



Transmission Expansion Advisory Committee

March 12, 2015



Interregional Planning Update

- 2025 summer and winter scenario build
 - Initial SSMLFWG kickoff – February 4
 - Case build and modeling effort underway
 - Target complete models late summer
- Ground work for production cost studies
 - February 17th task force call
 - March 11 TC discussion
 - July 9th TC targeted for recommendation

- NC Utility Commission study
 - Final draft report 2/12/15 TEAC materials
 - Comments to the RTEP email
 - Implement enhanced Order No. 1000 planning
 - NC operational readiness meeting 3/18/15 Charlotte
- Order 1000 compliance
 - 60 day extension to late May 2015

- PJM/MISO IPSAC
 - Order No. 1000 Interregional Compliance
 - June 16, 2015
 - IPSAC March-May timeframe
 - “Quick hit” study – M2M congestion 2013-2014
 - PJM list of top 30
 - MISO list of top 16 (7 overlap with PJM)
 - Review of congestion cause and remedy is underway
 - Currently evaluating which limits may have potential for quick hit upgrade
 - Targeted completion end 2nd quarter 2015
 - IPSAC review and input March 17, 2015

- “Quick Hit” reviews
 - Ability to implement in near term
 - Apparent economic or operational performance drivers
 - Evaluations of remedies considered:
 - Reliability analysis
 - Market efficiency beneficiaries
- Potential longer term focus area – Michigan interface
- Metric and Process review



2015 RTEP Scenario Studies

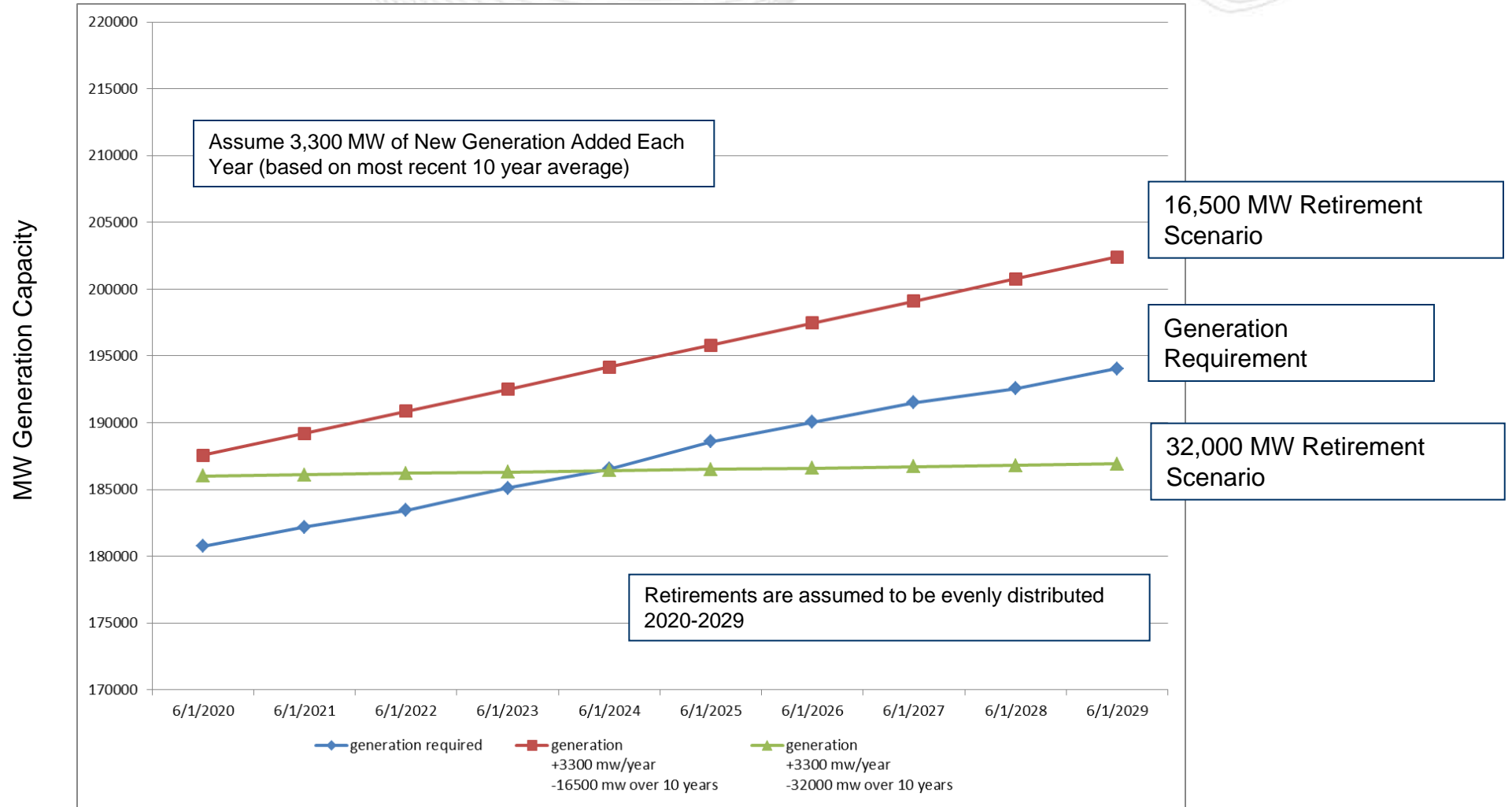
- Section 111(d) of the Clean Air Act
 - Develop and run Market Efficiency Scenarios
 - Reliability modeling
 - Reliability Criteria Violation identification
 - Transmission Overlay Development

- 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”

- Three at-risk studies: 6GW, 16GW and 32GW
- Base case: 2022 Summer Peak
- FSA generation will likely 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 monitored facilities (includes all BES - 100 kV facilities and above)
- Conductor ratings were used where available



Possible 2020 – 2029 Generation Reserve Picture as a function of at-risk retirement scenarios



- Resource Adequacy
 - Since we are studying 2022 we will need to fully utilize FSA generation
 - Planned Generation will need to be added to complete the 32 GW scenario
 - Add generation based on existing queue
 - Include western HVDC merchant transmission as resources up to firm injection capability
- 16 GW Initial Results
 - All of PJM was monitored for the Generation Deliverability test
 - The load deliverability test was run on the 12 LDAs that were impacted by 111(d) generation deactivations

- 16 GW Preliminary Results
 - Voltage violations were observed for the PJM West, Southwest MAAC and Dominion LDAs for several contingencies, mostly on the 500kV network
 - Thermal Violations
 - 5 of the LDAs were unable to import their CETO values in the Load Deliverability Test due to conductor limited thermal violations
 - The Generation Deliverability test identified multiple 230kV violations throughout PJM, mostly in Southwest MAAC. Also, several 500kV thermal violations were observed.



2014/15 RTEP Long Term Proposal Window

- Scope:
 - Reliability Criteria
 - 15 Year Reliability Analysis
 - Long Term Transmission Owner Criteria
 - Market Efficiency Criteria
 - Market Efficiency Congestion
 - Limiting Facilities in RPM
- Opened Friday, October 30, 2014
- Closed Monday, February 27, 2015



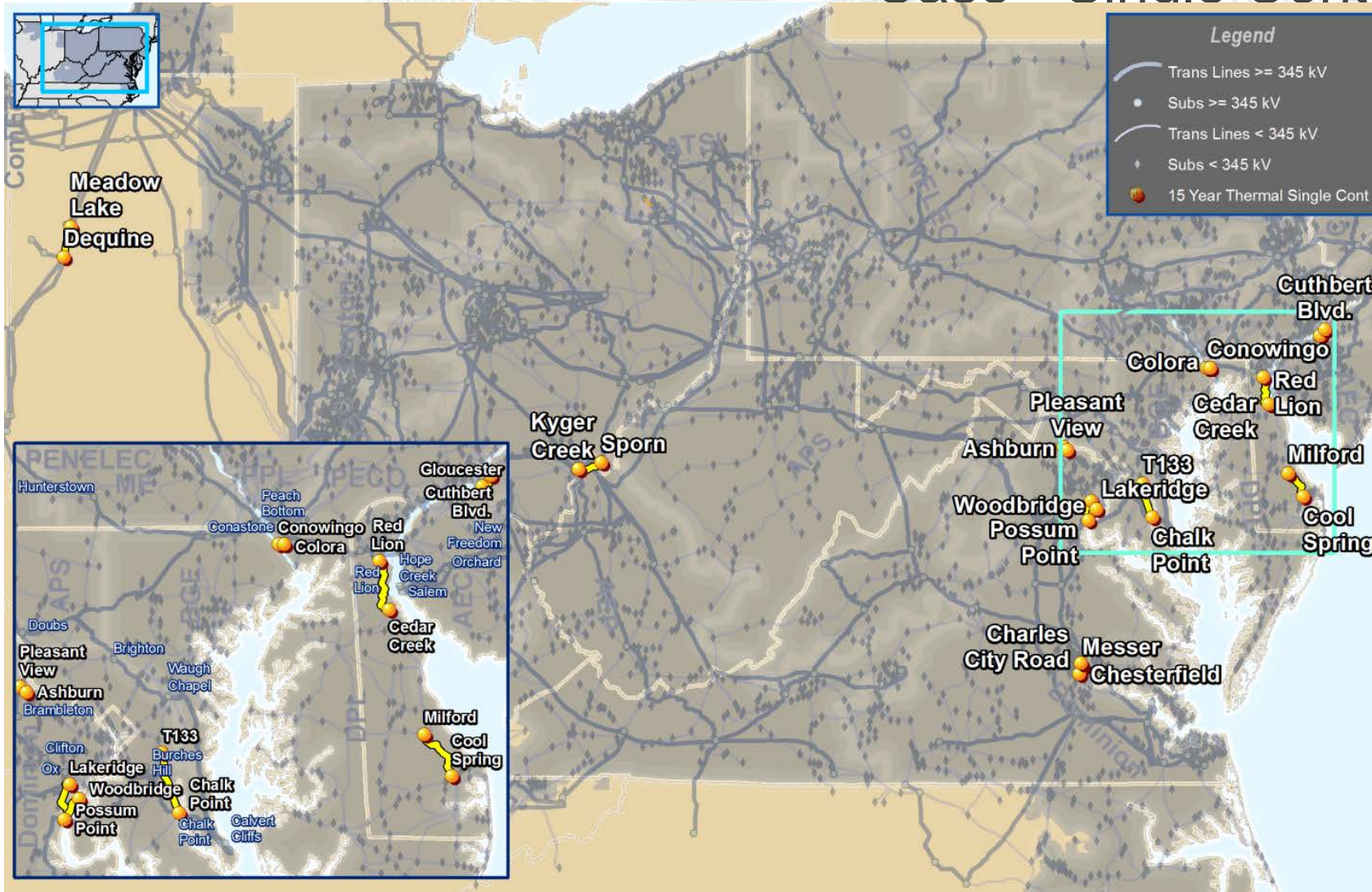
15 Year Reliability Analysis Identified Problems Using 2022 Case – Single Contingencies

15 Year Results Using 2022 Case – NERC Category B Single Contingency

FG#	Fr Bus	Fr Name	To Bus	To Name	CKT	KVs	Areas	100% Year	Contingency	TEST	Conductor Rating (MVA)*	
15Y-S1	232004	MILF_230	232001	COOLSPGS	1	230/230	DPL	2022	'CKT 23034'	Load Deliverability - DPL South LDA	678	
15Y-S2	314074	6POSSUM	314057	6LAKERD	1	230/230	Dominion	2029	'LN 2022'	Generator Deliverability	595.02	
15Y-S3	314228	6MESSER	314225	6CHARCTY	1	230/230	Dominion	2022	'LN 259'	Generator Deliverability	375.06	
15Y-S4	314072	6PL VIEW	314004	6ASHBURN	1	230/230	Dominion	2023	'LN 203'	Generator Deliverability	716.28	
15Y-S5	314074	6POSSUM	314096	6WOODB A	1	230/230	Dominion	2026	'LN 2001'	Generator Deliverability	678.68	
15Y-S6	314287	6CHSTF B	314228	6MESSER	1	230/230	Dominion	2022	'LN 259'	Generator Deliverability	375.06	
15Y-S7	248005	06KYGER	242528	05SPORN	2	345/345	OVEC/AEP	2022	'349_B2_TOR21'	Generator Deliverability	971	
15Y-S8	223983	CHALK230	292453	T133TAP1	4	230/230	PEPCO	2022	'PP42A'	Generator Deliverability	730	Removed in V7
15Y-S9	223983	CHALK230	292453	T133TAP1	2	230/230	PEPCO	2022	'PP40A'	Generator Deliverability	730	Removed in V7
15Y-S10	219110	GLOUCSTR_2	219755	CUTHBERT_4	2	230/230	PSEG	2029	'L_C-2308_LT'	Generator Deliverability	711	
15Y-S11	213519	CONOWG01	231006	COLOR_PE	1	230/230	PECO/DPL	2029	'220-03/* \$ CHESCO \$ 220-03 \$ L'	Generator Deliverability	577	
15Y-S12	231004	RL_230	232002	CEDAR CK	1	230/230	DPL	2022	'CKT 23033X'	Load Deliverability - DPL South LDA	678	
15Y-S13	243217	05DEQUIN	243878	05MEADOW	1	345/345	AEP	2027	'6490_B2_TOR16000'	Generator Deliverability	971	
15Y-S14	243217	05DEQUIN	243878	05MEADOW	2	345/345	AEP	2027	'6472_B2_TOR15258'	Generator Deliverability	971	

