency
- ✓ Public Safety

CWH's performance, measured through each of these metrics is indicated below:

Operating efficiency and effectiveness of cost control is measured through two normalized indices: Total cost per km of line and total cost per customer. Total cost per km of line and per customer for CWH service territory are indicated in Figure 5 and Figure 6 respectively. For the reporting period, CWH's actual operating costs fall within +/-10% of the predicted costs.

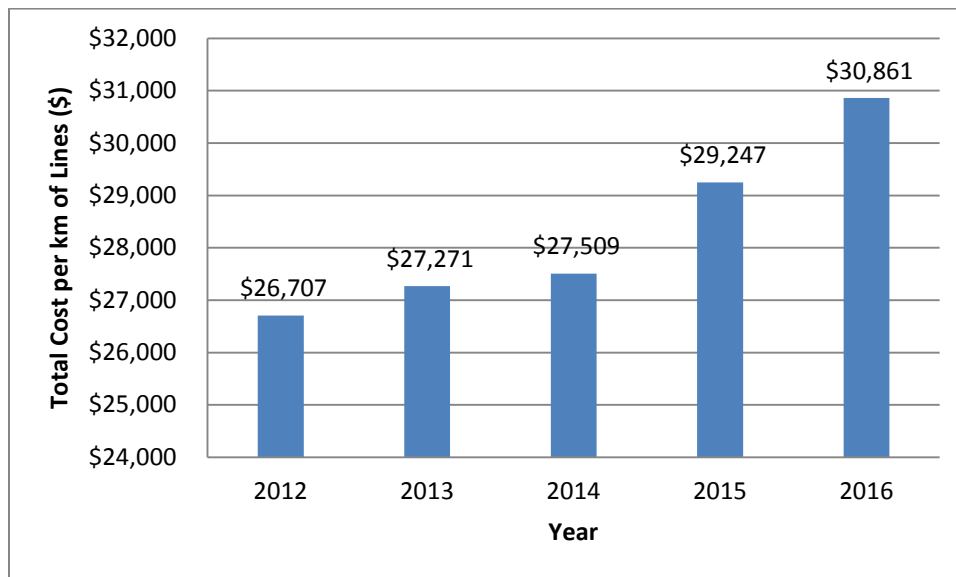


Figure 5: Operating Efficiency - Total Cost per km of Line

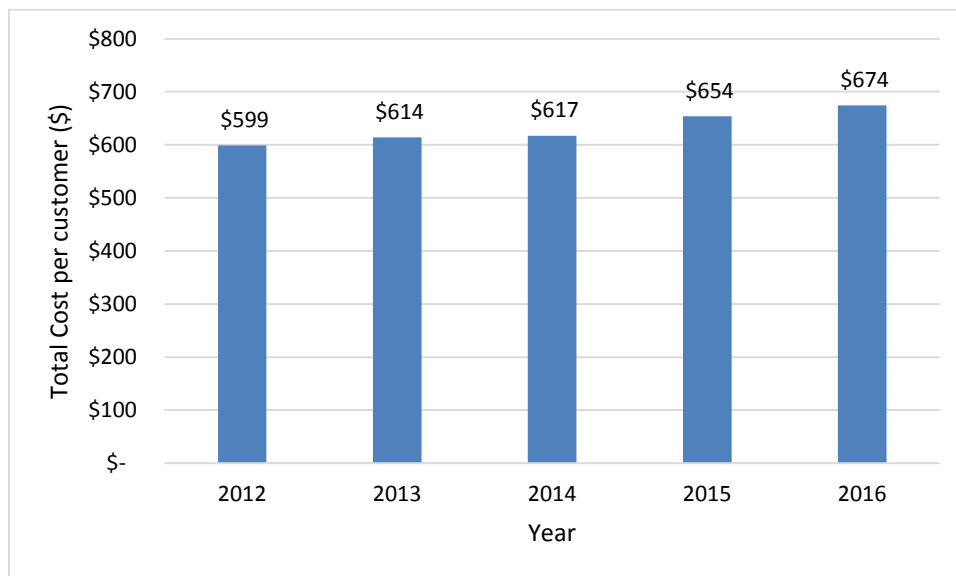


Figure 6: Operating Efficiency - Total Cost per Customer

At the time of filing this DSP the OEB's annual yearbook for 2016 statistics was not published. CWH calculated the "Cost per km of line" and "Cost per customer," based on the PEG report.

Electricity Distributor's performance on public safety record is measured based on:

- ✓ Level of Public Awareness of Electrical Safety within the LDC service territory;
- ✓ Compliance with Ontario Regulation 22-04 - Audit Results; and
- ✓ Number of serious safety incidents

CWH's performance on each of these measures during the past five years is indicated in Table 8 below:

Table 8: Service Quality Indicators - Historic Performance

Metric	Target	2011	2012	2013	2014	2015
Level of Public Awareness of Electrical Safety		NA	NA	NA	NA	84.10%
Compliance with Regulation 22-04		NC	C	C	C	C
Number of serious safety incidents		0	0	0	0	0

At the time of printing this DSP CWH did not have the above information for 2016, and therefore used 2011-2015 to still provide 5 years of historical data.

The investments in this DSP have been prudently prioritized to minimize potential increases in operating costs during the next five years. Investments into asset renewal are targeted to prevent failure of assets in service, which will ensure public safety is not compromised.

2.4.5 Financial Performance Indicators

This section summarizes CWH's financial performance during the past five years, based on the OEB specified metrics. As indicated by these metrics, CWH's financial performance meets or exceeds the performance level expected of a prudently managed public sector business organization.

CWH's Current Ratio, which is an indication of its ability to pay its short-term debts and financial obligations, is shown in Figure 7. Typically, a current ratio between 1 and 1.5 is considered good and higher values of current ratio indicate greater financial stability for a corporation.

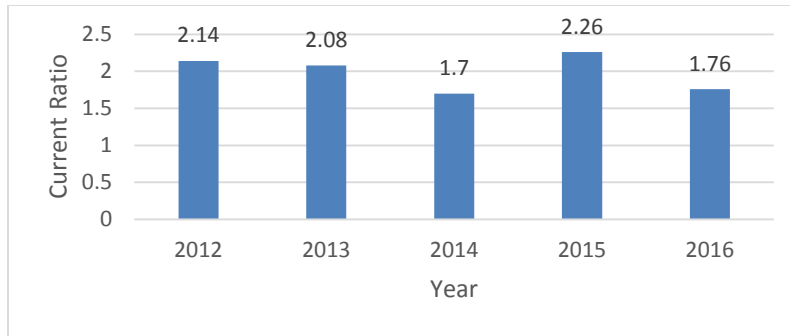


Figure 7: Current Ratio

The Debt to Equity ratio indicates the relative proportion of shareholders' equity and debt used to finance a company's assets. The OEB uses a capital structure with debt to equity ratio of 1.5 (60 debt :40 equity) for local distribution companies. As shown in Figure 8, CWH had a debt to equity ratio of 1.13 which is significantly less than 1.5 and an indication of a financially sound capital structure.

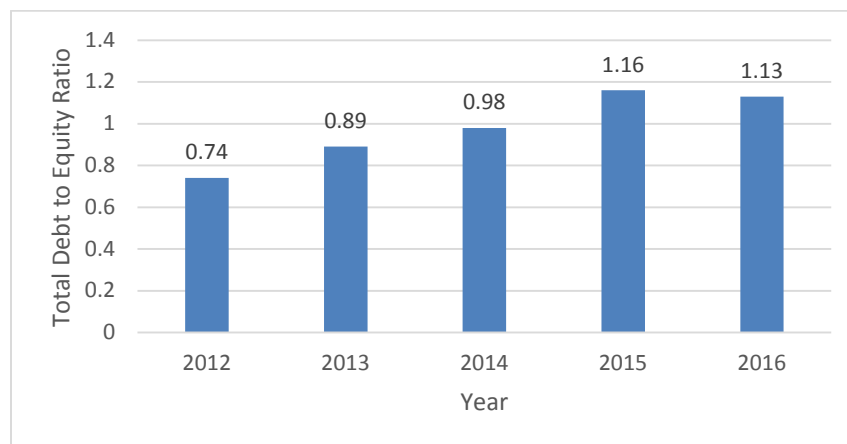


Figure 8: Total Debt to Equity Ratio

Return on Equity measures the rate of return on shareholder equity and is an indication of an organization's profitability. CWH's distribution rates are approved by the OEB and include an expected (deemed) regulatory return on equity of 8.98%. The OEB allows a distributor to earn within +/- 3% of the expected return on equity. As shown in Figure 9, CWH achieved a ROE within the OEB prescribed range, with the exception of 2016 and 2012. It is anticipated CWH's ROE will fall within the +/-3% range during the foreseeable future.

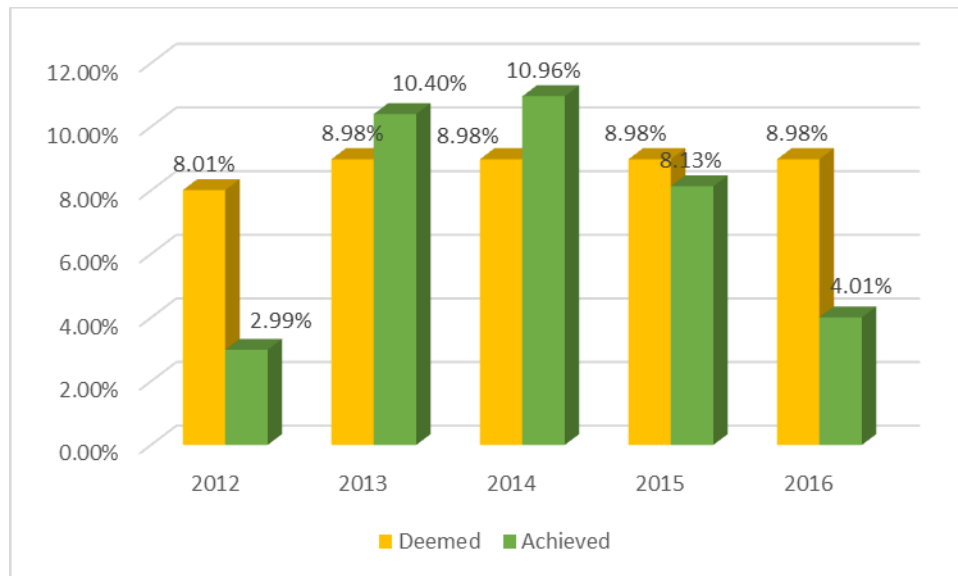


Figure 9: Regulatory Return on Equity

CWH's past financial performance did not have any impact on the capital investments proposed in this DSP.

2.4.6 Energy Conservation and Demand Management (CDM)

CWH has developed and implemented an energy conservation and demand management (CDM) strategy, which is aligned with the province's CDM program. Tables 9 and 10, respectively, show CWH's progress during 2011 to 2014, with respect to the peak demand savings and energy savings, under various CDM program components. The performance levels achieved by CWH in relation to the targets for peak demand savings and energy conservation are shown in Figure 10 and Figure 11, and as indicated, CWH has met or exceeded its CDM targets during this period.

The conservation and demand management initiatives implemented by CWH under the CDM program administered by the IESO have resulted in a reduction in energy use and overall peak demand. Partly due to this program and partly due to slow growth within CWH's service territory, no capacity constraints are anticipated in the distribution system during the five year period covered by this DSP and no investments are proposed to mitigate capacity constraints in the distribution system.

Table 9: Net Incremental Peak Demand Savings Quarterly Achievements (kW)

Year	Consumer Program	Business Program	Industrial Program	Home Assistance Program	Pre-2011 Programs	Other	Adjustment	IESO-Contracted LDC Profolio Total (Inc. Adjustment)
2011	53	62	0	0	115	0	0	229
2012	40	207	0	0	0	0	33	280
2013	40	164	484	1	0	0	3	692
2014	108	278	546	0	0	68	31	1,030

Table 10: Net Incremental Energy Savings Quarterly Achievements (kWh)

Year	Consumer Program	Business Program	Industrial Program	Home Assistance Program	Pre-2011 Programs	Other	Adjustment	IESO-Contracted LDC Profolio Total (Inc. Adjustment)
2011	174,514	137,122	0	0	662,941	0	0	974,577
2012	123,142	665,102	0	0	124	0	268,979	1,057,347
2013	104,315	548,757	11,025	14,298	0	0	9,676	689,071
2014	272,050	1,542,889	0	125	0	0	166,440	1,987,504

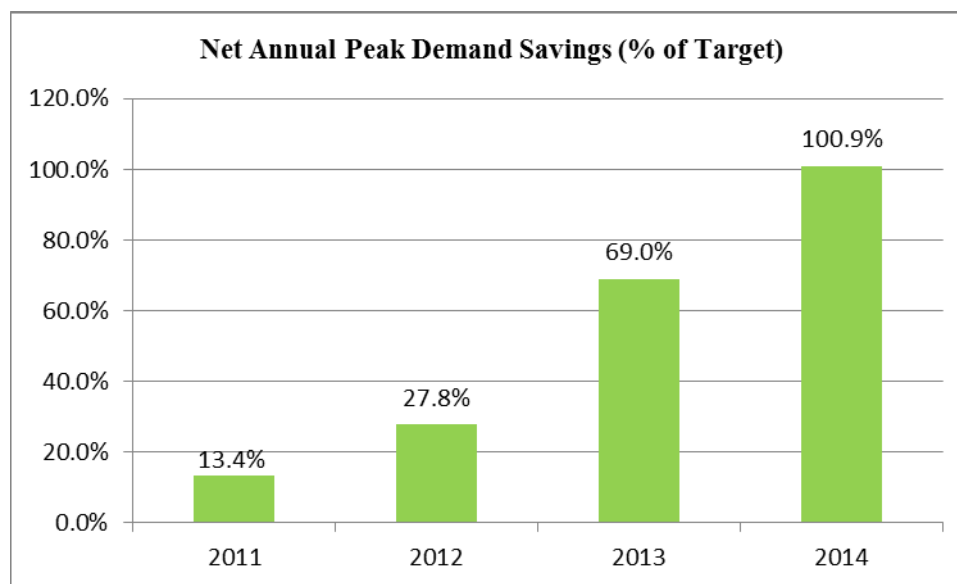


Figure 10: CDM Performance –Net Annual Peak Demand Savings vs Target

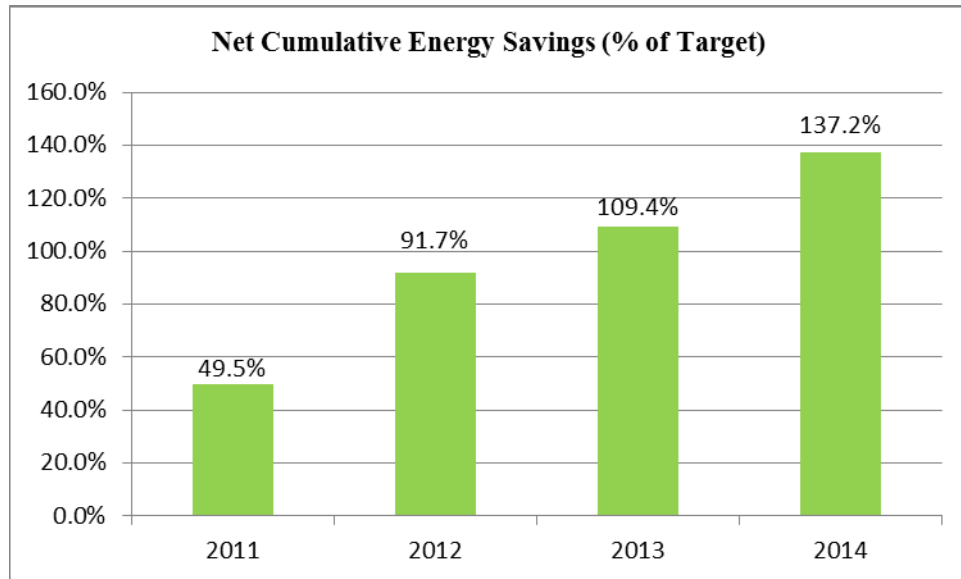


Figure 11: CDM Performance – Cumulative Net Peak Demand Savings vs Target

IESO verified energy and demand savings for CWH's service territory for 2015 are summarized in Table 11 and Table 12, respectively.

Table 11: IESO Verified Net Energy Savings in CWH Service Area

Final 2015 Annual Verified Results - Annual Persistence Report		
Net Verified Annual Energy Savings, at the End-User Level		
For: Centre Wellington Hydro Ltd.		
#	Program	2015
Legacy Framework		
1	Coupon Initiative	56,404
2	Bi-Annual Retailer Event Initiative	104,202
3	Appliance Retirement Initiative	17,118
4	HVAC Incentives Initiative	93,268
6	Energy Audit Initiative	71,271
7	Efficiency: Equipment Replacement Incentive Initiative	1,217,787
8	Direct Install Lighting and Water Heating Initiative	143,587
14	Low Income Initiative	17,069
Conservation First Framework		
21	Save on Energy Coupon Program	0
22	Save on Energy Heating and Cooling Program	0
23	Save on Energy Home Assistance Program	0
24	Save on Energy Audit Funding Program	0
25	Save on Energy Retrofit Program	0
Total		1,720,706

Table 12: IESO Verified Net Peak Demand Savings in CWH Service Area

Final 2015 Annual Verified Results - Annual Persistence Report		
Net Verified Annual Demand Savings, at the End-User Level (kW)		
For: Centre Wellington Hydro Ltd.		
#	Program	2015
Legacy Framework		
1	Coupon Initiative	4
2	Bi-Annual Retailer Event Initiative	7
3	Appliance Retirement Initiative	3
4	HVAC Incentives Initiative	49
6	Energy Audit Initiative	15
7	Efficiency: Equipment Replacement Incentive Initiative	122
8	Direct Install Lighting and Water Heating Initiative	32
14	Low Income Initiative	1
Conservation First Framework		
21	Save on Energy Coupon Program	0
22	Save on Energy Heating and Cooling Program	0
23	Save on Energy Home Assistance Program	0
24	Save on Energy Audit Funding Program	0
25	Save on Energy Retrofit Program	0
Total		233

CWH's past performance on this metric did not have any impact on the investments proposed in this DSP.

3 Asset Management Process (5.3)

This section describes in detail CWH's asset management process and the direct links between the asset management process and the expenditure decisions that comprise the capital investment plan covered by this Distribution System Plan.

3.1 Asset Management Process Overview (5.3.1)

Description of asset management objectives, relationship to corporate goals and how distributor ranks asset management objectives for the purpose of prioritizing investments (5.3.1 a):

In developing and implementing the asset management plan CWH's overarching objective is to distribute electricity safely and reliably with highest operating efficiency to maintain low distribution rates and provide the shareholders the full regulated return on equity.

The key objectives on which the asset management plan is based complete with their ranking on a scale of 5 to 1 (5 being the highest) in prioritizing investments is indicated below:

- | | | |
|---|--|-------------|
| ✓ | Maintaining public and employee safety | - Ranking 5 |
| ✓ | Maintaining reliability commensurate with customer needs | - Ranking 5 |
| ✓ | Providing customer service quality to satisfy customer needs | - Ranking 5 |
| ✓ | Controlling costs - minimizing asset life cycle costs | - Ranking 4 |
| ✓ | Minimizing risk of in-service failures | - Ranking 4 |
| ✓ | Minimizing environmental risks, | - Ranking 4 |
| ✓ | Aligning the DSP with regional planning objectives | - Ranking 3 |
| ✓ | Facilitating new renewable generation connections; | - Ranking 3 |
| ✓ | Facilitating the smart grid development | - Ranking 2 |

Decisions involving investment into fixed assets play a major role in determining the optimal performance of distribution system fixed assets. Investments that are either oversized or made too far in advance of the actual system need may result in non-optimal operation. On the other hand, investments not made on time when warranted by system needs raise the risk of performance targets not being achieved and contribute to sub-optimal operation. Optimal operation of the distribution system is achieved when "right sized" investments into renewal and replacement (capital investments) and into asset repair, rehabilitation and preventative maintenance are planned and implemented based on a "just-in-time" approach. In summary, the overarching objective of the Asset Management Strategy is to find the right balance between capital investments in new infrastructure and operating and maintenance costs so that the combined total cost over the life of the asset is minimized.

Investment Prioritization Process Flow Chart:

Figure 12 summarizes the flow chart used to sift through and objectively identify the assets that present the highest risk of in-service failures so that investments can be targeted to assets that present the highest risk.

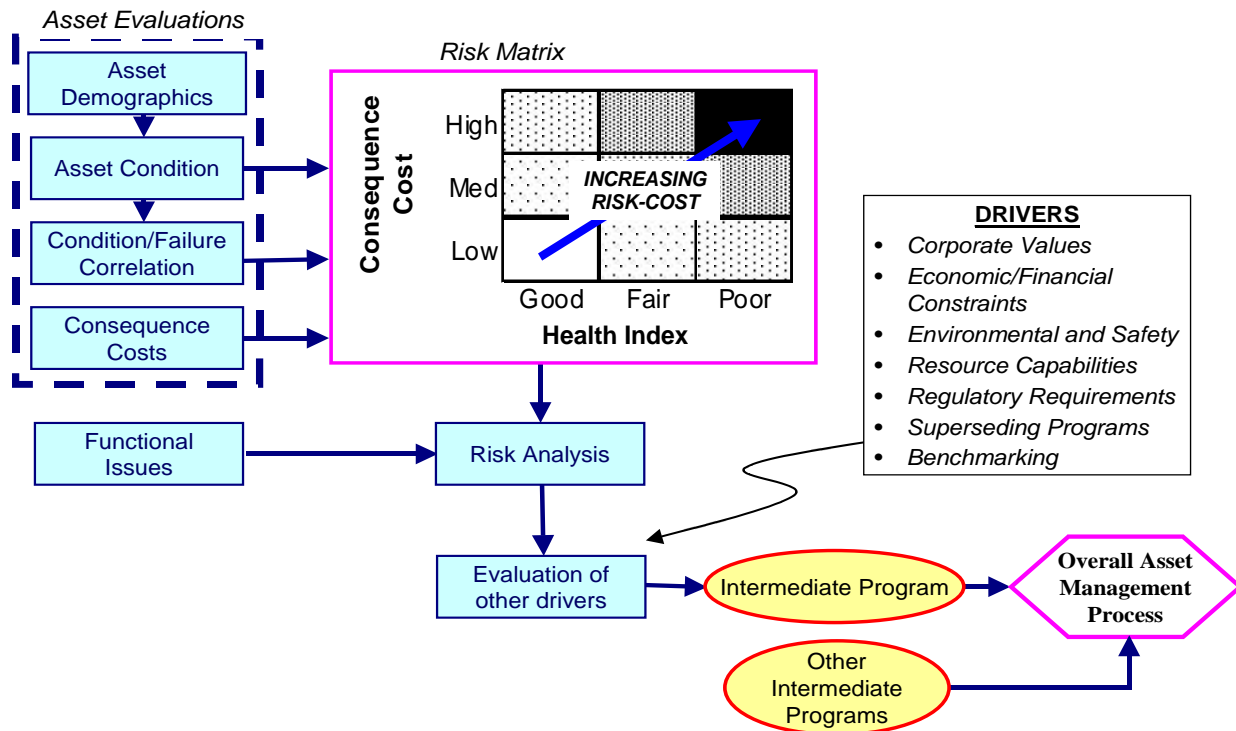


Figure 12:: Flow Chart for Asset Management Plan

Data Sets:

The data sets employed in prioritization of the investments include:

- Asset registers, station single line diagrams and operating maps, indicating line lengths, conductor sizes, equipment ratings and service age of assets
- Station peak loading data, indicating equipment capacities and maximum load
- Equipment inspection data sets, indicating operating condition of distribution system assets, and
- Substation test result data sets

e) AMP (attached at Appendix B)

Process Description:

The asset management process employed for prioritization of investments is described in detail in Appendix B and is briefly summarized below.

Using asset demographic information from CWH's data sets as an input, service age profiles were developed for all categories of distribution system assets, including distribution stations, overhead distribution system and underground distribution system. Anticipated loading levels for distribution stations during the next five years were compared with the station ratings to identify distribution system constraints. Results of physical inspections of distribution system performed by CWH staff were reviewed and supplemented by additional inspections of high risk assets performed by a third-party Professional Engineer. By taking into account asset demographic information and results of physical inspections and in-situ testing the condition of each major asset in service was assessed. Numeric health indices, normalized to a scale of 100, were used to express the health and condition of assets; this procedure allowed separation of the assets in "very good", "good" and "fair" condition that require minimal risk mitigation from those in "poor" and "very poor" condition, as illustrated in Figure 13.

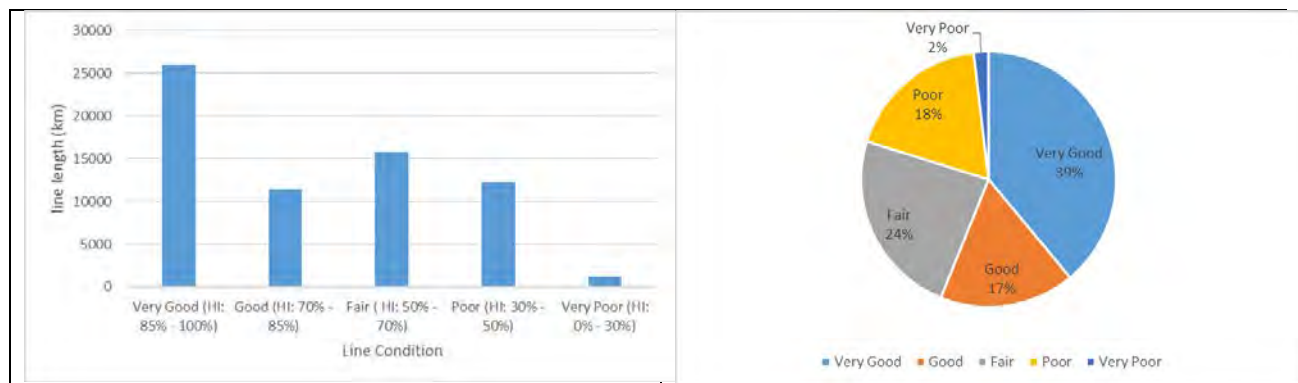


Figure 13: Identification of Assets with Higher Risk of Failure

For assets determined to be in poor or very poor condition, consequences of asset failures were assessed and assets with highest consequence of failure were identified. For assets posing the highest risk, the optimal scope and timing of intervention for risk mitigation was identified, by using the life cycle cost minimization strategy, described in Section 3.3, while capping the total expenditure at affordable levels, as indicated in Section 4.

3.2 Overview of Assets Managed (5.3.2)

Description/explanation of features of the distribution service area pertinent for asset management purposes (5.3.2 a):

CWH's service territory consists of two non-contiguous land parcels, serving the Town of Fergus and Village of Elora, covering a total service area of approximately 10 sq. km. The economic growth in the region is slow. The climate is typical of most towns in Ontario and reaches temperature extremes of -40°C during winter. The region is vulnerable to strong wind storms and ice storms. CWH's distribution system area can be considered predominantly urban. None of the above mentioned features are expected to change over the forecast period and should not impact the DSP.

Description of system configuration (5.3.2 b):

CWH owns and operates two distinct distribution networks, one in the Town of Fergus and a second in the Village of Elora. Both distribution networks receive power from Hydro One at 44 kV, which is stepped down to 4.16 kV at six distribution stations, four of which are located in town of Fergus and the remaining two are located in village of Elora.

Table 13 summarizes the station ratings and historic load levels for each of the stations. All stations receive power from 44 kV lines, embedded into the Hydro One 44 kV system. As shown, four of the municipal stations supply 4.16 kV feeders serving the town of Fergus and two of the municipal stations supply 4.16 kV feeders serving the town of Elora. System operating maps for each of the substations are documented in Appendix A.

Table 13: CWH Municipal Station Ratings

Station ID	Installed Capacity	Number of 4 kV Feeders
Fergus MS1	5 MVA	3
Fergus MS2	5 MVA	3
Fergus MS3	5 MVA	3
Fergus MS4	5 MVA	3
Fergus Total	20 MVA	12
Elora MS1	6/8 MVA	3
Elora MS2	5 MVA	3
Elora Total	11/13 MVA	6

As shown in Table 14, the 44 kV distribution system is predominantly overhead, while the 4.16 kV system consists of both overhead and underground circuits. CWH's distribution system consists of approximately 91 km of overhead lines and approximately 70 km of underground lines. An operating diagram for the 4.16 kV distribution system in the town of Fergus and village of Elora is provided in Figure 14 and Figure 15, respectively.

Table 14: Length of Overhead Lines and Underground Cable Circuits

Overhead Line Circuit Length (m)		
	4.16 kV	44 kV
1 Phase	12,574	-
3 Phase	43,893	25,070

Underground Cable Length (m)		
	4.16 kV	44 kV
1 Phase	64,687	-
3 Phase	5,303	400

The 44 kV supply lines to stations employ 556 kcmil and 336 kcmil aluminum conductor. On 4 kV feeders, the trunk lines on three phase circuits generally employ 336 kcmil aluminum and smaller conductor sizes are employed on branch circuits. It is noteworthy that there are single phase lines that employ #4 and #6 AWG solid copper conductors. These small conductors, particularly when they approach the end of their typical service life, are known to fail in service under mechanical stress and present a safety hazard.

The 4.16 kV distribution voltage is further stepped down to utilization voltages of 120/240V, 120/208V or 347/600V through approximately 830 distribution transformers. The distribution system is monitored through a control centre located in its office at Fergus.

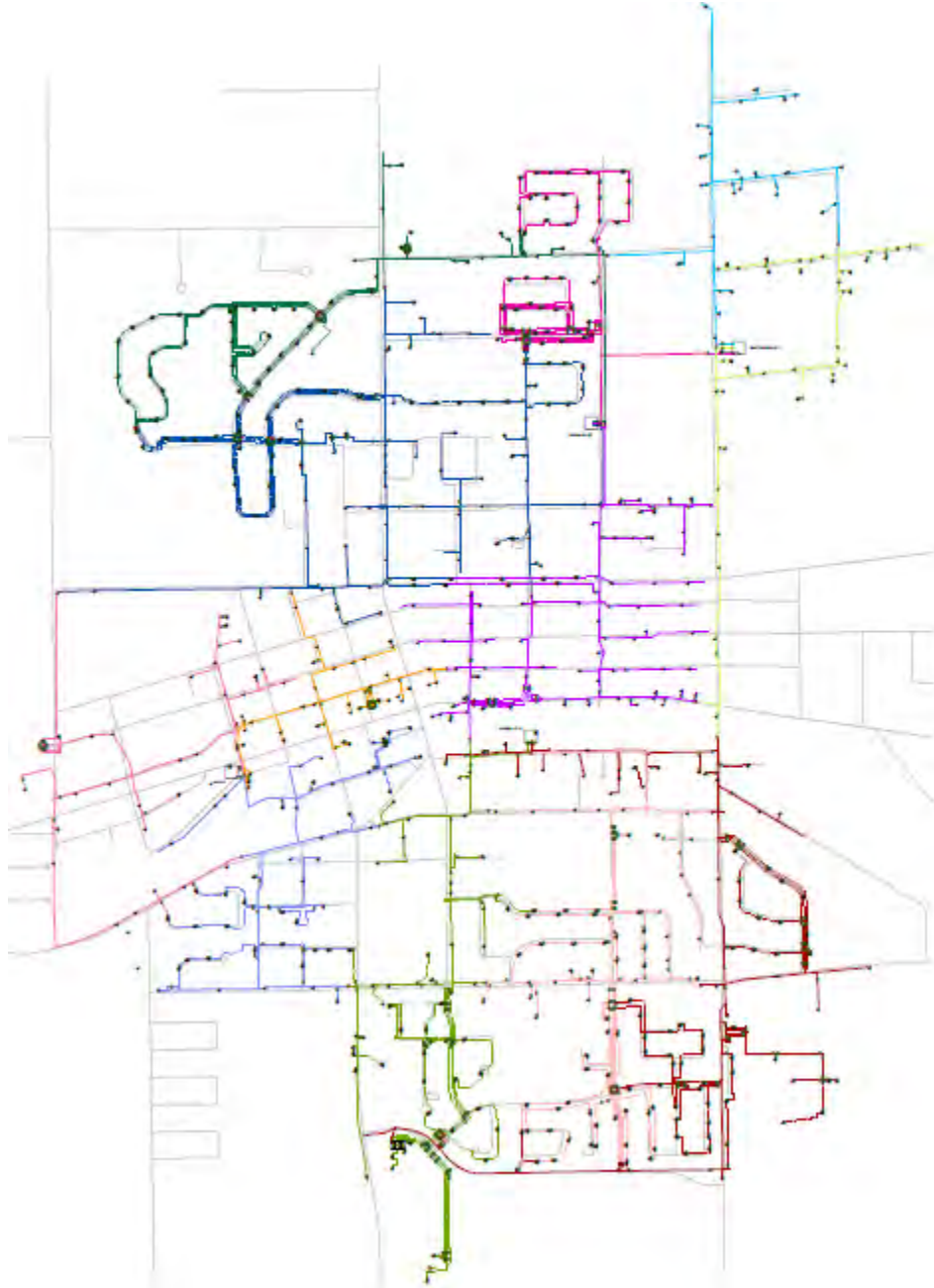


Figure 14: Operating Map (Fergus)



Figure 15: Operating Map (Elora)

System operating maps for each of the stations are included in Appendix A

Information by asset type on quantity/years in service profile and condition, including the date the data was compiled (5.3.2 c):

The demographic information on CWH's distribution system is included in full detail in Appendix B. The health and condition of the assets are summarized in Section 3.3, based on the data obtained in the last quarter of 2015.

3.3 Results of 2015 Asset Condition Assessment

CWH’s AMP in Appendix B provides complete demographic and asset condition information on material fixed assets employed in substations, overhead distribution system and the underground distribution system. The asset condition assessment report documents the condition of all major assets in units of health indices on a scale of 1 to 100. In determining the health indices of assets, all available information relevant to the assets’ health, including age, results of visual inspections and diagnostic testing has been utilized.

Figure 16 and 17 summarize the condition of major assets employed in each of the stations, in the form of health indices on a scale of 1 to 100. The power transformers at MS-1 and MS-2 stations in Fergus are very old, with unknown original manufacture date. Oil tests for power transformers at MS-3 and MS-4 in the town of Fergus indicate elevated levels of CO and CO2 in oil, a sign of insulation overheating, and are being monitored through routine oil testing. Similarly, oil testing of power transformer at MS-2 in the village of Elora has indicated slightly lower surface tension, a sign of insulation degradation, but still not alarming levels. Based on the power transformer health indices, the power transformer at Elora MS-1 is considered in “very good” condition and the remaining transformers with the exception of the transformer at Fergus MS-2, are considered to be in “fair” condition.

The power transformer at Fergus MS-2, was determined to have the lowest health index score. Although the original manufacture date for this transformer is not known with certainty, visual inspections indicate it is the oldest power transformer on CWH’s power supply system and presents an elevated risk of failure in service.

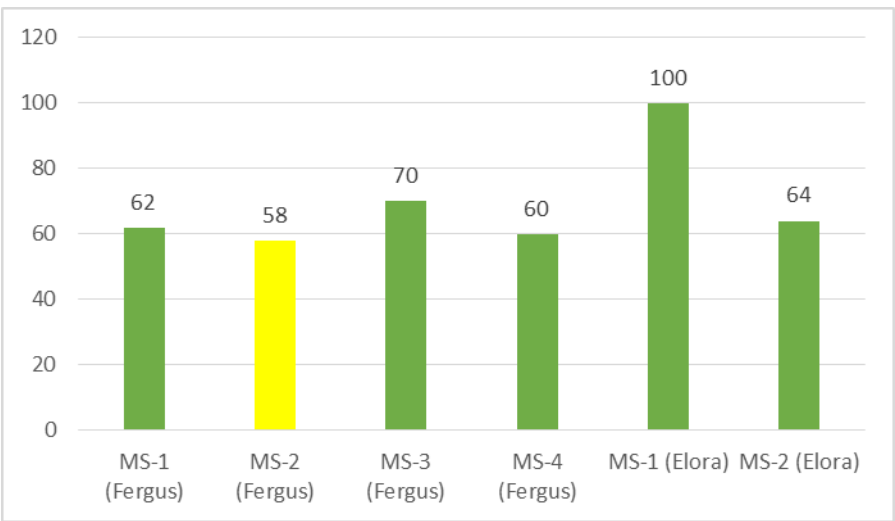


Figure 16: Substation Transformers Health Index

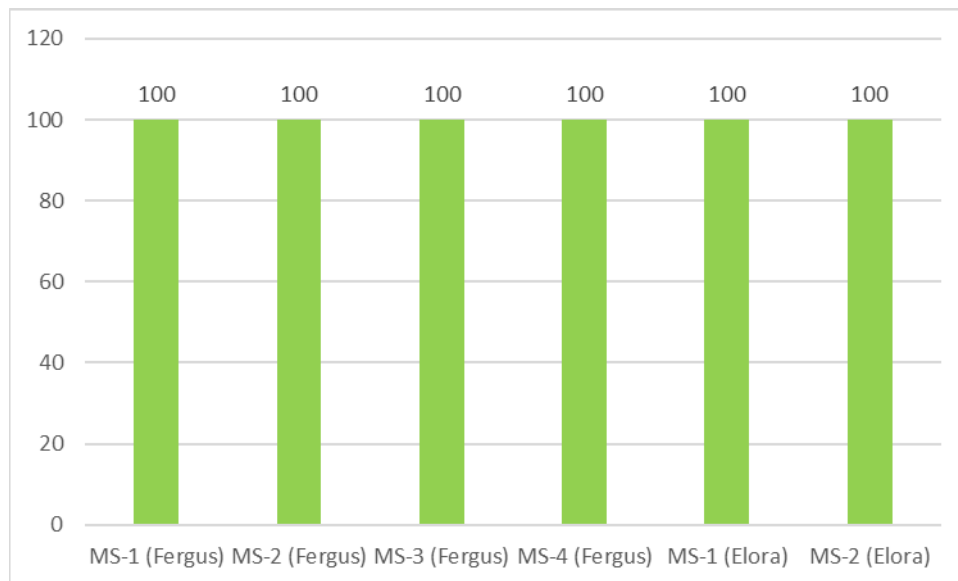


Figure 17: Substation Switchgear (44 kV and 4 kV) Health Index

By taking into account the original manufacture date, results of recent inspections and level of sophistication of protection and control relays, health indices were developed to benchmark the relative condition of switchgear and Figure 17 shows the relative condition of switchgear, expressed on a scale of 1 to 100. Switchgear at MS-4 in the town of Fergus and MS-2 in the village of Elora which were determined to be in “poor” condition at the time of preparation of asset management plan, have since been replaced and the switchgear at all of the substations at present is in “very good” condition, as shown in Figure 17.

By taking into account the service age of overhead lines, results of pole testing and the extent of small conductors (#4 and #6 copper) employed on overhead lines, Figure 18 summarizes the quantity of line sections based on health indices, ranging from very good to very poor.

For underground cables, service age is the only asset health indicator available for CWH’s assets and service age of 1-phase and 3-phase cable circuits employed on the underground distribution system is indicated in Figure 19. As shown, with the exception of approximately 2km length of 1-phase cable circuits and approximately 1 km of 3-phase circuits, the remainder of cable circuits are well below their typical useful service life.

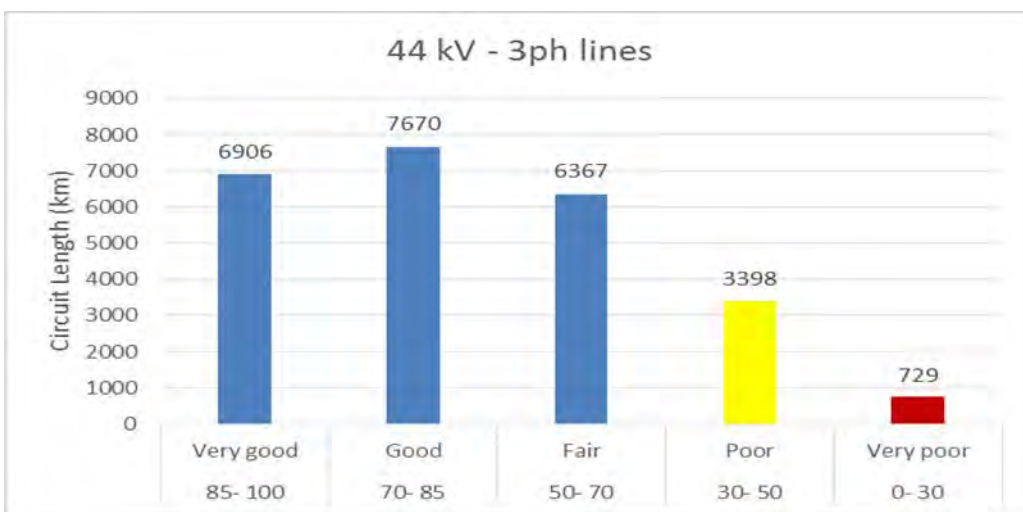
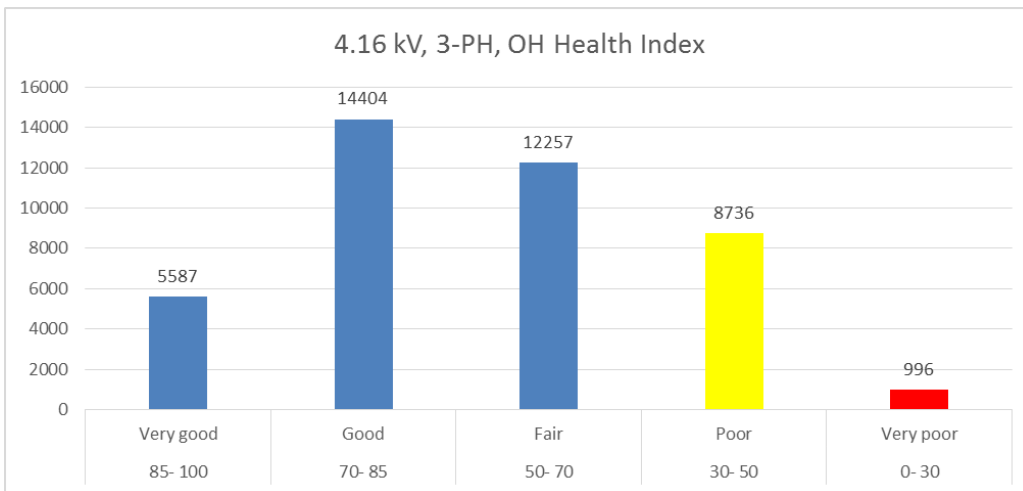
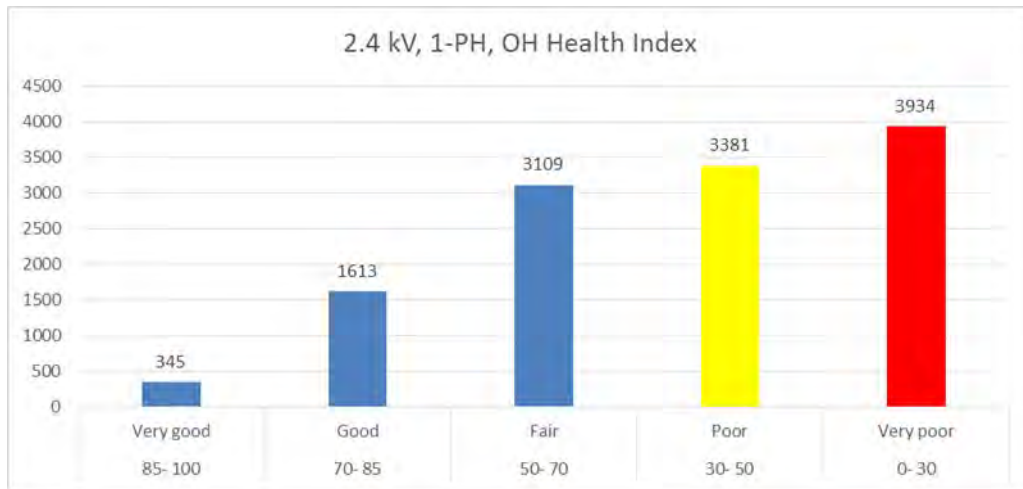


Figure 18: Condition Rating of Overhead Distribution Lines

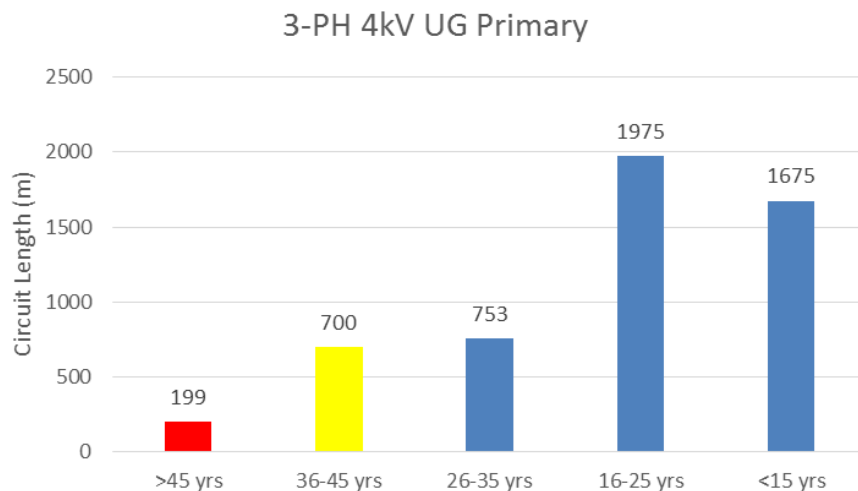
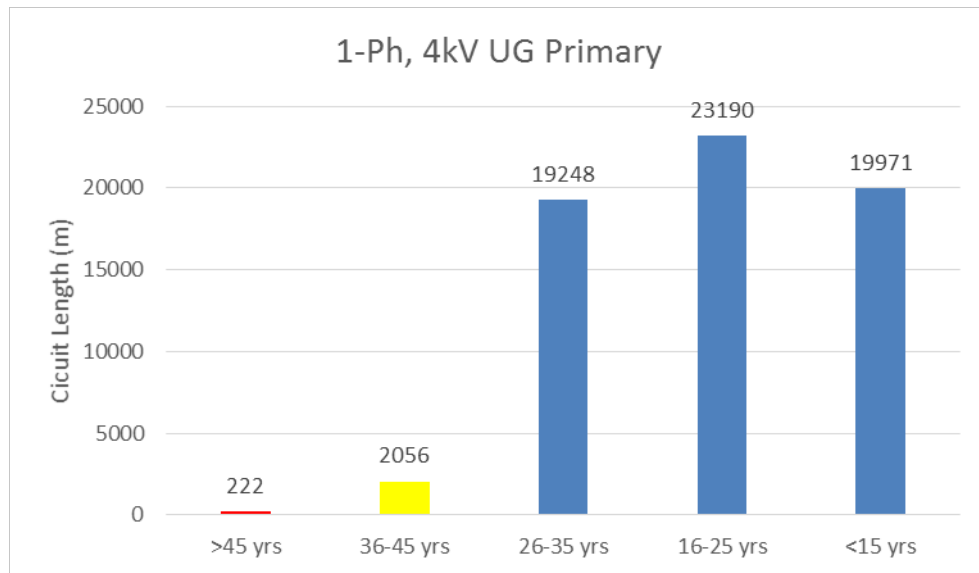


Figure 19: Service Age of Underground Cables

Figures 20 and 21, respectively, show the age profile of pole mounted and pad-mounted distribution transformers. The typical useful life of pole mounted distribution transformers is 40 years and that of pad mounted transformer is 30 years. CWH has not had extensive failure issues with distribution transformers, and like most distribution utilities, CWH manages this asset category in form of reactive replacement strategy, i.e. replace transformers upon failure, unless the inspections identify transformers that present safety risks. However, a significant number of pad mounted transformers installed along the main regional streets, where different types of road salts have been used for snow melting in the past, have experienced excessive corrosion of the enclosures, requiring rehabilitation or replacement.

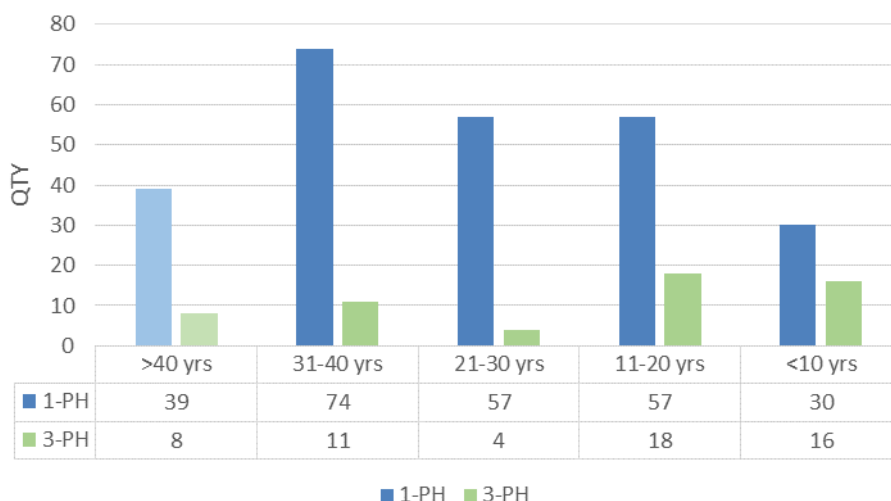


Figure 20: Service Age of Pole mounted Distribution Transformers

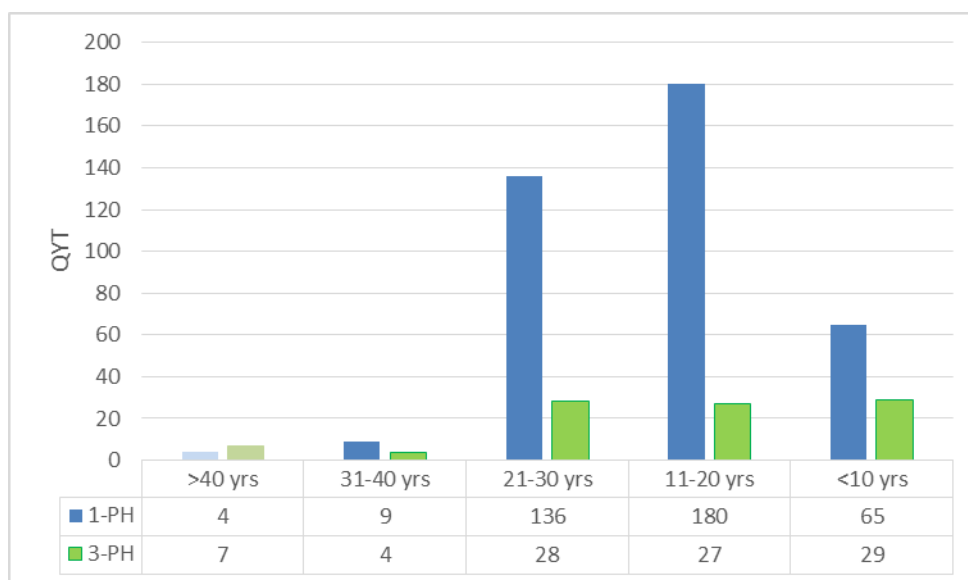


Figure 21: Service Age of Pad mounted Distribution Transformers

5.3.2 d) Assessment of the degree to which the capacity of existing system assets is utilized relative to planning criteria:

Table 15 and Figure 22 indicate the installed capacity and peak demand at each of the stations over the past five years. As indicated, the overall demand within the service territory is not increasing, but has come down during the past two years from the peak experienced in 2013 by about 10%, partly due to the implementation of CDM programs and introduction of the time of use tariff.

Table 15: Station Capacity and Loading

Station ID	Installed Capacity	2010	2011	2012	2013	2014	2015	2016
Fergus MS1	5 MVA	3.0	3.1	3.3	3.4	3.9	4.2	3.01
Fergus MS2	5 MVA	4.0	4.1	4.1	4.2	3.0	3.2	4.39
Fergus MS3	5 MVA	2.4	2.6	3.3	3.4	2.7	2.5	3.96
Fergus MS4	5 MVA	4.9	5.1	4.8	5.6	4.7	4.9	3.60
Fergus Total	20 MVA	14.3	14.9	15.5	16.6	14.3	14.7	15.0
Elora MS1	6/8 MVA	3.66	3.31	3.34	3.55	3.81	3.34	3.34
Elora MS2	5MVA	2.09	3.24	2.15	2.27	1.96	1.93	1.93
Elora Total	13 MVA	5.75	6.55	5.49	5.82	5.77	5.27	5.27
Overall Total	33MVA	20.05	21.45	20.99	22.42	20.07	19.98	20.23

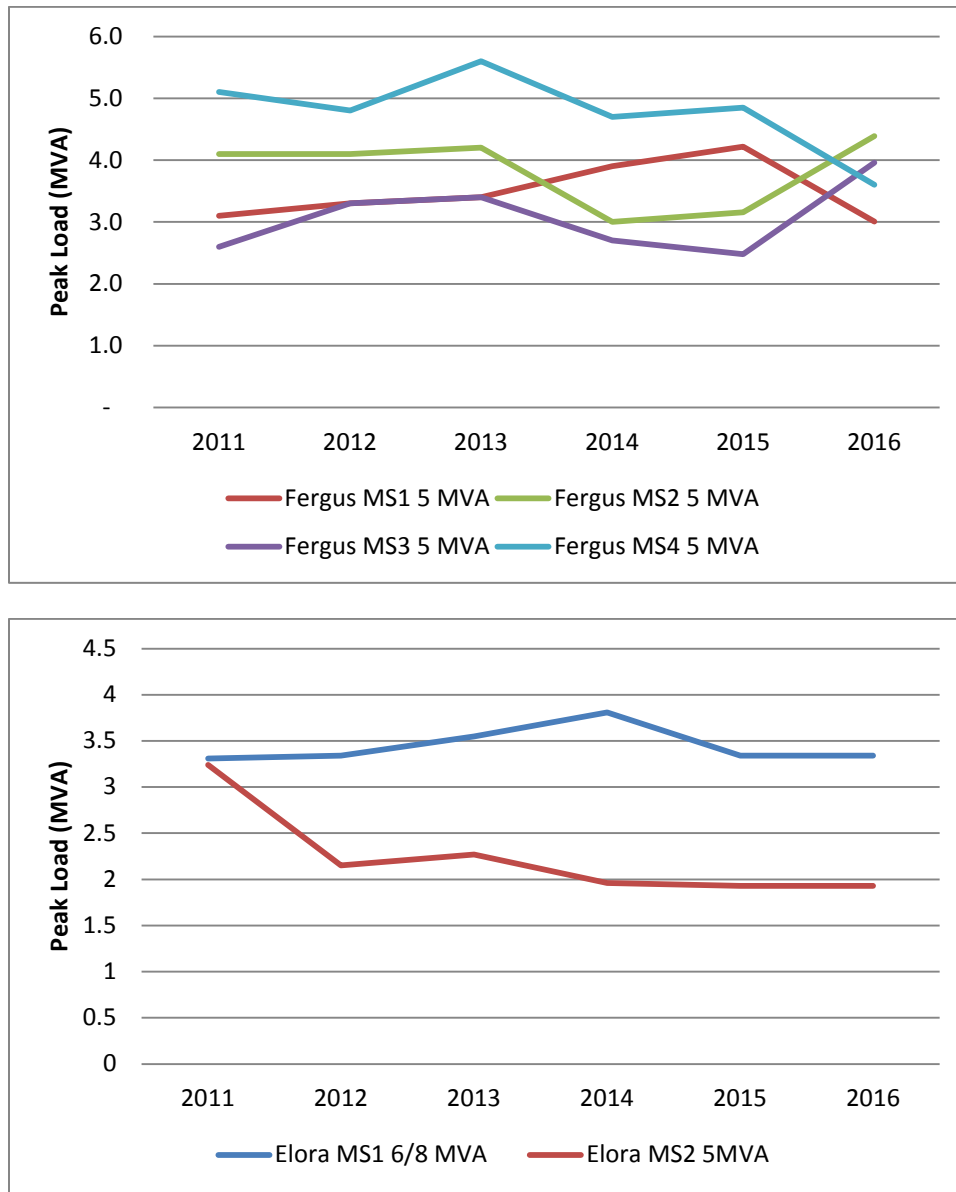


Figure 22: Station Loading

3.4 Asset Lifecycle Optimization Policies and Practices (5.3.3)

The life cycle optimization policies and procedures employed for preparation of this distribution plan, including the optimization of the capital investment plan as well as optimization of the preventative maintenance practices is described below:

3.4.1 Prioritization of Capital Investments

An overview of the asset management principles employed to achieve economic efficiency of the investments is provided in Section 3.1. Detailed methodologies employed in assessing the health and condition of assets, determining the probability of the risk of assets' failure in service and estimation of the consequences of asset failure are described in the AMP, included in Appendix B. The methodology for optimization of the capital investments into fixed assets is summarized below:

In preparing the consolidated distribution plan, CWH's overarching objective was to develop capital and preventative maintenance investment plans, which could be implemented to achieve optimal system performance by focusing on stakeholder needs, as shown in Figure 23.

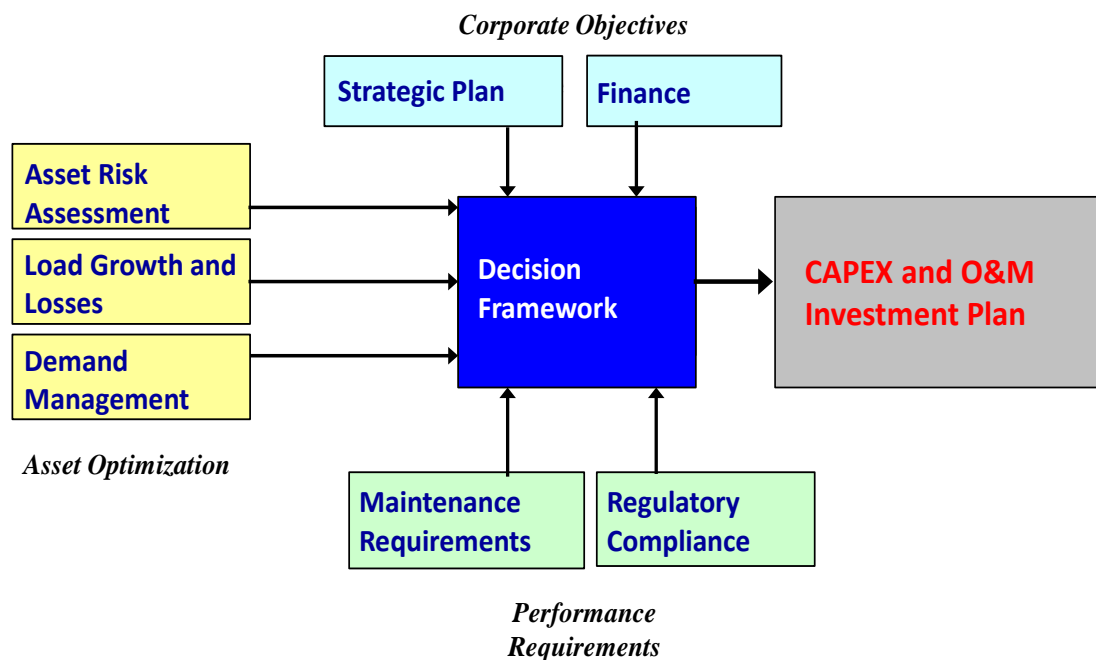


Figure 23: Multi-Prong Decision Framework

Figure 24 shows the basic decision support model employed by CWH in preparing this Distribution plan, determining the scope and timing of the investments and prioritizing the investments into specific projects. The timing and size of investments are selected to minimize the "Total Cost" of risk and risk mitigation initiatives.

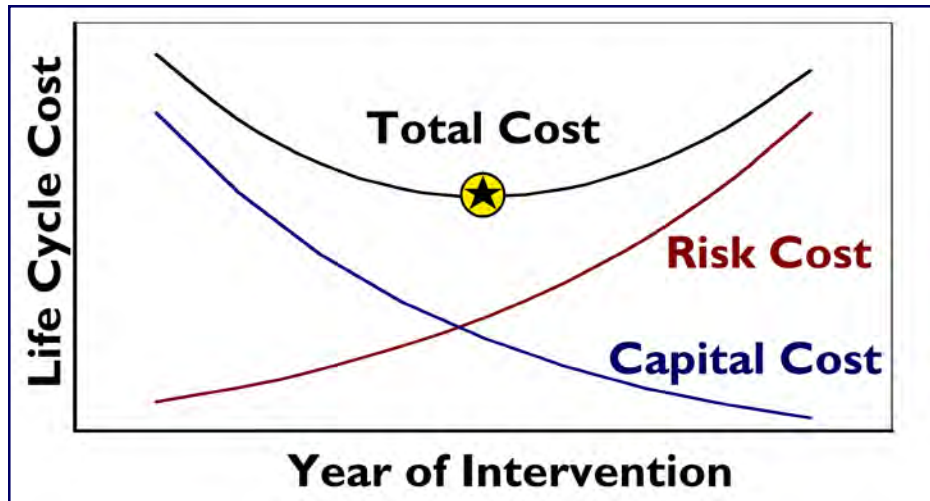


Figure 24: Risk Based Decision Support System

Figure 25 illustrates the impact of maintenance activities in extending the service life of an asset.¹ Optimization are carried out with the objective of minimizing overall life cycle costs of electricity distribution assets, while meeting the required performance levels, by taking into account all available information relevant to the condition of assets. Periodic asset inspections and testing provide valuable information on assets' health and probability of assets' failures, allowing appropriate risk management initiatives to be implemented over the lifecycle of each asset.

