Hydro One Networks Inc.
8th Floor, South Tower
483 Bay Street
Toronto, Ontario M5G 2P5
www.HydroOne.com

Tel: (416) 345-5700
Fax: (416) 345-5870
Cell: (416) 258-9383
Susan.E.Frank@HydroOne.com

Susan Frank
Vice President and Chief Regulatory Officer
Regulatory Affairs

BY COURIER

April 8, 2013

Ms. Kirsten Walli
Secretary
Ontario Energy Board
Suite 2700, 2300 Yonge Street
P.O. Box 2319
Toronto, ON.
M4P 1E4

Dear Ms. Walli:

EB-2013-0053 – Hydro One Networks' Section 92 – Guelph Area Transmission Refurbishment Project – Additional Evidence

I am attaching two (2) paper copies of additional evidence with respect to Hydro One Networks' Application and Prefiled Evidence that was filed with the Board on March 8, 2013.

Exhibit B, Tab 6, Schedule 4, pages 1–21 has been filed electronically using the Board's Regulatory Electronic Submission System.

Sincerely,

ORIGINAL SIGNED BY SUSAN FRANK

Susan Frank

Attach.

c. Intervenors (electronic)

CUSTOMER IMPACT ASSESSMENT

Hydro One Networks Inc.
483 Bay Street
Toronto, Ontario
M5G 2P5

CUSTOMER IMPACT ASSESSMENT

Guelph Area Transmission Refurbishment Project

AR:17389

Revision: **Draft**

Date: March 25, 2013

Issued by**:** Transmission Planning Department
System Development Division
Hydro One Networks Inc.

Prepared by:

Eva Tarasiewicz
Senior Network Management Officer
Transmission Projects Development
Hydro One Networks Inc.

Approved by:

John Sabiston, P. Eng
Manager, Transmission Planning
Transmission Projects Development
Hydro One Networks Inc.

Disclaimer

This Customer Impact Assessment was prepared based on information available about the Guelph Area Transmission Project. It is intended to highlight significant impacts to affected transmission customers listed in Table 1 of this document early in the project development process and thus allow an opportunity for these parties to bring forward any concerns that they may have. Subsequent changes and the required modifications or the implementation plan may affect the impacts of the proposed connection identified in Customer Impact Assessment. The results of this Customer Impact Assessment are also subject to change to accommodate the requirements of the IESO and other regulatory or municipal authority requirements. Hydro One shall not be liable to any third party which uses the results of the Customer Impact Assessment under any circumstances whatsoever for any indirect or consequential damages, loss of profit or revenues, business interruption losses, loss of contract or loss of goodwill, special damages, punitive or exemplary damages, whether any of the said liability, loss or damages arises in contract, tort or otherwise

CUSTOMER IMPACT ASSESSMENT

GUELPH AREA TRANSMISSION REFURBISHMENT

1.0 INTRODUCTION

1.1 Scope of the Study

This Customer Impact Assessment (CIA) study assesses the potential impacts of the proposed Guelph Area Transmission Project on the load customers and generators in the local vicinity.
This study is intended to supplement the Draft System Impact Assessment "CAA ID 2012- 478" issued by the IESO on February 28, 2013.
This study covers the impact of the Guelph Area Transmission (GATR) Project on the Hydro One Networks Inc. (Hydro One) system in the Kitchener-Waterloo-Cambridge-Guelph Area (KWCG). The primary focus of this study is to identify the fault levels and capacity changes on the transmission customer connected facilities.

This study does not evaluate the overall impact of the GATR project on the bulk system. The impact of the GATR project on the bulk system is the subject of the System Impact Assessment (SIA) which is issued by the Independent Electricity System Operator (IESO).

1.2. 0 Background

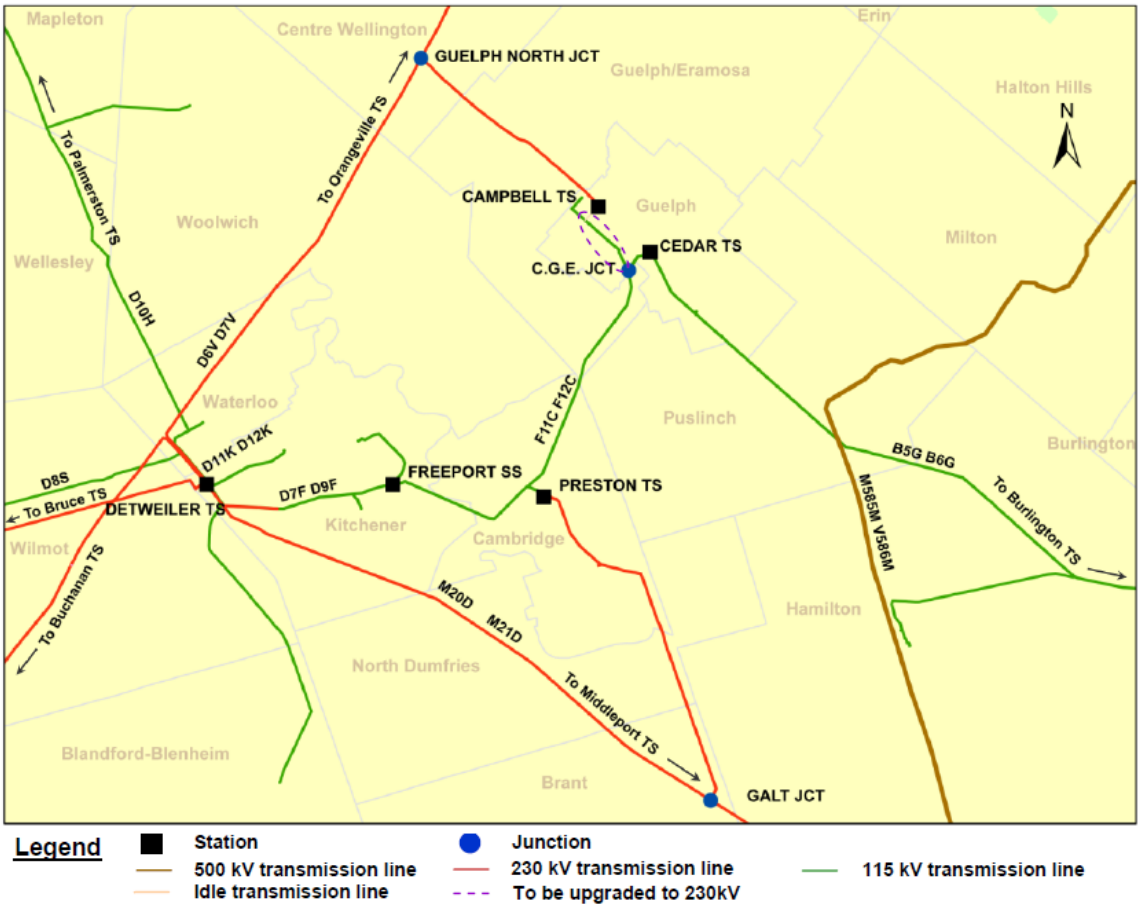
The Guelph Area Transmission Refurbishment project will contribute to meeting the supply needs of the South-Central Guelph, Kitchener-Guelph and the Cambridge area as well as improve the adequacy and reliability of electricity supply in the KWCG area.
The GATR project proposes the following transmission facilities:

