



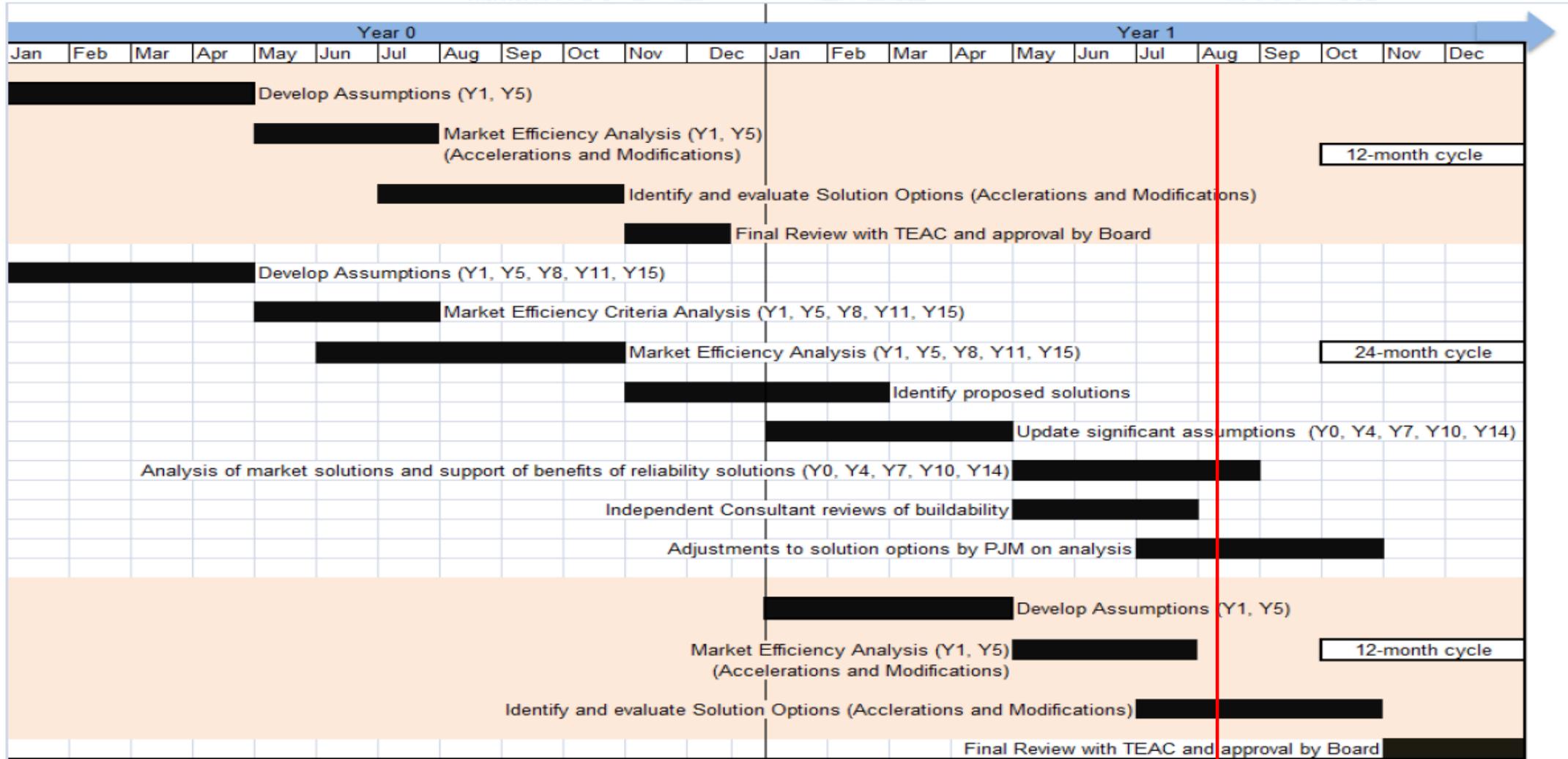
Market Efficiency Update

Transmission Expansion Advisory Committee
August 10, 2017





Where we are - Market Efficiency Timeline



- Market Efficiency Base Case Mid-Cycle Update
 - Base case to be reposted with updates from stakeholders feedback
- Analysis of proposed solutions: Aug 2017 - Dec 2017 (in-progress)
 - RPM Projects analysis completed
 - Interregional Projects analysis 90% completed
 - PPL projects analysis in-progress
 - BGE projects will be analyzed after PPL
 - Any high-value low-risk* type projects maybe analyzed in parallel with the above
 - All other regional projects will be analyzed last
- Target determination of final projects: Feb 2018
 - RPM projects to be recommended at Oct, 2017 Board meeting
 - Interregional, PPL 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.*



Base Case updates based on stakeholders feedback

- TMI nuclear unit retirement September 2019
- PPL supplemental project correction Juniata - Cumberland 230 kV line
- Impedance correction Conemaugh – Rice – Hunterstown
- NIPSCO retirements – Bailey units to retire in 2018
- AMEREN rating correction Kincaid – Austin 345 kV line

RPM Projects

- PJM Analysis completed:
 - Determined CETL impact of proposed projects (See next slide)
 - Completed RPM Base Residual Auction model for multiple study years
 - Determined RPM and Energy benefits for AEP and COMED (DEOK benefits in progress)
- Market Efficiency Status:
 - Acceleration of AEP baseline projects to be recommended for board approval:
 - Re-conductor the Dequine-Eugene 345 kV (b2777)
 - Re-conductor the Dequine - Meadow Lake 345 kV #2 line (b2776)
 - COMED projects to be recommended for board approval
 - Upgrade capacity on E. Frankfort - University Park 345 kV line*
 - Upgrade substation equipment at Pontiac Midpoint station to increase capacity on Pontiac-Brokaw 345 kV line.
 - DEOK Proposal by PJM to be recommended for board approval
 - Replace terminal equipment at Tanners Creek on Tanners Creek - Dearborn 345 kV line.
- Additional Projects provide no incremental benefit

**There is a pending ICTR request to upgrade capacity of E. Frankfort – University Park 345 kV line by 43.2 MW (ARR Merchant Upgrade AC1-223).*



RPM Evaluation Process – CETL Analysis Results

2016/17 Proj ID	LDA	Proposed Solution	Proposer	Cost Est (\$M)	CETL Change	Comment
11B	ComEd	Accelerate the previously approved baseline project to reconductor the Dequine-Eugene 345 kV and substation work at Dequine.	AEP	\$0.00	1,253	11B & 11C studied together
11C	ComEd	Accelerate the previously approved baseline project to reconductor the Dequine - Meadow Lake 345 kV #2 line and substation work at Dequine.	AEP	\$0.00	1,253	
3A	ComEd	Upgrade capacity on E. Frankfort - University Park 345 kV line.	Comed	\$0.84	772	Study included 11B and 11C
3B	ComEd	Upgrade substation equipment at Pontiac Midpoint station to increase capacity on Pontiac-Brokaw 345 kV line.	Comed	\$5.62	339	
17A	ComEd	Build a new 345 kV switchyard (Cottage Grove). Loop in the University Park North EC - Olive 345 kV line, Crete - St. John 345 kV line, Davis Creek - Bloom 345 kV line and Davis Creek - Burnham 345 kV line. Substation upgrades at Bloom and Burnham substations. Upgrade the University Park North-Olive 345 kV line.	AEP Exelon	\$66.90	-154	Study included 3A, 3B, 11B and 11C
17B	ComEd	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.	AEP Exelon	\$197.97	-435	Study included 3A, 3B, 11B and 11C
13H	DEOK	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.	Transource	\$71.89	-638	Examined without proposed PJM project
	DEOK	b2831 upgrade of Miami Fort - Tanners Creek 345 kV	DEOK/AEP	\$7.80	567	Approved during 2014/15 Window
	DEOK	Replace terminal equipment at Tanners Creek on Tanners Creek - Dearborn 345 kV line	PJM	\$1.50	332	Project proposed by PJM

Note: Dayton LDA did not bind in the 2020/2021 BRA Auction, therefore no CETL analysis was performed for Dayton LDA.

Project ID: 201617_1-11B

Proposed by: AEP

Proposed Solution:

Accelerate the previously approved baseline project to reconductor the Dequine-Eugene 345 kV and substation work at Dequine.

(See approved baseline upgrade b2777)

kV Level: 345 kV

In-Service Cost (\$M): 0, B/C Ratio >> 1.25 due to low cost

In-Service Date: 2019

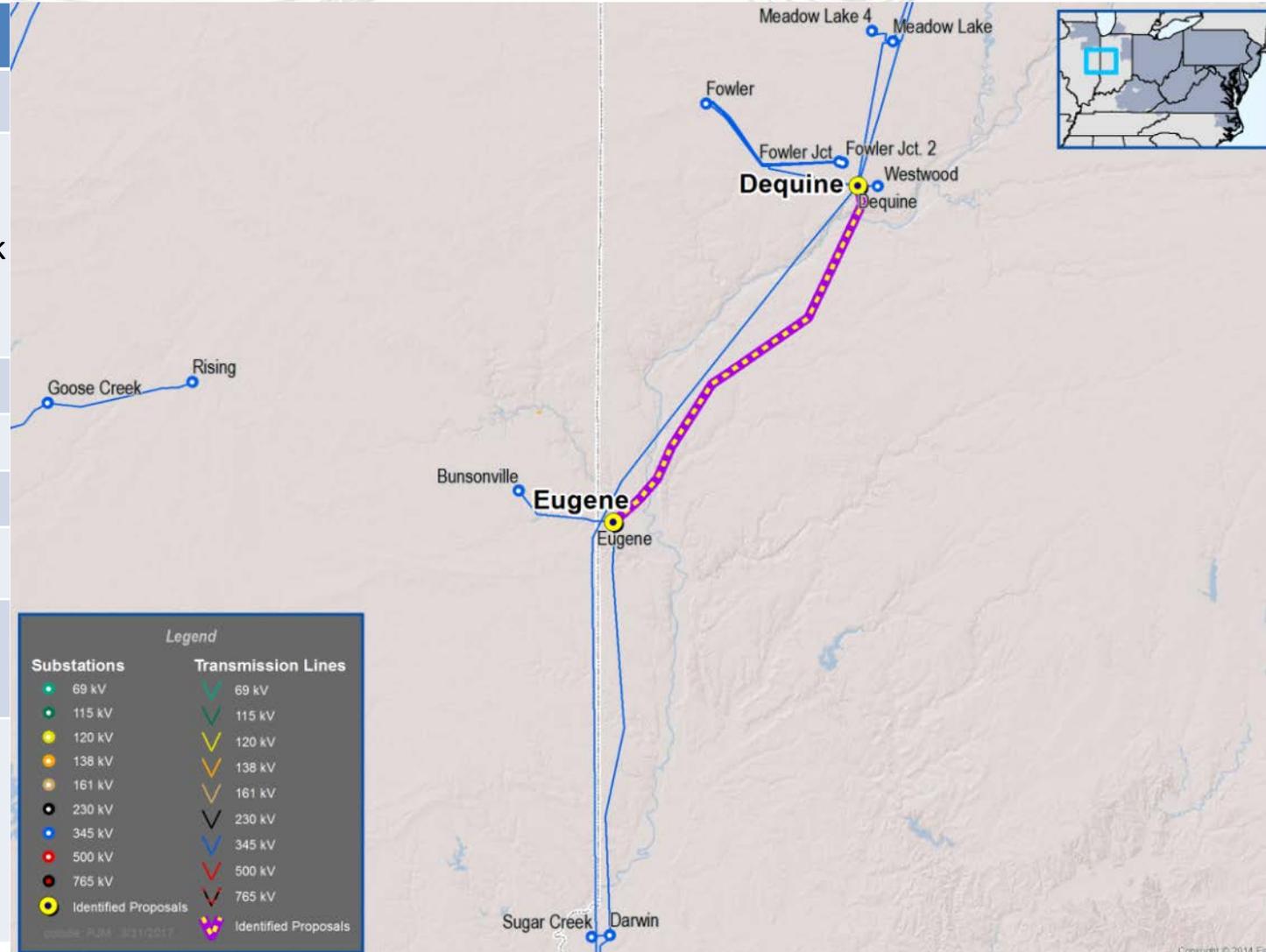
Target Zone: AEP

ME Constraints:

EUGENE - DEQUIN 345 kV + RPM Benefits

Notes:

- CETL improvement of 1253 MW and very low cost
- Anticipate request for Board approval in Oct 2017
- Designated Entity: AEP (the local TO)



Project ID: 201617_1-11C

Proposed by: AEP

Proposed Solution:

Accelerate the previously approved baseline project to reconductor the Dequine - Meadow Lake 345 kV #2 line and substation work at Dequine.

