Market Efficiency Update

Transmission Expansion Advisory Committee
March 8, 2018

Version 2

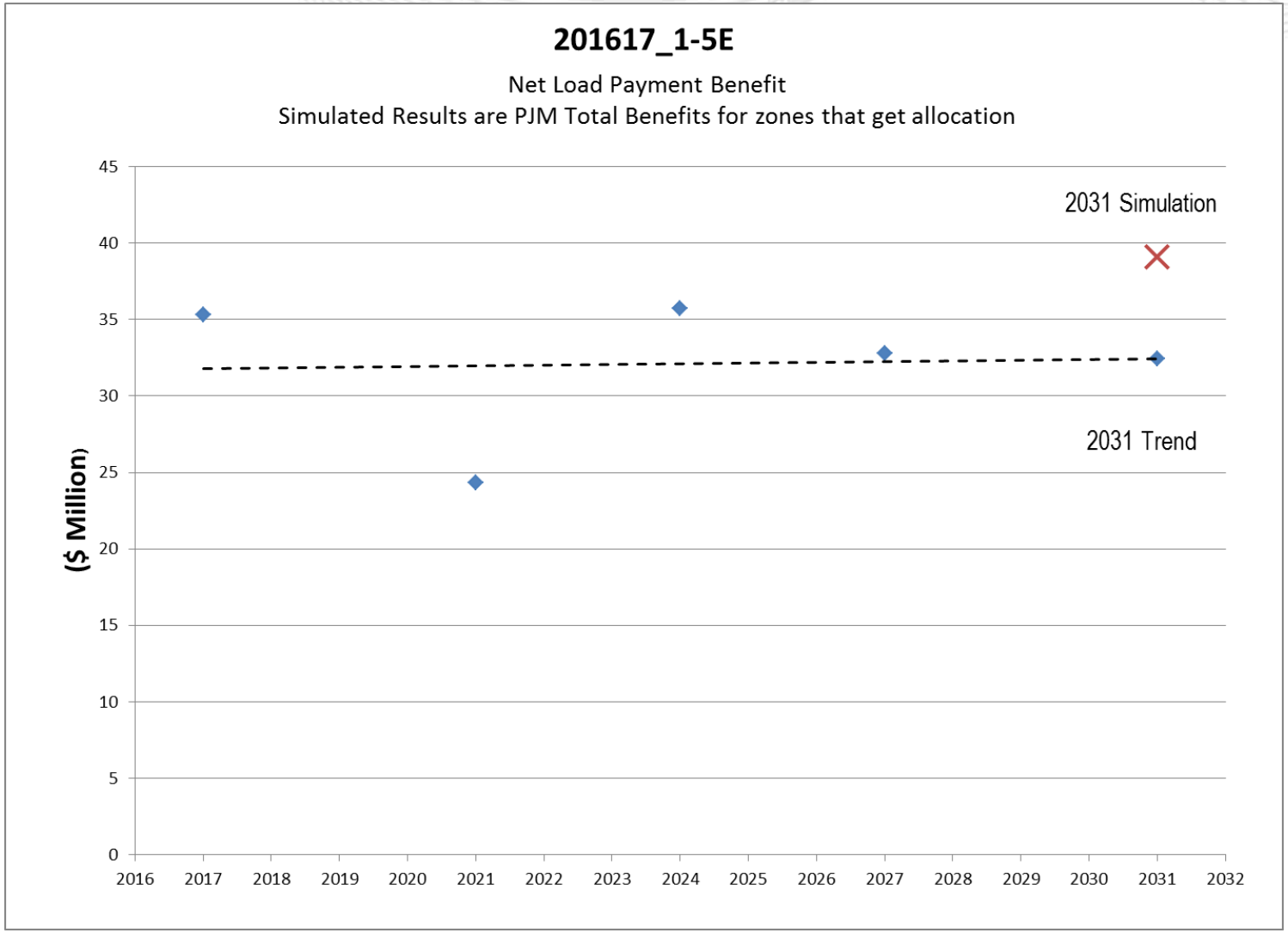
2016/17 Long Term Window

BGE Group Analysis Conclusion

Proposal 5E Analysis (BGE)

