



# Transmission Expansion Advisory Committee

Baseline Reliability Update  
July 16, 2008

- MAPP Project
  - Possum Point – Burches Hill – Chalk Point – Calvert Cliffs – Vienna – Indian River – Salem 500 kV
  - Vienna 500/230 kV transformer
  - Indian River 500/230 kV transformer
- The MAPP Project and four variations were compared
  - AC1: MAPP Project
  - AC2: MAPP Project + DPL 230 kV upgrades
  - AC Simple: Calvert Cliffs to Vienna 500 kV line + DPL 230 kV upgrades
  - DC1: MAPP Project with DC line (1,000 MW setting) from Calvert Cliffs to Vienna + DPL 230 kV upgrades
  - DC2: DC1 (750 MW setting) with additional DC line (1,000 MW setting) from Calvert Cliffs to Indian River and no 500 kV AC line from Vienna to Indian River
- DPL 230 kV upgrades
  - Convert Vienna – Loretto – Piney Grove from 138 kV to 230 kV
  - 230/138 kV transformer at Loretto

## 15 Year Comparison of 500 kV Facilities

<b>Overloaded Facility</b>		<b>100% Year*</b>					
<b><u>Fr Name</u></b>	<b><u>To Name</u></b>	<b><u>Base Case</u></b>	<b><u>AC1</u></b>	<b><u>AC2</u></b>	<b><u>AC Simple</u></b>	<b><u>DC1</u></b>	<b><u>DC2</u></b>
Rock Springs	Keeney	2016					
Airydale	Juniata	2019	2022	2022	2021	2021	2023
Keystone	Airydale	2021					
Airydale	Juniata	2018	2022	2022	2021	2021	2022
Mt. Storm	Doubs	2022	2019	2019	2021	2022	2020
Kempton	Conastone	2022					

\* 100% Year for blank cells is >2023

## 15 Year Comparison of 230 kV Facilities

Overloaded Facility		100% Year*					
<u>Fr Name</u>	<u>To Name</u>	<u>Base Case</u>	<u>AC1</u>	<u>AC2</u>	<u>AC Simple</u>	<u>DC1</u>	<u>DC2</u>
Doubs	Limekiln	2015	2017	2017	2017	2018	2020
Brandon Shores	Hawkins Pt 44	2020					
Warrington	Buckingham	2020	2023	2023	2022	2021	2022
Red Lion	Cedar Creek	2017					
Lewistown	Juniata	2017	2020	2021	2020	2021	2022
Soliers Pt.	Riverside 17	2022					
Sandy Spring	High Ridge	2019					
Elmwood	Graysferry						2021
Parrish	Master		2020	2019	2020	2019	2017
Graceton	Manor	2020					
Brandon Shores	Hawkins Pt 45	2022					
Graceton	Peach Bottom Tp	2021					
Soliers Pt.	Riverside 39	2020					
Conastone	Otter Creek	2020					

\* 100% Year for blank cells is >2023

## 15 Year Comparison of 138 kV Facilities

Overloaded Facility		100% Year*					
Fr Name	To Name	Base Case	AC1	AC2	AC Simple	DC1	DC2
Edgemoor	Carrcroft	2022					
Vienna	Nelson				2015		2013
Steele	Hillsboro	2021					
Reybold	Lums Pond	2013	2019	2019	2017	2021	2023
Indian River	Omar	2017	2018	2018	2019	2018	2018
Glasgow	Mt Pleasant	2013					
Townsend	Church	2021					
Red Lion	Hares Corner		2023	2022		2023	2020
Basin Rd	Kiamenski		2023	2023	2023	2023	2021
Milford	S Harrington	2023					
Omar	Bethany	2016	2017	2018	2019	2018	2018
Keeney	Glasgow	2018					

\* 100% Year for blank cells is >2023

## 15 Year Comparison of Transformers

<b>Overloaded Facility</b>	<b>100% Year*</b>					
<b>Fr Name</b>	<b>Base Case</b>	<b>AC1</b>	<b>AC2</b>	<b>AC Simple</b>	<b>DC1</b>	<b>DC2</b>
Keeney 1&2 500/230 kV	2015					
Conastone 1&2 500/230 kV		2022	2019	2023		2017
Vienna 500/230 kV			2023	2013		
Waugh Chapel 1&2 500/230 kV	2020					
Steele 1 230/138 kV		2023	2023	2023	2023	2021
Steele 2 230/138 kV	2020	2015	2016	2016	2015	2013

\* 100% Year for blank cells is >2023

- All variations show similar results
- All variations provide significant loading reduction on Rock Springs – Keeney 500 kV
- All variations solve 2013 voltage collapse issues in MAAC and EMAAC load deliverability studies for loss of Rock Springs – Keeney