(See approved baseline upgrade b2776)

kV Level: 345 kV

In-Service Cost (\$M): 0, B/C Ratio >> 1.25 due to low cost

In-Service Date: 2019

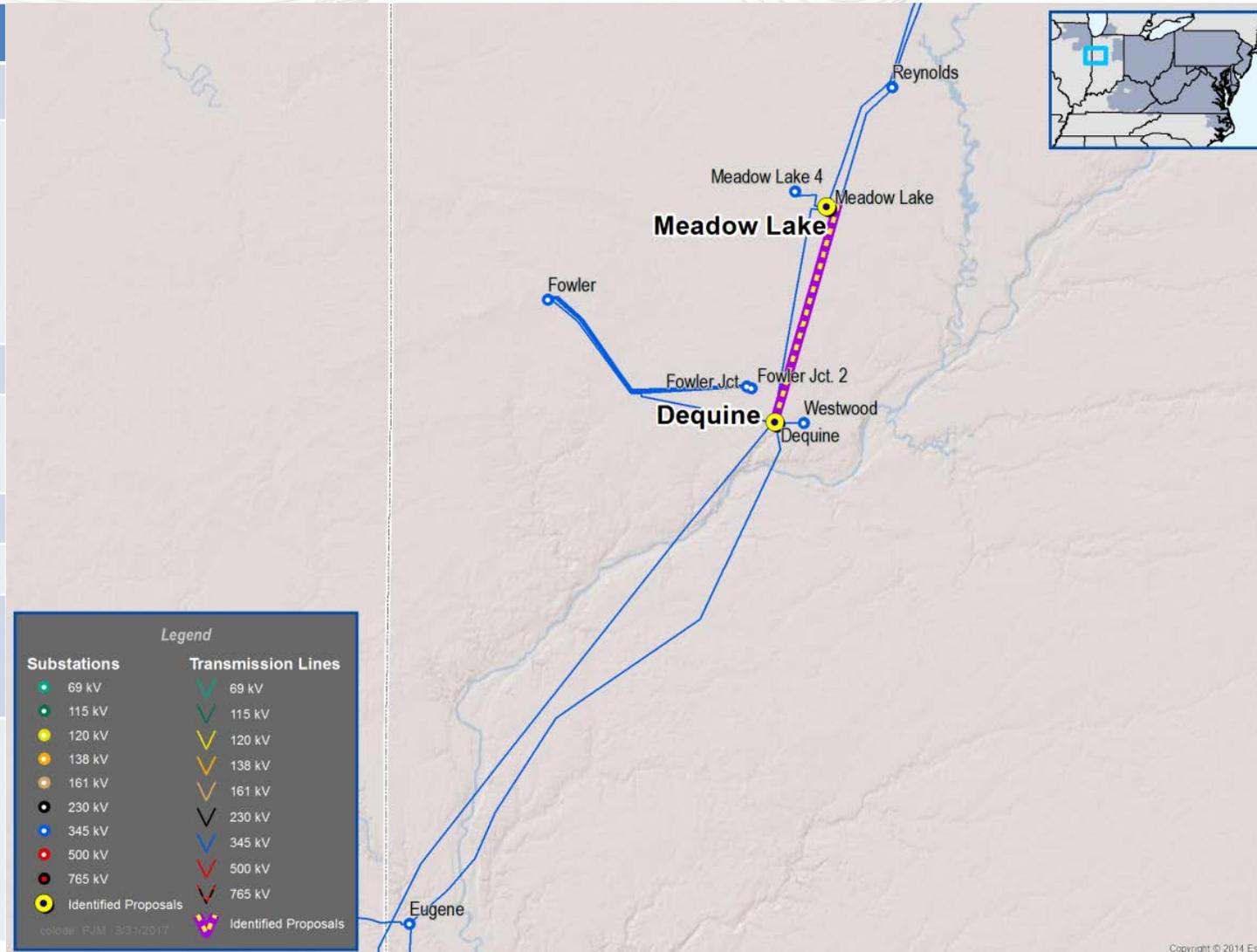
Target Zone: AEP

ME Constraints:

DEQUIN - MEADOW 345 kV + RPM Benefits

Notes:

- CETL improvement of 1253 MW and very low cost
- Anticipate request for Board approval in Oct 2017
- Designated Entity: AEP (the local TO)



Project ID: 201617_1-3A

Proposed by: ComEd

Proposed Solution:
Upgrade capacity on E. Frankfort - University Park 345 kV line.

kV Level: 345 kV

In-Service Cost (\$M): \$0.84, B/C Ratio =147.69

In-Service Date: 2021

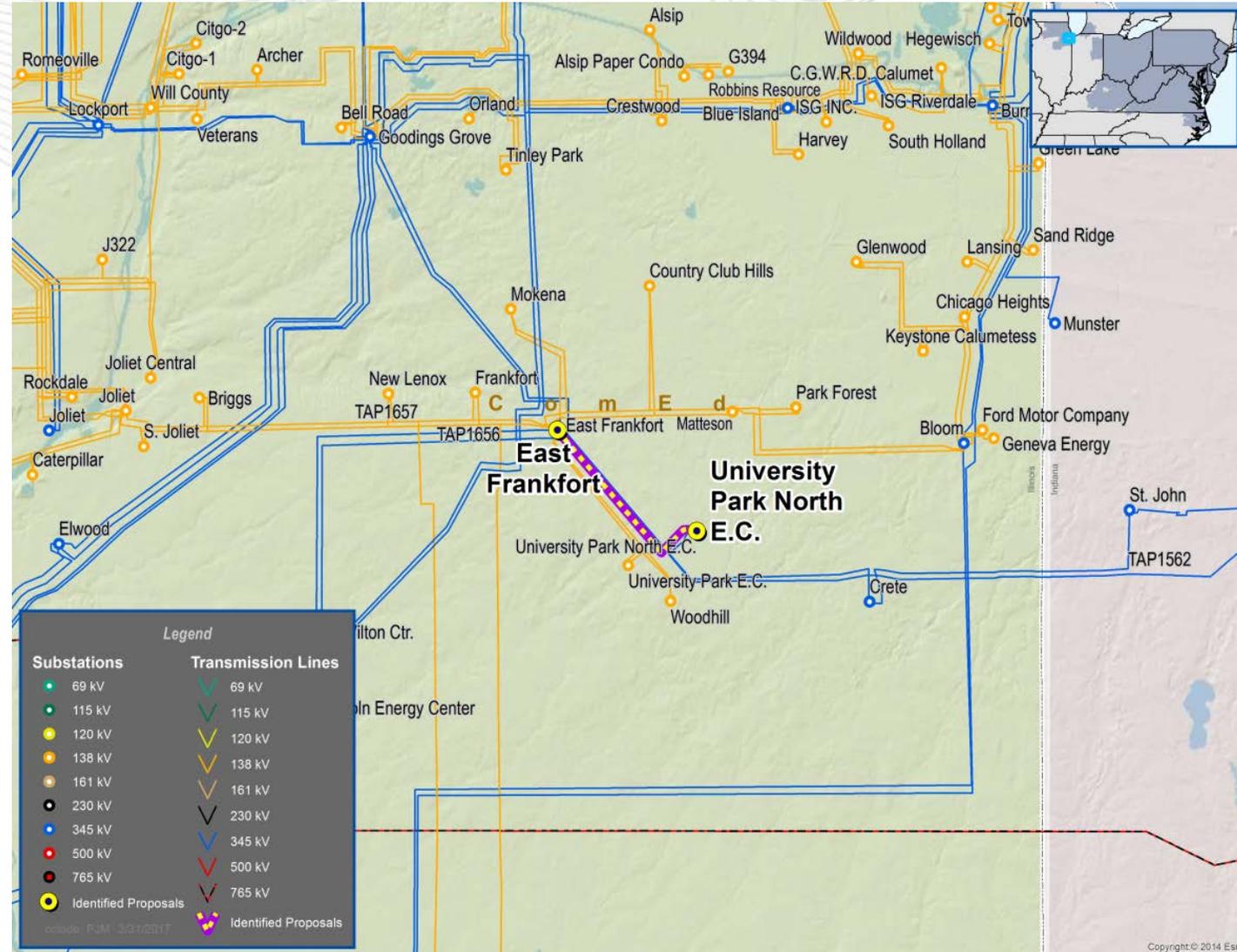
Target Zone: ComEd

ME Constraints:

E. FRANKFORT - UNIVERSITY PARK 345 kV + RPM Benefits

Notes:

- CETL improvement of 772 MW and very low cost
- Anticipate request for Board approval in Oct 2017
- Designated Entity: ComEd (the local TO)
- Cost Allocation: 100% ComEd



Project ID: 201617_1-3B

Proposed by: ComEd

Proposed Solution:

Upgrade substation equipment at Pontiac Midpoint station to increase capacity on Pontiac-Brokaw 345 kV line.

kV Level: 345 kV

In-Service Cost (\$M): \$5.62, B/C Ratio =13.45

In-Service Date: 2021

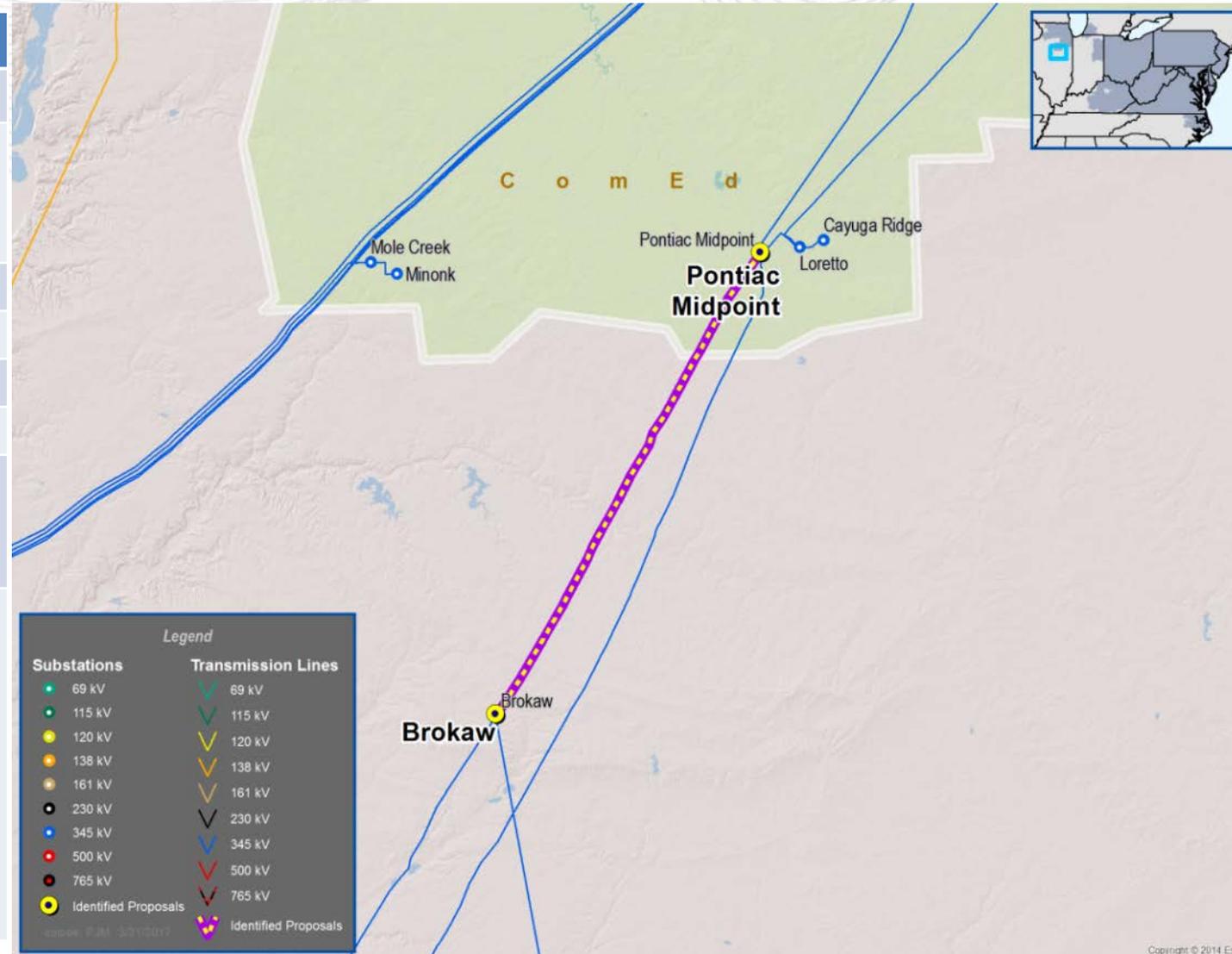
Target Zone: ComEd

ME Constraints:

PONTIAC - BROKAW 345 kV + RPM Benefits

Notes:

- CETL improvement of 339 MW and low cost
- Anticipate request for Board approval in Oct 2017
- Designated Entity: ComEd (the local TO)
- Cost Allocation: 100% ComEd



Project ID: 201617_PJM_RPM_DEOK

Proposed by: PJM

Proposed Solution:

Replace terminal equipment at Tanners Creek on Tanners Creek - Dearborn 345 kV line.

