



# Reliability Analysis Update

Transmission Expansion Advisory  
Committee  
September 15, 2016



# 2016 RTEP Window #3 Anticipated Scope and Timeline

- Anticipated 2016 RTEP Window #3
  - Scope
    - 2021 Winter
    - 2021 Light Load Reliability Analysis
    - Short Circuit
  - Timing
    - September 2016
    - Post preliminary results
    - Open Window
    - Close Window
    - Window Duration



# 2016 RTEP Proposal Window #2

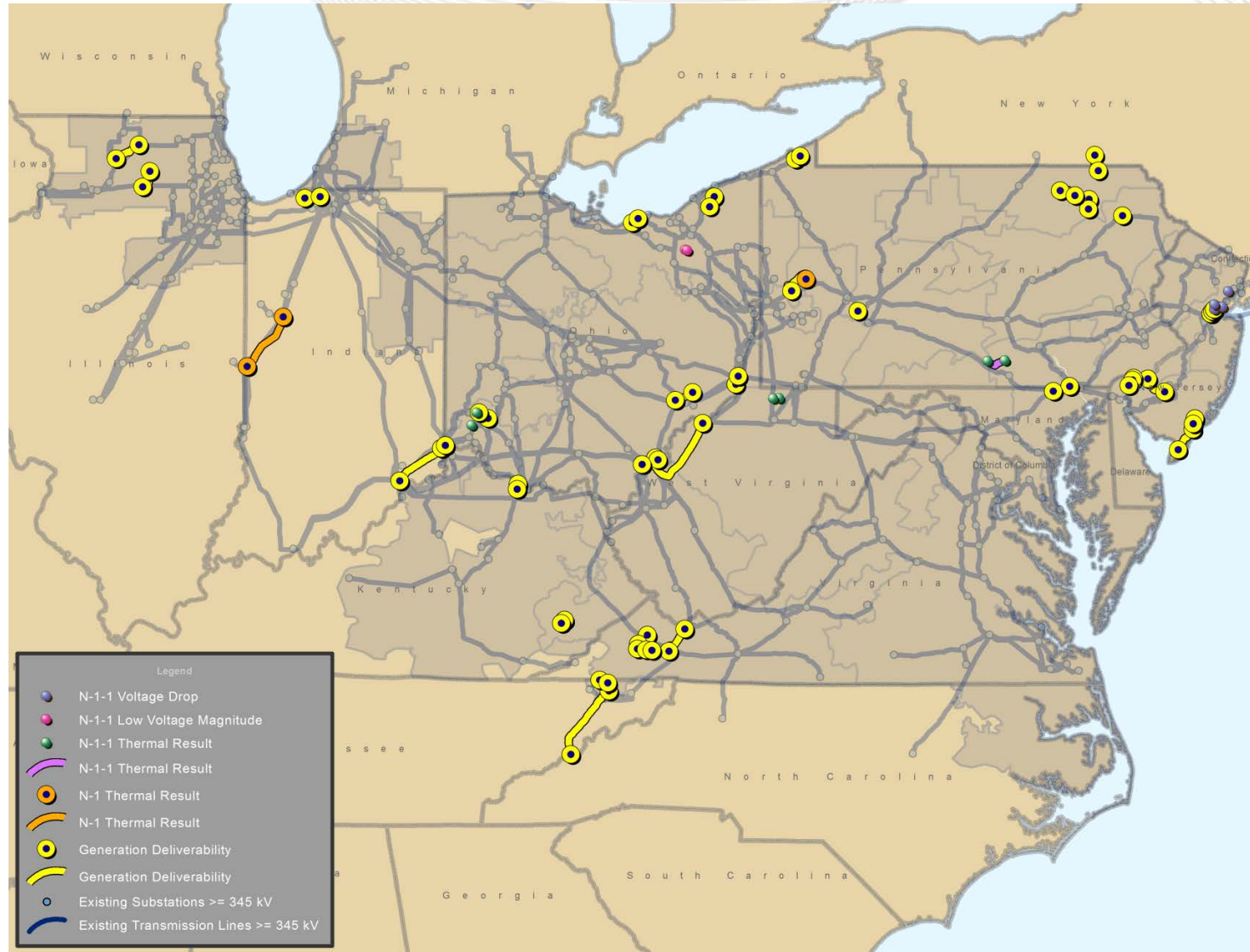
- Scope:
  - Baseline N-1 (thermal and voltage)
  - Generation Deliverability and Common Mode Outage
  - N-1-1 (thermal and voltage)
  - Load Deliverability (thermal and voltage)
- Window Opened: 6/29/2016
- Window Closed: 7/29/2016
  - Proposal definitions, simulation data and planning cost estimate due
- Detailed Cost due: 8/15/2016
  - Additional 15 days to develop and provide detailed cost data
  - See the window documentation for additional information

- 140 total flowgates

Test/kV Level*	100kV - 200kV	230kV	345kV	500kV	765kV	Total
N-1 Thermal	1		2			3
N-1 High Voltage						0
N-1 Low Voltage						0
N-1 Voltage Drop						0
Gen Deliv & CMO	76	9	13	3	1	102
Load Deliv Thermal						0
Load Deliv Voltage						0
N-1-1 Thermal	10					10
N-1-1 Low Voltage	2					2
N-1-1 Voltage Drop	2	18				20
N-1-1 Voltage Collapse						0
<b>Total</b>	<b>91</b>	<b>27</b>	<b>15</b>	<b>3</b>	<b>1</b>	<b>137</b>

\*xfmr are categorized based on low side kV

# 2016 RTEP Proposal Window 2 Violation Locations

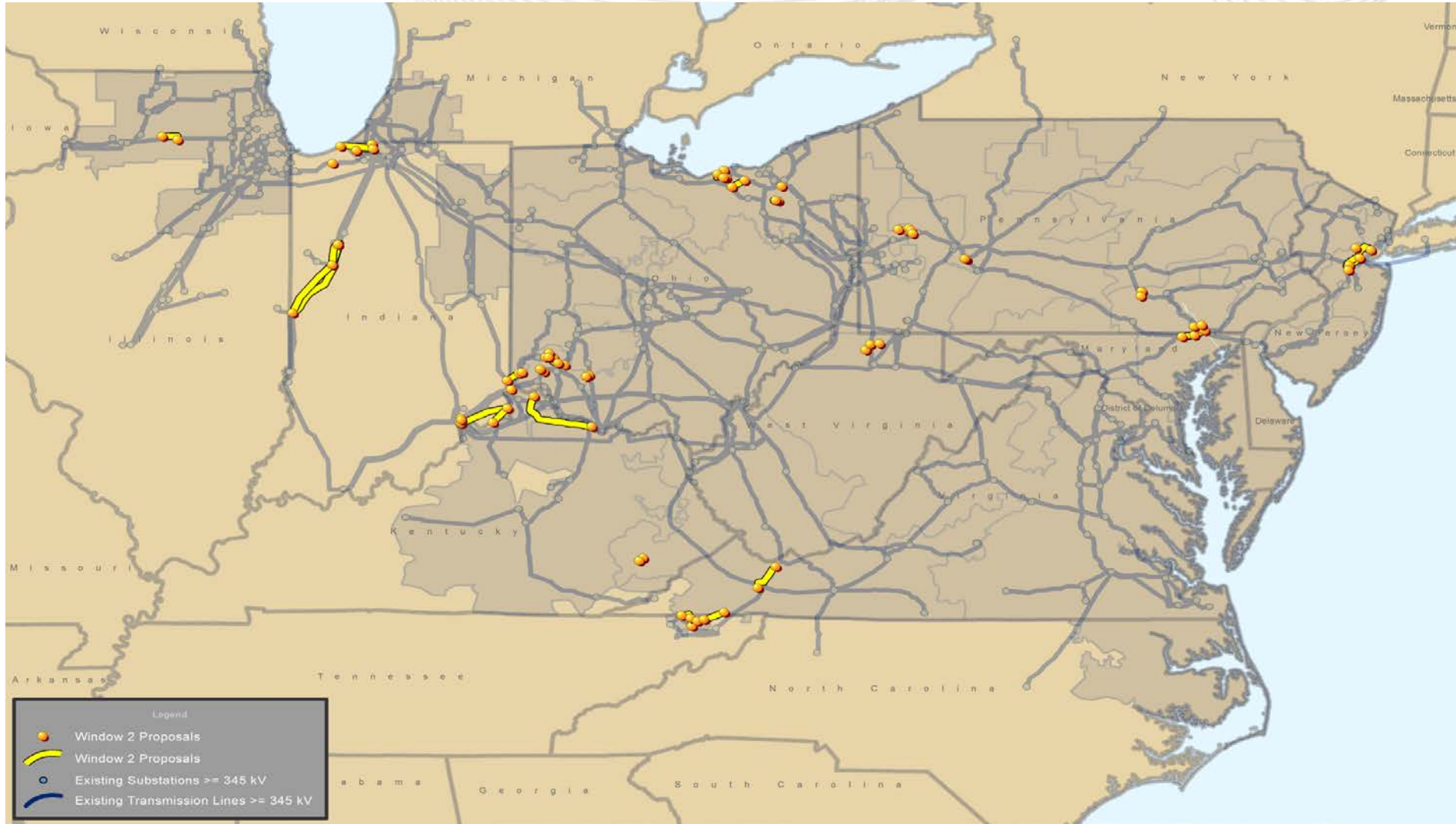


- Window Opened: 6/29/2016
- Window Closed: 7/29/2016
- Additional 15 day window close: 8/15/2016
- 137 Flowgates Identified, 71 Flowgates Recommended for proposals ( Remaining flowgates related to Retired Generators)
- 87 Proposals Received from 13 Entities addressing 12 TO Zones
  - 46 Greenfield
    - Cost Range \$5M - \$136.9M
  - 41 Transmission Owner Upgrades
    - Cost Range \$0.03M - \$125M



- Based on the work done to date proposals fall into the following high level categories
  1. Preliminary Recommendation
  2. Retirement/At Risk related (reliability violations will be re-evaluated pending the status of the retirement/at risk generation)
  3. Technical evaluation is on-going as necessary to develop a recommended solution
  4. Potential overlap with Winter and Light Load violations that will be posted in Window 3.

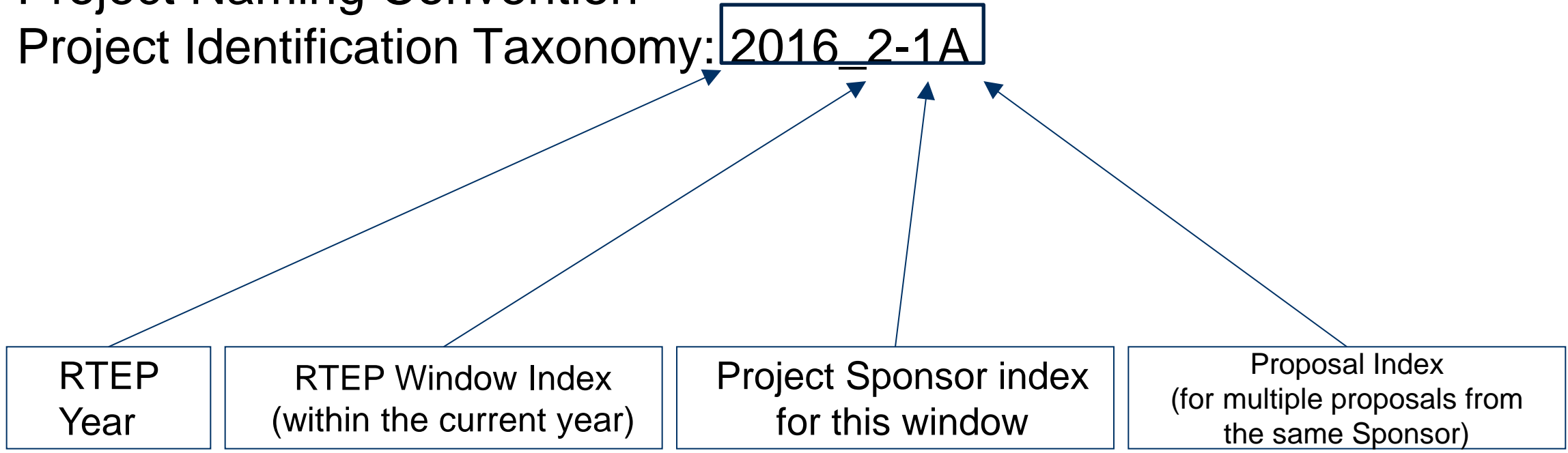
# 2016 RTEP Proposal Window 2 Proposal locations



