



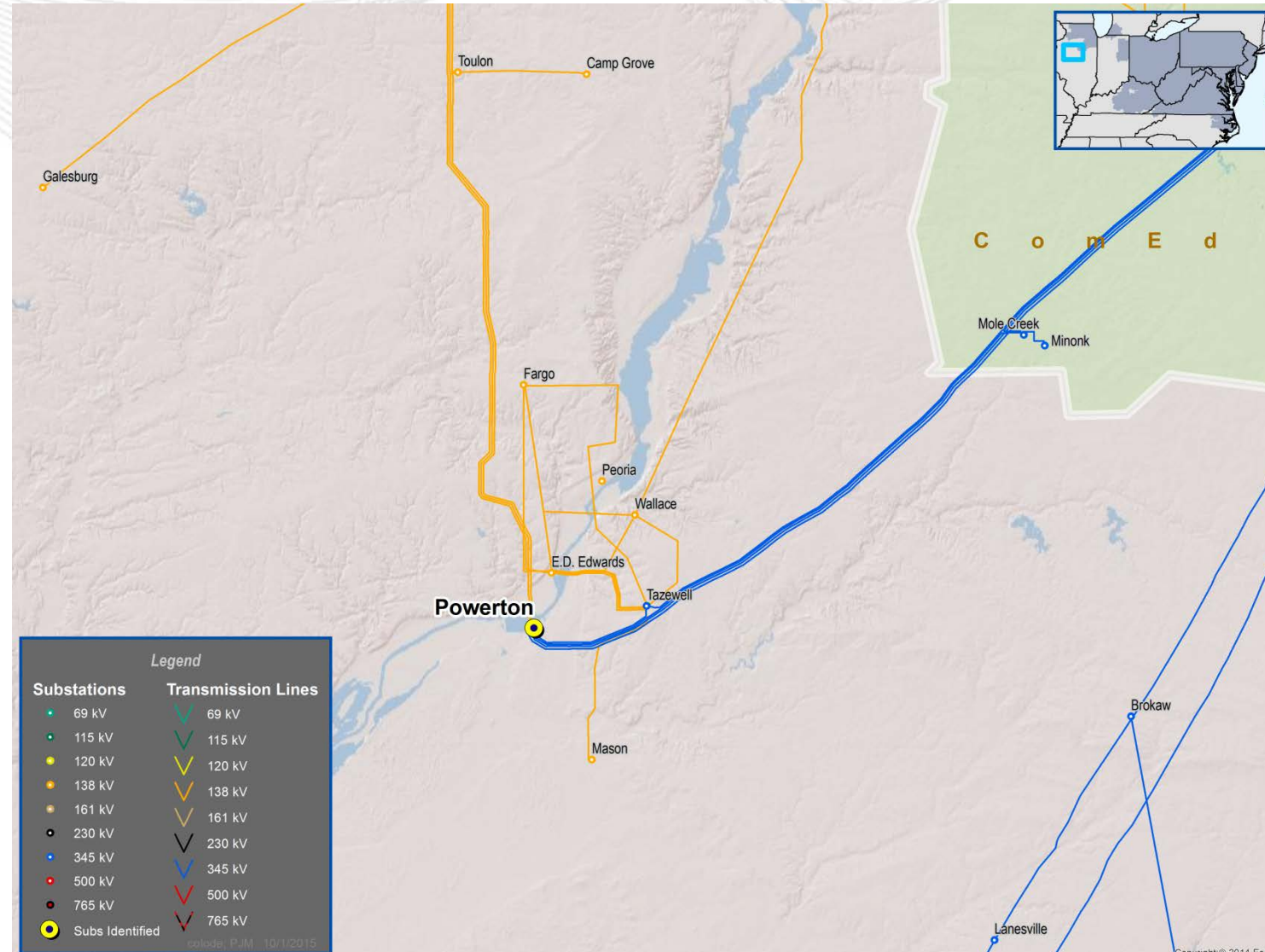
# Transmission Expansion Advisory Committee

## Reliability Analysis Update

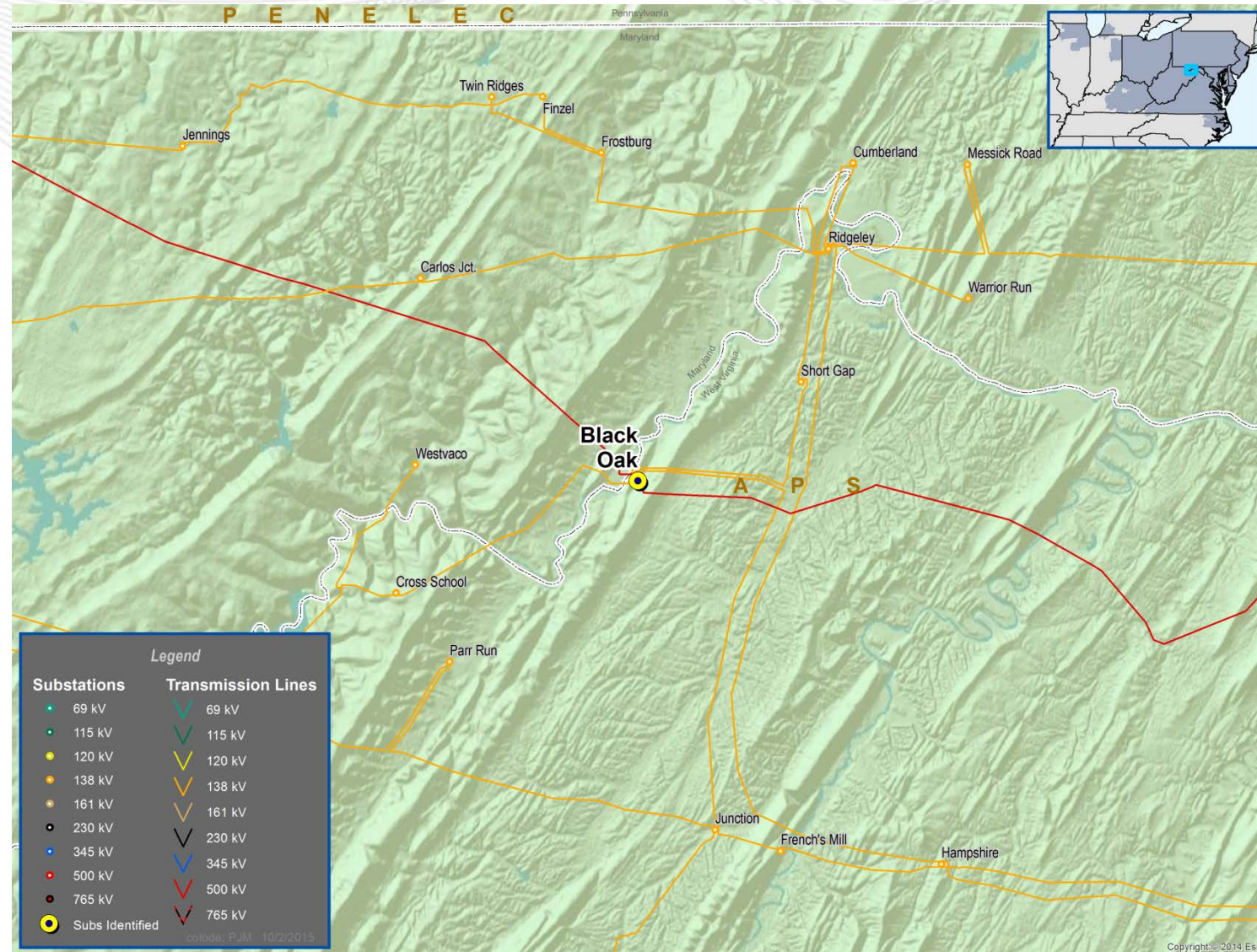
October 8, 2015

# Reliability Analysis Update

- Operational Performance
- Reduce the complexity of the existing Powerton SPS
  - The system has continued to change around Powerton, including the addition of new generation, including several wind farms
  - Recent studies show that some events require out-of-step relays to trip units to meet NERC criteria.
- This condition exists today in the immediate need time frame
- Alternatives Considered:** Add additional SPS schemes at Powerton, which will make the current SPS more complex
- Proposed Immediate Need Solution:**
  - Replace five Powerton 345 kV circuit breakers with 2 cycle IPO breakers and install one new 345 kV circuit breaker; Swap the line 0302 and line 0303 bus positions; Reconfigure the Powerton 345KV bus as a single ring configuration. (B2699.1)
  - Remove SPS logic that trips generators or sectionalizes the bus under normal conditions; minimal SPS logic will remain. (B2699.2)
- Estimated Cost:** \$15M
- Projected IS Date:** 6/1/2018



- Black Oak SPS Removal
- Recent studies demonstrate that the Black Oak SPS is no longer needed for reliability
- **Alternatives Considered:** No alternatives available
- **Proposed immediate Need Solution:**
  - Remove the existing Black Oak SPS
    - The current Black Oak SPS trips the Black Oak 500/138kV transformer #3 for the loss of Black Oak – Hatfield 500KV line. (B2700)
- **Estimated Cost:** \$0.1M
- **Projected IS Date:** 12/1/2015



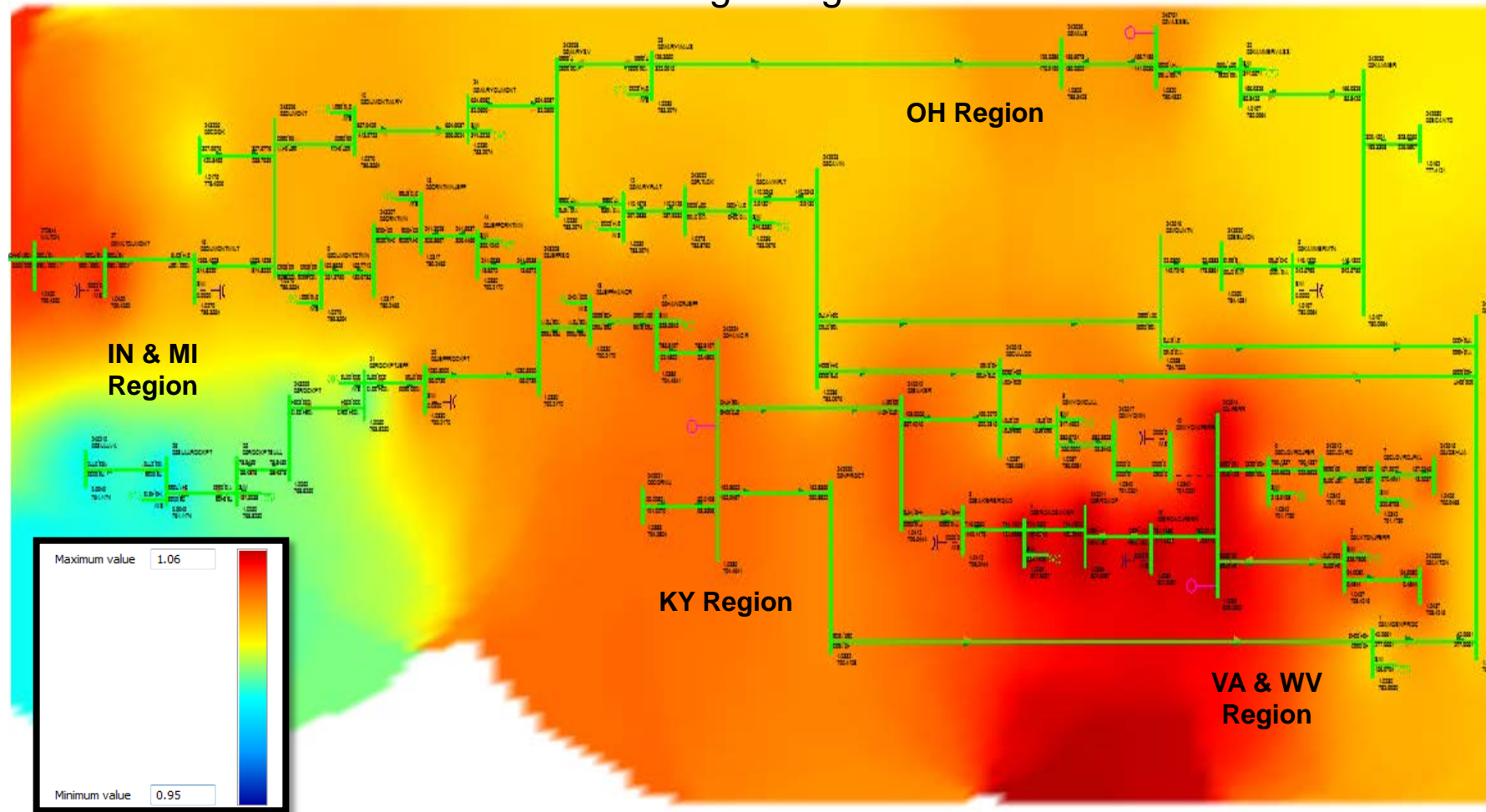


# High Voltage in PJM Operations

- In PJM Operations, the AEP transmission zone and northeastern Mid-Atlantic regions have experienced a large increase in high voltage warnings over the past year; Additionally, AEP has also experienced a large increase in reactor switching for both low and high voltage conditions
- There are several drivers that include changes in dispatch due to new and deactivated generation, reactive support deficiencies and increased line charging from new transmission facilities
- Conditions generally occur during light load periods
- Approved RTEP reactive devices planned to come online over the next several years will help lower the voltages to some extent, but anticipated generation deactivations and additional line charging from planned transmission facilities will further aggravate the problem

- Large increase in number high voltage alarms over the past year
- Operating conditions have required 765 kV circuits to be taken out of service to manage high voltages
- Over 5,000 MW of deactivations in 2015
  - Large reduction in dynamic reactive support
- Large increase in amount of switching of existing reactors for both high and low voltage conditions resulting in multiple failed reactors and reduced life expectancy.
- Simulations demonstrate a potential solution of new SVCs and replenishment of the existing reactors and inclusion of circuit breakers for enhanced switching capability. The first component of this solution has been identified and will be proposed as an immediate need solution.

## Bus Voltage Magnitude





## Recommendation for Immediate Need Reliability Solutions:

- Install a +/- 450 MVAR SVC at Jacksons Ferry 765 kV substation
- Install a 300 MVAR shunt line reactor on the Broadford end of the Broadford – Jacksons Ferry 765 kV line

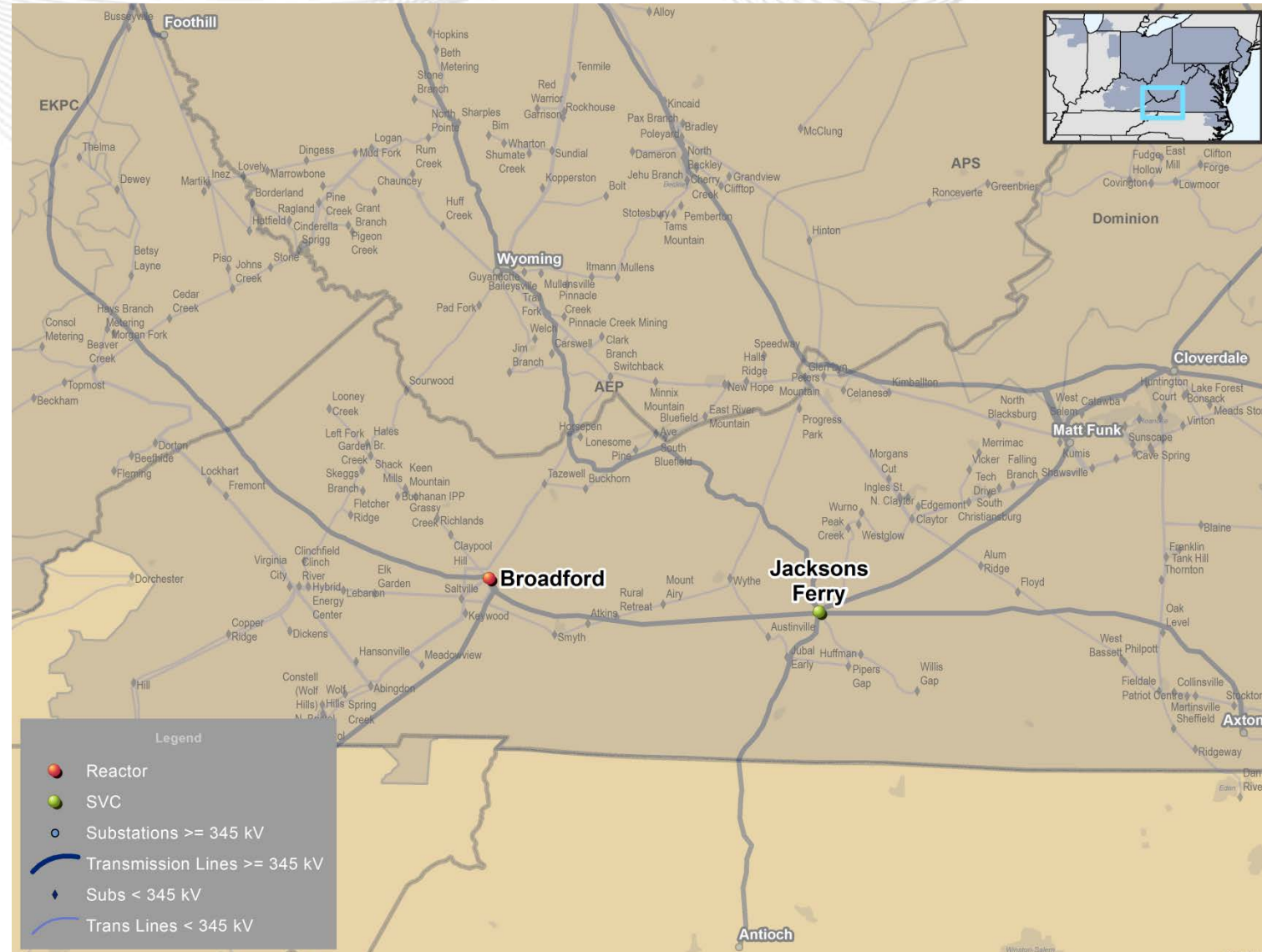
## Estimated Project Cost:

\$ 51M

- \$36.5M for SVC
- \$14.5M for 300 MVAR Reactor

## Projected IS Date:

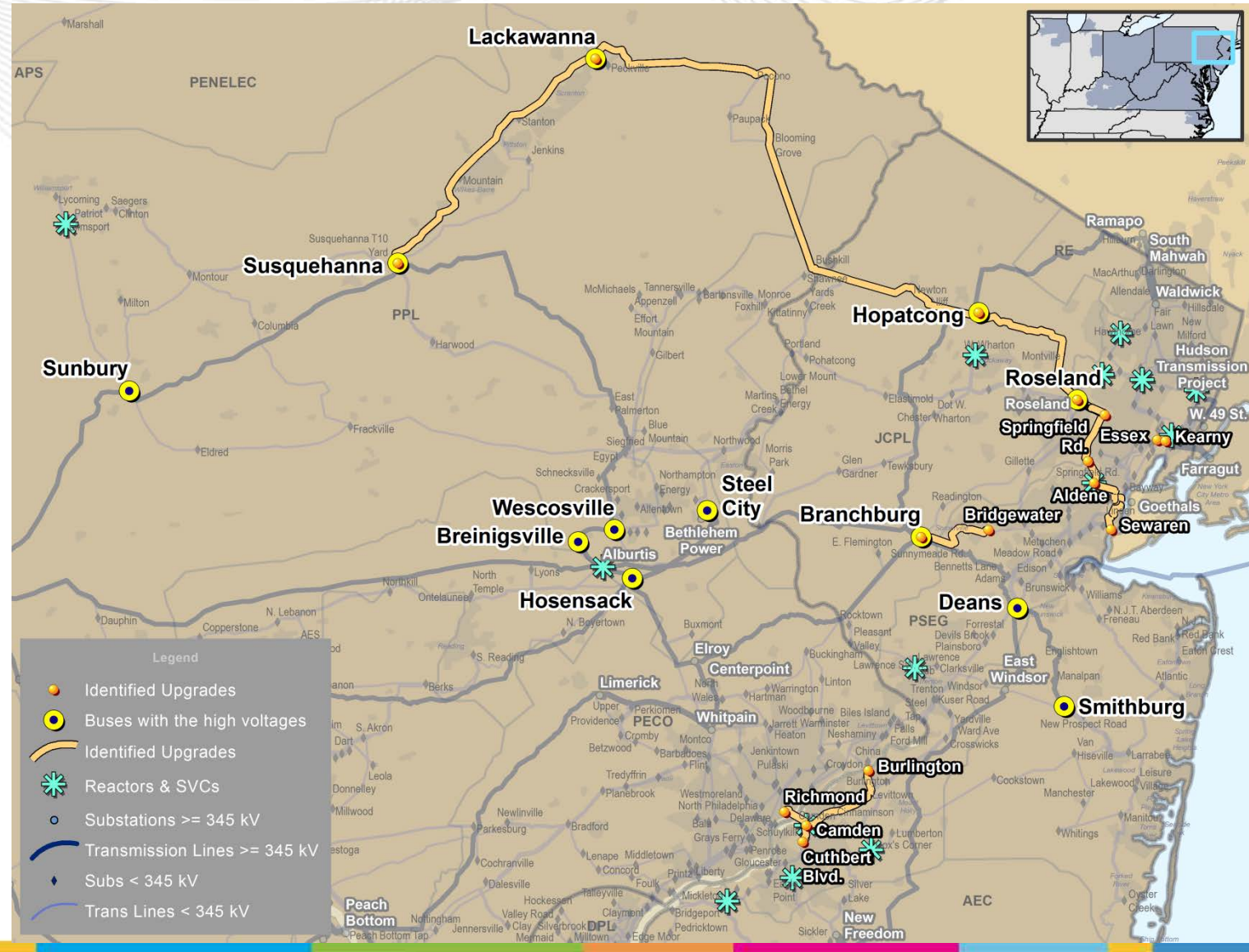
6/1/2018





# Northeastern Mid-Atlantic High Voltages

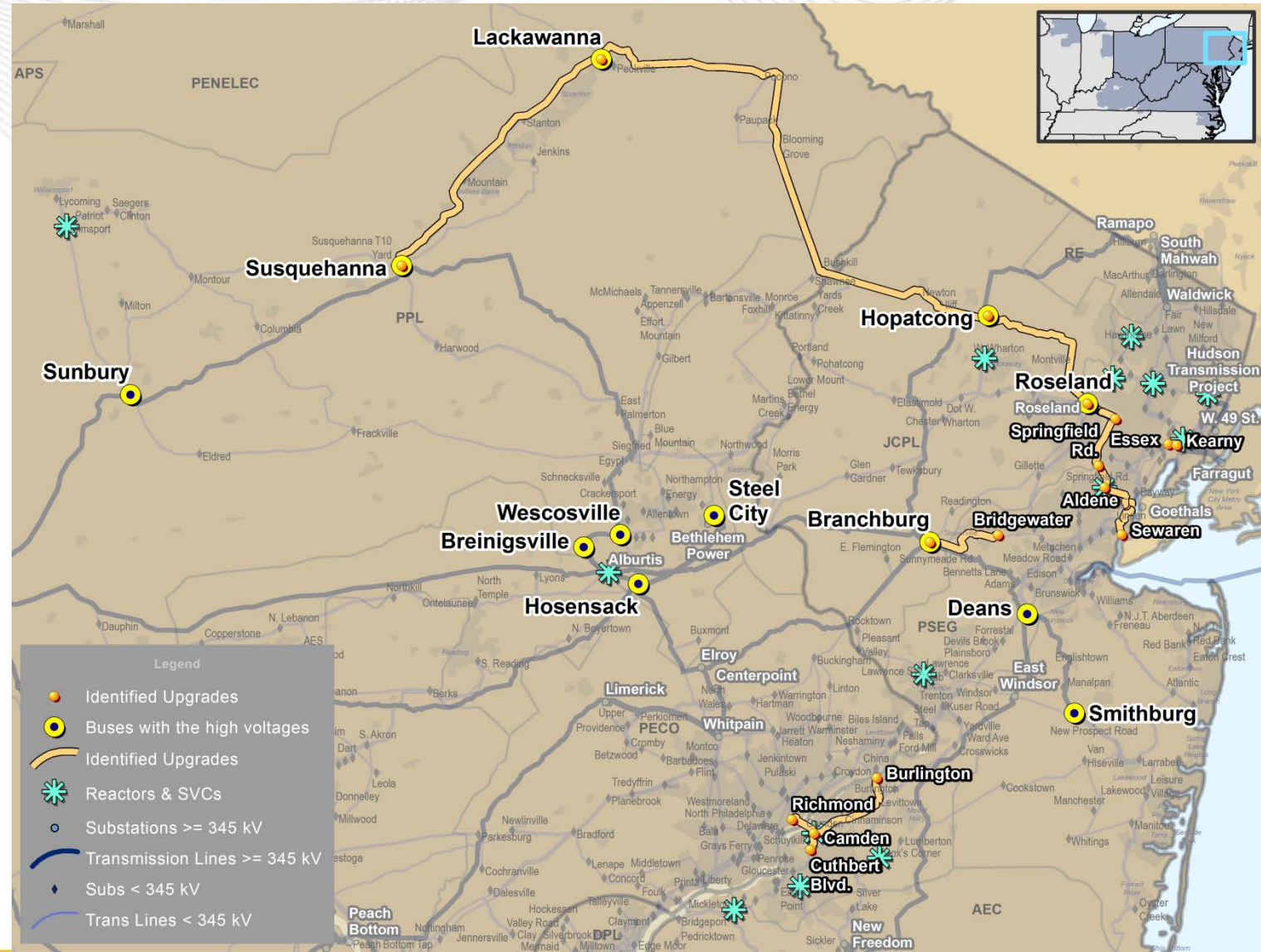
- PJM Operations observes high voltages mainly on the 500 kV system
  - Map shows the locations of recent high voltage locations
- Largest driver is increased line charging due to new required RTEP upgrades located mostly in the PSEG area coupled with loss of dynamic MVAR due to generation deactivations
- On the order of 1,500 MVARs of approved reactors and SVCs planned to go in service in 2015 and 2016 in this region – greatly reduces (improves) the voltage profile
- Planning studies, however, show that future planned transmission will require additional reactive devices to control voltages in the area





# Northeastern Mid-Atlantic High Voltages

- The need for additional shunt reactors has been identified on the PSEG system.
- Recommended new static shunt reactor installations:
  - 350 MVARs at Roseland 500 kV
  - 100 MVAR at Bergen 230 kV
  - 150 MVAR at Essex 230 kV
  - 200 MVAR at Bergen 345 kV
  - 200 MVAR at Bayway 345 kV
  - 100 MVAR at Bayonne 345 kV
- The first three devices are required as soon as possible to address the ongoing operational performance issues.
- The remaining three devices will be staged to accommodate the addition of the Bergen to Linden Corridor 345 kV project



- Next steps
  - December PJM Board Meeting
    - Make Southern AEP Transmission Zone and Northeastern Mid-Atlantic Transmission Zone reactive reinforcement recommendations to the PJM Board



# Winter Peak Study Update

- Update
  - All technical evaluation results of anticipated 2020 Winter conditions were reviewed at the 9/10/2015 TEAC meeting
- Anticipated Application of Winter Criteria
  - Analysis not including gas contingencies
    - Violations constitute a reliability violation and solutions will be developed through the PJM TEAC
  - Gas contingencies
    - PJM will perform additional analysis on the potentially problematic contingencies that are identified

- Analysis Performed With and Without Gas Contingencies
  - Not Including Gas Contingencies
    - Baseline N-1, Generator Deliverability and Common Mode Outage Thermal Results
    - Baseline N-1 Voltage Results
    - N-1-1 Thermal
    - N-1-1 Voltage
  - Gas Contingencies Included
    - Baseline N-1, Generator Deliverability and Common Mode Outage Thermal Results
    - Baseline N-1 Voltage Results
    - N-1-1 Thermal
    - N-1-1 Voltage
    - Winter Load Deliverability (Thermal & Voltage)

- See today's Planning Committee materials for additional information and Draft Winter Reliability Criteria language
- September Planning Committee
  - Review corresponding Manual 14B language
- September MRC
  - First Read
- October Planning Committee
  - Request endorsement of Manual 14B language
- October MRC
  - Request endorsement of Manual 14B language

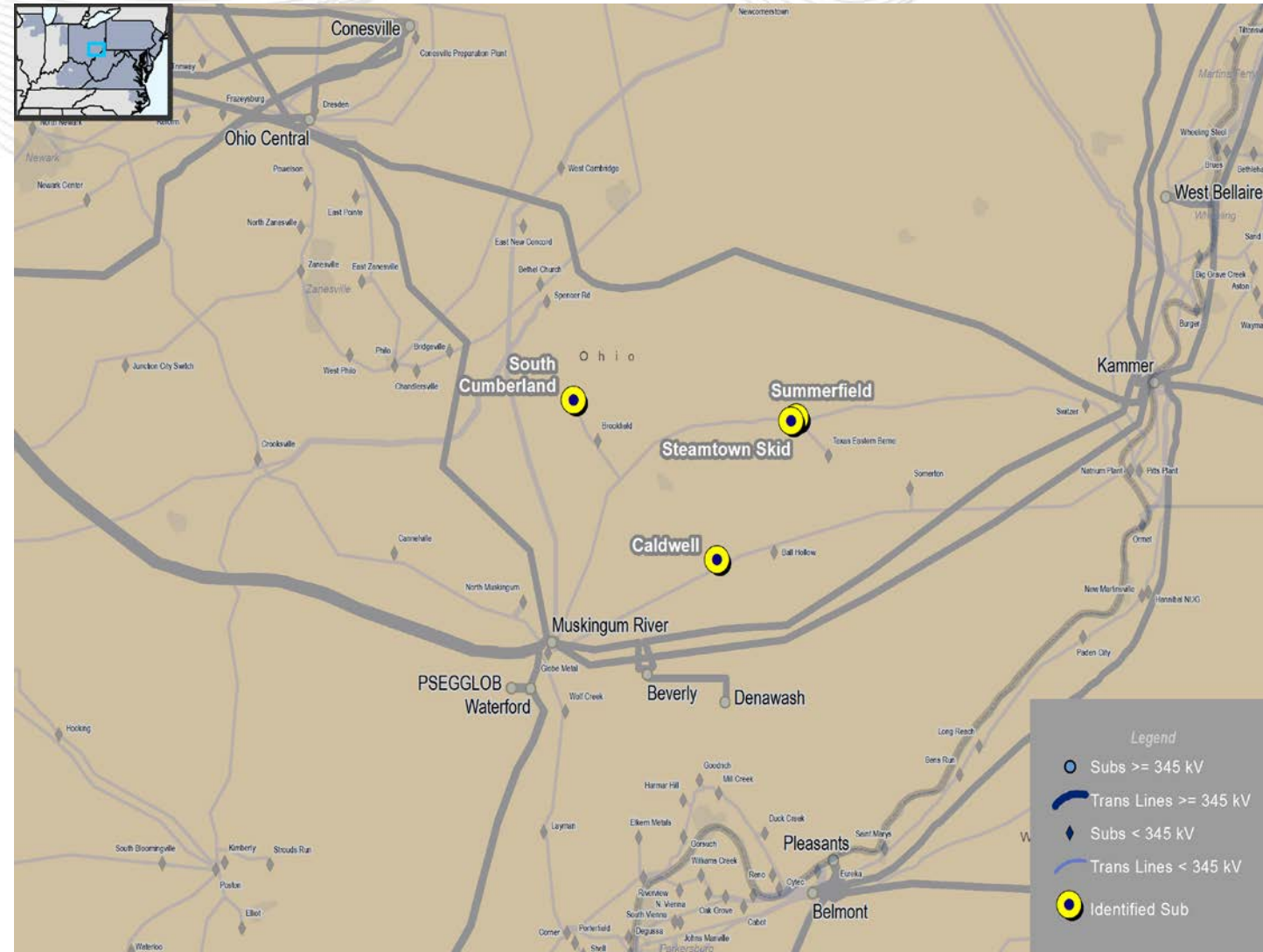




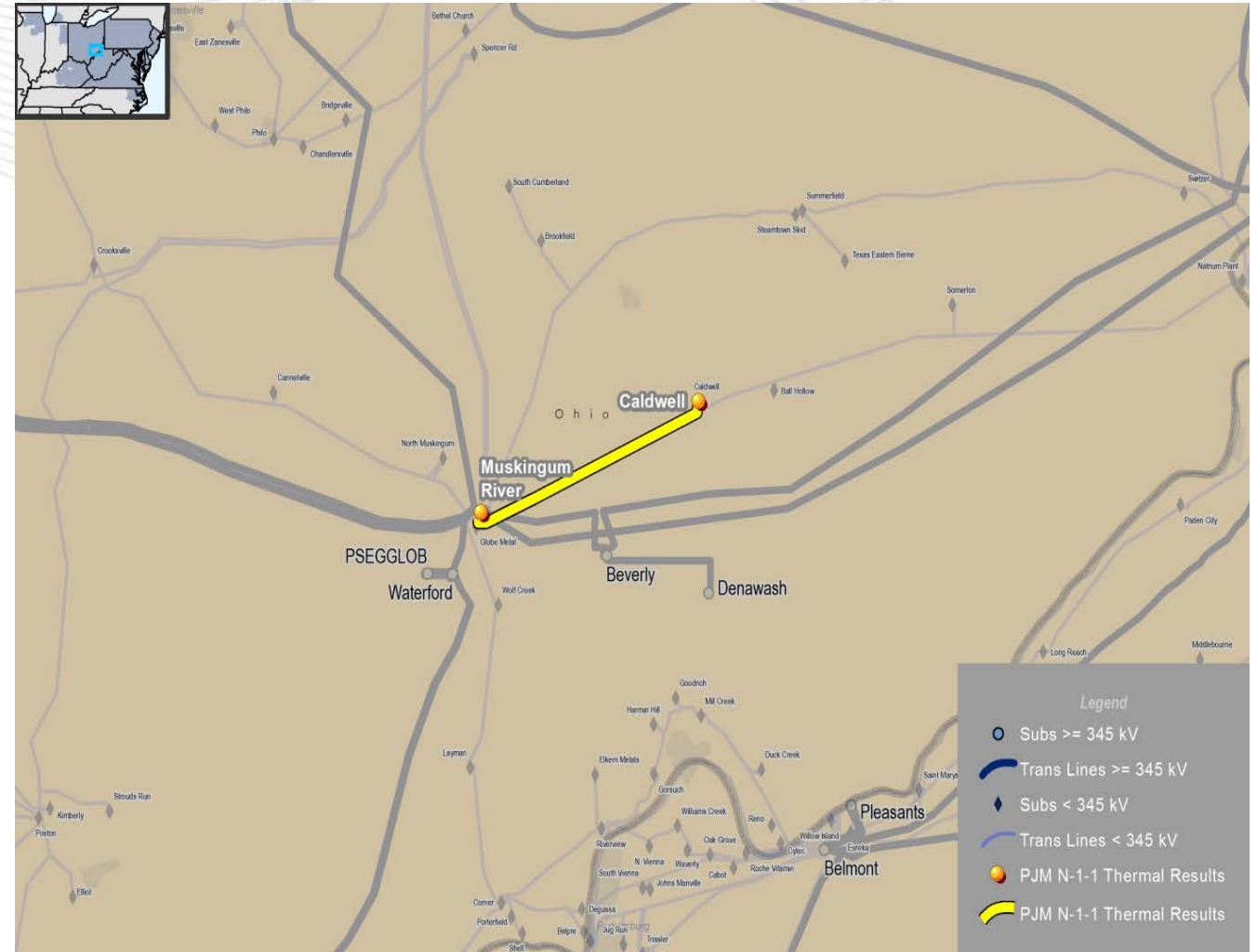
# 2015 RTEP Proposal Window #1

- 91 proposals
  - 26 Transmission Owner Upgrades
    - Cost range of \$0.013M to \$73M
  - 64 Greenfield Projects
    - Cost range of \$6M to \$167.1M
- 20 of the 2015 Window #1 recommendations were reviewed as recommendations at the September TEAC and will be recommended to the PJM Board in October 2015
  - At the September TEAC, two solution alternatives remained under consideration for N-1-1 thermal and voltage violations in the AEP zone
  - A recommendation for those violations is on the following slides

- **N-1-1 Voltage (FG#: N2-VM70 – 76, N2-VD73 – 74):**
- Low voltage at South Cumberland, Summerfield 138kV buses for several contingency pairs
- Low voltage at South Caldwell and Steamtown 138kV buses and voltage drop at South Caldwell and South Cumberland 138kV buses for the loss of the Muskingum – South Caldwell 138kV line and the loss of the Muskingum –East New Concord-West Cambridge 138kV line
- **Alternatives considered:**
  - 2015\_1-2L (\$25.82 M)
  - 2015\_1-8R (\$7.4 M)



- **N-1-1 Thermal Violation (FG# N2-T16 and N2-T17):**
- South Caldwell – Muskingum 138 kV circuit is overloaded for several contingencies.
- **Alternatives considered:**
  - 2015\_1-2L (\$25.82 M)
  - 2015\_1-8R (\$7.4 M)

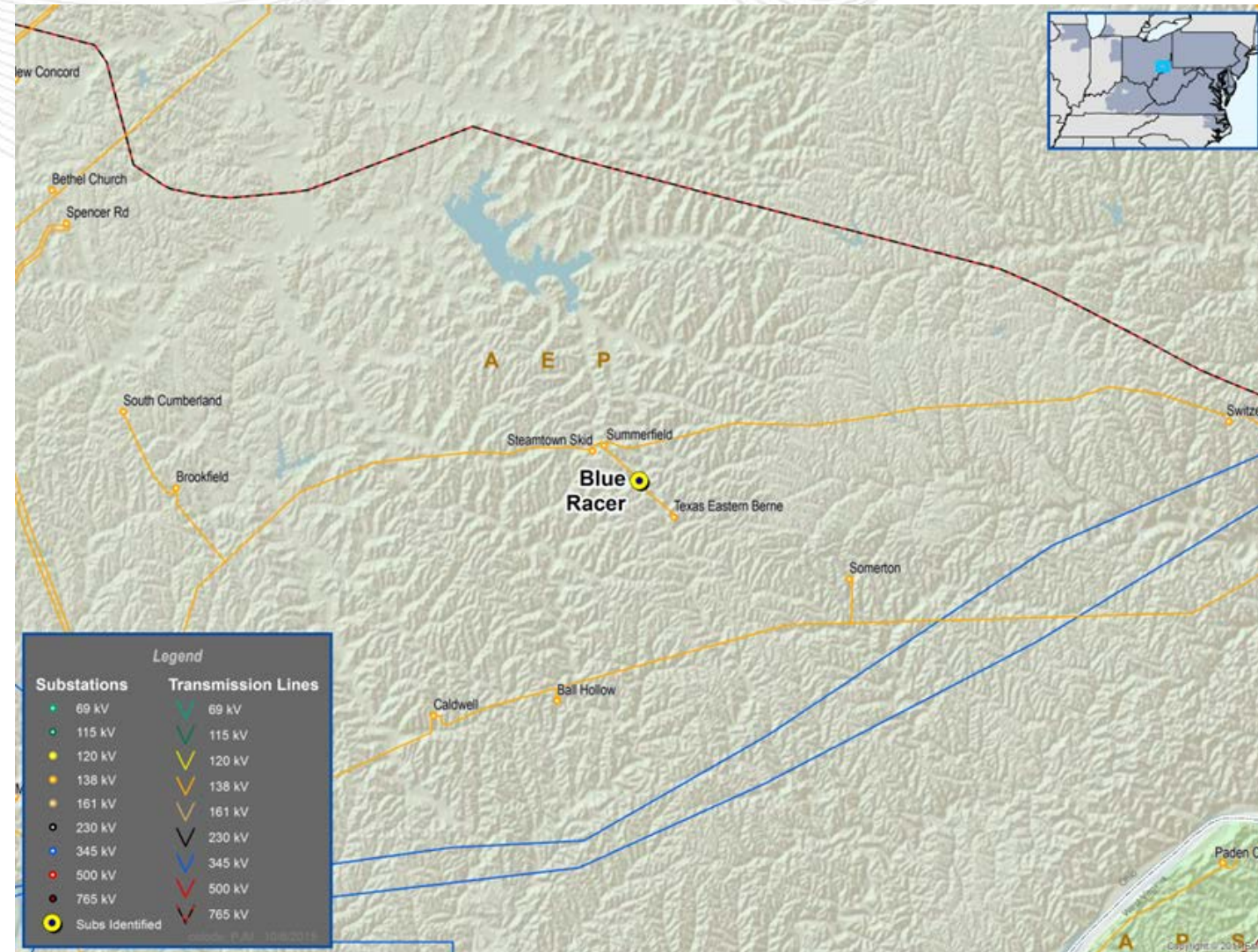


Project ID	Proposing Entity	General Description/Scope	Component 1	Component 2	Component 3	Component 4	Component 5
2015_1-2L	AEP	Construct Herlan Station and Herlan-Blue Racer 138kV circuit.	Construct Herlan station as breaker and a half configuration with 9-138kV CB's on 4 strings and with 2-28.8 MVar capacitor banks.	Construct new 138kV line from Herlan station to Blue Racer station. Estimated at approx. 3.2 miles of 1234 ACSS/TW Yukon and OPGW.	Install 1-138kV CB at Blue Racer to terminate new Herlan circuit.	Rebuild Summerfield-Berne 138kV line with 3.47 miles of 1234 ACSS/TW Yukon and OPGW.	Upgrade Summerfield MOAB and terminal equipment.
		AEP cost estimate	\$15.64 M	\$5.78 M	\$0.32 M	\$4.03 M	\$0.05 M
2015_1-8R	Northeast Transmission Development (NTD)	Build a 138 kV switching station ("Grassy Creek") interconnecting the Summerfield-Switzer 138 kV line, the Steamtown Skid-Natrium 138 kV line and the Tap to Somerton 138 kV line	Build a 138 kV switching station ("Grassy Creek") interconnecting the Summerfield-Switzer 138 kV line, the Steamtown Skid-Natrium 138 kV line and the Tap to Somerton 138 kV line	Construct 5 new towers to connect the existing transmission lines into the new Grassy Creek switching station. NTD anticipates completing this work.			
		NTD cost estimate	\$6.1M	\$ 1.3M			

