



Market Efficiency Update

Transmission Expansion Advisory Committee
December 14, 2017



- 2016/17 RTEP Window Status Update
- Reactive Proposals Group
- BGE Group Preliminary Results
- PPL Analysis Update
- Acceleration Analysis Update

2016-2017 Long Term Window

- Market Efficiency Base Case Event File Update
 - Added BGE flowgates resulted from contingency analysis across all BGE proposals
 - The added flowgates are not binding in the base case but may be binding in the project cases.
- Analysis of proposed solutions
 - RPM Projects analysis (completed)
 - Interregional Projects analysis (completed)
 - Reactive Proposals Group (completed)
 - PPL projects analysis (90% completed)
 - BGE projects in-progress
 - All other regional projects will be analyzed only if there is a congestion driver in the current base case.
- Target determination of recommended projects: Feb 2018

Reactive Proposals Group



Group 07A – PJM Interfaces (Reactive Proposals)

- **14 Projects:**

- 1-8A, 1-8B, 1-8C, 1-8D, 1-8E, 1-8F, 1-8G, 1-8H, 1-8I, 1-8J, 1-8K, 1-8Q, 1-18K, 1-18L

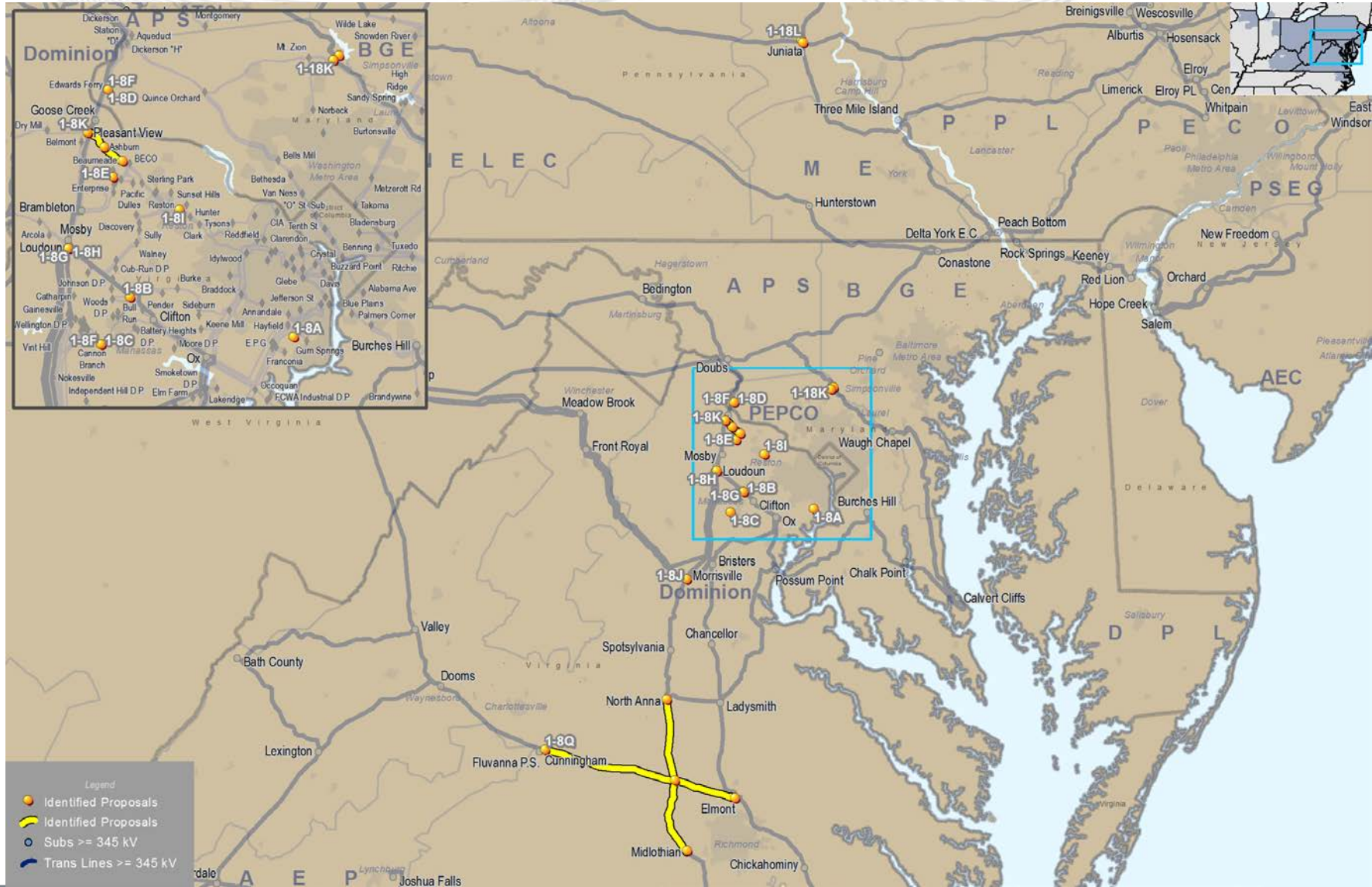
- **Cost:**

- From \$1.82 M to \$49.25 M

- **ME Constraints:**

- I:AP SOUTH
- I:AEP-DOM
- I:5004/5005
- I:BC_PEP
- I:CENTRAL

- Descriptions of submitted proposals included in Appendix A

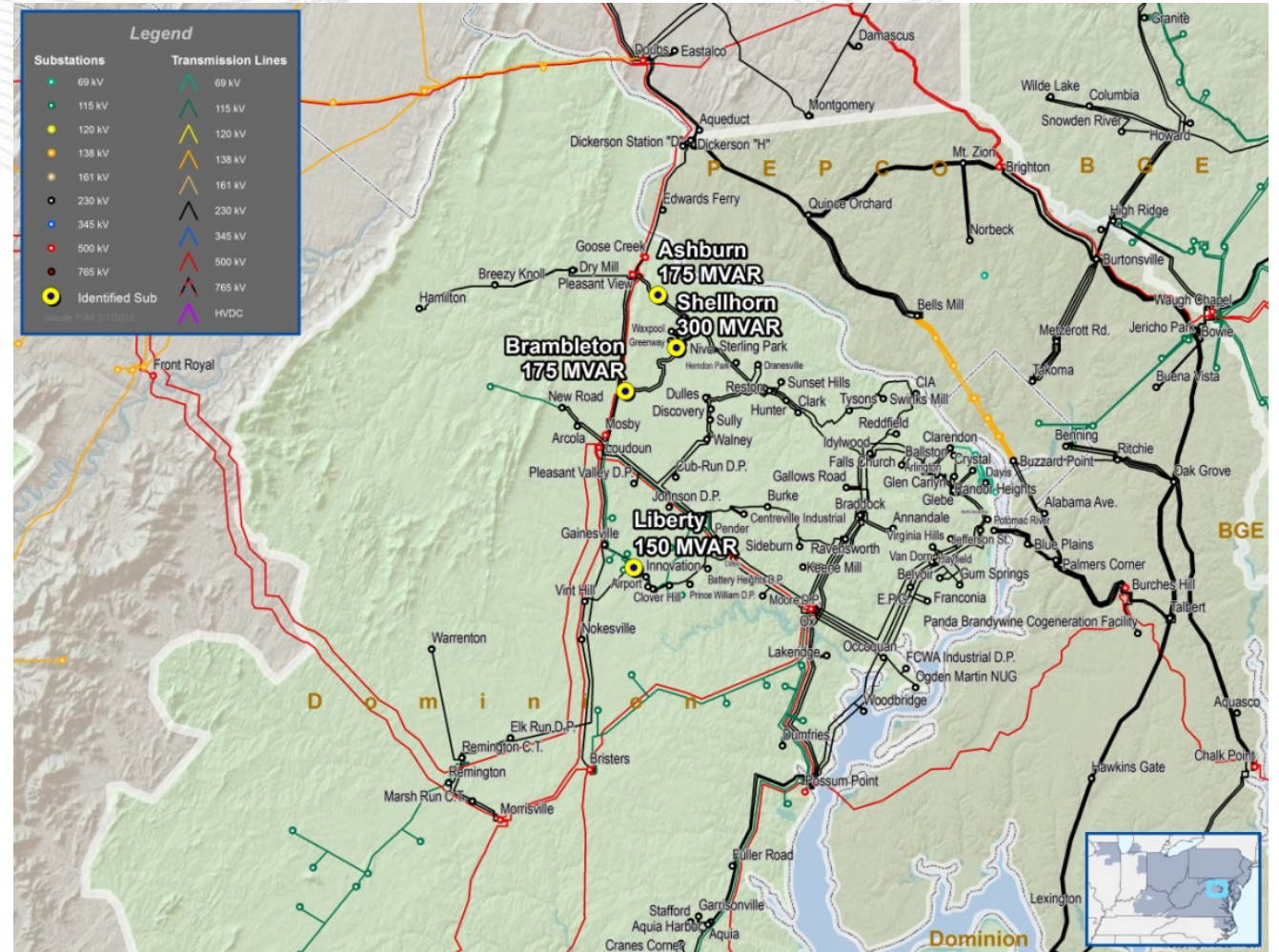


- Optimal Capacitor Configuration already approved during previous RTEP Window
 - At the February 2017 Board meeting PJM approved a capacitor configuration that provided high market congestion benefits and high reliability, while allowing for optimal operational impact (see next slide for details)
- Excess capacitors not practical to implement in PJM Operations
 - Many existing capacitors can't be turned on in PJM Operations because of high voltage problems
 - Some of the proposed capacitor locations already in areas where existing capacitors are located
- PJM is not currently recommending any reactive proposals to be included in the RTEP.

Optimal Capacitor Configuration*	
Bus	Capacitor Size (MVAR)
Brambleton substation	175
Ashburn substation	175
Shelhorn substation	300
Liberty substation	150
Total	800

*Includes recently approved RTEP project +/- 450 MVAR SVC at Jacksons Ferry 765 kV substation (B2687.1)

- ISD: 2019
- Costs: \$8.98 million
- B/C ratio: 15.4



BGE Group Preliminary Results

- Completed the base runs for 46 proposals received from 9 entities.
 - Projects modeled using the submitted assumptions
 - B/C ratios computed using the submitted in-service cost of components
- Results were presented at November 2017 TEAC*
 - More than half of the proposals did not pass the B/C ratio threshold
 - Some proposals did not fully address the congestion driver or shifted congestion downstream.
 - The highest B/C ratios were achieved by the upgrade proposals.

* <http://www.pjm.com/-/media/committees-groups/committees/teac/20171109/20171109-teac-market-efficiency-update.ashx>

- PJM will focus the analysis on determining the optimal upgrade configuration.
- Once the optimal upgrade configuration is determined, PJM will include it in the base case.
- If any congestion is shifted as result of the upgrade, then PJM will consider other proposals to address the shifted congestion.
- Other steps
 - Finalize Cost/Constructability Analysis
 - Finalize Reliability Analysis
 - Run sensitivities on gas and load forecasts
- Target for project approval is February board meeting.

PPL Group Evaluation

- Congestion driver decreased significantly due to lower load forecast and changes in generation expansion.
- Most of the SUSQ-HARW congestion is driven by PPL FSA units:
 - Sunbury #2 (AA2-182), 977 MW
 - Good Spring Power CC, 337 MW (withdrew October 2017)