kV Level: 345 kV

In-Service Cost (\$M): \$1.5, B/C Ratio = 53.13

In-Service Date: 2021

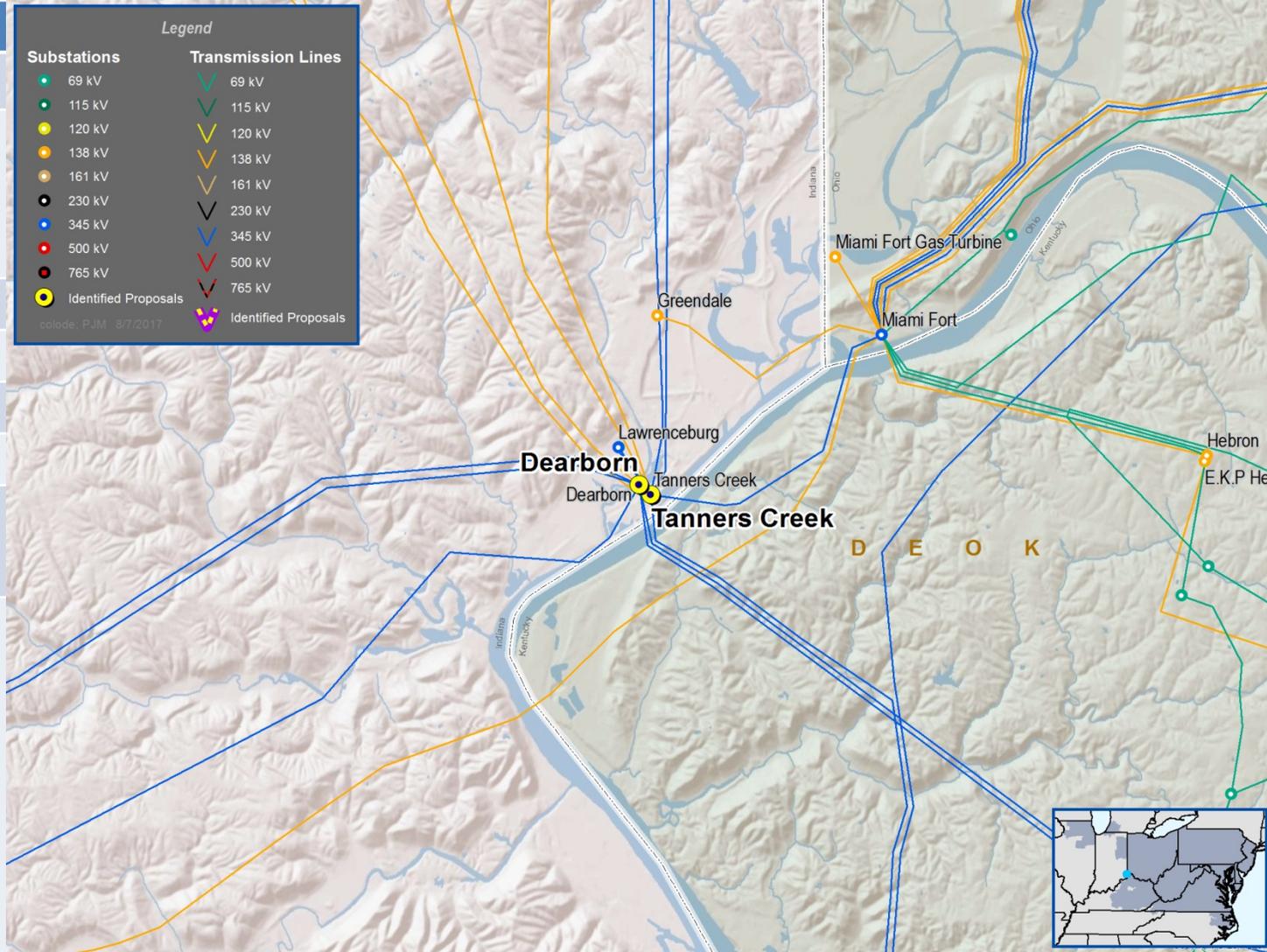
Target Zone: DEOK

ME Constraints:

TANNERS CREEK - MIAMI FORT 345 kV

Notes:

- CETL improvement of 332 MW and very low cost
- Anticipate request for Board approval in Oct 2017
- Designated Entity: AEP (the local TO)
- Cost Allocation: TBD



Project ID: 201617_1-17A

Proposed by: AEP Exelon

Proposed Solution: Greenfield

Build a new 345 kV switchyard (Cottage Grove). Loop in the University Park North EC - Olive 345 kV line, Crete - St. John 345 kV line, Davis Creek - Bloom 345 kV line and Davis Creek - Burnham 345 kV line. Substation upgrades at Bloom and Burnham substations. Upgrade the University Park North-Olive 345 kV line.

kV Level: 345 kV

In-Service Cost (\$M): \$66.90

In-Service Date: 2021

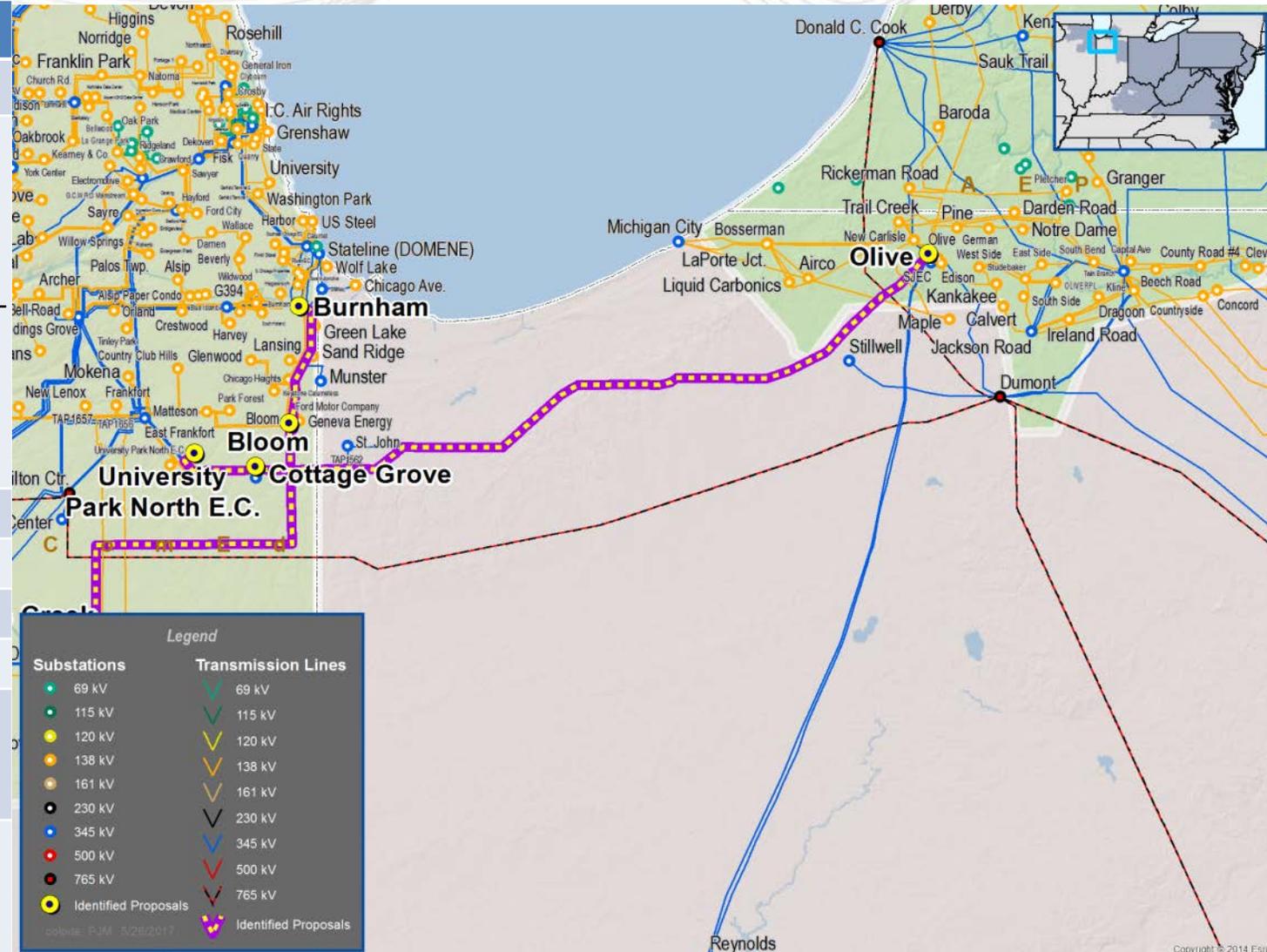
Target Zone: ComEd

ME Constraints:

E. FRANKFORT - UNIVERSITY PARK 345 kV + RPM Benefits

Notes:

- CETL degradation (-154 MW) and high cost.
- This RPM project is not currently recommended.



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

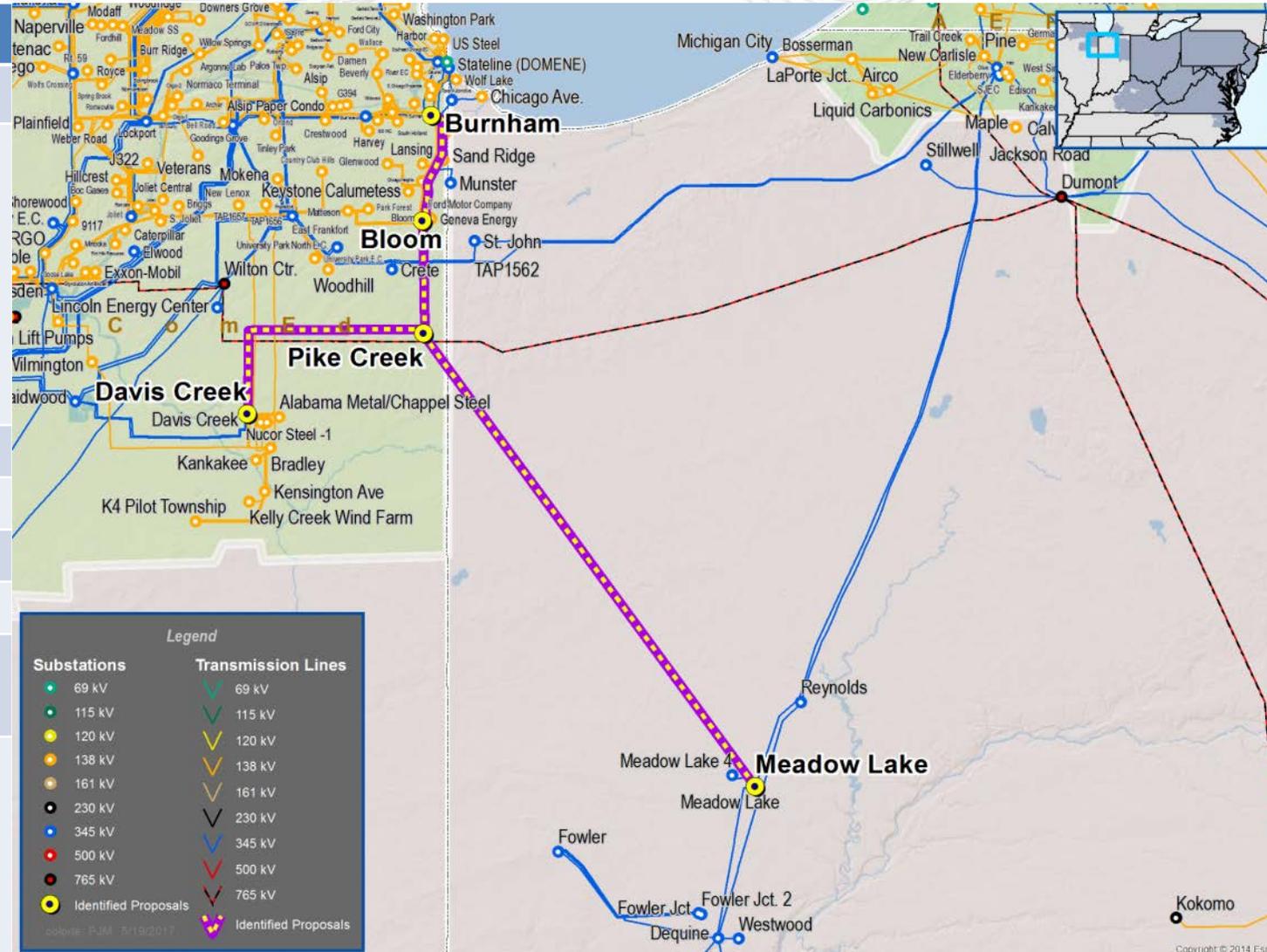
Target Zone: ComEd

ME Constraints:

OLIVE - BOSSERMAN 138 kV + RPM Benefits

Notes:

- CETL degradation (-435 MW) and high cost.
- This project is not currently recommended as a RPM project.