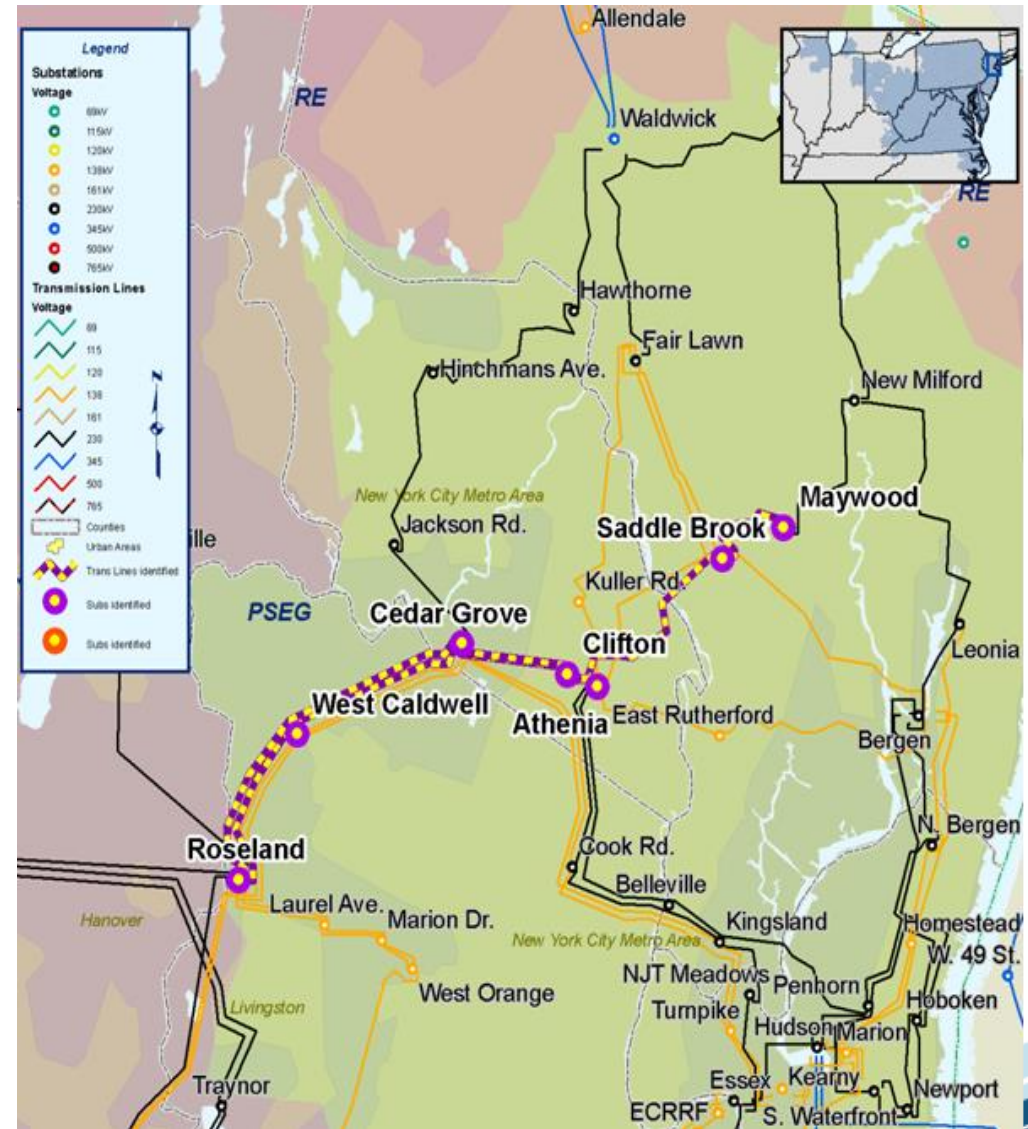


# PSEG Baseline Upgrades



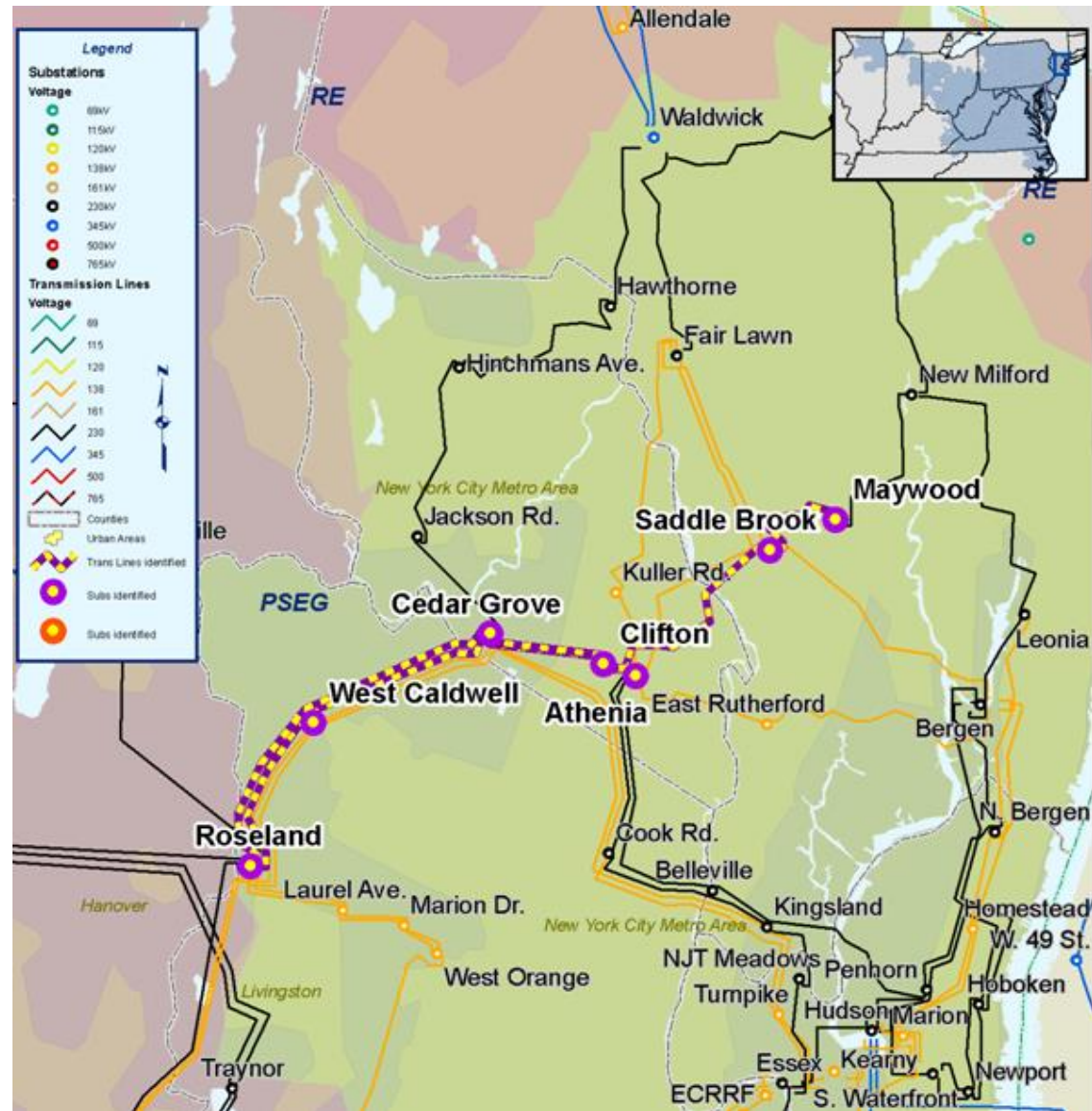
## Generator Deliverability

- Athenia - Saddle Brook 230 kV line / Basecase
- Athenia - Saddle Brook 230 kV line / Loss of Waldwick – Hillsdale 230 kV line (Single)
- Cedar Grove B - Clifton B 230 kV line / Loss of Roseland-Cedar Grove F - Clifton K - Athenia 230 kV line (Single)
- Cedar Grove F - Clifton K 230 kV line / Loss of Roseland-Cedar Grove B - Clifton B - Athenia 230 kV line + Roseland Breaker 3-4 to Cedar Grove B (Line\_FB)
- Cedar Grove F - Clifton K 230 kV line / Loss of Roseland-Cedar Grove B - Clifton B - Athenia 230 kV line (Single)
- Cedar Grove F - Clifton K 230 kV line / Basecase
- Cedar Grove F - Clifton K 230 kV line / Loss of Waldwick – Hillsdale 230 kV line (Single)
- Cedar Grove F - Clifton K 230 kV line / Loss of Roseland – Hudson 230 kV line (Single)
- Roseland - Cedar Grove B 230 kV line / Loss of Roseland – Cedar Grove F – Clifton K – Athenia 230 kV line + Roseland Breaker 1-2 to Cedar Grove F (Line\_FB)
- Roseland - Cedar Grove B 230 kV line Loss of Roseland – Cedar Grove F – Clifton K – Athenia 230 kV line (Single)



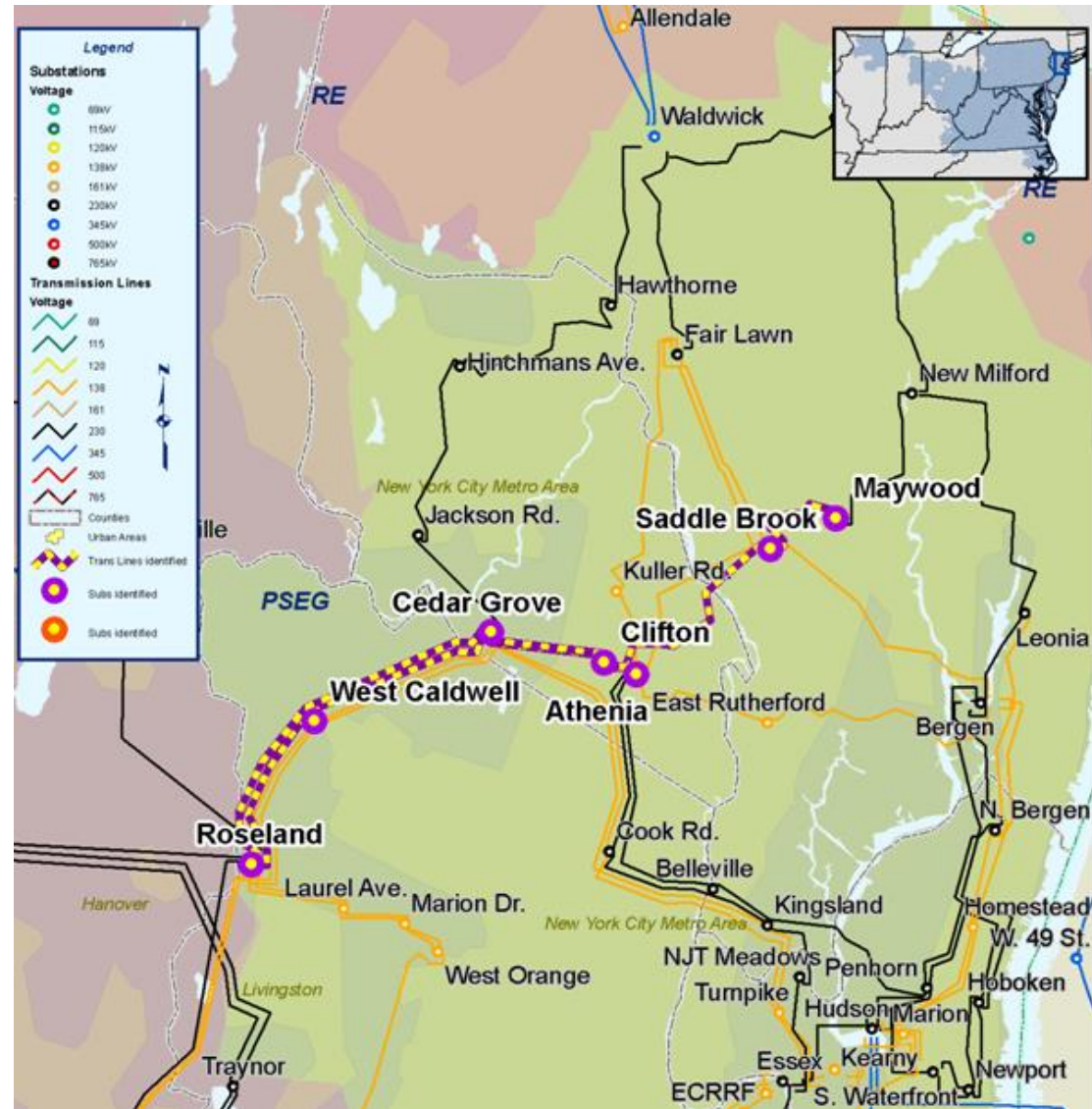
## • Generator Deliverability continued

- Roseland - Cedar Grove B 230 kV line / Loss of Ramapo – Jefferson 500 kV line (Single)
- Roseland - Cedar Grove B 230 kV line / Basecase
- Roseland - Cedar Grove B 230 kV line / Loss of Roseland – Hudson 230 kV line (Single)
- Roseland - Cedar Grove F 230 kV line / Loss of Roseland – Cedar Grove B – Clifton B – Athenia 230 kV line + Roseland Breaker 3-4 to Cedar Grove B (Line\_FB)
- Roseland - Cedar Grove F 230 kV line / Loss of Roseland – Cedar Grove B – Clifton B – Athenia 230 kV line + Roseland Breaker 2-3 to Cedar Grove B (Line\_FB)
- Roseland - Cedar Grove F 230 kV line / Loss of Roseland – Cedar Grove B – Clifton B – Athenia 230 kV line (Single)
- Roseland - Cedar Grove F 230 kV line / Loss of Ramapo – Jefferson 500 kV line (Single)
- Roseland - Cedar Grove F 230 kV line / Basecase
- Roseland - Cedar Grove F 230 kV line / Loss of Roseland – Hudson 230 kV line (Single)