- Upgrade approximately 5 km of the existing 115 kV double-circuit transmission line B5G and B6G between CGE Junction and Campbell TS to a 230 kV double-circuit transmission line that is capable of a higher thermal capacity.

- Install two new 230 / 115 kilovolt (kV) autotransformers at the existing Cedar Transformer Station (TS) in the City of Guelph;
- Install 115 kV switchgear facilities at Cedar TS to ensure security of the IESO-controlled grid for a variety of fault and operating scenarios, and
- Upgrade the existing Guelph North Junction in the Township of Centre Wellington to a switching station, Inverhaugh SS, by installing two 230 kV breakers and associated equipment.

This work will address the near- and medium-term needs in the KWCG area. Additional solutions to address longer-term reliability in the area will be identified as part of the continuing KWCG regional planning process.

The Guelph Area Transmission Project is located in southwestern Ontario. The transmission elements of this project extend from Guelph Cedar TS located in city of Guelph to Guelph North Jct. located in County of Centre Wellington. The 115 kV transmission corridor, comprises B5G/B6G, F11C/F12C and D9F/D7F lines that connect Burlington TS (in Burlington) to Detweiler TS (in Kitchener) (see Figure 1 below). Approximately five kilometers of 115 kV line B5G/B6G in this corridor, between Guelph Central (C.G.E. Jct) and Guelph North (Campbell TS), will be upgraded to 230 kV.



Source: Hydro One TLGIS

Figure 1 – The KWCG area

1.2.1 Existing Transmission Facilities in Southwestern Ontario

The generation capacity in southwestern Ontario is mainly a mix of nuclear, gas-fired, coal-fired and renewable sources. Some of the larger generating stations in the region are Bruce GS, Nanticoke GS, Lambton GS and Beck GS. The area also includes major load centers such as Hamilton, London, Windsor and Kitchener-Waterloo-Cambridge-Guelph ("**KWCG**").

The transmission assets in southwestern Ontario connect the major generation and load centers in the region to the interconnected grid. Almost half of the generating capacity in the region supplies the energy needs of other parts of the Province. The transmission system in this area is designed and placed to support this concentration of generation

capacity, respecting physical constraints such as voltage stability and thermal limits. This is a tightly interconnected system, where the availability and performance of each major element (especially the 230 kV facilities) can affect the integrity of the entire network and neighboring jurisdictions.

1.2.2. Transmission Resources in the KWCG Area

KWCG area is located in southwestern Ontario and consists of cities of Kitchener, Waterloo, Cambridge, and Guelph, townships of Wellesley, Woolwich, Wilmot, and North Dumfries, as well as County of Centre Wellington. Much of this area is within the Regional Municipality of Waterloo. Population growth in the four KWCG cities is among the highest in the province, and in the summer of 2005 the demand for electricity in the area peaked at roughly 1,400 MW. While the recent economic recession has impacted growth in the region, the demand for electricity had almost recovered to pre-recession levels in the summer of 2010, and is expected to grow at roughly 2% between 2010 and 2030; more than four times the forecast growth in peak demand for province over the same period. Within the KWCG area, the strongest growth in demand is expected in the Cambridge and North Dumfries and South-Central Guelph areas. As mentioned above, the KWCG area is one of the major load centers in Ontario. With the lack of local generation, the area relies entirely on the transmission system to deliver electricity from external generation sources to the area.

The transmission system supplying the KWCG area is highly integrated and interactive. It includes the 230 kV circuits between Detweiler TS (in Kitchener), Orangeville TS (in Orangeville) and Middleport TS (in Hamilton), as well as eight 115 kV circuits emanating from Detweiler TS and Burlington TS (in Burlington). High voltage autotransformers tie the 115 kV and 230 kV systems together at Detweiler TS, Burlington TS and Preston TS (in Cambridge). The 230 kV and 115 kV transmission lines in the KWCG area are as follows:

- The 230 kV Detweiler TS x Orangeville TS double-circuit tower line, D6V and D7V;