Project ID	Resolves Posted Violation	Final Project Cost (\$M)	PJM Cost Estimate (\$M)	Potential Future Violation	Pros	Cons	Recommended Solution
2015_1-2L (Components 1, 2, 3)	Yes (Components 4&5 are not needed)	21.42	29.1	Not anticipated in the 15 year horizon	Limited outage required	Higher cost	Yes
					Handles anticipated load growth (High possibility since it's the shale gas area)		
					Improves reliability for the local 69KV network (voltage support and thermal loading)		
					Solves Several Window #2 Reliability Criteria Violations		
					Solves the local radial voltage collapse (beyond criteria) for an N-1-1 condition		
2015_1-8R (Components 1, 2)	Yes	7.4	14.3	Yes (Grassy Creek – Summerfield 138KV line is loaded above 98% for the N-1-1 condition.)	Lower cost	High cost of Potential future overload (Grassy Creek – Summerfield 138KV line), >\$10M	No
					Limited outage		
					Solves Several Window #2 Reliability Criteria Violations		

- **Recommended Solution: (2015\_1-2L)**
  - Construct Herlan station as breaker and a half configuration with 9-138kV CB's on 4 strings and with 2-28.8 MVar capacitor banks. (B2701.1)
  - Construct new 138kV line from Herlan station to Blue Racer station. Estimated at approx. 3.2 miles of 1234 ACSS/TW Yukon and OPGW. (B2701.2)
  - Install 1-138kV CB at Blue Racer to terminate new Herlan circuit. (B2701.3)
- **Estimated Project Cost:** \$15.64 M for B2701.1, \$5.78M for B2701.2, \$0.32M for B2701.3
- **Required IS Date:** 6/1/2020

- Recommended Solution: (2015\_1-2L)
  - Construct Herlan station as breaker and a half configuration with 9-138kV CB's on 4 strings and with 2-28.8 MVar capacitor banks. (B2701.1)
  - Construct new 138kV line from Herlan station to Blue Racer station. Estimated at approx. 3.2 miles of 1234 ACSS/TW Yukon and OPGW. (B2701.2)
  - Install 1-138kV CB at Blue Racer to terminate new Herlan circuit. (B2701.3)
- Designate construction to the project sponsor and local Transmission Owner (AEP)
- Estimated Project Cost:
  - \$15.64 M for B2701.1
  - \$5.78M for B2701.2
  - \$0.32M for B2701.3
- Required IS Date: 6/1/2020

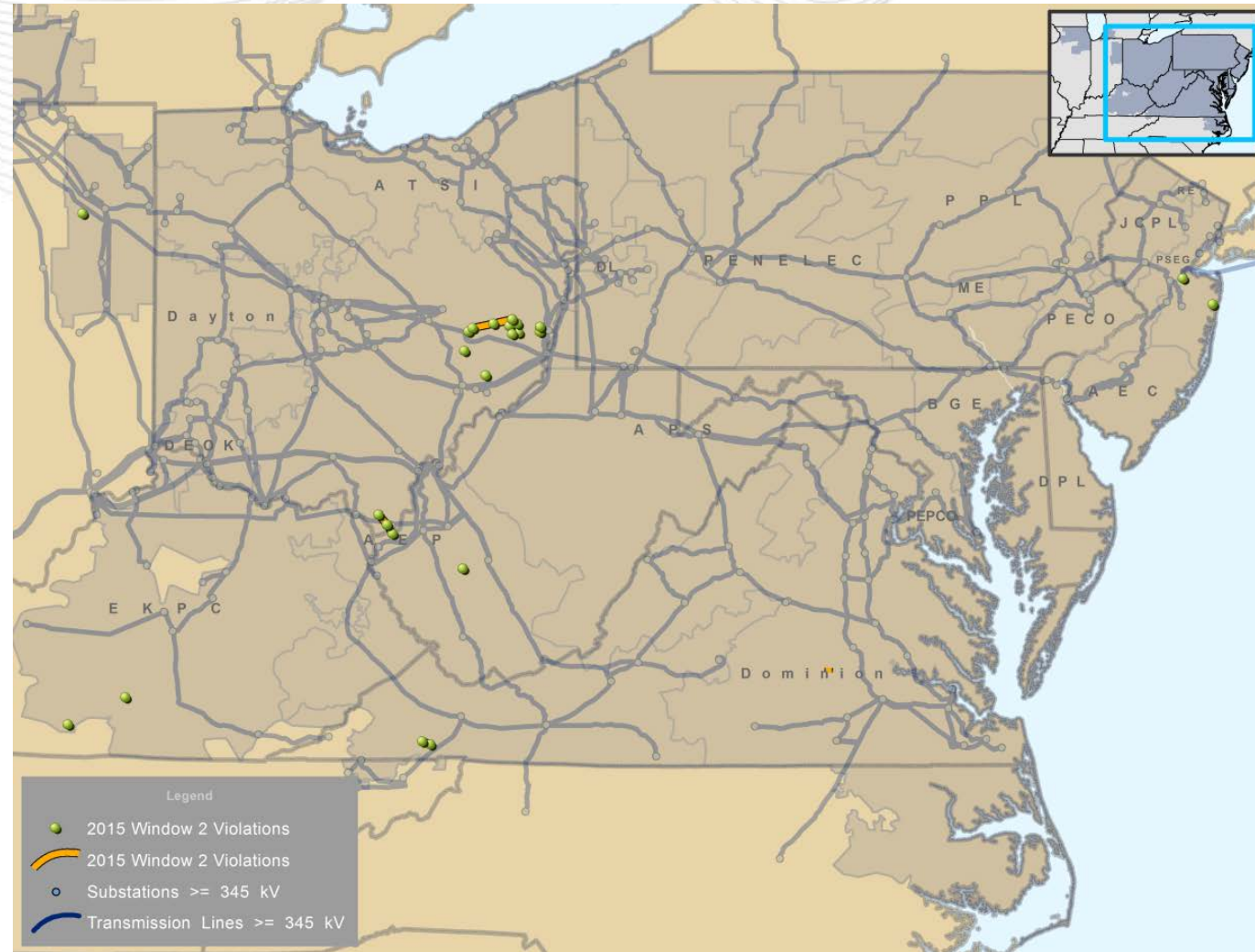




# 2015 RTEP Proposal Window #2 – Analytical Update



- Scope
  - Transmission Owner Criteria (thermal and voltage)
  - Light Load Reliability Criteria (thermal and voltage)
    - No Light load violations identified
- Window Opened: 8/5/2015
- Window Closed: 9/4/2015
  - Proposal definitions, simulation data and planning cost estimate due
- Detailed Cost due: 9/21/2015
  - Additional 15 days to develop and provide detailed cost data
  - See the window documentation for additional information

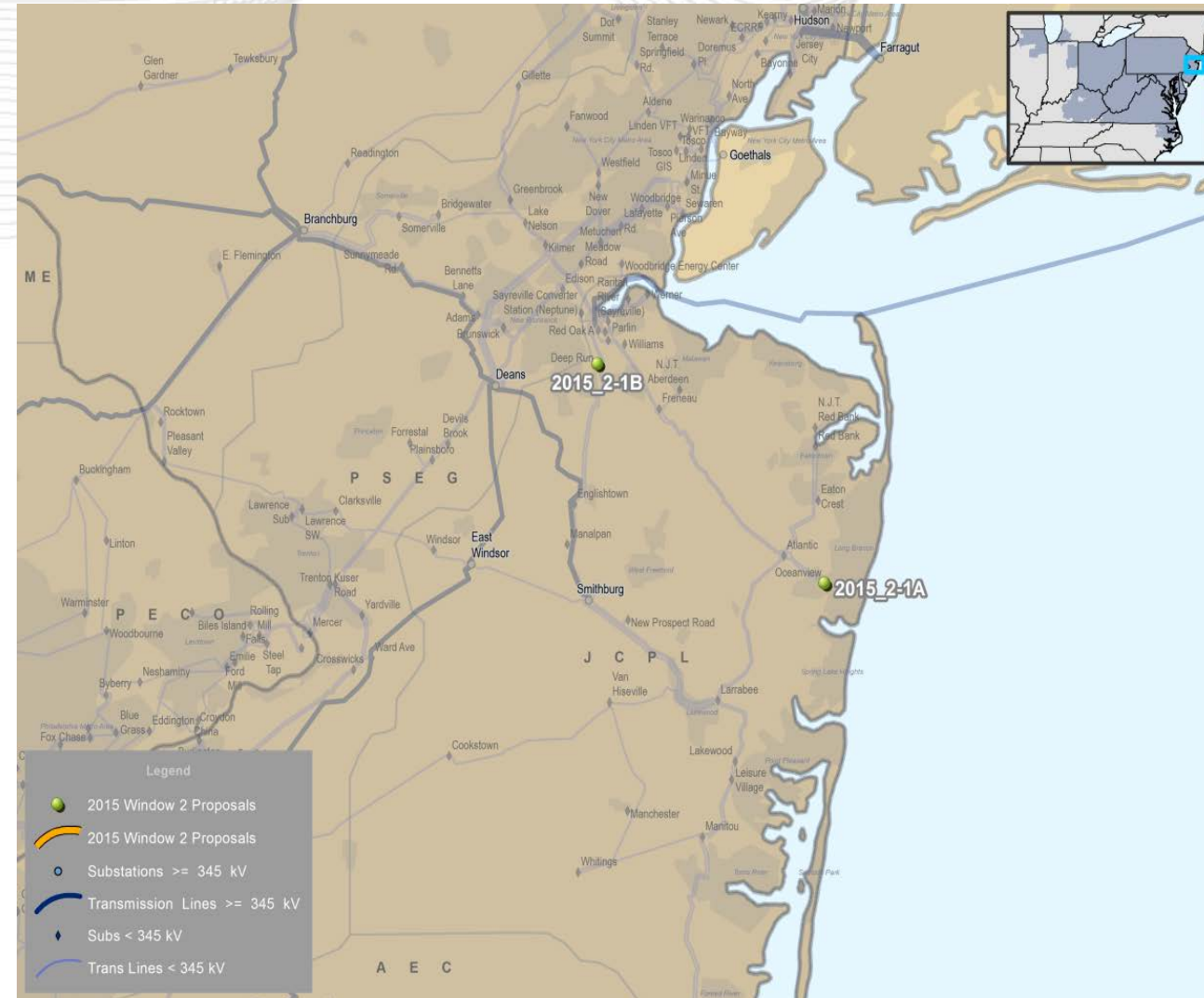


- Transmission Owner Criteria Violations by TO and type

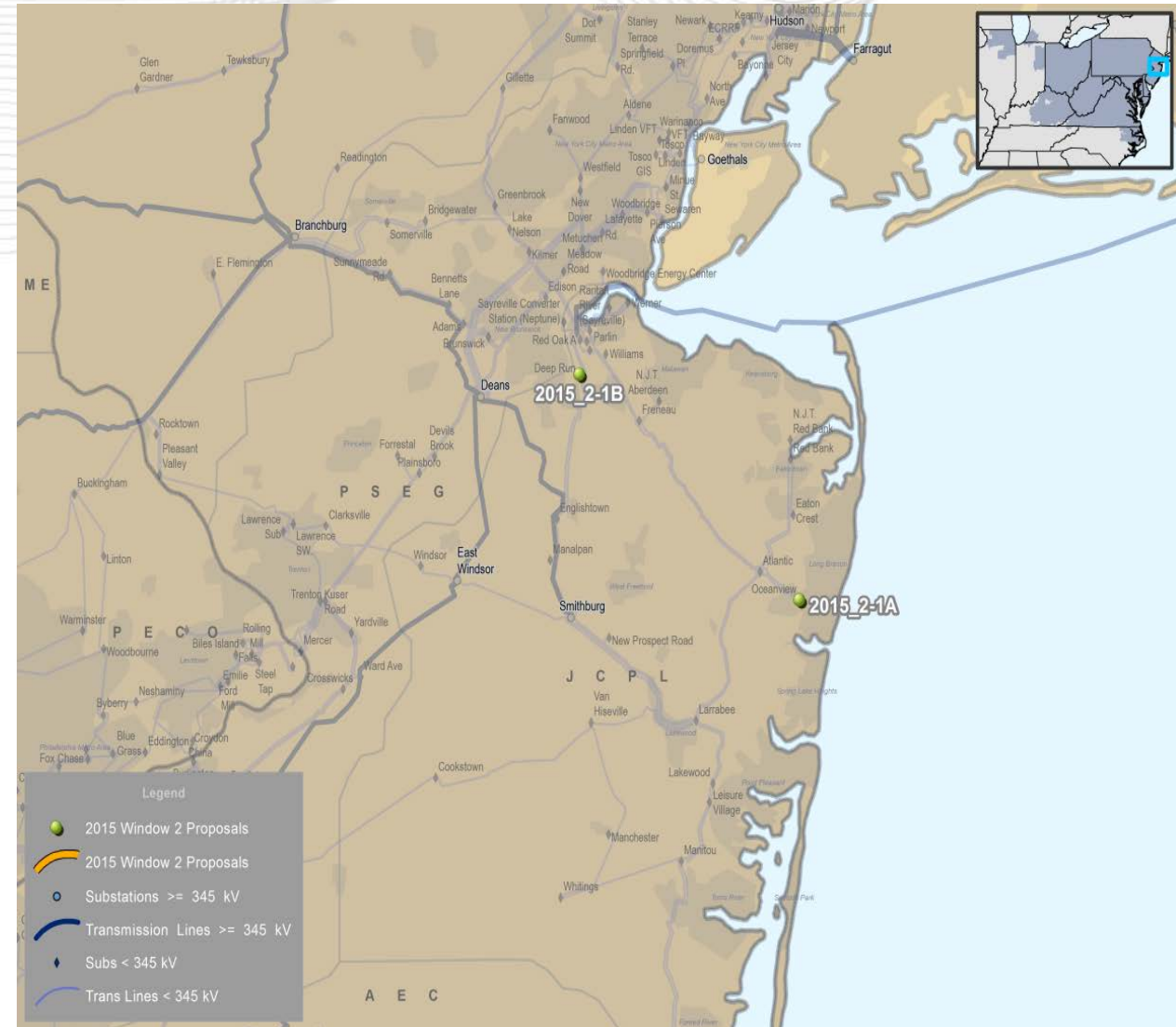
Transmission Owner	Thermal Violations	Voltage Violations
JCPL	4	0
EKPC	1	1
AEP	9	7

- Light Load Reliability Criteria Violations
  - No Light Load Reliability Criteria Violations are identified

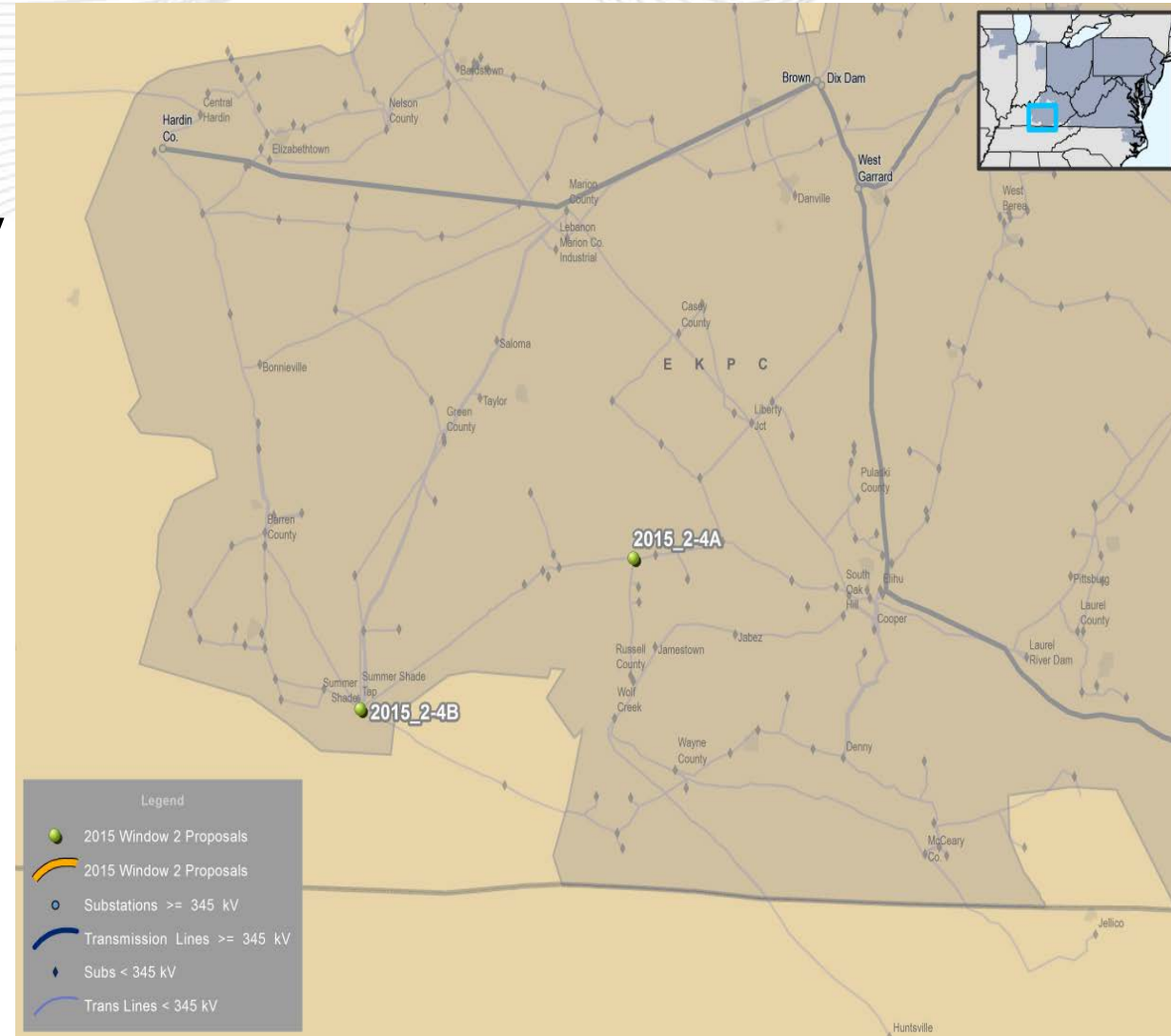
- **FE Transmission Owner Criteria Violation (FG# JC-1 and JC-2)**
- The Oceanview 230/34.5 kV transformer #1 is overloaded for loss of the Oceanview 230/34.5 kV transformer #2.
- **Alternatives considered:**
  - 2015\_2\_1A (\$4.065 M)
- **Recommended Solution:**
  - Replace the Oceanview 230/34.5 kV transformer #1 . (2015\_2\_1A)
- **Construction Designation:**
  - The local Transmission Owner, FirstEnergy
- **Estimated Project Cost: \$4.065 M**
- **Required IS Date: 6/1/2020**