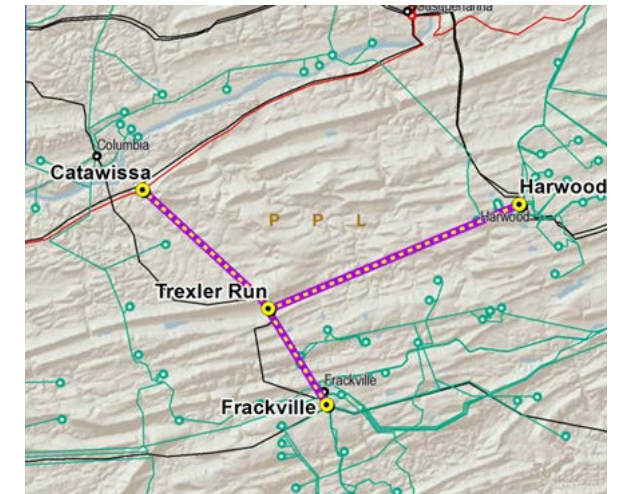
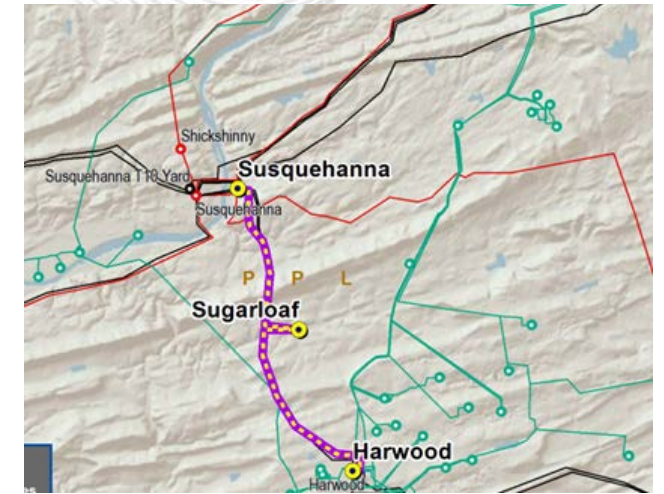
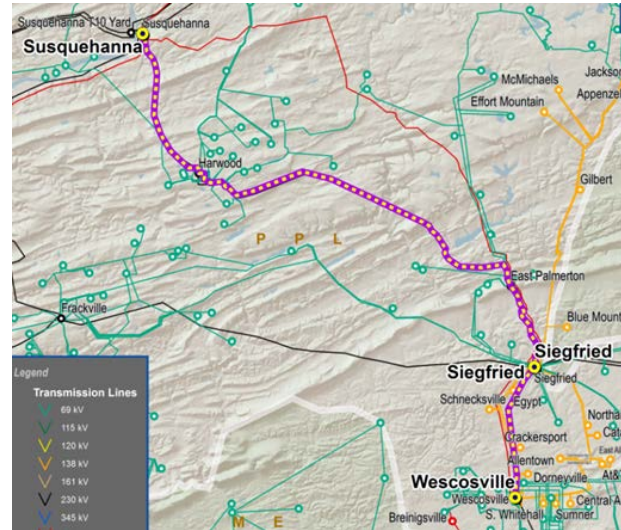
<i>Susquehanna to Harwood 230 kV</i>	<i>2021</i>	<i>2024</i>	
Scenario	Market Congestion (\$ Millions)	Market Congestion (\$ Millions)	Notes
Initial Driver Posted November 2016	\$3.98	\$5.60	Facilities Recommended for Proposals Criteria: \$1 million for 2021 and 2024
Current Base Case (Wescosville Open)	\$2.94	\$2.27	40% congestion decrease compared to initial driver
No FSA Sensitivity (Wescosville Open)	\$1.34	\$0.48	66 % congestion decrease compared to initial driver

Important Note: The No FSA Sensitivity only excluded the PPL FSA units.

It did not exclude New Jersey FSA that are helping decrease the congestion driver SUSQ-HARW.

If the New Jersey FSA Units are removed from the noFSA case, then SUSQ-HARW congestion driver increases.

- Reconductor Susquehanna – Harwood 230 kV line:
 - 2A: PPL, \$13.13M
 - 2B: PPL, \$13.01M
- 500/230 kV Transformer At/Near Siegfried:
 - 2C: PPL, \$18.32M
 - 10A: NextEra, \$33.8M
 - 18G: NTD, \$32.9M
- New Harwood – Trexler Run 230 kV line:
 - 18Q: NTD, \$33.7M



- Analysis comprised 6 projects received from 3 entities:
 - Nextera (1 project), PPL (3 projects), LS Power (2 projects)
- Base Scenarios:
 - Three different Wescosville 230/138 kV operating schemes: normally open, normally closed, normally closed with Operational Procedure.
- Sensitivity Scenarios:
 - No PPL FSA Scenario
 - High/Low Gas Price Forecast (+/- 20%)
 - Low Load Forecast (- 2%)
- Descriptions of submitted proposals included in Appendix B



PPL Group Analysis Details - Sensitivities

- Congestion Driver
 - Both the reconductoring proposal 2A and the new Harwood - Trexler Run 230 kV line fully solve the SUSQ-HARW congestion driver.
- B/C Ratio
 - 2A does not pass the Low Load sensitivity
 - 2C does not pass the Base, Low Load, and High Gas Sensitivities
 - 18Q does not pass the High Gas sensitivity

SUSQ - HARW Residual Congestion After Project In Service Two years, 2021+2024 (\$million)						
	Address Driver?	Base	No PPL FSA	Low Load	Low Gas	High Gas
2A	Completely solves the congestion driver					
2C	Partially solves driver	\$1.07	\$0.29	\$0.79	\$0.07	\$0.76
18Q	Completely solves the congestion driver					

B/C Ratios						
	Address Driver?	Base	No PPL FSA	Low Load	Low Gas	High Gas
2A	Fully solves driver	1.74	6.34	0.78	2.05	3.50
2C	Partially solves driver	0.83	3.02	1.02	1.52	0.81
18Q	Fully solves driver	2.70	2.34	1.63	2.14	1.22

Note: The latest gas forecast from ABB is lower than the gas forecast included in the current Market Efficiency base case.

- Assumed 20% cost increase

20% Cost Increase	B/C Ratios					
	Address Driver?	Base	No PPL FSA	Low Load	Low Gas	High Gas
2A	Fully solves driver	1.45	5.28	0.65	1.71	2.92
2C	Partially solves driver	0.69	2.52	0.85	1.27	0.68
18Q	Fully solves driver	2.25	1.95	1.36	1.78	1.02

- Although the B/C ratios for all projects decreased, the overall conclusions did not change.

- Conclusions
 - SUSQ-HARW congestion driver decreased significantly from the initial values posted at the start of the 2016/17 RTEP Window.
 - Proposal 2C only partially solves the congestion driver. It does not pass the B/C ratio if the Wescosville 230/138 kV transformer is operated as normally open.
 - Both 2A and 18Q fully solve the congestion driver but the B/C ratios are failing under some sensitivities.
- Results may be impacted by the solution selected for the BGE group.
- Further analysis will be performed after completing the BGE group analysis.

Acceleration Analysis

- Scope
 - Determine which reliability upgrades, if any, have an economic benefit if accelerated or modified.
- Study Years
 - 2018 and 2022 set of economic input assumptions used to study impacts of approved RTEP projects
- Process
 - Compare market congestion for near term vs. future topology
 - Estimate economic impact of accelerating planned upgrades

- Currently building the 2018 AS-IS PROMOD model
- Identifying RTEP reliability projects responsible for congestion reductions
- Acceleration analysis results to be presented at the January TEAC

Appendix A – Reactive Proposals Group

Project ID: 201617_1-8A

Proposed by: Dominion

Proposed Solution:
Install a 230 kV shunt capacitor bank at DVP's Belvoir substation.

kV Level: 230 kV

In-Service Cost (\$M): \$3.73

In-Service Date: 2021

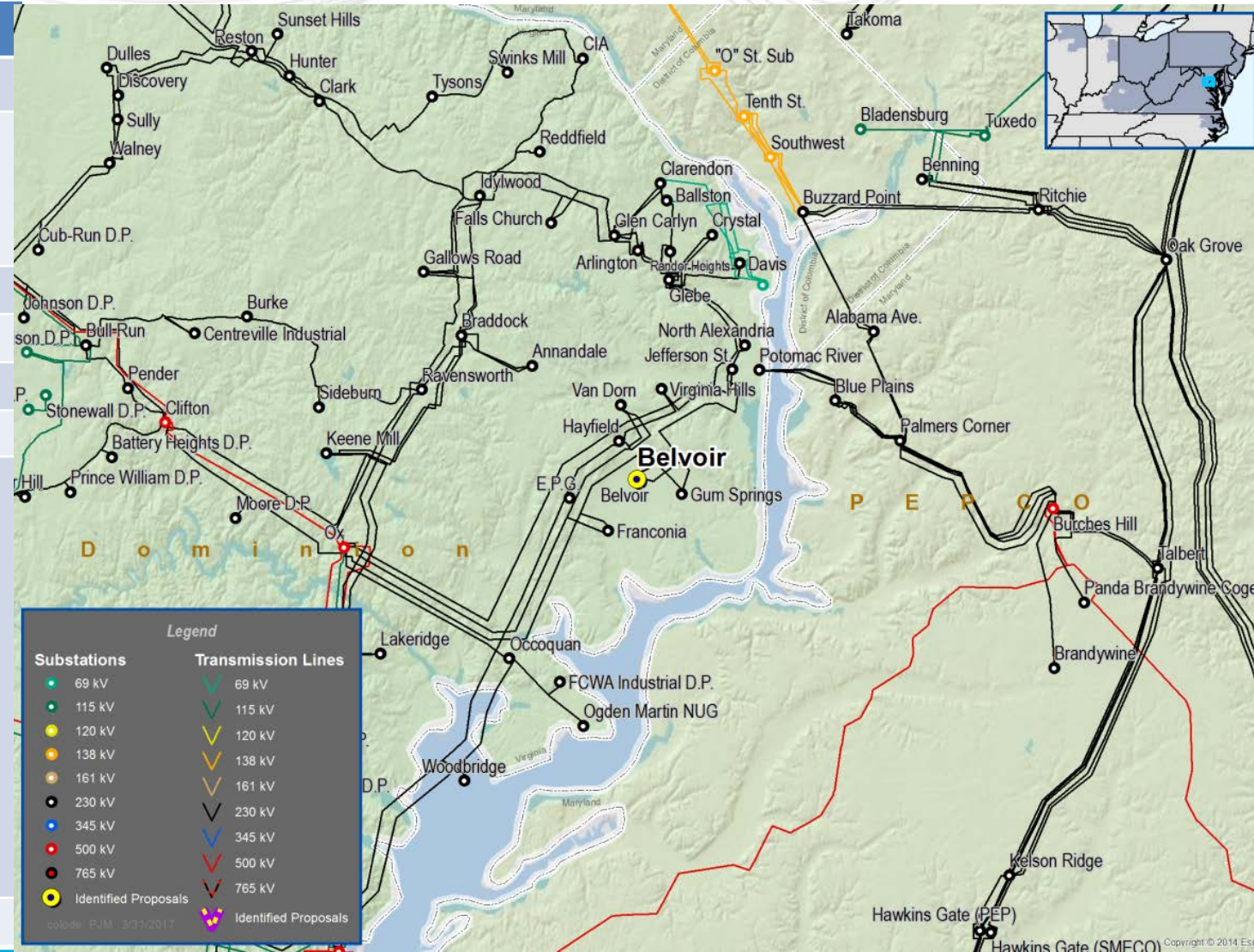
Target Zone: Dominion

ME Constraints:

AP South

AEP-DOM

Notes: **This project is not being recommended**



Project ID: 201617_1-8B

Proposed by: Dominion

Proposed Solution:
Install a 230 kV shunt capacitor bank at DVP's Bull Run substation.

kV Level: 230 kV

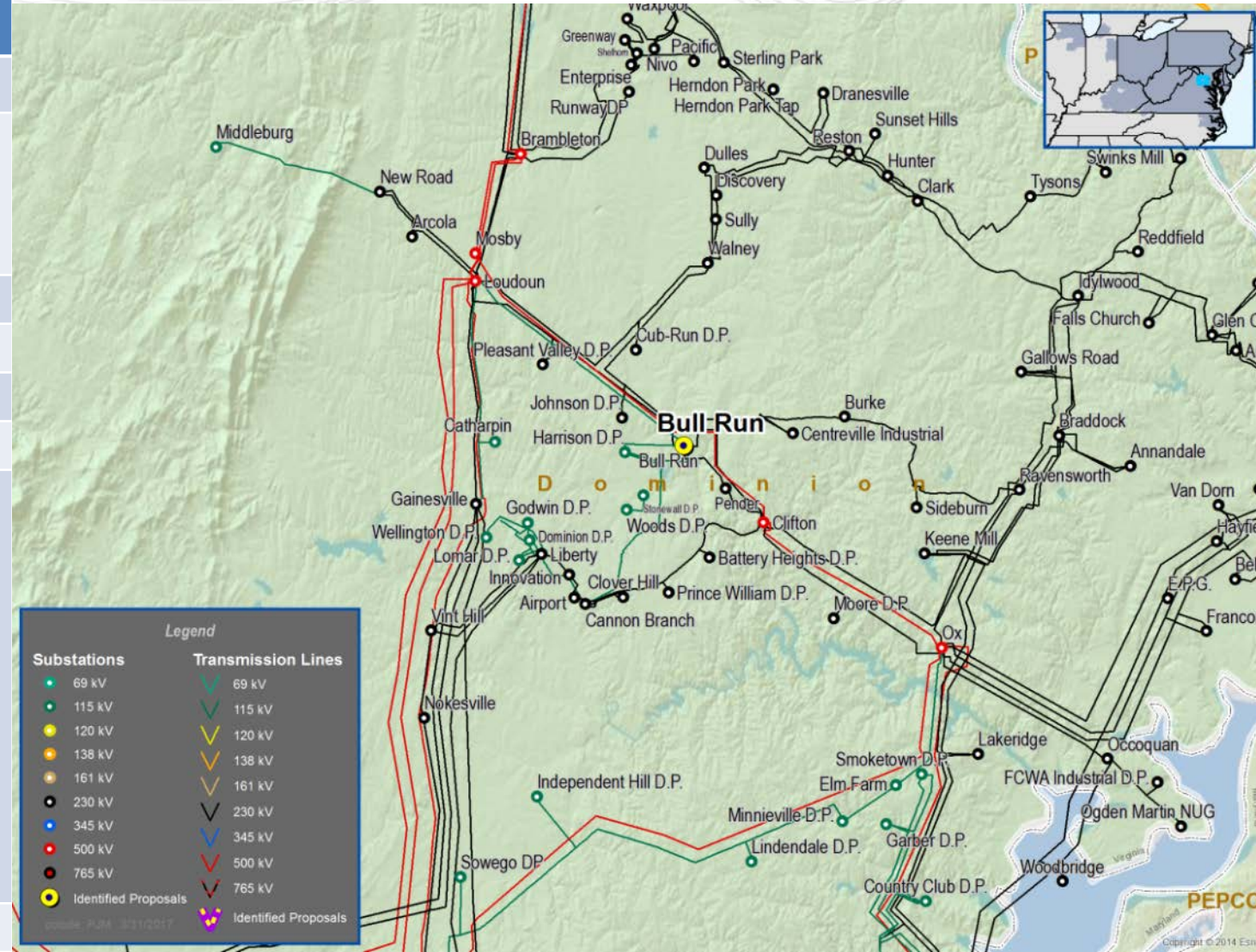
In-Service Cost (\$M): \$4.14

In-Service Date: 2021

Target Zone: Dominion

ME Constraints:
AP South
Central Interface

Notes: **This project is not being recommended**



Project ID: 201617_1-8C

Proposed by: Dominion

Proposed Solution:
Install a 230 kV shunt capacitor bank at DVP's Cannon Branch substation.