¹ "Predicting Future Asset Condition Based on Current Health Index and Maintenance Level" Thor Hjartarson, Shawn Ota, IEEE 11th International Conference on Transmission & Distribution Construction, Operation and Live-Line Maintenance, 2006, ESMO, Oct. 20

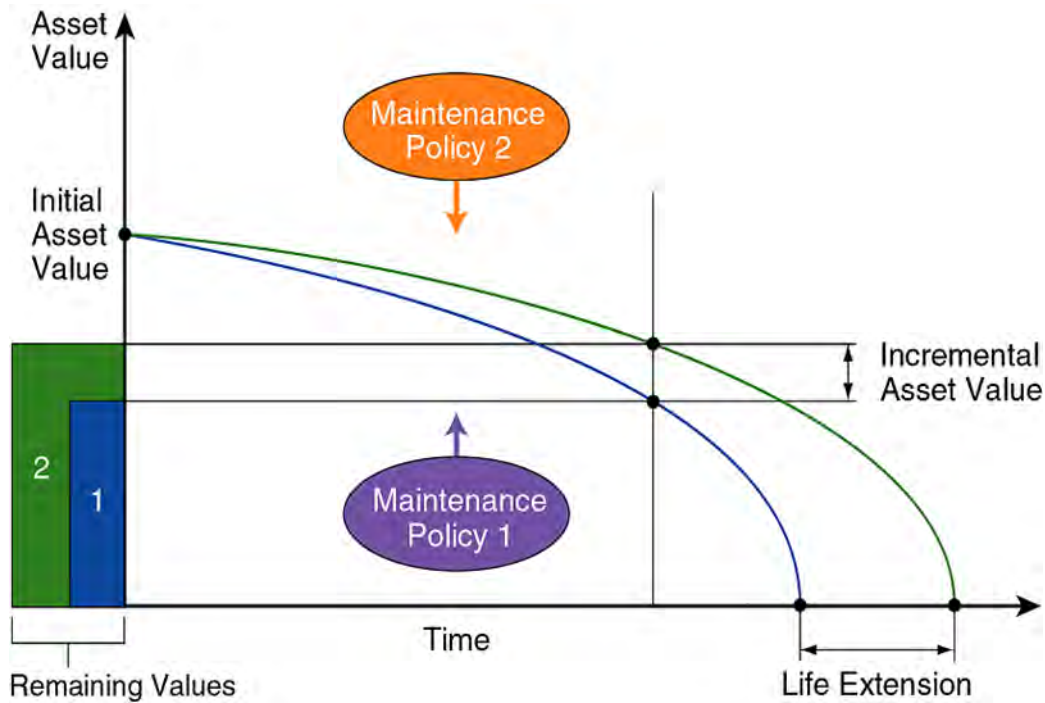


Figure 25: Risk Based Decision Support System

CWH's Operations & Maintenance ("O&M") programs are designed to follow the guidelines set out in the OEB's Appendix-C DSC for the inspection and maintenance of all key distribution system assets. CWH reviews its O&M programs annually in order to best align with our capital programs and aligning the program with the best industry practices and standards. Inspection and testing of assets is critical for the prioritization of operations and maintenance spending and optimization of the total life cycle asset cost. The results of inspections and testing are used to identify and prioritize system rehabilitation projects, resulting in selection of the optimal decision to either replace, repair or do-nothing. Assets for which replacement is identified as the optimal solution are included in the capital plan for replacement. For assets where replacement during the next five years is not determined to be the optimal solution, CWH's O&M programs include minor repairs and maintenance work designed to economically extend the life of assets. In both cases, planned replacement projects and planned operations and maintenance activities are selected in order to align with the budget envelopes by optimizing the scope and timing of work during project prioritization and selection processes. CWH employs the results of visual inspections, in-situ testing and service age of assets to determine the condition of assets by deriving a health index for each asset. The health index is related to the probability of failure for the asset by relating the health of the asset to an effective age and corresponding known failure curve. The probability of failure data is multiplied by the consequences of failure for assets within a project area to arrive at a risk score. Consequences of failure are derived from the analysis of each project area and

classification in terms of potential impacts to worker and public safety, the environment, reliability and operational effectiveness that could arise if a failure event occurs. Once the risk of each project area has been established it is placed into a prioritization and selection process that determines which projects require action and the extent of the action that is necessary to minimize unacceptable risks.

3.4.2 Preventative Maintenance and Safety Inspections

(a) Preventative Maintenance of Critical Equipment in Substations

METSCO reviewed the fixed asset preventative maintenance program currently in use at CWH and determined that it is in line with the best utility practices. The reliability performance over the recent years, indicated in Figures 3, 4 and 5, provides evidence that the current preventative maintenance strategy is working well. Therefore, no changes are recommended in the preventative maintenance program, which is briefly described below:

Assets installed in substations are inspected in accordance with the schedule, indicated in Table 16.

Table 16: Station Maintenance Schedule

	Inspection Schedule		
	Outdoor Open	Station Transformer Oil Testing	Full Station Maintenance
Distribution Station	Monthly	Annually	5 year cycle
Customer Substation	Annually	N/A	N/A

Preventative maintenance and testing is performed on the following critical assets, in compliance with the manufacturer's recommendations and best industry practices:

- Power Transformers
- Lightning Arrestors
- Circuit Breakers / Reclosers
- Switchgear
- Protection and controls
- Control battery and Battery chargers

Overhead lines are inspected annually by means of visual and infrared inspection.

Underground plant is inspected on a minimum 3-year cycle, to comply with Electrical Safety Authority's regulations. Distribution assets employed on overhead distribution system are inspected each year. Structural defects, clearance issues and electrical problems and hazards are identified through visual inspections and where problems are revealed, either repair work is scheduled or capital work is planned, as needed. Where the inspections determine an immediate hazard to the public, immediate follow up action is taken to mitigate the problem. Field inspection records are kept on file in the line superintendent's office until the next cycle of inspections.

On overhead distribution lines, the following deficiencies/defects are identified on various assets:

Poles/Supports:

- Bent, cracked or broken poles
- Excessive surface wear or scaling
- Loose, cracked or broken cross arms and brackets
- Woodpecker or insect damage, bird nests
- Loose or unattached guy wires or stubs
- Guy strain insulators pulled apart or broken
- Guy guards out of position or missing
- Grading changes, or washouts
- Indications of burning

Transformers:

- Paint condition and corrosion
- Phase indicators and unit numbers match operating map (where used)
- Leaking oil
- Flashed or cracked insulators
- Contamination/discolouration of bushings
- Ground lead attachments
- Damaged disconnect switches or lightning arresters
- Ground wire on arresters unattached

Switches and Protective Devices:

- Bent, broken bushings and cutouts
- Damaged lightning arresters
- Ground wire on arresters unattached

Hardware and Attachments:

- Loose or missing hardware
- Insulators unattached from pins
- Conductor unattached from insulators
- Insulators flashed over or obviously contaminated (difficult to see)
- Tie wires unravelled
- Ground wire broken or removed
- Ground wire guards removed or broken

Conductors and Cables:

- Low conductor clearance
- Broken/frayed conductors or tie wires
- Exposed broken ground conductors
- Broken strands, bird caging, and excessive or inadequate sag
- Insulation fraying on secondary

Third Party Plant:

- Attachment not secure
- Infringing on clearances
- Compromising access to electrical equipment
- Unapproved/unsafe occupation or secondary use

General Conditions & Vegetation:

- Leaning or broken “danger” trees
- Growth into line of “climbing” trees
- Accessibility compromised
- Vines or brush growth interference (line clearance)
- Bird or animal nests

- (a) On underground distribution lines, the following deficiencies/defects are identified on various assets:

Pad Mounted Transformers and Switching Kiosks:

- Paint condition and corrosion
- Placement on pad or vault
- Check for lock and penta bolt in place or damage

- Grading changes
- Access changes (Shrubs, trees, etc.)
- Phase indicators and unit numbers match operating map (where used)
- Leaking oil
- Lid damage, missing bolts, cabinet damage
- Cable connections
- Ground connections
- Nomenclature
- Animal nests/damage
- General conditions

Right of Way

- Accessibility compromised
- Grade changes that could expose cable
- Excessive vegetation on right of way

Tree trimming has been carried out on 2-year cycle in the past, which we consider satisfactory.

In accordance with the best utility practices, thermograph inspections of distribution assets are carried out with infra-red cameras and any hot spots are promptly attended to. The thermograph inspections appear to be extremely effective in detecting incipient faults and we recommend these should be continued as part of the maintenance program.

Due to the advanced age of distribution stations, power transformer oil samples are obtained and tested annually. The results of previous years oil testing have been used in assessing and ranking the condition of power transformers employed at distribution stations.

4 Detailed Capital Investment Plan (5.4)

4.1 Capital Expenditure Planning Process Overview (5.4.2)

The capital expenditure planning process employed by CWH consists of the following steps:

- (a) Determination of investment level needed for CWH to meet its regulatory obligations i.e. the level of investments required for system access projects;
- (b) Determination of investment level needed to maintain adequate capacity margins to supply system security and to maintain operating efficiency and safety, i.e. investments required system service projects;
- (c) Determination of investments required to maintain general plant operating safely and efficiently to support services;
- (d) Determination of economically efficient investments for system renewal, as described in detail in Section 3;
- (e) Summation of all of the investment components to determine the overall investment needed.
- (f) Evaluation of capital investment impacts on retail rates and scaling back of the investment levels, if the retail rate impacts are not acceptable.

The level of investments required for system access projects is determined through consultations with the municipal government, based on the number of anticipated development and building permits for residential and commercial construction. The investments into asset renewal are determined through condition assessment of assets and identification of economically efficient investments. Investment requirements into general plant are determined through condition assessment of motor vehicles, building and facilities and IT systems.

Customer feedback and impact on DSP. (5.4.2.d)

CWH strives to engage with our customers to ensure that our planning process for capital and maintenance work is in line with their expectations. These engagements are in the form of CWH attending the annual Home show, information sessions, open houses, customer class specific meetings and the bi-annual customer satisfaction survey, as well as informal means such as front line staff and management listening to customers at the front desk and operations staff working with customers and contractors on day to day projects. The continued message is a desire from our customers for CWH to continue providing the reliable service they receive

and to mitigate cost increases while providing the same level of service and responsible management. Below are the top 6 priority investment wants of our customers as recorded in the 2014 customer satisfaction survey:

- 1) Maintain and Upgrade Equipment
- 2) Reduce Time Needed to Restore Power
- 3) Education About Energy Conservation
- 4) Invest in the Electric Grid to Reduce Number of Outages
- 5) Invest in Tree Trimming
- 6) Burying Overhead Wires

CWH has built these priorities in to its planning process and specific project needs. Below are direct links to how CWH's DSP addresses these customer priorities:

Priority 1) Maintain and Upgrade Equipment

CWH's current fixed asset preventative maintenance program is in line with best utility practice as corroborated by METSCO's ACA described in section 6.6.

Priority 2) Reduce Time Needed to Restore Power

CWH's station rebuilds and improvements over the last 5 years included installing automated reclosers on all feeders to reduce outage times. CWH's future preventative maintenance plans include proactively inspecting these recloser and other integral station components to ensure their performance and reliability as seen in table 16: Station Maintenance Schedule.

Priority 3) Education About Energy Conservation

CWH's customers have performed well in conserving electrical energy as targets have been met through CDM initiatives. CWH regularly posts conservation tips on its website, informs C&I customers of incentives available to them and presents all local schools with conservation and safety seminars in an effort to educate them on energy usage and conserving.

Priority 4) Invest in the Electric Grid to Reduce Number of Outages

As demonstrated within CWH's DSP, capital investment plans are established with a balance between prudent spending and appropriate levels of replacement.

Priority 5) Invest in Tree Trimming

CWH has an aggressive 2-year tree trimming schedule and is a direct reflection of our low outage and duration of outage statistics.

Priority 6) Burying Overhead Wires

CWH works closely with the Municipality and other utilities as demonstrated in section 2.3 Coordinated Planning with Third Parties within the DSP. When rebuilding infrastructure placing assets underground is always a consideration and CWH endeavors to install plant underground when feasible, which is always more viable as a result of the reduced costs associated with joint common trenching practices and collaborative scheduling.

4.2 Capital Investment Plan (5.4.4)

The proposed six (6) year capital program from (2017 to 2022), summarized in Table 17, reflects an average annual capital expenditure of approximately \$1,004,000 per year. For comparison sake, the capital expenditure in the previous five years is indicated in Table 18, which indicates average annual capital expenditure of \$2,379,000. A comparison of Table 17 with Table 18 reveals a reduction of approximately 60% in average annual proposed expenditure from the actual average expenditure during the previous five years.

Table 17: Proposed Capital Investments

CAPEX Category	2017	2018	2019	2020	2021	2022
System Access	\$ 305,200	\$ 30,600	\$ 24,900	\$ 25,400	\$ 25,900	\$ 26,400
System Renewal	\$ 474,400	\$ 512,500	\$ 503,300	\$ 527,300	\$ 538,500	\$ 1,228,100
System Service	\$ 17,400	\$ 81,900	\$ 65,400	\$ 29,400	\$ 29,400	\$ 29,400
General Plant	\$ 580,600	\$ 250,300	\$ 157,000	\$ 392,800	\$ 126,200	\$ 141,800
Total Planned Capital Expenditure	\$ 1,377,600	\$ 875,300	\$ 750,600	\$ 974,900	\$ 720,000	\$ 1,425,700

Table 18: Historic Capital Expenditure (Actual)

CAPEX Category	2012 (Actual)	2013 (Actual)	2014 (Actual)	2015 (Actual)	2016 (Actual)
System Access	\$ 162,427	\$ 97,757	\$ 29,825	\$ 174,730	\$ 289,576
System Renewal	\$ 1,551,870	\$ 1,993,702	\$ 2,280,571	\$ 1,112,990	\$ 1,654,016
System Service	\$ 10,931	\$ 1,204,414	\$ 3,284	-\$ 2,613	\$ 19,291
General Plant	\$ 204,850	\$ 267,826	\$ 84,516	\$ 585,270	\$ 169,915
Total Capital Expenditure	\$ 1,930,077	\$ 3,563,699	\$ 2,398,195	\$ 1,870,376	\$ 2,132,797

The following is a list of the key drivers for all the investments included in this Capital Plan and these are described in detail in Section 2.

- System Access
- System Renewal
- System Service
- General Plant Upgrades

The proposed capital investments in each of these categories are summarized below:

a) System Access

The proposed investments into system access are summarized in Table 19. These include capital investments to implement customer service requests, line relocates to facilitate municipal infrastructure developments, such as road widening projects and investments into revenue metering.

Table 19: Planned Capital Investments into System Access Projects

System Access		2017	2018	2019	2020	2021	2022	TOTAL
CP1	New Services	\$ 26,100.00	\$ 30,600.00	\$ 24,900.00	\$ 25,400.00	\$ 25,900.00	\$ 26,400.00	\$ 159,300.00
CP33	Wellington Place Hospital Service	\$ 244,100.00						\$ 244,100.00
CP68	CWEI Pole, Transformers	\$ 35,000						\$ 35,000
								\$ -
TOTAL SYSTEM ACCESS		\$ 305,200.00	\$ 30,600.00	\$ 24,900.00	\$ 25,400.00	\$ 25,900.00	\$ 26,400.00	\$ 438,400.00

It is difficult to accurately quantify the impact of these investments on future O&M expenses. However qualitatively, investments into system access generally result in an increase in quantity of assets in service and therefore result in an increase in future O&M expenditure.

b) System Renewal

The proposed investments into system renewal are summarized in Table 20 and these include specific projects involving renewal and replacement of various components at the end of their useful service life and pose a high risk of failure in service as well as reactive expenditures for replacement of the assets that have actually failed in service.

It is not possible to quantitatively determine the impact of capital investments on future O&M expenditure, but qualitatively, investments into system renewal generally reduce the risk of increases in O&M expenditure because replacement of old vintage assets with new assets results in fewer equipment failures and lower expenditure into emergency repairs.

Table 20: Planned Capital Investments into System Renewal Projects

System Renewal	2017	2018	2019	2020	2021	2022	TOTAL
CP7-1 Annual Pole Replacement	\$ 89,300	\$ 94,500	\$ 90,500	\$ 91,400	\$ 93,100	\$ 94,900	\$ 553,700
CP9-9 Transformers	\$ 80,000	\$ 80,000	\$ 80,000	\$ 80,000	\$ 80,000	\$ 80,000	\$ 480,000
CP13-18 Rodan Meter Platform	\$ 18,000						\$ 18,000
CP69 Hill St Conversion	\$ 49,300						\$ 49,300
CP70 Hill St Re-routing	\$ 25,000						\$ 25,000
CP71 Hill St	\$ 49,900						\$ 49,900
CP72 44kV Tie Re Route	\$ 140,200						\$ 140,200
CP73 Brock St Conversion	\$ 22,700						\$ 22,700
CP75 St Patrick: Gartshore to Herrick		\$ 85,600					\$ 85,600
CP76 St Patrick: Gowrie to Herrick		\$ 103,800					\$ 103,800
CP77 St George: Herrick to Gartshore		\$ 103,800					\$ 103,800
CP79 Station Fans - Elora #2, Fergus #4		\$ 44,800					\$ 44,800
York St: Waterloo to Rd 7			\$ 49,900				\$ 49,900
Wellesly: Colborne to Moir			\$ 37,100				\$ 37,100
Victoria Terrace: Forfar to Strathallen			\$ 110,900				\$ 110,900
St George: St David to Cameron			\$ 78,900				\$ 78,900
Wellesly: Church to Colborne			\$ 56,000				\$ 56,000
DSP #2 Elora				\$ 60,100			\$ 60,100
Mary St: David St to Moir St				\$ 24,700			\$ 24,700
Moir St: Mary St to John St				\$ 30,300			\$ 30,300
John St: Moir to Colborne				\$ 30,500			\$ 30,500
John St: David to Colborne				\$ 54,100			\$ 54,100
Gzowski: Stn 4 to Herrick				\$ 156,200			\$ 156,200
McNab St: High to Bridge (A)					\$ 52,600		\$ 52,600
McNab St: High to Bridge (B)					\$ 92,600		\$ 92,600
Cameron St: Forfar to St Andrews					\$ 94,100		\$ 94,100
Gowrie St: St Patrick to Garafraxa					\$ 47,000		\$ 47,000
David St: Irvine to Geddes (B)					\$ 46,900		\$ 46,900
Irvine St: Church to Mill					\$ 32,200		\$ 32,200
Queen St Transformer Upgrade						\$ 700,000	\$ 700,000
St David St: Union to Albert						\$ 36,200	\$ 36,200
Albert St Pole upgrade						\$ 70,400	\$ 70,400
Angus: Union to Albert						\$ 30,800	\$ 30,800
Gartshore St Pole Upgrade						\$ 84,600	\$ 84,600
Glengary Pole Change						\$ 29,600	\$ 29,600
David St: Irvine to Geddes (A)						\$ 73,900	\$ 73,900
Mary St: Moir to Colborne						\$ 27,700	\$ 27,700
							\$ -
TOTAL SYSTEM RENEWAL	\$ 474,400	\$ 512,500	\$ 503,300	\$ 527,300	\$ 538,500	\$ 1,228,100	\$ 3,784,100

c) System Service

Capital investments related to system service are summarized in Table 21 and these include costs associated with revenue meters and mitigation of a localized capacity constraint through addition of an underground distribution circuit on St. David Street bridge. Other than these, there are no capacity constraints in the system to accept requests to connect load or generation customers anticipated during the next six years.

Table 21: Planned Capital Investments into System Service

System Service		2017	2018	2019	2020	2021	2022	TOTAL
CP13	Revenue Meters	\$ 17,400	\$ 41,400	\$ 65,400	\$ 29,400	\$ 29,400	\$ 29,400	\$ 212,400
CP78	St David St Bridge UG Addition		\$ 40,500					\$ 40,500
								\$ -
TOTAL SYSTEM SERVICE		\$ 17,400	\$ 81,900	\$ 65,400	\$ 29,400	\$ 29,400	\$ 29,400	\$ 252,900

d) General Plant

Table 22 shows investments into general plant. These investments are intended to provide a safe work environment for employees to maintain high productivity levels, while providing customer services.

Table 22: Planned Capital Investments into General Plant

General Plant		2017	2018	2019	2020	2021	2022	TOTAL
CG1609	Capital Conts Pd Hydro One							\$ -
CG1611	Computer Software		\$ 50,000	\$ 80,000			\$ 55,000	\$ 185,000
CG 1908-1	Building and Fixtures	\$ 22,000						\$ 22,000
CG 1908-3	Cold Storage Shed	\$ 55,000						
CG1915-1,2	Office Furniture	\$ 18,300	\$ 30,000					\$ 48,300
CG1920	Computer Hardware	\$ 62,500	\$ 19,000	\$ 25,600	\$ 77,600	\$ 77,000	\$ 37,600	\$ 299,300
CG1930	Transportation Equipment	\$ 400,000	\$ 130,000	\$ 40,000	\$ 300,000	\$ 40,000	\$ 36,000	\$ 946,000
CG1935	Stores Equipment	\$ 5,000						\$ 5,000
CG1940	Tools, Shop and Garage Equip	\$ 8,800	\$ 14,800	\$ 200	\$ 6,500	\$ 2,000	\$ 2,000	\$ 34,300
CG1945	Measurement & Testing Equip		\$ 4,500	\$ 3,700	\$ 3,700	\$ 3,700	\$ 3,700	\$ 19,300
CG1950	Power Operated Equipment					\$ 3,500		\$ 3,500
CG1955	Communication Equipment				\$ 5,000			\$ 5,000
CG1960	Misc Equipment	\$ 9,000	\$ 2,000					\$ 11,000
CG1980	System Supervisory Equipment			\$ 7,500			\$ 7,500	\$ 15,000
TOTAL GENERAL PLANT		\$ 580,600	\$ 250,300	\$ 157,000	\$ 392,800	\$ 126,200	\$ 141,800	\$ 1,648,700

4.2.1 Material Capital Investments (5.4.5.2)

Below are the historical capital projects that have been completed and are over the materiality threshold of \$50,000.

2012 Capital Jobs over Materiality Threshold

Job Reference: CP15	Total Job Amount: \$122,822.79
Investment Category: System Access	Description: Walmart Feed
Service Start Date: May 2012	In Service Date: December 2012
Related Customer Attachments: N/A	

Need:

Smart Centre requested a connection for a 1000 KVA customer owned transformer to accommodate a large box store at the corner of St David St N and Woodhill Dr., and a 500 KVA transformer requirement for an adjacent planned strip plaza connection for three medium sized commercial stores. To accommodate the 1000 KVA transformer the 73M3, 44 KV circuit will need to be extended to the project site from its current "end" location on Gzowski St.

Scope:

Engineer and construct replacement of 28 poles along current 73M3 feeder end point and new location of connection point. The majority of the poles will be sized to attach CWH 4 kV and 44 kV circuits as well as Hydro One 8 kV and 44 kV circuits and project will be coordinated with Hydro One. Total 73M3 extension length is approximately 1.3 km and the circuit conductor will be 336 AL.

Job Reference: CP9	Total Job Amount: \$111,731.23
Investment Category: System Renewal	Description: Transformers
Service Start Date: Ongoing as required	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Need:

CWH needs to purchase various new transformers in order to replace stock that are installed either for new connections, damaged by lightening or replacement of older transformers.

Scope:

Transformers will now only be ordered to replace any that are used so that CWH can keep inventory at the same level. Replacement transformers are for those that were used in the previous year.

Job Reference: CP17	Total Job Amount: \$104,583.43
Investment Category: System Renewal	Description: Argyll St
Service Start Date: May 2012	In Service Date: September 2012
Related Customer Attachments: N/A	

Need:

The underground cable system on Argyll St. was installed more than 35 years ago and consists of direct buried 5kV cable and “pole-trans” type transformers. The current age of the cable well exceeds the typical 25-year life expectancy of 5kV underground cable. Pole Trans have been identified within the industry as hazardous and create a risk to worker safety.

Scope:

A new underground system will be required; it will be designed by an engineering firm and stamped by a licensed electrical engineer in order to comply with CWH standards and Ontario Regulation 22-04. Design work to be completed by May 2012. Reconstruction of Argyll St. to be completed by December 2012. Budgeted amount is \$265,500 (\$186,000 for UG Conduits, \$40,300 for conductors and devices, \$36,200 for transformers and \$3,000 for UG Services)

Job Reference: CP19	Total Job Amount: \$1,182,235.47
Investment Category: System Renewal	Description: MS 2 Queen St
Service Start Date: May 2012	In Service Date: July 2012
Related Customer Attachments: N/A	

Need:

Original Fergus MS-2 substation was installed in 1962. Since then, the 5kV OCB-type switchgear circuit breakers and single cell fused-load break gear in the substation have become obsolete. This equipment would be impossible to replace if it failed and it is difficult to impossible to locate spare parts for refurbishment.

Scope:

The rehabilitation will bring the substation MS-2 up to Ontario Regulation 22-04 compliance.

Job Reference: CP23	Total Job Amount: \$57,414.20
Investment Category: System Renewal	Description: Tower St
Service Start Date: July 2012	In Service Date: July 2012
Related Customer Attachments: N/A	

Need:

The Municipality is reconstructing the intersection at McQueen Blvd and Tower St and CWH owns poles that need to be relocated to accommodate municipal standards.

Scope:

CWH will take this opportunity to upgrade said poles and replace 1/0 CU conductor, which limits feeder-switching capabilities between the F5 and F8 with 336 AL. The 44 kV circuit (M3) will also be extended by installing higher poles.

Job Reference: CG1980	Total Job Amount: \$129,884.56
Investment Category: General Plant	Description: Scada
Service Start Date: 2012	In Service Date: 2012
Related Customer Attachments: N/A	

Need:

CWH existing monitoring system was damaged in September 2011 and was no longer reliable. To replace the aging system with current software and service agreements would have cost \$25,000 to \$30,000.

Scope:

A new SCADA system was required to collect operating data (i.e. voltage, current, kW loading), provide remote automation capabilities, and prepare for distributed generation and smart GRID activities. The costs to implement were associated with computer hardware, software, and field devices for communications.

2013 Capital Jobs over Materiality Threshold

Job Reference: CP9	Total Job Amount: \$66,685.13
Investment Category: System Renewal	Description: Transformers
Service Start Date: Ongoing as required	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Need:

CWH needs to purchase various new transformers in order to replace stock that are installed either for new connections, damaged by lightening or replacement of older transformers.

Scope:

Transformers will now only be ordered to replace any that are used so that CWH can keep inventory at the same level. Replacement transformers are for those that were used in the previous year.

Job Reference: CP17	Total Job Amount: \$57,736.68
Investment Category: System Renewal	Description: Argyll St
Service Start Date: May 2013	In Service Date: Oct 2013
Related Customer Attachments: N/A	

Need:

The underground cable system on Argyll St was installed more than 35 yrs. ago and consists of direct buried 5kv cable and pole-trans type transformers. The lifespan of the 5kV cable is 25 yrs. Although we have no cable failures to date, it is time to replace the primary cables and the Pole-Trans type of transformer.

Scope:

A new underground system will be required; it will be designed by an engineering firm and stamped by a licenced electrical engineer in order to comply with regulation 22-04. Design work to be completed by May 2012. Reconstruction to be completed by November 2012. Budgeted amount is \$265,500 (\$186,000 for UG Conduits, \$40,300 for conductors and devices, \$36,200 for transformers and \$3,000 for UG Services)

Job Reference: CP26	Total Job Amount: \$78,726.07
Investment Category: System Renewal	Description: Tower St - Bridge
Service Start Date: May 2013	In Service Date: May 2013
Related Customer Attachments: N/A	

Need:

We need to install a duct bank in the new bridge at Tower St as a prudent measure for unforeseeable changes to the distribution system in a busy thoroughfare.

Scope:

Installation will take place during Tower St bridge reconstruction.

Job Reference: CP30	Investment Category: System Access
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Service Start Date: April 2013	Description: Fergus Library
Total Job Amount: \$96,402.19	In Service Date: November 2013
Related Customer Attachments: n/a	

Need:

The County of Wellington is developing an expansion of its Fergus Library branch. In conjunction with the Library expansion, the Township is reconstructing the parking and parkland adjacent to the Library building. Centre Wellington Hydro currently has a 3 phase overhead radial circuit normally fed from the F8 feeder running through the affected area. This Feeder services customers on both sides of the proposed library building.

The Library will be extended in to the existing overhead pole line right of way, therefore requiring all overhead plant to be replaced with underground to service current customers. The reconstructed Library will require a new underground service. The surrounding parking and parkland reconstruction will include extensive excavation and replacement of Centre Wellington Hydro plant, which will be placed underground. A loop feed will enhance reliability and maintenance operations.

Scope:

This rebuild will include the installation of underground primary cable placed in conduit and new underground services in conduit. One MJ unit, three (3) 3phase vaults and transformers, and two single-phase vaults and transformers will be installed.

Job Reference: CP31	Total Job Amount: \$101,041.96
Investment Category: System Access	Description: Elora Sewage
Service Start Date: Oct 2013	In Service Date: November 2013
Related Customer Attachments: N/A	

Need:

The Township of Centre Wellington is planning an expansion and upgrade to their Elora Wastewater Treatment Plant. The expansion will substantial increase the connected load at the site.

Due to the added connected load, the proposed Transformer size is a 1500 KVA and will need to be connected to a 44KV feeder. The construction of a pole line is required along Wellington Road 7 from the M7 feeder at the corner of Wellington Road 7 and 21 to the Wastewater

Treatment site. Existing 4 kV along approximately half of the distance will be transferred to the new poles.

Scope:

Install new poles, switches, and hardware. String approximately 400 meters of 336 Al conductor, three phase 44 kV circuit and attach to the M7 circuit at the corner of Wellington Road 7 and Wellington Road 21 in Elora. Transfer existing 4 kV F2 circuit and secondary.

Job Reference: CP34	Total Job Amount: \$1,238,505.27
Investment Category: System Renewal	Description: MS1 Rehabilitation – Blair St
Service Start Date: February 2013	In Service Date: October 2013
Related Customer Attachments: N/A	

Need:

In order to facilitate continued reliable servicing to the section of Fergus, station to be upgraded with refurbishment of existing transformer. This station feeds the S-1 F 1, S 1 F 2 and S 1 F 7 from Blair Street in Fergus.

Scope:

Install new perimeter fencing, concrete poles, duct bank, grounding, vipers and switching units also to be addressed.

Job Reference: CP35	Total Job Amount: \$150,358.72
Investment Category: System Renewal	Description: Beatty Line Tie Loop
Service Start Date: April 2013	In Service Date: November 2013
Related Customer Attachments: N/A	

Need:

Both the F1 and F7 Feeders from Fergus MS-1 end as radial feeds at the East side of Fergus along St George St and part of Beatty Line, and Garafraxa St respectively. The F1 along St George St and Beatty Line is a three phase 4 kV circuit built in the 1960's with 40' poles and #2 copper, and is fed from Fergus MS-1 station. The F7 is a single-phase 2.4 kV feed along Garafraxa St ending 200 meters west of Maiden Lane, and was built in 1970's with 40' poles. Connecting these two feeders between Garafraxa St and St George St via Beatty Line is a natural progression of the distribution system.

Age and condition of the existing polelines and conductor size is a consideration for rebuilding these sections to prepare for a loop feed that will add load. Rebuilding, extending and joining these circuit's to enable a loop system will improve reliability by enabling operational flexibility to balance phase's and transfer loading from one feeder to the other during outages and planned maintenance.

Scope:

The scope of this project will include rebuilding and extending the existing overhead circuits and constructing a new underground circuit to tie the two sections together.

St George St and Beatty Line section: Install 10 new 50' poles and hardware along St George St from Johnston St, and along Beatty Line to Hill St. String, 500 meters of 336 AL conductor X4(3 primary and neutral). Install new single phase and 3 phase transformers, secondary conductor, and underground services.

Garafraxa St section: install nine new 50' poles, hardware, and 400 meters of three phase 336 AL conductor X4 along Garafraxa St from Maiden Lane to Beatty line. Transfer existing transformer and service.

Beatty Line: Install a 400 meter, 4X4" (3 for primary cables and 1 spare) duct bank on Beatty Line from Garafraxa St to Hill St. Install 3, 350 MCM, 15 kV primary cables and construct risers at each end including terminations and 15 kV cluster switch bracket.

Job Reference: CP38	Total Job Amount: \$162,337.69
Investment Category: System Renewal	Description: MS#1 River Crossing
Service Start Date: July 2013	In Service Date: October 2013
Related Customer Attachments: N/A	

Need:

Continuing from the Fergus S 1 station, the river crossing provides back up route for continued service on the F4, F5 and F8 circuits. The crossing is a critical point in continued service and reliability. Poles are past service life and require upgrading. New USF standards for framing will be incorporated on the new structures and poles as there will be an increase in height and working area on the station

Scope:

Reconfigure the riser poles, new grounding and perimeter security. Refurbish of the transformer ,new switching units, reclosers and addition of an extra switch cabinet

Job Reference: CP46	Description: OH to UG Union to Highland Cemetery
Investment Category: System Renewal	
Service Start Date: September 2013	In Service Date: October 2013
Total Job Amount: \$72,997.28	
Related Customer Attachments: N/A	

Need:

Mature tree growth and residential powerlines to be rerouted underground and a continued loop feed access on the circuit. Poles are in need of replacement and continued tree contact can be avoided with installing conductor underground

Scope:

Contractor to excavate and install new 4 kv primary and u/g secondary conductor. Terminations to be completed by CWH staff.

2014 Capital Jobs over Materiality Threshold

Job Reference: CP43	Description: MS#1 Elora Rehabilitation – Mill St Elora
Investment Category: System Renewal	
Service Start Date: August 2014	In Service Date: November 2014
Total Job Amount: \$1,925,636.40	
Related Customer Attachments: N/A	

Need:

MS #1 Elora is the oldest working Station in the CWH territory. Based on the 2012 condition assessment taken on by Costello, it was deemed critical to upgrade the station and its components, including the upgrading of a replacement transformer. This station services the town of Elora with the F1, F2, and F3 feeders

Scope:

The new station location was moved north on Mill Street and an entire rebuild is required. Installation of new compound, grounding, structure and building work to be completed by contractors.

Job Reference: CP46	Description: OH to UG Union to Highland Cemetery
Investment Category: System Renewal	In Service Date: October 2014
Service Start Date: May 2014	
Total Job Amount: \$60,996.35	
Related Customer Attachments: N/A	

Need:

The pole line along Thistle and McTavish St, from Union St to Belsyde St is a 2.4/4.16 kV circuit normally fed from the F5 feeder out of Fergus MS-2 station. There are 414 mainly residential customers connected along and downstream of this section of the F5 feeder. The existing pole line along Thistle St was built in the 1960's with 35' poles and 5 kV insulated Hendrix conductor to protect the circuit from mature trees. This section of line runs through the Belsyde cemetery in Fergus and along a pathway that joins Thistle St and McTavish St for pedestrians. Accessibility is very limited due to terrain, municipal fencing, and trees. Along McTavish St., there are sectionalizing switches, and multiple risers that feed aging poletrans (transformers) with primary cables that have surpassed their life expectancy.

The main factors that pose a potential safety and reliability risk to the current pole line circuit:

- 1) Age and condition of the existing poles and their ability to maintain the weight of the insulated Hendrix conductor.
- 2) The hazard of mature trees in the cemetery and walkway alongside the pole line on the Thistle St section. Installing this plant underground will eliminate the hazards from trees and accessibility issues due to the terrain.

From a planning perspective, replacing the poles on the McTavish section will make ready future replacement of aging underground primary cable and transformers.

Scope:

Install new poles, switches, and hardware on McTavish St and transfer existing conductor and risers.

Install new poles, switches, secondary conductor, underground conduit, 300 meters of three phase, 350 MCM primary underground cable, and switching kiosk on Thistle St.

Job Reference: CP47	Total Job Amount: \$79,838.24
Investment Category: System Renewal	Description: Perth St OH to UG
Service Start Date: May 2014	In Service Date: August 2014

Related Customer Attachments: N/A

Need:

The pole line along Perth St, between Albert St and Belsyde St is a 2.4/4.16 kV circuit normally fed from the F2 feeder out of Fergus MS-1 station. There are 290 customers connected along and downstream of this section of the F2 feeder consisting of both residential and commercial. The existing pole line along Perth St was built in the 60's with 35' to 40' poles. This section of line runs through a municipal sidewalk right of way that joins Albert St and Perth St for pedestrians. Accessibility is limited due to space, terrain and trees/undergrowth.

The age and condition of the existing poles and pole line hardware necessitate this rebuild project. Installing the primary underground through the hard to access portion of this circuit will enable the ability to maintain reliability without clear cutting established mature trees.

Scope:

Install new poles, switches, hardware and string 336 AL primary conductor, and 3/0 secondary triplex along south section.

Install new riser poles, street light poles, switches, secondary conductor, underground conduit, and 350 MCM primary underground cable.

Job Reference: CP48	Total Job Amount: \$65,408.21
Investment Category: System Renewal	Description: Chalmers St
Service Start Date: June 2014	In Service Date: December 2014
Related Customer Attachments: N/A	

Need:

The pole line along Chalmers St, between Mill St and David St is a 2.4/4.16 kV single circuit normally fed from the F6 feeder out of Elora MS-2 station. There are 366 customers connected along and downstream of this section of the F6 feeder consisting of mostly residential services. The existing single circuit pole line was built in the 50's with sporadic pole replacements over the years.

The age and condition of the existing poles and pole line hardware is a consideration to this rebuild project. Along with the need to install another circuit in this area, close to the Elora MS-1 station to supply the increased residential customer base load IN the North East area of Elora.

Scope:

Install new poles, switches, hardware and string 336 AL primary conductor for 2, 3 phase circuits and 3/0 secondary triplex along Chalmers St from Mill St to David St. Replace all transformers and secondary services where necessary.

Job Reference: CP51	Description: Elora MS1 De commissioning and F1 F2 Feeder rerouting
Investment Category: System Renewal	
Service Start Date: September 2014	In Service Date: December 2014
Total Job Amount: \$98,873.10	
Related Customer Attachments: N/A	

Need:

A new station is being built in Bissell Park along Mill St E to replace the existing Elora MS-1 Station currently located at 10 Mill St E in Elora. The Existing Station including Transformer and all Secondary (2.4/4.16kV) equipment and apparatus will be removed from the sight for de-commissioning.

Currently the F1 and F2 Feeders egressing the existing Elora MS-1 Station leave the station via the load side of reclosers to an underground vault outside the Station perimeter.

To facilitate de-commissioning the property the current station is located on all equipment must be removed from service and physically removed from the site. This includes the existing F1 and F2 Feeder cables egressing the station, which need to be rerouted outside the P/L.

Scope:

The F1 feeder cables will be removed from the existing riser pole, through the U/G vault, to inside the station. New cable will be installed and spliced to existing cable heading West along Mill St. The F2 cables will be removed from the riser pole to the U/G vault and new cable will be installed and spliced to existing cable Heading South.

2015 Capital Jobs over Materiality Threshold

Job Reference: CP30	Total Job Amount: \$145,536.90
Investment Category: System Renewal	Description: Fergus Library parking
Service Start Date: April 2015	In Service Date: November 2015
Related Customer Attachments: N/A	

Need:

The County of Wellington is developing an expansion of its Fergus Library branch. In conjunction with the Library expansion, the Township is reconstructing the parking and parkland adjacent to the Library building. Centre Wellington Hydro currently has a 3 phase overhead radial circuit normally fed from the F8 feeder running through the affected area. This Feeder services customers on both sides of the proposed library building.

The Library will be extended in to the existing overhead pole line right of way, therefore requiring all overhead plant to be replaced with underground to service current customers. The reconstructed Library will require a new underground service. The surrounding parking and parkland reconstruction will include extensive excavation and replacement of Centre Wellington Hydro plant, which will be placed underground. A loop feed will enhance reliability and maintenance operations

Scope:

This rebuild will include the installation of underground primary cable placed in conduit and new underground services in conduit. One MJ unit, three (3) 3phase vaults and transformers, and two single-phase vaults and transformers will be installed

Job Reference: CP49	Total Job Amount: \$121,676.86
Investment Category: System Renewal	Description: Gartshore M3 Poles
Service Start Date: May 2015	In Service Date: July 2015
Related Customer Attachments: N/A	

Need:

The poleline along Gartshore St, North of Garafraxa St in Fergus is a high priority section due to CWH's M3 (44 kV) circuit which is the main feed for all of Fergus load. Also Hydro One's M1 (44 kV) circuit that is the main feed servicing the town of Arthur's load and Distribution Stations along the way. This section of line is approximately 4 km downstream from the Fergus TS and as such, the M1 and M3 have the entire load on these circuits on it. Hydro One also has an 8 kV distribution circuit on the pole line and CWH has a 4 kV distribution circuit on it for a total of 4 circuits.

Age and condition of the existing poles is a consideration for rebuilding this section. As well, a main switch (FE-5) on the M3 circuit just inside CWH's demarcation point requires replacing, as

determined through CWH's switch Maintenance program. Another factor is preparing for a residential development adjacent to the pole line, which will need two feeds for a loop system, which will come from said poleline.

The pole line is in poor condition, task would be considered critical in continuing to supply reliable dependable service

Scope:

The scope of this project will include rebuilding the poleline approximately 210 m with five new poles and transferring the existing conductor. A new Load Break switch will be installed to replace the current FER-5 faulty switch. The poles will be sized and situated in a manor to accommodate the future development lands.

Job Reference: CP53	Total Job Amount: \$807,551.19
Investment Category: System Renewal	Description: Gartshore M3 Rehabilitation
Service Start Date: April 2015	In Service Date: July 2015
Related Customer Attachments: N/A	

Need:

The 2012 Metsco Energy Solutions, in partnership with Centre Wellington Hydro, completed an asset condition assessment study which the objective of establishing the health and condition of the fixed assets employed at CWH distribution system and provided an asset management plan. The asset condition assessment indicated that there were concerns with fence security and grounding issues. Some deficiencies related to power transformers, distribution-side switchgear, protection and control equipment and underground cables. Comments were also made by Costello Associates about environmental concern with proximity to municipal water supply; cables near end of life (19 years in 2011), possible protection issue with 400A fuses and possible bushing leak.

In the Costello report, the station received a "Red" condition assessment in 2011 due to the lack of transformer oil containment and the fact that the station is adjacent to a municipal well. The station is equipped with 5 kV fused-switchgear, and there is no opportunity for SCADA or SG functionality. If this functionality is desired, the fused switchgear must be replaced with metalclad switchgear/breakers or three phase reclosers. The Costello inspection showed that there is a metallic communication cable connecting the substation to the Hydro office next door. This metallic cable will transfer the station GPR to the building under fault conditions,

and is a serious safety concern. Costello strongly recommend that this cable be replaced with a fibre optic cable or at a minimum optical isolation be provided to the station.

Scope:

Add three new padmount reclosers, c/w SEL 651R controllers. Add one new bay of S&C 5kV switchgear. New SCADA RTU and total station metering. New 4.16 kV feeder cables. Expand yard as necessary to accommodate equipment.

Job Reference: CG1611	Total Job Amount: \$68,020.08
Investment Category: General Plant	Description: Computer Software
Service Start Date: On going	In Service Date: Ongoing
Related Customer Attachments: N/A	

Projects in account 1611 include the following individual projects:

- Cayenta (Financial Software) upgrade \$66,178.75
- Spidacalc Engineering design software \$1,841.33

Need:

In order to stay on a current financial software platform an upgrade is required. There have been many enhancements made to Cayenta that makes it more user friendly as well as more functional for reporting and inputting information since our implantation in 2010.

Scope:

The upgrade includes all aspects of Cayenta financials that were purchased in 2010, including, GL, Payroll, Work Orders, Fixed Assets, Accounts Payable, Purchasing, Receiving, Inventory, Misc AR and Job Costing.

Job Reference: CG1920	Total Job Amount: \$71,184.04
Investment Category: General Plant	Description: Computer hardware
Service Start Date: Ongoing	In Service Date: Ongoing
Related Customer Attachments: N/A	

Projects in account 1920 include the following individual projects:

- Cisco Switch \$7,143.83
- Gatekeepers Modem \$61,132.40
- Laptop for Manager of Operations \$2,907.81

Need:

In 2015, Bell phased out the 1xRTT (CDMA) cellular network that CWH used to connect to the ELSTER Collectors/Gatekeepers that are used to collect, store and transmit interval meter data. New Gatekeepers were required with modems that could operate on Bells upgraded communications Technology in the LTE cellular network. The new gatekeepers utilize the ANSI C12.22 protocol, specifically designed for wireless IP communications where the previous gatekeepers utilized the ANSI C12.21 protocol designed for land line telephone communications. The gatekeepers, with the C12.22 protocol, greatly increase the utility's ability to leverage the AMI network for additional features such as power outage and restoration notification through an Outage management system (OMS), voltage monitoring, and communicating with In Home Displays (IHD).

Gatekeepers are the link to collecting all smart meter data as well as 2-way communication in the MESH network that allows for information and firmware upgrades to be pushed to the meters. CWH is currently using data from the meters to monitor power status through an Outage Management System and the Gatekeepers are an integral component of the system. In future these gatekeepers will continually be upgraded to accommodate the advanced technologies being introduced to the Distribution System and customers' homes.

Scope:

Required Gatekeeper replacement involves coordination with our smart meter technology provider, ELSTER/HONEYWELL and our Smart meter Network management service provider Olameter. Gatekeepers are spec'd with an electric meter type, including firmware version and modems are configured to the network of choice then a schedule of the physical replacement is decided. Smart meter data is collected from all meters and then the meters are disassociated with the gatekeepers and the gatekeepers are removed. The new gatekeepers are installed and the network is built by meters associating themselves with the new gatekeepers. The network communications is tested and smart meter connections checked and data reporting verified.

Job Reference: CG1930	Total Job Amount: \$421,051.52
Investment Category: General Plant	Description: Transportation Equip
Service Start Date: Ongoing	In Service Date: Ongoing
Related Customer Attachments: N/A	

Project in account 1930 include the following individual projects:

- Replace 1995 Bucket Truck \$393,532.58
- Replace Pole Trailers \$27,518.94

The following are the need and scope for the purchase of the Bucket Truck.

Need:

The truck that was being replaced was a 1995 double bucket truck and reached its end of use life. The double bucket truck is vital in the operations for CWH's line crew.

Scope:

A tender for a replacement was issued in 2014 due to long delivery times on new bucket trucks.

2016 Capital Jobs over Materiality Threshold

Job Reference: CP7	Total Job Amount: \$51,617.89
Investment Category: System Renewal	Description: Pole Replacement
Service Start Date: Ongoing as required	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Need:

Throughout any year, a number of poles are changed for various reasons. Sometimes work at a location is expanded to include poles that do not have to be changed for the usual reasons such as age, rot, splitting, height, etc. The poles are changed because it makes sense to change them when we are at that location and can include the work in the capital budget rather than the maintenance budget.

Scope:

New conductors and insulators are purchased to replace substandard #6 solid conductor at the following locations: Hill St from St David St to Gowrie St; St George St W at Maiden Lane; MacAllister St from Process St to Argyll St; Victoria St from Forfar to Parkside St; James St from Garafraxa St to Forfar St; Johnson St North and South and Churchill Cres W.

Job Reference: CP9	Service Start Date: Ongoing as required
Investment Category: System Renewal	Total Job Amount: \$78,568.67

Description: Transformers	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Need:

CWH needs to purchase various new transformers in order to replace stock that are installed either for new connections, damaged by lightening or replacement of older transformers.

Scope:

Transformers will now only be ordered to replace any that are used so that CWH can keep inventory at the same level. Replacement transformers are for those that were used in the previous year.

Job Reference: CP59	Description: Shortreed–Highland to McTavish
Investment Category: System Renewal	
Service Start Date: June 2016	In Service Date: Sep 2016
Total Job Amount: \$215,179.65	
Related Customer Attachments: N/A	

Project Driver:

CWH currently has eight poletran transformers in its service territory. All transformers are fed with 5 KV direct buried cable. The primary cables are at the end of their expected life span. Poletrons based on their design have been found to be a hazard to employees during maintenance procedures. Current distribution standards would be better met with 15KV cable being installed in 4' pvc duct.

Need:

There are six remaining poletrons to replace as a continuation from Argyll Street poletran replacement project, started in 2013. Polestrans in the above named streets were installed in 1974. Due to their age and limited safe working area, replacement should go ahead in 2016.

Scope:

Centre Wellington Hydro will contract out the directional bore portion of this project. Contractor is to install ducts, primary cable and excavate near existing poletrons to allow CWH crews to splice primary and secondary conductors. CWH crew to install concrete light standards to replace lighting form poletrons.

Job Reference: CP62	Total Job Amount: \$287,507.57
Investment Category: System Renewal	Description: Water St Widening
Service Start Date: May 2016	In Service Date: Oct 2016
Related Customer Attachments: N/A	

Project Driver:

Township of Centre Wellington has decided to widen Water Street in Elora between Bridge and High Street. This has provided CWH the opportunity to move primary O/H conductor to UG conductor. Project was started by Township in 2015 but not completed.

Need:

Mature tree growth will lead to many unplanned outages due to contact with O/H primary lines. Tree trimming would include tree removal as growth is in close proximity to existing line.

Scope:

Install four new 50 kVA pad mount transformers; Remove existing 1/0 O/H primary conductor; Install new 4" duct with new 1/0 primary U/G conductor.

Job Reference: CP64	Total Job Amount: \$491,599.70
Investment Category: System Renewal	Description: MS2 Elora Rehabilitation
Service Start Date: April 2016	In Service Date: July 2016
Related Customer Attachments: N/A	

Project Driver:

The study completed for the C.W.H. A.M.P plan calls for rehabilitation on Station #2 Elora based on worker/public safety. Also on risk of equipment, failure and future smart grid applications. The age of the station (built in 1997) and age of feeder cables (19 years old) are also a concern.

Need:

Project would include, but is not limited to, transformer/switchgear upgrades and additions to allow for future smart grid applications. Improved station grounding and perimeter fencing for improved security and worker/public safety. Based on CWH AMP, age of the station would be a factor in rehabilitation as to prevent equipment failures based on deterioration of plant.

Scope:

Design-Replace existing hydraulic reclosers with three phase electronic reclosers, c/w SEL 651R recloser controllers; new SCADA RTU and total station metering; voltage 44-4.16/2.4 kV; Installed capacity 5000 kV; switchgear type - outdoor overhead busses; main breaker - none; feeder breakers - 15 kV 800A solid dielectric; schedule - budget.

Job Reference: CP65	Total Job Amount: \$691,579.69
Investment Category: System Renewal	Description: MS 4 Fergus Rehabilitation
Service Start Date: April 2016	In Service Date: July 2016
Related Customer Attachments: N/A	

Project Driver:

The Costello study found that some of the station grounding condition could affect public/worker safety. The station is also equipped with 5KV-fused switchgear, which limits opportunity for scada or sg functionality.

Need:

Station #4 Fergus would involve switchgear and transformer upgrades. Grounding and oil containment upgrades to the station would also be part of the rehabilitation. Construction would allow CWH to remain proactive in its effort to improve station security, worker/public safety efforts, and prepare for future Smart grid and Scada requirements as part of its AMP plan.

Scope:

Design-Add three new padmount reclosers, w/w SEL 651R controllers; new SCADA RTU and total station metering; new 4.16 kV feeder cables; expand yard as necessary to accommodate equipment. Voltage 44-4.16/2.4 kV; installed capacity 5000 kVA; switchgear type - outdoor metalclad and padmount (inside station fence); main breaker - none; feeder breakers - 15 kV 800A solid dielectric; schedule - budget.

Job Reference: CP66	Total Job Amount: \$59,773.19
Investment Category: System Renewal	Description: Stn 4 Fergus Risers
Service Start Date: June 2016	In Service Date: June 2016
Related Customer Attachments: N/A	

Project Driver:

The station # 4 rebuild in Fergus requires a new pole to meet distribution standards. The F-9, F-10, and F-11 feeders coming from the #4 station would be relocated to a new 70' class 1 wood pole. New hardware and component upgrades are expected, with updated framing and anchoring standards being used.

Need:

A taller pole will have to be installed, replacing the existing pole to meet ESA / USF framing standards on the new riser configuration. Would also allow for improved components and anchoring, leading to improved reliability.

Scope:

This project will include installing a new 70" class 1 wood pole, with relocation of the primary feed conductors. New framing and material will have to be added to the new pole installation. Would also include transferring old plant from the old pole to the new pole with removal of the old pole to follow. A vac contractor would be used to excavate for installation of new pole and underground plant.

Job Reference: CG1908	Total Job Amount: \$73,701.00
Investment Category: General Plant	Description: General Plant
Service Start Date: Ongoing	In Service Date: Ongoing
Related Customer Attachments: N/A	

Projects going to account 1908 included the following individual projects, none of which are over the threshold:

- Front Office Ramp \$3,260.00
- Building Siding \$17,280.00
- Building Windows \$46,016.00
- Building Fencing \$7,145.00

Job Reference: CG1920	Total Job Amount: \$55,095.83
Investment Category: General Plant	Description: General Plant
Service Start Date: Ongoing	In Service Date: Ongoing
Related Customer Attachments: N/A	

Projects going to account 1920 included the following individual projects, which were not above the threshold:

- Linemen Notebooks \$10,360
- Security System \$16,666.54
- Scada Mapping \$13,439.42
- Office computers/laptops \$14,629.87

Below are Capital projects that are planned to be completed, which are over the materiality threshold of \$50,000.

2017 Capital Jobs over Materiality Threshold

Job Reference: CP7	Total Job Amount: \$89,300.00
Investment Category: System Renewal	Description: Pole Replacement
Service Start Date: Ongoing as required	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Project Driver:

CWH will endeavour to replace 10 system poles per calendar year. Poles may be replaced due to age, concerns of public safety or condition. Poles may be replaced due to poor grading following infrared or Pollux testing. Will not include poles damaged by public or nature.

Risk:

Pole replacements are scheduled continuously as needed

Need:

CWH crews will contract outside vac service to excavate holes as required. CWH staff will remove and re install new poles as required. Work to include re framing of new poles according to USF standards.

Scope:

Poles will be re placed as required based on yearly O/H, Infrared and Pollux testing as part of CWH maintenance and inspection program.

Job Reference: CP9	Total Job Amount: \$80,000.00
Investment Category: System Renewal	Description: Transformers
Service Start Date: Ongoing as required	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Project Driver:

Overhead transformers and Underground transformers. CWH will require new transformers, both O/H and U/G to maintain a reasonable supply at our service centre to be able to respond to planned and unplanned transformer replacements and installs. CWH is preparing for a large subdivision in our service territory, therefore will increase our transformer stock. The exact number can't not be determined at this point.

Risk:

N/A

Need:

Purchasing plan to maintain reasonable transformer supply on hand for both planned and unplanned transformer installations.

Scope:

Yearly estimate of transformer supply required to plan for planned and unplanned transformer needs.

Job Reference: CP33	Total Job Amount: \$244,100.00
Investment Category: System Access	Description: Wellington Place Service
Service Start Date: Once contract awarded	In Service Date: Q4 2017
Related Customer Attachments: N/A	

Project Driver:

The County of Wellington has requested a preliminary offer to connect and service a proposed hospital (Groves Memorial) relocation on County property in Aboyne. The purpose of the project is to provide a line extension for new connection.

Risk:

Contract has yet to be awarded to CWH

Need:

CWH has been asked to provide an offer to connect by Wellington County and Groves Hospital to extend the 44kV line to the new hospital site.

Scope:

Extend the 73M3 feeder by constructing a three phase u/g primary duct bank and install cable and terminations. The circuit will run from Beatty Line at St George St to the proposed Hospital site along a newly constructed road.

Job Reference: CP72	Investment Category: System Renewal
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Service Start Date:	July 2017	Description:	44kV Tie re Route
Total Job Amount:	\$140,200.00	In Service Date:	September 2017
Related Customer Attachments: N/A			

Project Driver:

The 73M3, 44KV feeder along St Andrew St and including a river crossing at Cameron St in Fergus is in need of upgrade. CWH plans to relocate the 44kV circuit along a new route through Queen St W to eliminate the need for the river crossing. Currently the crossing is a weak point in the system, with emergency repair access difficult. New feeder location would eliminate the crossing as a critical section, and future repairs being much more cost effective.

Risk:

Other capital work and unforeseen service work might delay start of project, but will be a priority to complete as scheduled.

Need:

Feeder is nearing life expectancy; upgrade is required as routine maintenance also allows for better routing of feeder to allow CWH access in emergency and planned situations.

Scope:

Install 16 65' poles on Queen St. /install 3 circuits of 336 conductor.

Job Reference:	CG1908	Total Job Amount:	\$55,000.00
Investment Category:	General Plant	Description:	Cold Storage Shed
Service Start Date:	May 2017	In Service Date:	June 2017
Related Customer Attachments: N/A			

Project Driver:

The original Cold Storage building was built in 2003 because CWH was having issues with theft of materials that was stored outside even though CWH had built a fence around the property and installed a security gate. Because of the increase in size of transportation equipment and previous case of theft of property when not under roof CWH deems it necessary to extend the existing cold storage building. Job was deferred from 2016 because of delay in getting the various permits.

Risk:

Work to be completed by contractor as scheduled.

Need:

CWH is planning an addition on the cold storage building that was built in 2003. The original building is not large enough to hold the all of the inventory and the emergency generator and forklift. CWH does not think it is prudent to leave the generator and forklift outside in the weather because this would result in the useful life being decreased.

Scope:

The construction will include all excavation, footings, concrete floating floor and building framing for 32'X56'X16'h. Also to include both man and equipment door costs and installation. To include exterior steel trim with 29 gauge exterior steel cladding. Steel roofing and eaves trough are also included in the construction. Contractor is to provide engineered drawings, WSIB coverage, Crane rental, Skyjack rental and all cleanup post construction. Tendered quote is \$51,780.00 + HST

Job Reference:	CG1920	Total Job Amount:	\$62,500.00
Investment Category:	General Plant	Description:	Computer Hardware
Service Start Date:	Scheduled as needed	In Service Date:	Ongoing
Related Customer Attachments: N/A			

Projects going to account 1920 included the following individual projects, which were not above the threshold:

- Replacement of main server \$45,000.00
- Replace office staff (4) computers and (1) laptop \$12,400.00
- Replace small portable projector \$1,000.00
- Wireless system \$4,100.00

Job Reference:	CG1930	Total Job Amount:	\$400,000.00
Investment Category:	General Plant	Description:	Transportation Equip
Service Start Date:	Summer 2017	In Service Date:	Summer 2017
Related Customer Attachments: N/A			

Projects going to account 1930 included the following individual projects:

- Electric Vehicle \$50,000.00
- Single Bucket Truck \$350,000.00

Project Driver

Replacement of 2005 International Single Bucket Truck. The 2005 International bucket truck currently has reached its use of life based on asset management timelines. Purchase of a new single bucket would ensure CWH maintains operational standards. The current truck #5, due to its advancing age and condition, has consistently been the vehicle requiring the most servicing. Maintenance costs have been significantly higher on #5 than the other fleet vehicles.

CWH requires a vehicle for numerous tasks including hand delivering notices, water reads for billing purposes, system inspections, banking and attending meetings and training sessions that currently employees use personal vehicles for.

Risk:

No foreseen risks/availability of a new vehicle.

Need:

Bucket truck: Existing bucket will reach its end of use life in 2017 and will need to tender for a replacement in 2016 due to long delivery times on new bucket trucks.

EV: CWH currently expects employees to use their personal vehicle to perform such tasks as hand delivered notices, water reads for billing purposes, system inspections, banking and attending meetings and training sessions. Although this works there are times that employees for personal reasons do not have access to a personal vehicle.

Scope:

Bucket truck: In 2016, CWH hired a consultant to spec out the truck and obtain quotes for the work that needs to be done. CWH is replacing the single bucket truck in 2017.

EV: CWH does not currently have an electric or electric hybrid vehicle (EV) in our fleet. In keeping with the province's goal to encourage electric vehicle use Centre Wellington Hydro has installed an EV charger at our Fergus office/service centre location for customers and business attendees to use. To continue in supporting the EV initiative Centre Wellington Hydro plans on purchasing an EV to complete the many tasks associated with the need to drive to complete them. Along with installing the EV charging unit a residential electric meter has been installed for CWH to test the usage on the electric system to charge vehicles and their habits as related to company use.