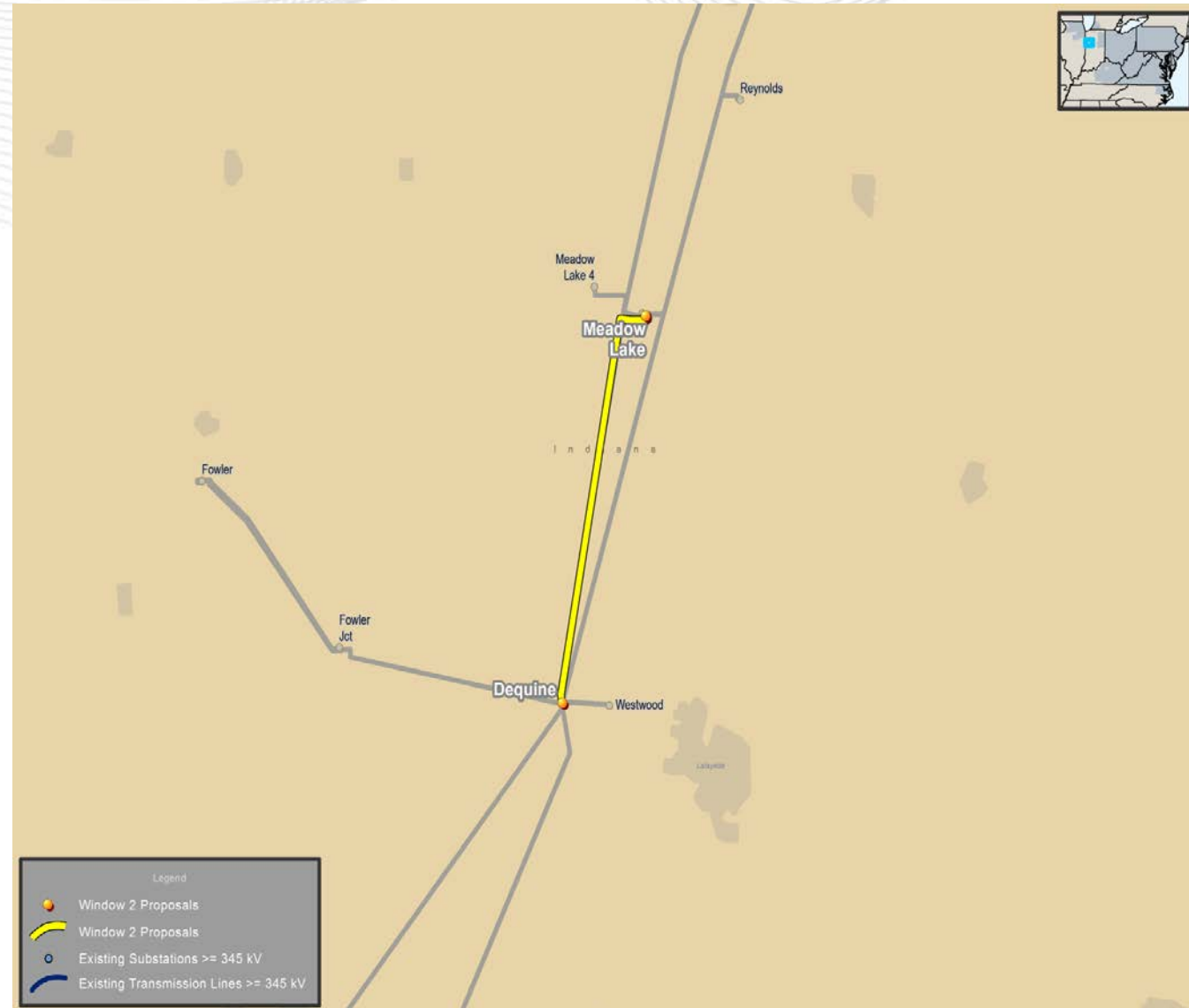
- Window Opened: 6/29/2016
- Window Closed: 7/29/2016

- Project Naming Convention

- Project Identification Taxonomy: **2016\_2-1A**



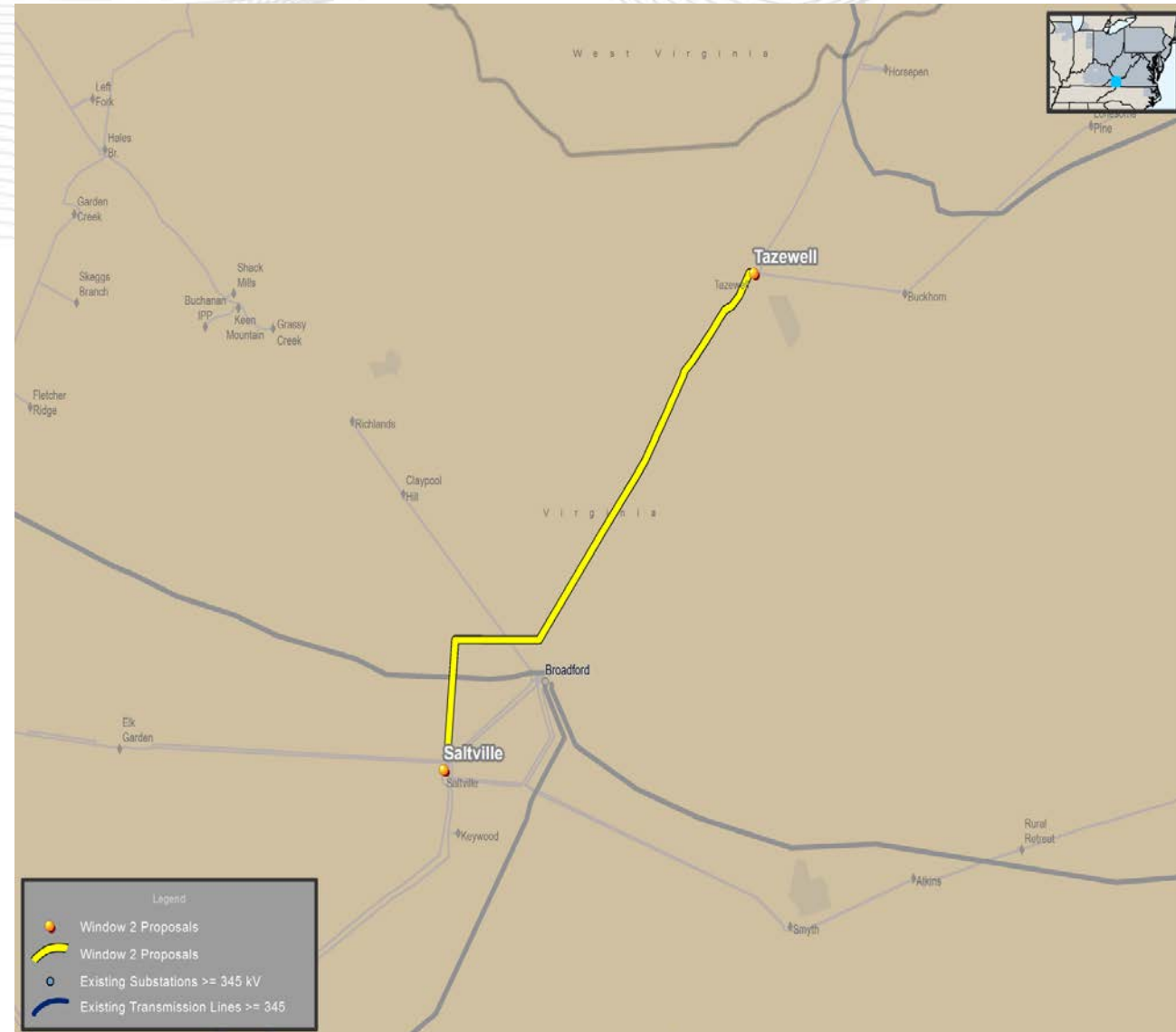
- Generation Deliverability (FG# 64):
- Dequine to Meadow Lake 345 kV circuit #2 is overloaded for loss of the Dequine to Meadow Lake 345 kV circuit #1.
  
- **Alternatives considered:**
  - 2016\_2-7H (\$33.7 M)
  - 2016\_2-7I (\$29.1 M)
  - 2016\_2-7K (\$28.1 M)
  - 2016\_2-7J (\$6.6 M)
  - 2016\_2-7P (\$127.6M)
  - 2016\_2-9I (\$80.5 M)
  - 2016\_2-11C (\$102.4 M)
  - 2016\_2-13G (\$136.9 M)
  
- **Status:**
  - Study in progress



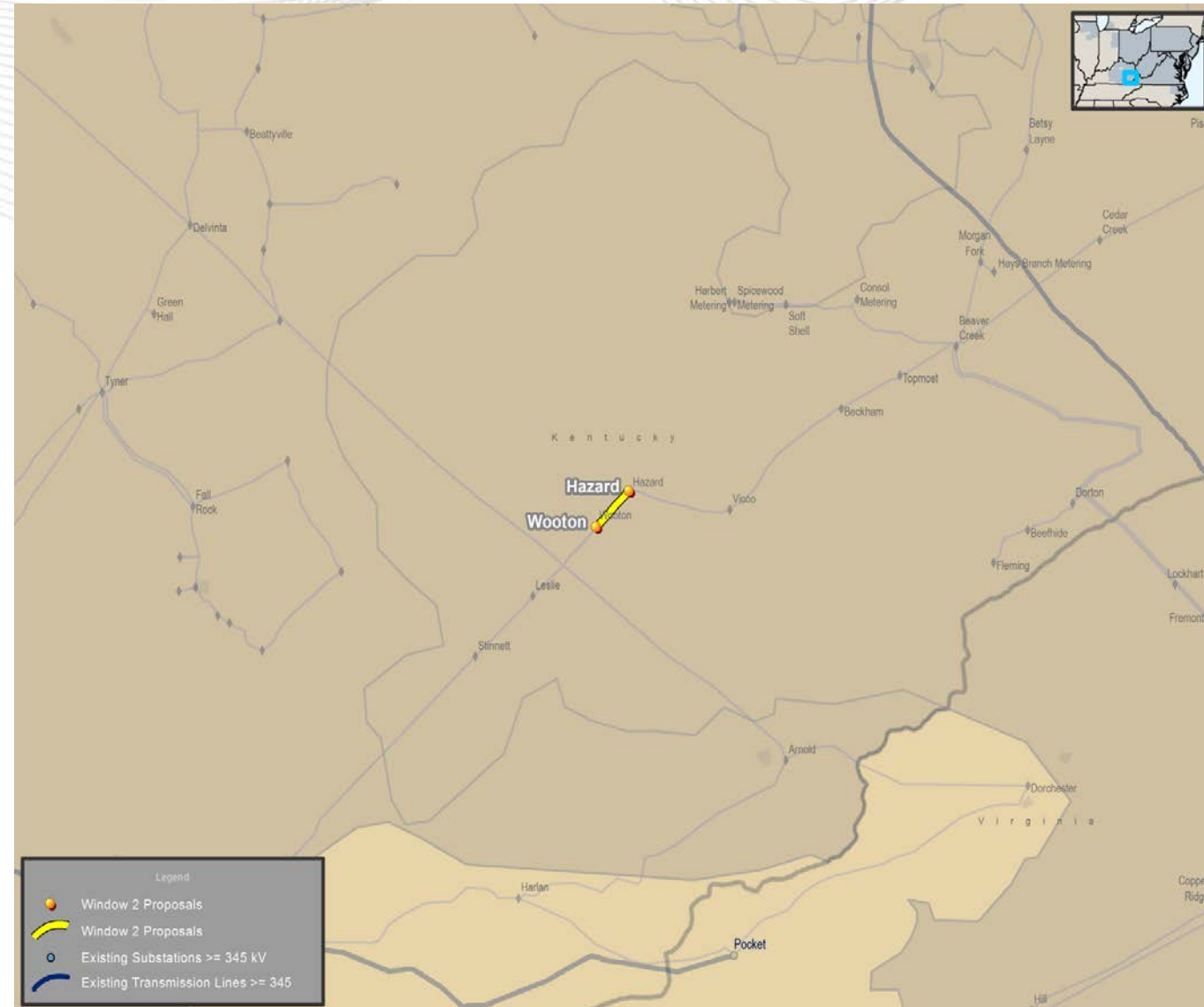
- Baseline and Generation Deliverability (FG# 101, 102 128, 130, 131,134) :
- Eugene to Dequine 345 kV circuit #1 is overloaded for several single contingencies.
- **Alternatives considered:**
  - 2016\_2-6B (\$32.5 M)
  - 2016\_2-7L (\$113.7 M)
  - 2016\_2-7M (\$99.1 M)
  - 2016\_2-7N (\$22.19 M)
  - 2016\_2-7O (\$99.3M)
  - 2016\_2-9I (\$80.5 M)
  - 2016\_2-11C (\$102.4 M)
  - 2016\_2-13G (\$136.9 M)
- **Status:**
  - Study in progress



