PJM Generator Interconnection

X4-039 Pleasant View - Brambleton 230 kV

750 MW Capacity / 800 MW Energy

Feasibility Study Report

May 2012
DMS #693780v1A

Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, §36.2, as well as the Feasibility Study Agreement between Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Virginia Electric and Power Company.

Preface

The intent of this Feasibility Study is to determine a plan, with preliminary cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by IC. As a requirement for interconnection, IC may be responsible for the cost of constructing Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM and the underlying system. All facilities required for interconnection of a generation interconnection project must be designed to meet ITO technical specifications.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. IC is responsible for its right of way, real estate, and construction permit issues.

General

The queue project X4-039 was studied as a 800 MW (Capacity 750 MW) injection in to the ITO area. Project X4-039 was evaluated for compliance with reliability criteria for summer peak conditions in 2015. Potential network impacts were as follows:

Summary

Upgrade Type	Option 1			Option 2		
	A	B	Max Duration	C	D	Max Duration
Attachment Facilities	1	1	24	1	1	24
Direct Connection Upgrades	3.2	1.5 0.4 4	30	8	1.5 0.4 8.8	30
Non-Direct Connection Upgrades						
Thermal Overloads	3	3		3	3.4	
New Breakers*	2.03	2.03	36	3.43	3.43	36
Pleasant View	2	15**		2	15**	
Total	11.23	26.93	36	17.43	33.53	36

* excludes contribution to other breakers
** excludes GIS alternative

Primary Option

The following contingencies resulted in overloads for the primary option:

Option 1 Impactful Contingencies	
Contingency Name	**File Description**
227&274	CONTINGENCY '227&274' /* LN 227 & 274 PLEASNT VIEW - BEAUMEADE OPEN BRANCH FROM BUS 314171 TO BUS 314006 CKT 1 /* 227 BRAMBLETON - ASHBURN OPEN BRANCH FROM BUS 314006 TO BUS 314010 CKT 1 /* 227 ASHBURN - BEAUMEADE OPEN BRANCH FROM BUS 314072 TO BUS 314004 CKT 1 /* 274 PLEASNT VIEW - ASHBURN OPEN BRANCH FROM BUS 314004 TO BUS 314010 CKT 1 /* 274 ASHBURN - BEAUMEADE END
AP_C5_19	CONTINGENCY 'AP_C5_19' /BRIGHTON LOOP - WITH PATH OPEN BRANCH FROM BUS 200003 TO BUS 235632 CKT 1 OPEN BRANCH FROM BUS 200003 TO BUS 235632 CKT 2 END

Network Impacts:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

X4-039 Opt. 1 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
001	Non	Non	PJM	01KEMPTOWN-EMORY GR500 500 kV line	235632	200101	1	DC	99.6	105.54	NR	2338	118.69

For X4-039 option 1 overload 001, the two breaker bay at Conastone for the Brighton line is over the continuous rating. Upgrade Conastone bay with two 4000A breakers, four 4000A breaker disconnects and a 4000 A line switch need to be either. $3M take 24-36 months to complete. New rating 3710 MVA.

Multiple Facility Contingency

(Double Circuit Tower Line Contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

X4-039 Opt. 1 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
002	DCTL	227&274	Dominion	6BRAMBL-6GREENW 230 kV line	314171	314098	1	DC	99.53	100.24	NR	948	41.54

For the X4-039 option 1 overload 002 overload of 230kV transmission Line #2095 section from Brambleton to Greenway identified above will be resolved when the proposed PJM Baseline Projects # b1503.1, b1503.2, b1503.3, b1503.4 are constructed. The in-service target date is November 2013.

Contribution to Previously Identified Overloads

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have % allocation of cost responsibility which will be calculated and reported for the Impact Study.)

X4-039 Opt. 1 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
003	DCTL	AP_C5_19	PJM	01KEMPTOWN-EMORY GR500 500 kV line	235632	200101	1	DC	104.44	107.89	NR	2901	100.33

For the X4-039 option 1 overload 003, is covered by X4-039 option 1 overload 001 overload.

Short Circuit

(Report Overdutied breakers here)