2018 Capital Jobs over threshold

Capital Project Allocation: CP 7-1 Annual Pole Replacement Program			
CP 7-1	CP7	Discretionary / Non-discretionary:	
Investment Category:	System Renewal	Project Start Date:	2018
CWH yearly pole replacement program		Project End Date:	2018
Asset Category: Distribution Plant		Project Driver(s):	CWH will endeavour to replace 10 system poles per calendar year. Poles may be replaced due to age, concerns of public safety or condition. Poles may be replaced due to poor grading following infrared or Pollux testing. Poles damaged by public or nature are included in maintenance and not capital.
Background: Pole replacement 4 KV			

USoA Account:	Estimate Cost	Cost Allocation:	Life Cycle	2018 Budget	Final Costs
1830-PoleTowers & Fixtures-4KV	\$ 52,521.14	-1	45 Years	\$ 52,500	
1830-O/H conductor & devices-4KV	\$ 42,001.36	-2	60 Years	\$ 42,000	
Total Cost of Project	\$ 94,522.50			\$ 94,500	\$ -
Project Need:					
CWH crews will contract outside vac service to excavate holes as required. CWH staff will remove and re-install new poles as required. Work to include re-framing of new poles according to USF standards.					
Scope:					
Poles will be replaced as required based on yearly O/H, Infrared and Pollux testing as part of CWH maintenance and inspection program.					
Customer Attachments and Load (5.4.5.2 A.2)					
No. Residential Customers:	n/a				
No. GS <50kW Customers:	n/a				
No. GS>50 kW Customers:	n/a				
Load Impacted:	n/a				
Start Date (5.4.5.2 A.3)	Apr-18	In Service Date (5.4.5.2 A.3)			Apr-Dec 2018
2018					
Expenditure Timing	Q1	2018 Q2	2018 Q3	2018 Q4	
	0	\$29,333.33	\$29,333.33	\$29,333.33	
Risk Identification & Mitigation (5.4.5.2 A.4)					
This is a typical pole replacement, which CWH has undertaken for years. Work to begin during the start of the 2018 spring construction season. The most urgent poles, i.e. in unsafe disrepair, will be replaced in a priority.					
Comparative information on expenditures for equivalent projects/activities (5.4.5.2 A.5)					
REG Investment Details including Capital and OMA Costs (5.4.5.2 A.6)					
There are no REG investments associated with this project.					
Leave to Construct Approval Under Section 92 of the OEB Act (5.4.5.2 A.7)					
This project does not fall in the leave to construct category. Project will go forward using USF approved standards.					
Efficiency, Customer Value and Reliability - Investment Main Driver (5.4.5.2 B.1.a)					
Supply power reliability will be the main project driver					
Efficiency, Customer Value and Reliability - Investment Secondary Driver (5.4.5.2 B.1.a)					
Public safety will be the secondary project driver, replacement will lessen opportunity for poles or conductor to fall to the ground creating a very unsafe condition for the public					
Efficiency, Customer Value and Reliability - Investment Objectives and/or Performance Targets (5.4.5.2 B.1.a)					
The investment objectives are to mitigate the risk of power supply reliability from degrading below CWH targets.					
Efficiency, Customer Value and Reliability - Source and Nature of the Information used to justify the investments (5.4.5.2 B.1.a)					
The source of information for justification of this project is the asset condition report and based on past asset life expectancy targets.					
Efficiency, Customer Value and Reliability - Priority Level/Project Prioritization and Reasoning (5.4.5.2 B.1.b) Priority relative to other investments					
This is a medium priority project as other projects will be scheduled ahead of this one but as need and urgency rises this project will also take some priority					
Analysis of Project & Alternatives - Effect of the Investment on System Operation Efficiency and Cost-Effectiveness (5.4.5.2 B.1.c)					
Analysis of Project & Alternatives -Net Benefits Accruing to Customers (5.4.5.2 B.1.ci)					
Net benefits to customers have been qualitatively identified but have not been quantitatively calculated at this stage.					
Analysis of Project & Alternatives -Impact of the Investment on Reliability Performance including Frequency and Duration of Outages (5.4.5.2 B.1.cii)					

After replacement, this project will positively aid in reliability as deterioration or inadvertent falling will be minimized.
Project Alternatives (Design, Scheduling, Funding/Ownership (5.4.5.2 B.1.ciii))
There are no other alternatives, as it is CWH's sole owned poles which will need replacement
Project Alternatives (Design, Scheduling, Funding/Ownership (5.4.5.2 B.1.ciii))
see above
Safety (5.4.5.2 B2)
Public safety is a driver of this project and replacement will greatly aid in improved public safety at all levels
Cyber-Security, Privacy (5.4.5.2 B.3) (where applicable)
n/a
Co-ordination, Interoperability (5.4.5.2 B.4i) Recognized Standards, Co-ordination with Utilities, Regional Planning and/or 3rd Party Providers (where applicable)
Will be constructed with USF standards.
Co-ordination, Interoperability (5.4.5.2 B.4ii) Future Technological Functionality and/or Future Operational Requirements (where applicable)
USF standards account for future safety and construction standards which will accommodate future operational requirements
Economic Development (5.4.5.2 B.5) (where applicable)
Contributes to economic development by assuring reliability.
Economic Development (5.4.5.2 B.6) (where applicable)
n/a
Asset Performance-related operational targets & Asset lifecycle Optimization Policies and Practices (5.2.3 & 5.3.3) (5.4.5.2 SR-C1.1)
This project is prioritized based on asset lifecycle optimization policies.
Information on the Condition of the Assets Relative to their Typical life-cycle and Performance Record (5.4.5.2 SR-C1.2)
Poor or unsafe assets will be given priority in replacement scheduling
The number of customers in each class potential affected by failure of the assets (5.4.5.2 SR-C1.3)
Can't be calculated at this stage of the project
Quantitative Customer Impacts (5.4.5.2 SR-C1.4)
n/a
Qualitative Customer Impacts (5.4.5.2 SR-C1.5)
Unplanned pole failure and falling will affect all customers in a prolonged power outage. With planned replacement, that event is lessened immensely
Value of customer impact in terms of characteristics of customers potentially affected by failure that have bearing on the criticality and/or cost of failure (5.4.5.2 SR-C1.6)
see above
Timing and Priority of Project (5.4.5.2 SR-C2)
Medium priority to be scheduled along with other capital projects
Consequences for system O&M Costs (5.4.5.2 SR-C3)
Similar replacements require minimum impact on O&M costs
Impact on reliability performance and/or safety (5.4.5.2 SR-C4)
Positive impact on both reliability and safety.
Analysis of Project Benefits and Timing (5.4.5.2 SR-C5)
Pole replacement is given high priority as to benefits
Like for Like Renewal Analysis, Alternatives Comparison (like for like vs not like for like, timing, rate of replacements, etc.) (5.4.5.2 SR-C6)
Like for like replacement with updated USF standards incorporated

Capital Project Allocation:		CP9-9 OH Transformers & CP9-13 UG Transformers & Mtce	
CP 9-9 CP 9-13	CP9	Discretionary / Non-discretionary:	
Investment Category:	System Renewal	Project Start Date:	2018
Transformer replacements		Project End Date:	2018
Asset Category:	Distribution	Project Driver(s):	CWH will require new transformers, both O/H and U/G to maintain a reasonable supply at our service centre to be able to respond to planned and unplanned transformer replacements and installs.
Background:	Plant		
CWH reviews the current inventory levels of Overhead transformers and Underground transformers annually to ensure that CWH has			

sufficient on hand to meet the annual needs. Some transformers have long lead times that require CWH to have replacements on hand.					
USoA Account:	Estimate Cost	Cost Allocation:	Life Cycle	2018 Budget	Final Costs
1850 OH Transformers	\$ 30,000.00	-9	40 Years	\$ 30,000.00	
1850 UG Transformers	\$ 50,000.00	-13	30 Years	\$ 50,000.00	
Total Capital Cost	\$ 80,000.00			\$ 80,000.00	
5160-Mtce Line Transformers OH	\$ 4,113.19	MT510-1		\$ 4,100.00	
5160-Mtce Line Transformers OH	\$ 180.18	MT556-4		\$ 200.00	
5160-Mtce Line Transformers OH	\$ 5,917.78	MT561-7		\$ 5,900.00	
5160-Mtce Line Transformers UG	\$ 31,483.86	MT510-2		\$ 31,500	
5160-Mtce Line Transformers UG	\$ 1,311.41	MT561-8		\$ 1,300.00	
Total Maintenance Cost	\$ 43,006.41			\$ 43,000.00	
Total Cost of Project	\$123,006.41			\$123,000.00	
Project Need:					
Purchasing plan to maintain reasonable transformer supply on hand for both planned and unplanned transformer installations.					
Scope:					
Yearly estimate of transformer supply required to plan for planned and unplanned transformer needs.					

Customer Attachments and Load (5.4.5.2 A.2)				
No. Residential Customers:	6006			
No. GS <50kW Customers:	743			
No. GS>50 kW Customers:	49			
Load Impacted:	n/a			
Start Date (5.4.5.2 A.3)			In Service Date (5.4.5.2 A.3)	
Expenditure Timing	2018 Q1	2018 Q2	2018 Q3	2018 Q4
	25%	25%	25%	25%
Risk Identification & Mitigation (5.4.5.2 A.4)				
No risks are anticipated, project involves underground and overhead transformer replacement, maintenance and painting				
Comparative information on expenditures for equivalent projects/activities (5.4.5.2 A.5)				
CWH has maintained a transformer maintenance program for years, to better anticipate any transformer problems before they occur				
REG Investment Details including Capital and OMA Costs (5.4.5.2 A.6)				
n/a				
Leave to Construct Approval Under Section 92 of the OEB Act (5.4.5.2 A.7)				
Leave to construct does not apply. Transformers are purchased with approved CSA ANSI and CWH transformer specs. All specs are on file for each purchase				
Efficiency, Customer Value and Reliability - Investment Main Driver (5.4.5.2 B.1.a)				
Main driver is to have transformers on site and available for unseen replacement and planned conversions, to minimize customer outage times				
Efficiency, Customer Value and Reliability - Investment Secondary Driver (5.4.5.2 B.1.a)				
secondary driver would be to use maintenance i.e. painting and inspections to see any transformers which may be in need of replacement because of public safety, oil leaks -environmental, also saving on unplanned outage time for CWH customers				
Efficiency, Customer Value and Reliability - Investment Objectives and/or Performance Targets (5.4.5.2 B.1.a)				
Suitable transformer stock on site would greatly provide CWH with replacements to keep outage times very low and well within our performance targets				
Efficiency, Customer Value and Reliability - Source and Nature of the Information used to justify the investments (5.4.5.2 B.1.a)				
Historically CWH would replace 0-5 transformers in a year as a general course of attrition. Asset inventory and condition reports				

would require replacement based on life in service
Efficiency, Customer Value and Reliability - Priority Level/Project Prioritization and Reasoning (5.4.5.2 B.1.b) Priority relative to other investments
priority level is high in the sense that CWH must keep adequate stock on site to allow for replacement in planned and unplanned transformer replacements
Analysis of Project & Alternatives - Effect of the Investment on System Operation Efficiency and Cost-Effectiveness (5.4.5.2 B.1.c)
There aren't any other options feasible instead of having transformers on site. No neighboring LDC have CWH primary operating voltage to assist with a transformer
Analysis of Project & Alternatives -Net Benefits Accruing to Customers (5.4.5.2 B.1.ci)
Analysis of Project & Alternatives -Impact of the Investment on Reliability Performance including Frequency and Duration of Outages (5.4.5.2 B.1.cii)
transformers in stock greatly enhance CWH ability to limit outages and increase reliability targets
Project Alternatives (Design, Scheduling, Funding/Ownership (5.4.5.2 B.1.ciii)
CWH is sole owner of transformers
Project Alternatives (Design, Scheduling, Funding/Ownership (5.4.5.2 B.1.ciii)
see above
Safety (5.4.5.2 B2)
transformers replaced because of poor outer shell condition greatly aid in customer safety. Customers are provided proper barriers to any energized apparatus
Cyber-Security, Privacy (5.4.5.2 B.3) (where applicable)
Co-ordination, Interoperability (5.4.5.2 B.4i) Recognized Standards, Co-ordination with Utilities, Regional Planning and/or 3rd Party Providers (where applicable)
USF,ANSI,CSA,CWH standards are all on file for all transformer purchases
Co-ordination, Interoperability (5.4.5.2 B.4ii) Future Technological Functionality and/or Future Operational Requirements (where applicable)
current transformer standards and life expectancy are in incorporated in CWH transformer purchases
Economic Development (5.4.5.2 B.5) (where applicable)
by assuring sustainable power supply, new transformers contribute to economic development in this area
Environmental Development (5.4.5.2 B.6) (where applicable)
all new transformers purchased are PCB free, low grade mineral oil with no environmental issues. New tanks also contribute to chance of oil spills to be rare
Asset Performance-related operational targets & Asset lifecycle Optimization Policies and Practices (5.2.3 & 5.3.3) (5.4.5.2 SR-C1.1)
based on CWH asset replacement schedule
Information on the Condition of the Assets Relative to their Typical life-cycle and Performance Record (5.4.5.2 SR-C1.2)
see above
The number of customers in each class potential affected by failure of the assets (5.4.5.2 SR-C1.3)
Not available at this time
Quantitative Customer Impacts (5.4.5.2 SR-C1.4)
figures not available
Qualitative Customer Impacts (5.4.5.2 SR-C1.5)
Customers would be only impacted by planned outages to do replacements. Although an outage would be required, the duration would be greatly improved by having it occur during a planned outage.
Value of customer impact in terms of characteristics of customers potentially affected by failure that have bearing on the criticality and/or cost of failure (5.4.5.2 SR-C1.6)
Unplanned transformer failure provides a much longer and un planned outage for customers affected.
Timing and Priority of Project (5.4.5.2 SR-C2)
CWH will purchase a predetermined amount of transformers for in stock as required by usage.
Consequences for system O&M Costs (5.4.5.2 SR-C3)
Costs of replacements are incorporated into CWH budget
Impact on reliability performance and/or safety (5.4.5.2 SR-C4)
Transformers replace failed or dangerous transformers as needed with limited impact on performance
Analysis of Project Benefits and Timing (5.4.5.2 SR-C5)
Benefits are highest in risk mitigation

Like for Like Renewal Analysis, Alternatives Comparison (like for like vs not like for like, timing, rate of replacements, etc.) (5.4.5.2 SR-C6)

Like for like with updated equipment and standards applying

Capital Project Allocation: CP75					
St.Patrick-Gartshore to Herrick - DSP4A		Discretionary / Non-discretionary:			
Investment Category:	System Renewal	Project Start Date:		2018	
St.Patrick-Gartshore to Herrick - DSP4A		Project End Date:		2018	
Asset Category:	Distribution Plant	Project Driver(s):	As Phase #1 of St Patrick conversion (between Gartshore St and Herrick) poles are as much as 43 years in service. Pole condition and public safety are drivers of this project. The single phase line (F10 Station #4 Fergus) consists of deteriorating poles,#6 primary conductor with open secondary bus. New 40' wood poles with anchoring and guying would allow CWH to better comply with current USF framing standards.		
Background:					
Overhead Maintenance					
USoA Account:	Estimate Cost	Cost Allocation:	Life Cycle	2018 Budget	Final Costs
1835-OH Conductor & Devices 4 KV	\$ 45,654.19	-2		\$45,600.00	
1830-Poles Towers & Fixtures 44KV	\$ 39,958.96	-3		\$40,000.00	
1835-OH Conductor & Devices 44 KV	\$ -				
1845-UG Conductor & Devices 4 kV	\$ -				
Total Cost of Project	\$ 85,613.15			\$85,600.00	\$ -

Customer Attachments and Load (5.4.5.2 A.2)

No. Residential Customers:	45
No. GS <50kW Customers:	0
No. GS>50 kW Customers:	0
Load Impacted:	n/a

Start Date (5.4.5.2 A.3)	Apr-18	In Service Date (5.4.5.2 A.3)			May-18
Expenditure Timing	2018 Q1	2018 Q2	2018 Q3	2018 Q4	
	10%	90%	0	0	
Risk Identification & Mitigation (5.4.5.2 A.4)					
This is a typical line rebuild project and CWH has extensive experience in implanting projects of similar scope and content. The start date of this project may vary, and no risks are anticipated that would affect completion of this project.					
Comparative information on expenditures for equivalent projects/activities (5.4.5.2 A.5)					
Cost estimate is based on similar projects of similar scope in previous years and is considered accurate.					
REG Investment Details including Capital and OMA Costs (5.4.5.2 A.6)					

No REG investments associated with this project.
Leave to Construct Approval Under Section 92 of the OEB Act (5.4.5.2 A.7)
This project does not fall in the category requiring leave to construct
Efficiency, Customer Value and Reliability - Investment Main Driver (5.4.5.2 B.1.a)
Main driver of this project is pole condition. Some of the existing plant has been in service 43 years, and pole line is in disrepair.
Efficiency, Customer Value and Reliability - Investment Secondary Driver (5.4.5.2 B.1.a)
Secondary driver is public safety. Pole line condition would put it at risk to fall in windy conditions or winter conditions leading to possible injury to the public.
Efficiency, Customer Value and Reliability - Investment Objectives and/or Performance Targets (5.4.5.2 B.1.a)
Investment objective is to mitigate risk of power supply reliability
Efficiency, Customer Value and Reliability - Source and Nature of the Information used to justify the investments (5.4.5.2 B.1.a)
Pole inspection and asset management information was used to determine job need
Efficiency, Customer Value and Reliability - Priority Level/Project Prioritization and Reasoning (5.4.5.2 B.1.b) Priority relative to other investments
Project received priority based on asset condition in the field. Poles and hardware are in disrepair and at end of useful life cycle.
Analysis of Project & Alternatives - Effect of the Investment on System Operation Efficiency and Cost-Effectiveness (5.4.5.2 B.1.c)
No alternatives to this project, the pole line is a supply to a section of plant that must stay in service to keep customers connected
Analysis of Project & Alternatives -Net Benefits Accruing to Customers (5.4.5.2 B.1.ci)
Improved power delivery condition to customers
Analysis of Project & Alternatives -Impact of the Investment on Reliability Performance including Frequency and Duration of Outages (5.4.5.2 B.1.cii)
Will greatly reduce prolonged unforeseen outages
Project Alternatives (Design, Scheduling, Funding/Ownership (5.4.5.2 B.1.ciii)
No alternatives or co ownership opportunities available on this project
Project Alternatives (Design, Scheduling, Funding/Ownership (5.4.5.2 B.1.ciii)
See above
Safety (5.4.5.2 B2)
Public safety to greatly improve based on new construction standards and materials used
Cyber-Security, Privacy (5.4.5.2 B.3) (where applicable)
n/a
Co-ordination, Interoperability (5.4.5.2 B.4i) Recognized Standards, Co-ordination with Utilities, Regional Planning and/or 3rd Party Providers (where applicable)
USF standards to be implemented on project
Co-ordination, Interoperability (5.4.5.2 B.4ii) Future Technological Functionality and/or Future Operational Requirements (where applicable)
New material and assets to be reasonably expected to remain in service in to the future
Economic Development (5.4.5.2 B.5) (where applicable)
New build will not adversely affect future economic development
Environmental Development (5.4.5.2 B.6) (where applicable)
No significant impact on the environment
Asset Performance-related operational targets & Asset lifecycle Optimization Policies and Practices (5.2.3 & 5.3.3) (5.4.5.2 SR-C1.1)
Asset life cycle policies were used in planning this project
Information on the Condition of the Assets Relative to their Typical life-cycle and Performance Record (5.4.5.2 SR-C1.2)
The condition of these assets have been deemed to be in "poor" condition
The number of customers in each class potential affected by failure of the assets (5.4.5.2 SR-C1.3)
45 residential
Quantitative Customer Impacts (5.4.5.2 SR-C1.4)
n/a
Qualitative Customer Impacts (5.4.5.2 SR-C1.5)
Improved reliability and safety conditions for CWH customers
Value of customer impact in terms of characteristics of customers potentially affected by failure that have bearing on the criticality and/or cost of failure (5.4.5.2 SR-C1.6)

Timing and Priority of Project (5.4.5.2 SR-C2)
Will be a capital planned project in 2018 deemed a priority
Consequences for system O&M Costs (5.4.5.2 SR-C3)
No significant O&M costs
Impact on reliability performance and/or safety (5.4.5.2 SR-C4)
Great impact based on improved reliability and safety standards
Analysis of Project Benefits and Timing (5.4.5.2 SR-C5)
Timing helped lessen impact of risk to the reliability of our distribution
Like for Like Renewal Analysis, Alternatives Comparison (like for like vs not like for like, timing, rate of replacements, etc.) (5.4.5.2 SR-C6)
Like for like with improved USF standards and design

Capital Project Allocation: CP76					
St. Patrick-Gowrie to Herrick (DSP 4B)		Discretionary / Non-discretionary:			
Investment Category:	System Renewal	Project Start Date:		2018	
St. Patrick-Gowrie to Herrick (DSP 4B)		Project End Date:		2018	
Asset Category: Background:	Distribution Plant	Project Driver(s):	As a separate project (Phase 2 from Project N-A) The single phase pole line on St Patrick St between Herrick St and Gowrie (F10 feeder from Station #4 Fergus) is showing age and potential safety concerns. The poles were installed from 1972-1980 and the single phase primary is #6. Age and condition, as well as public safety are all considerations for the rebuild.		
Overhead maintenance					
USoA Account:	Estimate Cost	Cost Allocation:	Life Cycle	2018 Budget	Final Costs
1835-OH Conductor & Devices 4 KV	\$ 46,923.96	-2		\$46,900.00	
1830-Poles Towers & Fixtures 44KV	\$ 56,935.88	-3		\$56,900.00	
1835-OH Conductor & Devices 44 KV	\$ -				
1845-UG Conductor & Devices 4 kV	\$ -				
Total Cost of Project	\$ 103,859.84			\$103,800.00	\$ -
Project Need:					
Poles to be replaced/new conductor installed/new anchoring/new secondary bus					
Scope:					
Install 15-45' poles on St Patrick St between Gowrie St and Herrick St (F10 circuit from, Station #4 Fergus); upgrade primary conductor to 1/0 ACSR (approx. 400 meters) with new hardware and guying and anchoring to acquire current USF standards. Open secondary bus to be upgraded to 3/0 Al spun triplex conductor.					

Customer Attachments and Load (5.4.5.2 A.2)
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No. Residential Customers:	56				
No. GS <50kW Customers:	0				
No. GS>50 kW Customers:	0				
Load Impacted:	n/a				
Start Date (5.4.5.2 A.3)	May-18	In Service Date (5.4.5.2 A.3)			Jun-18
Expenditure Timing	2018 Q1	2018 Q2	2018 Q3	2018 Q4	
	0	100%	0	0	
Risk Identification & Mitigation (5.4.5.2 A.4)					
This is a typical line rebuild project. CWH has extensive experience in projects of similar scope and content. Risk is limited, project will be completed without any foreseeable delay					
Comparative information on expenditures for equivalent projects/activities (5.4.5.2 A.5)					
REG Investment Details including Capital and OMA Costs (5.4.5.2 A.6)					
No REG investment associated with this project					
Leave to Construct Approval Under Section 92 of the OEB Act (5.4.5.2 A.7)					
This project does not fall into the category of leave to construct					
Efficiency, Customer Value and Reliability - Investment Main Driver (5.4.5.2 B.1.a)					
Pole line condition is the main project driver. Some assets have been in service for over 40 years and are starting to deteriorate rapidly					
Efficiency, Customer Value and Reliability - Investment Secondary Driver (5.4.5.2 B.1.a)					
Public safety is a secondary driver. Improved equipment would lessen opportunity for plant to come to he ground harming any customers					
Efficiency, Customer Value and Reliability - Investment Objectives and/or Performance Targets (5.4.5.2 B.1.a)					
Mitigation of risk to power supply reliability					
Efficiency, Customer Value and Reliability - Source and Nature of the Information used to justify the investments (5.4.5.2 B.1.a)					
Poleline inspection and asset management information used to schedule this project					
Efficiency, Customer Value and Reliability - Priority Level/Project Prioritization and Reasoning (5.4.5.2 B.1.b) Priority relative to other investments					
Based on end of life cycle and deterioration used in prioritization of this project					
Analysis of Project & Alternatives - Effect of the Investment on System Operation Efficiency and Cost-Effectiveness (5.4.5.2 B.1.c)					
No alternative if continued power supply is to be maintained					
Analysis of Project & Alternatives -Net Benefits Accruing to Customers (5.4.5.2 B.1.ci)					
Improved reliability and pole line appearance					
Analysis of Project & Alternatives -Impact of the Investment on Reliability Performance including Frequency and Duration of Outages (5.4.5.2 B.1.cii)					
Greatly lessen opportunity for significant outages based on pole line condition					
Project Alternatives (Design, Scheduling, Funding/Ownership (5.4.5.2 B.1.ciii)					
No ownership or alternatives to this project					
Project Alternatives (Design, Scheduling, Funding/Ownership (5.4.5.2 B.1.ciii)					
See above					
Safety (5.4.5.2 B2)					
Great improvement in public safety					
Cyber-Security, Privacy (5.4.5.2 B.3) (where applicable)					
n/a					
Co-ordination, Interoperability (5.4.5.2 B.4i) Recognized Standards, Co-ordination with Utilities, Regional Planning and/or 3rd Party Providers (where applicable)					
USF standards to be implemented on project					
Co-ordination, Interoperability (5.4.5.2 B.4ii) Future Technological Functionality and/or Future Operational Requirements (where applicable)					
New material and framing standards to be expected to improve future functionality					
Economic Development (5.4.5.2 B.5) (where applicable)					
Will not adversely affect economic developments					
Environmental Development (5.4.5.2 B.6) (where applicable)					
No significant environmental impact					

Asset Performance-related operational targets & Asset lifecycle Optimization Policies and Practices (5.2.3 & 5.3.3) (5.4.5.2 SR-C1.1)	
Asset lifecycle policies used to implement this project	
Information on the Condition of the Assets Relative to their Typical life-cycle and Performance Record (5.4.5.2 SR-C1.2)	
Assets deemed to be in "poor" condition and in need of replacement	
The number of customers in each class potential affected by failure of the assets (5.4.5.2 SR-C1.3)	
56 residential	
Quantitative Customer Impacts (5.4.5.2 SR-C1.4)	
n/a	
Qualitative Customer Impacts (5.4.5.2 SR-C1.5)	
Improved reliability and safer conditions around pole line	
Value of customer impact in terms of characteristics of customers potentially affected by failure that have bearing on the criticality and/or cost of failure (5.4.5.2 SR-C1.6)	
Greatly limits impact from prolonged or unforeseen outages	
Timing and Priority of Project (5.4.5.2 SR-C2)	
Capital project in 2018 deemed a priority	
Consequences for system O&M Costs (5.4.5.2 SR-C3)	
No significant impact	
Impact on reliability performance and/or safety (5.4.5.2 SR-C4)	
Improved reliability and safety standards	
Analysis of Project Benefits and Timing (5.4.5.2 SR-C5)	
Lessen the impact of unforeseen plant failure	
Like for Like Renewal Analysis, Alternatives Comparison (like for like vs not like for like, timing, rate of replacements, etc.) (5.4.5.2 SR-C6)	
Like for like with improved framing standards	

Capital Project Allocation: CP 77					
St. George-Herrick to Gartshore (DSP #6)		Discretionary / Non-discretionary:			
Investment Category:	System Renewal	Project Start Date:		2018	
St. George-Herrick to Gartshore (DSP #6)		Project End Date:		2018	
Asset Category:	Distribution Plant	Project Driver(s):	Age and condition of pole line and conductor on St George St between Herrick and Gartshore (F10 station #4) are factors in this rebuild. Original poles and conductor were installed in 1963 and 1975. The single phase 2.4KV circuit has undersized conductor-#6 and #2 primary with porcelain insulators which will become a public safety concern.		
Background:					
Overhead Maintenance					
USoA Account:	Estimate Cost	Cost Allocation:	Life Cycle	Budget	Final Costs
1835-OH Conductor & Devices 4 KV	\$ 46,913.56	-2		\$ 46,900	
1830-Poles Towers & Fixtures 44KV	\$ 56,862.14	-3		\$ 56,900.00	
1835-OH Conductor & Devices 44 KV	\$ -				
1845-UG Conductor & Devices 4 kV	\$ -				
Total Cost of Project	\$ 103,775.70			\$ 103,800.00	\$ -

Project Need:					
Poles to be replaced/new conductor installed/new anchoring/new secondary bus.					
Scope:					
Install 14-45' poles on St George St between Gartshore and Herrick St (F10 station #4)/upgrade primary conductor to 1/0 ACSR along with pole hardware and anchoring and guys. Open and under sized secondary conductor to be replaced with 3/0 Al spun conductor.					

Customer Attachments and Load (5.4.5.2 A.2)					
No. Residential Customers:		53			
No. GS <50kW Customers:		0			
No. GS>50 kW Customers:		0			
Load Impacted:	n/a				
Start Date (5.4.5.2 A.3)	summer 2018	In Service Date (5.4.5.2 A.3)			fall 2018
Expenditure Timing	2018 Q1	2018 Q2	2018 Q3	2018 Q4	
	0	0	50%	50%	
Risk Identification & Mitigation (5.4.5.2 A.4)					
Typical line rebuild, CWH has vast experience is projects of similar scope and content					
Comparative information on expenditures for equivalent projects/activities (5.4.5.2 A.5)					
Cost estimate based on similar projects undertaken in past years.					
REG Investment Details including Capital and OMA Costs (5.4.5.2 A.6)					
No REG investment associated with this project					
Leave to Construct Approval Under Section 92 of the OEB Act (5.4.5.2 A.7)					
Project does not fall under leave to construct conditions					
Efficiency, Customer Value and Reliability - Investment Main Driver (5.4.5.2 B.1.a)					
Main driver is poor condition of overhead plant reliability and safety are all concerns					
Efficiency, Customer Value and Reliability - Investment Secondary Driver (5.4.5.2 B.1.a)					
Safety and reliability would be secondary drivers on this project					
Efficiency, Customer Value and Reliability - Investment Objectives and/or Performance Targets (5.4.5.2 B.1.a)					
Mitigation of risk of disruption in service and plant reliability					
Efficiency, Customer Value and Reliability - Source and Nature of the Information used to justify the investments (5.4.5.2 B.1.a)					
Pole visual inspection, infrared and asset management information all used to schedule this project					
Efficiency, Customer Value and Reliability - Priority Level/Project Prioritization and Reasoning (5.4.5.2 B.1.b) Priority relative to other investments					
Prioritization was established on condition of poles and overhead plant in this area					
Analysis of Project & Alternatives - Effect of the Investment on System Operation Efficiency and Cost-Effectiveness (5.4.5.2 B.1.c)					
No alternatives to project, plant to remain to service customers in this area					
Analysis of Project & Alternatives -Net Benefits Accruing to Customers (5.4.5.2 B.1.ci)					
Improved system reliability and safety					
Analysis of Project & Alternatives -Impact of the Investment on Reliability Performance including Frequency and Duration of Outages (5.4.5.2 B.1.cii)					
Reliability and performance targets will be improved from the project/unforeseen outages to be greatly reduced					
Project Alternatives (Design, Scheduling, Funding/Ownership (5.4.5.2 B.1.ciii)					
No alternatives or co funding on this project					
Project Alternatives (Design, Scheduling, Funding/Ownership (5.4.5.2 B.1.ciii)					
See above					
Safety (5.4.5.2 B2)					
Public and worker safety to be greatly improved as a by-product of the rebuild					
Cyber-Security, Privacy (5.4.5.2 B.3) (where applicable)					
n/a					

Co-ordination, Interoperability (5.4.5.2 B.4i) Recognized Standards, Co-ordination with Utilities, Regional Planning and/or 3rd Party Providers (where applicable)
USF standards and design to be used throughout the project
Co-ordination, Interoperability (5.4.5.2 B.4ii) Future Technological Functionality and/or Future Operational Requirements (where applicable)
New equipment and material expected to be in service and current into the near future to stay even with tech advances
Economic Development (5.4.5.2 B.5) (where applicable)
Not expected to hinder economic development
Environmental Development (5.4.5.2 B.6) (where applicable)
No negative environmental impacts expected during and after completion of this project
Asset Performance-related operational targets & Asset lifecycle Optimization Policies and Practices (5.2.3 & 5.3.3) (5.4.5.2 SR-C1.1)
Asset management data was used in targeting this project as a need
Information on the Condition of the Assets Relative to their Typical life-cycle and Performance Record (5.4.5.2 SR-C1.2)
Historical and asset data used
The number of customers in each class potential affected by failure of the assets (5.4.5.2 SR-C1.3)
53
Quantitative Customer Impacts (5.4.5.2 SR-C1.4)
n/a at this time
Qualitative Customer Impacts (5.4.5.2 SR-C1.5)
Greatly improve reliability/safety/appearance
Value of customer impact in terms of characteristics of customers potentially affected by failure that have bearing on the criticality and/or cost of failure (5.4.5.2 SR-C1.6)
Project to mitigate unplanned outages, to enhance reliability and lessen outage durations
Timing and Priority of Project (5.4.5.2 SR-C2)
It is a need project, work to begin and end in summer/fall 2018/no unforeseen delays
Consequences for system O&M Costs (5.4.5.2 SR-C3)
No significant costs expected
Impact on reliability performance and/or safety (5.4.5.2 SR-C4)
Large impact on both performance and safety targets and conditions
Analysis of Project Benefits and Timing (5.4.5.2 SR-C5)
2018 construction will satisfy improving reliability in reasonable time frame,
Like for Like Renewal Analysis, Alternatives Comparison (like for like vs not like for like, timing, rate of replacements, etc.) (5.4.5.2 SR-C6)
Like for like with improved materials and design standards

Capital Project Allocation:			
Transportation-Dump Truck			
Job Number:	CG1930-2	Discretionary / Non-discretionary:	
Investment Category:	General Plant	Project Start Date:	2018
		Project End Date:	2018
Asset Category:	General Plant	Project Driver(s):	The drivers for the replacement of the vehicle is age and maintenance fees.
Background: Purchase of Dump truck to replace the vehicle purchased in 2007 and will be 12 years old at that time. The Dump truck is scheduled to be replaced every 12 years unless inspections and maintenance deems that the life of the vehicle can be extended.			

USoA Account:	Estimate Cost	Cost Allocation:	Life Cycle	2018 Budget	Final Costs
Transportation Eq-1930	\$ 90,000.00	CG1930-2	12 Years	\$ 90,000.00	
Total Cost of Project	\$ 90,000.00			\$ 90,000.00	
Project Need:					
Centre Wellington Hydro's dump truck is used extensively in the disposal of branches during tree trim and throughout the year for various construction activities. The vehicle is now due for replacement. CWH has reviewed the schedule of vehicle replacement and has spread-out the vehicles to even out the financial costs.					
Scope:					
Centre Wellington Hydro will be replacing the current pickup truck with a similar vehicle. Quotes will be obtained from the various auto dealerships within the service area.					
Customer Attachments and Load (5.4.5.2 A.2)					
No. Residential Customers:	n/a				
No. GS <50kW Customers:					
No. GS>50 kW Customers:					
Load Impacted:					
Start Date (5.4.5.2 A.3)	N/A	In Service Date (5.4.5.2 A.3)			2018
Expenditure Timing	2018 Q1	2018 Q2	2018 Q3	2018 Q4	
		100%			
Risk Identification & Mitigation (5.4.5.2 A.4)					
Replacement of our oldest fleet vehicle. CWH employee and Ministry standards would require updating vehicle					
Comparative information on expenditures for equivalent projects/activities (5.4.5.2 A.5)					
Following asset life in service, truck is dated for replacement					
REG Investment Details including Capital and OMA Costs (5.4.5.2 A.6)					
N/A					
Leave to Construct Approval Under Section 92 of the OEB Act (5.4.5.2 A.7)					
N/A					
Efficiency, Customer Value and Reliability - Investment Main Driver (5.4.5.2 B.1.a)					
To avoid increased maintenance costs replacement is the main driver					
Efficiency, Customer Value and Reliability - Investment Secondary Driver (5.4.5.2 B.1.a)					
Customer and employee safety along with attention to Ministry of Transport standards for vehicle safety					
Efficiency, Customer Value and Reliability - Investment Objectives and/or Performance Targets (5.4.5.2 B.1.a)					
To mitigate rising maintenance costs					
Efficiency, Customer Value and Reliability - Source and Nature of the Information used to justify the investments (5.4.5.2 B.1.a)					
Asset life in use					
Efficiency, Customer Value and Reliability - Priority Level/Project Prioritization and Reasoning (5.4.5.2 B.1.b) Priority relative to other investments					
Medium priority, but CWH does use the vehicle on a daily basis					
Analysis of Project & Alternatives - Effect of the Investment on System Operation Efficiency and Cost-Effectiveness (5.4.5.2 B.1.c)					
Ease maintenance costs					
Analysis of Project & Alternatives -Net Benefits Accruing to Customers (5.4.5.2 B.1.ci)					
Not identified at this time					
Analysis of Project & Alternatives -Impact of the Investment on Reliability Performance including Frequency and Duration of Outages (5.4.5.2 B.1.cii)					
Not identified at this time					
Project Alternatives (Design, Scheduling, Funding/Ownership (5.4.5.2 B.1.ciii)					
Part of CWH owned fleet					
Project Alternatives (Design, Scheduling, Funding/Ownership (5.4.5.2 B.1.ciii)					
No alternatives, specific truck...dump box					

Safety (5.4.5.2 B2)
Safe vehicle for on road travel and on site travel
Cyber-Security, Privacy (5.4.5.2 B.3) (where applicable)
N/A
Co-ordination, Interoperability (5.4.5.2 B.4i) Recognized Standards, Co-ordination with Utilities, Regional Planning and/or 3rd Party Providers (where applicable)
N/A
Co-ordination, Interoperability (5.4.5.2 B.4ii) Future Technological Functionality and/or Future Operational Requirements (where applicable)
N/A
Economic Development (5.4.5.2 B.5) (where applicable)
N/A
Economic Development (5.4.5.2 B.6) (where applicable)
N/A
Asset Performance-related operational targets & Asset lifecycle Optimization Policies and Practices (5.2.3 & 5.3.3) (5.4.5.2 SR-C1.1)
Asset lifecycle policies followed to replace this vehicle
Information on the Condition of the Assets Relative to their Typical life-cycle and Performance Record (5.4.5.2 SR-C1.2)
See above
The number of customers in each class potential affected by failure of the assets (5.4.5.2 SR-C1.3)
N/A
Quantitative Customer Impacts (5.4.5.2 SR-C1.4)
N/A
Qualitative Customer Impacts (5.4.5.2 SR-C1.5)
N/A
Value of customer impact in terms of characteristics of customers potentially affected by failure that have bearing on the criticality and/or cost of failure (5.4.5.2 SR-C1.6)
N/A
Timing and Priority of Project (5.4.5.2 SR-C2)
Priority for 2018
Consequences for system O&M Costs (5.4.5.2 SR-C3)
Low impact
Impact on reliability performance and/or safety (5.4.5.2 SR-C4)
Low impact
Analysis of Project Benefits and Timing (5.4.5.2 SR-C5)
See asset lifecycle optimization policies
Like for Like Renewal Analysis, Alternatives Comparison (like for like vs not like for like, timing, rate of replacements, etc.) (5.4.5.2 SR-C6)
Like for like with updated equipment

2019 Capital Jobs over Materiality Threshold

Job Reference: CP7	Total Job Amount: \$90,500.00
Investment Category: System Renewal	Description: Pole Replacement
Service Start Date: Ongoing as required	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Project Driver:

CWH will endeavour to replace 10 system poles per calendar year. Poles may be replaced due to age, concerns of public safety or condition. Poles may be replaced due to poor grading following infrared or Pollux testing. Will not include poles damaged by public or nature.

Risk:

Pole replacements are scheduled continuously as needed

Need:

CWH crews will contract outside vac service to excavate holes as required. CWH staff will remove and re install new poles as required. Work to include re framing of new poles according to USF standards.

Scope:

Poles will be re placed as required based on yearly O/H, Infrared and Pollux testing as part of CWH maintenance and inspection program.

Job Reference: CP9	Total Job Amount: \$80,000.00
Investment Category: System Renewal	Description: Transformers
Service Start Date: Ongoing as required	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Project Driver:

Overhead transformers and Underground transformers. CWH will require new transformers, both O/H and U/G to maintain a reasonable supply at our service centre to be able to respond to planned and unplanned transformer replacements and installs.

Risk:

N/A

Need:

Purchasing plan to maintain reasonable transformer supply on hand for both planned and unplanned transformer installations.

Scope:

Yearly estimate of transformer supply required to plan for planned and unplanned transformer needs.

Job Reference: not assigned	Total Job Amount: \$110,900.00
Investment Category: System Renewal	Description: Victoria Terrace
Service Start Date: May 2019	In Service Date: June 2019
Related Customer Attachments: N/A	

Project Driver:

Upgrade poles and conductor on Victoria Terrace between Forfar St. and Strathallen, age and condition are factors/poles were installed from 1972 to 1998 but poles are in rough condition and are in need of upgrade. Circuit is the F9 from Fergus #4 station. 2.4KV voltage 3 phase .Poles and conductor are undersized. New poles to allow USF framing. Pole and insulators are in poor condition and are an issue for public safety.

Risk:

Weather or unforeseen service work

Need:

To upgrade services and conductor to customers /poles to be replaced/open bus secondary to be replaced.

Scope:

Install 14-45" poles on Victoria Terrace between Forfar and Strathallen. Install new 3 phase primary conductor (approx. 550 meters of 336)/upgrade secondary to 3/0 (approx. 550 meters)/install new #2 secondary to homes/install new pole line hardware, insulators, connections, anchors, guying to follow current USF framing standards.

Job Reference: not assigned	Description: St George: St David to Cameron
Investment Category: System Renewal	
Service Start Date: July 2019	In Service Date: August 2019
Total Job Amount: \$78,900.00	
Related Customer Attachments: N/A	

Project Driver:

The pole line on St George St between St David and Cameron St (F10 Station #4 Fergus) is a single-phase feed-2.4Kv with poles installed in 1963/The pole line and conductors are in poor

condition with public safety also a concern. Hardware, guying and anchors to be installed with framing to follow current USF standards. Secondary will be upgraded to 3/0 AL spun conductor

Risk:

Delays on earlier projects or weather

Need:

Poles to be replaced/new conductor installed/new anchoring/new secondary bus

Scope:

Install 18-45' poles on St George St between St David and Cameron St. on the Fergus F10 from Station #4 /upgrade primary conductor to 1/0 ACSR single phase. Install new pole line hardware, insulators, guying and anchors to comply with current USF standards replace secondary bus with 3/0 Al and install new connections with new materials.

Job Reference: not assigned	Description: Wellesley: Church to Colborne
Investment Category: System Renewal	
Service Start Date: September 2019	In Service Date: October 2019
Total Job Amount: \$56,000.00	
Related Customer Attachments: N/A	

Project Driver:

Upgrade poles and conductor, age and condition are factors/poles set 1989 but are deteriorating /safety is a concern.

Risk:

Delays on earlier projects or weather

Need:

To upgrade services and conductor to customers /poles to be replaced.

Scope:

Install 6-40" poles//upgrade secondary to 3/0

Job Reference: CP13	Service Start Date: ongoing 2019
Investment Category: System Service	Total Job Amount: \$65,400.00

Description: Revenue Meters	In Service Date: ongoing 2019
Related Customer Attachments: N/A	

Project Driver:

Replacement of failed meters, meter exchanges for reverification purposes and sample testing as per Measurement Canada regulations. C&I annual meter replacement needs are estimated as being: two new C&I Connections, 1 new generator connection, 1 upgrade to GS>50 and 3 annual meter failures. Reverification of C&I meters that have seals expiring in accordance with Measurement Canada regulations.

Risk:

No unforeseen risks

Need:

The majority of CWH smart meters for residential and GS <50 kW connections were installed in 2009 with a seal year of 2019, and the majority of the C&I meters for >50 kW connections were installed in 2009 and 2010. CWH has experienced a total meter failure (disposal) rate of 226 between 2009 and 2015. These failures have escalated to 69 in 2014 and 75 in 2015 for residential and small commercial meters and a year over year average of 3 meter failures for C&I meters.

Scope:

Pursuant to a sampling group schedule CWH plans on exchanging out of seal meters in the field with meters that have a current seal through a rotating meter reverification schedule. The bulk of active C&I meters have a seal year of 2019 therefore all of these meters will require testing and calibrating at an accredited meter shop. In addition, it is estimated that there is a requirement of six new C&I meters annually for new connections, generation, and service upgrades to GS>50.

Job Reference: CG1611	Total Job Amount: \$80,000.00
Investment Category: General Plant	Description: Computer Software
Service Start Date: Scheduled as needed	In Service Date: Ongoing
Related Customer Attachments: N/A	

Project Driver:

Cayenta Financial System is hosted through UCS with CWH, St Thomas Energy and Welland all on the same system. The last major upgrade to the Cayenta System took place March-June 2015. Major upgrades should be done once every three years to ensure that the LDC is taking advantage of all major program changes. The new upgrade allows for streamlining of processes, faster processing time and has a number of system enhancements that has taken place since the last major upgrade.

Risk:

CWH doesn't foresee any major risk that will require this project to be delayed. The timeframe to complete is not specific so CWH is flexible.

Need:

CWH is a member of Utility Collaborative Services (UCS) where programming, software, and hosting costs are shared and results in lower costs to all members. The upgrade allows CWH take advantage of programs changes and streamlining which in turns helps to reduce the need for additional staff to handle the day-to-day business.

Scope:

Upgrade of Cayenta Financial system to the latest Version for all UCS members. The cost reflected here is the CWH portion only.

2020 Capital Jobs over Materiality Threshold

Job Reference: CP7	Total Job Amount: \$91,400.00
Investment Category: System Renewal	Description: Pole Replacement
Service Start Date: Ongoing as required	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Project Driver:

CWH will endeavour to replace 10 system poles per calendar year. Poles may be replaced due to age, concerns of public safety or condition. Poles may be replaced due to poor grading following infrared or Pollux testing. Will not include poles damaged by public or nature.

Risk:

Pole replacements are scheduled continuously as needed

Need:

CWH crews will contract outside vac service to excavate holes as required. CWH staff will remove and re install new poles as required. Work to include re framing of new poles according to USF standards.

Scope:

Poles will be re placed as required based on yearly O/H, Infrared and Pollux testing as part of CWH maintenance and inspection program

Job Reference: CP9	Total Job Amount: \$80,000.00
Investment Category: System Renewal	Description: Transformers
Service Start Date: Ongoing as required	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Project Driver:

Overhead transformers and Underground transformers. CWH will require new transformers, both O/H and U/G to maintain a reasonable supply at our service centre to be able to respond to planned and unplanned transformer replacements and installs.

Risk:

N/A

Need:

Purchasing plan to maintain reasonable transformer supply on hand for both planned and unplanned transformer installations.

Scope:

Yearly estimate of transformer supply required to plan for planned and unplanned transformer needs

Job Reference: Not yet assigned	Total Job Amount: \$60,100.00
Investment Category: System Renewal	Description: DSP #2 Elora
Service Start Date: May 2020	In Service Date: June 2020
Related Customer Attachments: N/A	

Project Driver:

Upgrade poles and conductor, age and condition are factors/poles were set in 1965.

Risk:

N/A

Need:

To upgrade services and conductor to customers /poles to be replaced.

Scope:

Install 10-40" poles//upgrade secondary to 3/0/upgrade services

Job Reference: Not yet assigned	Total Job Amount: \$54,100.00
Investment Category: System Renewal	Description: John St: David to Colborne
Service Start Date: July 2020	In Service Date: August 2020
Related Customer Attachments: N/A	

Project Driver:

Upgrade poles and conductor on John St, Elora between Moir St and Colborne St (F-3 Feeder from Station #1 Elora) age and condition are factors/old poles installed 1989 but are in rough shape and will have to be changed for 40' wood poles to meet current USF framing standards.

Risk:

No risk is anticipated

Need:

To upgrade services and conductor to customers /poles to be replaced/open bus secondary to be replaced

Scope:

Install 6-40"wood poles/install new primary conductor(Approx. 500 meters of 1/0 ACSR)/upgrade secondary to 3/0(approx. 150 meters AL)/install new #2 secondary to homes/install new pole hardware, anchors and guying to meet current USF standard.

Job Reference: Not yet assigned	Total Job Amount: \$156,200.00
Investment Category: System Renewal	Description: Gzowski: Stn 4 to Herrick
Service Start Date: August 2020	In Service Date: September 2020
Related Customer Attachments: N/A	

Project Driver:

Poles were found to be deteriorating and in general poor condition based on CWH asset management plan. Poles to be upgraded to comply with current USF framing standards

Risk:

No risk is anticipated

Need:

To upgrade services and conductor to customers /poles to be replaced/open bus secondary to be replaced

Scope:

Replace 19 60' poles on Gzowski St.

Job Reference: CG1920	Total Job Amount: \$77,600.00
Investment Category: General Plant	Description: Computer Hardware
Service Start Date: Scheduled as needed	In Service Date: Ongoing
Related Customer Attachments: N/A	

Projects going to account 1920 included the following individual projects, which were not above the threshold:

- Upgrade Supervisory Equipment \$17,300.00
- Wi-Fi \$4,500.00
- Office Computer (1 desktop, 1 laptop) \$ 5,300.00
- SCADA server \$48,000.00
- Projector \$2,500.00

Job Reference: CG1930	Total Job Amount: \$300,000.00
Investment Category: General Plant	Description: Transportation Equip
Service Start Date: July 2020	In Service Date: July 2020
Related Customer Attachments: N/A	

Project Driver:

The digger derrick truck has reached its maximum lifespan in 2020. CWH in its efforts to use safe and efficient equipment will replace the radial boom derrick (RBD) in 2020

Risk:

No foreseen risks/availability of a new vehicle

Need:

Estimated costs of a 2020 RBD will fall near the \$300,000.00 range including taxes, delivery

Scope:

All aspects of the vehicle will be out for tenders

2021 Capital Jobs over Materiality Threshold

Job Reference: CP7	Total Job Amount: \$93,100.00
Investment Category: System Renewal	Description: Pole Replacement
Service Start Date: Ongoing as required	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Project Driver:

CWH will endeavour to replace 10 system poles per calendar year. Poles may be replaced due to age, concerns of public safety or condition. Poles may be replaced due to poor grading following infrared or Pollux testing. Will not include poles damaged by public or nature.

Risk:

Pole replacements are scheduled continuously as needed

Need:

CWH crews will contract outside vac service to excavate holes as required. CWH staff will remove and re install new poles as required. Work to include re framing of new poles according to USF standards.

Scope:

Poles will be re placed as required based on yearly O/H, Infrared and Pollux testing as part of CWH maintenance and inspection program

Job Reference: CP9	Total Job Amount: \$80,000.00
Investment Category: System Renewal	Description: Transformers
Service Start Date: Ongoing as required	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Project Driver:

Overhead transformers and Underground transformers. CWH will require new transformers, both O/H and U/G to maintain a reasonable supply at our service centre to be able to respond to planned and unplanned transformer replacements and installs.

Risk:

N/A

Need:

Purchasing plan to maintain reasonable transformer supply on hand for both planned and unplanned transformer installations.

Scope:

Yearly estimate of transformer supply required to plan for planned and unplanned transformer needs

Job Reference: Not yet assigned	Total Job Amount: \$52,600.00
Investment Category: System Renewal	Description: McNab St A
Service Start Date: May 2021	In Service Date: May 2021
Related Customer Attachments: N/A	

Project Driver:

Township of centre wellington will be doing road upgrades on McNab St Elora between High St and Bridge. The construction would allow CWH crews access to upgrade poles and conductor currently in rough and unsafe condition/safety with pole condition to be addressed/upgrade in hardware and guying to comply with USF framing standards.

Risk:

No risk anticipated

Need:

To upgrade services and conductor to customers /poles to be replaced

Scope:

Install 13-45" poles//upgrade secondary to 3/0 from existing #2 undersized conductor/upgrade services to repair unsafe and deteriorating connections/upgrade primary conductor from existing 1/0 and #2 to 336ACSR to meet current USF standards and too allow for future feeder route in the event of subdivision growth.

Job Reference:	Not yet assigned	Total Job Amount:	\$92,600.00
Investment Category:	System Renewal	Description:	McNab St B
Service Start Date:	June 2021	In Service Date:	July 2021
Related Customer Attachments: N/A			

Project Driver:

Upgrade poles and conductor, age and condition are factors/poles are getting older and safety is a concern.

Risk:

No risk anticipated

Need:

To upgrade services and conductor to customers /poles to be replace

Scope:

Install 13-45" poles//upgrade secondary to 3/0/upgrade services/upgrade primary

Job Reference: Not yet assigned	Description: Cameron St: Forfar to St Andrew St
Investment Category: System Renewal	In Service Date: September 2021
Service Start Date: July 2021	
Total Job Amount: \$94,100.00	
Related Customer Attachments: N/A	

Project Driver:

Upgrade poles and conductor on Cameron St between Forfar and St. Andrew St (Fergus Station #4 F10 Feeder), age and condition are factors/poles were installed in 1975, and are in poor condition/safety is a factor/a 3 phase 2.4KV primary circuit needs pole and conductor-insulator upgrades to better comply with current USF framing standards.

Risk:

No risk anticipated

Need:

To upgrade services and conductor to customers /poles to be replaced/open bus secondary to be replaced.

Scope:

Install 20-45" poles on Cameron between Forfar and St Andrews(approx. 1800 meters of 336 primary conductor to install)/install new primary and secondary insulators and connectors/upgrade secondary to 3/0/ (approx. 600 meters 3/0 AL)install new #2 secondary to homes/upgrade guys and anchors to USF standards

Job Reference: Not yet assigned	Total Job Amount: \$77,000.00
Investment Category: General Plant	Description: Computer Hardware
Service Start Date: not assigned	In Service Date: not assigned
Related Customer Attachments: N/A	

Projects going to account 1920 included the following individual projects:

- Office computers (2 desktops, 1 laptop) \$7,000.00
- Operation computers (2 laptops) \$5,000.00
- Gatekeeper \$65,000.00

Project Driver:

In 2015 Bell phased out the 1xRTT (CDMA) cellular network that CWH used to connect to the ELSTER Collectors/Gatekeepers that are used to collect, store and transmit interval meter data. New Gatekeepers were required with modems that could operate on Bells upgraded communications Technology in the LTE cellular network. The new gatekeepers utilize the ANSI C12.22 protocol, specifically designed for wireless IP communications where the previous gatekeepers utilized the ANSI C12.21 protocol designed for land line telephone communications. The gatekeepers, with the C12.22 protocol, greatly increase the utility's ability to leverage the AMI network for additional features such as power outage and restoration notification through an Outage management system (OMS), voltage monitoring, and communicating with In Home Displays (IHD).

Risk:

No risks are anticipated as the timing is flexible.

Need:

Gatekeepers are the link to collecting all smart meter data as well as 2-way communication in the MESH network that allows for information and firmware upgrades to be pushed to the meters. CWH is currently using data from the meters to monitor power status through an Outage management system and the Gatekeepers are integral component of the system. In future these gatekeepers will continually be upgraded to accommodate the advanced technologies being introduced to the Distribution system and customers' homes.

Scope:

Required Gatekeeper replacement involves coordination with our smart meter technology provider, ELSTER/HONEYWELL and our Smart meter Network management service provider Olameter. Gatekeepers are spec'd with an electric meter type, including firmware version and modems are configured to the network of choice then a schedule of the physical replacement is decided. Smart meter data is collected from all meters and then the meters are disassociated with the gatekeepers and the gatekeepers are removed. The new gatekeepers are installed and the network is built by meters associating themselves with the new gatekeepers. The network communications is tested and smart meter connections checked and data reporting verified.

2022 Capital Jobs over Materiality Threshold

Job Reference: CP7	Total Job Amount: \$94,900.00
Investment Category: System Renewal	Description: Pole Replacement
Service Start Date: Ongoing as required	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Project Driver:

CWH will endeavour to replace 10 system poles per calendar year. Poles may be replaced due to age, concerns of public safety or condition. Poles may be replaced due to poor grading following infrared or Pollux testing. Will not include poles damaged by public or nature.

Risk:

Pole replacements are scheduled continuously as needed

Need:

CWH crews will contract outside vac service to excavate holes as required. CWH staff will remove and re install new poles as required. Work to include re framing of new poles according to USF standards.

Scope:

Poles will be re placed as required based on yearly O/H, Infrared and Pollux testing as part of CWH maintenance and inspection program

Job Reference: CP9	Total Job Amount: \$80,000.00
Investment Category: System Renewal	Description: Transformers
Service Start Date: Ongoing as required	In Service Date: Ongoing as required
Related Customer Attachments: N/A	

Project Driver:

Overhead transformers and Underground transformers. CWH will require new transformers, both O/H and U/G to maintain a reasonable supply at our service centre to be able to respond to planned and unplanned transformer replacements and installs.

Risk:

N/A

Need:

Purchasing plan to maintain reasonable transformer supply on hand for both planned and unplanned transformer installations.

Scope:

Yearly estimate of transformer supply required to plan for planned and unplanned transformer needs

Job Reference: Not yet assigned	Description: Queen St Transformer Upgrade
Investment Category: System Renewal	In Service Date: June 2022
Service Start Date: May 2022	
Total Job Amount: \$700,000.00	
Related Customer Attachments: N/A	

Project Driver:

The S1 transformer will be the oldest station transformer in CWH service area and based on Costello's asset management plan will be past or nearing its service life maximum.

Risk:

Availability of contractor and transformer

Need:

Transformer to be removed from service and a new 5 mva transformer to be installed and put into service.

Scope:

Outside contractor to be hired to remove and replace the existing 5 MVA transformer. Station upgrades can also be considered at time of construction, to ensure reliable and safe continued service from station 1 Fergus.

Job Reference: Not yet assigned	Total Job Amount: \$70,400.00
Investment Category: System Renewal	Description: Albert St Pole upgrade
Service Start Date: May 2022	In Service Date: June 2022
Related Customer Attachments: N/A	

Project Driver:

Secondary poles need replacement on Albert St between Perth and Union age and condition are factors

Risk:

No risk anticipated

Need:

To upgrade poles and secondary due to age and condition and to improve reliability

Scope:

Installing 10-40' wood poles and conductor, both primary and secondary. New services to homes

Job Reference: Not yet assigned	Total Job Amount: \$84,600.00
Investment Category: System Renewal	Description: Gartshore St Pole upgrade
Service Start Date: June 2022	In Service Date: June 2022
Related Customer Attachments: N/A	

Project Driver:

CWH to upgrade five 70-foot poles on Gartshore

Risk:

No risk anticipated

Need:

Poles to be replaced/relocate hard to access poles/remove from private property.

Scope:

CWH to upgrade 5 70 foot poles on Gartshore

Job Reference: Not yet assigned	Total Job Amount: \$73,900.00
Investment Category: System Renewal	Description: David St: Irvine to Geddes (A)
Service Start Date: July 2022	In Service Date: August 2022
Related Customer Attachments: N/A	

Project Driver:

Upgrade 15 x 45' poles and 3 phase conductor and secondary

Risk:

No risk anticipated

Need:

To install 15x45' wood poles/install new o/h triplex/remove old poles and old conductor

Scope:

Upgrade 15 x 45' poles and 3 phase conductor and secondary

Job Reference: Not yet assigned	Total Job Amount: \$55,000.00
Investment Category: General Plant	Description: Computer Software
Service Start Date: Will depend on scheduling of UCS and Northstar, no specific start time	In Service Date: Approx. 3 months after start of project, it will not span a fiscal yearend
Related Customer Attachments: N/A	

Project Driver:

The NorthStar customer billing software last major upgrade was Nov 2014, with next upgrade schedule for 2018, then 2022. Between major releases should be upgraded at least once every 3 years. In between major releases, branch patches are completed. CWH's upgrades are done at the same time as other UCS members. The new upgrade allows for streamlining of processes, faster processing time and has a number of system enhancements that has taken place since the last major upgrade.

Risk:

No risk anticipated

Need:

CWH is a member of Utility Collaborative Services (UCS) where programming, software, and hosting costs are shared and results in lower costs to all members. The CIS billing systems, for UCS members, are upgraded at the same time, which results in lower costs to members. The reduction is the result of combined customer numbers with suppliers and shared testing amongst the member LDC's. CWH has been a member of UCS since 2007. Major upgrades allows for streamlining of processes that occur partly from regulatory requirements.

Scope:

Upgrade of NorthStar billing system to the latest Version for all UCS members. The cost detailed here is the CWH cost only.

4.3 Capital Project Prioritization

The capital projects have been prioritized based on the risk assessment process described in detail in Section 3.