kV Level: 230 kV

In-Service Cost (\$M): \$1.82

In-Service Date: 2021

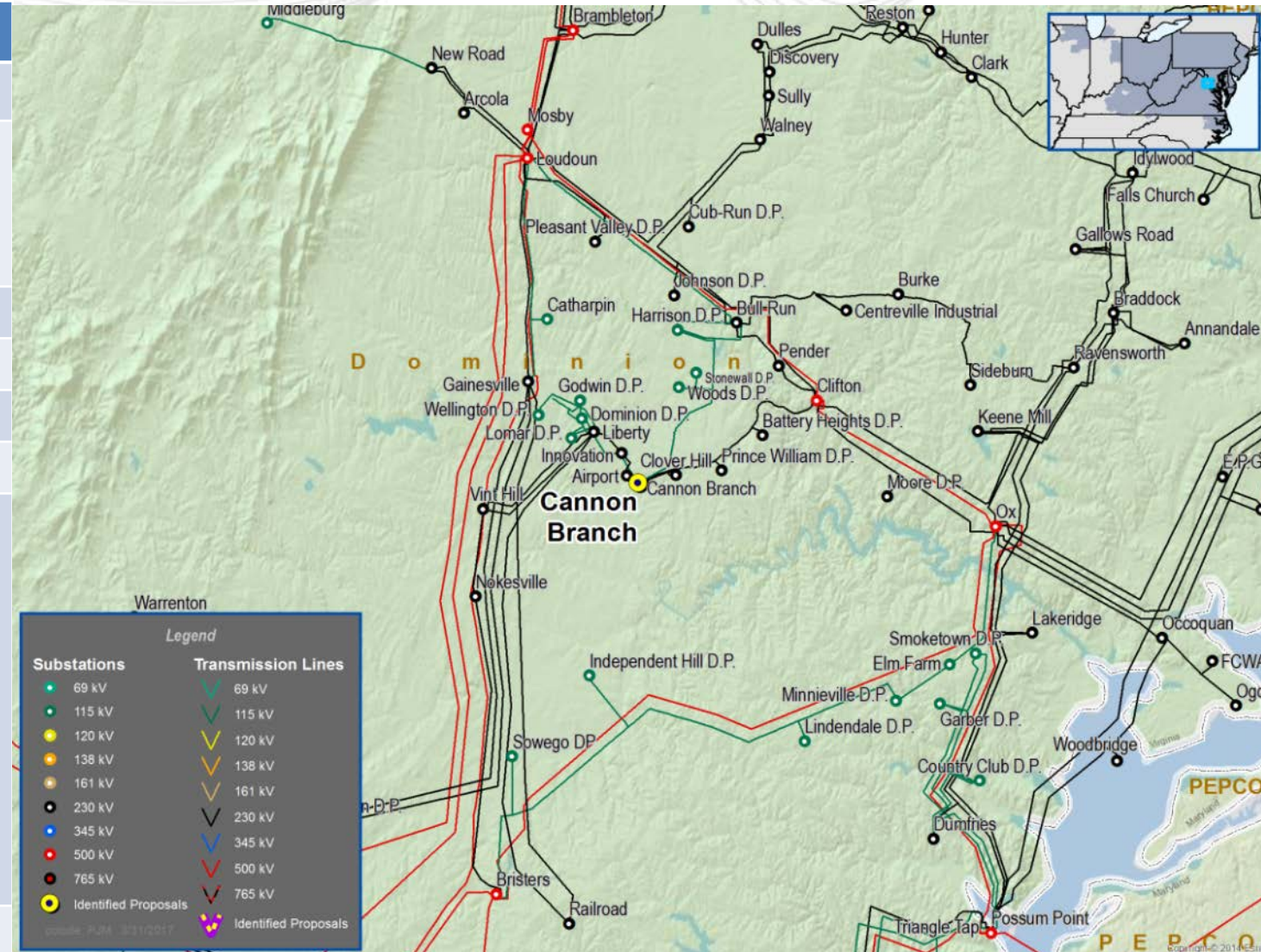
Target Zone: Dominion

ME Constraints:

AP South

AEP-DOM

Notes: **This project is not being recommended**



Project ID: 201617_1-8D

Proposed by: Dominion

Proposed Solution:
Install a 230 kV shunt capacitor bank at DVP's Edwards Ferry substation.

kV Level: 230 kV

In-Service Cost (\$M): \$6.11

In-Service Date: 2021

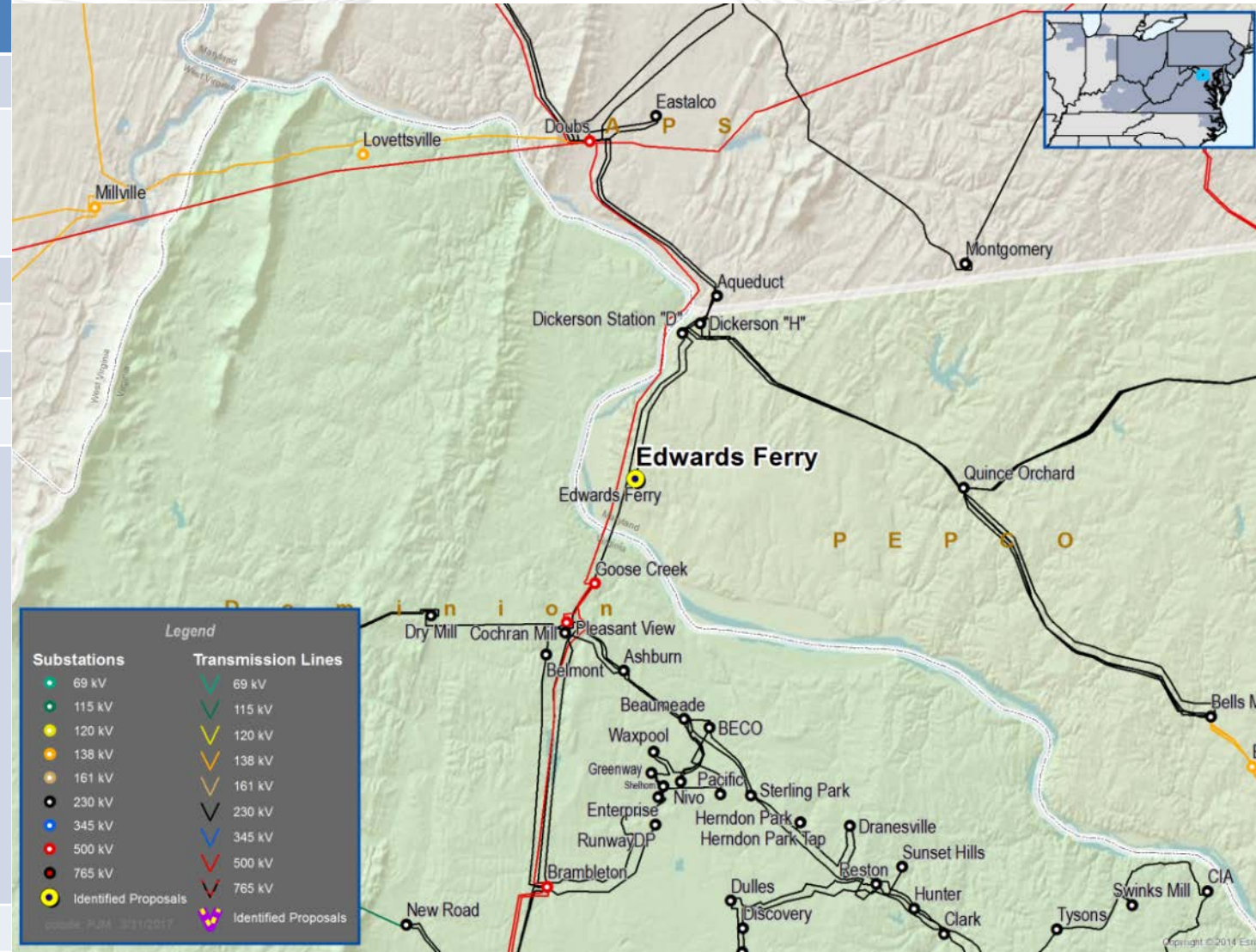
Target Zone: Dominion

ME Constraints:

AP SOUTH

Peach Bottom – Conastone 500kV

Notes: **This project is not being recommended**



Project ID: 201617_1-8E

Proposed by: Dominion

Proposed Solution:
Install a 230 kV shunt capacitor bank at DVP's Greenway substation.

kV Level: 230 kV

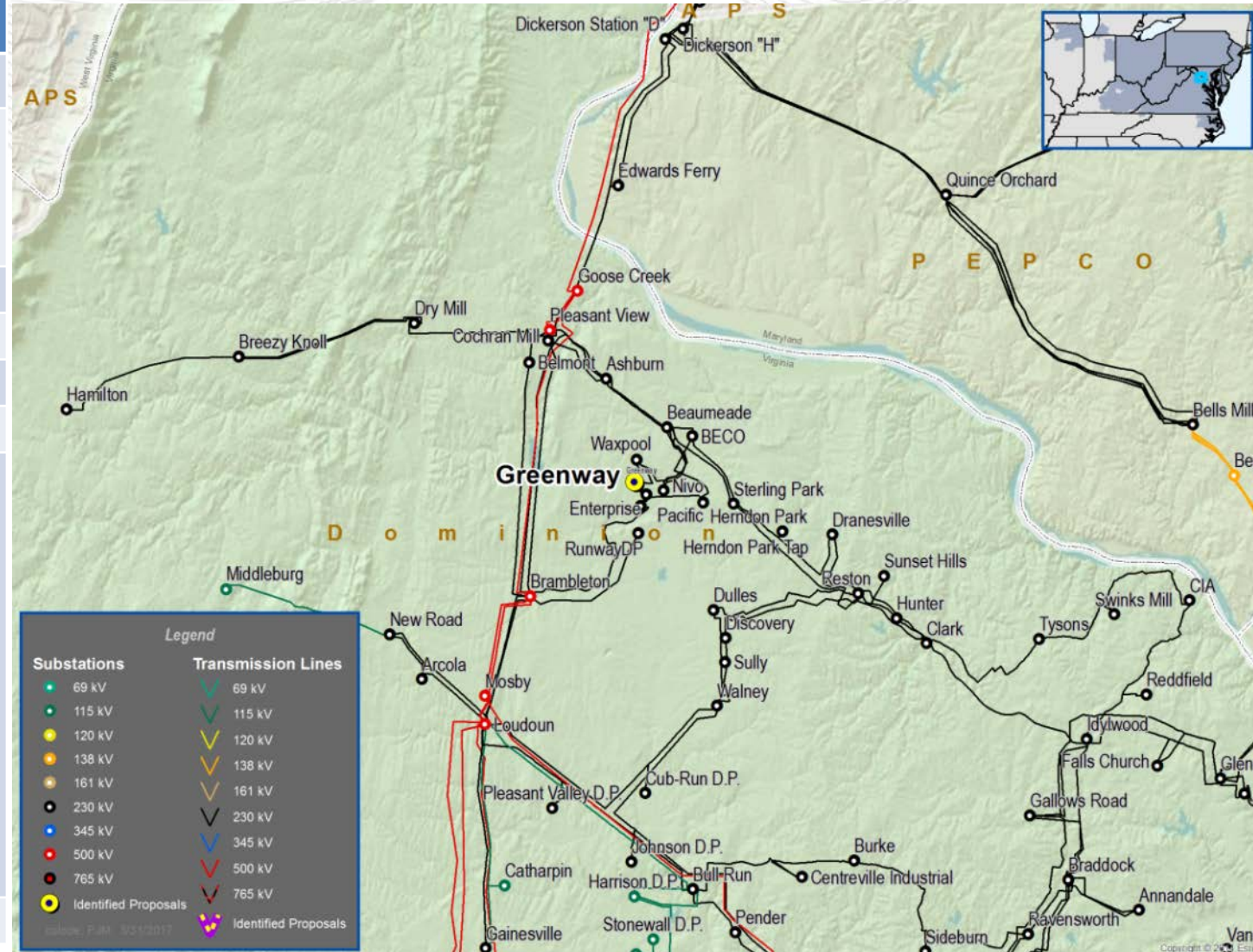
In-Service Cost (\$M): \$3.79

In-Service Date: 2021

Target Zone: Dominion

ME Constraints:
AP South
Central Interface

Notes: **This project is not being recommended**



Project ID: 201617_1-8F

Proposed by: Dominion

Proposed Solution:
Install 230 kV shunt capacitor banks at four (4) DVP's substations: Edwards Ferry, Greenway, Belvoir and Cannon Branch.