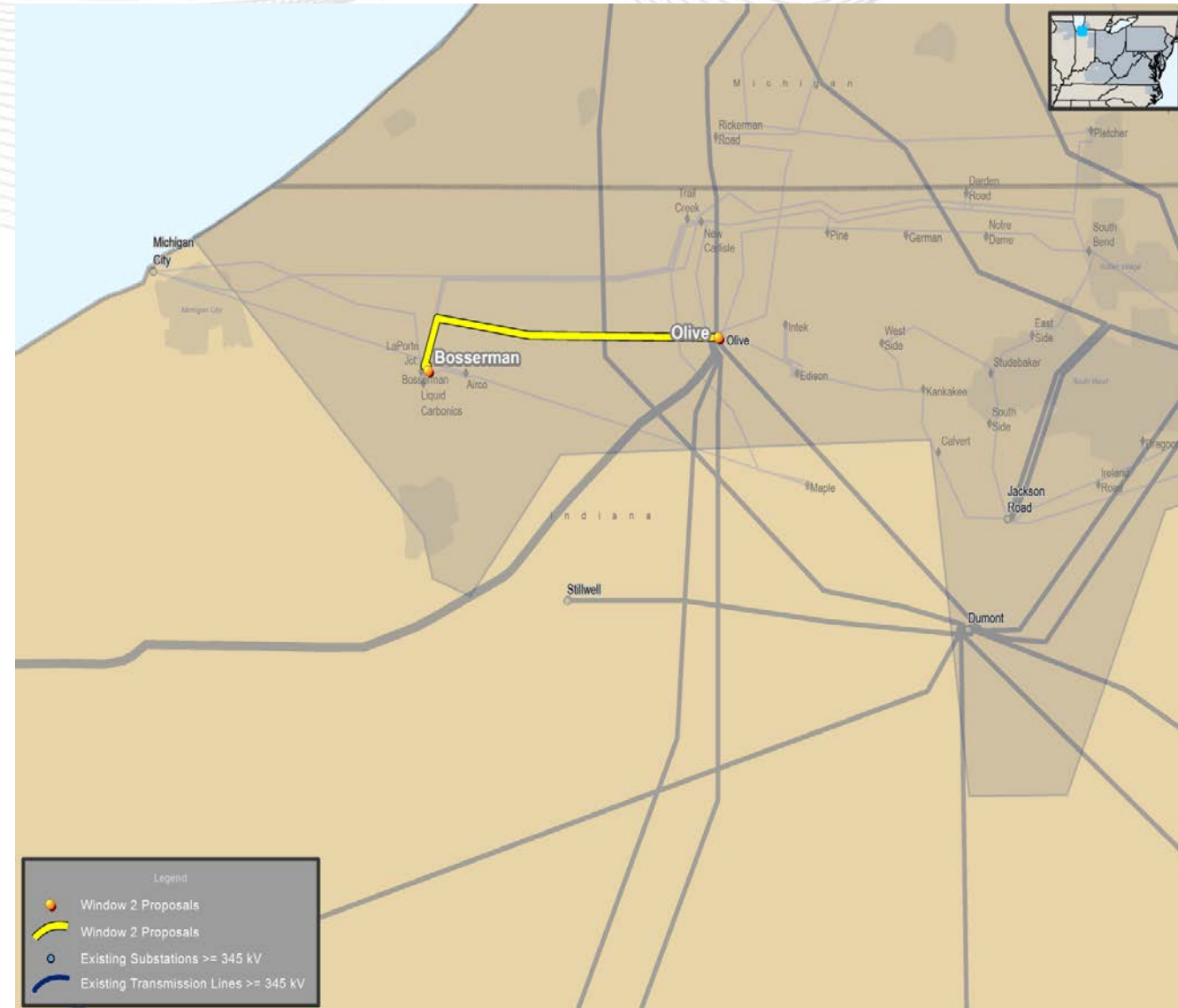
- Generation Deliverability (FG# 150) :
- Saltville to Tazewell 138 kV circuit is overloaded for the loss of the Jackson Ferry – Broadford 765 kV and Broadford 138 kV bus tie .
- **Alternatives considered:**
  - 2016\_2-7E (\$0.1 M)
- **Preliminary Recommendation:**
  - Sag Study of Saltville to Tazewell 138 kV line. (2016\_2-7E)
- **Estimated Project Cost: \$ 0.1 M**
- **Required IS Date: 6/1/2021**



- Common Mode Outage (FG# 874, 875, 901, 902) :
- Hazard 161/138 kV transformer and Hazard to Wooton 138 kV circuit are overloaded for multiple 138 kV tower contingencies from Clinch River to Fremont/Lockhart to Dorton.
- **Alternatives considered:**
  - 2016\_2-7A (\$2.3 M)
  - 2016\_2-7B (\$10.45M)
- **Preliminary Recommendation:**
  - Replace Hazard XF / Sag Study Hazard – Wooton. (2016\_2-7A )
- **Estimated Project Cost: \$ 2.3 M**
- **Required IS Date: 6/1/2021**

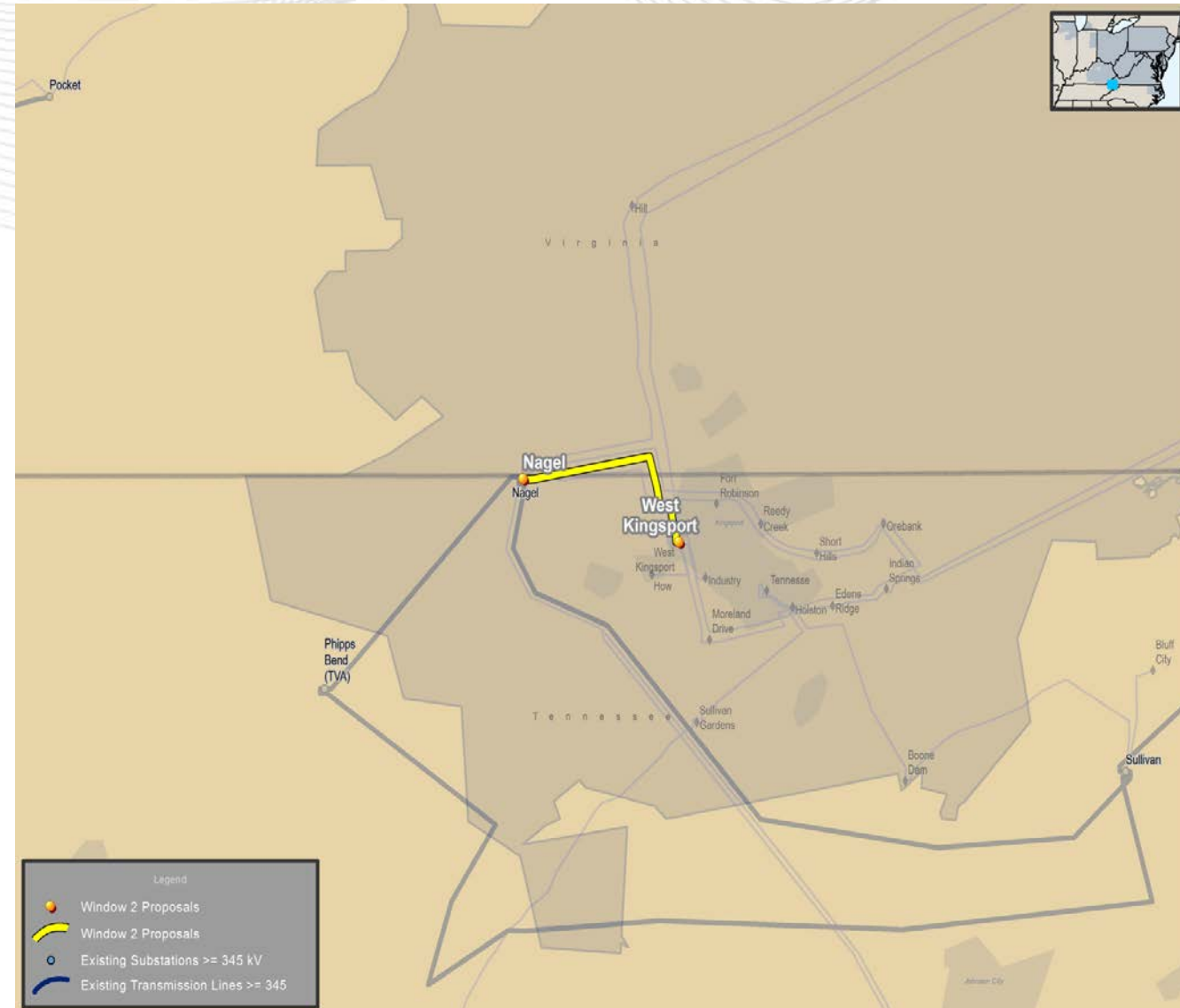


- Common Mode Outage (FG# 1141) :
- Olive to Bosserman 138 kV circuit is overloaded for line fault stuck breaker contingency loss of the New Carlisle 138 kV station.
- **Alternatives considered:**
  - 2016\_2-7Q (\$0.6 M)
  - 2016\_2-7R (\$24.2 M)
  - 2016\_2-9E (\$15.8 M)
  - 2016\_2-12A (\$5.0 M)
  - 2016\_2-12B (\$95 M)
- **Preliminary Recommendation:**
  - Reconfigure New Carlisle station and install an additional 138kV bus tie breaker. (2016\_2-7Q)
- **Estimated Project Cost:** \$ 0.6 M
- **Required IS Date:** 6/1/2021