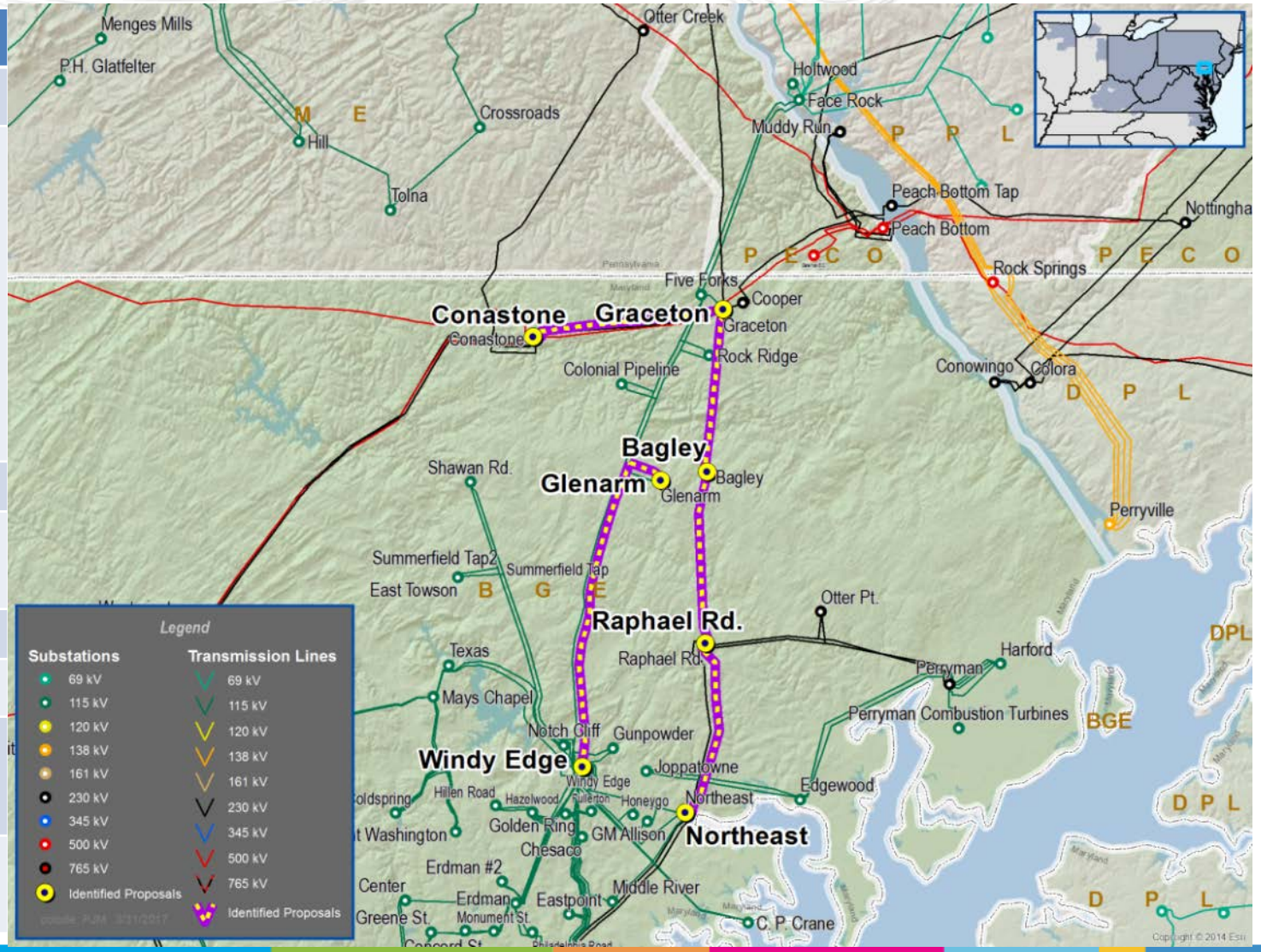
- PJM completed analysis for the BGE Group and selected proposal 5E
  - 5E passes all PROMOD sensitivity scenarios
  - Reliability Analysis has been completed and no reliability violation identified as a result of the 5E Market Efficiency proposal
  - Cost/Constructability Analysis completed
- PJM will be recommending BGE's proposal 5E for approval at the April Board meeting.
  - Highest among proposals submitted for the BGE constraints.
  - Fully addresses target congestion driver Conastone – Graceton – Bagley 230 kV
  - Addresses downstream congestion expected to be relieved on the 230 kV & 115 kV system
  - Remaining shifted congestion is within acceptable levels

Trend for Net Load Benefits of Recommended Proposal 5E



BGE 1-5E

Project ID: 201617_1-5E	
Proposed by: BGE	
Proposed Solution: Reconductor the Conastone to Graceton 230kV lines. Upgrade substation equipment at Conastone. Add bundled conductors to the Graceton-Bagley-Raphael Road 230kV double circuit lines. Reconductor the Raphael Road to Northeast 230 kV double circuit lines. Upgrade substation equipment at Windy Edge substation.	
kV Level: 115/230 kV	
In-Service Cost ($M): $25.40 PJM Cost Estimate ($M): $39.65	B/C: 8.16 B/C: 5.23
In-Service Date: 2021	
Target Zone: BGE	
ME Constraints: CONASTONE - GRACETON - BAGLEY 230 kV	
Notes: To be recommended for approval at the April 2018 Board meeting.	



PPL Group Analysis Results

PPL Analysis Overview

- PJM completed the analysis for the PPL group using the latest posted Market Efficiency base case updated to include the solution selected for the BGE group

- Sensitivity Scenarios considered:
  - No FSA Scenario
  - High/Low Gas Price Forecast (+/- 20%)
  - Low Load Forecast (- 2%)

- Descriptions of submitted proposals included in Appendix B

SUSQ – HARW Congestion Driver Decrease

- Compared to the start of the 2016/17 Window, congestion driver decreased significantly
  - 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)

Simulated Congestion Susquehanna – Harwood 230 kV

Susqeuhanna to Harwood 230 kV	*2021*	*2024*	
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
Base Case (vintage November 2017)	$2.94	$2.27	45% congestion decrease compared to initial driver
No PPL FSA Sensitivity (vintage November 2017)	$1.34	$0.48	80% congestion decrease compared to initial driver
Latest Posted Base Case + 5E	$2.46	$1.73	56 % congestion decrease compared to initial driver
Latest No FSA Sensitivity (5E included)	$1.41	$0.60	79% congestion decrease compared to initial driver

PPL Group Analysis Details

- 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
  - Significant decrease in B/C ratios compared to values posted at November 2017 TEAC
  - No proposal passes the 1.25 threshold when considering a PJM wide no FSA sensitivity scenario.

Proposal Description	Company	ID	Proposal Cost ($ million)	New B/C Ratios (Base Case with 5E)	
				Base Case	no FSA* Units
Reconductor Susquehanna - Harwood 230 kV	PPL	2A	13.13	0.24	0.19
New Siegfried 500/230 kV transformer	PPL	2C	18.32	0.51	0.31
New Harwood - Trexler Run 230 kV line	NTD	18Q	33.70	1.73	0.07

* No FSA Sensitivity scenario removed all FSA units from PJM.