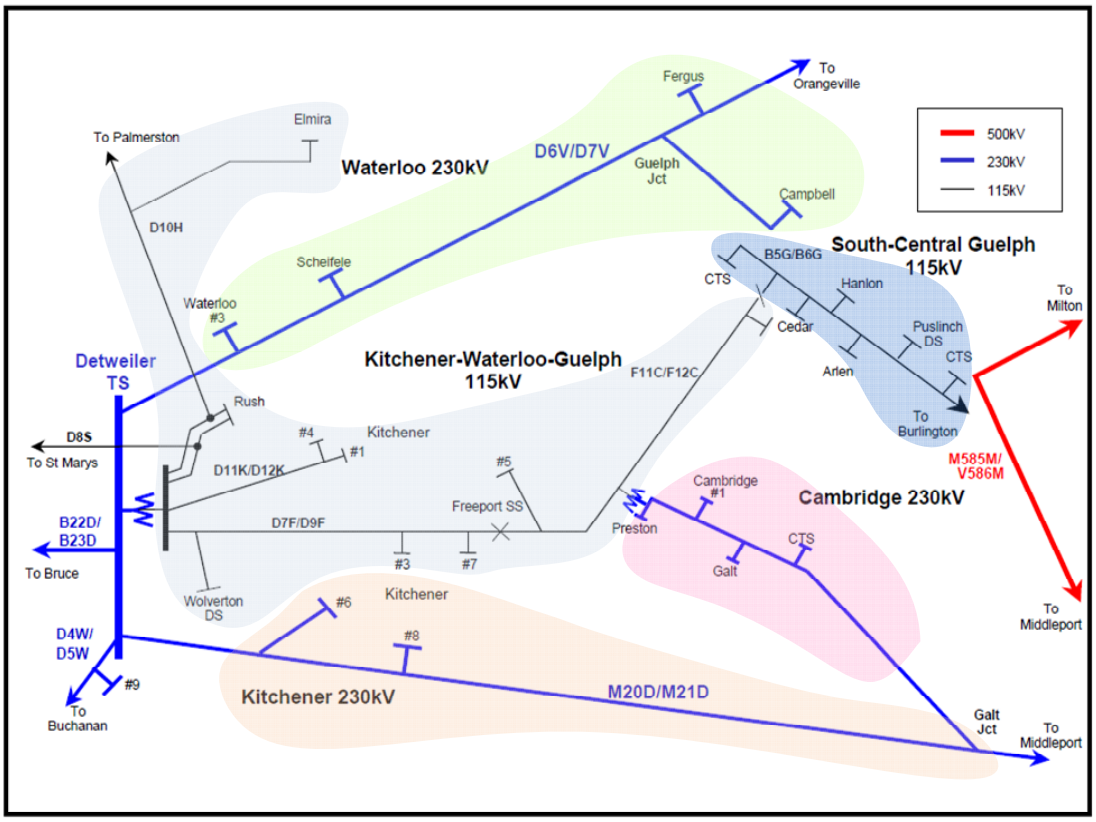
- The 230 kV Middleport TS x Detweiler TS and Preston TS double-circuit tower line, M20D and M21D;
- The 115 kV Burlington TS x Cedar TS double-circuit tower line, B5G and B6G;
- The 115 kV Detweiler TS x Freeport SS double-circuit tower line, D7F and D9F;
- The 115 kV Detweiler TS x St. Mary's TS single-circuit tower line, D8S;
- The 115 kV Detweiler TS x Palmerston TS single-circuit pole line, D10H;
- The 115 kV Detweiler TS x Kitchener TS double-circuit tower line, D11K and D12K;
- The 115 kV Freeport SS x Cedar TS double-circuit tower line, F11C and F12C.

Other major 230 kV facilities connected the KWCG area include transformer and switching stations at Detweiler TS, Burlington TS, Orangeville TS, Middleport TS, Freeport SS and Preston TS.

For the purpose of this submission, the transmission system in the KWCG area can be separated into five subsystems as follows:

- The South-Central Guelph 115 kV Subsystem: customers supplied from Burlington TS via B5G/B6G;
- The Kitchener-Waterloo-Guelph 115 kV Subsystem: customers supplied from Detweiler TS via D7F/D9F, F11C/F12C, D11K/D12K and D8S/D10H;
- The Cambridge 230 kV Subsystem - customers supplied from M20D/M21D via the "Preston Tap";
- The Kitchener 230 kV Subsystem - customers supplied directly from Detweiler TS via M20D/M21D;
- The Waterloo 230 kV Subsystem - customers supplied directly from Detweiler TS via D6V/D7V.

Figure 2 provides a graphical representation of these subsystems.



Source: Hydro One

Figure 2 – Five Existing Subsystems of the KWCG Area Network

The Hydro One proposed Guelph Area Transmission Refurbishment project will contribute to meeting the supply needs of the South-Central Guelph, Kitchener-Guelph and the Cambridge area as well as improve the adequacy and reliability of electricity supply in the KWCG area.

2.0 DETAILS OF THE PROPOSED FACILITIES

Line Work

Approximately 5 km of an existing 115 kV transmission line (B5G/B6G) between CGE Junction and Campbell TS will have to be replaced with a double circuit 230 kV line to address the supply needs in the KWCG area. The transmission line passes through the city of Guelph. An existing customer owned station directly connected to the 115 kV B5G/B6G circuits will need to be disconnected from Hydro One's Transmission system

and reconnected to Guelph Hydro Electric System's distribution system at Campbell TS in order to maintain supply to the customer.

Cedar TS to CGE Jct

The line section from Cedar TS to CGE Jct can currently operate at 230 kV (with existing 230 kV towers and conductors), therefore, only the grounding conductor (skywire) in this section needs to be replaced with Optic Ground Wire (OPGW) conductor which will allow for grounding and communication.

CGE Jct to ABB Jct

The line section from CGE Jct to ABB Jct is designed for 115 kV operation and needs to be rebuilt to 230 kV voltage level. This section was built in 1953. The 3.8 km existing double circuit 115 kV line on double wood pole structures from CGE Jct to ABB Jct consists of 35 wood poles and 1 steel tower. 26 out of 35 wood poles are 59 years old, exceeding the expected life of 50 years for wood poles. The other 9 wood poles were replaced in 2002. The wood poles in this section will be removed and replaced with double circuit 230 kV steel structures, conductors and accessories.

As per Hydro One's policy on the use of steel pole structures in residential areas it is recommended to install steel *pole* structures (instead of the standard steel *lattice* structures) in residential areas, where it is technically feasible and where such a preference has been indicated. Therefore, as requested by residents in the Deerpath Drive Community and by staff from the City of Guelph's Planning, Building, Engineering and Environment group, steel poles are recommended for use in current residential areas on this line section, where possible. This includes approximately 1.9 km of line from the railway just north of the Speed River, to just south of Willow Road. Steel lattice structures are recommended for use on the remainder of the line section to be refurbished and in locations where steel poles are not technically feasible (i.e. locations where there is an angle in the line, such as structures on either side of the line crossing over the Hanlon Parkway).

ABB Jct to Campbell TS

The line section from ABB Jct to Campbell TS is designed for 115 kV operation and needs to be rebuilt to 230 kV voltage level. This section was built in 1964 and is presently idle. The line section from ABB Jct to Campbell TS consists of 4 steel towers. This section will also be removed and replaced with double circuit 230 kV steel structures, conductors and accessories. One OPGW will be installed from CGE Jct. to Campbell TS.

Station Work

The GATR project requires work to be completed at Cedar TS and the planned Guelph North Junction Switching Station.