*All potential violations are conductor limited

15 Year Reliability Analysis Identified Problems Using 2022 Case - Single Contingencies





15 Year Reliability Analysis Identified Problems Using 2022 Case – Tower Contingencies

15 Year Results Using 2022 Case – NERC Category C5 Double Circuit Towerline Contingency

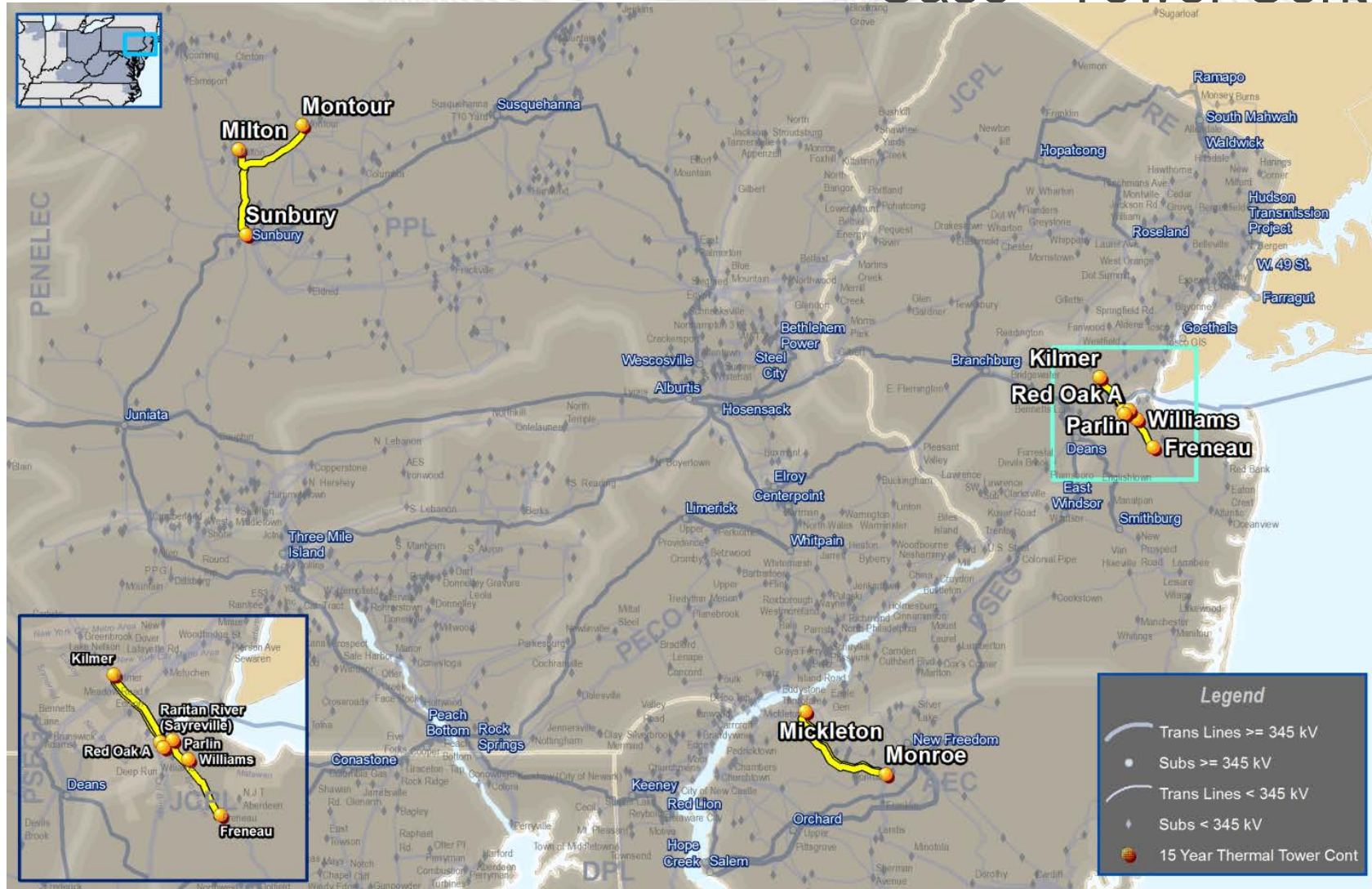
FG#	Fr Bus	Fr Name	To Bus	To Name	CKT	KVs	Areas	100% Year	Contingency	TEST	Conductor Rating (MVA)*
15Y-T1	208034	MILT	208109	SUNB	4	230/230	PPL	2022	'PL100484'	Generator Deliverability	730
15Y-T2	228401	MCKLTON	228402	MONROE	1	230/230	AE	2022	'V2274+P2242_LT'	Generator Deliverability	446
15Y-T3	228401	MCKLTON	228402	MONROE	2	230/230	AE	2022	'V2274+P2242_LT'	Generator Deliverability	446
15Y-T4	208040	MONT	208034	MILT	4	230/230	PPL	2022	'PL100484'	Generator Deliverability	802
15Y-T5	206305	28RAR RVR	218331	KILMER_I	1	230/230	JCPL/PSEG	2028	'C5_CNJ-DCT-#4'	Generator Deliverability	869
15Y-T6	206298	28WILLIAMS	206292	28FRENEAU	1	230/230	JCPL	2029	'37PS_B'	Generator Deliverability	869
15Y-T7	206322	28PARLIN	206298	28WILLIAMS	1	230/230	JCPL	2028	'37PS_B'	Generator Deliverability	869
15Y-T8	206314	28RED OAKA	206305	28RAR RVR	1	230/230	JCPL	2028	'C5_CNJ-DCT-#4'	Generator Deliverability	869

Removed as part of V3 after the window open

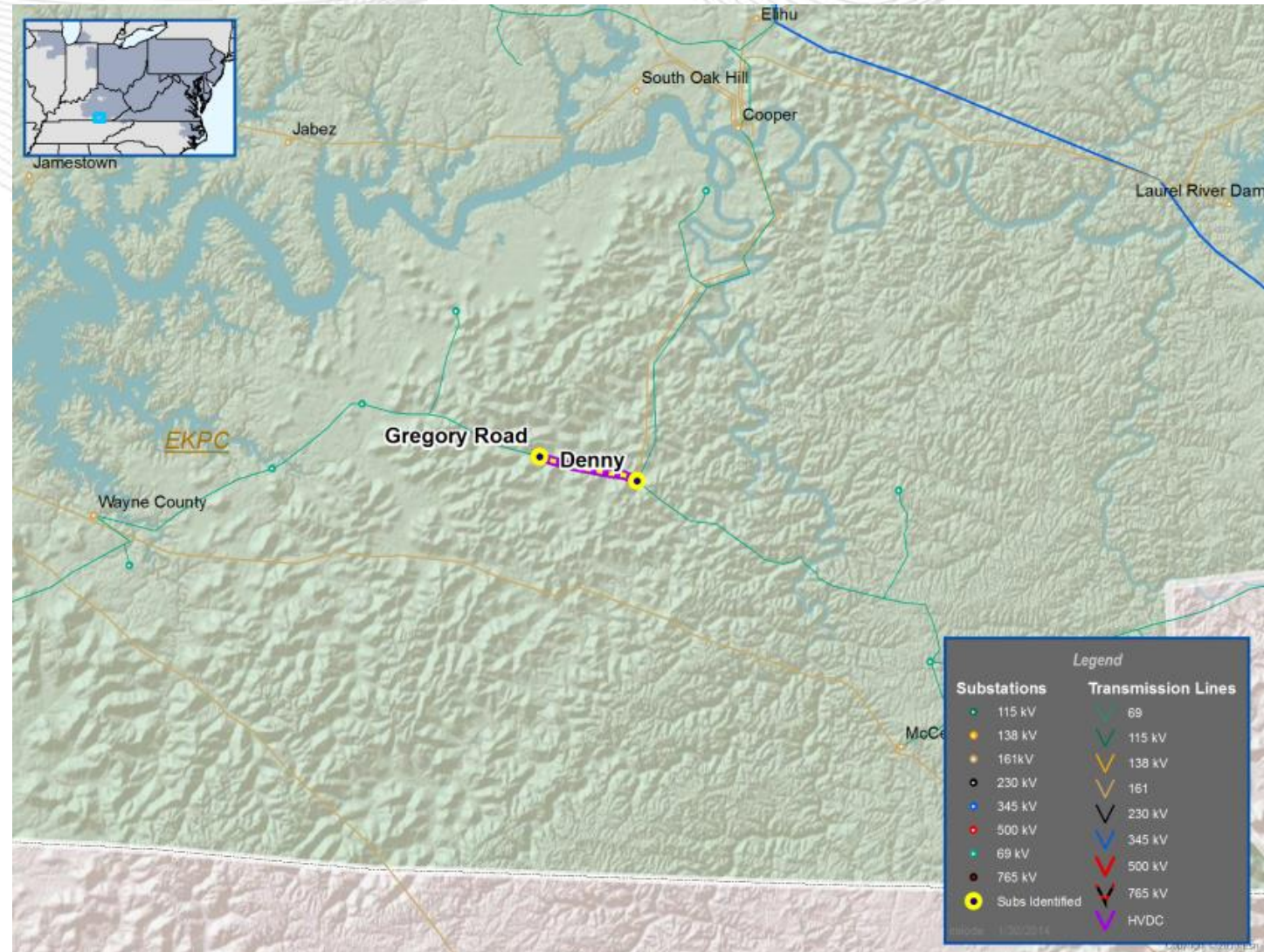
Removed as part of V3 after the window open

*All potential violations are conductor limited

15 Year Reliability Analysis Identified Problems Using 2022 Case - Tower Contingencies



- **EKPC Local TO Criteria Violation**
- Long Term Transmission Owner Criteria
- Overload of the Denny-Gregory Road Jct. 69 kV line during an outage of the Wayne County 161/69 kV transformer with LGE/KU's Mill Creek Unit #4 off.
- Violation Date: 6/1/2020



- 20 Proposing entities
 - PJM Transmission Owners
 - PJM Non incumbent Entities
- 119 Proposals
- 22 target TO Zones (Including multi-zone combinations)
- Detailed list and descriptions are posted with today's meeting materials