Proposal Description	Company	ID	Proposal Cost ($ million)	Old B/C Ratios (presented Nov 2017 TEAC)	
				Base Case	no PPL** FSA Units
Reconductor Susquehanna - Harwood 230 kV	PPL	2A	13.13	1.74	6.34
New Siegfried 500/230 kV transformer	PPL	2C	18.32	0.83	3.02
New Harwood - Trexler Run 230 kV line	NTD	18Q	33.70	2.70	2.34

** No PPL FSA Sensitivity scenario removed FSA units in PPL.

PPL Supplemental Impacts

- Base Case includes monitoring of PPL Wescosville supplemental project (s0864).
- s0864 supplemental project changes operations around Wescosville transformer:
  - New Wescosville 230/138 kV transformer is projected to be operated as normally closed
  - Removes the current Wescosville 230/69 kV #2 transformer (currently operated as normally open)
- The new configuration creates a new flow path
  - from Wescosville 500 kV bus, down through Wescosville 500/138 kV transformer, back up through Wescosville 138/230 kV transformer, toward Hosensack 230 kV bus.
- The new configuration changes congestion pattern
  - Susquehanna – Harwood congestion driver is significantly diminished
  - New congestion pattern around Wescosville 500/138 kV transformer

Analysis Conclusions

- B/C ratios decreased
  - In the latest analysis, the B/C ratios for all proposals significantly decreased.
- Impact of FSA Units
  - Significant part of the congestion driver is FSA driven.
  - The B/C ratios for all proposals are failing when FSA units are excluded from the base case
- Congestion Pattern
  - SUSQ-HARW congestion driver decreased significantly from the initially posted values.
  - Moreover, the SUSQ-HARW congestion driver disappears with the Wescosville 230/138 kV supplemental project closed and a new congestion pattern is introduced.
  - The new congestion pattern was not evident prior to opening of the window.
- PJM is currently not recommending any proposals in the PPL area.

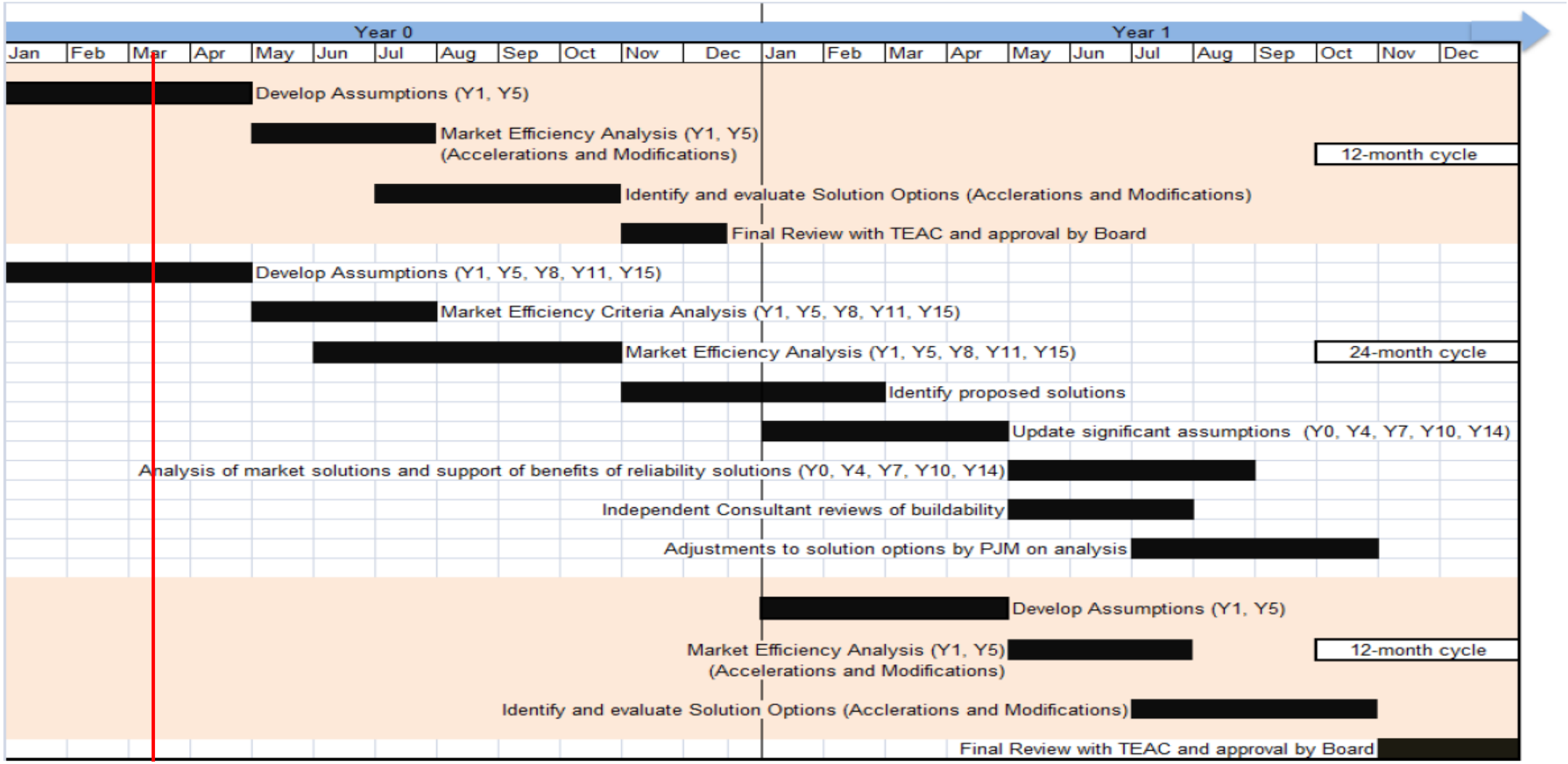
2016/17 RTEP Window Conclusions

- PJM will be recommending BGE's proposal 5E for approval at the April Board meeting.

- PJM is not currently recommending any proposals in the PPL area for the 2016/17 Market Efficiency Long Term window.