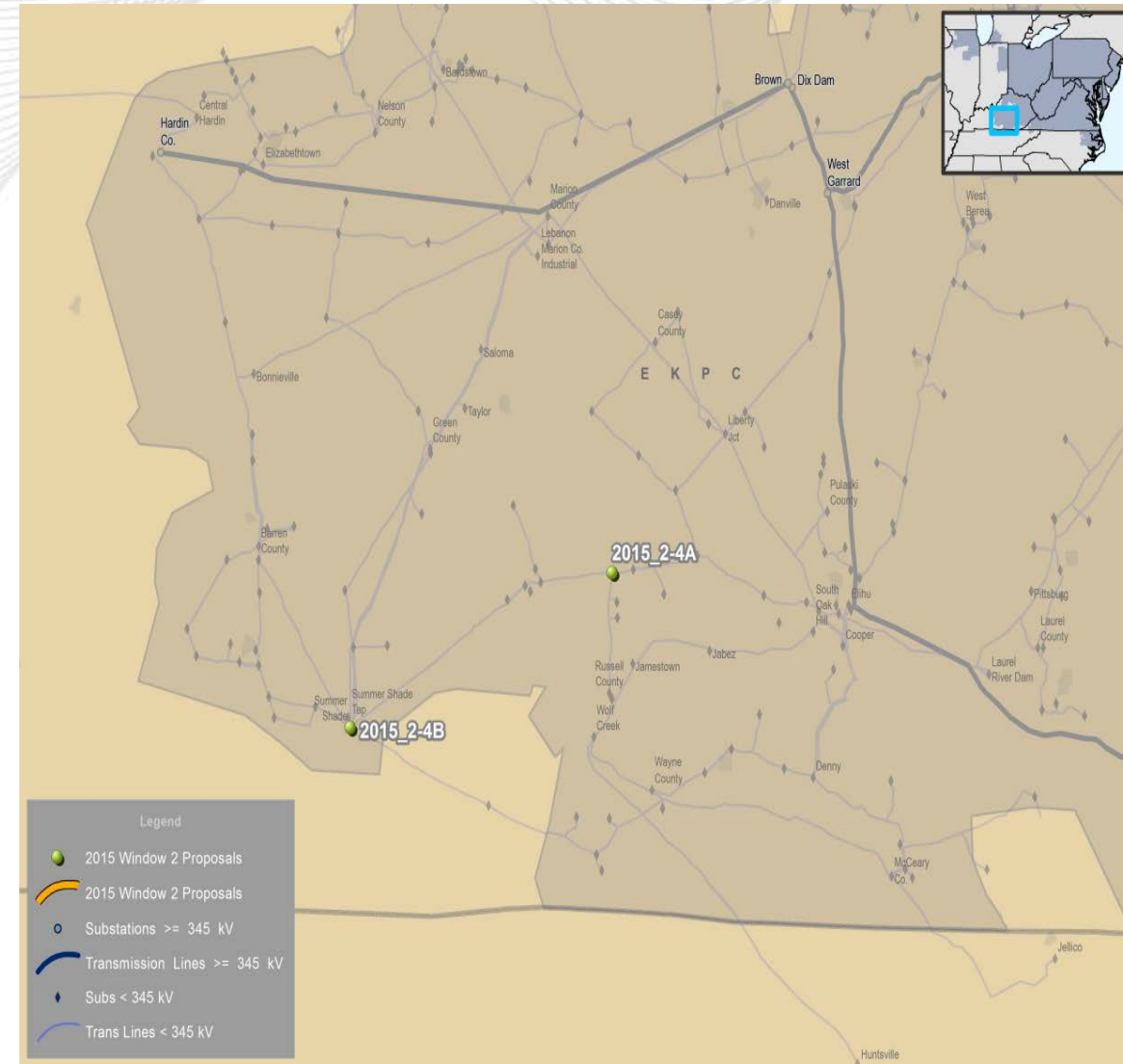
- **FE Transmission Owner Criteria Violation (FG# JC-3 and JC-4)**
- The Deep Run 230/34.5 kV transformer #1 is overloaded for several contingencies.
- **Alternatives considered:**
  - 2015\_2\_1B (\$2.432 M)
- **Recommended Solution:**
  - Replace the Deep Run 230/34.5 kV transformer #1 . (2015\_2\_1B)
- **Construction Designation:**
  - The local Transmission Owner, FirstEnergy
- **Estimated Project Cost: \$2.432 M**
- **Required IS Date: 6/1/2020**



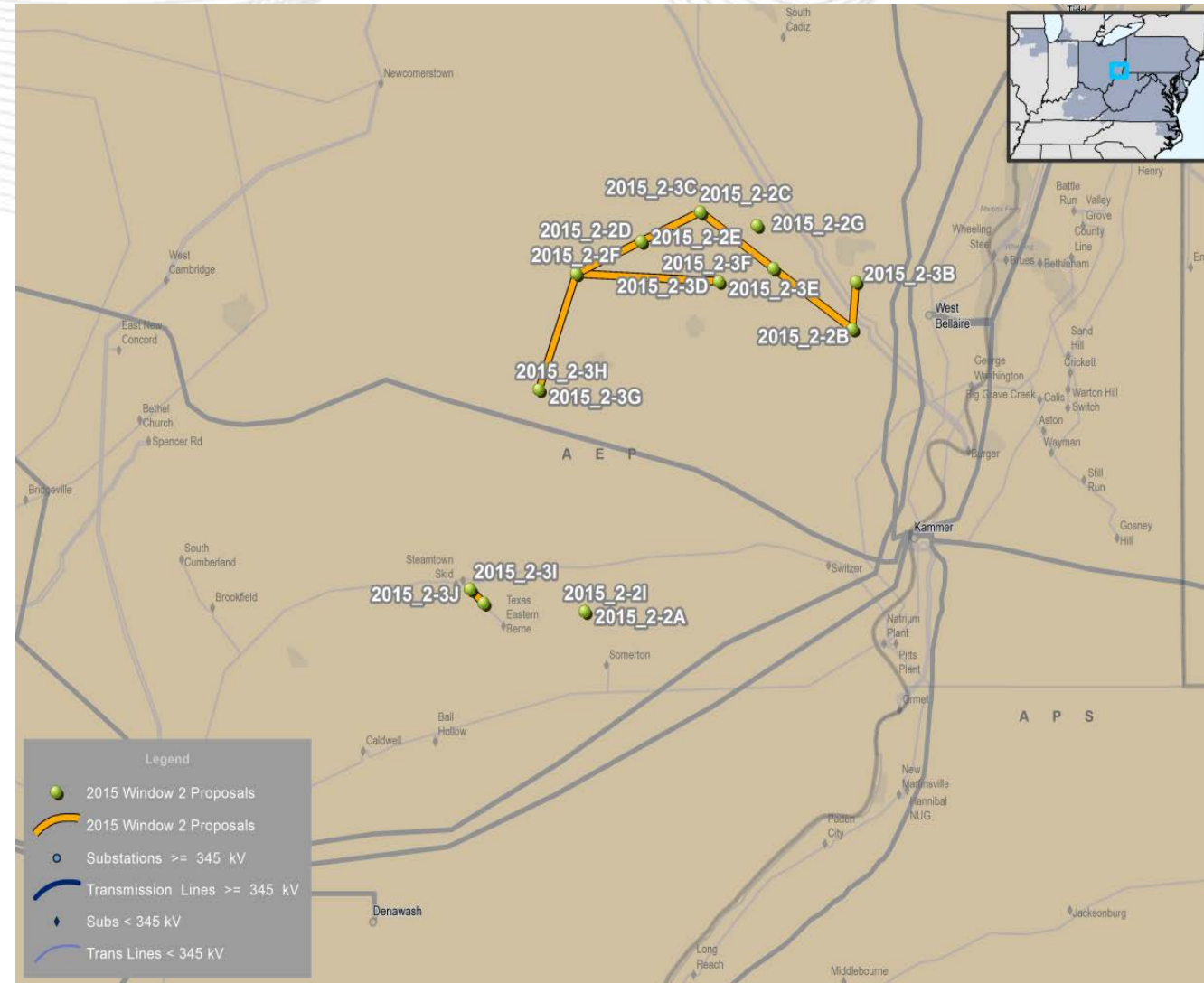
- **EKPC Transmission Owner Criteria Violation (FG# EKPC-T1)**
- The Summer Shade 161/69 kV transformer #1 is overloaded for the loss of the Barren County 161/69 kV.
- **Alternatives considered:**
  - 2015\_2\_4B (\$0.075 M)
- **Recommended Solution:**
  - Upgrade the Summer Shade bus and CT associated with the 161/69 kV transformer #1. (2015\_2\_4B)
- **Construction Designation:**
  - The local Transmission Owner, EKPC
- **Estimated Project Cost: \$0.075 M**
- **Required IS Date: 6/1/2020**



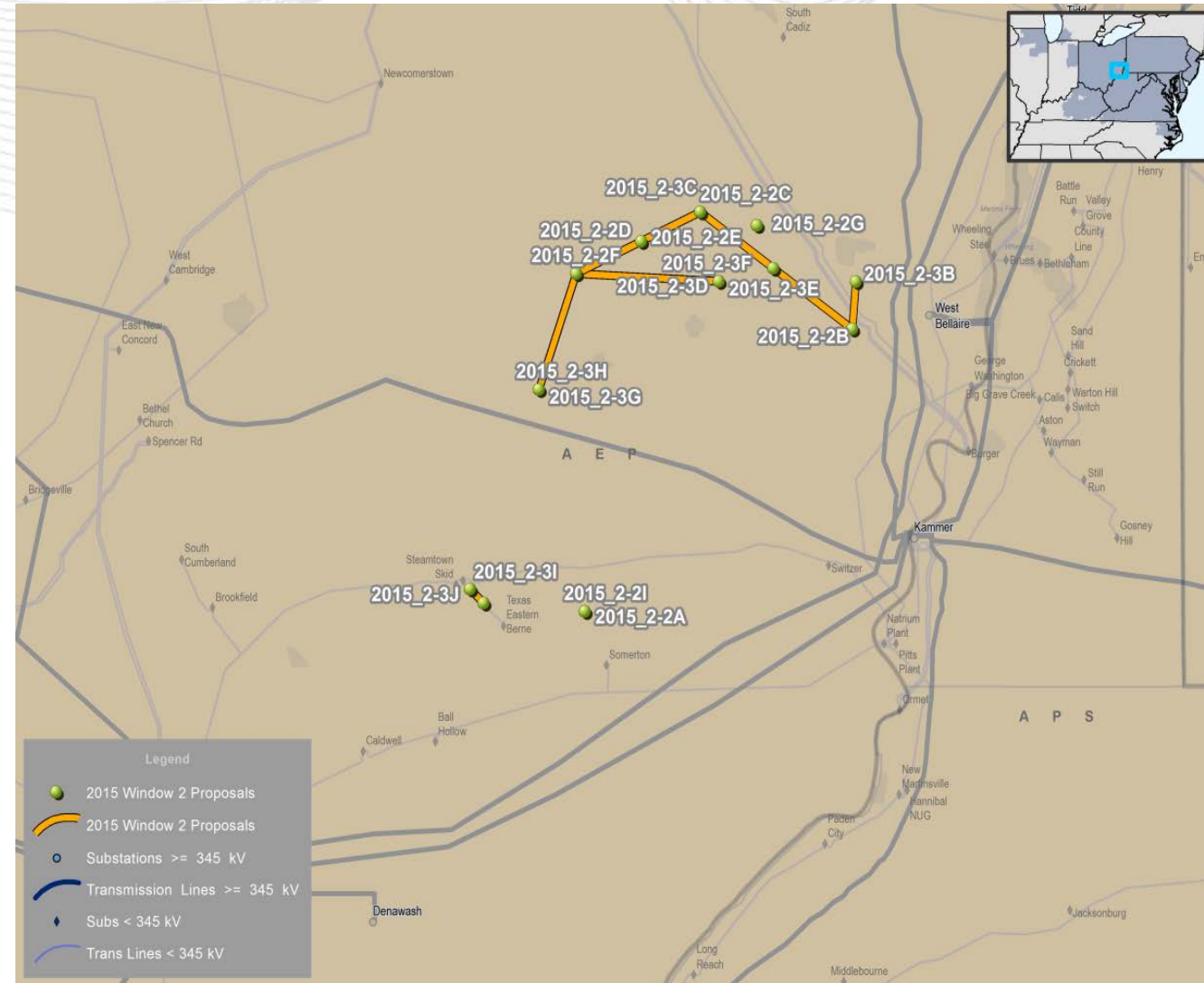
- **EKPC Transmission Owner Criteria Violation (FG# EKPC-V1)**
- Low Voltage violation at Sewellton Junction 69 kV substation for single contingency loss of the Cooper – Wolf Creek 161 kV path.
- **Alternatives considered:**
  - 2015\_2\_4A (\$0.4M)
- **Recommended Solution:**
  - Install 25.5 MVAR 69 kV capacitor at Sewellton Junction 69 kV substation. (2015\_2\_4A)
- **Construction Designation:**
  - The local Transmission Owner, EKPC
- **Estimated Project Cost: \$0.4 M**
- **Required IS Date: 6/1/2020**



- **AEP Transmission Owner Criteria Violation (FG# AEP-T1 and AEP-T3)**
- The Barnesville – Speidel 69 kV circuit is overloaded for multiple contingencies
- **Alternatives considered:**
  - 2015\_2\_2A (\$7.4 M)
  - 2015\_2\_2I (\$29.7 M)
  - 2015\_2\_3I (\$25.7 M)
  - 2015\_2\_3J (\$18.2 M)
- **Recommended Solution Status:** The recommended proposal (2015\_1-2L) from the 2015 Proposal Window #1 resolves the violation

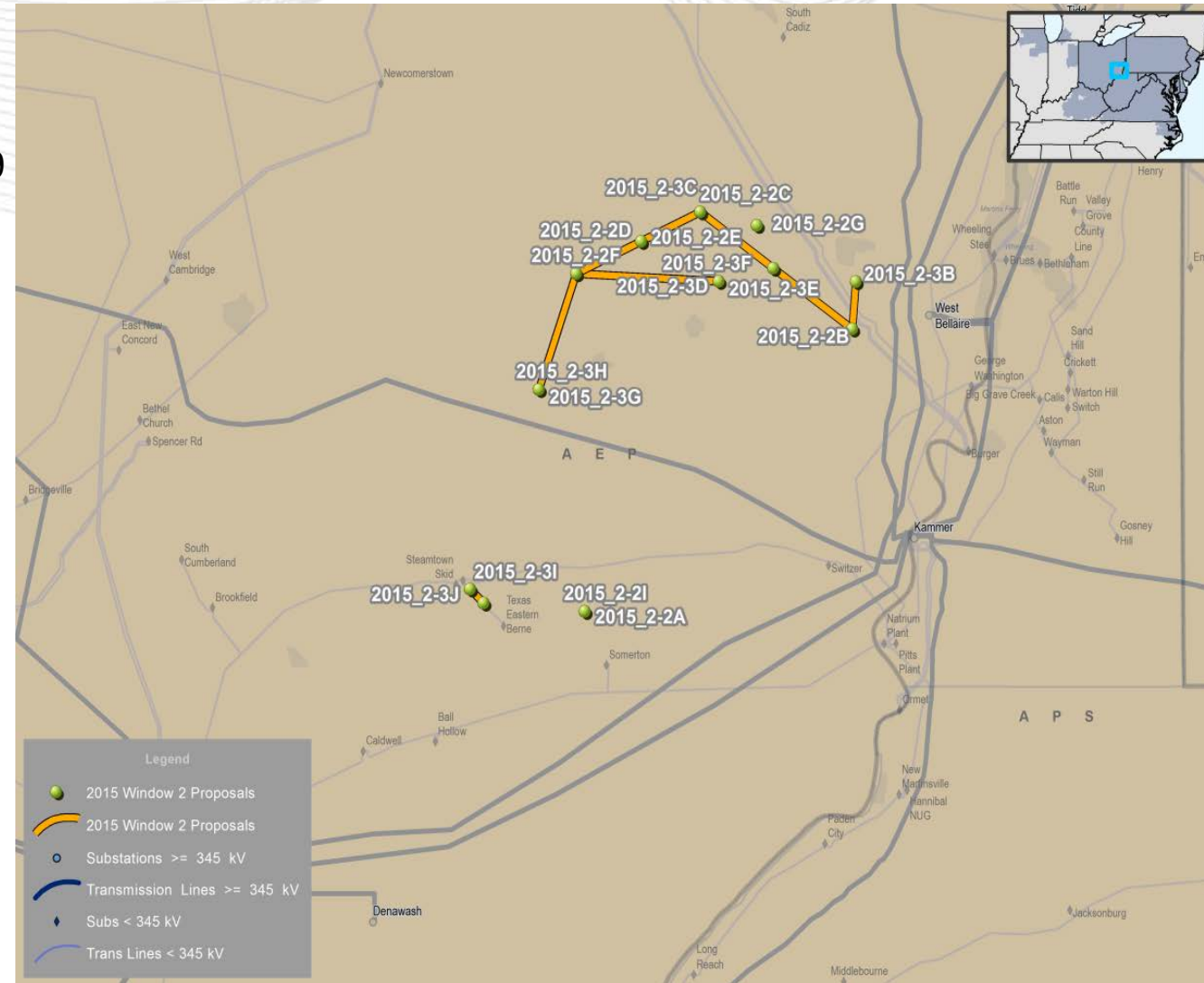


- **AEP Transmission Owner Criteria Violation (FG# AEP-T2)**
- The Caldwell 138/34.5 kV transformer is overloaded for the loss of the Caldwell – Muskingum River 138 kV circuit.
- **Alternatives considered:**
  - 2015\_2\_2A (\$7.4 M)
  - 2015\_2\_2I (\$29.7 M)
  - 2015\_2\_3I (\$25.7 M)
  - 2015\_2\_3J (\$18.2 M)
- **Recommended Solution Status:** The recommended proposal (2015\_1-2L) from the 2015 Proposal Window #1 resolves the violation