kV Level: 230 kV

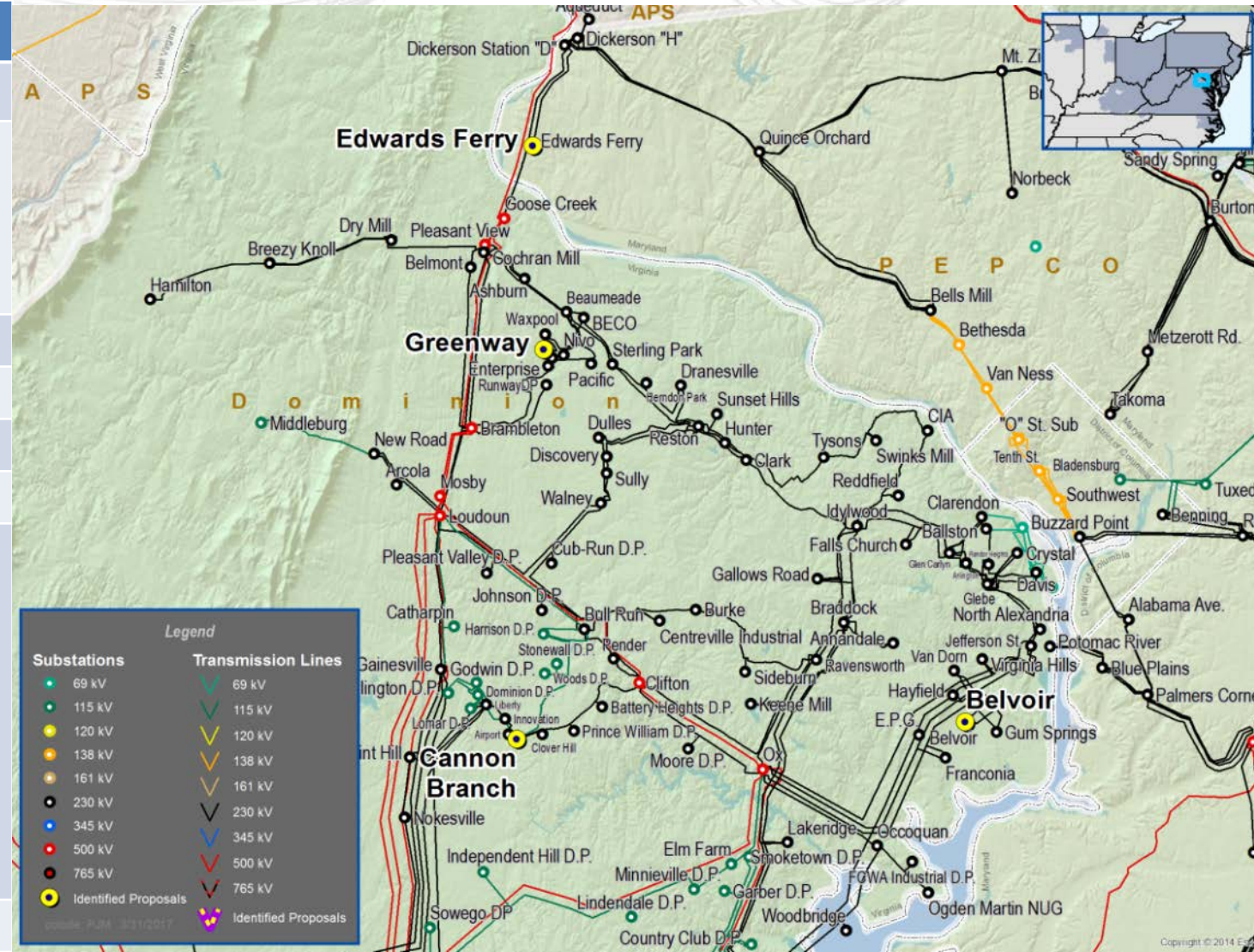
In-Service Cost (\$M): \$15.45

In-Service Date: 2021

Target Zone: Dominion

ME Constraints:
AP South
Central Interface

Notes: **This project is not being recommended**



Project ID: 201617_1-8G

Proposed by: Dominion

Proposed Solution:
Install 230 kV shunt capacitor banks at three (3) DVP's substations: Bull Run, Loudoun and Reston.

kV Level: 230 kV

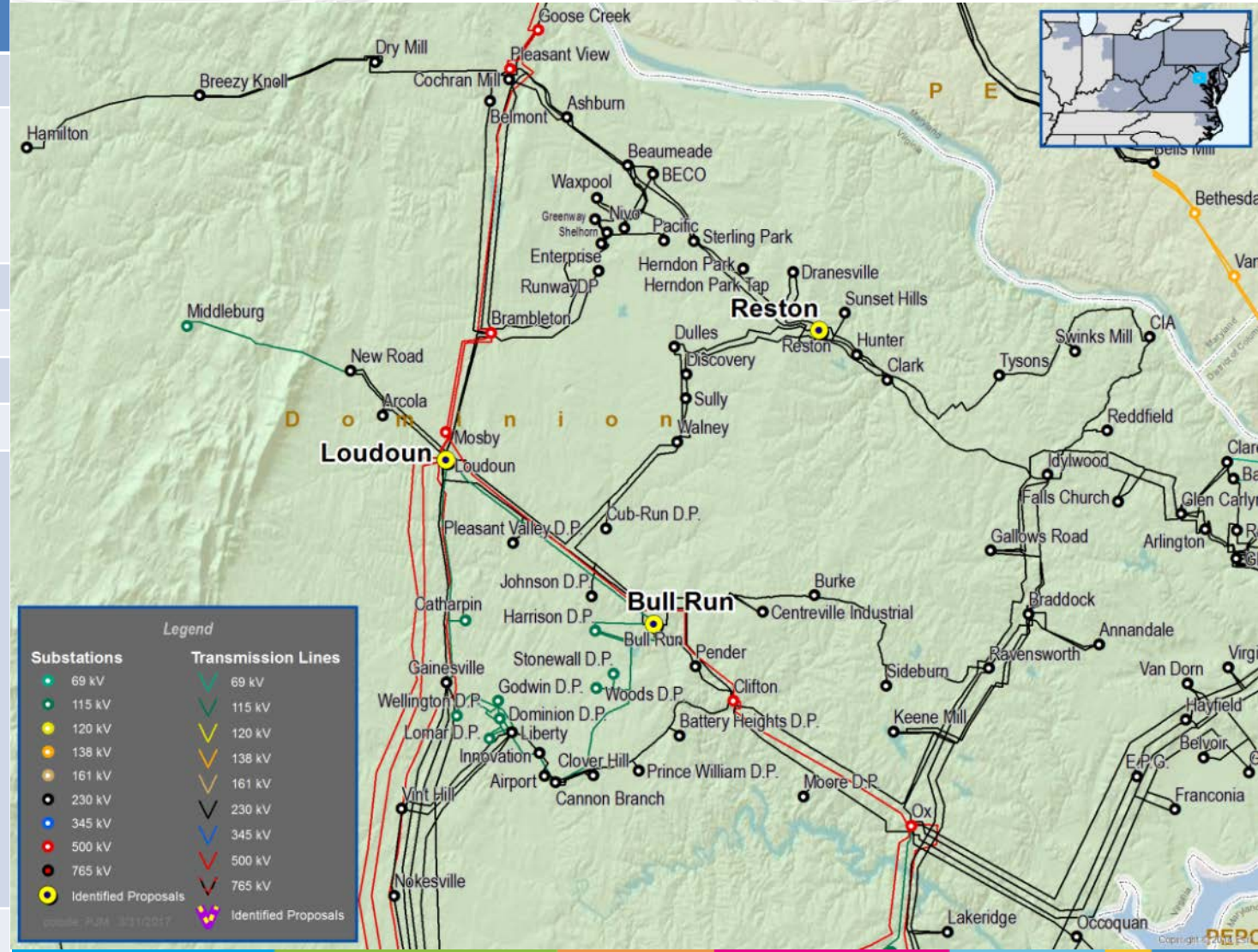
In-Service Cost (\$M): \$10.68

In-Service Date: 2021

Target Zone: Dominion

ME Constraints:
AP South
Central Interface

Notes: **This project is not being recommended**



Project ID: 201617_1-8H

Proposed by: Dominion

Proposed Solution:
Install a 230 kV shunt capacitor bank at DVP's Loudoun substation.

kV Level: 230 kV

In-Service Cost (\$M): \$4.81

In-Service Date: 2021

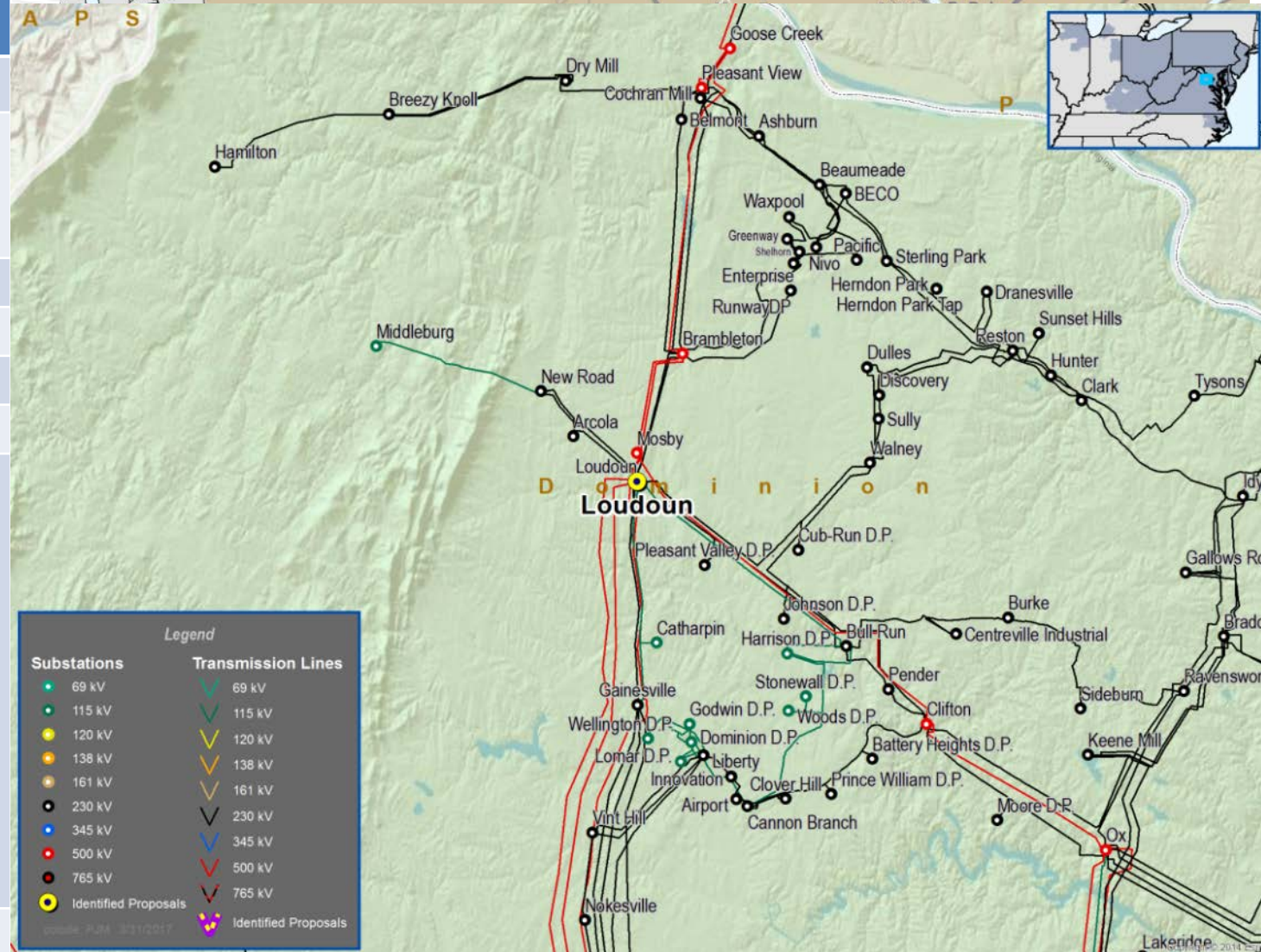
Target Zone: Dominion

ME Constraints:

AP South

AEP-DOM

Notes: **This project is not being recommended**



Project ID: 201617_1-8I

Proposed by: Dominion

Proposed Solution:
Install a 230 kV shunt capacitor bank at DVP's Reston substation.

kV Level: 230 kV

In-Service Cost (\$M): \$1.58

In-Service Date: 2021

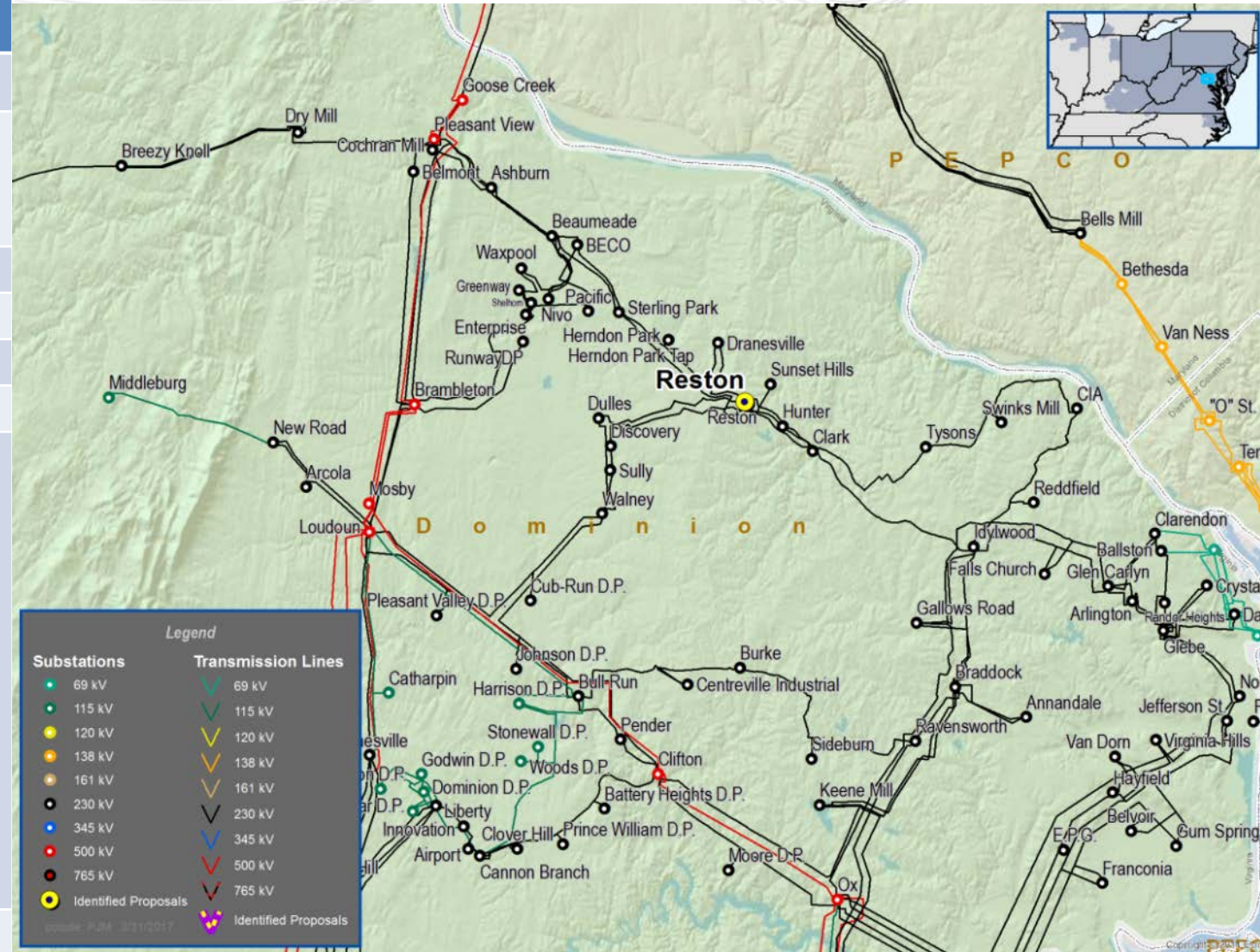
Target Zone: Dominion

ME Constraints:

AP South

AEP-DOM

Notes: **This project is not being recommended**



Project ID: 201617_1-8J

Proposed by: Dominion

Proposed Solution:

Install a 500 kV Thyristor Controlled Series Capacitor (TCSC) at DVP's Morrisville substation on the Front Royal - Morrisville 500kV line (Line 541) .

kV Level: 500 kV

In-Service Cost (\$M): \$44.11

In-Service Date: 2021

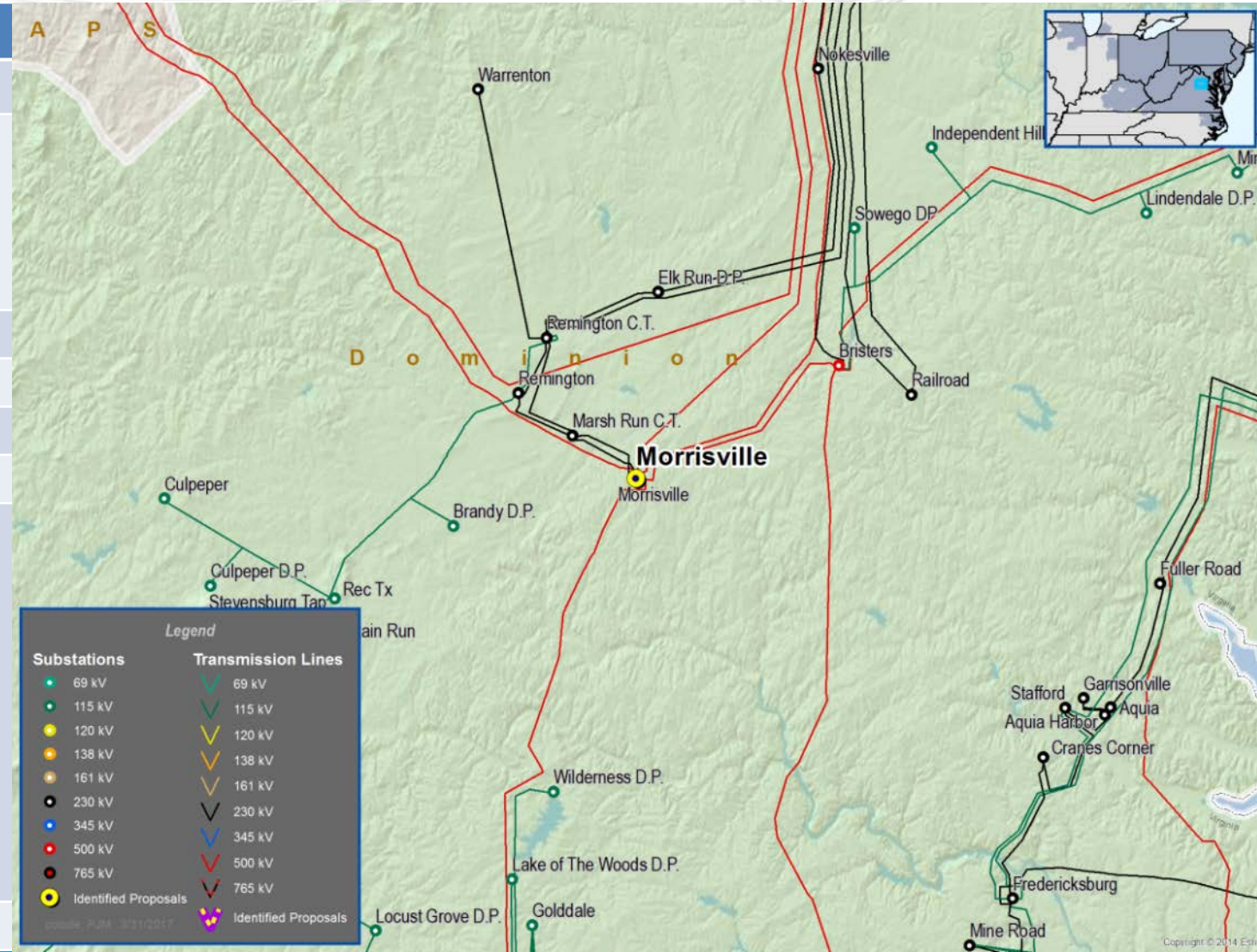
Target Zone: Dominion

ME Constraints:

AP SOUTH

Peach Bottom – Conastone 500kV

Notes: **This project is not being recommended**



Project ID: 201617_1-8K

Proposed by: Dominion

Proposed Solution:
 Reconductor and replace limiting equipment on the Pleasant View - Ashburn - Beaumeade 230 kV line. Install a 230 kV Thyristor Controlled Series Capacitor at DVP's Pleasant View substation on the Pleasant View - Beaumeade 230kV line.

kV Level: 230 kV

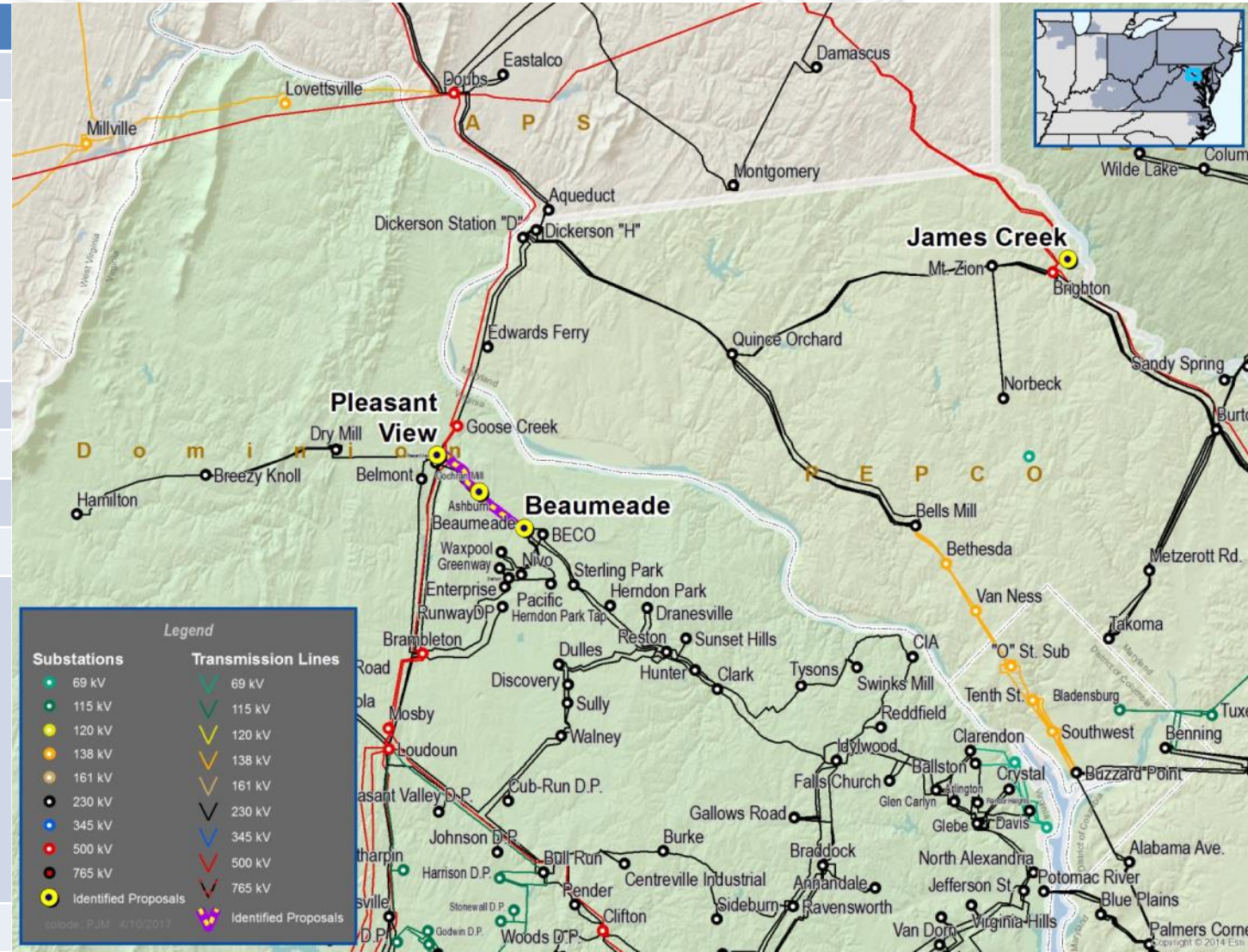
In-Service Cost (\$M): \$49.25

In-Service Date: 2021

Target Zone: Dominion

ME Constraints:
 AP SOUTH
 Ashburn - Pleasant View 230kV

Notes: **This project is not being recommended**



Project ID: 201617_1-8Q

Proposed by: Dominion

Proposed Solution: Greenfield
 Build a new 500kV ring bus switchyard (Palmyra). Cut the North Anna - Midlothian 500kV line (Line 576) and Cunningham - Elmont 500 kV line (Line 553), and tie into the new ring bus. Install a 300MVAR capacitor bank at Palmyra.