2018/19 RTEP Long Term Window

2018/19 Market Efficiency Timeline



Next Steps

Step	Timeline
Develop Assumptions	March – May 2018
Build Base Case	June – July 2018
Identify Congestion Drivers	August – September 2018
Post Base Case and Congestion Drivers	October 2018
Proposal Window	November 2018 - February 2019
Analysis of Proposed Solutions	March - November 2019
Final TEAC Review and Board Approval	November - December 2019

Appendix A

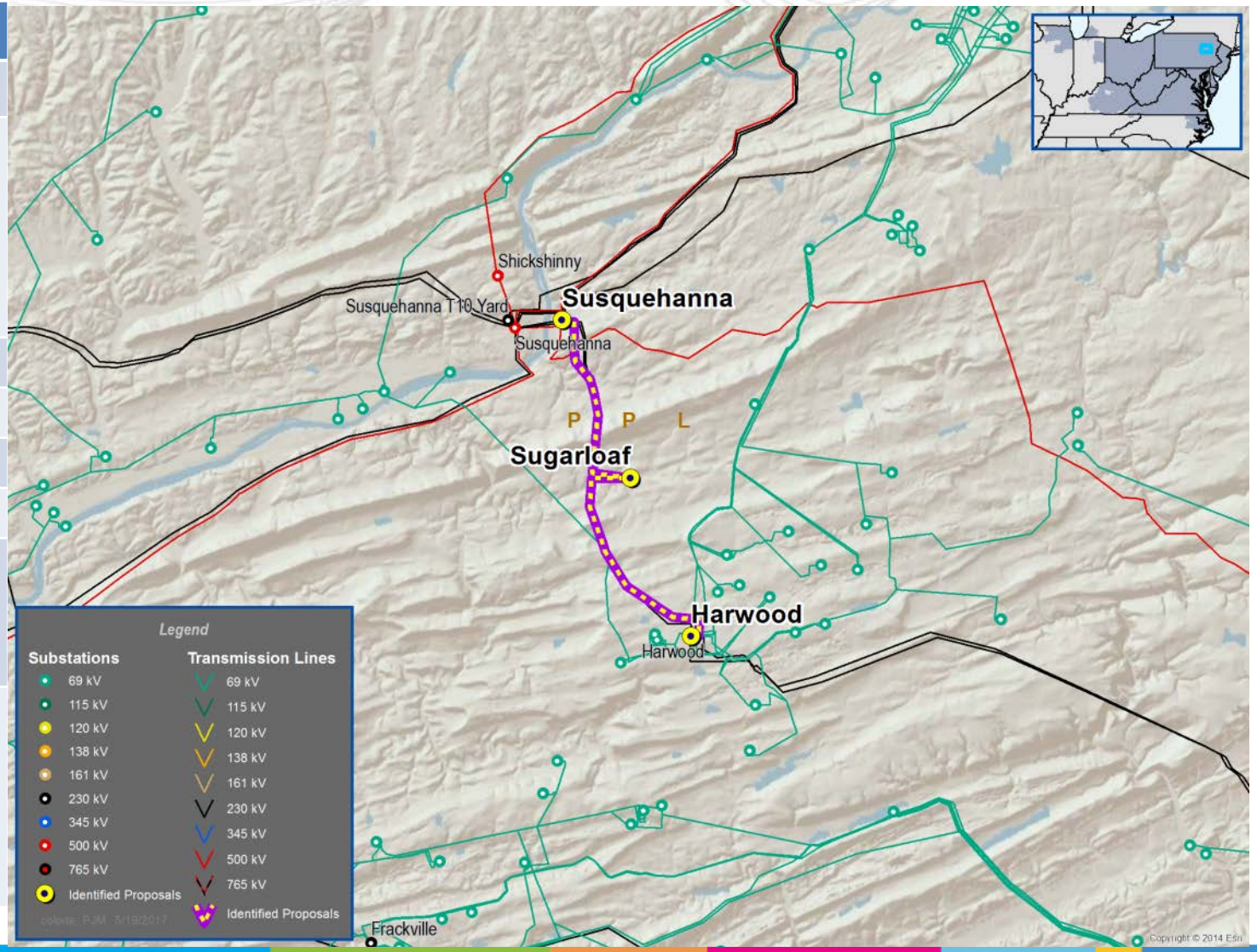
PPL Group Proposals

PPL 1-2A

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
- This project is not currently recommended.

