

Transmission Expansion Advisory Committee

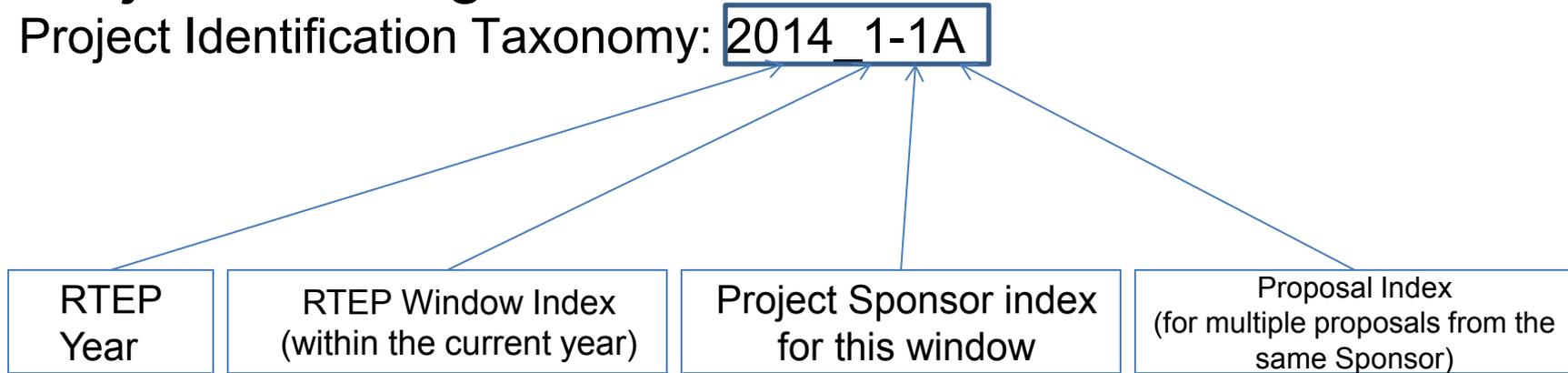
Webex – September 25, 2014
Version 3

Reliability Analysis Update

2014 RTEP Proposal Window #1 Update

- Window opened on 6/27/2014
- Closed on 7/28/2014

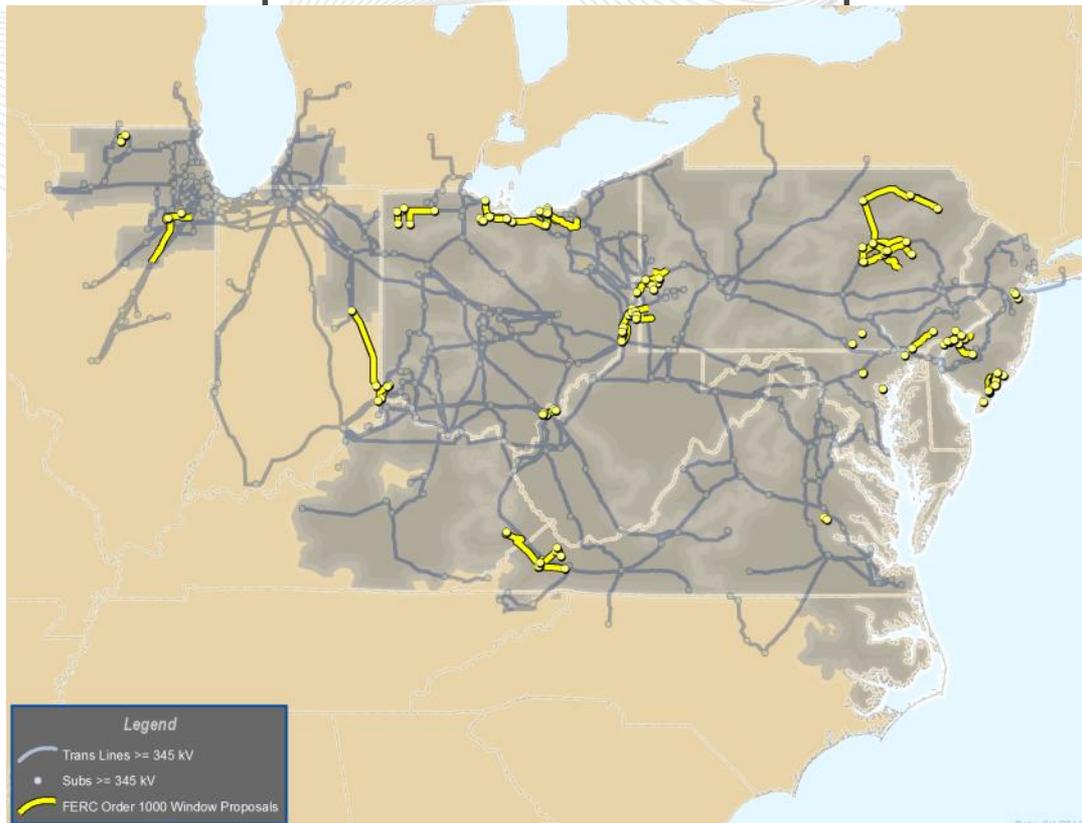
- Project Naming Convention
- Project Identification Taxonomy: 2014_1-1A



- Transmission Owner Upgrade is a Defined Term
- *“Transmission Owner Upgrade” shall mean an upgrade to a Transmission Owner’s own transmission facilities, which is an improvement to, addition to, or replacement of a part of, an existing facility and is not an entirely new transmission facility.*

2014 RTEP Proposal Window #1 Proposals

- Approximately 50 individual facilities with reliability criteria violations
 - Approximately 112 flow gates are identified
- 15 proposing entities
- 106 proposals
 - 46 Transmission Owner Upgrades
 - Cost range of \$0.02M to \$139.2M
 - 60 Greenfield Projects
 - Cost range of \$10.2M to \$1,367M
- 18 target TO zones
- Proposals span 10 States
 - DE, IL, IN, KY, MD, NJ, OH, PA, VA, WV



- PJM continues to evaluate the proposed projects
- Based on the work done to date proposals fall into the following high level categories
 1. Recommended solutions
 2. Retirement/At Risk related (reliability violations will be re-evaluated pending the status of the retirement/at risk generation)
 3. FSA generation related (reliability violations will be re-evaluated pending the status of the planned generation)
 4. Technical evaluation is on-going as necessary to develop a preliminary recommended solution

- As part of the evaluation, PJM considered the 15-year analysis results when making recommendations to check if a more robust solution would be needed due to that test
- The 15-year analysis results did not indicate a need for more robust solution recommendations

2014 RTEP Proposal Window #1

Continuing PPL Zone Evaluation

- **2014 RTEP Proposal Window #1**

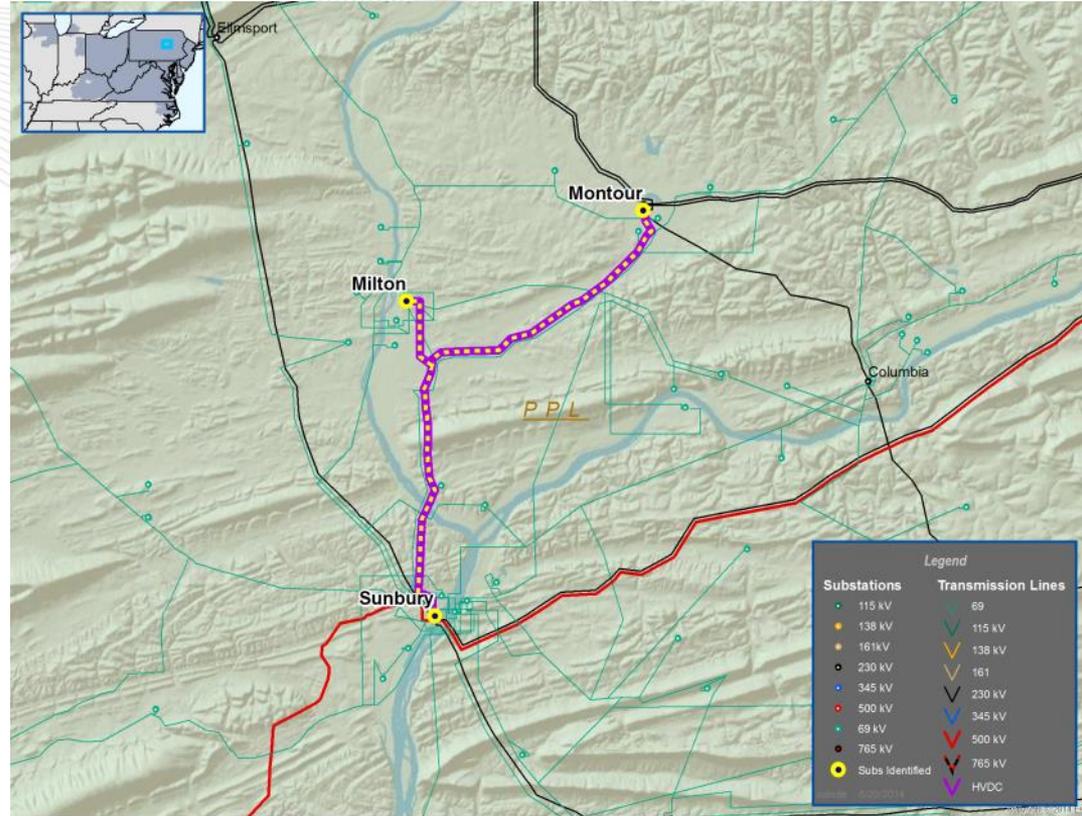
- **Common Mode Outage (FG # 797, 801) Violation**

- The Montour – Milton – Sunbury 230 kV circuit is overloaded for tower contingency loss of Montour – Susquehanna 230 kV circuits.

- **Solution Alternatives Submitted:**

– P2014_1-3I	\$146.4M
– P2014_1-4C	\$31.8M
– P2014_1-7I	\$139.2M
– P2014_1-7J	\$29.2M
– P2014_1-7K	\$114.1M
– P2014_1-7L	\$87.1M
– P2014_1-7M	\$102.9M
– P2014_1-7N	\$112.5M
– P2014_1-7O	\$164.2M
– P2014_1-7P	\$1,367M
– P2014_1-13B	\$55.36
– P2014_1-14E	\$29.8M
– P2014_1-14E1	\$80.9M

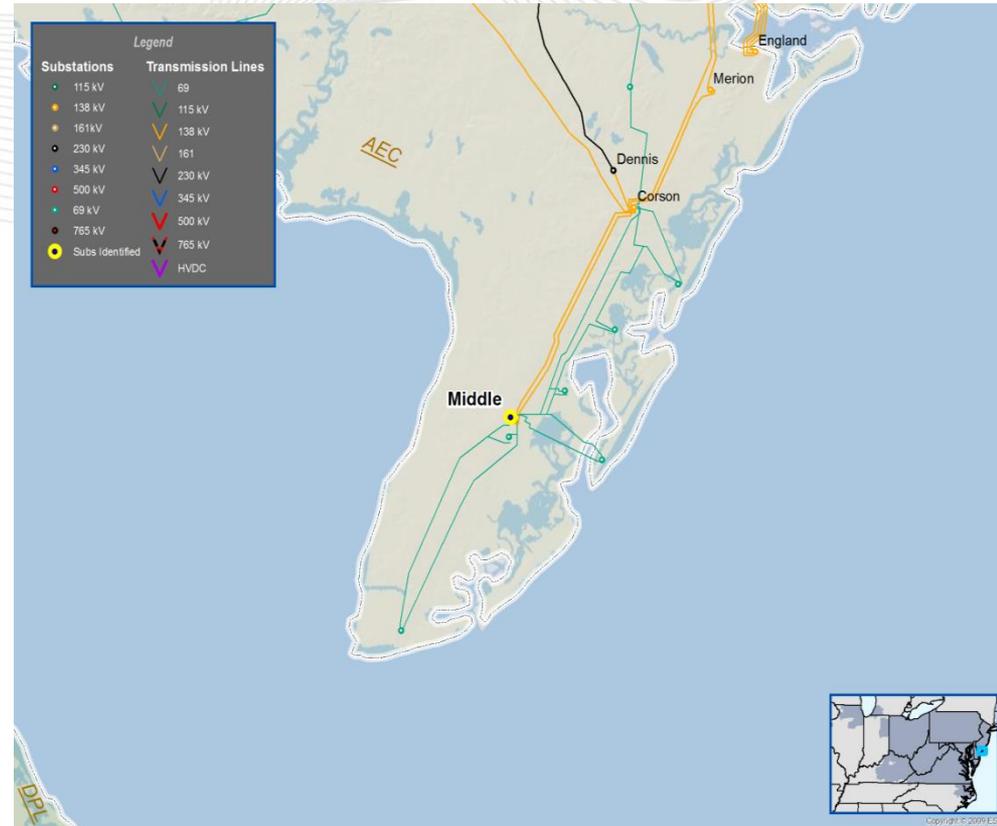
- PJM is in the process of evaluating these potential solution alternatives



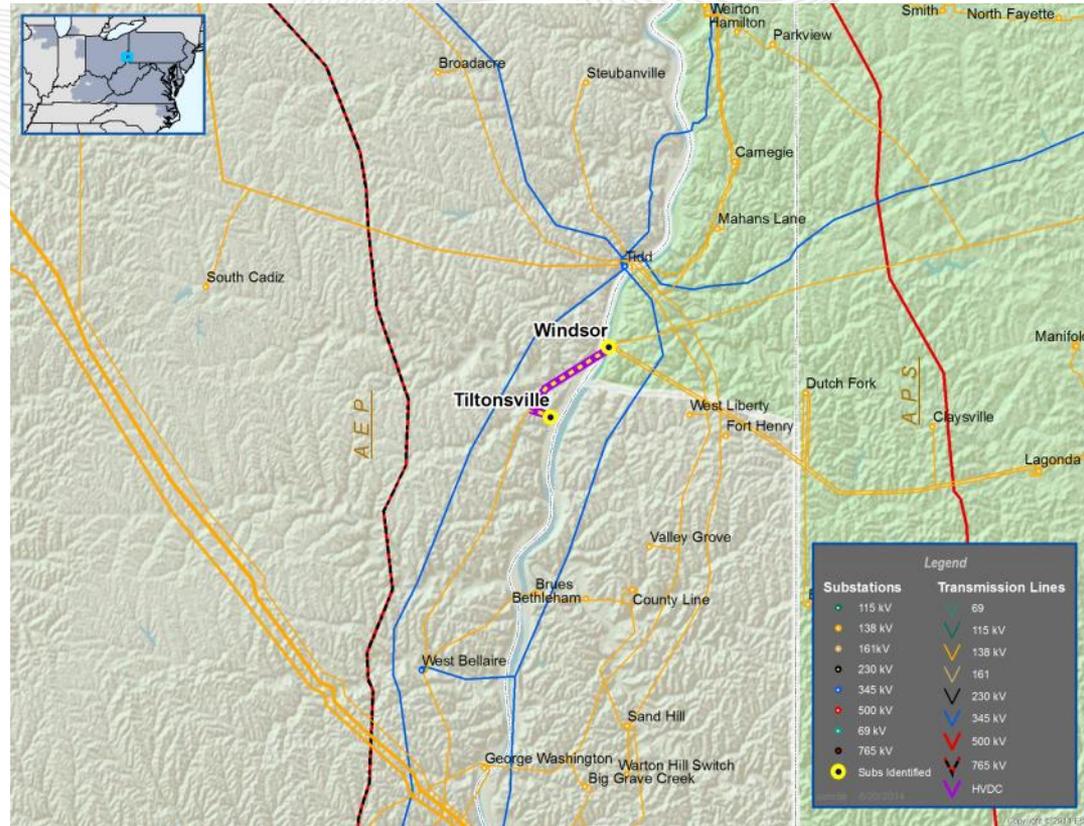
- Next Steps for the Montour – Milton – Sunbury area in the PPL Zone
 - Continue to perform the analytical evaluation
 - Scope and begin work for a cost and constructability review

2014 RTEP Proposal Window 1 Recommendations

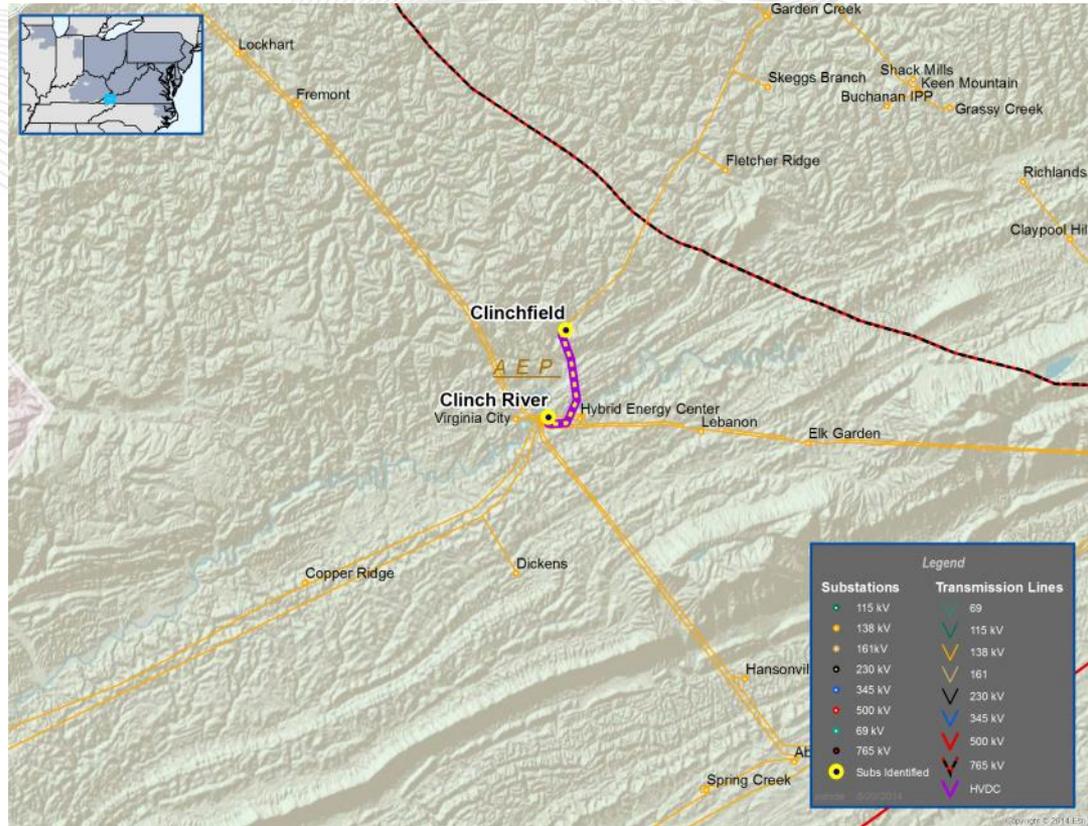
- **Common Mode Outage Violation**
- **2014 RTEP Proposal Window #1 Violation (FG # New 1)**
- The Middle 138/69 kV transformer #1 is overloaded for line stuck breaker contingency loss of the BL England – Middle Tap – Corson and Corson – Dennis 138 kV circuits, plus Corson 138/69 kV transformer #2.
- **Recommended Solution:**
 - Replace Middle T3 138/69 kV transformer with 225 MVA nameplate. (B2553) (P2014_1-12J)
- **Estimated Project Cost:**
\$ 7.5 M
- **Required IS Date:** 6/1/2019



- **Baseline (FG# 133, 204, 205) and Generator Deliverability /Common Mode Outage**
- **2014 RTEP Proposal Window #1 Violation (FG# 232, 234, 799, 1042)**
- The Tilton – Windsor 138kV is overloaded for system normal and multiple contingencies.
- Recommended Solution: Reconductor 0.5 miles of Tiltonsville-Windsor 138 kV and string the vacant side of the 4.5 mile section using 556 ACSR in a six wire configuration. (B2555) (P2014_1-2A)
- Estimated Project Cost: \$2.0M
- Required IS Date: 6/1/2019



- **Common Mode Outage**
- **2014 RTEP Proposal Window #1 Violation (FG# 794)**
- The Clinch River – Clinch Field 138kV line is overloaded for the tower outage of the Clinch River – Fremont 138kV line and Clinch River – Dorton 138kV line.
- Recommended Solution: Install two 138 kV prop structures to increase the Maximum Operating Temperature of the Clinch River – Clinch Field 138 kV line.(B2556) (P2014_1-2D)
- Estimated Project Cost: \$1.1M
- Required IS date: 6/1/2019



- **Common Mode Outage**
- **2014 RTEP Proposal Window #1 Violation (FG# 1057)**
- The Avon 345/138 kV transformer #92 is overloaded for line fault stuck breaker contingency loss of Avon – Juniper 345 kV circuit and Avon 345/138 kV transformer #91.
- Recommended Solution: At Avon substation, replace the existing 345/138kV 448MVA #92 transformer with a 560MVA unit. (B2557) (P2014_1-9E)
- Estimated Project Cost: \$5.4M
- Required IS date: 6/1/2019



- **Common Mode Outage**
- **2014 RTEP Proposal Window #1 Violation (FG# 720)**
- The Richland to Naomi 138 kV circuit is overloaded for bus contingency loss of the Richland 138 kV bus section.
- Recommended Solution: Close normally open switch A13404 to create a Richland J Bus - Richland K Bus 138kV line. (B2558) (P2014_1-9H)
- Estimated Project Cost: \$0.02M
- Required IS date: 6/1/2019



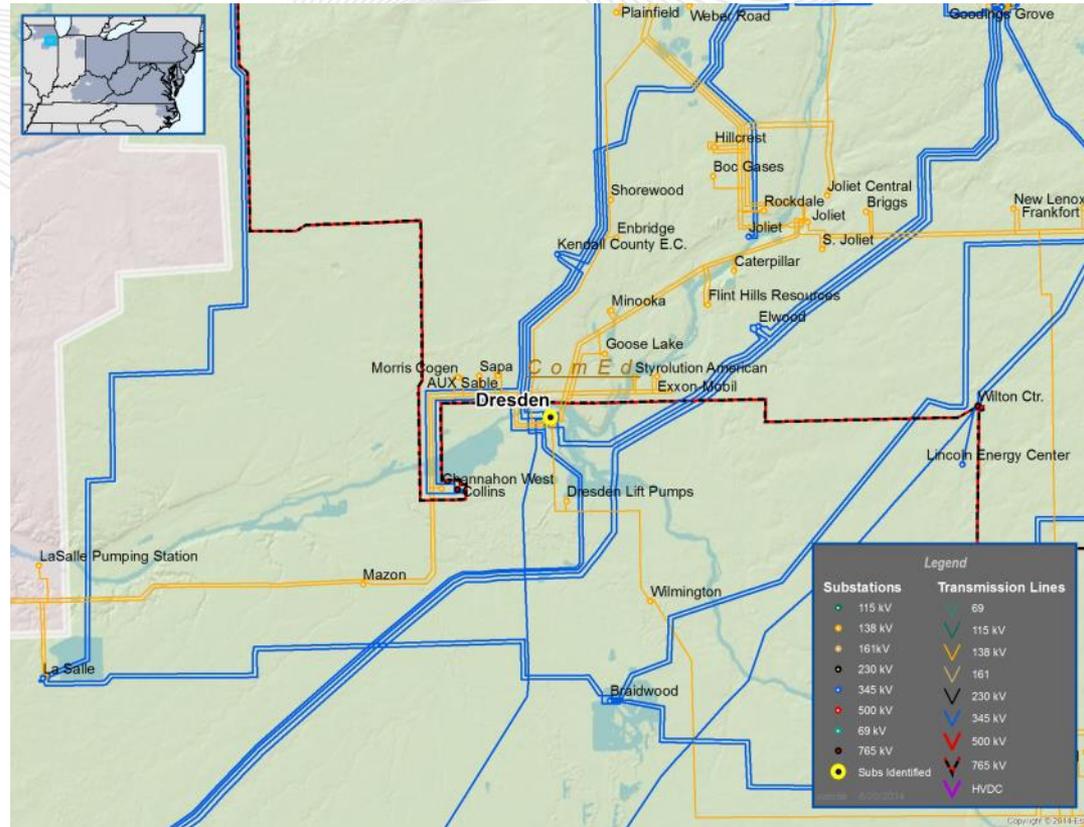
- **Baseline (FG# 99, 100, 101) and Common Mode Outage (FG# 754, 918, 919, 920, 921) Violation**
- **2014 RTEP Proposal Window #1 Violations**
- The Black River to Lorain 138 kV circuit is overloaded for multiple category C contingencies.
- Recommended Solution: Reconductor the Black River-Lorain 138kV line and upgrade Black River and Lorain substation terminal end equipment. (B2559) (P2014_1-9F)
- Estimated Project Cost: \$9.6M
- Required IS date: 6/1/2019



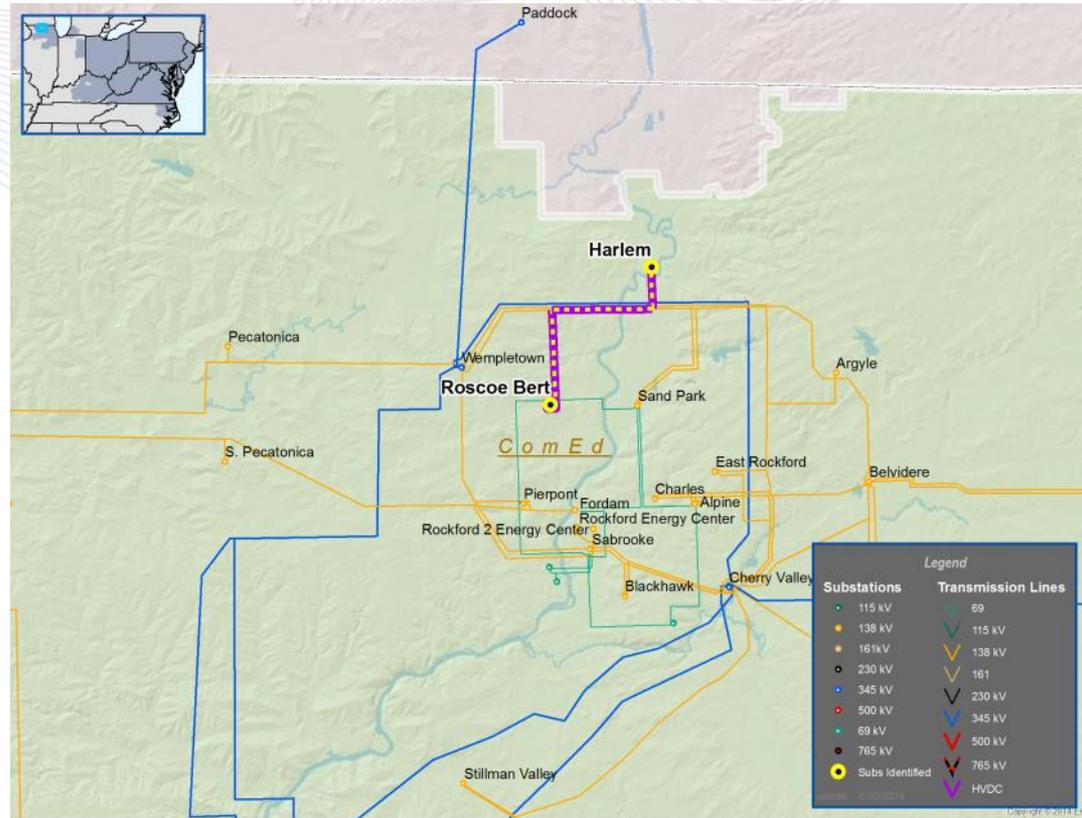
- **Common Mode Outage**
- **2014 RTEP Proposal Window #1 Violation (FG# 790, 802)**
- The Ottawa -Lakeview – Greenfield 138 kV circuit is overloaded for tower contingency loss of the Dave Besse – Lemoyne and Dave Besse – Beaver 345 kV circuits.
- Recommended Solution: Construct second 138kV line between West Fremont and Hayes substation on open tower position of the West Fremont - Groton - Hayes 138kV line. (B2560) (P2014_1-9G)
- Estimated Project Cost: \$7.4M
- Required IS date: 6/1/2019



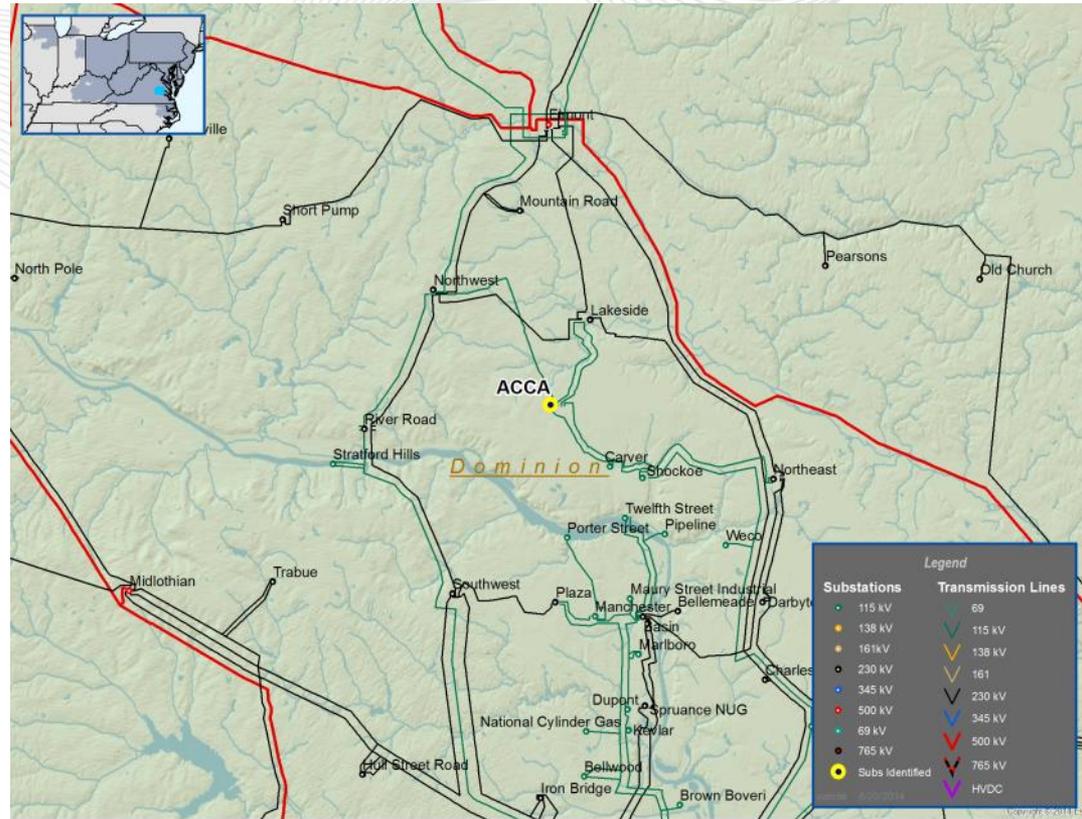
- **Common Mode Outage**
- **2014 RTEP Proposal Window #1 Violation (FG# 993)**
- The Dresden 345/138 kV transformer 83 is overloaded for line fault stuck breaker contingency loss of Dresden – Elwood 345 kV circuit and Elwood bus tie.
- Recommended Solution: Install new 345 kV circuit breaker 5-7 at Elwood substation. (B2561) (P2014_1-6C)
- Estimated Project Cost: \$2.6M
- Required IS date: 6/1/2019