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With X4-039_opt1	Duty Percent Without X4-039_opt1	Duty Percent Difference	Note
314072	PLEASANTVIEW 230.kV	H1T201	S	115.80%	99.00%	16.80%	New Over-duty
314072	PLEASANTVIEW 230.kV	203T274	S	106.20%	89.40%	16.80%	New Over-duty
314061	LOUDOUN 230.kV	L152	S	103.80%	99.60%	4.20%	New Over-duty
314061	LOUDOUN 230.kV	L252	S	103.80%	99.60%	4.20%	New Over-duty
3070	BRAMBLETON 230.kV	201T2045	S	103.00%	96.00%	7.00%	New Over-duty
42	OX 230.kV	206342	S	100.70%	99.70%	1.00%	New Over-duty
314074	POSSUM POINT 230.kV	202292	S	100.20%	99.80%	0.40%	New Over-duty
314074	POSSUM POINT 230.kV	252T2022	S	100.20%	99.80%	0.40%	New Over-duty
314072	PLEASANTVIEW 230.kV	H1T274	S	119.10%	101.50%	17.60%	Over 100%, > 3% contribution
125	LOUDOUN CAP 230.kV	SC352	S	116.80%	113.00%	3.80%	Over 100%, > 3% contribution
1371	PLEASANT CAP 230.kV	SC322	S	114.80%	101.50%	13.30%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	200852	S	113.60%	109.10%	4.50%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	2008T2094	S	113.60%	109.10%	4.50%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	29552	S	112.20%	107.50%	4.70%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	295T2030	S	112.20%	107.50%	4.70%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	204552	S	111.90%	108.10%	3.80%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	209452	S	111.90%	108.10%	3.80%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	WT2045	S	111.90%	108.10%	3.80%	Over 100%, > 3% contribution
3070	BRAMBLETON 230.kV	22702	S	109.50%	102.70%	6.80%	Over 100%, > 3% contribution
3070	BRAMBLETON 230.kV	227T2094	S	109.50%	102.70%	6.80%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	203052	S	107.40%	102.70%	4.70%	Over 100%, > 3% contribution
3070	BRAMBLETON 230.kV	2045T2095	S	107.20%	100.70%	6.50%	Over 100%, > 3% contribution
3070	BRAMBLETON 230.kV	2094T2095	S	107.20%	100.70%	6.50%	Over 100%, > 3% contribution
314913	LOUDOUN 500.kV	H1T569	S	106.10%	102.40%	3.70%	Over 100%, > 3% contribution
314913	LOUDOUN 500.kV	H2T558	S	106.10%	102.40%	3.70%	Over 100%, > 3% contribution
314913	LOUDOUN 500.kV	H2T559	S	106.10%	102.40%	3.70%	Over 100%, > 3% contribution

- The estimated cost to replace two overdutied 230 kV breakers H1T201 and 203T274 at Pleasant View substation with 63 kA breakers will be $205,000 per breaker and will take 12 months including equipment order time.
- The estimated cost to replace two overdutied 230 kV breakers L152 and L252 at Loudoun substation with 63 kA breakers will be $205,000 per breaker and will take 12 months including equipment order time.
- The estimated cost to replace one overdutied 230 kV breaker 201T2045 at Brambleton substation with 63 kA breaker will be $205,000 and will take 12 months including equipment order time.
- The estimated cost to replace one overdutied 230 kV breaker 206342 at Ox substation with 63 kA breaker will be $205,000 and will take 12 months including equipment order time.
- The estimated cost to replace two overdutied 230 kV breakers 202292 and 252T2022 at Possum Point substation with 80 kA breakers will be $500,000 per breaker and will take 20 months including equipment order time.
- For the all of the contribution breakers, PJM will provide allocations if any at the System Impact Study:
    - Breakers 203052, SC352, 200852, 2008T2094, 209452, WT2045,29552, 295T2030, 22702, 227T2094 appear to be baseline projects, which this queue will not have to contribute;
    - Breakers H1T569, H2T558, H2T559, H1T274, SC322, 204552, 2045T2095, 2094T2095 appear to be caused by X3 projects; this determination requires retool of the X3-case, which will occur at the System Impact Study. If these all were to become higher-order queue project(s) responsibility, X4-039 would receive an allocation. It is estimated that each breaker will cost $205,000 and take 12 months to replace.

ITO Analyses

ITO assessed the impact of the proposed queue #X4-039 interconnection as a 800 MW Energy (750 MW Capacity) injection on to the ITO system. The system was assessed using the summer 2015 RTEP case provided to ITO by PJM, where the proposed generation capacity was injected on ITO 230kV transmission system. For the primary option the proposed generation capacity was injected on the 230kV transmission line at Cohran Mill between the Pleasant View and Brambleton substations. This analysis did include the impacts of the generation output for all higher order queue generators within the ITO system. When performing a generation analysis, ITO main analysis will be load flow study results under single contingency (both normal and stressed system conditions) and import/export system conditions. ITO criterion considers a transmission

facility overloaded if it exceeds 94% of its emergency rating under normal and stressed system conditions. For import/export studies ITO considers a transmission facility overloaded if it exceeded 100% of its emergency rating. A full listing of ITO planning criteria and interconnection requirements can be found in the ITO facility connection requirements which are publicly available at: http://www.dom.com.

For the primary option, the proposed generation capacity was injected on the 230kV transmission line at Cohran Mill between the Pleasant View and Brambleton substations. As part of its generation impact analysis Dominion routinely evaluates the impact that a proposed new generation resource will have under maximum generation conditions and stressed system conditions. For the X4-039 Option #1 evaluation, three different assessments were conducted.

1. The first being when local generation including the proposed X4-039 facility is operated at their maximum capability. The result of this study is shown below in Table A.

Table A: PMax System Conditions

Overloaded Element	Cont. Loading(MVA)	Base Loading (MVA)	Rating (MVA)	Cont. Loading(%)	Contingency Description
314072 6PL VIEW 230314170 6COHMIL 230 2	1000.7	818.3	1057.0	94.7	314072 6PL VIEW 230 314925 8PL VIEW 500 1
314072 6PL VIEW 230 314170 6COHMIL 230 2	*1086.0*	818.3	1057.0	*102.7*	314925 8PL VIEW 500 314933 8BRAMBLETON 500 1

As shown above in Table A, the impact of the X4-039 generator under single contingency conditions results in:

a. Thermal overload of the 230kV transmission Line #201 section from Cohran Mill to Pleasant View for the N-1 outage of the Pleasant View 500/230kV transformer.

b. Thermal overload of the 230kV transmission Line #201 section from Cohran Mill to Pleasant View for the N-1 outage of the 500kV transmission Line #558 from Pleasant View to Brambleton.