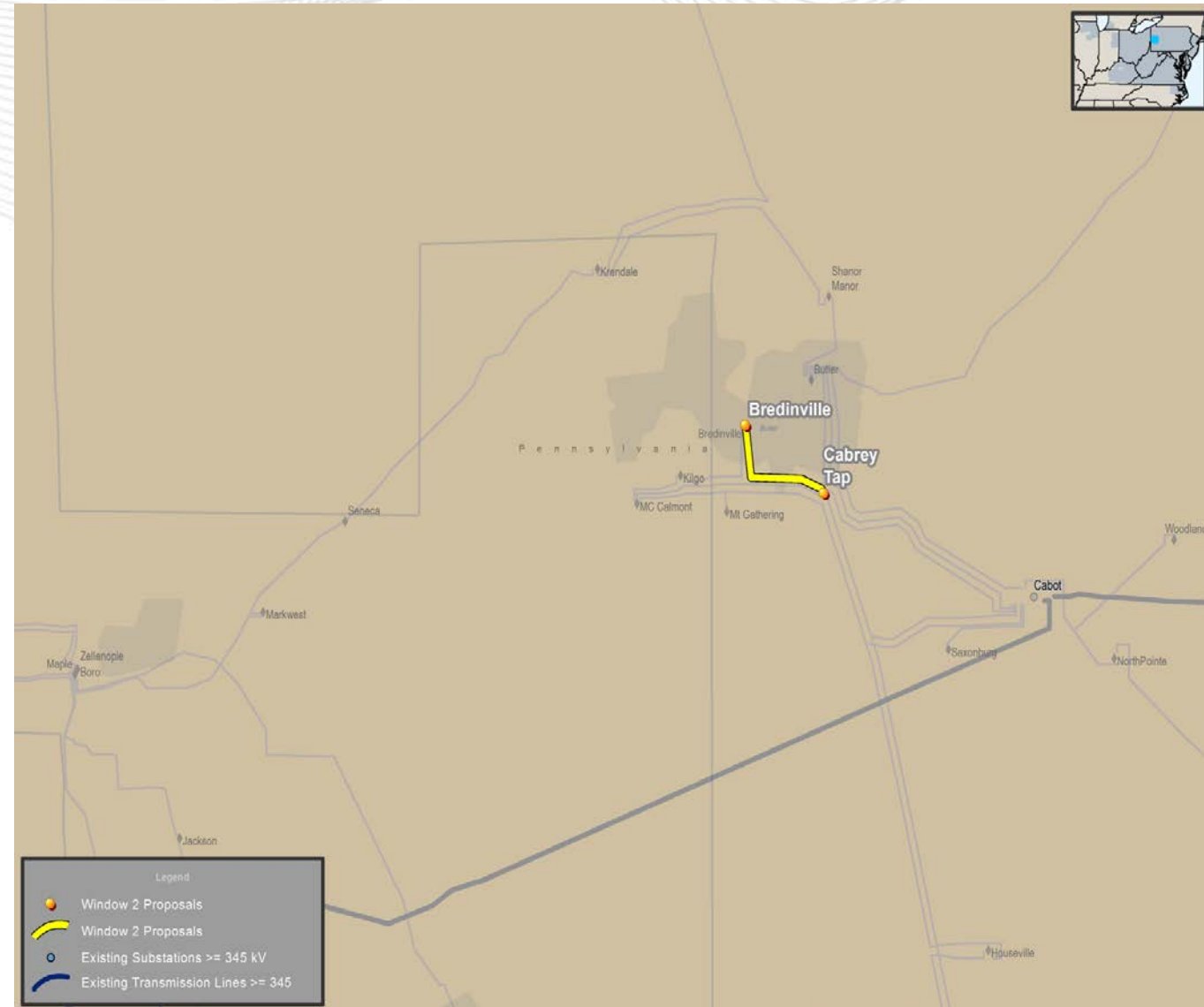




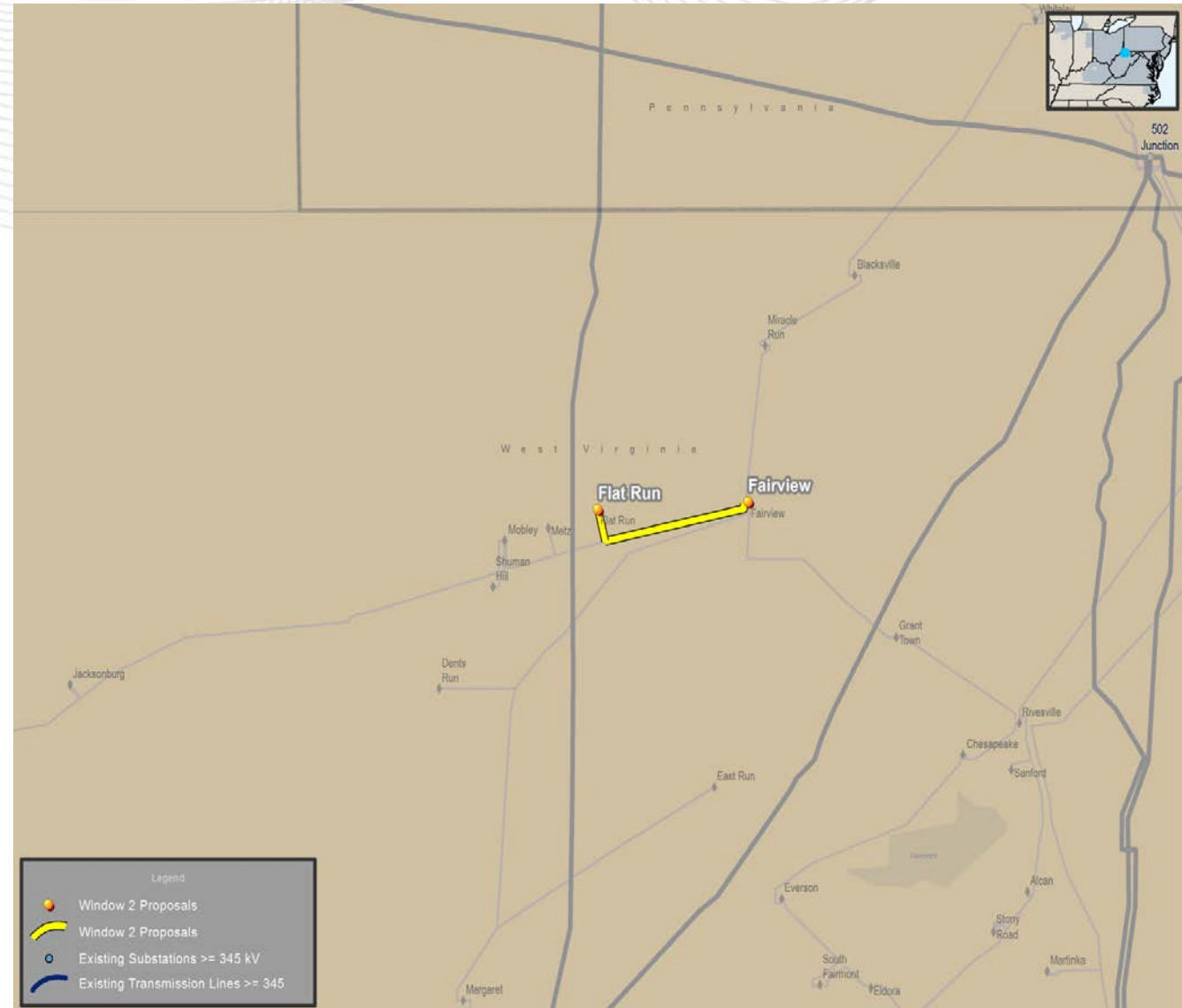
- Common Mode Outage (FG# 1152) :
- Nagel to West Kingsport 138 kV circuit is overloaded line fault stuck breaker contingency loss of the Nagel – Sullivan Gardens and Nagel – Phipps Bend 500 kV circuits.
- **Alternatives considered:**
  - 2016\_2-7D (\$0.1 M)
  - 2016\_2-9V (\$12.1 M)
- **Preliminary Recommendation:**
  - Sag Study of Nagel to West Kingsport 138 kV line. (2016\_2-7D)
- **Estimated Project Cost:** \$ 0.1 M
- **Required IS Date:** 6/1/2021



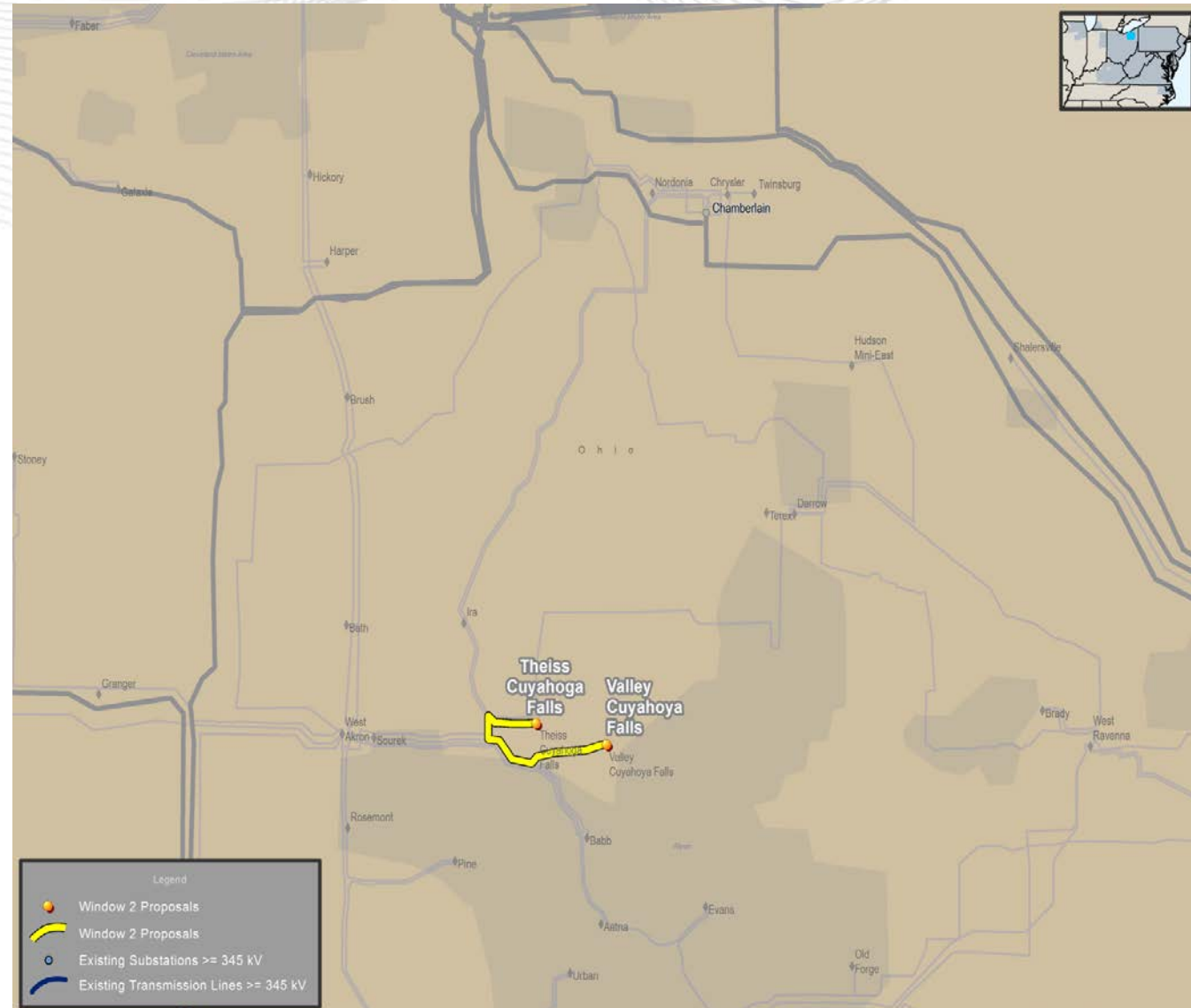
- Baseline and Common Mode Outage (FG# 109, 916) :
- Bredinville – Cabrey Tap 138 kV circuit is overloaded for 138 kV tower contingency loss of the Mc Calmont – Mt. Gathering – Cobot – Houseville – Fawn.
- **Alternatives considered:**
  - 2016\_2-3D (\$12 M)
  - 2016\_2-8K (\$0.97 M)
  - 2016\_2-9C (\$7.4M)
  - 2016\_2-9BS(\$12.1 M)
- **Preliminary Recommendation:**
  - Replace the Breaker Risers and Wavetrap at Bredinville Substation on the Cabrey Junction terminal. (2016\_2-8K)
- **Estimated Project Cost:** \$ 0.97 M
- **Required IS Date:** 6/1/2021



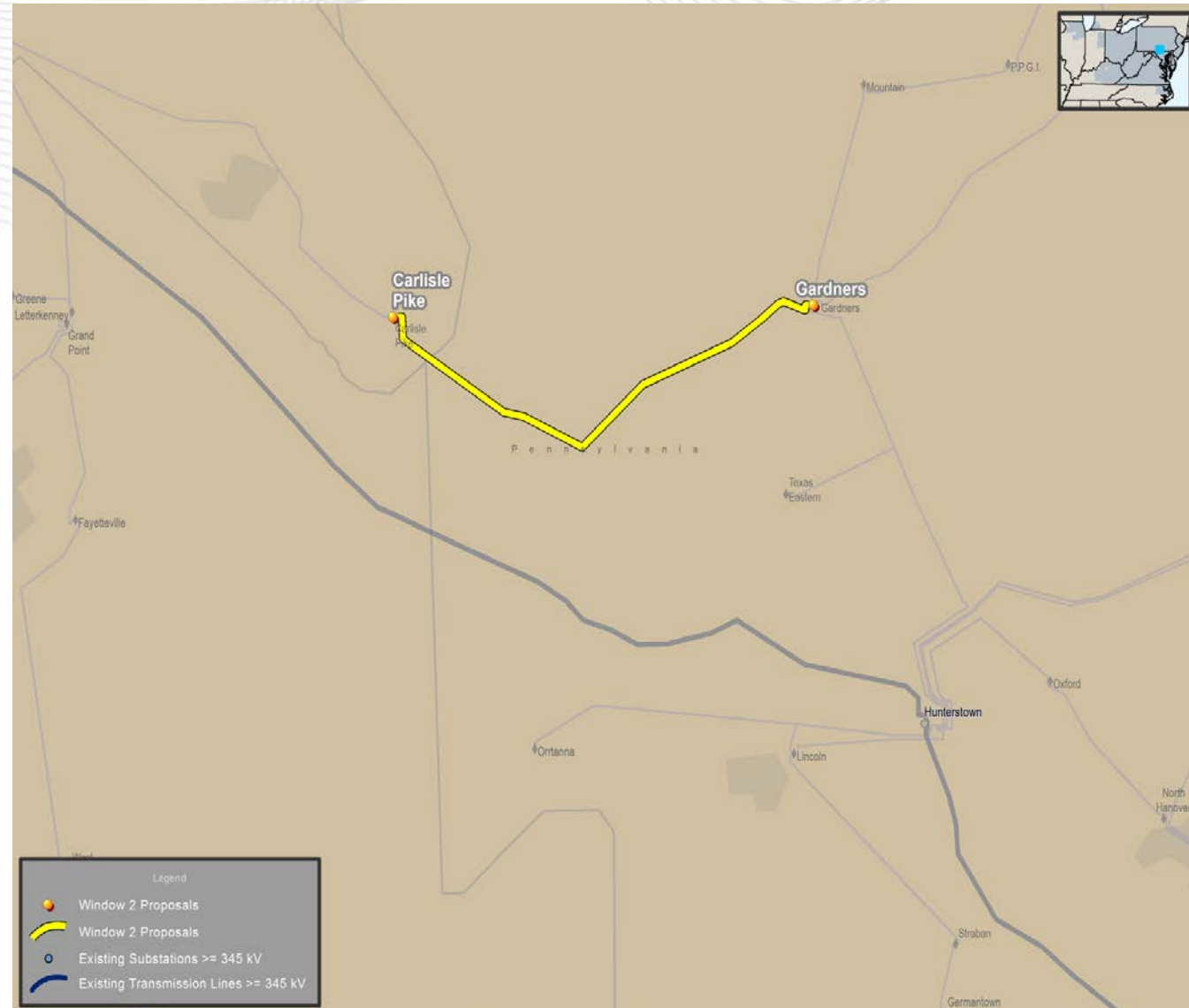
- N-1-1 Thermal (FG# N2-T2 ) :
- Fairview to Flat Run 138 kV circuit is overloaded for N-1-1 contingency loss of the Belmont – Middlebourne – Jacksonburg 138 kV.
  
- **Alternatives considered:**
  - 2016\_2-8E (\$ 0.03 M)
  - 2016\_2-9O (\$ 9.3 M)
  
- **Preliminary Recommendation:**
  - Upgrade breaker risers and disconnect leads;  
Replace 500 CU breaker risers and 556 ACSR disconnect leads with 795 ACSR.. (2016\_2-8E)
  
- **Estimated Project Cost:** \$ 0.03 M
  
- **Required IS Date:** 6/1/2021



- N-1-1 Voltage (FG# N2-VM5, N2-VM6) :
- Low voltage violation at Valley and Theiss 138 kV stations for the N-1-1 contingency loss of the Chamberlain 345/138 kV transformer and Valley – Babb 138 kV circuit .
  