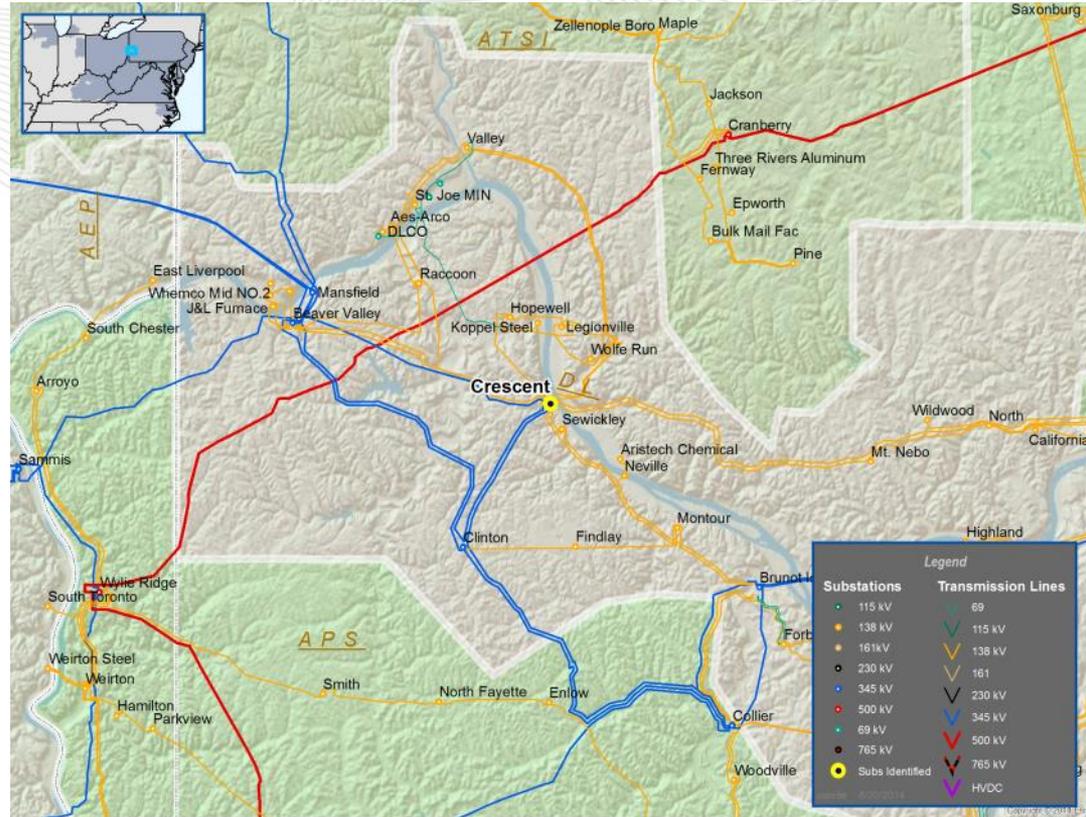
- **Baseline (FG# 175), Generation Deliverability (FG# 190) and N-1-1 (FG# 1.4, 1.5, 1.7, 2.6) Violation**
- **2014 RTEP Proposal Window #1 Violation**
- The Harlem to Roscoe Bert 138kV Blue line is overloaded for single contingency loss of the Cherry Valley – Belvidere 138 kV circuit and for multiple contingency pairs.
- Recommended Solution : Remove 2.0 miles of wood poles on 138 kV line 17105, erect new steel structures, and install new 1113 kcmil ACSR conductor from Roscoe Bert to Harlem. (B2562) (P2014_1-6A)
- Estimated Project Cost: \$4.6M
- Required IS date: 6/1/2019



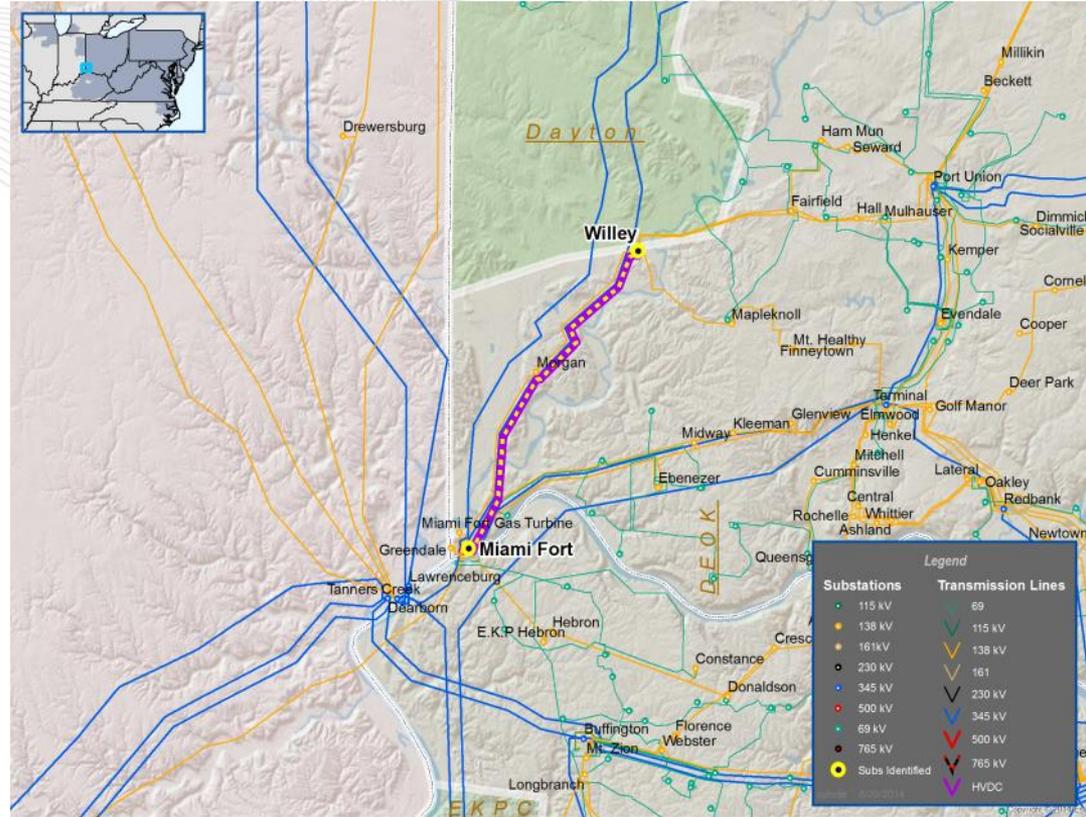
- **Baseline (FG# 366) and Generation Deliverability (FG# 289) Violation**
- **2014 RTEP Proposal Window #1 Violation**
- The ACCA to Herm 115 kV circuit is overloaded for single contingency loss of Northeast – Shockoe 115 kV circuit.
- Recommended Solution: Reconductor 1.41 miles of existing line between Acca and Hermitage and upgrade associated terminal equipment. **(b2566)** (P2014_1-4A)
- Estimated Project Cost: \$1.82M
- Required IS date: 6/1/2019



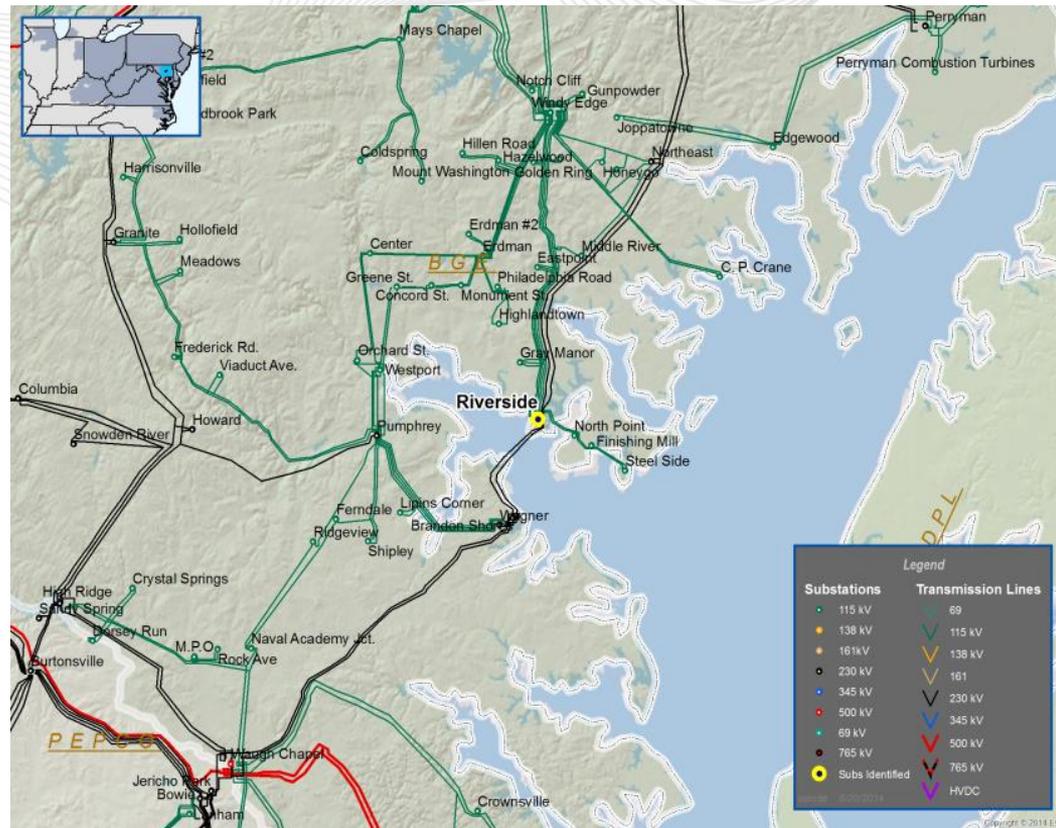
- **Baseline (FG# 195, 196, 197) and Generation Deliverability (FG# 719, 1108, 1109) Violation**
- **2014 RTEP Proposal Window #1 Violation**
- The Crescent 345/138 kV transformers #1 and #2 are overloaded for multiple category C contingencies.
- Recommended Solution: Operate with the Crescent # 3 - 345/138kV autotransformer in-service by replacing eight (8) overdutied 138kV breakers at Crescent and three (3) 138kV breakers at Beaver Valley and install a # 1 section 345kV breaker for the 331 circuit at Crescent. (B2563) (P2014_1-10A)
- Estimated Project Cost: \$7.285M
- Required IS date: 6/1/2019



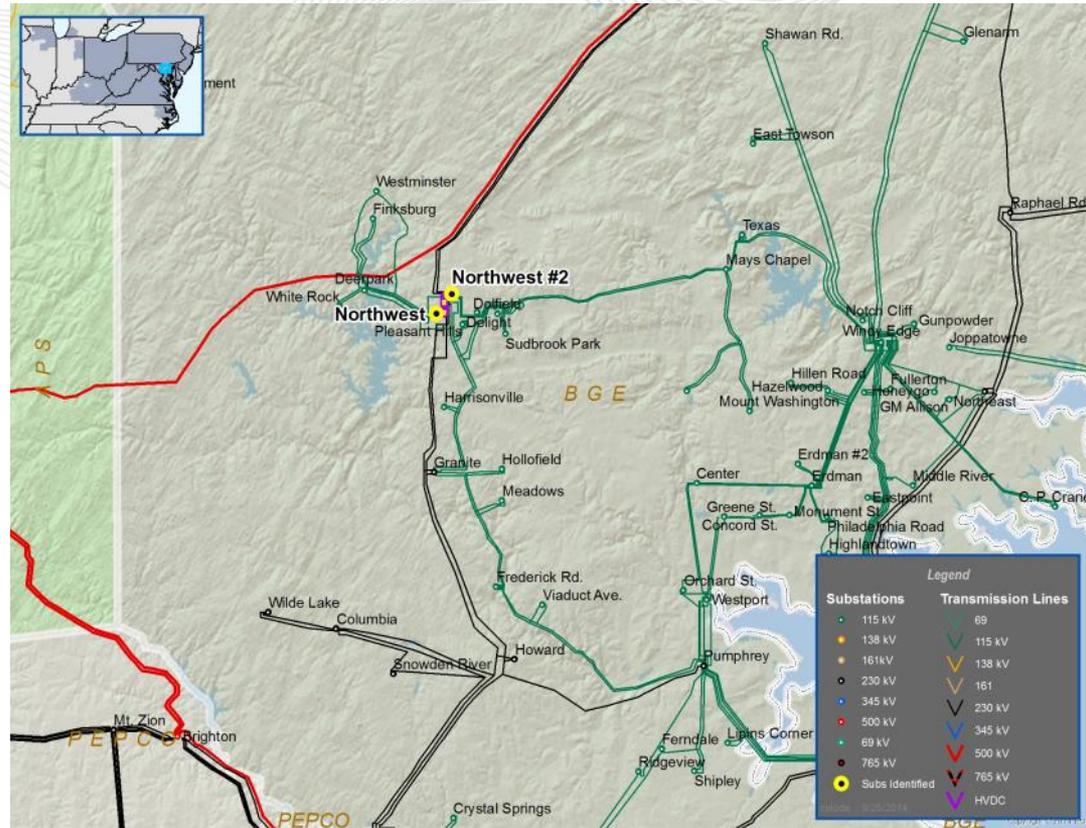
- **Baseline (FG# 124) and Common Mode Outage (FG# 1037) Violation**
- **2014 RTEP Proposal Window #1 Violation**
- The Miami Fort - Willey 138 kV circuit is overloaded for line fault stuck breaker contingency loss of the Miami Fort – Clifty Creek, Miami Fort – Hebron Tap, Miami Fort – Midway, Miami Fort – Morgan 138 kV circuits and one of the Miami Fort 345/138 kV transformer.
- Recommended Solution: Add two breakers at Miami Fort 138 kV. (B2564) (P2014_1-1A)
- Estimated Project Cost: \$2M
- Required IS date: 6/1/2019



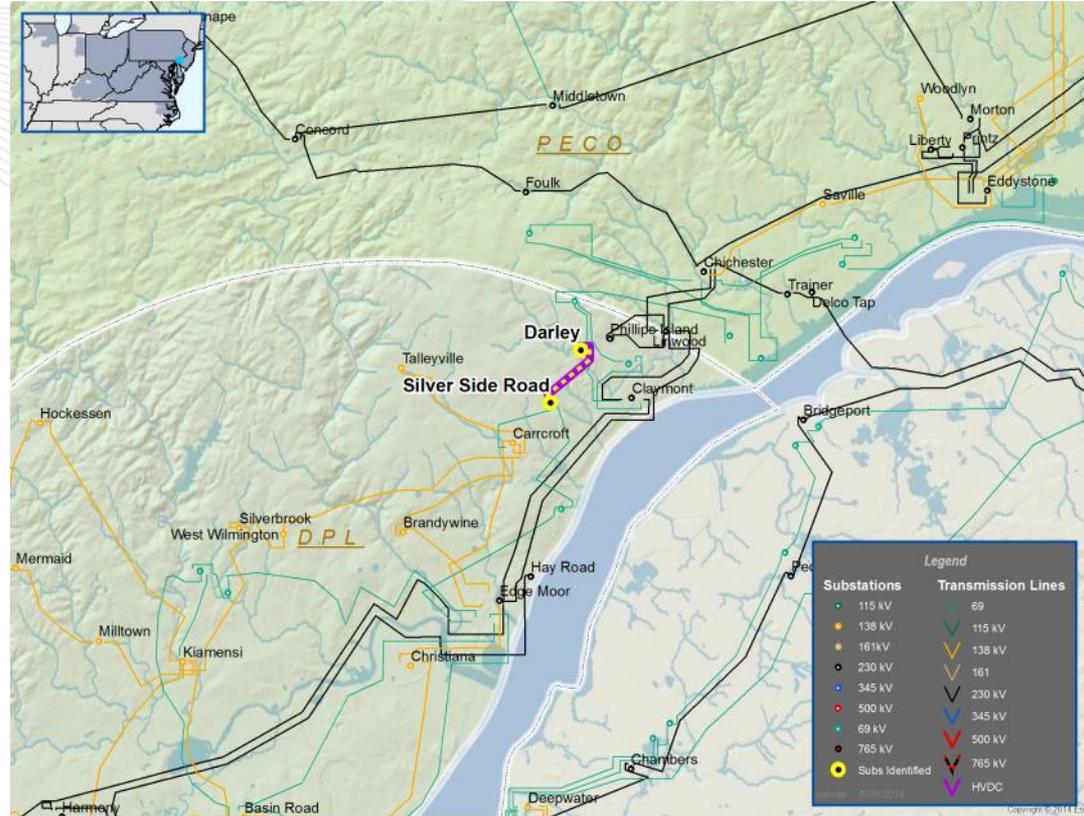
- **Baseline (FG# 222) and Common Mode Outage (FG# 1099) Violation**
- **2014 RTEP Proposal Window #1 Violation**
- The Riverside 115 kV bus section is overloaded for line fault stuck breaker contingency loss of the Brandon Shores to Riverside 230 kV circuit '2344', Riverside 230/115 kV transformer #1 and Brandon Shores 230/115 kV transformer #2.
- **Recommended Solution:**
Upgrade the Riverside 115kV substation strain bus conductors on circuits 115012 and 115011 with double bundled 1272 ACSR to achieve ratings of 491/577 MVA SN/SE on both transformer leads. (B2567) (P2014_1-8A)
- Estimated Project Cost: \$1.14M
- Required IS date: 6/1/2019



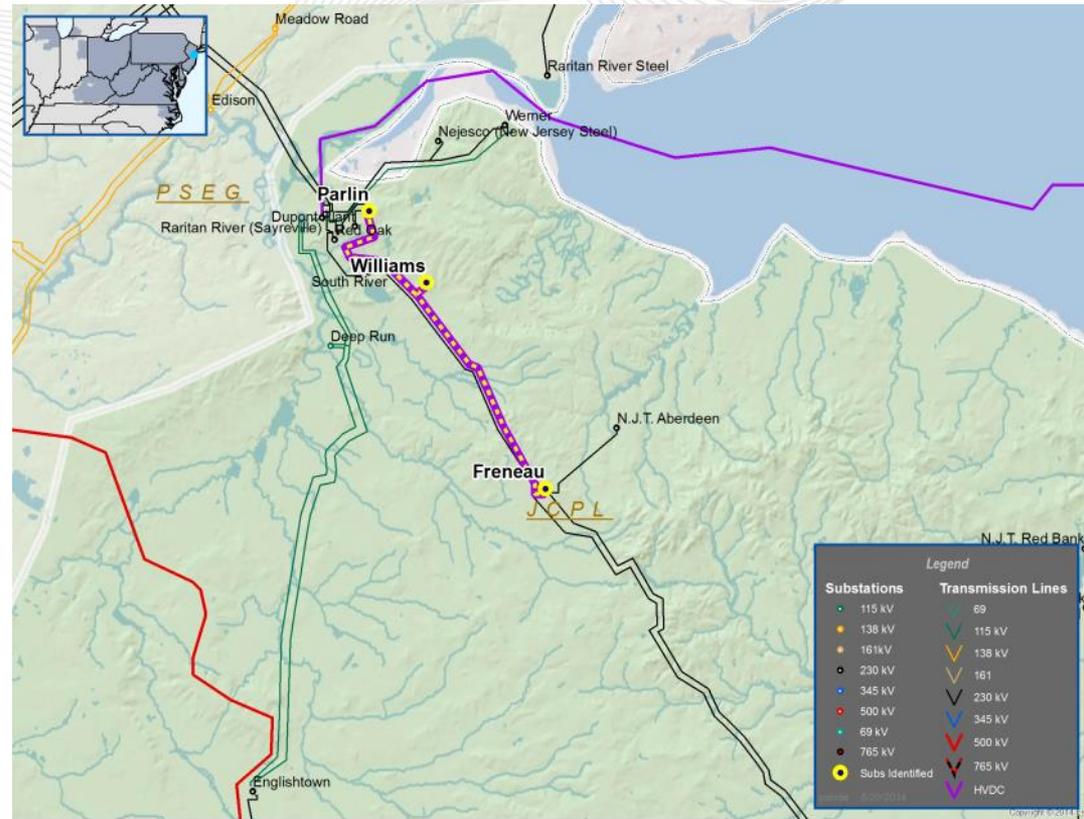
- **N-1-1 Thermal (FG# 1.8) Violation**
- **2014 RTEP Proposal Window #1 Violation**
- Northwest – Northwest #2 115kV tie circuit is overloaded for the loss of the Northwest 230-2 transformer and the loss of the Northwest 230-3 transformer
- Recommended Solution:
Reconductor Northwest – Northwest #2 115kV 110574 substation tie circuit with 2167 ACSR to achieve ratings of 400/462 MVA SN/SE. (B2568) (P2014_1-8D)
- Estimated Project Cost: \$1.2M
- Required IS date: 6/1/2019



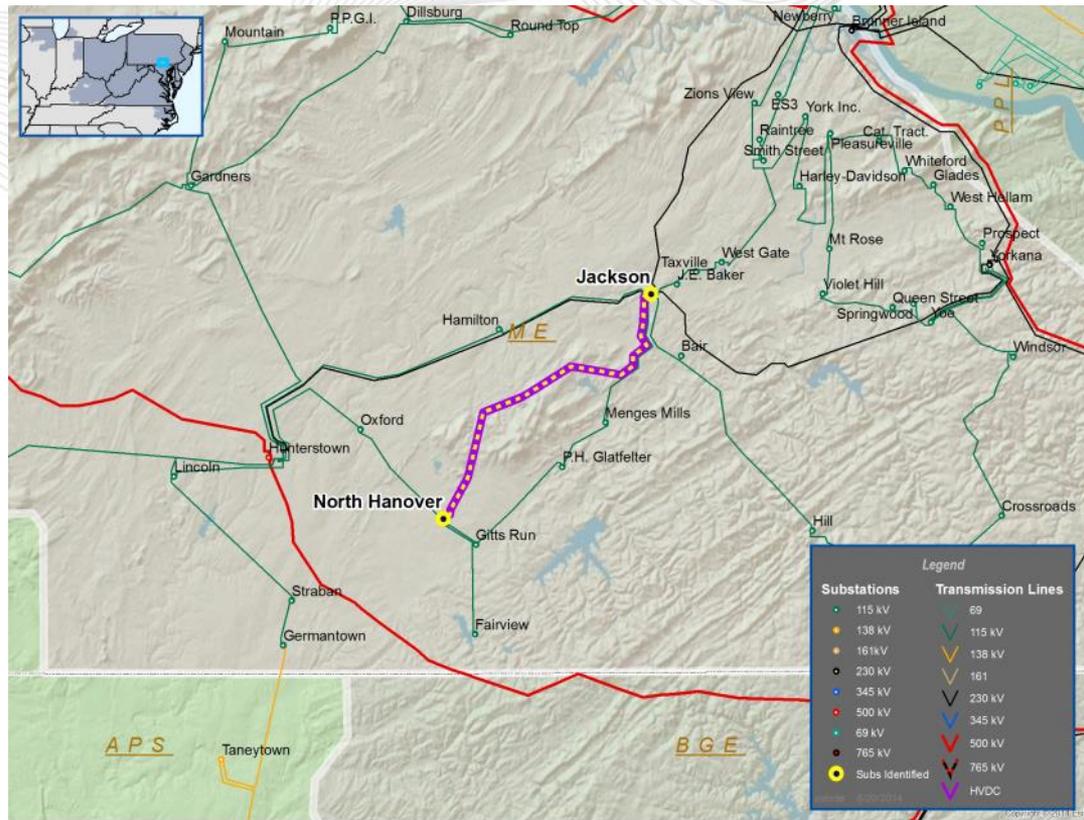
- **Common Mode Outage (FG# 804) Violation**
- **2014 RTEP Proposal Window #1 Violation**
- The Silver Side Road to Darley 69 kV circuit is overloaded for tower contingency loss of the Edgemore – Clay and Edgemore – Linwood 230 kV circuits
- Recommended Solution:
Replace Terminal equipment at Silverside 69 kV substation. (B2569) (2014_1-12K)
- Estimated Project Cost: \$0.04M
- Required IS date: 6/1/2019



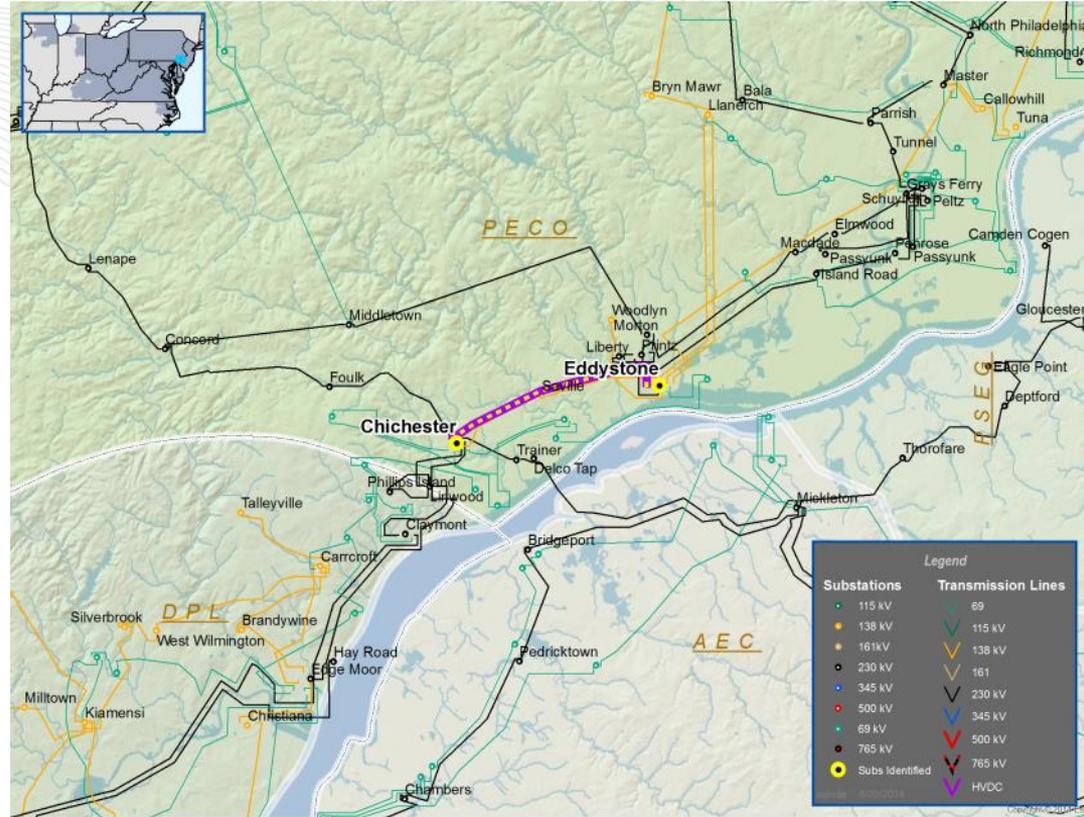
- **Common Mode Outage (FG# 843, 844, 846, 847, 1128) Violation**
- **2014 RTEP Proposal Window #1 Violation**
- The Parlin – Williams – Freneau 230 kV circuit is overloaded for multiple tower and breaker contingencies.
- Recommended Solution:
Upgrade limiting terminal facilities at Freneau, Parlin, and Williams substations. (B2570) (2014_1-9D)
- Estimated Project Cost: \$0.6M
- Required IS date: 6/1/2019



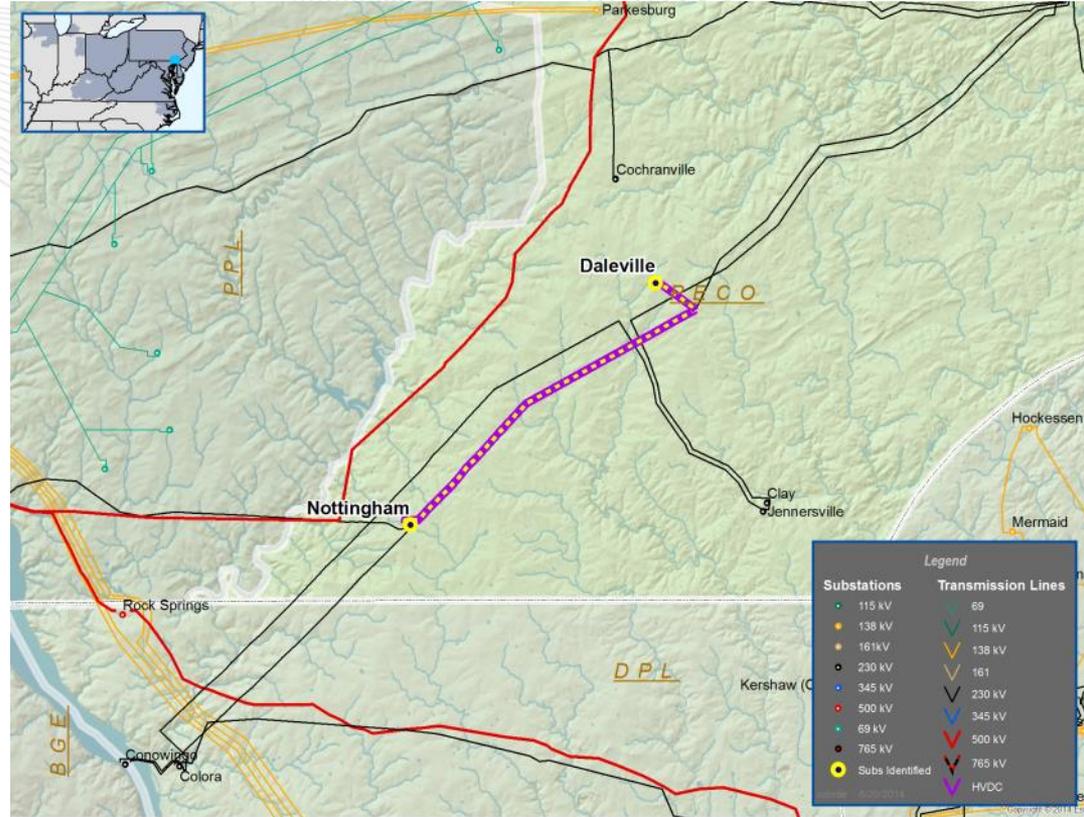
- **N-1-1 Thermal (FG# 1.1, 1.2) Violation**
- **2014 RTEP Proposal Window #1 Violation**
- The Jackson to North Hanover 115 kV circuit is overloaded for multiple N-1-1 contingencies.
- Recommended Solution:
Upgrade the limiting terminal facilities at both Jackson and North Hanover. (B2571) (P2014_1-9C)
- Estimated Project Cost: \$0.1M
- Required IS date: 6/1/2019