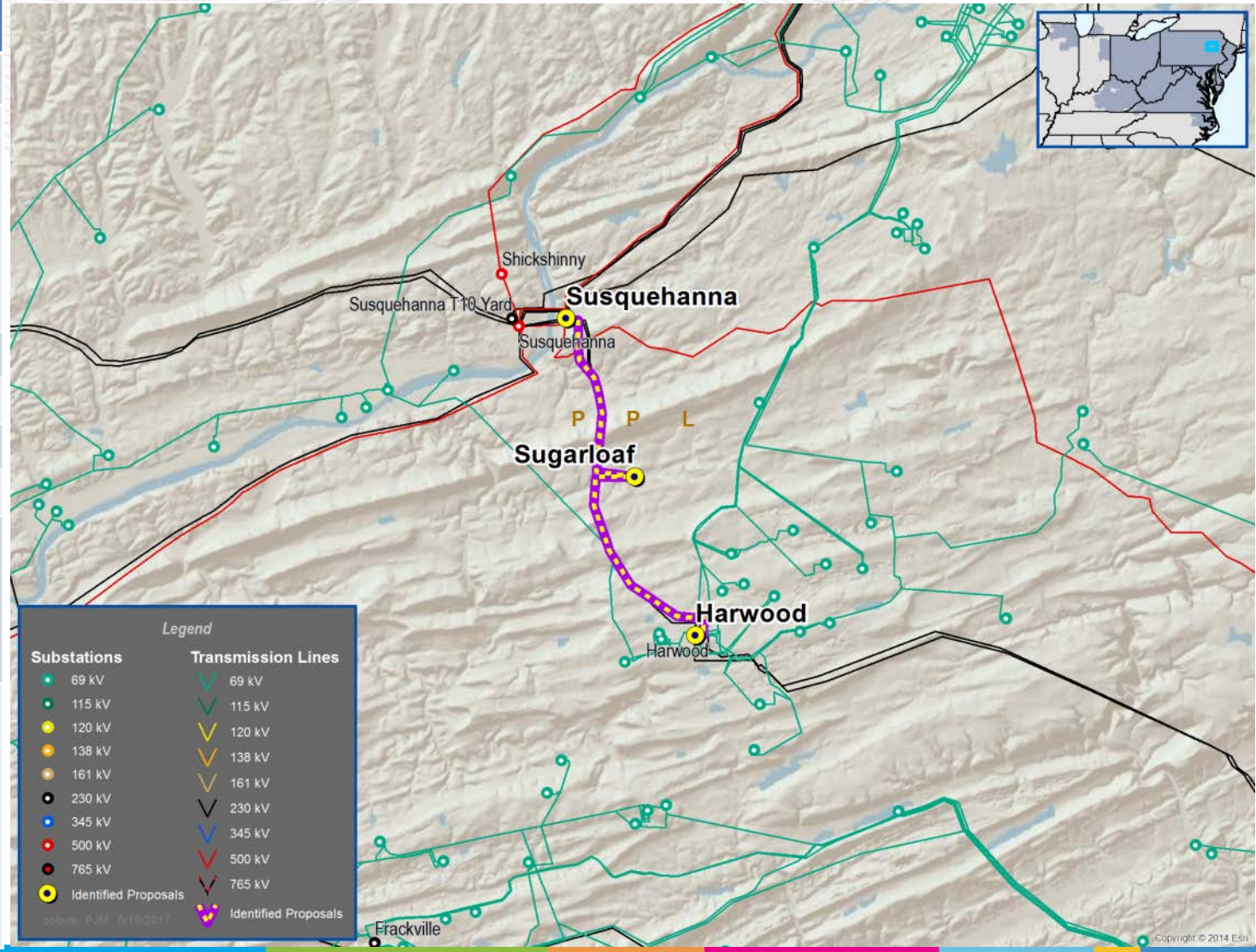


PPL 1-2B

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

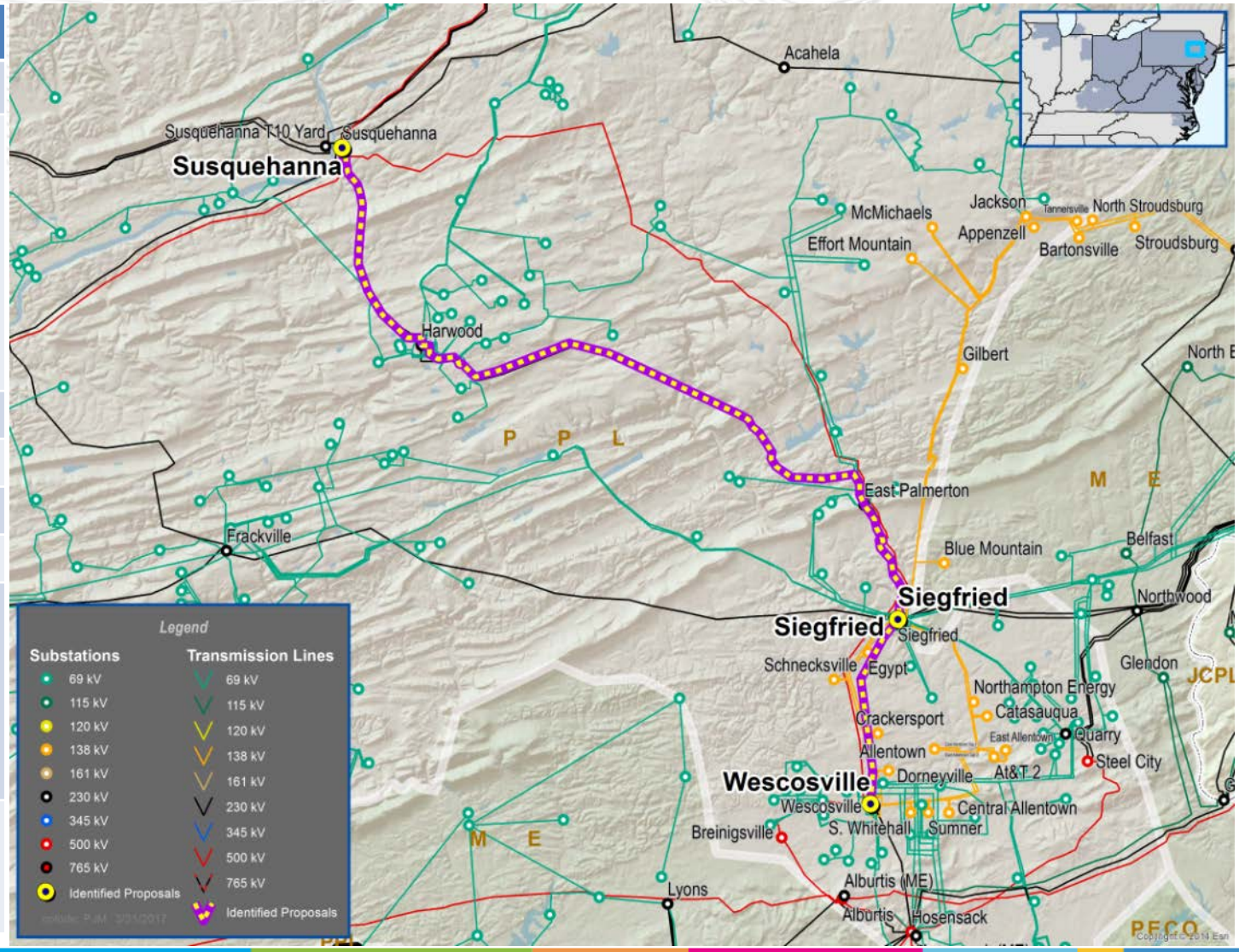
Notes:

- This is an upgrade.
- Due to different conductor size, 2B has lower ratings than 2A
- This project is not currently recommended.