Cedar TS

Cedar TS in the City of Guelph is currently supplied from Burlington TS via the double circuit 115 kV line B5G/B6G (T7 and T6 step-down transformers) and from Detweiler TS (T1 and T2 step-down transformers) via the double circuit 115 kV line F11C/F12C. At Cedar TS, Hydro One plans to:

- Install two new 230/115 kV autotransformers and associated electrical equipment allowing for supply at 230 kV from circuits D6V/D7V via the Campbell tap
- Install new 115 kV switchgear facilities to connect the existing 115 kV circuits: F11C, F12C, B5G and B6G, existing step-down transformers: T1, T2, T7 and T8 , and two new 230/115 kV autotransformers: T3 and T4, and ensure that adequate transmission supply capability is maintained following the loss of any one of the existing transmission lines without interrupting customers.
- The installation of the facilities listed above at Cedar TS would close the normally open point between the 115 kV circuits: B5G/B6G and F11C/F12C, and thus the D6V/D7V 230 kV system would be connected to the B5G/B6G 115 kV and F11C/F12C 115 kV systems, reinforcing the supply to both South-Central Guelph and Kitchener- Guelph.

Upon completion, Cedar TS will become a strong source of supply within KWCG area. By augmenting the existing Burlington TS 115 kV supply to Cedar TS, Hanlon TS and Arlen MTS through the installation of autotransformers connecting the existing 115 kV circuits B5G/B6G to the 230 kV D6V/D7V circuit from Orangeville TS and Detweiler TS, the GATR project will provide sufficient incremental supply capacity to meet the needs of South-Central Guelph.

Inverhaugh Switching Station at Guelph North Junction

The existing Guelph North Jct. is located in the County of Wellington, in the Township of Centre Wellington, just north of Sideroad 10 and west of 2nd Line East. The double circuit 230 kV transmission line (D6V/D7V) between Detweiler TS in Kitchener and Orangeville TS is tapped to Campbell TS. With the proposed 230 kV line upgrade and autotransformers at Cedar TS the B5G/B6G 115 kV and F11C/F12C 115 kV systems will be connected to D6V/D7V, hence reinforcing the supply to both South-Central Guelph and Kitchener-Waterloo-Guelph.

In order to improve the reliability of electrical supply to South Central Guelph stations on B5G/B6G, Guelph North Jct is proposed to be upgraded by building a Switching Station (SS) and installing two 230 kV circuit breakers and associated station facilities. The existing tap to Campbell TS will connect to the upgraded transmission line section from Campbell TS to Cedar TS to provide supply to Cedar TS, Hanlon TS and Arlen MTS from D6V/D7V. Adding the current and future load on D6V/D7V requires upgrading the junction to a switching station to meet customer supply reliability requirements. Access to the new SS would be from Sideroad 10.

2.1 Single Line Diagrams

Cedar TS

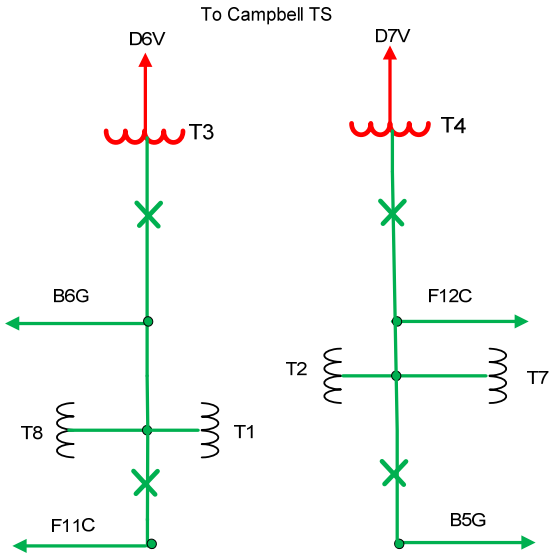


Figure 3: STAGE 1 - Schematic Single Line Diagram of CEDAR TS with Implementation of GATR

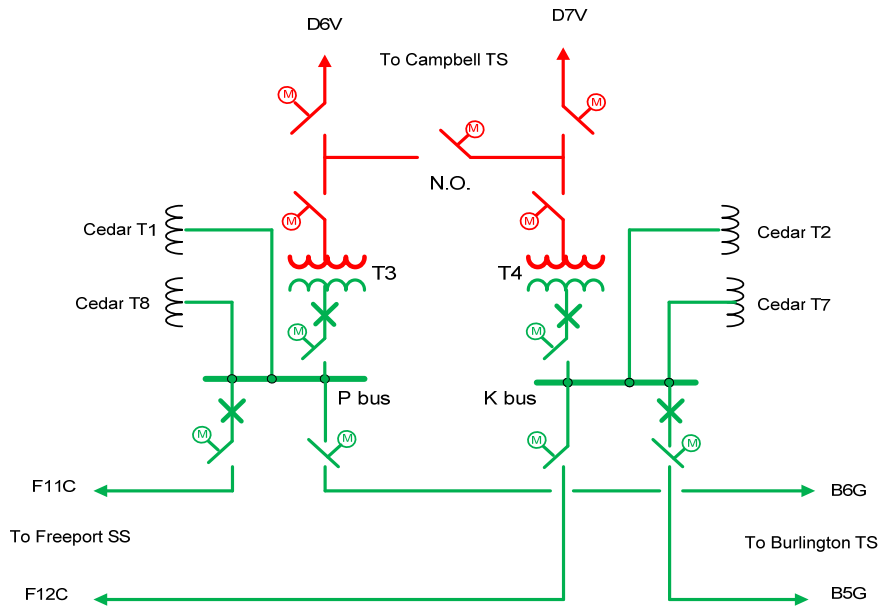


Figure 4: STAGE 1 - Detailed Single Line Diagram of CEDAR TS with Implementation of GATR
(CEDAR bus split – 4 in-line breakers)