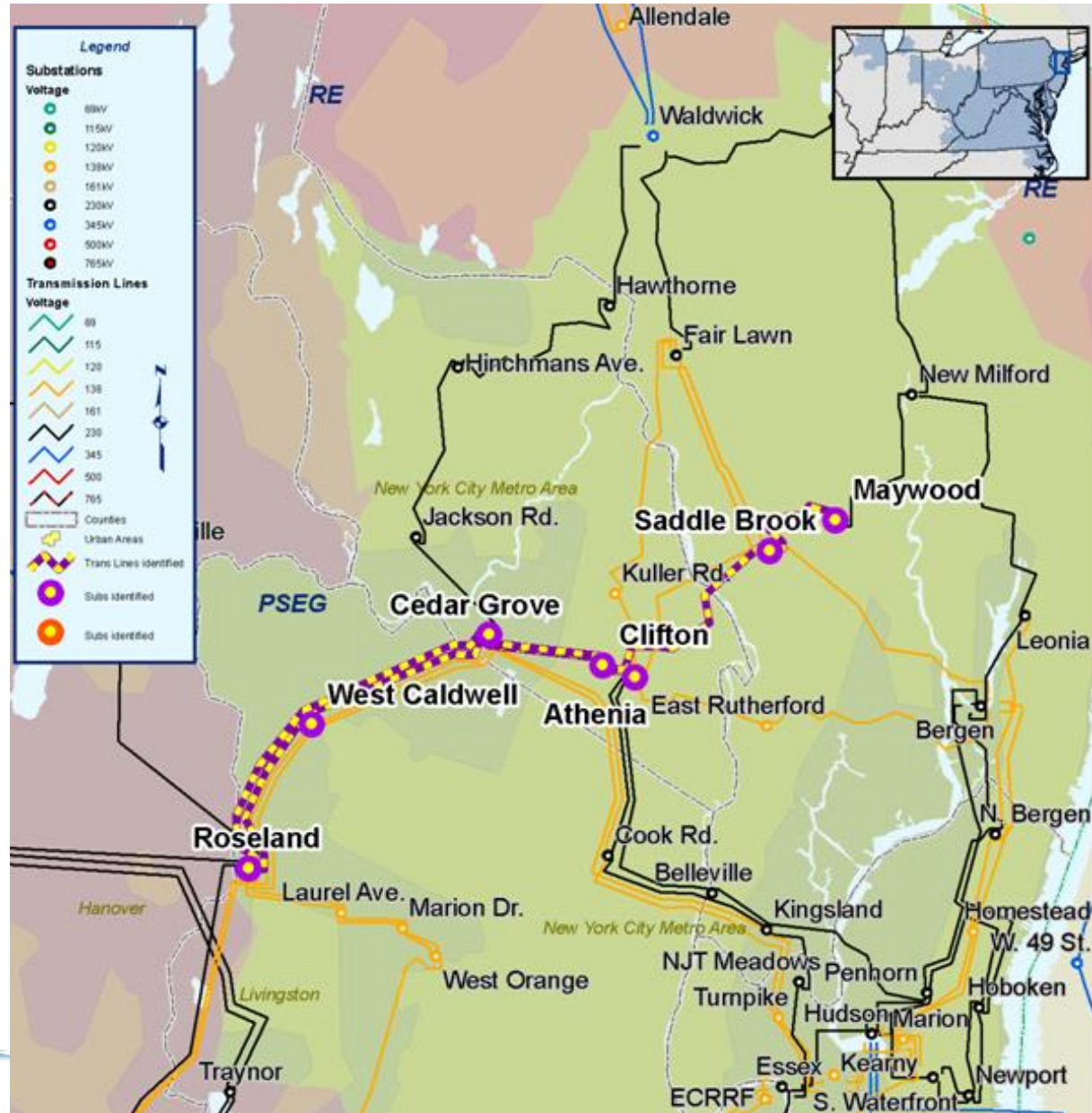
## • Load Deliverability Violations

- Roseland – West Caldwell 138 kV line / Loss of Roseland – Athenia 230 kV DCTL (Tower)
- Clifton B - Athenia 230 kV line / Loss of Roseland - Cedar Grove F - Clifton K - Athenia 230 kV line Clifton K - Athenia 230 kV line / Loss of Roseland-Cedar Grove B - Clifton B - Athenia 230 kV line + Roseland 230/138 kV transformer (Line\_FB)
- Clifton K - Athenia 230 kV line / Loss of Roseland-Cedar Grove B - Clifton B - Athenia 230 kV line (Single)
- Athenia – Saddle Brook 230 kV for the loss of Athenia – Bergen 230 kV
- Roseland - Cedar Grove B 230 kV line / loss of the other circuit
- Roseland - Cedar Grove F 230 kV line / loss of the other circuit



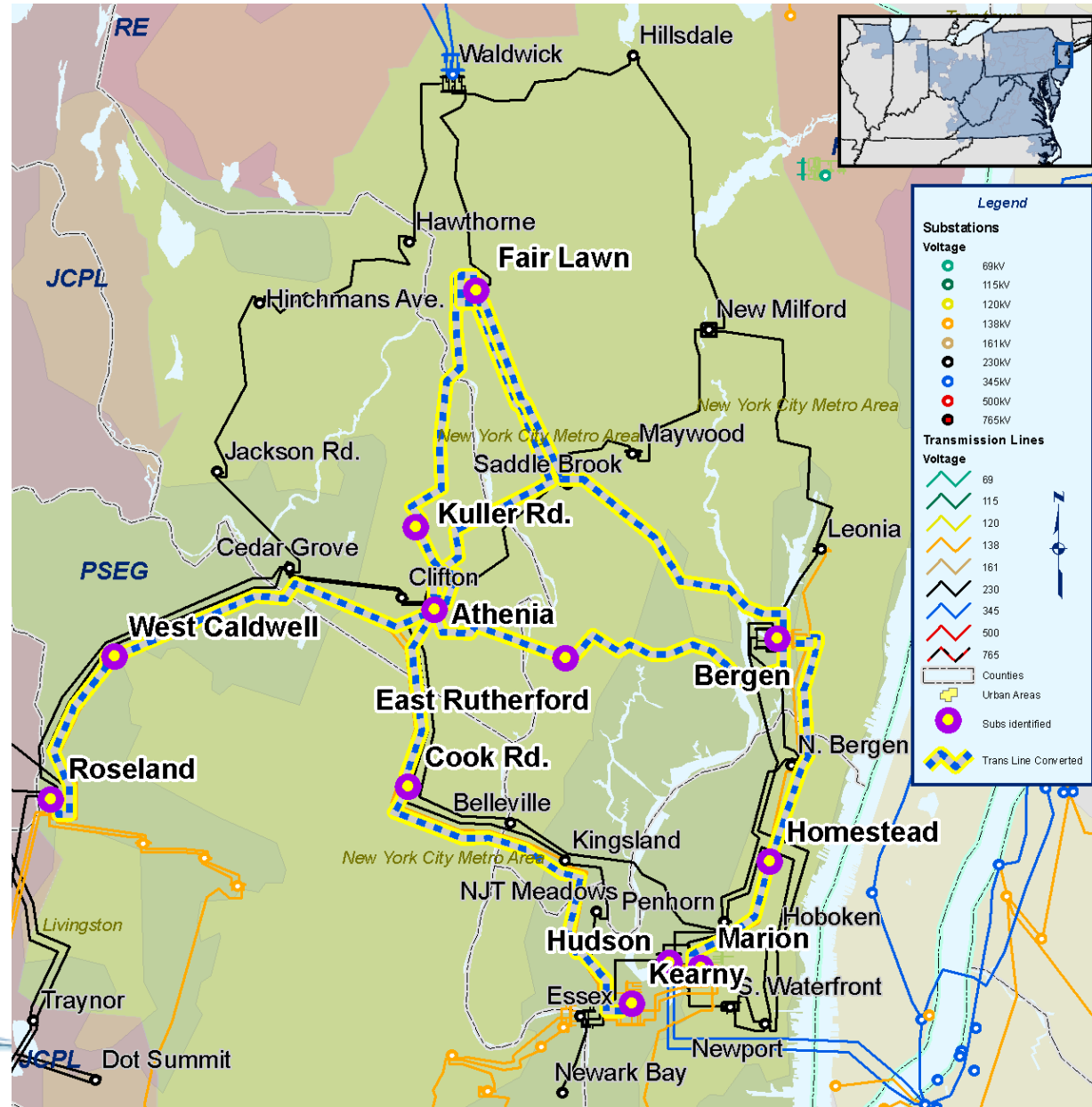
## • Load Deliverability violations continued

- Cedar Grove F - Clifton K 230 kV line / loss of Roseland-Cedar Grove B - Clifton B - Athenia 230 kV line
- Cedar Grove B - Clifton B 230 kV line / loss of Roseland-Cedar Grove F - Clifton K - Athenia 230 kV line
- Clifton K - Athenia 230 kV line / loss of Roseland-Cedar Grove B - Clifton B - Athenia 230 kV line
- Saddle Brook - Maywood 230 kV line / loss of Athenia - Bergen 230 kV line