2. The second being a stressed system condition where the largest generator in the area is unavailable. With the X4-039 generator geographically located in Northern Virginia, Possum Pt. Unit #5 is considered the most critical generating unit in the area. The impact of X4-039 was studied with the outage of Possum Point Unit #5. The result of this study is shown below in Table B.

Table B: Stressed System Conditions

Overloaded Element	Cont. Loading (MVA)	Base Loading (MVA)	Rating (MVA)	Cont. Loading (%)	Contingency Description
314072 6PL VIEW 230 314170 6COHMIL 230 2	1054.6	802.3	1057.0	99.8	314925 8PL VIEW 500 314933 8BRAMBLETON 500 1

As shown above in Table B, the impact of the X4-039 generator under single contingency conditions results in:

a. Thermal overload of the 230kV transmission Line #201 section from Cohran Mill to Pleasant View for the N-1 outage of the 500kV transmission Line #558 from Pleasant View to Brambleton.

3. The third being import and export conditions into and out of the Dominion System. Any new facility that is interconnected with the Dominion System should not significantly decrement First Contingency Incremental Transfer Capability between utilities. The results of these studies can be found in Tables C and D.

Table C: Import Study Results

Import Study Results			
Area	**Summer 2015**	**Summer 2015 with X4-039**	**Limiting Element**
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

Table D: Export Study Results

Export Study Results			
Area	**Summer 2015**	**Summer 2015 with X4-039**	**Limiting Element**
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

ITO planning criteria indicates a need to have approximately 2000 MW of import and export capability. The results of these import and export studies are indicate that the proposed generation facility will not impact ITO import or export capability. Note the results for the studies with X4-039 included are based on the proposed reliability deficiencies noted below. Since facilities are overloaded for single contingency conditions the First Contingency Incremental Transfers would be negative without the inclusion of these proposed solutions.

Primary Option Upgrades:

Attachment Facilities:

Figures A and B below illustrate the proposed layout and attachment facilities for the X4-039 interconnection. Figure A illustrates the layout of X4-039 primary option with the Non-Direct Connection network upgrade option 1A, and Figure B illustrates the layout of X4-039 primary option with the Direct Connection network upgrade option 1B.

The estimated cost of these Attachment Facilities which includes metering, protection equipment along with one 0.5 mile 230kV line is $1.0 Million dollars and is estimated to take 24 to 30 months to complete.

If the customer would like to separate the gas and steam units, it will require one additional 230kV breaker plus one additional 0.5 mile 230kV transmission line with associated metering and protection equipment. The estimated cost of these additional Attachment Facilities is $1.8 Million dollars and is estimated to take 24 to 30 months to complete.

Direct Connection Network Upgrades:

ITO identified two alternatives to connect X4-039, listed as option 1A and option 1B. The Direct Connect Network Facilities needed to reliably interconnect the proposed generation with the Dominion Transmission System for X4-039 option 1 are as follows:

- For X4-039 with Non-Direct Connection upgrade option 1A, described under Non-Direct Connection Network Upgrades, it will be necessary to build a three breaker 230kV ring bus at the customer's site as shown below in Figure A. The 230kV transmission Line #201 (Pleasant View to Brambleton) will then be looped (approximately 0.5 miles) into the new 230kV switching substation as shown in the Figure A below. The estimated cost of this work is $3.2 Million and is estimated to take 24 to 30 months.

- For X4-039 Direct Connection Upgrade Option 1B, ITO could build a new 230kV transmission line approximately one mile from the new 230kV switching station that is needed to interconnect X4-039 and the Pleasant View Substation. This new transmission line will be constructed for a capacity of 1047 MVA:

  i. One feasible option for the construction of this new transmission line would be to expand the existing right-of-way and build a new single circuit 230kV transmission line approximately one mile from the new X4-039 230kV switching station to Pleasant View Substation. Excluding the cost for additional right-of-way, the cost of the transmission line work is estimated be $1.5 Million dollars and is expected 24 to 36 months to complete; or

  ii. another construction option for this new transmission line would be to advance the existing project to rebuild the 500kV transmission Line #558 from Pleasant View to Loudon (PJM Baseline Project #b1694), and utilize the 230kV under-build of the 5-2 transmission line structures to construct a new transmission line approximately one mile from the new X4-039 230kV switching station to Pleasant View Substation. The estimated cost of the transmission line work for this option is approximately $400,000 dollars and is expected to take 24 to 36 months to complete. This estimate does not include the cost to advance the rebuild project of the 500kV transmission Line #558.

- In addition, it will be necessary to build a four breaker 230kV ring bus at the customer's site as shown below in Figure B. The 230kV transmission Line #201 (Pleasant View to Brambleton) will then be looped (approximately 0.5 miles) into the new 230kV switching substation as shown in the Figure B below. The estimated cost of this work is $4.0 Million and is estimated to take 24 to 30 months.