- **Alternatives considered:**
  - 2016\_2-8B (\$ 1.8 M)
  - 2016\_2-8C (\$ 3.8 M)
  
- **Status:**
  - Study in progress



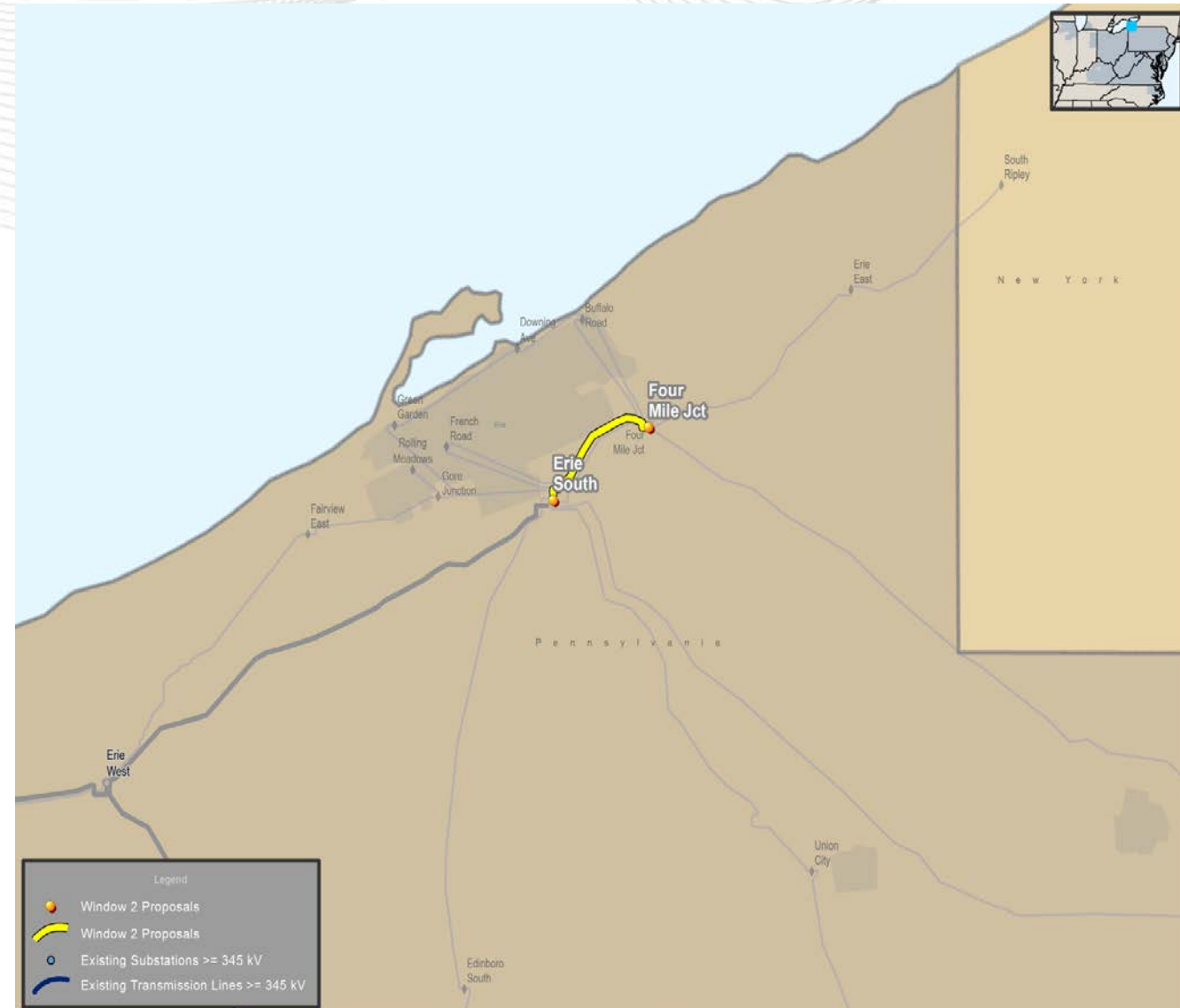
- N-1-1 Thermal (FG# N2-T1 and N2-T3) :
- Carlisle to Gardners 115 kV circuit is overloaded for N-1-1 contingency loss of the Hunterstown – Gardners and Middletown Jct. – Collins – Newberry –Round Tap 115 kV circuits.
- **Alternatives considered:**
  - 2016\_2-3E (\$10 M)
  - 2016\_2-8D (\$0.1 M)
  - 2016\_2-9F (\$13.3 M)
  - 2016\_2-9G (\$18.7 M)
- **Preliminary Recommendation:**
  - Upgrade bus conductor Gardners substation. Upgrade bus conductor and adjust CT ratios at Carlisle Pike. (2016\_2-8D)
- **Estimated Project Cost:** \$ 0.1 M
- **Required IS Date:** 6/1/2021



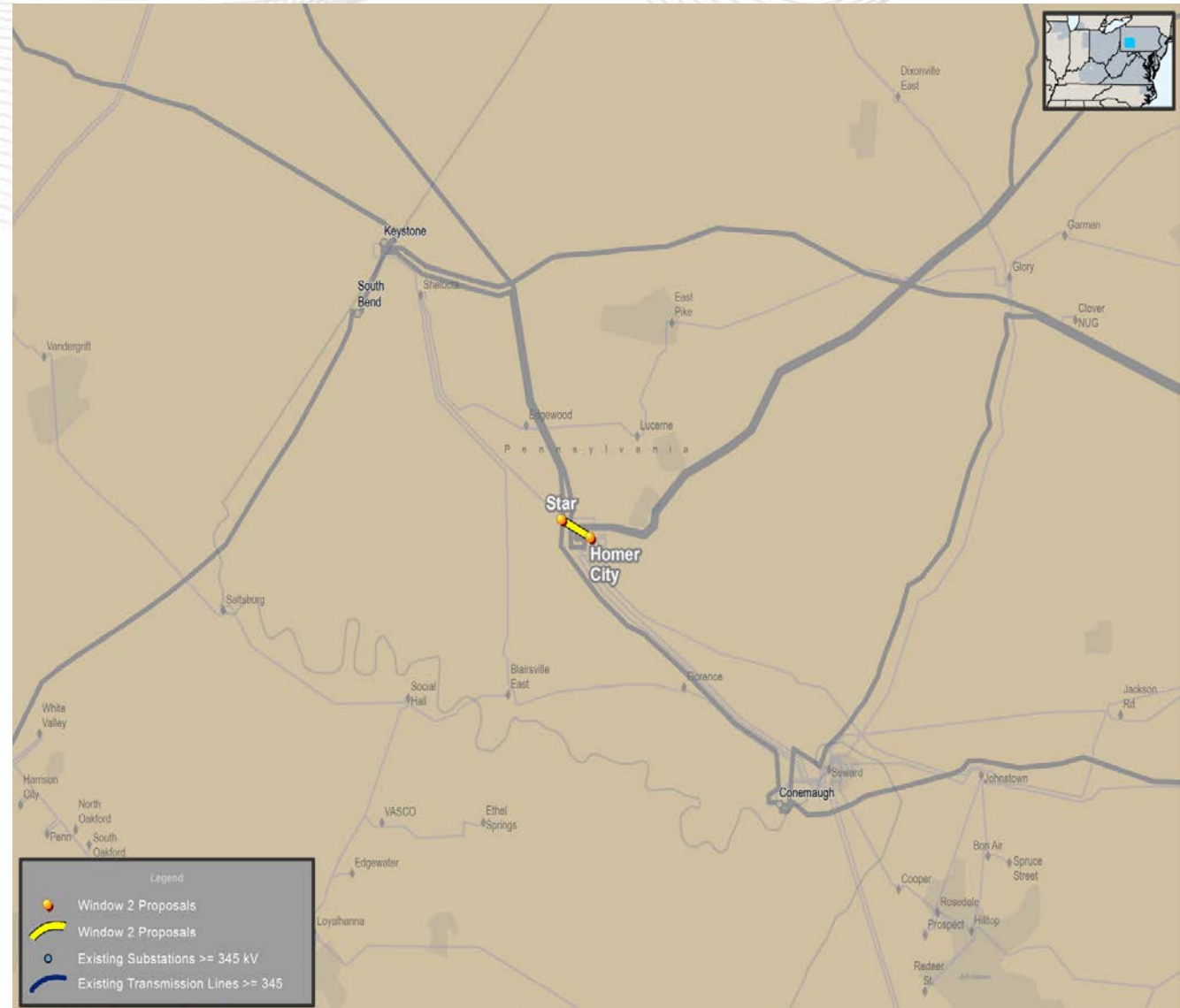
- Generation Deliverability (FG# 294, 295, 296) :
- Conastone to Peach Bottom 500 kV circuit is overload pre-contingency and for the loss of the Peach Bottom – TMI 500 kV circuit.
- **Alternatives considered:**
  - 2016\_2-4A (\$2.0 M)
  - 2016\_2-4B (\$7.0 M)
  - 2016\_2-9A (\$12.5 M)
  - 2016\_2-9B (\$19.2 M)
  - 2016\_2-9P (\$26.8 M)
  - 2016\_2-9Q (\$13.4 M)
- **Preliminary Recommendation:**
  - Upgrade Substation Equipment at Conastone and Peach Bottom to increase facility rating to 2826 MVA normal and 3525 MVA emergency. (2016\_2-4B)
- **Estimated Project Cost:** \$ 7.0 M
- **Required IS Date:** 6/1/2021



- Common Mode Outage (FG# 1059) :
- Fourmile to Erie SE. 115 kV circuit is overloaded for line fault stuck breaker contingency loss of the Warren – Erie South and Fourmile – Erie SE 230 kV circuits.
  
- **Alternatives considered:**
  - 2016\_2-8H (\$3.9 M)
  - 2016\_2-9N (\$11.5 M)
  
- **Preliminary Recommendation:**
  - Reconductor 4.62 miles of Erie South to Fourmile 115 kV circuit 636 ACSR with 636 ACSS high temperature conductor and replace bus and substation conductors on both Erie South and Fourmile stations. (2016\_2-8H)
  
- **Estimated Project Cost: \$ 3.9 M**
  
- **Required IS Date: 6/1/2021**



- Common Mode Outage (FG# 1026):
- The Homer City 345/230 kV transformer #S is overloaded for a line fault stuck breaker contingency loss of the Homer City – Armstrong 345 kV circuit and Homer City 345/230 kV transformer #N.
- **Alternatives considered:**
  - 2016\_2-3B (\$36 M)
  - 2016\_2-8G (\$6.6 M)
  - 2016\_2-9D (\$23 M)
- **Status:**
  - Study in progress



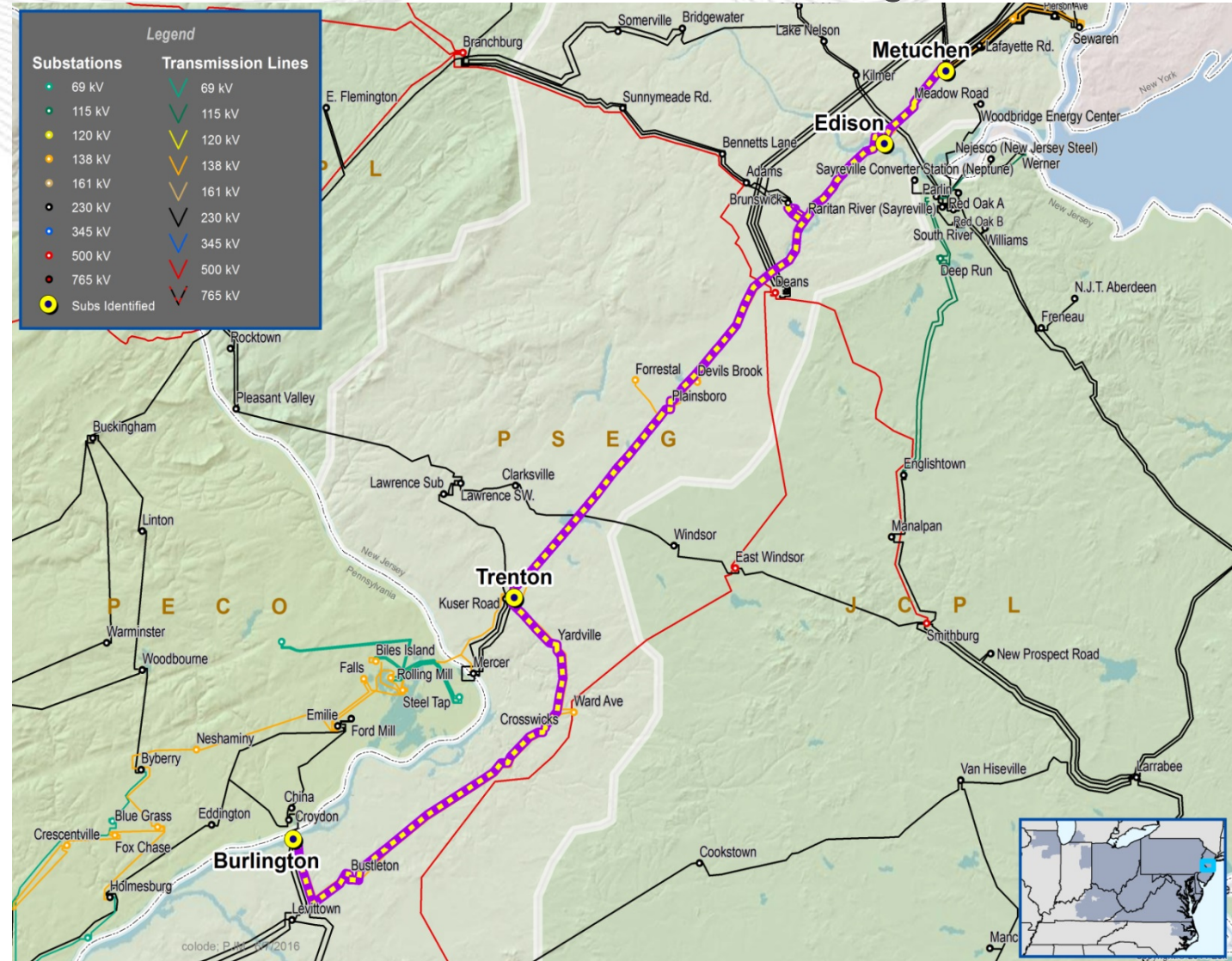


# PSE&G End Of Life Assessment Metuchen – Edison – Trenton – Burlington Corridor



# PSE&G Transmission Zone Metuchen – Burlington Corridor

- PSE&G's FERC 715 Transmission Owner criterion addresses equipment condition assessments
  - PSE&G assessed the condition of the Metuchen to Trenton (MT-T) and Trenton to Burlington (T-BU) 138 kV circuits.