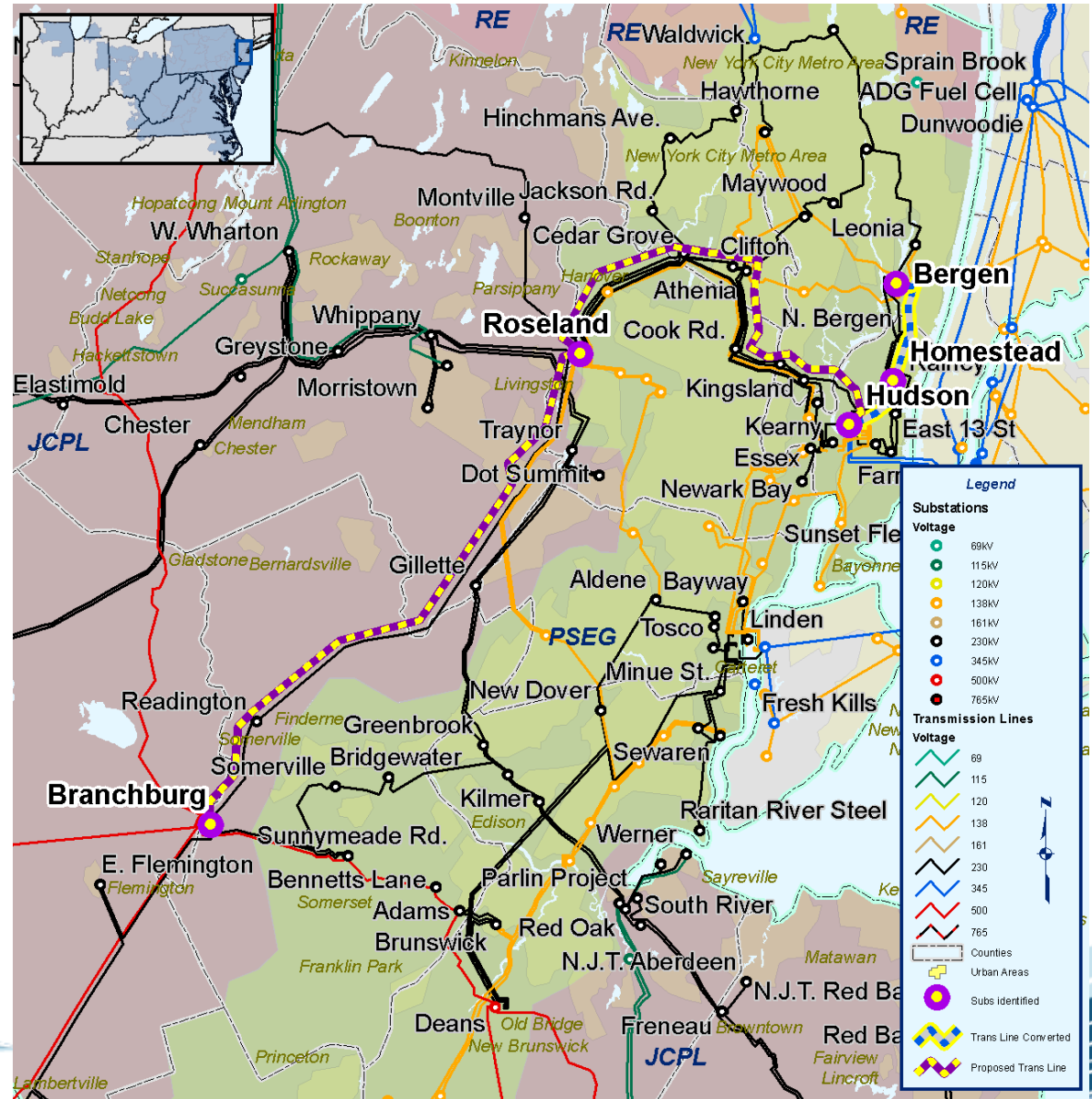


- **230 kV Option**

- Loop the converted Roseland to Kearny “D” 230 kV circuit into Athenia
- Convert Roseland to Kearny “G” 138 kV circuit to 230 kV and terminate at Hudson
- Convert 138 kV between Athenia and Bergen to 230 kV
- Convert Marion to Homestead “E” to Bergen from 138 kV to a 230 kV circuit from Hudson to Homestead “E” to Bergen
- Remove Marion to Homestead “F” to Bergen 138 kV circuit



- 500 kV Option
  - New Branchburg to Roseland to Hudson 500 kV circuit
  - Convert Marion to Homestead “E” to Bergen from 138 kV to a 230 kV circuit from Hudson to Homestead “E” to Bergen
  - Reconductor Hudson – South Waterfront 230 kV



## 15 Year Comparison of PSEG Options

Overloaded Facility			100% Year		
<u>From Name</u>	<u>To Name</u>	<u>kV</u>	<u>Base Case</u>	<u>230 kV Option</u>	<u>500 kV Option</u>
Roseland	Cedar Grove "F"	230	2013	> 2023	> 2023
Cedar Grove "F"	Clifton "K"	230	2013	> 2023	> 2023
Clifton "K"	Athenia	230	2013	> 2023	> 2023
Roseland	Cedar Grove "B"	230	2013	> 2023	> 2023
Cedar Grove "B"	Clifton "B"	230	2013	> 2023	> 2023
Clifton "B"	Athenia	230	2015	> 2023	> 2023
Athenia	Saddlebrook	230	2013	> 2023	> 2023
Roseland	West Caldwell "G"	138	2017	> 2023	> 2023
Somerville	Bridgewater	230	2022	> 2023	> 2023

- 230 kV Option
  - Loop the converted Roseland to Kearny “D” 230 kV circuit into Athenia
  - Convert Roseland to Kearny “G” 138 kV circuit to 230 kV and terminate at Hudson
  - Convert 138 kV between Athenia and Bergen to 230 kV
    - Athenia to Fairlawn
    - Athenia to Kuller Rd
    - Kuller Rd to Fairlawn
    - Athenia to East Rutherford
    - East Rutherford to Bergen
    - Fairlawn to Bergen
  - Convert Marion to Homestead “E” to Bergen from 138 kV to a 230 kV circuit from Hudson to Homestead “E” to Bergen
  - Remove Marion to Homestead “F” to Bergen 138 kV circuit
- Potential Issues
  - Outages required to implement
  - Real estate requirements
  - Limited capability

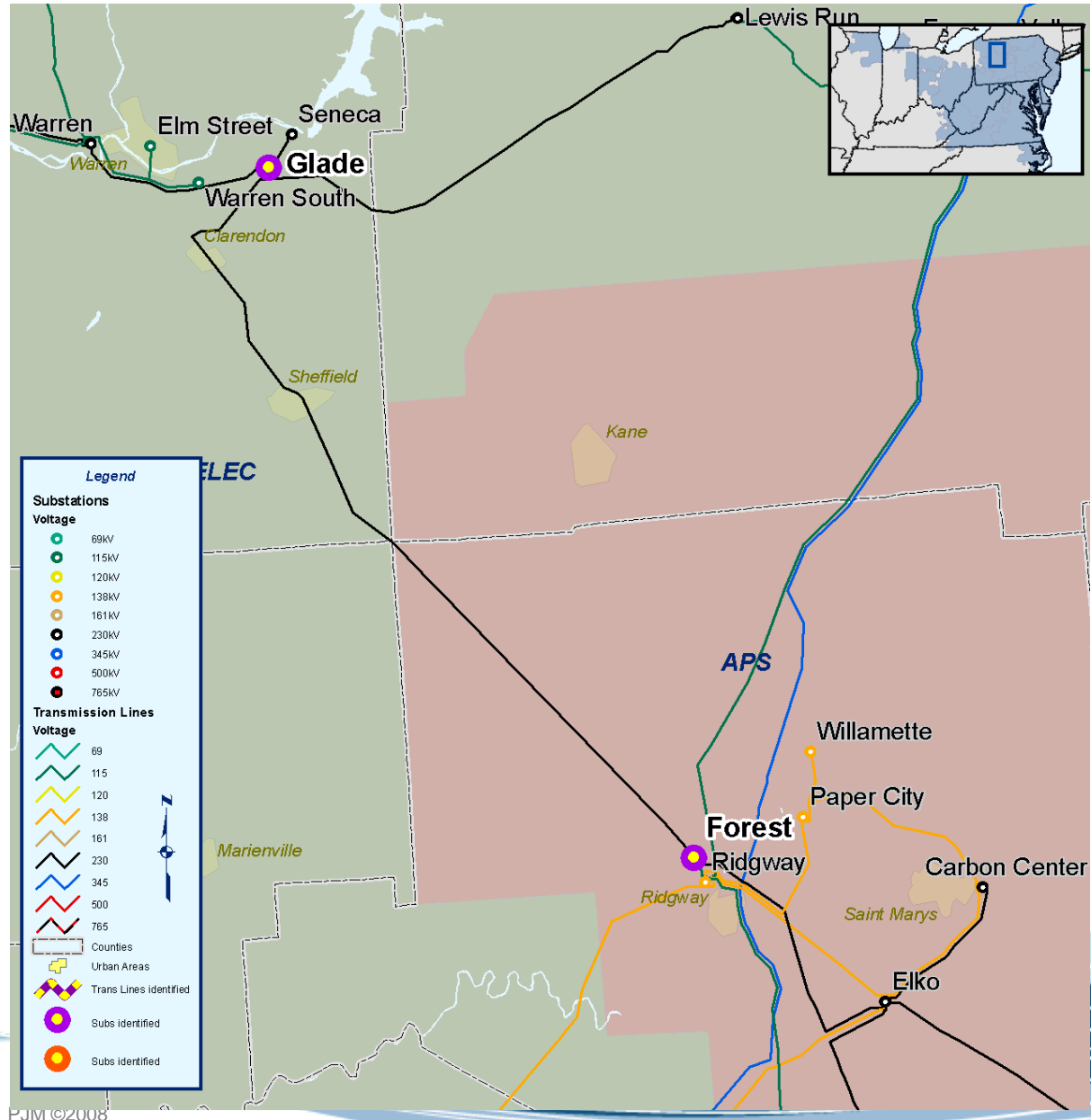


- 500 kV Option
  - New Branchburg to Roseland to Hudson 500 kV circuit
  - Convert Marion to Homestead “E” to Bergen from 138 kV to a 230 kV circuit from Hudson to Homestead “E” to Bergen
  - Reconductor Hudson – South Waterfront 230 kV
- Robust solution
  - Larger reduction in loading on 230 kV circuits in Northern New Jersey
- Potential Challenges
  - ROW congestion
  - Real estate at Hudson