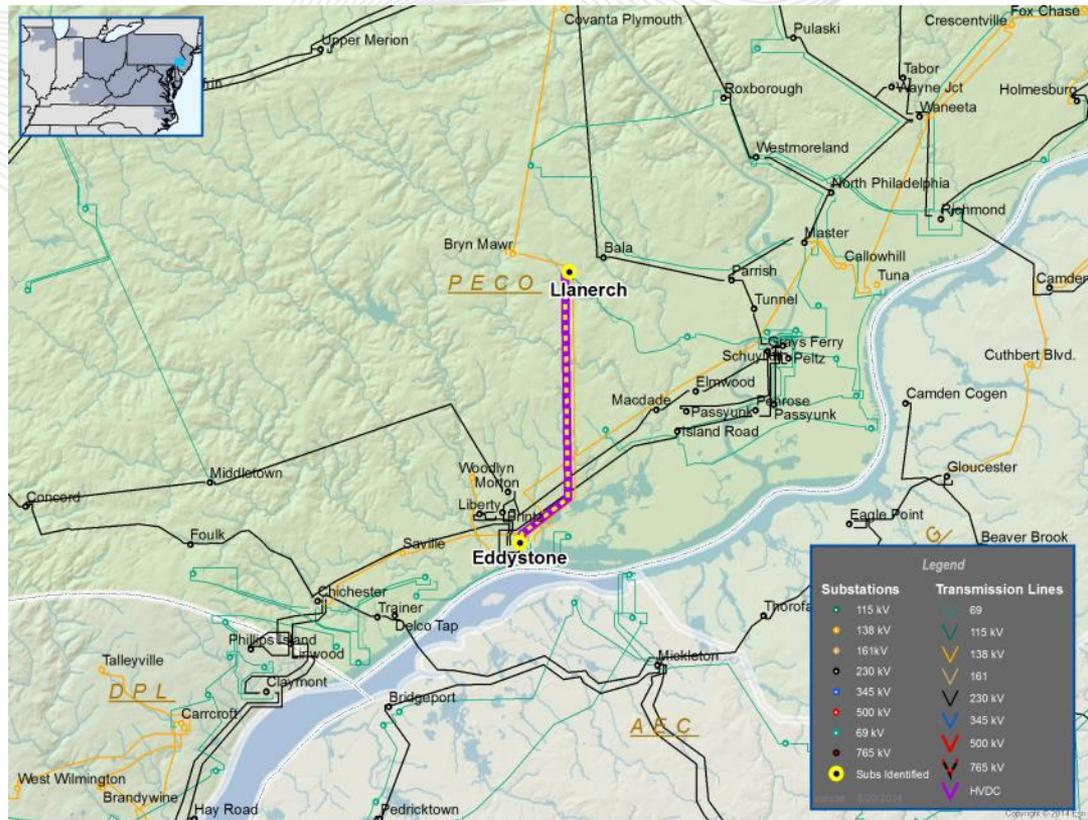
- **Generation Deliverability (FG# 170, 171) Violation**
- **2014 RTEP Proposal Window #1 Violation**
- The Chichester – Eddystone 230 kV circuit is overloaded for multiple single contingencies.
- Recommended Solution:
Replace terminal equipment inside Chichester substation on the 220-36 (Chichester – Eddystone) 230 kV line. (B2549) (P2014_1-5A)
- Estimated Project Cost:\$ 0.4 M
- Required IS Date: 6/1/2019



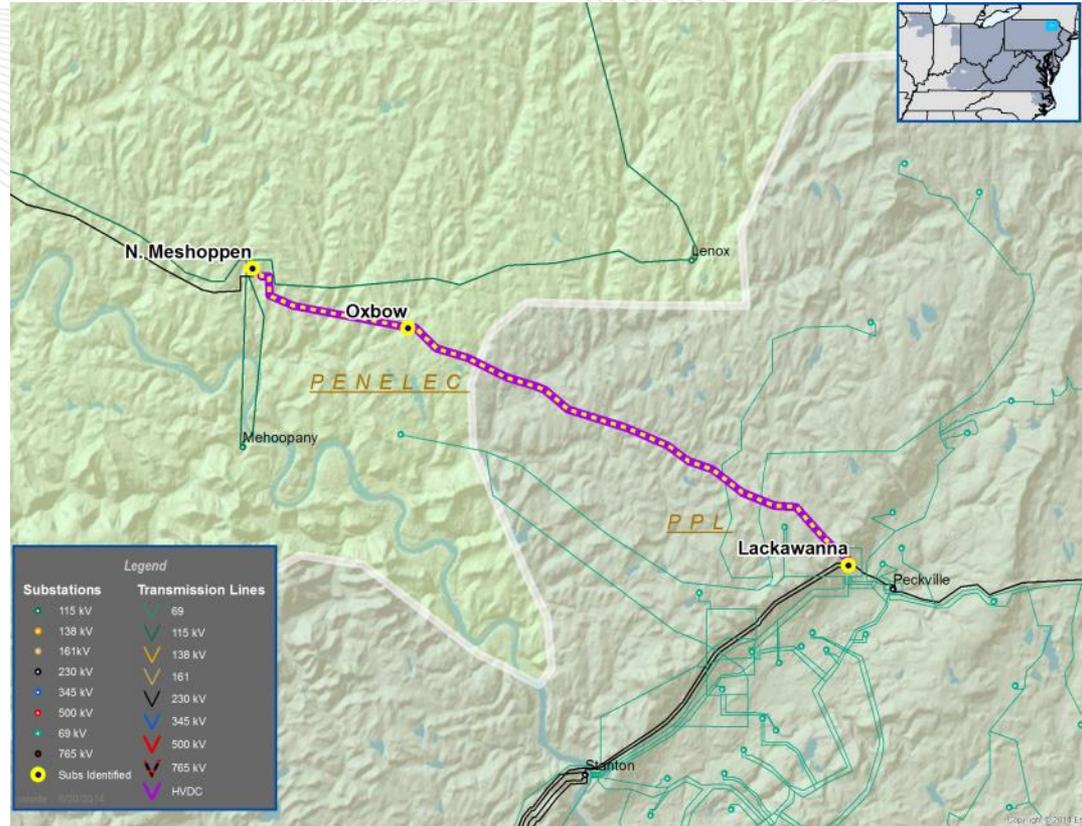
- **Generation Deliverability (FG# 315) Violation**
- **2014 RTEP Proposal Window #1 Violation**
- The Nottingham – Daleville 230 kV circuit is overloaded for single contingency loss of Colora – Conowingo 230 kV circuit.
- Recommended Solution:
Replace terminal equipment inside Nottingham substation on the 220-05 (Nottingham – Daleville – Bradford) 230 kV line. (B550) (P2014_1-5C)
- Estimated Project Cost:\$ 0.1 M
- Required IS Date:6/1/2019



- **N-1-1 (FG# 2.3) Violation**
- **2014 RTEP Proposal Window #1 Violation**
- The Eddystone to Llanerch 138 kV circuit '130-45' is overloaded for N-1-1 contingency loss of Plymouth – Brynmawr 230 kV and Eddystone to Llanerch 138 kV '130-42' circuits.
- Recommended Solution:
Replace terminal equipment inside Llanerch substation on the 130-45 (Eddystone to Llanerch) 138 kV line. (B2551) (P2014_1-5E)
- Estimated Project Cost: \$ 0.1 M
- Required IS Date: 6/1/2019

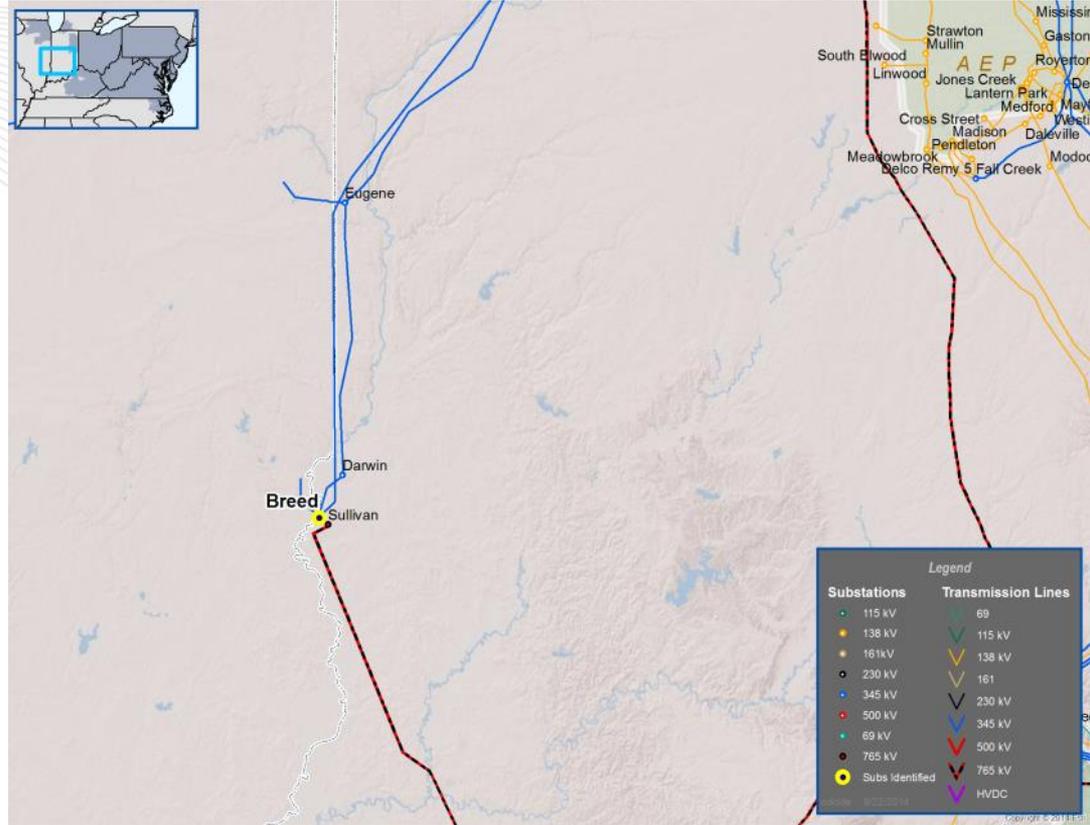


- **Common Mode Outage (FG# 965, 971) Violation**
- **2014 RTEP Proposal Window #1 Violation**
- The North Meshoppen – Oxbow - Lackawanna 230 kV circuit is overloaded for line fault stuck breaker contingency loss of Susquehanna generator # 1 and Susquehanna – Mountain 230 kV circuit.
- Recommended Solution:
Reconductor the North Meshoppen – Oxbow - Lackawanna 230 kV circuit and upgrade terminal equipment. (B2552) (P2014_1-9A)
- Estimated Project Cost: \$ 26.5 M
- Required IS Date: 6/1/2019

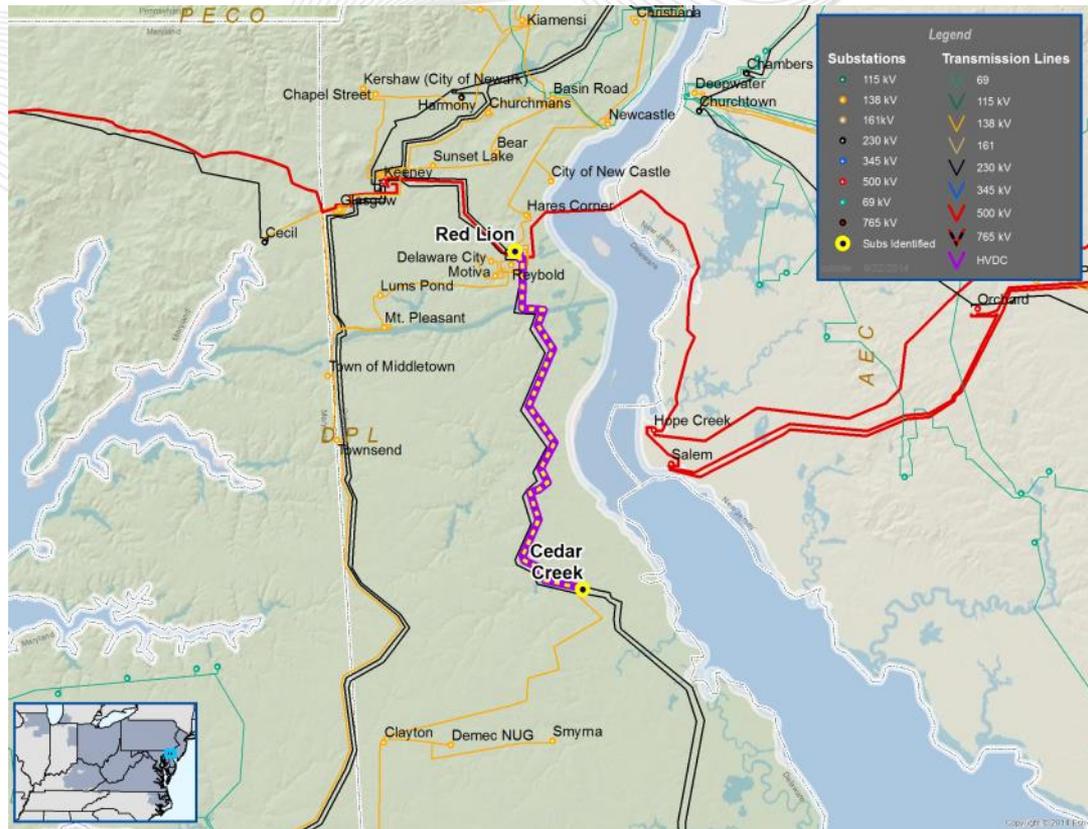


Supplemental Projects

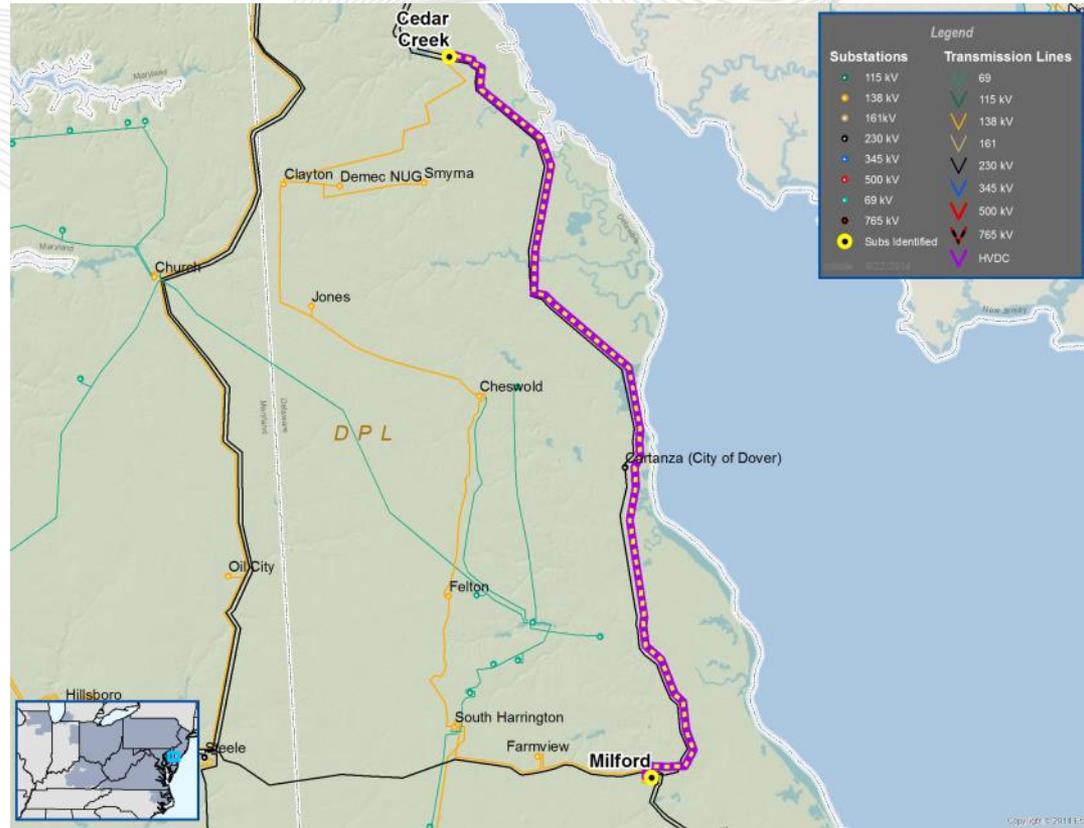
- Supplemental Project
- Rebuild Breed 345 kV station adjacent to the existing Sullivan station (S0764)
- Estimated Project Cost: \$75M
- Projected IS Date: 6/1/2017



- Supplemental Project :
- Improves reliability due to age and condition of the circuit.
- Proposed Solution:
 - Rebuild approximately 15.3 miles of the Red Lion - Cedar Creek 230 kV circuit '23030'. (S0819)
- Estimated Project Cost: \$ 20.8 M
- Projected IS Date: 12/31/2016



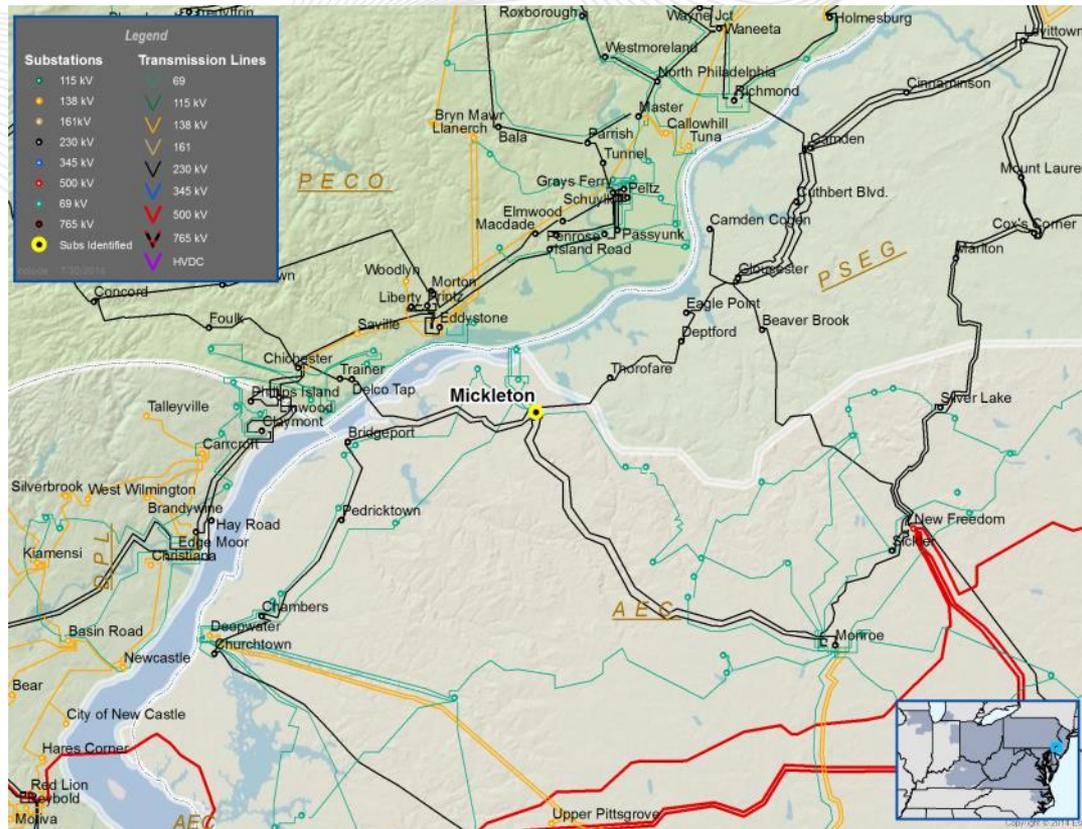
- Supplemental Project :
- Improves reliability due to age and condition of the circuit.
- Proposed Solution:
 - Upgrade the Cedar Creek - Milford 230 kV circuit'. (S0823)
- Estimated Project Cost: \$ 52.74 M
- Projected IS Date: 12/31/2017



Recommendations to PJM Board in October 2014

- In October 2014, the PJM Board will be requested to approve projects in this section of the presentation for inclusion in the RTEP
 - Includes several reliability projects reviewed at the 2/2014 through 9/24/2014 (today's) TEAC meetings with the exception of the BL England at-risk baseline upgrades that were approved in 7/2014
 - Includes several reliability projects reviewed at the SRRTEP meetings between 2/2014 and 9/2014
 - Includes several recommendations from the 2014 RTEP Proposal Window #1 (see the previous section in this presentation)

- The Mickleton 230kV breaker 'MK' is overstressed
- Recommended Solution: Replace the Mickleton 230kV breaker 'MK' with a 63 kA breaker (B2538)
- Estimated Project Cost: \$400 K
- Required IS Date: 6/1/2016

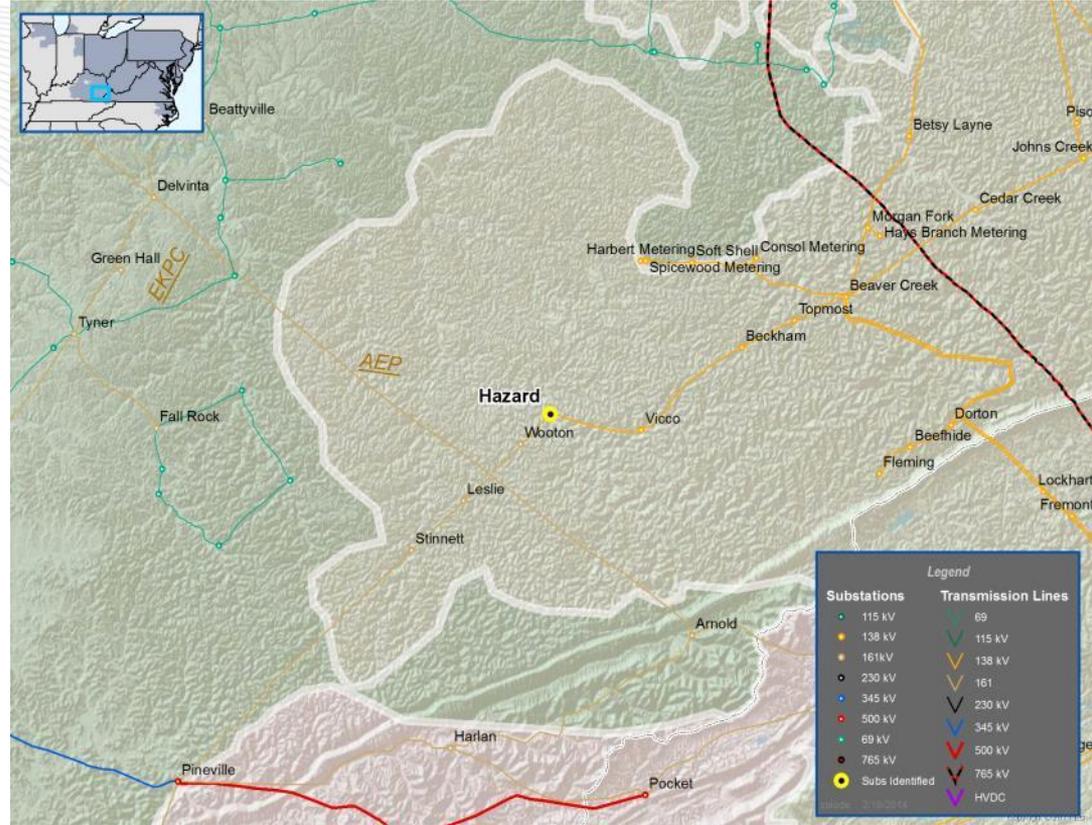


- **Project Cancellation**
- Reason: The project is no longer needed due to the withdrawal of queue project S073
- B2347: Replace the North Delphos 600A switch. Rebuild approximately 18.7 miles of 138 kV line North Delphos - S073. Reconductor the line and replace the existing tower structures
- Recommendation: Cancel B2347

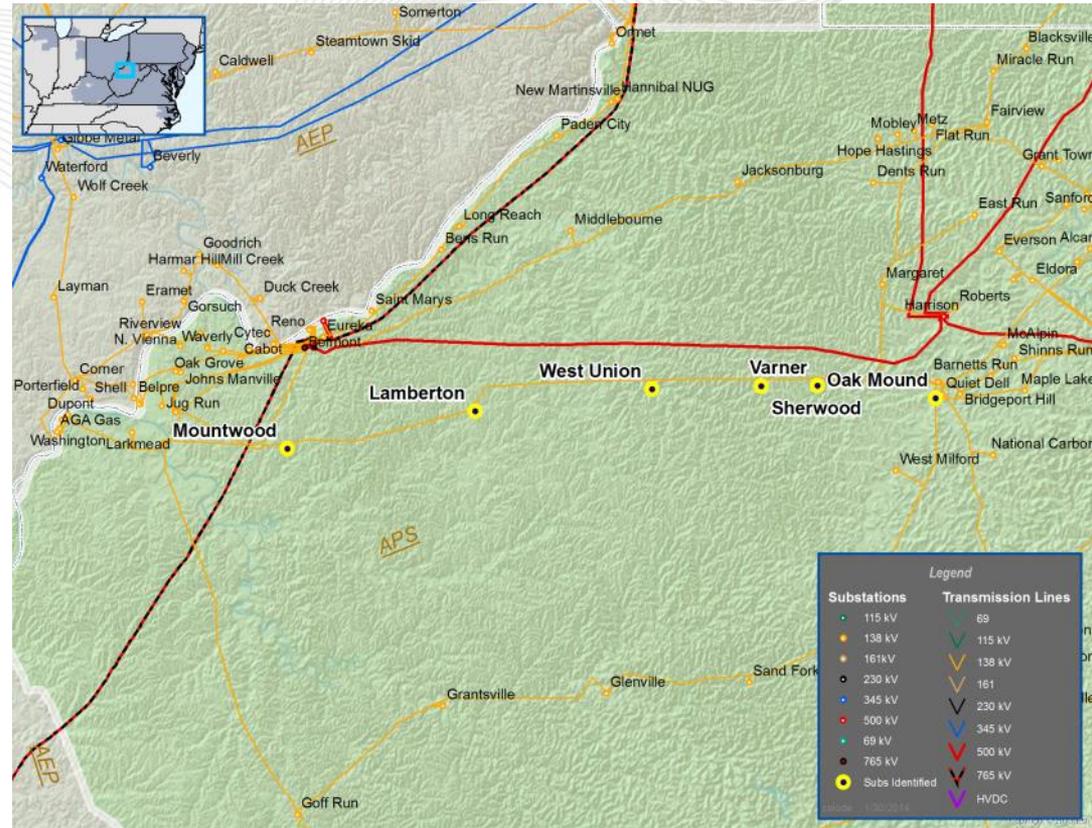


AEP Transmission Zone

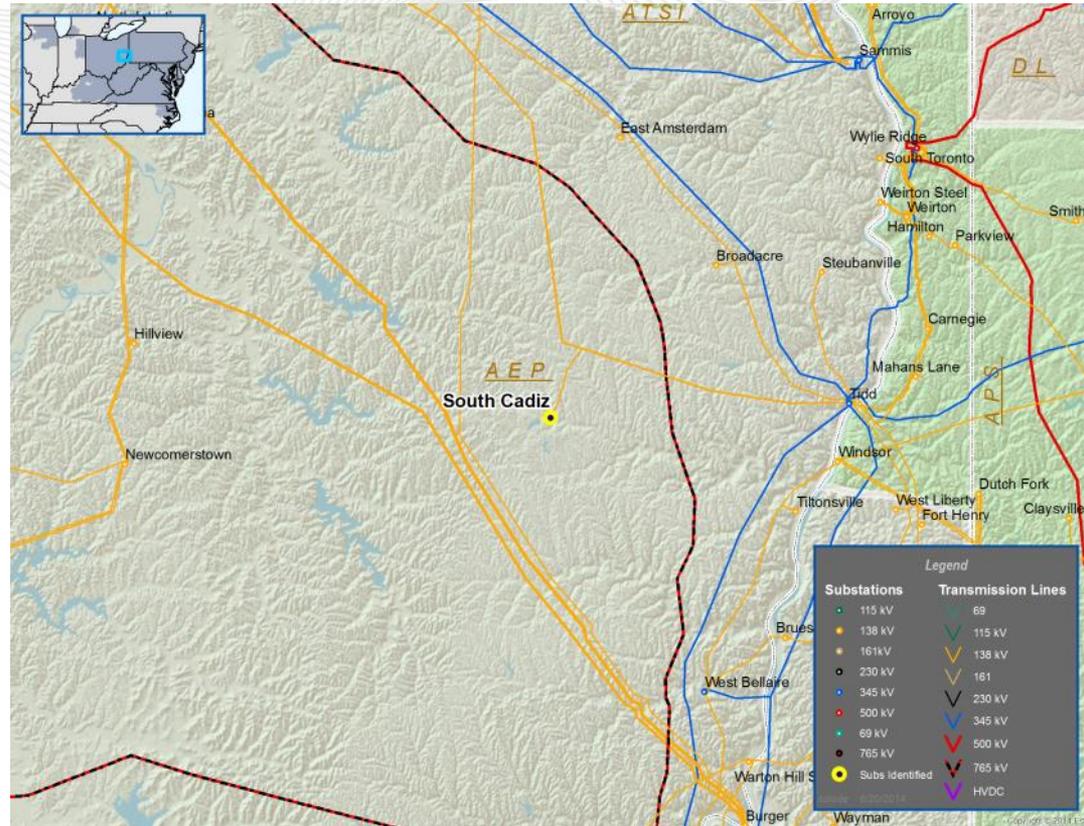
- Generation Deliverability Violation
- Hazard 161/138 kV transformer is overloaded for the tower contingency loss of Dorton – Lock Haven – Clinch River 138 kV line and Beaver Creek – Freemont 138 kV line, Freemont 138/69 kV transformer ('408_2')
- Baseline upgrade (B2462): The reinforcement is to add two 138 kV circuit breakers at Fremont station to fix the tower contingency '408_2'.
- Estimated Project Cost: \$1.2 M
- Required IS Date:
6/1/2015



- Driver: Block load addition in the APS zone
- Lead time: less than 24 months
- Low voltage and voltage drop violations at West Union, Varner, Mountwood, Lamberton, and Sherwood 138kV buses for various contingencies
- Construct a new line between Oak Mound 138kV Substation and Waldo Run 138kV Substation. (B2475)
- Estimated Project Cost: \$38M
- Required IS Date: 12/31/2015

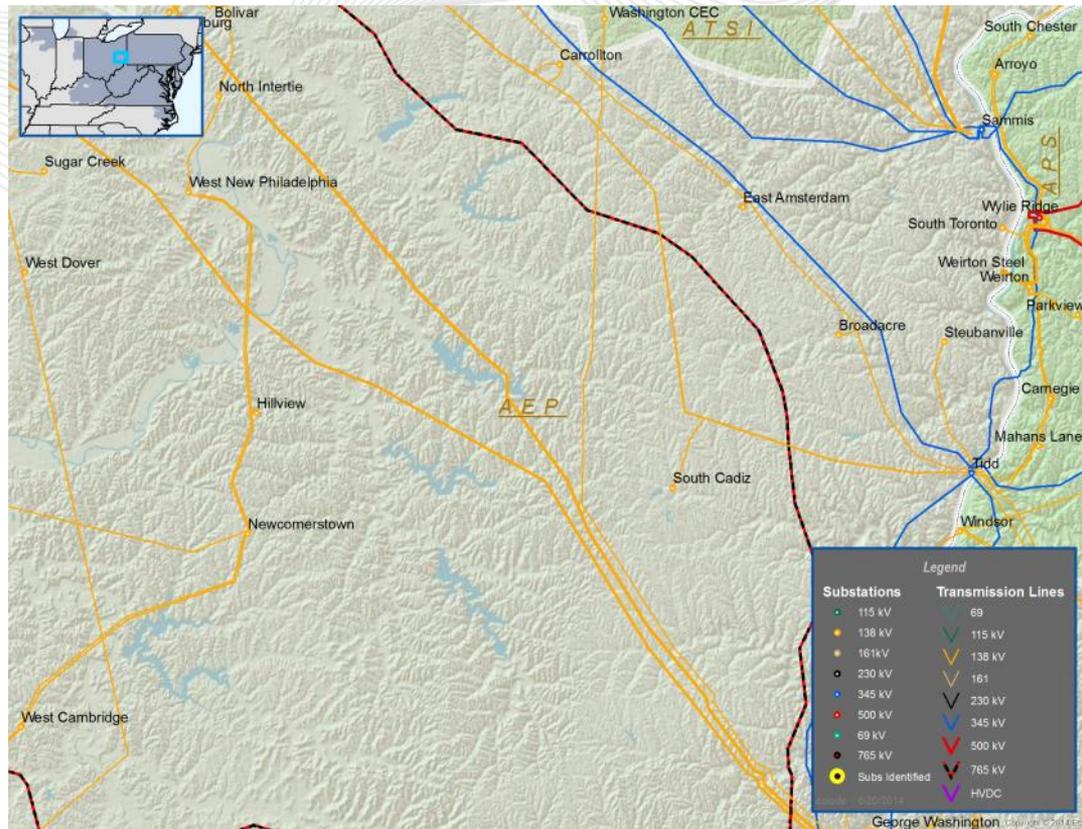


- **AEP Criteria Violation**
- Block load addition in the AEP zone
- The Stone Plant – South Cadiz 69KV line, the South Cadiz 138/69KV transformer and Gable – Tidd 138Kv circuit are overloaded in base case, plus there are numerous N-1 thermal violations
- Low Voltage violations at Freebyrd, South Cadiz and nearby 69KV vicinities for normal and N-1 conditions
- Construct a new 138 kV switching station Nottingham tapping 6-138 kV First Energy circuits (Holloway-Brookside, Holloway –Harmon (#1), Holloway-Reeds, Holloway-New Stacy, Holloway-Cloverdale). Exit a 138 kV circuit from new station to Freebyrd station. Convert Freebyrd 69 kV to 138 kV. Rebuild/Convert Freebyrd-South Cadiz 69 kV circuit to 138 kV. Upgrade South Cadiz to 138 kV breaker and a half. (B2502)
- Estimated Project Cost: \$90M
- Required IS Date: 6/1/2014
- Projected IS Date: 12/1/2016