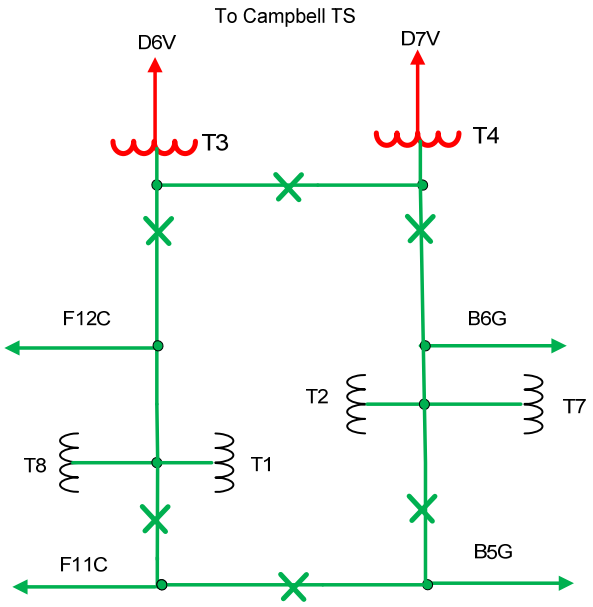


Figure 5: STAGE 2 - Schematic Single Line Diagram CEDAR TS ring bus configuration with six 115 kV breakers (future configuration - ultimate design)

Inverhaugh SS

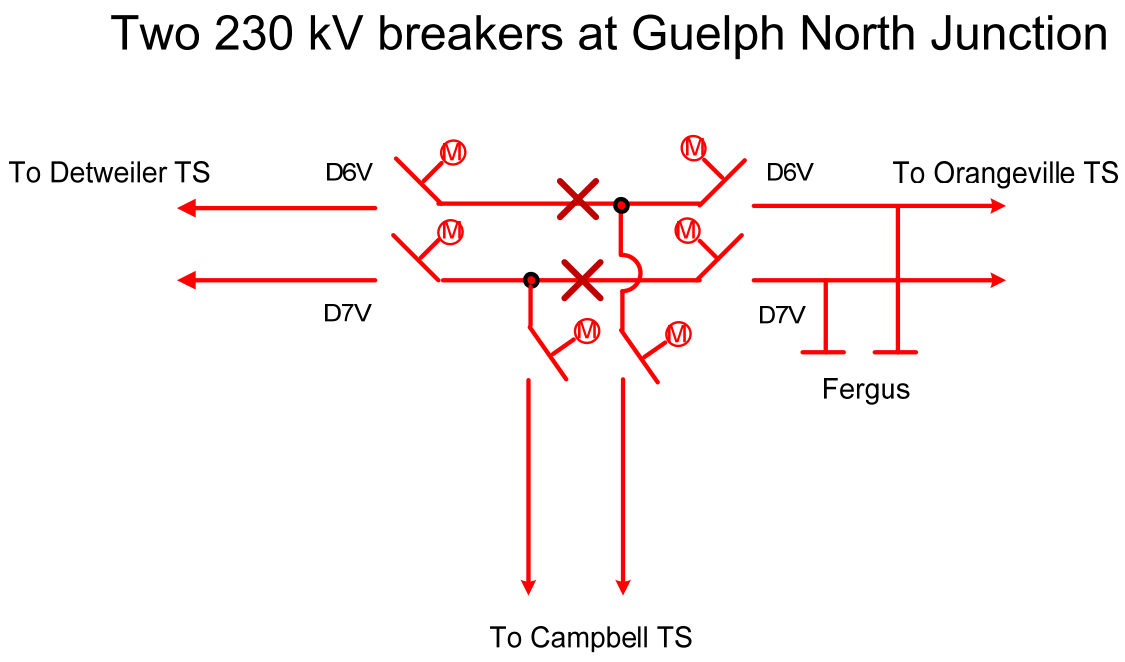


Figure 6 : Two 230 kV circuit breakers at Guelph North Junction

3.0 CUSTOMER IMPACT ASSESSMENT

This Customer Impact Assessment (CIA) is a requirement of the Transmission System Code (TSC) to assess the potential impacts on the existing transmission connected customer(s). The primary focus of this study is to communicate the Guelph Area Transmission Project to customers supplied directly in the KWCG area and in the vicinity of the mentioned geographical area (Figure 2). Table 1 summarizes the customers connected at each station:

Table 1: Transmission Customers in the KWCG Area

Customers	Station
Ameri Steel Cambridge	Gerdau-Courtice Steel CTS
Cambridge and North Dumfries Hydro Inc.	Cambridge NDum MTS#1
	Galt TS
	Preston TS
	Wolverton DS
Centre Wellington Hydro Ltd.	Fergus TS
Guelph Hydro Electric System - Rockwood Division	Fergus TS
Guelph Hydro Electric Systems Inc.	Arlen MTS
	Campbell TS
	Cedar TS
	Hanlon TS
Halton Hills Hydro Inc.	Fergus TS
Hydro One Networks Inc.	Fergus TS
	Puslinch DS
	Wolverton DS
Kitchener-Wilmot Hydro Inc.	Kitchener MTS#1
	Kitchener MTS#3
	Kitchener MTS#4
	Kitchener MTS#5
	Kitchener MTS#6
	Kitchener MTS#7
	Kitchener MTS#8
	Kitchener MTS#9
Milton Hydro Distribution Inc.	Fergus TS
Waterloo North Hydro Inc.	Elmira TS
	Fergus TS
	Rush MTS
	Scheifele MTS
	Waterloo North MTS 3
Wellington North Power Inc	Fergus TS
Westover	Enbridge Westover CTS

3.1 Study Assumptions

The short circuit study was carried out with the following primary system assumptions:

(1) Generation Facilities In-service

East

Lennox G1-G4 Chenaux G1-G8
Kingston Cogen G1-G2 Mountain Chute G1-G2
Wolf Island 300 MW Stewartville G1-G5
Arnprior G1-G2 Brockville G1
Barrett Chute G1-G4 Havelock G1
Chats Falls G2-G9 Saunders G1-G16
Cardinal Power G1, G2

Toronto

Pickering units G1, G4-G8 Sithe Goreway G11-13, G15
Darlington G1-G4 TransAlta Douglas G1-G3
Portlands GS G1-G3 GTAA G1-G3
Algonquin Power G1, G2 Brock west G1
Whitby Cogen G1

Niagara

Thorold GS GTG1, STG2 Beck 2 G11-G26
Beck 1 G3-G10 Beck 2 PGS G1-G6
Decew G1, G2, ND1