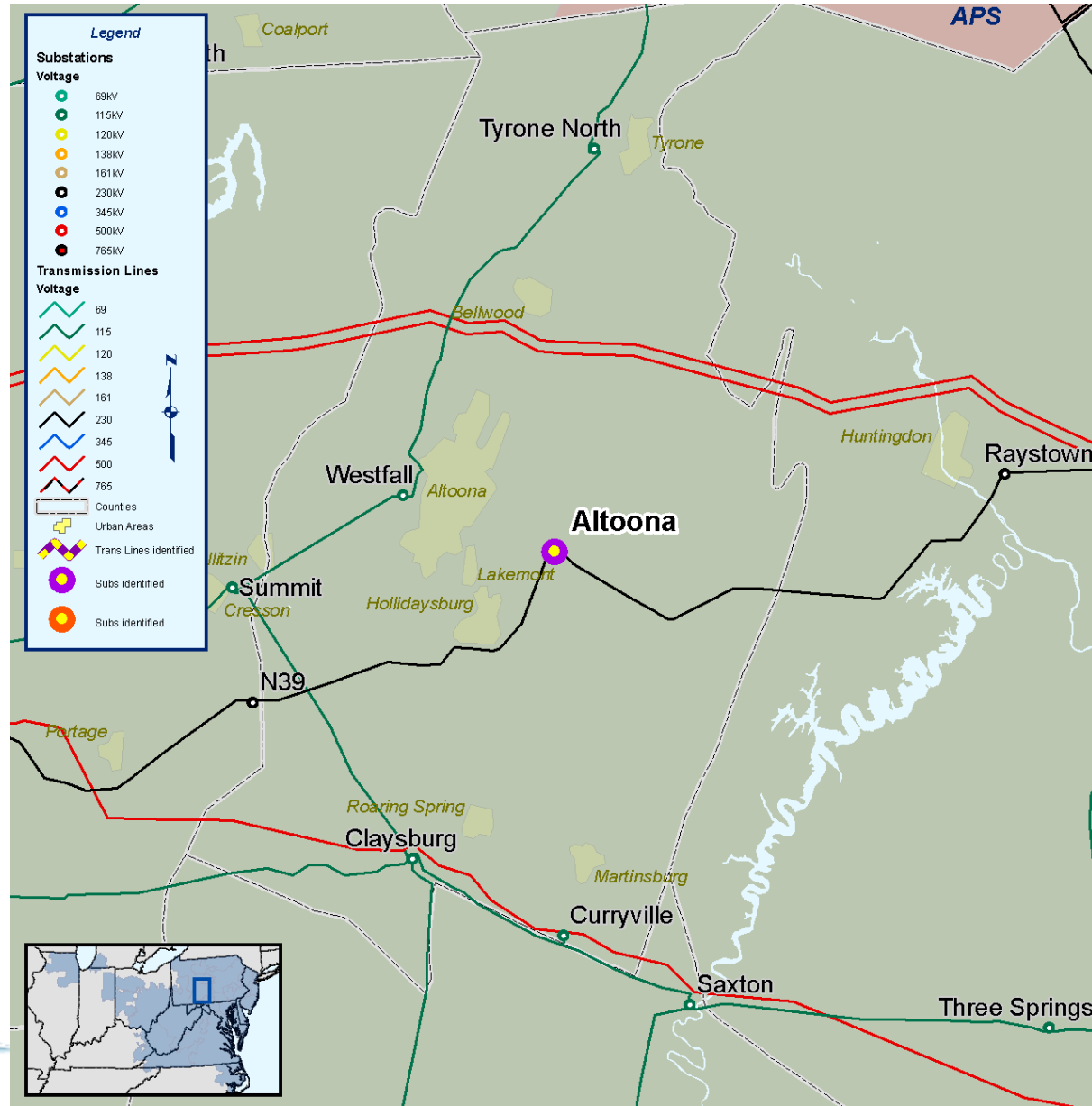


# FE Baseline Projects

- Voltage collapse / Forest 230 kV circuit breaker fault causing the loss of the Forest-Glade Tap 230 kV line
- Reconfigure and expand the Glade 230 kV ring bus to eliminate the Glade Tap 230 kV 3-terminal line
- Estimated Project Cost: \$5.64 M
- Expected IS Date: 6/01/2010



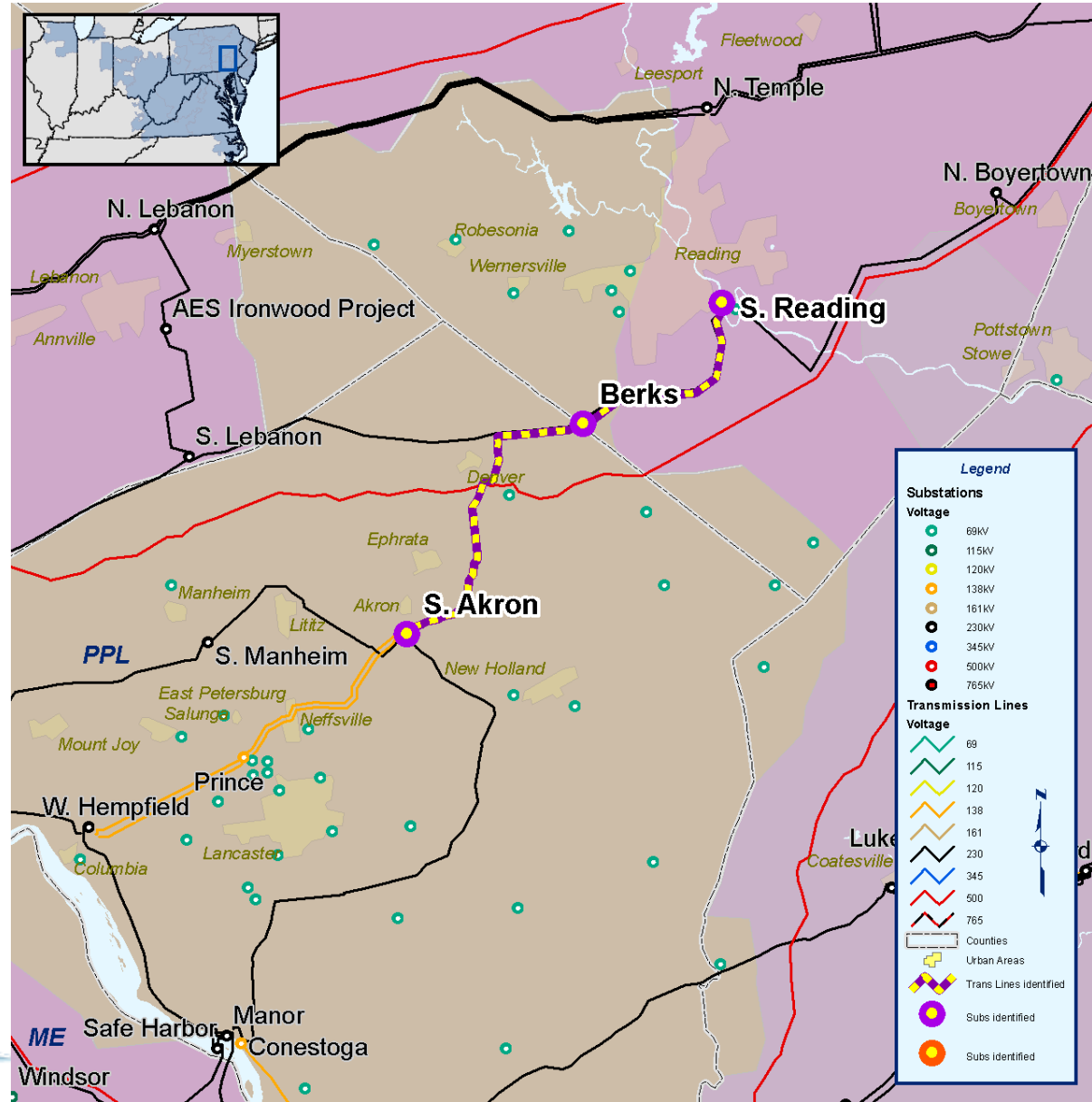
- Altoona 230/46 kV transformer #1 / loss of Altoona-Raystown 230 kV line and Altoona 230/46 kV transformer #2
- Add 3 breakers to form a ring bus at Altoona 230 kV
- Estimated Project Cost: \$2.73 M
- Expected IS Date: 6/01/2010