- Refer to PSE&G criteria:

VII. EQUIPMENT ASSESSMENT AND STORM HARDENING

<http://www.pjm.com/~media/planning/planning-criteria/PSE&G-planning-criteria.ashx>

- Metuchen to Trenton is approximately 30 miles of 138 kV circuit and the average structure age is 86 years.
- Trenton to Burlington is approximately 22 miles of 138 kV circuit and the average structure age is 75 years.

- Assessment Result:
  - Consultant - Foundation assessment
    - 23% and 30% of structures for MT-T and T-BU respectively will require extensive foundation rehabilitation or total foundation replacement.
  - Consultant – Tower line assessment
    - 25% of the tower structures exceed the tower load carrying design capability
    - 35% of the towers are at 99-100% of the tower's load bearing capability, and 81% of the towers at 95-100% of the tower's capability.



Figure 1: Examples of 25-30% foundation structure loss

- Deteriorating tower leg, gusset plates and angles due to corrosion
- “Condition E” in the consultant report indicates greater than 50% thickness loss of steel member
- Load carrying capability compromised



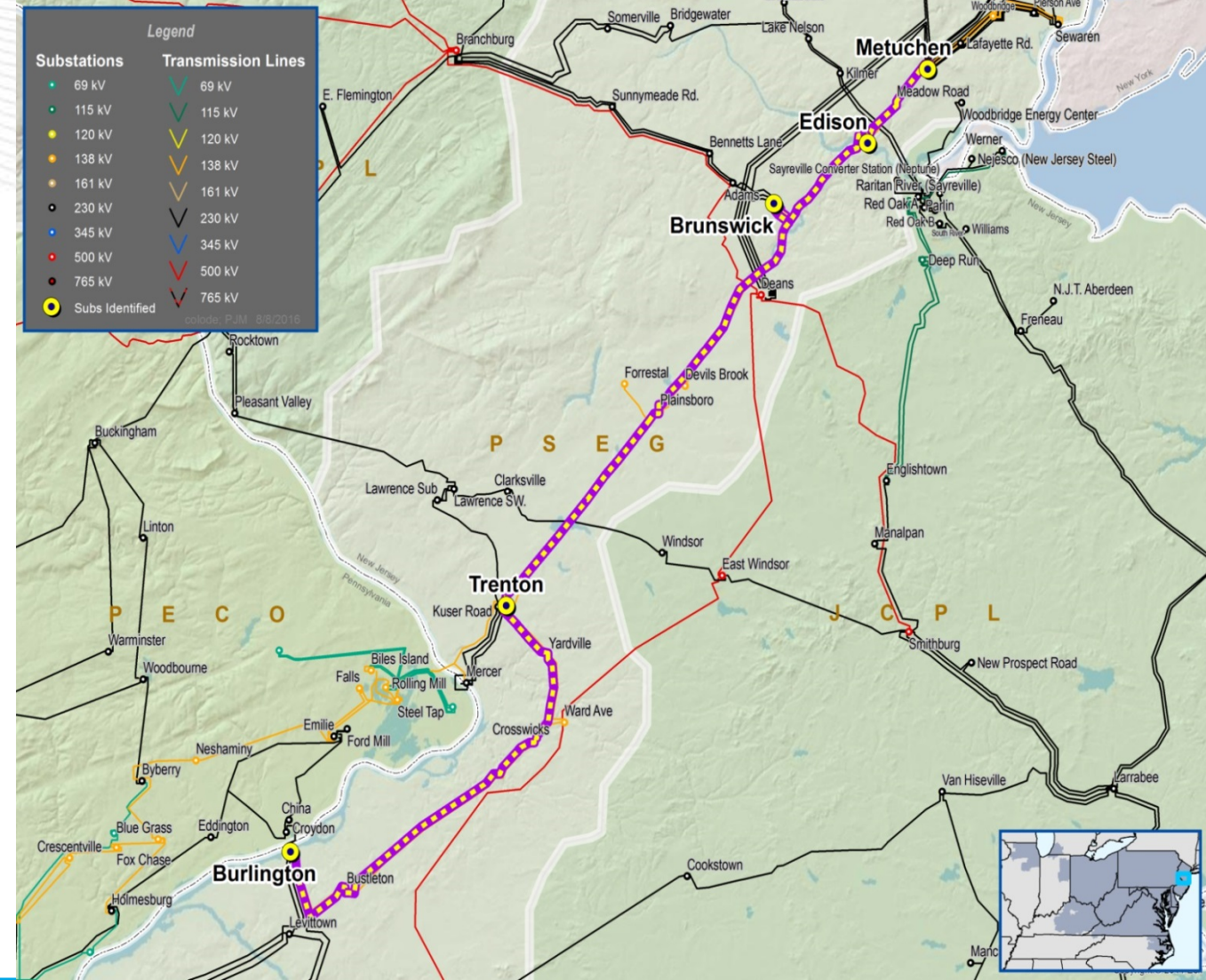
### Problem:

### PSE&G FERC 715 Transmission Owner Criteria

- Equipment condition assessment for the entire corridor
- Equipment has reached its end of life

### NERC Reliability Criteria

- N-1-1 voltage violations in the Metuchen vicinity in the 2016 RTEP Window #2



- Remove the 138 kV corridor without replacing
- Install new parallel circuit on new right of way and remove the existing corridor
- Replace / rebuild the 138 kV corridor in kind with new foundations, 138 kV structures and hardware.
- Convert the 138 kV corridor to 230 kV



# Remove Existing Corridor Without Replacing

- Load (approximately 544 MVA) would need alternative supply at nine stations
- No transmission supply available near Devils Brook, Plainsboro, Yardville, Crosswicks, and Bustleton.
- Would require extensive new 69kV line construction
- Loss of existing transmission corridor
- High population density
  - Would require extensive underground construction.
- This option does not eliminate b2590, “Install two 75 MVAR 230 kV capacitors at Sewaren station” (\$8.4M). Also, does not eliminate b2589, “Install a 100 MVAR 230 kV shunt reactor at Mercer station” (\$7.2M).



# Install New Circuit and Remove/Abandon Existing

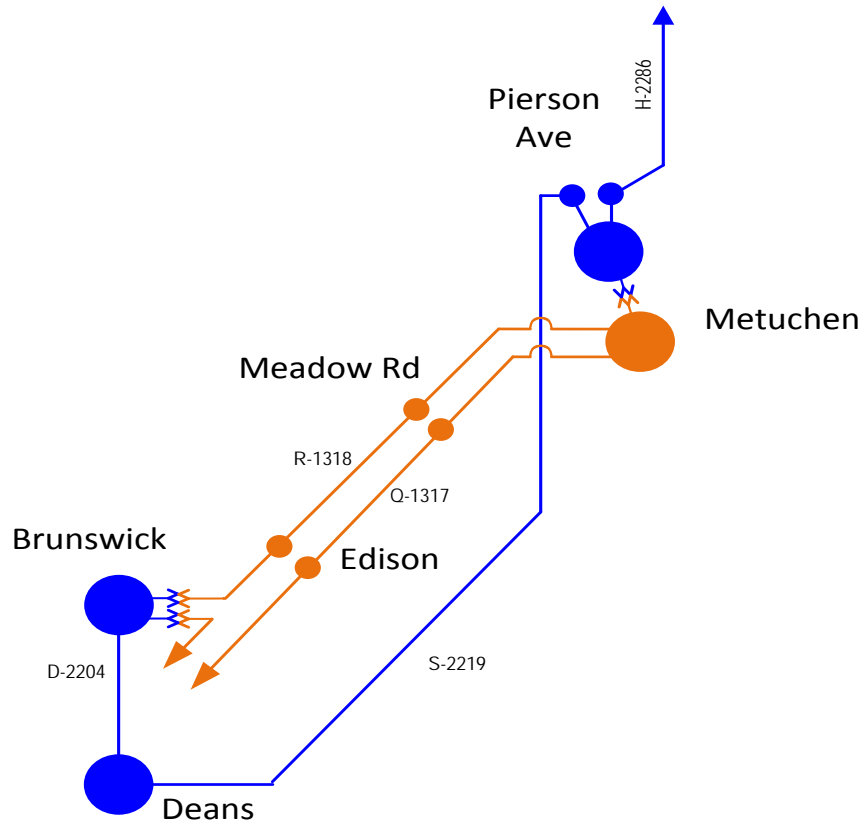
- High population density in the corridor
  - ability to obtain new transmission ROW feasibility is challenging or not feasible
  - would require extensive underground construction
- Need to supply nine existing stations, requiring new circuits to loop in an out of the existing stations
- Would require extensive new 69kV line construction.
- Limited 69 kV circuit capacity and line length due to voltage drop
- This option does not eliminate b2590, “Install two 75 MVAR 230 kV capacitors at Sewaren station” (\$8.4M). Also, does not eliminate b2589, “Install a 100 MVAR 230 kV shunt reactor at Mercer station” (\$7.2M).

- Rebuild / Replace existing facilities
- Costs
  - Metuchen to Brunswick - \$126M
  - Brunswick to Trenton - \$265M
  - Trenton to Burlington - \$293M

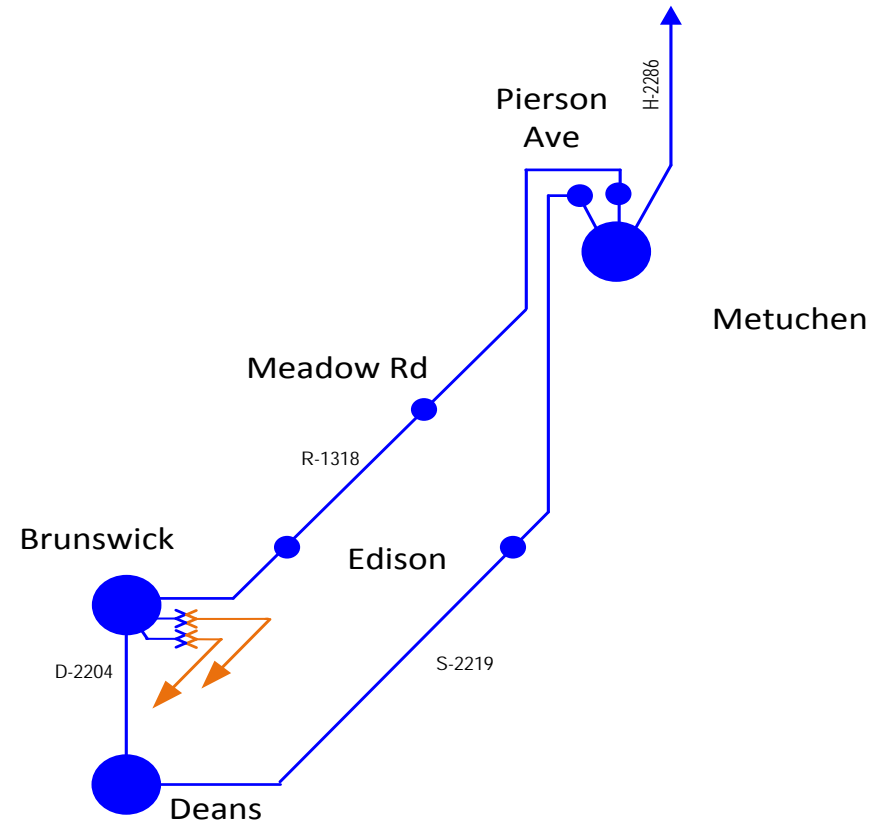
- Potential Solution for Metuchen - Burlington:
  - Convert the R-1318 and Q1317 (Edison – Metuchen) 138 kV circuits to one 230 kV circuit
    - Metuchen 138 kV will be eliminated
    - The Brunswick 230/138 kV autotransformer will be eliminated
    - The new converted 230 kV circuit will be terminated at the existing Metuchen and Brunswick 230 kV stations.
- Project Benefits:
  - Resolves voltage violation in the Metuchen vicinity identified in the 2016 RTEP 2<sup>nd</sup> Window
  - Eliminates the need for baseline upgrade (B2590 – Install two 75 MVAR 230 kV capacitors at Sewaren station) identified in the 2014 RTEP window.
  - Strengthens the system by replacing 138 kV circuits with 230 kV circuits, improving capacity and voltage.
  - Creates a strong tie between Southern and Central PSE&G
  - Increases transfers capability to Central PSE&G
  - Addresses future reliability and economic needs
- Estimated Project Cost: \$ 125 M

# Metuchen – Brunswick Existing and Future Diagram

Before



After



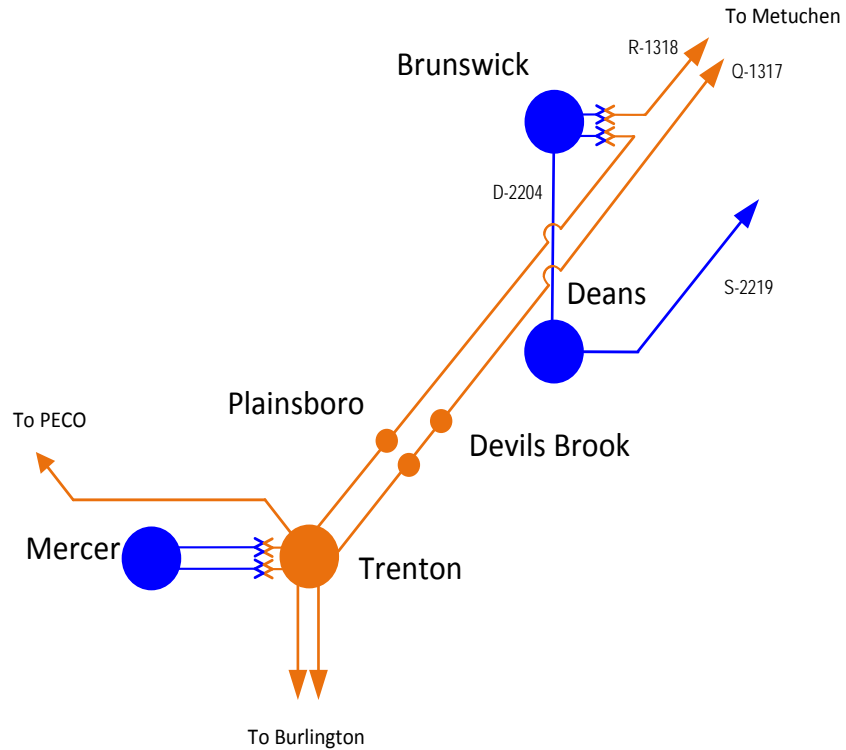
Convert the R-1318 and Q1317 (Edison – Metuchen) 138 kV circuits to one 230 kV circuit