Non-Direct Connection Network Upgrades:

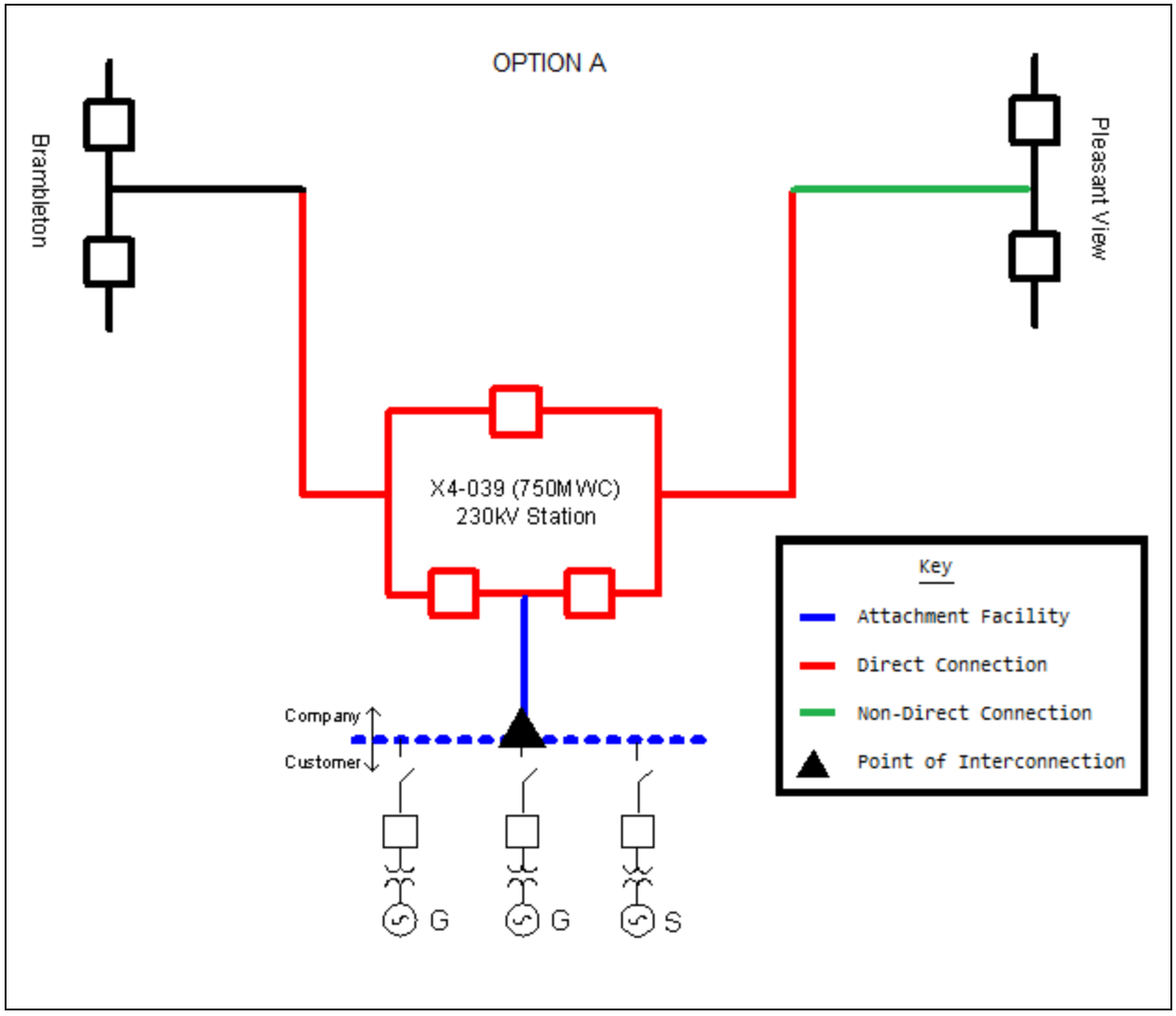
The following Non-Direct Connection network upgrade options have been identified to resolve the overload of the 230kV transmission Line #201 from Cohran Mill to Pleasant View associated with the X4-039 interconnection option 1.