# PPL Baseline Projects

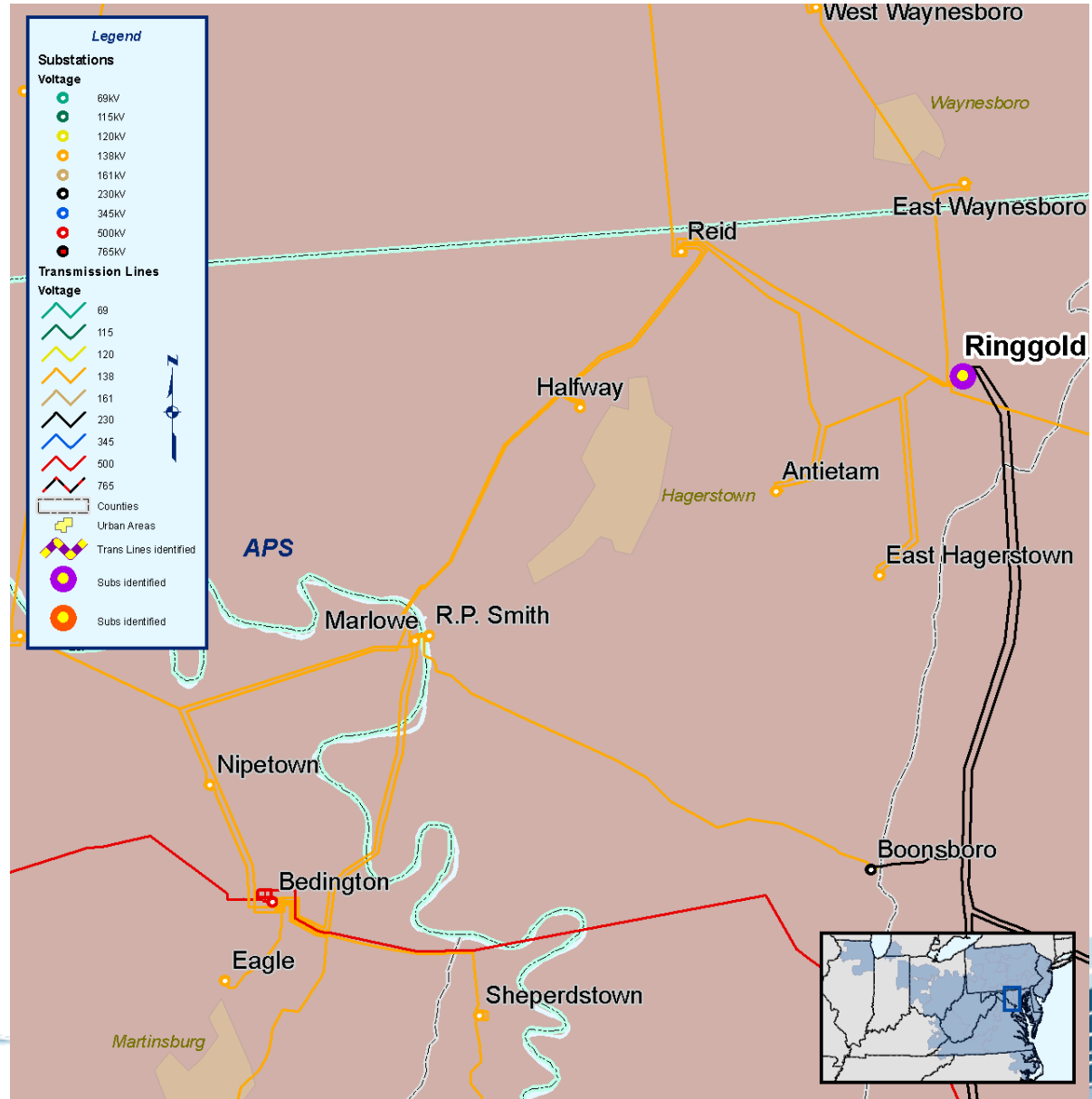
- 210 MVA load loss / loss of double circuit South Akron-South Reading 230 kV lines and Berks transformers #1 and #2
- Exceeds PPL guidelines for maximum allowable load loss
- Berks Substation modification on Berks-South Akron 230 kV Line. Modification will isolate the line fault on the South Akron line and will allow Berks transformer #2 to be energized by the South Lebanon 230kV circuit
- Estimated Project Cost: \$0.523 M
- Expected IS Date: 5/01/2010





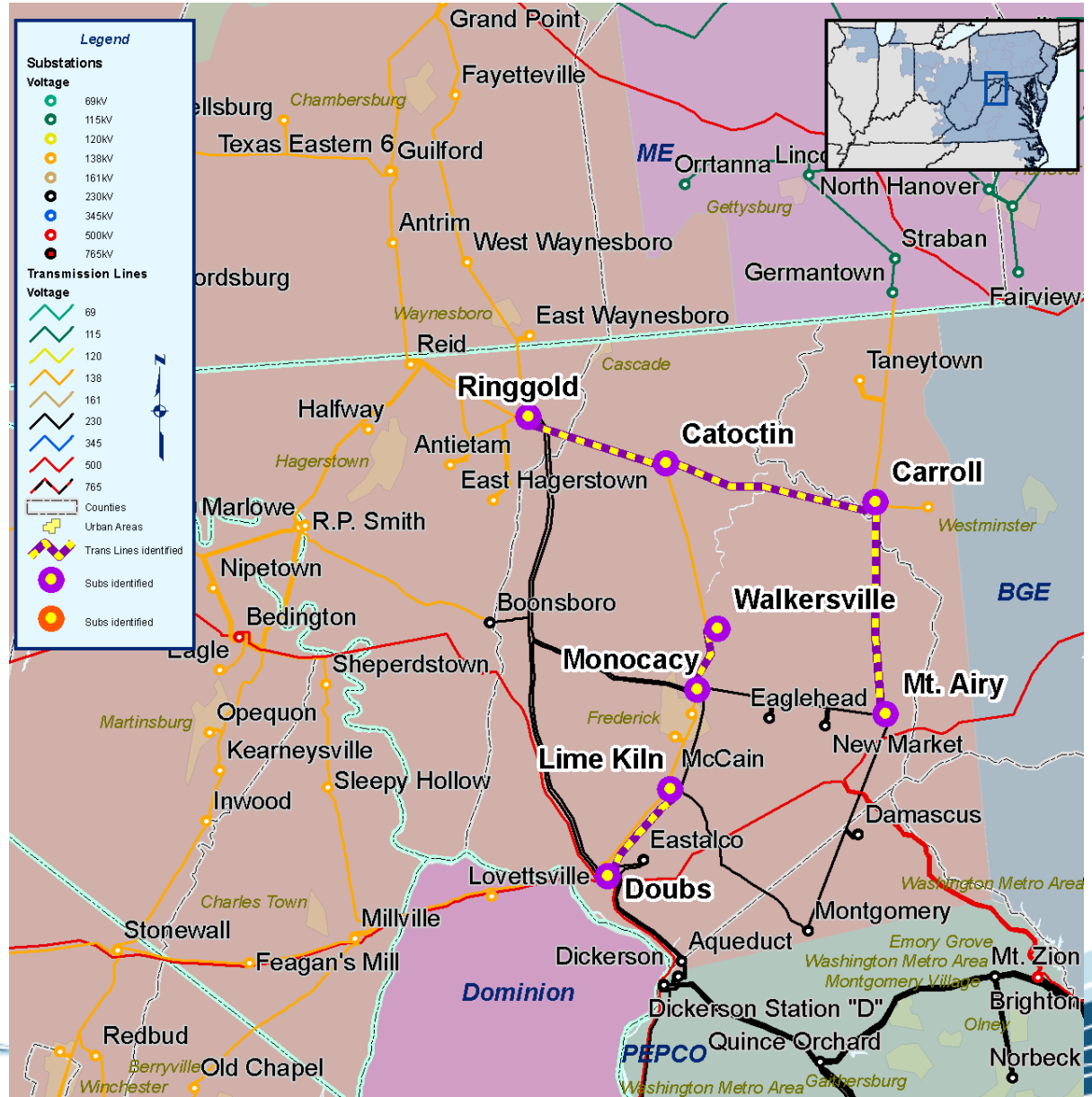
# APS Baseline Upgrades

- In 2013, the Ringgold #3 230/138 kV transformer is overloaded for the tower outage of Reid - Nipetown 138 kV and Marlowe - Halfway 138 kV.
- Solution: Replace the Ringgold #3 230/138 kV transformer with a larger transformer
- Estimated Project Cost: TBD
- IS Date: June 2013