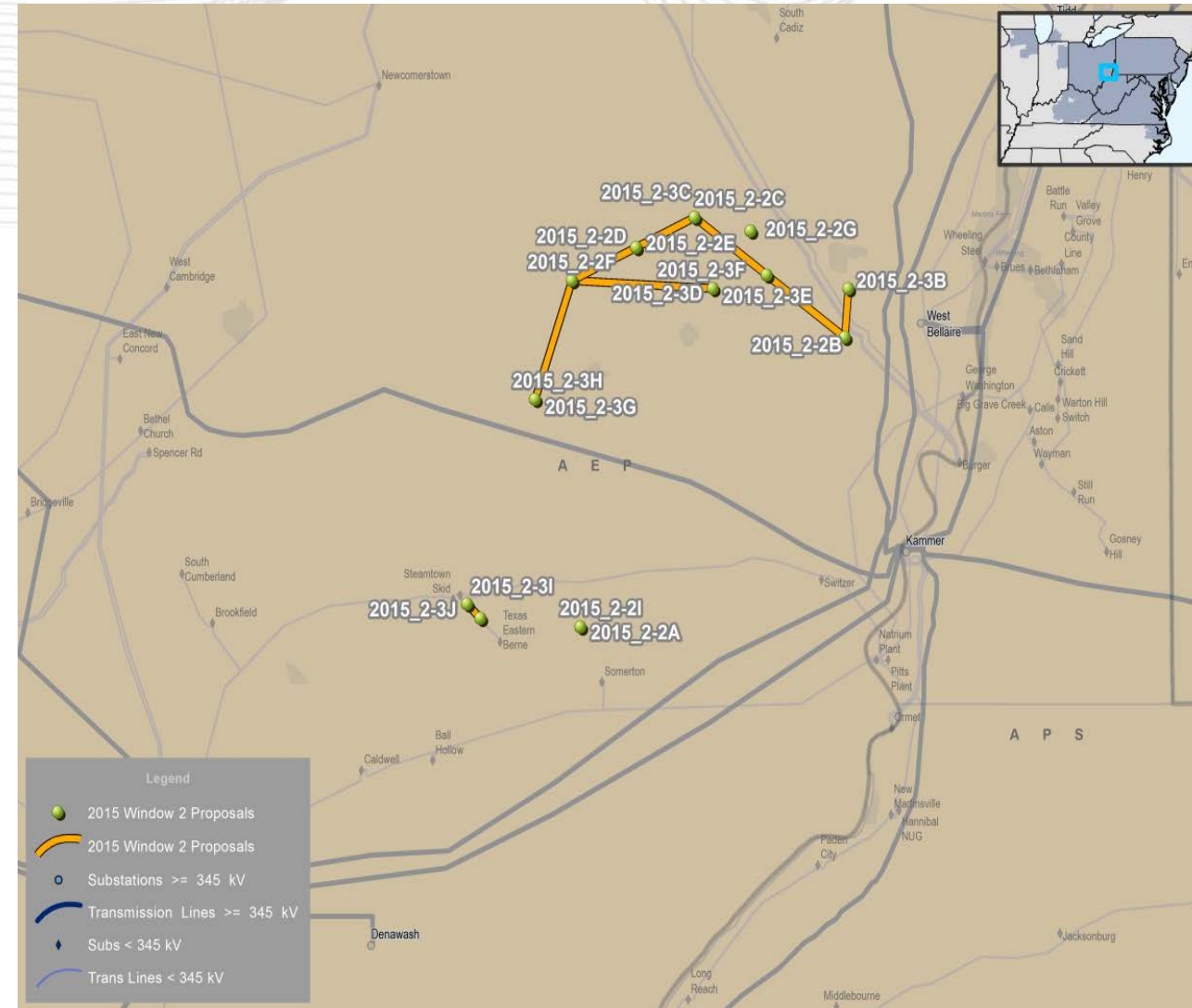




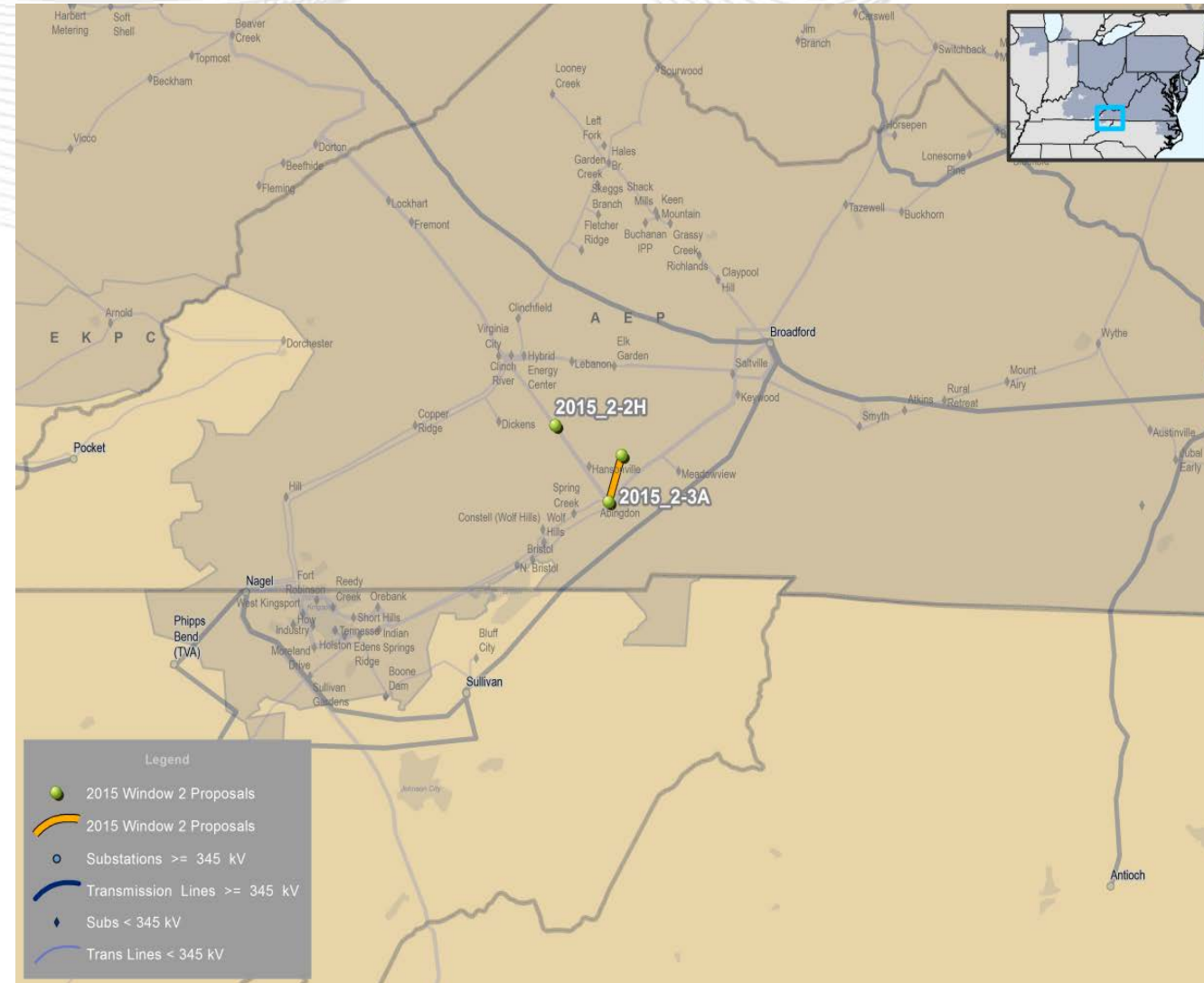
- **AEP Transmission Owner Criteria Violation (FG# AEP-T4 and AEP-V2)**
- Thermal overload on the Fairdale – South Cambridge 69 kV circuit and low voltage violation at Ruannell Sw. 69 kV bus for single contingency loss of the Muskingum – S. Caldwell Switch – Steamtown 138 kV circuit and the South Cumberland 138 kV, 69 kV and 34.5 kV buses.
- **Alternatives considered:**
  - 2015\_2\_2A (\$7.4 M)
  - 2015\_2\_2D (\$18.4 M)
  - 2015\_2\_2E (\$12.6 M)
  - 2015\_2\_2F (\$19.8 M)
  - 2015\_2\_2I (\$29.7 M)
  - 2015\_2\_3I (\$25.7 M)
  - 2015\_2\_3J (\$18.2 M)
- **Recommended Solution Status:** The recommended proposal (2015\_1-2L) from the 2015 Proposal Window #1 resolves the violation



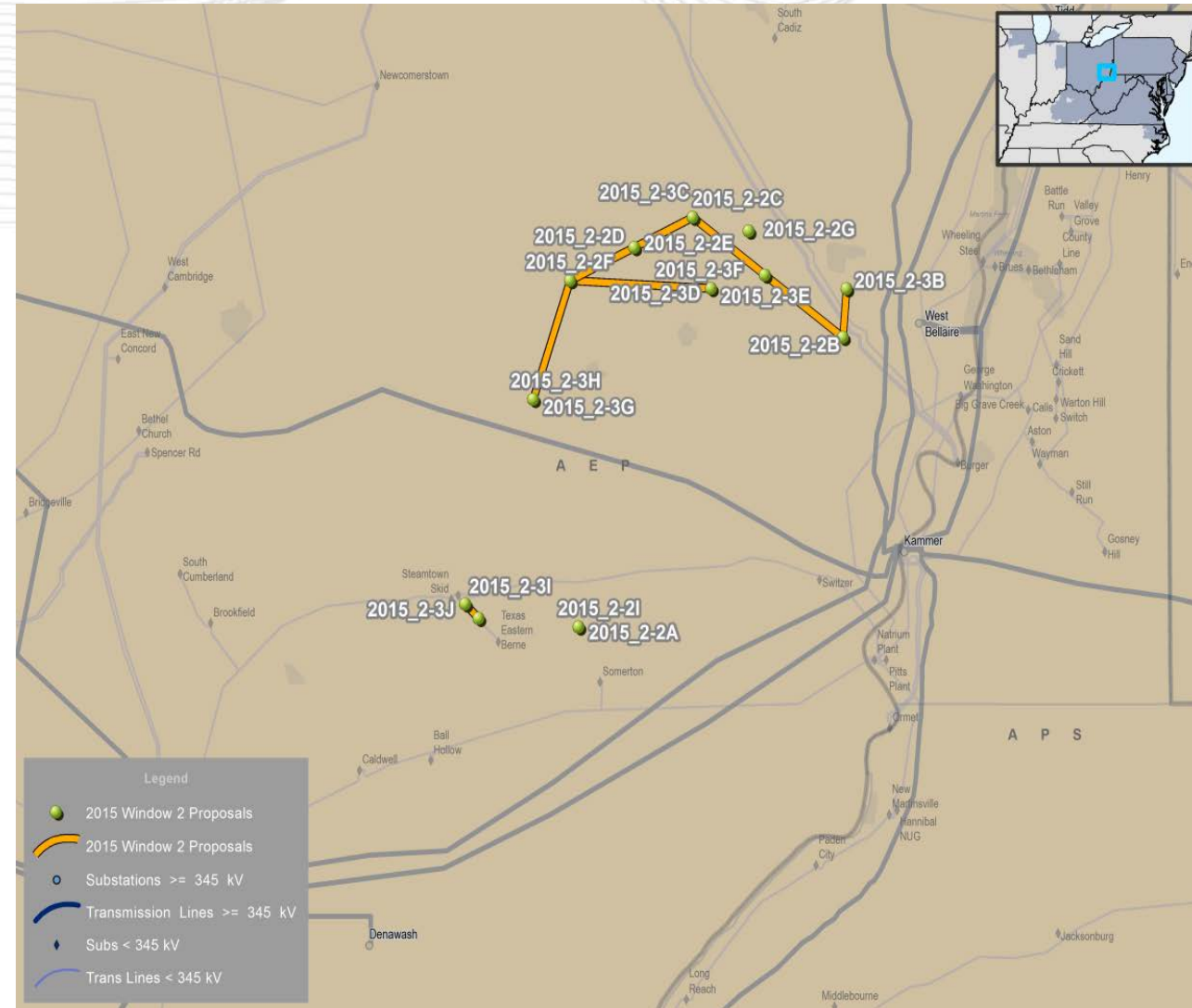
- **AEP Transmission Owner Criteria Violation (FG# AEP-V1 and AEP-V3)**
- Low Voltage violation at Round Bottom 69 kV station for the loss of the Natrium – Switzer 138 kV circuit.
- **Alternatives considered:**
  - 2015\_2\_2A (\$7.4 M)
  - 2015\_2\_2I (\$29.7 M)
  - 2015\_2\_3I (\$25.7 M)
  - 2015\_2\_3J (\$18.2 M)
- **Recommended Solution Status:** The recommended proposal (2015\_1-2L) from the 2015 Proposal Window #1 resolves the violation



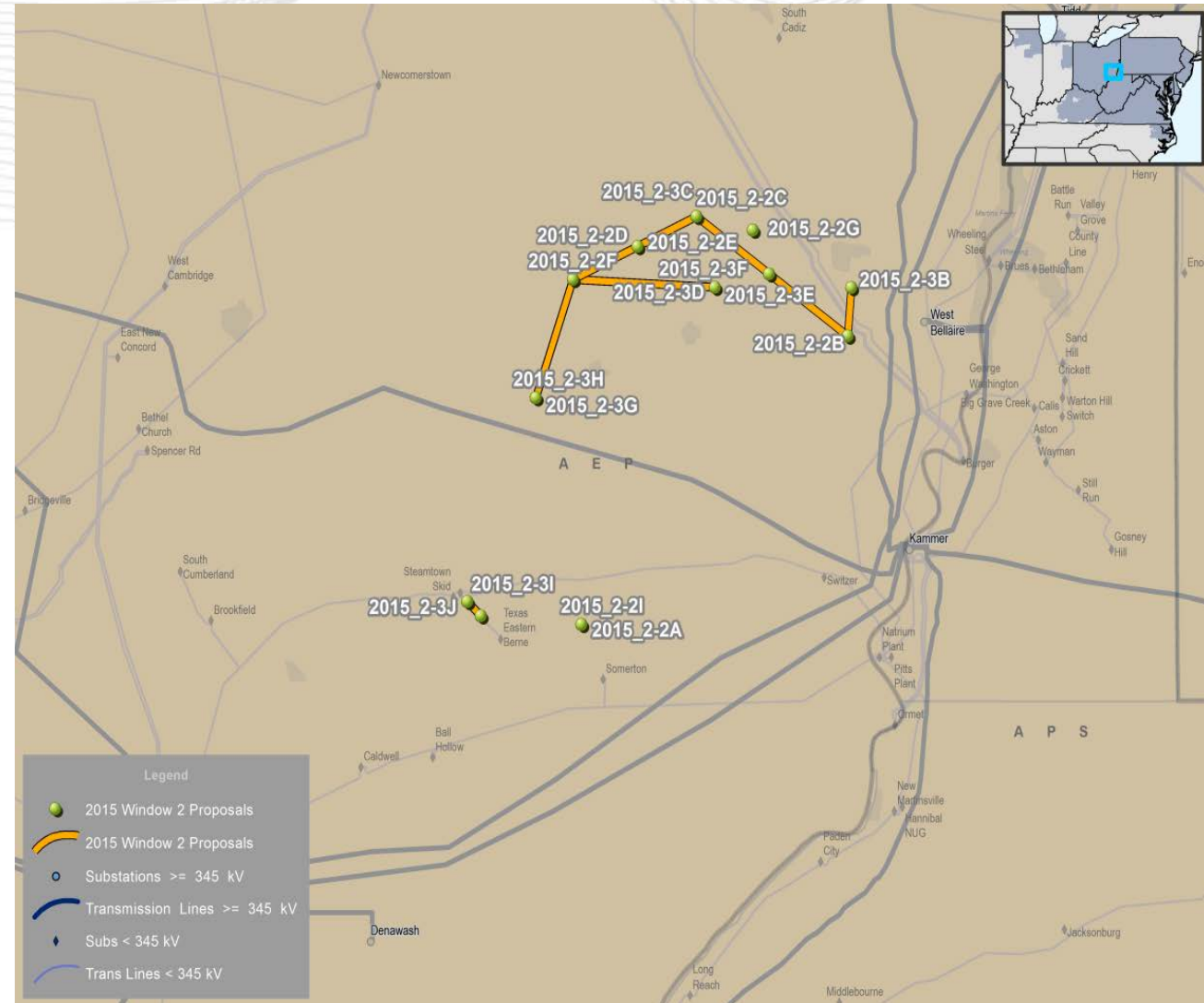
- **AEP Transmission Owner Criteria Violation (FG# AEP-T9)**
- The Abingdon – Hillamn 69 kV line is overloaded for single contingency loss of the Broadford 765/500 kV transformer and Broadford – Sullivan 500 kV circuit.
- **Alternatives considered:**
  - 2015\_2\_2H (\$6.0 M)
  - 2015\_2\_3A (\$25.19 M)
- **Recommended Solution Status:**  
Technical Evaluation in progress



- **AEP Transmission Owner Criteria Violation (FG# AEP-T5 and AEP-T6)**
- The Glencoe – Willow Grove 69 kV line is overloaded for multiple contingencies.
- **Alternatives considered:**
  - 2015\_2\_2B (\$6.2 M)
  - 2015\_2\_2C (\$4.0 M)
  - 2015\_2\_2G (\$6.0 M)
  - 2015\_2\_2I (\$29.7 M)
  - 2015\_2\_3B (\$6.014 M)
- **Recommended Solution Status:**  
Technical Evaluation in progress



- **AEP Transmission Owner Criteria Violation (FG# AEP-T10, AEP-T11, AEP-V6, AEP-V7, AEP-V8 and AEP-V9 )**
- The East Cambridge – Old Washington - Antrim 34.5 kV circuit is overloaded for basecase pre-contingency condition.
- Low Voltage violations at Antrim Sw., Antrim(G.M. Co-op), Vail Sw. and Smyrna 69 kV stations for basecase pre-contingency condition.
- **Alternatives considered:**  
 2015\_2\_2D, 2015\_2\_2E, 2015\_2\_2F, 2015\_2\_2I  
 2015\_2\_3C, 2015\_2\_3D, 2015\_2\_3E, 2015\_2\_3F  
 2015\_2\_3G, 2015\_2\_3H
- **Recommended Solution Status:**  
 Technical Evaluation in progress





# Summary of Proposals For AEP Zone Window #2 Flowgates

FG#s Highlighted in red are resolved by a recommended proposal (2015\_1-2L) from 2015 RTEP Proposal Window #1

Project ID	Upgrade/ Greenfield	Proposing Entity	Final Project Cost (\$M)	Target Zone(s)	FG#	Major Components/Project Description
2015_2-2A	Greenfield	Northeast Transmission Development	7.4	AEP	AEP-T1, AEP-T2, AEP-T3, AEP-T4, AEP-T6; AEP-V1, AEP-V2, AEP-V3	Build a 138 kV switching station ("Grassy Creek") interconnecting the Summerfield-Switzer 138 kV line, the Ball Hollow-Natrium 138 kV line and the Tap to Somerton 138 kV line
2015_2-2B	Greenfield	Northeast Transmission Development	6.2	AEP	AEP-T5, AEP-T6	Build a double circuit 138 kV line from the Nottingham-Holloway 138 kV line to the Glencoe 138 kV substation
2015_2-2C	Greenfield	Northeast Transmission Development	4	AEP	AEP-T5, AEP-T6	Build a 138 kV line from the Nottingham-Holloway 138 kV line to the Glencoe 138 kV substation
2015_2-2D	Greenfield	Northeast Transmission Development	18.4	AEP	AEP-T4, AEP-T10, AEP-T11; AEP-V2, AEP-V6, AEP-V7, AEP-V8, AEP-V9	Build a double circuit 138 kV line from the Nottingham-Reedsburg 138 kV line to a new 138/34.5 kV substation ("Smyrna 138 kV") and interconnecting to the Smyrna 34.5 kV substation
2015_2-2E	Greenfield	Northeast Transmission Development	12.6	AEP	AEP-T4, AEP-T10, AEP-T11; AEP-V2, AEP-V6, AEP-V7, AEP-V8, AEP-V9	Build a 138 kV line from the Nottingham-Reedsburg 138 kV line to a new 138/34.5 kV substation ("Smyrna 138 kV") and interconnecting to the Smyrna 34.5 kV substation
2015_2-2F	Greenfield	Northeast Transmission Development	19.8	AEP	AEP-T4, AEP-T10, AEP-T11; AEP-V2, AEP-V6, AEP-V7, AEP-V8, AEP-V9	Build a new 138 kV line from the Nottingham 138 kV switching station to a new 138/34.5 kV substation ("Smyrna 138 kV") and interconnecting to the Smyrna 34.5 kV substation
2015_2-2G	Greenfield	Northeast Transmission Development	6	AEP	AEP-T5, AEP-T6	Build a 138 kV switching station ("Oak Ridge") interconnecting the West Bellaire-Glencoe 138 kV line and the Nottingham-Holloway 138 kV line
2015_2-2H	Greenfield	Northeast Transmission Development	6	AEP	AEP-T9	Build a 138 kV switching station ("Rattle Creek") interconnecting the Hansonville-Meadowview 138 kV line and the Clinch River-Abingdon 138 kV line



# Summary of Proposals For AEP Zone Window #2 Flowgates

FG#s Highlighted in red are resolved by a recommended proposal (2015\_1-2L) from 2015 RTEP Proposal Window #1

Project ID	Upgrade/ Greenfield	Proposing Entity	Final Project Cost (\$M)	Target Zone(s)	FG#	Major Components/Project Description
2015_2-2I	Greenfield	Northeast Transmission Development	29.7	AEP	AEP-T1, AEP-T2, AEP-T3, AEP-T4, AEP-T5, AEP-T6, AEP-T10, AEP-T11; AEP-V1, AEP-V2, AEP-V3, AEP-V6, AEP-V7, AEP-V8, AEP-V9	Build a 138 kV switching station ("Grassy Creek") interconnecting the Summerfield-Switzer 138 kV line, the Ball Hollow-Natrium 138 kV line and the Tap to Somerton 138 kV line. Build a 138 kV switching station ("Oak Ridge") interconnecting the West Bellaire-Glencoe 138 kV line and the Nottingham-Holloway 138 kV line. Build a double circuit 138 kV line from the Nottingham-Reedsburg 138 kV line to a new 138/34.5 kV substation ("Smyrna 138 kV") and interconnecting to the Smyrna 34.5 kV substation.
2015_2-3A	Greenfield	AEP	25.19	AEP	AEP-T9	South Abingdon station, install a 138/69kV step down transformer, one 138kV circuit breaker, one 138kV circuit switcher and one 69kV circuit breaker. Extend a new 8 miles 69kV line from the proposed South Abingdon station to the Arrowhead station. Arrowhead station, Install three 69kV circuit breakers.
2015_2-3B	Upgrade	AEP	6.014	AEP	AEP-T5, AEP-T6	Rebuild/upgrade line between Glencoe and Willow Grove Switch.
2015_2-3C	Greenfield	AEP	24.32	AEP	AEP-T10, AEP-T11; AEP-V6, AEP-V7, AEP-V8, AEP-V9	Install a new 138 kV line from Nottingham station to Smyrna station 138 kV, approximately 11 miles. Install 138 kV circuit breakers at Nottingham station and at Smyrna station. Install a 34.5 kV Vail Sw circuit breaker.
2015_2-3D	Greenfield	AEP	21.9	AEP	AEP-T10, AEP-T11; AEP-V6, AEP-V7, AEP-V8, AEP-V9	Install a new 69 kV line from Flushing station to Smyrna station, approximately 11.5 miles. Install circuit breakers at Flushing, Smyrna and Vail Sw station.
2015_2-3E	Greenfield	AEP	22.57	AEP	AEP-T10, AEP-T11; AEP-V6, AEP-V7, AEP-V8, AEP-V9	Install a new 34.5 kV line (to be built at 69 kV) from Flushing station to Smyrna station, approximately 11.5 miles. Install 69 kV circuit breakers (to be operated at 34.5 kV) at Smyrna station and at Flushing station. Install a 34.5 kV Vail Sw circuit breaker. Install a 69/34.5 kV 30 MVA transformer at Flushing station.
2015_2-3F	Greenfield	AEP	14.355	AEP	AEP-T10, AEP-T11; AEP-V6, AEP-V7, AEP-V8, AEP-V9	Build approximately 11.5 miles of 34.5 kV line with 556.5 ACSR 26/7 Dove wood poles from Flushing station to Smyrna station.