- **28 Reliability Criteria Proposals**

- 15 Transmission Owner Upgrades

- Cost range of \$0.3M to \$62.48M

- 13 Greenfield Projects

- Cost range of \$17.6M to \$290M

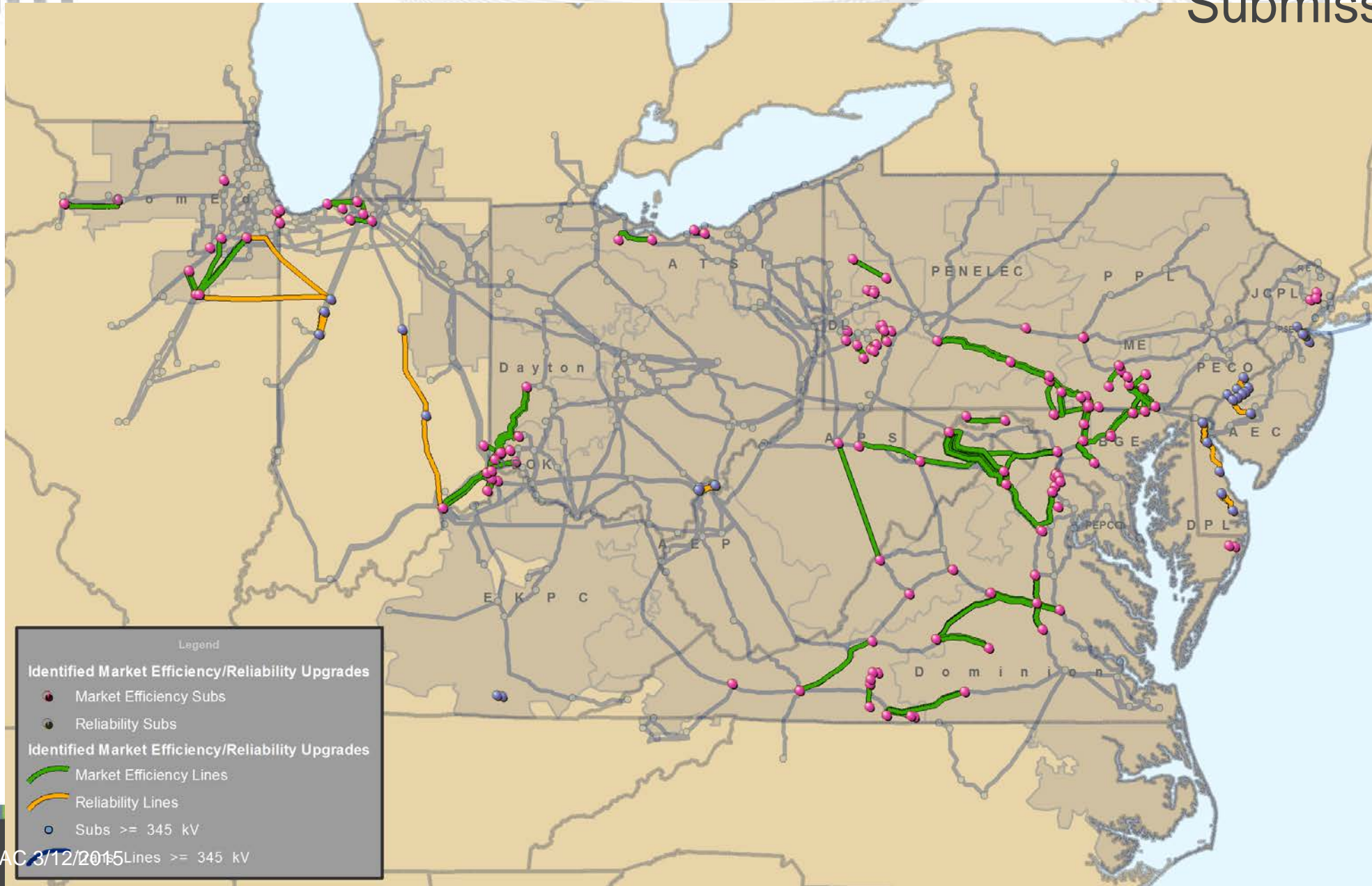
- **91 Market Efficiency Proposals**

- 34 Transmission Owner Upgrades

- Cost range of \$0.1M to \$68M

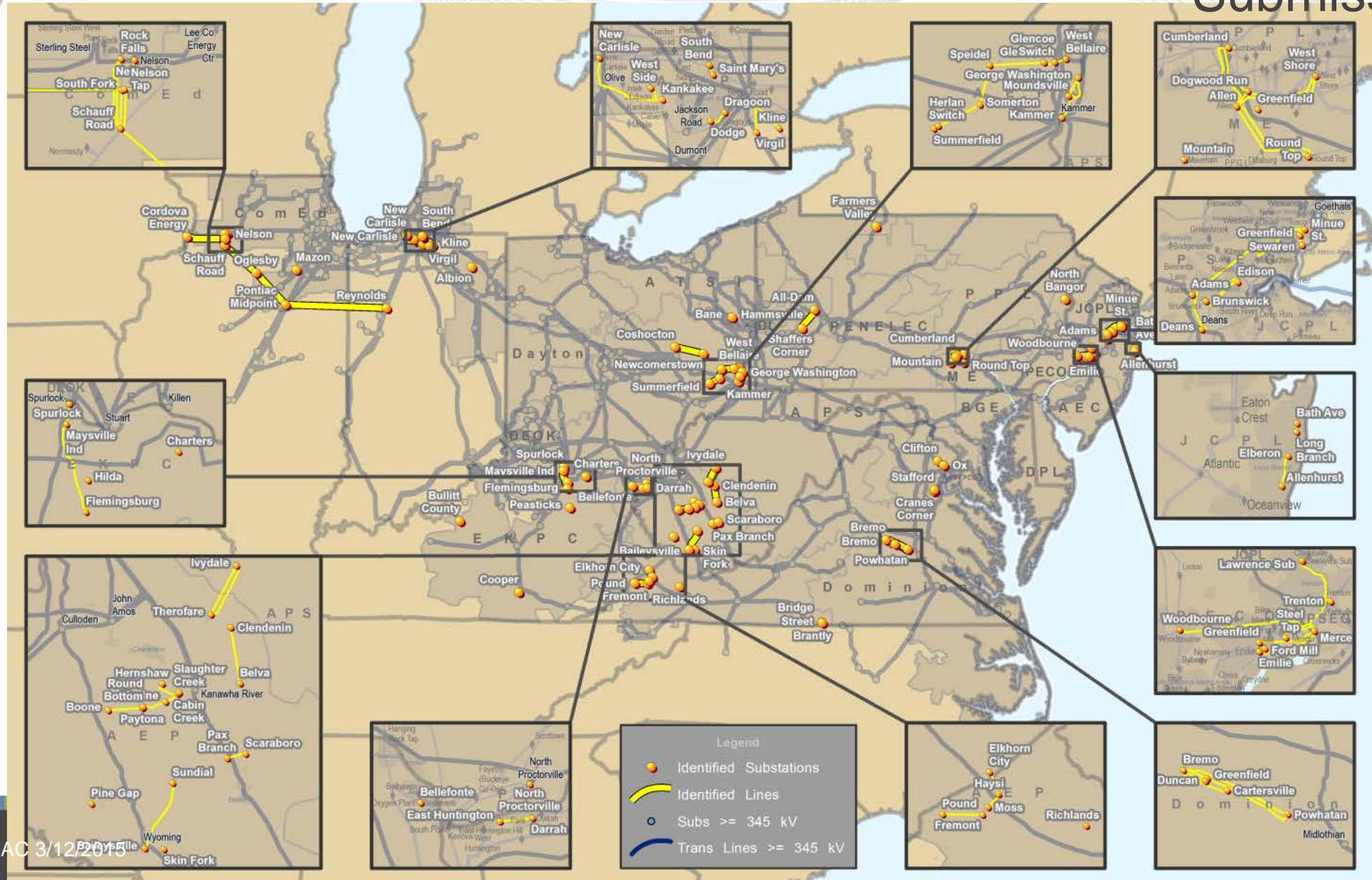
- 57 Greenfield Projects

- Cost range of \$9.2M to \$432.5M



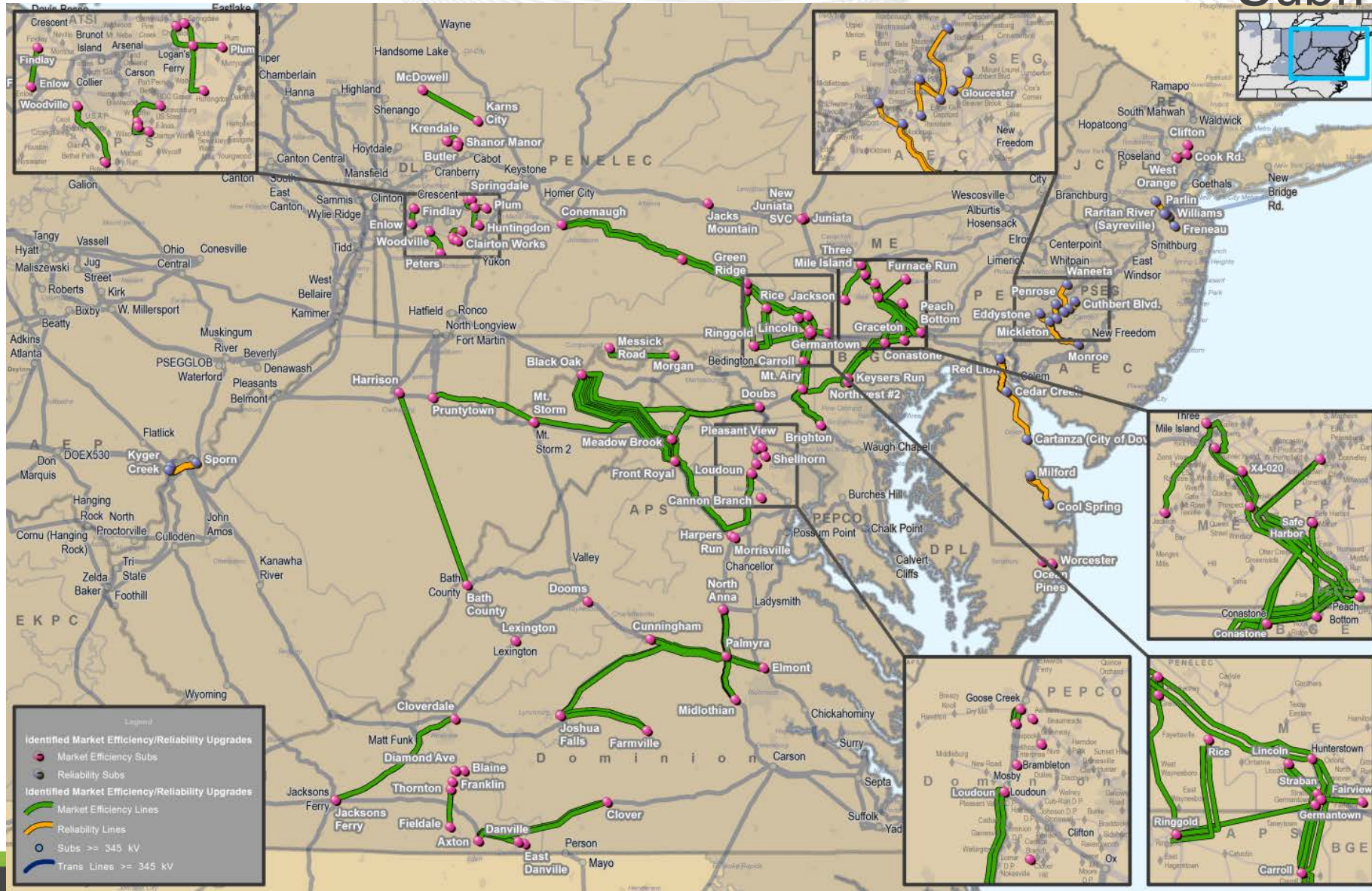


2014/15 RTEP Long Term Proposal Window – Project Submissions



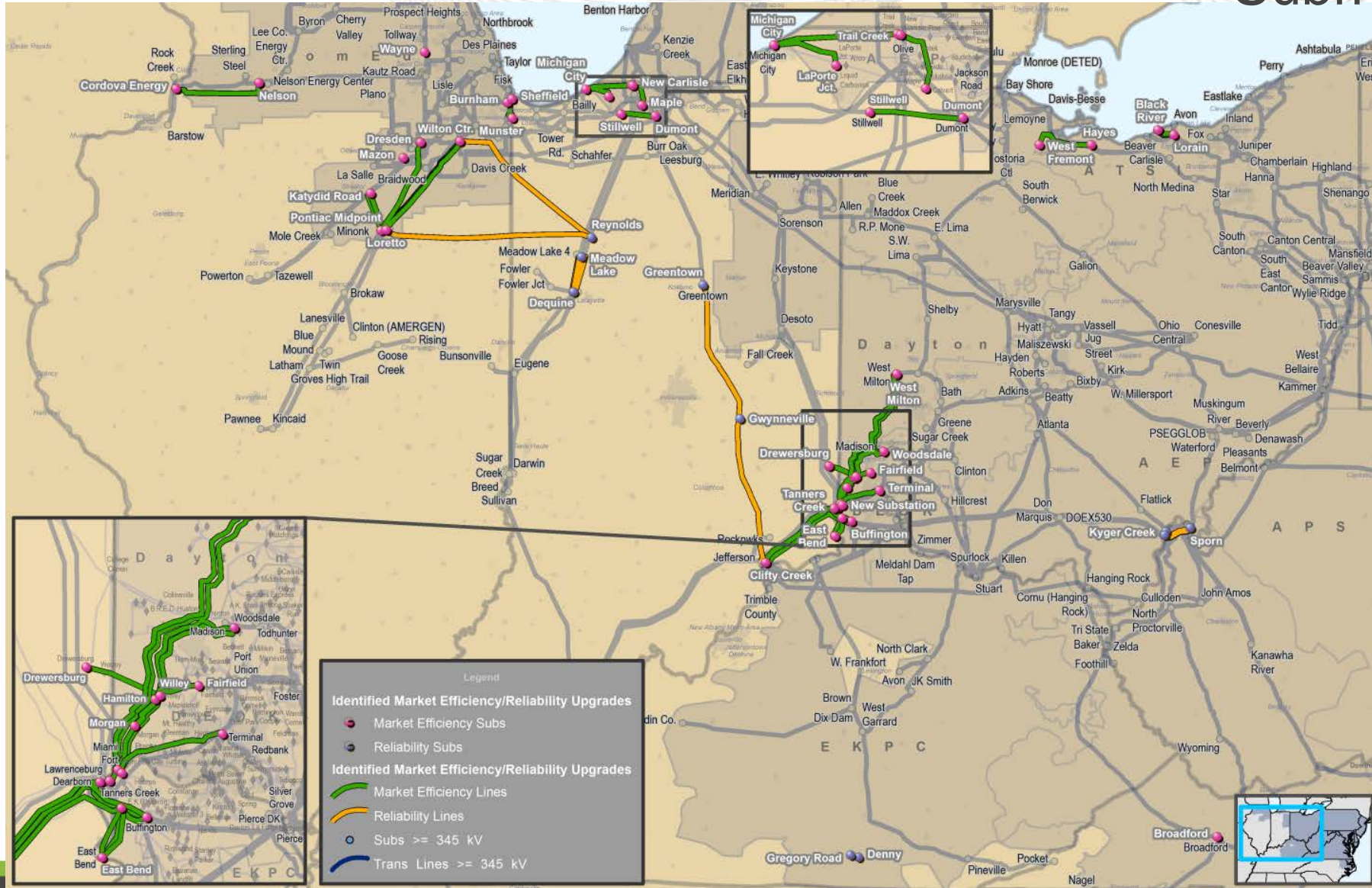


2014/15 RTEP Long Term Proposal Window – Project Submissions





2014/15 RTEP Long Term Proposal Window – Project Submissions



Reliability Analysis Update

Problem:

- Transmission upgrades are needed on GSU units #4 and #5 for Operational Performance.

Proposed Solution:

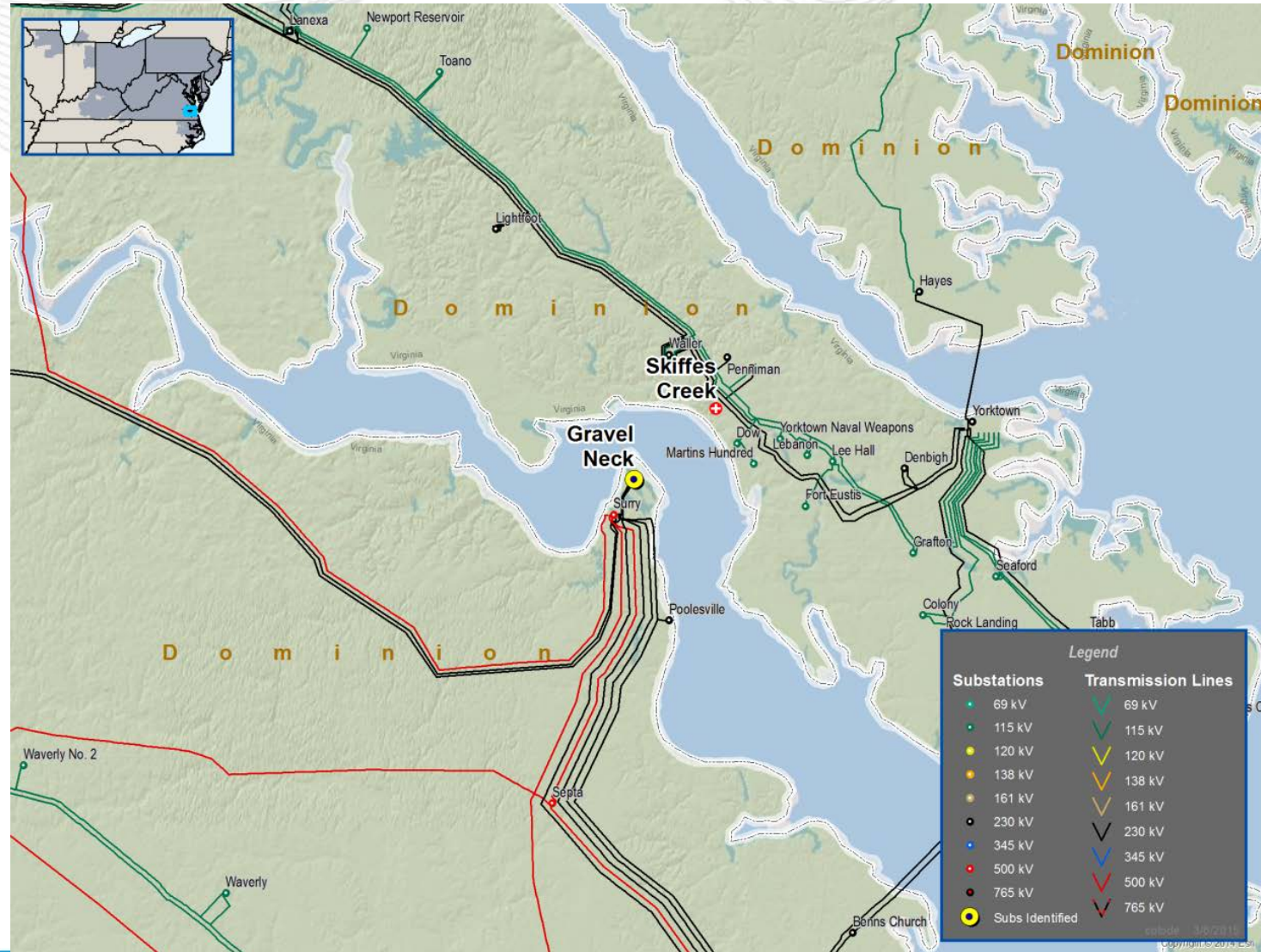
- Install circuit switchers on GSU units #4 and #5. Install two 230kV CCVT's on Lines #2407 and #2408 for loss of source sensing (B2630)

Estimated Project Cost: \$662 K

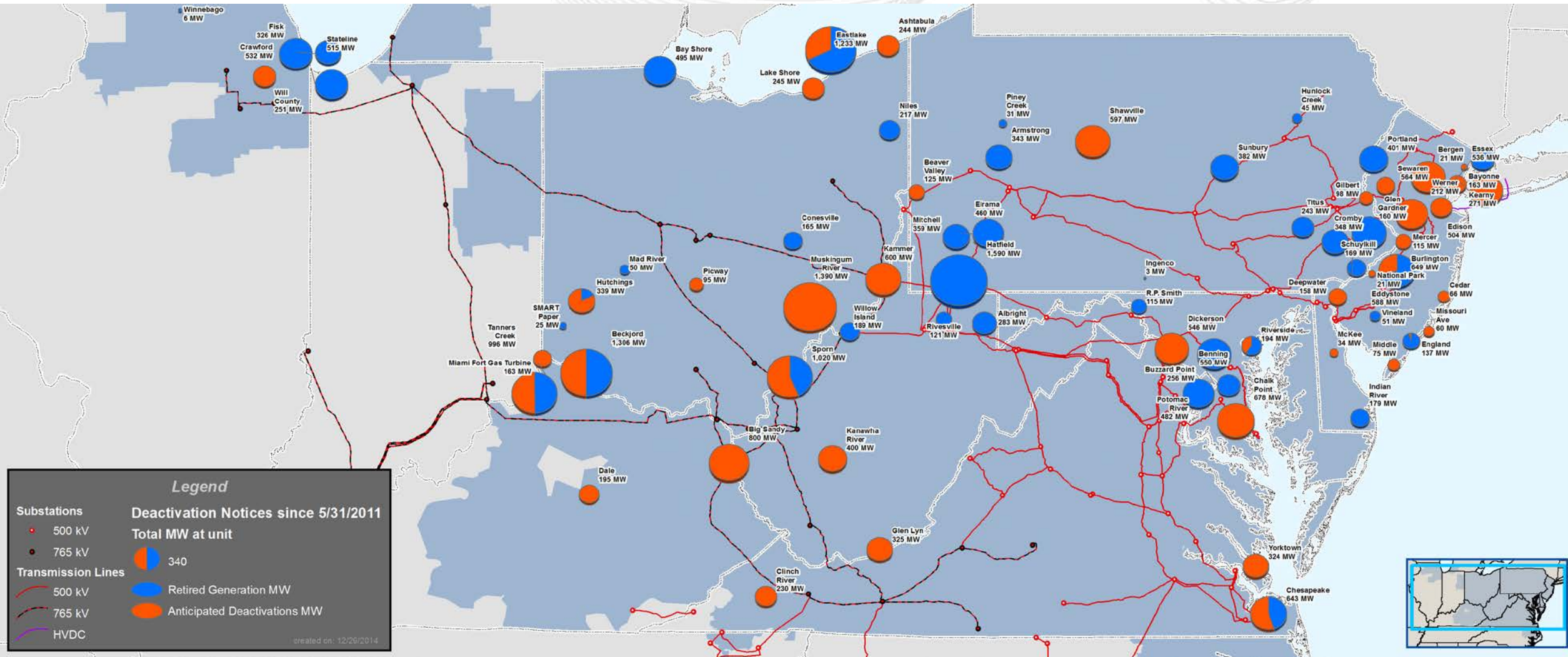
Required IS Date: Immediate Need

Designated Construction Entity: The local TO
(Dominion)