- **Potential Solution for Brunswick - Trenton:**
  - Convert the N-1340 and T-1372/D-1330 (Brunswick – Trenton) 138 kV circuits to 230 kV circuits
    - The converted circuits will be terminated at the existing Brunswick 230 kV
    - The Deans 230 kV station will be expanded with additional two breaker and half bay
    - The converted two 230 kV circuits will be looped in to Deans 230 kV station
    - The new converted 230 kV circuit will be terminated at the Trenton 138 kV station with two 138 kV transformers
- **Project Benefit:**
  - Strengthens the system by replacing 138 kV circuits with 230 kV circuits, improving capacity and voltage.
  - Loops in a strong source at Deans improving reliability
  - Provides better transfers across the network
  - Addresses future reliability and economic needs

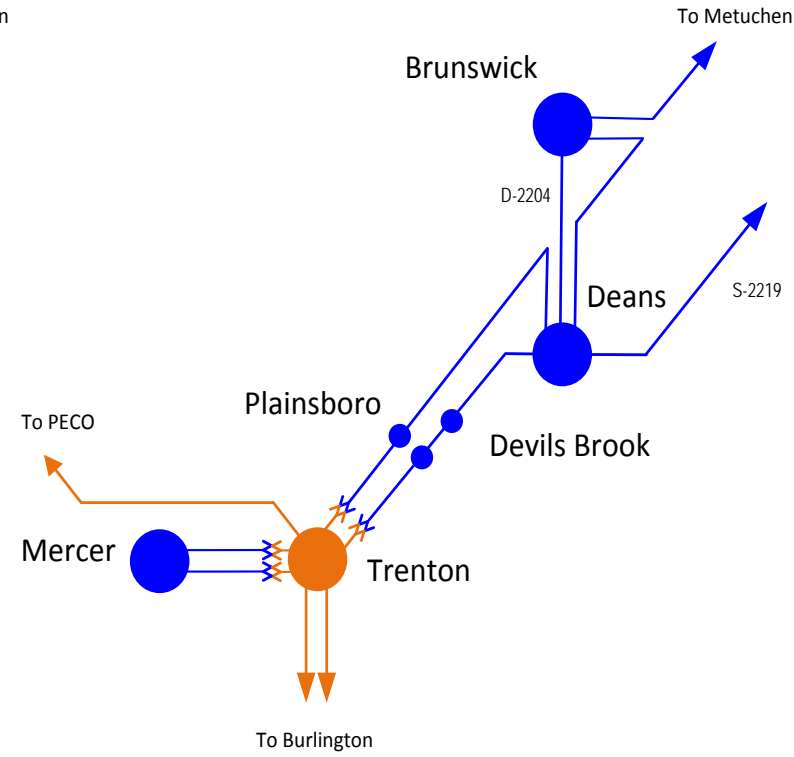
**Estimated Project Cost: \$ 327 M**

# Brunswick – Trenton Existing and Future Diagram

Before



After



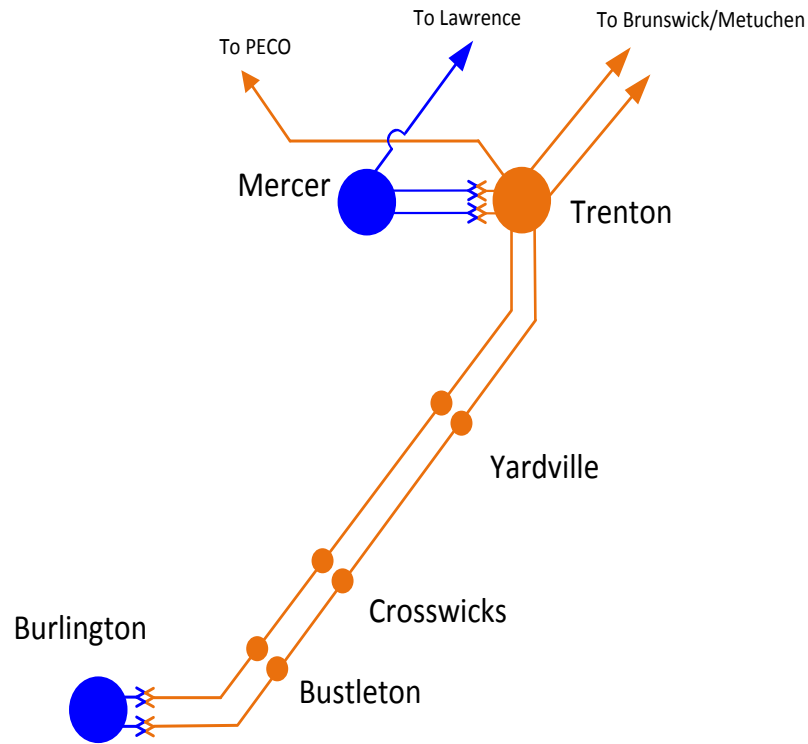
Convert the R-1318 and Q1317 (Edison – Metuchen) 138 kV circuits to one 230 kV circuit

- Potential Solution for Trenton - Burlington:
  - Convert the F-1358/Z1326 and K1363/Y-1325 (Trenton - Burlington) 138 kV circuits to 230 kV circuits
    - Trenton 138 kV substation will be replaced with six bay breaker and half 230 kV substation
    - The A-130-27 138 kV currently from Trenton - US Steel (PECO) will be terminated at Mercer 230 kV with 230/138 kV transformer and the Trenton – Mercer portion of the circuit will be converted to 230 kV
    - Mercer station will be expanded with additional breaker and half bay.
- Project Benefit:
  - Eliminates the need for baseline upgrade (B2589 – Install a 100 MVAR 230 kV shunt reactor at Mercer station) identified in the 2014 RTEP window.
  - Strengthens the system by replacing 138 kV circuits with 230 kV circuits, improving capacity and voltage.
  - Provides better transfers across the network
  - Addresses bottled generation issue at Mercer

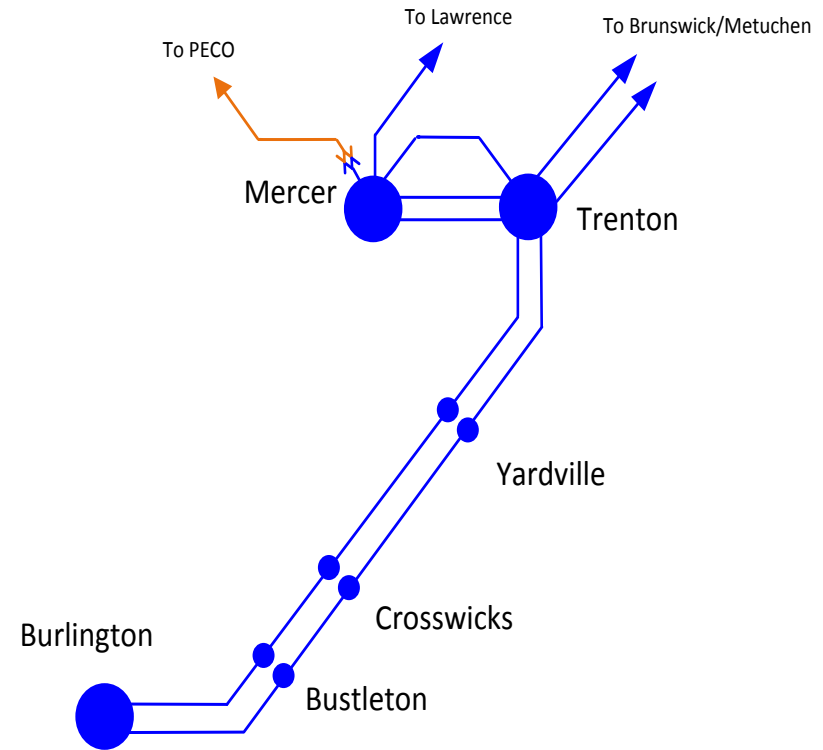
Estimated Project Cost: \$ 349 M

# Trenton – Burlington Existing and Future Diagram

Before



After





- Cost: 138kV vs 230kV cost estimates
  - Metuchen – Brunswick
    - \$126M for 138 kV and \$125M\* for 230 kV
  - Brunswick – Trenton
    - \$265M for 138 kV and \$327M for 230 kV
  - Trenton – Burlington
    - \$293M for 138 kV and \$349M for 230 kV
- Replacing with 138kV does not address voltage issues in the Metuchen area
- Older transformers still require replacement with the 138 kV alternative
- The 138 kV option does not eliminate b2590, “Install two 75 MVAR 230 kV capacitors at Sewaren station” (\$8.4M). Also, does not eliminate b2589, “Install a 100 MVAR 230 kV shunt reactor at Mercer station” (\$7.2M). Neither projects are required with the 230kV plan.

\*Higher cost of the 138kV attributed to replacement of the existing Brunswick 230-138kV transformer, the 230kV option eliminates the transformer.

# PSE&G End Of Life Assessment Newark Switch Review

- Refer to PSE&G criteria:  
VII. EQUIPMENT ASSESSMENT AND STORM HARDENING  
<http://www.pjm.com/~media/planning/planning-criteria/PSE&G-planning-criteria.ashx>
  - Risk of a transformer fire that may result in the entire building on fire and thus the loss of ~>300 MVA of load for a long duration. Nearby school/church & healthcare facility.
  - Several common mode of failures
  - .

- Age: Substation: 1957
- T1: 1972 – T2 & T3: 1958
- Spare: 1992
- Special transformer: Dual ratio (138/26/13)
  - Wye-Wye 13 kV All PSEG 13 kV transformers are delta-wye (30°)
- Maintenance and Maintenance outages
- Rooftop transmission system
- Lower level indoor transformers
- Critical Station (City of Newark - Downtown) ~300 MVA Load
  - Financial buildings
  - City Hall
  - Other Government Buildings
  - NJIT, Rutgers
  - PATH Train, NJ Transit
  - 26kV and 13kV Source station
  - Several Data Centers
  - Downtown Newark
  - Prudential Arena, NJ Performing Arts Center
  - United States Citizenship and Immigration Services (USCIS)

- Basement: Oil rooms, 13 & 26 kV feeders & transmission lines entering the station
- 1st Floor: 26 kV switchgear & Transformers' vaults
- 2nd floor: Distribution reactors
- 3rd floor: Control room/AUX power rooms
- Roof: 138 kV Yard

- Station age and condition
  - Based on unique design, aged equipment and obsolete equipment Newark Switch is considered at end-of-Life.
- Potential risks and consequences
  - Any transformer fire or catastrophic failure would result in the destruction of the whole facility and the loss of 300 MVA of critical load for an extended period of time.
- 26/13 kV bus faults
- Other risks and common modes of failure
- Environmental/structural concerns

- Urban location
- Proximity to existing transmission system



- Distribution feeds below transformer vaults





- Transformers located below the 138 kV rooftop switchyard.
- A transformer fire would be significant and result in catastrophic loss