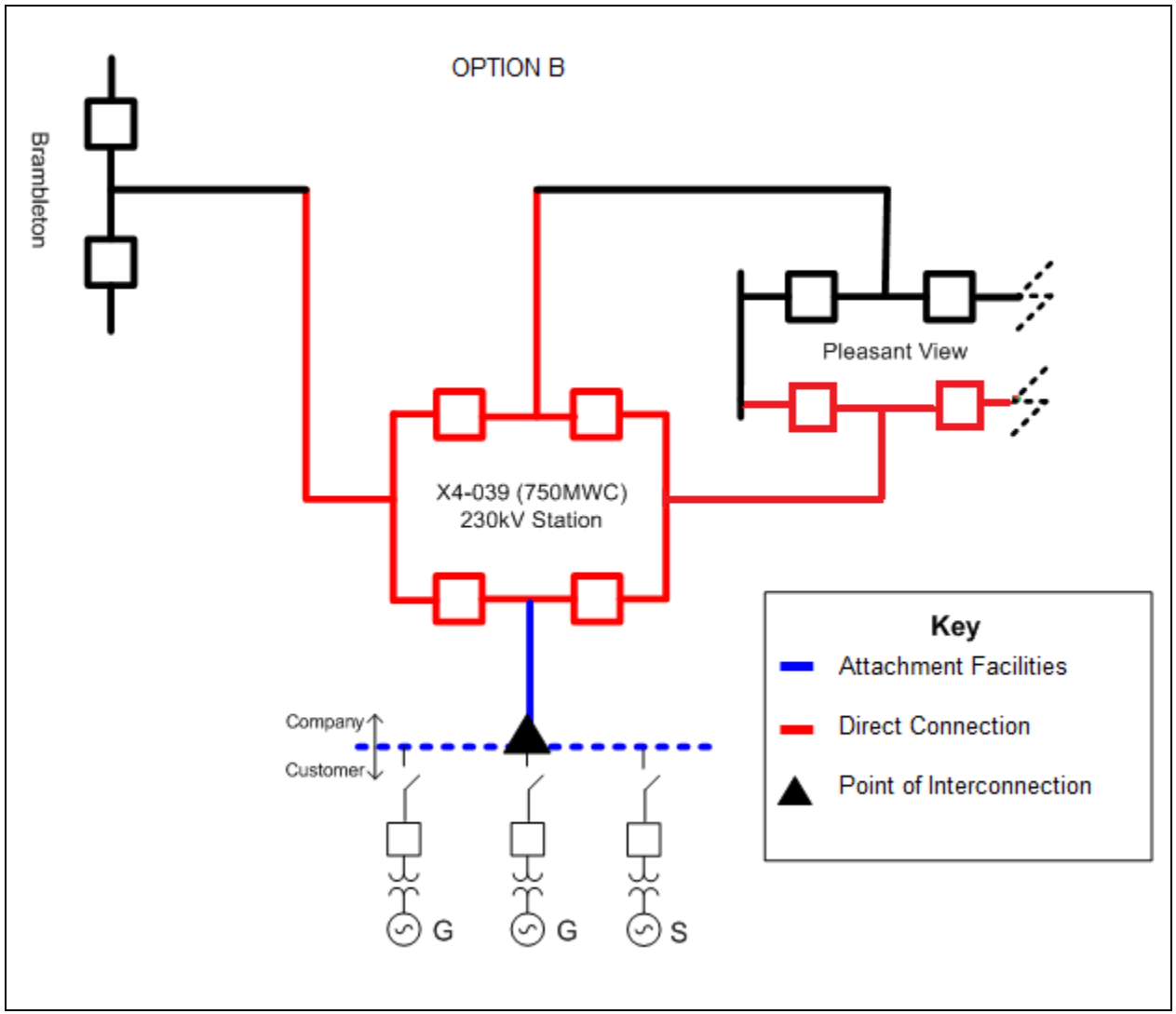
- Non-Direct Option A: Wreck and rebuild approximately one mile of the existing 230kV Line #201 and Line #227 double circuit transmission line between Cohran Mill Substation and Pleasant View Substation for a higher capacity of approximately 1386 MVA. This is estimated to cost $2.0 Million dollars and is expected to take 24 to 36 months to complete.

- Non-Direct Option B: In order to accommodate a new 230kV transmission line at Pleasant View, it will be necessary to expand the existing 230kV substation, rearrange the existing six breaker 230kV ring bus to a six breaker 230kV breaker-and-a-half bus, and install three new 230kV circuit breakers in a breaker-and-a-half bus arrangement. If it is possible to use conventional switchgear, the proposed rearrangement and installation of these breakers and associated equipment is estimated to cost $15 million and take 24 to 36 months to complete. However, due to space limitations it is possible that these new facilities will need to be Gas Insulated Switchgear (GIS). If GIS is required, the installation of these breakers and associated equipment is estimated to cost $30 million and take 24 to 36 months to complete.

If IC elects to move forward with option 1, the two alternatives will be evaluated further at the System Impact Study.

Primary Option One-line:





Secondary Option:

The following contingencies resulted in overloads for the secondary option:

Option 2 Impactful Contingencies	
Contingency Name	**File Description**
LN 201	CONTINGENCY 'LN 201' /* BRAMBLETON - PLEASANT VIEW(NORTHERN 201) OPEN BRANCH FROM BUS 314171 TO BUS 314170 CKT 2 /* BRAMBLETON COCHRAN MILL DP OPEN BRANCH FROM BUS 314170 TO BUS 314072 CKT 2 /* COCHRAN MILL DP PLEASANT VIEW END
227&274_X4-039A	CONTINGENCY '227&274_X4-039A' /* LN 227 & 274 PLEASNT VIEW - BEAUMEADE OPEN BRANCH FROM BUS 314171 TO BUS 912290 CKT 1 /* 227 BRAMBLETON - ASHBURN OPEN BRANCH FROM BUS 314006 TO BUS 314010 CKT 1 /* 227 ASHBURN - BEAUMEADE OPEN BRANCH FROM BUS 314072 TO BUS 314004 CKT 1 /* 274 PLEASNT VIEW - ASHBURN OPEN BRANCH FROM BUS 314004 TO BUS 314010 CKT 1 /* 274 ASHBURN - BEAUMEADE END
AP_C5_19	CONTINGENCY 'AP_C5_19' /BRIGHTON LOOP - WITH PATH OPEN BRANCH FROM BUS 200003 TO BUS 235632 CKT 1 OPEN BRANCH FROM BUS 200003 TO BUS 235632 CKT 2 END

Network Impacts:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

X4-039 Opt. 2 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
001	Non	Non	PJM	01KEMPTOWN-EMORY GR500 500 kV line	235632	200101	1	DC	99.61	105.53	NR	2338	118.58
002	Non	Non	PJM	01KEMPTOWN-EMORY GR500 500 kV line	235632	200101	1	DC	99.61	105.54	NR	2338	118.58
003	N-1	LN 201	Dominion	X4-039 TAP-6ASHBRNA 230 kV line	912290	314006	1	DC	67.02	131.36	NR	470	302.42

For X4-039 option 1 overload 001 and 002, the two breaker bay at Conastone for the Brighton line is over the continuous rating. Upgrade Conastone bay with two 4000A breakers, four 4000A breaker disconnects and a 4000 A line switch need to be either. $3M take 24-36 months to complete. New rating 3710 MVA.