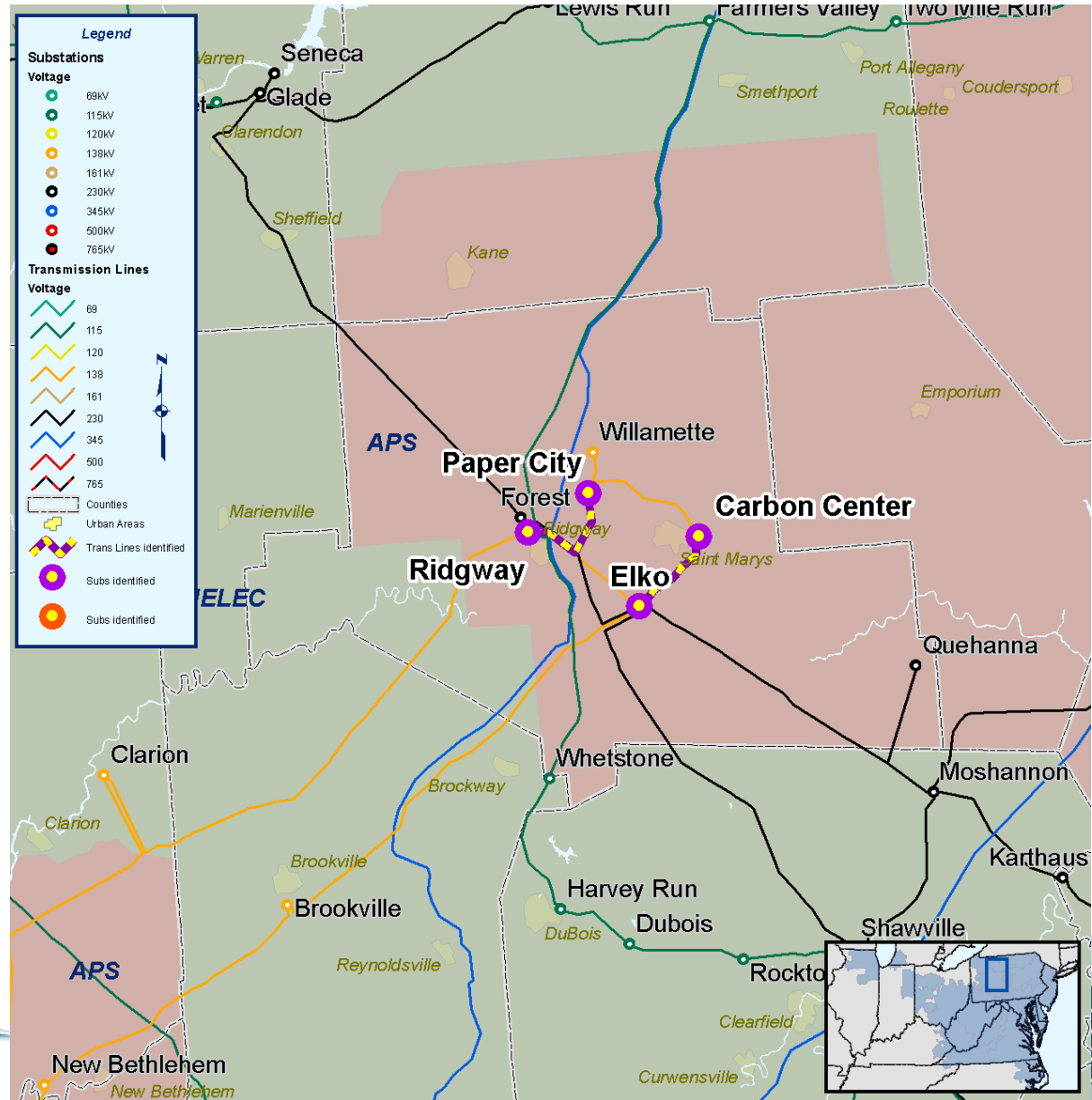




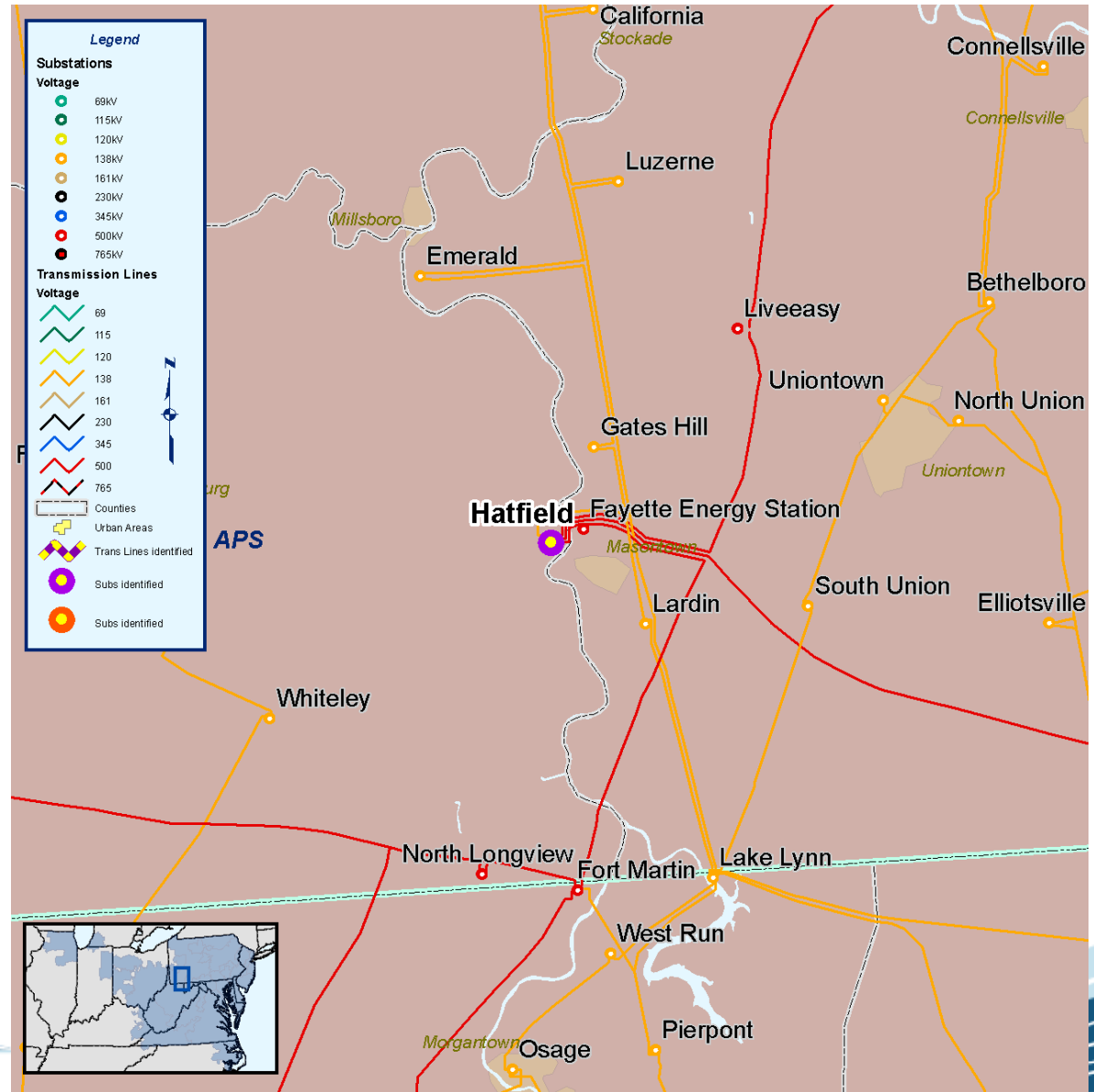
- Catoctin – Ringgold 138 kV line / loss of Lime Kiln – Montgomery 230 kV line + loss of Eaglehead – New Market 230 kV line
- Carroll – Catoctin 138 kV line / loss of Lime Kiln – Montgomery 230 kV line + loss of Eaglehead – New Market 230 kV line
- Carroll 230/138 kV transformer / loss of Lime Kiln – Montgomery 230 kV line + loss of Eaglehead – Monocacy 230 kV line-
- Carroll – Mount Airy 230 kV line / loss of Lime Kiln – Montgomery 230 kV line + loss of Eaglehead – New Market 230 kV line
- Monocacy – Walkersville 138 kV line / loss of Lime Kiln – Montgomery 230 kV line + loss of Eaglehead – New Market 230 kV line
- Doubs – Limekiln ckt 2 230 kV line / loss of Doubs – Jefferson 230 kV line + loss of Doubs – Limekiln ckt 1 230 kV line
- Doubs – Limekiln ckt 1 230 kV line / loss of Doubs – Jefferson 230 kV line + loss of Doubs – Limekiln ckt 2 230 kV line
- Potential solutions being evaluated:
  - Install 500-230 kV facilities at Kemptown Switching Station and extend 230 kV loop lines to points on the existing local 230 kV lines OR Convert the 138 kV network in northern Frederick County, Maryland to 230 kV operation by June 2013
  - Cost: TBD



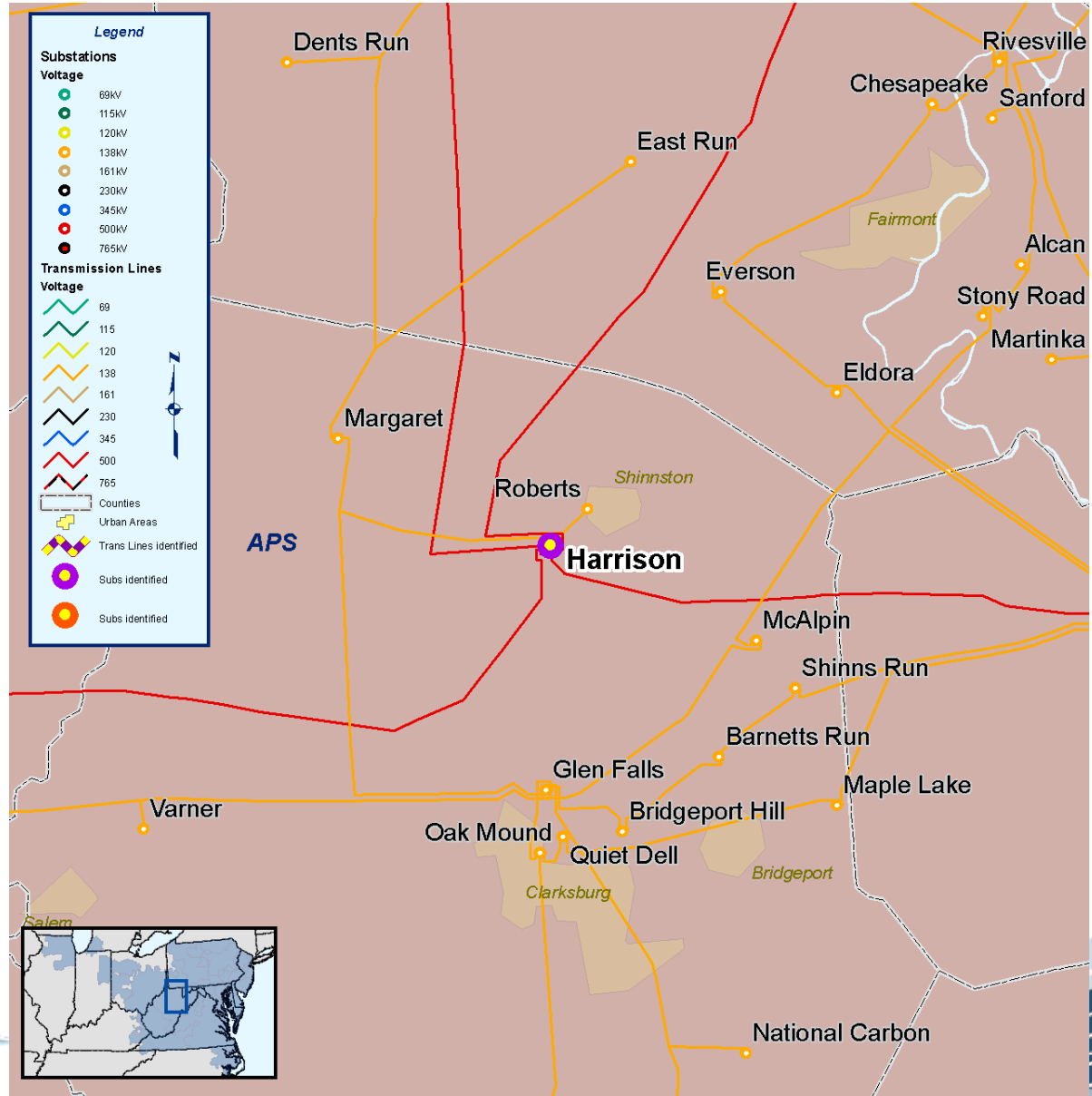
- Paper City – Ridgeway  
138 kV line / loss of  
Carbon Center – Elko  
230 kV line + loss of  
Carbon Center JCT –  
Elko 138 kV line
- Carbon Center JCT -  
Elko 138 kV line / loss  
of Paper City -  
Ridgeway 138 kV line  
+ loss of Carbon  
Center - Elko 230 kV  
line
- Solution:
  - Convert Bear Run,  
Carbon Center,  
Squab Hollow to  
230 kV by June  
2013
  - Cost: TBD