South West

Nanticoke G5-G8 Kingsbridge WGS 39.6 MW
Halton Hills GS G1-G3 Amaranth WGS 199.5 MW

Bruce

Bruce A G1-G4 Ripley WGS 76 MW
Bruce B G5-G8 Underwood WGS 198 MW
Bruce A Standby SG1

West

Lambton units G3-G4 Imperial Oil G1
Brighton Beach G1, G1A, G1B Kruger Port Alma WGS 101.2 MW
Greenfield Energy Centre G1-G4 Gosfield Wind Project 50.6 MW
St. Clair Energy Centre CTG3, STG3, CTG4, STG4 Kruger Energy Chatham WF 101 MW
East Windsor Cogen G1-G2 Raleigh Wind Energy Centre 78 MW
TransAlta Sarnia G861, G871, G881, G891 Talbot Wind Farm 98.9 MW

Ford Windsor CTS STG5 Dow Chemicals G1, G2, G5
TransAlta Windsor G1, G2 Port Burwell WGS 99 MW
West Windsor Power G1, G2 Fort Chicago London Cogen 23 MVA
Great Northern Tri-Gen Cogen 15 MVA

(2) Previously Committed Generation Facilities

- Port Dover and Nanticoke
- Big Eddy GS and Half Mile Rapids GS • Grand Renewable Energy Park
- White Pines Wind Farm • Green Electron
- Amherst Island • Comber East C24Z
- York Energy Centre • Comber West C23Z

• Conestogo Wind Energy Centre 1 • Pointe-Aux-Roches Wind
• Dufferin Wind Farm • South Kent Wind Farm
• Summerhaven Wind Farm • Wolfe Island Shoals
• Bluewater Wind Energy Centre • East Lake St. Clair Wind
• Jericho Wind Energy Centre • Adelaide Wind Power Project
• Bornish Wind Energy Centre • Gunn's Hill Wind Farm
• Goshen Wind Energy Centre • Silvercreek Solar Park
• Cedar Point Wind Power Project Phase II • K2 wind
• Adelaide Wind Energy Centre • Armow
• Grand Bend Wind Farms • 300 MW wind at Orangeville
• Grand Valley Wind Farms (Phase 3) • 100 MW wind at S2S
• Erieau Wind

(3) Existing and Committed Embedded Generation

• Essa area: 264 MW • Niagara area: 52 MW
• Ottawa area: 90 MW • Southwest area: 348 MW
• East area: 580 MW • Bruce area: 26 MW
• Toronto area: 168 MW • West area: 585 MW

(4) Transmission System Upgrades

• Woodstock Area transmission reinforcement (CAA2006-253);
o Karn TS in-service and connected to M31W & M32W at Ingersol TS
o W7W/W12W terminated at LFarge CTS
o Woodstock TS connected to Karn TS
• Rodney (Duart) TS DESN connected to W44LC and W45LS 230 kV circuits (CAA2007-260)

(5) System Operation Conditions

• Lambton TS 230 kV operated *open*
• Claireville TS 230 kV operated *open*
• Leaside TS 230 kV operated *open*
• Leaside TS 115 kV operated *open*
• Middleport TS 230 kV bus operated *open*
• Hearn SS 115 kV bus operated *open*
• Preston T2 connected to M21D
• Cherrywood TS north & south 230kV buses operated ***open***
• Richview TS 230 kV bus operated ***open***
• All tie-lines in-service and phase shifters on neutral taps
• Maximum voltages on the buses

4.0 Results of Assessment

4.1 Short-Circuit Analysis

The GATR project will have no material impact on fault levels after completion of the Project, therefore, existing levels at each bus are shown in Table 2 and 3. Two cases were included to simulate scenarios whether the Cedar 115 kV bus is split and closed (ring bus). 2016 system conditions have the Cedar 115 kV bus split.

Table 2: Present Fault Levels

Area Customers	Fault Levels (kA)			
	3-phase		Line-to-ground	
	Symmetrical	Asymmetrical	Symmetrical	Asymmetrical
Ameri Steel CTS 230kV	11.449	13.388	9.715	11.662
Burlington TS 230kV	51.410	61.691	43.592	55.718
Cambridge MTS #1 230kV M20D	8.916	10.422	6.349	6.814
Cambridge MTS #2 230kV M21D	10.344	12.080	8.901	11.004
Detweiler TS 230kV	23.608	27.687	23.116	29.508
Kitchener MTS #6 230kV M20D	17.938	20.908	16.092	18.554
Kitchener MTS #6 230kV M21D	17.897	20.865	16.110	18.575
Kitchener MTS #8 230kV M20D	17.584	20.830	14.409	16.560
Kitchener MTS #8 230kV M21D	17.424	20.661	14.443	16.656
Kitchener MTS #9 230kV D4W	14.738	17.106	11.452	12.839
Kitchener MTS #9 230kV D5W	14.738	17.106	11.463	12.849
Middleport TS 230kV DK1	47.130	59.276	44.120	57.728
Middleport TS 230kV DK2	42.868	55.035	40.126	54.459
Orangeville TS 230kV	19.411	22.207	20.916	24.991
Scheifele CTS 230kV D6V	16.211	18.489	13.637	15.311
Scheifele CTS 230kV D7V	16.180	18.454	13.610	15.280
Waterloo North CTS 230kV D6V	18.752	21.494	16.825	19.338
Waterloo North CTS 230kV D7V	18.667	21.390	16.735	19.225
Arlen MTS 115kV B5G	5.017	5.097	2.606	2.624
Arlen MTS 115kV B6G	5.017	5.097	2.605	2.623
Burlington TS 115kV	34.996	43.549	39.214	50.887
Detweiler TS 115kV	24.602	28.487	28.510	35.151
Enbridge Westover CTS 115kV North	5.222	5.223	3.315	3.315
Enbridge Westover CTS 115kV South	5.024	5.025	3.196	3.196
Kitchener MTS #1 115kV D11K	14.219	14.944	11.382	11.873
Kitchener MTS #1 115kV D12K	14.220	14.944	11.383	11.873
Kitchener MTS #3 115kV D7F	13.875	14.928	11.292	11.903
Kitchener MTS #3 115kV D9F	11.322	12.251	8.587	8.916
Kitchener MTS #4 115kV D11K	14.286	15.020	11.455	11.952
Kitchener MTS #4 115kV D12K	14.287	15.021	11.455	11.953
Kitchener MTS #5 115kV F12C	10.207	10.707	7.540	7.850
Kitchener MTS #5 115kV F11C	8.298	8.769	5.727	5.888
Kitchener MTS #7 115kV D7F	14.374	15.586	12.426	13.299
Kitchener MTS #7 115kV D9F	10.690	11.575	8.143	8.416
Puslinch DS 115kV B5G	5.382	5.458	2.894	2.914
Puslinch DS 115kV B6G	5.382	5.458	2.893	2.914
Rush MTS 115kV D10	14.005	14.562	11.360	11.784
Rush MTS 115kV D8S	13.812	14.331	11.297	11.703
Wolverton DS 115kV	5.899	5.899	3.941	3.941
Fergus TS 44kV	14.514	14.707	6.911	8.097
Elmira TS 27.6kV	7.062	7.062	7.188	7.188
Galt TS 27.6kV J	12.293	12.657	9.845	11.315
Galt TS 27.6kV Y	12.227	12.587	9.816	11.278
Preston TS 27.6kV J	12.359	12.960	9.771	11.287
Preston TS 27.6kV Q	12.712	13.293	9.919	11.436
Campbell TS 13.8kV BY	16.940	17.221	8.328	9.760
Campbell TS 13.8kV EZ	17.367	17.729	8.397	9.885
Campbell TS 13.8kV JQ	16.924	17.183	8.324	9.744
Cedar TS 13.8kV JQ	13.109	13.109	7.691	7.691
Cedar TS 13.8kV BY	14.061	14.061	6.819	7.435
Cedar TS 13.8kV EZ	13.998	13.998	6.805	7.410
Hanlon TS 13.8kV BY	13.939	13.939	7.858	7.858

