Transmission Expansion Advisory Committee

Reliability Analysis Update

May 7, 2015

2015 RTEP Scenario Studies

2015 RTEP Scenario and Sensitivity Studies

- Section 111(d) of the Clean Air Act
  - Develop and run Market Efficiency Scenarios
  - Reliability modeling
  - Reliability Criteria Violation identification
  - Transmission Overlay Development

- Analysis of critical Winter conditions – Gas/Electric interaction
  - Develop and document planning analysis procedures to assess risk associated with gas / electric interdependencies
  - Development of gas contingencies

EPA 111(d) Study

111(d) At-Risk Scenario Study – Assumptions

- Three at-risk levels: 6GW, 16GW and 32GW
- Base case: 2022 Summer Peak
- FSA generation will need to be turned on to satisfy load and interchange
- Reliability tests:
  - Generation Deliverability
  - Load Deliverability of select areas based on location of at-risk generation
- Monitor all PJM 230 kV+ facilities
- Use transmission facility conductor ratings

111(d) At-Risk Scenario Study

- 2022 Summer Peak case creation and analysis is underway
  - Generator Deliverability
  - Load Deliverability
- The 17 Locational Deliverability Areas (LDAs) below were selected (out of 27 possible) due to the magnitude of at-risk generation
  - The LDAs noted below will be evaluated for thermal and voltage performance using the PJM Load Deliverability Test

At-Risk/LDA	BGE	DPL	DPL S	DAY	DVP	AEP	EKPC	FE	CE	DEOK	SWMAAC	PJM W	AE	PL	PENELEC	WMAAC	MAAC
6 GW	x	x	x	x	x	x	x				x	x					
16 GW	x	x	x	x	x	x	x	x	x	x	x	x					
32GW	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

- Next Steps
  - Complete generator deliverability and load deliverability analysis for the identified LDAs and at-risk scenarios
  - Consider additional scenarios

Winter Peak Study Update

2015 RTEP PJM Winter Peak Study

- Year 2019
- Transmission Owner Feedback and Benchmarking
  - Re-ran the 2014 RTEP study with an updated load profile
  - Added additional sub-transmission contingencies provided by TOs
  - Benchmarkedl the violations TO identified in their internal studies and observed in PJM Operations
    - Some violations are N-1-1 violations which were not in last year's study scope
    - Some violations are on Non-BES facilities, which are TO's planning criteria violation
- Year 2020
  - Initial case will be sent to TOs for a winter ratings and load profile update in May
  - The planned study will have similar initial scope as last year: winter generator deliverability, load deliverability
  - Gas contingencies will be evaluated

Winter Peak Evaluation

- The 2014 Winter study
  - N-1-1 thermal and voltage tests were not performed
  - Modeled the gas contingency outages as part of the base case assumptions then ran the load deliverability test only
    - Did not have the exact definitions, used the magnitudes of at-risk gas by TO zone
- The 2015 study will evaluate additional existing RTEP test procedures
  - Each of the 34 gas contingencies will be included in the following test procedures:
    - N-1 thermal, voltage
    - Generator deliverability
    - Load deliverability
    - N-1-1
  - This year, we will just use the gas event as a contingency that we study as part of the tests
    - Now have the specific contingency definitions (at the individual generator level)

Gas Contingency Evaluation

- A complete set of PJM gas pipeline contingencies that result in 1000 MW or more of generation loss will be studied
  - Assumptions:
    - All gas generation downstream of the gas contingency on the same gas infrastructure is lost
    - Assume that all gas generation is lost, regardless of dual fuel status
  - Pipeline outages or compressor failure (30 contingencies)
  - Also include temperature threshold contingencies (4 contingencies)
    - At a pre-determined temperature threshold, assume that non-firm customers (i.e. non-heating demand) will be interrupted

Gas Contingency Evaluation

- Load Deliverability
  - Last year, we modeled the gas contingency outages as part of the base case assumptions then ran the load deliverability test
    - Did not have the exact definitions, used the magnitudes of at-risk gas by TO zone
  - This year, we will just use the gas event as a contingency that we study as part of the load deliverability test
    - Now have the specific contingency definitions (at the individual generator level)

2015 RTEP PJM Winter Peak Study

- Development of Winter Reliability Criterion
  - 2014
    - Learned about the process of developing an updated Winter model
      - Load profile and internal PJM zonal interchange are critical
      - Initial dispatch and ramping of generation by fuel type
    - Ran initial power flow studies
    - Feedback and lessons learned
  - 2015
    - Evaluate additional test procedures
    - Evaluate detailed gas contingencies (specific units)
    - Establish high level winter peak study criteria
    - Begin to establish a method to mitigate criteria violations
    - Draft Manual 14B Winter Peak Study procedure
    - Approve Winter Peak Study procedure
  - 2016
    - Provide a 5 year out winter peak study case that is consistent with the approved procedure (for use in RTEP and TO Local Planning)
    - Implement Winter Peak Study criteria in 2016 RTEP
    - Identify reliability criteria violations resulting from the new criteria and develop solutions through the RTEP process as needed

2015 RTEP Proposal Window Update

2015 RTEP Analysis Update

- Progress summary of thermal results (N-1, Generator Deliverability, Common Mode Outage)
  - Potential violations of applicable ratings by Voltage Class
    - 500 kV – 1
    - 345 kV – 1
    - 230 kV – 3
    - 138 kV – 4
    - 115 kV – 1
    - 345/138 kV – 1
  - Conductor limits are requested and will be provided
- Based on this result, the approach on the next slide is suggested

2015 Proposal Window Update

- Similar approach as 2014 RTEP
- Year 2020 studies update
  - N-1 Thermal
    - complete and posted
  - Generator Deliverability and Common Mode Outage Thermal
    - complete, initial version posted, updated version to be posted next week
  - Load Deliverability Thermal
    - in-progress, results anticipated to be posted end of May 2015
  - N-1-1 Thermal
    - Results anticipated to be posted 1st week of June 2015
  - 15 year results will also be complete and available by the anticipated window open date
- Anticipated 2015 RTEP Proposal Window #1 Open – week of June 8th, 2015

2015 Proposal Window Update

- Analysis Next Steps
  - N-1 Voltage
  - N-1-1 Voltage
  - Light Load Reliability Criteria
  - TO Planning Criteria Violations

2014 RTEP Proposal Window 2 Addendum 2

2014 RTEP Proposal Window 2 Addendum 2 – Project Submissions

- 4 Proposing entities

- 10 Proposals
  - 9 Greenfield
    - Cost Range $10.55M - $31.5M
  - 1 TO Upgrade
    - Cost: $0.96M

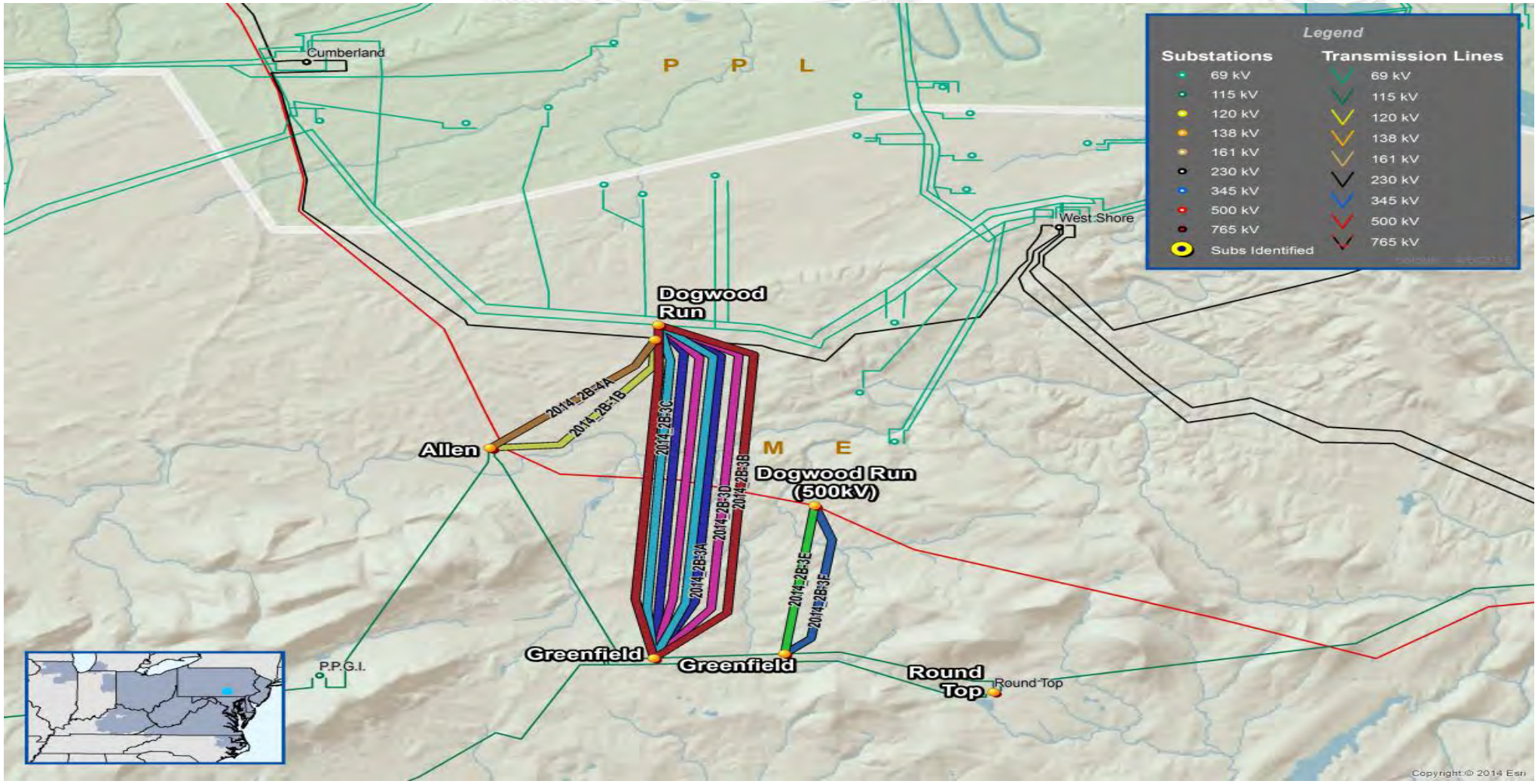
- 1 target TO Zone - Meted

- Detailed list and descriptions are posted with today's meeting materials

2014 RTEP Proposal Window 2 Addendum 2 – Project Submissions

Project ID	Upgrade/ Greenfield	Proposing Entity	Cost ($M)	Target Zone	kV Level	Analysis Type	Major Components
2014_2B-1A	Greenfield	Transource	16.13	Meted	230	N-1-1 Voltage Drop	Build a new 230/115 kV Station. Install 2-230 kV breakers, 2-115 kV breakers, and a 230/115 kV transformer.
2014_2B-1B	Greenfield	Transource	10.55	Meted	115	N-1-1 Voltage Drop	Allen - Williams Grove (PPL's Cumberland-West Shore 230/69kV Station S0859) 115kV project will build a new 115kV single ckt line from METED's Allen Station to Williams Grove station. Williams Grove station will incorporate a new 230/115kV transformer (300 MVA) and install a 115kV breaker as part of the proposed project. We assume that PPL will still cut in the 2-69kV lines between Cumberland and West Shore as well as build 69kV lines to West Carlisle and Carlisle Barack Stations. Allen Station will have to be expanded to incorporate the new 115kV line including 2-115kV breakers.
2014_2B-2A	Upgrade	First Energy	0.96	Meted	115	N-1-1 Voltage Drop	Install a 28.8 MVAR 115 kV capacitor at the Mountain substation. Capacitor should be switched on prior to the second contingency.
2014_2B-3A	Greenfield	Northeast Transmission Development	11.1 - 13.80	Meted	69	N-1-1 Voltage Drop	Approximately 2.5-mile double-circuit 115 kV transmission line interconnecting the existing Allen-Roundtop 115 kV transmission line to a new 115/69 kV substation ("Dogwood Run") adjacent to the PPL S0859 230/69 kV substation
2014_2B-3B	Greenfield	Northeast Transmission Development	13.9 - 17 .10	Meted	69	N-1-1 Voltage Drop	Approximately 2.5-mile double-circuit 115 kV transmission line interconnecting the existing Allen-Roundtop 115 kV transmission line to a new 115/69 kV substation ("Dogwood Run") adjacent to the PPL S0859 230/69 kV substation with 60 MVAR Fast Switched Shunt.
2014_2B-3C	Greenfield	Northeast Transmission Development	13.3 - 16.30	Meted	230	N-1-1 Voltage Drop	Approximately 2.5-mile double-circuit 115 kV transmission line interconnecting the existing Allen-Roundtop 115 kV transmission line to a new 115/230 kV substation ("Dogwood Run") adjacent to the PPL S0859 230/69 kV substation
2014_2B-3D	Greenfield	Northeast Transmission Development	17.4 - 21.20	Meted	230	N-1-1 Voltage Drop	Approximately 2.5-mile double-circuit 115 kV transmission line interconnecting the existing Allen-Roundtop 115 kV transmission line to a new 115/230 kV substation ("Dogwood Run") adjacent to the PPL S0859 230/69 kV substation with 90 MVAR Fast Switched Shunt.
2014_2B-3E	Greenfield	Northeast Transmission Development	16.9 - 20.30	Meted	500	N-1-1 Voltage Drop	Build 500/115 kV Substation (Dogwood Run) Interconnecting Juniata-Three Mile Island 500 kV Line to Allen-Roundtop 115 kV Line
2014_2B-3F	Greenfield	Northeast Transmission Development	25.5 - 31.50	Meted	500	N-1-1 Voltage Drop	Build 500/115 kV Substation (Dogwood Run) Interconnecting Juniata-Three Mile Island 500 kV Line to Allen-Roundtop 115 kV Line with 2.5-mile 115 kV Line to a new 115/69 kV substation adjacent to the PPL S0859 230/69 kV substation.
2014_2B-4A	Greenfield	PPL/FE	11.94	Meted	230	N-1-1 Voltage Drop	Expand the existing Allen substation, and connect via new ~2.6 Mile 115kV transmission to PPL's Williams Grove Substation, with transformation to 230kV at Williams Grove Substation

2014 RTEP Proposal Window 2 Addendum 2 – Project Submissions

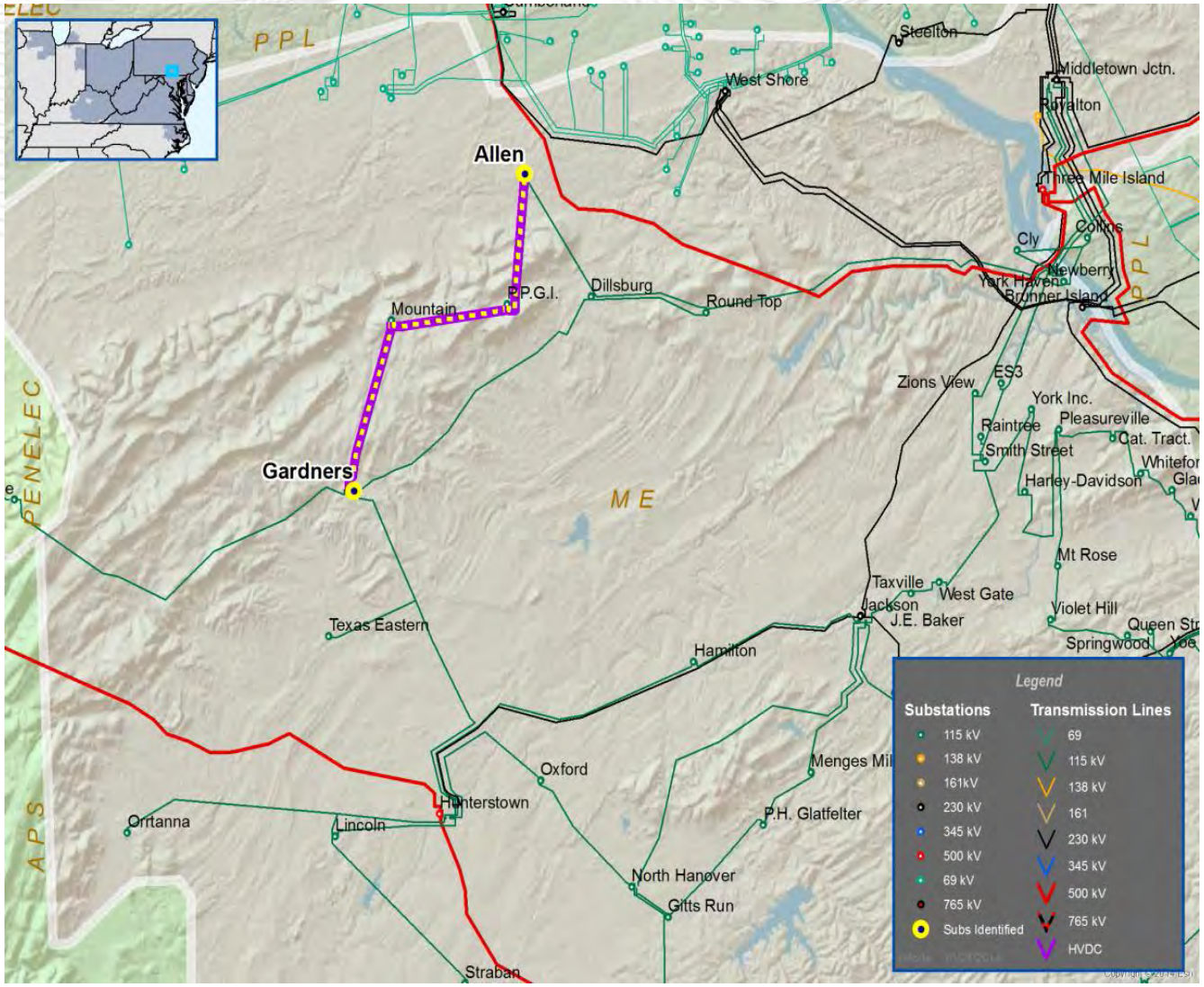


MetEd - Allen Area Recommendation

- First Energy 2014-2B-2A proposal to Install a 28.8 MVAR 115 kV capacitor at the Mountain substation
  - The estimated cost is $0.96 M
  - Solves the required reliability criteria violations
  - Is the most cost effective in resolving the violations
- Recommend the First Energy 2014-2B-2A proposal for inclusion in the RTEP
- Designate the work to FirstEnergy/MetEd

MetEd Transmission Zone

- N-1-1 Voltage Violation:
- Voltage drop violation in the Allen and Gardner vicinity for the N-1-1 contingency loss of the Hunterstown – Texas Eastern – Gardner and Middletown Jct. – Collins – Newberry – Round Top 115 kV circuits.
- Alternatives Considered:
  1) 2014_2B-4A ($11.94 M)
  2) 2014_2B-1B ($10.55 M)
  3) 2014_2B-1A ($16.13 M)
  4) 2014_2B-3A ($11.1 M)
  5) 2014_2B-3B ($13.9 M)
  6) 2014_2B-3C ($13.3 M)
  7) 2014_2B-3D ($17.4 M)
  8) 2014_2B-3E ($16.9 M)
  9) 2014_2B-3F ($25.5 M)
- Recommended Solution:
  Install a 28.8 MVAR 115 kV capacitor at the Mountain substation. (2014_2B-2A)
- Estimated Project Cost:
  $0.96 M
- Required IS Date:
  6/1/2019



Immediate Need Reliability Projects

Immediate Need Project

Dominion Transmission Zone

Operational Performance Problem:

- The Northern Neck area has recently been experiencing high voltage issues on the 230kV system in the area during light load conditions

Alternatives Considered:

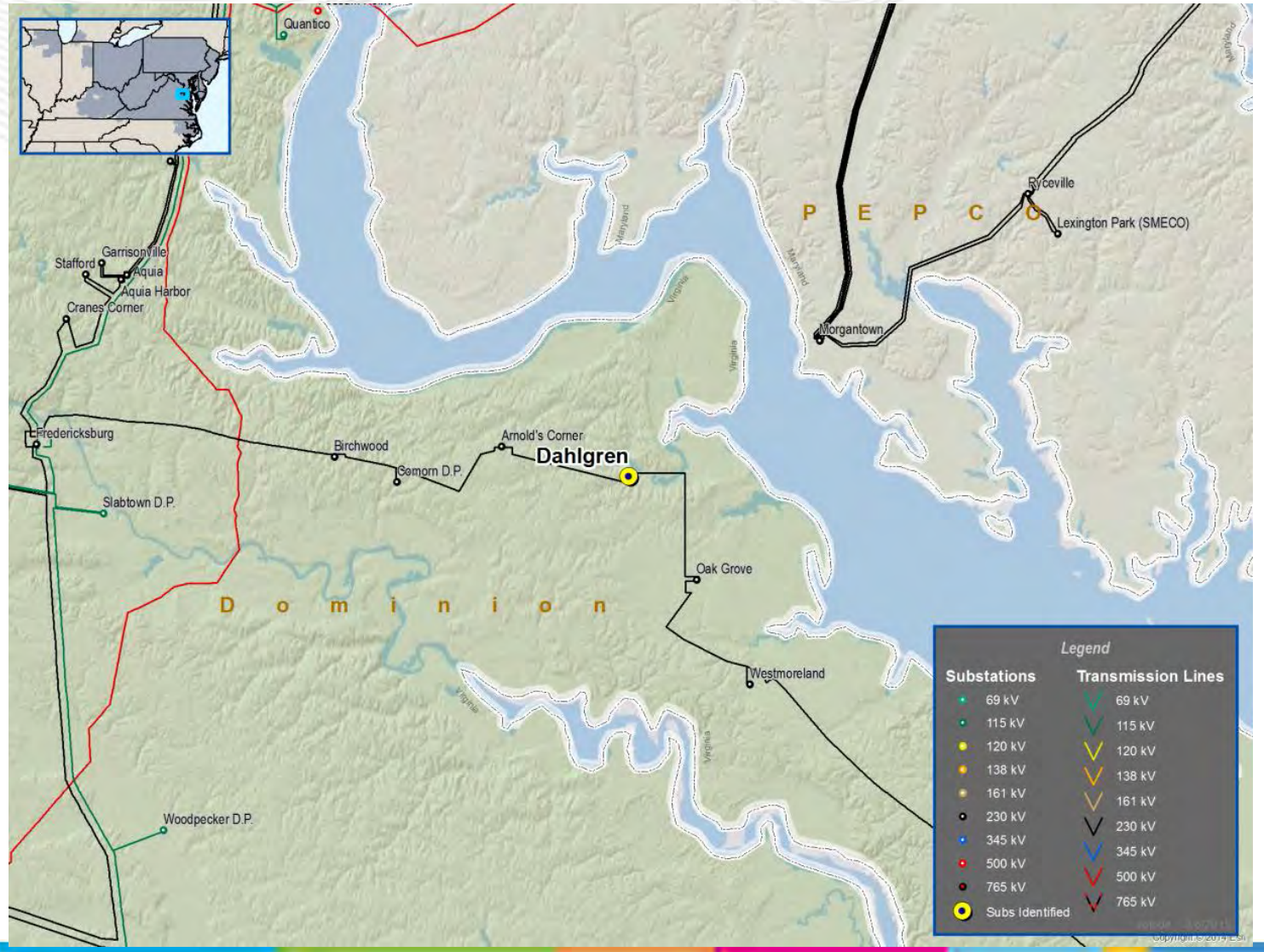
- PJM Operations has implemented operational adjustments such as switching out the Yorktown-Hayes lines and cap banks, however the high voltages still persist

Preliminary Proposed Solution:

- At Dahlgren, Install three 230kV bus breakers and a 230kV, 100MVAR Variable Shunt Reactor (B2636)
- Due to the time sensitive nature that this current issue presents, Dominion (Local TO) will be the Designated Entity

Estimated Project Cost: $6.7 M

Required IS Date: 5/1/2016



Immediate Need Project

MetEd Transmission Zone

N-1-1 Thermal Violation

- The Middletown Junction 230/115 kV transformer is overloaded for a fault on Middletown Jctn. transformer #1, #2, #3 or loss of the 230 kV #4 bus combined with the loss of the West Gates –Smith Street Tap – York Inc. 115 kV circuit
- This violation was identified recently due to a contingency file definition update to reflect current system topology

Alternatives Considered:

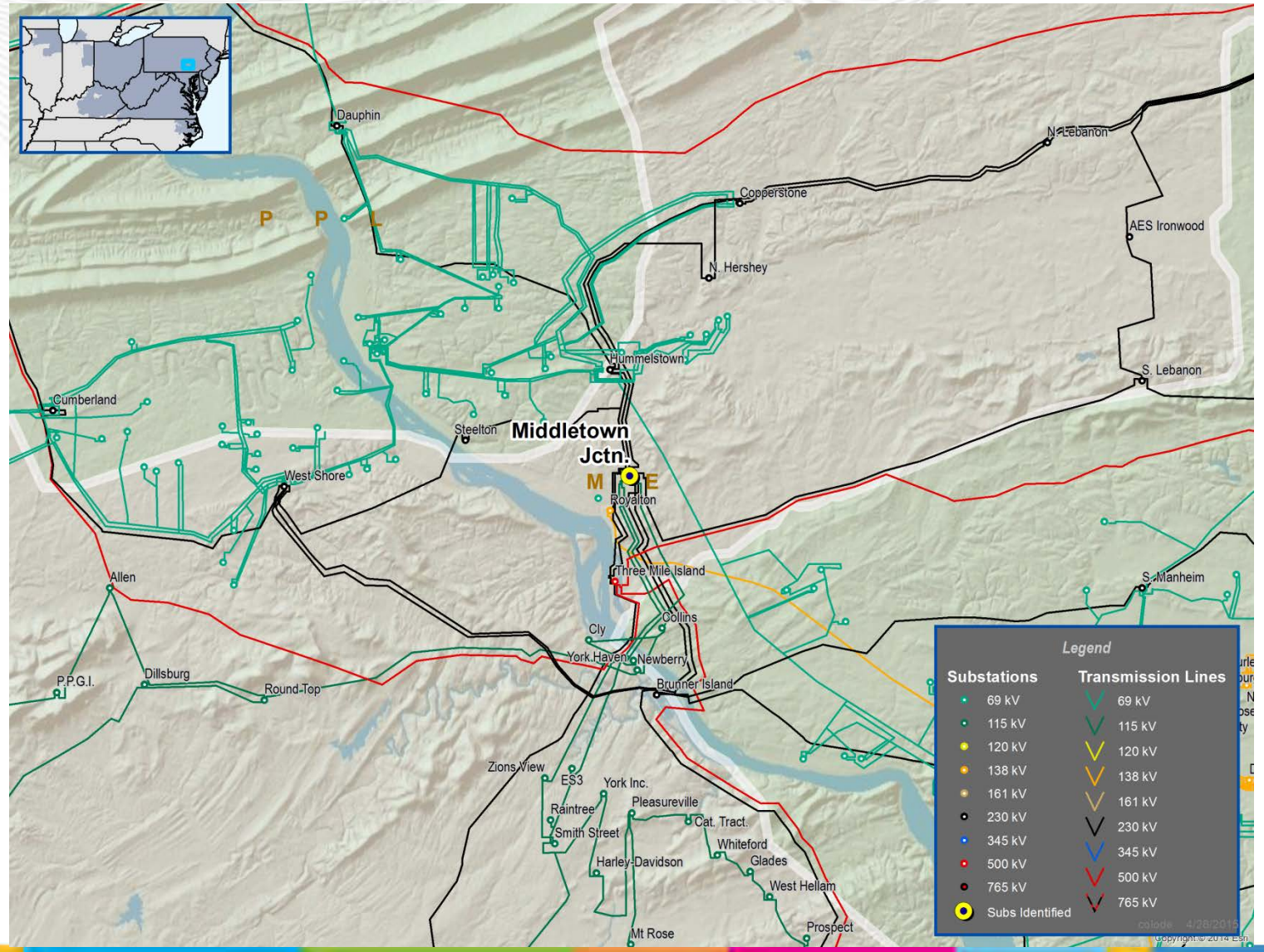
- Replace the Middletown 230/115 kV #5 transformer.

Proposed Solution:

- Convert Middletown Junction 230 kV substation to nine bay double breaker configuration (B2637)
- Due to the time sensitive nature that this current issue presents, MetEd/FirstEnergy (Local TO) will be the Designated Entity

Estimated Project Cost: $15.5 M

Required IS Date: 6/1/2015



Short Circuit Upgrades

PPL Transmission Zone

Problem:

- The Monroe 138 kV 'Transformer 2' breaker is overstressed

Significant Driver:

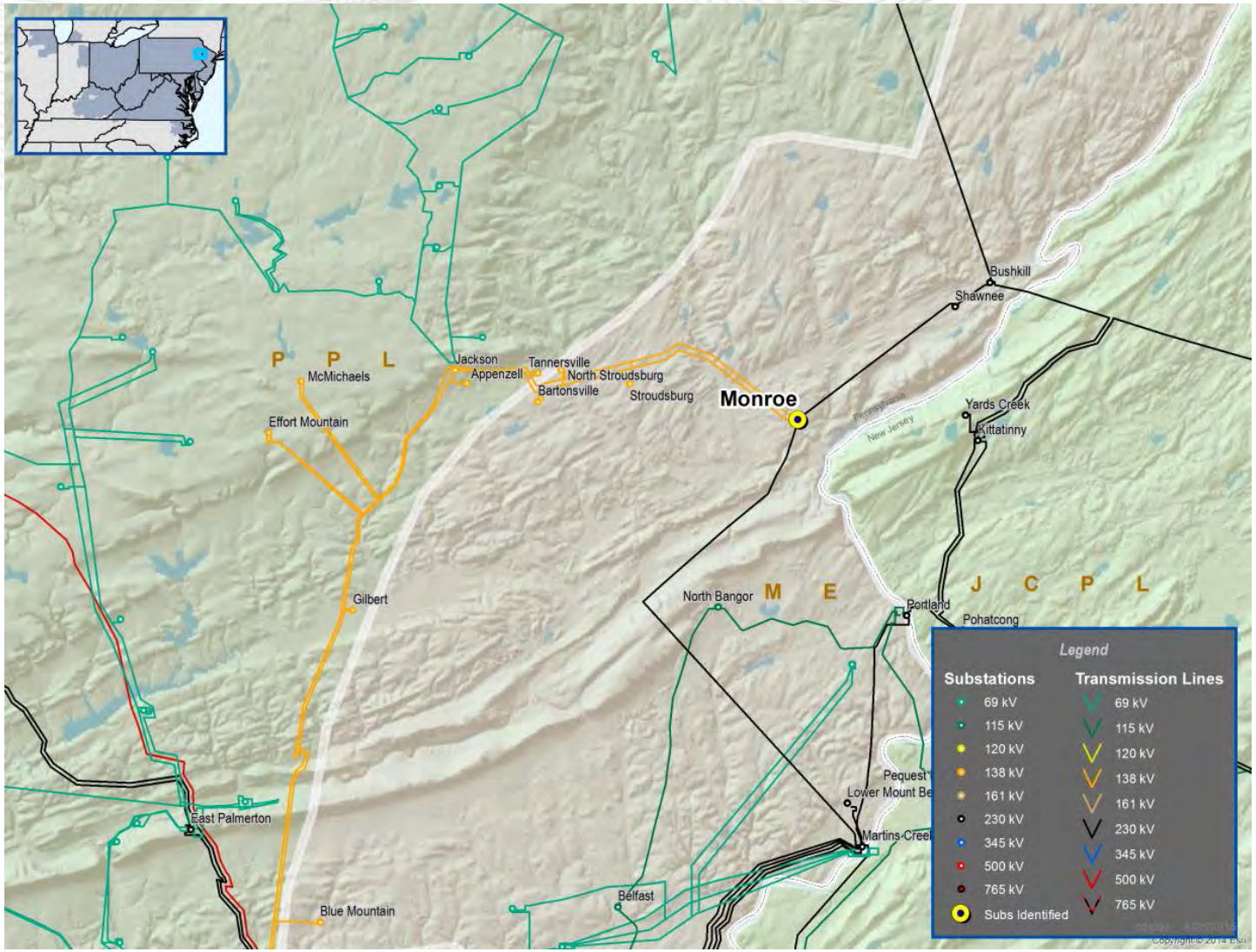
- Build approx. 6 miles of 2nd circuit on existing Alburtis - Breinigsville; Reconfigure Wescosville 500 kV station to double breaker arrangement; Install new Wescosville 230/138 kV transformer (s0864)

Proposed Solution:

- Replace the Monroe 138 kV 'Transformer 2' breaker with a 40kA breaker (s0864.1)

Cost Estimate: $300 K

Projected In-Service Date: 12/31/2017



Supplemental Projects

AEP Transmission Zone

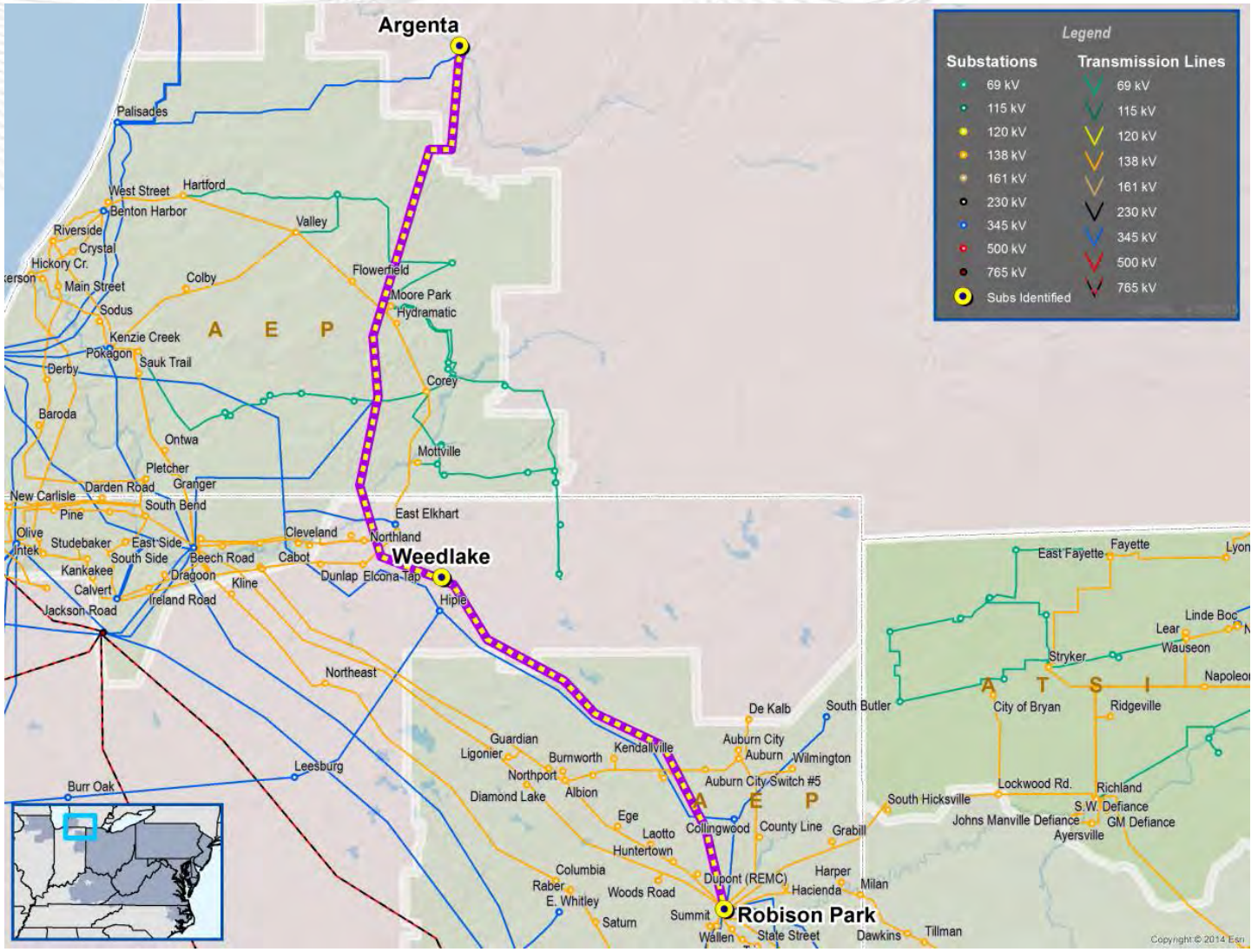
- Supplemental Project

- Looping in of the Robison Park-Argenta/Weeds Lake 345 kV ckt into NIPSCO's Hiple station; Remote end work at AEP's Robison Park station (S0935)

- Reason: MISO Hiple MVP project

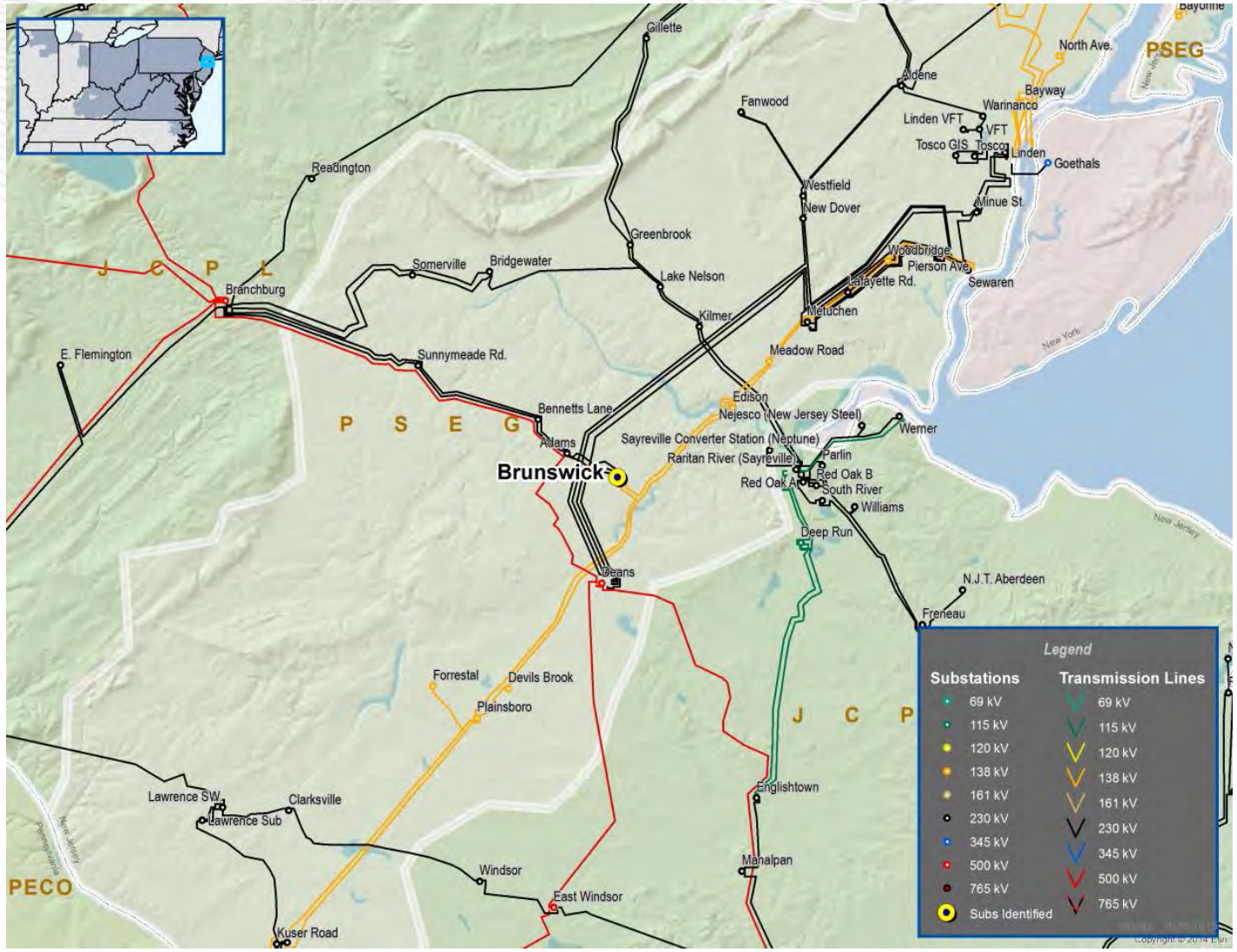
- Estimated Project Cost: $2M

- Projected IS Date: 12/31/2019



PSE&G Transmission Zone

- Supplemental Upgrade:
- The B2146 upgrade re-configures the Brunswick 230 kV and 69 kV substation with 63 kA. Rebuilding the 230 kV station with 80 kA interrupting capability will provide additional margin for future development.
- Proposed Solution:
  - Build the Brunswick 230 kV station to 80 kA. (S0936)
- Cost Estimate:
  - $7.3 M
- Projected IS Date:
  - 6/1/2015.



Artificial Island Update

Artificial Island Recommendation Next Steps

- Recommendation to TEAC made at 4/28/2015 Artificial Island TEAC
- At a future PJM Board meeting, PJM staff will recommend for inclusion in the RTEP:
  - 230kV transmission line under the Delaware river from Salem to a new substation near the 230kV transmission RoW in Delaware utilizing HDD under the river designated to LS Power
    - Associated substation work at Salem designated to PSE&G
    - Associated work on the 230kV RoW designated to PHI
  - SVC at New Freedom designated to PSE&G
  - OPGW upgrades designated to PSE&G and PHI
  - Artificial Island GSU tap settings upgrade designated to PSEG Power
- All stakeholder comments for the PJM Board must be sent no later than close of business on May 29

Next Steps

- If the PJM Board approves these recommendations, PJM staff will proceed to draft the Designated Entity Agreement
  - Recommendation is based upon PJM's understanding of the cost commitment terms and conditions, which will be finalized and incorporated into the Designated Entity Agreement
  - The first required milestone will be related to engineering feasibility of the river crossing utilizing horizontal directional drilling installation

RTEP Next Steps

2015 RTEP Next Steps

- Prepare documentation of Winter Reliability Criteria for initial review with PJM Planning Committee

- Continue to update posted 2015 RTEP results and prepare for June 8th 2015 RTEP Proposal Window #1 Open

- Request that the PJM Board approve the recommended Artificial Island solution

Questions?

Email: RTEP@pjm.com

Revision History

- Revision History
  - Original version distributed to the PJM TEAC 5/6/2015
  - 5/7/2015
    - Minor edits to slide #9 - 2015 RTEP PJM Winter Peak Study