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 M. 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 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

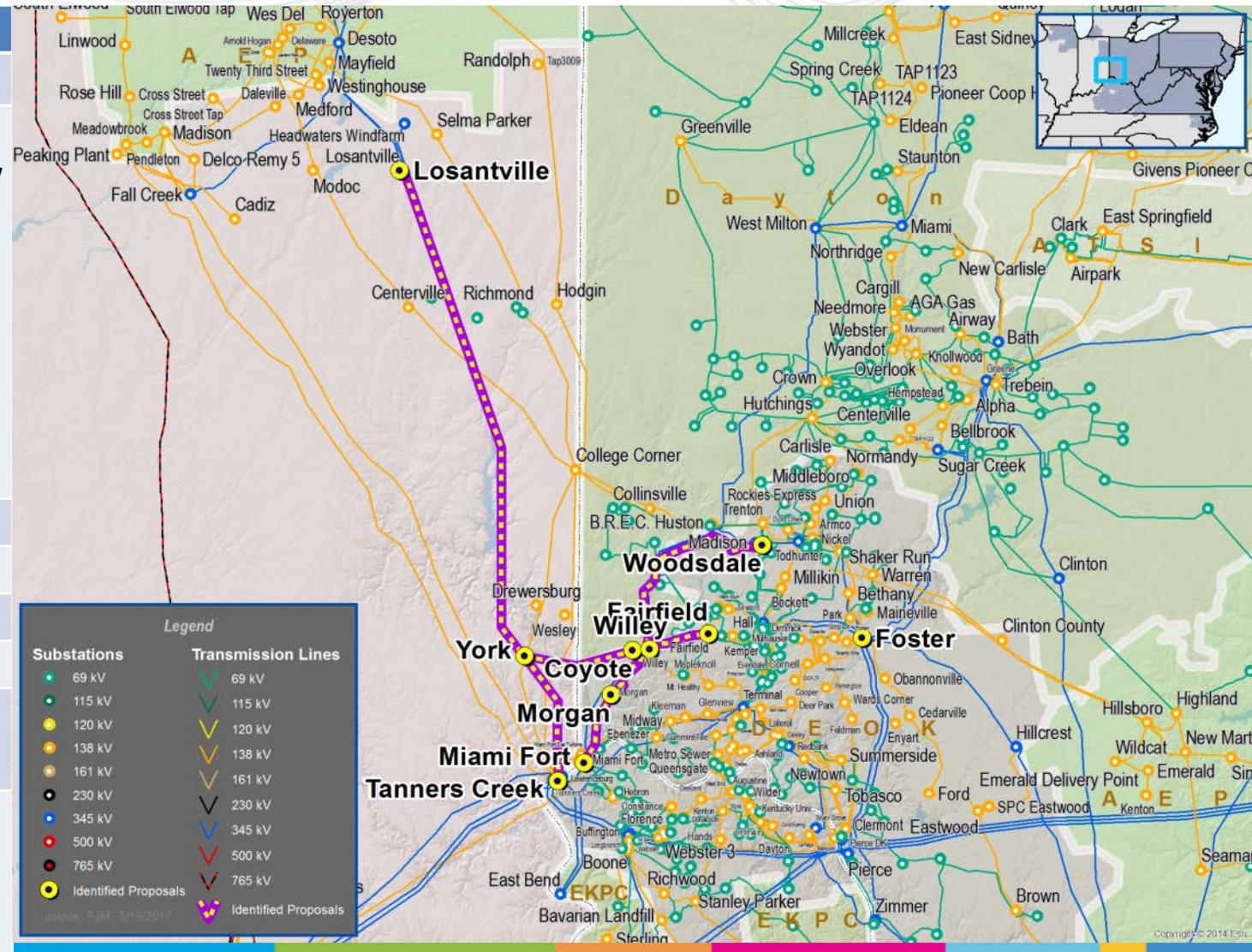
Target Zone: DEOK

ME Constraints:

TANNERS CREEK - MIAMI FORT 345 kV

Notes:

- CETL degradation (-638 MW) and high cost.
- This project is not currently recommended as a RPM project.



Project ID: 201617_1-18M

Proposed by: Northeast Transmission Development

Proposed Solution: Greenfield

Build a new 345/138 kV substation (Bull Branch) near Urbana 138/69 kV substation. Build a new Marysville - Bull Branch 345 kV line and a new Miami - Bull Branch 345 kV line. Connect the Bull Branch 138kV to Urbana 138/69 kV substation. Tap the West Milton - Miami Fort 345 kV line and build a new 345/138 kV substation (Spring Run). Build a new Spring Run - Crown 138 kV line.

kV Level: 138/345 kV

In-Service Cost (\$M): \$117.30

In-Service Date: 2021

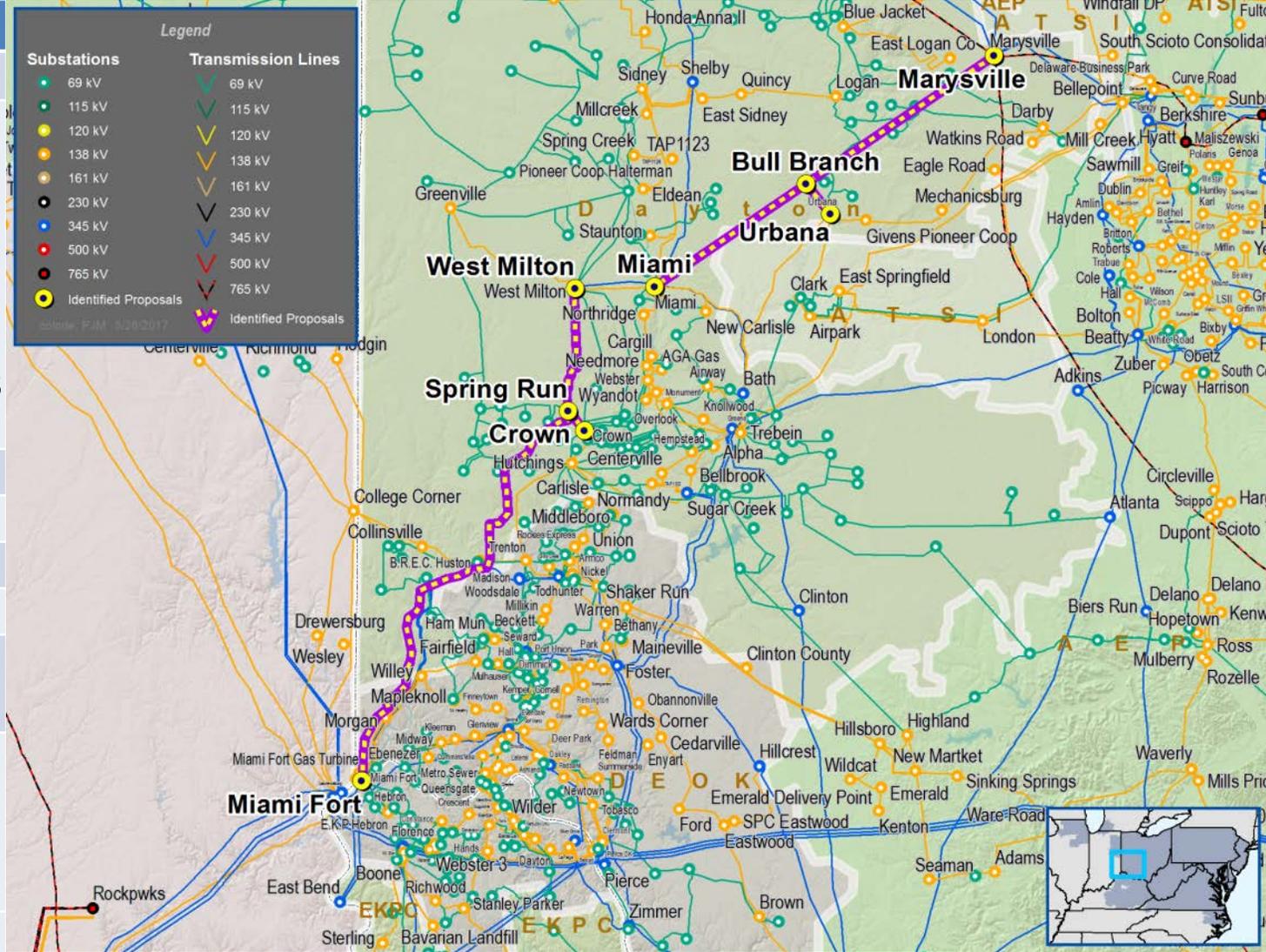
Target Zone: AEP

ME Constraints:

Dayton LDA RPM Benefits

Notes:

- No RPM benefits, Dayton LDA did not bind in recent BRA.
- This RPM project is not currently recommended.



Project ID: 201617_1-18N

Proposed by: Northeast Transmission Development

Proposed Solution: Greenfield

Build a new 345/138 kV substation (Bull Branch) near Urbana
 138/69 kV substation. Build a new Marysville - Bull Branch
 345 kV line and a new Miami - Bull Branch 345 kV line.
 Connect the Bull Branch 138 kV to Urbana 138/69 kV
 substation.

kV Level: 138/345 kV

In-Service Cost (\$M): \$97.70

In-Service Date: 2021

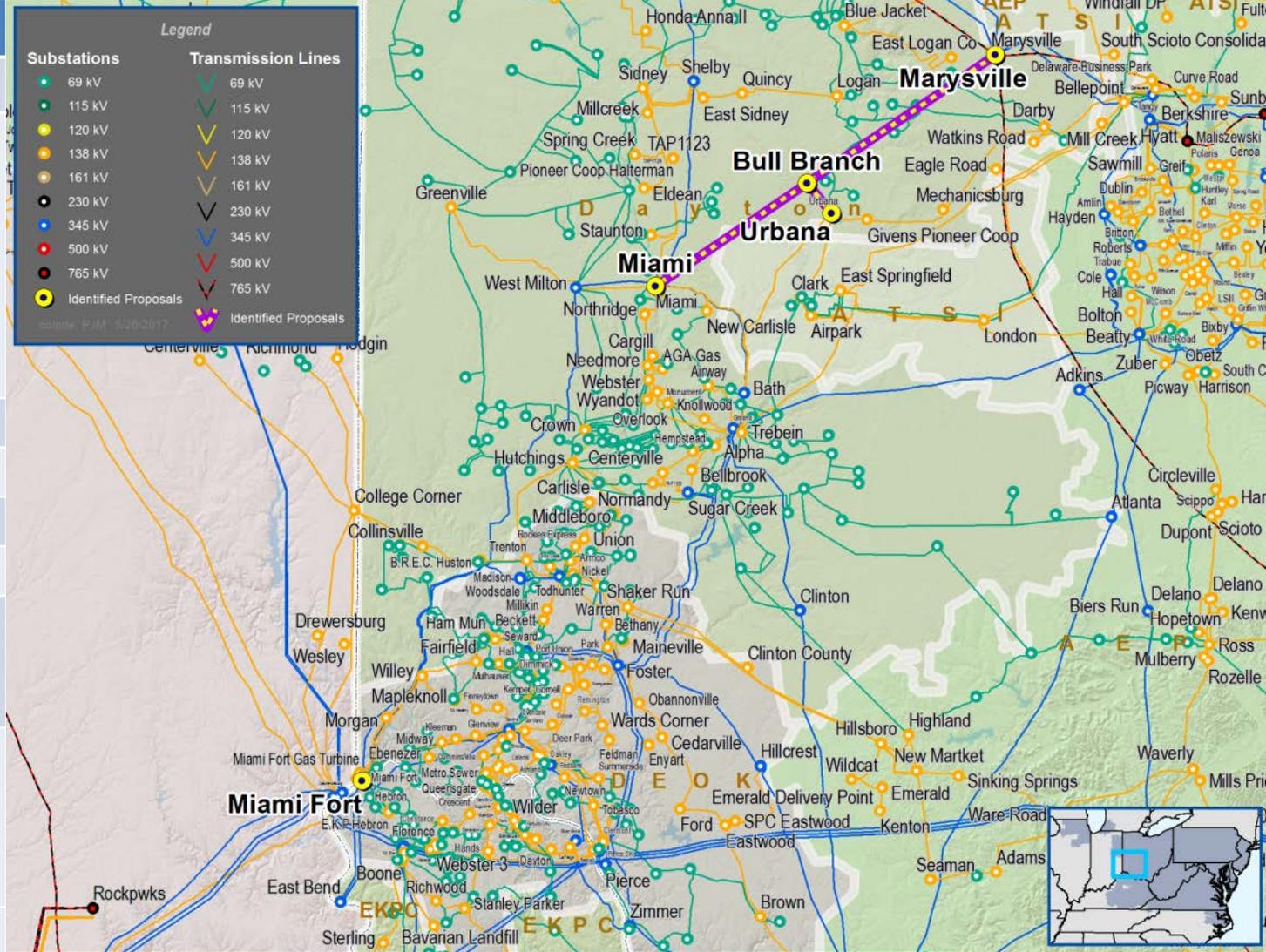
Target Zone: AEP

ME Constraints:

Dayton LDA RPM Benefits

Notes:

- No RPM benefits, Dayton LDA did not bind in recent BRA.
- This RPM project is not currently recommended.