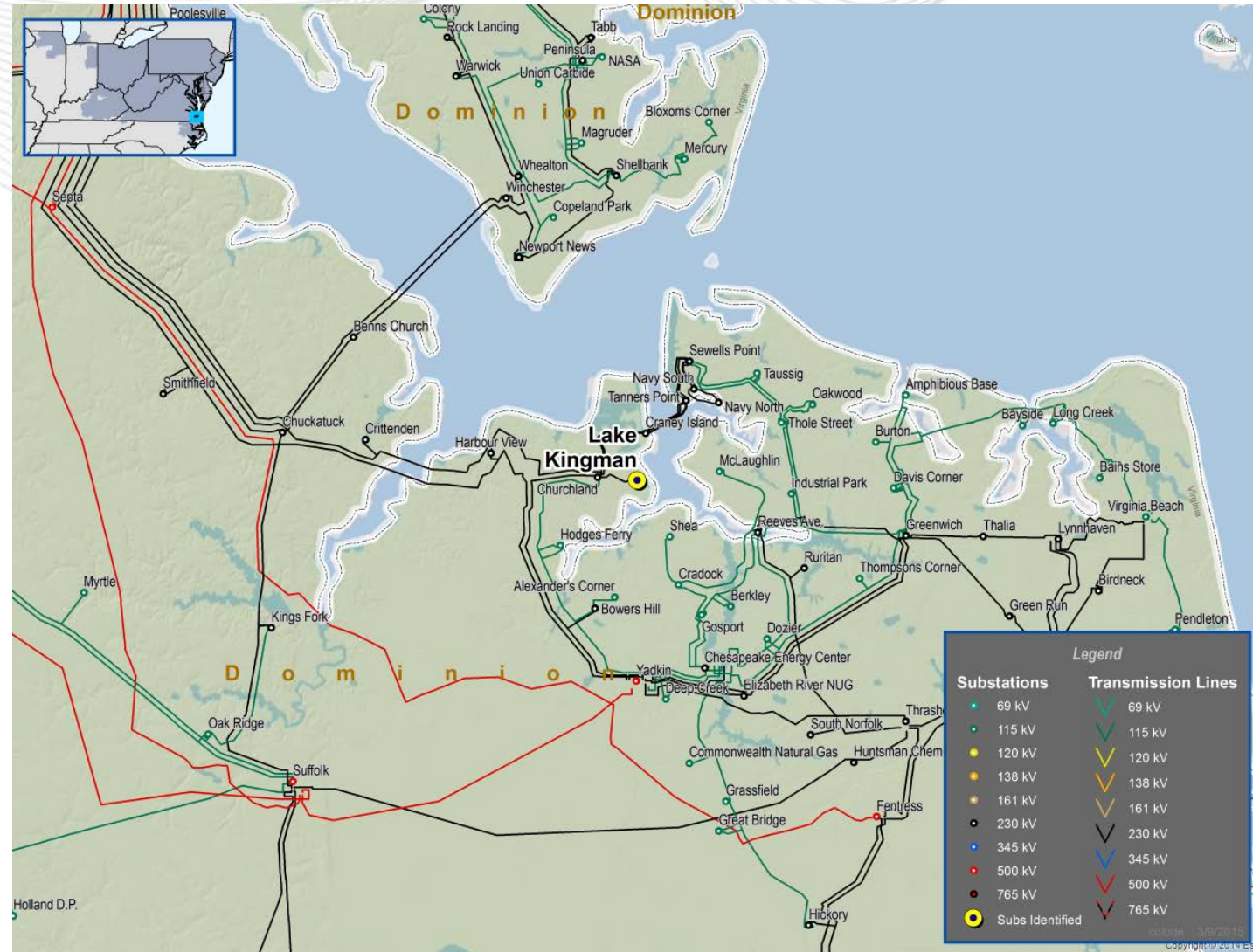
Projected IS Date: 5/31/2015



Generation Deactivation Notification (Retirements) Update

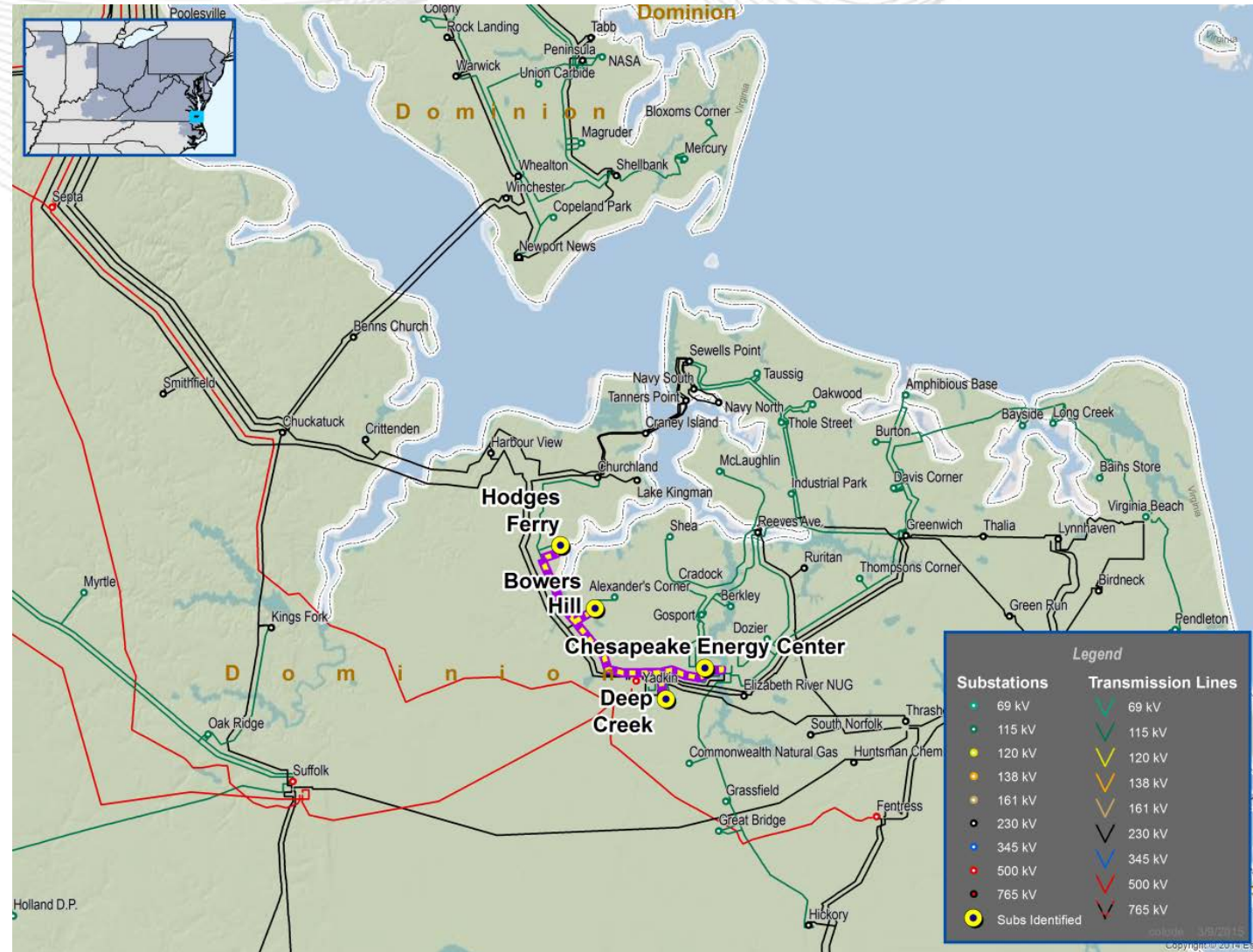


- Lake Kingman Units A & B
- Dominion Transmission Zone
 - 115 MW total
 - Deactivation date: 5/31/2015



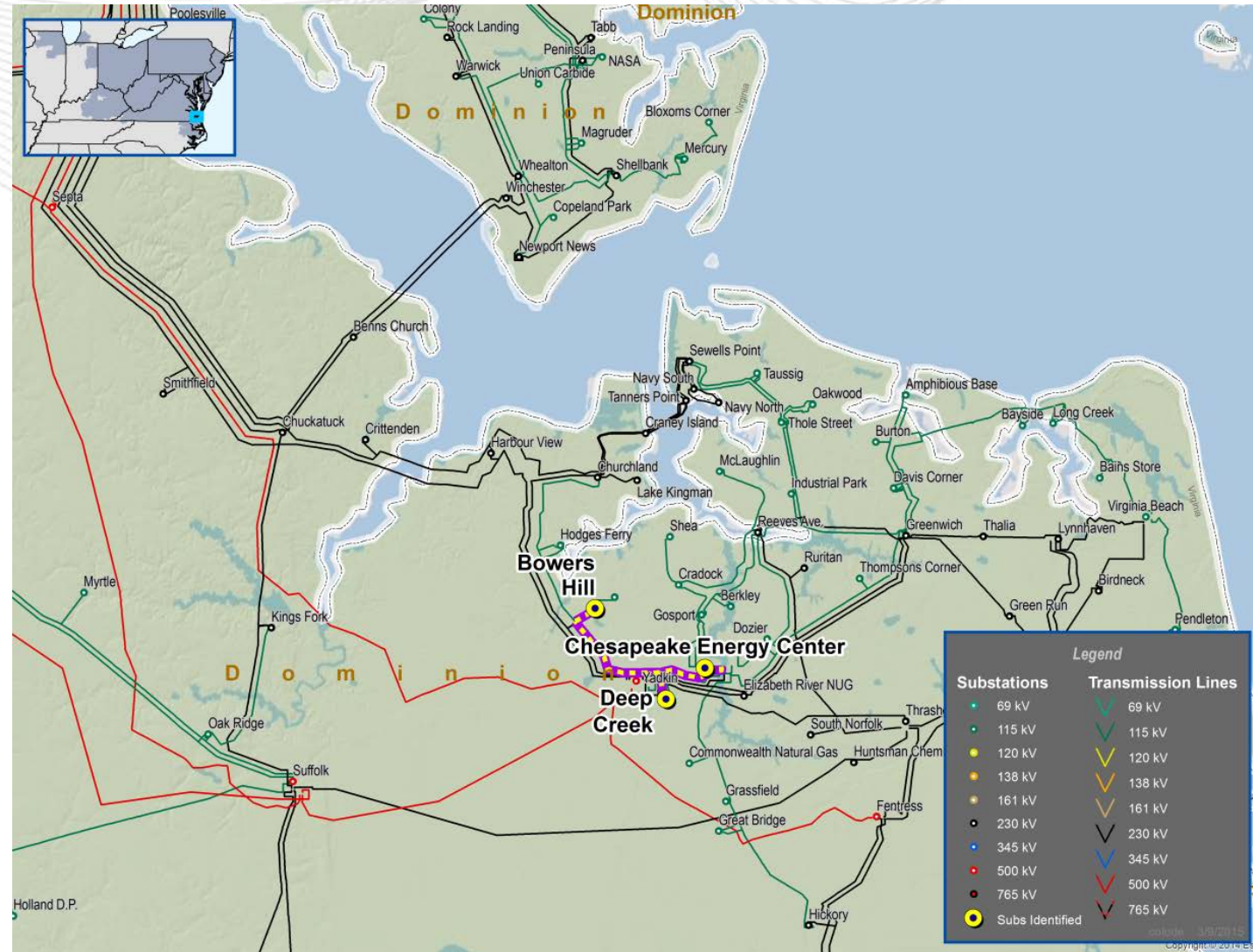
Dominion Transmission Zone

- Generator Deliverability Violations:**
 - Bowers Hill – Hodges Ferry 115 kV line is loaded to 106.98% of its emergency rating (176 MVA) for the tower contingency loss of Crittenden - Harbor View – Churchland 230 kV line, Crittenden – Surry 230 kV line and Churchland – Bower Hill – Yadkin 230 kV line ('LN 226-267').
 - Chesapeake - Deepcreek 115 kV line is loaded to 116.75% of its emergency rating (176 MVA) for the tower contingency loss of Crittenden - Harbor View – Churchland 230 kV line, Crittenden – Surry 230 kV line and Churchland – Bower Hill – Yadkin 230 kV line ('LN 226-267').
 - Deepcreek - Bowers Hill 115 kV line is loaded to 116.81% of its emergency rating (176 MVA) for the tower contingency loss of Crittenden - Harbor View – Churchland 230 kV line, Crittenden – Surry 230 kV line and Churchland – Bower Hill – Yadkin 230 kV line ('LN 226-267').



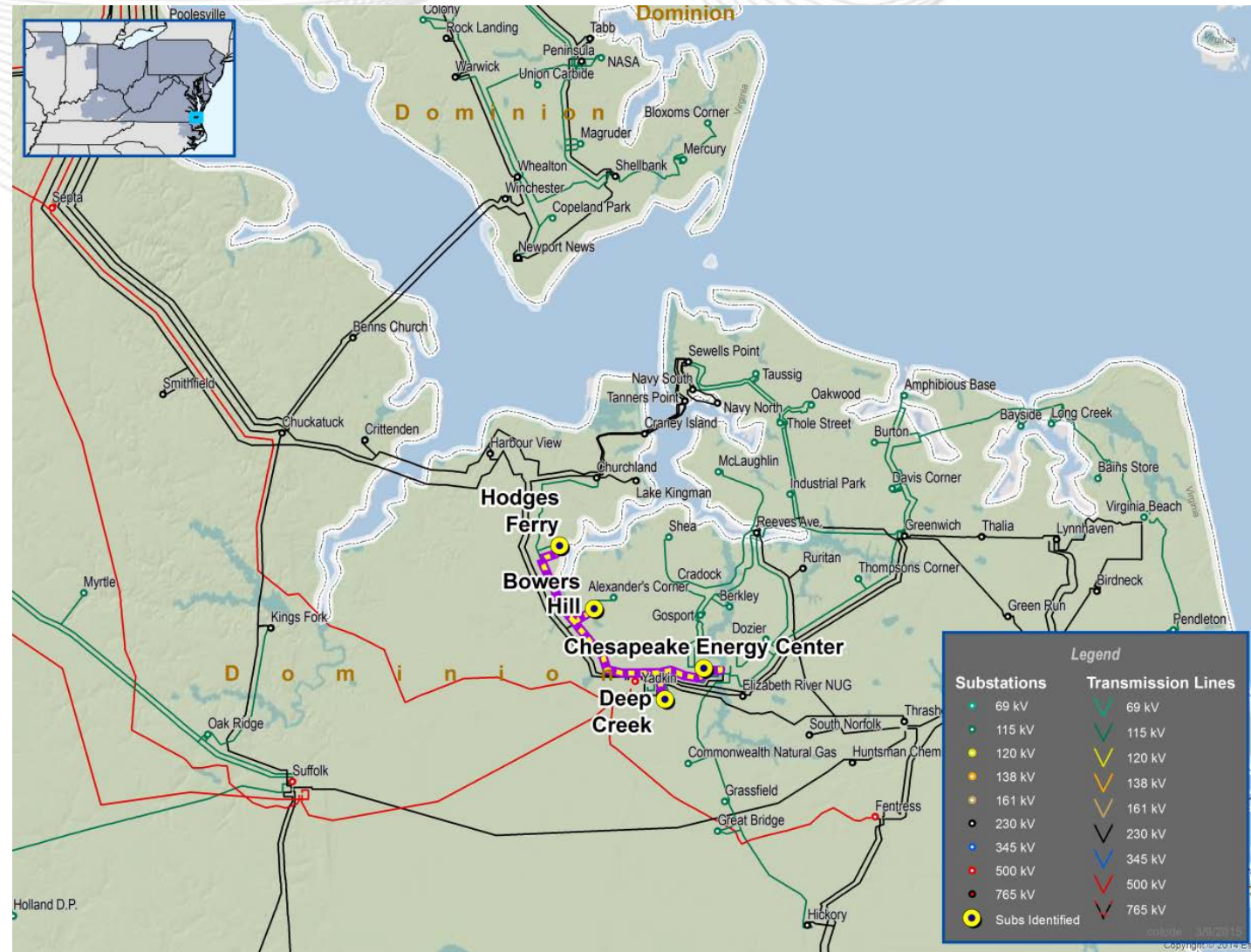
Dominion Transmission Zone

- N-1-1 Violations:
 - Chesapeake - Deepcreek 115 kV line is loaded to 107.63% of its emergency rating (176 MVA) for the contingency loss of Churchland – Bower Hill – Yadkin 230 kV line ('LN267') followed by the loss of Churchland - Harbor View – Crittenden – Surry 230 kV line ('LN 226').
 - Deepcreek – Bowers Hill 115 kV line is loaded to 107.63% of its emergency rating (176 MVA) for the contingency loss of Churchland – Bower Hill – Yadkin 230 kV line ('LN267') followed by the loss of Churchland - Harbor View – Crittenden – Surry 230 kV line ('LN 226').