- **AEP Criteria Violation**

- Block load addition in the AEP zone
- The Desert – Bowerston 69KV line is overloaded in the basecase; The Leesville – Bowerston 69KV line and the E. Amsterdam – Miller 69KV line is overloaded for the loss of the Desert – Petersburg 69KV line; Low voltage violation at Azalee, Leesville and nearby 69Kv vicinity for the loss of the Desert – Petersburg 69KV line
- Construct a new 138/69 kV Yager station by tapping 2-138 kV First Energy circuits (Nottingham – Cloverdale, Nottingham -Harmon)
- Build a new 138 kV line to Azalea station.
- Close the 138 kV loop back into Yager 138KV by converting part of the local 69 kV facilities to 138 kV.
- Build 2 new 69 kV exits to reinforce area 69 kV facilities and upgrade conductor between Irish Run 69KV Switch and Bowerston 69kV Switch. (B2501)
- Estimated Project Cost: \$55M
- Required IS Date: 6/1/2014
- Projected IS Date: 12/1/2015



- Remediation from sag study includes:
 - Add / modify / replace structures
 - Conductor or line hardware
 - Grading of land
 - Third party clearance issue



AEP Transmission Zone – Sag study

Baseline ID for original Sag study	New Sub-ID Number	Circuit	Line	Total Mitigation Costs	Projected In-Service Date	PJM Need Date	Adding / Modifying / Replacing Structures	Conductor or Line Hardware	Grading	Third Party Clearance Issues
B1037	B1037.1	Cloverdale - Reusens	Roanoke - Reusens	\$832,260	10/31/2014	6/1/2014	3	2	2	2
B1038	B1038.1	Crooksville - Muskingum River	Philo - Muskingum River	\$104,214	7/31/2014	6/1/2014	0	0	2	0
B1039	B1039.1	Hogan - Madison	Delaware - Madison	\$394,445	8/29/2014	6/1/2015	1	0	1	9
B1053	B1053.1	Claytor-Matt Funk	Roanoke - Claytor	\$423,121	5/29/2014	6/1/2014	1	2	3	2
B1053	B1053.2	Claytor-Matt Funk	Funk Loop	\$17,365	6/1/2014	6/1/2014	0	0	2	0
B1416	B1416.1	Deer Creek - Desoto	Deer Creek - Delaware	\$309,025	6/1/2015	6/1/2015	3	0	0	4
B1416	B1416.2	Deer Creek - Desoto	Desoto - Deer Creek - Delaware	\$1,537,370	6/1/2015	6/1/2015	13	4	0	0
B1424	B1424.1	Benton Harbor - Riverside	Riverside - Hartford	\$157,125	12/31/2014	6/1/2015	0	0	1	2
B1428	B1428.2	Beatty Road - Harrison (CSP)	Harrison - Beatty Road	\$155,032	12/31/2014	6/1/2015	7	3	1	2
B1434	B1434.1	Desoto - Madison	Medford - Desoto	\$103,625	6/1/2014	6/1/2014	0	3	0	0
B1434	B1434.2	Desoto - Madison	Medford Extension	\$53,277	5/30/2014	6/1/2014	0	0	0	1
B1434	B1434.3	Desoto - Madison	Delaware - Madison	\$146,000	6/30/2014	6/1/2014	1	0	0	3



AEP Transmission Zone – Sag study

Baseline ID for original Sag study	New Sub-ID Number	Circuit	Line	Total Mitigation Costs	Projected In-Service Date	PJM Need Date	Adding / Modifying / Replacing Structures	Conductor or Line Hardware	Grading	Third Party Clearance Issues
B1448	B1448.1	Dexter Switch - Rutland	Philo - Rutland	\$484,566	5/30/2014	6/1/2014	1	2	1	0
B1451	B1451.1	North Newark - West Mount Vernon	North Newark - West Mount Vernon	\$1,239,778	6/1/2014	6/1/2015	9	0	2	5
B1454	B1454.1	Circleville - Scippo	Scioto Trail - Circleville	\$210,884	12/31/2014	6/1/2015	2	0	0	4
B1454	B1454.2	Delano - Kenworth - Ross	Clayburne - Kenworth	\$23,380	12/31/2014	6/1/2015	0	0	0	1
B1454	B1454.3	Delano - Kenworth - Ross	Ross-Delano	\$191,522	9/22/2014	6/1/2015	5	2	0	1
B1454	B1454.4	Scioto Trail - Scippo	Scioto Trail - Circleville	\$177,000	12/31/2014	6/1/2015	2	0	0	0
B1454	B1454.5	Delano - Scioto Trail	Delano - Scioto Trail	\$75,700	12/31/2015	6/1/2015	14	1	0	5
B1456	B1456.1	Kammer - Tidd	Muskingum River - Tidd	\$2,943,737	5/30/2014	12/31/2012*	3	5	0	2
B1477	B1477.1	Natrium - Paden City	Natrium - Monongahela	\$146,000	12/31/2014	12/31/2013*	1	0	0	0
B1480	B1480.1	Corner - Muskingum River	Wolf Creek - Corner	\$1,298,888	12/31/2014	6/1/2014	7	0	6	11
B1483	B1483.1	Clinch River - Garden Creek	Clinch River - Garden Creek	\$1,256,000	5/30/2014	6/1/2014	7	4	0	0



AEP Transmission Zone – Sag study

Baseline ID for original Sag study	New Sub-ID Number	Circuit	Line	Total Mitigation Costs	Projected In-Service Date	PJM Need Date	Adding / Modifying / Replacing Structures	Conductor or Line Hardware	Grading	Third Party Clearance Issues
B1501	B1501.1	Moseley - Reusens	Roanoke - Reusens	Included in B1037.1	10/31/2014	6/1/2014	3	4	1	8
B1735	B1735.1	Adams - Allen	Jay - Lincoln	\$121,799	12/31/2014	6/1/2016	0	0	0	1
B1859	B1859.1	Hancock - Matt Funk No. 2	Hancock - Roanoke	\$50,283	6/30/2014	6/1/2016	0	0	0	3
B1863	B1863.1	Brues-Kammer - Tidd	Tidd - Weirton No. 1 (OP)	5/10/3263	12/31/2014	6/1/2015	1	0	3	1
B1863	B1863.2	Brues - Kammer - Tidd	Tidd - Natrium (WP)	Included in B1863.1	12/31/2014	6/1/2015	0	0	4	1
B1865	B1865.1	Gilboa - Kanawha	Carbondale - Kanawha River	\$814,725	7/10/2014	6/1/2014	4	0	1	0
B1866	B1866.1	Beaver Creek - Clinch River	Beaver Creek - Clinch River (KP)	\$1,148,431	9/30/2014	6/1/2015	3	1	1	0
B1866	B1866.2	Beaver Creek - Clinch River	Dorton Loop	\$893,000	6/5/2014	6/1/2015	5	2	0	0
B1866	B1866.3	Beaver Creek - Clinch River	Dorton - Fleming	\$515,800	6/30/2014	6/1/2015	3	0	0	0
B1866	B1866.4	Beaver Creek - Clinch River	Beaver Creek - Clinch River (AP)	\$865,155	6/30/2014	6/1/2015	2	0	0	1
B1866	B1866.5	Beaver Creek - Fremont	Beaver Creek - Clinch River (KP)	Included in B1866.1	9/30/2014	6/1/2016	3	1	1	0



AEP Transmission Zone – Sag study

Baseline ID for original Sag study	New Sub-ID Number	Circuit	Line	Total Mitigation Costs	Projected In-Service Date	PJM Need Date	Adding / Modifying / Replacing Structures	Conductor or Line Hardware	Grading	Third Party Clearance Issues
B1866	B1866.6	Beaver Creek - Fremont	Beaver Creek - Clinch River (AP)	Included in B1866.4	6/30/2014	6/1/2016	1	0	0	1
B1866	B1866.7	Clinch River - Fremont	Beaver Creek - Clinch River (AP)	Included in B1866.4	6/30/2014	6/1/2016	1	0	0	1
B1867	B1867.1	Newcomerstown - South Coshocton	Newcomerstown - South Coshocton	\$976,300	12/1/2014	6/1/2016	7	0	3	0
B1871	B1871.2	Ohio Central - West Millersburg	South Coshocton - Wooster	\$519,633	7/31/2014	6/1/2015	0	0	2	2
B1879	B1879.1	Clinch River-Saltville No. 2	Clinch River - Abingdon	\$666,600	12/31/2014	6/1/2016	1	2	0	1
B1882	B1882.1	College Corner - Jay	College Corner - Randolph	\$362,025	12/31/2014	6/1/2016	6	0	4	7
B1882	B1882.2	College Corner - Jay	Randolph - Jay	Included in B1882.1	12/31/2014	6/1/2016	1	0	0	11
B1884	B1884.1	Deer Creek - Fisher Body - Mullin	Grant Extension	Included in B1949.3	6/30/2014	6/1/2016	0	0	0	0
B1901	B1901.1	Academia - Ohio Central	Philo - Howard	\$187,225	12/31/2014	6/1/2015	0	4	0	0
B1949	B1949.3	Deer Creek - Fisher Body - Mullin	Deer Creek - Grant - Kokomo	\$372,934	6/30/2014	6/1/2016	1	7	0	0
B1973	B1973.1	Sunnyside - Tidd	Windsor - Canton	\$433,608	12/31/2014	12/1/2014	1	0	2	9



AEP Transmission Zone – Sag study

Baseline ID for original Sag study	New Sub-ID Number	Circuit	Line	Total Mitigation Costs	Projected In-Service Date	PJM Need Date	Adding / Modifying / Replacing Structures	Conductor or Line Hardware	Grading	Third Party Clearance Issues
B1974	B1974.1	Philo Switch - South Canton	Bridgeville Extension	Included in B1974.2	12/1/2014	6/1/2015	0	0	0	1
B1974	B1974.2	Philo Switch - South Canton	Philo - Torrey	\$1,464,000	12/1/2014	6/1/2015	7	8	7	9
B2018	B2018.1	Bixby - Conesville	Conesville - Bixby	\$5,249,656	12/31/2014	6/1/2015	16	9	2	8
B2018	B2018.2	Bixby - Conesville	Bixby Corridor	Included in B2018.1	12/31/2014	6/1/2015	0	2	0	2
B2027	B2027.1	Collier - Tidd	Tidd - Collier (OP)	\$586,852	6/1/2015	6/1/2015	0	1	0	0
B2027	B2027.2	Collier - Tidd	Tidd - Collier (WP)	\$4,482,929	5/29/2014	6/1/2015	7	0	3	0
B2054	B2054.1	Rutland - Sporn	Rutland - Sporn	\$865,953	12/3/2014	6/1/2014	0	3	0	1
B2122	B2122.1	Howard - Brookside	Howard - Ashland	\$243,002	6/30/2014	6/1/2015	1	0	0	2
B1445	B1445.1	Gavin - North Proctorville	Thivener - Buckeye Co-Op	\$168,860	6/1/2015	6/1/2015	20	0	0	0



AEP Transmission Zone – Sag study

Baseline ID for original Sag study	New Sub-ID Number	Circuit	Line	Total Mitigation Costs	Projected In-Service Date	Adding / Modifying / Replacing Structures	Conductor or Line Hardware	Grading	Third Party Clearance Issues
B1040	B1040.1	New Carlisle - Olive	Jackson Rd. - New Carlisle	\$99,658	IS	0	1	0	0
B1044	B1044.1	South Point - Tri State	Turner - South Point (AP)	\$256,171	IS	0	1	0	3
B1045	B1045.1	Darrah - TriState	Darrah Tap	\$262,802	IS	0	1	0	0
B1045	B1045.2	Darrah - TriState	Turner - Southpoint	\$23,903	IS	0	0	0	1
B1418	B1418.1	Findlay Center - Fostoria Central - New Liberty	Fostoria - East Lima	\$635,973	IS	0	1	0	4
B1420	B1420.1	Keystone - Sorenson	Tanners Creek - Desoto - Sorenson	\$664,581	IS	2	3	0	0
B1427	B1427.1	Altavista - New London	Altavista - Lynchburg	\$1,988,535	IS	31	0	1	0
B1427	B1427.2	Opossum Creek - Smith Mountain	Leesville-Smith Mountain	\$122,346	IS	0	1	0	0
B1428	B1428.1	Opossum Creek - Smith Mountain	Opossum Creek - Smith Mountain	\$663,348	IS	4	0	1	3
B1452	B1452.1	Ohio Central - Zanesville	Zanesville - Ohio Central	\$348,934	IS	4	0	1	6
B1455	B1455.1	Canton Central - Wagenhals #1	Central Canton - Wagenhals	\$107,486	IS	0	4	0	0



AEP Transmission Zone – Sag study

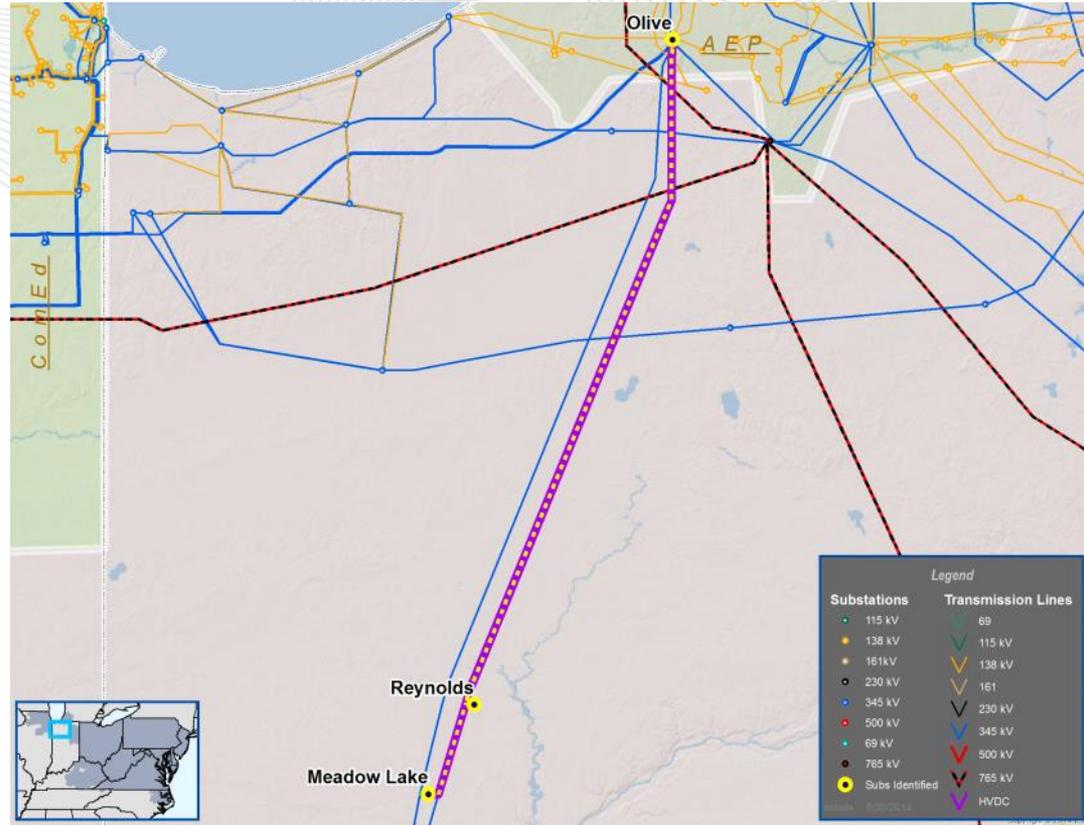
Baseline ID for original Sag study	New Sub-ID Number	Circuit	Line	Total Mitigation Costs	Projected In-Service Date	Adding / Modifying / Replacing Structures	Conductor or Line Hardware	Grading	Third Party Clearance Issues
B1457	B1457.1	West Bellaire - Windsor	Tiltonsville - Windsor Jct	\$222,263	IS	0	4	0	0
B1458	B1458.1	Circleville - Harrison	Harrison - Circleville	\$104,998	IS	0	1	0	0
B1491	B1491.1	Big Sandy - Thelma	Big Sandy - Thelma	\$109,171	IS	1	0	0	1
B1491	B1491.2	Big Sandy - Thelma	Big Sandy - Thelma	\$49,526	IS	0	0	0	1
B1492	B1492.1	Bellefonte - North Proctorville	Bellefonte Extension (KPCo)	\$51,474	IS	0	0	0	1
B1494	B1494.1	Bellefonte - North Proctorville	South Point-Portsmouth	\$82,413	IS	0	0	0	1
B1859	B1859.2	New London - Reusens	Reusens - Altavista	\$268,905	IS	3	0	0	3
B1869	B1869.1	Ohio Central - South Coshocton	Ohio Central - Coshocton Junction	\$627,797	IS	1	0	4	4
B1871	B1871.1	Ohio Central - South Coshocton	South Coshocton - Wooster	\$401,240	IS	0	1	0	2
B1951	B1951.1	East Lima - Maddox Creek	East Lima - Sorenson (OP)	\$506,117	IS	0	21	0	0
B1951	B1951.2	Maddox Creek - RP Mone	East Lima - Sorenson (OP)	\$118,739	IS	0	2	0	0



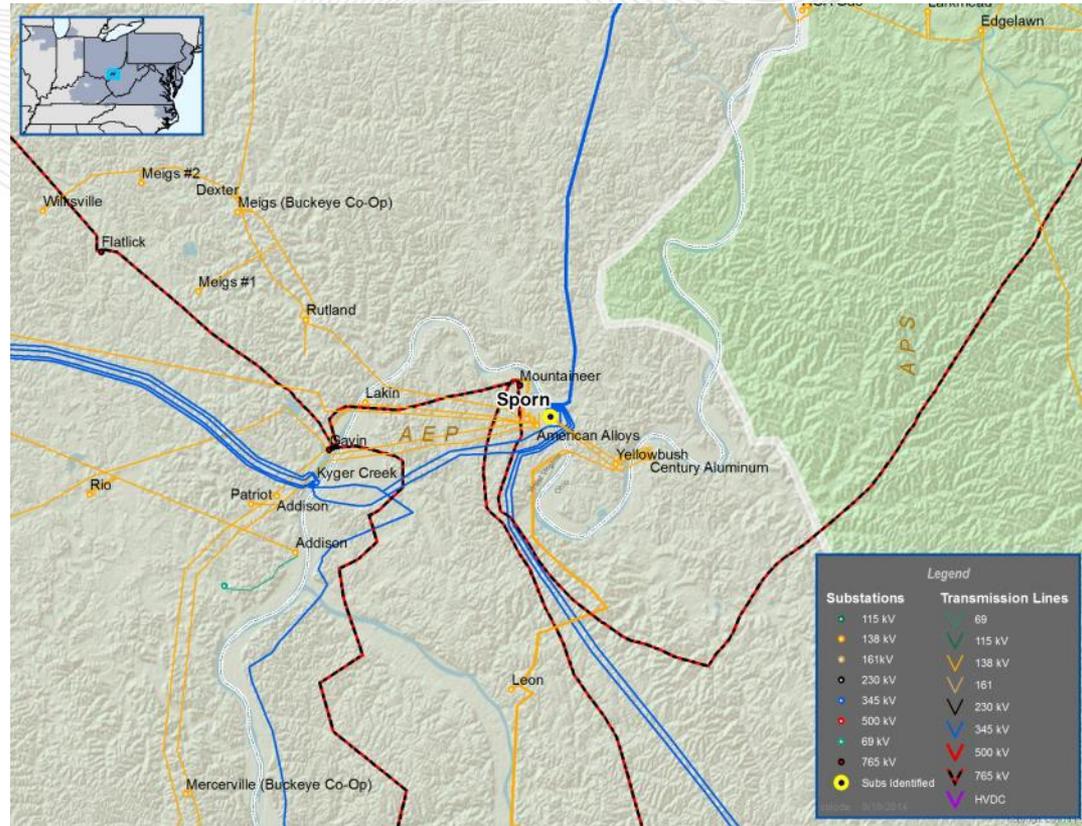
AEP Transmission Zone – Sag study

Baseline ID for original Sag study	New Sub-ID Number	Circuit	Line	Total Mitigation Costs	Projected In-Service Date	Adding / Modifying / Replacing Structures	Conductor or Line Hardware	Grading	Third Party Clearance Issues
B2028	B2028.1	East Lima - North Findlay	Fostoria - East Lima	\$845,581	IS	5	2	0	16
S0639	S0639.1	Danville - East Danville	Roanoke - Carolina	\$431,518	IS	3	2	0	0
B1423	B1423.1	Capitol Hill - Chemical	Chemical - Capitol Hill	\$66,540	IS	0	1	0	0

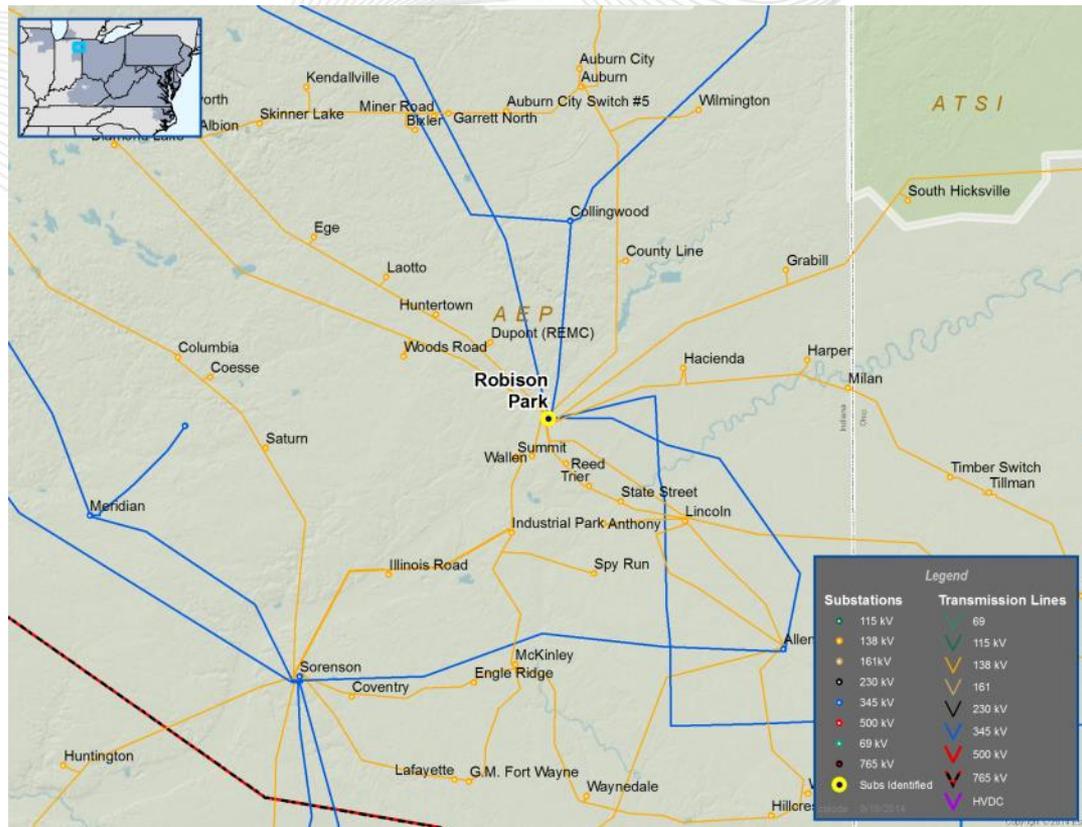
- Project cancellation
- Cancel B2287: Loop in the Meadow Lake - Olive 345 kV circuit into Reynolds 765/345 kV station
- This project is no longer needed due to project B2449 to Rebuild the 7-mile 345 kV line section between Meadow Lake and Reynolds 345 kV stations
- Estimated Cost: \$1M
- Required IS Date: 6/1/2018



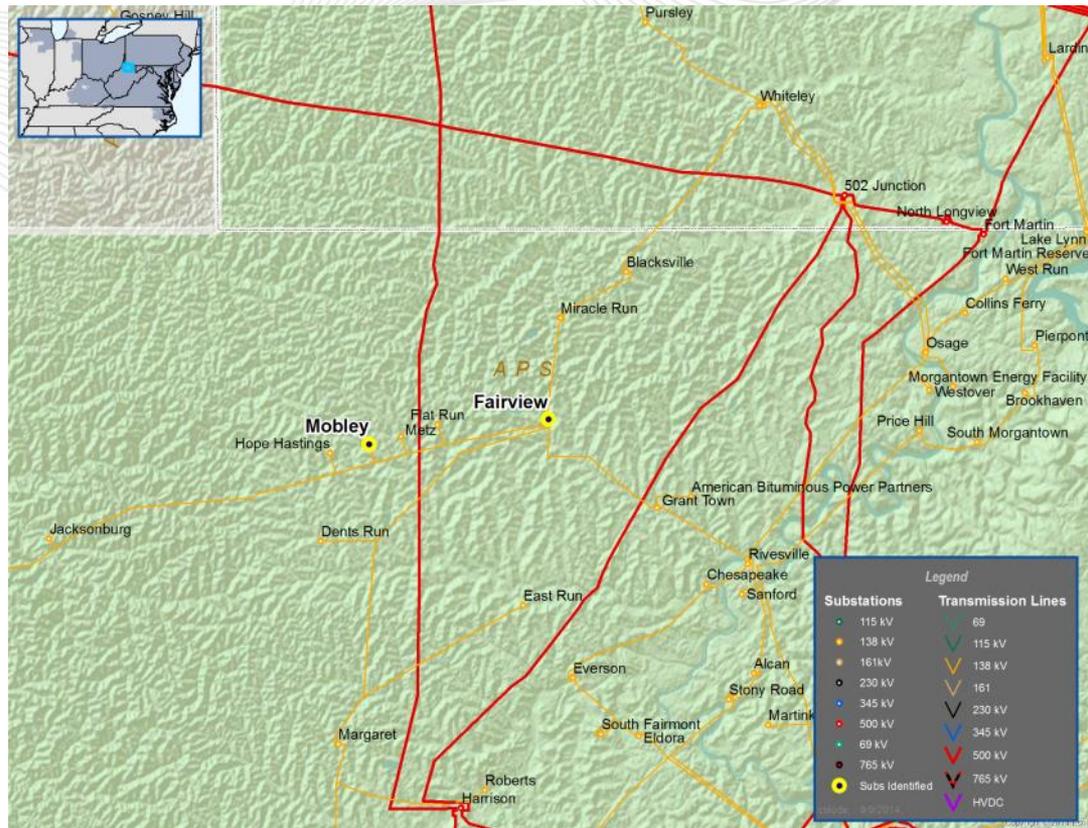
- The Sporn 138kV breakers 'D', 'G1', 'O', 'O1', 'O2', 'P2', and 'U' are overstressed
- Proposed Solution: Replace the Sporn 138kV breakers 'D', 'G1', 'O', 'O1', 'O2', 'P2', and 'U' with 80kA breakers (B2530 - B2536)
- Estimated Project Cost: \$1M per breaker
- Required IS Date: 6/1/2018



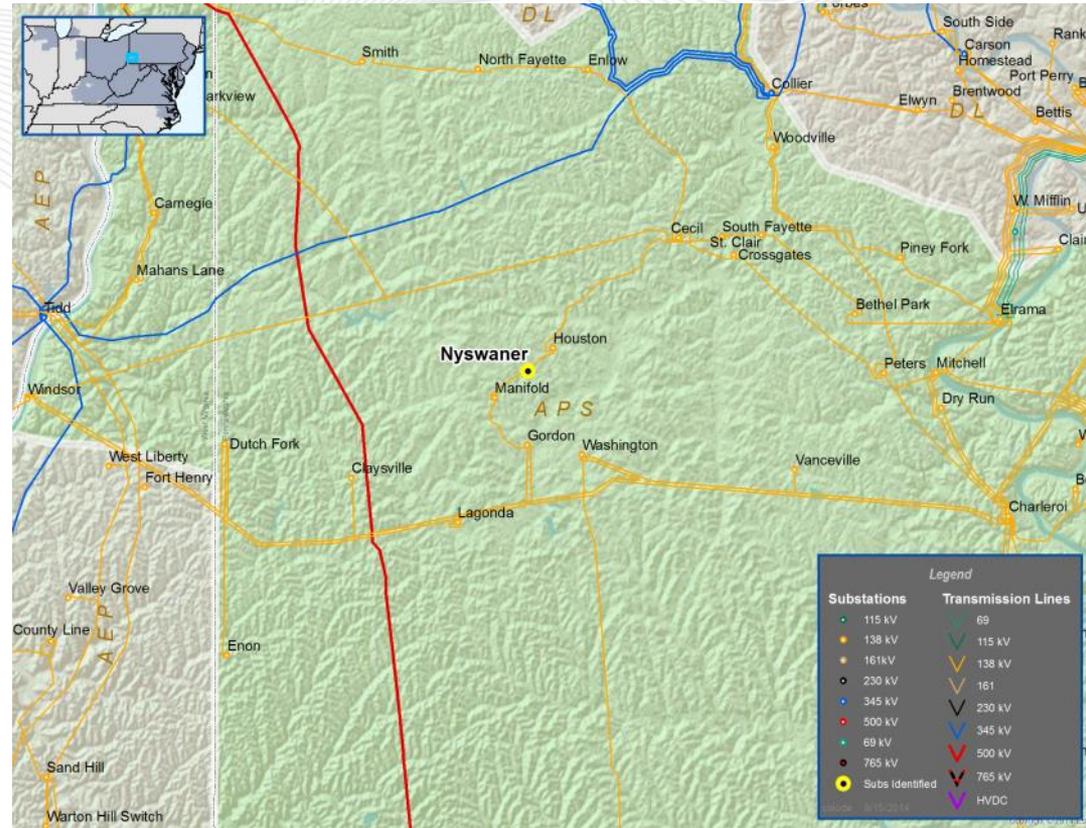
- The Robinson Park 138 kV breakers 'A1', 'A2', 'B1', 'B2', 'C1', 'C2', 'D1', 'D2', 'E1', 'E2', and 'F1' are overstressed
- Proposed Solution: Replace the Robinson Park 138 kV breakers 'A1', 'A2', 'B1', 'B2', 'C1', 'C2', 'D1', 'D2', 'E1', 'E2', and 'F1' with 63 kA breakers (B2537)
- Estimated Project Cost: \$15M
- Required IS Date: 6/1/2016