4.4 O&M Investment Plan

Table 23 shows CWH's actual operating and maintenance expenditure during each of the past five years. The O&M activities include preventative maintenance of assets, minor repairs (which are not capitalized), tree trimming, power restoration following outages, line switching operations, testing and inspection of assets for regulatory compliance and asset management. While some of the O&M activities are proactively planned, the cost of which can be accurately estimated, some other activities, particularly those related to switching and power restoration, are performed in response to power interruptions, the cost of which cannot be accurately estimated in advance.

Table 23 indicates average annual expenditure of approximately \$1,111,000 on O&M activities, during the past five years.

Table 23: Historic O&M Expenditure

	2012	2013	2014	2015	2016	5-yr Average
Distribution Expenses - Operations	\$ 340,133	\$ 303,224	\$ 313,306	\$ 326,133	\$ 312,568	\$ 319,073
Distribution Expenses - Maintenance	\$ 280,611	\$ 317,930	\$ 283,489	\$ 310,601	\$ 354,386	\$ 309,404
Billing and Collecting	\$ 468,118	\$ 434,218	\$ 437,448	\$ 449,490	\$ 461,688	\$ 450,193
Community Relations	\$ 29,570	\$ 25,327	\$ 31,565	\$ 23,290	\$ 51,588	\$ 32,268
Total	\$ 1,118,432	\$ 1,080,699	\$ 1,065,808	\$ 1,109,514	\$ 1,180,232	\$ 1,110,937

In CWH's 2017 and beyond budgets, there are increases to the O&M expenses. Some of the drivers of these increases are additional materials and labour used in pole inspection and replacement, however, if a major storm occurs CWH will reallocate those funds to perform storm restoration, work as the historical 5 year annualised cost has increased due to storm activity in the area. Another added/increased expense is due to addressing the smart meter replacement and reverification of out of seal meters that were installed as a mass deployment in 2009. Increased costs for contract services are planned for painting padmount transformers to ensure public and environmental safety, as well as distribution station maintenance including major station equipment inspection, testing, and cleaning that has not been performed during the last 5 years during CWH's distribution stations major rebuild projects.

Full details of the increases are provided in Exhibit 4, Operating Costs of the Cost of Service.

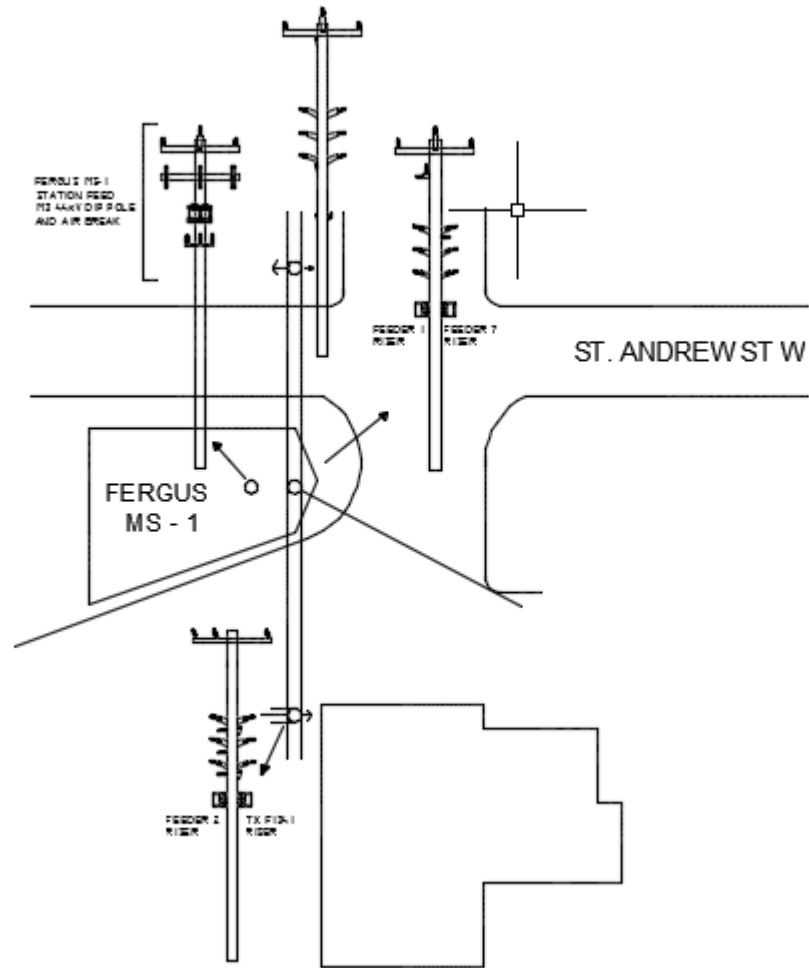
Table 24: Planned O&M Expenditure

	2017	2018	2019	2020	2021	2022
Operations	\$366,200	\$366,900	\$ 376,100	\$ 385,500	\$ 395,100	\$ 405,000
Maintenance	\$344,000	\$361,500	\$ 370,500	\$ 379,800	\$ 389,300	\$ 399,000
Billing and Collecting	\$487,500	\$520,700	\$ 533,700	\$ 547,000	\$ 560,700	\$ 574,700
Community Relations	\$55,900	\$43,500	\$ 44,600	\$ 45,700	\$ 46,800	\$ 48,000
	\$1,253,600	\$1,292,600	\$1,324,900	\$1,358,000	\$1,391,900	\$1,426,700

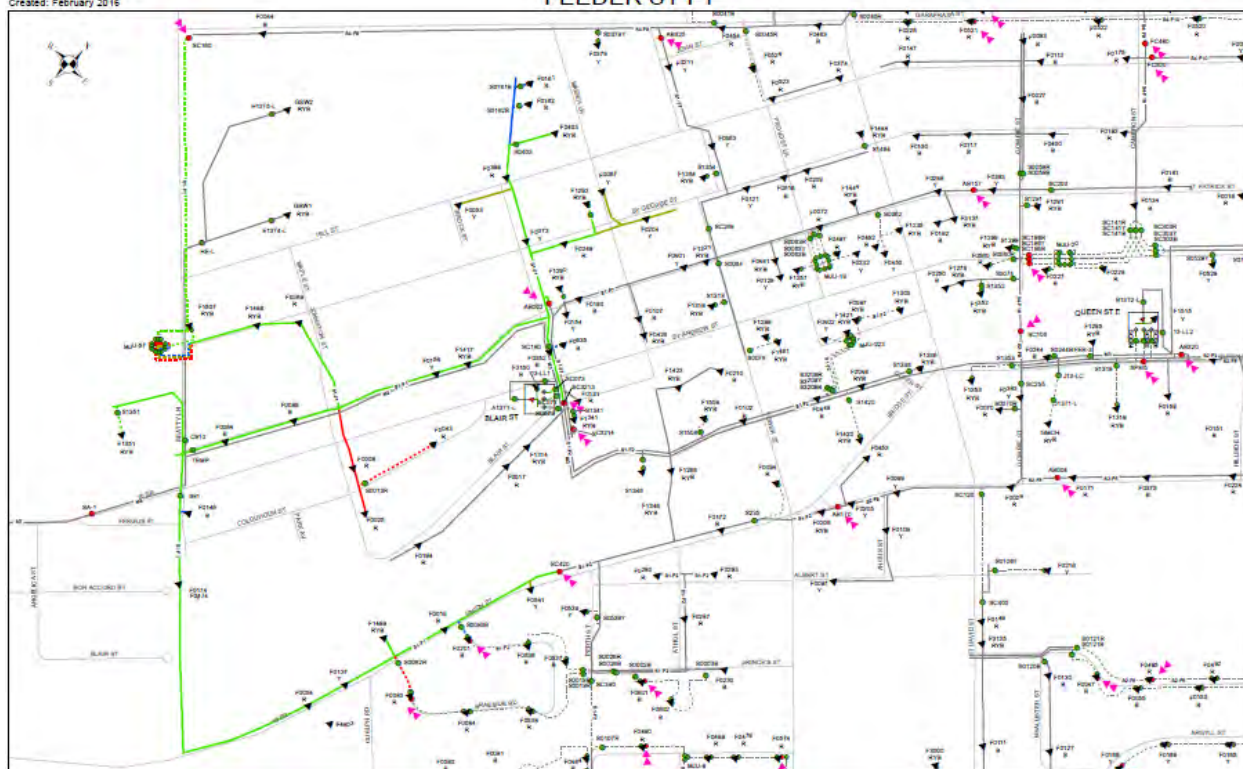
Appendix A

Distribution System Operating Maps

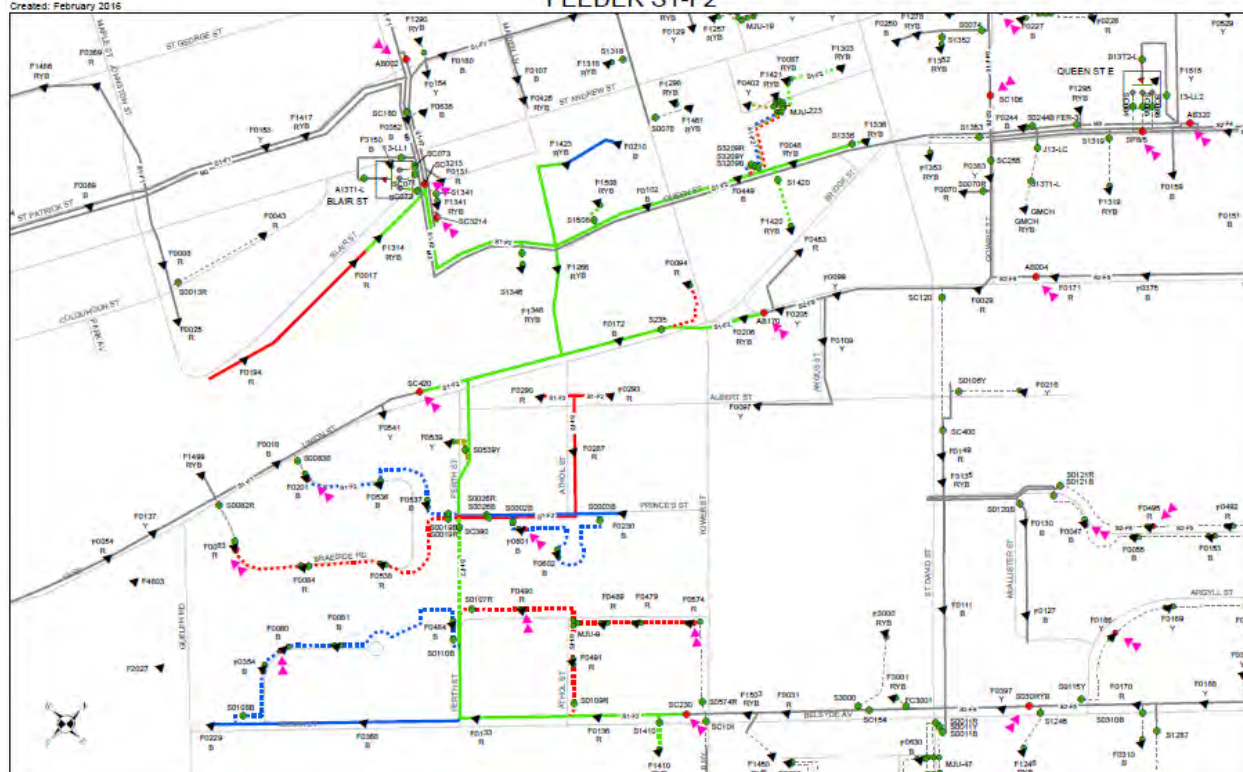
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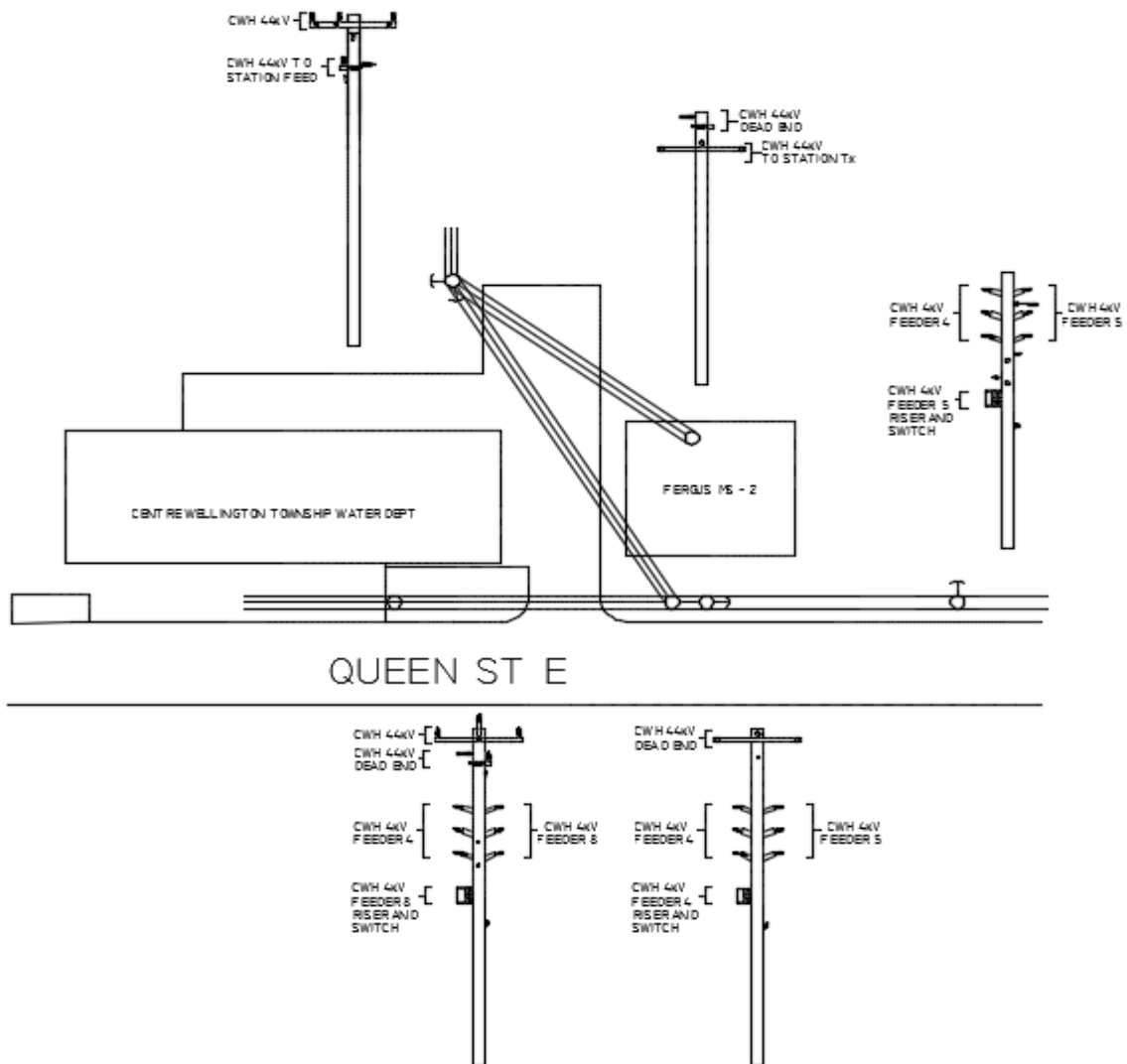


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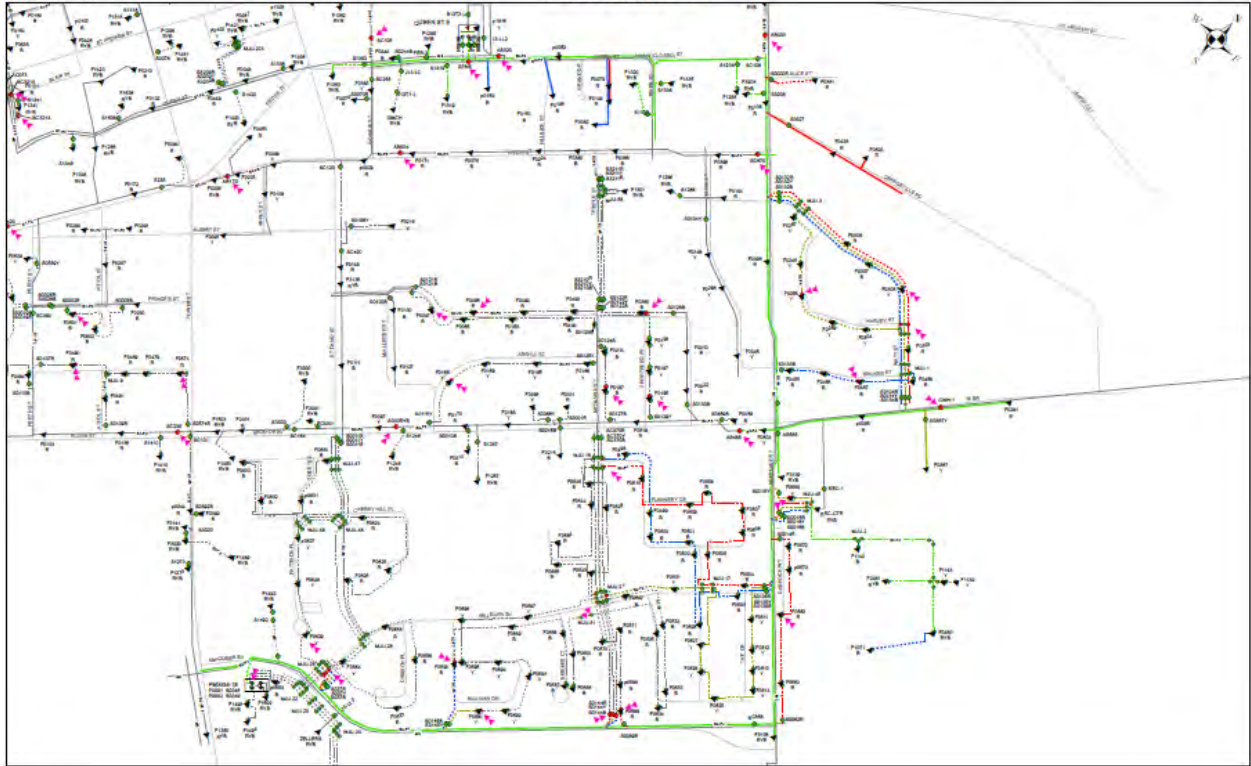


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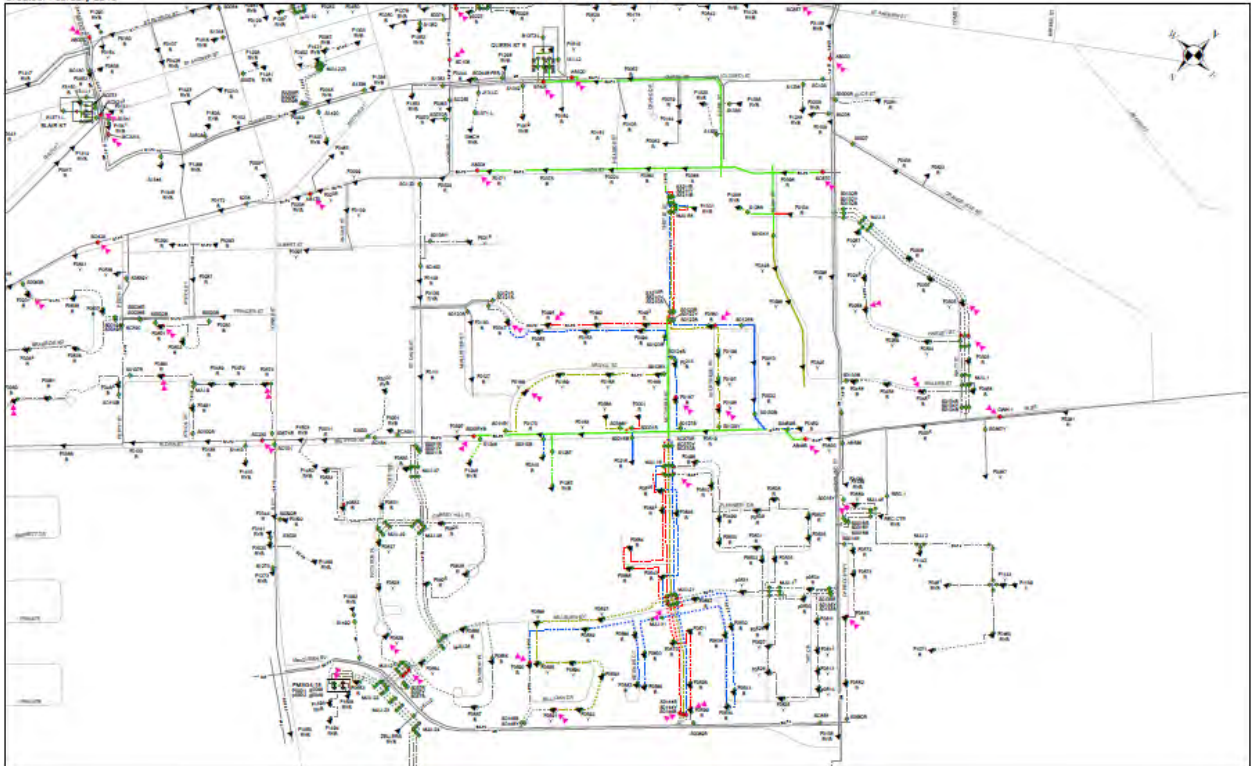
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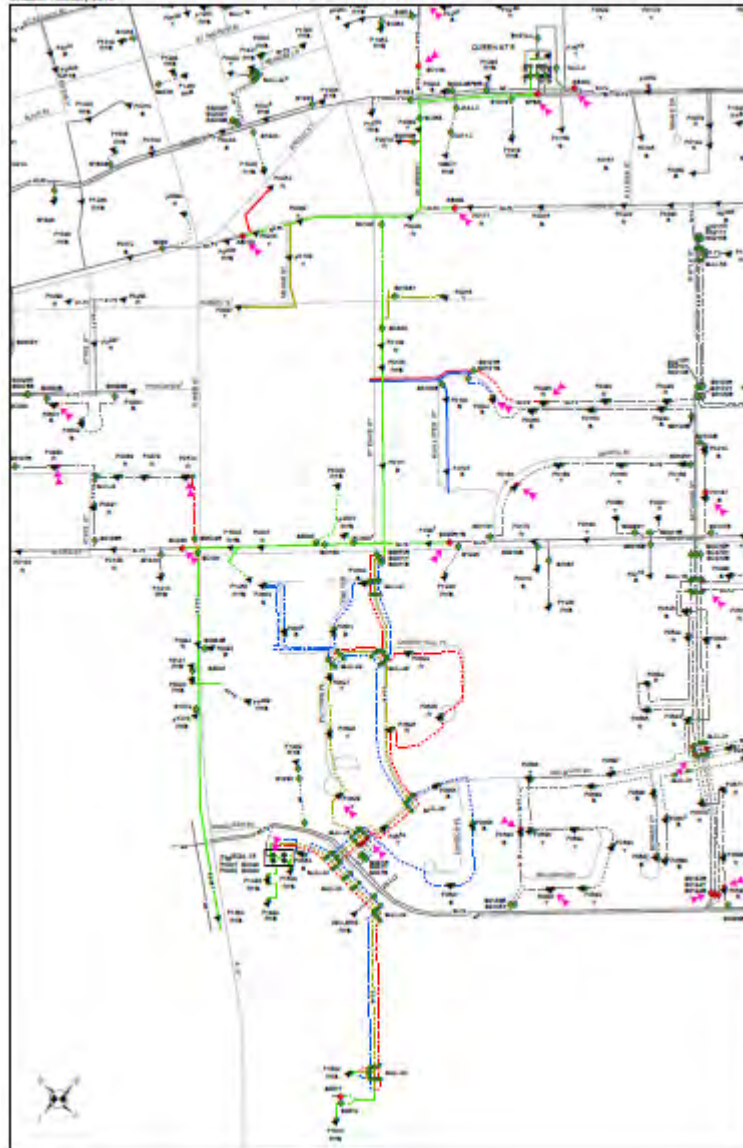
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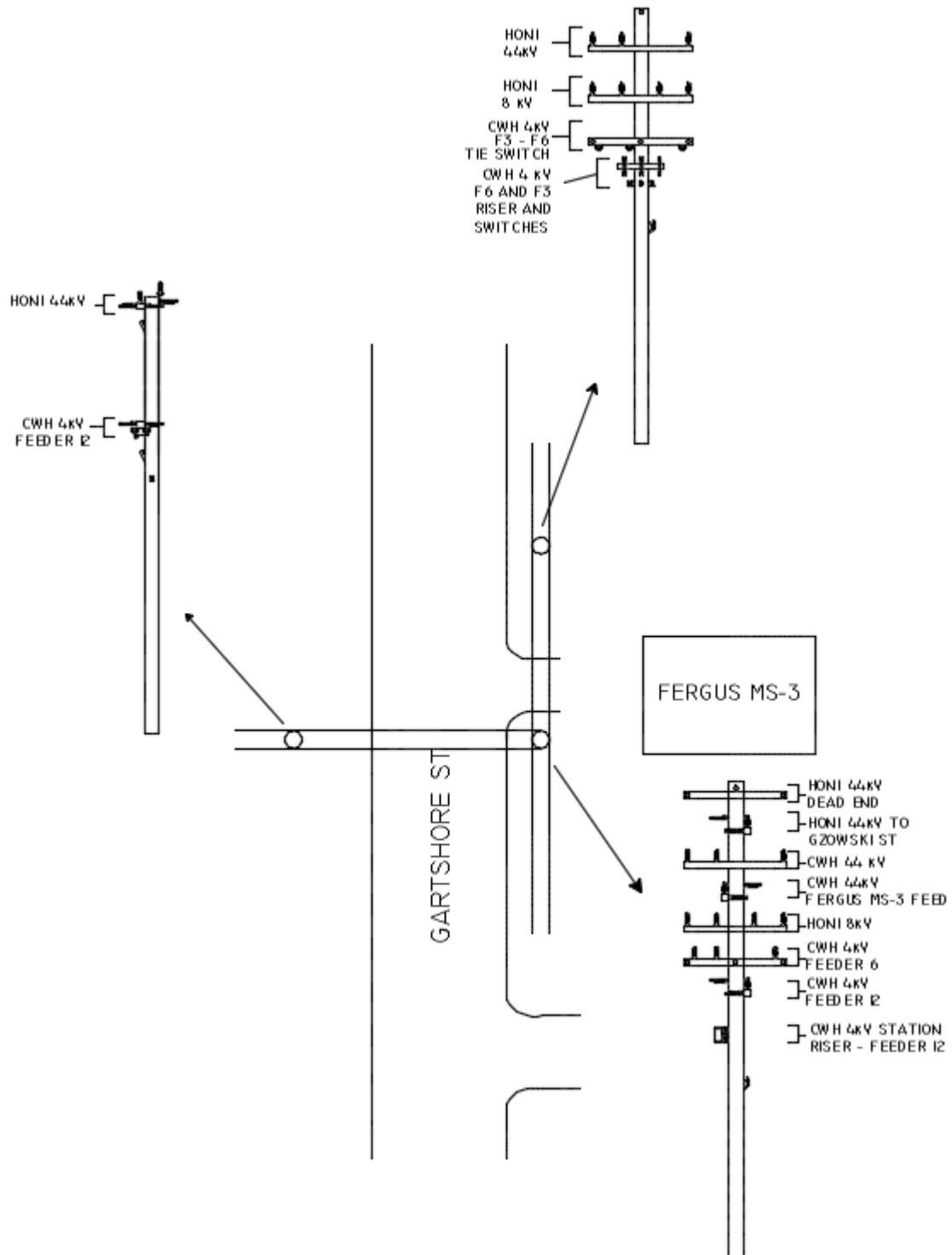


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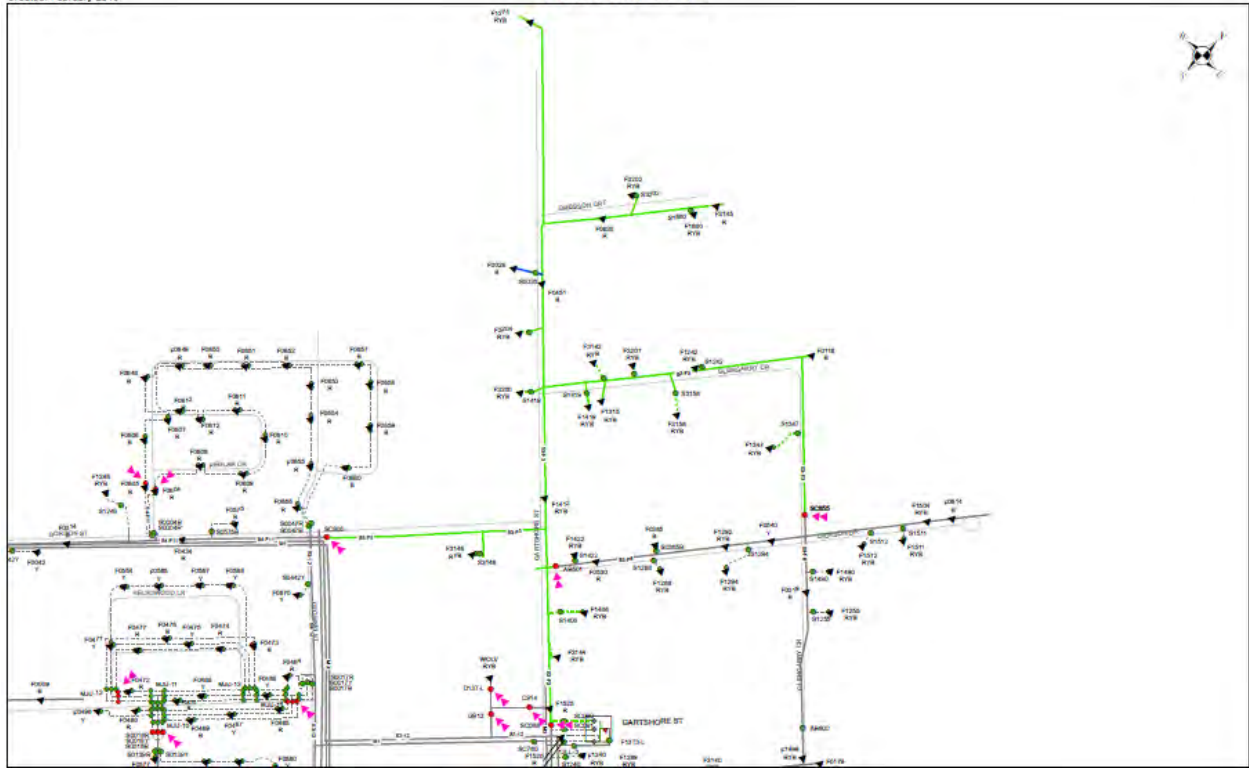
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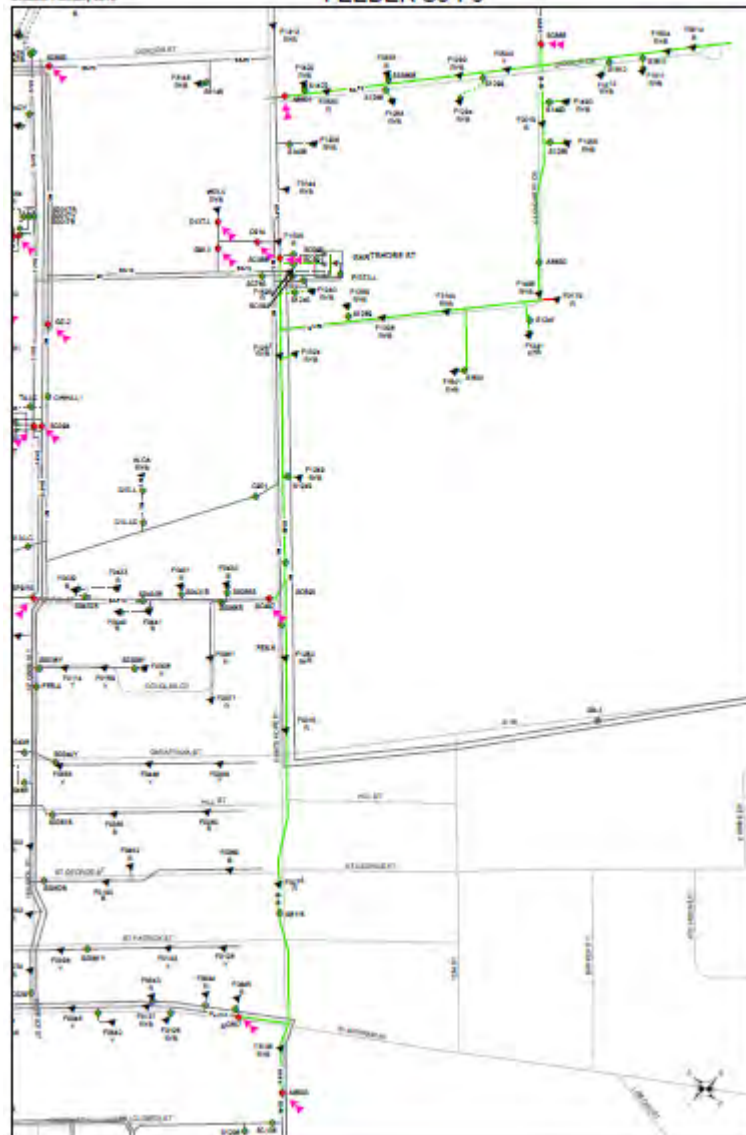
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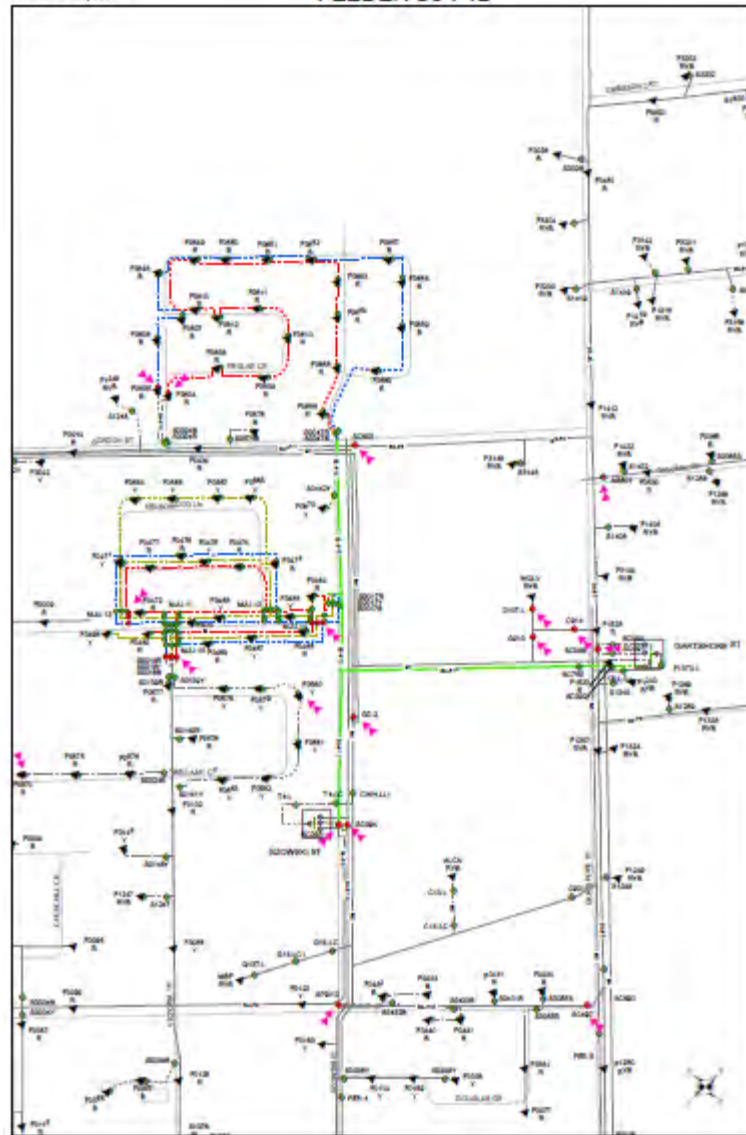
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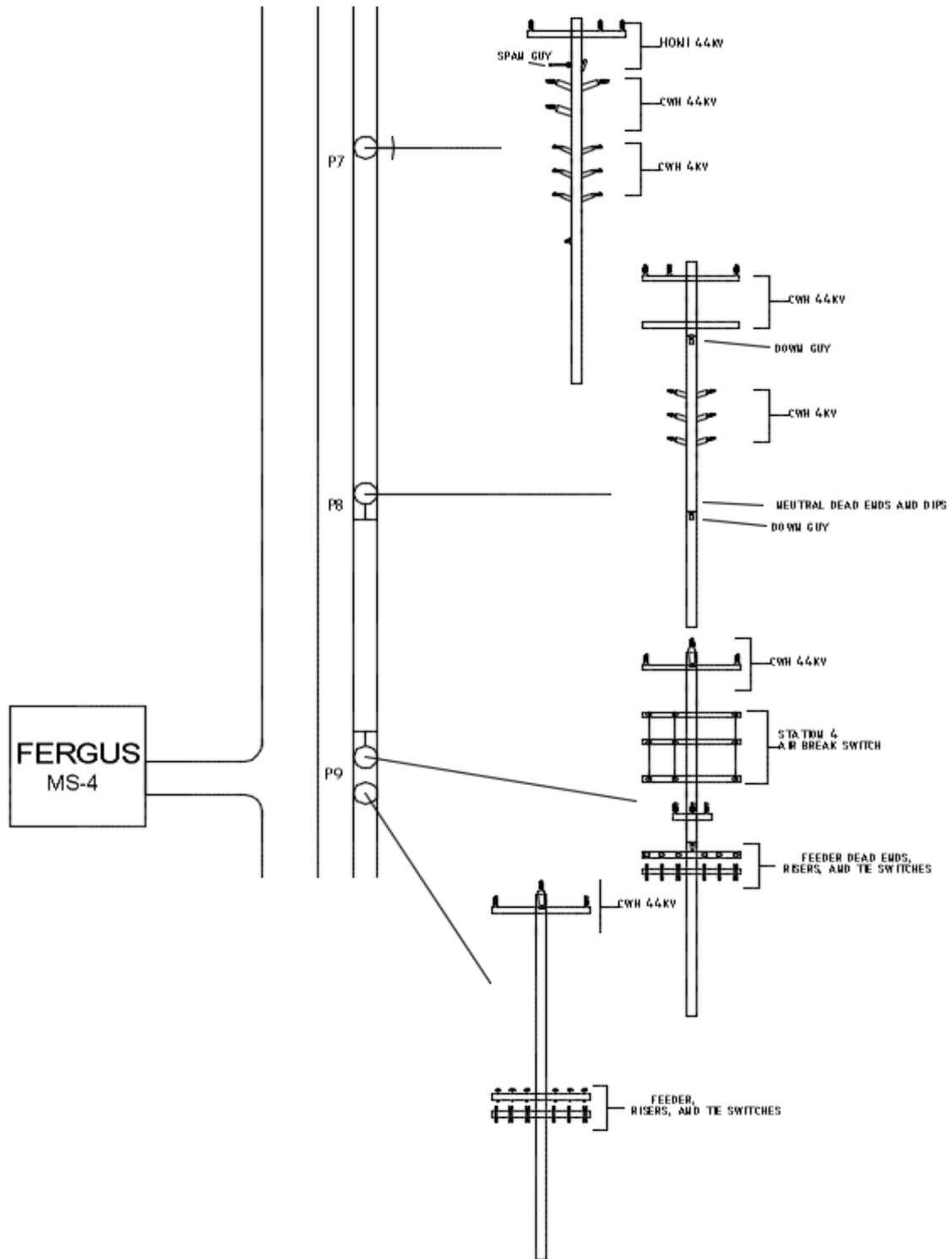
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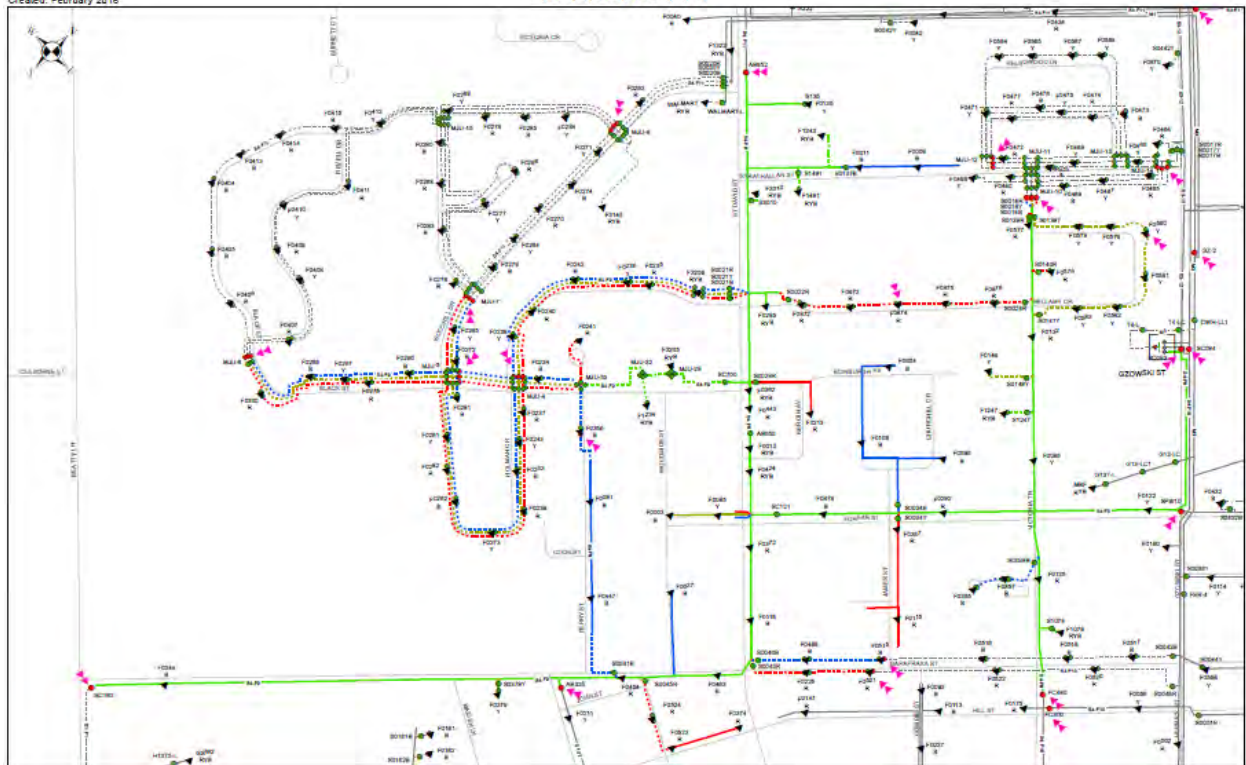


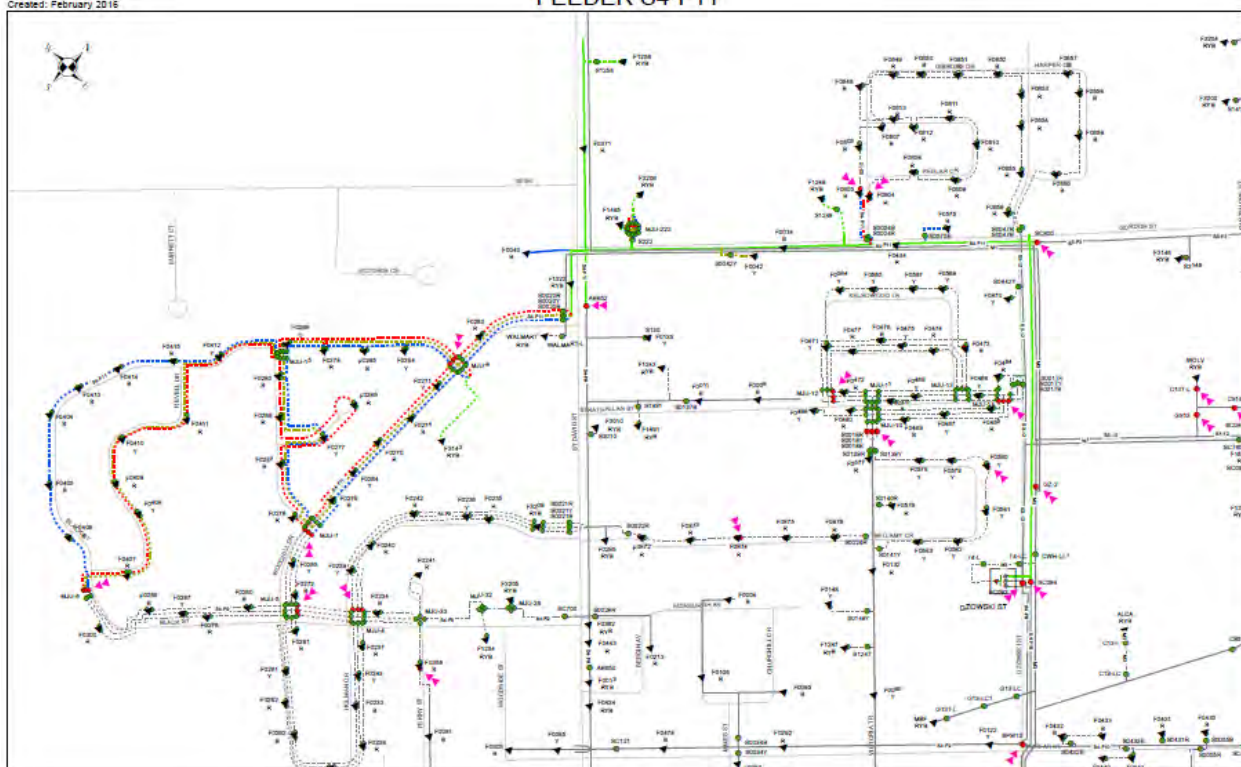
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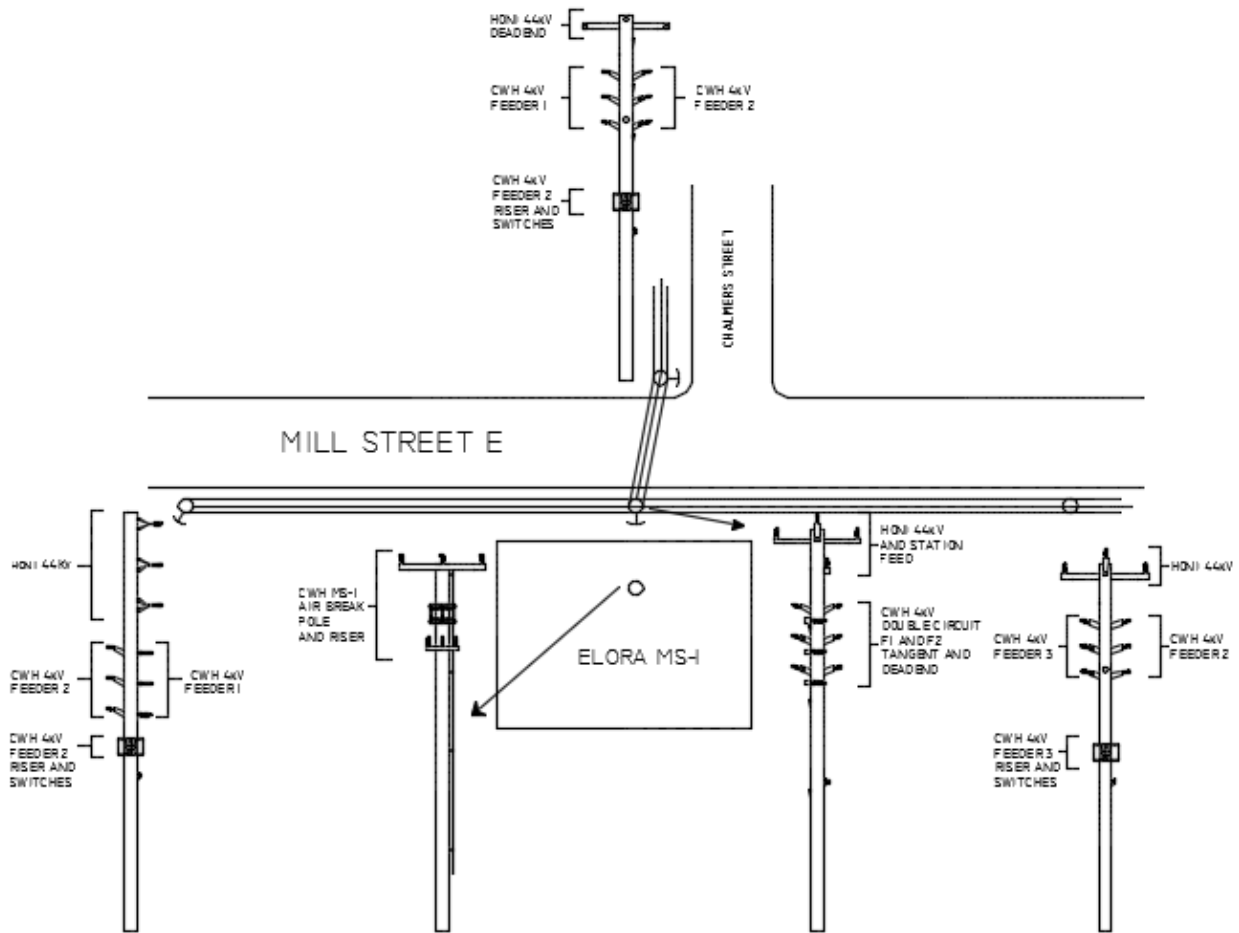
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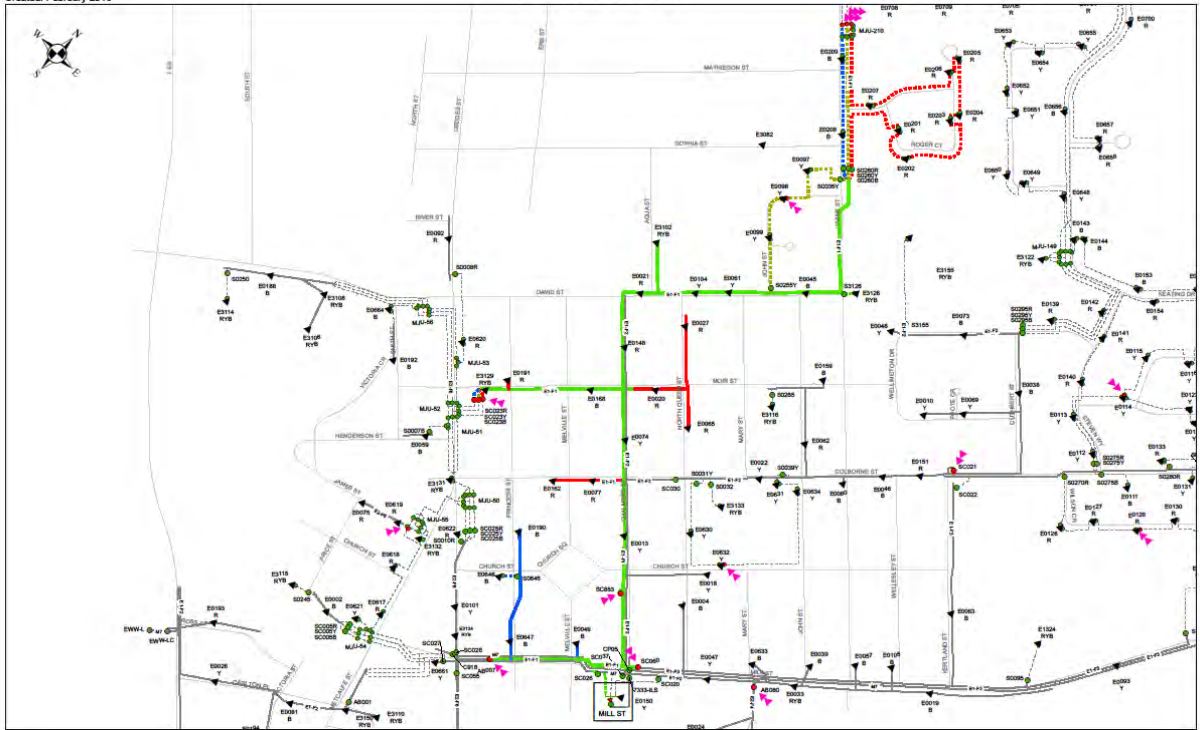


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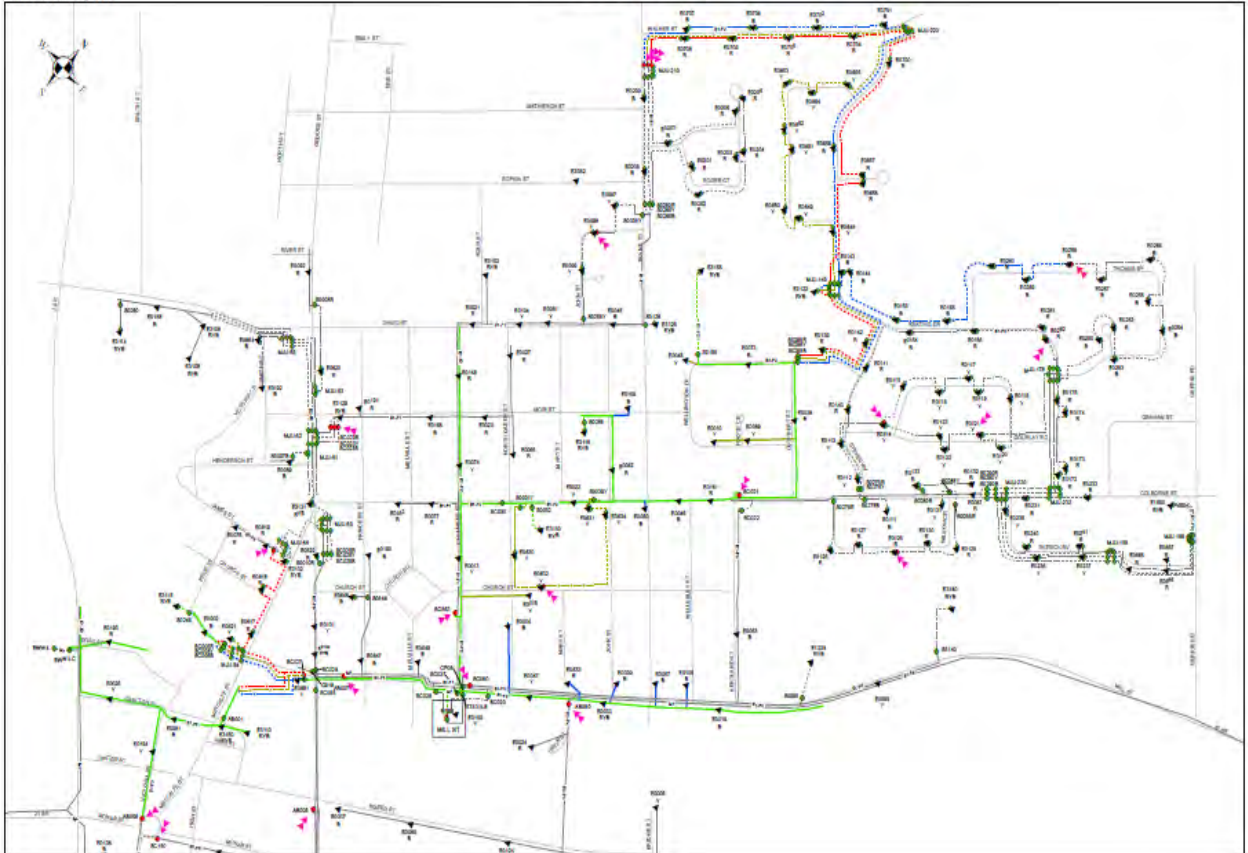
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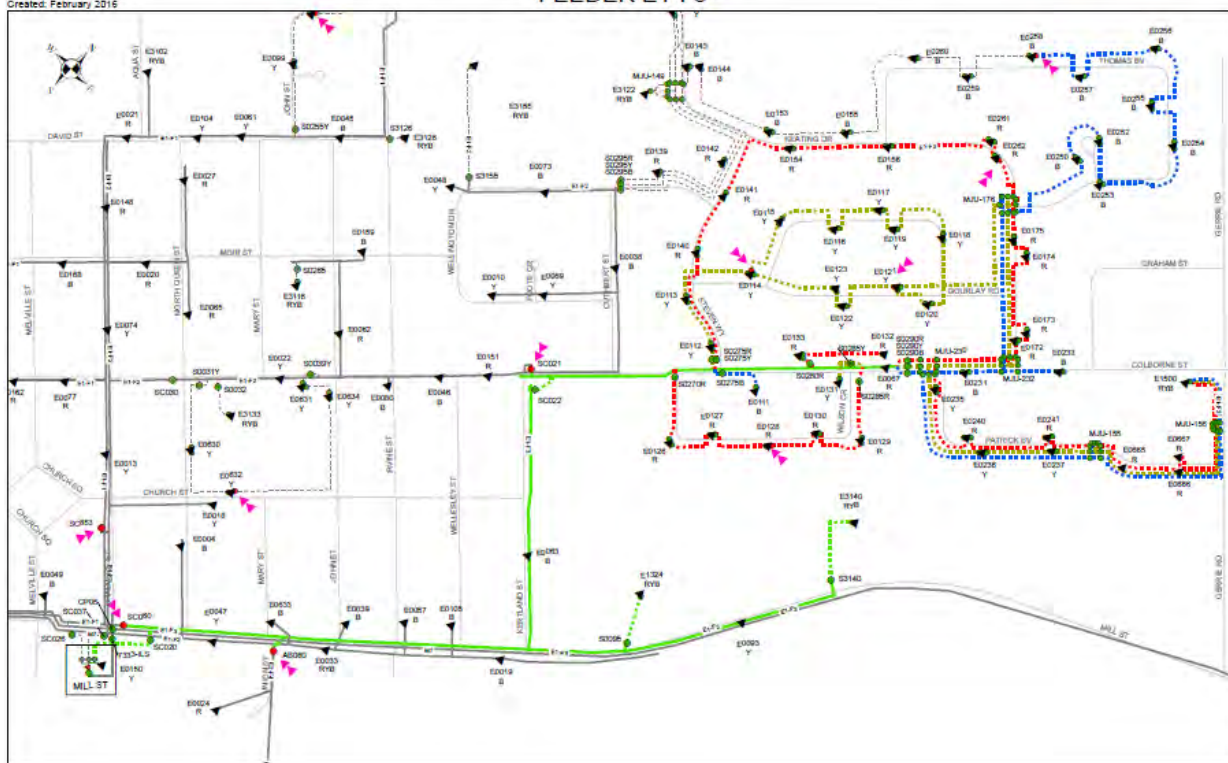


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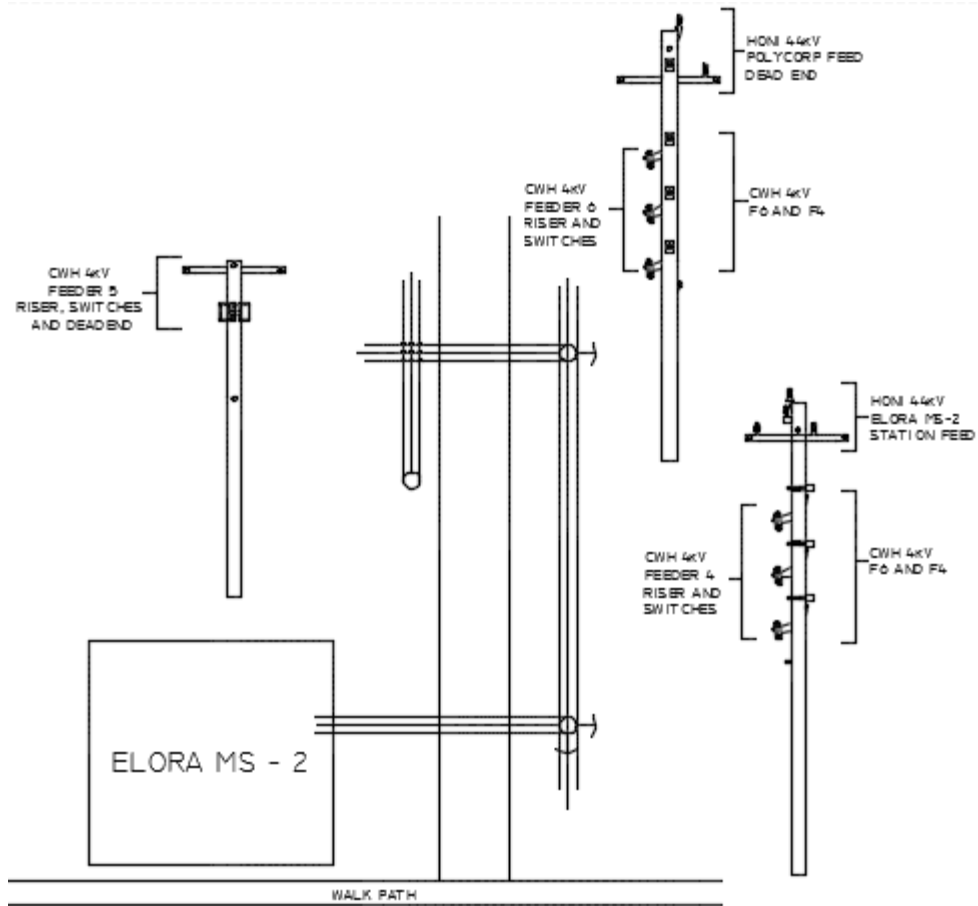
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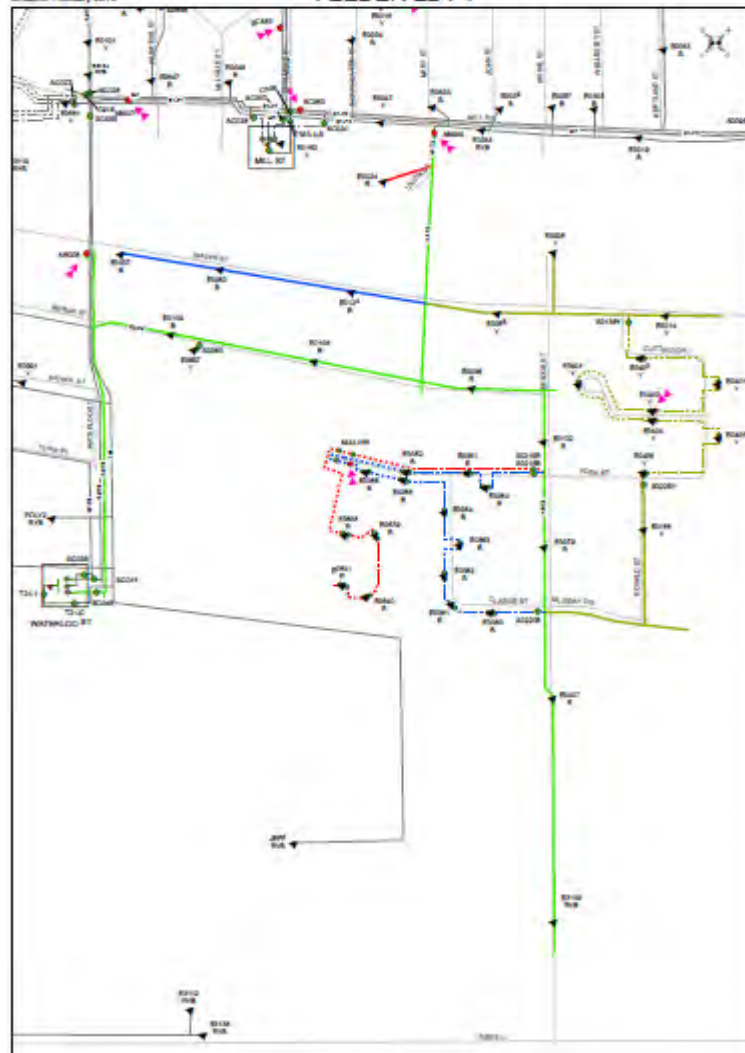


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Appendix B

Asset Management Plan (AMP)



CENTRE WELLINGTON HYDRO

Asset Management Plan

Prepared by



December 2015

1 Executive Summary

The following report is prepared by METSCO Energy Solutions (hereafter referred to as METSCO) and details the Six-Year Asset Management Plan for Centre Wellington Hydro (CWH). This report outlines background of the utility and its customers, as well as key asset and project needs in order to achieve the goals set forth by the Utility with respect to system performance.