Dominion Transmission Zone

- Proposed Solution: Upgrade the Chesapeake – Deepcreek – Bowers Hill – Hodges Ferry 115 kV line (b2620).
- Cost Estimate: \$10 M
- Required IS Date: Immediate Need - 6/1/2015
- Designated Construction Entity: The Local TO (Dominion)
- Projected IS Date: Post Summer 2015
- Interim Solution: Line #87 could be opened at Churchland and no other violations would exist for these contingency conditions.

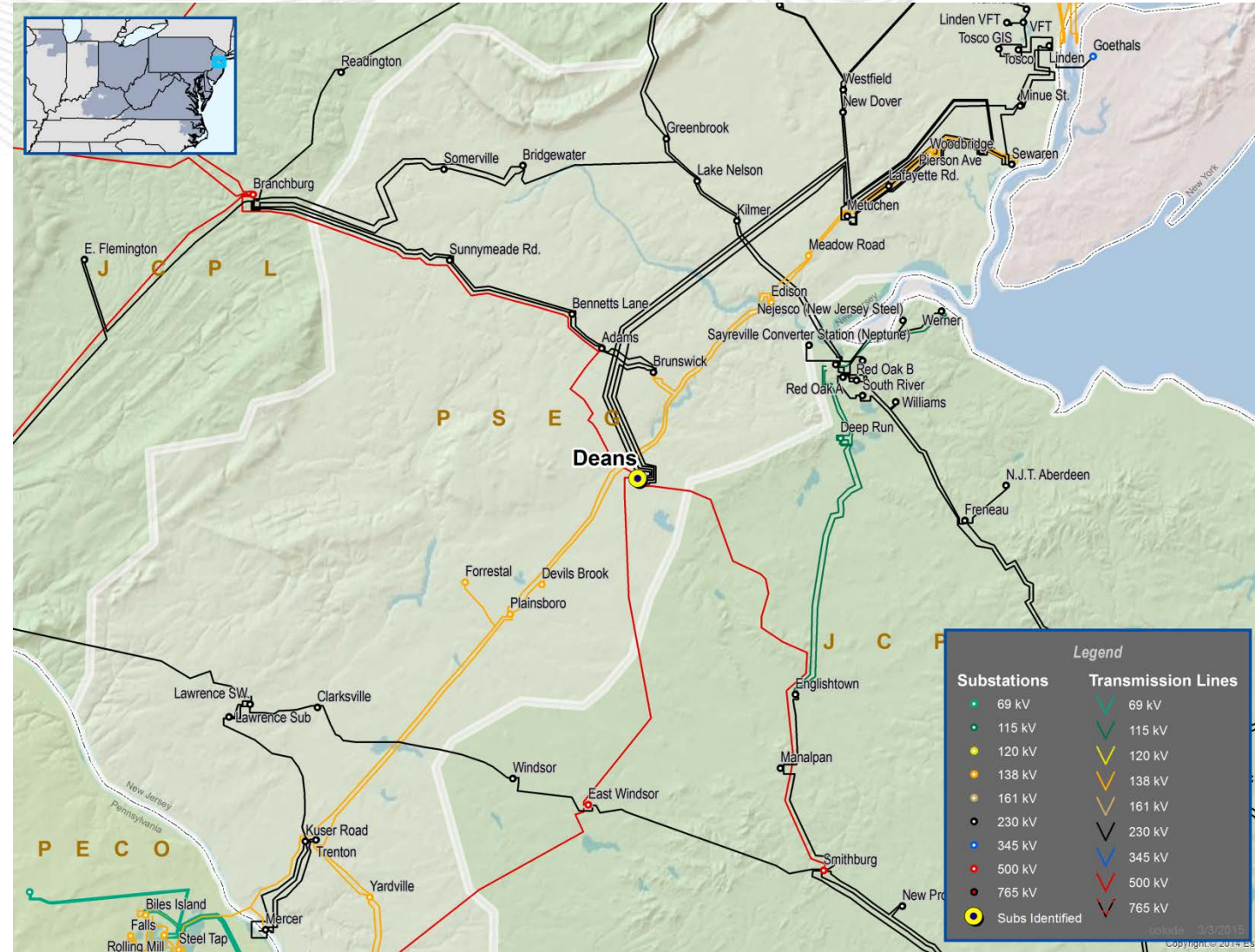


2019 Light Load Analysis

- PJM conducted a Light Load Reliability analysis for the 2019 planning year
- Results coordinated with the TOs as part of the Quality Control Check
- No violations identified

Supplemental Projects

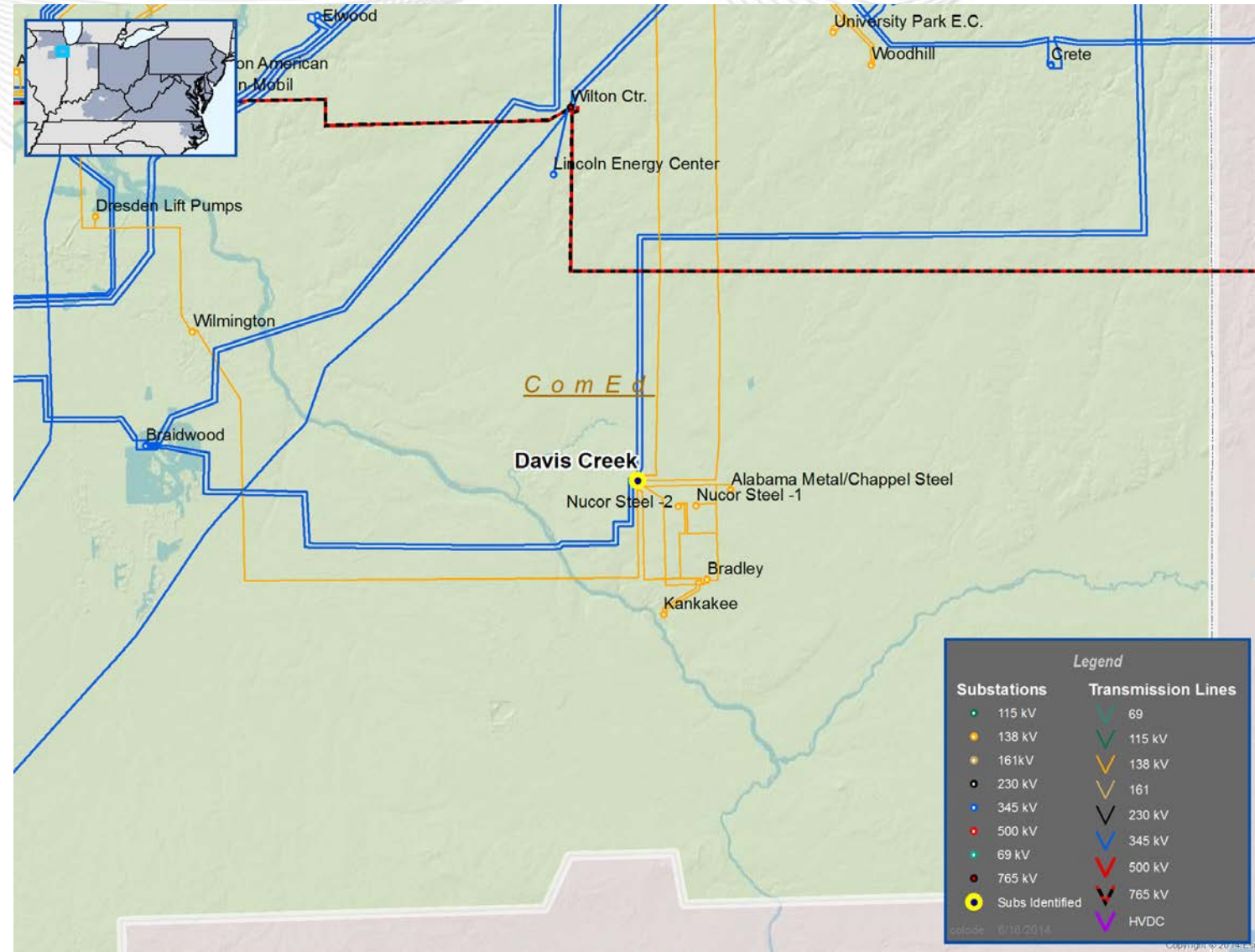
- Supplemental Upgrade :
- Install Optical Ground Wire to improve reliability. This provides strength, lightning protection and a potential communications path for high speed relaying.
- Proposed Solution:
 - Install OPGW (Optical Ground Wire) on the W-2249 (Westfield to Deans Sw 230 kV) (S0902).
- Estimated Project Cost: \$ 6.15 M
- Expected IS Date: 12/31/2015



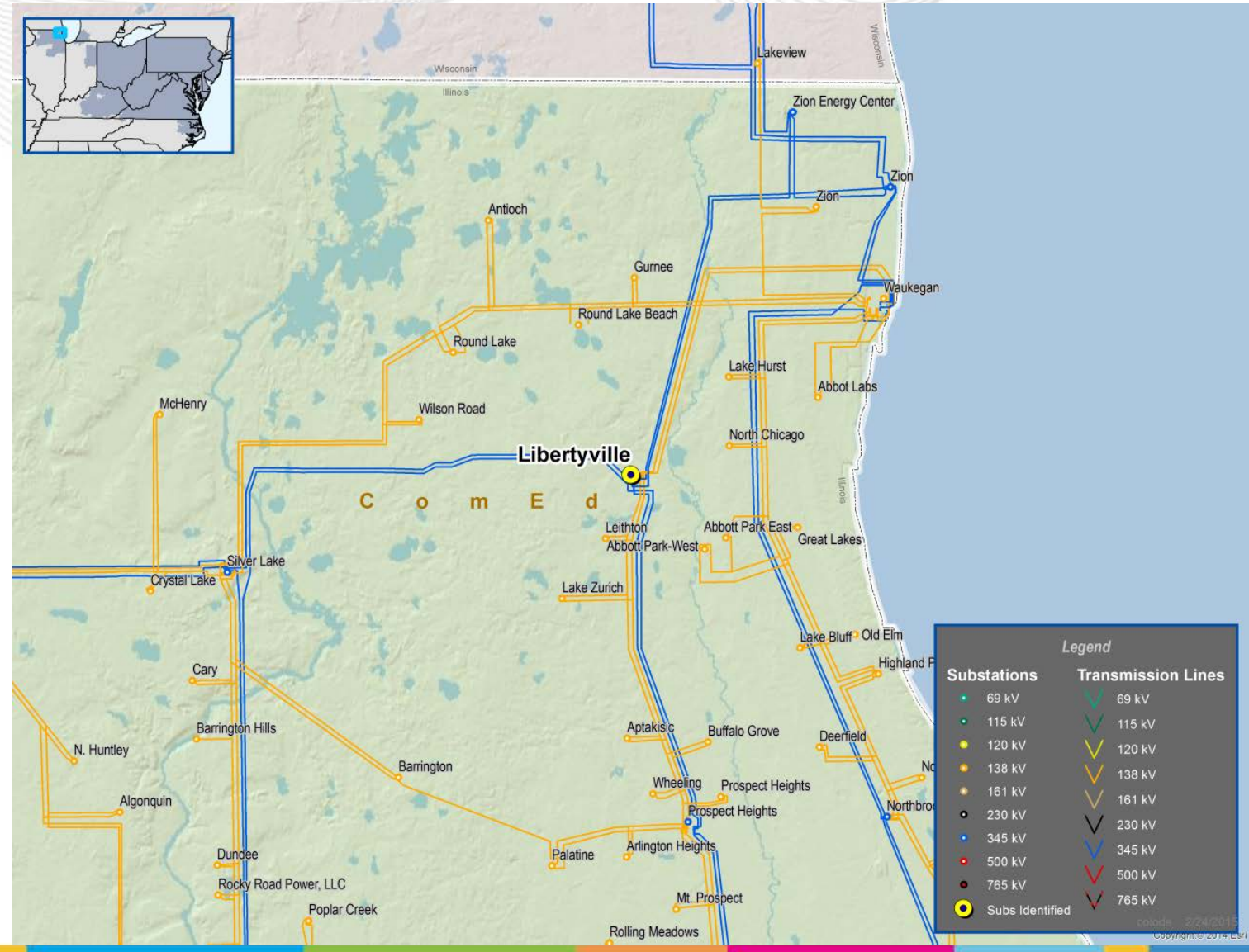
- **Supplemental Project**
- Reconductor 9.5 miles of 345 kV line 1311 from Goodings Grove to Crawford. (S0880)
- Reason: NERC Alert
- Estimated Cost: \$14.6M
- Projected IS Date: 12/31/2015