kV Level: 500 kV

In-Service Cost (\$M): \$31.9

In-Service Date: 2021

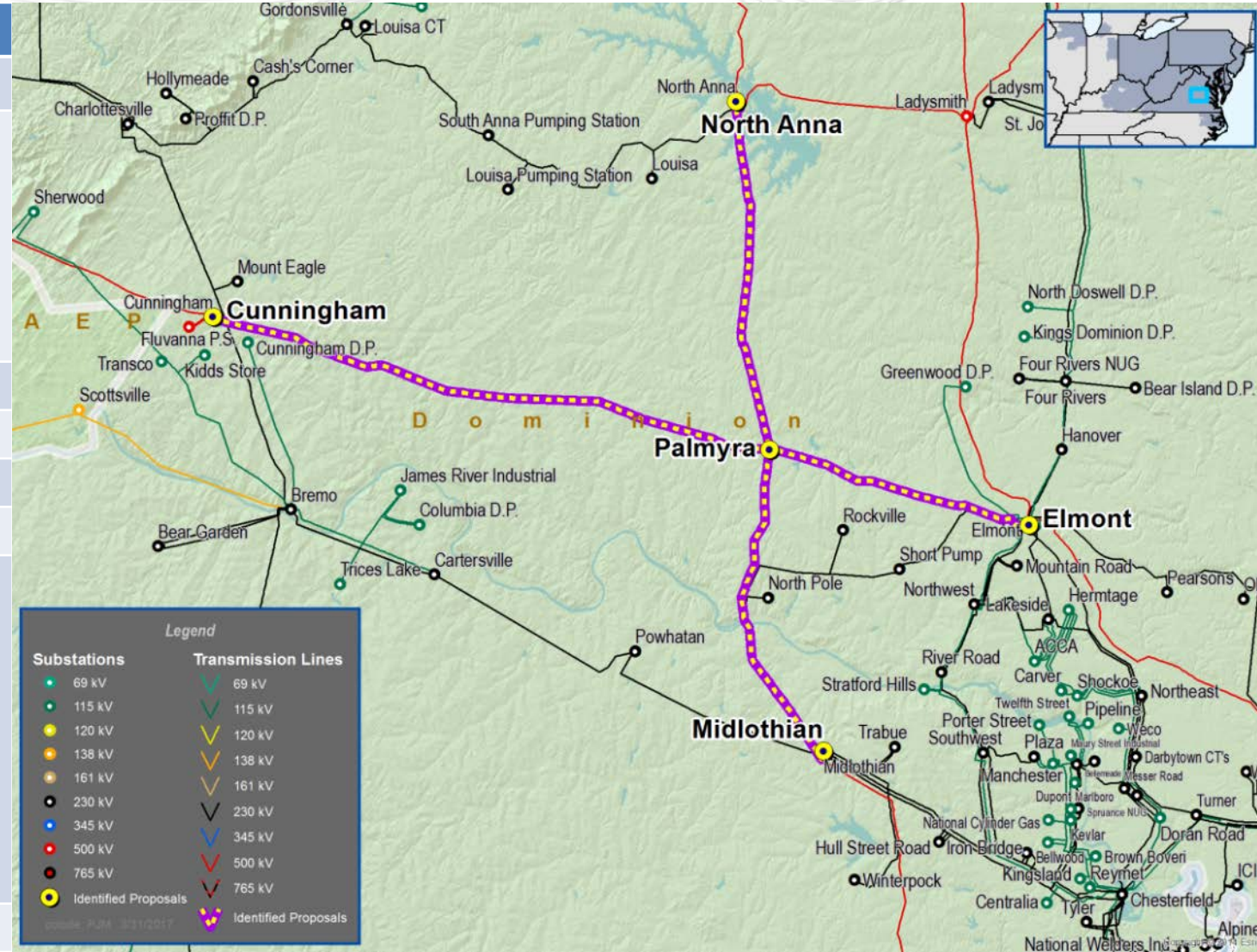
Target Zone: Dominion

ME Constraints:

AP South

AEP-DOM

Notes: **This project is not being recommended**



Project ID: 201617_1-18K

Proposed by: Northeast Transmission Development

**Proposed Solution: Greenfield
Build 600 MVAR 500 kV Static VAR Compensator (James Creek)
and interconnect to Brighton 500 kV Substation.**

kV Level: 500 kV

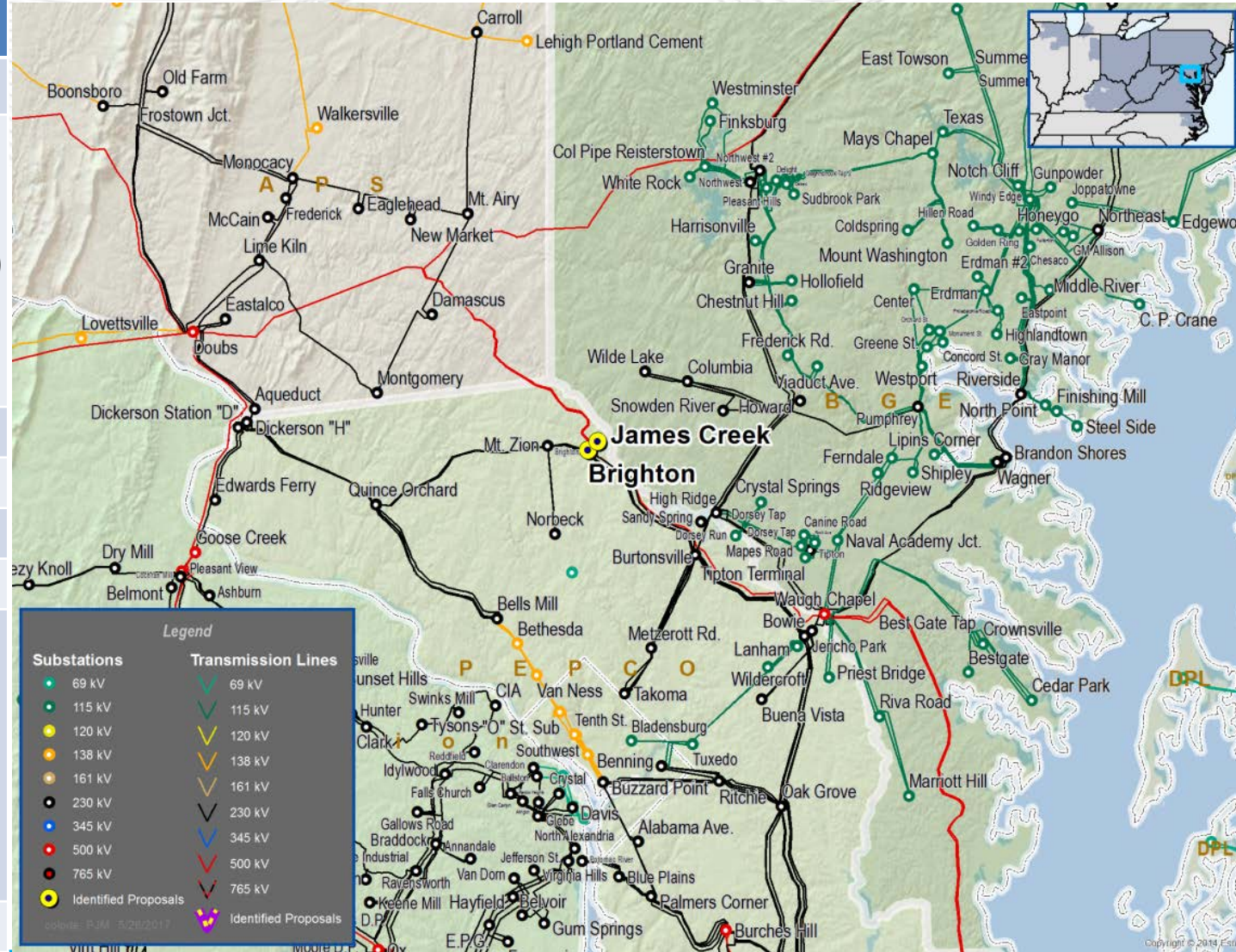
In-Service Cost (\$M): \$39.70

In-Service Date: 2021

Target Zone: PEPCO

**ME Constraints:
BC_PEP**

Notes: This project is not being recommended



Project ID: 201617_1-18L

Proposed by: Northeast Transmission Development

Proposed Solution: Greenfield
 Build 600 MVAR 500 kV Static VAR Compensator (Limestone Ridge) and interconnect to Juniata 500 kV Substation.

kV Level: 500 kV

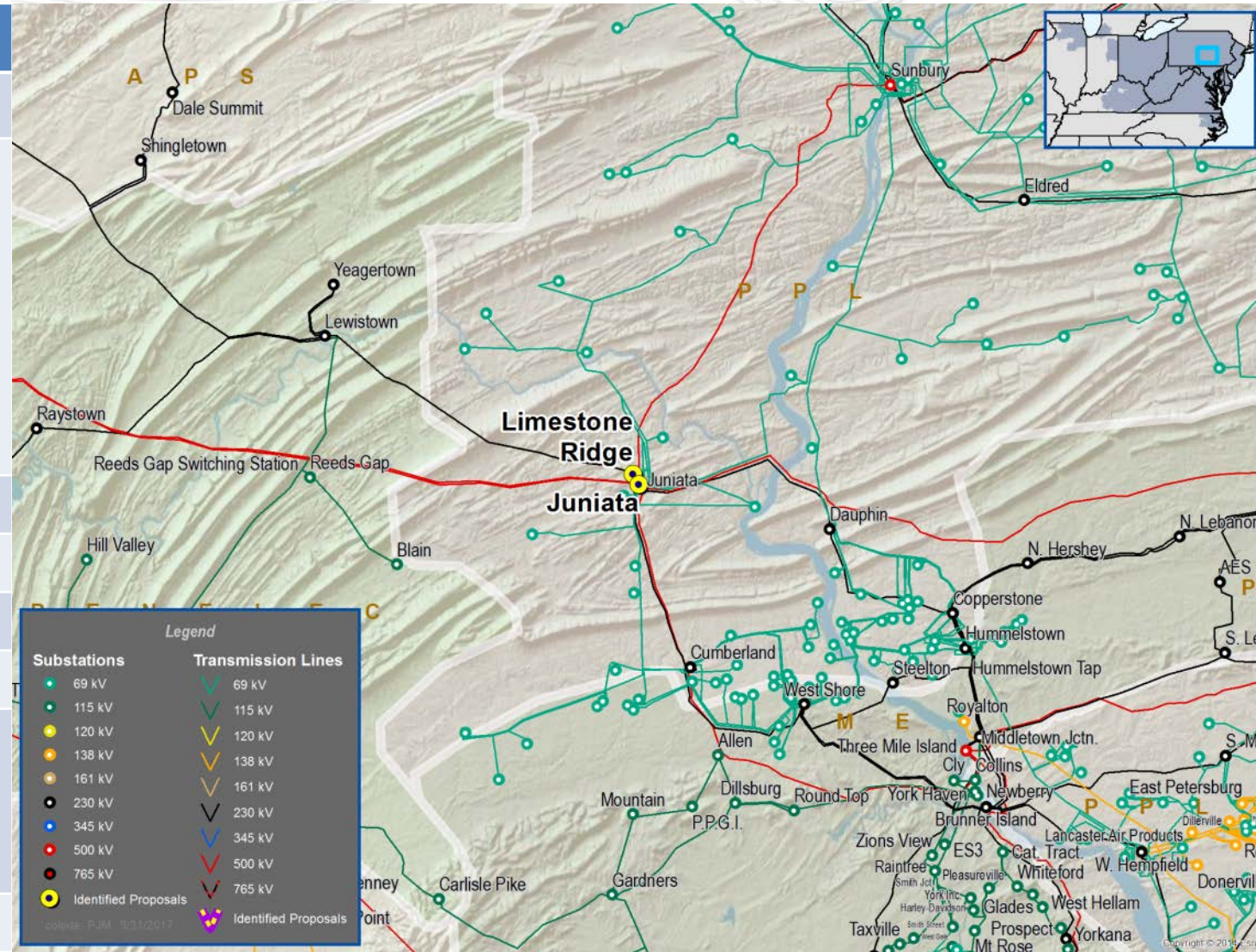
In-Service Cost (\$M): \$38.60

In-Service Date: 2021

Target Zone: PPL

ME Constraints:
 5004/5005, CENTRAL

Notes: **This project is not being recommended**



Appendix B - PPL Group Proposed Projects

Project ID: 201617_1-2A

Proposed by: PPL

Proposed Solution:
 Reconductor the Susquehanna - Harwood and
 Susquehanna-Sugarloaf-Harwood 230 kV DCT lines and
 replace a limited number of structures as necessary to
 accommodate the heavier conductor.