The plan is based on information gathered through review of historical records, visual inspections during site visits, as well as information gathered through discussions with management and crew members. Following the analysis of all information a number of system needs were identified using a risk conscious approach. The approach by which the plan was developed is further detailed in the methodology section of the report. The plan is developed based on data available at the end third quarter of 2015 (where possible most recent records were used). Where data was unavailable, reasonable assumptions were made, substantiated by CWH staff input and METSCO's engineering expertise.

Key investments identified in this asset management plan include primarily switchgear upgrade at two of the distribution stations and replacement of overhead lines and underground lines at the end of their service life. Overall, investments proposed into underground lines are relatively small, as there is no indication of extreme deterioration of these assets impacting reliability.

Proposed capital expenditures have been grouped into the following investment portfolios:

- System renewal for overhead lines, underground distribution and substations;
- System access, representing expenditure towards new services, revenue meters and line relocates; and
- General plant

The total capital expenditures over the next six years in each of these investment portfolios is summarized in Table 1.

	2016	2017	2018	2019	2020	2021
System Renewal - Overhead line assets	369,433	408,866	417,043	425,384	433,892	442,570
System Renewal - Underground distribution assets	203,424	104,128	125,313	129,699	132,293	134,939
System Renewal - Substation assets	1,048,600	-	-	-	-	-
System Access Expenditure Estimate	175,200	118,200	128,924	101,672	102,946	104,245
General Plant Expenditure Estimate	230,800	631,194	200,000	256,756	269,131	281,753
Total Capital Expenditure Estimate	2,027,456	1,262,388	871,280	913,512	938,262	963,506

Table 1: Summary of 5 Year Capital Requirement [NTD: Figures to be confirmed by CWH]

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2 Utility Overview

Centre Wellington Hydro (CWH)'s service territory is shown in Figure 1 and it covers the town of Fergus and village of Elora, serving approximately 6,800 Residential and General Service customers in addition to some Unmetered Scattered Load customers as well as Street Light and Sentinel Light connections.

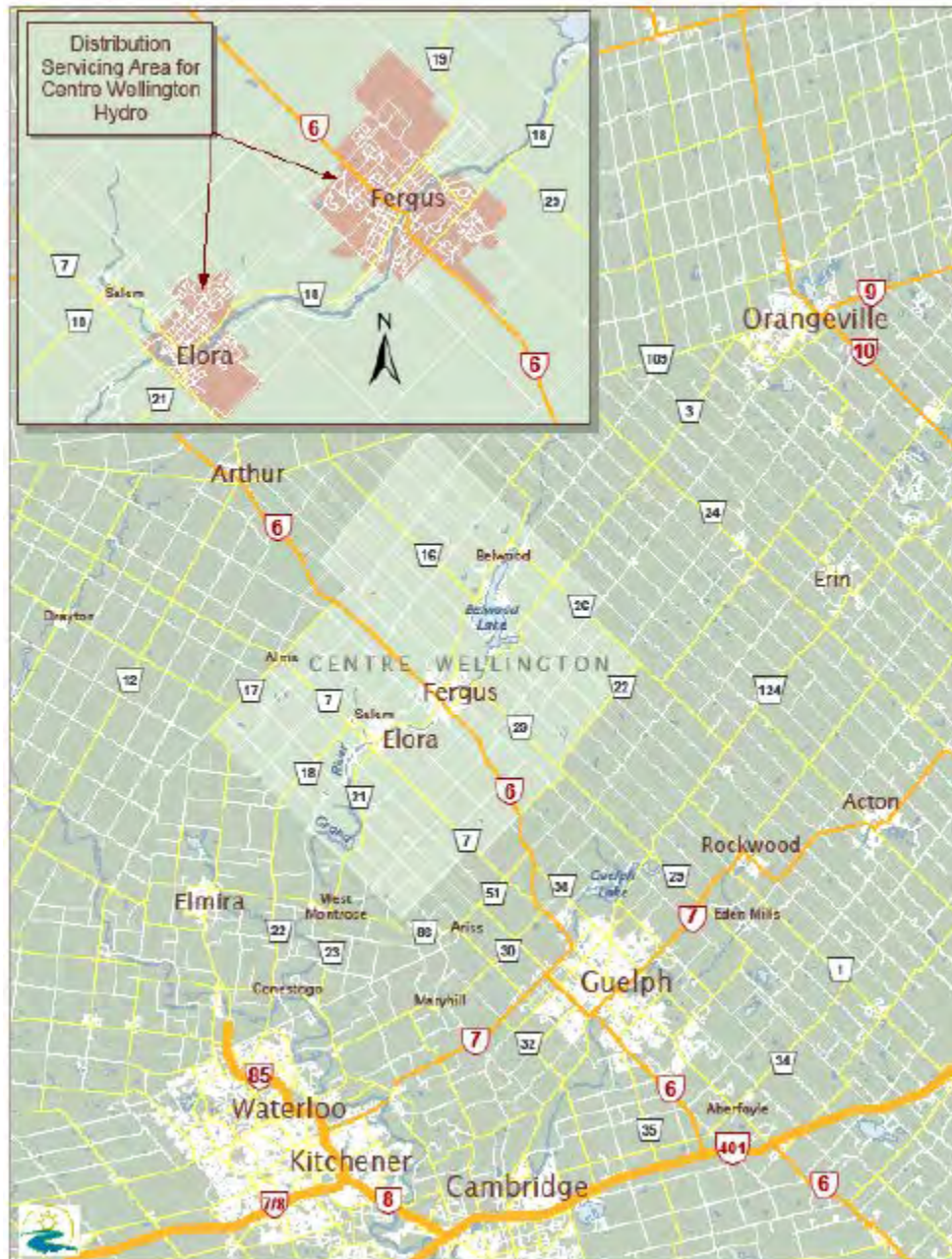


Figure 1: CWH Service Territory

The service territory is comprised of approximately 10 sq. km. of high density urban area, with customer density of approximately 660 per sq. km. CWH's distribution system consists of

approximately 91 km of overhead lines and approximately 70 km of underground lines. The distribution system receives power from Hydro One through the Fergus TS at 44kV, which is stepped down to 4.16 kV at six distribution stations, four of which are located in town of Fergus and the remaining two are located in village of Elora. The 4.16 kV distribution voltage is further stepped down to utilization voltages of 120/240V, 120/208V or 347/600V through approximately 830 distribution transformers. The distribution system is monitored through a control centre located in its office at Fergus.

The service areas have a combined population of approximately 21,000. The electric utility customer base is indicated in Figure 1 and Table 2.

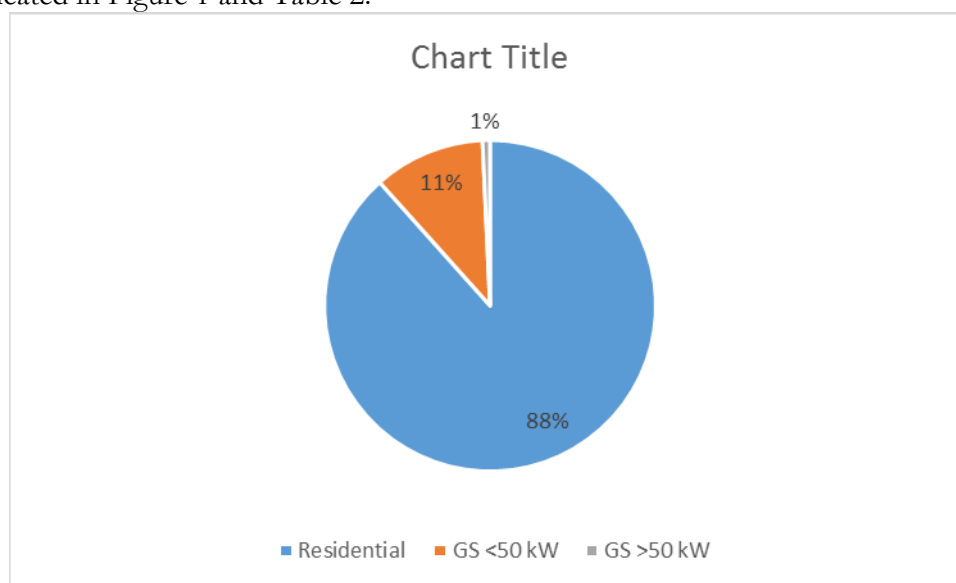


Figure 2: Customer Mix by Type

Customer Type	Count
General Service (<50kW)	739
General Service (>=50kW)	50
Residential	6002
Total	6791

Table 2: Customer Count by Type

3 Objectives and Goals of the Plan

This plan and the underlying capital investments conform to CWH's objectives and high level goals as illustrated in Figure 3 and further detailed within this section of the document.

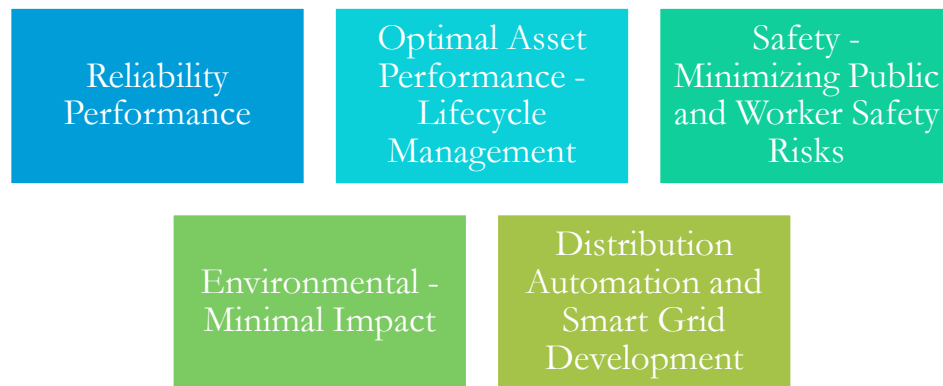


Figure 3: Utility Asset Management Goals

1. Reliability Performance – Over the past five years, with the exception of interruptions resulting from the major ice storm in 2013, system performance has been good and in line with the customer's expectations and needs. CWH's objective is to maintain the same level of system performance, by mitigating and managing the risk of asset failures as the infrastructure ages.

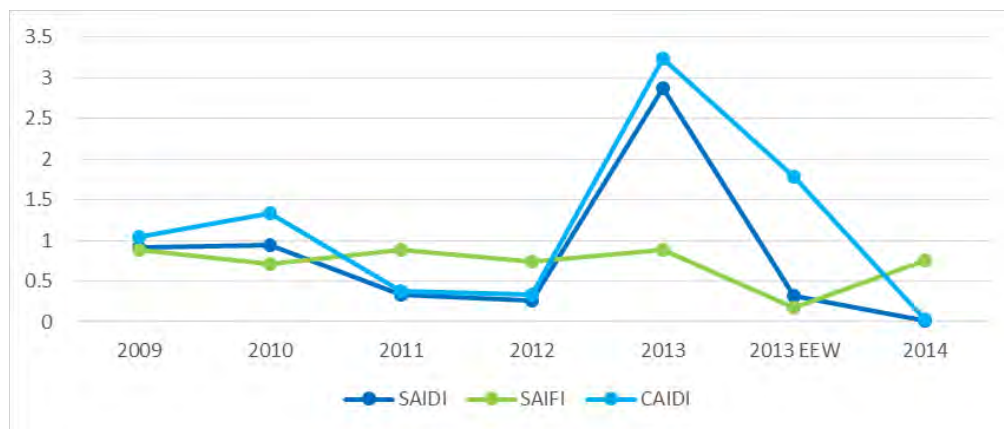


Figure 4: Utility Asset Management Goals

2. Life Cycle Management – Life cycle management decisions involve implementing the least cost life cycle solutions in order to achieve the optimal balance between equipment renewal and replacement costs on one hand and maintenance and repair costs on the other. In the early stages of assets' life cycle, it is often economically efficient to invest into preventative maintenance activities, which result in corresponding increase in useful service life of assets. However as the assets approach advanced service age, when they require large investments

to restore reliable operating condition, investments into renewal and replacement rather than maintenance and repair become the optimal option.

Due to lack of adequate investments into infrastructure renewal in the past, the distribution infrastructure and particularly the assets employed in 44 kV / 4.2 kV substations at CWH had reached an advanced service age, where the probability of asset failure in service was becoming very high. Over the past four years, CWH began upgrading the assets at distribution stations, starting with the stations that presented the highest risk of failure in service. Under this program the high risk equipment at four of the six substations, including MS-1, MS-2 and MS-3 in the town of Fergus and MS-1 in the village of Elora has been replaced and upgraded. The high risk assets at MS-4 in the town of Fergus and MS-2 in Elora are schedule for renewal in 2016. During these station rebuild program, only assets that reached the end of service life were replaced. The transformers were refurbished.

3. Safety – Both public and staff safety is of paramount importance. CWH has had no serious injuries or safety related incidents in the past and CWH's goal is to continue to have no safety incidents through the addressing of any issues raised through the asset management plan. Some of the sheet metal enclosures for pad-mounted switchgear and junction boxes have been badly rusted and corroded, to the point that rodents can get inside energized equipment through the holes created by corrosion. These degraded switchgear enclosures have been identified through inspections and are planned to be replaced, or repaired where possible.
4. Environmental – CWH performs regular maintenance on distribution equipment and has established processes for the disposal, recycling, and containment of materials harmful to the environment. To date there have been no hazardous materials released into the environment through operation and renewal of system assets. The goal is to continue to have zero impact on the environment and wildlife in which the service area resides.
5. Distribution Automation and Smart Grid Development – CWH implemented the provincially mandated smart metering program in 2009. The 4 kV distribution feeders at each of the municipal stations were originally supplied through pole mounted reclosers. In conjunction with the rebuild of the municipal stations, the 4kV feeders are being equipped with automated reclosers, controlled through modern SEL protection relays. CWH has a plan to equip all the remaining stations with feeder reclosers when they are reconstructed. This automation initiative will not only help improve reliability and safety but would also remove constraints in the distribution system to accept connections of small and medium sized generation from renewables. CWH, in partnership with other entities, has applied for smart grid funding to run a Micro Smart Grid test site connected to CWH's distribution system. The test project will involve integration of Photo-Voltaic, wind, Diesel/gas generators connections to distribution grid with help of software, which would test their impacts on distribution system operations. The funding for this project is expected to be awarded in 2016 at which time CWH will possibly implement the project plans.

4 Asset Management Planning Process

During preparation of the last asset management plan in 2012, an effort was made to compile demographic information on distribution system assets and establish health indices of major assets employed on distributions system by taking into account all available information relevant to assets' health and condition. This asset management plan builds on the previously completed work and combines the information on assets' operating condition with risk-based frameworks, using all available information, including asset age, asset operating condition determined through inspections and results of asset testing, where available. In addition to these, consequences of risk of asset failure as well as tradeoffs between maintenance and replacement are incorporated into the proposed program. The process undertaken as part of this Asset Management Plan is illustrated in Figure 5 and further detailed in the section below.

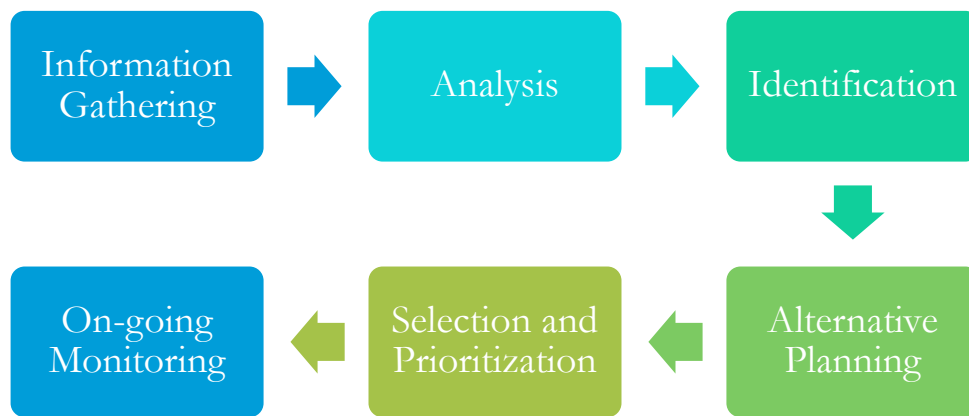


Figure 5: AM Planning Process

1. Data and information gathering – Understanding what intervention is required to achieve the objectives set forth is the first task. In order to assess the system needs, the first step is to gather all pertinent information such as asset counts, types, condition and maintenance information etc. This is done through three mediums
 - a. Review of Records – CWH has a centralized asset database or GIS system, in which demographic information on all distribution system assets is maintained, including system operating maps
 - b. Site visits – The information gathered from the records was augmented through field inspections during site visits through visually inspections, line patrols and substation visits. The site visits allowed us to confirm data provided by the records as well as gather additional information not available through records
 - c. Staff Interviews – During site visits information was also gathered directly through staff interviews. This includes gathering customer connection requests for load and generation, identification of problem areas on the network, which they deal with on a daily basis.
2. Analysis of information, application of asset condition assessment, creating the overall system overview and needs – During this step in the planning process, our objective was to sort information gathered to complete asset condition assessment, system constraints and asset health indices, as well as remaining useful service life of assets and failure probabilities.

3. Identification of the specific system needs (target areas) – During this step, targeted areas requiring investments to mitigate capacity constraints or the risk of in-service failure were identified and detailed analysis were performed in order to substantiate the required investment levels with a greater level of confidence.
4. This step involved analysis of alternatives to address the needs and impacts of each alternative – to identify the optimal alternative for implementation.
5. Selection of optimal alternative and prioritization of investments was made on the impact assessment completed in previous steps. Consideration was also given to practicality of executing the proposed plan, by balancing the system needs against available resources to implement the projects.
6. Continuous monitoring of changing operating environment and asset performance, be flexible to adapt to changing circumstances where some needs may change in priority and new needs may be brought to forward.

4.1 Analysis Overview

I Asset Condition Assessment (ACA) Analysis

An asset condition assessment (ACA) analysis was completed for each major asset class. This analysis results in the production of a Health Index score – a normalized score from a scale of 0 (Very Poor) to 100 (Very Good), that provides a numerical representation of the condition of the asset. Contained within this health index are weighted degradation factors for key components of assets that contribute to the overall failure probability of the asset – these factors will vary from asset class to asset class.

Each degradation factor for each health index will be evaluated on a scale from A to E. These letter grades are generally defined below:

“A”/ “4”	evaluation of the degradation factors has yielded no issues/concerns – “as new” condition
“B”/ “3”	evaluation of the degradation factors has identified some minor problems – evidence of aging
“C” / “2”	evaluation of the degradation factors has identified multiple minor problems or a major problem – without intervention, aging will be accelerated
“D” / “1”	evaluation of the degradation factors has identified many serious problems – without intervention, problems will lead to in-service asset failure
“E”/ “0”	evaluation of the degradation factor has identified that overall asset failure is imminent and the asset requires immediate replacement

As noted above, each letter grade can be converted into a numerical factor, from the worst value of 0 to the best value of 4. Equation 1 further illustrates how the final Health Index score is produced, using the populated degradation factors, weightings and applying a normalization procedure:

$$HI = \left(\frac{\sum_{i=1}^n (W_i)(DF_i)}{MAX} \right) \times 100\%$$

(Equation 1)

Where:

- “i” refers to the series (from 1 to n) of degradation factors for a given asset class within the health index formulation.
- “W_i” refers to the weight for a specific degradation factor (i)
- “DF_i” refers to the numerical factor (from 1 to 5) assigned for a given degradation factor (i)
- “MAX” refers to the maximum possible score that can be produced as per the equation: $\sum_{i=1}^n (W_i)(DF_i)$. This variable is ultimately as part of the normalization process.
- “HI” refers to the normalized health index score from 0 to 100.

It is important to note that the Health Index formula is modular and scalable in instances where not all degradation factors are readily available for a given asset within an asset class. For these instances, the respective degradation factors will be removed from the formulation, and the maximum possible score (as defined by “MAX”) will be adjusted accordingly. This approach was applied to those CWH’s assets where only age was available as an input variable.

Once each degradation factor is populated and weighted, the final Health Index score can be produced. The Health Index scale is further defined in Table 3.

Health Index	Condition	Description
85 <= HI < 100	Very Good	Minor deterioration for a limited number of components
70 <= HI < 85	Good	Significant deterioration of some number of components
50 <= HI < 70	Fair	Widespread significant deterioration of components
30 <= HI < 50	Poor	Widespread serious deterioration of the asset as a whole, asset approaching the end of its life
0 <= HI < 30	Very Poor	Extensive serious deterioration of the asset as a whole, the asset at the end of

		its life
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Table 3: Health Index Scale

The results of the assessment are provided within the plan section of this report. The following subsections provide the specific degradation factors, numerical scale definitions and degradation factor weights for each asset class that were applied as part of this assessment.

(a) Overhead Lines

Major assets employed on overhead lines include conductors, insulators and support poles and all of these assets degrade in service. A line section is considered to have reached the end of its useful service life, when either of these major assets is unable to carry its intended function. Typical useful life of most common conductors employed on overhead lines is 60 years, which is significantly greater than the 45 year typical useful service life of wood poles and therefore conductors are not generally on the critical path, leading to a line's end of life. However, overhead lines constructed with #6 and #4 copper are known to experience conductor failures due to low mechanical strength of the conductor and in such cases, the small conductor size may reach the end of its service life before the poles and determine end of service life for the line.

When there are no small conductors employed, Table 4 and 5 can be used to determine the health index of conductors.

Degradation Factor	Weight	Condition Rating	Factors	Maximum Score
Service Age	5	A,B,C,D,E	4,3,2,1,0	20
Maximum Score				20

Table 4: Conductor Health Index Scoring Table

Condition Rating	Description
A	0 - 15 years
B	16 - 30 years
C	31 - 45 years
D	46 - 60 years
E	Greater than 60 years

Table 5: Conductor Service Age Degradation Factor Scoring

When #6 or #4 copper conductors are employed on lines, the conductor health index formulation takes into account the service age of the conductor spans as well as the risks associated with smaller conductor sizes, as shown in Tables 6, 7 and 8.

Degradation Factor	Weight	Condition Rating	Factors	Maximum Score
Service Age	5	A,B,C,D,E	4,3,2,1,0	20
Small Conductor Risk	5	A,E	4,0	20

Maximum Score			40
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Table 6: Conductor Health Index Scoring Table

Condition Rating	Description
A	0 - 15 years
B	16 - 30 years
C	31 - 40 years
D	41 - 50 years
E	Greater than 50 years

Table 7: Conductor Service Age Degradation Factor Scoring

Condition Rating	Description
A	No small sized conductors present
E	Small sized conductors are present (#4 to #6 copper)

Table 8: Conductor Small Conductor Risk Degradation Factor Scoring

The applied wood pole health index formulation accounts for asset age and remaining strength, which account for the greatest formula weighting, in addition to other degradation factors such as condition of the crossarm and shell, infestation by woodpeckers or insects, and whether a pole treatment has already been applied. The remaining strength test, which examines the shell thickness, provides insight into the remaining life of the pole.

Degradation Factor	Weight	Ranking	Numerical Grade	Max Grade
Age	15	A,B,C,D,E	4,3,2,1,0	60
Crossarm Condition	1	A,C,E	4,2,0	4
Insect Infestation	1	A,C	4,2	4
Shell Condition	1	A,C,E	4,2,0	4
Wood Pecker Damage	1	A,C,E	4,2,0	4
Remaining Strength	20	A,B,C,D,E	4,3,2,1,0	80
Pole Treatment	5	A,C,E	4,2,0	20
Maximum Score				92

Table 9: Wood Pole Health Index Scoring Table

Condition Rating	Corresponding Condition
A	0 - 10 years
B	10 - 30 years
C	30 - 40 years
D	40 - 50 years
E	Greater than 50 years

Table 10: Wood Pole Age Degradation Factor Scoring

Condition Rating	Corresponding Condition
A	Unknown; No crossarm; Good; normal; no problem
C	Some deterioration
E	Schedule for replacement

Table 11: Wood Pole Crossarm Degradation Factor Scoring

Condition Rating	Corresponding Condition
A	No/Unknown
C	Yes

Table 12: Wood Pole Insect Infestation Degradation Factor Scoring

Condition Rating	Corresponding Condition
A	Unknown; Good; normal; no problem
C	Some deterioration
E	Significant deterioration

Table 13: Wood Pole Shell Degradation Factor Scoring

Condition Rating	Corresponding Condition
A	Unknown; Good; none visible or minor surface damage
C	Moderate repairable damage
E	Severe damage

Table 14: Wood Pole Woodpecker Damage Degradation Factor Scoring

Condition Rating	Corresponding Condition
A	91% - 100%
B	82% - 90 %
C	73% - 81%
D	65% - 72%
E	Less than 65%

Table 15: Wood Pole Remaining Strength Degradation Factor Scoring

Condition Rating	Corresponding Condition
A	Fully treated
C	Butt treated
E	No treatment

Table 16: Wood Pole Treatment Degradation Factor Scoring

(b) Distribution Transformers

The applied distribution transformer health index formulation only accounts for the age of the transformer, which aligns to the available data within CWH's asset registry.

As transformers age, the winding insulation paper material will be subject to depolymerization, whereby the paper will deteriorate within the transformer mineral oil, resulting in the formation of sludge. The mineral oil is subjected to oxidation, and the rate of oxidation is proportional to the transformers' operating temperature. Distribution transformers will fail when the insulation material has fully broken down, resulting in an internal transformer fault.

Degradation Factor	Weight	Condition Rating	Factors	Maximum Score
Transformer Age	3	A,B,C,D,E	4,3,2,1,0	12
Maximum Score				12

Table 17: Distribution Transformer Health Index Scoring Table

Condition Rating	Description
A	0 - 10 years
B	11 - 20 years
C	21 - 30 years
D	31 - 40 years
E	Greater than 40 years

Table 18: Distribution Transformer Age Degradation Factor Scoring

(c) Underground Cables

The applied underground cable health index formulation accounts for the service age, historical failures as well as the loading history. The number of historical failures will indicate the overall degradation of the cables in a given area. The loading history is used to provide insight into the thermal degradation of the cable segments. A greater amount of load on the cable will result in a greater level of thermal stress, which will ultimately result in deterioration of the cable insulation.

Degradation Factor	Weight	Condition Rating	Factors	Maximum Score
Service Age	10	A,B,C,D,E	4,3,2,1,0	40
Cable Failure Analysis	10	A,C,D,E	4,2,1,0	40
Loading History	5	A,B,C,D,E	4,3,2,1,0	20
Maximum Score				100

Table 19: Cable Health Index Scoring Table

Condition Rating	Description (TRXLPE Cables)	Description (PILC Cables)
A	Less than 15 years	Less than 20 years old
B	16 – 25 years old	21-35 years old
C	26 – 35 years old	36-45 years old
D	36 – 45 years old, cable is nearing typical end of life age	46-60 years old, cable is nearing typical end-of-life age
E	Greater than 45 years, cable is past the typical end of life age	Greater than 50 years, cable is past typical end-of-life age

Table 20: Cable Service Age Degradation Factor Scoring

Condition Rating	Description
A	Less than 0.5 historical failures per 10 km per year
B	Between 0.5 to 1.0 historical failure per 10 km per year
C	Between 1.0 to 2.0 historical failures per 10 km per year – cable is deteriorating
D	Between 2.0 to 4.0 failures per 10 km per year – cable is close to end-of-life, plan replacement
E	Greater than 4.0 failures per 10 km per year, cable is at end-of-life, replacement needed

Table 21: Cable Failure Analysis Degradation Factor Scoring

Condition Rating	Description
A	Cable has been consistently loaded below 50% of its continuous design rating, and has not been subjected to emergency loading
B	Cable has been consistently loaded to between 51% and 70% of its continuous design rating, and has been subjected to emergency loading within recommended time-temperature limits
C	Cable has been consistently loaded to between 71% and 90% of its continuous design rating. The cable has been subjected to emergency loading within recommended time-temperature limits
D	Cable has been consistently loaded to between 91% and 100% of its continuous design rating or the cable has been subjected to emergency loading exceeding recommended time-temperature limits
E	Cable has been loaded above 100% of its continuous design rating or above recommended time-temperature limits that it has become damaged/degraded beyond repair

Table 22: Cable Loading History Degradation Factor Scoring

(d) Station Power Transformers

Power transformers are designed to step down transmission or sub-transmission voltage to distribution voltage. CWH's power transformers step down from 44kV sub-transmission voltages to 4.16kV. As was discussed in part (b) regarding Distribution Transformers, Power Transformers experience similar degradation processes with respect to depolymerisation of the paper insulation and oxidation of the mineral oil. Partial discharge can also occur within the transformer if the level of moisture within the mineral oil builds up or should other minor defects formulate within the insulation material. Partial discharge activity can be detected and monitored through the Dissolved Gas Analysis (DGA) procedure, where hydrocarbon gases within the oil are measured. Another

form of oil analysis is Furan testing, which can provide condition assessment information corresponding to the de-gradation of paper insulation.

Degradation Factor	Weight	Condition Rating	Factors	Maximum Score
Main Tank/Cabinets and Controls	1	A,B,C,D, E	4,3,2,1,0	4
Overall Power Transformer	2	A,B,C,D, E	4,3,2,1,0	8
DGA Oil Analysis	4	A,B,C,D, E	4,3,2,1,0	16
Furan Oil Analysis	4	A,B,C,D, E	4,3,2,1,0	16
Oil Quality Test	3	A,B,C,D, E	4,3,2,1,0	12
Maximum Score				56

Table 23: Station Power Transformer Health Index Scoring Table

Condition Rating	Description
A	No rust or corrosion identified on main tank. No external or internal rust found within cabinets – no evidence of condensation, moisture or insect ingress. No rust or corrosion on weld seals, flanges, valve fittings, gauges, monitors. All wiring, terminal blocks, switches, relays, monitoring and control devices are in good condition.
B	No rust or corrosion identified on main tank, some evidence of slight moisture ingress or condensation in cabinets
C	Some rust and corrosion on both tank and on cabinets.
D	Significant corrosion on main tank and on cabinets. Defective sealing leading to water ingress and insects/rodent damage.
E	Corrosion, water ingress or insect/rodent damage or degradation is beyond repair.

Table 24: Station Power Transformer Main Tank Degradation Factor Scoring

Condition Rating	Description
A	Power transformer externally is clean, and corrosion free. All primary and secondary connections are in good condition. All monitoring, protection and control, pressure relief, gas accumulation and silica gel devices, and auxiliary systems, mounted on the power transformer, are in good condition. No external evidence of overheating or internal overpressure. Appears to be well maintained with service records readily available.
B	Normal signs of wear with respect to the above characteristics.
C	One or two of the above characteristics are unacceptable.
D	More than two of the above characteristics are unacceptable.
E	More than two of the above characteristics are unacceptable and cannot be brought into acceptable condition.

Table 25: Overall Station Power Transformer Degradation Factor Scoring

Condition Rating	Description
A	DGA overall factor is less than 1.2
B	DGA overall factor is between 1.2 and 1.5
C	DGA overall factor is between 1.5 and 2.0
D	DGA overall factor is between 2.0 and 3.0
E	DGA overall factor is greater than 3.0

Table 26: Station Power Transformer DGA Degradation Factor Scoring

Scores	1	2	3	4	5	6	Weight
H ₂	<=100	<=200	<=300	<=500	<=700	>700	2
CH ₄	<=120	<=150	<=200	<=400	<=600	>600	3
C ₂ H ₆	<=50	<=100	<=150	<=250	<=500	>500	3
C ₂ H ₄	<=65	<=100	<=150	<=250	<=500	>500	3
C ₂ H ₂	<=3	<=10	<=50	<=100	<=200	>200	5
CO	<=700	<=800	<=900	<=1100	<=1300	>1300	1
CO ₂	<=3000	<=3500	<=4000	<=4500	<=5000	>5000	1

Table 27: DGA Scores

Condition Rating	Description	If Unavailable
A	Less than 1.0 PPM of 2-furaldehyde and no significant change from last test	Less than 20 years old
B	Between 1 – 1.5 PPM of 2-furaldehyde and no significant change from last test	20-40 years old
C	Between 1.5 – 10 PPM of 2-furaldehyde or significant change from last test	40-60 years old
D	Between 3 - 10 PPM of 2-furaldehyde and significant change from last test	Greater than 60 years old
E	Greater than 10 PPM of 2-furaldehyde	Not Applicable

Table 28: Station Power Transformer Furan Oil Analysis Degradation Factor Scoring

Condition Rating	Description
A	F1 + F2 + F3 = 0 or 1
B	If: F1 + F2 + F3 = 2 or 3
C	If: F1 + F2 + F3 = 4
D	If: F1 + F2 + F3 = 5
E	If: F1 + F2 + F3 > 5

Table 29: Station Power Transformer Oil Quality Test Degradation Factor Scoring

Moisture PPM	Factor 1	IFT (dynes/cm)	Factor 2	Dielectric Str. (kV)	Factor 3
Less than 20	0	>20	0	>50	0
20 – 30	2	16-20	1	>40 – 50	1
>30 – 40	4	13.5-16	2	30 - 40	2
Greater than 40	6	<13.5	4	less than 30	4

Table 30: Oil Quality Test Factors

(e) 44 kV Station Switches

The condition indicators, letter grades, numeric scores and weights assigned to each condition indicator for pole-mounted load break switches are summarized in Table 31. All available indicators of asset health have been included in the HI algorithm. IR scans are assigned a higher weight, as these may reveal more serious impairments requiring corrective action.

#	Condition Criteria	Weight	Condition Rating	Factors	Maximum Score
1	Service Age	4	A,B,C,D,E	4,3,2,1,0	16
2	Condition of Insulators	2	A,B,C,D,E	4,3,2,1,0	8
3	Condition of blades	2	A,B,C,D,E	4,3,2,1,0	8
4	Condition of operating mechanism	2	A,B,C,D,E	4,3,2,1,0	8
5	Infrared (IR) scan results	4	A,C,E	4, 2, 0	16
	MAX SCORE				56

Table 31: 44 kV Switchgear**(f) 4 kV Reclosers**

The condition indicators, letter grades, numeric scores and weights assigned to each condition indicator for oil insulated reclosers are summarized in Table 32. Health index algorithm for vacuum reclosers is presented in Table 31.

#	Condition Criteria	Weight	Condition Rating	Factors	Maximum Score
1	Service Age	3	A,B,C,D,E	4,3,2,1,0	12
2	Condition of Tank	3	A,B,C,D,E	4,3,2,1,0	12
3	Condition of Terminations	2	A,B,C,D,E	4,3,2,1,0	8
4	Counter Readings	3	A,B,C,D,E	4,3,2,1,0	12
5	Oil Leaks	2	A,B,C,D,E	4,3,2,1,0	8
6	Condition of Oil	2	A,B,C,D,E	4,3,2,1,0	8
7	Condition of Operating Mechanism and Controls	2	A,B,C,D,E	4,3,2,1,0	8
	MAX SCORE				68

Table 32: Oil Recloser Health Index

#	Condition Criteria	Weight	Condition Rating	Factors	Maximum Score
1	Service Age	3	A,B,C,D,E	4,3,2,1,0	12
2	Condition of Enclosure	3	A,B,C,D,E	4,3,2,1,0	12
3	Condition of Terminations	2	A,B,C,D,E	4,3,2,1,0	8
4	Counter Readings	3	A,B,C,D,E	4,3,2,1,0	12
5	Integrity of Vacuum Bottle	6	A,B,C,D,E	4,3,2,1,0	24
6	Condition of Operating Mechanism and Controls	2	A,B,C,D,E	4,3,2,1,0	8
	MAX SCORE				76

Table 33: Vacuum Recloser Health Index**II Typical Mean Service Life of Distribution Assets**

Typical mean service life of assets refers to the midpoint within the range of years in which an asset is expected to operate as intended, without reaching its end-of-life criteria whereby the asset must be replaced or refurbished. The useful life metric was used in addition to asset condition assessment when evaluating the various asset classes contained within CWH's distribution system. The range of years and the useful life itself were derived from the 2010 Asset Depreciation Study for the Ontario Energy Board and for assets not covered by the Depreciation Study, the useful life was determined based on general industry experience.

Asset Class	Typical Useful Life (years)
Power Transformers at Stations	45
Overhead Distribution Transformer	40
Pad-mounted Distribution Transformer	35
Wood Poles	45
Overhead Line conductors	60
Underground Cable (direct buried)	30
Overhead line switches	45
Underground line switches	35

Table 34: Major Asset Class Useful Life

5 System Loading Vs Capacity

CWH owns and operates two distinct distribution networks, one in the town of Fergus and a second in the village of Elora. Both distribution networks receive power from Hydro One at 44 kV, step down to 4.16 kV through distribution stations and distribute power within the service area through 4.16 kV feeders.

Table 35 and Figure 6 indicate the installed capacity and kVA demand at each of the stations over the past five years. As indicated, the overall demand within the service territory is not increasing, but has come down during the past two years from the peak experienced in 2013 by about 10%, partly due to the implementation of CDM programs and introduction of the time of use tariff. Under this load growth scenario, there are no incentives to implement station capacity upgrades or voltage conversion projects.

Station ID	Installed Capacity	2010	2011	2012	2013	2014	Jan-Sep 2015
Fergus MS1	5 MVA	3.0	3.1	3.3	3.4	3.9	4.2
Fergus MS2	5 MVA	4.0	4.1	4.1	4.2	3.0	3.2
Fergus MS3	5 MVA	2.4	2.6	3.3	3.4	2.7	2.5
Fergus MS4	5 MVA	4.9	5.1	4.8	5.6	4.7	4.9
Fergus Total	20 MVA	14.4	14.9	15.5	16.6	14.3	14.7
Elora MS1	6/8 MVA	3.66	3.31	3.34	3.55	3.81	3.96
Elora MS2	5 MVA	2.09	3.24	2.15	2.27	1.96	1.69
Elora Total	13 MVA	5.75	6.54	5.48	5.81	5.76	5.65
Overall Total	33 MVA	20.14	21.40	21.00	22.46	20.06	20.37

Table 35: Station Capacity and Loading

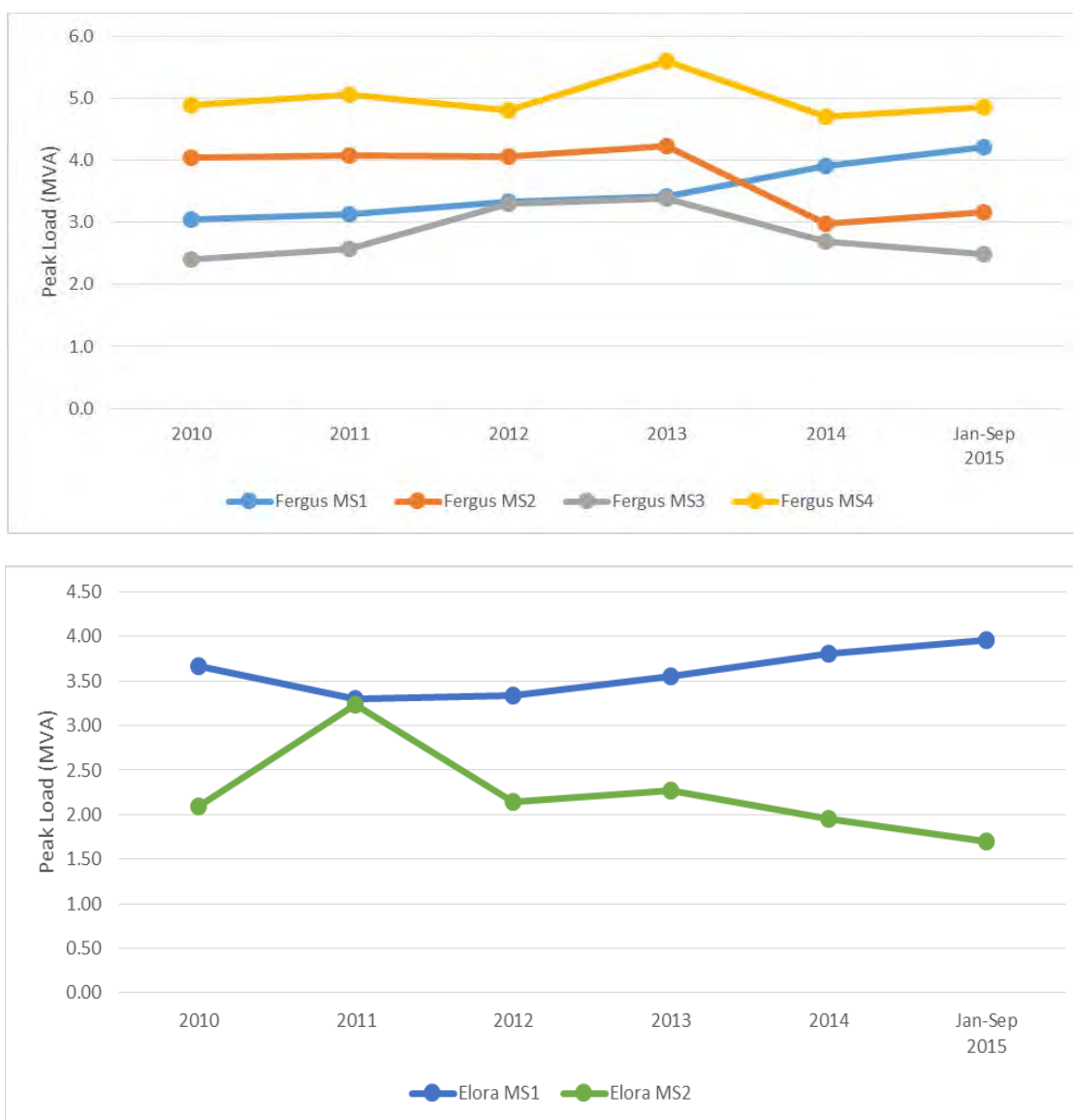


Figure 6: Station Loading

As shown, within the distribution network in the town of Fergus, peak loading among the substations is not proportional to their transformer ratings. MS-4 is the heaviest loaded station where peak demand in 2013 exceeded the transformer nameplate rating and MS-3 has the most lightly loaded station. To address the overload issue at MS-4 station, one new feeder was added to MS-3 Station in 2015, allowing transfer of some load from MS-4 to MS-3. Also during refurbishment of the stations, cooling fans were added to the existing transformers, with objective of increasing their loading capacity above their nameplate rating.

The total of power transformer nameplate capacities at all substations in the town of Fergus is 20 MVA, which is sufficient to supply the peak demand of approximately 15 MVA under normal operating conditions. However, if one the power transformers were to experience failure in service, load transfer to the remaining stations will need to be performed extreme precision, to prevent overloading of the transformers, beyond their rated capacity. CWH has performed a load flow analysis and developed a load transfer plan for such a contingency. In addition to the above, an old

5MVA spare transformer is kept energized (on potential), so it could be moved in to temporarily replace a failed transformer.

In the village of Elora, there is adequate transformer capacity available at MS-1 station to pick up the entire village load from MS-1, if the power transformer at MS-2 fails in service. However MS-2 station does not have adequate transformer capacity to pick up the entire load of the village, during failure of the power transformer at MS-1. However, since the transformer at MS-1 is virtually brand new, the probability of its failure in service is extremely low and even if such a scenario were to arise, the spare 5 MVA transformer in Fergus can be used to temporarily replace the failed transformer.

6 Asset Condition Assessment

This section details the results of CWH's distribution system assets' condition assessment as of October 2015. The condition assessment exercise was completed by taking into account all available indicators of asset health, including service age, results of inspections and testing. Health index algorithms described in section 4 were employed to benchmark the condition of the assets on a scale of 1 to 100. Where only partial information on health indicators was available for certain assets, the health index algorithm was modified to establish normalized health index for the asset based on the available information.

6.1 Overhead Distribution

Overhead distribution encompasses all assets downstream of the station which are configured in a typical Overhead design. As egress feeders leave the station they are either underground to a riser pole or overhead directly to the overhead circuit. Major asset classes of overhead distribution include:

- Lines conductor
- Poles
- Insulators and hardware
- Pole mounted transformers
- Protective devices
 - Switches, and cut-outs (both fused and not fused), arresters etc.

The overhead distribution network at CWH employs 3-phase 44 kV lines and both 1-phase and 3-phase 4 kV lines. Total circuit lengths employed on 44 kV and 4 kV lines is in Figure 7.

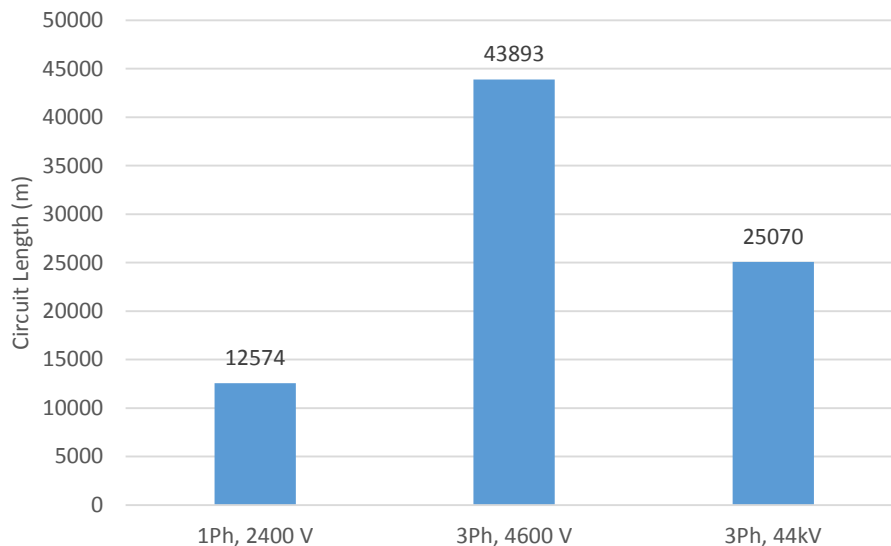


Figure 7: OH Line Circuit Lengths in Service

The 44 kV supply lines to stations employ 556 kcmil and 336 kcmil aluminum conductor. The conductor sizes employed on three phase and one phase 4kV lines are indicated in Figures 8 and 9 respectively.

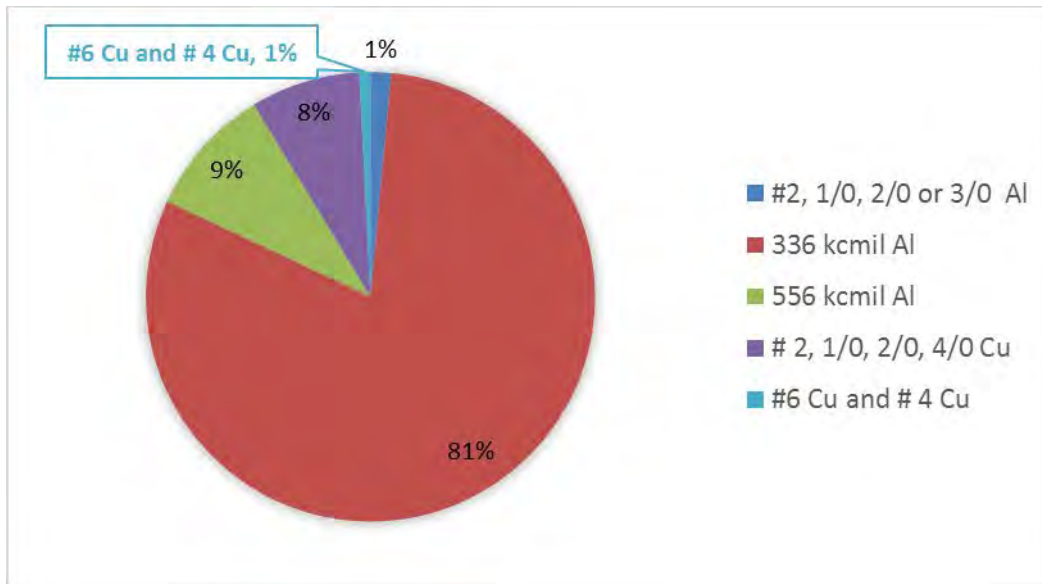


Figure 8: Conductor Sizes on 3-Ph, 4160V Lines

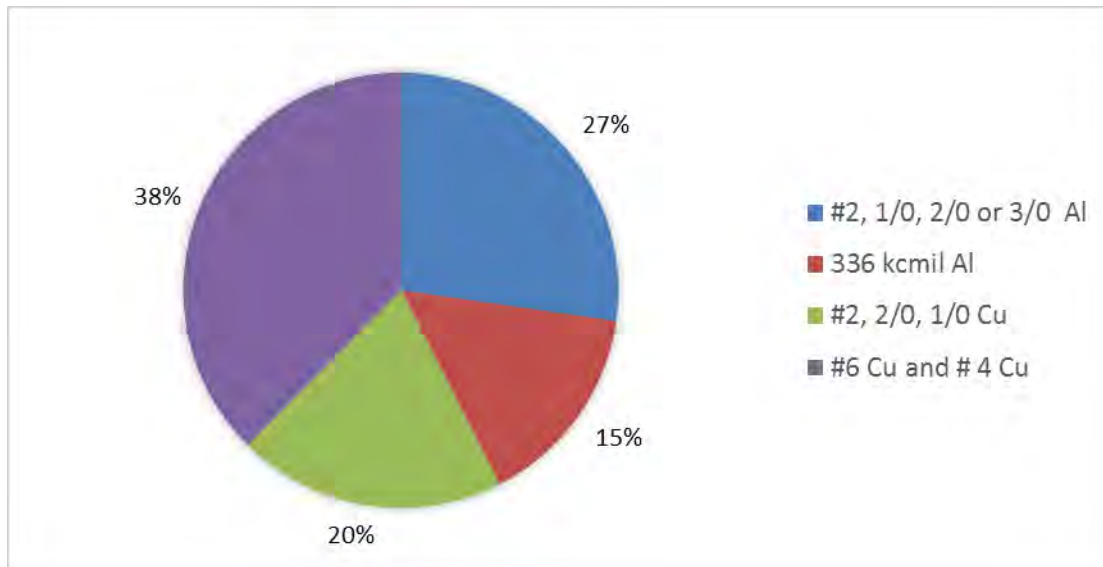


Figure 9: Conductor Sizes on 1-Ph, 2400V Lines

As indicated in Figure 8, the trunk lines on three phase circuits generally employ 336 kcmil aluminum and smaller conductor sizes are employed on branch circuits. The conductor sizes on single phase lines are also adequate for the load levels. It is noteworthy that a significantly large fraction of the single phase lines employ #4 and #6 AWG solid copper conductors. These small conductors, particularly when they approach the end of their typical service life, are known to fail in service under mechanical stress.

The typical useful life of overhead conductor is approximately 60 years. Figures 10, 11 and 12 indicate the age profile of various distribution lines as of 2015.

1-PH, 2400V OH Lines

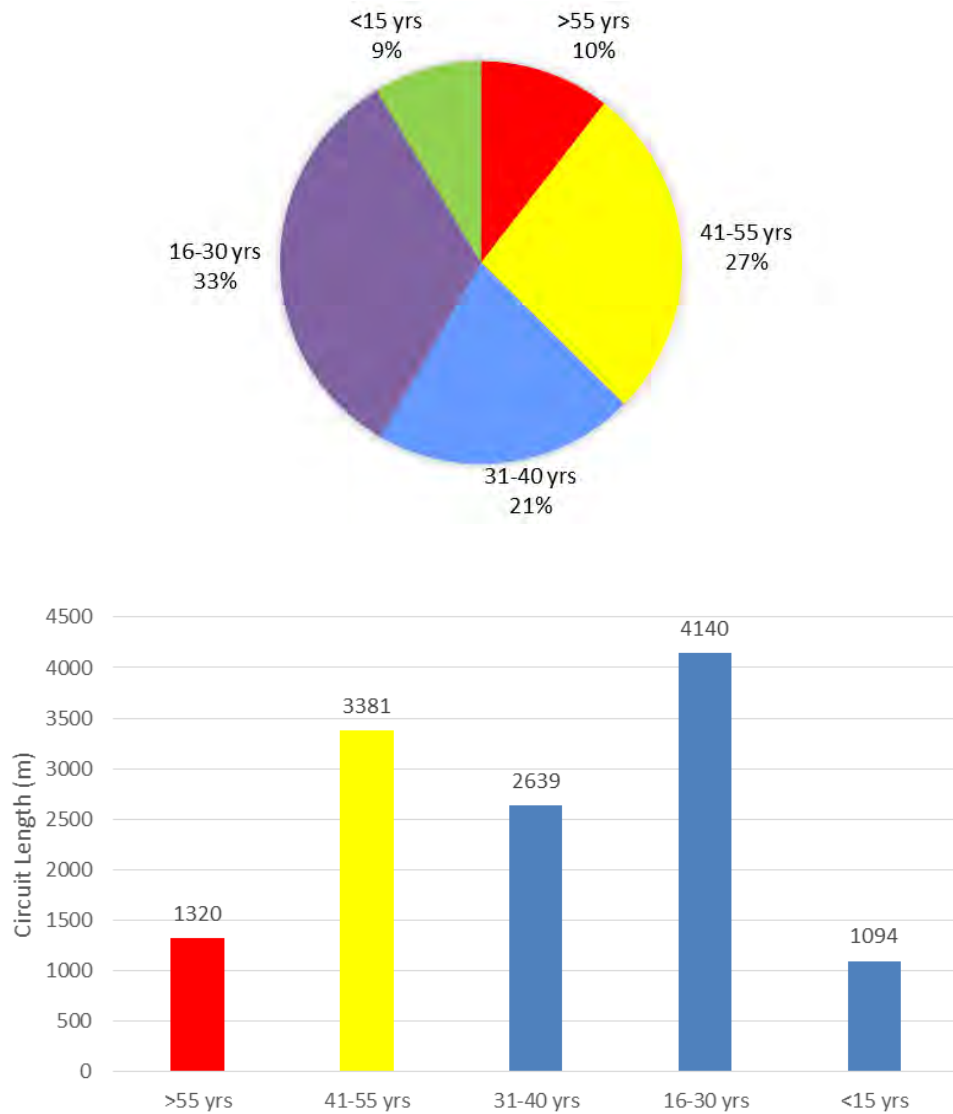


Figure 10: Age Profiles of 1-Ph 4 kV Overhead Lines

3-PH, 4160V OH Lines

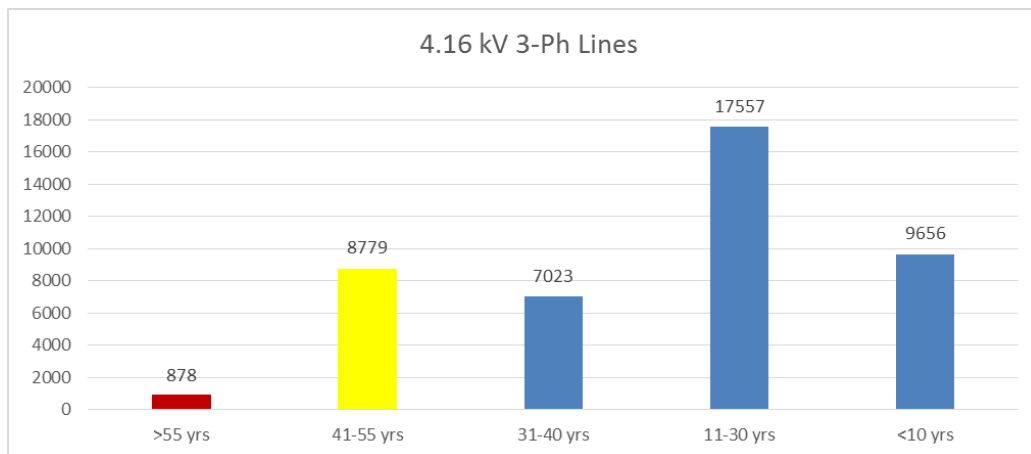
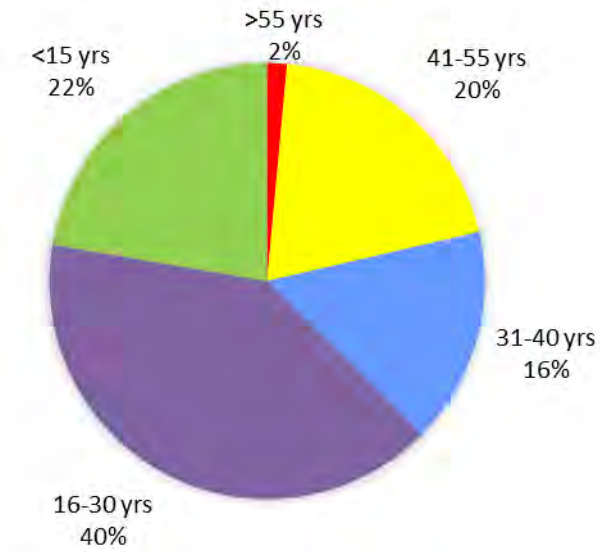


Figure 11: Age Profiles of 3-Ph 4 kV Overhead Lines

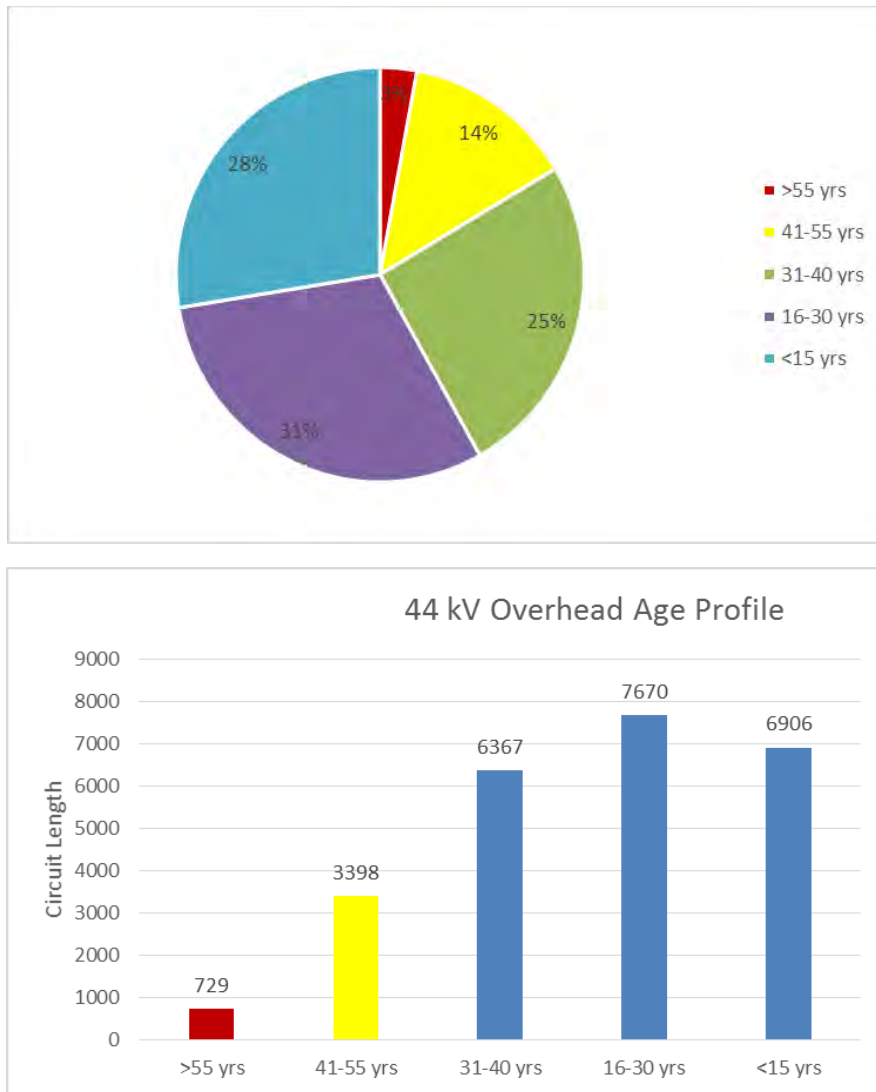


Figure 12: Age Profiles of 44 kV Overhead Lines

CWH's pole population totals 1881 poles. As indicated in Figure 13, a majority of the poles are wood poles (77%), while approximately 22% of the poles are concrete poles and a small number of steel poles are also employed. Figure 14 indicates the age profile of wood and non-wood poles.