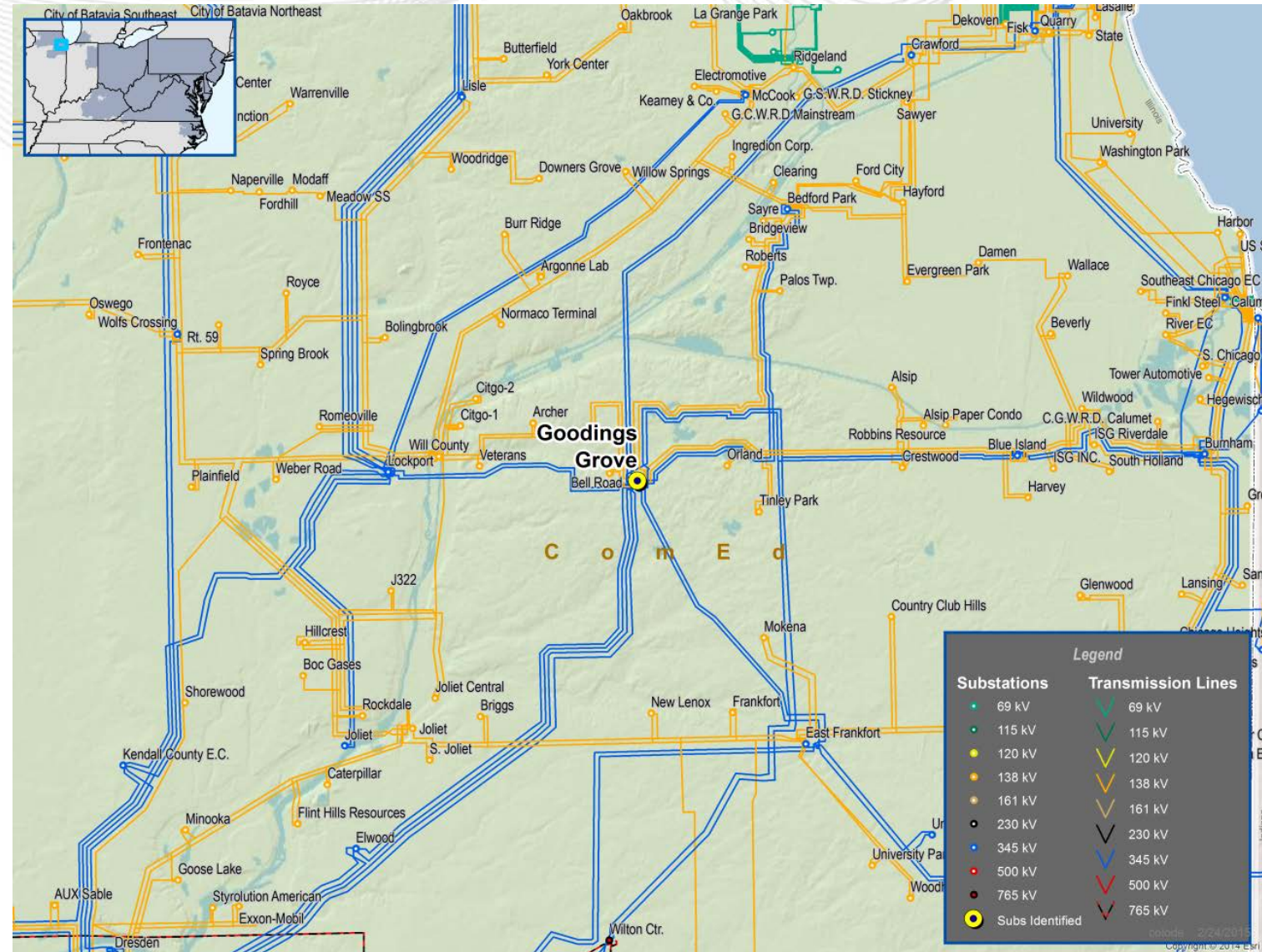
- **Supplemental Project**
- Davis Creek – Replace 345 kV bus tie 1-2. (S0881)
- Reason: Material Condition
- Estimated Cost: \$2.2M
- Projected IS Date: 10/31/2015



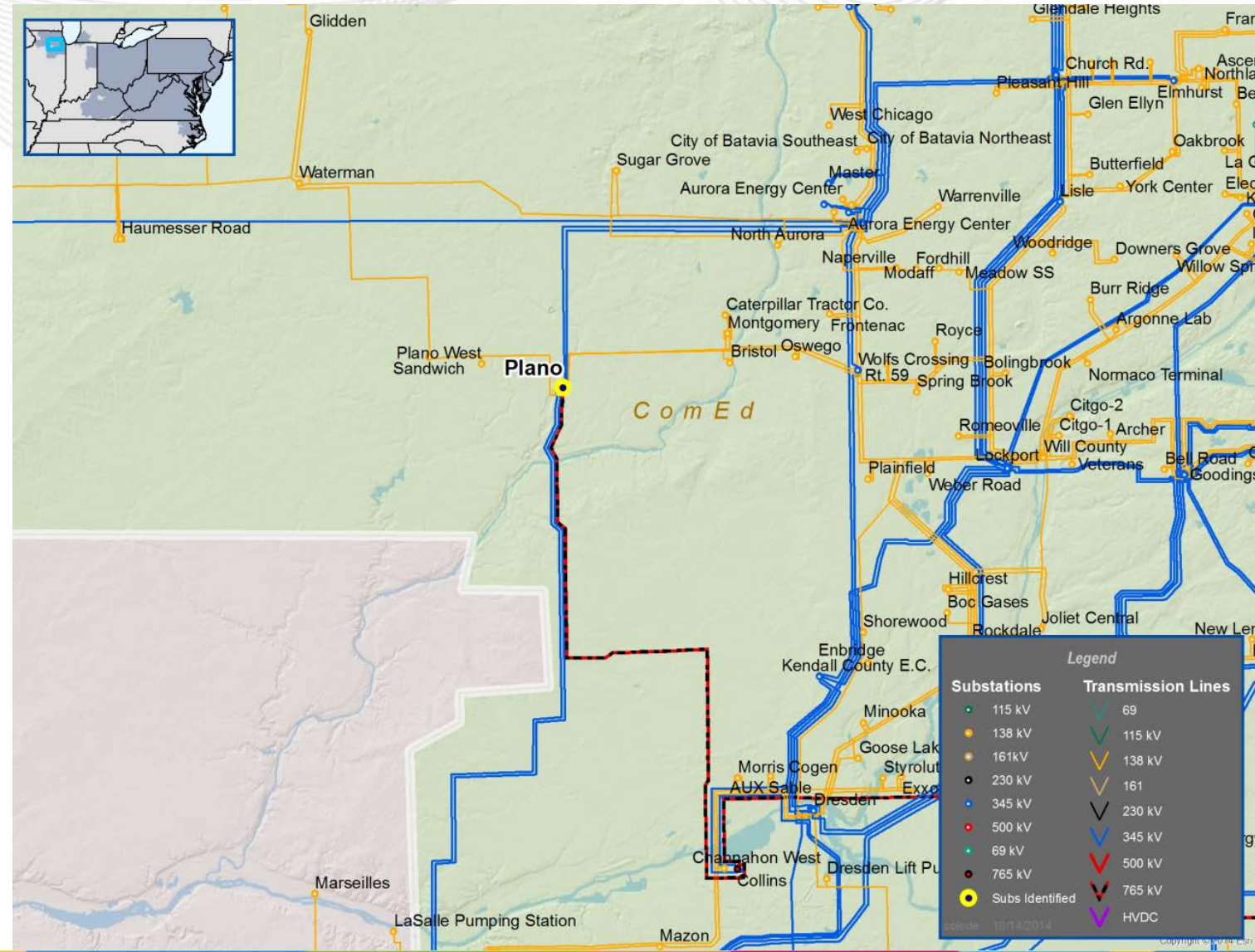
- **Supplemental Project**
- Libertyville – Replace 345 kV bus tie 8-9. (S0883)
- Reason: Material Condition
- Estimated Cost: \$3.1M
- Projected IS Date: 11/30/2015



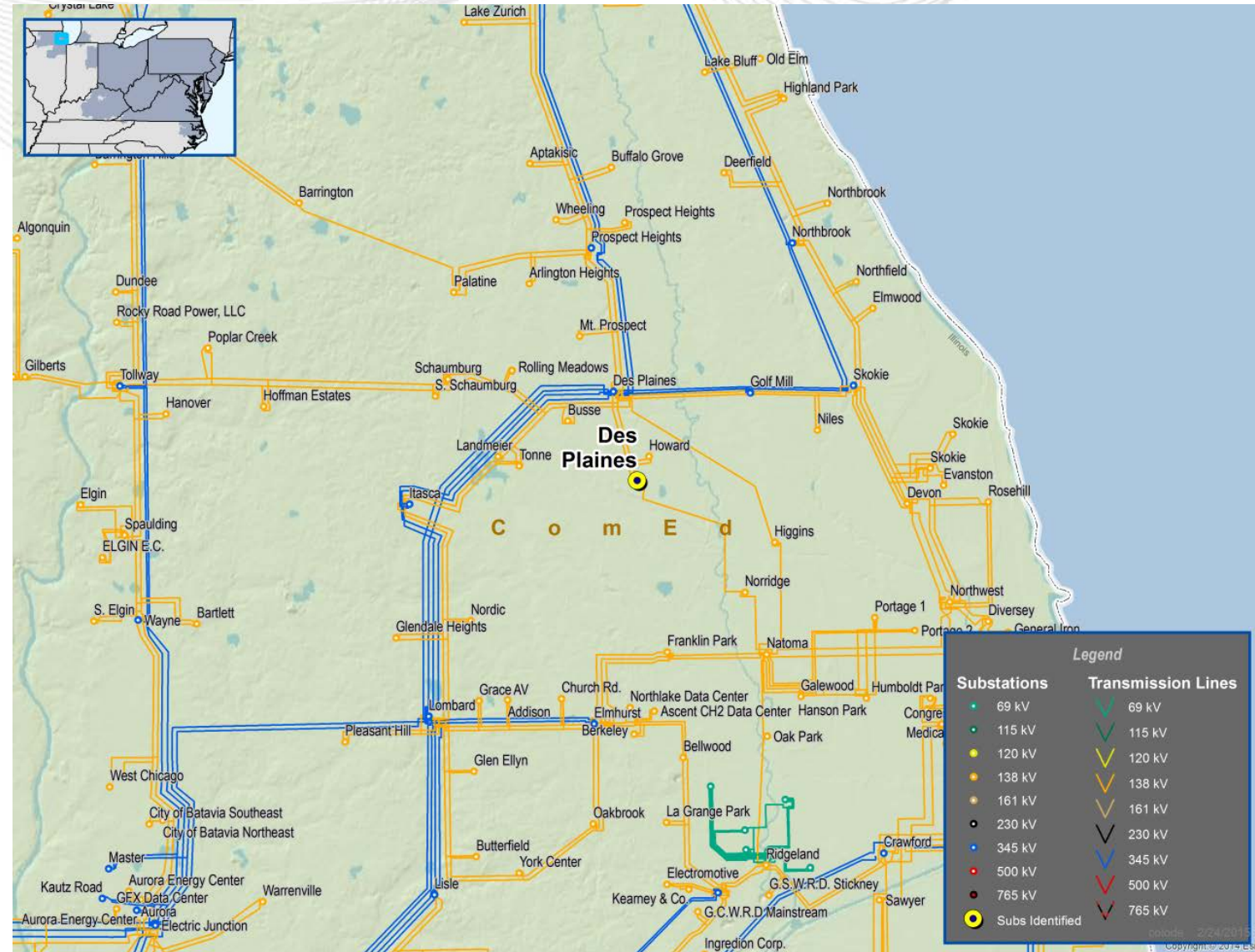
- **Supplemental Project**
- Goodings Grove – Balance Station Load (swap bus positions for 345 kV lines 1312 & 11620 and 345 kV lines 11604 & 11622) and replace 138 kV bus tie 2-3. (S0884)
- Reason: Potential Generation Retirement
- Estimated Cost: \$5.4M
- Projected IS Date: 1/31/2016



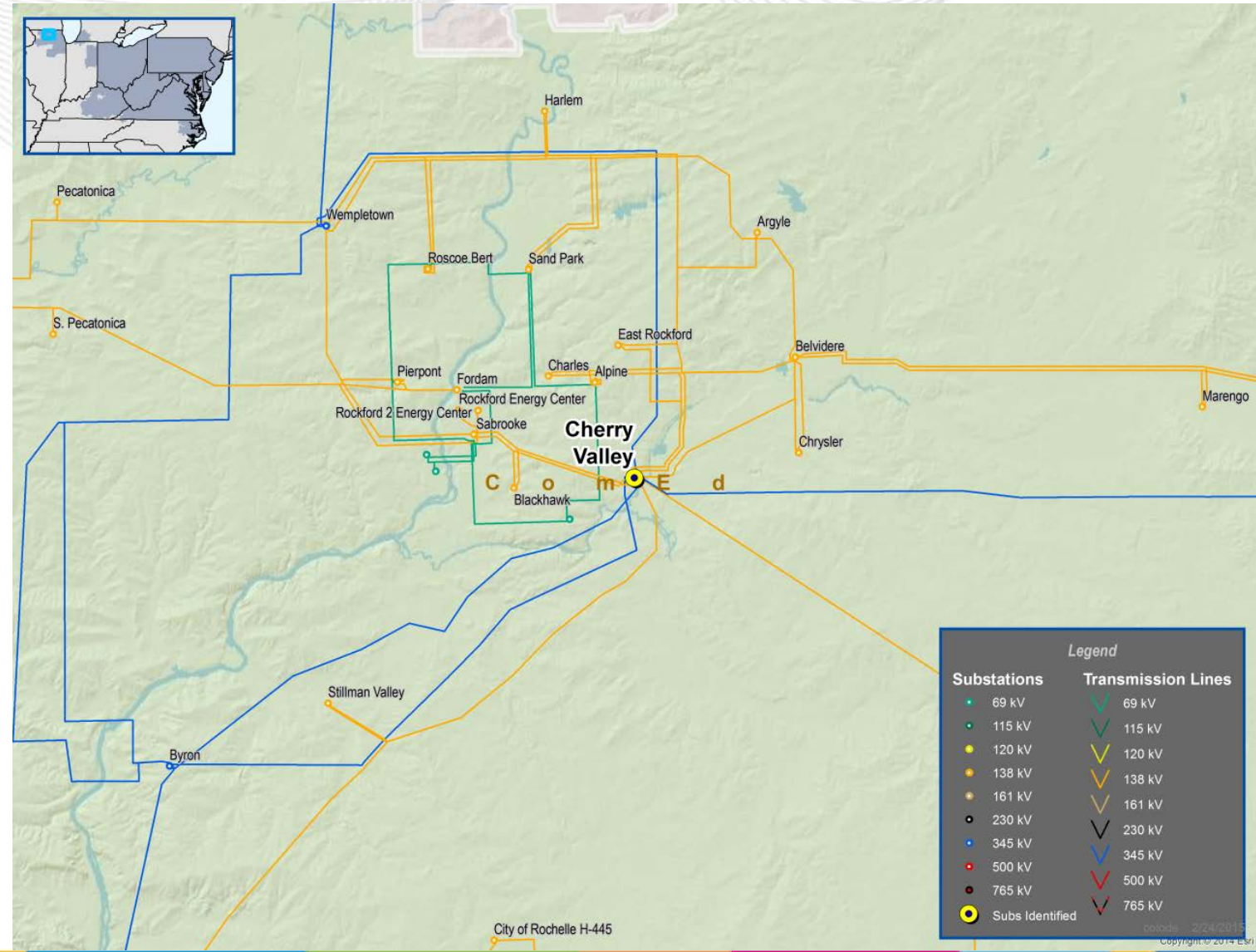
- **Supplemental Project**
- Plano – Replace 345 kV Bus Tie 8-9. (S0892)
- Reason: Material Condition
- Estimated Cost: \$2.2M
- Projected IS Date: 6/1/2016