For item X4-039 option 2 overload 003 please see the discussion of Option 2 below in the ITO analysis section. The overload of 230kV transmission Line #227 section from Cohran Mill to Ashburn is identified, and the feasible solutions are discussed.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

X4-039 Opt. 2 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
004	DCTL	227&274_X4-039A	Dominion	6BRAMBL-6GREENW 230 kV line	314171	314098	1	DC	99.31	100.02	NR	948	41.54

The X4-039 option 2 overload 004 overload of 230kV transmission Line #2095 section from Brambleton to Greenway identified above will be resolved when the proposed PJM Baseline Project # b1503.1, b1503.2, b1503.3, b1503.4 is constructed. The in-service target date is November 2013.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. “Network Impacts”, identified for earlier generation or transmission interconnection projects in the PJM Queue.)

X4-039 Opt. 2 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
005	DCTL	AP_C5_19	PJM	01KEMPTOWN-EMORY GR500 500 kV line	235632	200101	1	DC	104.43	107.91	NR	2901	100.95
006	DCTL	AP_C5_19	PJM	01KEMPTOWN-EMORY GR500 500 kV line	235632	200101	1	DC	104.43	107.91	NR	2901	100.95

For items X4-039 option 2 overload 005 and 006, are mitigated by option 001 upgrade.

Short Circuit

(Report over-dutied breakers.)

Analysis found new breakers for the secondary option to be over-duty in the ITO transmission area.

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With X4-039_DOM_opt2	Duty Percent Without X4-039_DOM_opt2	Duty Percent Difference	Note
314072	PLEASANTVIEW 230.kV	H1T201	S	120.40%	99.00%	21.40%	New Over-duty
314072	PLEASANTVIEW 230.kV	203T274	S	117.60%	89.40%	28.20%	New Over-duty
3070	BRAMBLETON 230.kV	20102	S	112.60%	95.50%	17.10%	New Over-duty
3070	BRAMBLETON 230.kV	201T2045	S	112.60%	96.00%	16.60%	New Over-duty
314061	LOUDOUN 230.kV	L152	S	106.70%	99.60%	7.10%	New Over-duty
314061	LOUDOUN 230.kV	L252	S	106.70%	99.60%	7.10%	New Over-duty
42	OX 230.kV	206342	S	101.10%	99.70%	1.40%	New Over-duty
314074	POSSUM POINT 230.kV	202292	S	100.40%	99.80%	0.60%	New Over-duty
314074	POSSUM POINT 230.kV	252T2022	S	100.40%	99.80%	0.60%	New Over-duty
314074	POSSUM POINT 230.kV	21592	S	100.10%	99.50%	0.60%	New Over-duty
314072	PLEASANTVIEW 230.kV	H1T274	S	123.70%	101.50%	22.20%	Over 100%, > 3% contribution
125	LOUDOUN CAP 230.kV	SC352	S	118.90%	113.00%	5.90%	Over 100%, > 3% contribution
1371	PLEASANT CAP 230.kV	SC322	S	118.40%	101.50%	16.90%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	200852	S	116.30%	109.10%	7.20%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	2008T2094	S	116.30%	109.10%	7.20%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	29552	S	115.00%	107.50%	7.50%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	295T2030	S	115.00%	107.50%	7.50%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	204552	S	113.80%	108.10%	5.70%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	209452	S	113.80%	108.10%	5.70%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	WT2045	S	113.80%	108.10%	5.70%	Over 100%, > 3% contribution
3070	BRAMBLETON 230.kV	2045T2095	S	113.20%	100.70%	12.50%	Over 100%, > 3% contribution
3070	BRAMBLETON 230.kV	2094T2095	S	113.20%	100.70%	12.50%	Over 100%, > 3% contribution
314061	LOUDOUN 230.kV	203052	S	110.30%	102.70%	7.60%	Over 100%, > 3% contribution
3070	BRAMBLETON 230.kV	227T2094	S	109.90%	102.70%	7.20%	Over 100%, > 3% contribution
3070	BRAMBLETON 230.kV	22702	S	109.80%	102.70%	7.10%	Over 100%, > 3% contribution
314913	LOUDOUN 500.kV	H1T569	S	106.70%	102.40%	4.30%	Over 100%, > 3% contribution
314913	LOUDOUN 500.kV	H2T558	S	106.70%	102.40%	4.30%	Over 100%, > 3% contribution
314913	LOUDOUN 500.kV	H2T559	S	106.70%	102.40%	4.30%	Over 100%, > 3% contribution

- The estimated cost to replace two overdutied 230 kV breakers H1T201 and 203T274 at Pleasant View substation with 63 kA breakers will be $205,000 per breaker and will take 12 months including equipment order time.
- The estimated cost to replace two overdutied 230 kV breakers L152 and L252 at Loudoun substation with 63 kA breakers will be $205,000 per breaker and will take 12 months including equipment order time.
- The estimated cost to replace two overdutied 230 kV breakers 20102 and 201T2045 at Brambleton substation with 63 kA breakers will be $205,000 per breaker and will take 12 months including equipment order time.
- The estimated cost to replace one overdutied 230 kV breaker 206342 at Ox substation with 63 kA breaker will be $205,000 and will take 12 months including equipment order time.
- The estimated cost to replace four overdutied 230 kV breakers 202292, 252T2022, 21592 and G5T215 at Possum Point substation with 80 kA breakers will be $500,000 per breaker and will take 22 months including equipment order time.
- For the all of the contribution breakers, PJM will provide allocations if any at the System Impact Study:

    - Breakers 203052, SC352, 200852, 2008T2094, 209452, WT2045,29552, 295T2030, 22702, 227T2094 appear to be baseline projects, which this queue will not have to contribute, however, the project may have to advance them if the project in-service date is in advance of the baseline project. The baselines are respectively: b0328.5, b0888, b1188.1, b1188.2, b1188.4, b1188.5, b1538, b1651, b1809, b1810; and
    - Breakers H1T569, H2T558, H2T559, H1T274, SC322, 204552, 2045T2095, 2094T2095 appear to be caused by X3 projects; this determination requires retool of the X3-case, which will occur at the System Impact Study. If these all were to become higher-order queue project(s) responsibility, X4-039 would receive an allocation. It is estimated that each breaker will cost $205,000 and take 12 months to replace.

ITO Analyses

ITO assessed the impact of the proposed queue X4-039 interconnection as a 800 MW Energy (750 MW Capacity) injection on to the ITO system. The system was assessed using the summer 2015 RTEP case provided to ITO by PJM, where the proposed generation capacity was injected on ITO 230kV transmission system. For secondary option, the proposed generation capacity was injected at Cohran Mill on the 230kV transmission line between the Pleasant View and Brambleton substations and at Cohran Mill on the transmission line between the Ashburn and Brambleton substations. This analysis did include the impacts of the generation output for all higher order queue generators within the ITO system. When performing a generation analysis, ITO main analysis will be load flow study results under single contingency (both normal and stressed system conditions) and import/export system conditions. ITO criterion considers a transmission facility overloaded if it exceeds 94% of its emergency rating under normal and stressed system conditions. For import/export studies ITO considers a transmission facility overloaded if it exceeded 100% of its emergency rating. A full listing of ITO planning criteria and interconnection requirements can be found in the ITO facility connection requirements which are publicly available at: http://www.dom.com.

For the secondary option, the proposed generation capacity was injected at Cohran Mill on the 230kV transmission line between the Pleasant View and Brambleton substations and at Cohran Mill on the transmission line between the Ashburn and Brambleton substations. As part of its generation impact analysis Dominion routinely evaluates the impact that a proposed new generation resource will have under maximum generation conditions and stressed system conditions. For the X4-039 secondary option evaluation, three different assessments were conducted.

1. The first being when local generation including the proposed X4-039 Facility is operated at their maximum capability. The result of this study is shown below in Table E.

Table E: PMax System Conditions

Overloaded Element	Cont. Loading (MVA)	Base Loading (MVA)	Rating (MVA)	Cont. Loading (%)	Contingency Description
314072 6PL VIEW 230 314170 6COHMIL 230 2	1008.8	718.6	1057.0	95.4	314072 6PL VIEW 230 314925 8PL VIEW 500 1
314072 6PL VIEW 230 314170 6COHMIL 230 2	***1139.0***	718.6	1057.0	***107.8***	314925 8PL VIEW 500 314933 8BRAMBLETON 500 1
314006 6ASHBRNA 230 314170 6COHMIL 230 1	451.9	337.0	470.0	96.1	314004 6ASHBURN 230 314010 6BEAMEAD 230 1
314006 6ASHBRNA 230 314170 6COHMIL 230 1	449.6	337.0	470.0	95.7	314004 6ASHBURN 230 314072 6PL VIEW 230 1
314006 6ASHBRNA 230 314170 6COHMIL 230 1	***644.0***	337.0	470.0	***137.0***	314072 6PL VIEW 230 314170 6COHMIL 230 2

As shown above in Table e, the impact of the X4-039 generator under single contingency conditions results in:

a. Thermal overload of the 230kV transmission Line #201 section from Cohran Mill to Pleasant View for the N-1 outage of the Pleasant View 500/230kV transformer.

b. Thermal overload of the 230kV transmission Line #201 section from Cohran Mill to Pleasant View for the N-1 outage of the 500kV transmission Line #558 from Pleasant View to Brambleton.

c. Thermal overload of the 230kV transmission Line #227 section from Cohran Mill to Ashburn for the N-1 outage of the 230kV transmission Line #274 from Pleasant View to Beaumeade.

d. Thermal overload of the 230kV transmission Line #227 section from Cohran Mill to Ashburn for the N-1 outage of the 230kV transmission Line #201 section from Cohran Mill to Pleasant View.

2. The second being a stressed system condition where the largest generator in the area is unavailable. With the X4-039 generator geographically located in Northern Virginia, Possum Pt. Unit #5 is considered the most critical generating unit in the area. The impact of X4-039 was studied with the outage of Possum Point Unit #5. The result of this study is shown below in Table F.