# Summary of Proposals For AEP Zone Window #2

FG#s Highlighted in red are resolved by proposal in Window #1

Project ID	Upgrade/ Greenfield	Proposing Entity	Final Project Cost (\$M)	Target Zone(s)	FG#	Major Components/Project Description
2015_2-3G	Greenfield	AEP	21.9	AEP	AEP-T10, AEP-T11; AEP-V6, AEP-V7, AEP-V8, AEP-V9	Install a new 34.5 kV line from Slater station to Smyrna station, approximately 10.1 miles. Install circuit breakers at Slater, Smyrna, Nottingham and Vail Sw station.
2015_2-3H	Greenfield	AEP	14.335	AEP	AEP-T10, AEP-T11; AEP-V6, AEP-V7, AEP-V8, AEP-V9	Install a new 34.5 kV line from Slater station to Smyrna station, approximately 10.1 miles. Install circuit breakers at Slater, Smyrna, Nottingham and Vail Sw station.
2015_2-3I	Greenfield	AEP	25.7	AEP	AEP-T1, AEP-T2, AEP-T3, AEP-T4; AEP-V1, AEP-V2, AEP-V3	Construct Herlan Station (Breaker and a half) and Herlan-Blue Racer 138kV circuit.
2015_2-3J	Greenfield	AEP	18.2	AEP	AEP-T1, AEP-T2, AEP-T3, AEP-T4; AEP-V1, AEP-V2, AEP-V3	Construct Herlan Station (ring Bus)and Herlan-Blue Racer 138kV circuit.



# Dominion End of Life Criteria Violations (Immediate Need)

## Dominion End of Life Criteria decision point metrics:

- 1) Facility is nearing, or has already passed, its end of life, and*
- 2) Continued operation risks negatively impacting reliability of the transmission system.*

- Dominion Local TO Criteria
  - End of Life Criteria
    1. End of Life Assessment
      - Industry guidelines indicate equipment life standards
        - Wood structures - 35-55 years,
        - Conductor and connectors - 40-60 years
        - Porcelain insulators - 50 years.
    2. Reliability and System Impact

## Problem:

- End of Life Criteria -The 34 mile section of the Line #47 between Kings Dominion 115kV and Fredericksburg 115kV was constructed on wood H-frames in 1957 and has 795 ACSR conductor with a 3/8" steel static wire.
- System Impact Assessment - Failure of Line #47 would permanently drop 96 MW of load
- This is an immediate need project based on "End of Life" criteria.
- When this criteria violation was identified, the need date was already in the immediate need timeframe This is an immediate need project based on "End of Life" criteria.

## Alternatives Considered

- Given the immediate need timing of the violation, alternatives that would require new lines to be built were not considered.

## 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.

## Proposed Solution:

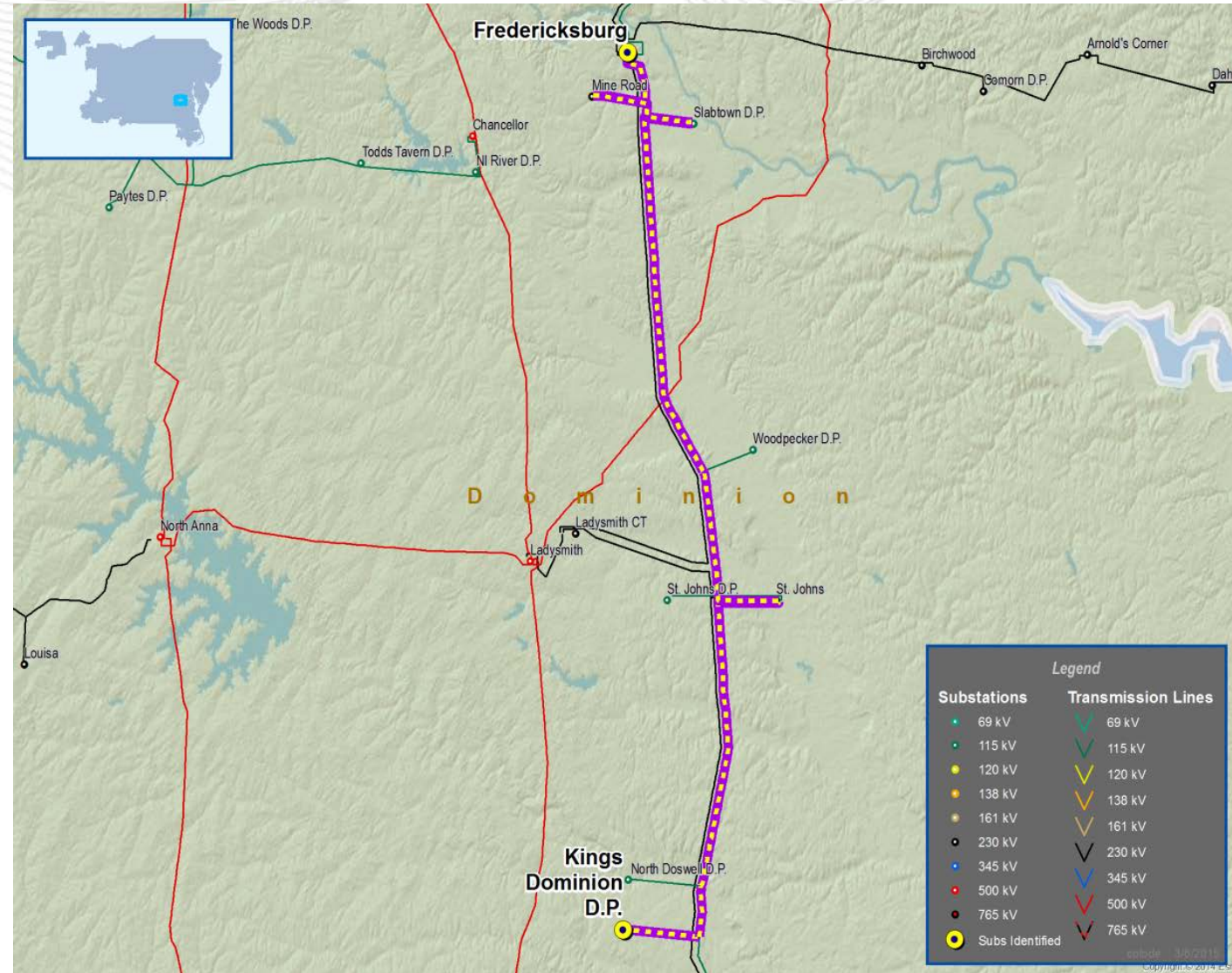
- Rebuild Line #47 between Kings Dominion 115kV and Fredericksburg 115kV to current standards with a summer emergency rating of 353 MVA at 115kV. (B2622)

## Construction Designation:

The local Transmission Owner (Dominion Virginia Power)

**Estimated Project Cost:** \$51.0 M

**Projected IS Date:** 12/31/2017



**Problem:**

- End of Life Criteria - Line #4 between Brema 115kV and Structure 8474 115kV was constructed on wood H-frame structures in 1947. This line has copper conductor and 3/8" steel static.
- System Impact Assessment - Failure of Line #4 would permanently drop 86.7 MW of load
- This is an immediate need project based on "End of Life" criteria.
- When this criteria violation was identified, the need date was already in the immediate need timeframe This is an immediate need project based on "End of Life" criteria.

**Alternatives Considered**

- Given the immediate need timing of the violation, alternatives that would require new lines to be built were not considered.

**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.

**Proposed Solution:**

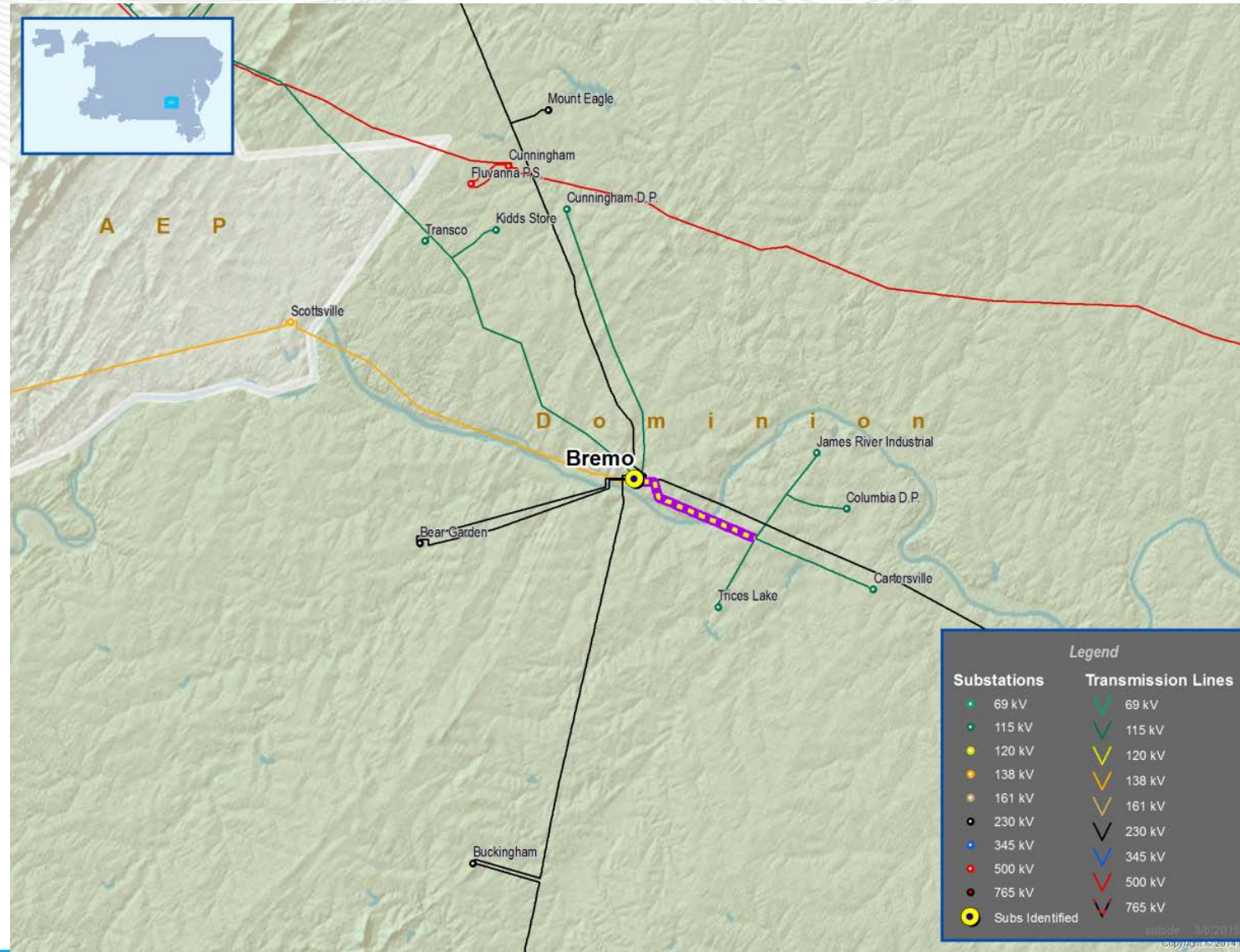
- Rebuild Line #4 between Brema 115 kV and Structure 8474 (4.5 miles) to current standards with a summer emergency rating of 261 MVA at 115kV. (B2623)

**Construction Designation:**

The local Transmission Owner (Dominion Virginia Power)

**Estimated Project Cost:** \$6.8 M

**Projected IS Date:** 12/31/2016



**Problem:**

- End of Life Criteria - 115kV Lines #18 and #145 are approximately 8.35 miles long and were constructed on double-circuit, 3-pole wood H-frame structures in the timeframe between 1948 and 1954..
- System Impact Assessment - Failure of Lines #18 & #145 would permanently drop 68.5 MW of load
- This is an immediate need project based on “End of Life” criteria.
- When this criteria violation was identified, the need date was already in the immediate need timeframe This is an immediate need project based on “End of Life” criteria.

**Alternatives Considered**

- Given the immediate need timing of the violation, alternatives that would require new lines to be built were not considered.

**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.

**Proposed Solution:**

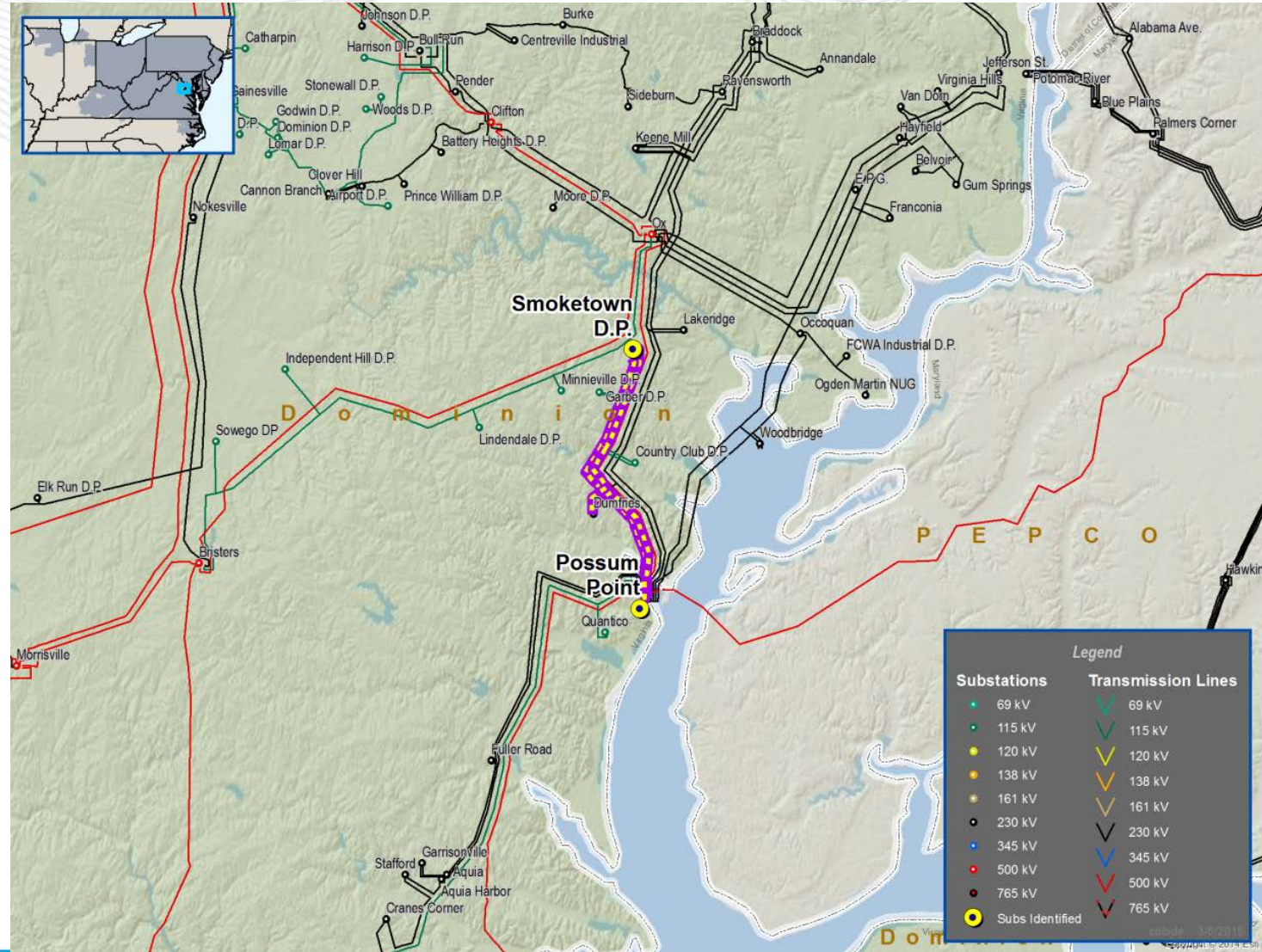
- Rebuild 115kV Lines #18 and #145 between Possum Point Generating Station and NOVEC’s Smoketown DP (approx. 8.35 miles) to current 230kV standards with a normal continuous summer rating of 524 MVA at 115kV (1047 MVA at 230kV) (B2624)

**Construction Designation:**

The local Transmission Owner (Dominion Virginia Power)

**Estimated Project Cost:** \$24.7 M

**Projected IS Date:** 12/31/2016



**Problem:**

- End of Life Criteria - The 115kV Lines #48 (Sewells Point to Thole Street) and #107 (Sewells Point to Oakwood) were built on double circuit weathering steel (corten) towers in 1965. Field reports and condition assessment indicate the corten structures are in poor condition and additional structure loading will be required due to a need for fiber to be installed on these structures
- System Impact Assessment - Failure of Lines #48 & #107 would permanently drop 27 MW of load
- This is an immediate need project based on “End of Life” criteria.
- When this criteria violation was identified, the need date was already in the immediate need timeframe This is an immediate need project based on “End of Life” criteria.

**Alternatives Considered**

- Given the immediate need timing of the violation, alternatives that would require new lines to be built were not considered.

**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.

**Proposed Solution:**

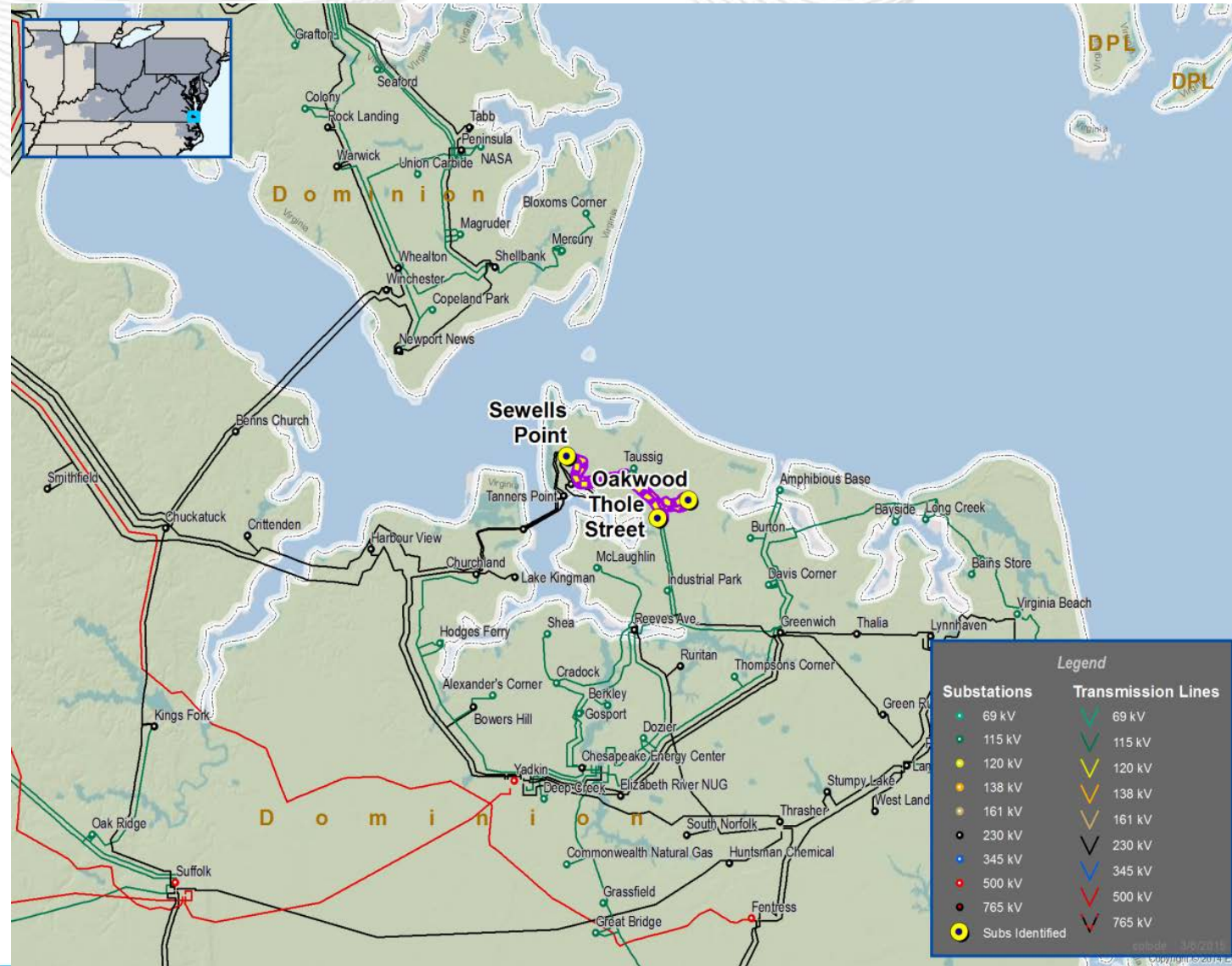
- Rebuild 115kV Line #48 between Thole Street and structure 48/71 to current standard. The remaining line to Sewells Point is 2007 vintage. Rebuild 115kV Line #107 line between structure 107/17 and 107/56 to current standard (B2625)

**Construction Designation:**

The local Transmission Owner (Dominion Virginia Power)

**Estimated Project Cost:** \$15.3 M

**Projected IS Date:** 12/31/2018



**Problem:**

- End of Life Criteria - The 13 mile 115kV Line #34 from Skiffes Creek – Yorktown was built on wood H-frames in the 1940’s and 1950’s. This line has sections of 4/0 copper conductor and 3/8” steel static. The first 4.5 miles out of Yorktown is on 3 pole double circuit wood H-frames with the Line #61 line.
- System Impact Assessment - Failure of Lines #34 & #61 would permanently drop 198 MW of load
- This is an immediate need project based on “End of Life” criteria.
- When this criteria violation was identified, the need date was already in the immediate need timeframe This is an immediate need project based on “End of Life” criteria.

**Alternatives Considered**

- Given the immediate need timing of the violation, alternatives that would require new lines to be built were not considered.

**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.

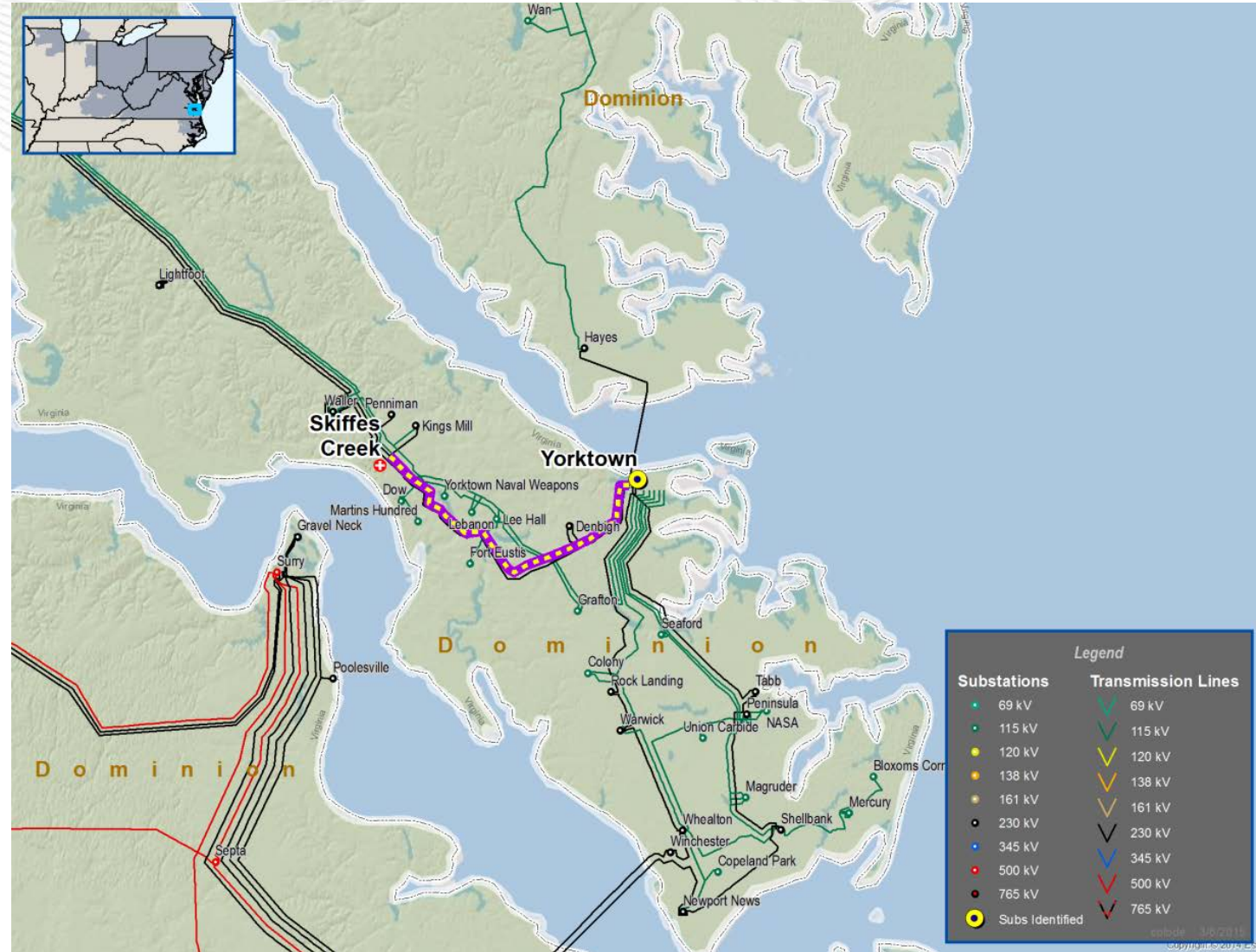
**Proposed Solution:**

- Rebuild the 115kV Line #34 and the double circuit portion of 115kV Line # 61 to current standards with a summer emergency rating of 353 MVA at 115kV. (B2626)

**Construction Designation:**

The local Transmission Owner (Dominion Virginia Power)

- **Estimated Project Cost:** \$24 M
- **Projected IS Date:** 12/31/2018





**Problem:**

- End of Life Criteria - The 115kV Line # 1 was constructed on wood H-frame structures in 1942. This line has 2/0 copper conductor and 3/8 inch steel static.
- System Impact Assessment - Failure of Line #1 would permanently drop 31 MW of load
- This is an immediate need project based on “End of Life” criteria.
- When this criteria violation was identified, the need date was already in the immediate need timeframe This is an immediate need project based on “End of Life” criteria.

**Alternatives Considered**

- Given the immediate need timing of the violation, alternatives that would require new lines to be built were not considered.

**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.

**Proposed Solution:**

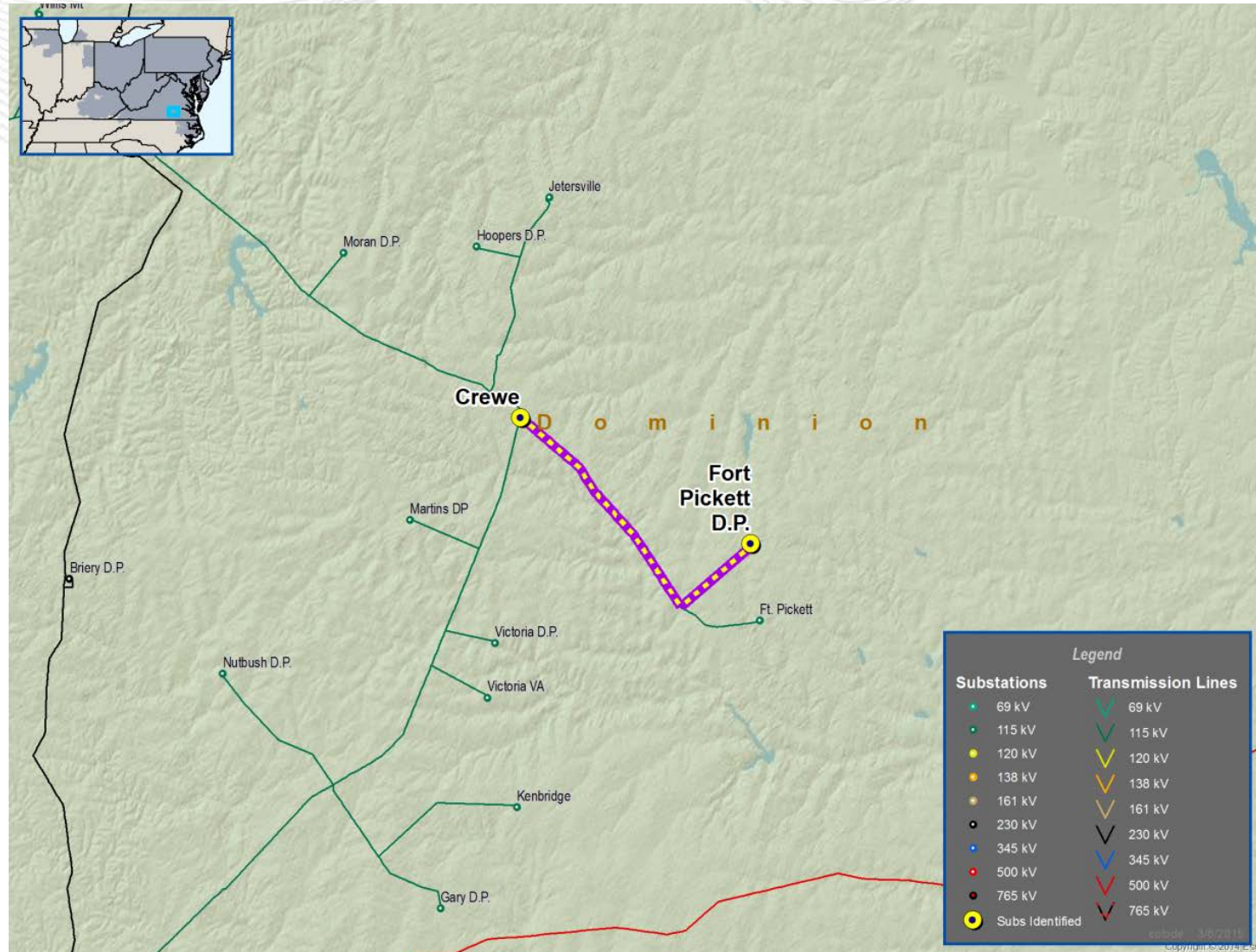
- Rebuild 115kV Line #1 between Crewe 115kV and Fort Pickett DP 115kV (12.2 miles) to current standards with a summer emergency rating of 261 MVA at 115kV. (B2627)

**Construction Designation:**

The local Transmission Owner (Dominion Virginia Power)

**Estimated Project Cost:** \$18.3 M

**Projected IS Date:** 12/31/2016



**Problem:**

- End of Life Criteria - The Line #82 line was constructed on wood H-frame structures in 1953. This line has ACSR conductor and 3/8 inch steel static.
- System Impact Assessment - Failure of Line #82 would permanently drop 49 MW of load
- This is an immediate need project based on “End of Life” criteria.
- When this criteria violation was identified, the need date was already in the immediate need timeframe This is an immediate need project based on “End of Life” criteria.

**Alternatives Considered**

- Given the immediate need timing of the violation, alternatives that would require new lines to be built were not considered.

**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.

**Proposed Solution:**

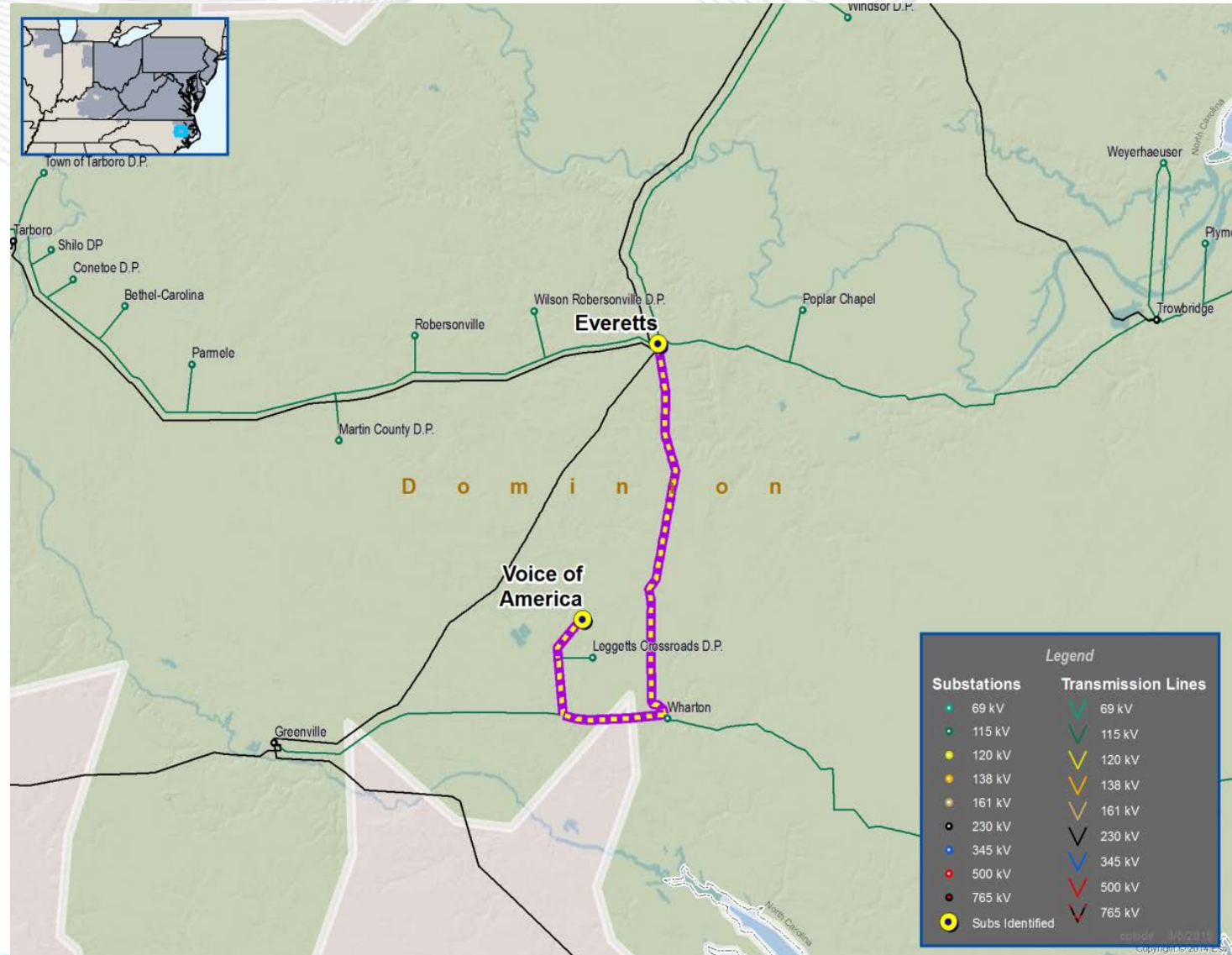
- Rebuild 115kV Line #82 Everetts – Voice of America (20.8 miles) to current standards with a summer emergency rating of 261 MVA at 115kV (B2628)

**Construction Designation:**

The local Transmission Owner (Dominion Virginia Power)

**Estimated Project Cost:** \$24 M

**Projected IS Date:** 12/31/2017



## Problem:

- End of Life Criteria - The 115kV Lines #27 (new line 166) and # 67 lines from Greenwich to Burton were built on double circuit weathering steel (Corten) towers in 1964. The corten structures are in poor condition and additional structure loading will be required due to a need for fiber to be installed on these structures.
- System Impact Assessment - Failure of Lines #27 & #67 would permanently drop 90 MW of load
- This is an immediate need project based on “End of Life” criteria.
- When this criteria violation was identified, the need date was already in the immediate need timeframe This is an immediate need project based on “End of Life” criteria.

## Alternatives Considered

- Given the immediate need timing of the violation, alternatives that would require new lines to be built were not considered.