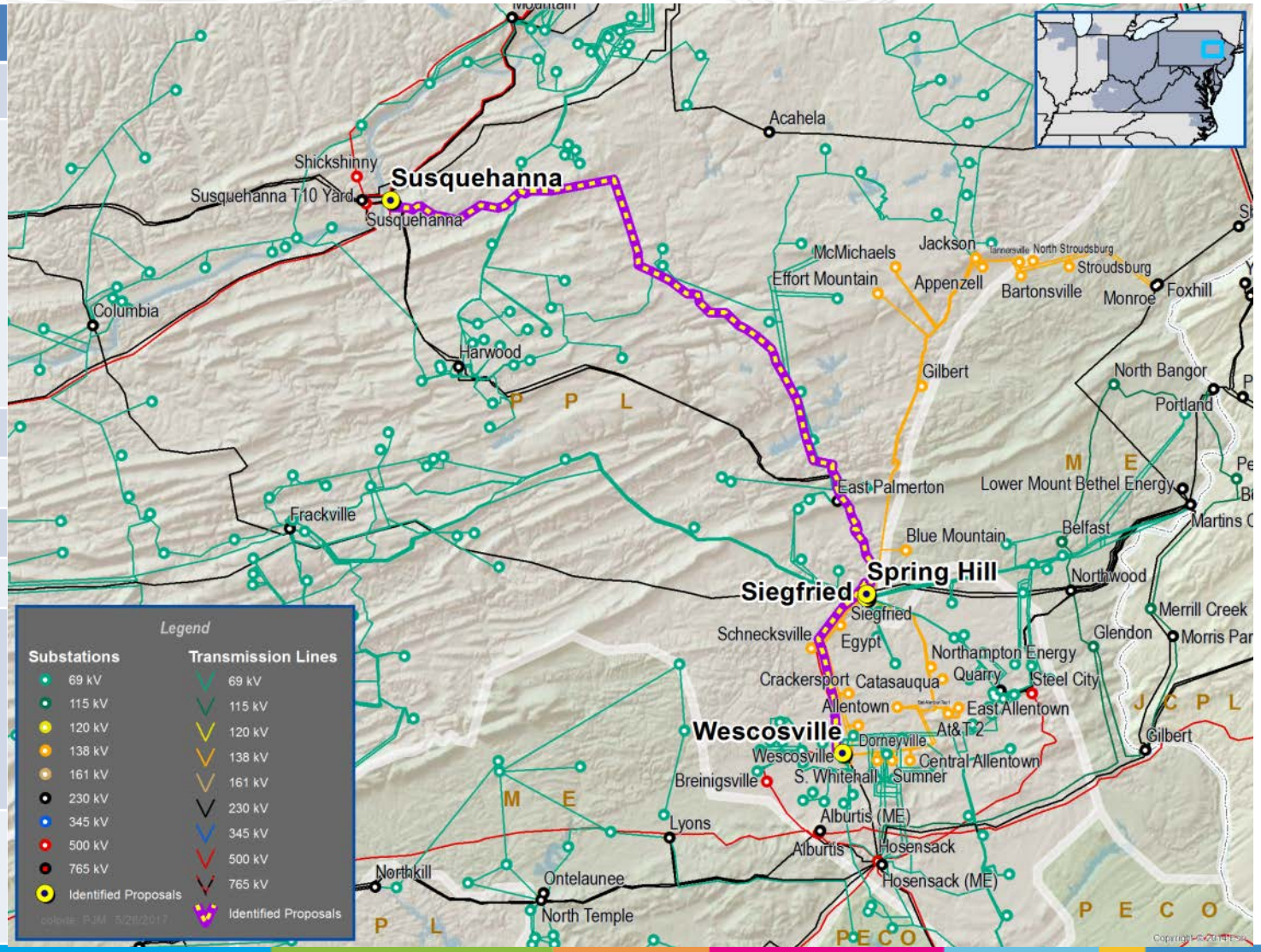
PPL 1-2C

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 • This project is not currently recommended.



NEXTERA 1-10A

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 • This project is not currently recommended.



NTD 1-18G

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

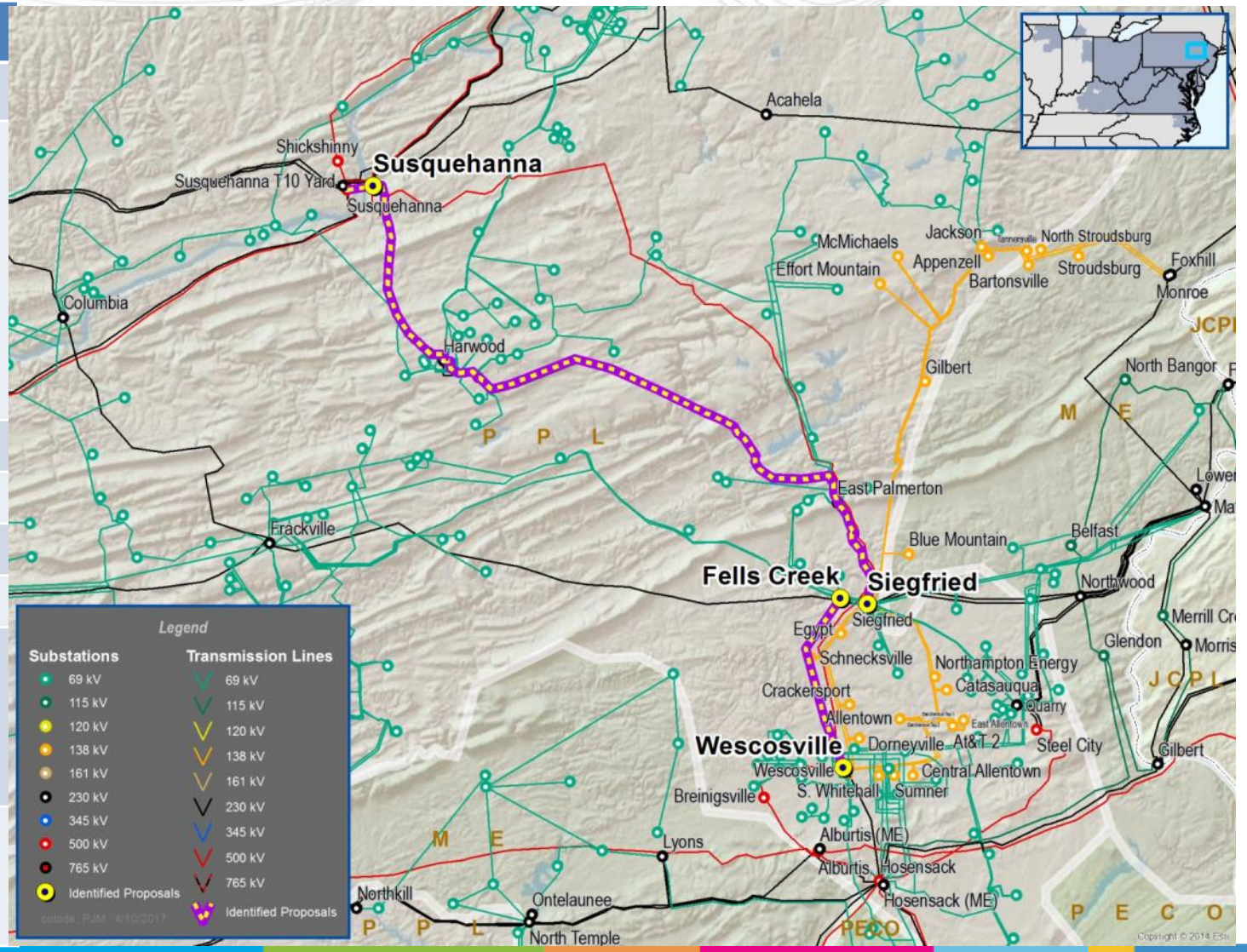
In-Service Cost ($M): $32.9

In-Service Date: 2021

Target Zone: PPL

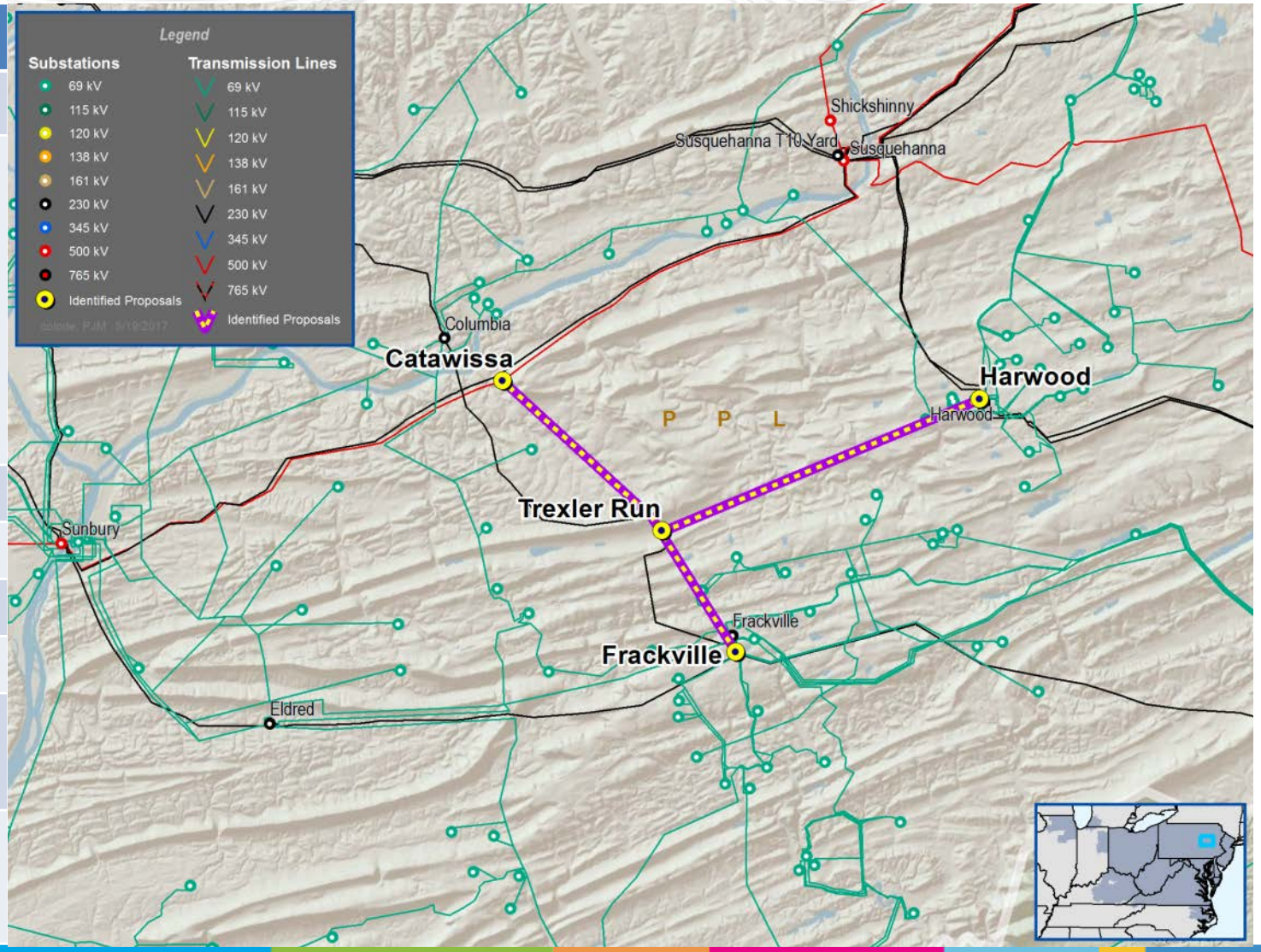
ME Constraints:
SUSQUEHANNA - HARWOOD 230 kV

Notes:
- This is a greenfield project
- This project is not currently recommended.



NTD 1-18Q

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 • This project is not currently recommended.



Appendix B – PPL Supplemental Project Wescosville Transformer 230/138 kV

PPL Transmission Zone (presented at TEAC 04/09/2015)

- S0864 Supplemental Upgrade Scope Change:
- Old Scope:

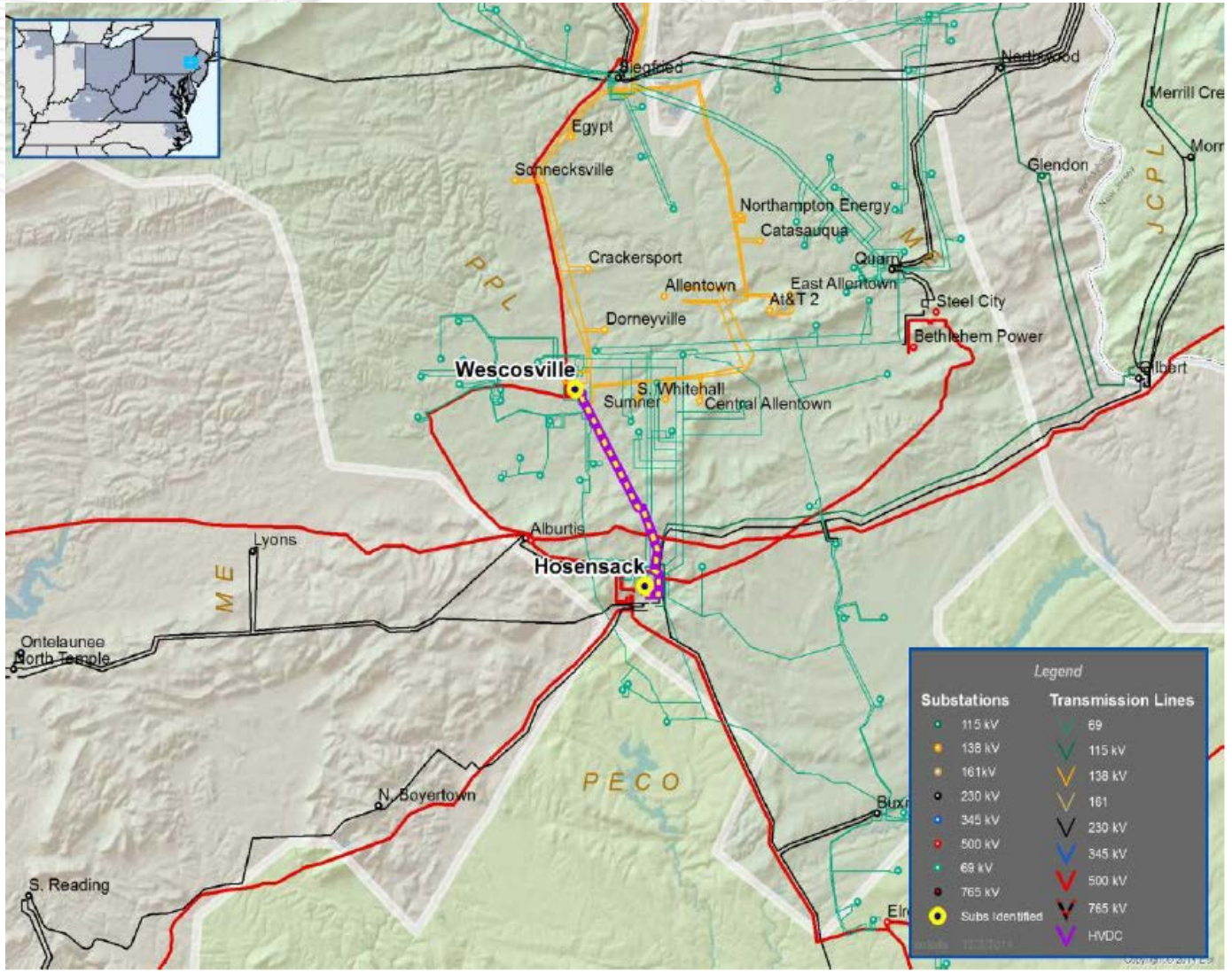
  Rebuild approximately 10 miles of the Hosensack-Wescosville 230 kV line to 500 kV and upgrade Wescosville 500-138 kV Substation.

  New Scope:
  - Build approximately 6 miles 500 kV 2nd circuit on the existing Alburtis – Breinigsville.
  - Reconfigure the Wescosville 500 kV station to double breaker arrangement.
  - Install a new Wescosville 230/138 kV transformer.
- Estimated Project Cost:

  $ 58.4 M
- Projected IS Date:

  12/31/2017

Note: New Projected IS Date is 3/1/2019



Revision History

- Revision History
  - V1 – 3/05/2018 – Original Version Posted to PJM.com
  - V2 – 3/20/2018 – Slide 5 updated with independent cost estimate and adjusted B/C ratio for project 5E reflecting the information which was presented at the March 8, 2018 meeting