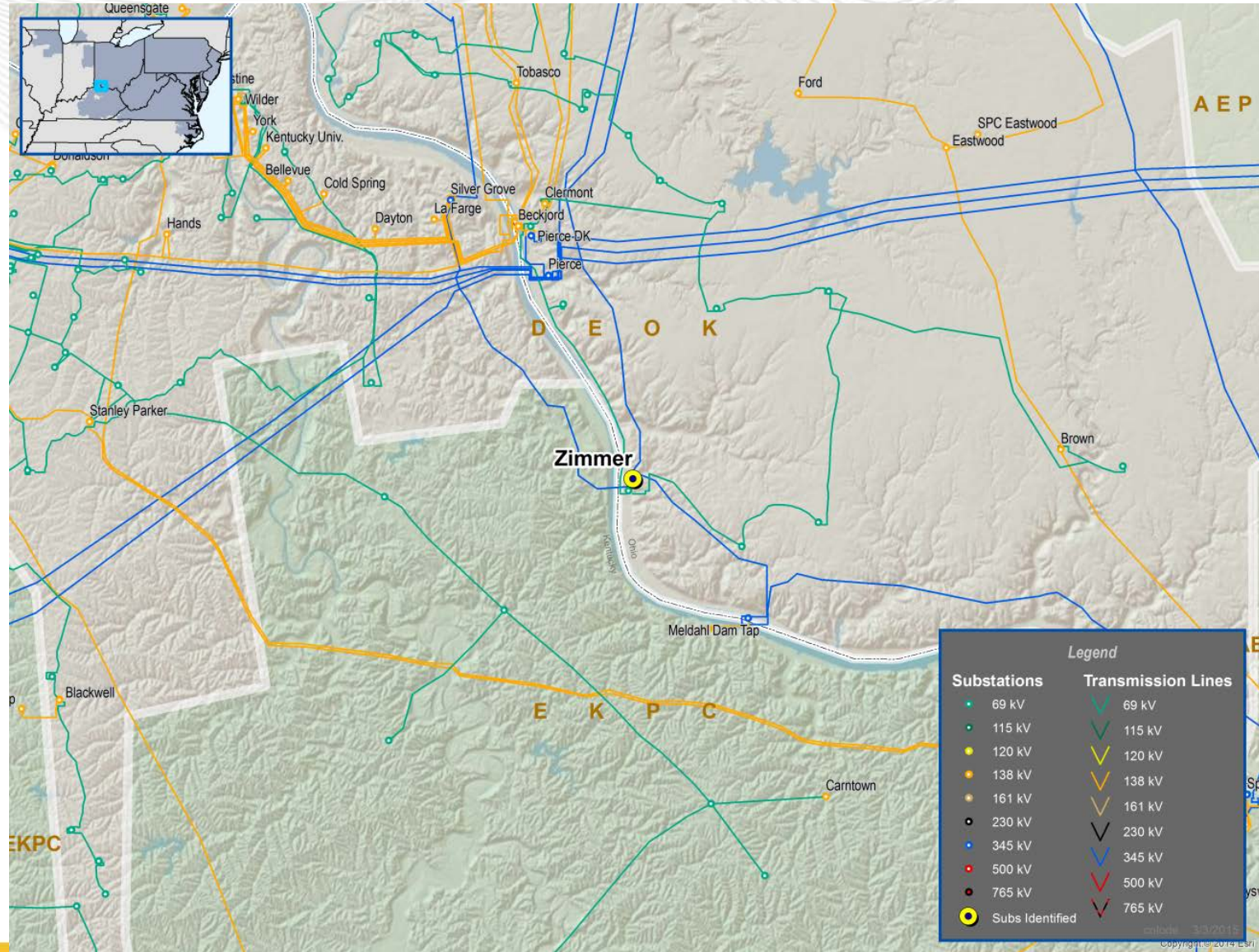
- **Supplemental Project**
- Des Plaines – Install 4 Transformer high side 345KV CBs for transformer 81, 82, 83, &84, replace 138 kV Bus Tie 2-3. (S0899)
- Reason: Operating Flexibility
- Estimated Cost: \$12.7M
- Projected IS Date: 12/31/2016



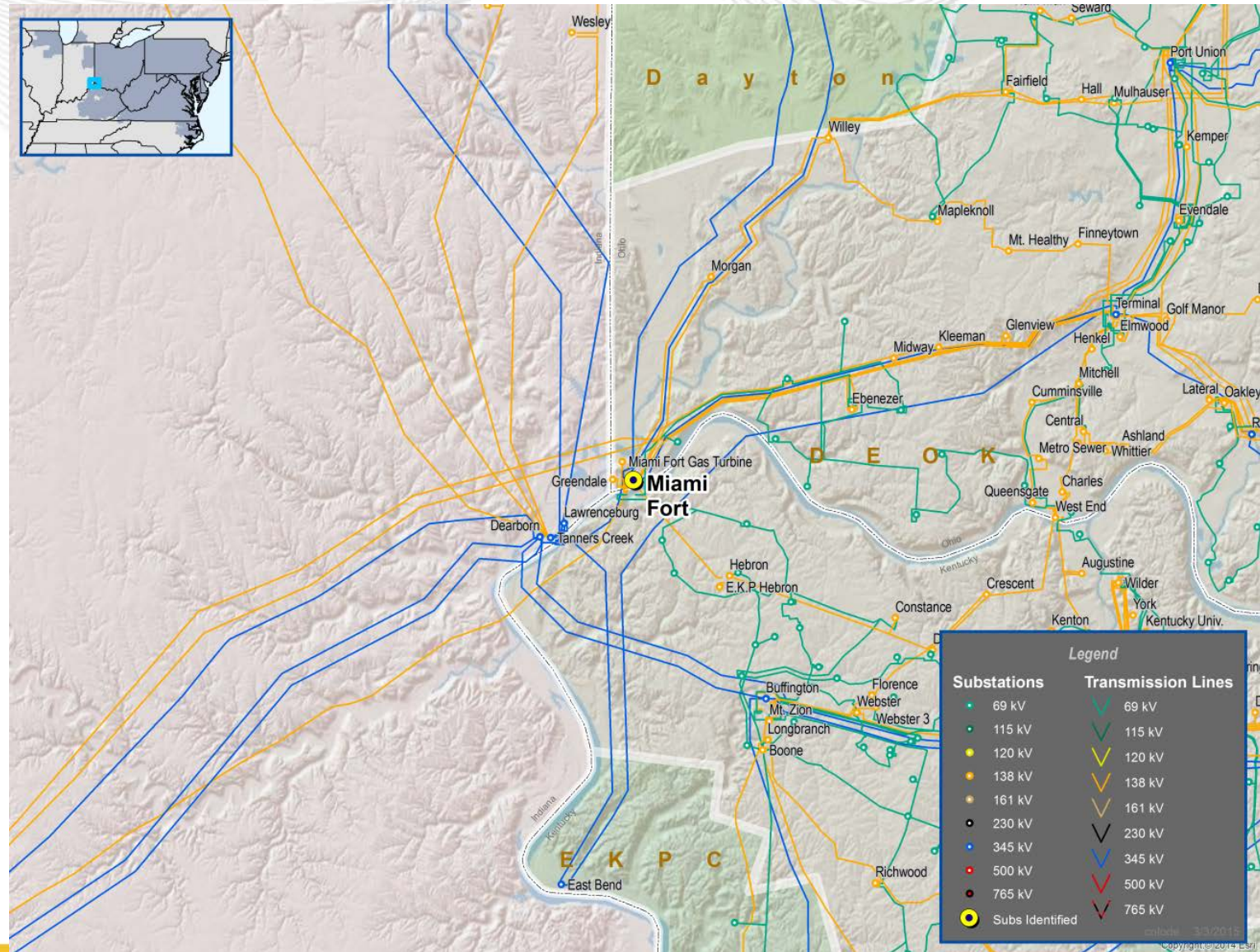
- **Supplemental Project**
- Cherry Valley – Replace 345/138kV Transformer 81, install high side 345kV circuit switcher, move cap bank from tertiary to 138 kV bus 1. (S0900)
- Reason: Material Condition
- Estimated Cost: \$21.5M
- Projected IS Date: 12/31/2015



- **Supplemental Project**
- Install a new 345kV synchronizing circuit breaker at Zimmer. (S0907)
- Estimated Cost: \$1.7M
- Projected IS Date: 12/31/2016



- **Supplemental Project**
- Install 2 new 345kV synchronizing circuit breakers at Miami Fort (S0908)
- Reason: Generation Separation
- Estimated Cost: \$6.33M
- Projected IS Date: 6/1/2017





Dominion Transmission Zone

Problem:

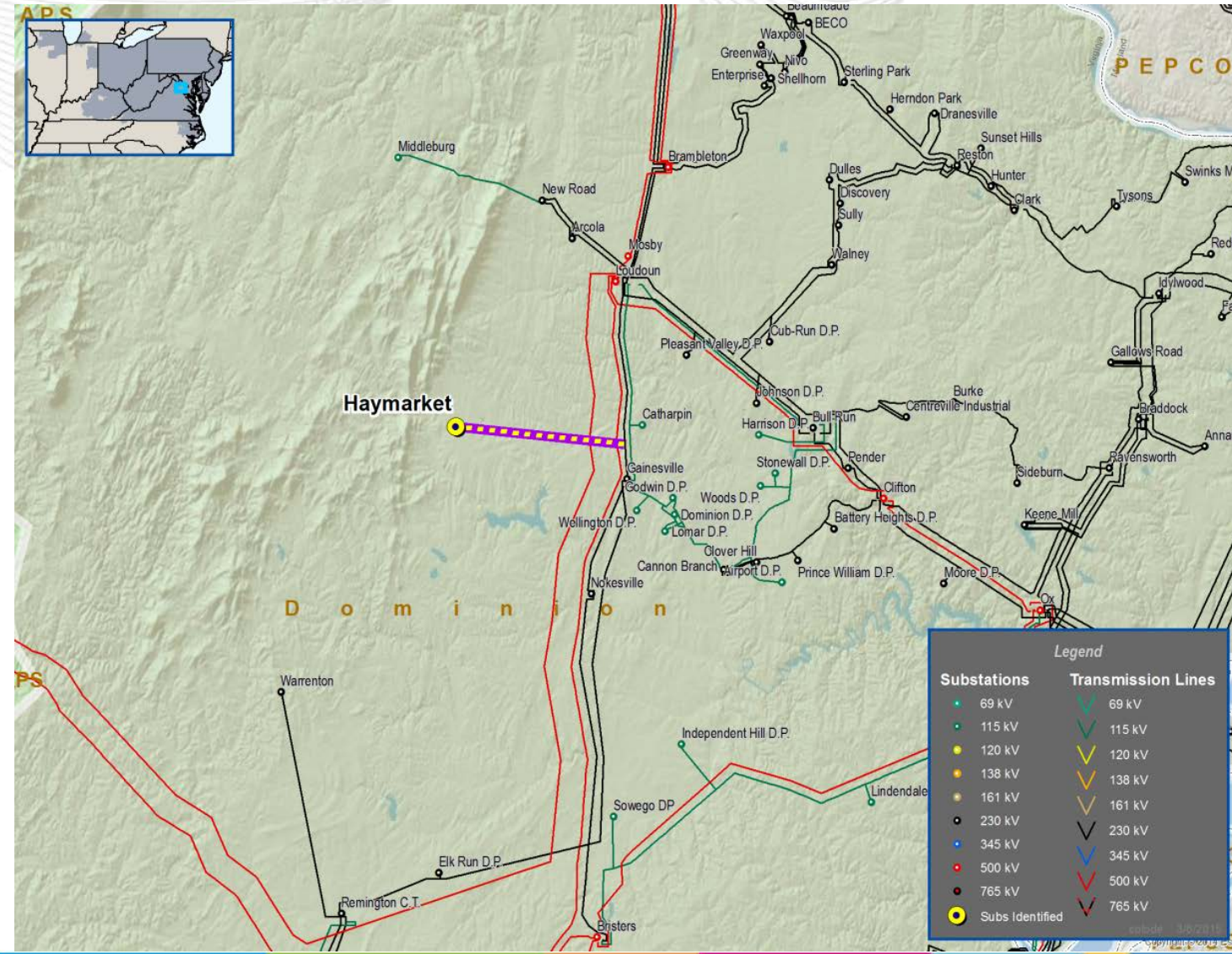
- Dominion Distribution (DVP) has submitted a Delivery Point (DP) Request for a proposed Haymarket Substation (site to be acquired) with an energization date of 01/31/2018 (energization likely will be summer 2018). The main driver for the new substation is a block load addition. Initial load will be approximately 80 MVA, growing to over 100 MVA by 2019.

Proposed Solution:

- Loop (in-and-out) an overhead, double-circuit, 230kV transmission line extension approximately 6 miles (along new right-of-way) from a point in the corridor north of Gainesville to the proposed Haymarket Substation site (**s0918.1**). Install four 230kV breakers in a ring arrangement to accommodate the connection of DVP's 84 MVA ,230-34.5kV transformers (two initial, three ultimate) (**s0918.2**)

• **Estimated Project Cost: \$45-57 M**

Projected IS Date: 5/1/2018



Problem:

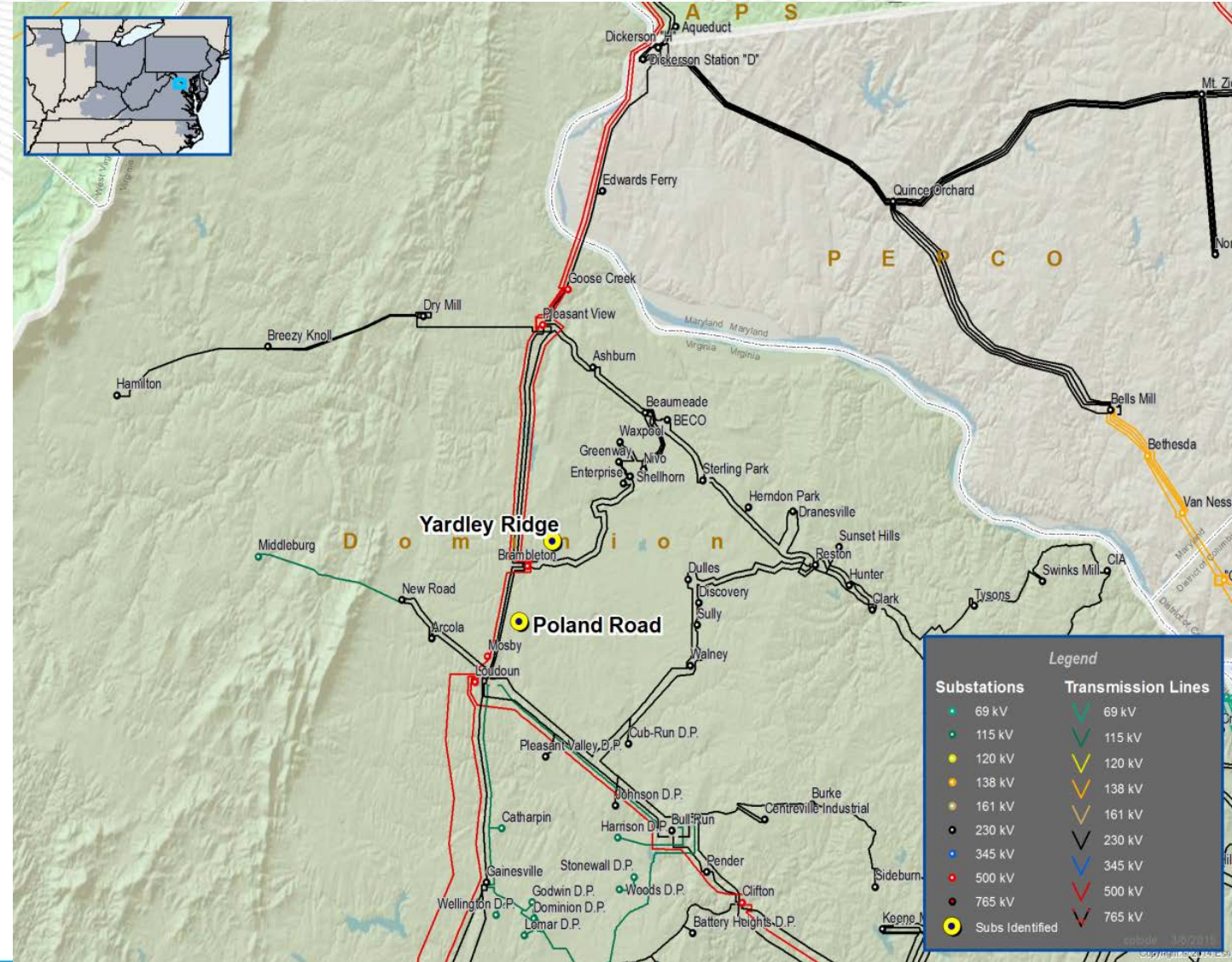
- Dominion Distribution (DVP) has submitted a Delivery Point (DP) Request for a proposed Poland Road Substation with an energization date of 04/30/2017. NOVEC has also submitted a DP Request for a proposed Yardley Ridge Substation with an energization date of 12/01/2017. The driver for each new substation is a block load addition (approx. 110 MVA at Poland Road and approx 150 MVA at Yardley Ridge).