## 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.

## Proposed Solution:

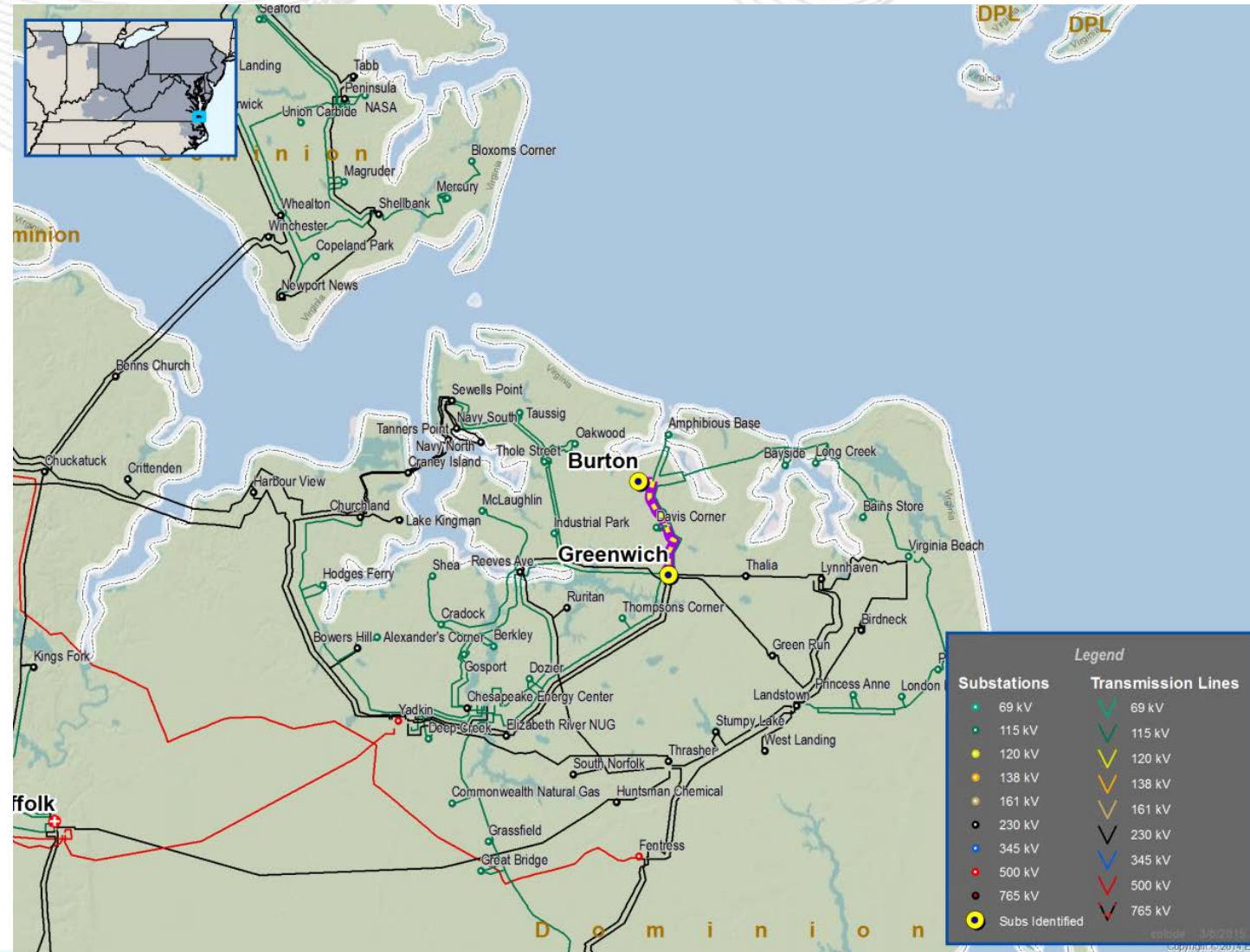
- Rebuild the 115kV Lines #27 & #67 lines from Greenwich 115kV to Burton 115kV Structure 27/280 to current standard with a summer emergency rating of 262 MVA at 115kV (B2629)

## Construction Designation:

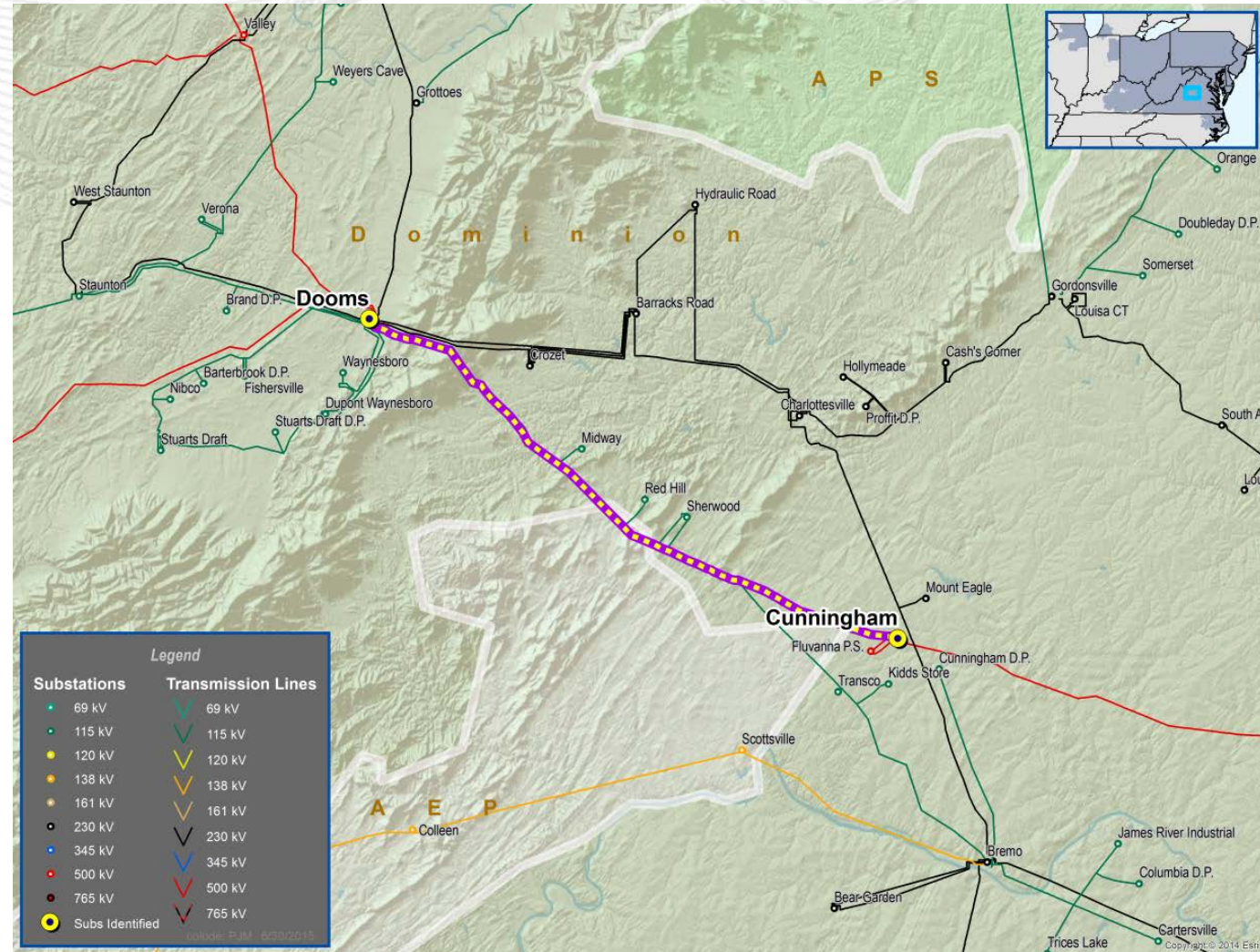
The local Transmission Owner (Dominion Virginia Power)

**Estimated Project Cost:** \$8.85 M

**Projected IS Date:** 12/31/2019



- Dominion End of Life Criteria Violation on the Cunningham to Dooms 500 kV Line
  - Third party evaluation:
    - Confirmed the Cunningham to Dooms 500 kV is nearing or has reached its End of Life
    - Performed a Risk Assessment
  - Reliability Assessments without the line result in Criteria violations:
    - PJM validated the following violations
  - NERC B “N-1” (New NERC TPL-001-4 P3) Violations:
    - Initial Loss of Front Royal generation followed by loss of Mt Storm- Valley 500kV line
      - Overload of Edinburg - Strasburg 138 Kv
- ..... Continued on the next slide



..... Continued from previous slide

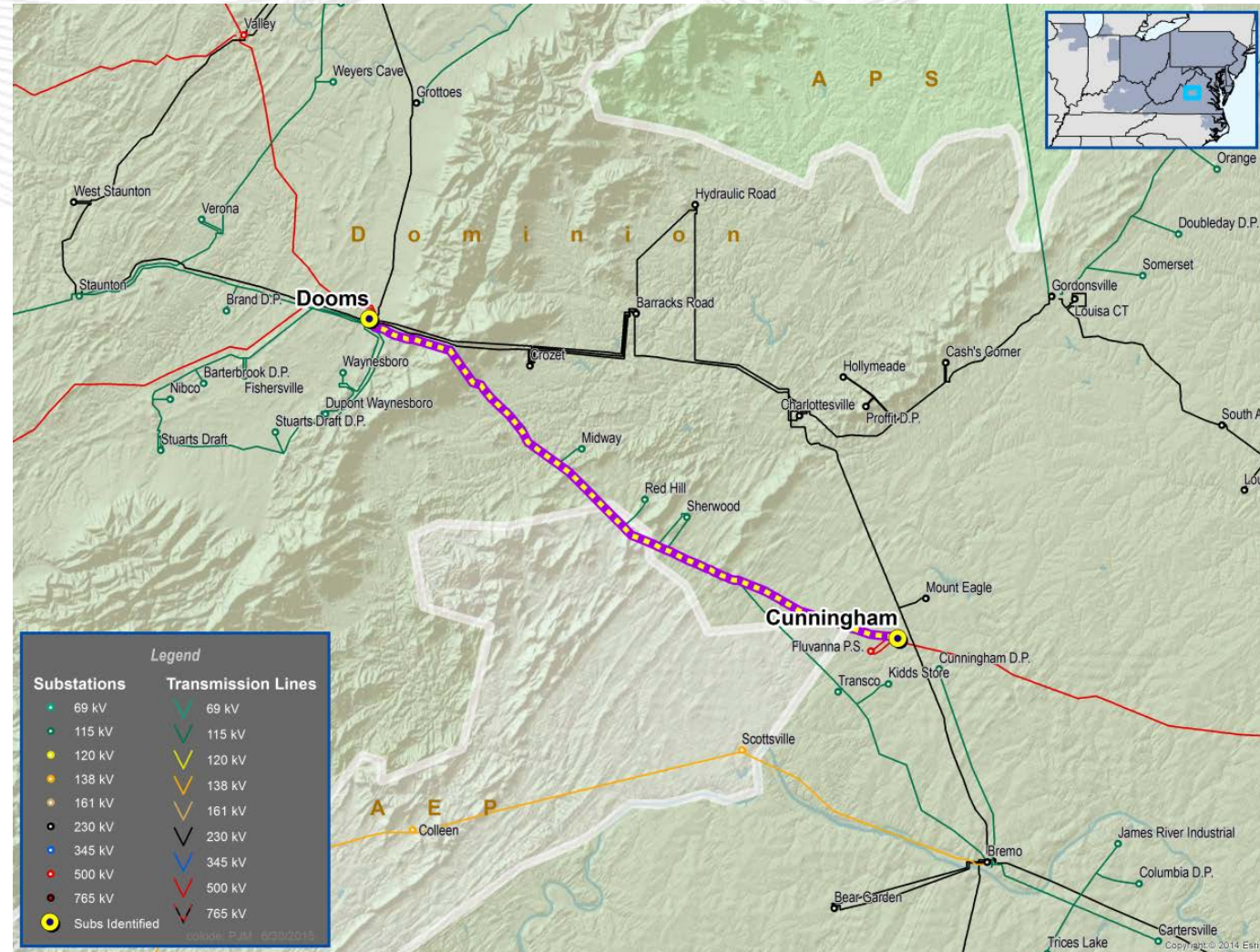
- NERC C3 “N-1-1” (New NERC TPL-001-4 P6)
  - Loss of Lexington – Cloverdale 500kV and Bath County to Valley 500kV lines causes the following issues
    - Low voltage and voltage drop in the 500kV area of Bath County, Dooms, Lexington, and Valley
    - Voltage drop in the 230kV area of Lexington Low Moor, and Clifton
- When this criteria violation was identified, the need date was already in the immediate need timeframe This is an immediate need project based on “End of Life” criteria.

### Alternatives Considered

- Given the immediate need timing of the violation, alternatives that would require new lines to be built were not considered.

### Immediate Need

- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner (Dominion) is the Designated Entity.
- Recommended Solution: Rebuild the Cunningham – Dooms 500 kV line as a PJM baseline upgrade
- Estimated Cost: \$110M
- Projected In Service Date: June 2020



# Other Immediate Need Violations



### Driver:

- The Chesapeake - Deepcreek - Bowers Hill - Hodges Ferry 115 kV line is overloaded for various GenDeliv and N-1-1 contingencies.
- PJM was notified of this generation deactivation in the immediate need timeframe. When this criteria violation was identified, the need date was already in the immediate need timeframe.

### Alternatives Considered

- Given the immediate need timing of the violation, alternatives that would require new lines to be built were not considered.

### 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.

### Proposed Solution:

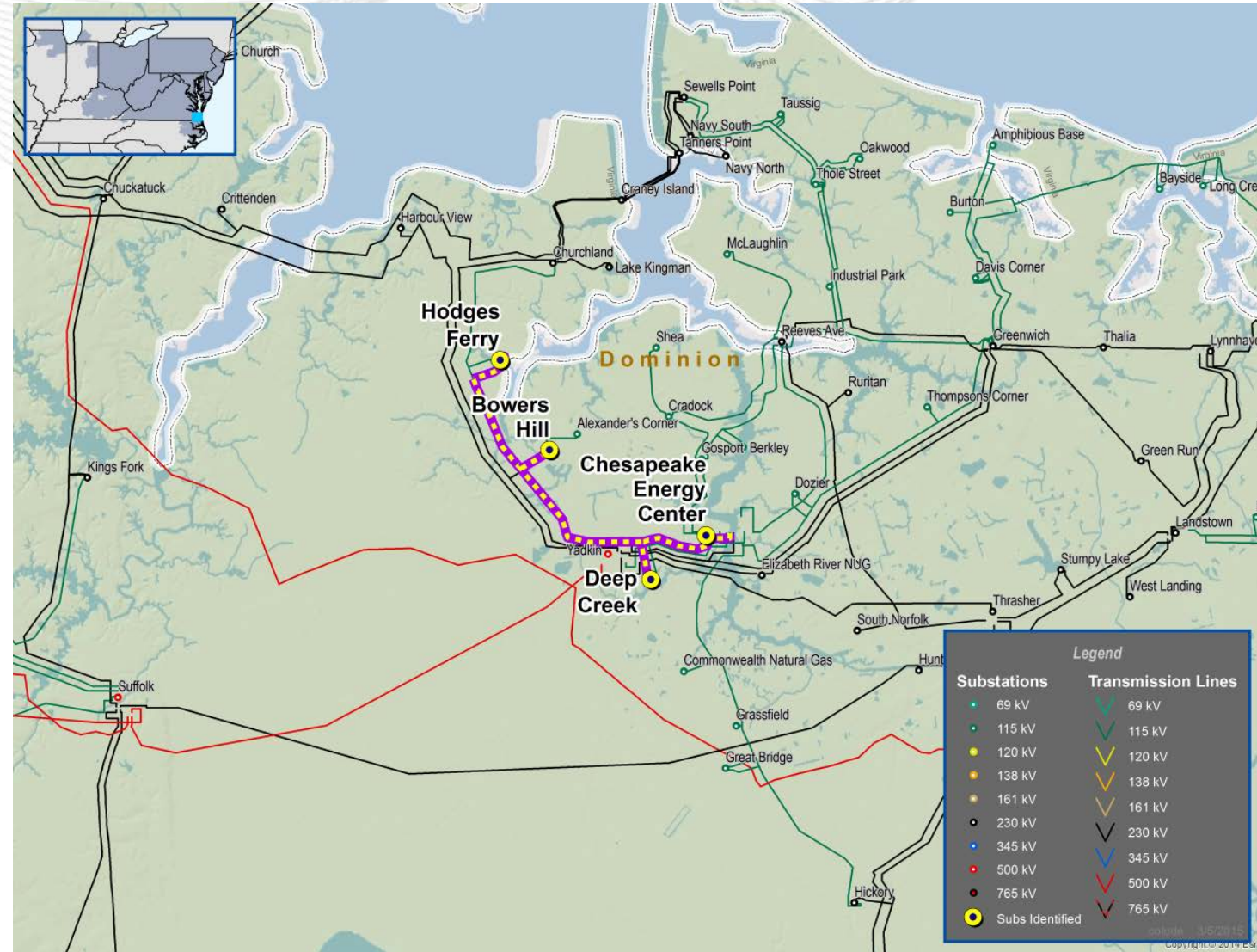
- Wreck and rebuild the Chesapeake - Deepcreek - Bowers Hill - Hodges Ferry 115 kV line; minimum rating 239 MVA normal/emergency, 275 MVA load dump rating (b2620)

### Construction Designation:

- The local Transmission Owner (Dominion Virginia Power)

Estimated Project Cost: \$10 M

Required IS Date: 6/1/2016



**Problem:**

- Transmission upgrades are needed on GSU units #4 and #5 at Gravel Neck to improve Operational Performance.

**Alternatives Considered**

- Given the immediate need timing of the violation and estimated cost of the solution additional alternatives were not considered.

**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.

**Proposed Solution:**

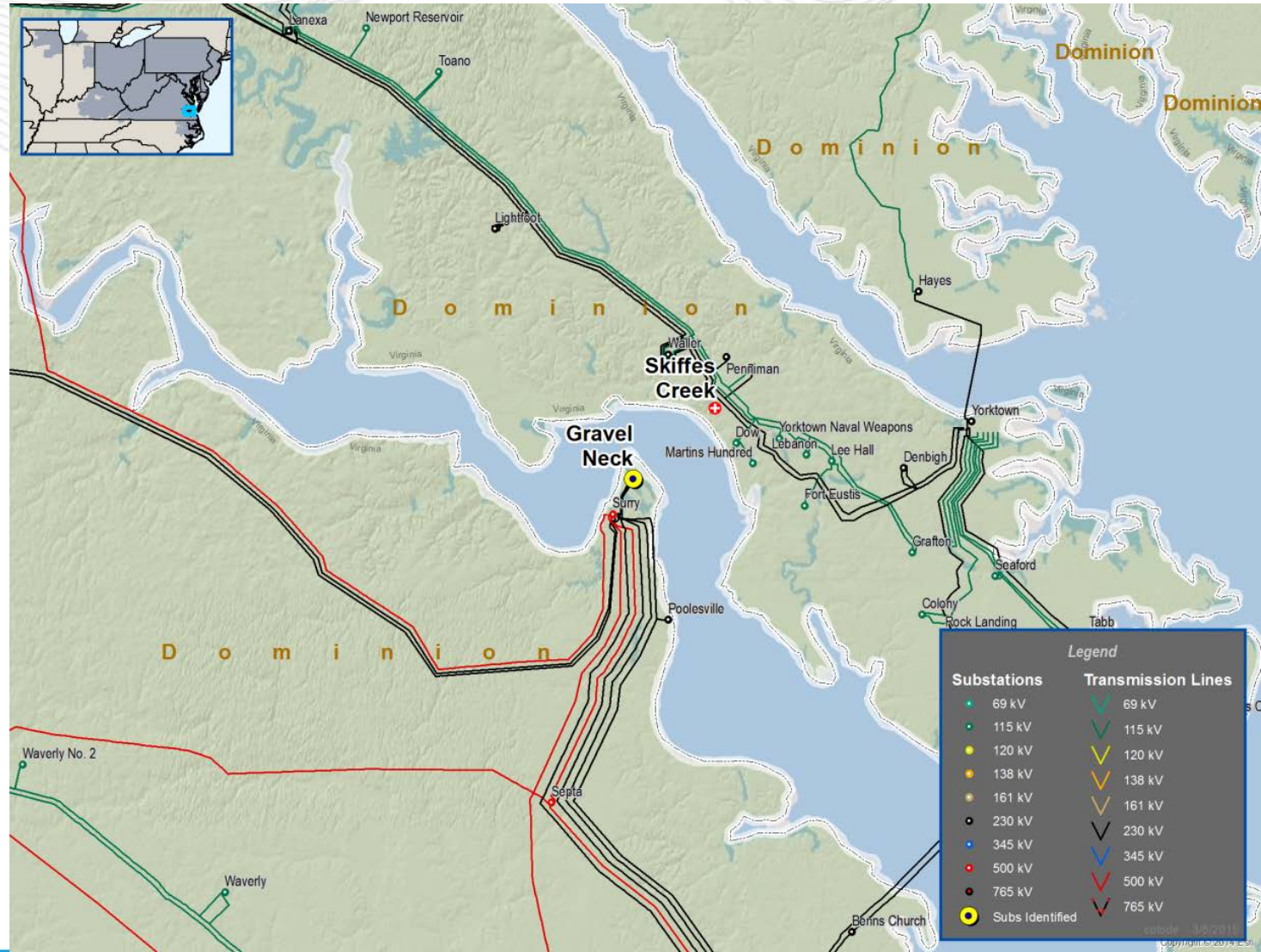
- Install circuit switchers on GSU units #4 and #5. Install two 230kV CCVT's on Lines #2407 and #2408 for loss of source sensing (B2630)

**Construction Designation:**

The local Transmission Owner (Dominion Virginia Power)

**Estimated Project Cost:** \$662 K

**Projected IS Date:** 5/31/2015





# RTEP Next Steps

- Finalize the 2015 RTEP Window #2 analysis and recommend solution alternatives
  - November 2015 TEAC
  - December 2015 PJM Board
- Continue to populate PJM Model on Demand Database
  - Continued Transmission Owner support is needed
- Development of 2021 Models – For the 2016 RTEP
  - Summer
  - Winter
  - Light Load

# Questions?

Email: [RTEP@pjm.com](mailto:RTEP@pjm.com)

- Revision History
  - Original version posted to PJM.com – 10/7/2015
  - Slide #22, added the header for the table, added “Solves Several Window #2 Reliability Criteria Violations” to the column PROs for 8R
  - Slide 55 updated for Cunningham-Doom Cost Estimate