Project ID: 201617_1-18P

Proposed by: Northeast Transmission Development

Proposed Solution: Greenfield

Tap the West Milton - Miami Fort 345 kV line and build a new 345/138 kV substation (Spring Run). Build a new Spring Run - Crown 138 kV line.

kV Level: 138/345 kV

In-Service Cost (\$M): \$19.70

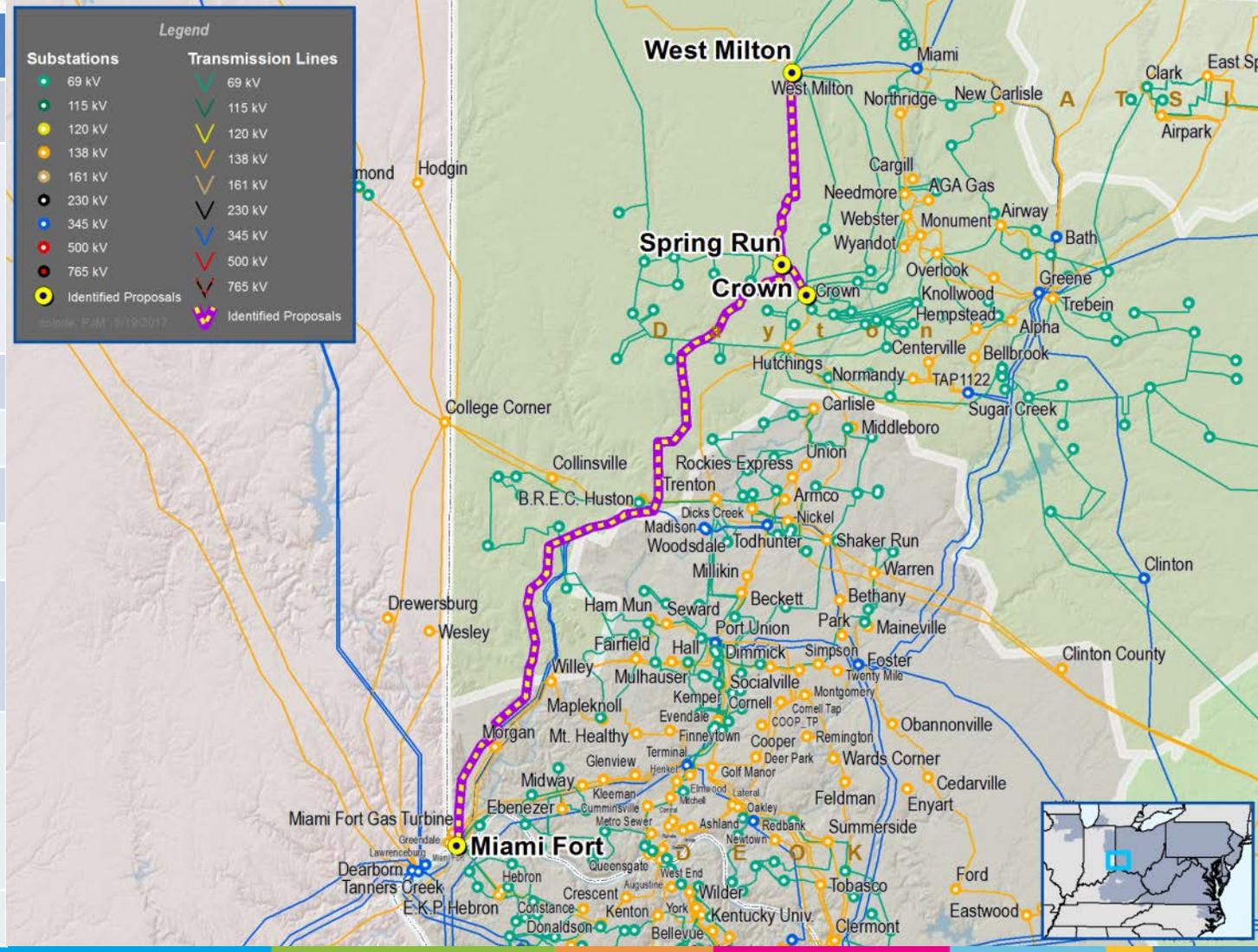
In-Service Date: 2021

Target Zone: Dayton

ME Constraints:
Dayton LDA RPM Benefits

Notes:

- No RPM benefits, Dayton LDA did not bind in recent BRA.
- This RPM project is not currently recommended.



Interregional Projects

- Mid cycle update removed the congestion driver “Olive – Bosserman” *
 - There may be joint RTO benefits that may reveal opportunity for an interregional project.
- Analysis completed 90%
 - Results show most projects don’t pass the B/C threshold when cost is fully allocated to PJM.
 - Rerunning cases with the latest updates.
 - Currently performing additional analysis on projects that shifted congestion downstream.
- Coordination with MISO
 - PJM discussed preliminary results with MISO.
- Next steps
 - PJM to share final results with MISO and vice versa.
 - RTOs jointly select the most beneficial project (if any) and inform stakeholders.

*AEP supplemental project removes congestion driver for the Olive – Bosserman constraint (see Appendix B - AEP Supplemental Project)

Re-evaluation of Approved Market Efficiency Projects (2014/15 RTEP Window)

- Applies to market efficiency projects approved during the 2014/15 RTEP Window
- Using the Market Efficiency Base Case Mid-Cycle Update
- Analysis performed individually, one project at a time
- Reevaluation Study Process
 - Create a new base case by removing/reversing the topology related to the approved market efficiency project
 - Measure the impact of adding back the approved market efficiency project
 - Measure benefits for 15-year period starting with the in-service date
 - For RPM projects also measure the capacity benefits
 - Calculate the new B/C ratios
- Projects must meet the B/C criterion of 1.25

- Reevaluation models created for all projects to be reevaluated.
- Preliminary runs on the posted base case completed.
- Currently rerunning the cases with the corrections based on stakeholders feedback.
- PJM will be reaching out to project owners if the project does not meet the reevaluation threshold

Milestone	Schedule 2016 - 2017
Reevaluation Approved Market Efficiency Projects	Aug - Sept 2017
Proposed projects analysis - Interregional, PPL and slam dunks	Aug – October 2017
Proposed projects analysis - BGE and other	Sept– Dec 2017
Acceleration Analysis	August – November 2017
Final TEAC Review and Board Recommendation	February 2018

Appendix A - Interregional Projects Descriptions



AEP/COMED/NIPSCO Interregional Proposals

- **7 Projects:**

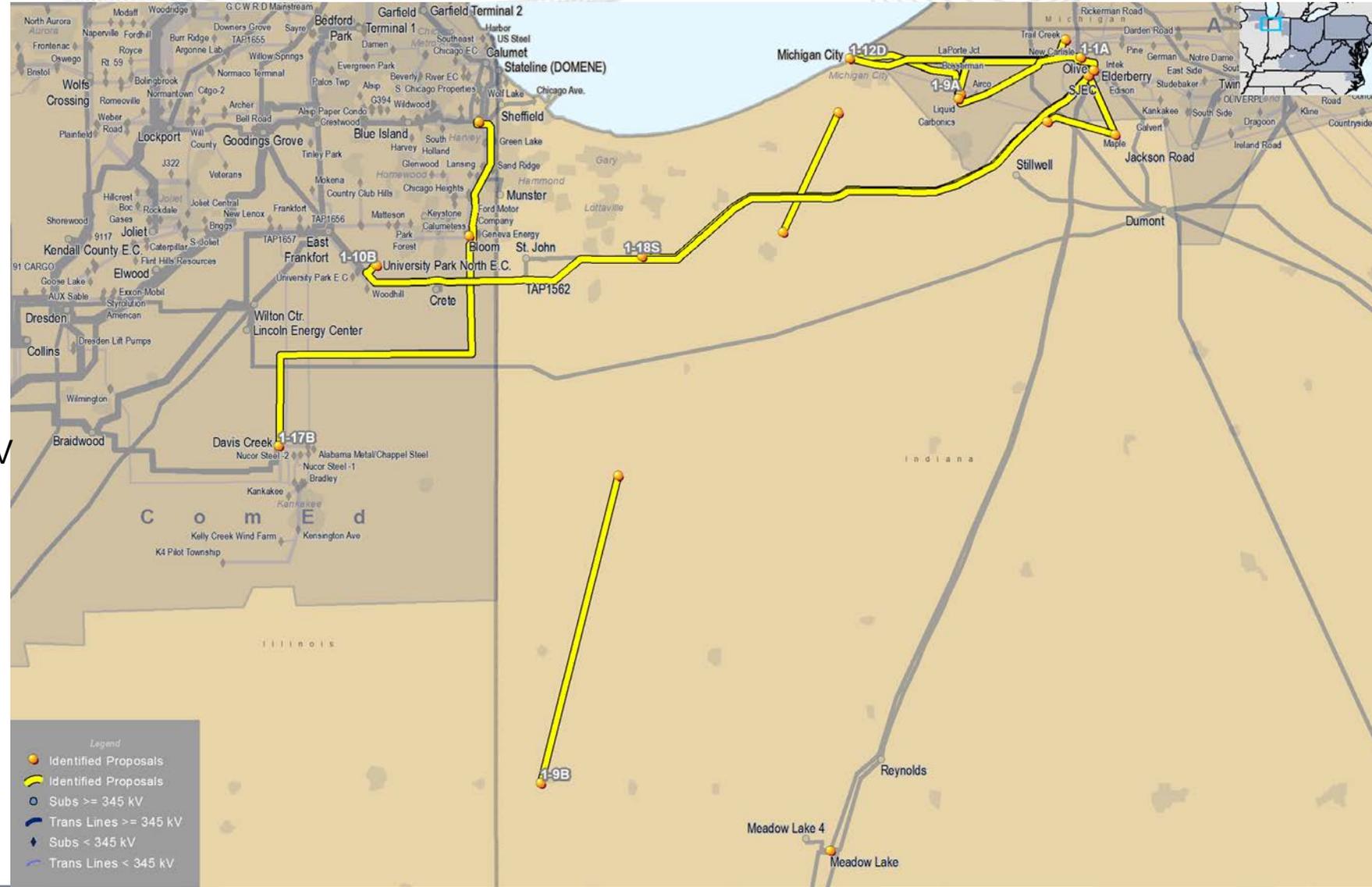
- 1-1A, 1-9A, 1-9B, 1-10B, 1-12D, 1-17B, 1-18S