Table F: Stressed System Conditions

Overloaded Element	Cont. Loading (MVA)	Base Loading (MVA)	Rating (MVA)	Cont. Loading (%)	Contingency Description
314072 6PL VIEW 230 314170 6COHMIL 230 2	***1084.8***	683.4	1057.0	***102.6***	314925 8PL VIEW 500 314933 8BRAMBLETON 500 1
314006 6ASHBRNA 230 314170 6COHMIL 230 1	445.6	356.7	470.0	94.8	313805 6SHELLHORN1 230 314098 6GREENWAY1 230 1
314006 6ASHBRNA 230 314170 6COHMIL 230 1	457.3	356.7	470.0	97.3	313805 6SHELLHORN1 230 314171 6BRAMBL 230 1
314006 6ASHBRNA 230 314170 6COHMIL 230 1	***485.0***	356.7	470.0	***103.2***	314004 6ASHBURN 230 314010 6BEAMEAD 230 1
314006 6ASHBRNA 230 314170 6COHMIL 230 1	***483.2***	356.7	470.0	***102.8***	314004 6ASHBURN 230 314072 6PL VIEW 230 1
314006 6ASHBRNA 230 314170 6COHMIL 230 1	***650.8***	356.7	470.0	***138.5***	314072 6PL VIEW 230 314170 6COHMIL 230 2

As shown above in Table F, the impact of the X4-039 generator under single contingency conditions results in:

a. Thermal overload of the 230kV transmission Line #201 section from Cohran Mill to Pleasant View for the N-1 outage of the 500kV transmission Line #558 from Pleasant View to Brambleton.

b. Thermal overload of the 230kV transmission Line #227 section from Cohran Mill to Ashburn for the N-1 outage of the 230kV transmission Line #2137 from Brambleton to Beco with load restored from Beco.

c. Thermal overload of the 230kV transmission Line #227 section from Cohran Mill to Ashburn for the N-1 outage of the 230kV transmission Line #274 from Pleasant View to Beaumeade.

d. Thermal overload of the 230kV transmission Line #227 section from Cohran Mill to Ashburn for the N-1 outage of the 230kV transmission Line #201 section from Cohran Mill to Pleasant View.

3. The third being import and export conditions into and out of the Dominion System. Any new facility that is interconnected with the Dominion System should not significantly decrement First Contingency Incremental Transfer Capability between utilities. The results of these studies can be found in Tables G and H.

Table G: Import Study Results

Import Study Results			
Area	**Summer 2015**	**Summer 2015 with X4-039**	**Limiting Element**
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

Table H: Export Study Results

Export Study Results			
Area	**Summer 2015**	**Summer 2015 with X4-039**	**Limiting Element**
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

ITO planning criteria indicates a need to have approximately 2000 MW of import and export capability. The results of these import and export studies are indicate that the proposed generation facility will not impact Dominion's import or export capability. **Note the results for the studies with X4-039 included are based on the proposed reliability deficiencies noted below. Since facilities are overloaded for single contingency conditions the First Contingency Incremental Transfers would be negative without the inclusion of these proposed solutions.

Required Interconnection Facilities:

The Network Upgrade options identified to resolve the overload of the 230kV transmission Line #201 section from Cohran Mill to Pleasant View associated with the X4-039 interconnection Option 2 are identical to the Network Upgrade options identified above for option 1. Please see the descriptions and estimated costs above.

Should the Non-Direct Option A be constructed to resolve the overload of the Line #201 section from Cohran Mill to Pleasant View, it would also resolve the overload identified on the 230kV transmission Line #227 section from Cohran Mill to Pleasant View.

Should the Direct Connection option 1B be elected to resolve the overload of the Line #201 section from Cohran Mill to Pleasant View, it would be necessary to reconductor approximately one mile of Line #227 between Cohran Mill and Ashburn to achieve a capacity of approximately 795MVA. The estimated cost to reconductor one mile section of Line #227 from Cohran Mill to Ashburn is approximately $400,000 dollars and is expected to take 24 months to complete. This addresses X4-039 option 2 overload 003. The transmission line structures will need to be evaluated to ensure they can accommodate the new conductor.

Attachment Facilities:

Figures C and D below illustrate the proposed layout and attachment facilities for the X4-039 secondary option interconnection. Figure C illustrates the layout of X4-039 secondary option with the Non-Direct Connection network upgrade option 1A and Figure D illustrates the layout of X4-039 secondary option with the network upgrade option 1B.

The estimated cost of these Attachment Facilities which includes metering, protection equipment along with one 0.5 mile 230kV line is $1.0 Million dollars and is estimated to take 24 to 30 months to complete.

If the customer would like to separate the gas and steam units, it will require one additional 230kV breaker plus one additional 0.5 mile 230kV transmission line with associated metering and protection equipment. The estimated cost of these additional Attachment Facilities is $1.8 Million dollars and is estimated to take 24 to 30 months to complete.

Direct Connection Network Facilities:

The Direct Connect Network Facilities needed to reliably interconnect the proposed generation with the Dominion Transmission System for X4-039 secondary are as follows:

- For X4-039 secondary option with Non-Direct Connection Upgrade option 1A, it will be necessary to build an eight breaker 230kV breaker-and-a-half bus at the customer's site as shown below in Figure C. The 230kV transmission Line #201 (Pleasant View to Brambleton) and transmission Line #227 (Brambleton to Beaumeade) will then be looped (approximately 0.5 miles) into the new 230kV switching substation as shown in the Figure C below. The estimated cost of this work is $8.0 million and is estimated to take 24 to 36 months.

- For X4-039 secondary option with Direct Connection Upgrade option 1B, it will be necessary to build a nine breaker 230kV breaker-and-a-half bus at the customer's site as shown below in Figure D. The 230kV transmission Line #201 (Pleasant View to Brambleton) and transmission Line #227 (Brambleton to Beaumeade) will then be looped (approximately 0.5 miles) into the new 230kV switching substation as shown in the Figure D below. The estimated cost of this work is $8.8 Million and is estimated to take 24 to 36 months.

Secondary Option One-line: