



Market Efficiency Update

Transmission Expansion Advisory Committee
October 12, 2017





Market Efficiency Proposal Window 2016-2017 Long Term Proposal Window 1A

- Addendum 2016-2017 Long Term Proposal Window 1A
 - Opened on September 14, 2017
 - Closed on September 28, 2017.
 - Solicited proposals to address the Tanners Creek - Dearborn 345 kV thermal constraint, which is a Reliability Pricing Model (RPM) constraint.
- Target facility Tanners Creek - Dearborn 345 kV is the next limiting element in the 2020/2021 RPM Base Residual Auction CETL study for the DEOK LDA*
- Data available on the PJM website here:
 - <http://www.pjm.com/planning/rtep-development/expansion-plan-process/ferc-order-1000/rtep-proposal-windows/2016-2017-rtep-long-term-proposal-window.aspx>

*After RTEP baseline upgrade b2831 (Upgrade the Tanner Creek - Miami Fort 345 kV circuit) is constructed

- 3 Market Efficiency Proposals
 - 1 Greenfield
 - \$12.7M
 - 2 Upgrades
 - \$0.6 - \$4.9M
- 2 proposing entities
 - Northeast Transmission Development
 - AEP

- The Reliability Pricing Model Benefit component of the Benefit/Cost Ratio evaluates the benefits of a proposed economic-based enhancement or expansion that will be realized in the capacity market and is expressed as:
 - Reliability Pricing Benefit for Regional Projects = $[.50] * [\text{Change in Total System Capacity Cost}] + [.50] * [\text{Change in Load Capacity Payment}]$
 - Reliability Pricing Benefit for Lower Voltage Projects = $[1.0] * [\text{Change in Load Capacity Payment}]$
- RPM Benefits Study Process:
 1. Determine if upgrades impact CETL values.
 2. Run RPM auction for multiple study years using updated CETL values.
 3. Measure Benefits for 15 year period.
- Total Benefits = Energy Benefits + RPM Benefits

*Only PJM transmission zones that show a decrease will be considered in determining the Change in Load Capacity Payment

Project ID: 201617_1A-1A

Proposed by: LS Power

Proposed Solution: Greenfield.

New 345 kV switching station ("Twelvemile"). Build a 345 kV switching station ("Twelvemile") interconnecting the existing Silver Grove - Zimmer 345 kV transmission line and the Pierce - Buffington 345 kV transmission line.

kV Level: 345 kV

In-Service Cost (\$M): 12.7

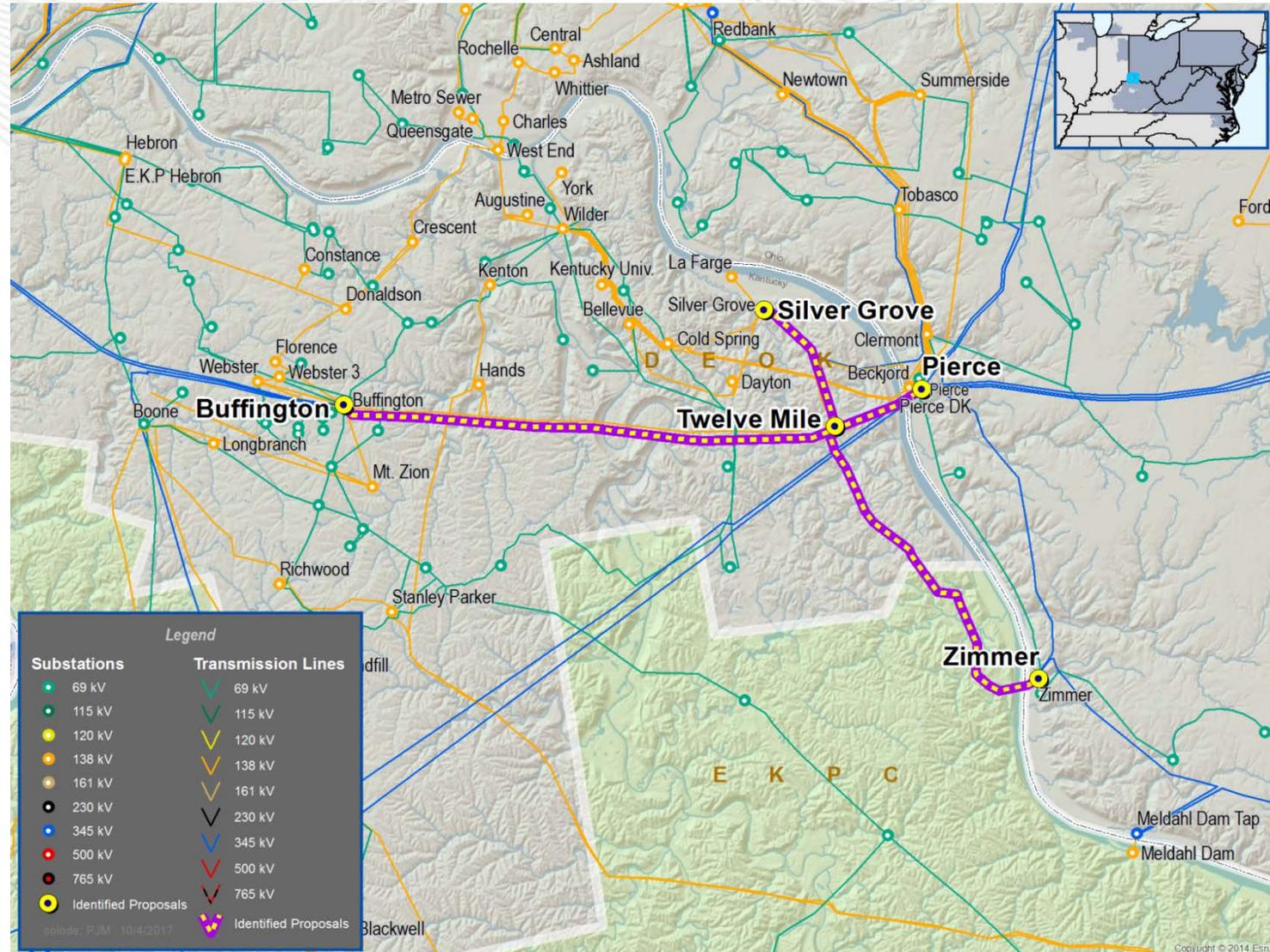
In-Service Date: 2021

Target Zone: DEOK LDA

ME Constraints:

Tanners Creek - Dearborn 345 kV

Notes: Same project was submitted as 2017_1-2E to the reliability window, PJM 2017 RTEP Proposal Window 1, to address reliability violations GD-S763, GD-S746, GD-S814, GD-S745, GD-S813; N1-S91, N1-S92, N1-S126, N1-S155, N1-S156.



Project ID: 201617_1A-2A

Proposed by: AEP

Proposed Solution: Upgrade
 Upgrade terminal equipment at Tanners Creek 345kV station
 Upgrade 345kV Bus and Risers at Tanners Creek for the Dearborn circuit.

kV Level: 345 kV

In-Service Cost (\$M): \$0.6

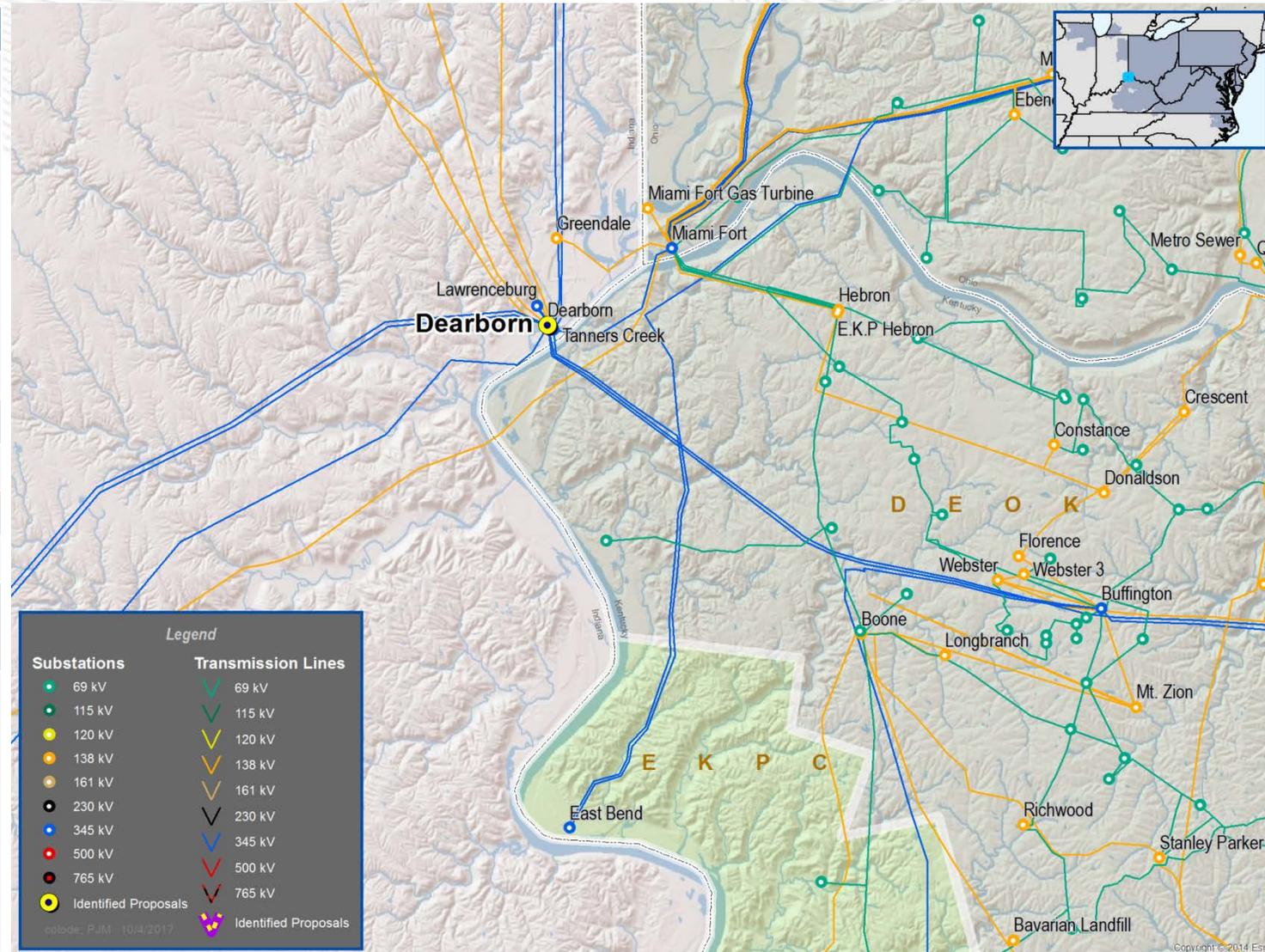
In-Service Date: 2021

Target Zone: DEOK LDA

ME Constraints:

Tanners Creek - Dearborn 345 kV

Notes: Preliminary analysis shows CETL improvement of 332 MW and high B/C ratio.



Project ID: 201617_1A-2B

Proposed by: AEP

Proposed Solution: Upgrade
 Establish Tanners Creek - Dearborn 345kV Circuit #2
 Install two 345kV CB at Dearborn station for Tanners Creek Circuits #1 and #2 and one 345kV CB at Tanners Creek for Dearborn Circuit #2.

kV Level: 345 kV

In-Service Cost (\$M): \$4.9

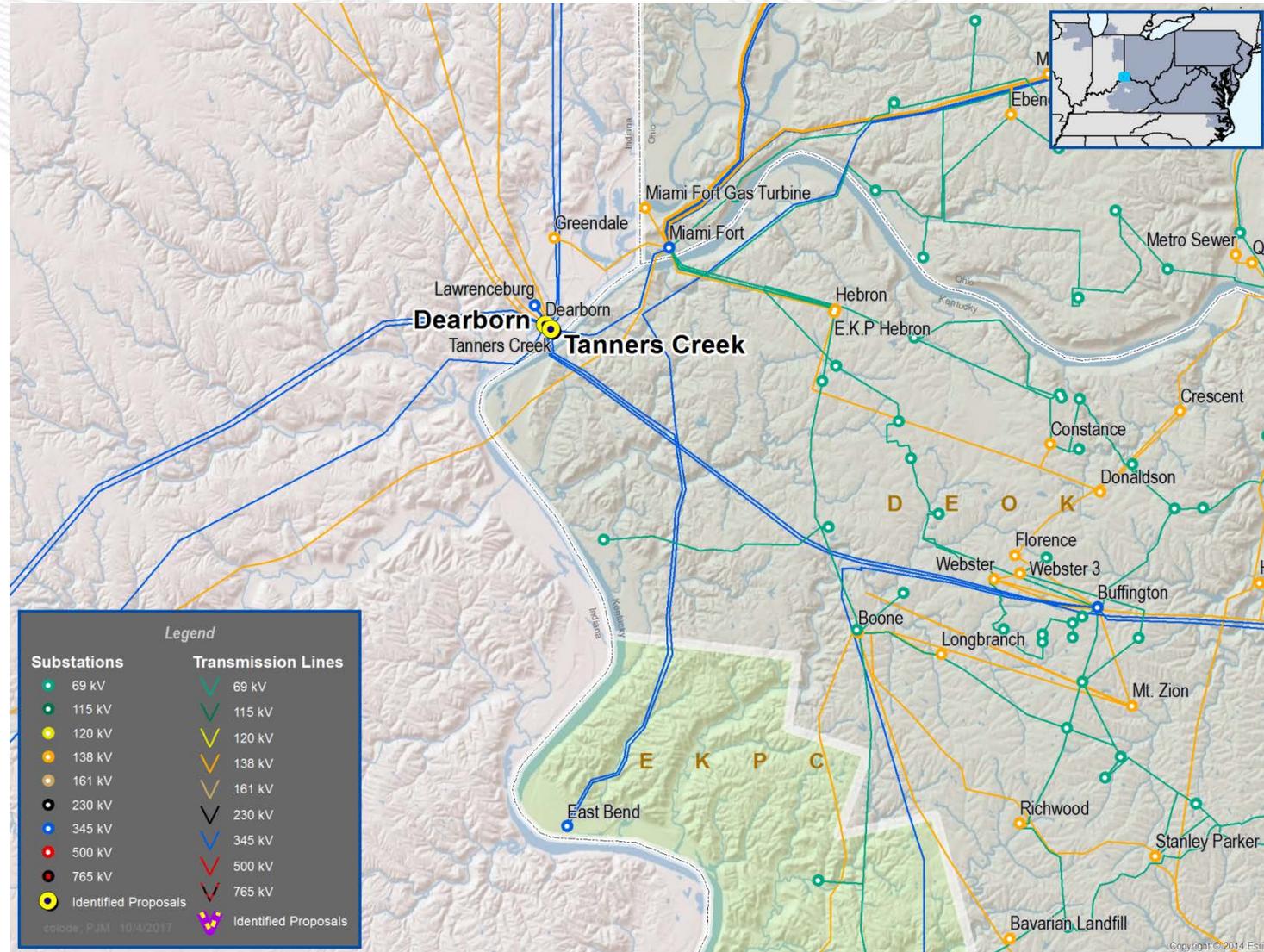
In-Service Date: 2021

Target Zone: DEOK LDA

ME Constraints:

Tanners Creek - Dearborn 345 kV

Notes:



- **Current Steps**
 - Reviewed data for projects received (completed)
 - Determine CETL impact of proposed projects (in-progress)
- **Next Steps**
 - Run RPM Base Residual Auction model for multiple study years using updated CETL values and determine RPM benefits
 - Reliability and constructability analysis
- **Project Recommendations**
 - Analysis results to be presented at Special TEAC session on 19th Oct, 2017
 - Recommend the selected project at the December Board meeting

2016-2017 Long Term Window

- Market Efficiency Base Case Mid-Cycle Update
 - Base case reposted
 - AEP Olive - Bosserman supplemental project added to the base case
 - Added flowgate modeling the PPL Wescosville supplemental project
- Analysis of proposed solutions: Oct 2017 - Dec 2017 (in-progress)
 - Portion of RPM and Interregional Projects analysis completed
 - PPL projects analysis in-progress
 - BGE projects in-progress
 - Any high-value low-risk* type projects may be analyzed in parallel with the above
 - All other regional projects will be analyzed last
- Target determination of recommended projects: Feb 2018
 - Interregional, RPM and high-value low-risk projects at Dec, 2017 Board meeting
 - BGE and other projects to be recommended at Feb, 2018 Board meeting

**High-value low-risk projects are generally classified as low cost upgrades, with significant B/C, and with minimum competition.*

Interregional Projects

- Benefits to each RTO shall be determined by that RTO using their respective regional process and metrics
- Costs shall be allocated interregionally based on pro rata share of benefits
- Projects must meet the B/C criteria in each RTO (based on allocated costs) and identified by both RTOs as the best solution to be recommended.
- Benefits type
 - PJM: Net Load Payments (NLP) benefits
 - MISO: Adjusted Production Cost (APC) benefits
- Benefits horizon
 - PJM: 15 years stream of benefits
 - MISO: 20 years
- Discount rates
 - PJM: 7.4%; MISO: 7.1%

- AEP will complete the Olive - Bosserman supplemental project to address the identified supplemental needs as presented in previous SRRTEP and TEAC meetings.
- PROMOD interregional simulations included AEP Supplemental project and Dune Acre Transformer 345/138 kV closed.
- AEP Supplemental project removed the congestion driver Olive – Bosserman.
- Coordination with MISO
 - PJM shared final benefits calculations with MISO and vice versa.
 - Projects with no MISO benefits were not considered for further interregional analysis.
- PJM is not currently recommending any Interregional project for the Olive – Bosserman congestion driver (see Appendix B for descriptions of Interregional projects).



Interregional Projects Results

Project information						PJM Benefits		MISO Benefits
Project Id	Submitter	Description	In-Service	Cost (\$M)	Constraint	BC Ratio ¹⁾	NLP (\$M)	APCP (\$M)
201617_1-10B	Nextera	Build a new 345/138 kV substation (Rolling Prairie) connecting the following an existing 345 kV line to two existing 138 kV lines.	2021	\$ 19.25	Olive-Bosserman 138 kV	0.95	\$24.87	--
201617_1-12D	AEP NIPSCO	Rebuild the 34.5 kV line between New Carlisle and Silver Lake as 138 kV. Rebuild the Michigan City - Trail Creek-Bosserman 138 kV.	2022	\$ 17.0	Olive-Bosserman 138 kV	1.06	\$24.48	--
201617_1-13H	Transource	Tap the Tanners Creek – Losantville 345 kV line and build a single circuit line to a new 345/138 station (Coyote) next to Wiley.	2022	\$ 71.89	Tanners Creek - Miami Fort 345 kV	0.27	\$26.55	--
201617_1-17B	AEP Exelon	Meadow Lake – Pike Creek 345 kV Double Circuit Greenfield Line and Pike Creek 345kV Station	2022	\$ 197.97	Olive-Bosserman 138 kV	0.24	\$49.02	\$18
201617_1-18S ²⁾	Northeast Transmission Development	Build a 345/138 kV substation ("Coffee Creek") interconnecting Green Acres to Olive 345 kV line and Flint Lake to Luchtman Road 138 kV line.	2022	\$ 17.40	Olive-Bosserman 138 kV	0.47	\$10.07	\$1.85
201617_1-1A ³⁾	WPPI	Provide a second New Carlisle-Olive 138 kV circuit. Upgrade substation equipment at New Carlisle and Olive substations.	2020	\$ 2.50	Olive-Bosserman 138 kV	0.31	\$1.07	--
201617_1-9A	NIPSCO	Reconductor existing NIPSCO line sections between AEP Bosserman and Olive 138 kV substations and between AEP Bosserman and New Carlisle 138 kV substations.	2020	\$ 8.00	Olive-Bosserman 138 kV	0	--	--
201617_1-9B	NIPSCO	New NIPSCO line section between Thayer and Morrison 138 kV substations.	2023	\$ 42.50	Paxton-Gifford 138 kV	1.8	\$46.8	\$76

Notes: 1. Regional PJM B/C Ratio estimated based on current PJM and MISO regional benefits, and PJM estimated cost allocation.

2. 201617_1-18S does not fully solve Olive – Bosserman congestion driver.

3. WPPI interest in 201617_1-1A is limited to submitting the project description. If approved this upgrade will be assigned to the incumbent TO (AEP).

- Comparing MISO and PJM regional benefits, project 9B, new Thayer – Morrison 138 kV line, may be considered as a potential Interregional project
- RTOs will split interregional costs and determine regional B/Cs
- Perform M2M coordination, and no-harm reliability test on potential interregional project
- Results will be presented at the IPSAC meeting on Oct. 20th, 2017

PPL Group Evaluation

- Base Case Mid-cycle Update 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 around Wescosville 500/138 kV transformer

- No FSA Sensitivity Scenario
 - Significant portion of congestion was identified to be related to nearby FSA units.
 - PJM currently performing a No FSA sensitivity scenario that excludes FSA units in the PPL zone.
- Sensitivity Scenarios around the Wescosville transformer
 - Wescosville 230/138 kV operated as normally open
 - Wescosville 230/138 kV operated as normally closed
- Cost/Constructability evaluation

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 December TEAC



Market Efficiency TEAC updates and anticipated Board Reviews

- Upcoming TEAC Meetings
 - 10/12 TEAC Market Efficiency Update – Today’s Meeting
 - 10/19 Special TEAC Market Efficiency Update (WebEx)
 - 2016/17 Long Term Window – RPM Market Efficiency Recommendations (1st read)
 - 11/2 Special TEAC Reliability and Market Efficiency Update (WebEx)
 - 2016/17 Long Term Window – RPM Market Efficiency Recommendations (2nd read)
 - 12/14 – TEAC Market Efficiency Analysis Update
 - Acceleration Analysis Results
- Anticipated PJM Board Review
 - 10/17 PJM Board of Managers Review of September TEAC Recommendations
 - 12/4 – PJM Board of Managers Review of November TEAC Recommendations

Note: If necessary, additional online/teleconference meetings to be held to review potential and recommended solutions

Appendix A

2016/17 Long Term Window Proposals PPL 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

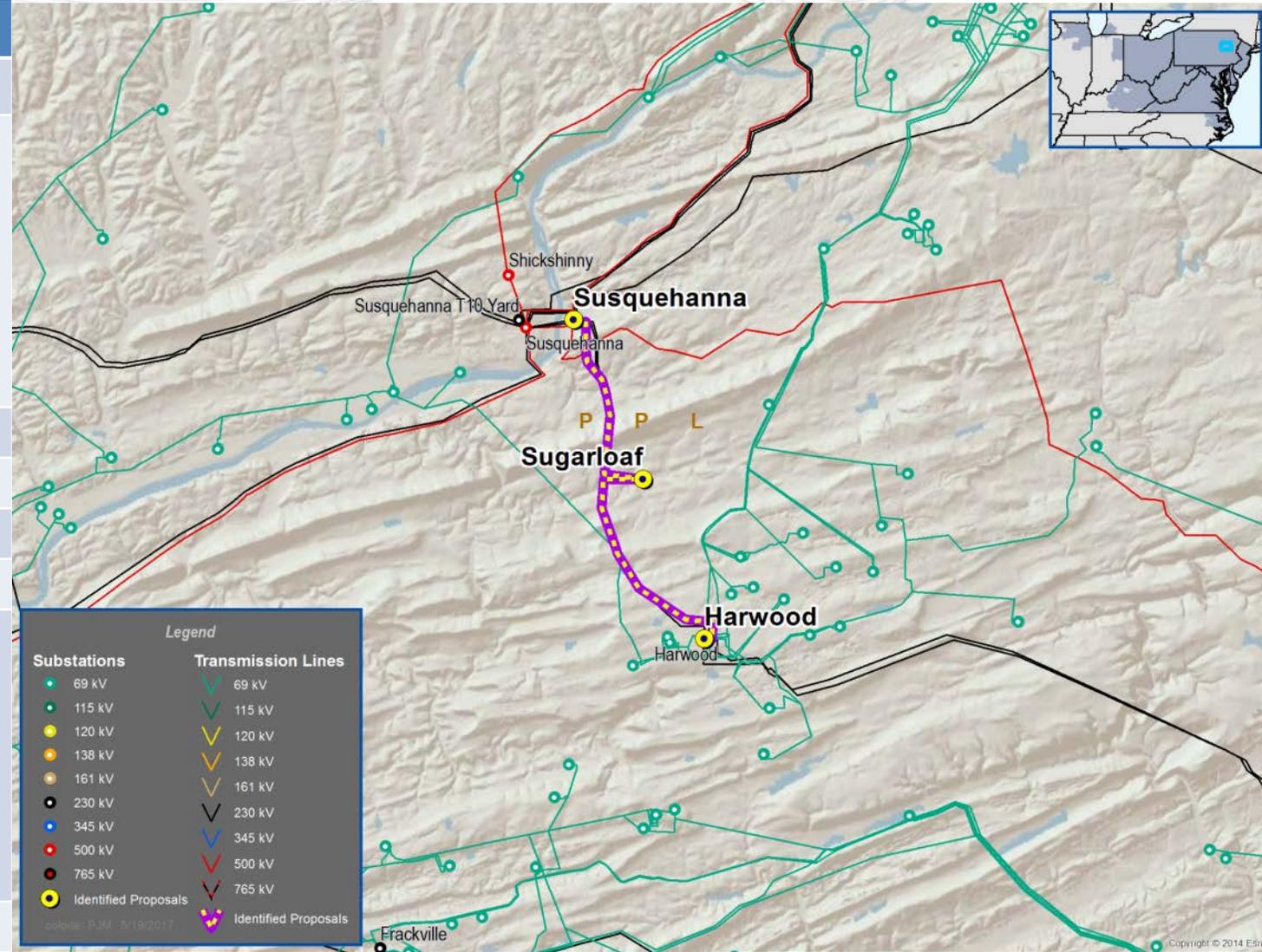
In-Service Cost (\$M): \$13.13

In-Service Date: 2021

Target Zone: PPL

ME Constraints:
 SUSQUEHANNA - HARWOOD 230 kV

Notes:



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

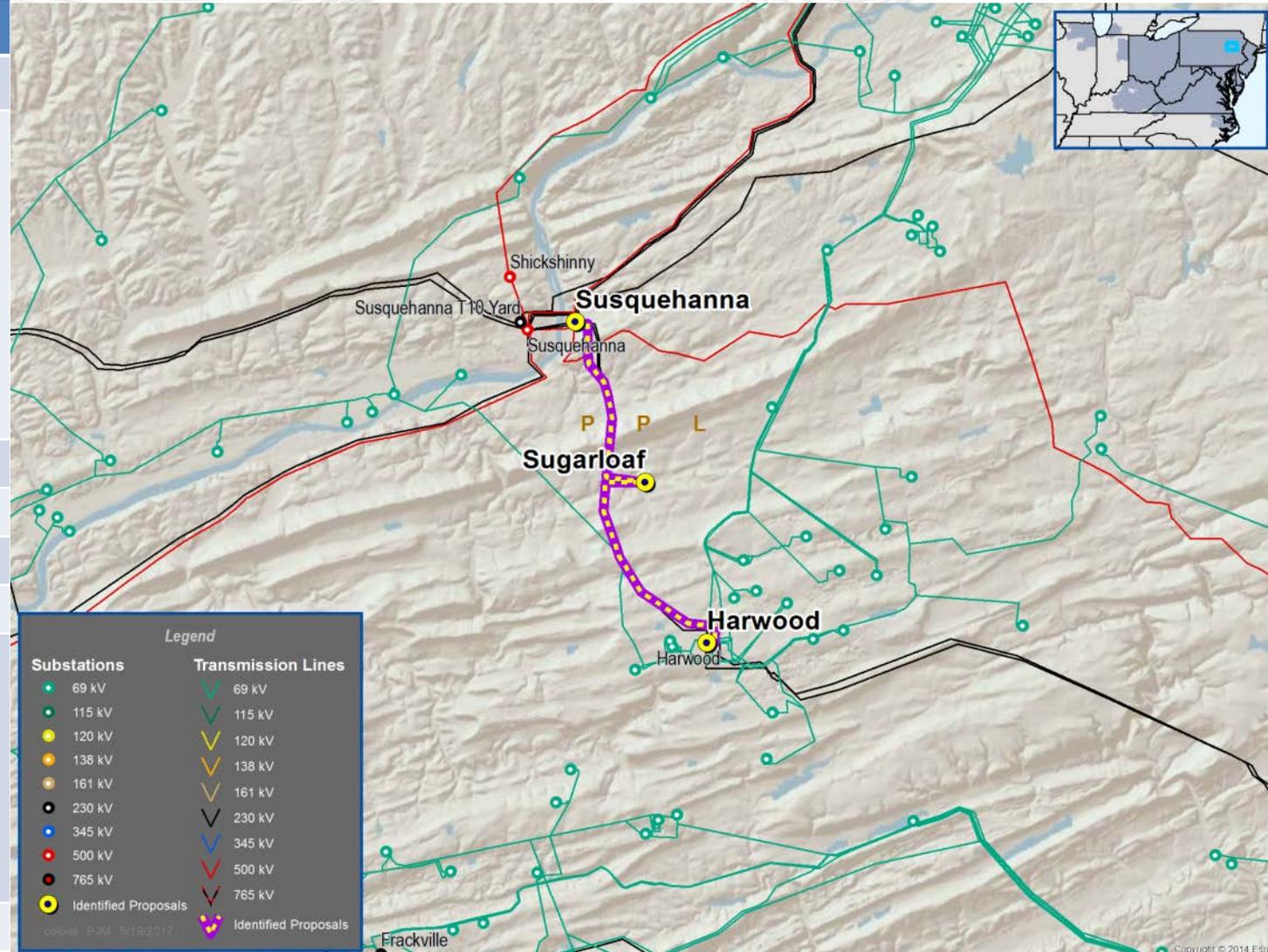
In-Service Cost (\$M): \$13.01

In-Service Date: 2021

Target Zone: PPL

ME Constraints:
 SUSQUEHANNA - HARWOOD 230 kV

Notes:



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

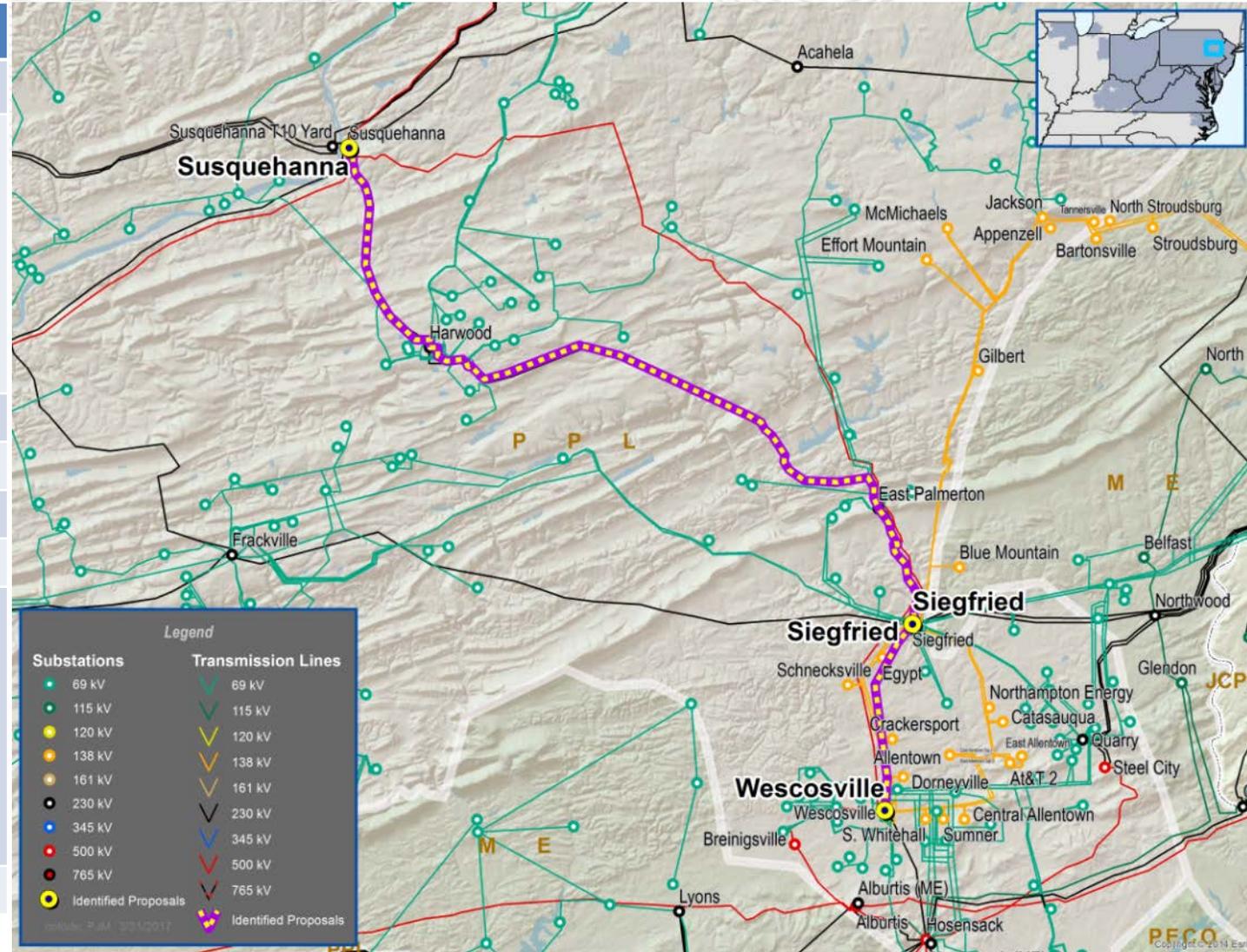
In-Service Cost (\$M): \$18.32

In-Service Date: 2021

Target Zone: PPL

ME Constraints:
 SUSQUEHANNA - HARWOOD 230 kV

Notes:



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 kV

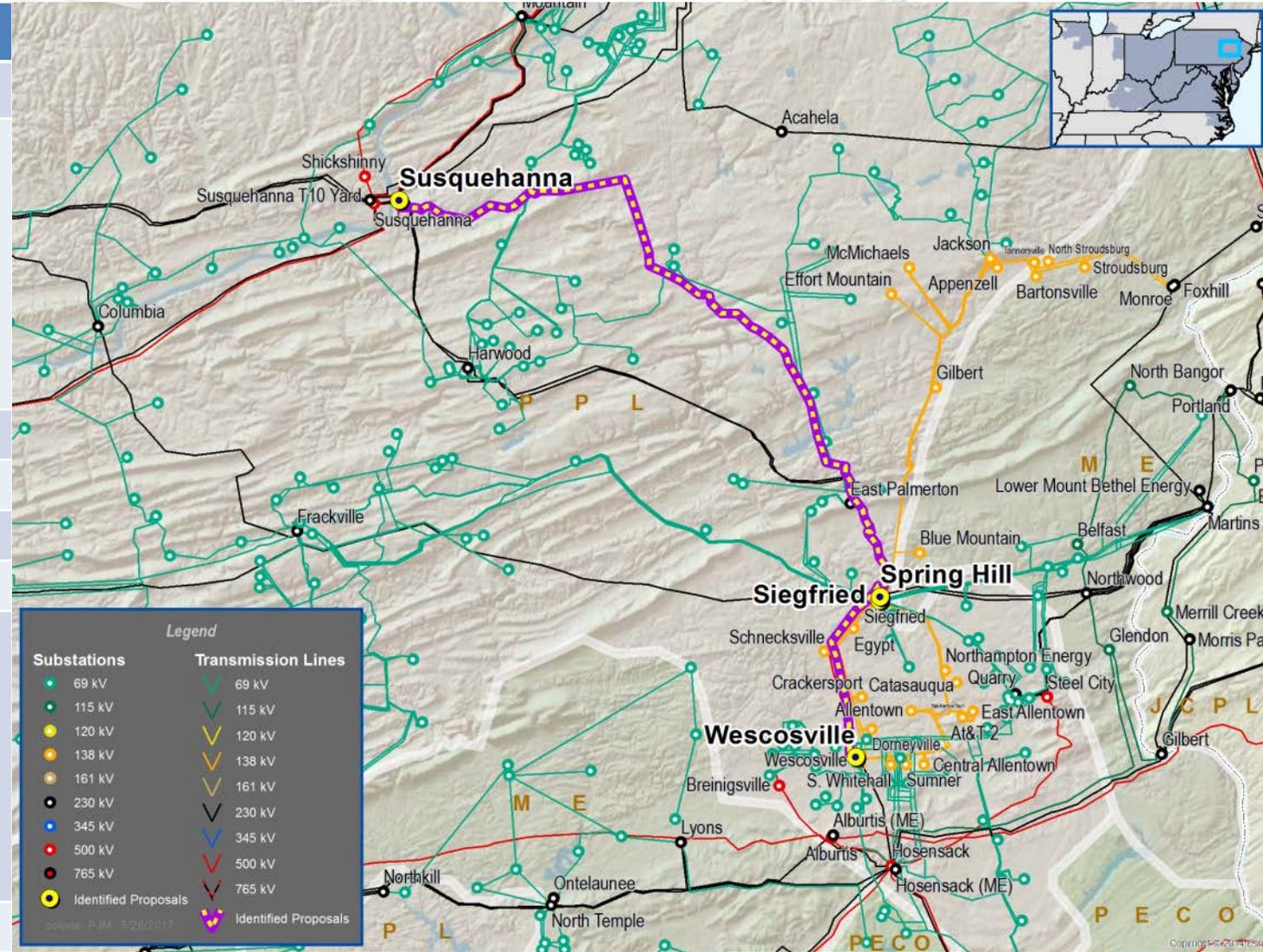
In-Service Cost (\$M): \$33.8

In-Service Date: 2021

Target Zone: PPL

ME Constraints:
 SUSQUEHANNA - HARWOOD 230 kV

Notes:



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

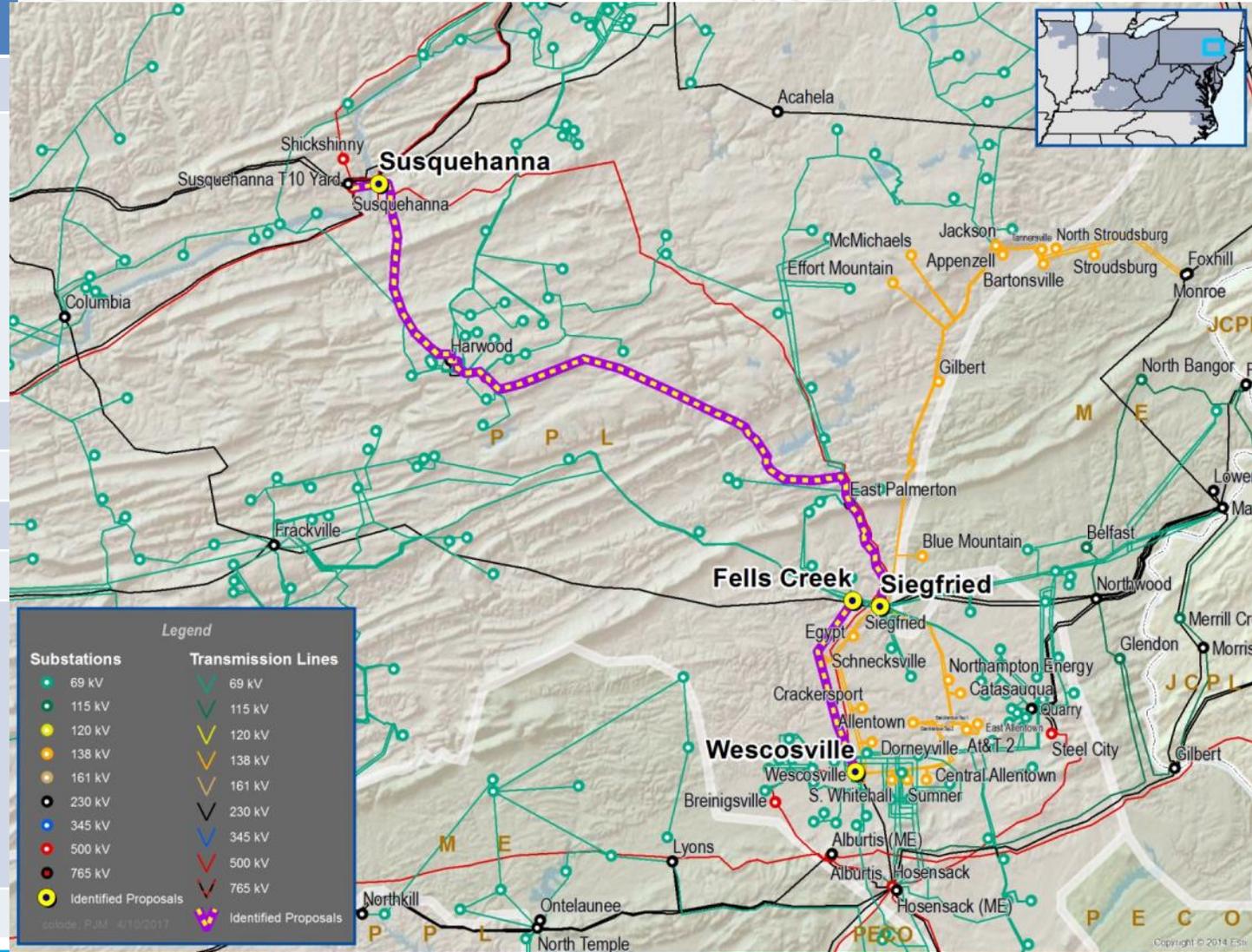
In-Service Cost (\$M): \$31.20

In-Service Date: 2021

Target Zone: PPL

ME Constraints:
 SUSQUEHANNA - HARWOOD 230 kV

Notes:



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

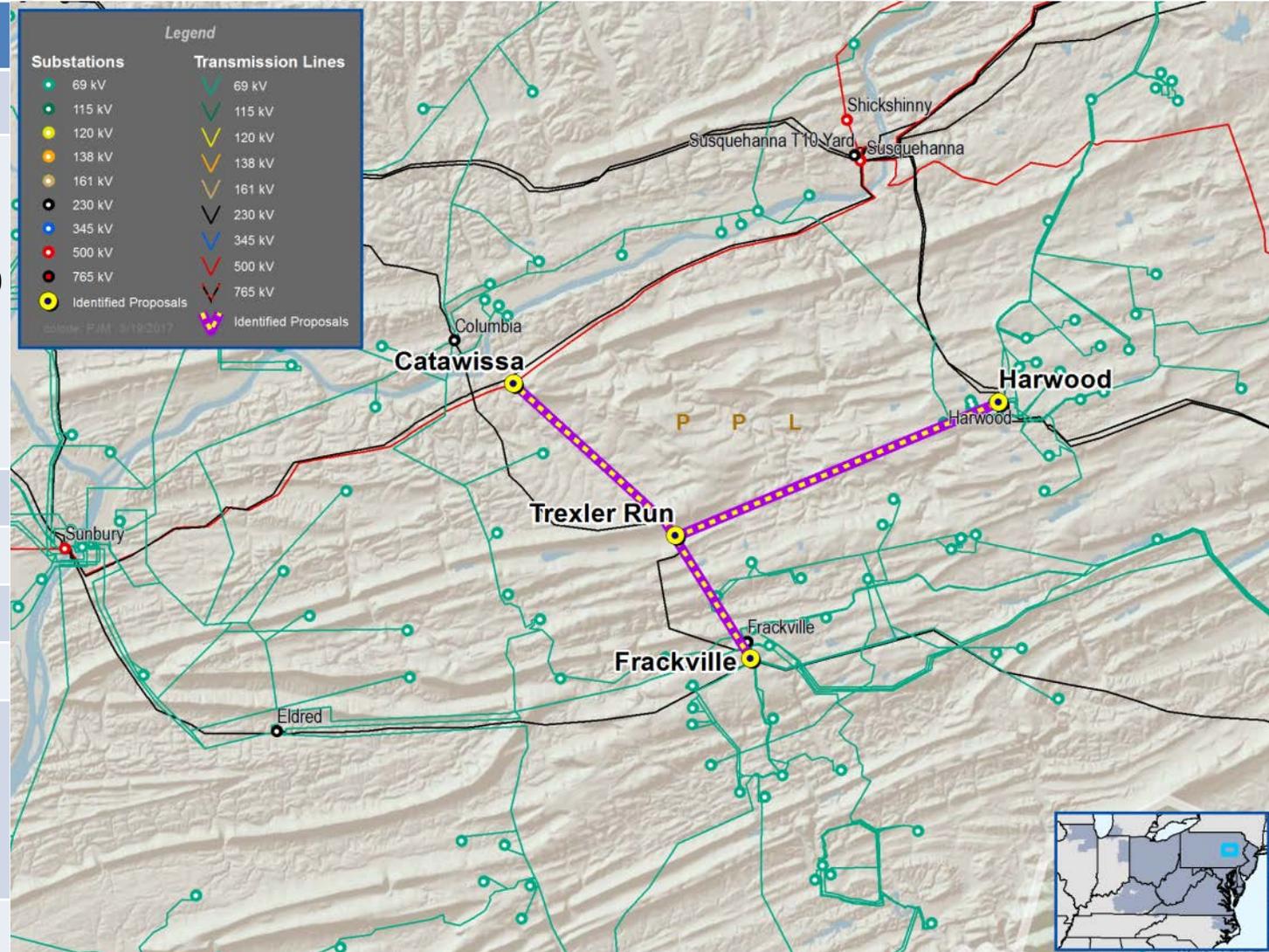
In-Service Cost (\$M): \$32.00

In-Service Date: 2021

Target Zone: PPL

ME Constraints:
 SUSQUEHANNA - HARWOOD 230 kV

Notes:



Appendix B - Interregional Projects Descriptions



AEP/COMED/NIPSCO Interregional Proposals

- **7 Projects:**

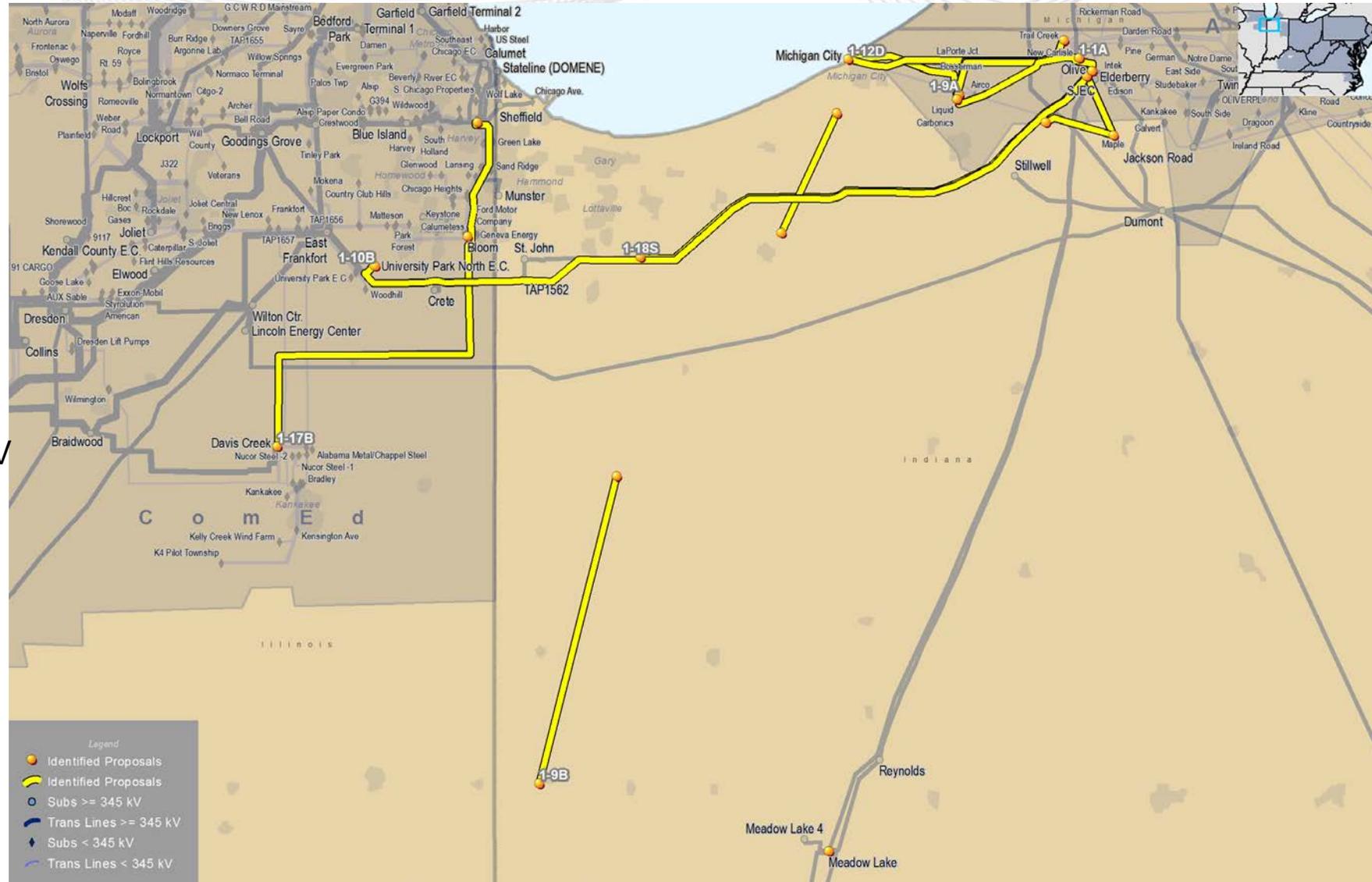
- 1-1A, 1-9A, 1-9B, 1-10B, 1-12D, 1-17B, 1-18S

- **Cost:**

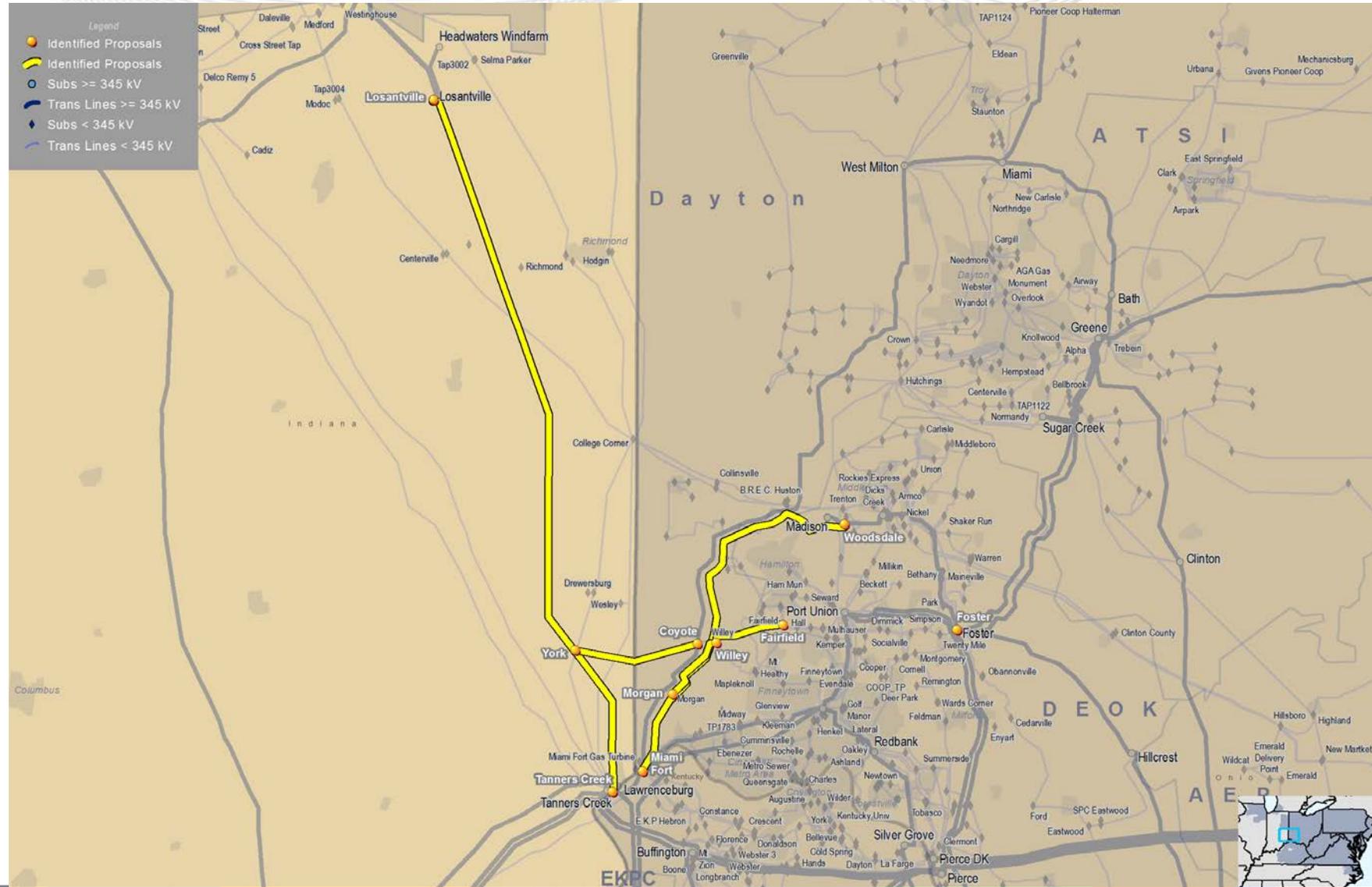
- From \$1.00 M to \$197.97 M

- **ME Constraints:**

- BOSSERMAN - OLIVE 138 kV
- PAXTON - GIFFORD 138 kV



- **1 Project:**
 - 1-13H
- **Cost:**
 - \$71.88 M
- **ME Constraint:**
 - TANNERS CREEK - MIAMI FORT 345 kV
- **2020/2021 RPM BRA Results**
 - DEOK LDA binding with Tanners Creek - Miami Fort 345KV as limiting CETL constraint



Project ID: 201617_1-1A

Proposed by: WPPI

Proposed Solution: Interregional
 Provide a second New Carlisle-Olive 138 kV circuit. Upgrade substation equipment at New Carlisle and Olive substations.

kV Level: 138 kV

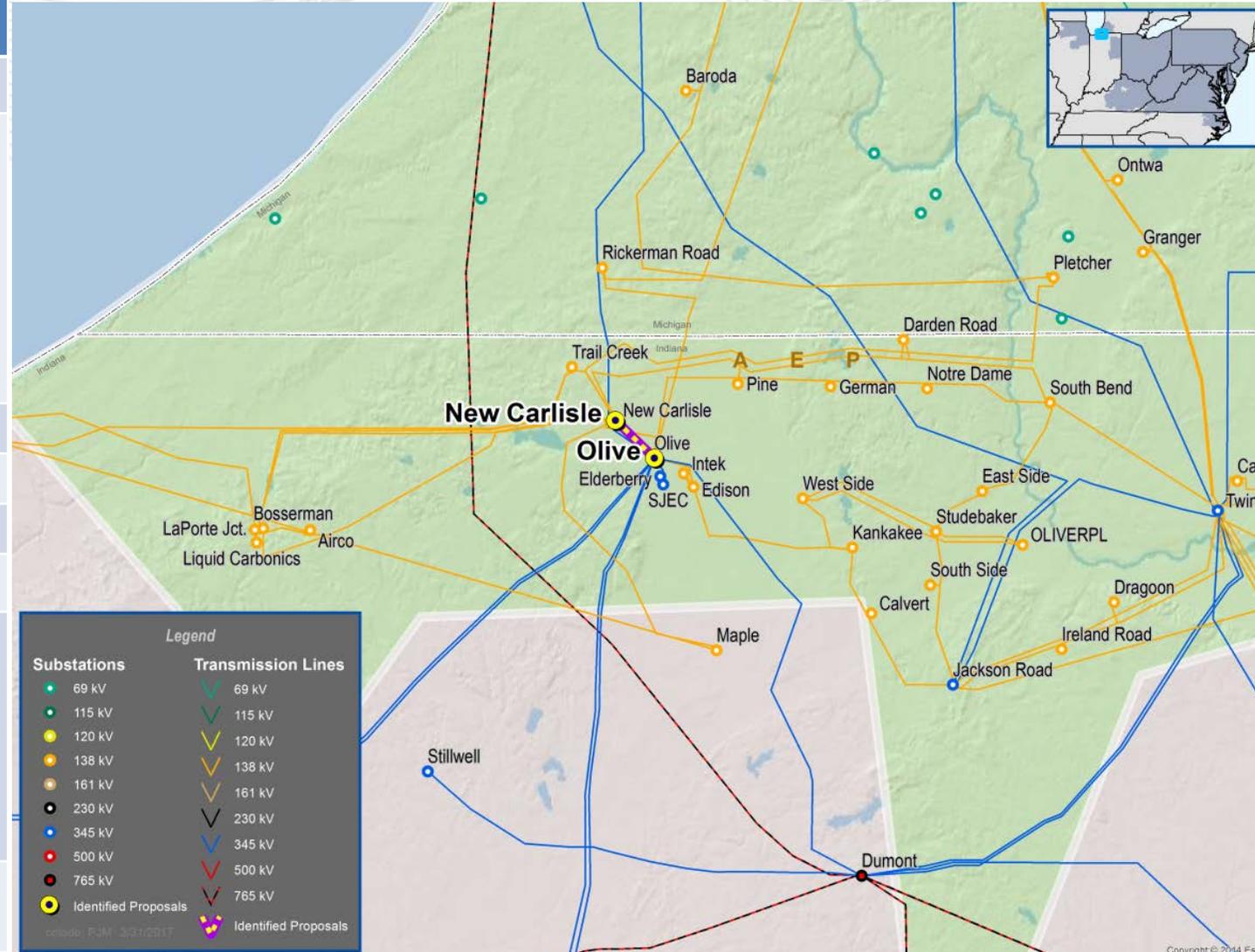
In-Service Cost (\$M): \$2.5

In-Service Date: 2019

Target Zone: AEP

ME Constraints:
 OLIVE - BOSSERMAN 138 kV

Notes:



Project ID: NIPSCO 1-9A

Proposed by: NIPSCO

Proposed Solution: Interregional Reconductor existing NIPSCO line section between AEP Bosserman and Olive 138 kV substations. Reconductor existing NIPSCO line section between AEP Bosserman and New Carlisle 138 kV substations.

kV Level: 138 kV

In-Service Cost (\$M): \$8.00

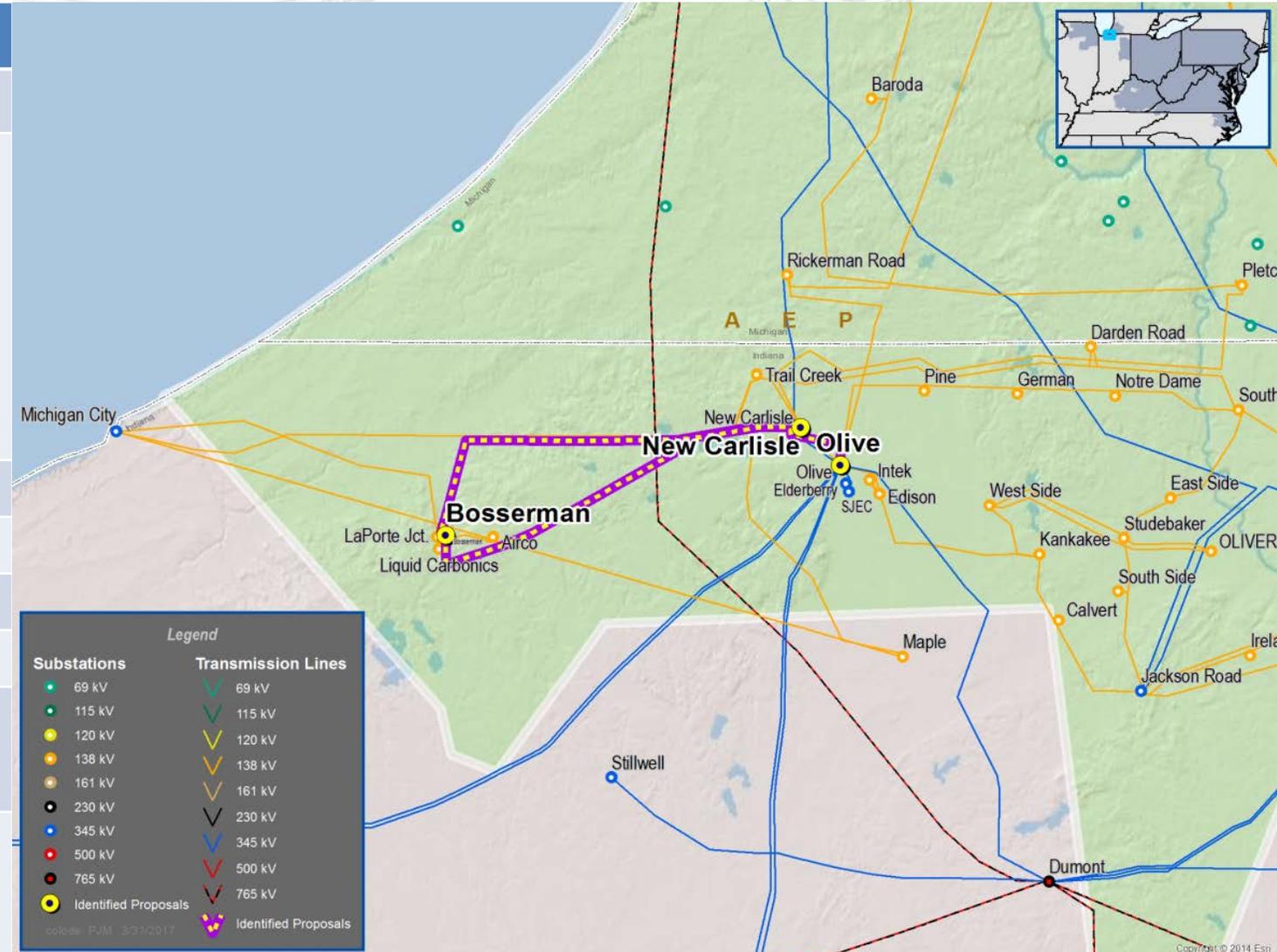
In-Service Date: 2019

Target Zone: AEP NIPSCO

ME Constraints:

OLIVE - BOSSERMAN 138 kV

Notes:



Project ID: 201617_1-9B

Proposed by: NIPSCO

Proposed Solution: Greenfield, Interregional
 New NIPSCO line section between Thayer and Morrison 138 kV substations.

kV Level: 138 kV

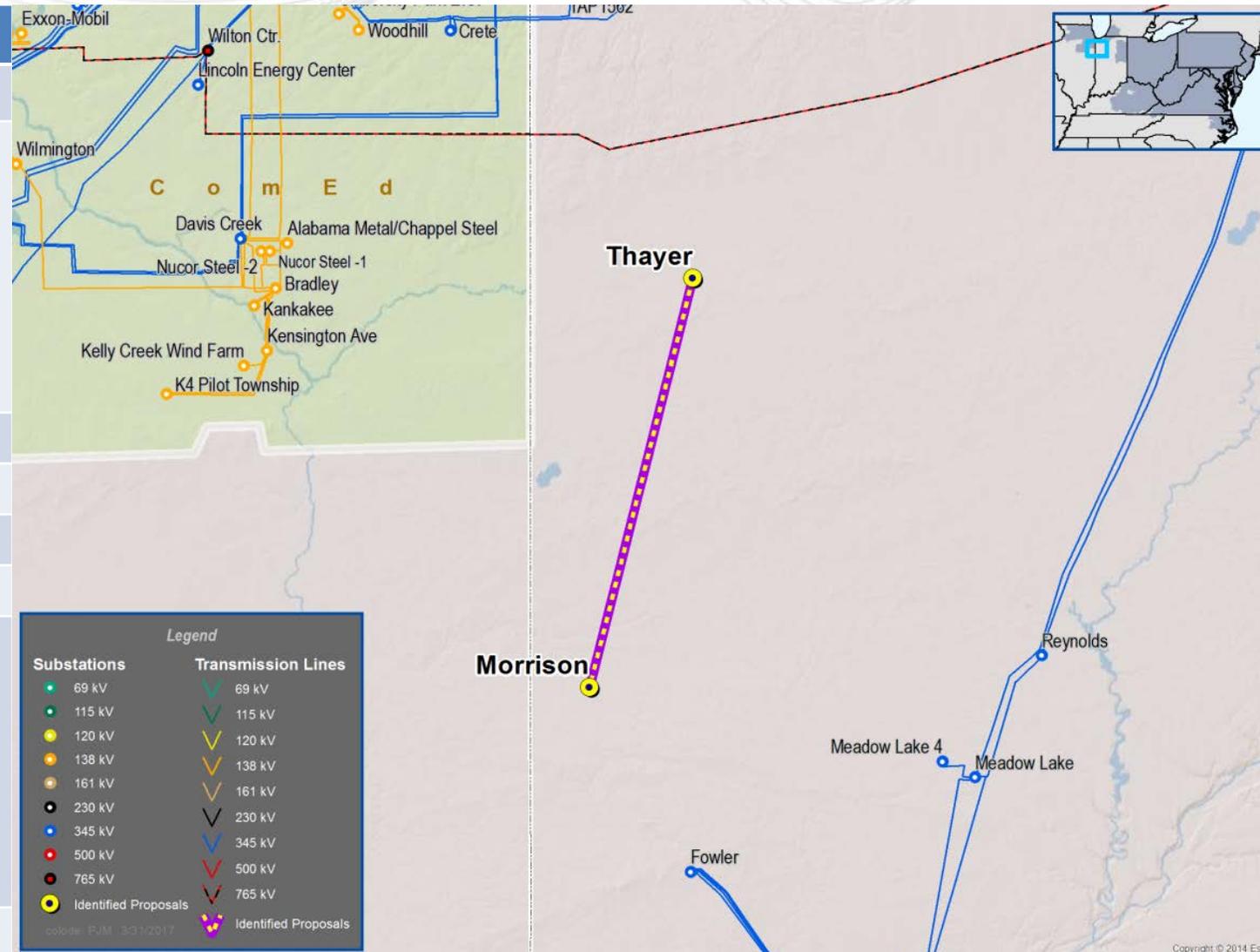
In-Service Cost (\$M): \$42.50

In-Service Date: 2022

Target Zone: AML ComEd NIPSCO

ME Constraints:
 PAXTON - GIFFORD 138 kV

Notes:



Project ID: 201617_1-10B

Proposed by: Nextera

Proposed Solution: Greenfield, Interregional
 Cut the University Park - Olive 345 kV and tie into a new 345/138 kV substation (Rolling Prairie). Cut the Maple - New Carlisle 138 kV and Maple - LNG 138 kV lines and tie into the new substation.

kV Level: 138 kV

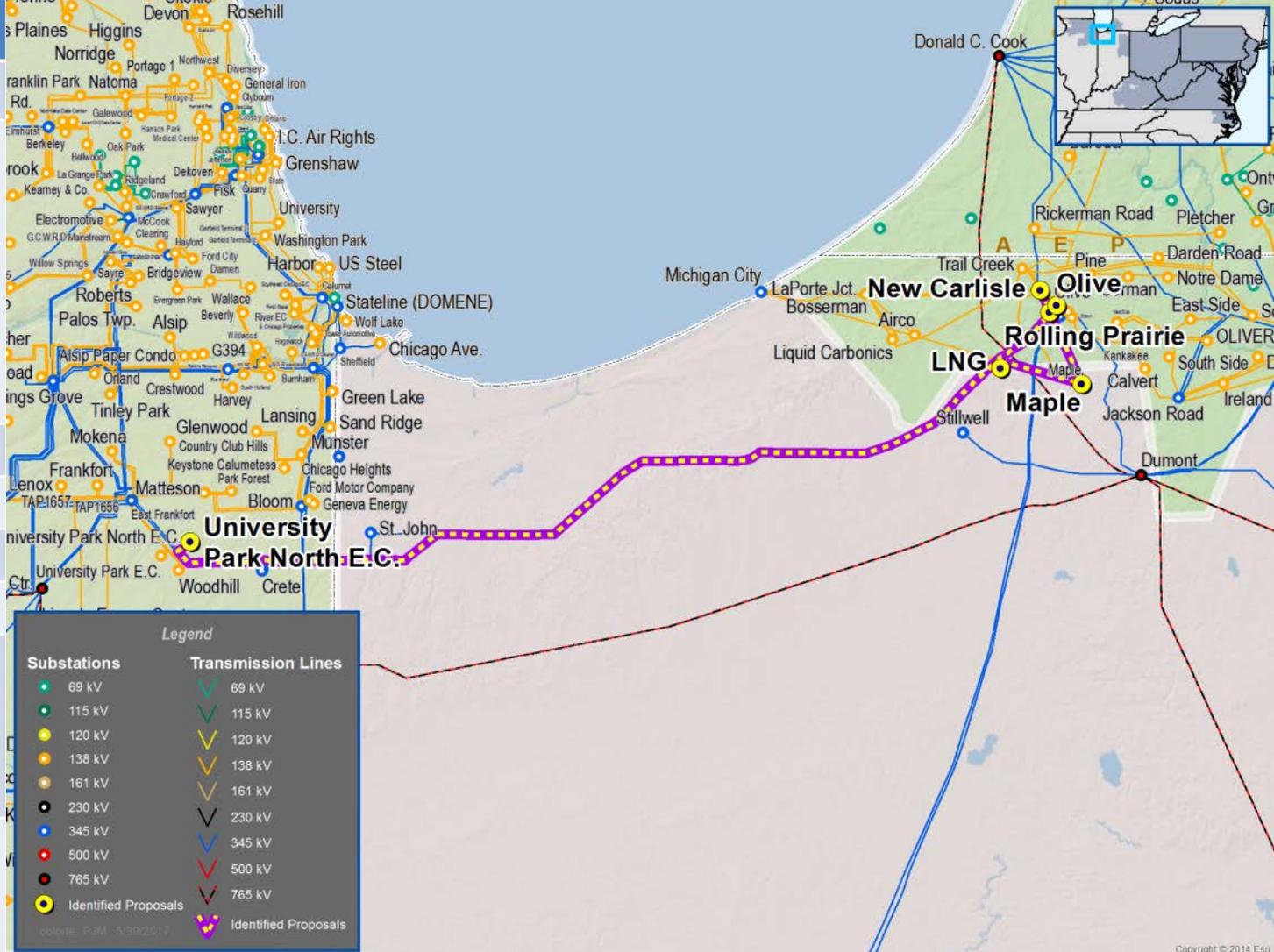
In-Service Cost (\$M): \$19.2

In-Service Date: 2021

Target Zone: AEP

ME Constraints:
 BOSSERMAN - OLIVE 138 kV

Notes:



Project ID: 201617_1-12D

Proposed by: AEP NIPSCO

Proposed Solution: Interregional

Terminate Olive-Bosserman 138 kV line at New Carlisle. Rebuild the 34.5 kV line between New Carlisle and Silver Lake as double circuit 138 kV, operating one circuit as 34.5 kV while extending the other at 138 kV with a new circuit to Liquid Carbonics. Establish an Olive-Liquid Carbonics-Bosserman 138 kV line. Rebuild the Michigan City-Trail Creek-Bosserman 138 kV.

kV Level: 138 kV

In-Service Cost (\$M): \$41.86

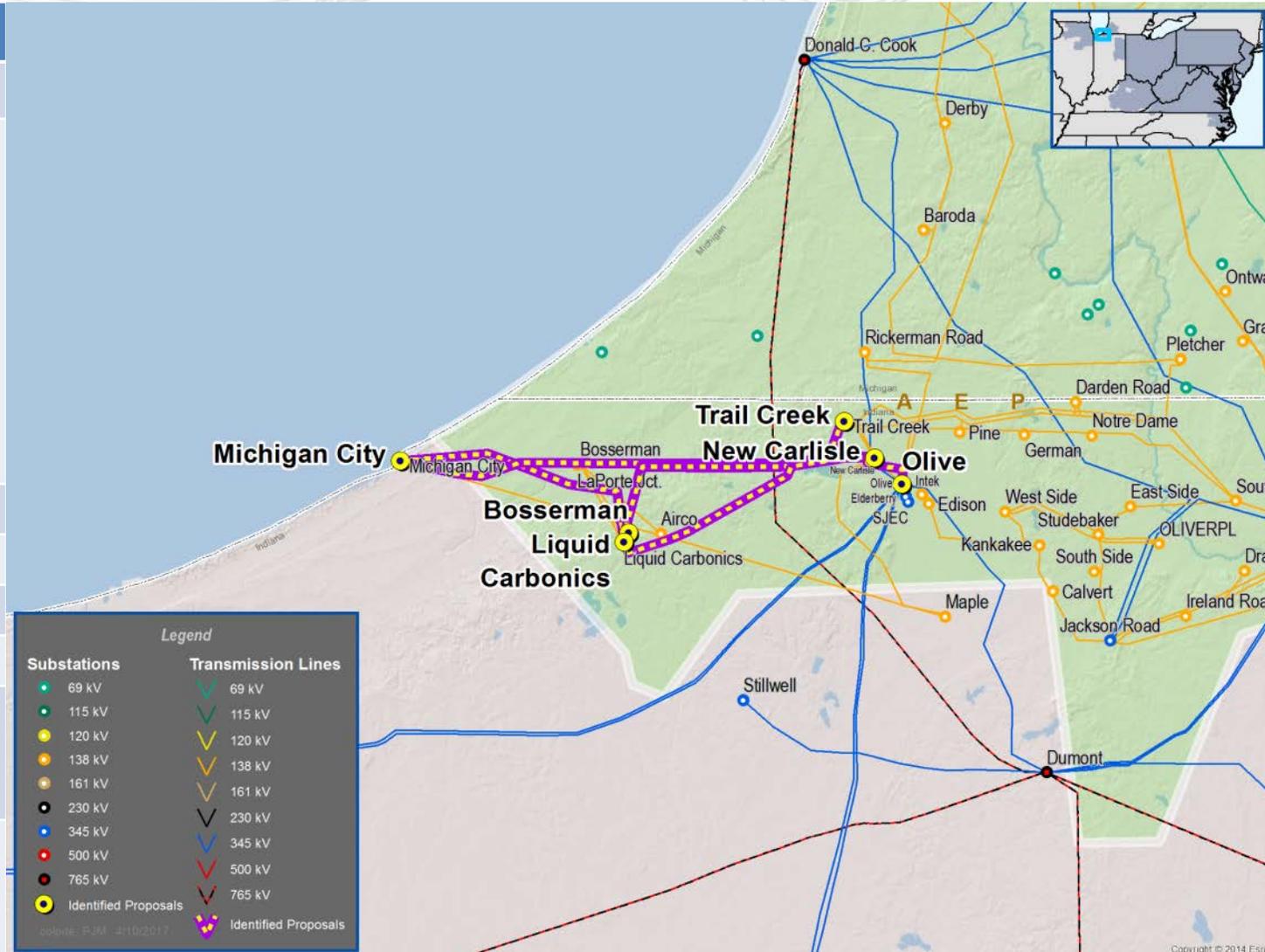
In-Service Date: 2021

Target Zone: AEP

ME Constraints:

OLIVE - BOSSERMAN 138 kV

Notes:



Project ID: 201617_1-13H

Proposed by: Transource

Proposed Solution: Greenfield, Interregional
 Tap the Tanners Creek - Losantville 345 kV line and build a new 345 kV switchyard (York). Tap the Miami Fort - Woodsdale 345 kV line and build a new 345/138 kV substation (Coyote) next to Wiley 138kV switchyard. Build a new 345 kV line between York and Coyote stations. Expand Wiley 138 kV switchyard by tying the Coyote 345/138 kV transformer into the Wiley 138 kV yard. Loop the Morgan-Fairfield 138 kV line into Wiley 138 kV station. Install a new 345/138 kV transformer at Foster substation.

kV Level: 138/345 kV

In-Service Cost (\$M): \$71.89

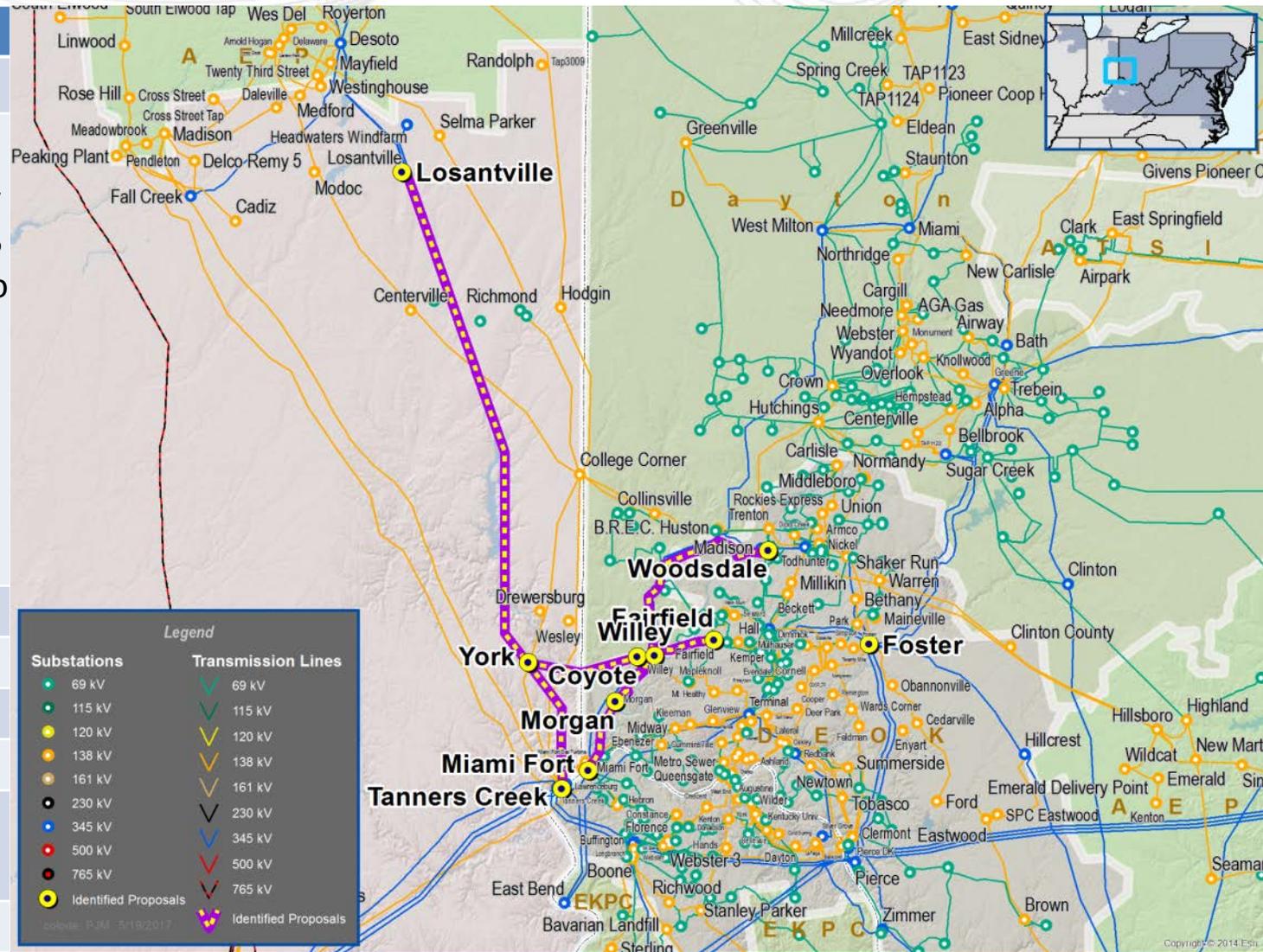
In-Service Date: 2021

Target Zone: DEOK

ME Constraints:

TANNERS CREEK - MIAMI FORT 345 kV

Notes:



Project ID: 201617_1-17B

Proposed by: AEP Exelon

Proposed Solution: Greenfield, Interregional
 Build a new 345 kV switchyard (Pike Creek). Build a new Meadow Lake - Pike Creek 345 kV double circuit line. Loop the Bloom - Davis Creek 345 kV line and Burnham - Davis Creek 345 kV line into Pike Creek switchyard.

kV Level: 345 kV

In-Service Cost (\$M): \$197.97

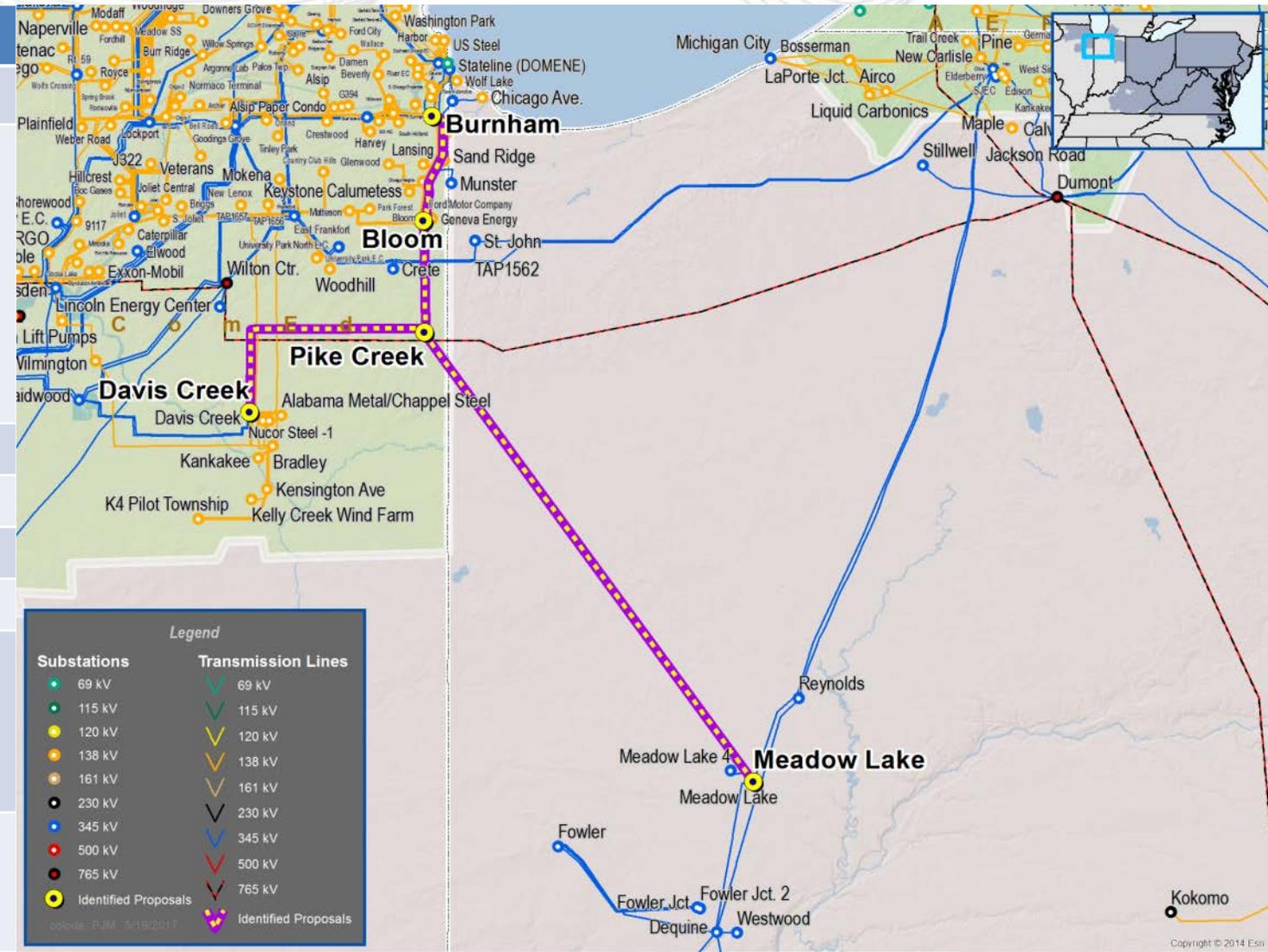
In-Service Date: 2021

Target Zone: ComEd

ME Constraints:

OLIVE - BOSSERMAN 138 kV + RPM Benefits

Notes:



Project ID: 201617_1-18S

Proposed by: Northeast Transmission Development

Proposed Solution: Greenfield, Interregional
 Tap the Green Acres - Olive 345 kV line and build a new 345/138 kV substation (Coffee Creek). Loop the Flint Lake to Luchtman Road 138 kV line into Coffee Creek.

kV Level: 138/345 kV

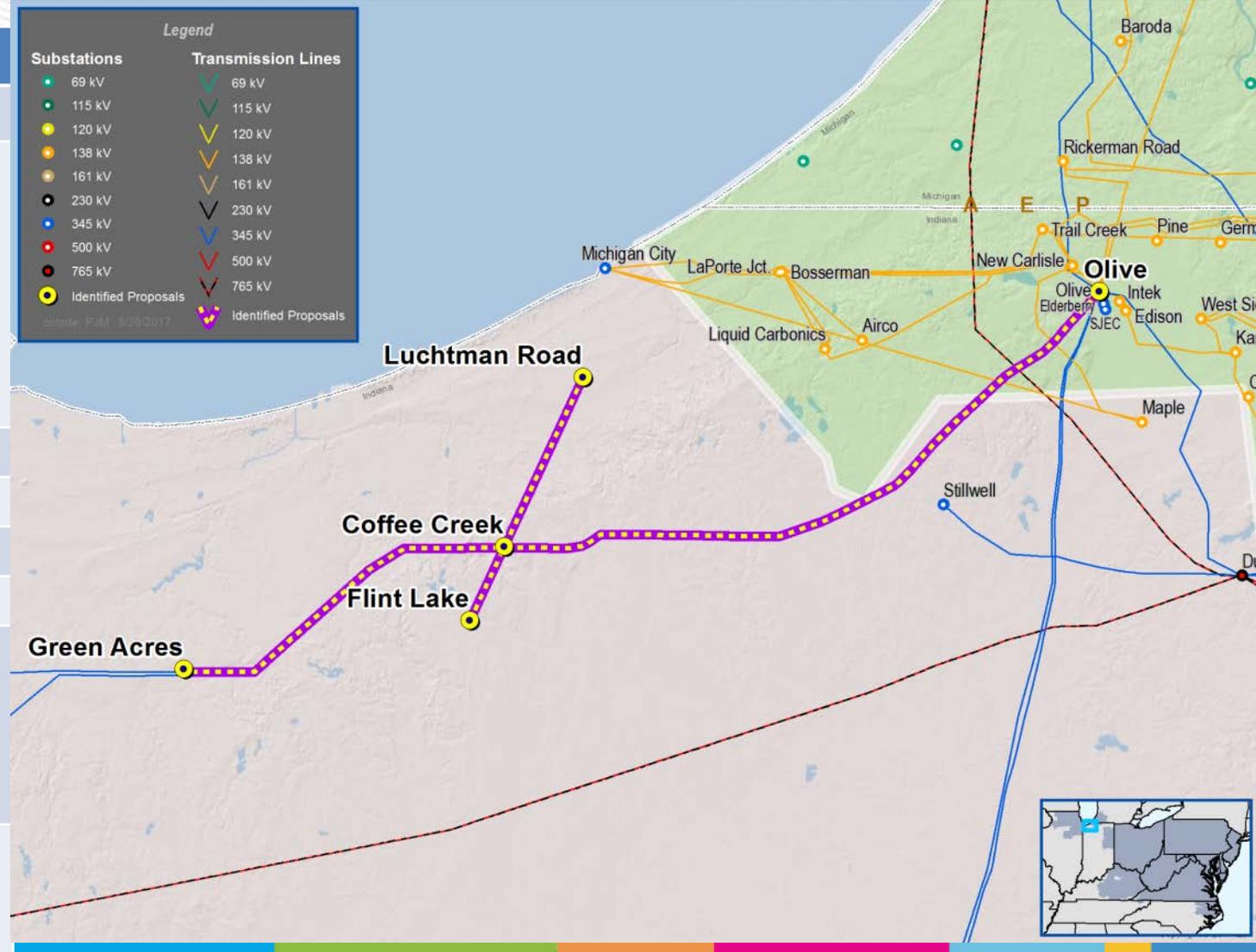
In-Service Cost (\$M): \$17.4

In-Service Date: 2021

Target Zone: AEP

ME Constraints:
 OLIVE - BOSSERMAN 138 kV

Notes:



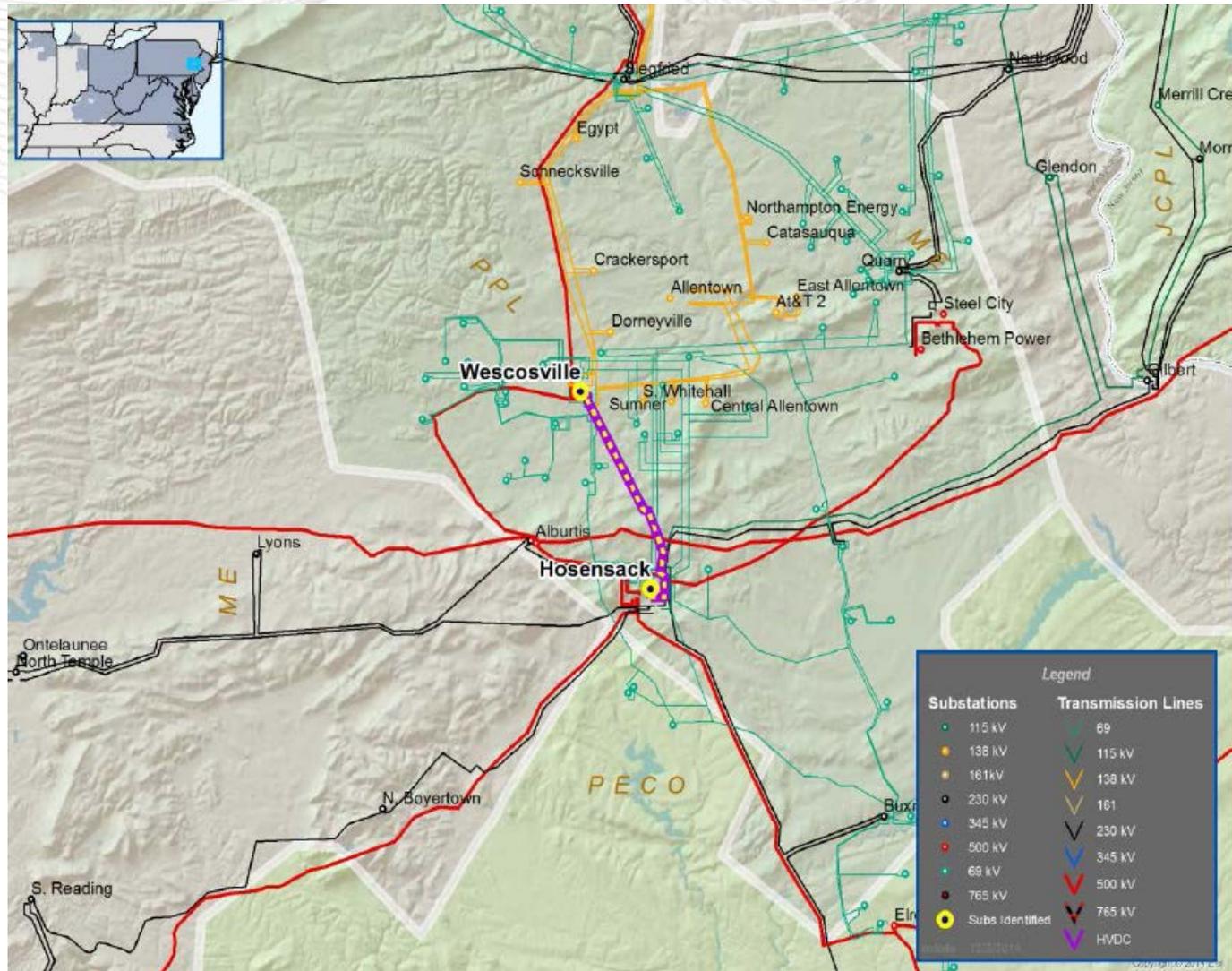
Appendix C – PPL Supplemental Project Wescosville Transformer 230/138 kV



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 Alburdis – 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



Appendix D - AEP Supplemental Project Olive – Bosserman 138 kV

Supplemental Project: Olive-Bosserman 138 kV
Previously Presented at 4/13/2017 TEAC and 4/21/2017 Western SRTEAC

Problem Statement/Driver:

The LaPorte Junction - New Carlisle 34.5 kV circuit has a vintage from 1930s and is wood pole construction. Between 2010-2015, ~2 million customer minutes of interruption (CMI) were recorded at Silver Lakes station. There are 183 open conditions, 95 of which are category A conditions on the ~20 mile long line.

Indiana and Michigan Power Company has requested to convert Silver Lake and Springville to 138 kV operation.

This project would also resolve congestion on the Olive-Bosserman 138 kV identified during MISO-PJM JOA market efficiency studies in addition to addressing the a potential overload identified on this facility during the PJM 2021 RTEP. It was submitted (without the new distribution station additions) to the PJM reliability and market efficiency windows.

Recommended Solution:

Construct two 138/12 kV distribution stations, Bootjack and Marquette, to replace Silver Lake 34.5 kV and Springville 69 kV stations. (S1279.1)

Cut the existing Olive – Bosserman line into New Carlisle station. (S1279.2)

Rebuild sections of the LaPorte Junction-New Carlisle/New Buffalo 34.5 kV line to 138 kV to establish Bootjack-Olive 138 kV circuit. (S1279.3)

Install a three way phase over phase switch, called Kuchar, near Liquid Carbonics station and construct a new 138 kV line between Bootjack and Kuchar. (S1279.4)

Construct a 138 kV extension to Marquette station by tapping the Bosserman-Liquid Carbonics 138 kV line. (S1279.5)

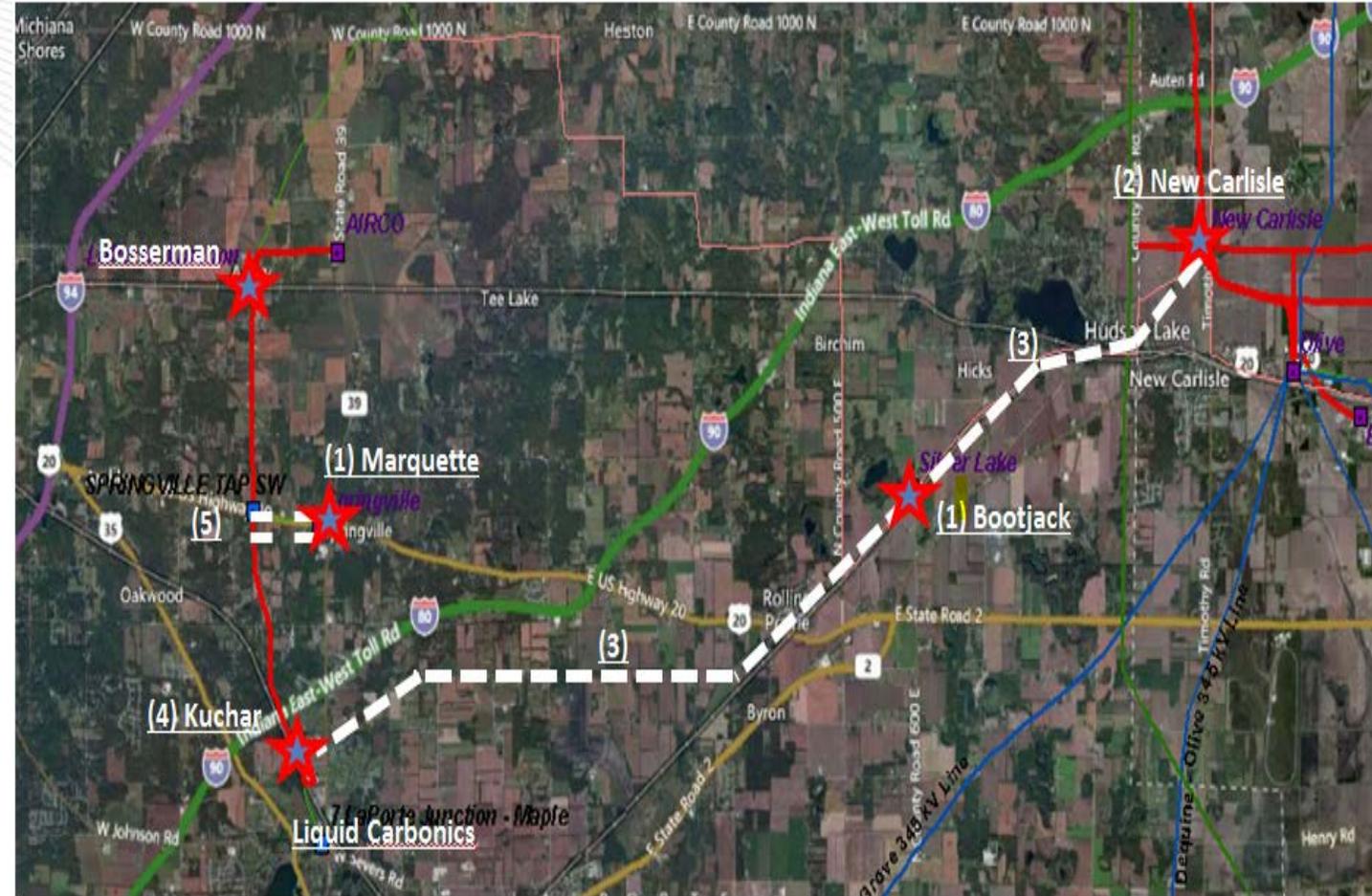
Alternatives:

Rebuild ~20 mile long New Carlisle – LaPorte Junction 34.5 kV utilizing existing line ROW corridor. This alternative was not selected because it did not provide the operational flexibility & efficiency and customer service benefits provided by the preferred option. Estimated cost: ~\$32M

Cost Estimate: \$36.786M

Projected IS date: 12/1/2019

Status: Conceptual



- Revision History
 - V1 – 10/09/2017 – Original Version Posted to PJM.com
 - V2 – 10/12/2017
 - Slides 6,7,8 corrected ME Constraint to “Tanners Creek - Dearborn 345 kV”
 - Inserted slide 23 “Upcoming TEAC meetings”