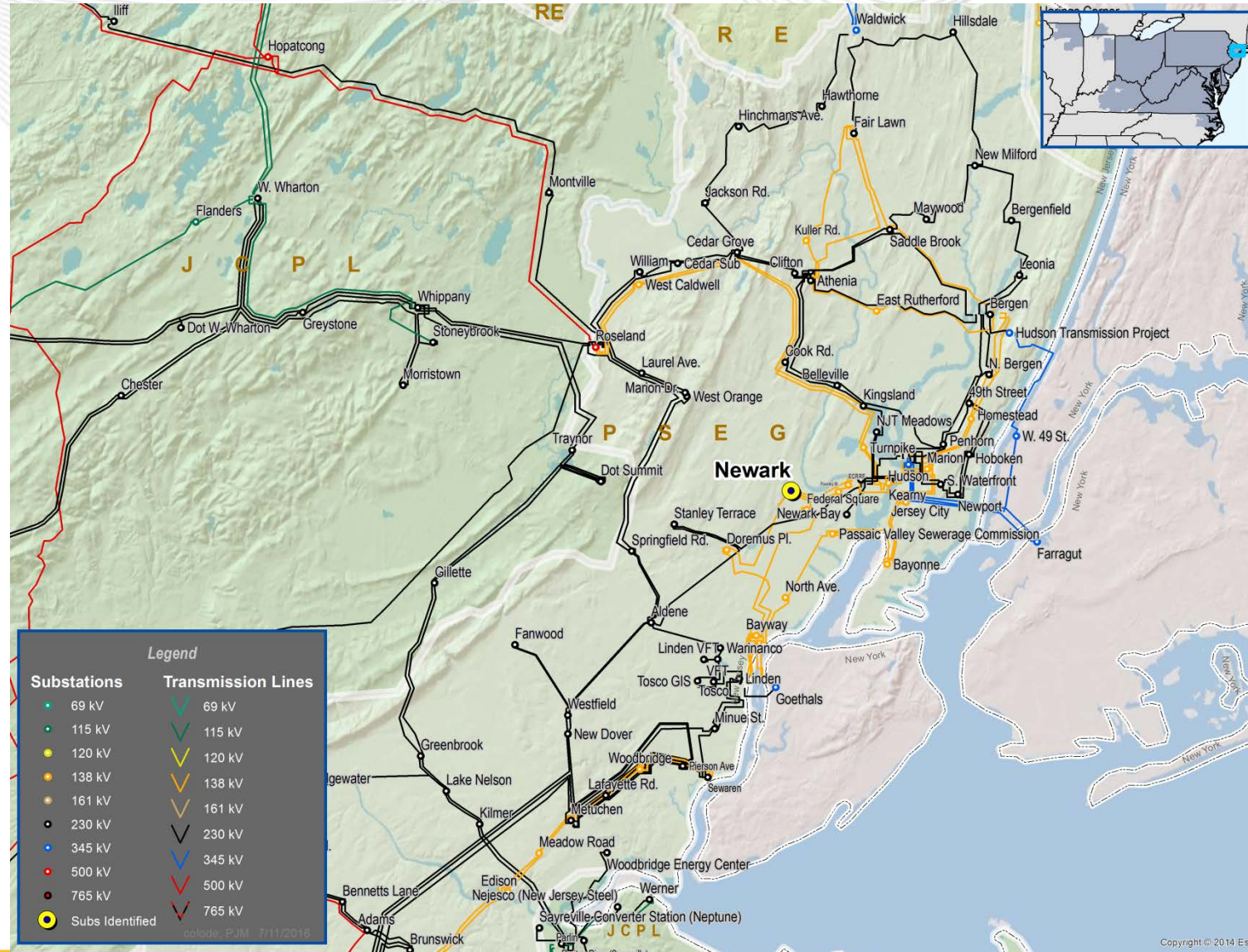
\* Newark Switch transformer



\* PSE&G Pierson transformer fire



# PSE&G Transmission Zone



**Problem:**  
**PSE&G FERC 715 Transmission Owner Criteria**  
**Newark Switch Aging Infrastructure**

**PSE&G FERC 715 Transmission Owner Criteria**

- Age
  - Substation: 1953
  - Transformer 1: 1972
  - Transformer 2&3: 1958
  - Spare: 1992
- Housed in an urban building
- Equipment condition assessment
- Equipment has reached its end of life

**Alternatives Considered:**

1. Build new Newark GIS station in a building located adjacent to the existing Newark Switch and demolish the existing Newark Switch
2. Build a new Newark GIS station elsewhere in Newark and relocate all transmission and distribution cables and protection equipment

**Potential Solution:**

**Alternative #1** - Build new Newark GIS station in a building located adjacent to the existing Newark Switch and demolish the existing Newark Switch

**Estimated Cost:** \$353 M

## Other Alternatives Considered:

Alternative #2: Find a large property and build a new substation challenges: No large property available in the city of Newark

- Find new property
  - Challenge: No large property available in the city of Newark
- Relocate four (4) 138 kV transmission lines
- Relocate over thirty 26 & 13 kV distribution feeders.
- Requires extended transmission & distribution outages
- Assuming available property, the cost to relocate and rebuild Newark Switch will be ~\$458M

## Alternative #3:

- Status quo: Risk of a transformer fire that may result in the loss of entire building and station. The result is the loss of ~>300 MVA of load for a long duration.

# Short Circuit

## Problem: Short Circuit

- The Bergen 138kV breakers “40P” and “90P” are overstressed.

## Immediate Need:

- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

## Alternatives Considered:

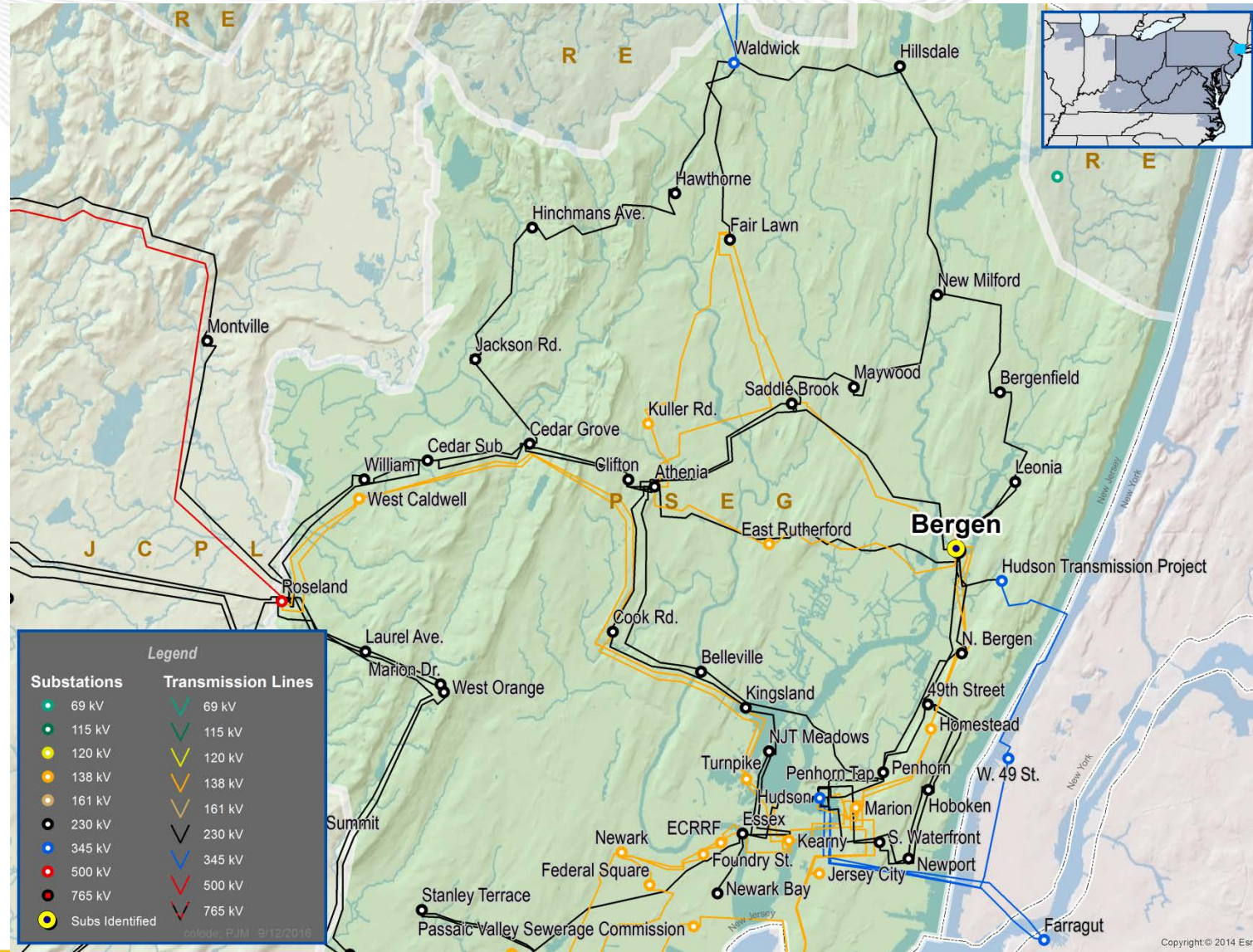
- Due to the immediate need of the project no alternatives were considered

## Proposed Solution:

- Replace 1 Bergen 138kV breakers “40P” and “90P” with 80kA breakers (b2712 –B2713)

**Estimated Cost:** \$3.27 M per breaker

**Required IS Date:** 06/01/2018



# Artificial Island Update

- At their August meetings the PJM Board of Managers directed PJM staff to perform a comprehensive analysis to support a future course of action
- To that end PJM has been focusing on three areas:
  - Project estimates and cost
  - Design and data review
  - Solution configuration

# RTEP Next Steps





# October 2016 PJM Board Approval

- The “Newark Airport 3<sup>rd</sup> Source” baseline reliability project will be presented to the PJM Board in October and recommended for inclusion in the RTEP.
  - Reviewed and previously at several TEAC meetings and recommended in July 2016.
    - <http://www.pjm.com/~media/committees-groups/committees/teac/20160714/20160714-reliability-analysis-update.ashx>

## Problem: PSE&G FERC 715 Transmission Owner Criteria

- Acceptable load drop levels and durations.
- An N-1-1 outage of the 345 kV cables serving Newark Airport would outage the facility for more than 24 hours

## Immediate Need:

- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

## Alternatives Considered:

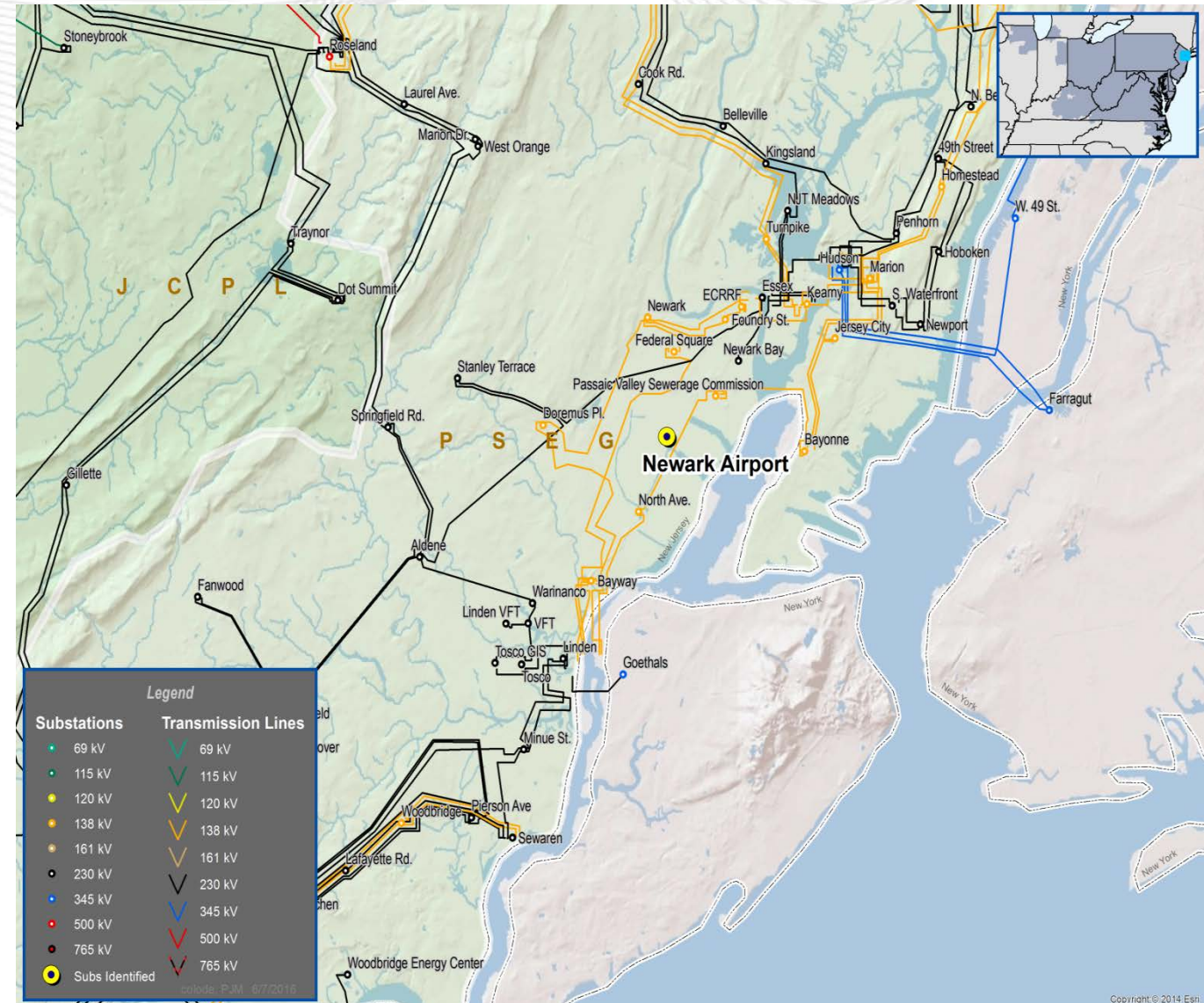
- 345 kV third source
- 138 kV supply
- 26 kV supply
- 69kV third source

## Recommended Solution:

- Build a third 345 kV source into Newark Airport

**Estimated Cost: \$43 M**

**Required IS Date: 6/1/2018**



# Questions?

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- Revision History
  - V1 – 9/12/2016 – Original Version Posted to PJM.com
  - V2 – 9/13/2016 – Updated Slide 23, Added Short Circuit and AI Slides, Added pictures/photographs to the Newark Switch section
  - V3 – 9/14/2016 – Added condition photographs to the Metuchen – Burlington section
  - V4 – 9/15/2016 – Updated Slide 21, update the contingency description and map
  - V5 – 9/15/2016 – Removed Slide focusing on FG 1123
  - V6 – 9/15/2016 – Updated cost of 2016\_2-13G, project number on slide 20 and 22