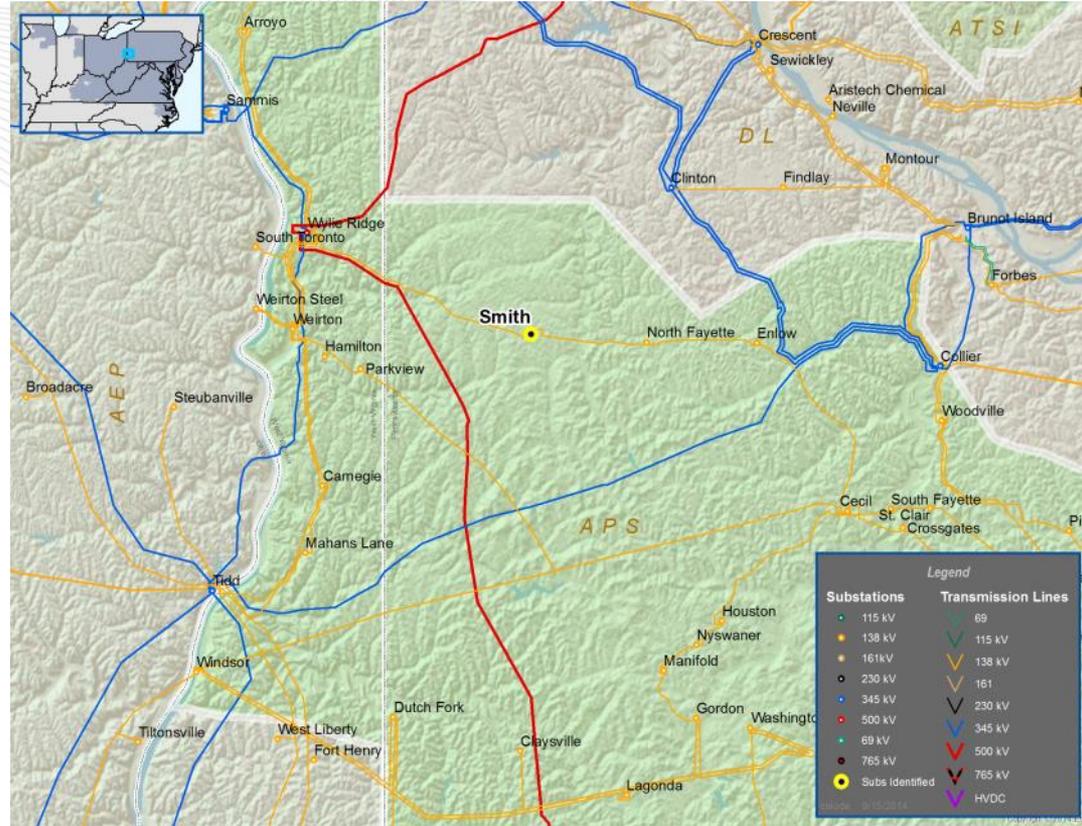


- N-1 Voltage Violation
- Driver: Block load addition in the APS zone
- Lead time: less than 24 months
- N-1 Low voltage and voltage drop violation at Mobley 138 kV and surrounding buses for multiple contingencies
- Construct a new 138 kV substation (Shuman Hill substation) connected to the Fairview-Willow Island (84) 138 kV line(B2545.1)
- Install a ring bus station with five active positions and two 52.8 Mvar capacitors with 0.941 mH reactors(B2545.2)
- Install a +90/-30 Mvar SVC protected by a 138 kV breaker(B2545.3)
- Remove the 31.7MVAR capacitor bank at Mobley 138 kV (B2545.4)
- Estimated Project Cost: \$40M
- Required IS Date: 7/1/2015



- N-1-1 Voltage Violation
- Driver: Block load addition in the APS zone
- Lead time: less than 24 months
- Low Voltage at Gordon, and Lagonda 138 kV buses for the loss of Cecil-Houston 138 kV line and the loss of Charleroi-Gordon 138 kV line
- Install a 51.8 MVAR (Rated) 138 kV Capacitor at Nyswaner 138kV substation (B2546)
- Estimated Project Cost: \$1.0M
- Required IS Date: 4/1/2015





N-1 Voltage Violation

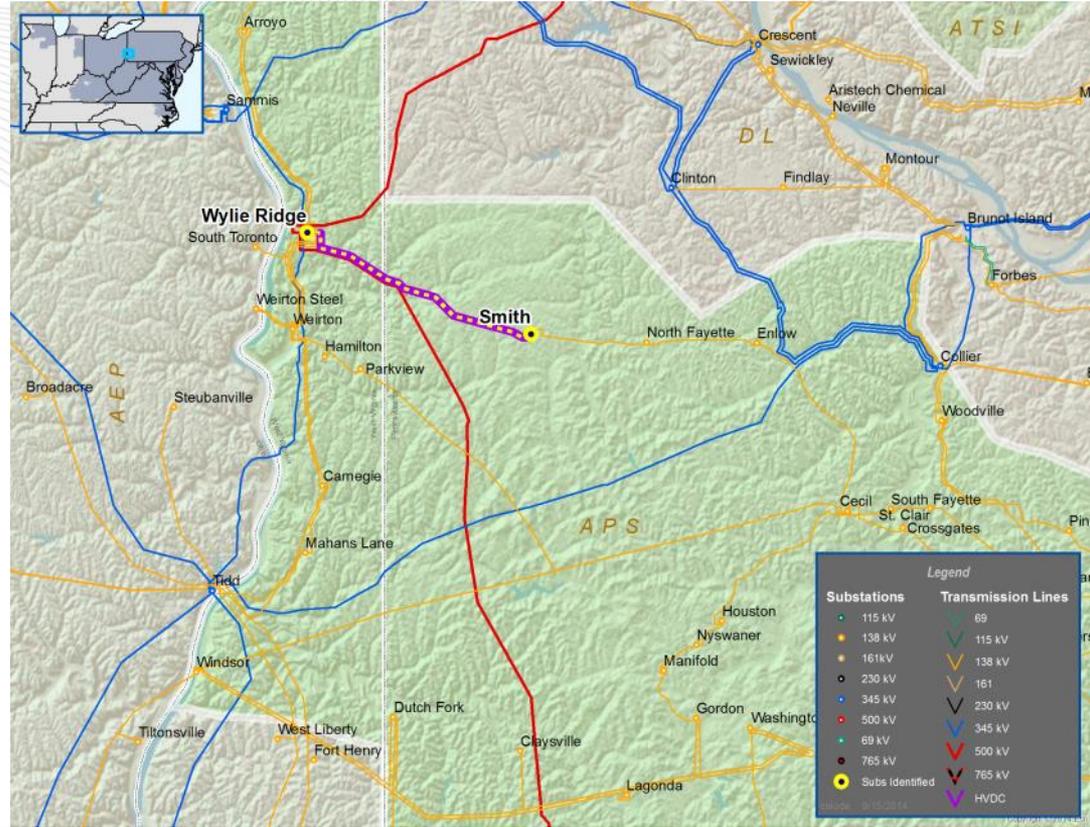
- Driver: Block load addition in the APS zone
- Lead time: less than 24 months
- Low Voltage and Voltage Drop at Smith, Enlow, North Fayette, Hillman, and Imperial 138 kV buses for the loss of Smith – Wylie Ridge 138 kV line

- Construct new 138 kV 6 breaker ring bus Hillman substation (B2547.1)
- Loop Smith-Imperial 138 kV line into the new Hillman substation (B2547.2)
- Install +125/-75 MVAR SVC at Hillman substation (B2547.3)
- Install two 31.7Mvar 138kV capacitors (B2547.4)

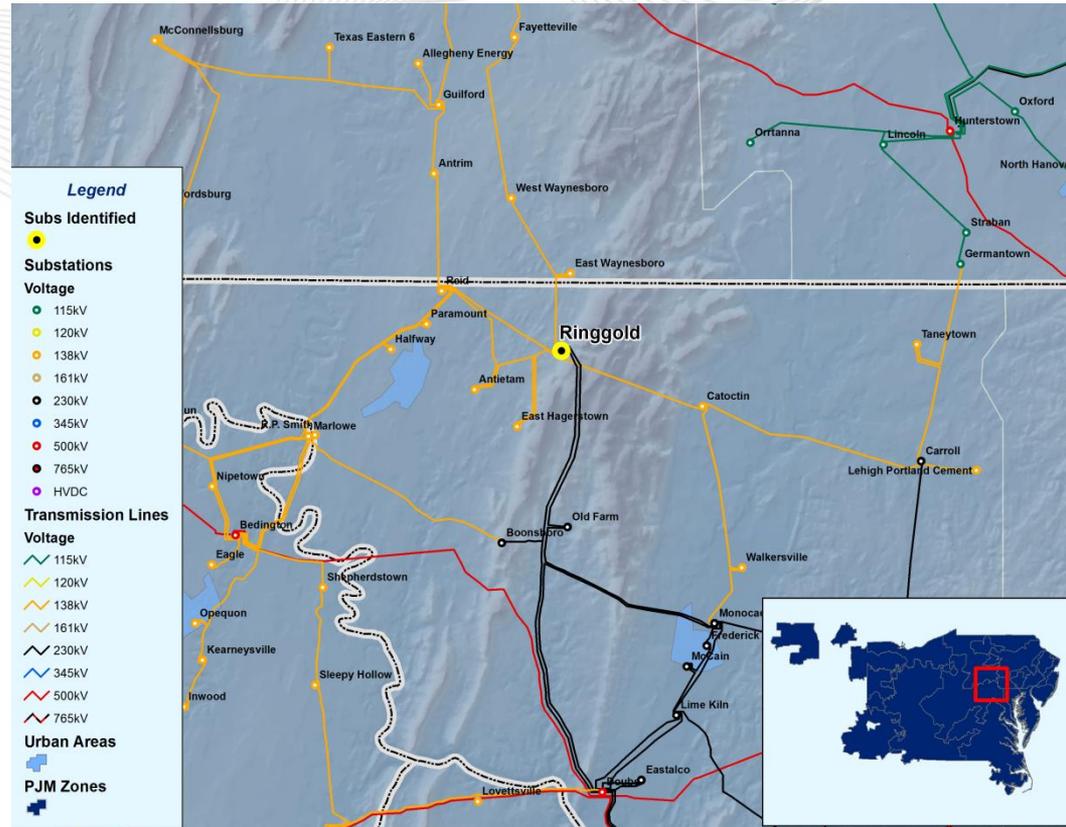
Estimated Project Cost: \$31.5M

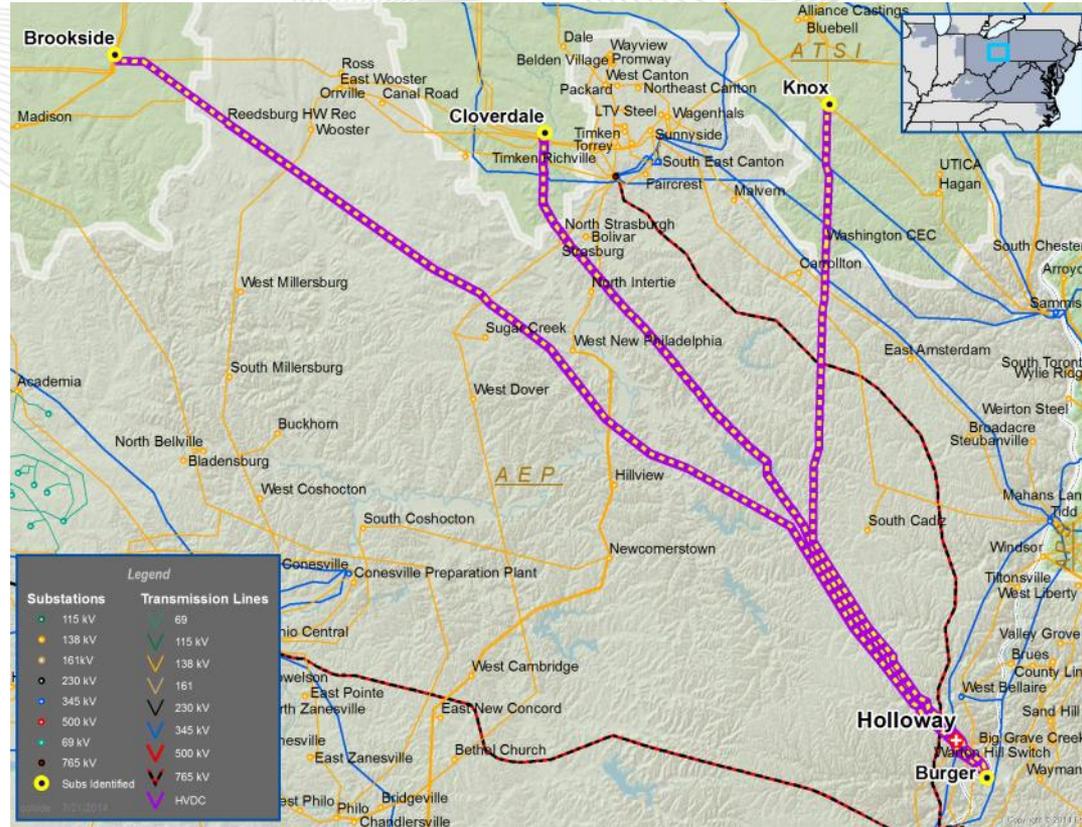
Required IS Date: 2/1/2016

- Basecase N-1 Thermal Violation
- Driver: Block load addition in the APS zone
- Lead time: less than 24 months
- The Wylie Ridge –Smith 138 kV line is overloaded in base case and for multiple single contingencies
- Eliminate Clearance De-Rate on Wylie Ridge-Smith and upgrade terminals at Smith; New Line Rating 294 MVA (Rate A) and 350 MVA (Rate B) (B2548)
- Estimated Project Cost: \$2.3M
- Required IS Date: 2/1/2016



- The Ringgold 138kV breakers ‘RCM-1’ and ‘#4XFMR’ are overstressed
- Recommended Solution: Replace the Ringgold 138kV breakers ‘RCM-1’ and ‘#4XFMR’ with 40kA (B2472 & B2473)
- Estimated Project Cost: \$250 K
- Required IS Date: 6/1/2018





Addition to B2019 Project Scope

B2019: Establish Burger (Holloway) 345/138 kV station

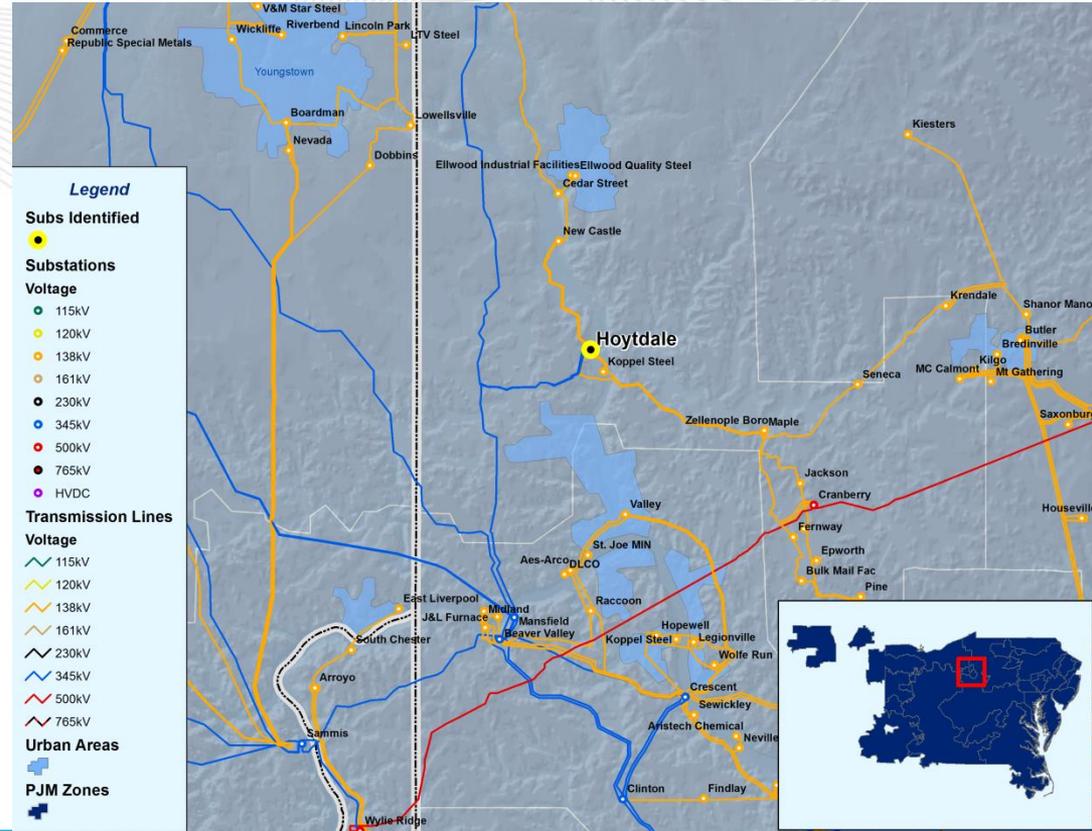
Terminate the Burger-Longview 138kV, Burger-Brookside 138kV, Burger-Cloverdale #1 138kV, and Burger-Harmon #2 138kV line into the new Holloway substation and Loop the Burger-Harmon #1 138kV and Burger-Knox 138kV lines into the new Holloway substation. (B2019.2)

Reconfigure Burger 138kV substation to accommodate two 138kV line exits and the generation facilities. (B2019.3)

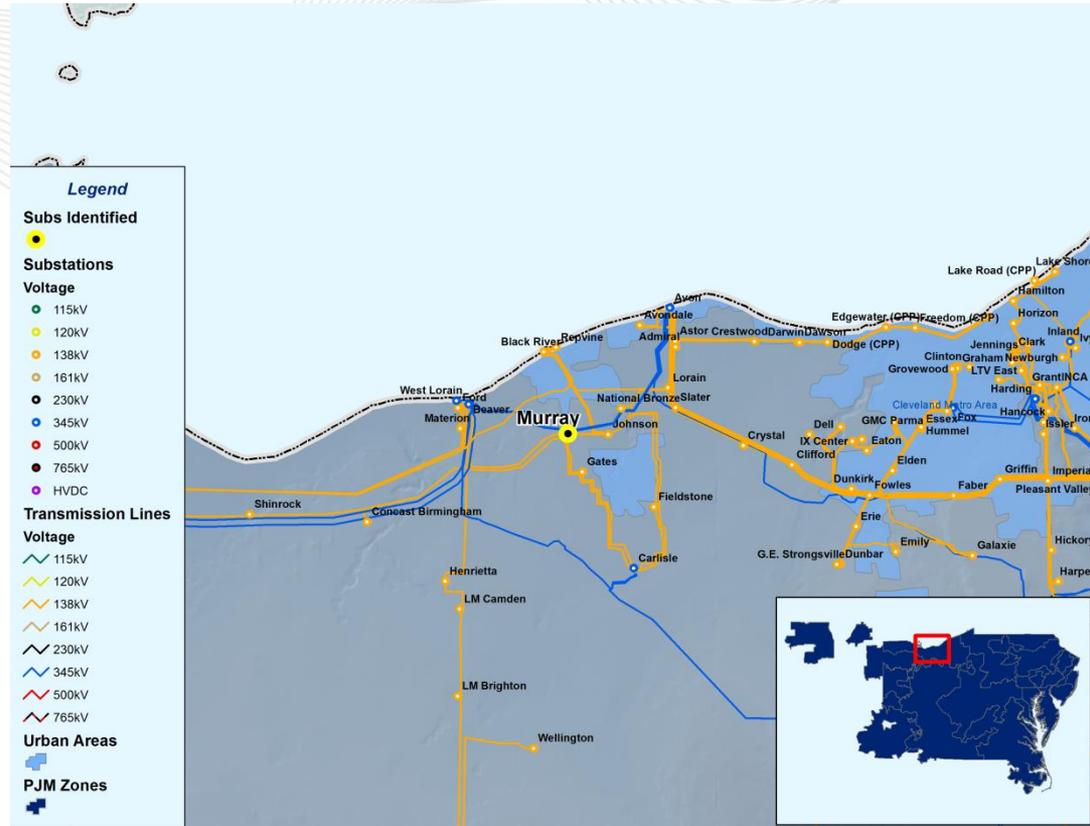
Estimated Project Cost: \$1.5M

Required IS Date: 6/1/2014

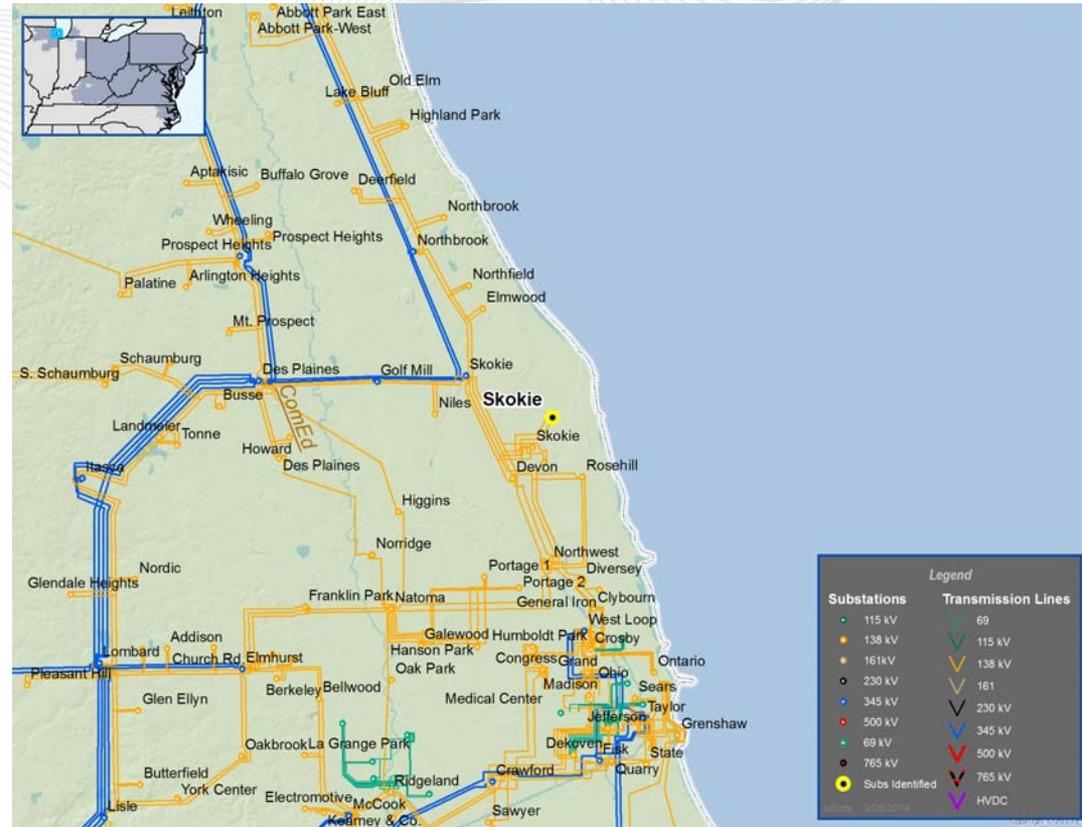
- The Hoytdale 138kV breaker '83-B-30' is overstressed
- Recommended Solution: Replace the Hoytdale 138kV breaker '83-B-30' with 63kA (B2493)
- Estimated Project Cost: \$350 K
- Required IS Date: 6/1/2016



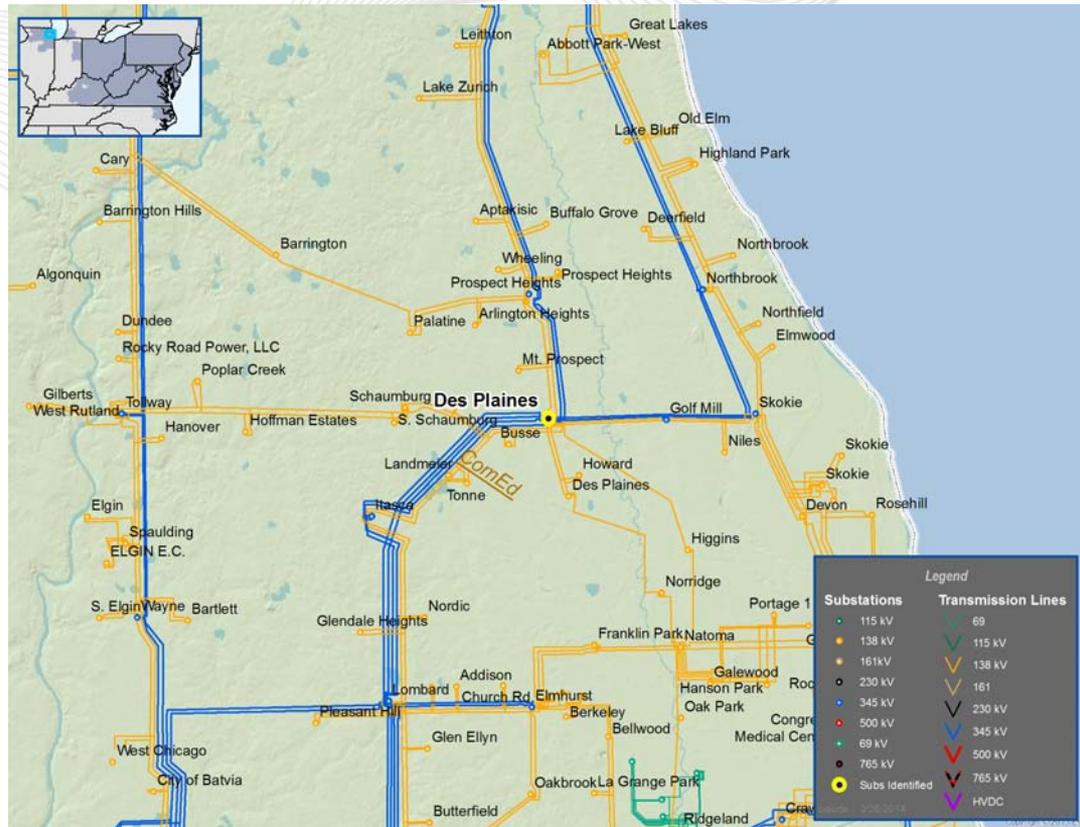
- The Murray 138kV breaker '453-B-4' is overstressed
- Significant Driver: Build new 345/138 kV Lake Avenue substation (S0663)
- Recommended Solution: Replace the Murray 138kV breaker '453-B-4' (S0663.1)
- Estimated Project Cost: \$280 K
- Required IS Date: 6/1/2016



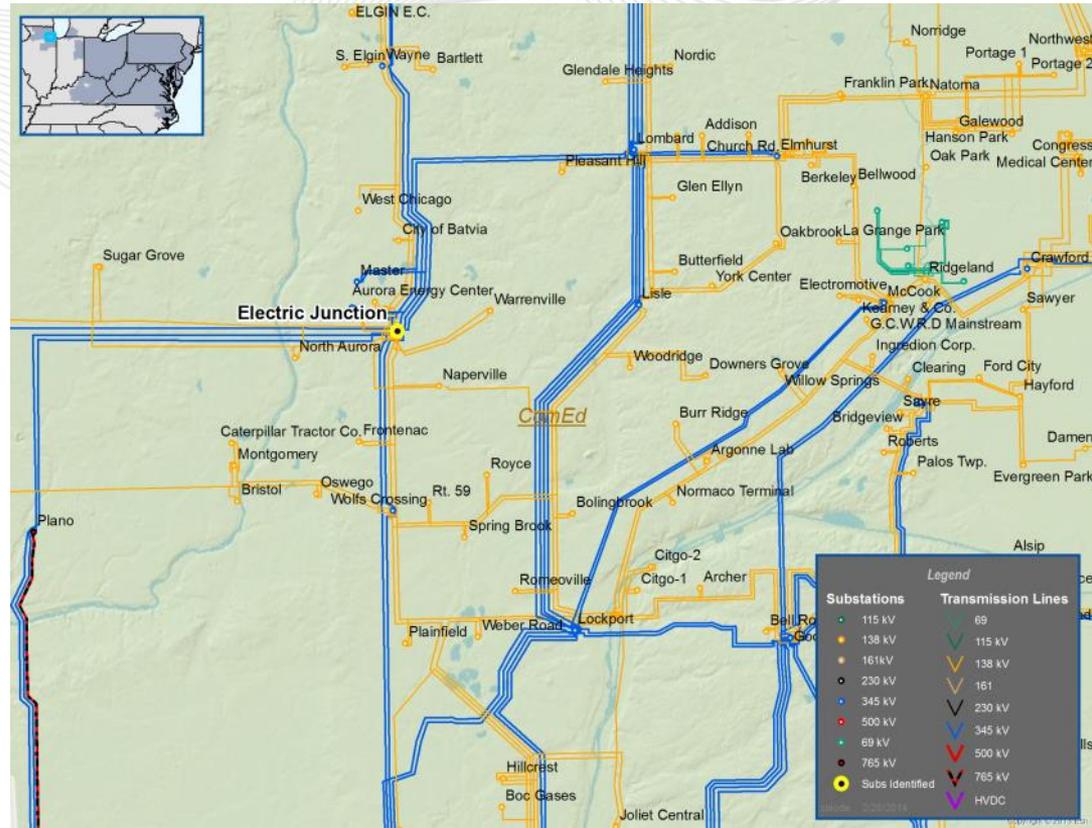
- Several of the Skokie 138kV breakers are overstressed when the Skokie 345 kV bus-tie closes for the loss of 345 kV line 8823 (Skokie88 B3 – Golfmil B) (SPOG 3-23).
- Recommended solution: Replace the Skokie 138 kV breakers '88 L8809', '88 L8810', '88 L11416', '88 L8803' with 63kA breakers (B2465-B2468)
- Estimated Project Cost: \$1.789 M (per breaker)
- Required In-Service Date: 6/1/2016



- The Des Plaines 138kV breakers '46 11702' and '46 11701' are overstressed.
- Recommended solution: Replace the Des Plaines 138 kV breakers '46 11702' & '46 11701' with 63kA breakers (B2469 & S0692)
- Estimated Project Cost: \$1.875 M (per breaker)
- Required In-Service Date: 6/1/2016



- Project Cancellation
- B1852.1: Upgrade five 345 kV circuit breakers (L1223, L11124, L14321, BT2-3 and BT3-4) at Electric Junction
- B1852.2: Modify reclosing on 138 kV line (L11103) at TSS 111 Electric Junction
- B0661, which will be in service this year, will operate the Plano 345 kV red-blue bus tie normally closed. It will relieve the overload on the Electric Junction 345/138/34.5kV transformer #83, which is the original driver for B1852.1 and b1852.2 Due to B0661, B1852.1 and b1852.2 are no longer needed.
- Original required IS Date: 6/1/2016



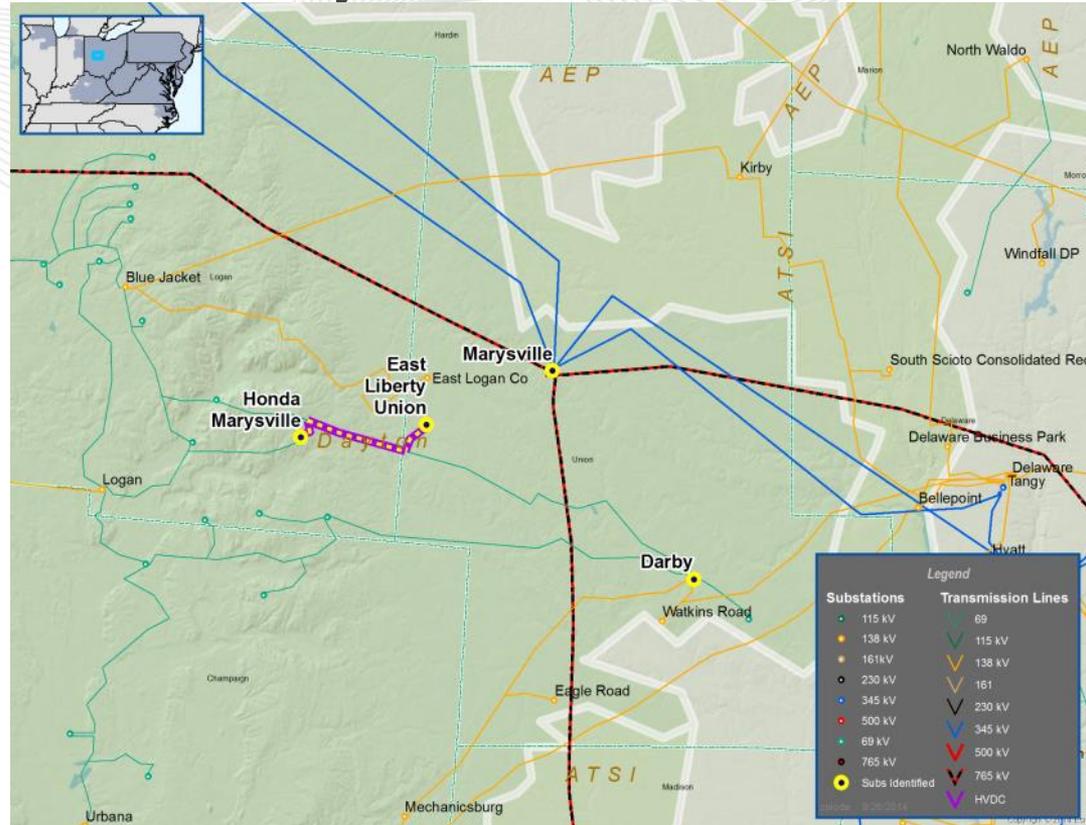
Plan to mitigate the Construction Delay of B1570, B1570.1, B1570.2, B1570.3

Existing Approved Plan:

- B1570: Add a 345/69 kV transformer at AEP Marysville 345 kV bus
- B1570.1: Add Marysville - Darby 69 kV line
- B1570.2: Add Marysville - Union REA 69 kV line
- B1570.3: Reconductor Union REA - Honda MT 69 kV line
- Required IS date: 6/1/2014
- Projected IS date: 6/1/2018

Additional recommended scope to maintain reliability in the near term:

- Increase the rating of the Shelby-E. Sidney-Quincy-Logan 138 kV line to 224 MVA by Replace/raise a three pole swing out structure; Push/pull/retension conductors on two spans; Lower eight spans of single phase underbuild (B2540)
- Estimated Project Cost: \$0.042M
- Required IS Date: 6/1/2015



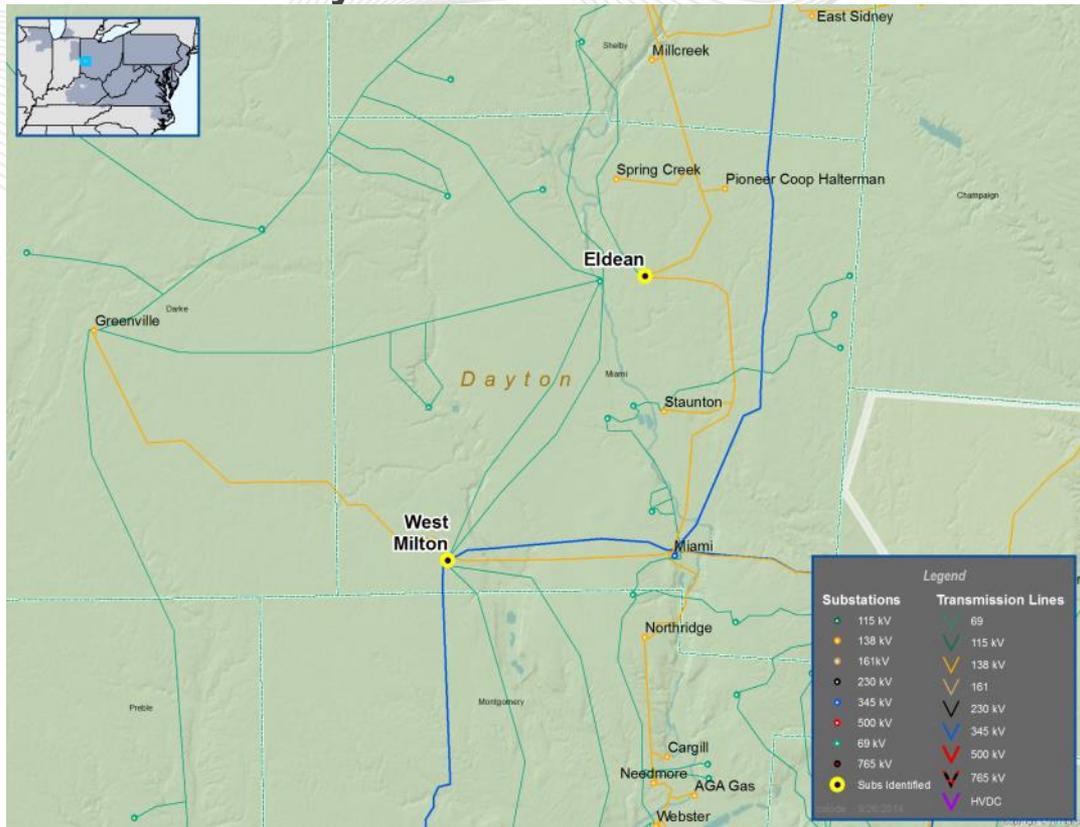
Plan to mitigate the Construction Delay of B1572

Existing Approved Plan:

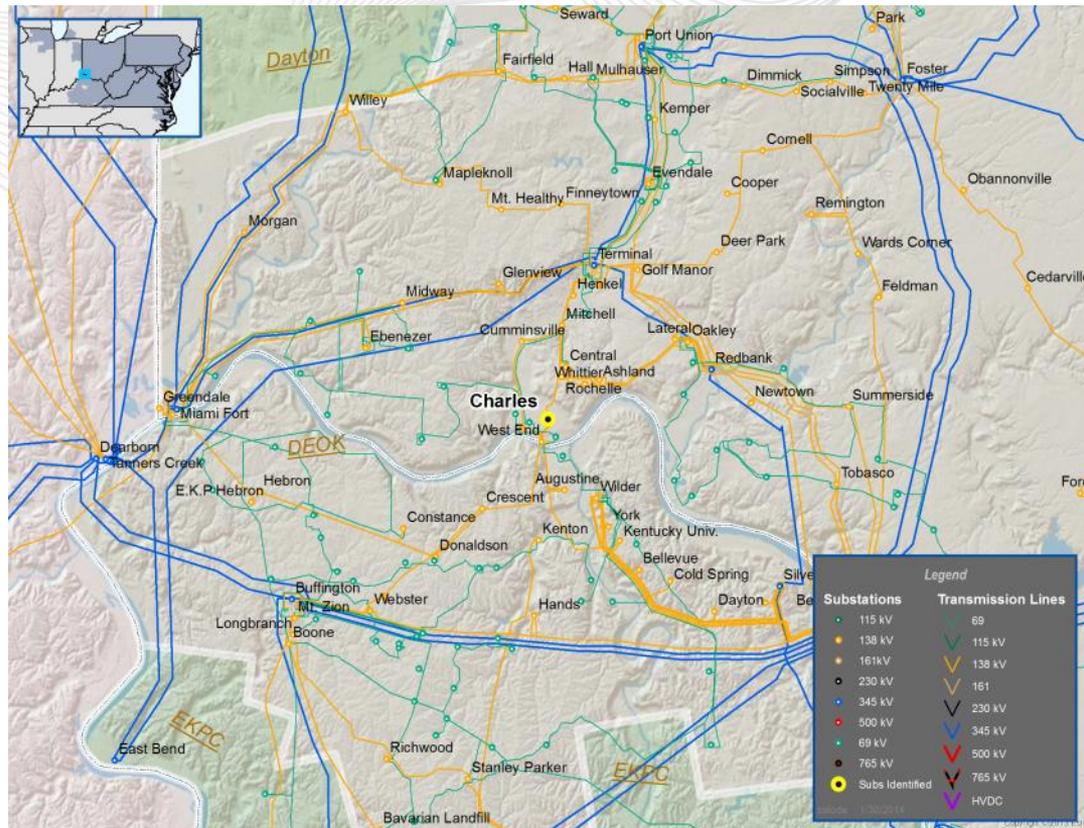
- B1572: Construct a new 138 kV line from West Milton to Eldean
- Required IS date: 6/1/2014
- Projected IS date: 6/1/2018

Additional recommended scope to maintain reliability in the near term:

- As needed in PJM Operations, connect two 30MVAR mobile shunts to Eldean 69kV and Sidney 69kV buses, Block the LTCs for Eldean 138/69kV and Sidney 138/69kV transformers after either the loss of the Shelby – Sidney 138kV line or the loss of Miami – Eldean - Staunt 138kV line (B2541)
- Estimated Project Cost: \$0M
- Required IS Date: Immediate Need



- The Charles 138 kV breaker '919' is overstressed
- Recommended Solution: Replace the Charles 138 kV breaker '919' (B2451)
- Estimated Project Cost: \$0.25M
- Required IS Date: 6/1/2018



NERC Category B Violation

Problem:

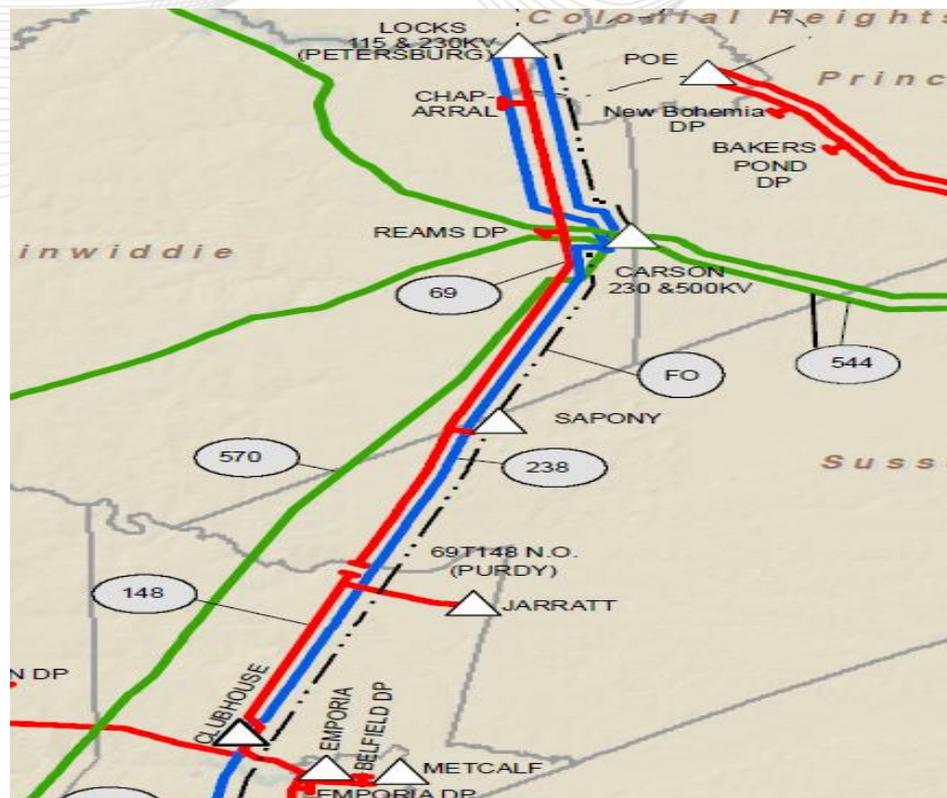
- For loss of Line #69 segment (Locks – Reams 115kV DP), opening switch #6976 at Reams and closing switch 69T148 at Purdy results in Line #148 (Clubhouse – Purdy 115kV) exceeding 94% of its summer rating of 41 MVA.
- On line #148 4 spans have insufficient ground clearance and 16 wood H frames are in poor condition

Recommended Solution:

- LIDAR survey shows that Line #148 (795 ACSR conductor) can be re-rated from 50C to 75C with a summer rating of 161 MVA.
- Replace 24 115kV wood H-frames with 230kV Dominion-pole H-frame structures (B2457).

Required IS Date: Immediate Need

Estimated Cost: \$ 2.9M



NERC Category B Violation

Project b1793 Update

Problem:

- In 2016 an outage of the Line #90 (Kerr Dam – Carolina 115kV) breaker at Kerr overloads Line #22 (Eatons Ferry – Carolina 115kV) by 1.8% (No Surry 230 kV generation)

Recommended Solution –

- Wreck and rebuild remaining section of Line #22, 19.5 miles and replace two pole H frame construction built in 1930.

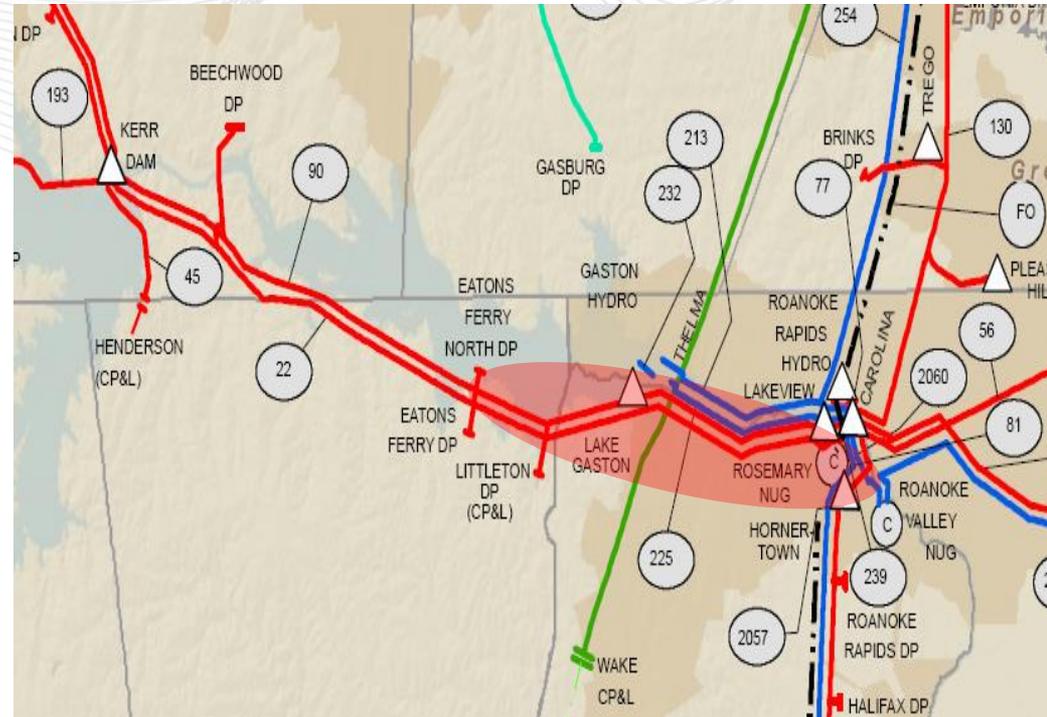
Recommended addition to solution –

- The Carolina 22 SPS prevents overload of Line #22 for loss of Line #90. After this project is complete, the Carolina 22 SPS will no longer be needed. Remove the Carolina 22 SPS to include relay logic changes, minor control wiring, relay resets and SCADA programming (B1793.1).

Estimated Cost: \$ 25.0 M

Estimated Additional Cost: \$25.0 K

Required IS Date: May 2016



NERC Category B Violation

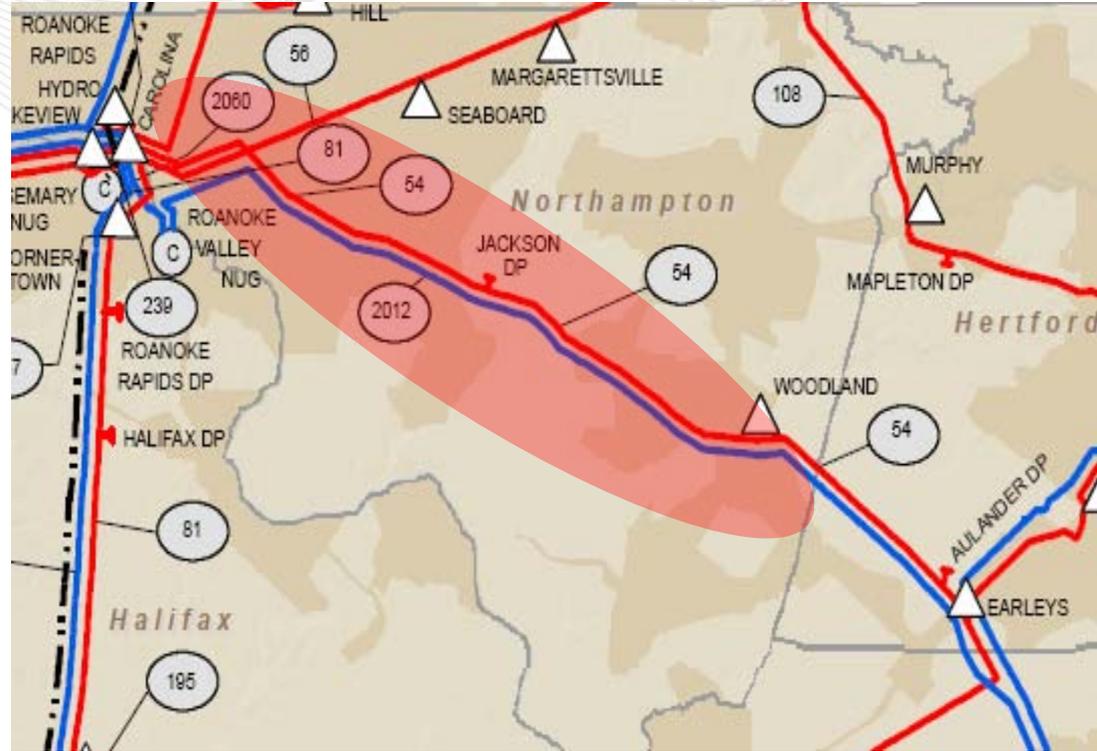
Project B1795 Update

Line #54 Uprate

Problem:

- In 2016 an outage of Line #2012 (Roanoke Valley NUG to Earleys 230 kV) overloads a segment of Line #54 (Carolina to Woodland 115 kV) by 3% (No Surry 230 kV Generation)

Continued on next slide.....



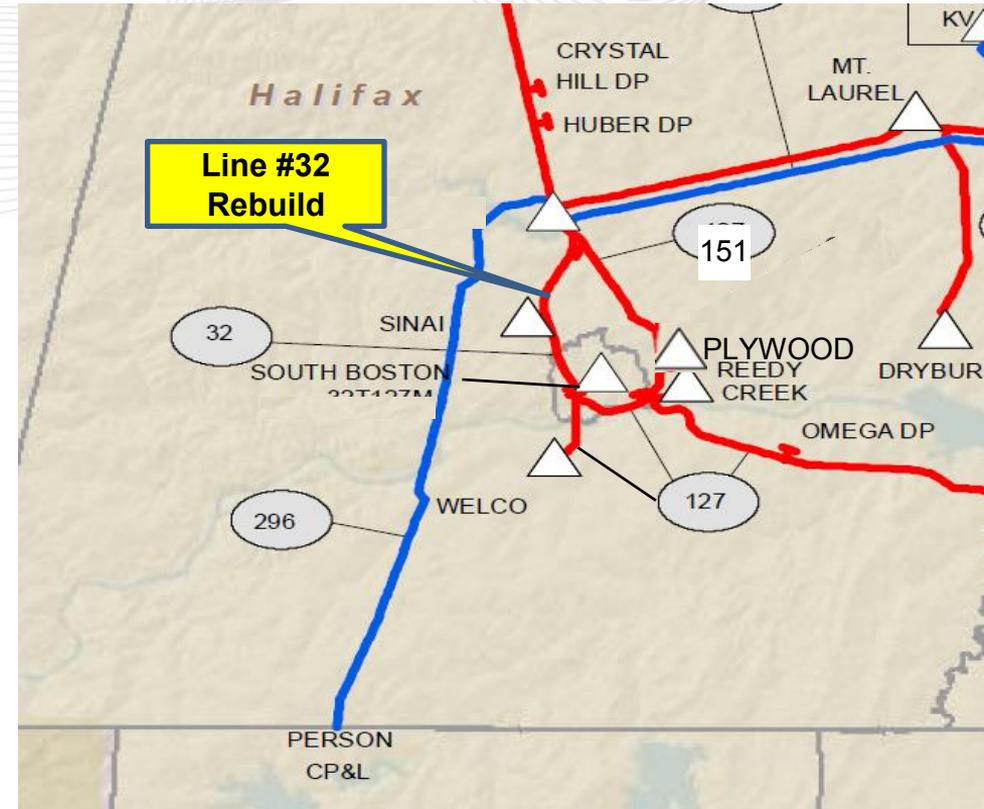


Dominion Transmission Zone

Line #54 Uprate

- Recommended Solution
Reconductor segment of Line #54 (Carolina to Woodland) to a minimum of 300 MVA. Most of the 27 miles of line are on the same structures with Line # 2012. Preliminary Engineering review indicates that the structures will not need to be replaced due to the reconductoring.
- Proposed Revised Solution
Further engineering review has shown that the existing 336 ACSR sagged at 90°C can be uprated to a sag of 150°C by replacing 12 wood H-frame structures with steel H-frame structures and installing shunts on all conductor splices. All line switches and substation components at Carolina will be upgraded to meet or exceed the new conductor rating. This will increase the line rating from 118 MVA to 174 MVA. Replace 14 wood H-frame structures with steel H-frame structures that are in the same line section. These 14 structures are being replaced due to poor condition, mostly in a swampy area and while the mats are in place. Replace 2.5 miles of static wire (B2458.1 – B2458.4).
- Proposed Addition to Solution –
The Carolina 54 SPS prevents overload of Line #54 for loss of Line # 2012. After this project is complete, the Carolina 54 SPS will no longer be needed. Remove the Carolina 54 SPS to include relay logic changes, minor control wiring, relay resets and SCADA programming
- Previous Estimated Cost: \$ 18.0 M
- Revised Estimated Cost: \$ 4.9 M (includes \$25,000 for SPS removal)
- Required IS Date: May 2016

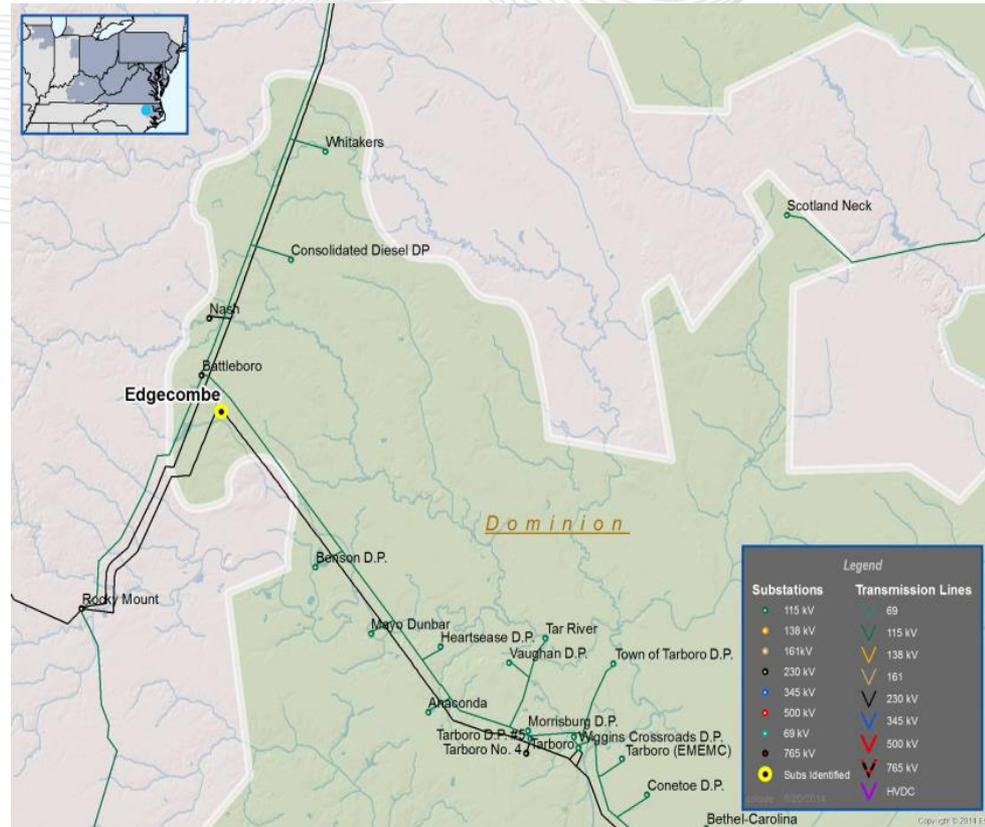
- Operational Performance:
- Line # 32 from South Boston – Halifax 115 kV has 6 miles of exposure serving 7600 customers. The line built in 1928 is mostly 3/0 ACSR on 2 pole wood H frame that is deteriorating. It has a motor operator auto-sectionalizing scheme that transfers South Boston's 4500 customers to Line # 127 (Reedy Creek – Halifax 115 kV) for Line #32 lockout. Line # 32 has had 3 momentary operations in the last 5 years.
- Line #127 has 27 miles of exposure serving 5300 customers. It has had 12 momentary operations and 2 lockouts in the last 5 years.
- Recommended Solution:**
 - Rebuild the 115 kV Line #32 from Halifax to South Boston (6 miles) for a minimum of 240 MVA and transfer the Welco tap to Line #32. Moving Welco to Line #32 requires disabling the auto-sectionalizing scheme (B2504).
- Estimated Project Cost:
\$ 6.5 M
- Required IS Date:
6/30/2015



- Operational Performance:
 - Line #65 Whitestone – Harmony Village 115kV is presently attached to the Rt. 3 bridge crossing the Rappahannock River
 - VDOT maintenance on the bridge requires an outage of the 65 Line segment between Harmony Village and Whitestone Substations and creates a radial line for several months to over a year at time.
 - This line serves almost 19,000 customers including over 5,800 NNEC customers.
 - Outages attributed to bridge maintenance equipment have occurred while line segment is energized.
 - Damaged insulators have been found due to objects thrown from bridge.
- Recommended Solution:
 - Install structures in river to remove the 115 kV #65 line from bridge and improve reliability of the line (B2505).
- Estimated Project Cost:
 - \$ 10 M
- Required IS Date:
 - 5/31/2016



- B1794 Cost Increase:
- Project Scope:
 - Build a new substation near the Edgecombe NUG to be called Morning Star Substation with a 230-115kV Tx, 4-230kV breakers in a breaker and half scheme, 3-115kV breakers in a ring. Re-configure Lines 80 (Battleboro – Anaconda), 229 (Edgecombe – Tarboro) and 2058 to terminate into Morning Star Substation.
- Cost increase due to revised engineering cost. The increased cost includes an additional \$1.2M for site development from previous estimate.
- Estimated Project Cost:
 Previous → \$ 14.5 M
 New → \$ 19 M
- Required IS Date:
 5/30/2016



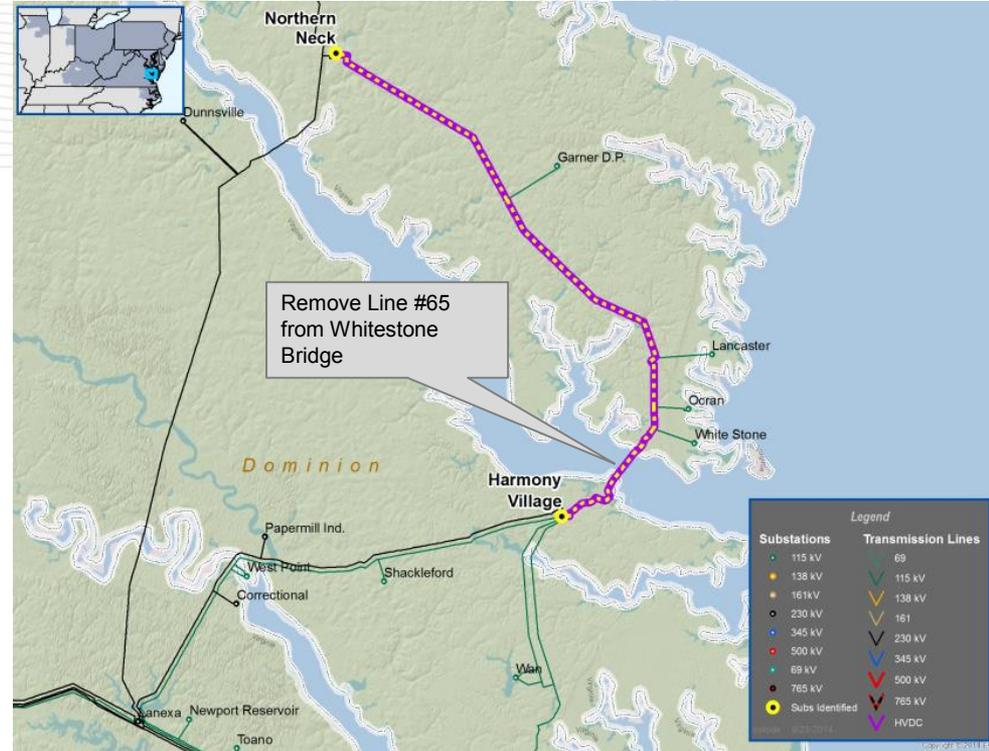
B2505 Cost Increase:

- The project is to remove Line #65 Harmony Village to Northern Neck 115 kV from the Whitestone Bridge by installing structures in the water to improve operability and reliability

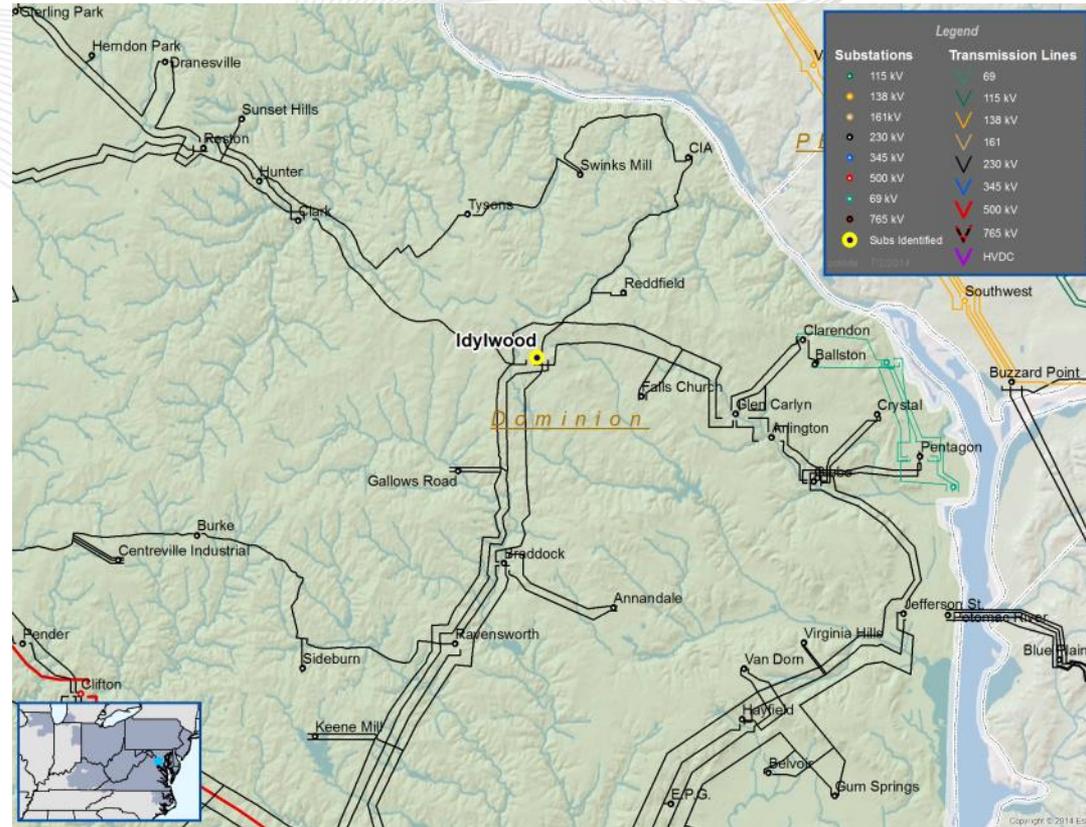
Revised Project Cost: From \$10M to \$30M due to:

- Greater Water depth than anticipated.
- 11 H-Frame structures on quad cylinder pile foundations required in the river.
 - 9 structures at 120'
 - 2 structures at 200'
- 4 new structures on land required.
- Permitting required with FAA, Army Corps, Virginia Marine Resource Commission, local wetlands board (Lancaster and Middlesex Co)

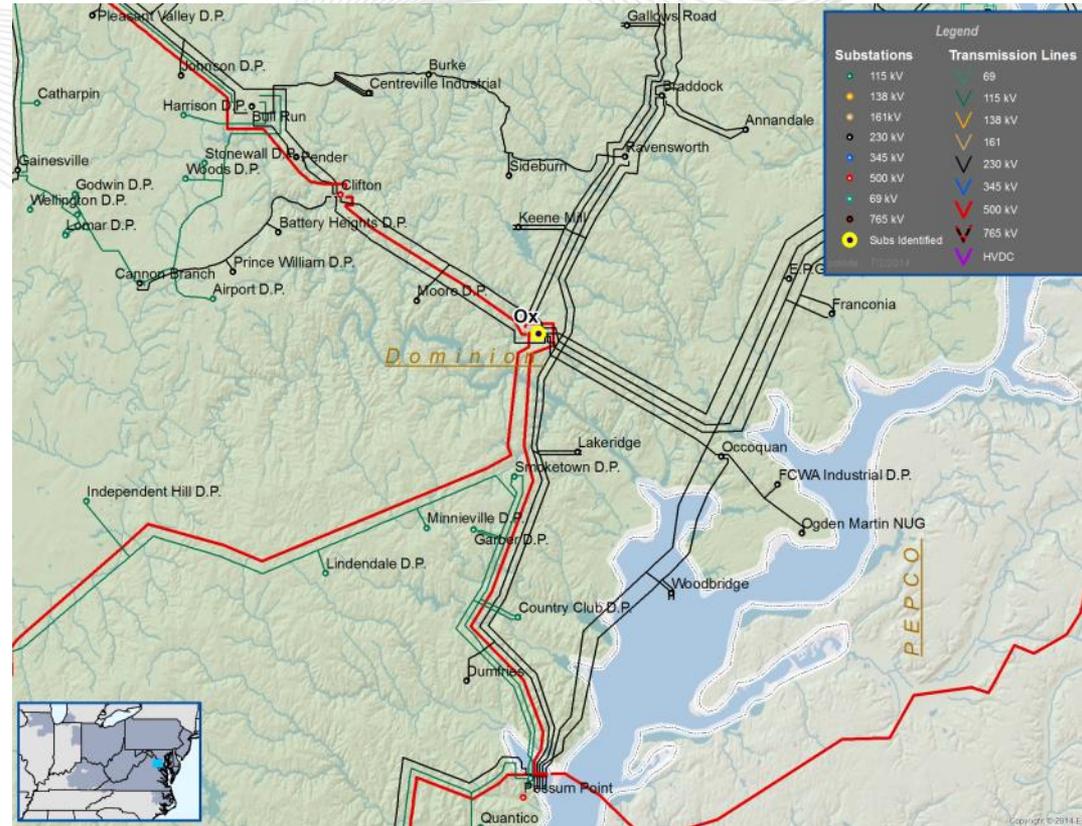
Revised IS Date: 12/30/2017

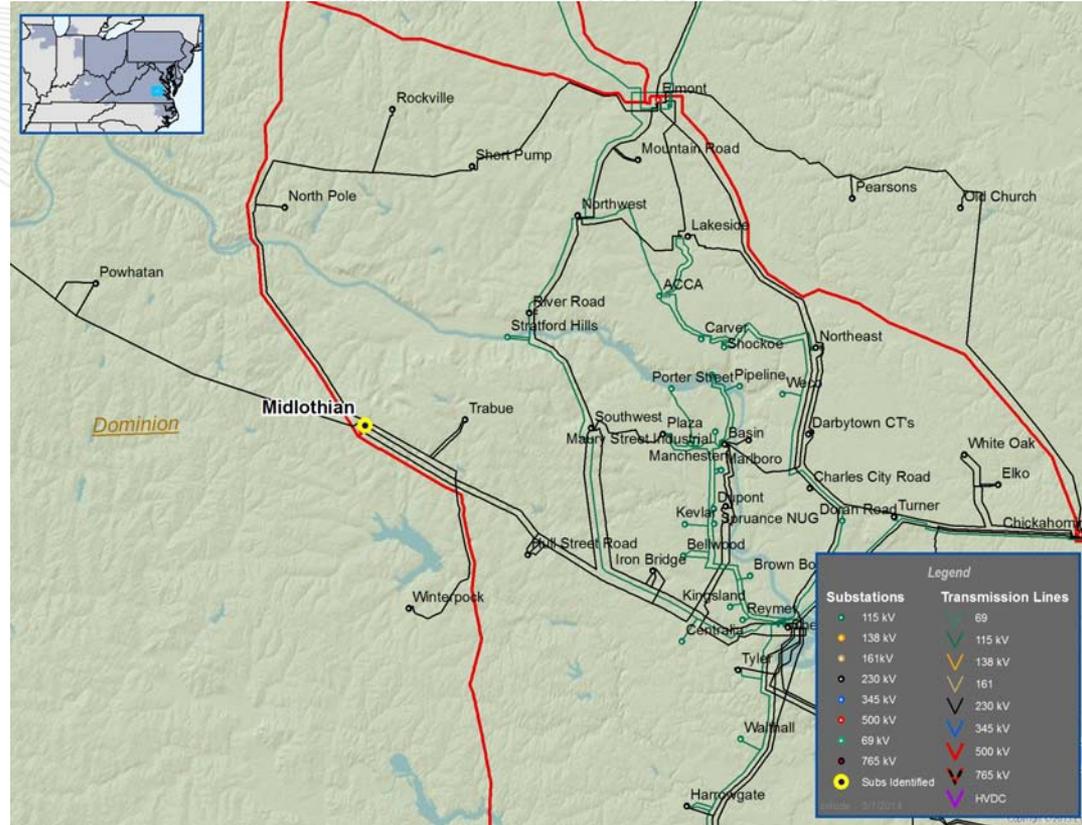


- The Idylwood 230kV breaker '203512' is overstressed
- Significant Driver: Construct new underground 230 kV line from Glebe to Station C (B2443)
- Recommended Solution: Replace the Idylwood 230kV breaker '203512' with a 50 kA breaker (B2443.1)
- Estimated Project Cost: \$255 K
- Required IS Date: 6/1/2018



- The Ox 230kV breaker '206342' is overstressed
- Significant Driver: Construct new underground 230 kV line from Glebe to Station C (B2443)
- Recommended Solution: Replace the Ox 230kV breaker '206342' with a 63 kA breaker (B2443.2)
- Estimated Project Cost: \$270 K
- Required IS Date: 6/1/2018



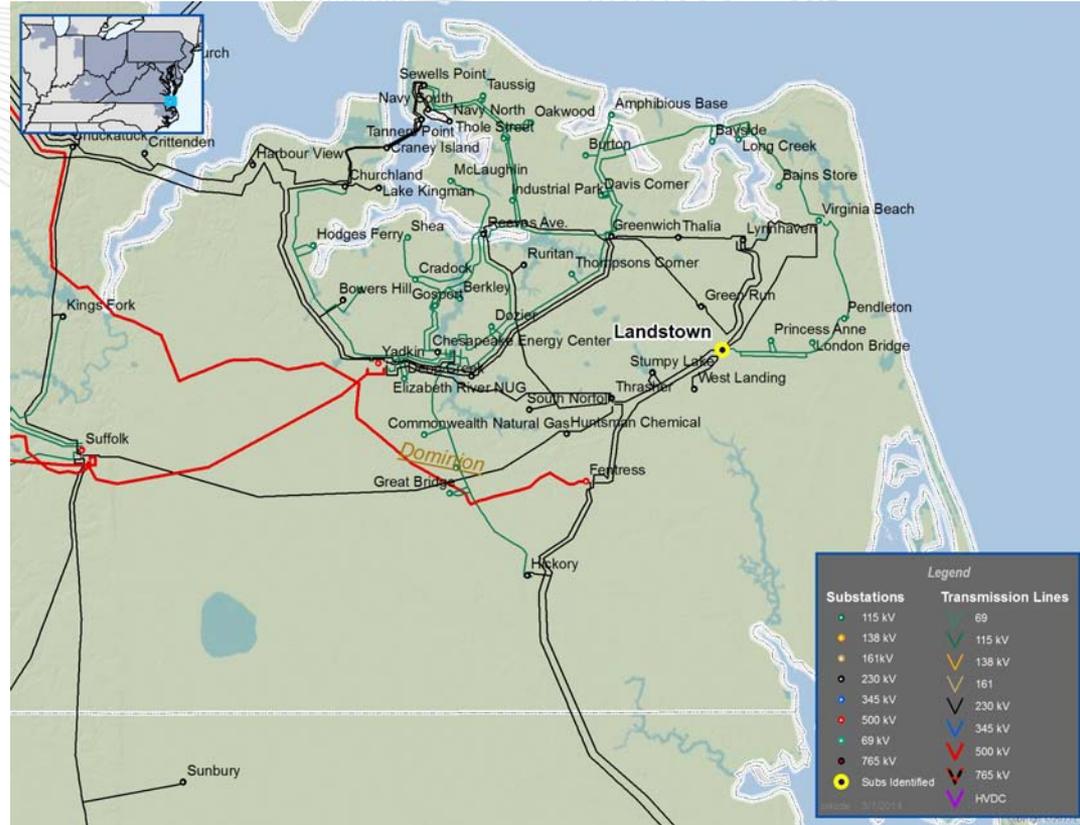


Operational Performance

Midlothian 500kV Ring Bus

- Midlothian is the last remaining substation on the Dominion system that has a 500/230kV transformer that is tapped directly to a 500kV line and has motor operated switches. This does not meet Dominion's minimum operating standards for 500kV.
- Recommended Solution: At Midlothian, replace 500kV breaker 563T576 and motor operated switches with a 3 breaker 500kV ring bus. Also, terminate Lines #563 Carson to Midlothian and #576 Midlothian to North Anna and Transformer #2 in the new ring (B2471).
- Required IS Date: 11/1/2015
- Estimated project cost: \$ 9 M

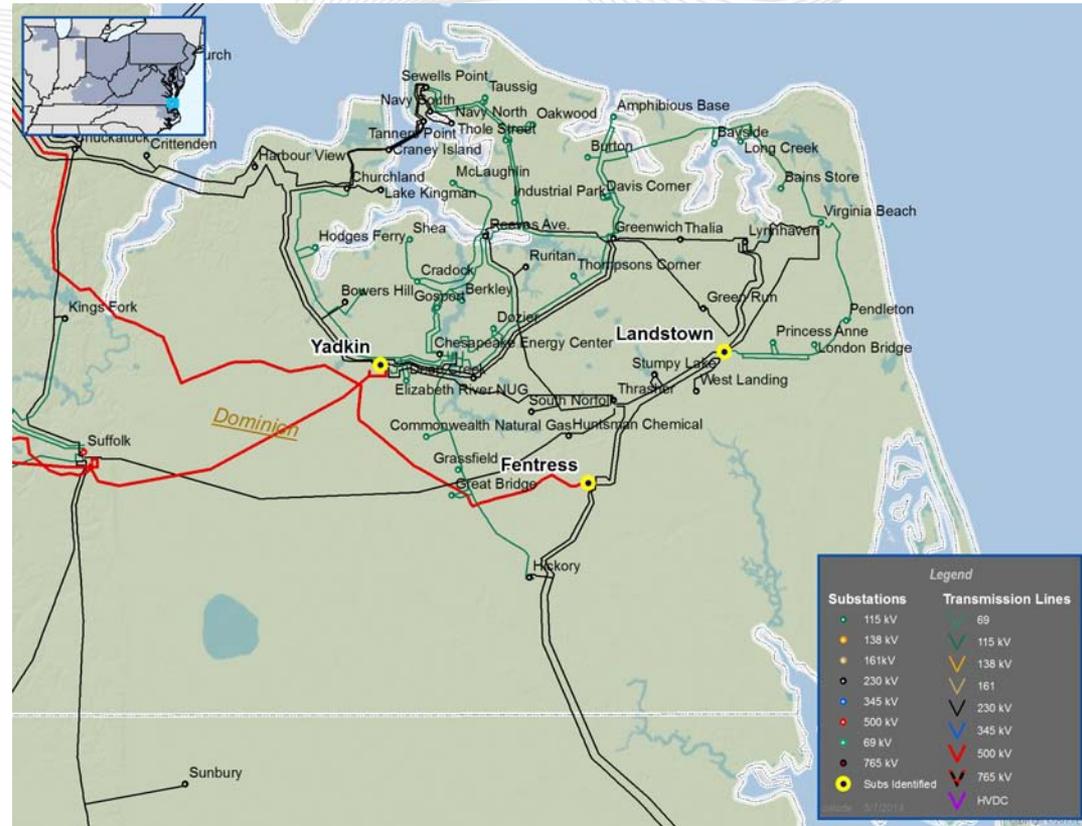
- **Baseline Project b1912 scope update**
 - Project B1912 was established due to the Chesapeake Units #1-4 Retirement
 - Re-consider scope due to electrical and physical considerations
 - Existing Problem: Voltage collapse in the Va Beach area for an N-1-1 outage of Suffolk-Yadkin 500 kV Line and the Yadkin – Fentress 500 kV Line
 - Previous Recommended Solution: (B1912) – Install a 500 MVAR SVC at Landstown.
 - Re-consider this solution due to electrical and physical considerations
 - Previous Estimated Project Cost: \$60 M.
 - Required IS Date: 06/01/2016
- Continued on the next slide.....



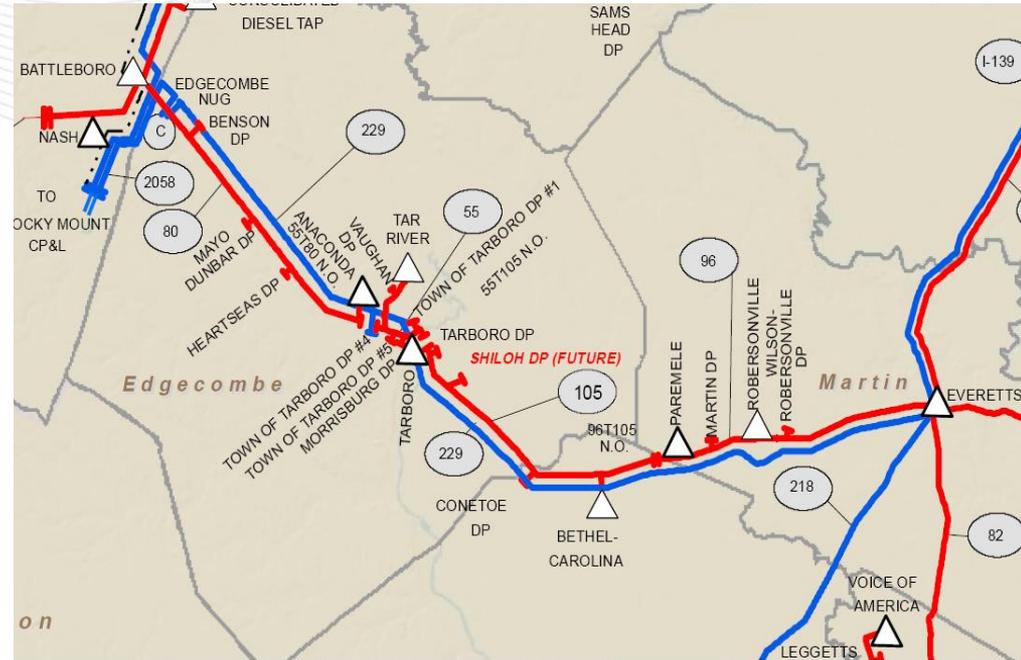
...continued from the previous slide

Chesapeake Units #1-4 Retirement - Revised Solution

- **Existing solution:** Install a 500 MVar SVC at Landstown.
- Estimated Project Cost: \$67 M
- **New recommended solution:** Install three smaller +/- 125 MVar STATCOM at three different Substations (Landstown, Yadkin, Fentress) (B1912).
- New Estimated Project Cost \$70 M
- New recommended solution benefits:
 - Three smaller distributed resources, instead of a single larger resource
 - Improved reliability in coastal environment due to the indoor configuration of a STATCOM
 - Less acoustic noise in urban areas
 - Three locations provide better physical security and a smaller foot print
 - Device response
 - Located closer to load centers
- Required IS Date: 06/01/2016



- Recommended Change to Existing Approved Baseline Project
- Project B2184 - Tarboro 230kV breaker cost increase
- Reason for change: Reliability improvements and necessary construction increased cost from \$2.5M to \$3.9M:
 - Installation of 230kV breakers on high side of both transformers instead of circuit switchers
 - Installation of 115kV breaker at 55T105 instead of installing sectionalizing scheme
 - Replacement of A-frame in station with a 230kV backbone to accommodate new breaker
- Estimated cost \$3.9M
- Projected IS Date: 12/31/2014



NERC Category B Violation

Problem:

- In 2016 summer an outage of the Fredericksburg to Ladysmith 230 kV line (Line #2090) with Surry 230kV Generation off-line results in the Elmont to Four Rivers 230kV (Line #2032) loading to above 94% of the emergency rating.

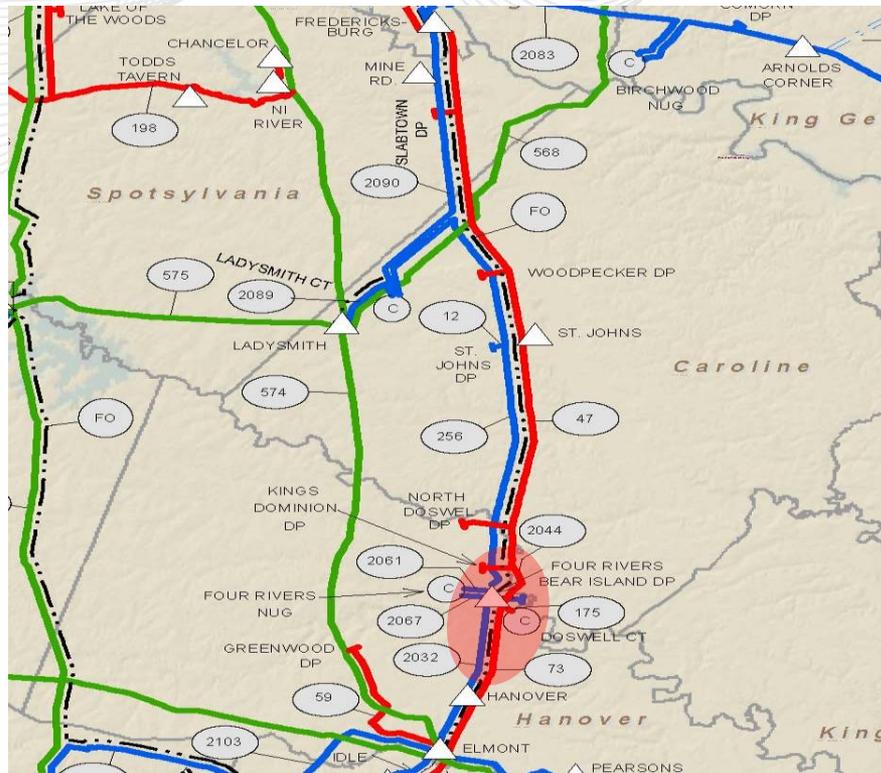
This overload also occurs in the 2018 RTEP analysis for Category C contingencies.

Proposed Solution:

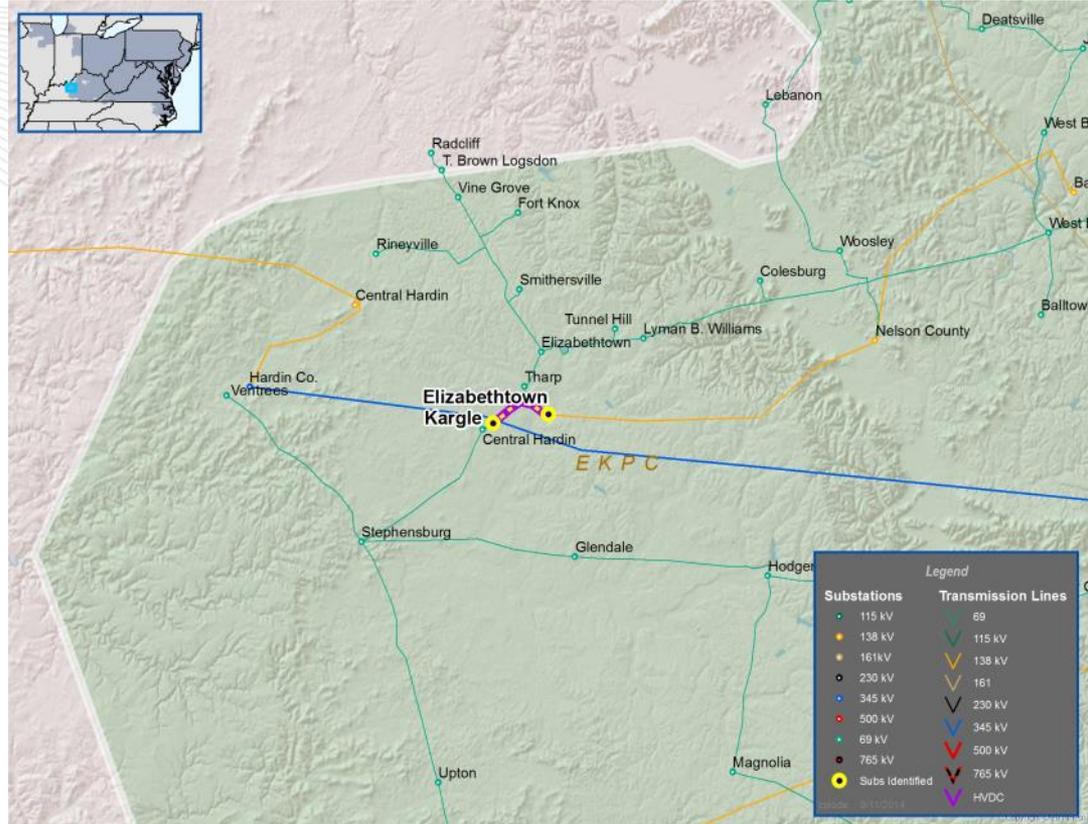
- Uprate the summer emergency rating of Line #2032 to 1195 MVA by replacing the 230kV line switches at Hanover Substation with 3000a switches and replacing the Line #2032 wave traps at Four Rivers and Elmont with 3000a wave traps (B2460.1 and b2460.2).

Estimated cost \$ 0.25 M

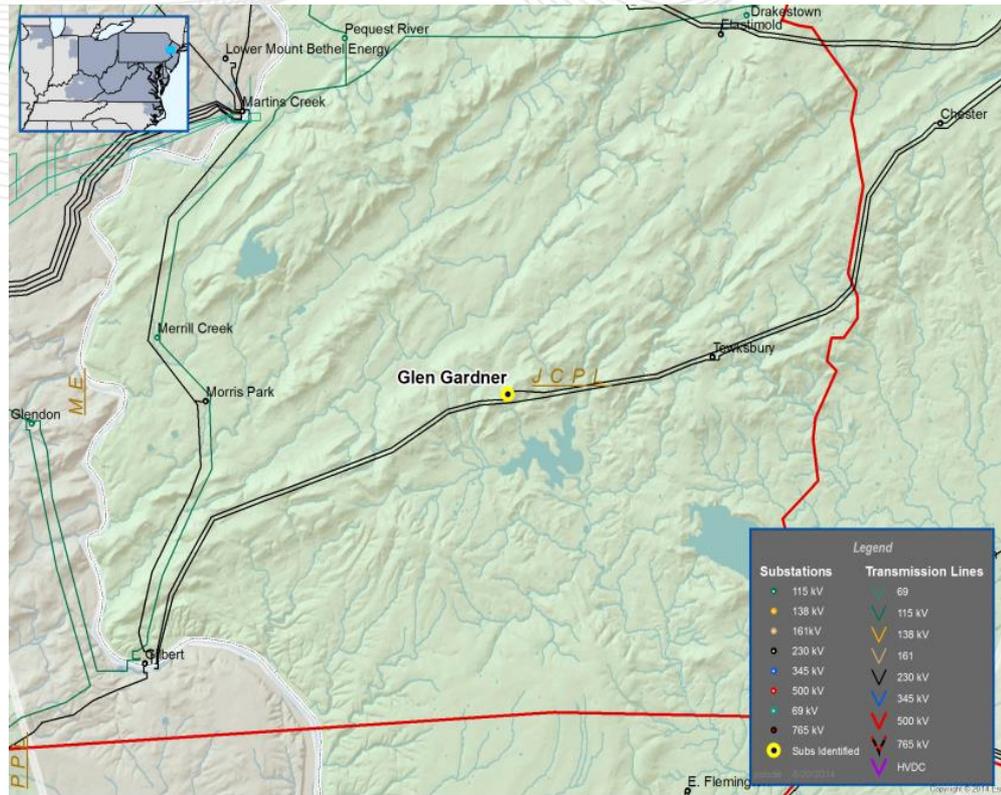
Required IS Date: 5/1/2016



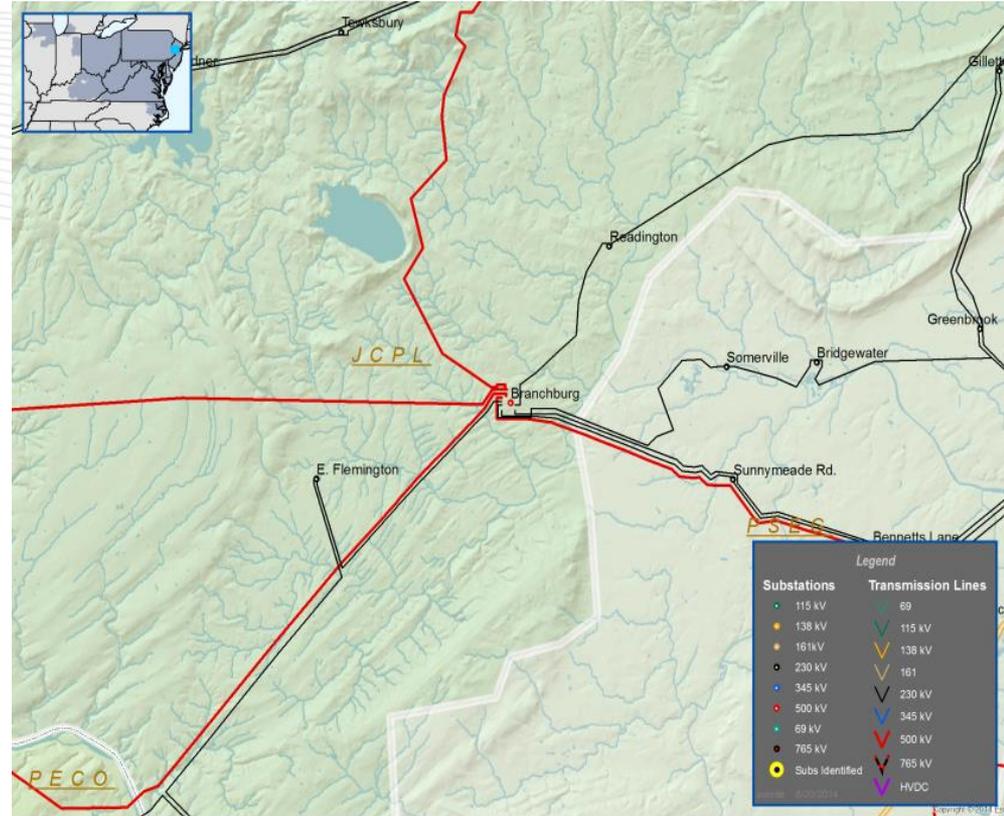
- EKPC Criteria Violation
- The Kargle-KU Elizabethtown 69 KV line section is overloaded for an outage of the Central Hardin-Hardin County 138 KV line section with LGE/KU's brown #3 out.
- Increase the MOT of the 266.8 MCM ACSR section (1.4 miles), of the Kargle-KU Elizabethtown 69 KV line section to 266°F. (B2544)
- Estimated Project Cost: \$0.0276M
- Required IS Date: 6/1/2015



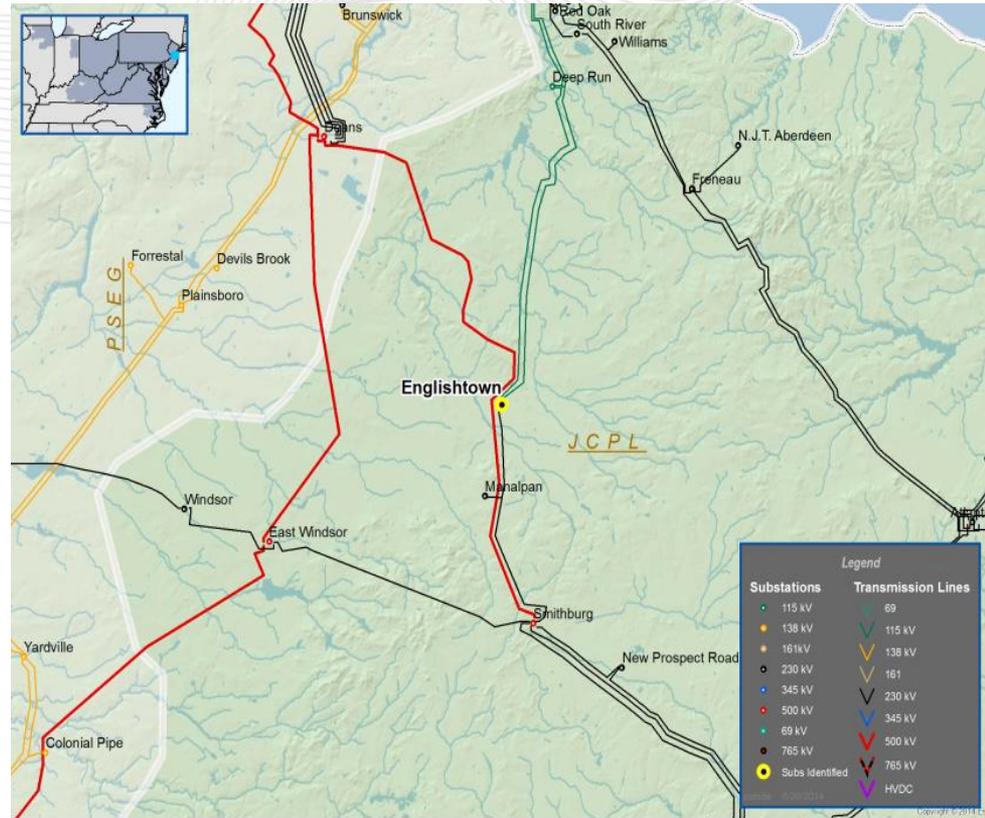
- FE Planning Criteria Violation :
- The Captive Plastics to Morris Park 34.5 kV circuit is overloaded for the loss of the Gilbert – Glen Gardner 230 kV circuit.
- Recommended Solution:
 - Reconductor 0.9 miles of the Captive Plastics to Morris Park 34.5 kV circuit (397 ACSR) with 556 ACSR (B2497).
- Estimated Project Cost: \$ 0.6 M
- Required IS Date: 6/1/2015



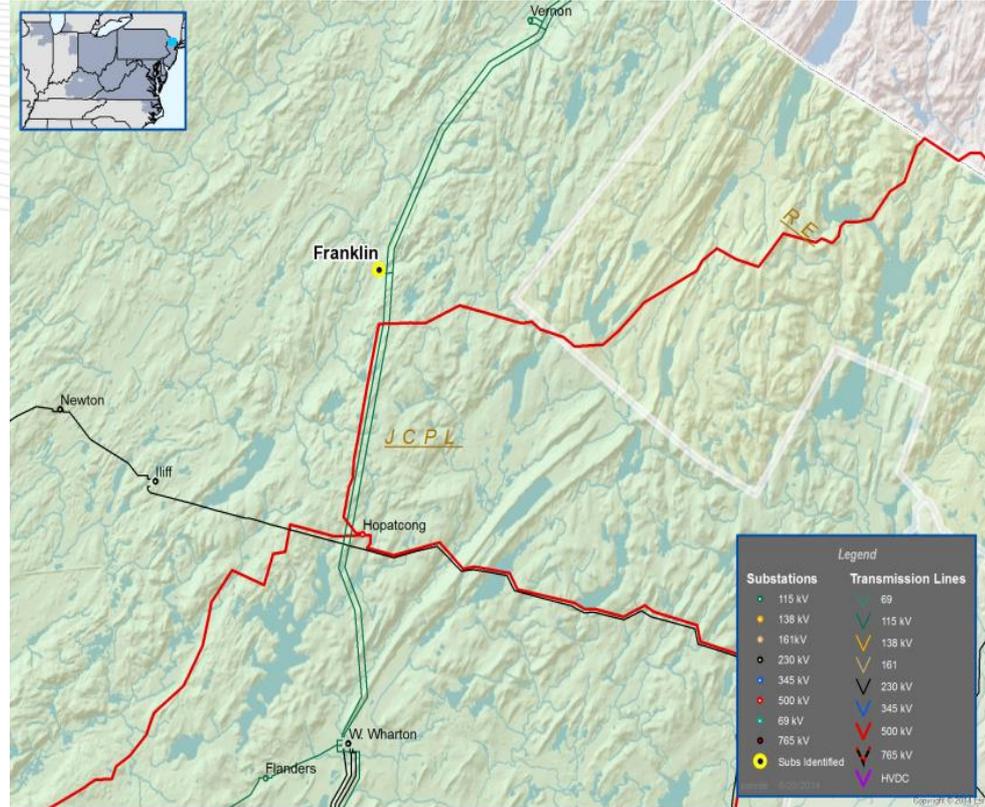
- FE Planning Criteria Violation :
- The Lebanon to North Branch 34.5 kV circuit is overloaded for the loss of the Branchburg – Readington 230 kV and the Readington 230/34.5 kV transformer #1.
- Recommended Solution:
 - Extend 5.8 miles of 34.5 kV circuit from north Branch substation to Lebanon substation with 397 ACSR and install 34.5 kV breaker at Lebanon substation (B2498).
- Estimated Project Cost: \$ 2 M
- Required IS Date: 6/1/2015



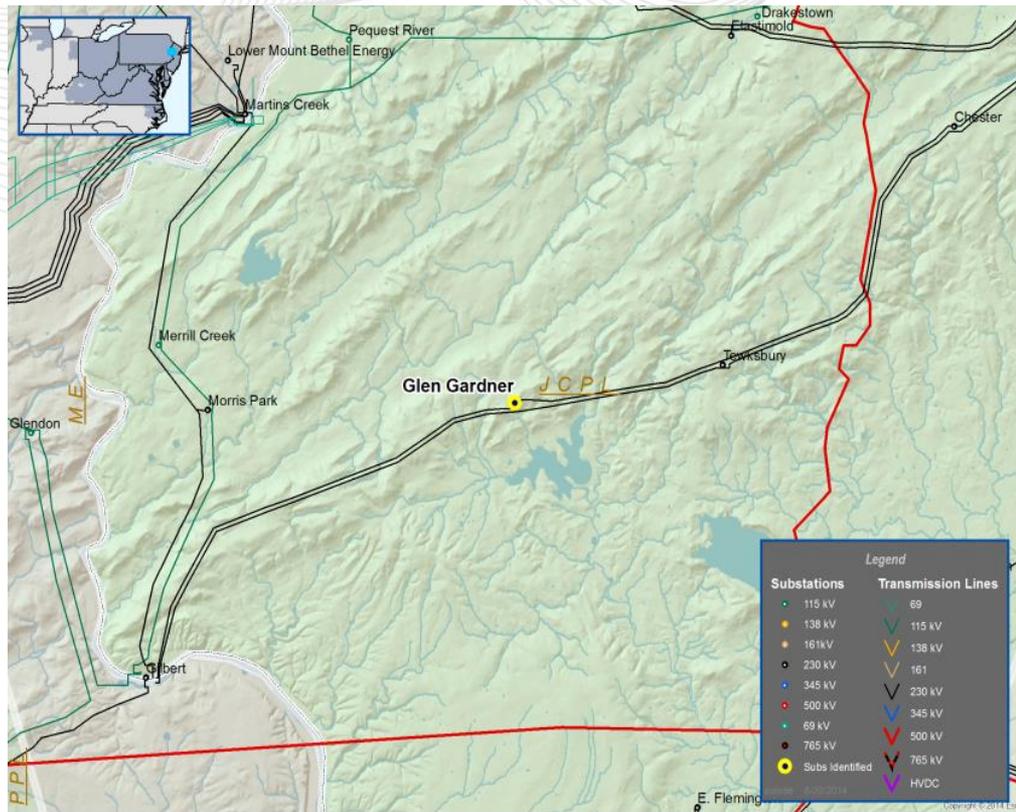
- FE Planning Criteria Violation :
- The Englishtown to Monroe (H34) 34.5 kV circuit is overloaded for the loss of the Englishtown –Monroe – Wyckoff St. (D82) 34.5 kV circuit.
- Recommended Solution:
 - Upgrade the terminal equipment at Monroe on the Englishtown to Monroe (H34) 34.5 kV circuit (B2500).
- Estimated Project Cost: \$ 0.1 M
- Required IS Date: 6/1/2015



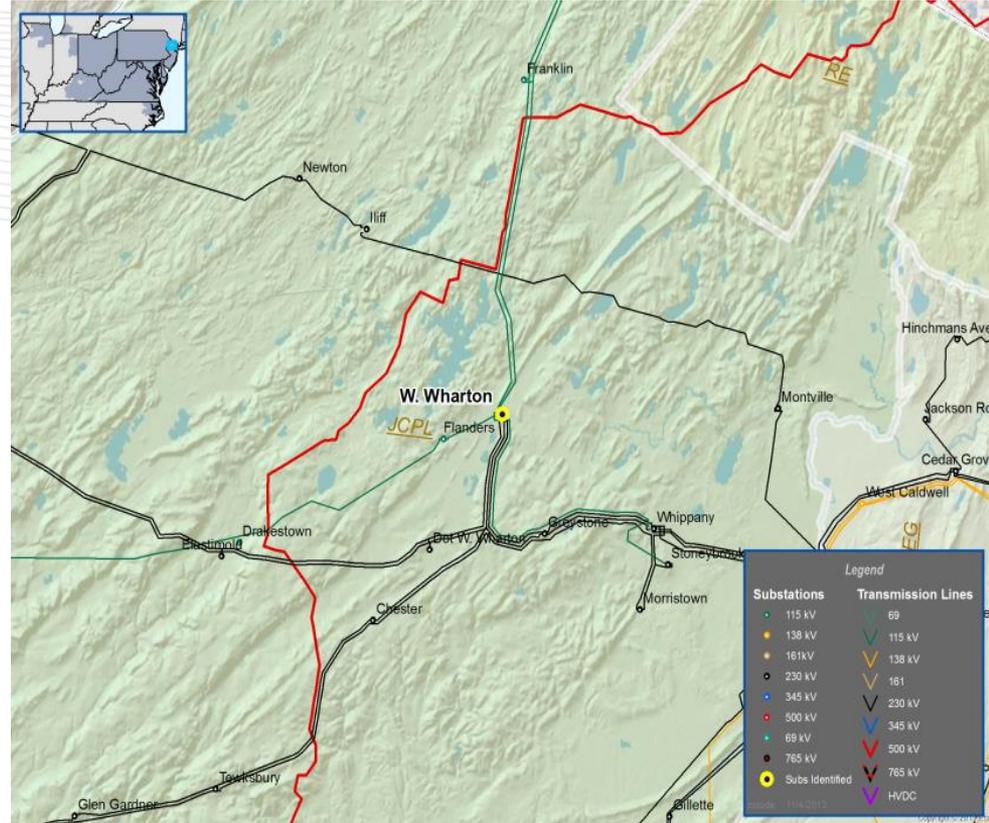
- FE Planning Criteria Violation :
- The Franklin 115/34.5 kV transformer #2 is overloaded for the loss of the Franklin 115/34.5 kV transformer #1.
- Recommended Solution:
 - Replace the Franklin 115/34.5 kV transformer #2 with a 90 MVA transformer (B2496).
- Estimated Project Cost: \$ 3 M
- Required IS Date: 6/1/2015



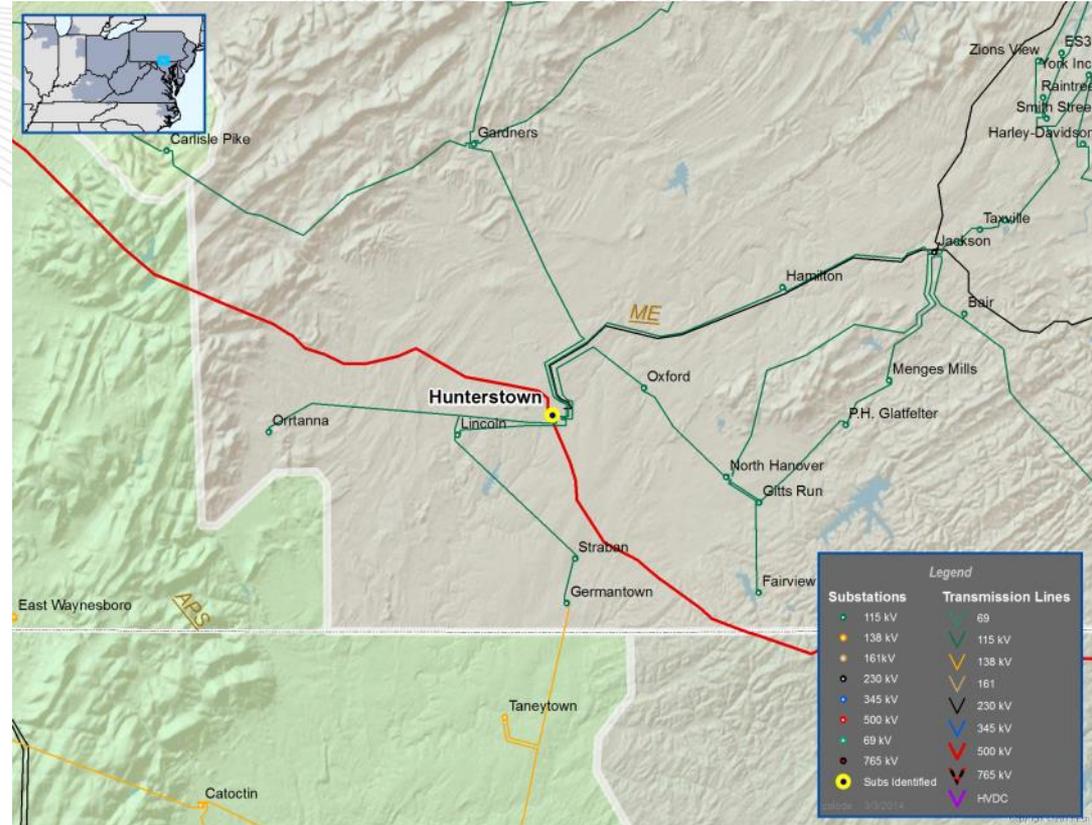
- FE Planning Criteria Violation:
- The Glen Gardner 230/34.5 kV transformer #1 is overloaded for loss of Chester – Glen Gardner 230 kV circuit.
- Recommended Solution:
 - Replace the transformer leads on the Glen Gardner 230/34.5 kV #1 transformer (B2495).
- Estimated Project Cost: \$ 0.1 M
- Required IS Date: 6/1/2015



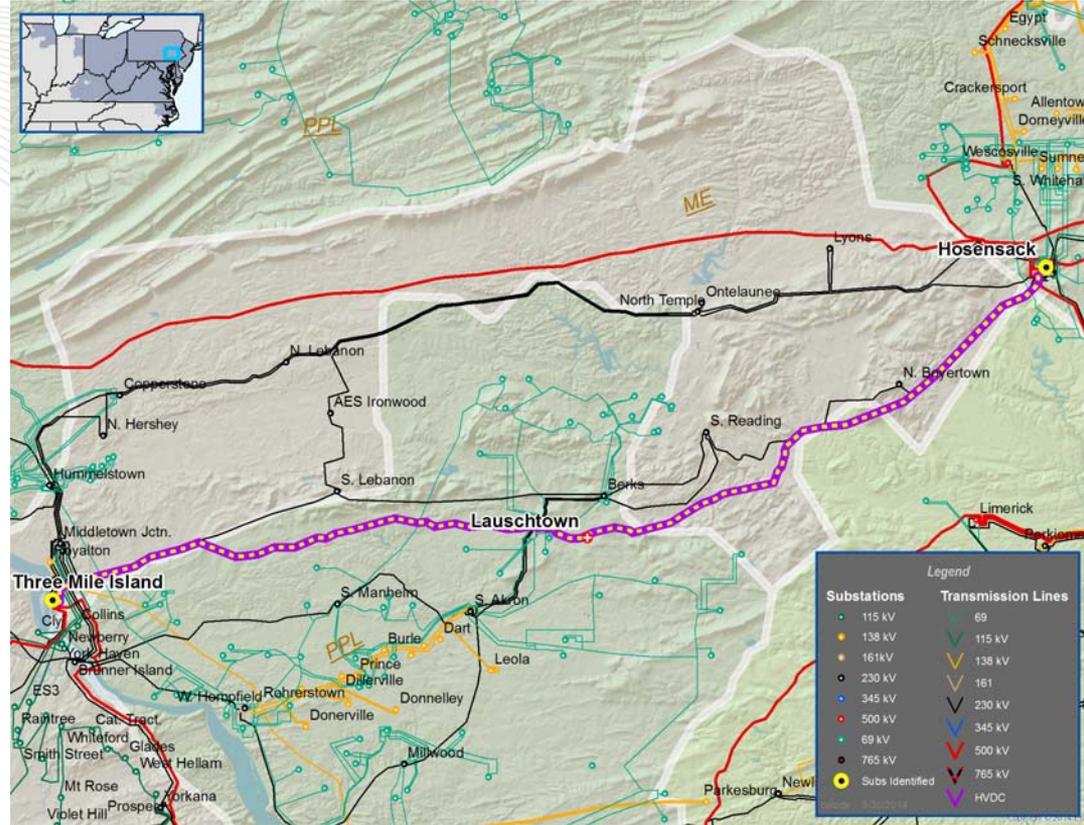
- B2234 Scope Change:
- Existing Scope:
Install 260 MVAR reactor at West Wharton 230 kV.
- New Proposed Scope:
Install -260/+40 MVAR SVC at West Wharton 230 kV substation.
 - The SVC will have the ability to control an existing 350 MVAR capacitors at West Wharton. It replaces the loss of dynamic reactive reserve due to generator retirements in the area. It will mitigate any potential voltage collapse due to an excessive number of capacitor switching steps required.
- Estimated Project Cost:
Existing → \$ 8.6 M
New → \$ 41.4 M
- Expected IS Date:
4/1/2015



- The Hunterstown 115 kV breaker '96192' is overstressed
- Significant Driver : Install 2nd Hunterstown 230/115kV transformer (B2452)
- Recommended Solution: Replace the Hunterstown 115 kV breaker '96192' with 40kA rated breaker (B2452.3)
- Estimated Project Cost: \$285 K
- Required IS Date: 6/1/2017

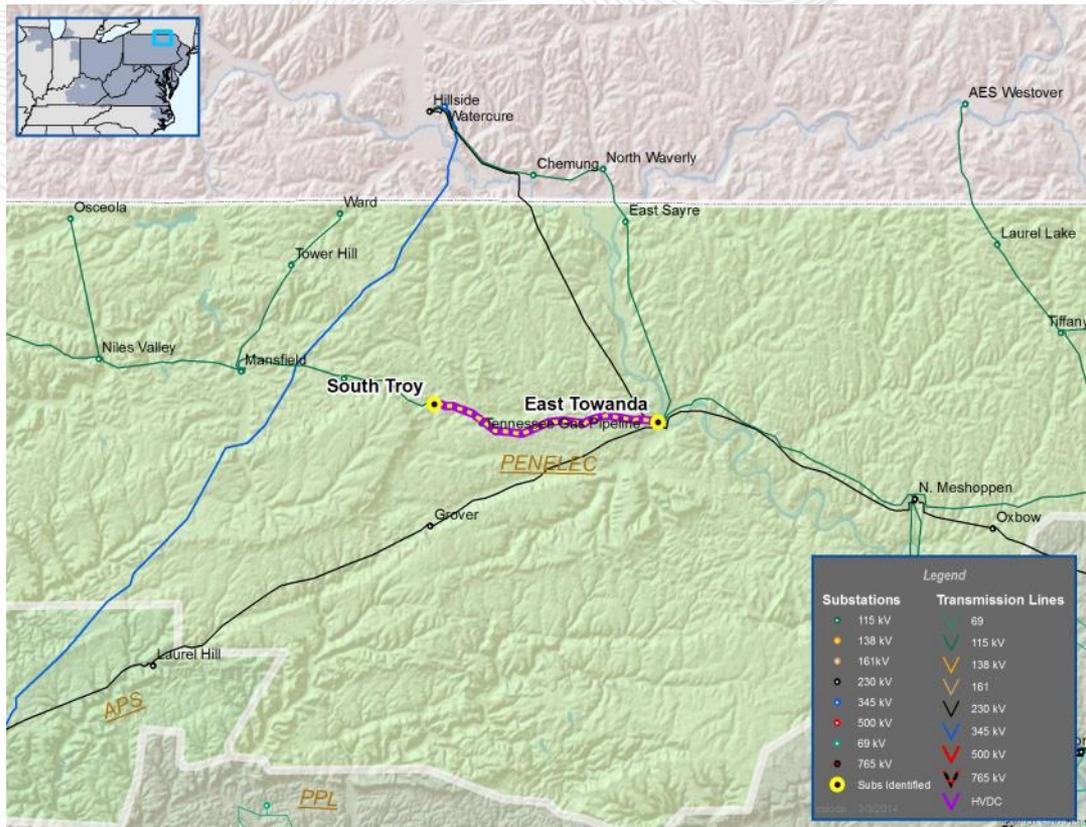


- Add Additional upgrades to existing project scope to address required work in neighboring transmission zones
- The existing B2006 upgrade establishes Lauschtown 500/230/69 kV stations and loops TMI – Hosensack 500 kV into the new 500 kV stations. (Estimated Project Cost: \$95 M)
- Add additional upgrades (B2006.1.1 and B2006.2.1) to address the required MetEd/FirstEnergy work that is required as part of the existing B2006 upgrade.
- **B2006.1.1:** Build new sections to loop the 5026 (TMI – Hosensack 500 kV) line in to the Lauschtown substation and upgrade relay at TMI 500 kV.
- **Estimated Project Cost:** \$5.25 M
- **Required IS Date:** 6/1/2017
- **B2006.2.1:** Upgrade relay at South Reading, on the 1072 230 kV line.
- **Estimated Project Cost:** \$0.25 M
- **Required IS Date:** 5/1/2016

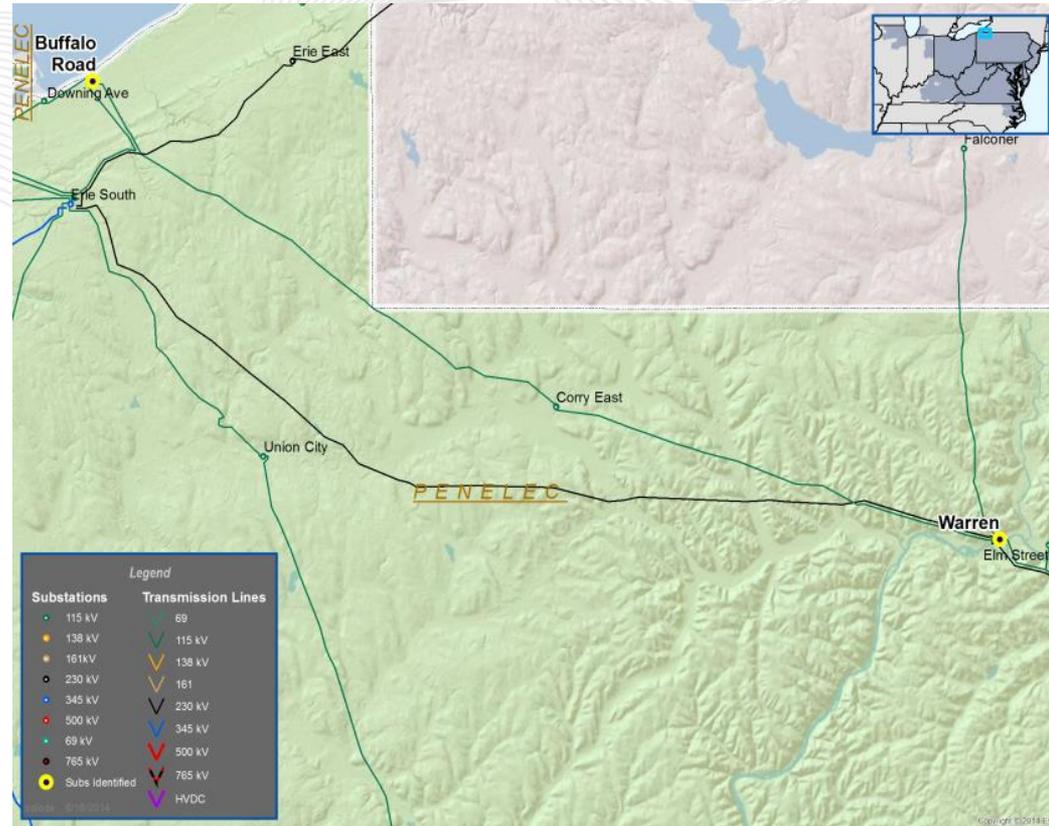


- **Light Load Reliability Analysis**

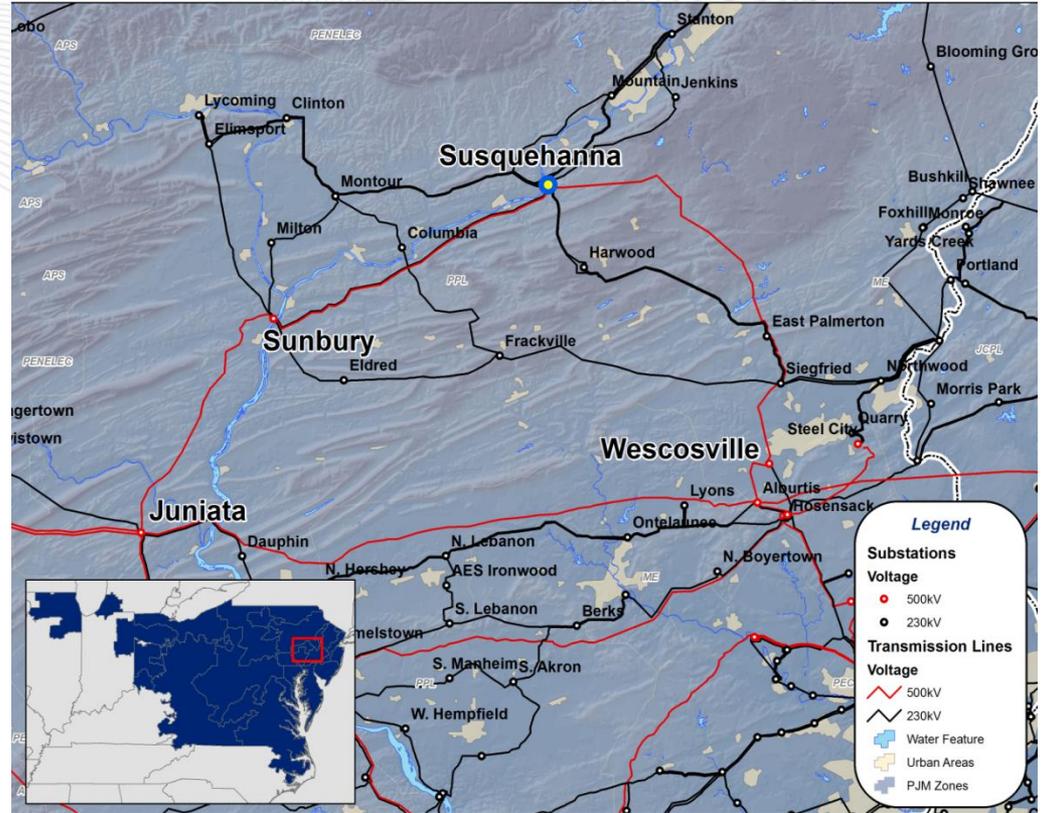
- The South Troy – East Towanda 115kV line is overloaded due to various single contingencies
- Recommended Solution: Rebuild and Reconductor 115 kV line from East Towanda to S. Troy & upgrade terminal equipment at East Towanda, Tennessee Gas & South Troy. (B2463)
- Estimated Project Cost: \$40 M
- Required IS Date: 3/1/2016



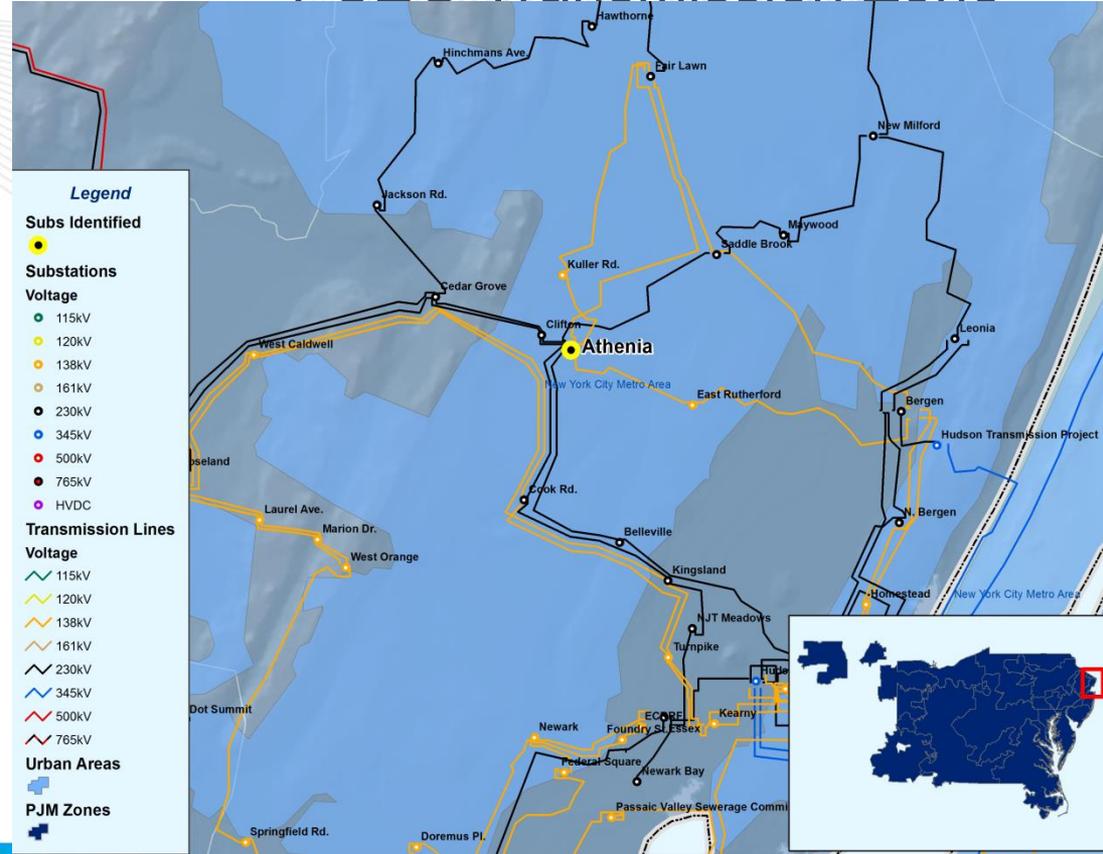
- FE Planning Criteria Violation and Operational Performance:
- Voltage violation in the North Western Pennsylvania (Warren/Buffalo Road) vicinity for multiple contingencies.
- Recommended Solution:
 - Construct Warren 230 kV ring bus and install a second Warren 230/115 kV transformer (B2494).
- Estimated Project Cost: \$ 15 M
- Required IS Date: 6/1/2016



- **Cancellation of B1808.2 and B1808.4 upgrades**
- B1808.2 (replace AVR and rectifier bank on Susquehanna unit 1) and B1808.4 (replace AVR and rectifier bank on Susquehanna unit 2) were identified as part of the overall plan to mitigate a previous stability criteria violation at the Susquehanna generation plant.
- However, the stability issue is already mitigated by B1808.1 (install PSS at Susquehanna unit 1) and B1808.3 (install PSS at Susquehanna unit 2).
- As a result, B1808.2 and B1808.4 are not required and will be canceled.



- The Athenia 138kV breakers '2LH' and '2TH' are overstressed
- Recommended solution: Rebuild the Athenia 138kV substation to 80kA (B2474).
- Estimated Project Cost: \$131 M
- Required In-Service Date: 6/1/2018



Questions?

Email: RTEP@pjm.com

- **Revision History**

- Version 1: Original version posted to the PJM TEAC on 9/24/2014
- Version 2: Slide 72 Baseline Upgrade ID Typo corrected; Slide 80 (B1794) removed due to duplication; Posted on 9/25/2014
- Version 3: Updated Flowgate Number from 1.1 to 1.4 on Slide 22 on 10/3/2014