kV Level: 230 kV

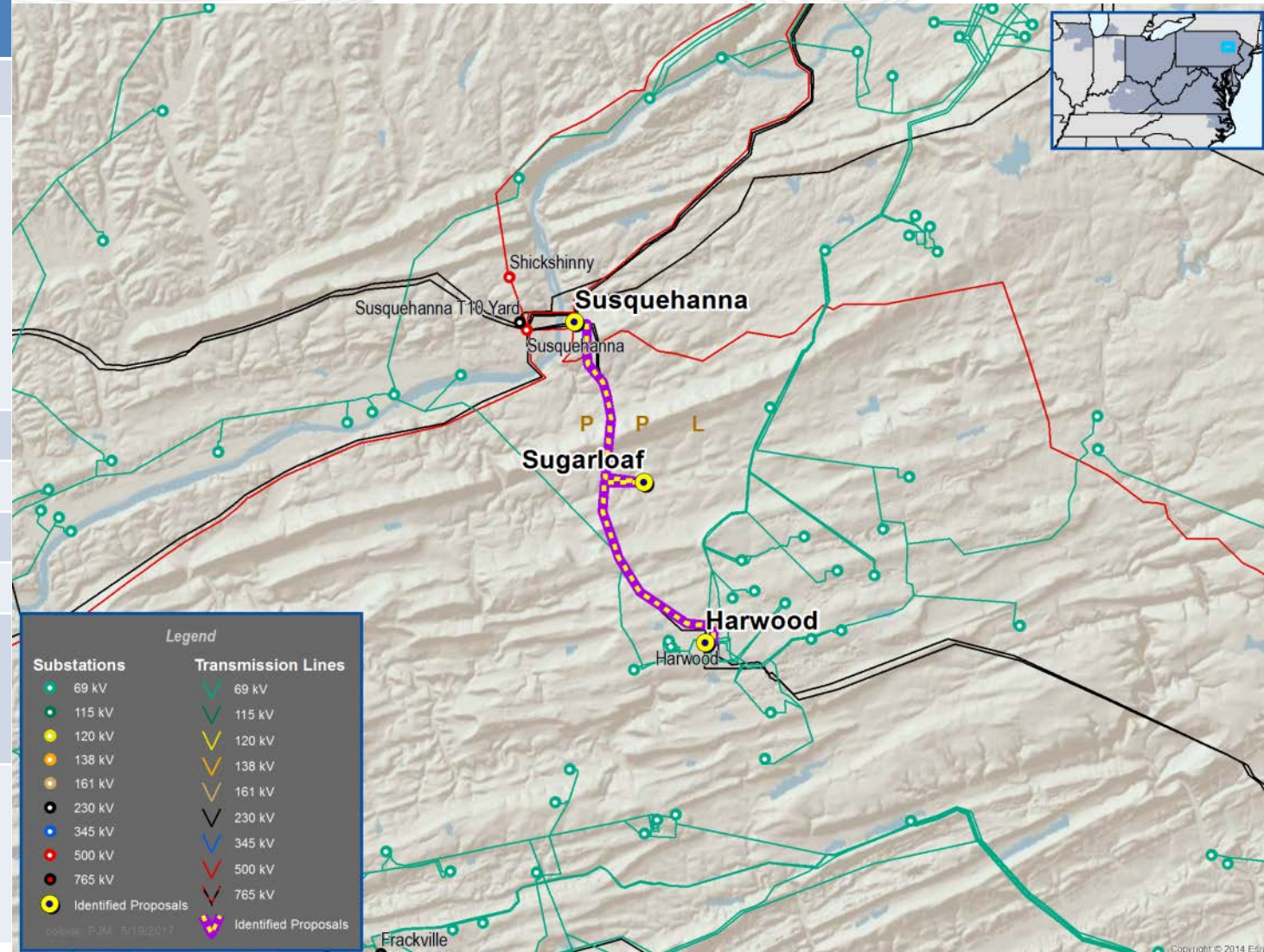
In-Service Cost (\$M): \$13.13

In-Service Date: 2021

Target Zone: PPL

ME Constraints:
 SUSQUEHANNA - HARWOOD 230 kV

- Notes:
- This is an upgrade.
 - Due to different conductor size, 2A has higher ratings than 2B



Project ID: 201617_1-2B

Proposed by: PPL

Proposed Solution:
 Reconductor the Susquehanna - Harwood and
 Susquehanna-Sugarloaf-Harwood 230 kV DCT lines and
 replace a limited number of structures as necessary to
 accommodate the heavier conductor.

kV Level: 230 kV

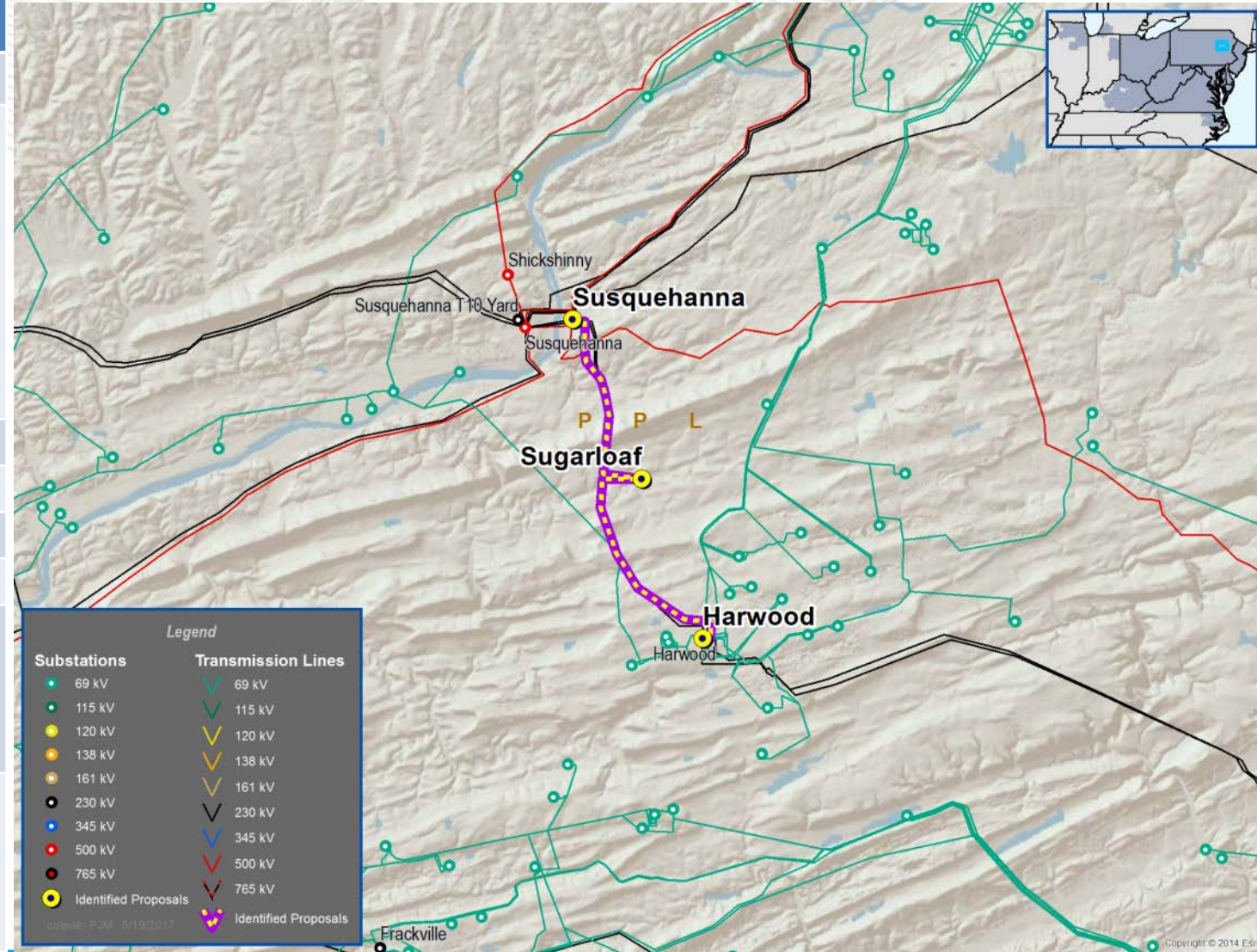
In-Service Cost (\$M): \$13.01

In-Service Date: 2021

Target Zone: PPL

ME Constraints:
 SUSQUEHANNA - HARWOOD 230 kV

- Notes:
- This is an upgrade.
 - Due to different conductor size, 2B has lower ratings than 2A



Project ID: 201617_1-2C

Proposed by: PPL

Proposed Solution:
 Tap the Susquehanna - Wescosville 500 kV line at Siegfried.
 Expand Siegfried to include a 500/230 kV substation.

kV Level: 230/500 kV

In-Service Cost (\$M): \$18.32

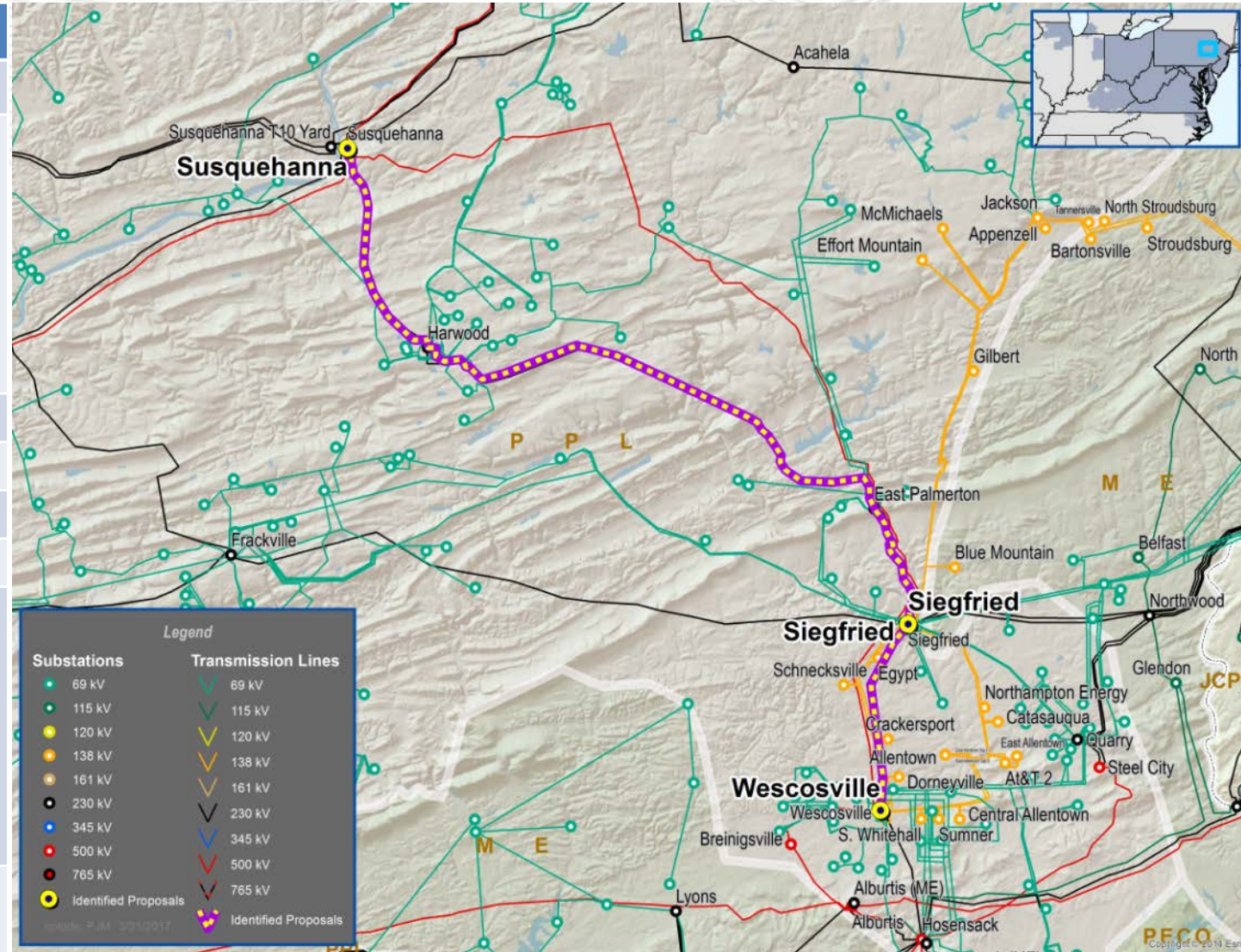
In-Service Date: 2021

Target Zone: PPL

ME Constraints:
 SUSQUEHANNA - HARWOOD 230 kV

Notes:

- This is an upgrade of Siegfried station



Project ID: 201617_1-10A

Proposed by: Nextera

Proposed Solution: Greenfield
 Tap the Susquehanna - Wescosville 500 kV line near Siegfried and build a new 500/230 kV substation (Spring Hill). Tie Spring Hill 230 kV into the existing Siegfried 230 kV substation.

kV Level: 230/500 kV

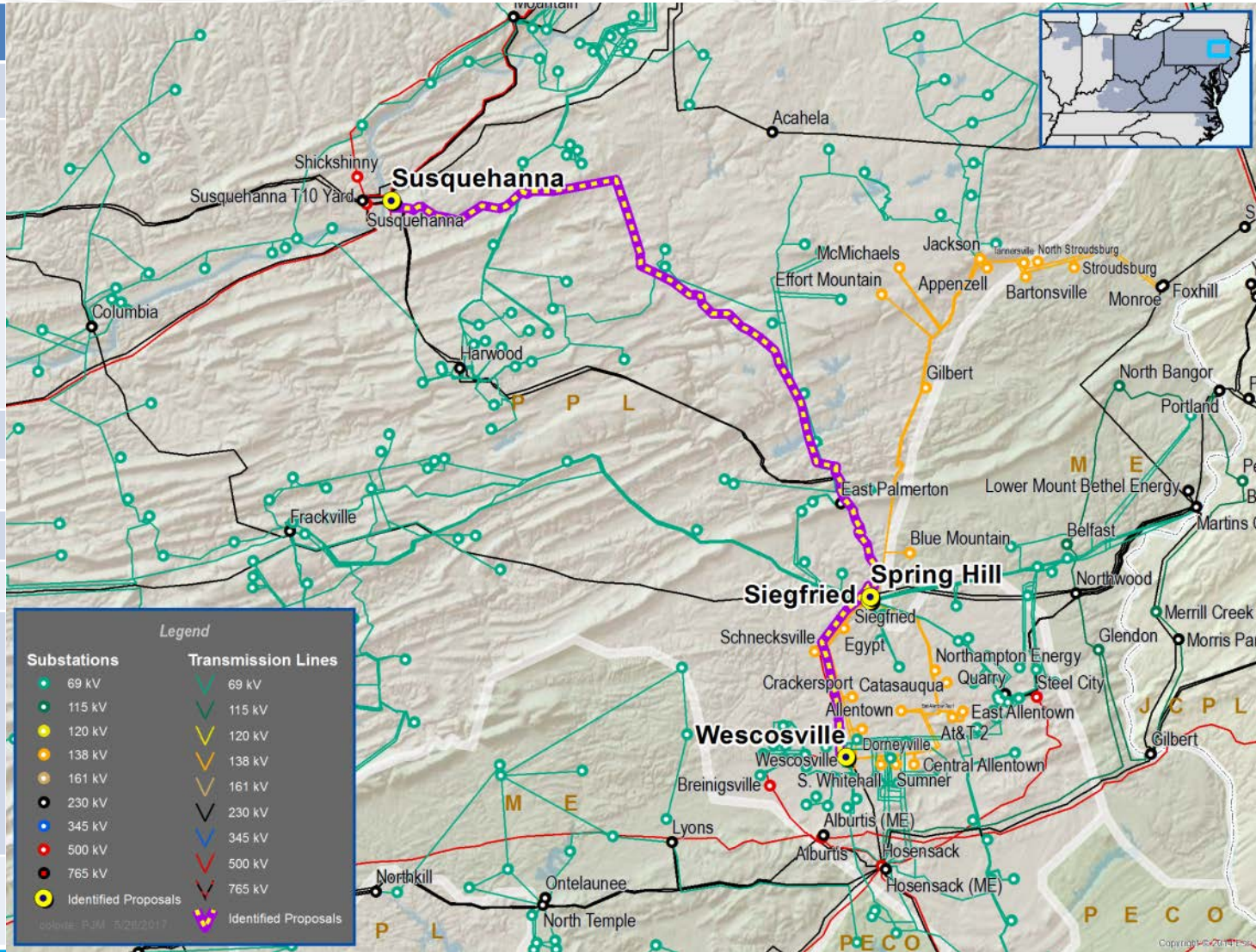
In-Service Cost (\$M): \$33.8

In-Service Date: 2021

Target Zone: PPL

ME Constraints:
 SUSQUEHANNA - HARWOOD 230 kV

Notes:
 • This is a greenfield project



Project ID: 201617_1-18G

Proposed by: Northeast Transmission Development

Proposed Solution: Greenfield
 Tap the Susquehanna - Wescosville 500 kV line near Siegfried and build a new 500/230 kV substation (Fells Creek). Tie the Fells Creek 230 kV into the existing Siegfried 230 kV substation.

kV Level: 230/500 kV

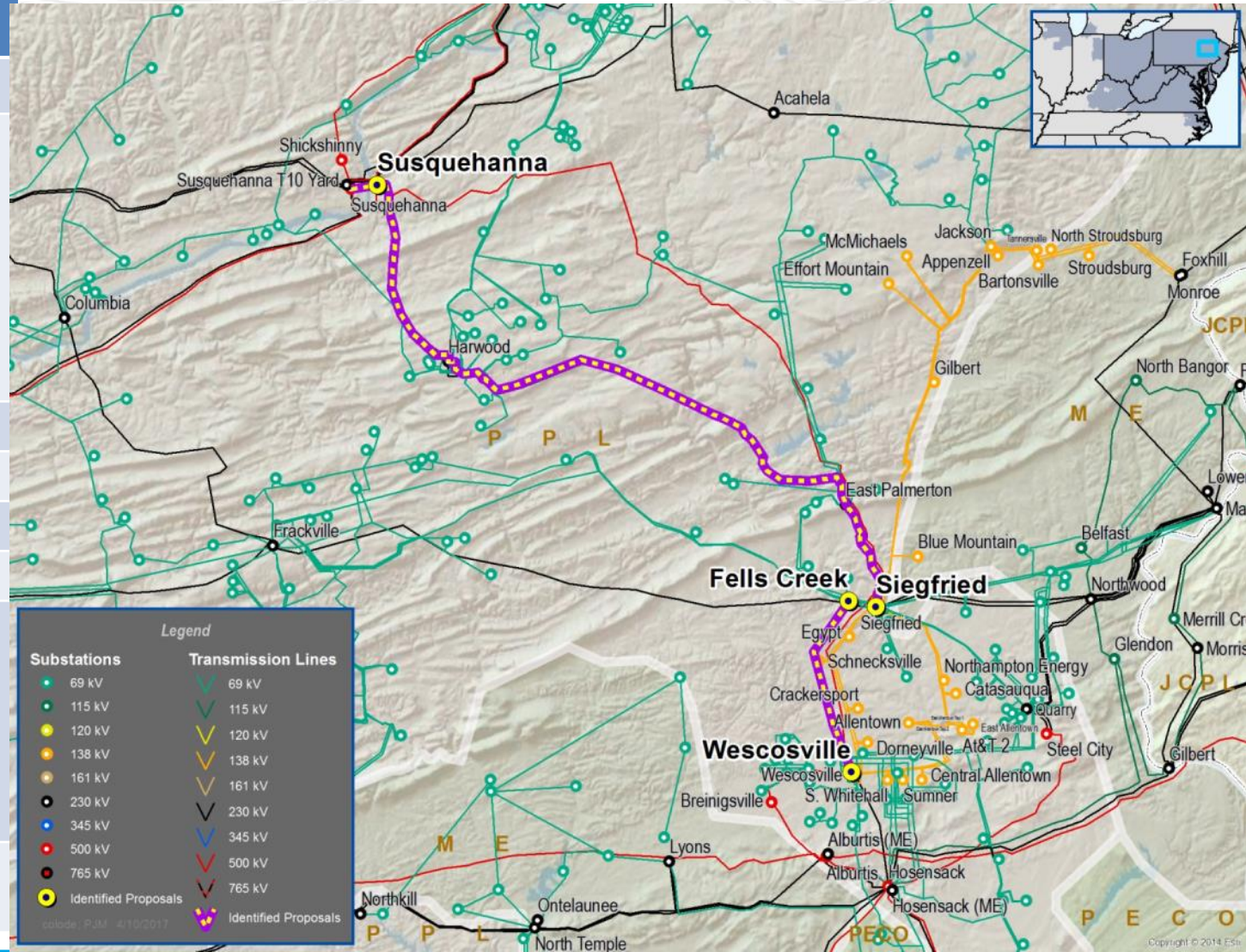
In-Service Cost (\$M): \$32.9

In-Service Date: 2021

Target Zone: PPL

ME Constraints:
 SUSQUEHANNA - HARWOOD 230 kV

Notes:
 • This is a greenfield project



Project ID: 201617_1-18Q

Proposed by: Northeast Transmission Development

Proposed Solution: Greenfield
 Tap the Catawissa - Frackville 230 kV line and build a new 230 kV switchyard (Trexler Run). Build a new Harwood - Trexler Run 230 kV line.

kV Level: 230 kV

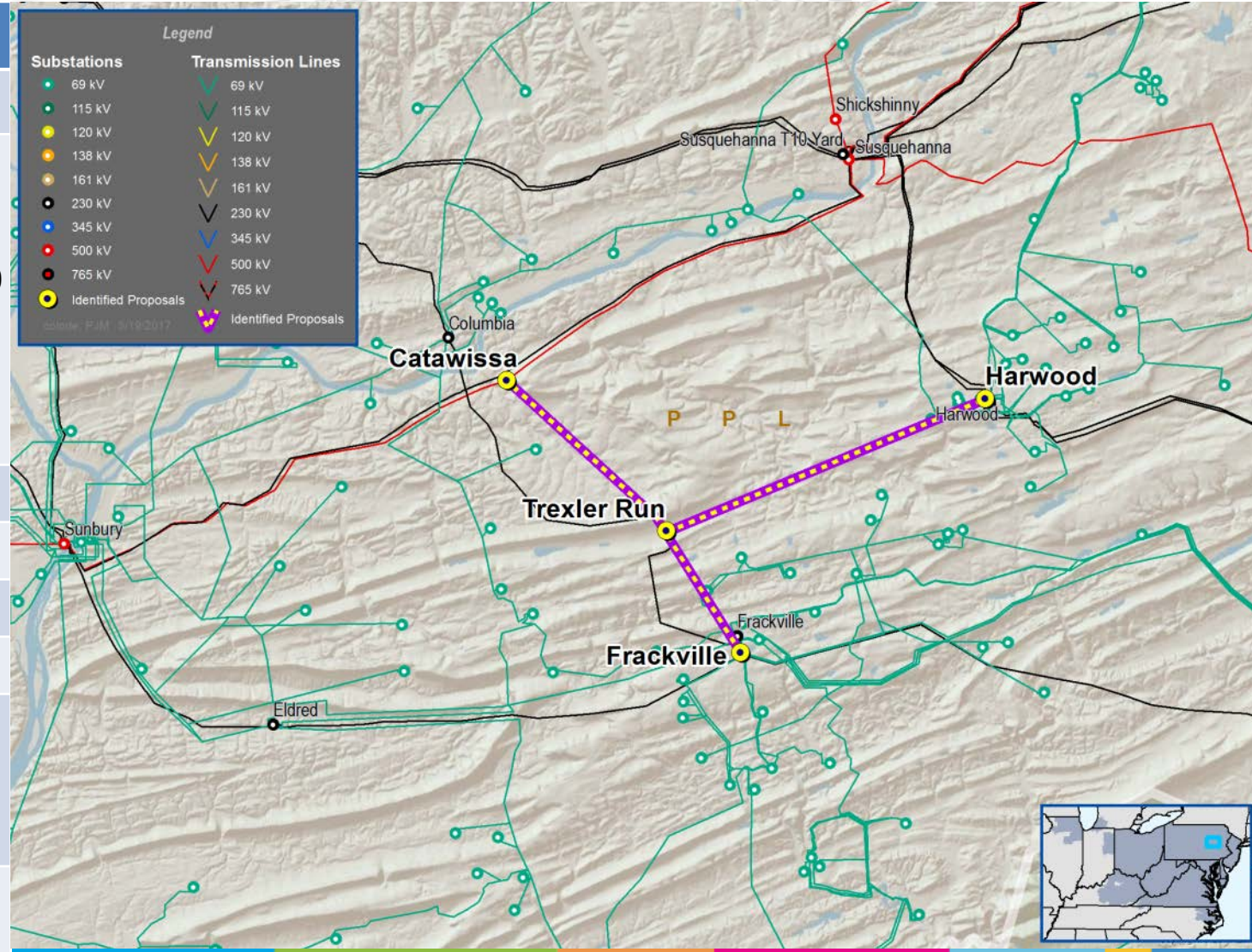
In-Service Cost (\$M): \$33.7

In-Service Date: 2021

Target Zone: PPL

ME Constraints:
 SUSQUEHANNA - HARWOOD 230 kV

- Notes:
- This is a greenfield project



- Revision History

- V1 – 12/11/2017 – Original Version Posted to PJM.com
- V2 – 12/13/2017 – Updated slide 10 with paragraph about upgrades value

Updated slide 11 with optimal upgrade configuration