- **Cost:**

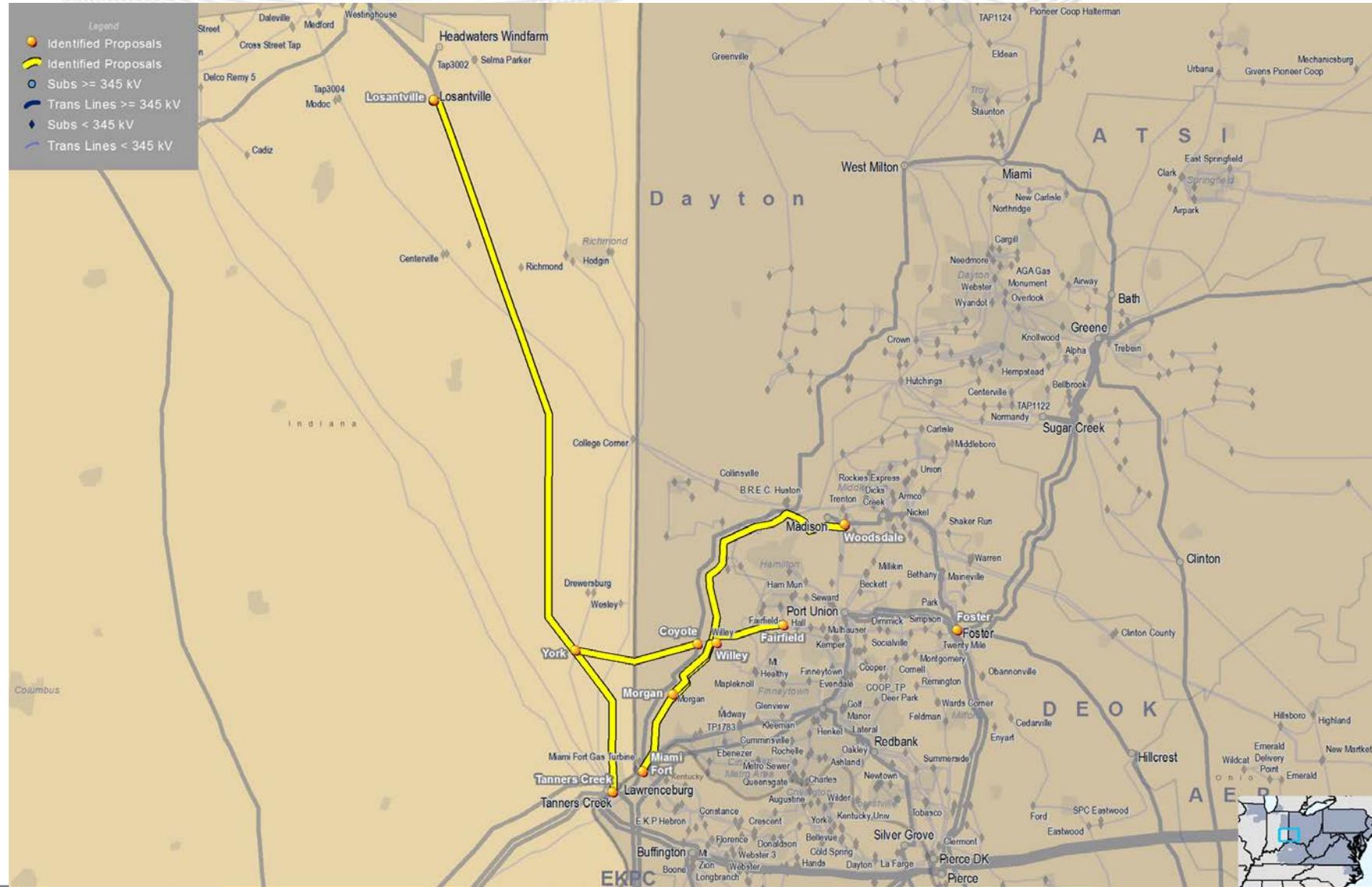
- From \$1.00 M to \$197.97 M

- **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

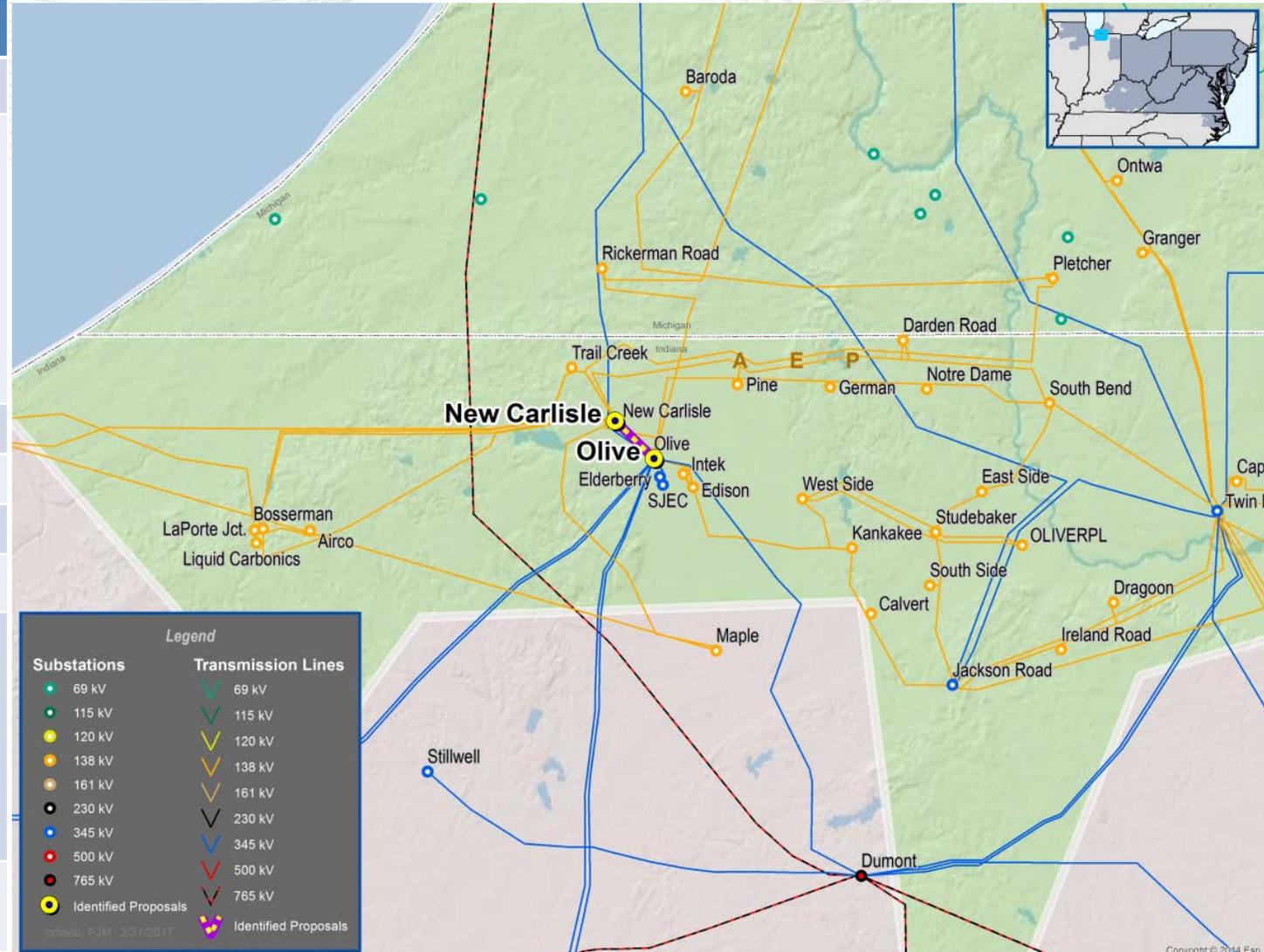
In-Service Cost (\$M): \$2.5

In-Service Date: 2019

Target Zone: AEP

ME Constraints:
 OLIVE - BOSSERMAN 138 kV

Notes: See supplemental project Olive – Bosserman discussion in the Reliability Update presentation at April TEAC.



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

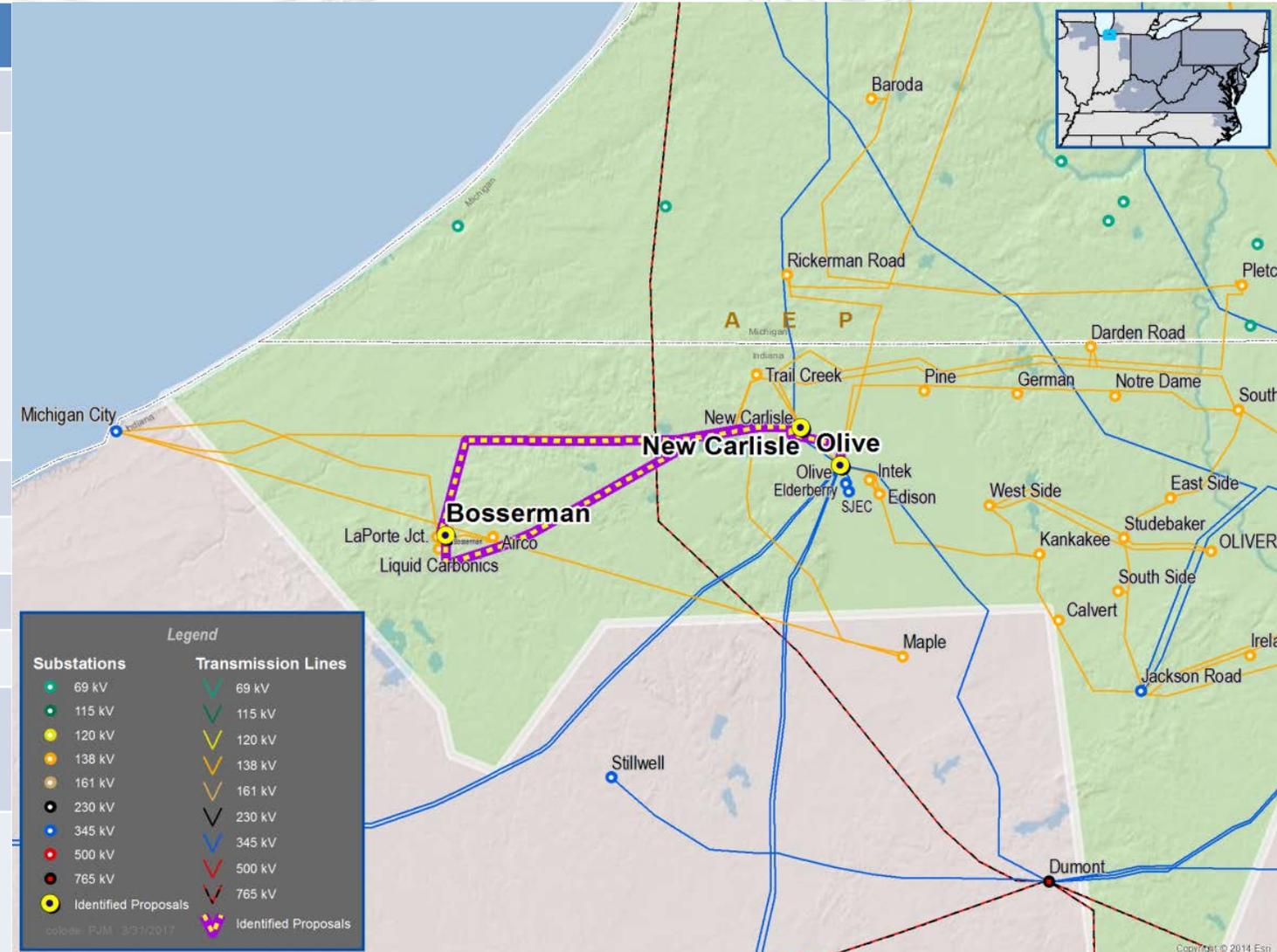
In-Service Date: 2019

Target Zone: AEP NIPSCO

ME Constraints:

OLIVE - BOSSERMAN 138 kV

Notes: See supplemental project Olive – Bosserman discussion in the Reliability Update presentation at April TEAC.