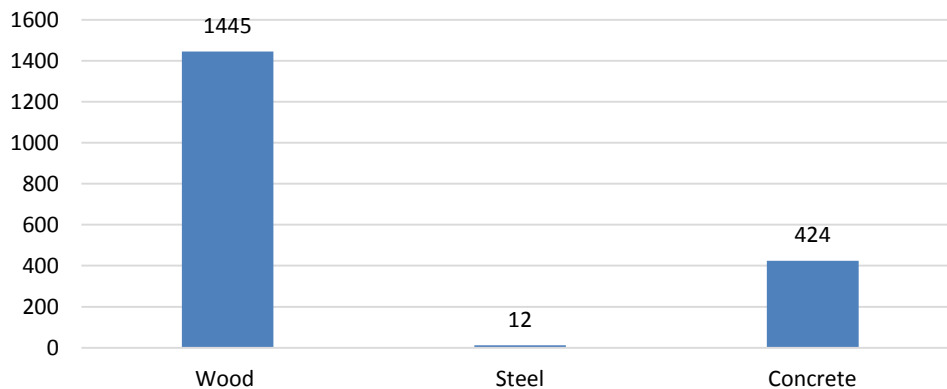
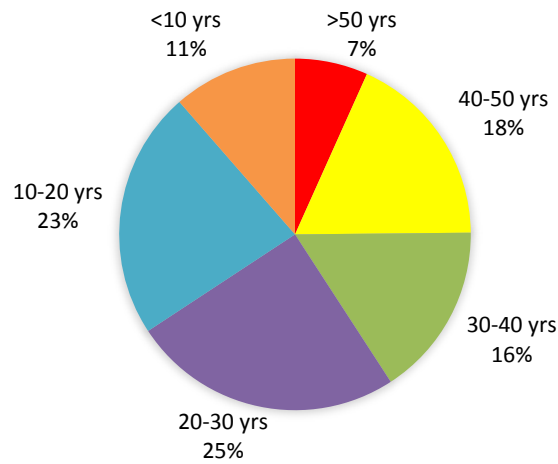
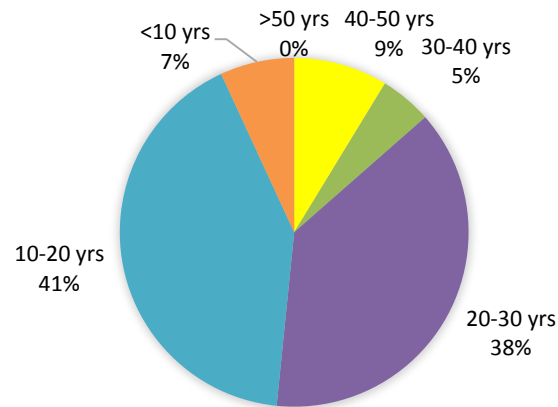


Figure 13: Pole Types Employed on CWH's Distribution System



(a) Wood Poles



(b) Concrete and Steel Poles

Figure 14: Pole Service Age Profile

The age profile presented in Figure 14 indicates approximately 25% of the wood poles will reach or exceed the typical useful service life mark of 45 years for wood poles, during the next five years. To confirm the remaining life of poles CWH tested approximately 200 randomly selected poles during 2014. The results of testing are summarized in Figure 15 and 16. As shown in Figure 15, from a batch of 100 tested poles with service life of 30 years or greater, 5% of the poles were found in poor condition, 47% in fair condition and 48% in good condition. As shown in Figure 16, from a batch of 100 poles with service age of less than 30 years, no poles were found in poor condition, 13% of poles were in fair condition and a vast majority of 87% poles were found in good condition. These test results suggest, wood poles in CWH service territory will provide a mean service life greater than the typical useful life reported in OEB commissioned asset depreciation study, summarized in Table 32.

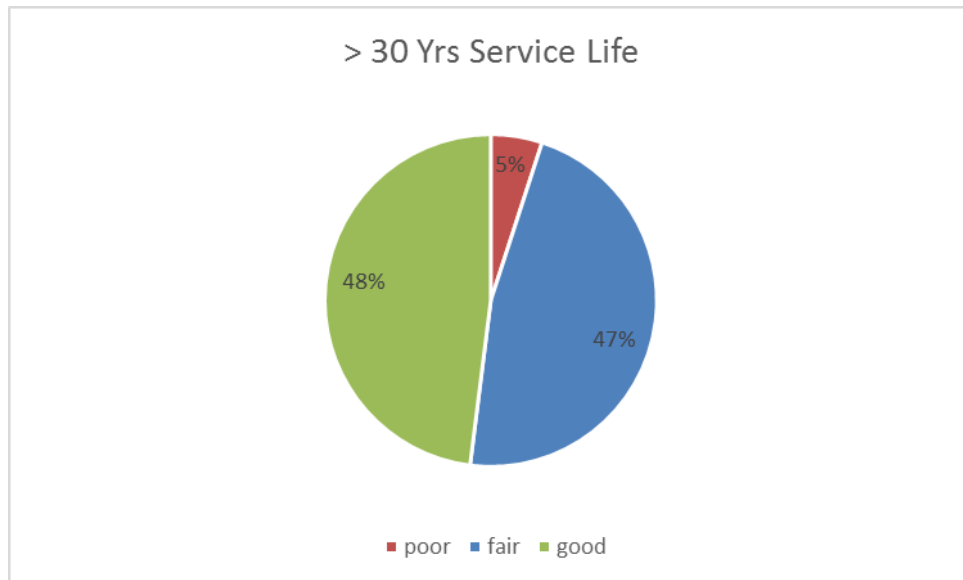


Figure 15: Wood Pole Test Results (Service Life > 30 Years)

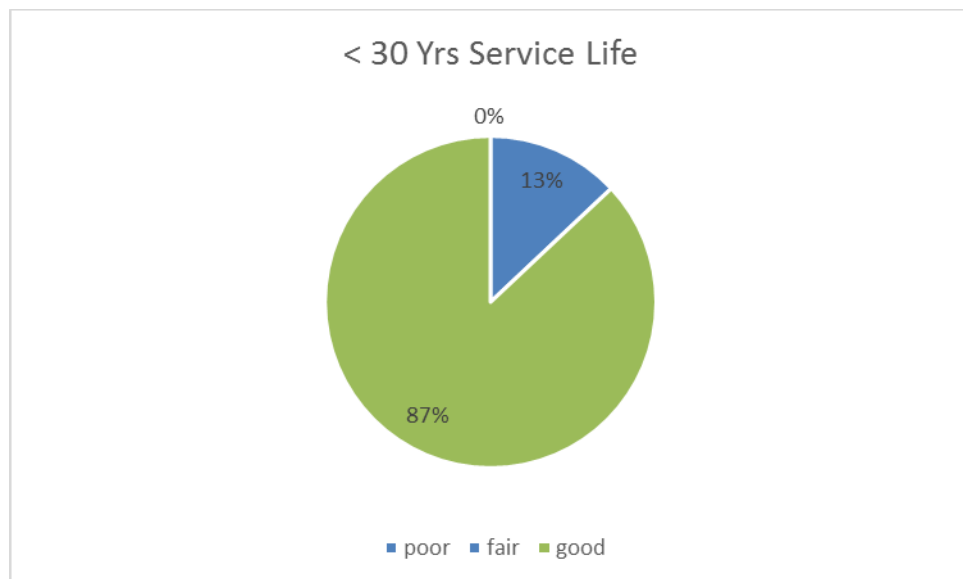


Figure 16: Wood Pole Test Results (Service Life < 30 Years)

By taking into account the service age of overhead lines, results of pole testing and the extent of small conductors (#4 and #6 copper) employed on overhead lines, Figure 17 summarizes the quantity of line sections based on health indices, ranging from very good to very poor.

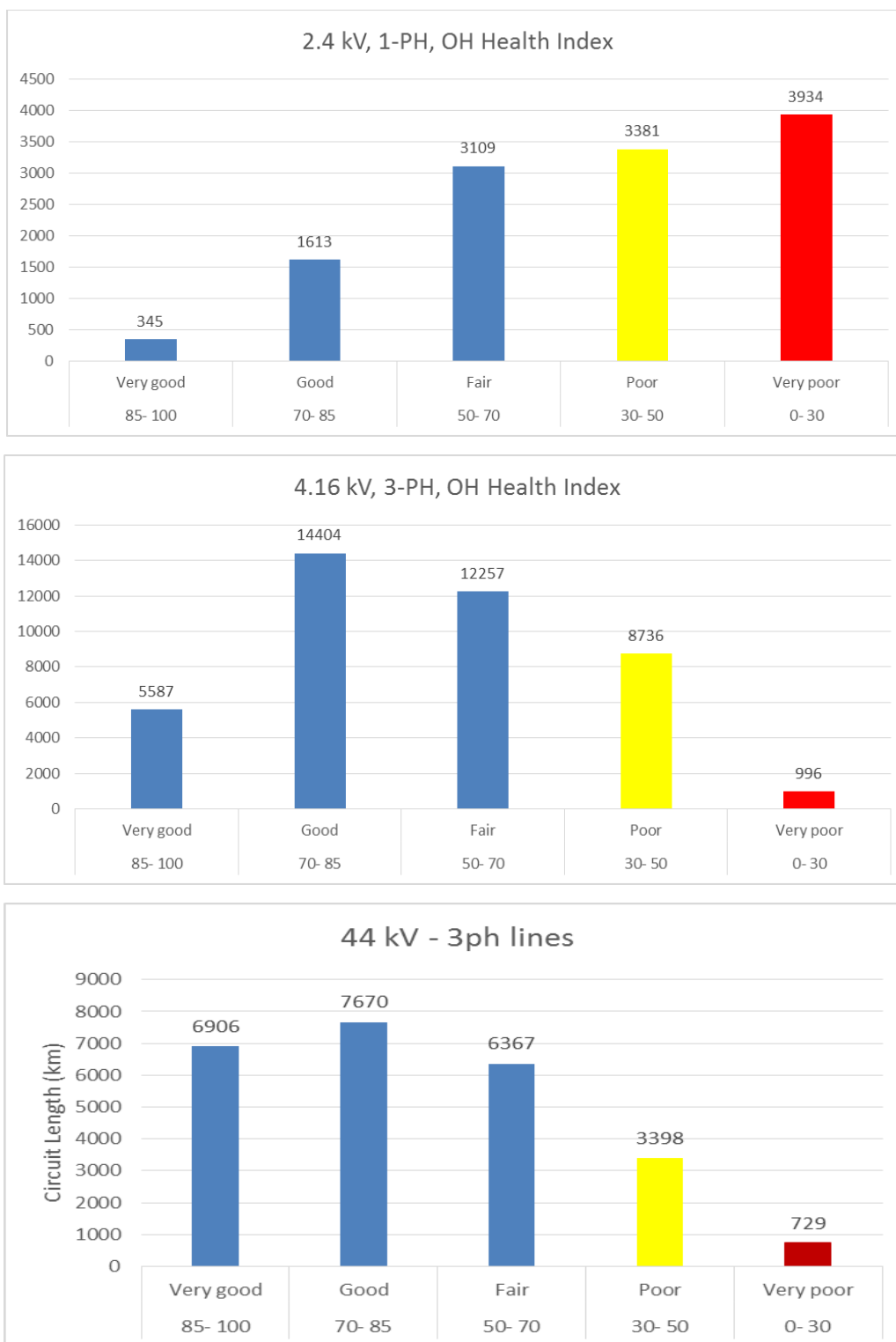


Figure 17: Overhead Line Health Indices

CWH employs approximately 318 pole-mounted distribution transformers. Figures 18 and 19 show the kVA ratings of pole mounted transformers employed in single phase, three phase (bank) applications.

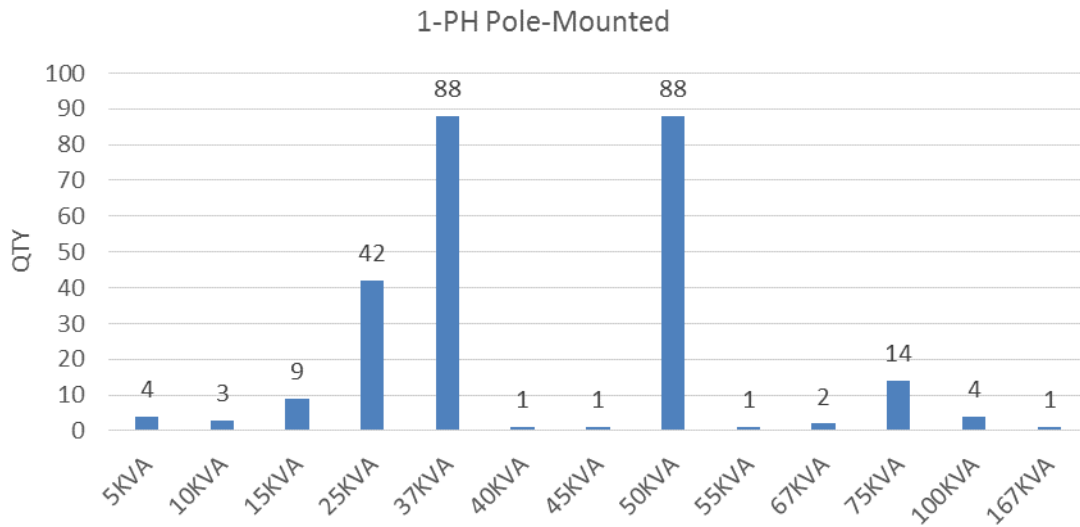


Figure 18: kVA Ratings of 1-Phase Pole-mounted Transformer

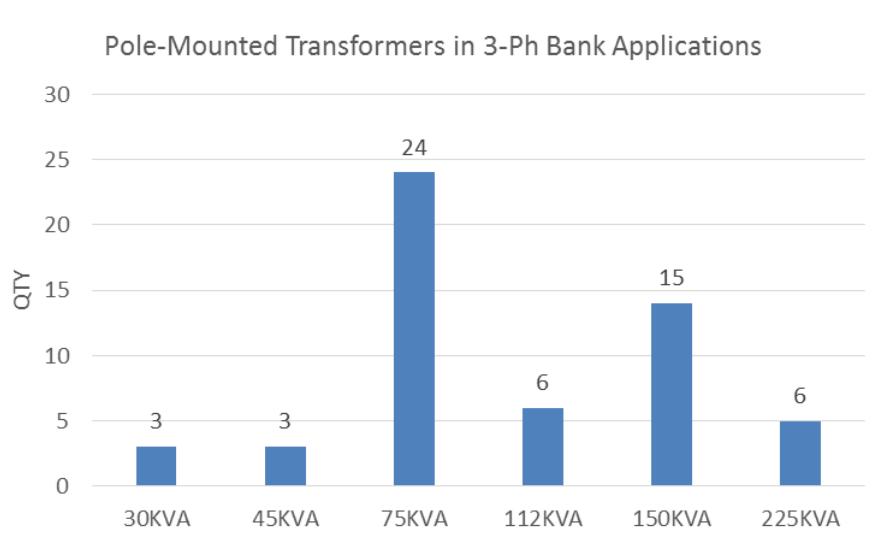


Figure 19: Number of Pole Mounted Transformers in 3-Phase Bank Applications

Figure 20 shows the number of pole-trans type distribution transformers in various ratings, which are scheduled to be replaced due to safety concerns.

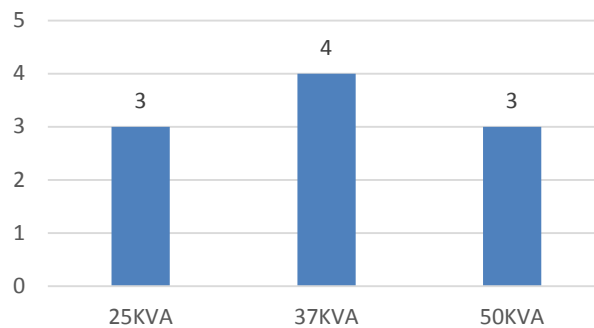


Figure 20: Pole-Trans Transformers Various Sizes

Figure 21 shows the age profile of pole mounted distribution transformers. The typical useful life of an overhead distribution transformer is 40 years. Figure 22 indicates the condition of pole-mounted transformers, based on the service age. CWH has not had extensive failure issues with distribution transformers, and like most distribution utilities, CWH manages this asset category in form of reactive replacement strategy, i.e. replace transformers upon failure, unless the inspections identify transformers that present safety risks.

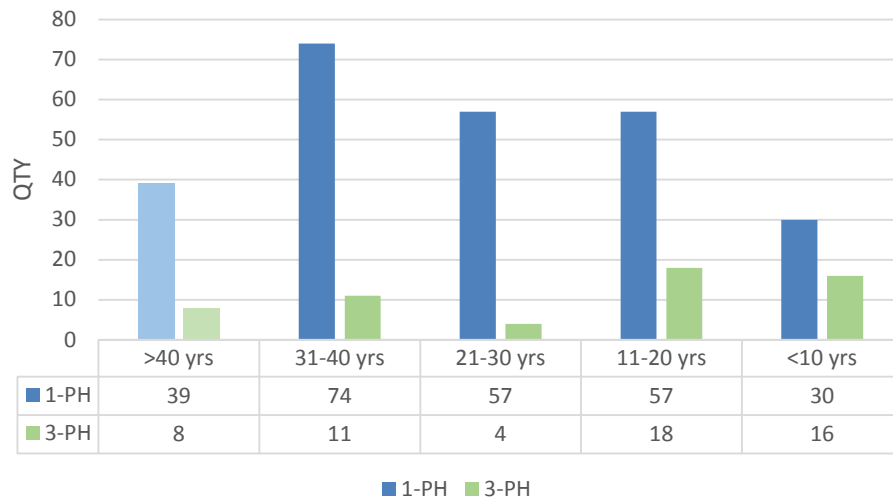


Figure 21: Age Profiles of Pole-mounted Transformers

Figure 22 summarizes the age profile of fused-cutouts, disconnect switches and load break air switches employed on CWH overhead lines.

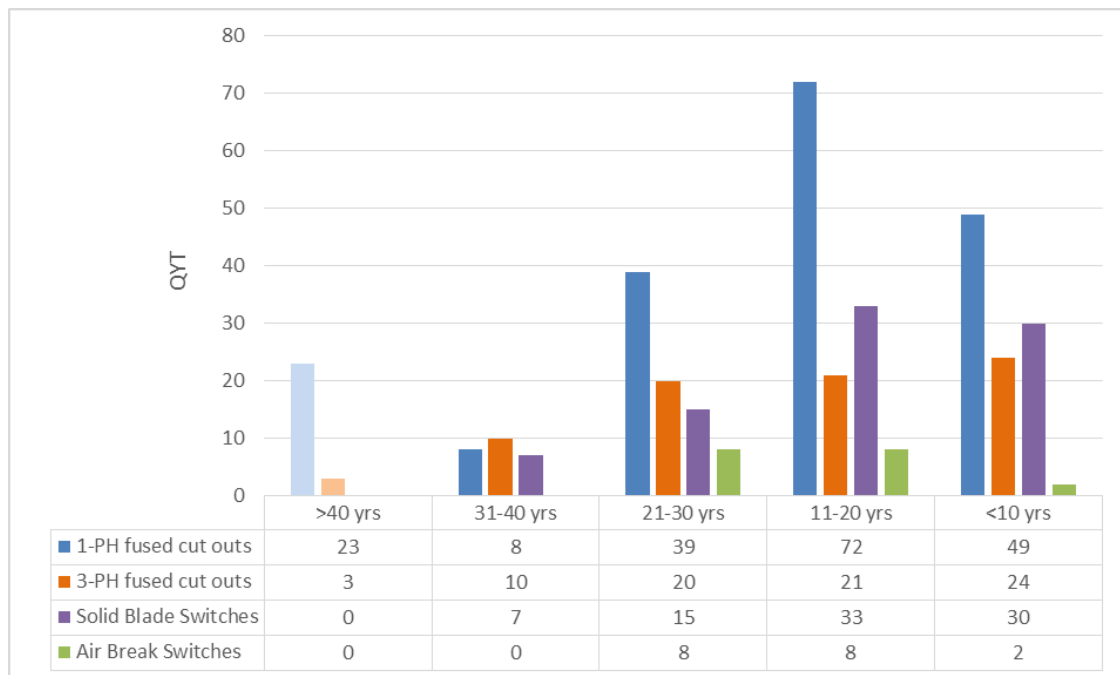


Figure 22: Overhead Line switches and Fused Cutouts

6.2 Underground Distribution System

Underground distribution system encompasses insulated cables, pad-mounted distribution transformers and pad-mounted switching kiosks. Figure 23 shows the age profile of insulated cables employed on 44 kV distribution network, mostly at the distribution stations. As shown, with the exception of a very small length of cable section, the vast majority of cables are well below their typical useful service life. The short length of old vintage 44 kV cable will be replaced in conjunction with the rebuild of distribution stations scheduled for 2016.

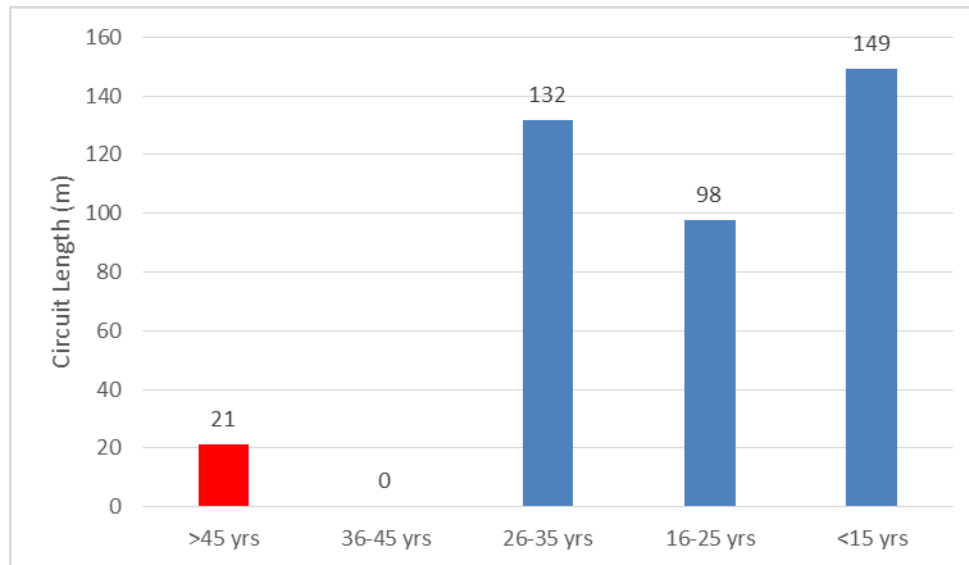


Figure 23: Age Profile of Insulated Cables Employed on 44 kV System

Figures 24 and 25, respectively, show the age profile of cables employed on 1-phase and 3 phase circuits of 4 kV underground network and Figure 26 shows the age profile of cables employed on LV lines and services. Although a small fraction of the installed cable circuits have reached beyond the typical service life expected for underground cables, so far CWH has not experienced many cable failures. CWH has schedule a poletran and underground cable replacement project for 2016 which will eliminate the majority of underground cable over 45 years old.

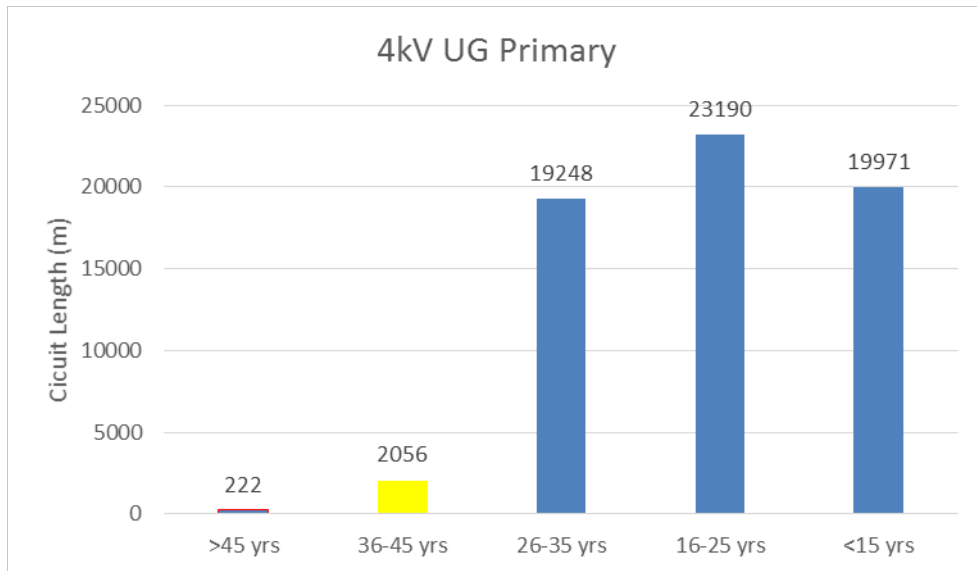


Figure 24: Age Profile of 1-phase Insulated Cables Employed on 4 kV System

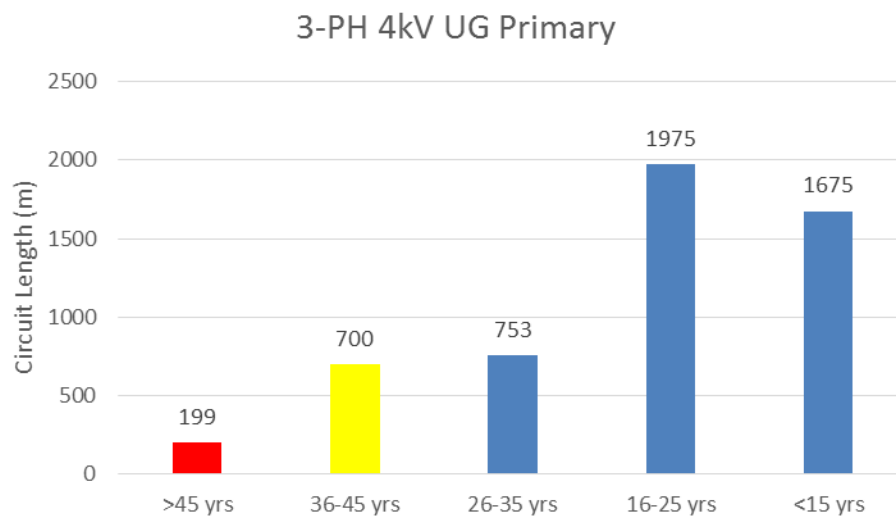


Figure 25: Age Profile of 3-phase Insulated Cables Employed on 4 kV System

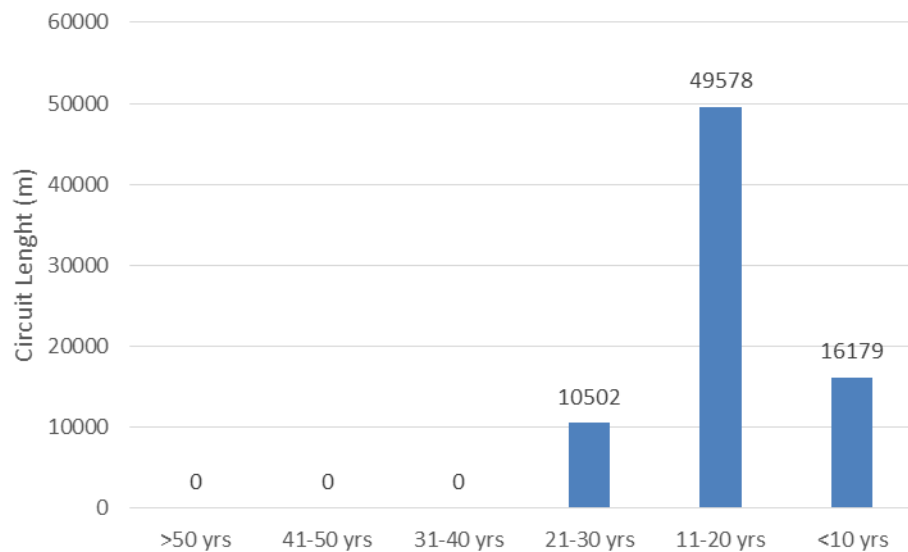


Figure 26: Age Profile of LV Cables

CWH employs approximately 394 single-phase and 96 three-phase, pad-mounted distribution transformers. Figures 27 and 28 show the kVA ratings of pad mounted transformers employed in single phase, three phase applications.

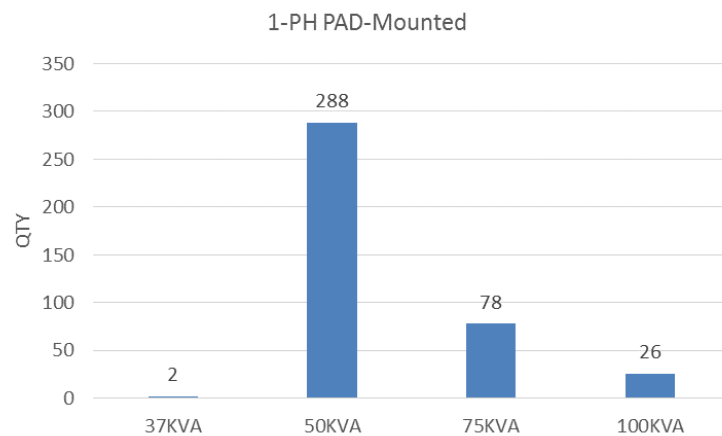


Figure 27: kVA Ratings of 1-Phase Pad-mounted Transformer

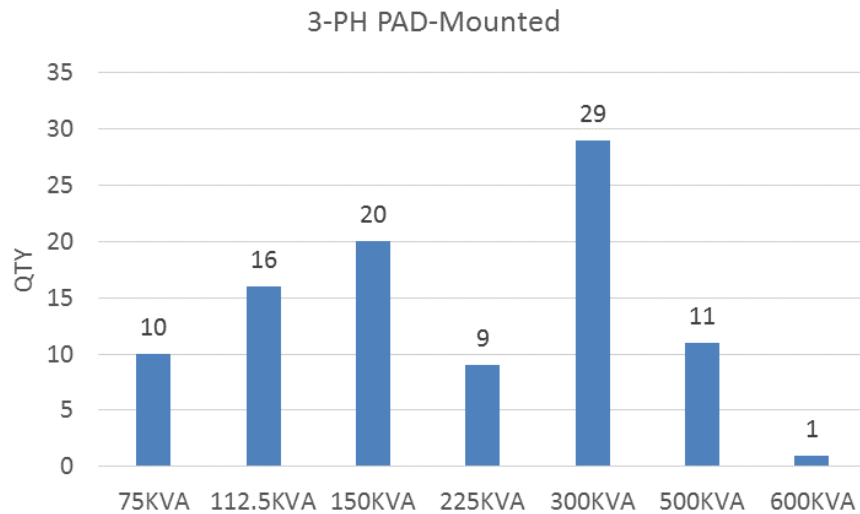


Figure 28: kVA Ratings of 3-Phase Pad-mounted Transformer

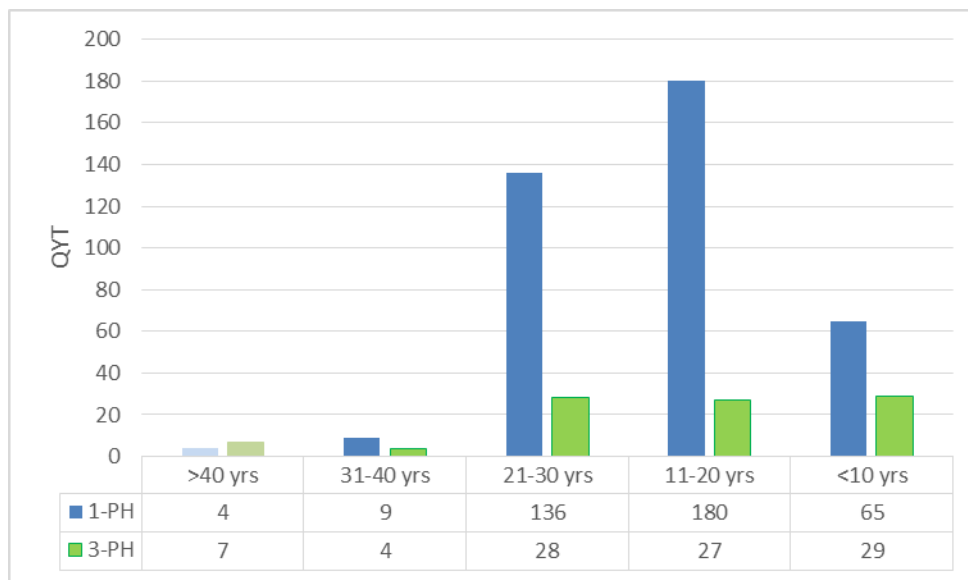


Figure 29: Age Profiles of Pad-mounted Transformers

The typical useful life of a pad-mounted transformer is 35 years. Figure 30 shows the condition of pad-mounted transformers. CWH has not had extensive failure issues with distribution transformers, and like most distribution utilities, CWH manages this asset category in form of reactive replacement strategy, i.e. replace transformers upon failure, unless the inspections identify transformers that present safety risks. As shown in Figure 30, along some main regional streets, where different types of road salts have been tried for snow melting, distribution transformers have experienced excessive corrosion of the enclosures, requiring rehabilitation.



Figure 30: Excessive Corrosion of Enclosures on UG Pads

6.3 Stations

As previously described, there are six municipal stations serving the Centre Wellington Hydro (CWH) service territory. The town of Fergus is served by four stations, designated: MS1, MS2, MS3, and MS4 and the village of Elora is served by two stations, designated MS1 and MS2. Major assets employed at municipal stations include: Power transformers, 44 kV switchgear and 4 kV switchgear.

Based on the condition assessment of major equipment and the asset management plan developed in 2012, CWH has upgraded the 44 kV and 4 kV switchgear at three of the six stations: MS-1, MS-2 and MS-3 in the town of Fergus, during the past five years. For power transformer, the tanks were repainted and equipped with cooling fans, but no work was undertaken to upgrade the coil insulation. MS-1 substation in the village of Elora was completed rebuilt and equipped with a new power transformer, in addition to new 44 kV and 4 kV switchgear. Table 36 summarizes the original manufacture/rebuilt date of power transformers and documents the recently completed and planned switchgear upgrade initiative.

Station Designation	Transformer In Service/ Rebuilt Date	Transformer Capacity	44 kV Switchgear	4 kV Switchgear with Automated Reclosers
MS-1 (Fergus)	Not Known	5MVA	Upgraded During Past Five Years	Upgraded During Past Five Years
MS-2 (Fergus)	Not Known	5MVA	Upgraded During Past Five Years	Upgraded During Past Five Years
MS-3 (Fergus)	1992	5MVA	Upgraded During Past Five Years	Upgraded During Past Five Years
MS-4 (Fergus)	1989	5MVA	Scheduled for Upgrade in 2015/16	Scheduled for Upgrade in 2015/16
MS-1 (Elora)	2014	6/8MVA	Upgraded During Past Five Years	Upgraded During Past Five Years
MS-2 (Elora)	1997	5MVA	Scheduled for Upgrade in 2015/16	Scheduled for Upgrade in 2015/16

Table 36: Recently Completed and Planned Switchgear Upgrade Projects

By taking into account the original manufacture or rebuilt date, historic loading levels, results of recent inspections and oil tests performed in 2015, health indices were developed to benchmark the relative condition of power transformers and Figure 31 shows the relative condition of power transformers, expressed on a scale of 1 to 100. The power transformers at MS-1 and MS-2 stations in Fergus are very old (MS-2 power transformer appears to be the oldest), with unknown original manufacture date. Although the insulating oil tests performed in 2015, do not reveal any concerns with internal coil insulation, due to their advanced age, the power transformers at MS-2 and MS-1 will require replacement within the 10-year period. Oil tests for power transformers at MS-3 and MS-4 in the town of Fergus indicate elevated levels of CO and CO₂ in oil, a sign of insulation overheating. The overheating situation is not at an alarming level, but should be monitored through routine oil testing. Similarly, oil testing of power transformer at MS-2 in the village of Elora has indicated slightly lower surface tension, a sign of insulation degradation, but still not alarming levels. Based on the power transformer health indices, the power transformer at Elora MS-1 is considered in “very good” condition and all of the remaining transformers are considered to be in “fair” condition.

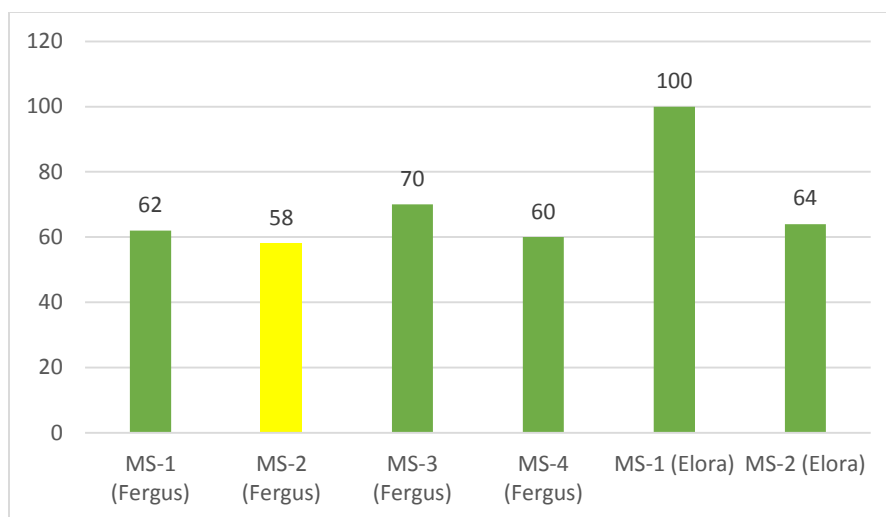


Figure 31: Power Transformer Condition

By taking into account the original manufacture date, results of recent inspections and level of sophistication of protection and control relays, health indices were developed to benchmark the relative condition of switchgear and Figure 33 shows the relative condition of switchgear, expressed on a scale of 1 to 100. Switchgear at MS-4 in the town of Fergus and MS-2 in the village of Elora is considered in “poor” condition and switchgear at all of the remaining substations is determined to be in “very good” condition.

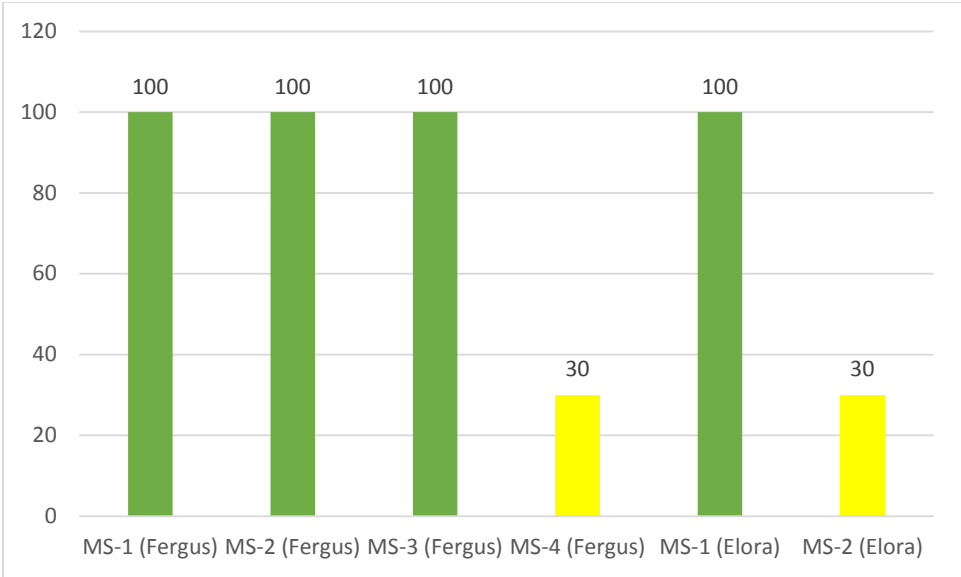


Figure 32: Switchgear (44 kV and 4 kV) Condition

6.4 Smart Grid Initiative:

Ontario Energy Board has mandated the local distribution companies (LDCs) to develop and implement smart grid initiative within their jurisdictions to improve reliability and operating efficiency of the distribution grid and to increase its capacity to accept connection of distributed generation from environmentally friendly (green) power sources.

The distribution system at CWH distributes power through 4 kV feeders, served from six substations. CWH has acquired and installed a SCADA system and it currently provides remote monitoring and metering functions. Four of the existing stations are now equipped with automated and remote controlled reclosers, protected through SEL relays. The remaining two stations are scheduled to undergo switchgear upgrade during 2016. Upon completion of this project, full features of the SCADA system will be fully utilized.

The estimated cost to equip the remaining two stations with SCADA controlled switchgear is approximately \$0.95 million.

6.5 Revenue Meters

CWH owns approximately 6,793 revenue meters, installed on its customers' premises for the purpose of measuring electric consumption and demand of connected load for the purpose of billing. These meters are all ELSTER manufactured and vary in type depending on the connection type and customer class, and are capable of measuring kWh consumption, for TOU and interval customers, kW and KVA demand for GS >50, as well as bi-directional meters for renewable generation applications. CWH completed the installation of all of its Residential and General Service <50kW Smart Meters by December 2010 as part of the Province of Ontario's mandated Smart Meter initiative. Figure 33 shows the breakout of CWH active meters by customer/meter types.

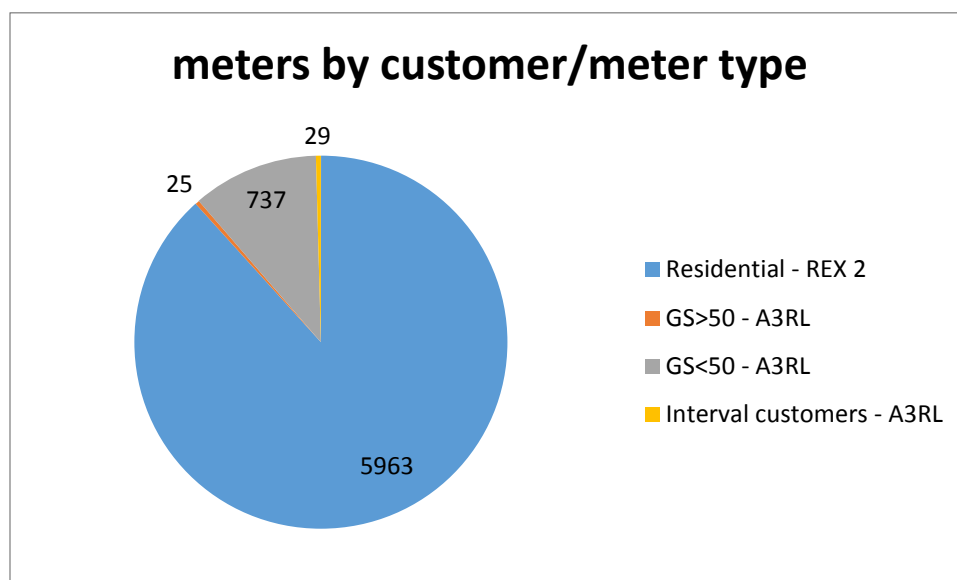


Figure 33: CWH Revenue Meter Quantities

The majority of CWH's electric meters were installed in 2009 and have a seal year of 2019. CWH has experienced a total meter failure (disposal) rate of 226 meters since 2009 or a 3.4% failure rate with its installed meters. As shown in Figure 34, revenue meter failure rate has escalated during the last 2 years with a total of 69 failures in 2014 and 75 failures to date (Nov 19) in 2015.

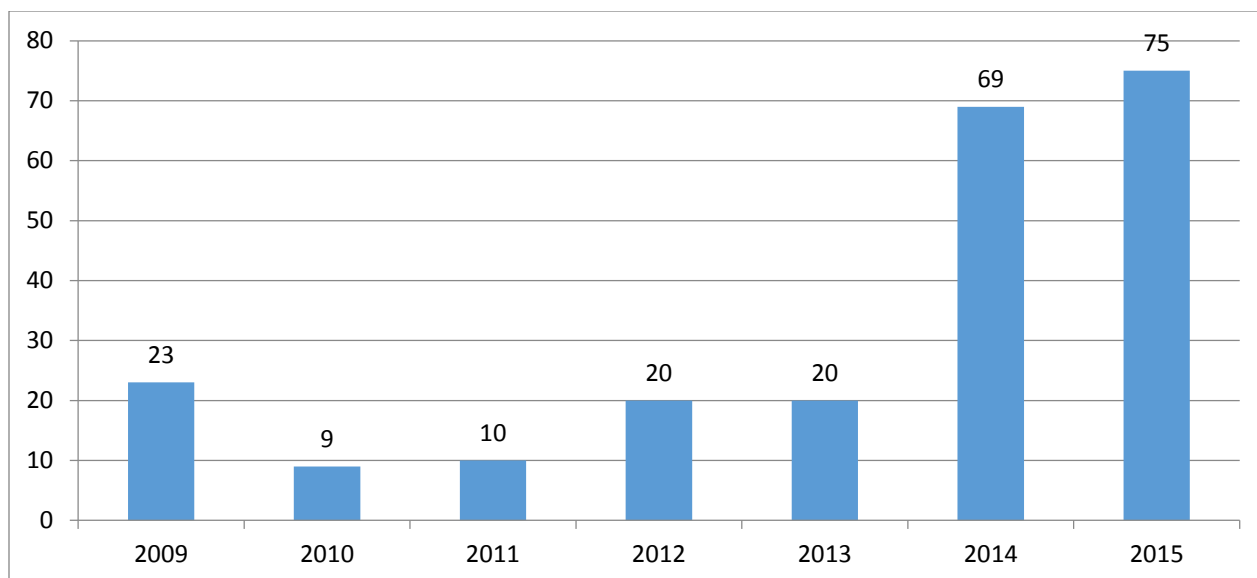


Figure 34: CWH – Number of Failed (Scrapped) Revenue Meters

CWH plans to sample 200 meters in each year of 2016 and 2017 and in accordance with Measurement Canada’s “S-S-05—Performance Requirements Applicable to Meters Granted a Conditionally Lengthened Initial Reverification Period under S-EG-01” - sample its meter population to acquire an extension of 8 years.

The following is a schedule for the meter replacements/change outs that will be completed by CWH staff.

	2016	2017	2018	2019	2020	2021
Revenue Meter Requirements for Recalibration	200	200	250			
Revenue Meter Requirements to replace failed meters	100	100	100	200	200	200
Total Revenue Meter Requirements	300	300	350	200	200	200

6.6 Preventative Maintenance:

We have reviewed the fixed asset preventative maintenance program currently in use at CWH and determined that it is in line with the best utility practices. The reliability performance over the recent years, indicated in Figure 4, provides evidence that the current preventative maintenance strategy is working well. Therefore, no changes are recommended in the preventative maintenance program, which is briefly described below:

- (a) Assets installed in substations are inspected in accordance with the following schedule.

	Inspection Schedule		
	Outdoor Open	Outdoor Enclosed	Indoor Enclosed
Distribution Station	1 month	Annually	Annually
Customer Substation	Annually	3 Years	3 Years

(b) Preventative maintenance and testing is performed on the following critical assets, in compliance with the manufacturer's recommendations and best industry practices:

- Power Transformers
- Lightning Arrestors
- Circuit Breakers / Reclosers
- Switchgear
- Protection and controls
- Control battery and Battery chargers

(c) Overhead lines and underground pads are inspected on a 3-year cycle, to comply with Electrical Safety Authority's regulations. One third of the distribution assets employed on overhead distribution system are inspected each year. Structural defects, clearance issues and electrical problems and hazards are identified through visual inspections and where problems are revealed, either repair work is scheduled or capital work is planned, as needed. Where the inspections determine an immediate hazard to the public, immediate follow up action is taken to mitigate the problem. Field inspection records are kept on file in the line superintendent's office until the next cycle of inspections.

(d) On overhead distribution lines, the following deficiencies/defects are identified on various assets:

Poles/Supports:

- Bent, cracked or broken poles
- Excessive surface wear or scaling
- Loose, cracked or broken cross arms and brackets
- Woodpecker or insect damage, bird nests
- Loose or unattached guy wires or stubs
- Guy strain insulators pulled apart or broken
- Guy guards out of position or missing
- Grading changes, or washouts
- Indications of burning

Transformers:

- Paint condition and corrosion
- Phase indicators and unit numbers match operating map (where used)
- Leaking oil
- Flashed or cracked insulators
- Contamination/discholoration of bushings
- Ground lead attachments
- Damaged disconnect switches or lightning arresters
- Ground wire on arresters unattached

Switches and Protective Devices:

- Bent, broken bushings and cutouts
- Damaged lightning arresters
- Ground wire on arresters unattached

Hardware and Attachments:

- Loose or missing hardware
- Insulators unattached from pins
- Conductor unattached from insulators
- Insulators flashed over or obviously contaminated (difficult to see)
- Tie wires unraveled
- Ground wire broken or removed
- Ground wire guards removed or broken

Conductors and Cables:

- Low conductor clearance
- Broken/frayed conductors or tie wires
- Exposed broken ground conductors
- Broken strands, bird caging, and excessive or inadequate sag
- Insulation fraying on secondary

Third Party Plant:

- Attachment not secure
- Infringing on clearances
- Compromising access to electrical equipment
- Unapproved/unsafe occupation or secondary use

General Conditions & Vegetation:

- Leaning or broken “danger” trees
 - Growth into line of “climbing” trees
 - Accessibility compromised
 - Vines or brush growth interference (line clearance)
 - Bird or animal nests
- (e) On underground distribution lines, the following deficiencies/defects are identified on various assets:

Pad Mounted Transformers and Switching Kiosks:

- Paint condition and corrosion
- Placement on pad or vault
- Check for lock and penta bolt in place or damage
- Grading changes
- Access changes (Shrubs, trees, etc.)
- Phase indicators and unit numbers match operating map (where used)
- Leaking oil
- Lid damage, missing bolts, cabinet damage
- Cable connections
- Ground connections
- Nomenclature
- Animal nests/damage
- General conditions

Right of Way

- Accessibility compromised
 - Grade changes that could expose cable
 - Excessive vegetation on right of way
- (f) Tree trimming has been carried out on a 2-3-year cycle in the past, which we consider to be satisfactory.
- (g) In accordance with the best utility practices, thermograph inspections of distribution assets are carried out with infra-red cameras and any hot spots are promptly attended. The thermograph inspections appear to be extremely effective in detecting incipient faults and we recommend these should be continued as part of the maintenance program.
- (h) Due to the advanced age of distribution stations, power transformer oil samples are obtained and tested annually. The results of previous years oil testing have been used in assessing and ranking the condition of power transformers employed at distribution stations.

7 Capital Investment Plan

Based on the condition assessment of major assets employed in substations, overhead lines and underground distribution system described in Section 6, this section provides the budgetary estimates of capital investments required during the next six years to keep the system operating at optimal levels. The estimates are based on unit-cost in 2015 and an annual inflation rate of 2% has been used in projecting the cost estimates for 2016 through 2021.

7.1 Capital Expenditure Requirement for System Renewal - Overhead Line Assets

Based on the 2015 per-unit replacement costs and the quantities of assets requiring replacement during the next six years from 2016 to 2021, Table 37 provides estimates of capital expenditure requirements during the next six years for system renewal on overhead lines.

		Estimated Replacement Quantity During 6 Years (2016-2021)	Unit Cost	Estimated Cost over 6 years	2016	2017	2018	2019	2020	2021
			\$	\$	\$	\$	\$	\$	\$	\$
Overhead Lines	Overhead lines 3 ph 44 kV	550	280	154,000		32,044	32,685	33,339	34,006	34,686
	Overhead lines 3 ph 4.16 kV	5364	220	1,180,059	200,610	204,622	208,715	212,889	217,147	221,490
	Overhead lines 1 ph 2.4 kV	5625	140	787,476	133,871	136,548	139,279	142,065	144,906	147,804
	Replacement of 1-ph transformers	39	4,800	186,720	31,742	32,377	33,025	33,685	34,359	35,046
	Replacement of switches and cutouts	24	800	18,880	3,210	3,274	3,339	3,406	3,474	3,544
	Subtotal Overhead Lines				369,433	408,866	417,043	425,384	433,892	442,570

Table 37: Estimate of Capital Expenditure required to sustain OH Line Assets

7.2 Capital Expenditure Requirement for System Renewal - Underground Distribution Assets

Based on the 2015 per-unit replacement costs and the quantities of assets requiring replacement during the next six years, Table 38 provides estimates of capital expenditure requirements during the next six years to sustain assets employed on underground distribution system.

		Estimated Replacement Quantity During 6 Years (2016-2021)		Unit Cost	Estimated Cost over 6 years	2016	2017	2018	2019	2020	2021
		m		\$	\$	\$	\$	\$	\$	\$	\$
Underground Cable Circuits	Underground 3 ph cables 4.16 kV	724	m	300	217,162	36,918	37,656	38,409	39,177	39,961	40,760
	Underground 1 ph cables 2.4 kV	1764	m	125	220,447	37,476	38,226	38,990	39,770	40,565	41,377
	Replace rusted 1-ph pad mounted transformers	20	#	4,000	80,000	81,600					
	Padmount 1-Ph transformers (including pole trans)	18	#	9,000	162,900	27,693	28,247	28,812	29,388	29,976	30,575
	Padmount 3-Ph transformers	4	#	18,000	77,400	19,737		19,102	21,364	21,791	22,227
	Subtotal Underground Lines					203,424	104,128	125,313	129,699	132,293	134,939

Table 38: Estimate of Capital Expenditure required to sustain UG Line Assets

7.3 Capital Expenditure Requirement for System Renewal - Substation Assets

Based on the planned projects for upgrade and modernization of substations, detailed estimates of investments required into substations are summarized in Table 39.

		Estimated Replacement Quantity During 6 Years (2016-2021)	Unit Cost	Estimated Cost over 6 years	2016	2017	2018	2019	2020	2021
Substations	Reconstruction of MS-2 (Elora)	1	370,400	370,400	370,400	0	0	0	0	0
	Replacing 4 kV Protection and Making MS-4, SCADA Ready	1	678,200	678,200	678,200	0	0	0	0	0
	Subtotal Substations			1,048,600	1,048,600	0	0	0	0	0

Table 39: Estimate of Capital Expenditure required to sustain Substation Fixed Distribution Assets

7.4 CAPEX Investment Requirements for System Access:

CWH is required to invest into distribution system extensions and expansions to meet its regulatory obligations to serve new residential and commercial customers within its service territory. Similarly, the LDC is required to relocate its lines installed in the public right of ways when requested by the local municipalities in conjunction with their road widening projects.

Based on the historical expenditure levels, Table 40 provides estimates of required investment level for system access. Using the cost base of 2015, the projected costs have been adjusted for anticipated inflation of 2% per annum.

	2016	2017	2018	2019	2020	2021
New Services	32,200	10,200	10,404	10,612	10,824	11,041
Municipal Projects	131,300	51,000	52,020	53,060	54,122	55,204
Revenue meters	11,700	57,000	66,500	38,000	38,000	38,000
Subtotal System Access Expenditure	175,200	118,200	128,924	101,672	102,946	104,245

Table 40: Estimate of System Access Capital Expenditure

7.5 CAPEX investment Requirements for General Plant

(a) Service Center Renovations – New Doors and Windows

Centre Wellington Hydro's service center, located at 730 Gartshore Street, Fergus, Ontario, was constructed in 1996 with an addition put on in 2000. The windows have now degraded to the point where, they will not open or close securely. The doors at the service center are getting corroded and have warped over time to the point where, they too do not open or close securely. During the winter months, the concrete slab at the main entrance lifts to the point where the door will not open, and it has become a tripping hazard for Centre Wellington customers. The front facade has developed a substantial leak into the office spaces of the facility. Efforts have been made to correct this problem, but a more permanent solution will need to be implemented.

To maintain facility security and customer safety it is recommended to retrofit the service center with new windows and doors. Repairs to the customer entrance and facade of the facility are also recommended. A quote for repairs to the building has been obtained based on which cost estimate for the repairs is provided below:

	2016
Replace defective windows and doors	\$ 30,200
Replace concrete ramp	\$ 3,500
Sub total - Service Center Renovations	\$ 33,700

Table 41: Estimate of Capital Expenditure – Service Center Renovations

(b) Construction of Storage Barn

The current storage facility at 730 Gartshore Street, Fergus, Ontario, used for warehousing equipment and materials requiring indoor storage, has been in service for approximately 15 years. Over that time period, increase in material storage requirements have created a very congested facility. In order to maintain a safe and secure storage area for Centre Wellington Hydro equipment and staff, an addition to the current storage facility is required. Based on a quotation received, the estimated cost of the storage facility is indicated in Table 42.

	2016
Addition of 32' x 56' x 16'H indoor storage facility	\$ 55,000

Table 42: Estimate of Capital Expenditure – Indoor Storage Facility

(c) XPLORE Tablet

To improve productivity and accuracy of operating records CWH is planning to acquire XPLORE tablet set with accessories, the cost estimate for which is provided in Table 43.

	2016
Computer hardware/software system	28,200

Table 43: Estimate of Capital Expenditure – XPLORE Tablet

7.6 Estimate of Annual Capital Expenditure:

Based on the capital expenditure requirements itemized in Sections 7.1 through 7.5, Table 44 represents our estimate of total capital investments into fixed distribution system assets, required over the next six years from 2016 to 2021. The 2016 column reflects the actual total capital budget for 2016. The budget for 2017 includes procurement of a bucket truck.

	2016	2017	2018	2019	2020	2021
System Renewal - Overhead line assets	369,433	408,866	417,043	425,384	433,892	442,570
System Renewal - Underground distribution assets	203,424	104,128	125,313	129,699	132,293	134,939
System Renewal - Substation assets	1,048,600	-	-	-	-	-
System Access Expenditure Estimate	175,200	118,200	128,924	101,672	102,946	104,245
General Plant Expenditure Estimate	230,800	631,194	200,000	256,756	269,131	281,753
Total Capital Expenditure Estimate	2,027,456	1,262,388	871,280	913,512	938,262	963,506

Table 44: Overall Annual Capital Investment Requirements for Fixed Distribution System Assets

Appendix C

IESO Comment Letter

IESO Letter of Comment

Center Wellington Hydro Ltd.

Distribution System Plan
(October 2016)

January 17, 2017

Introduction

On March 28, 2013, the Ontario Energy Board (“the OEB” or “Board”) issued its Filing Requirements for Electricity Transmission and Distribution Applications; Chapter 5 – Consolidated Distribution System Plan Filing Requirements (EB-2010-0377). Chapter 5 implements the Board’s policy direction on ‘an integrated approach to distribution network planning’, outlined in the Board’s October 18, 2012 Report of the Board - A Renewed Regulatory Framework for Electricity Distributors: A Performance Based Approach.