Table 3: Fault Levels with Implementation of GATR (CEDAR bus split – 4 in-line breakers)

Area Customers	Fault Levels (kA)			
	3-phase		Line-to-ground	
	Symmetrical	Asymmetrical	Symmetrical	Asymmetrical
Ameri Steel CTS 230kV	11.970	13.982	10.068	12.052
Burlington TS 230kV	52.661	63.061	44.375	56.591
Cambridge MTS #1 230kV M20D	8.969	10.499	6.387	6.852
Cambridge MTS #2 230kV M21D	10.932	12.771	9.329	11.517
Detweiler TS 230kV	24.726	28.857	24.030	30.483
Kitchener MTS #6 230kV M20D	18.545	21.541	16.548	19.005
Kitchener MTS #6 230kV M21D	18.515	21.509	16.561	19.023
Kitchener MTS #8 230kV M20D	18.030	21.305	14.668	16.818
Kitchener MTS #8 230kV M21D	17.942	21.210	14.744	16.956
Kitchener MTS #9 230kV D4W	15.064	17.445	11.623	13.007
Kitchener MTS #9 230kV D5W	15.064	17.445	11.634	13.017
Middleport TS 230kV DK1	47.212	59.369	44.175	57.792
Middleport TS 230kV DK2	42.953	55.137	40.185	54.535
Orangeville TS 230kV	20.169	23.062	21.555	25.744
Scheifele CTS 230kV D6V	16.957	19.281	14.297	15.989
Scheifele CTS 230kV D7V	16.955	19.279	14.298	15.986
Waterloo North CTS 230kV D6V	19.551	22.328	17.489	20.013
Waterloo North CTS 230kV D7V	19.479	22.239	17.408	19.908
Arlen MTS 115kV B5G	13.071	13.509	9.656	9.899
Arlen MTS 115kV B6G	12.597	13.048	6.414	6.449
Burlington TS 115kV	39.372	48.028	43.055	55.019
Detweiler TS 115kV	27.474	31.332	31.142	37.811
Enbridge Westover CTS 115kV North	5.976	5.976	3.811	3.812
Enbridge Westover CTS 115kV South	5.716	5.717	3.654	3.655
Kitchener MTS #1 115kV D11K	15.129	15.821	11.776	12.248
Kitchener MTS #1 115kV D12K	15.129	15.822	11.776	12.249
Kitchener MTS #3 115kV D7F	16.247	17.272	12.521	13.094
Kitchener MTS #3 115kV D9F	14.255	15.160	10.073	10.388
Kitchener MTS #4 115kV D11K	15.205	15.907	11.854	12.333
Kitchener MTS #4 115kV D12K	15.205	15.907	11.854	12.333
Kitchener MTS #5 115kV F12C	11.763	12.231	8.236	8.523
Kitchener MTS #5 115kV F11C	10.331	10.767	6.626	6.777
Kitchener MTS #7 115kV D7F	17.634	18.821	14.420	15.247
Kitchener MTS #7 115kV D9F	14.434	15.319	10.111	10.373
Puslinch DS 115kV B5G	11.524	11.740	7.999	8.113
Puslinch DS 115kV B6G	11.231	11.457	6.033	6.060
Rush MTS 115kV D10	14.858	15.384	11.747	12.152
Rush MTS 115kV D8S	14.656	15.144	11.687	12.074
Wolverton DS 115kV	6.062	6.063	3.992	3.993
Fergus TS 44kV	14.745	14.986	6.948	8.167
Elmira TS 27.6kV	7.111	7.111	7.222	7.222
Galt TS 27.6kV J	12.335	12.712	9.863	11.347
Galt TS 27.6kV Y	12.270	12.641	9.834	11.311
Preston TS 27.6kV J	12.409	13.036	9.791	11.329
Preston TS 27.6kV Q	12.764	13.371	9.940	11.478
Campbell TS 13.8kV BY	17.254	17.617	8.378	9.864
Campbell TS 13.8kV EZ	17.680	18.124	8.445	9.984
Campbell TS 13.8kV JQ	17.238	17.576	8.374	9.846
Cedar TS 13.8kV JQ	16.653	16.653	8.387	8.649
Cedar TS 13.8kV BY	16.498	16.981	7.160	8.269
Cedar TS 13.8kV EZ	16.410	16.856	7.145	8.227
Hanlon TS 13.8kV BY	17.226	17.226	8.461	8.715

Table 4: Fault Levels with CEDAR bus closed
(Future arrangement – 6 breaker ring bus – ultimate design)

Table 4: Fault Levels with Implementation of GATR (Cedar Solid Buses)