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

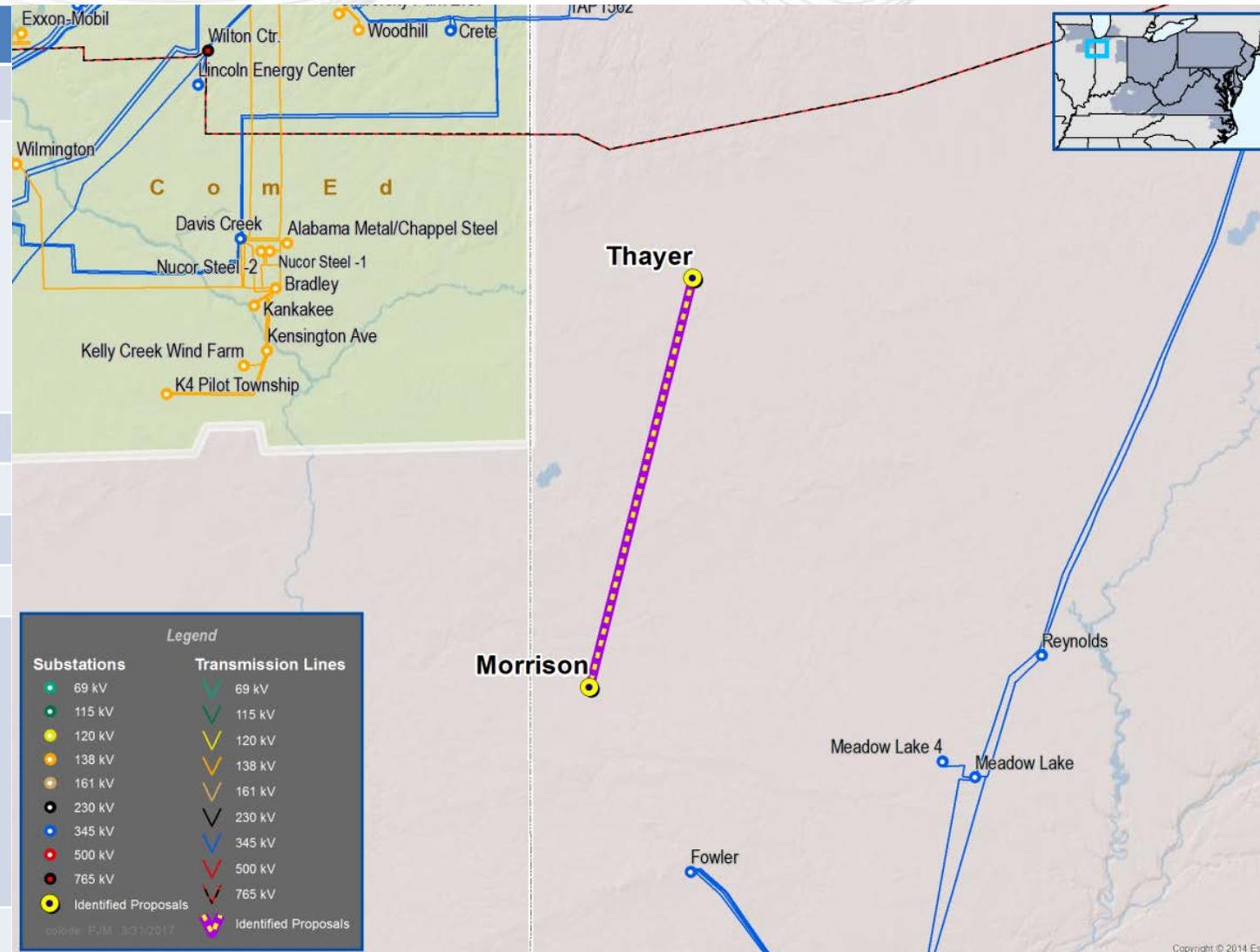
In-Service Cost (\$M): \$42.50

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

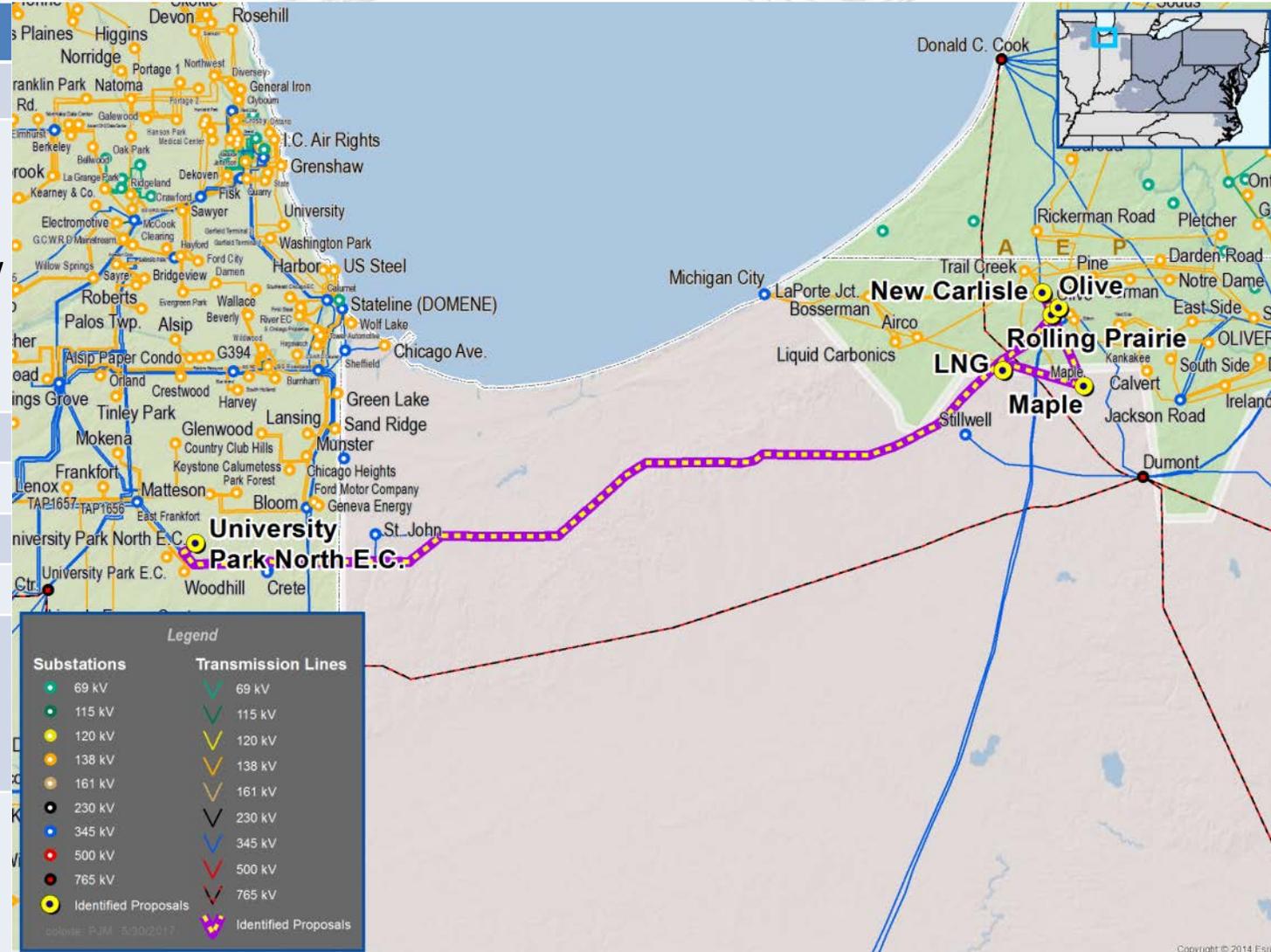
In-Service Cost (\$M): \$19.2

In-Service Date: 2021

Target Zone: AEP

ME Constraints:
 BOSSERMAN - OLIVE 138 kV

Notes: Notes: See supplemental project Olive – Bosserman discussion in the Reliability Update presentation at April TEAC.



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

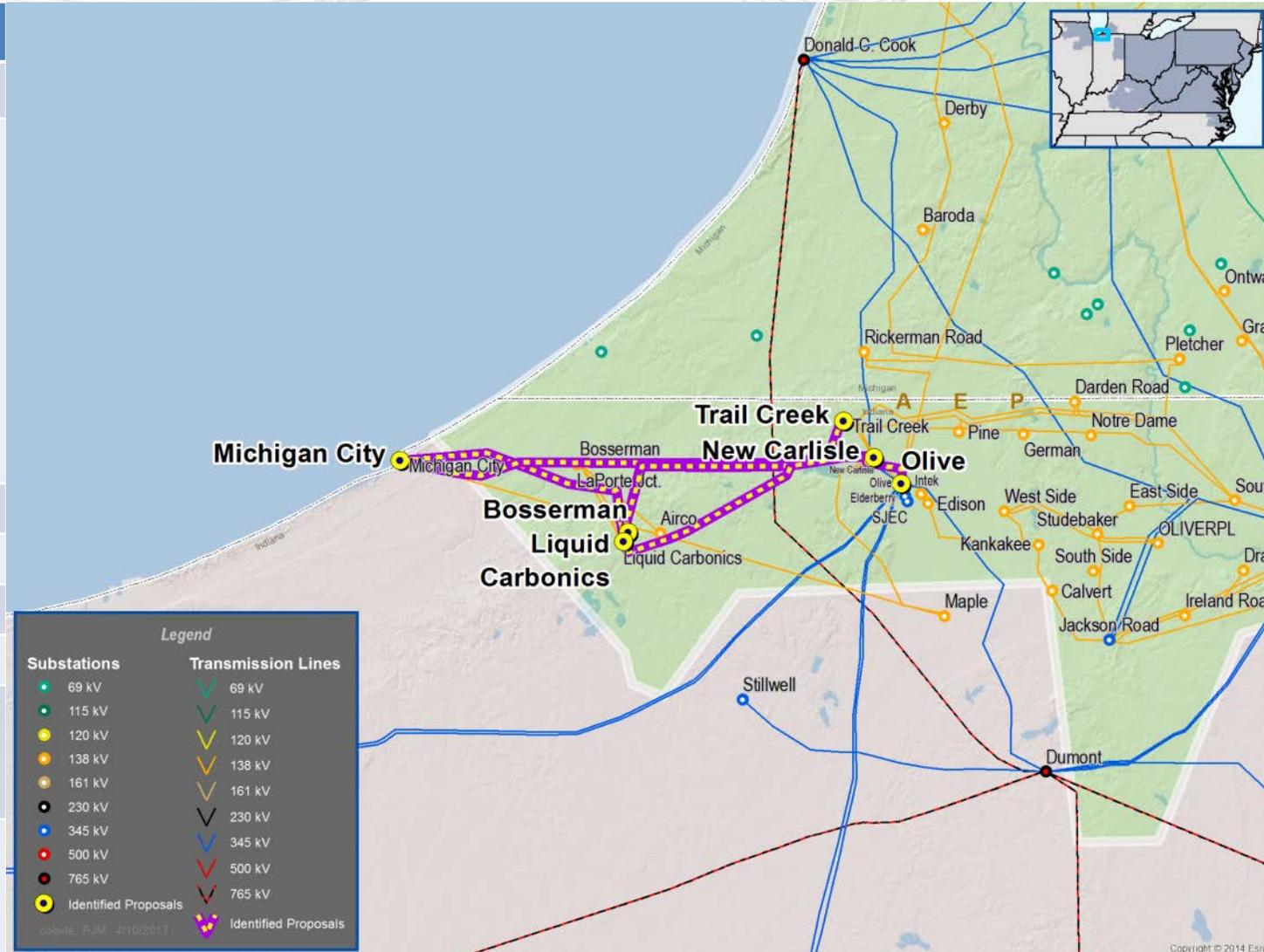
In-Service Date: 2021

Target Zone: AEP

ME Constraints:

OLIVE - BOSSERMAN 138 kV

Notes: See supplemental project Olive – Bosserman discussion in the Reliability Update presentation at April TEAC.