As outlined in the Chapter 5 filing requirements, the Board expects that the Ontario Power Authority¹ (“OPA”) comment letter will include:

- the applications it has received from renewable generators through the FIT program for connection in the distributor’s service area;
- whether the distributor has consulted with the OPA, or participated in planning meetings with the OPA;
- the potential need for co-ordination with other distributors and/or transmitters or others on implementing elements of the REG investments; and
- whether the REG investments proposed in the DS Plan are consistent with any Regional Infrastructure Plan.

Centre Wellington Hydro Ltd. – Distribution System Plan

On January 2, 2017 Centre Wellington Hydro Ltd. (“CWH”) provided renewable energy generation investments information to the IESO as part of its Distribution System Plan until 2022. The IESO has reviewed CWH’s Plan and provides the following comments.

OPA FIT/microFIT Applications Received

Centre Wellington Hydro’s Plan identifies 30 microFIT projects totalling 273 kW of capacity, 3 FIT projects totalling 495 kW in capacity and 1 RESOP project of 150 kW in capacity that are connected to its distribution system.

The renewable energy generation connections information of the IESO, as of November 30, 2016, is reasonably consistent with the information presented in the Plan. The IESO has offered contracts to 32 microFIT projects representing a capacity of 286 kW, and 4 FIT projects totalling 1,445 kW of capacity. The IESO confirms that it has also contracted for 1 RESOP project of 250 kW (nameplate capacity) connected to CWH’s distribution system. Any differences between the number of renewable energy generation projects in the Plan and the IESO’s records may be attributed to different dates for data collection.

¹ On January 1, 2015, the Ontario Power Authority (“OPA”) merged with the Independent Electricity System Operator (“IESO”) to create a new organization that will combine the OPA and IESO mandates. The new organization is called the Independent Electricity System Operator.

Consultation / Participation in Planning Meetings; Coordination with Distributors / Transmitters / Others; Consistency with Regional Plans

For regional planning purposes, the IESO notes that CWH belongs to the Kitchener-Waterloo-Cambridge-Guelph (“KWCG”) Region.

The regional planning process endorsed by the OEB in August 2013, established that the host distributor (Hydro One Distribution in this case) in a region, is required to gather information from their respective embedded LDCs for regional planning purposes, but does not require that embedded LDCs be directly involved in the regional planning process.

In the KWCG Region, Centre Wellington Hydro is a fully embedded utility of Hydro One Distribution and was not part of the working group for the IESO’s Integrated Regional Resource Plan (“IRRP”) published in April 2015.² However, CWH participated as a working group member in the subsequent Regional Infrastructure Plan (“RIP”) published by Hydro One in December 2015.³

Centre Wellington Hydro’s Plan indicates that no capacity constraints are expected over the Plan period, requiring investments in capacity upgrades.⁴ This is supported by a decrease in the overall demand the utility has experienced in the last two years partly resulting from CDM programs and time-of-use pricing implementation.⁵

The IESO confirms that both the IRRP and the RIP found that the existing infrastructure meets the needs of CWH’s service territory in the short term (0-5 years) and medium term (5-10 years).

The IESO looks forward to participating with Centre Wellington Hydro on further regional planning activities and appreciates the opportunity to comment on the renewable energy generation information provided as part of its Distribution System Plan at this time.

² The KWCG IRRP can be found on the IESO website at <http://www.ieso.ca/Documents/Regional-Planning/KWCG/2015-KWCG-IRRP-Report.pdf>

³ Hydro One’s KWCG Region Rip, December 15, 2015

<http://www.hydroone.com/RegionalPlanning/KWCG/Documents/KWCG%20RIP%20Report.pdf>

⁴ Centre Wellington Hydro Ltd. Distribution System Plan, October 2016, Section 1.2.3.

⁵ Ibid., Section 5.3.2 d).

Appendix D

Regional Infrastructure Planning Report



Kitchener-Waterloo-Cambridge-Guelph REGIONAL INFRASTRUCTURE PLAN

December 11, 2015



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Prepared and supported by:

Company
Hydro One Networks Inc. (Lead Transmitter)
Cambridge and North Dumfries Hydro Inc.
Centre Wellington Hydro
Guelph Hydro Electric System Inc.
Halton Hills Hydro
Hydro One Distribution
Independent Electricity System Operator
Kitchener Wilmot Hydro Inc.
Milton Hydro
Waterloo North Hydro Inc.
Wellington North Power Inc.

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DISCLAIMER

This Regional Infrastructure Plan (“RIP”) report was prepared for the purpose of developing an electricity infrastructure plan to address needs identified in previous planning phases and also any additional needs identified based on new and/or updated information provided by the RIP Working Group.

The preferred solution(s) that have been identified in this report may be reevaluated based on the findings of further analysis. The load forecast and results reported in this RIP report are based on the information provided and assumptions made by the participants of the RIP Working Group.

Working Group participants, their respective affiliated organizations, and Hydro One Networks Inc. (collectively, “the Authors”) make no representations or warranties (express, implied, statutory or otherwise) as to the RIP report or its contents, including, without limitation, the accuracy or completeness of the information therein and shall not, under any circumstances whatsoever, be liable to each other, or to any third party for whom the RIP report was prepared (“the Intended Third Parties”), or to any other third party reading or receiving the RIP report (“the Other Third Parties”), for any direct, indirect or consequential loss or damages or for any punitive, incidental or special damages or any loss of profit, loss of contract, loss of opportunity or loss of goodwill resulting from or in any way related to the reliance on, acceptance or use of the RIP report or its contents by any person or entity, including, but not limited to, the aforementioned persons and entities.

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EXECUTIVE SUMMARY

THIS REGIONAL INFRASTRUCTURE PLAN (“RIP”) WAS PREPARED BY HYDRO ONE AND THE WORKING GROUP IN ACCORDANCE WITH THE ONTARIO TRANSMISSION SYSTEM CODE REQUIREMENTS. IT IDENTIFIES INVESTMENTS IN TRANSMISSION FACILITIES, DISTRIBUTION FACILITIES, OR BOTH, THAT SHOULD BE DEVELOPED AND IMPLEMENTED TO MEET THE ELECTRICITY INFRASTRUCTURE NEEDS WITHIN THE KITCHENER-WATERLOO-CAMBRIDGE-GUELPH (“KWCG”) REGION.

The participants of the RIP Working Group included members from the following organizations:

- Cambridge and North Dumfries Hydro Inc.
- Centre Wellington Hydro
- Guelph Hydro Electric System Inc.
- Halton Hills Hydro One
- Hydro One Distribution
- Hydro One Transmission
- Independent Electricity System Operator
- Kitchener Wilmot Hydro Inc.
- Milton Hydro
- Waterloo North Hydro Inc.
- Wellington North Power Inc.

This RIP provides a consolidated summary of needs and recommended plans for the KWCG Region for the near-term (up to 5 years) and mid-term (5 to 10 years). No long term needs (10 to 20 years) have been identified.

This RIP is the final phase of the regional planning process and it follows the completion of the KWCG Integrated Regional Resource Plan (“IRRP”) by the IESO in April 2015.

The major infrastructure investments planned for the KWCG Region over the near and mid-term, identified in the various phases of the regional planning process, are given in the table below.

No.	Project	In-Service Date	Cost
1	Guelph Area Transmission Reinforcement	May 2016	\$95 M
2	Arlen MTS: Install Series reactors	May 2016	\$0.95 M
3	M20D/M21D – Install 230 kV In-line Switches	May 2017	\$6 M
4	Waterloo North Hydro: MTS #4	2024	TBD

In accordance with the Regional Planning process, the Regional Plan should be reviewed and/or updated at least every five years. The Region will continue to be monitored and should there be a need that emerges earlier due to a change in load forecast or any other reason, the next regional planning cycle will be started to address the need.

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1. INTRODUCTION

THIS REPORT PRESENTS THE REGIONAL INFRASTRUCTURE PLAN (“RIP”) TO ADDRESS THE ELECTRICITY NEEDS OF THE KWCG REGION.

The report was prepared by Hydro One Networks Inc. (“Hydro One”) and documents the results of the joint study carried out by Hydro One, Kitchener-Wilmot Hydro Inc. (“Kitchener-Wilmot Hydro”), Waterloo North Hydro Inc. (“WNH”), Cambridge & North Dumfries Hydro Inc. (“CND”), Guelph Hydro Electric Systems Inc. (“Guelph Hydro”), Hydro One Distribution and the Independent Electricity System Operator (“IESO”) in accordance with the Regional Planning process established by the Ontario Energy Board (“OEB”) in 2013.

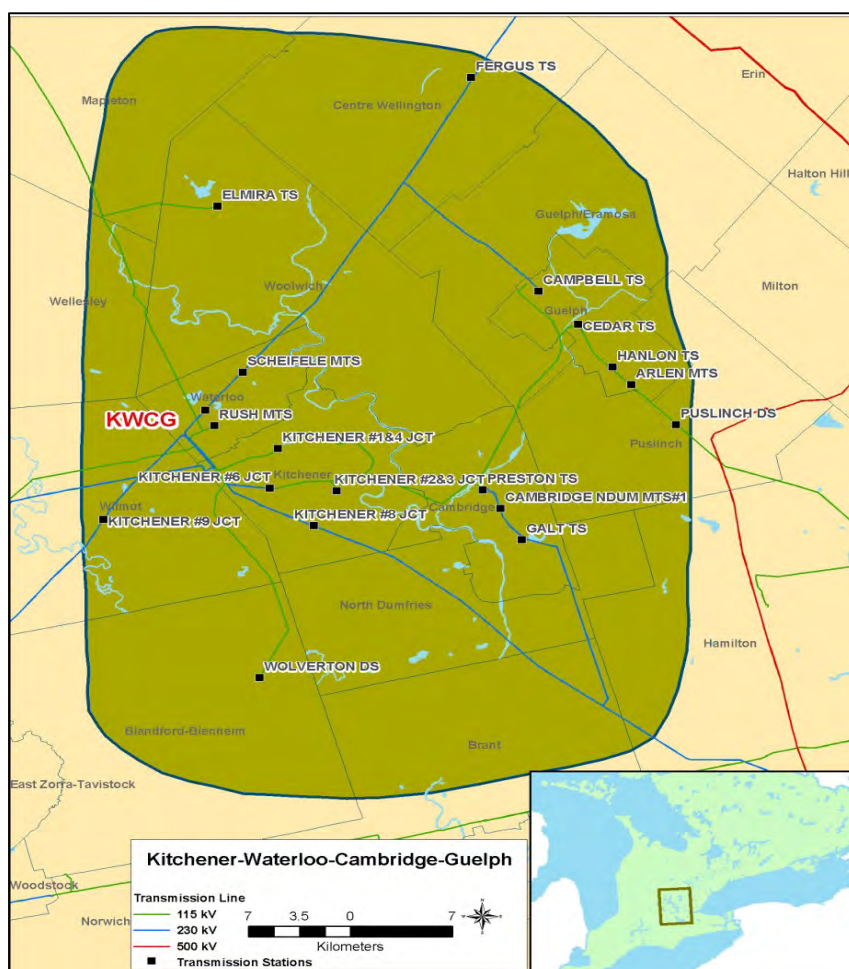


Figure 1-1 KWCG Region

The KWCG Region covers the cities of Kitchener, Waterloo, Cambridge and Guelph, portions of Oxford and Wellington counties and the townships of North Dumfries, Puslinch, Woolwich, Wellesley and Wilmot. Electrical supply to the Region is provided from eleven 230 kV and thirteen 115 kV step-down transformer stations. The summer 2015 coincident regional load was about 1240 MW. The boundaries of the Region are shown in Figure 1-1 above.

1.1 Scope and Objectives

This RIP report examines the needs in the KWCG Region. Its objectives are:

- To identify new supply needs that may have emerged since previous planning phases (e.g. Needs Assessment, Scoping Assessment, Local Plan, and/or Integrated Regional Resource Plan)
- To assess and develop a wires plan to address these needs
- To provide the status of wires planning currently underway or completed for specific needs
- To identify investments in transmission and distribution facilities or both that should be developed and implemented on a coordinated basis to meet the electricity infrastructure needs within the region.

The RIP reviews factors such as load forecast, transmission and distribution system capabilities along with any updates with respect to local plans, conservation and demand management (“CDM”), renewable and non-renewable generation development, and other electricity system and local drivers that may impact the need and alternatives under consideration.

The scope of this RIP is as follows:

- A consolidated report of all the needs and relevant plans to address near and mid-term needs (2015-2025) identified in previous planning phases (Needs Assessment, Scoping Assessment, Local Plan or Integrated Regional Resource Plan)
- Identification of any new needs over the 2015-2025 period and a wires plan to address these needs based on new and/or updated RIP phase information
- Develop a plan to address any longer term needs identified by the Working Group

The IRRP or RIP Working Group did not identify any long term needs at this time. If required, further assessment will be undertaken in the next planning cycle because adequate time is available to plan for required facilities.

1.2 Structure

The rest of the report is organized as the follows:

- Section 2 provides an overview of the regional planning process
- Section 3 describes the region
- Section 4 describes the transmission work completed over the last ten years
- Section 5 describes the load forecast and study assumptions used in this assessment
- Section 6 describes the results of the adequacy assessment of the transmission facilities and identifies the needs
- Section 7 summarizes the Regional Plan to address the needs
- Section 8 provides the conclusions and next steps

2. REGIONAL PLANNING PROCESS

2.1 Overview

Planning for the electricity system in Ontario is done at essentially three levels: bulk system planning, regional system planning, and distribution system planning. These levels differ in the facilities that are considered and the scope of impact on the electricity system. Planning at the bulk system level typically looks at issues that impact the system on a provincial level, while planning at the regional and distribution levels looks at issues on a more regional or localized level.

Regional planning looks at supply and reliability issues at a regional or local area level. Therefore, it largely considers the 115 kV and 230 kV portions of the power system that supply various parts of the province.

2.2 Regional Planning Process

A structured regional planning process was established by the Ontario Energy Board in 2013, through amendments to the Transmission System Code (“TSC”) and the Distribution System Code (“DSC”). The process consists of four phases: the Needs Assessment¹ (“NA”), the Scoping Assessment (“SA”), the Integrated Regional Resource Plan (“IRRP”), and the Regional Infrastructure Plan (“RIP”).

The regional planning process begins with the NA phase which is led by the transmitter to determine if there are regional needs. The NA phase identifies the needs and the Working Group determines whether further regional coordination is necessary to address them. If no further regional coordination is required, further planning is undertaken by the transmitter and the impacted local distribution company (“LDC”) or customer and develops a Local Plan (“LP”) to address them. These needs are local in nature and can be best addressed by a straight forward wires solution.

In situations where identified needs require coordination at the regional or sub-regional levels, the IESO initiates the SA phase. During this phase, the IESO, in collaboration with the transmitter and impacted LDCs, reviews the information collected as part of the NA phase, along with additional information on potential non-wires alternatives, and makes a decision on the most appropriate regional planning approach. The approach is either a RIP, which is led by the transmitter, or an IRRP, which is led by the IESO. If more than one sub-region was identified in the NA phase, it is possible that a different approach could be taken for different sub-regions.

The IRRP phase will generally assess infrastructure (wires) versus resource (CDM and Distributed Generation (“DG”)) options at a higher or more macro level but sufficient to permit a comparison of options. If the IRRP process identifies that infrastructure options may be most appropriate to meet a need, the RIP phase will conduct detailed planning to identify and assess the specific wires alternatives and recommend the preferred wires solution. Similarly, resource options which the IRRP identifies as best

¹ Also referred to a Needs Screening

suited to meet a need are then further planned in greater detail by the IESO. The IRRP phase also includes IESO led stakeholder engagement with municipalities and establishes a Local Advisory Committee in the region or sub-region.

The RIP phase is the final stage of the regional planning process and involves: confirmation of previously identified needs; identification of any new needs that may have emerged since the start of the planning cycle; and development of a wires plan to address the needs where a wires solution would be the best overall approach. This phase is led and coordinated by the transmitter and the deliverable of this stage is a comprehensive report of a wires plan for the region. Once completed, this report can be referenced in rate filing submissions or as part of LDC rate applications with a planning status letter provided by the transmitter. Reflecting the timeliness provisions of the RIP, plan level stakeholder engagement is not undertaken at this stage. However, stakeholder engagement at a project specific level will be conducted as part of the project approval requirement.

To efficiently manage the regional planning process, Hydro One has been undertaking wires planning activities in collaboration with the IESO and LDCs for the region as part of and/or in parallel with:

- Planning activities that were already underway in the region prior to the new regional planning process taking effect
- The NA, SA, and LP phases of regional planning
- Participating in and conducting wires planning as part of the IRRP for the region or sub-region

Figure 2-1 illustrates the various steps of the regional planning process (NA, SA, IRRP and RIP) and their respective phase trigger, lead, and outcome.

Note that as the KWCG Region was identified as a “transitional” region at the onset of the OEB defined Regional Planning process in 2013, the Needs Assessment and Scoping Assessment phases were deemed complete and the region was placed into the IRRP phase of the process.

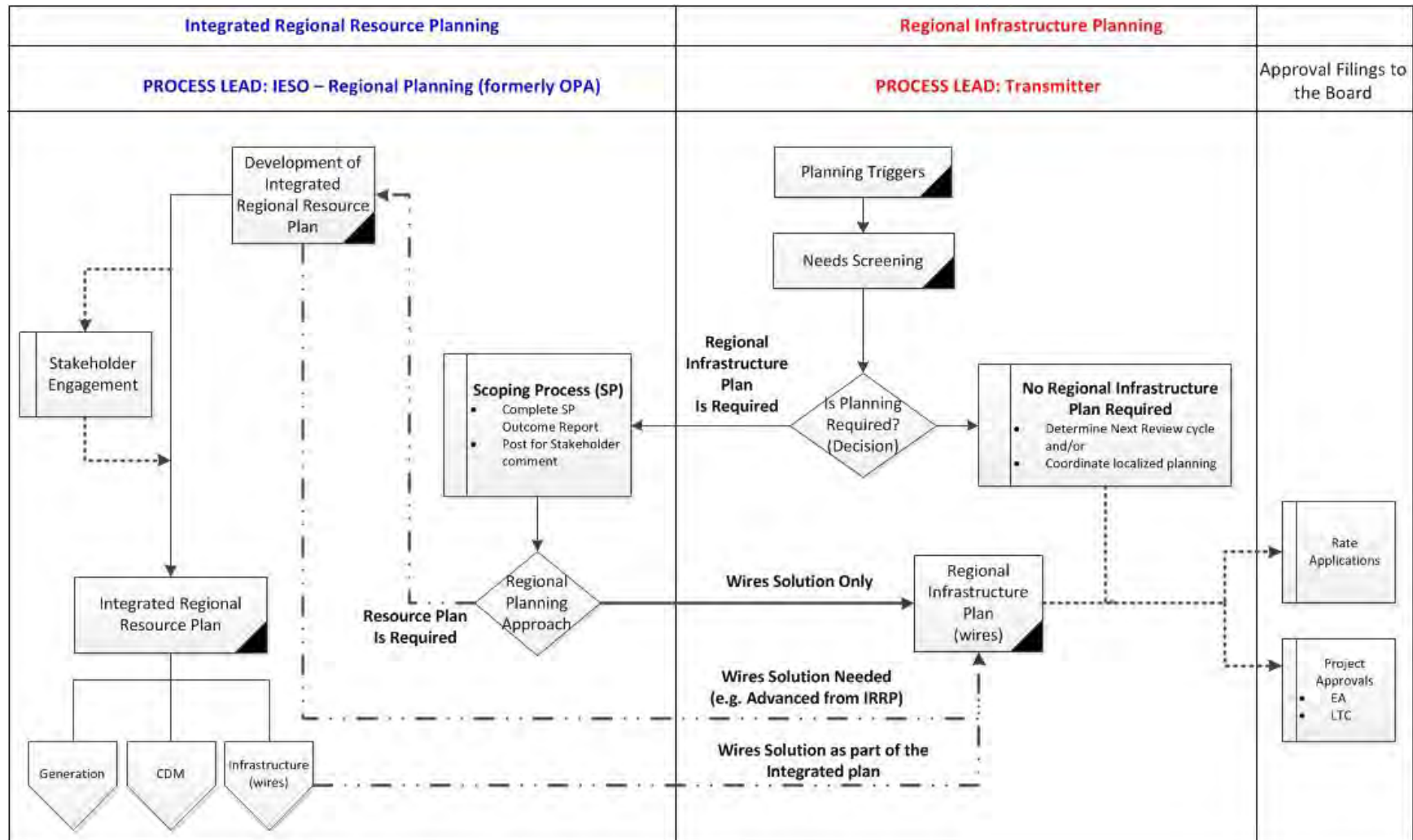


Figure 2-1 Regional Planning Process Flowchart

2.3 RIP Methodology

The RIP phase consists of four steps (see Figure 2-2) as follows:

- 1) **Data Gathering:** The first step of the RIP phase is the review of planning assessment data collected in the previous stages of the regional planning process. Hydro One collects this information and reviews it with the Working Group to reconfirm or update the information as required. The data collected includes:
 - Net peak demand forecast at the transformer station level. This includes the effect of any distributed generation or conservation and demand management programs.
 - Existing area network and capabilities including any bulk system power flow assumptions.
 - Other data and assumptions as applicable such as asset conditions; load transfer capabilities, and previously committed transmission and distribution system plans.
- 2) **Technical Assessment:** The second step is a technical assessment to review the adequacy of the regional system including any previously identified needs. Additional near and mid-term needs may be identified at this stage.
- 3) **Alternative Development:** The third step is the development of wires options to address the needs and to come up with a preferred alternative based on an assessment of technical considerations, feasibility, environmental impact and costs.
- 4) **Implementation Plan:** The fourth and last step is the development of the implementation plan for the preferred alternative.

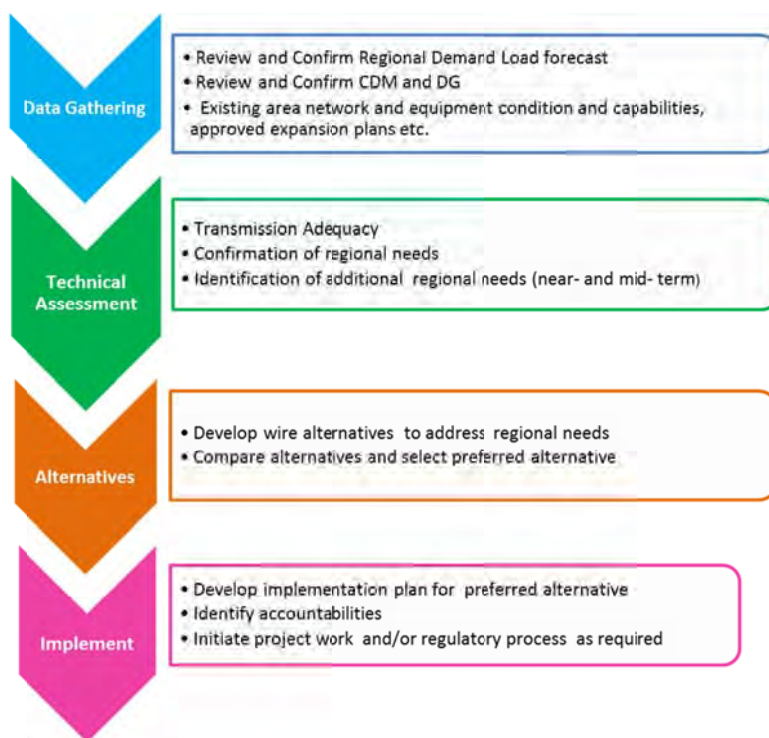


Figure 2-2 RIP Methodology

3. REGIONAL CHARACTERISTICS

THE KWCG REGION COMPRISES OF THE CITIES OF KITCHENER, WATERLOO, CAMBRIDGE AND GUELPH, PORTIONS OF OXFORD AND WELLINGTON COUNTIES AND THE TOWNSHIPS OF NORTH DUMFRIES, PUSLINCH, WOOLWICH, WELLESLEY AND WILMOT AS SHOWN IN FIGURE 3-1.

The main sources of electricity into the KWCG Region are from four Hydro One stations: Middleport TS, Detweiler TS, Orangeville TS and Burlington TS. At these stations electricity is transformed from 500 kV and 230 kV to 230 kV and 115 kV, respectively. Electricity is then delivered to the end users of LDCs and directly-connected industrial customers by 24 step-down transformer stations. Figure 3-2 illustrates these stations as well as the four major regional sub-systems: Waterloo-Guelph 230 kV sub-system, Cambridge-Kitchener 230 kV sub-system, Kitchener-Guelph 115 kV sub-system and South-Central Guelph 115 kV sub-system. Appendix A lists all step-down transformer stations in the KWCG Region, Appendix B lists all transmission circuits in the KWCG Region and Appendix C lists LDCs in the KWCG Region.

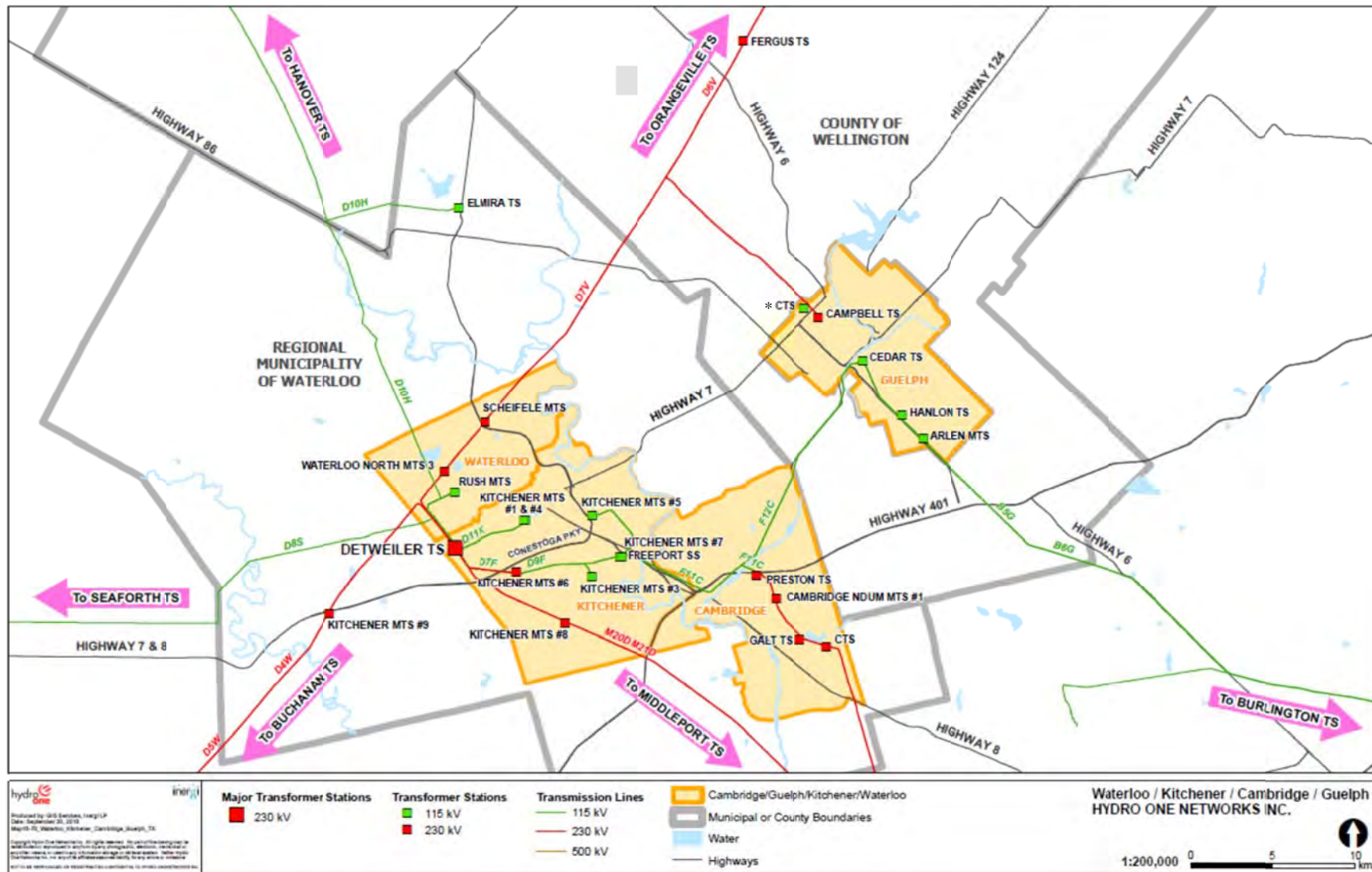


Figure 3-1 Geographical Area of the KWCG Region with Electrical Layout

*CTS relocated to the distribution system as part of the GATR project

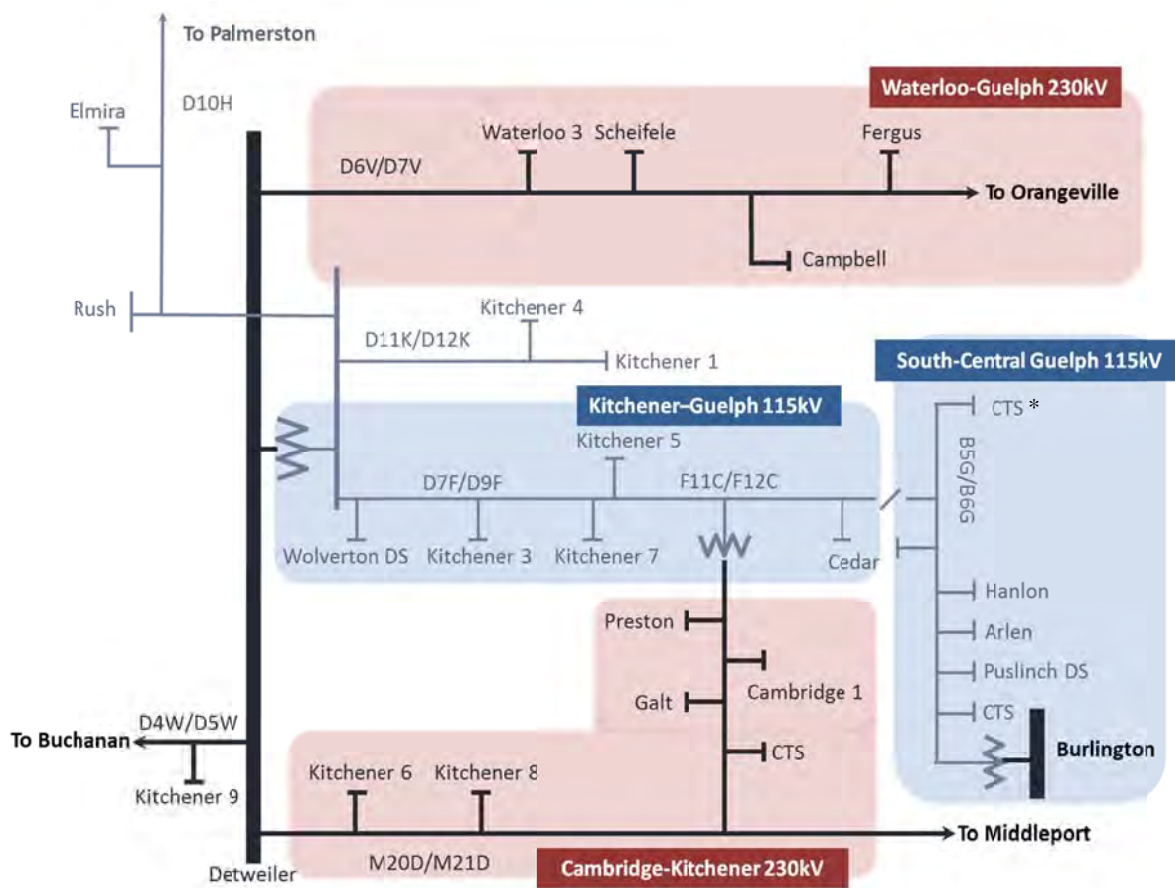


Figure 3-2 KWCG Single Line Diagram

*CTS relocated to the distribution system as part of the GATR project

4. TRANSMISSION FACILITIES COMPLETED OVER LAST TEN YEARS OR CURRENTLY UNDERWAY

OVER THE LAST 10 YEARS A NUMBER OF TRANSMISSION PROJECTS HAVE BEEN COMPLETED BY HYDRO ONE, OR ARE UNDERWAY, AIMED AT IMPROVING THE SUPPLY TO THE KWCG REGION.

These projects were identified as a result of joint planning studies undertaken by Hydro One, IESO and the LDCs; or initiated to meet the needs of the LDCs; and/or to meet Provincial Government policies. A brief listing of the completed projects is given below.

For transmission voltage level transformation capacity needs:

- 250 MVA 230/115 kV autotransformer T4 at Burlington TS replaced in 2006
- 250 MVA 230/115 kV autotransformer T6 at Burlington TS replaced in 2009

For distribution voltage level transformation capacity needs:

- Kitchener MTS#9 connected to replace the Detweiler TS DESN in 2010
- Arlen MTS connected in 2011

For reactive and voltage support needs:

- a 13.8 kV shunt capacitor bank installed at Cedar TS in 2006
- a 230 kV shunt capacitor bank installed at Detweiler TS in 2007
- a 230 kV shunt capacitor bank installed at Orangeville TS in 2008
- a 230 kV shunt capacitor bank installed at Burlington TS in 2010
- a 115 kV shunt capacitor bank installed at Detweiler TS in 2012

For transmission circuit capacity needs:

- M20D/M21D circuit sections capacity increased by sag limit mitigation in 2014

For transmission load security needs:

- Freeport SS installed to sectionalize circuits D7G/D9G (Detweiler TS by Cedar TS) in 2008

For transmission load restoration needs:

- 250 MVA 230/115 kV autotransformer T2 installed at Preston TS in 2007

The following projects are underway:

- Guelph Area Transmission Reinforcement (GATR) project that entails the extension the 230kV circuits D6V/D7V to Cedar TS; the installation of two new 250MVA, 230/115kV

autotransformers at Cedar TS; and the installation of two 230 kV in-line switches onto circuits D6V/D7V at Guelph North Junction. This project reinforces the Kitchener-Guelph and South-Central Guelph 115kV sub-systems as well as improves restoration capability to the Waterloo-Guelph 230 kV sub-system. This project is identified in the IESO KWCG IRRP, reference [1].

- The installation of a 13.8 kV series reactor to mitigate short circuit levels at Arlen MTS. This project was identified in the RIP phase.
- The installation two new 230kV in-line switches onto circuits M20D/M21D near Galt Junction to improve restoration capability in the Cambridge-Kitchener 230 kV sub-system. This project is identified in Hydro One's KWCG Adequacy of Transmission Facilities & Transmission Plan 2016-2025 report, reference [2]/Appendix F as well as reference [1].

5. FORECAST AND OTHER STUDY ASSUMPTIONS

5.1 Load Forecast

The load in the KWCG Region is forecast to increase at an average rate of approximately 1.7% annually between 2015 and 2025. The growth rate varies across the Region with most of the growth concentrated in the cities of Waterloo and Guelph, each at an average rate of 2.5% over the next ten years.

Figure 5-1 shows the KWCG Region's planning load forecast (summer net, regional-coincident extreme weather peak). The regional-coincident (at the same time) forecast represents the total peak load of the 24 step-down transformer stations in the KWCG Region. By 2025 the forecasted coincident regional peak load is approximately 1765 MW.

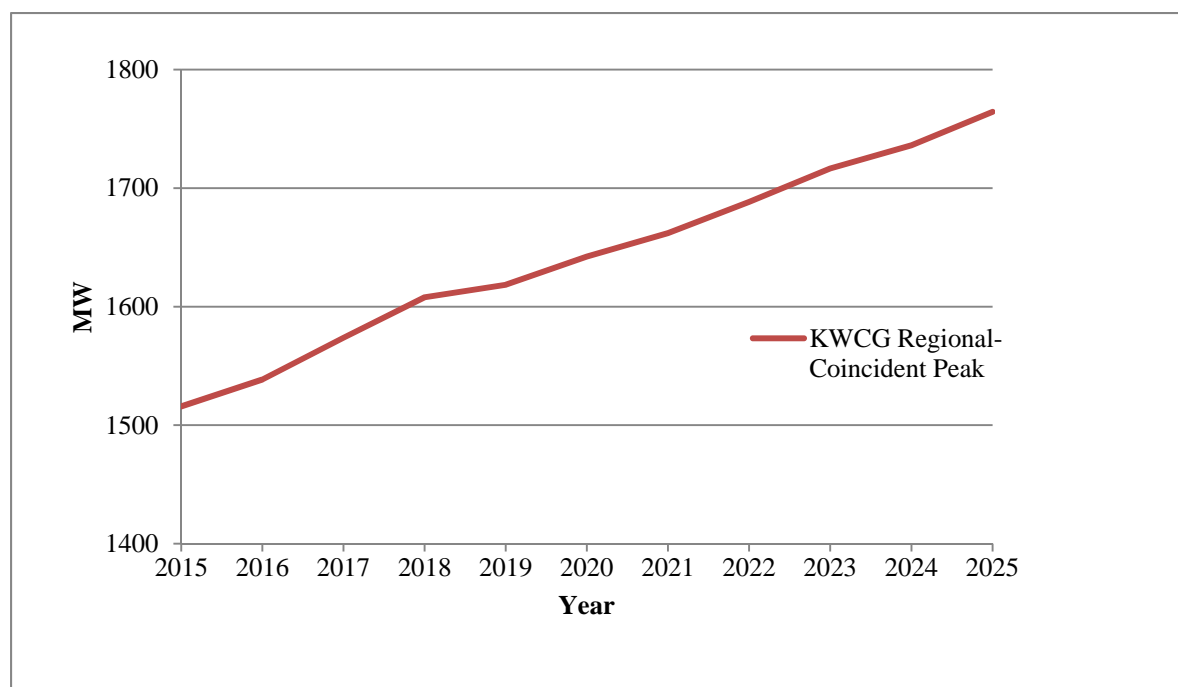


Figure 5-1 KWCG Region's Planning Forecast

The KWCG 2015 RIP planning load forecast is provided in Appendix D and is based upon the KWCG IRRP planning load forecast prepared by the IESO and was reaffirmed by the Working Group upon initiation of the RIP phase. In the IRRP phase, the LDC's provided the IESO with a 10 year gross, normal weather, regional-coincident, peak load forecast in MW. The IESO adjusted the forecast by subtracting the effective CDM capacity, applying an extreme weather factor and then subtracting the effective DG capacity. Further details regarding the CDM and connected DG are provided in reference [1]. The RIP forecast is identical to the IRRP forecast except as otherwise noted in Appendix D.

5.2 Other Study Assumptions

The following other assumptions are made in this report.

- 1) The Study period for the RIP assessment is 2015-2025.
- 2) All planned facilities for which work has been initiated and are listed in Section 4 are assumed to be in-service.
- 3) Summer is the critical period with respect to line and transformer loadings. The assessment is based therefore based on summer peak loads.
- 4) Station capacity adequacy is assessed by comparing the non-coincident peak load with the station's normal planning supply capacity, assuming a 90% lagging power factor for stations having no low-voltage capacitor banks and 95% lagging power factor for stations having low-voltage capacitor banks. Normal planning supply capacity for Hydro One transformer stations in this Region is determined by the summer 10-Day Limited Time Rating (LTR), while some LDCs use different methodologies for determining transformer station LTR.
- 5) Adequacy assessment is done as per the Ontario Resource and Transmission Adequacy Criteria ("ORTAC").

6. ADEQUACY OF FACILITIES AND REGIONAL NEEDS OVER THE 2015-2025 PERIOD

THIS SECTION REVIEWS THE ADEQUACY OF THE EXISTING TRANSMISSION SYSTEM AND DELIVERY STATION FACILITIES SUPPLYING THE KWCG REGION AND LISTS THE FACILITIES REQUIRING REINFORCEMENT OVER THE NEAR AND MID-TERM.

Within the current regional planning cycle two regional assessments have been conducted for the KWCG Region. The findings of these studies are input to the RIP. The studies are:

- 1) IESO's KWCG Integrated Regional Resource Plan – dated April 28, 2015^[1]
- 2) Hydro One's Adequacy of Transmission Facilities and Transmission Plan 2016-2025 – dated April 1, 2015 with revision 1 – dated October 30, 2015^[2] (please see Appendix F)

The IRRP identified a number of regional needs to meet the forecast load demand over the near to mid-term. Due to the immediate nature of the needs the Guelph Area Transmission Reinforcement (GATR) project was initiated to provide adequate load supply capability to the KWCG area while the IRRP study was still underway. A detailed description and status of the GATR project and other work initiated or planned to meet these needs is given in Section 7.

This RIP reviewed the loading on transmission lines and stations in the KWCG Region assuming the GATR project is in-service. Sections 6.1-6.4 present the results of this review and Table 6-1 lists the Region's needs identified in both the IRRP and RIP phases.

Table 6-1 Near and Medium Term Regional Needs

Type	Section	Needs	Timing
Needs Identified in the IRRP ^[1] and the Adequacy Report ^[2]			
Transmission Circuit Capacity	7.1.1	South-Central Guelph 115 kV sub-system- Capacity of 115kV circuits B5G/B6G	Immediate
	7.1.2	Kitchener–Guelph 115 kV sub-system – Capacity of 115kV circuits D7F/D9F and F11C/F12C	Immediate
Load Restoration	7.1.3	Waterloo-Guelph 230 kV sub-system	Immediate
	7.2.1	Cambridge-Kitchener 230 kV sub-system	Immediate
Step-down Transformation Capacity	7.3.1	Waterloo North Hydro Inc.	2018
Additional Needs identified in RIP Phase			
Station Short Circuit Capability	7.4.1	Arlen MTS: Short Circuit capability	2016

6.1 230 kV Transmission Facilities

All 230 kV transmission circuits in the KWCG Region are classified as part of the Bulk Electricity System (“BES”). They connect the Region to the rest of the Ontario’s transmission system and are also part of the transmission path from generation in Southwestern Ontario to the load centers in the Hamilton, Niagara and GTA areas. These circuits also serve local area stations within the Region and the power flow on them depends on the bulk system transfer as well as local area loads. These circuits are as follows (refer to Figure 3-2):

- 1) Detweiler TS to Orangeville TS 230 kV transmission circuits D6V/D7V – supplies Fergus TS, Campbell TS, Waterloo North MTS#3 and Scheifele MTS
- 2) Detweiler TS to Middleport TS 230 kV transmission circuits M20D/M21D – supplies Kitchener MTS #6, Kitchener MTS # 8, Cambridge MTS #1, Galt TS, Preston TS and Customer #1 CTS
- 3) Detweiler TS to Buchanan TS 230 kV transmission circuits D4W/D5W – supplies Kitchener MTS#9.

The RIP review shows that based on current forecast station loadings and bulk transfers, all 230 kV circuits are expected to be adequate over the study period. Refer to section 3.4.2 of Appendix F for the detailed analysis.

6.2 500/230 kV and 230/115 kV Transformation Facilities

Bulk power supply to the KWCG Region is provided by Hydro One’s 500 kV to 230 kV and 230 kV to 115 kV autotransformers. The number and location of these autotransformers are as follows:

- 1) Two 500/230 kV autotransformers at Middleport TS
- 2) Four 230/115 kV autotransformers at Burlington TS
- 3) Three 230/115 kV autotransformers at Detweiler TS
- 4) Two 230/115 kV autotransformers at Cedar TS
- 5) One 230/115 kV autotransformer at Preston TS

The RIP review shows that based on current forecast station loadings and bulk transfers, the auto-transformation supply capacity is adequate over the study period. Refer to section 3.4.1 of Appendix F for the detailed analysis.

6.3 Supply Capacity of the 115 kV Network

The KWCG Region contains five pairs of double circuit 115 kV lines. This 115 kV network serves local area load. These circuits are as follows (see Figure 3-2):

- 1) Detweiler TS to Freeport SS 115 kV transmission circuits D7F/D9F – supplies Wolverton DS, Kitchener MTS #3, Kitchener MTS#7
- 2) Freeport SS to Cedar TS 115 kV transmission circuits F11C/F12C – supplies Kitchener MTS#5 and Cedar T1/T2 transformers
- 3) Burlington TS to Cedar TS 115 kV transmission circuits B5G/B6G – supplies Puslinch DS, Arlen MTS, Hanlon TS, Customer #2 CTS and Cedar T7/T8 transformers
- 4) Detweiler TS 115 kV radial transmission circuit D11K/D12K – supplies Kitchener MTS#1 and Kitchener MTS#4
- 5) Detweiler TS to Seaforth TS/Hanover TS 115 kV transmission circuit D8S/D10H with Normally Open (N/O) points – supplies Rush MTS and Elmira TS

The RIP review shows that based on current forecast station loadings and bulk transfers, the supply capacity of the 115 kV network is adequate over the study period. Refer to section 3.4.3 of Appendix F for the detailed analysis.

6.4 Step-down Transformer Stations

There are 24 step-down transformer stations within the KWCG Region. Twenty-two supply electricity to LDCs and two are transmission-connected industrial customer stations. These stations are listed within the load forecast in Appendix D. Of those 24 stations, 15 of them are owned and operated by the LDCs.

As part of the IRRP, step-down transformation station capacity was reviewed and resulted in the IRRP forecast which was reaffirmed by the Working Group for use in the RIP phase. According to the load forecast, Waterloo North Hydro anticipates requiring additional step-down transformation capacity in 2018.

6.5 Other Items Identified During Regional Planning

6.5.1 Customer Impact Assessment for the GATR project

Based on the Customer Impact Assessment^[3] for the GATR project, Guelph Hydro identified the need to mitigate short circuit levels at Arlen MTS in order to ensure the short circuit levels remain within the TSC limits and equipment ratings. The project need date is May 2016 so as to correlate with the completion of the GATR project.

6.5.2 System Impact Assessment for the GATR Project

A System Impact Assessment (“SIA”)^[4] was performed for Hydro One’s application to the IESO for the Guelph Area Transmission Reinforcement (GATR) project.

Several findings emanated from the SIA report due to conservative assumptions made for the Bulk Power System. The Working Group has reviewed these findings and recommends that the assumptions be

looked at in greater detail within a Bulk Power System study. If the Bulk Power System study results in regional needs then an early trigger of the next Regional Planning cycle may occur.

6.5.3 Load Restoration to the Cambridge area

The IRRP recommended Hydro One to continue to explore options with Cambridge and North Dumfries Hydro (“CND”) to further improve the load restoration capability to the Cambridge area. During the RIP phase Hydro One presented to CND a detailed explanation of its capability to restore power to transformer stations that service the Cambridge area. Based on this discussion, CND and Hydro One have agreed that, at this time, no additional infrastructure is required and the restoration capability afforded by the GATR project and the 230 kV in-line switches at Galt Junction is acceptable for the study period.

6.6 Long-Term Regional Needs

The IRRP examined high-growth and low-growth scenarios to identify long-term needs. Under the high-growth scenario, there is sufficient transmission capacity afforded by the GATR project to meet demand in the long-term; however the need for additional step-down transformation capacity may arise. LDC’s to closely monitor their load to determine the timing of potential step-down transformation needs. Under the low-growth scenario, no needs were identified in the long-term.

As there has not been additional new information since the IRRP, the Working Group did not identify any additional long-term needs during the RIP phase. Therefore, there are no major regional supply and reliability needs identified in the KWCG Region in the long-term.

7. REGIONAL PLANS

THIS SECTION DISCUSSES THE ELECTRICAL SUPPLY NEEDS FOR THE KWCG REGION AND SUMMARIZES THE REGIONAL PLANS FOR ADDRESSING THE NEEDS. THESE NEEDS ARE LISTED IN TABLE 6-1 AND INCLUDE NEEDS PREVIOUSLY IDENTIFIED IN THE IRRP AS WELL AS THE NEEDS IDENTIFIED DURING THE RIP PHASE.

7.1 Transmission Circuit Capacity and Load Restoration

7.1.1 South-Central Guelph 115 kV Sub-system

The South-Central Guelph area is supplied by the 115 kV double circuit line B5G/B6G. As per section 6.2.1 of the IRRP, historical peak demand on the B5G/B6G line has already exceeded the 100 MW line Load Meeting Capability (“LMC”).

7.1.2 Kitchener-Guelph 115 kV Sub-system

The Kitchener-Guelph area is supplied by two 115 kV double-circuit lines D7F/D9F and F11C/F12C supported by 230/115 kV autotransformers at Detweiler TS and Preston TS. As per section 6.2.1 of the IRRP, the planning forecast peak demand in the Kitchener-Guelph 115 kV sub-system will exceed the 260 MW line LMC by summer 2014.

7.1.3 Waterloo-Guelph 230 kV Sub-system

As per section 6.2.2 of the IRRP, the transmission infrastructure supplying load in the Waterloo-Guelph 230 kV sub-system does not meet reliability requirements to quickly restore supply in the event of a major outage involving the loss of both transmission circuits, D6V and D7V.

7.1.4 Recommended Plan and Current Status

To address the transmission circuit capacity needs for the South-Central Guelph 115 kV sub-system and the Kitchener-Guelph 115 kV sub-system, the IRRP Working Group recommended reinforcement of the 115 kV transmission system by introducing a new 230 kV – 115 kV injection point. The new injection point is to be located at Cedar TS using two new 230 kV/115 kV autotransformers in conjunction with a 5 km extension of the existing 230 kV double-circuit transmission line, D6V/D7V from Campbell TS to Cedar TS. This reinforcement is covered under the GATR project.

To address the load restoration need of the Waterloo-Guelph 230 kV sub-system, the IRRP Working Group’s preferred alternative is to install two new 230 kV in-line switches near Guelph North Junction. The switches will enable Hydro One to quickly isolate a problem and allow the resupply of load to occur expeditiously. This work is also covered under the GATR project.

Current Status of the GATR Project

Hydro One initiated construction on the GATR project in fall 2013 following the OEB approval in September 2013. The project has three components:

- Campbell TS x Cedar TS: Extend the 230 kV D6V/D7V tap from Campbell TS to Cedar TS. This requires replacing approximately a 5 km section of the existing 115 kV double circuit transmission section between CGE Junction and Campbell TS with a new 230 kV double circuit transmission line,
- Cedar TS: Install two new 230/115 kV autotransformers and associated 115 kV switching facilities at Cedar TS. Connect 115 kV switching facilities to the existing B5G/B6G line and the F11C/F12C at Cedar TS.
- Guelph North Junction: Install two in-line 230 kV switches at Guelph North Jct.

This investment will provide for sufficient 230/115 kV autotransformation capacity beyond the study period. The current in-service date of the project is May 2016.

The cost of this project is approximately \$95 million. The project is a transmission pool investment as the autotransformers provide supply to all customers in the Region.

7.2 Load Restoration

7.2.1 Cambridge-Kitchener 230 kV Sub-system

As per section 6.2.2 of the IRRP and the section 3.4.8 of the Adequacy of Transmission Facilities report, transmission infrastructure supplying load in the Cambridge-Kitchener 230 kV sub-system does not meet reliability requirements to quickly restore supply in the event of a major outage involving the loss of both transmission circuits, M20D and M21D.

7.2.2 Recommended Plan and Current Status

To address the load restoration need of the Cambridge-Kitchener 230 kV sub-system, the IRRP Working Group's preferred alternative is to install two new 230 kV in-line switches on the M20D/M21D line near Galt Junction. The switches will enable Hydro One to quickly isolate a problem and allow the resupply of load to occur expeditiously. This work is covered under the M20D/M21D Install 230 kV In-line Switches project.

Current Status of the 230 kV In-Line Switches near Galt Junction

Hydro One has established a project to install the two 230 kV in-line switches onto the M20D/M21D double circuit line. One set of switches to be installed onto each circuit. One set of switches to be installed north of the Junction while the other to be installed south of Galt Junction. The switches will enable

Hydro One to quickly isolate a problem on either side of the junction and initiate the restoration of load to the Cambridge-Kitchener 230 kV sub-system.

The project is currently in the detailed design and estimation phase which also includes real estate negotiations. The cost of this project is approximately \$6 million and it will be a transmission pool investment. The planned in-service date is May 2017.

7.3 Step-down Transformation Capacity

7.3.1 Waterloo North Hydro

The RIP/IRRP planning load forecast indicates that additional step-down transformation capacity is required by 2018, specifically Waterloo North Hydro's MTS #4.

7.3.2 Recommended Plan and Current Status

To address step-down transformation capacity needs of Waterloo North Hydro, Waterloo North Hydro will, wherever possible, manage load growth by maximizing the utilization of existing stations by increasing distribution load transfer capability between those stations and will continue to explore opportunities for CDM and DG. In addition Waterloo North Hydro will also explore, with other LDCs, opportunities to coordinate possible joint use and development of step-down transformer stations in the Region over the long term. With this in mind, additional step-down transformation capacity is not anticipated prior to 2024. This need will be reviewed in the next cycle of regional planning.

7.4 Station Short Circuit Capability

7.4.1 Arlen MTS

Arlen MTS is a 115/13.8 kV step-down transformer station owned by Guelph Hydro. As a result of the new 230/115 kV injection point afforded by the GATR project, the short circuit levels at Arlen MTS's 13.8 kV bus will exceed the TSC limit and equipment capability.

7.4.2 Recommended Plan and Current Status

To address the station short circuit capability need at Arlen MTS, Guelph Hydro will install series reactors to bring station short circuit levels within TSC limits and within equipment ratings.

Current Status of Short Circuit Mitigation

Guelph Hydro has initiated a project to install series reactors to bring station short circuit levels within TSC limits and equipment ratings. The cost of this project is \$0.95 million and the expected completion date is May 2016 so as to correlate with the completion of the GATR project.

8. CONCLUSIONS

THIS REGIONAL INFRASTRUCTURE PLAN REPORT CONCLUDES THE REGIONAL PLANNING PROCESS FOR THE KWCG REGION. THIS REPORT MEETS THE INTENT OF THE PROCESS DESCRIBED IN SECTION 2 WHICH IS ENDORSED BY THE OEB AND MANDATED IN THE TSC AND DSC.

Six near and mid-term needs were identified for the KWCG Region. They are:

- I. Transmission capacity in the South-Central Guelph 115 kV sub-system
- II. Transmission capacity in the Kitchener-Guelph 115 kV sub-system
- III. Load restoration capability in the Waterloo-Guelph 230 kV sub-system
- IV. Load restoration capability in the Cambridge-Kitchener 230 kV sub-system
- V. Step-down transformation capacity for Waterloo North Hydro
- VI. Station Short Circuit Capacity at Arlen MTS

This RIP report addresses all six of these needs. Next Steps, Lead Responsibility, and Timeframes for implementing the wires solutions for the near and mid-term needs are summarized in the Table 8-1 below.

Table 8-1 Regional Plans – Next Steps, Lead Responsibility and Plan In-Service Dates

No.	Project	Next Steps	Lead Responsibility	I/S Date	Cost	Needs Mitigated
1	Guelph Area Transmission Reinforcement	Construction in the final stages	Hydro One	May 2016	\$95M	I, II, III
2	Mitigate Short Circuit Levels at Arlen MTS	Construction underway	Guelph Hydro	May 2016	\$0.95M	VI
3	M20D/M21D – Install 230 kV In-line Switches	Transmitter to carry out this work	Hydro One	May 2017	\$6M	IV
4	Waterloo North Hydro: MTS #4	LDC to monitor growth	Waterloo North Hydro	2024	TBD	V

In accordance with the Regional Planning process, the Regional Plan should be reviewed and/or updated at least every five years. The region will continue to be monitored and should there be a need that emerges due to a change in load forecast or any other reason, the next regional planning cycle will be started earlier to address the need.

9. REFERENCES

- [1] Independent Electricity System Operator, Kitchener-Waterloo-Cambridge-Guelph Region Integrated Region Resource Plan, 28 April 2015.
<http://www.ieso.ca/Documents/Regional-Planning/KWCG/2015-KWCG-IRRP-Report.pdf>
- [2] Hydro One Networks Inc., Kitchener-Waterloo-Cambridge-Guelph Area – Adequacy of Transmission Facilities and Transmission Plan 2016-2025, 1 April 2015, revised 30 October 2015.
- [3] Hydro One Networks Inc., Customer Impact Assessment Guelph Area Transmission Refurbishment Project, 28 May 2013,
- [4] Independent Electricity System Operator, System Impact Assessment, CAA ID: 2012-478, Project: Guelph Area Transmission Refurbishment, 17 May 2013.
http://www.ieso.ca/Documents/caa/CAA_2012-478_GATR_Final_Report.pdf

Appendix A. Step-Down Transformer Stations in the KWCG Region

Station	Voltage (kV)	Supply Circuits
Waterloo-Guelph 230 kV sub-system		
Fergus TS	230 kV	D6V/D7V
Scheifele MTS	230 kV	D6V/D7V
Waterloo North MTS #3	230 kV	D6V/D7V
Campbell TS	230 kV	D6V/D7V
Cambridge-Kitchener 230 kV sub-system		
Kitchener MTS #6	230 kV	M20D/M21D
Kitchener MTS #8	230 kV	M20D/M21D
Cambridge MTS #1	230 kV	M20D/M21D
Preston TS	230 kV	M20D/M21D
Galt TS	230 kV	M20D/M21D
Customer #1 CTS	230 kV	M21D
Kitchener–Guelph 115 kV sub-system		
Wolverton DS	115 kV	D7F/D9F
Kitchener MTS #3	115 kV	D7F/D9F
Kitchener MTS #7	115 kV	D7F/D9F
Kitchener MTS #5	115 kV	F11C/F12C
Cedar TS (T1/T2)	115 kV	F11C/F12C
South-Central Guelph 115 kV sub-system		
Puslinch DS	115 kV	B5G/B6G
Arlen MTS	115 kV	B5G/B6G
Hanlon TS	115 kV	B5G/B6G
Cedar TS (T8/T7)	115 kV	B5G/B6G
Customer #2 CTS	115 kV	B5G
Other Stations in the KWCG Region		
Kitchener MTS #9	230 kV	D4W/D5W
Rush MTS	115 kV	D8S/D10H
Elmira TS	115 kV	D10H
Kitchener MTS #1	115 kV	D11K/D12K
Kitchener MTS #4	115 kV	D11K/D12K

Appendix B. Transmission Lines in the KWCG Region

Location	Circuit Designations	Voltage (kV)
Detweiler TS – Orangeville TS	D6V/D7V	230 kV
Detweiler TS - Middleport TS	M20D/M21D	230 kV
Detweiler TS - Buchanan TS	D4W/D5W	230 kV
Detweiler TS - Freeport SS	D7F/D9F	115 kV
Freeport SS - Cedar TS	F11C/F12C	115 kV
Burlington TS - Cedar TS	B5G/B6G	115 kV
Detweiler TS – Kitchener MTS #4	D11K/D12K	115 kV
Detweiler TS – Palmerston TS	D10H	115 kV
Detweiler TS – Seaforth TS	D8S	115 kV

Appendix C. Distributors in the KWCG Region

Distributor Name	Station Name	Connection Type
Cambridge and North Dumfries Hydro Inc.	Cambridge NDum MTS#1	Tx
	Galt TS	Tx
	Preston TS	Tx
	Wolverton DS	Dx
Centre Wellington Hydro Ltd.	Fergus TS	Dx
Guelph Hydro Electric System - Rockwood Division	Fergus TS	Dx
Guelph Hydro Electric Systems Inc.	Arlen MTS	Tx
	Campbell TS	Tx
	Cedar TS	Tx
	Hanlon TS	Tx
Halton Hills Hydro Inc.	Fergus TS	Dx
Hydro One Networks Inc.	Fergus TS	Tx
	Elmira TS	Tx
	Puslinch DS	Tx
	Wolverton DS	Tx
	Galt TS	Dx
Kitchener-Wilmot Hydro Inc.	Kitchener MTS#1	Tx
	Kitchener MTS#3	Tx
	Kitchener MTS#4	Tx
	Kitchener MTS#5	Tx
	Kitchener MTS#6	Tx
	Kitchener MTS#7	Tx
	Kitchener MTS#8	Tx
	Kitchener MTS#9	Tx
Milton Hydro Distribution Inc.	Fergus TS	Dx
Waterloo North Hydro Inc.	Elmira TS	Dx
		Tx
	Fergus TS	Dx
	Rush MTS	Tx
	Scheifele MTS	Tx
	Waterloo North MTS #3	Tx
	Preston TS	Dx
	Kitchener MTS#9	Dx
Wellington North Power Inc.	Fergus TS	Dx

Appendix D. KWCG Regional Load Forecast (2015-2025)

Table D-1 RIP Planning Demand Forecast (MW)

Station	LDC	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cambridge MTS #1	Cambridge & North Dumfries Hydro	92.3	93.8	95.6	98.1	99.7	102.7	101.8	102.1	102.4	102.2	101.6
Galt TS	Cambridge & North Dumfries Hydro	108.1	109.5	112.3	113.7	116.1	119.0	122.8	127.9	134.8	141.9	148.8
Preston TS ⁽¹⁾	Cambridge & North Dumfries Hydro	108.0	100.3	102.0	104.4	105.9	108.7	109.6	111.8	111.9	111.5	111.8
Kitchener MTS #6	Kitchener-Wilmot Hydro	72.8	72.8	73.0	73.0	72.4	72.1	71.7	71.6	71.5	71.1	71.1
Kitchener MTS #8	Kitchener-Wilmot Hydro	44.2	37.6	40.3	43.1	45.3	38.6	41.1	43.5	46.0	48.2	50.6
Kitchener MTS #3	Kitchener-Wilmot Hydro	54.3	64.4	66.5	67.3	67.5	77.0	77.5	78.1	78.7	79.0	79.6
Kitchener MTS #7	Kitchener-Wilmot Hydro	44.9	45.1	45.9	46.0	45.6	45.6	45.6	45.7	39.9	39.8	39.9
Wolverton DS	Hydro One Distribution	21.2	21.4	21.6	21.6	21.6	21.6	21.6	21.7	21.8	21.7	21.9
Cedar TS T1/T2	Guelph Hydro	72.3	74.9	75.8	77.4	78.3	79.5	79.8	82.2	84.6	85.5	87.9
Cambridge MTS # 2 ⁽²⁾	Cambridge & North Dumfries Hydro	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kitchener MTS #5	Kitchener-Wilmot Hydro	73.9	73.8	74.6	74.5	73.8	73.5	73.2	73.1	78.8	78.3	78.2
Cedar TS T7/T8	Guelph Hydro	30.2	32.0	32.0	32.8	32.3	33.0	33.7	33.4	34.2	34.8	35.5
Hanlon TS	Guelph Hydro	29.8	30.7	31.6	32.5	33.0	33.7	34.4	35.1	34.9	35.5	35.3
Puslinch DS	Hydro One Distribution	35.6	36.2	36.8	37.3	37.5	37.9	38.3	38.7	39.2	39.5	39.9
Arlen MTS	Guelph Hydro	30.0	33.0	37.0	40.9	33.3	37.9	41.4	43.0	44.6	45.9	47.5
Campbell TS	Guelph Hydro	131.9	136.3	139.0	140.2	141.2	142.8	144.4	148.4	152.2	156.2	160.1
Scheifele MTS	Waterloo North Hydro	169.0	166.0	170.7	150.3	151.2	152.7	154.3	156.2	158.1	153.4	155.4
Waterloo North MTS #3	Waterloo North Hydro	61.9	70.8	72.7	75.3	79.3	64.6	58.0	75.3	76.8	76.9	78.4
MTS #4 ⁽²⁾	Waterloo North Hydro	0.0	0.0	0.0	30.6	35.2	50.9	60.3	61.9	64.4	65.6	68.1
Fergus TS	Hydro One Distribution	108.9	108.8	109.5	109.7	108.5	108.3	108.2	108.5	108.7	108.3	108.7
Kitchener MTS #1	Kitchener-Wilmot Hydro	29.1	29.6	31.1	31.6	31.8	32.1	32.4	32.9	33.3	33.5	33.9
Kitchener MTS #4	Kitchener-Wilmot Hydro	67.8	68.2	69.1	69.3	69.0	69.0	68.9	69.2	69.3	69.1	69.3
Kitchener MTS #9	Kitchener-Wilmot Hydro	33.7	33.9	34.3	34.6	34.5	34.7	34.9	35.0	35.3	35.4	35.5
Elmira TS ⁽³⁾	Waterloo North Hydro/ Hydro One Distribution	38.0	32.6	33.5	33.3	34.8	35.4	36.0	36.8	38.4	39.0	40.6
Rush MTS	Waterloo North Hydro	54.9	63.8	65.7	67.4	67.4	67.8	69.1	53.0	53.6	60.7	61.3
Customer #1 CTS ⁽⁴⁾	Customer Station	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Customer #2 CTS	Customer Station (Assumed Values)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

Table D1 -is based upon KWCG 2015 IRRP Planning Load Forecast except as noted.