Area Customers	Fault Levels (kA)			
	3-phase		Line-to-ground	
	Symmetrical	Asymmetrical	Symmetrical	Asymmetrical
Ameri Steel CTS 230kV	12.008	14.021	10.086	12.071
Burlington TS 230kV	52.661	63.061	44.389	56.608
Cambridge MTS #1 230kV M20D	8.970	10.501	6.387	6.853
Cambridge MTS #2 230kV M21D	10.980	12.821	9.352	11.542
Detweiler TS 230kV	24.729	28.861	24.038	30.493
Kitchener MTS #6 230kV M20	18.547	21.543	16.580	19.036
Kitchener MTS #6 230kV M21	18.516	21.511	16.576	19.037
Kitchener MTS #8 230kV M20	18.031	21.306	14.672	16.821
Kitchener MTS #8 230kV M21	17.942	21.210	14.747	16.959
Kitchener MTS #9 230kV D4W	15.064	17.446	11.625	13.008
Kitchener MTS #9 230kV D5W	15.064	17.446	11.636	13.018
Middleport TS 230kV DK1	47.212	59.370	44.176	57.793
Middleport TS 230kV DK2	42.958	55.142	40.188	54.539
Orangeville TS 230kV	20.170	23.064	21.557	25.746
Scheifele CTS 230kV D6V	17.005	19.336	14.320	16.015
Scheifele CTS 230kV D7V	16.972	19.299	14.306	15.995
Waterloo North CTS 230kV D6V	19.575	22.355	17.503	20.029
Waterloo North CTS 230kV D7V	19.482	22.243	17.410	19.911
Arlen MTS 115kV B5G	15.295	15.666	10.451	10.661
Arlen MTS 115kV B6G	15.293	15.665	10.439	10.648
Burlington TS 115kV	39.374	48.029	43.077	55.044
Detweiler TS 115kV	27.499	31.357	31.192	37.863
Enbridge Westover CTS 115kV North	6.023	6.023	3.824	3.825
Enbridge Westover CTS 115kV South	5.759	5.760	3.666	3.667
Kitchener MTS #1 115kV D11	15.136	15.829	11.783	12.255
Kitchener MTS #1 115kV D12	15.137	15.830	11.783	12.255
Kitchener MTS #3 115kV D7F	16.334	17.355	12.555	13.126
Kitchener MTS #3 115kV D9F	14.573	15.468	10.827	11.207
Kitchener MTS #4 115kV D11	15.212	15.914	11.861	12.340
Kitchener MTS #4 115kV D12	15.213	15.915	11.861	12.340
Kitchener MTS #5 115kV F12	11.846	12.311	8.264	8.549
Kitchener MTS #5 115kV F11	10.582	11.010	7.141	7.325
Kitchener MTS #7 115kV D7F	17.861	19.038	14.521	15.342
Kitchener MTS #7 115kV D9F	14.980	15.849	11.356	11.717
Puslinch DS 115kV B5G	12.789	12.962	8.406	8.501
Puslinch DS 115kV B6G	12.788	12.961	8.400	8.495
Rush MTS 115kV D10	14.865	15.391	11.753	12.158
Rush MTS 115kV D8S	14.663	15.151	11.693	12.080
Wolverton DS 115kV	6.063	6.064	3.993	3.993
Fergus TS 44kV	14.746	14.987	6.948	8.167
Elmira TS 27.6kV	7.111	7.111	7.222	7.222
Galt TS 27.6kV J	12.338	12.714	9.864	11.349
Galt TS 27.6kV Y	12.272	12.644	9.835	11.312
Preston TS 27.6kV J	12.412	13.039	9.793	11.330
Preston TS 27.6kV Q	12.768	13.375	9.942	11.480
Campbell TS 13.8kV BY	17.254	17.618	8.378	9.864
Campbell TS 13.8kV EZ	17.681	18.125	8.445	9.984
Campbell TS 13.8kV JQ	17.238	17.577	8.374	9.847
Cedar TS 13.8kV JQ	16.654	16.654	8.387	8.649
Cedar TS 13.8kV BY	16.501	16.994	7.160	8.273
Cedar TS 13.8kV EZ	16.412	16.867	7.145	8.230
Hanlon TS 13.8kV BY	17.228	17.228	8.462	8.716

Notes

1. Pre-fault voltages of 250 kV at 230 kV stations and 29 kV at 27.6 kV stations are assumed.
2. A breaker contact parting time of 25ms was assumed for asymmetrical current calculation for 230kV breakers and a contact parting time of 30ms was assumed for asymmetrical current calculation for 27.6kV breakers.
3. 2 units at Lambton GS, 6 units at Nanticoke, latest FIT project additions and all 5 phases of Samsung projects were considered.

4.2 Observations

Results show that fault levels are within maximum symmetrical three-phase and single line-to-ground faults (kA) of 230 kV, 115kV, 27.6 kV and 13.8 kV systems for all equipment connected to Hydro One transmission system as set out in Appendix 2 of the TSC when the Cedar 115kV bus is split or closed.

The largest changes observed were found to be at Arlen MTS, 8.4 kA, Cedar TS, 3.5 kA and Hanlon TS 3.3 kA. As noted above, the magnitude of these changes are acceptable.

The maximum symmetrical three-phase and single line-to-ground faults given for those voltages in the TSC may be summarized as follows:

Nominal Voltage (kV)	***Max. 3-Phase Fault (kA)***	***Max. SLG Fault (kA)***
230	63	80 (usually limited to 63 kA)
115	50	50
44	20	19 (usually limited to 8 kA)
27.6	17	12 (4 wire)/ 0.45 (3 wire)
13.8	21	10

5.0 Conclusions and Recommendations

This CIA report presents results of incorporating the transmission facilities planned for meeting the reliability needs of the Kitchener-Waterloo-Cambridge-Guelph Area in the near- and medium-terms. In particular, the results of short-circuit analyses have been presented.

Short-circuit studies were carried out to determine the new projected fault levels at customer transmission connection points. The short-circuit levels observed at connection points are within the requirements of the Transmission System Code.

It is recommended that the customers review the impact of the short-circuit change on their facilities and take appropriate and timely action to address any safety/technical issues arising out of these changes which will result following incorporation of the transmission facilities in the Fall of 2015.