Proposed Solution:

- Poland Road – Cut Line #2094 (Loudoun-Brambleton) and extend a double-circuit 230kV line approximately 4.0 mile to Poland Road Substation (**S0919.1**). At Poland Road Sub, install two backbone structures and a four-breaker 230kV ring bus. (**S0919.3**)
- Yardley Ridge – Cut Line #2137 (Brambleton-BECO) and extend a double-circuit 230kV line approximately 0.5 miles to Yardley Ridge Substation (**S0919.2**). At Yardley Ridge Sub, install two backbone structures and a four-breaker 230kV ring bus (**S0919.4**)

Estimated Project Cost: \$35 M

Projected IS Date: 5/1/2018



Problem:

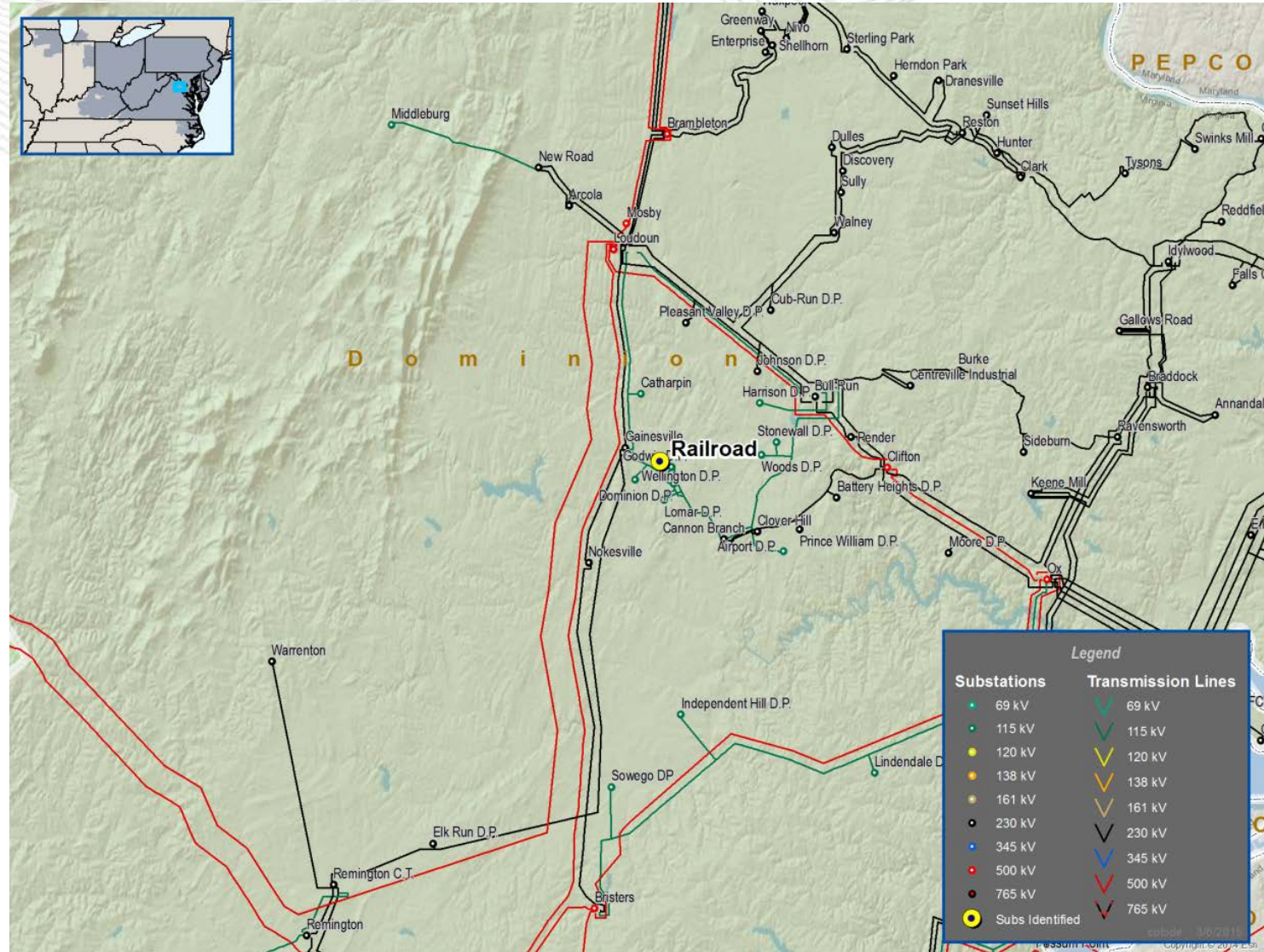
- NOVEC has submitted a Delivery Point (DP) Request for a proposed Railroad Substation with an energization date of 12/01/2015. The driver for the new substation is a large (76 MVA) data center load that cannot be fed by expansion of existing NOVEC substation.

Proposed Solution:

- Cut 230kV Line #2151 (Liberty-Gainesville) and loop approximately one span (in-and-out) to the proposed Railroad Substation. (S0923.1)
- Install two single-circuit 230kV backbones, four 230kV breakers in a ring arrangement, control enclosure, and protective relaying (S0923.2)

Estimated Project Cost: \$3 M

Projected IS Date: 12/1/2015



Problem:

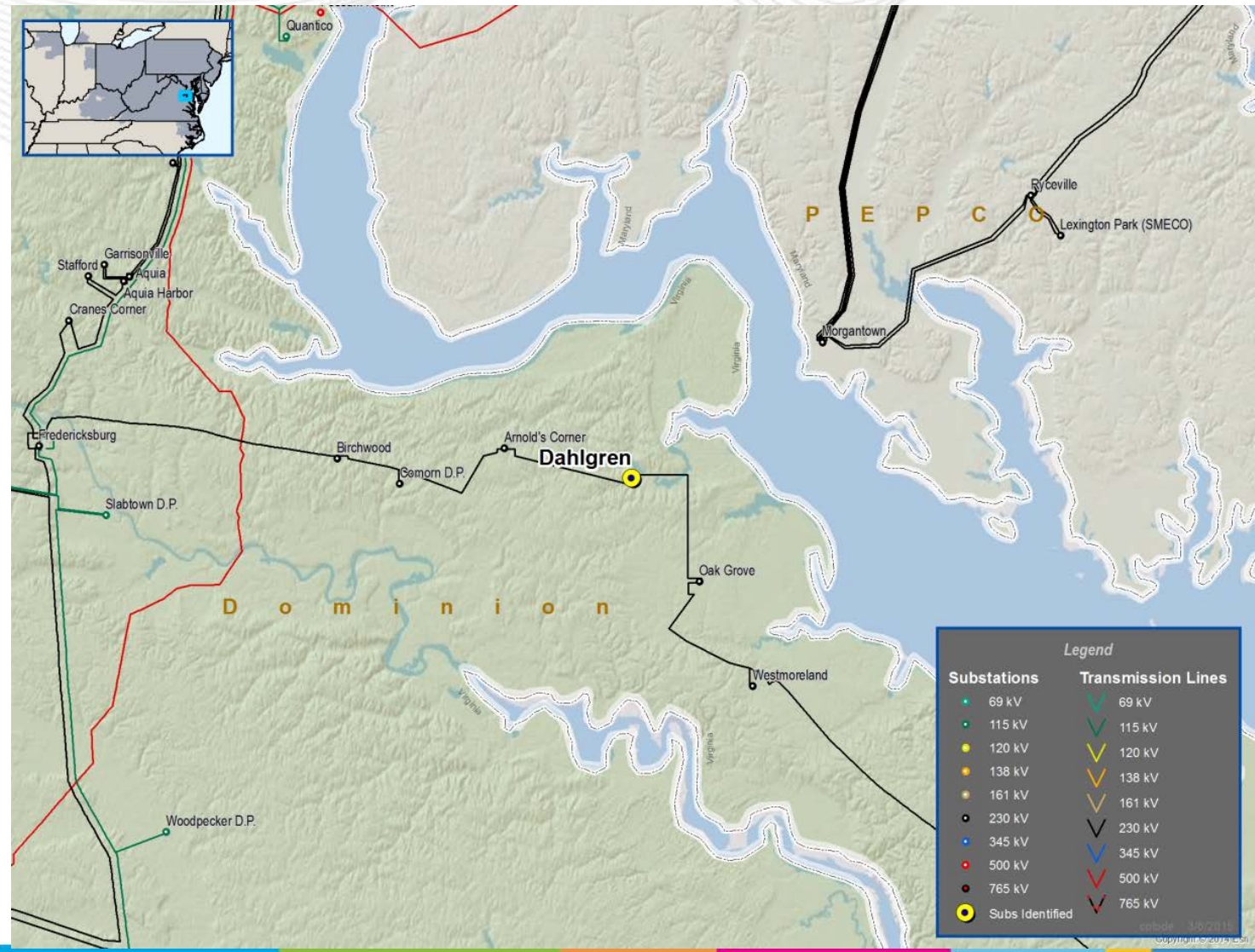
- Breaker maintenance on the 230kV breaker requires that the two 230kV lines be operated radial while maintenance is performed. The existing arrangement also creates an operational hazard where the 230kV breaker can be inadvertently bypassed during switching which could result in outages to the 230kV lines and generation at Birchwood NUG. This area has also been experiencing high voltage on the 230kV system in the area during light load conditions

Proposed Solution:

- Install three 230kV bus breakers and a 230kV, 100MVAR Variable Shunt Reactor to provide line protection during maintenance, remove the operational hazard and provide voltage reduction during light load conditions (S0924)

Estimated Project Cost: \$6.7 M

Projected IS Date: 5/1/2016

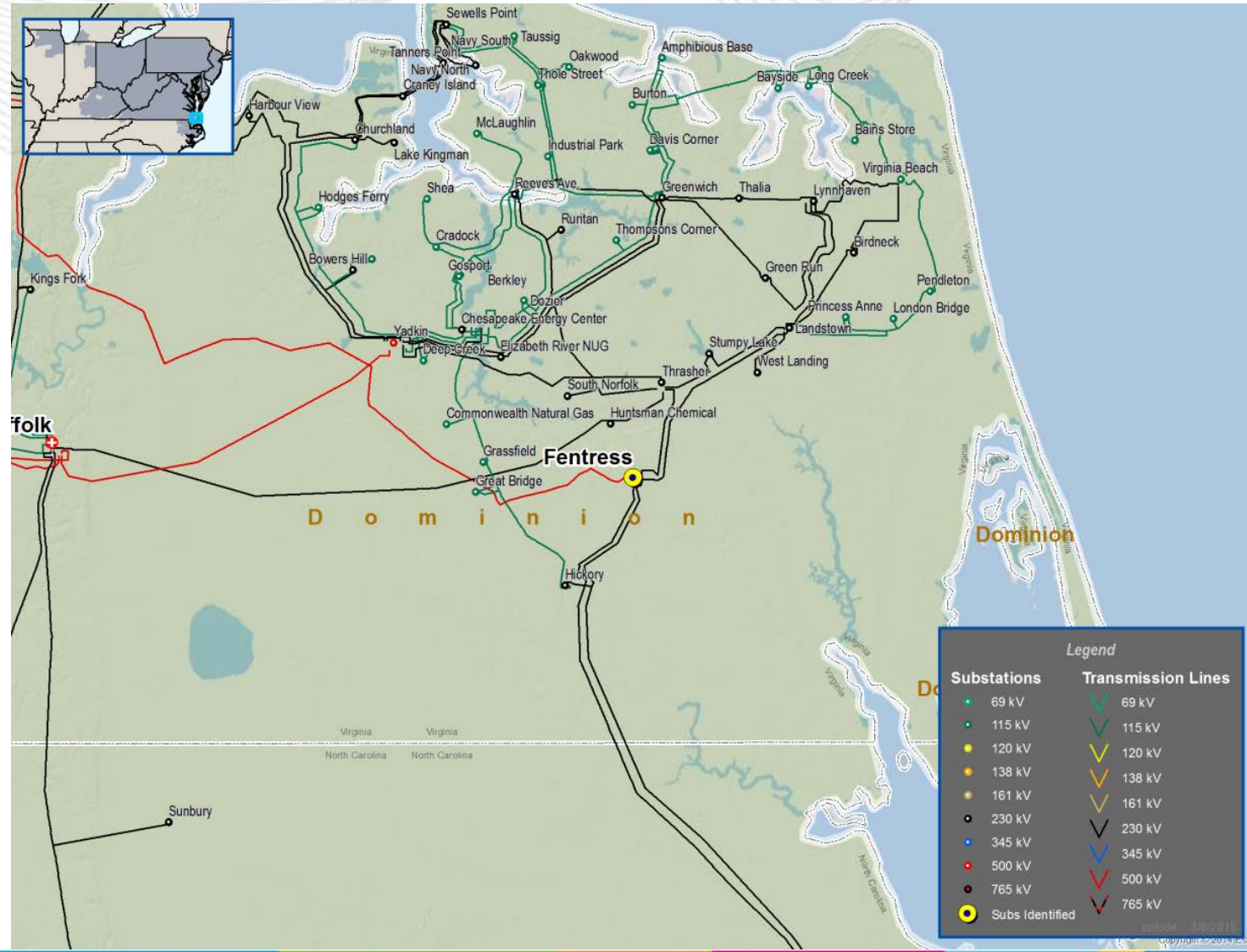


Supplemental Project:

- Dominion Distribution has identified the need to install a 2nd 230/34.5kV LTC transformer at Fentress substation. Transmission will need to support Dominion Distribution's effort with the installation of a 230kV circuit switcher on high side of this transformer and perform other associated work (S0926)

Estimated Project Cost: \$400 K

Projected IS Date: 5/31/2017





Artificial Island Update

- Working to finalize independent consultant review
- Performing failure mode analysis with Optical Grounding Wire (OPGW) and GSU tap changes at the island.
- Next Steps



RTEP Next Steps

- 2020 Summer RTEP Case is currently being exercised and benchmarked
- Analysis Next Steps
 - Baseline N-1, Generator Deliverability, Common Mode Outage, N-1-1, Load Deliverability
- Next Steps

Questions?

Email: RTEP@pjm.com

- Revision History
 - 3/10/2015 – original version posted to PJM.com
 - 3/13/2015 – Updated to include feedback discussed at the TEAC meeting