- (1) Cambridge and North Dumfries Hydro (“CND”) has confirmed 9.2 MW of cogeneration at a large customer to be accounted for in the Preston TS forecast starting year 2016. The generation plant is expected to run most of the time and would offset the customer's load. This cogeneration was not factored into the KWCG 2015 IRRP Planning Load Forecast.
- (2) Both CND and Waterloo North Hydro (“WNH”) are monitoring the load closely to determine the timing of potential transformation needs. For planning purposes, WNH has moved back the in service date of MTS #4 from 2018 to 2024. WNH is closely monitoring the need for additional transformation capacity to determine if the load growth indicated at MTS #4 in the forecast can be managed through a combination of improving transformer station interties, CDM and DG in the Waterloo Region. Where possible, these LDCs are exploring opportunities to coordinate possible joint use and development of step-down transformer station facilities in the KWCG Region over the long term.
- (3) Updated to include Hydro One Distribution load
- (4) Based on information provided by the transmission-connected customer

Appendix E. List of Acronyms

Acronym	Description
A	Ampere
BES	Bulk Electric System
BPS	Bulk Power System
CDM	Conservation and Demand Management
CIA	Customer Impact Assessment
CGS	Customer Generating Station
CTS	Customer Transformer Station
DESN	Dual Element Spot Network
DG	Distributed Generation
DSC	Distribution System Code
GS	Generating Station
GTA	Greater Toronto Area
HV	High Voltage
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Plan
kV	Kilovolt
LDC	Local Distribution Company
LP	Local Plan
LTE	Long Term Emergency
LTR	Limited Time Rating
LV	Low Voltage
MTS	Municipal Transformer Station
MW	Megawatt
MVA	Mega Volt-Ampere
MVAR	Mega Volt-Ampere Reactive
NA	Needs Assessment
NERC	North American Electric Reliability Corporation
NGS	Nuclear Generating Station
NPCC	Northeast Power Coordinating Council Inc.
NUG	Non-Utility Generator
OEB	Ontario Energy Board
OPA	Ontario Power Authority
ORTAC	Ontario Resource and Transmission Assessment Criteria
PF	Power Factor
PPWG	Planning Process Working Group
RIP	Regional Infrastructure Plan
ROW	Right-of-Way
SA	Scoping Assessment
SIA	System Impact Assessment
SPS	Special Protection Scheme
SS	Switching Station
TS	Transformer Station
TSC	Transmission System Code
UFLS	Under Frequency Load Shedding
ULTC	Under Load Tap Changer
UVLS	Under Voltage Load Rejection Scheme

Appendix F. KWCG Adequacy of Transmission Facilities and Transmission Plan 2016-2025

Revision 1

KITCHENER/WATERLOO/CAMBRIDGE/GUELPH AREA

ADEQUACY OF TRANSMISSION FACILITIES

AND

TRANSMISSION PLAN 2016 – 2025

October 30, 2015

Prepared by Hydro One Networks Inc. in Consultation with the KWCG Working Group

Foreword

This report is the result of a joint study by KWCG Working Group. It has been prepared by Hydro One Networks in consultation with the Working Group.

The working group members were:

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Cambridge & North Dumfries Hydro	Ron Sinclair Shawn Jackson
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Ontario Power Authority	Bob Chow Bernice Chan
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The preferred plan has been selected based on technical and economic considerations. The issue of cost allocation between utilities was not addressed.

Prepared by: Qasim Raza – Transmission Planning Officer

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Approved by: Farooq Qureshy – Manager, Transmission System Development, Central & East

October 30, 2015

Revision History

Revision	Date	Author	Description of change
1	October 30, 2015	Qasim Raza	Refreshed based on 2015 IRRP/RIP load forecast (April/August2015)
0	April 1, 2015	Alessia Dawes	Original- based on May 2013 forecast

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EXECUTIVE SUMMARY

In 2010 an integrated regional planning study was initiated to assess the electricity supply and reliability over a twenty year period for the Kitchener-Waterloo-Cambridge-Guelph (KWCG) areas and continues to be conducted by a Working Group led by the Ontario Power Authority (OPA) and includes staff from the Independent Electricity System Operator (IESO), Hydro One Networks Inc., Kitchener-Wilmot Hydro, Waterloo North Hydro, Cambridge & North Dumfries Hydro, Guelph Hydro Electric Systems Inc. and Hydro One Distribution.

The early results of the integrated regional planning study identified the need to reinforce supply capacity for the South-Central Guelph and the City of Cambridge over the near and medium term. It also identified the need to minimize the impact of double circuit interruptions in the area¹. As a result, the Working Group recommended two transmission projects in conjunction with conservation and distributed generation:

1. The Guelph Area Transmission Reinforcement (GATR) project – comprising a new 230/115kV autotransformer station at Guelph Cedar TS, upgrading the circuit section between Campbell TS and CGE Junction to 230 kV and in-line switching on the Orangeville TS x Detweiler TS 230kV circuits D6V/D7V – to reinforce supply to South Central Guelph,
2. The Preston TS Autotransformer Project – comprising the installation of a second 230/115kV autotransformer at Preston TS - to reinforce supply to the City of Cambridge.

Work on the GATR project was started in 2014 following approval from the Ontario Energy Board and the Ministry of Environment. The project's planned in-service date is June 2016.

For the Preston project, the OPA issued Hydro One a hand off letter to develop a "Wires" solution to improve the supply to the Cambridge area and to facilitate the connection of a future Cambridge and North Dumfries Hydro transformer station by 2018.

This report presents the results of Hydro One led "Wires" study of the adequacy of supply to the City of Cambridge and the wider KWCG area based on the planned in-service of the GATR project in summer 2016. The main conclusions of the report are as follows:

- The supply capability to the KWCG 115kV area has been significantly increased to meet all 2025 forecast loads by the addition of the GATR project. The need for the Preston autotransformer can be deferred to beyond 2025.
- There is inadequate load restoration capability for load connected to Middleport TS x Detweiler TS 230kV double circuit line M20D and M21D

This report recommends that the most cost effective plan to improve load restoration capability for load connected to circuits M20/21D is to install 230 kV in-line switches onto circuits M20/21D.

¹ OPA Submission to the OEB for the GATR Project – Document EB-2013-0053 dated March 8, 2013 entitled, "Kitchener-Waterloo-Cambridge-Guelph Area

1.0 INTRODUCTION

This transmission adequacy assessment focused on the electrical supply to the municipalities of Kitchener, Waterloo, Cambridge and Guelph and their surrounding areas of Ontario, collectively referred to as the KWCG area in this report. Its primary focus was to confirm the near and mid-term transmission needs for the area and to provide a 10-year transmission plan in order satisfy those Needs.

Geographically, the KWCG area consists of 4 municipalities – Kitchener, Waterloo, Cambridge, Guelph and portions of two counties - Perth and Wellington. Hydro One Networks Inc. is the sole high voltage transmitter in the KWCG area; however the low voltage distribution of electricity in the KWCG area is carried out by Cambridge and North Dumfries Hydro Inc., Guelph Hydro Electric System Inc., Hydro One Distribution, Kitchener-Wilmot Hydro Inc., and Waterloo North Hydro. A geographic map of the area is shown in Appendix A, Map 1 while an electrical map of the area is shown in Appendix A, Map 2.

The KWCG area is a major regional load centre in Ontario. The area has a well-established history in manufacturing and technology. The area peak load is approximately 1400 MW.

This report presents the results of the Hydro One led “Wires” study of the adequacy of supply to the City of Cambridge and the wider KWCG area based on the planned in-service of the GATR project in summer 2016.

2.0 EXISTING TRANSMISSION INFRASTRUCTURE

2.1 TRANSMISSION IN KWCG

Electrical Supply in this area is provided through 230 kV and 115 kV transmission lines and step down transformation facilities (transmission stations, TS) as show in Appendix A, Map 2.

The main sources of electricity into the KWCG Region are Middleport TS, Detweiler TS, Orangeville TS, Cedar TS and Burlington TS. At these stations electricity is transformed from 500 kV and 230 kV to 230 kV and 115 kV, respectively. The KWCG Region transmission system is connected as follows:

- Two 230 kV circuits (D6V/D7V) that run North-East from Detweiler TS to Orangeville TS that supply five load serving stations;
- Two 230 kV circuits (M20/21D) that run South-East from Detweiler TS to Middleport TS that supply five load serving stations and one transmission-connected customer;
- Two 230 kV circuits (D4W/D5W) that run South-West from Detweiler TS to Buchanan TS (in the “London area”) that supply one load serving station;
- Four 115 kV circuits (D7F/D9F, F11C/F12C) that run East-West: D7/9F from Detweiler TS to Freeport SS that supply three load serving stations and F11/12C from Freeport SS to Cedar TS that supply one load serving station;
- Two 115 kV circuits (B5G/B6G) that run North-West from Burlington TS to Cedar TS that supply three load serving stations and one transmission-connect customer;
- Two 115 kV radial circuits (D11K/D12K) emanating East from Detweiler TS that supply two load serving stations; and,
- Two 115 kV circuit (D8S and D10H) emanating North from Detweiler TS that supply two load serving stations in the KWCG area.

Voltage support is provided in the area by:

- Four high voltage shunt capacitor banks and one SVC at Detweiler TS
- Four high voltage shunt capacitor banks at Middleport TS
- Three high voltage shunt capacitor banks at Burlington TS
- One high voltage shunt capacitor bank at Orangeville TS
- 43.2 MVar low voltage station shunt capacitor at Galt TS
- 21.6 MVar low voltage station shunt capacitors at Campbell TS
- 59.81 MVar low voltage station shunt capacitors at Cedar TS
- 9.92 MVar low voltage station shunt capacitors at Elmira TS
- Low voltage feeder shunt capacitors were lumped at: C&ND MTS#1, Waterloo North Hydro MTS #3, Scheifele MTS

All stations in the KWCG Region were considered in the analysis to determine the adequacy of the existing transmission system. Transformation capacity at individual load serving stations was previously analyzed by the OPA as part of the Integrated Regional Resource Plan (IRRP). The result of that analysis was a load forecast that included proposed new stations, as shown in Appendix C. Therefore, transformation capacity at individual load serving stations was not considered in this study.

2.2 TRANSMISSION-CONNECTED GENERATION

There are no existing large-scale transmission-connected generation plants in the KWCG area; however two contracted renewable transmission-connected wind farms were included in the study area and are listed in Appendix B.

3.0 ADEQUACY OF EXISTING TRANSMISSION INFRASTRUCTURE IN KWCG AREA

3.1 STUDY ASSUMPTIONS

Assumptions were made in order to assess the effects of contingencies to verify the adequacy of the transmission system. The assumptions used in the study were:

1. A 10 year load forecast: years 2016 to 2025; shown in Appendix C
2. Forecasted loads were provided by the LDC's in MW. The MVAR portion of the load was set to 40% of the MW load which is a reasonable assumption to achieve a power factor of 0.9 at the defined meter point of load serving transformer stations (TS, CTS, MTS)
3. A summer assessment was performed as the KWCG area is summer load peaking while the equipment is at its lowest rating during summer ambient conditions. This was deemed to be the most conservative approach;
4. Equipment continuous and Limited Time Ratings (LTR) were based on an ambient temperature of 35°C for summer and a wind speed of 4 km/hour;
5. The Guelph Area Transmission Reinforcement (GATR) project would be in-service in June 2016;
6. Circuits M20D and M21D are assigned their updated long-term emergency rating (LTE) based on a maximum temperature of 127°C;
7. Simulation of year 2025 load forecast was performed as it was the maximum loading of the area for the duration of the study period; year 2016 was simulated as necessary;
8. Waterloo North Hydro's Snider MTS #4 (MTS #4) will connect to 230 kV circuit D6/7V between Scheifele MTS and Guelph North Jct., projected in-service date 2024 (refer to Note 2 in Appendix C, Table C1)
9. The flows on Ontario's major internal transmission interfaces were assumed as follows:
 - FETT ~ 4500 MW
 - FS ~1250 MW
 - FABCW ~ 5800MW
 - NBLIP ~ 1650 MW (the slightly high NBLIP was offset by the lower FABCW)
 - QFW ~ 1550 MW

3.2 STUDY CRITERIA

The adequacy of the transmission system is assessed as per the IESO Ontario Resource and Transmission Assessment Criteria, Issue 5.0.

3.3 LOAD FORECAST

The load forecast used in this assessment is the KWCG 2015 RIP forecast as shown in Appendix C. This summer forecast is an extreme weather, area coincident, net, peak load forecast.

The KWCG 2015 RIP forecast is based upon the KWCG 2015 IRRP forecast. The LDC's provided the IESO with a 20 year gross, normal weather, area coincident, peak load forecast in MW. The IESO adjusted the forecast by subtracting the effective conservation and demand management (CDM) capacity, applying an extreme weather factor and then subtracting the effective Distribution Generation (DG) capacity.

3.4 SUPPLY CAPACITY NEEDS

Single element contingencies were considered in assessing the adequacy and reliability of the local transmission system that serves the KWCG area. Figure 1 summarizes the local KWCG area Needs for the 10-year period under study. Appendices D, F and G detail the technical study and results.

At stations, within the KWCG area, classified as NPCC Bulk Power System (BPS) additional contingencies were considered to establish their impact to the local KWCG area. Appendix E details the technical study and results.

3.4.1 AUTO-TRANSFORMATION SUPPLY CAPACITY

There is no major generation station in the KWCG area. Hence, the majority of supply to the load is provided by Hydro One's 500 kV to 230 kV and 230 kV to 115 kV auto-transformers. The number and location of these auto-transformers are as follows:

- Two 500/230 kV autotransformers at Middleport TS
- Four 230/115 kV autotransformers at Burlington TS²
- Three 230/115 kV autotransformers at Detweiler TS
- Two 230/115 kV autotransformers at Cedar TS
- One 230/115 kV autotransformer at Preston TS

Single autotransformer contingencies were performed to assess the adequacy of the transmission system to supply bulk power into the KWCG area via the autotransformers for year 2025 loading.

The results indicate that there are no thermal overloads and no voltage violations for the loss of a single autotransformer.

² The loading of the autotransformers at Burlington TS is mainly driven by the load connected in the Burlington to Nanticoke area. Only a small percentage of the autotransformer load is due to local Guelph load and as such, analysis of the Burlington TS autotransformers was undertaken in the 'Burlington to Nanticoke' Regional Infrastructure Plan.

3.4.2 SUPPLY CAPACITY OF THE 230 kV NETWORK

The KWCG area contains three pairs of double circuit 230 kV lines: M20D/M21D, D6V/D7V and D4W/D5W.

Single circuit contingencies were performed to assess the adequacy of the local 230 kV transmission system for year 2025 loading³.

As indicated in Appendix D there are no thermal overloads and no voltage violations for the loss of a single 230 kV circuit.

3.4.3 SUPPLY CAPACITY OF THE 115 kV NETWORK

The KWCG area contains five pairs of double circuit 115 kV lines: D7F/D9F, F11C/F12C, B5G/B6G, D11K/D12K and D8S/D10H.

Single circuit contingencies were performed to assess the adequacy of the local 115 kV transmission system for year 2025 loading.

As indicated in Appendix D there are no thermal overloads and no voltage violations for the loss of a single 115 kV circuit. Appendix H details supply capacity on circuit D8S and D10H as request by the LDC.

3.4.4 VOLTAGE PERFORMANCE

Single circuit contingencies as well as single element HV shunt capacitor bank contingencies were performed to determine the overall voltage performance of the KWCG area for year 2025 loading.

As indicated in Appendix D there are no thermal overloads and no voltage violations for these contingencies. Appendix H details voltage performance at Elmira TS and Rush MTS as request by the LDC.

3.4.5 LOAD SECURITY ANALYSIS

The most stringent load security criterion that applies to the KWCG area states that with any two elements out of service:

- Voltage must be within applicable emergency ratings and equipment loading must be within applicable short-term emergency ratings;
- Load transfers to meet the applicable long-term emergency ratings must be able to be made in the time afforded by short-time ratings;
- Planned load curtailment or load rejection in excess of 150 MW is not permissible (except for local generation outages) and;

³ Note, if another element such as an autotransformer, circuit or capacitor bank shared the same “switching position” and/or zone of protection with the circuit under contingency, both were removed from service.

- Not more than 600 MW of load may be interrupted by configuration and by planned load curtailment or load rejection excluding voluntary demand management with any two transmission elements out of service.

There are three pairs of 230 kV double circuit lines and five pairs of 115 kV double circuit lines in the KWCG area. While one circuit of a double circuit line is out of service, the loss of the companion circuit in the pair would result in the loss of all load stations connected to the pair by configuration. Tables F1 and F2 in Appendix F illustrate the load lost due to configuration in both years 2016 and 2025.

There are five stations in the KWCG area that have autotransformers. Overlapping autotransformer contingencies were taken and Table F3 in Appendix F illustrates any load transfer requirements due to two overlapping autotransformer outages.

As seen in Appendix F, the load forecasted on all circuit pairs is less than 600 MW within the 10-year study period and the loss of two autotransformers within this local area does not result in equipment loading beyond their applicable emergency ratings; therefore there is no concern with Load Security in the KWCG area for the study period.

3.4.6 LOAD RESTORATION CAPABILITY ANALYSIS

The load restoration criteria requires that the transmission system be planned such that following local area design criteria contingencies, the affected loads can be restored within the restoration times indicated below⁴:

- All load lost must be restored within 8 hours;
- Load lost in excess of 250 MW must be restored within 30 min; and
- Load lost between the amount of 150 MW and 250 MW must be restored within 4 hours.

Each pair of double circuit 230 kV and 115 kV lines were assessed to verify their load restoration capability. This assessment is detailed in Appendix G.

The results indicated the existing transmission system can adequately restore load to each circuit pair with the exception of M20/21D. Therefore, improvement to the restoration capability of load connected to circuits M20D and M21D is required.

3.4.7 IMPACT OF CONTINGENCIES ON THE BPS TO THE KWCG AREA

Northeast Power Coordinating Council (NPCC) Bulk Power System stations in the KWCG area are:

- Middleport TS 500 kV bus
- Middleport TS 230 kV bus
- Detweiler TS 230 kV bus

⁴ As per ORTAC: “These approximate restoration times are intended for locations that are near staffed centres. In more remote locations, restoration times should be commensurate with travel times and accessibility.”

All elements connected to BPS buses are considered BPS facilities. Elements refer to circuit breakers, transmission lines, generators, transformers and reactive devices (e.g. SVC or capacitor bank).

Appendix E: Technical Results-Bulk Power System Considerations provides a list of BPS contingencies and the results. A *limited* number of BPS contingencies were performed in order to establish the impact of contingencies on the BPS to the local KWCG area.

Three NPCC Directory 1 contingency events were utilized in this study:

1. Simultaneous loss of two adjacent transmission circuits on a multiple circuit tower
2. Loss of any element with delayed fault clearing (a.k.a. Breaker Failure)
3. Loss of a critical element, followed by system adjustment, then loss of a critical element.

These BPS contingency events were applied to BPS buses only. The results can be summarized as follows:

- As per Table E3 and E5 when two of the three auto-transformers at Detweiler TS are not available the remaining auto-transformer may become overloaded. Since the loading of the remaining auto-transformer is within its 15-minute Short-Term Emergency Rating (STE) operational control actions can be taken to reduce the loading to within acceptable limits. Control actions could entail isolation of the faulted element e.g. circuit breaker, bus or transformer, and placing back in-service a healthy auto-transformer (at Detweiler TS and/or Preston TS). Another control action could entail opening of 115kV breakers at Freeport SS to redirect flows through the Cedar TS autotransformers.

3.4.8 SUMMARY OF NEEDS

Figure 1 illustrates the Needs timeline for the KWCG region.



Figure 1: Transmission Needs in the KWCG Area

4.0 OPTIONS TO ADDRESS THE NEED

Options were considered to address the insufficient load restoration capability for loads connected to circuits M20D and M21D. These options are shown in Table 1. Although there are several metrics that can be utilized to measure and compare options, the simple metric “initial capital cost/MW of load restored” was selected because it compares the unit costs of remedial measures. This was deemed sufficient in order to select the preferred option

Table 1: Options to Improve M20/21D Load Restoration

Option	Options to Improve Restoration	Fault on the Main Line – Restorable Load (Note 1)	Fault on the Tap – Restorable Load (Note 1)	Initial Capital Cost (Note 3)	Initial Capital Cost/ MW Load Restored
--	Existing (Benchmark)	100 MW (Preston TS only)	100 MW (Preston TS only)	0	\$0/MW
1	230 kV in-line switches on M20/21D at Preston Junction	100 MW (C&ND load only-Note 2)	100 MW (C&ND load only-Note 2)	\$6M	\$60k/MW
2	230 kV in-line switches on M20/21D at Galt Junction (main line)	368 MW - 484 MW	234 MW (100 MW via existing Preston Auto)	\$6M	\$12k/MW to \$26k/MW
3	One 230 kV cap bank at Preston TS plus 230 kV in-line switches on MxD at Preston Junction	140 MW (Note 4) (C&ND load only-Note 2)	140 MW (Note 4) (C&ND load only-Note 2)	\$11M	\$79k/MW
4	2nd autotransformer at Preston TS plus 230 kV in-line switches on MxD at Preston Junction	200 MW (Note 4) (C&ND load only-Note 2)	200 MW (Note 4) (C&ND load only-Note 2)	\$21M	\$105k/MW
5	2nd autotransformer at Preston TS plus 230 kV in-line switches on MxD at Preston Junction plus two 230 kV cap banks at Preston TS	280 MW (Note 4) (C&ND load only-Note 2)	280 MW (Note 4) (C&ND load only-Note 2)	\$31M	\$111k/MW

NOTE 1 Restorable load values are approximate values only as the actual amount of restorable load will depend on the prevailing system conditions and Operating/Control Centre protocols and priorities

NOTE 2 “C&ND load only” means that only those customers connected to Galt TS, C&ND MTS#1 and Preston TS will benefit. Cambridge and North Dumfries Hydro customers are the sole customers of these three stations.

NOTE 3 All prices are based on historical data: taxes extra, overhead extra, no escalation considered, no assumptions are made to feasibility or constructability, no assumptions made as to space requirements, real estate and environmental cost extra

NOTE 4 Restoration of 230 kV load (Cambridge and North Dumfries load) via the Preston TS auto-transformer may require operational measures on the 115 kV system to secure the transmission system to handle a subsequent contingency e.g. open the low voltage bus-tie breakers/switches at 115kV connected stations

5.0 DISCUSSION OF PREFERRED OPTIONS

5.1 PREFERRED OPTION TO IMPROVE RESTORATION TO M20/21D LOAD

Currently, loads connected to circuits M20/21D do not meet the restoration criteria.

Of the five options, option #2: 230 kV in-line switches on M20/21D at/near Galt Junction is the preferred option to satisfy the Need as it will provide the capability to restore the most load supplied from M20/21D.

Not only does Option #2 allow for more load to be restored, it provides for better operational flexibility; and is the most economical solution. As option 2 substantially meets the need by significantly improving the existing restoration capability, it is therefore the preferred option.

6.0 DEVELOPMENT PLAN

The transmission infrastructure development plan for the KWCG area is as followings:

1) Immediate Action: Install 230 kV In-Line Switches

Install 230 kV Load Interrupter type in-line switches on circuits M20D and M21D on the main line near Galt Junction. Note that load interrupter type switches cannot be used to interrupt fault current.

7.0 CONCLUSIONS

The following conclusions can be reached from the analysis performed by this study.

Local Area Performance

1. Improvement to the load restoration capability of transmission-connected customers on circuits M20D and M21D is required. The preferred option can be implemented by summer 2017.

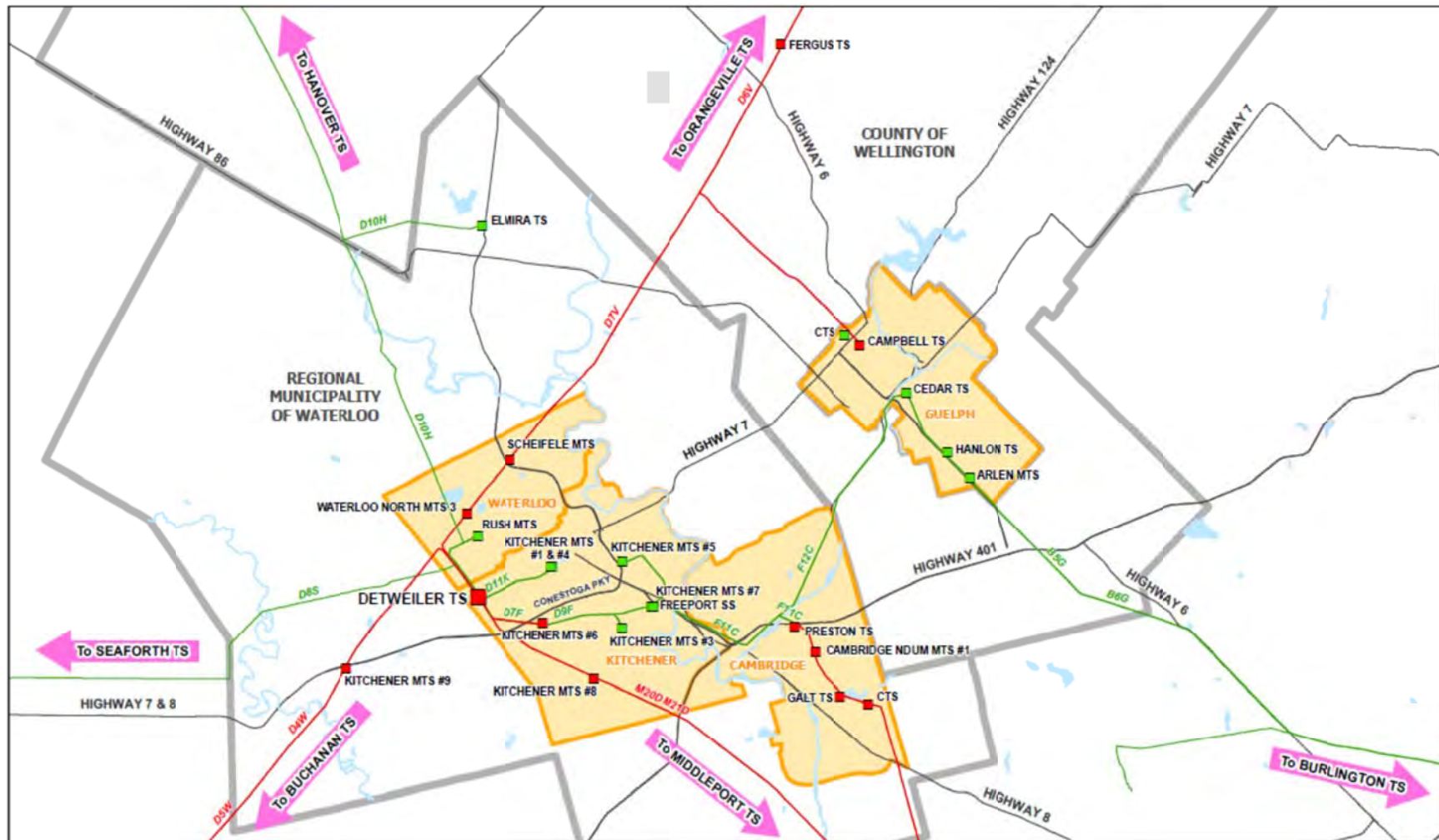
BPS Performance

2. Autotransformer T2 at Detweiler TS is expected to be at 104.4% of LTE loading for year 2016 for the following contingency:
 - i. Detweiler T4 outage plus Detweiler T3 with M20D (includes Preston T2 via Preston SPS). Since the post-contingency flow is below the auto-transformer STE, operational control actions can be taken to reduce loading to within the LTE rating.

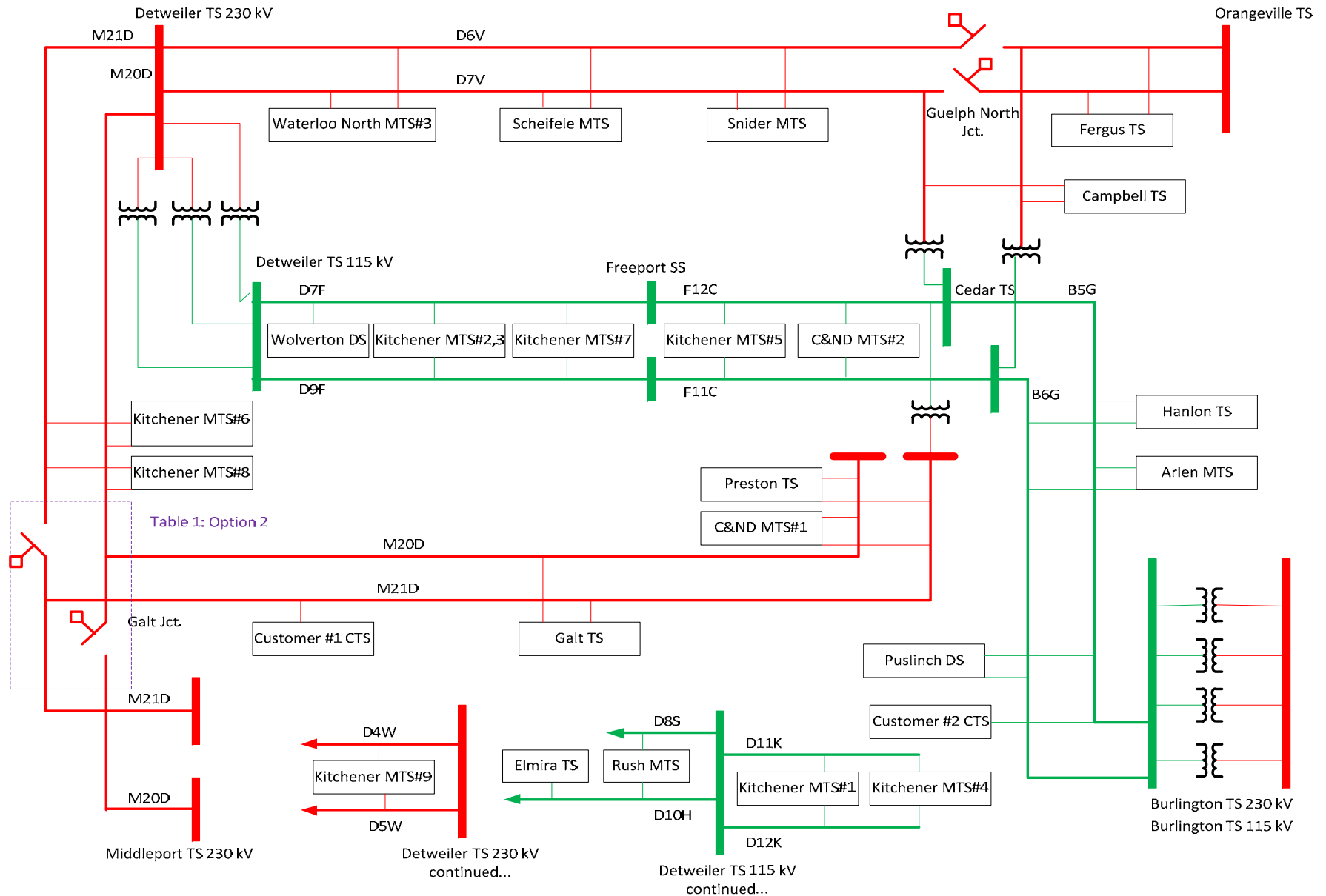
8.0 RECOMMENDATIONS

The following recommendations are to address the transmission infrastructure deficiencies within the study period for the KWCG area. These recommendations are:

1. Hydro One Networks to install a set of 230 kV in-line switches onto the main line of circuits M20D and M21D near Galt Junction as soon as possible.
2. Hydro One Networks, the LDCs and the IESO to review the KWCG local area in 2019 with updated KWCG load forecasts to decide on appropriate actions to meet longer-term needs as they emerge.

APPENDIX A: KWCG MAPS

Map 1: Geographical Area of KWCG with Electrical Layout



Map 2: KWCG Electrical Single-Line

APPENDIX B: TRANSMISSION-CONNECTED GENERATION IN THE KWCG AREA

Name	Installed Capacity	Peak Capacity Contribution⁵	Location	Existing or Contracted
Dufferin Wind Farm	97	13.6	Orangeville TS	Existing
Conestoga Wind Farm	67	10.8	D10H	Contracted (future i/s date unknown)

⁵ Percentage of installed capacity is 14 % for wind generation

APPENDIX C: KWCG CUSTOMER & LDC LOAD FORECASTS

Table C1: KWCG 2015 RIP Load Forecast*

TS	LDC	Load Forecast	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cambridge MTS #1	Cambridge & North Dumfries Hydro	Planning Demand	92.3	93.8	95.6	98.1	99.7	102.7	101.8	102.1	102.4	102.2	101.6
Galt TS	Cambridge & North Dumfries Hydro	Planning Demand	108.1	109.5	112.3	113.7	116.1	119.0	122.8	127.9	134.8	141.9	148.8
Preston TS-Note 1	Cambridge & North Dumfries Hydro	Planning Demand	108.0	100.3	102.0	104.4	105.9	108.7	109.6	111.8	111.9	111.5	111.8
Cambridge MTS # 2-Note	Cambridge & North Dumfries Hydro	Planning Demand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kitchener MTS #6	Kitchener-Wilmot Hydro	Planning Demand	72.8	72.8	73.0	73.0	72.4	72.1	71.7	71.6	71.5	71.1	71.1
Kitchener MTS #8	Kitchener-Wilmot Hydro	Planning Demand	44.2	37.6	40.3	43.1	45.3	38.6	41.1	43.5	46.0	48.2	50.6
Kitchener MTS #3	Kitchener-Wilmot Hydro	Planning Demand	54.3	64.4	66.5	67.3	67.5	77.0	77.5	78.1	78.7	79.0	79.6
Kitchener MTS #7	Kitchener-Wilmot Hydro	Planning Demand	44.9	45.1	45.9	46.0	45.6	45.6	45.6	45.7	39.9	39.8	39.9
Kitchener MTS #5	Kitchener-Wilmot Hydro	Planning Demand	73.9	73.8	74.6	74.5	73.8	73.5	73.2	73.1	78.8	78.3	78.2
Detweiler TS	Kitchener-Wilmot Hydro	Planning Demand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kitchener MTS #4	Kitchener-Wilmot Hydro	Planning Demand	67.8	68.2	69.1	69.3	69.0	69.0	68.9	69.2	69.3	69.1	69.3
Kitchener MTS #9	Kitchener-Wilmot Hydro	Planning Demand	33.7	33.9	34.3	34.6	34.5	34.7	34.9	35.0	35.3	35.4	35.5
Kitchener MTS #1	Kitchener-Wilmot Hydro	Planning Demand	29.1	29.6	31.1	31.6	31.8	32.1	32.4	32.9	33.3	33.5	33.9
Wolverton DS	Hydro One Distribution	Planning Demand	21.2	21.4	21.6	21.6	21.6	21.6	21.6	21.7	21.8	21.7	21.9
Fergus TS	Hydro One Distribution	Planning Demand	108.9	108.8	109.5	109.7	108.5	108.3	108.2	108.5	108.7	108.3	108.7
Puslinch DS	Hydro One Distribution	Planning Demand	35.6	36.2	36.8	37.3	37.5	37.9	38.3	38.7	39.2	39.5	39.9
Cedar TS T1/T2	Guelph Hydro	Planning Demand	72.3	74.9	75.8	77.4	78.3	79.5	79.8	82.2	84.6	85.5	87.9
Cedar TS T7/T8	Guelph Hydro	Planning Demand	30.2	32.0	32.0	32.8	32.3	33.0	33.7	33.4	34.2	34.8	35.5
Hanlon TS	Guelph Hydro	Planning Demand	29.8	30.7	31.6	32.5	33.0	33.7	34.4	35.1	34.9	35.5	35.3
Arlen MTS	Guelph Hydro	Planning Demand	30.0	33.0	37.0	40.9	33.3	37.9	41.4	43.0	44.6	45.9	47.5
Campbell TS	Guelph Hydro	Planning Demand	131.9	136.3	139.0	140.2	141.2	142.8	144.4	148.4	152.2	156.2	160.1
Scheifele MTS	Waterloo North Hydro	Planning Demand	169.0	166.0	170.7	150.3	151.2	152.7	154.3	156.2	158.1	153.4	155.4
Waterloo MTS #3	Waterloo North Hydro	Planning Demand	61.9	70.8	72.7	75.3	79.3	64.6	58.0	75.3	76.8	76.9	78.4
Snider MTS-Note 2	Waterloo North Hydro	Planning Demand	0.0	0.0	0.0	30.6	35.2	50.9	60.3	61.9	64.4	65.6	68.1
Bradley MTS-Note 2	Waterloo North Hydro	Planning Demand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elmira TS	Waterloo North Hydro	Planning Demand	30.4	25.1	26.0	25.8	27.4	28.1	28.8	29.6	31.3	31.9	33.6
Rush MTS	Waterloo North Hydro	Planning Demand	54.9	63.8	65.7	67.4	67.4	67.8	69.1	53.0	53.6	60.7	61.3
Customer #1 CTS-Note 3	Customer Tx Stations	Planning Demand	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Customer #2 CTS	Customer Tx Stations (Assumed values)	Planning Demand	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

Planning demand (MW) = ((Gross-CDM) x Extreme Weather Factor) – DG

*Based upon KWCG 2015 IRRP Planning Load Forecast except where otherwise noted.

Note 1: The LDC has confirmed 9.2 MW of cogeneration at a large customer to be accounted for in the Preston TS forecast starting year 2016. The generation plant is expect to run most of the time and would offset the customer's load. This cogeneration was not factored into the KWCG 2015 IRRP Planning Load Forecast.

Note 2: The LDC has confirmed that additional transformation capacity (Snider/Bradley TS) would not be required until after 2024. The exact location and timing of these TS's have not been determined at this time. The load growth indicated at Snider and Bradley in the forecast can be managed by existing TS's/impact of CDM/DG in the Waterloo Region. LDCs are monitoring the load closely to determine the timing of potential transformation needs.

Where possible, these LDCs are exploring opportunities to coordinate use and development of TS facilities in the KWCG Region over the long term. Cambridge #2 is assumed to be supplied off the KWCG 115kV system

Note 3: Slight modification from KWCG 2015 IRRP Planning forecast based on information provided by the transmission-connected customer

Note: Guelph CTS 1 forecast was removed as the LDC confirmed the load was already accounted for within their forecast

APPENDIX D: TECHNICAL RESULTS – LOCAL AREA ANALYSIS

Single element contingencies were considered in order to determine the presence of thermal overload and/or voltage violations.

Table D1: Single Element Contingencies (single zone of protection)

Loss of a Single Circuit (N-1)					
D11K	D12K	D8S	D10H	D7F	D9F
F11C	F12C	B5G	B6G	D4W	D5W
M20D*	M21D**	D6V***	D7V****		
Loss of a Single Autotransformer (N-1)					
Detw. T2	Detw. T3♦	Detw. T4♦♦	Cedar T3♦♦♦	Cedar T4♦♦♦♦	Preston T2**
Middleport T3♦♦♦♦♦		Middleport T6♦♦♦♦♦♦			
Loss of a Single HV Reactive Element (N-1)					
Detweiler 230 kV cap. bank	Middleport 230 kV cap. bank(K1D1)	Orangeville 230 kV cap. bank		Burlington 230 kV cap. bank	
Detweiler 230 kV SVC	Middleport 230 kV cap. bank(K2D2)	Detweiler 115 kV cap bank		Burlington 115 kV cap bank	

*M20D (includes Detweiler T3 and Preston T2 via Preston Special Protection Scheme)

**M21D (includes Preston T2)

***D6V (includes Detweiler T4 and Cedar T3)

****D7V (includes Cedar T4)

♦Detweiler T3 (includes circuit M20D and Preston T2 via Preston SPS)

♦♦Detweiler T4 (includes circuit D6V and Cedar T3)

♦♦♦Cedar T3 (includes circuit D6V and Detweiler T4)

♦♦♦♦Cedar T4 (includes circuit D7V)

♦♦♦♦♦Middleport T3 (includes circuit N580M and V586M due to Line End Open)

♦♦♦♦♦Middleport T6 (includes circuit N581M and M585M due to Line End Open)

Results: Thermal Overload and Voltage Violations

Table D3: Thermal Analysis (>100% LTE), year 2025

Element	Contingency	%LTE
All circuits and auto-transfers are within ratings		

Table D4: Voltage Analysis, year 2025

Element	Contingency	%Voltage Decline	Voltage kV
All voltages are within criteria			

APPENDIX E: TECHNICAL RESULTS – BULK POWER SYSTEM CONSIDERATIONS

Applicable contingencies were considered on BPS elements to establish their impact on the local area.

Table E1: N-2 Contingencies

Loss of a Double Circuit Line (N-2) emanating from a BPS station		
B22D and B23D	D4W and D5W	M20D and M21D
D6V and D7V	--	--
Breaker Failure (B/F) Contingencies at BPS station (N-2)		
Detweiler TS 230 kV bus	B/F of AL6	Loss of: D6V, Cedar T3, Detw T4, M21D, Preston T2
	B/F of AL7	Loss of: D7V, Cedar T4, M21D, Preston T2
	B/F of L7L20	Loss of: D7V, Cedar T4, M20D, Detw T3, Preston T2
	B/F of HT1A	Loss of: M21D, Preston T2, SVC1
	B/F of ACS21	Loss of : M21D, Preston T2, SC21
	B/F of HL20	Loss of: M20D, Detw T3, D5W, SC22
	B/F of T2SC21	Loss of: Detw T2, SC21
	B/F of HT2	Loss of: Detw T2, SC21, D5W
	B/F of DL22	Loss of: B22D, D6V, Cedar T3, Detw T4
Middleport TS 500 kV bus	Covered under Loss of Middleport T3 and T6 autotransformers for the local area analysis (Appendix D)	
Middleport TS 230 kV bus	There are no B/F conditions that would be critical to the supply to the KWCG area.	

Table E2: N-1-1 Contingencies

Loss of a Critical Element, System Adjustment, Loss of a Critical Element (N-1-1)
Loss of: Detw T4 plus Detw T3 (plus M20D by configuration which also includes the loss of Preston T2 via Preston SPS)
Loss of: Preston T2 plus D7V (plus Cedar T4 by configuration)

Note that during the simulations no System Adjustment was afforded; this is considered a conservative approach.

Results: Thermal Overloads and Voltage Violations

As per Table E3 and E5: Detweiler TS 230/115 kV autotransformer T2 will become overloads when Detweiler TS autotransformer T4 is out-of-service followed by the loss of Detweiler TS autotransformer T3 in conjunction with circuit M20D by configuration. Preston TS autotransformer T2 is also removed from service via the Preston SPS.

Table E3: Thermal Analysis (>95% LTE), year 2016

Element	Contingency	%LTE
Detweiler TS T2 autotransformer	Detweiler T4 plus Detweiler T3 with M20D (includes Preston T2 via Preston SPS)	104.4 (74.2% STE*) %

*STE rating of Detweiler T2 auto-transformer is 396 MVA.

Table E4: Voltage Analysis, year 2016

Element	Contingency	%Voltage Decline	Voltage kV
All voltages are within criteria			

Table E5: Thermal Analysis (>95% LTE), year 2025

Element	Contingency	%LTE
Detweiler TS T2 autotransformer	Detweiler T4 plus Detweiler T3 with M20D (includes Preston T2 via Preston SPS)	114.2 (81.4%STE*)

*STE rating of Detweiler T2 auto-transformer is 396 MVA.

Table E6 Voltage Analysis, year 2025

Element	Contingency	%Voltage Decline	Voltage kV
All voltages are within criteria			

APPENDIX F: LOAD SECURITY ANALYSIS

Load connected to each circuit pair that is lost by configuration following an [N-2] double circuit contingency is:

Table F1: Load Lost Due to Configuration, year 2016

Circuit Pair	MW
M20/21D	420
D6/7V	482
D4/5W	34
D7/9F	131
F11/12C	74
B5/6G	105
D11/12K	98
D8S/D10H	89

Table F2: Load Lost Due to Configuration, year 2025

Circuit Pair	MW
M20/21D	489
D6/7V	571
D4/5W	36
D7/9F	141
F11/12C	78
B5/6G	128
D11/12K	103
D8S/D10H	95 ⁶

Table F1 illustrates that none of the double circuit contingencies result in more than 482 MW of load lost in year 2016.

Table F2 illustrates that none of the double circuit contingencies result in more than 571 MW of load lost in year 2025.

⁶ D8S and D10H emanate out of Detweiler TS as a double circuit line however after ~ 5 km they each become a single circuit 115 kV line. Based on their N/O open points, the loss of the double circuit line within the 5 km span out of Detweiler TS, will results in approximately 95 MW of load lost.

Table F3: Two Elements Out of Service

Loss of a Double Circuit Line				
D7F and D9F		F11C and F12C		B5G and B6G
D4W and D5W		M20D and M21D		D11K and D12K
D6V and D6V				
Loss of Two Autotransformers ⁷				
Station	Detweiler Auto	Preston Auto	Cedar Auto	Burlington Auto
Detweiler Auto	N/A	Detweiler T3 + Preston T2	Cedar T3 + Detweiler T4	Burlington T6 + Detweiler T3
Preston Auto	Detweiler T3 + Preston T2	N/A	Cedar T4 + Preston T2	Burlington T6 + Preston T2
Cedar Auto	Cedar T3 + Detweiler T4	Cedar T4 + Preston T2	Cedar T3 + Cedar T4	Burlington T6 + Cedar T3
Burlington Auto	Burlington T6 + Detweiler T3	Burlington T6 + Preston T2	Burlington T6 + Cedar T3	N/A

Results: Thermal Overload and Voltage Violations

Table F5: Thermal Analysis (>100% STE), year 2025

Element	Contingency	%STE
All circuits and auto-transfers are within ratings		
Element	Contingency	%LTE
All circuits and auto-transfers are within ratings		

Table F6: Voltage Analysis (> emergency ratings), year 2025

Element	Contingency	%Voltage Decline	Voltage kV
All voltages are within criteria			

⁷ For stations that have three or more autotransformers connected in parallel typical operating practice after the loss of one autotransformer is to make load transfers to other interconnected autotransformer station(s) such that the remaining load at the affected station would be at or below the station's reduced Limited Time Rating (LTR). It is assumed in this case that sufficient time between single autotransformer contingencies is available for such load transfers to be carried out by operator response.

APPENDIX G: LOAD RESTORATION ANALYSIS

Restoration of Load Connected to M20/21D

By year 2025 the total forecasted load connected to circuits M20/21D is 489 MW. Loss of this double circuit line would result in the loss of all 489 MW. In order to restore load to these stations at least one circuit would have to be placed back in service, noting that to restore Customer #1 CTS circuit M21D must specifically be placed back in service due to the customer's single-circuit transmission-connection

Based on criteria:

Load Required to be Restored	Duration
239MW	30 min.
100 MW	Within 4 hrs.
150 MW	Within 8 hrs.

Existing infrastructure allows for only the restoration of 100 MW of load in approximately 30 min. This can be accomplished by opening the M20/211D line disconnect switches at Preston TS and back-feed Preston TS T2 230-115 kV autotransformer to supply load at Preston TS only.

Therefore, the existing restoration capability to loads connected to M20/21D does not meet criteria for the duration of the study period.

Restoration of Load Connected to D6/7V

By year 2025 the total forecasted load connected to D6/7V is 571 MW. Loss of this double circuit line would result in the loss of all 571 MW. As part of the Guelph Area Transmission Reinforcement project, two 230 kV in-line switches will be installed in year 2016 on the main line between Detweiler TS and Orangeville TS at Guelph North Junction. To restore load to these stations, the operator will utilize these switches to isolate the problem and return to service the remaining healthy circuit sections. These switches allow for more flexibility to restore load to the affected stations in a timely fashion.

Based on criteria:

Load Required to be Restored	Duration
321MW	30 min.
100 MW	Within 4 hrs.
150 MW	Within 8 hrs.

Depending on:

1. the severity of the double circuit contingency;
2. the prevailing system conditions and

3. the relative distance from the nearest field maintenance centre⁸

the load restoration criterion is substantially met. Therefore, no additional transmission restoration capability is warranted at this time.

Restoration of Load Connected to D4/5W

By year 2025 the total forecasted load connected to D4/5W is 36 MW. Loss of this double circuit line would result in the loss of all 36 MW. To restore load to this station at least one circuit would have to be placed back in service.

Based on criteria:

Load Required to be Restored	Duration
36 MW	Within 8 hrs.

Depending on:

1. the severity of the double circuit contingency;
2. the prevailing system conditions and
3. the relative distance from the nearest field maintenance centre

the load restoration criteria can be met. Therefore, no additional transmission restoration capability is warranted at this time.

Restoration of Load Connected to D7/9F

By year 2025 the total forecasted load connected to D7/9F is 141 MW. Loss of this double circuit line would result in the loss of all 141 MW. To restore load to these stations at least one circuit would have to be placed back in service.

Based on criteria:

Load Required to be Restored	Duration
141 MW	Within 8 hrs.

Depending on:

1. the severity of the double circuit contingency;
2. the prevailing system conditions and
3. the relative distance from the nearest field maintenance centre

the load restoration criteria can be met. Therefore, no additional transmission restoration capability is warranted at this time.

⁸ The KWCG area is considered an urban area and as such, access to transmission facilities, repair materials and personnel in order to make a repair within 8 hours is realistic. A Hydro One field maintenance centre is located in Guelph.

Restoration of Load Connected to F11/12C

By year 2025 the total forecasted load connected to F11/12C is 78 MW. Loss of this double circuit line would result in the loss of all 78 MW. To restore load to these stations at least one circuit would have to be placed back in service.

Based on criteria:

Load Required to be Restored	Duration
78 MW	Within 8 hrs.

Depending on:

1. the severity of the double circuit contingency;
2. the prevailing system conditions and
3. the relative distance from the nearest field maintenance centre

the load restoration criteria can be met. Therefore, no additional transmission restoration capability is warranted at this time.

Restoration of Load Connected to B5/6G

By year 2025 the total forecasted load connected to B5/6G is 128 MW. Loss of this double circuit line would result in the loss of all 128 MW. To restore load to Enbridge Westover CTS's circuit B5G must be placed back in service due to the CTS's single-circuit transmission connection. To restore load at the other stations at least one circuit would to be placed back in service.

Based on criteria:

Load Required to be Restored	Duration
128 MW	Within 8 hrs.

Depending on:

1. the severity of the double circuit contingency;
2. the prevailing system conditions and
3. the relative distance from the nearest field maintenance centre

the load restoration criteria can be met. Therefore, no additional transmission restoration capability is warranted at this time.

Restoration of Load Connected to D11/12K

The total forecasted load serviced by radial circuits D11/12K will not exceed 103 MW by 2025. Loss of this double circuit line would result in the loss of all 103 MW. To restore load to these stations at least one circuit would have to be placed back in service.

Based on criteria:

Load Required to be Restored	Duration
103 MW	Within 8 hrs.

Depending on:

1. the severity of the double circuit contingency;
2. the prevailing system conditions and
3. the relative distance from the nearest field maintenance centre

the load restoration criteria can be met. Therefore, no additional transmission restoration capability is warranted at this time.

Restoration of Load Connected to D8S/D10H

The total forecasted load serviced by these radially operated 115 kV circuits will not exceed approximately 95 MW by year 2025. Loss of this double circuit line would result in loss of all 95MW. To restore Rush MTS either circuit can be placed back into service or the station could possibly be fed via circuit L7S out of Seaforth TS; however to restore Elmira TS circuit D10H must be placed back in service due to Elmira TS's single-circuit transmission-connection.

Based on criteria:

Load Required to be Restored	Duration
95 MW	Within 8 hrs.

Depending on:

1. the severity of the double circuit contingency;
2. the prevailing system conditions and
3. the relative distance from the nearest field maintenance centre

the load restoration criteria can be met. Therefore, no additional transmission restoration capability is warranted at this time.

APPENDIX H: SUPPLY TO ELMIRA TS AND RUSH MTS**Study Results:**

Table H1: Station Capacity: Summer Ratings and Summer Load Forecast

Station	Transformer Capacity (10-day LTR)	Year 2025 Load Forecast
Rush MTS	69 MVA*	61.3 MW / 69.9 MVA (0.88 pf** at defined meter point, 115 kV side)
Elmira TS	58.5 MVA	33.6 MW / 37.1 MVA*** (0.91 pf at defined meter point, 115 kV side)

*The limiting component is a low voltage cable; when required the limiting component will be modified and the rating to be 75 MVA

** Power factor at the defined meter point improves to 0.92 when 5.4 MVar of installed feeder capacitor banks assumed lumped at the LV bus and results in 66.8 MVA loading

*** A 9.2 MVar @ 27.6 kV shunt capacitor bank is installed at Elmira TS not in-service; when in-service power factor improves and loading through the transformers decrease.

Table H2: Transmission Capacity of circuits D8S and D10H

Year	Contingency	D10H – Detweiler TS x Waterloo Jct.	D8S – Detweiler TS x Leong Jct.
		590 A Continuous 640 A Long-Term Emergency (LTE) 660 A Short-Term Emergency (15-min.)	590 A Continuous 640 A Long-Term Emergency (LTE) 660 A Short-Term Emergency (15-min.)
2016	Pre	287 A	285 A
	Loss of D8S	454 A	--
	Loss of D10H	--	459 A
2025	Pre	319 A /	302 A
	Loss of D8S	511	--
	Loss of D10H	--	500 A

-assume all St. Mary's TS load is supplied by D8S (as this is more conservative for the study), assume Conestogo Wind Farm not-service (as it would displace load on D10H) and the normally-open point on D10H is between Elmira TS and Palmerston TS

Table H3: Voltage Profile at Rush MTS and Elmira TS

Year	Contingency	Rush MTS 115 kV D8S	Rush MTS 115 kV D10H	Rush MTS 13.8 kV	Elmira TS 115 kV	Elmira TS 27.6 kV
2016	Pre	122.2	122.2	14.4	120.8	27.2
	Loss of D8S	--	121.8	13.7	120.6	27.1
	Loss of D10H	121.5	--	13.7	--	--
2025	Pre	123.2	123.1	14.2	121.6	27.3
	Loss of D8S	--	122.6	13.6	121.1	27.2
	Loss of D10H	122.4	--	13.6	--	--

-assume all St. Mary's TS load is supplied by D8S (as this is more conservative for the study), assume Conestogo Wind Farm not-service (as it would displace load on D10H) and the normally-open point on D10H is between Elmira TS and Palmerston TS

Analysis:

D8S

Circuit D8S has a normally open point at St. Mary's TS separating the circuit from circuit L7S. D8S normally supplies half the load at Rush MTS and half the load at St. Mary's TS. The other half of the load at Rush MTS is normally supplied by circuit D10H and the other half of the load at St. Mary's TS is normally supplied by L7S. Referring to Table H2, for the loss of circuit D10H, circuit D8S has sufficient capacity to supply all load at Rush MTS and St. Mary's TS for year 2025 and beyond.

D10H

Circuit D10H runs between Detweiler TS and Hanover TS and has a normally open point between Elmira TS and Palmerston TS. Elmira TS is normally supplied from Detweiler TS while Palmerston TS is normally supplied from Hanover TS. Referring to Table H2, D10H has sufficient capacity to supply all load at Elmira TS for year 2025 and beyond. When circuit D8S is out of service, D10H has sufficient capacity to supply all load at Elmira TS and Rush MTS (while St. Mary's TS is supplied by circuit L7S).

Rush MTS

Since this station is a Municipal owned station, Waterloo North Hydro is to ensure there is sufficient transformation capacity to accommodate load growth. According to load forecasts and referring to Table H1, over the next 10-years load will fluctuate above and below the year 2025 forecast but will remain within the station's Limited Time Rating (LTR). Waterloo North Hydro is to inform Hydro One if the connection requires

modification and/or if a new station connection is required in order to accommodate load growth. Waterloo North Hydro has already incorporated their future Snider MTS and Bradley MTS into the KWCG regional plan to cater for load growth.

Rush MTS is supplied by two 115 kV circuits, D8S and D10H. Referring to Tables H2 and H3, when one of these circuits is out of service, the voltage profile at Rush MTS is healthy and the other circuit has sufficient capacity to supply all load to Rush MTS.

Elmira TS

According to the forecast and referring to Table H1, transformers at Elmira TS have sufficient capacity for year 2025 loading and beyond.

Elmira TS is supplied by one 115 kV circuit, D10H. Referring to Tables H2 and H3, the voltage profile at Elmira TS is healthy and the circuit has sufficient capacity to supply load to Elmira TS for year 2025 loading and beyond.

When circuit D10H out of Detweiler TS is unavailable, Elmira TS may also be supplied by D10H out of Hanover TS (by closing the normally open point between Palmerston TS and Elmira TS). Assuming Palmerston TS is at its forecasted year 2025 normal weather peak load, approximately 25 MW of load at Elmira TS may be supplied out of Hanover TS. The limiting factor being the 115 kV voltage profile on D10H as Elmira TS is nearly 80 circuit km from Hanover TS.