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

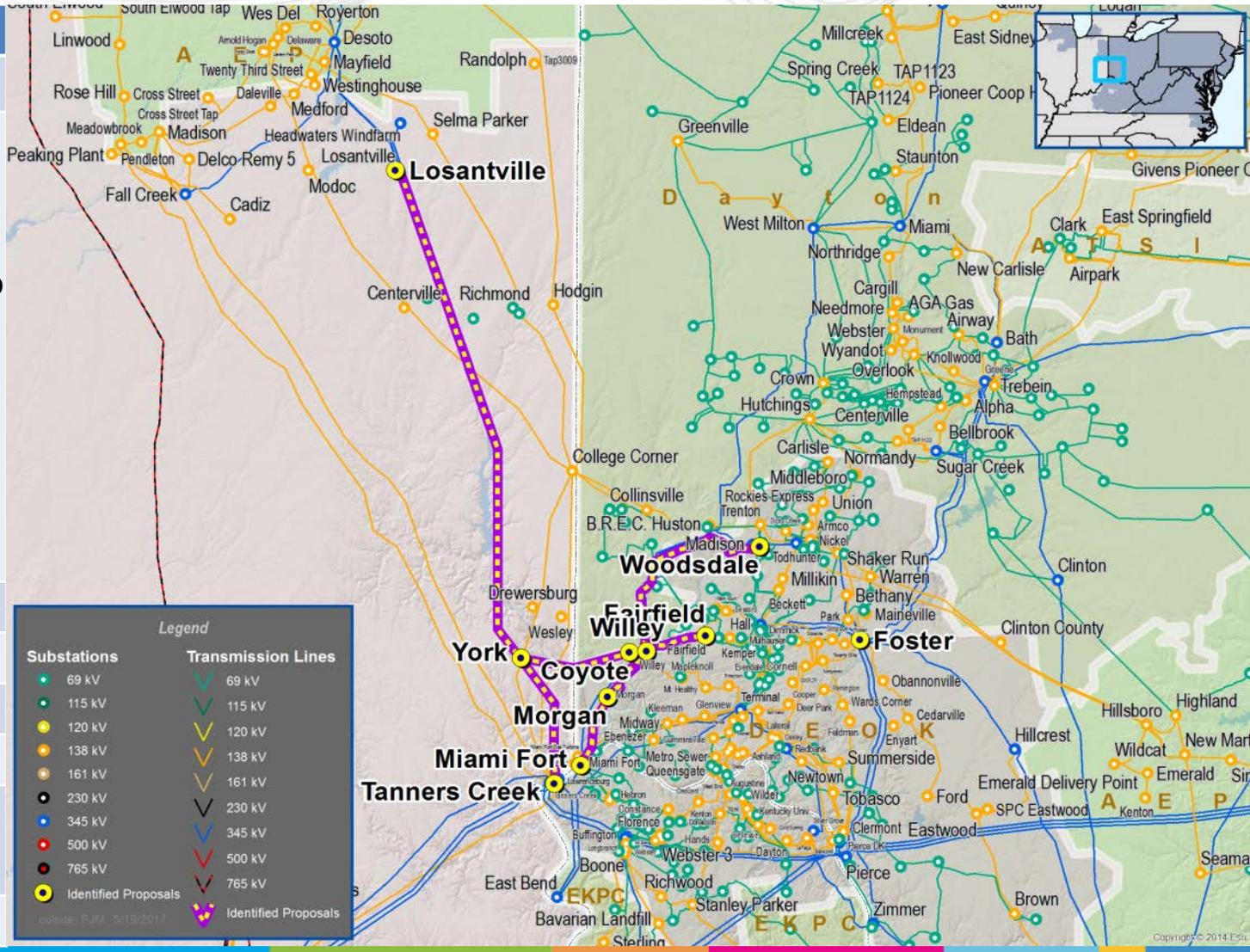
In-Service Cost (\$M): \$71.89

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

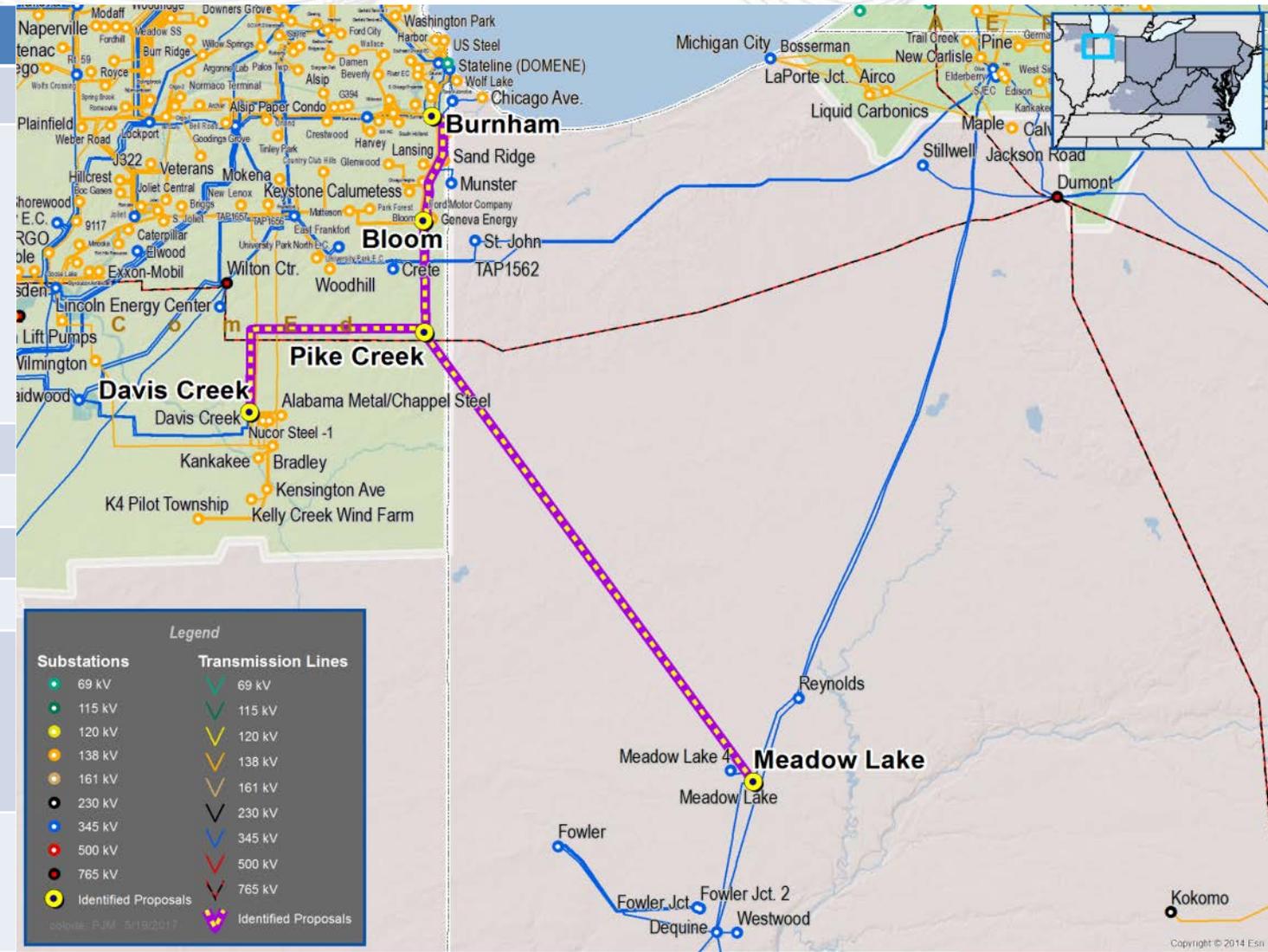
In-Service Date: 2021

Target Zone: ComEd

ME Constraints:

OLIVE - BOSSERMAN 138 kV + RPM Benefits

Notes: See supplemental project Olive – Bosserman discussion in the Reliability Update presentation at April TEAC.



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

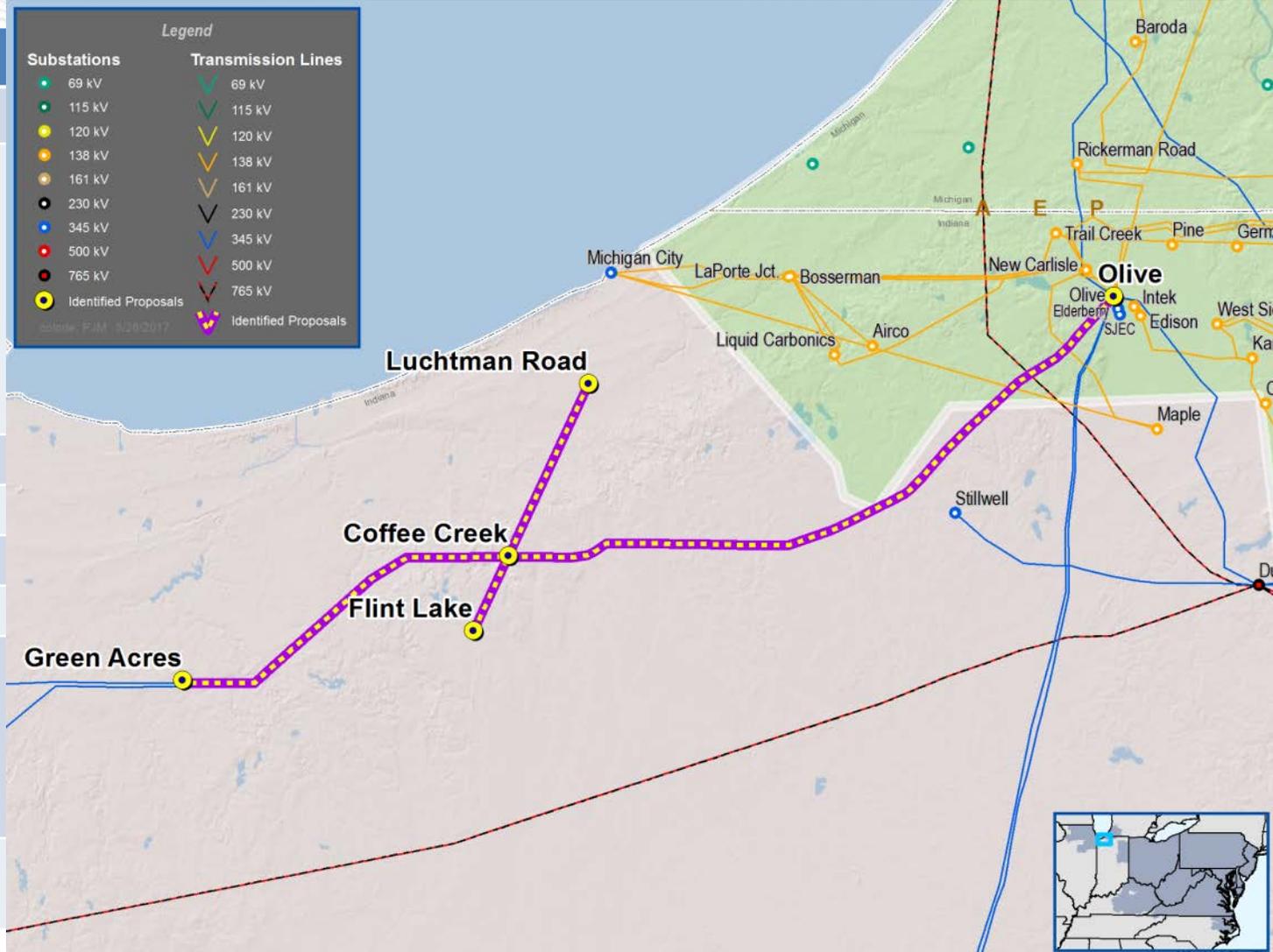
In-Service Date: 2021

Target Zone: AEP

ME Constraints:

OLIVE - BOSSERMAN 138 kV

Notes: See supplemental project Olive – Bosserman discussion in the Reliability Update presentation at April TEAC.



Appendix B - AEP Supplemental Project Olive – Bosserman 138 kV

- AEP has planned a supplemental project that impacts the Olive – Bosserman market efficiency constraint
- Supplemental projects are:
 - Not needed for reliability criteria, market efficiency, or operational performance
 - Funded wholly by Transmission Owner
 - No PJM approval needed
- This supplemental project is included in the Market Efficiency base case and all submitted projects to address Olive-Bosserman constraint will be evaluated under this assumption

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)

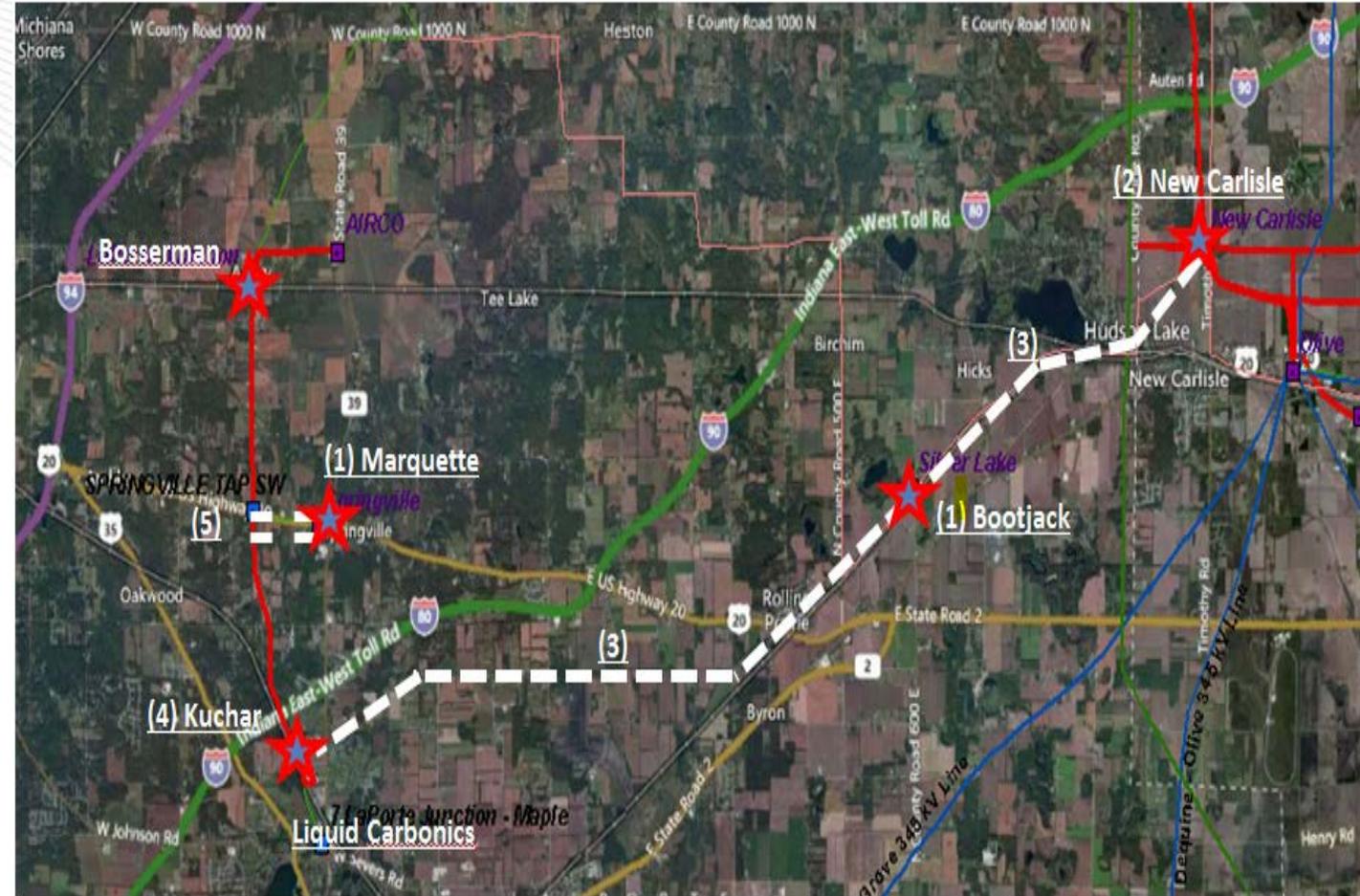
Alternatives:

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 – 8/07/2017 – Original Version Posted to PJM.com
 - V2 – 8/10/2017
 - Updated slide 6 with “DEOK Proposal by PJM to be recommended for board approval”
 - V2 – 8/11/2017
 - Updated slide 7 to show projects 3A and 3B were studied with 11B and 11C included in the base case.
 - Updated slides 7 and 12 with In-Service Cost (\$M): \$1.5, B/C Ratio = 53.13
 - Added slides 36, 37, 38 comprising “Appendix B - AEP Supplemental Project Olive – Bosserman 138 kV”