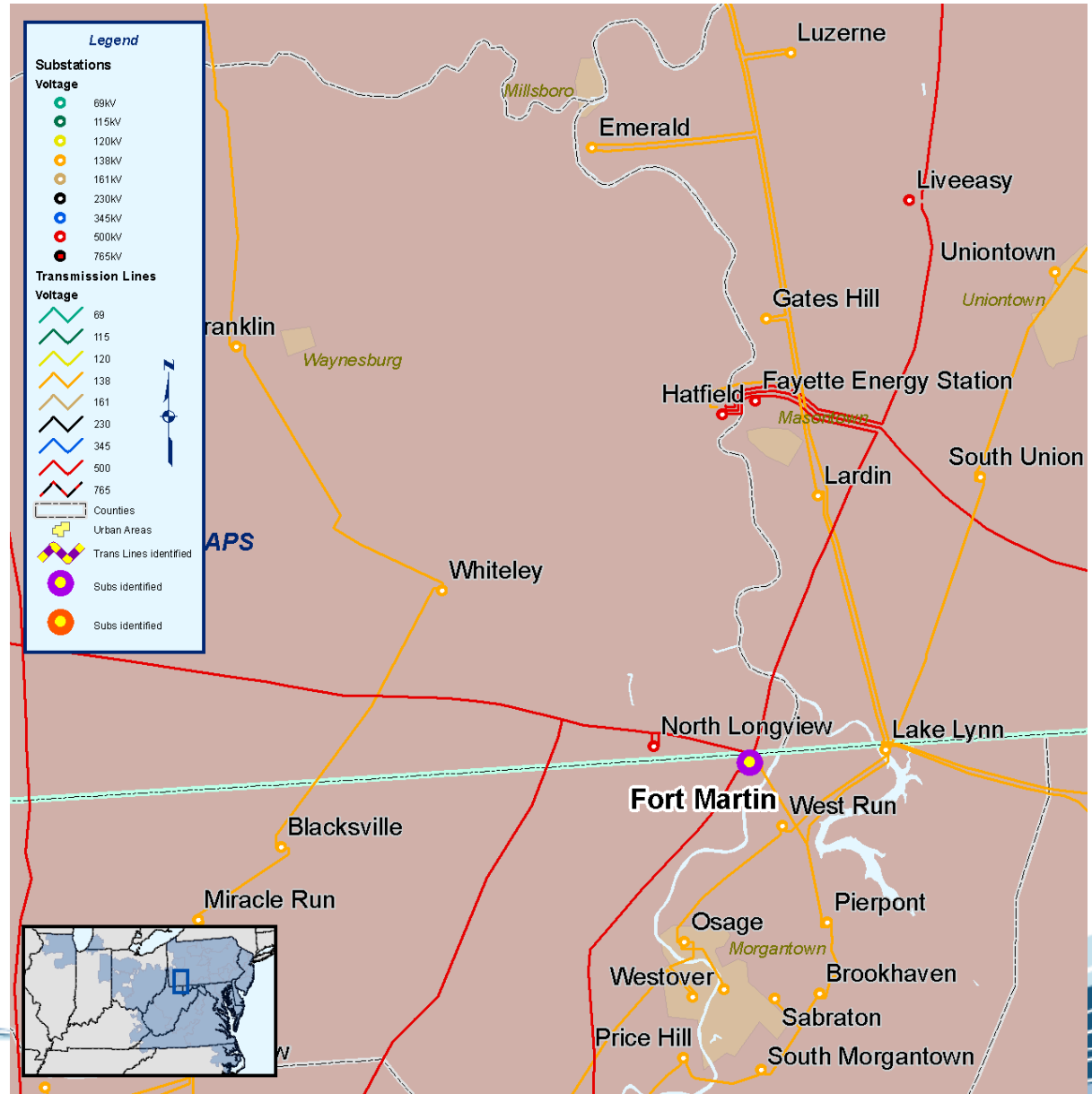
- Upgrade (per ABB inspection) Hatfield 500 kV breakers due to Short Circuit
  - HFL-1
  - HFL-3
  - HFL-4
  - HFL-6
  - HFL-7
  - HFL-9
- Estimated Project Cost: \$60K per breaker
- IS Date: 6/1/2011



- Replace Harrison 500 kV breaker HL-3
- Estimated Cost: \$0.7M
- Upgrade (per ABB inspection) Harrison 500 kV breakers due to Short Circuit
  - HL-6
  - HL-7
  - HL-8
  - HL-10
- Estimated Cost: \$60K per breaker
- IS Date: 6/1/2011



- Replace Fort Martin 500 kV breaker 'FL-1' due to Short Circuit
- Estimated Project Cost: \$ 0.7 M
- IS Date: 6/1/2011

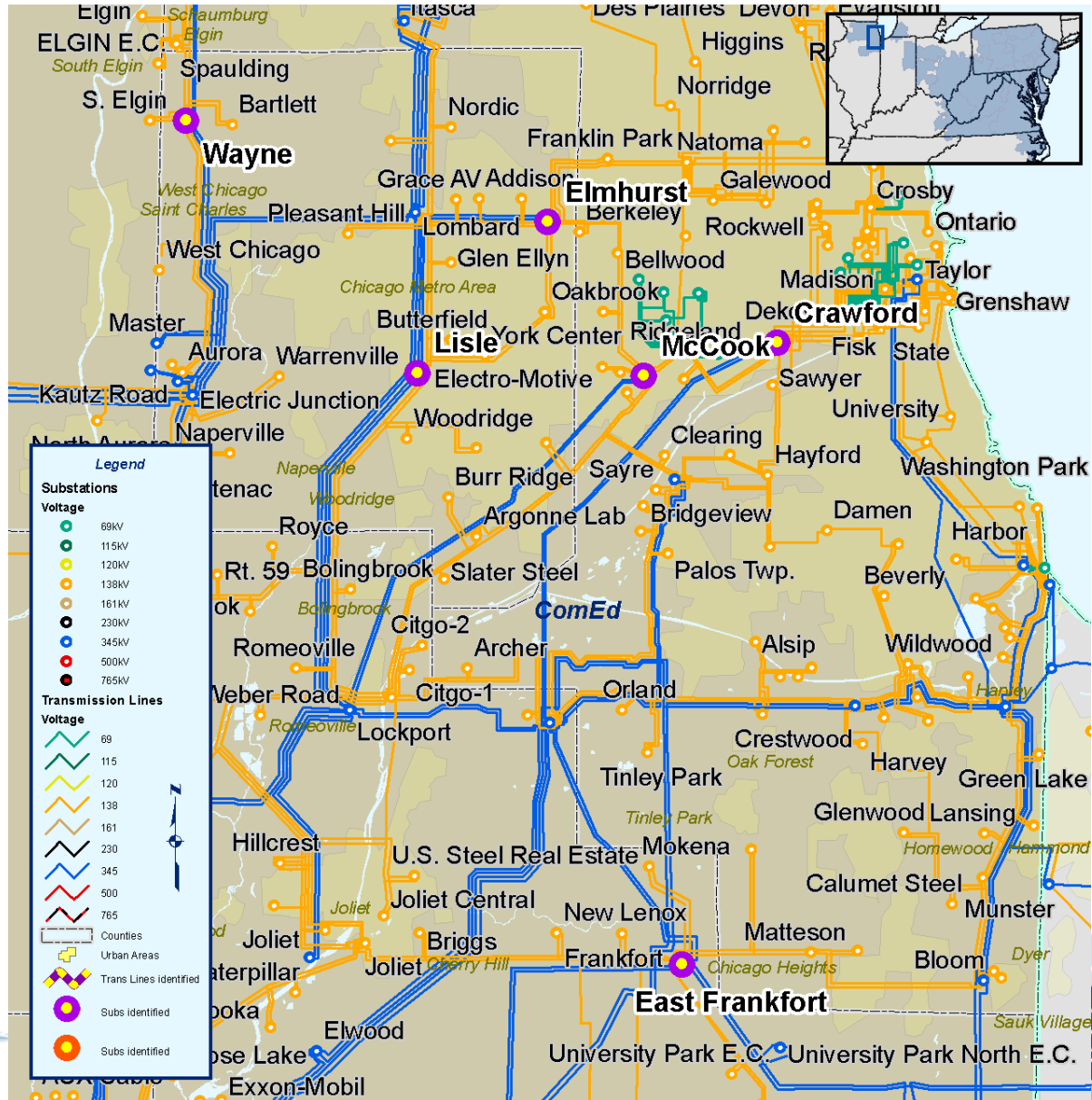




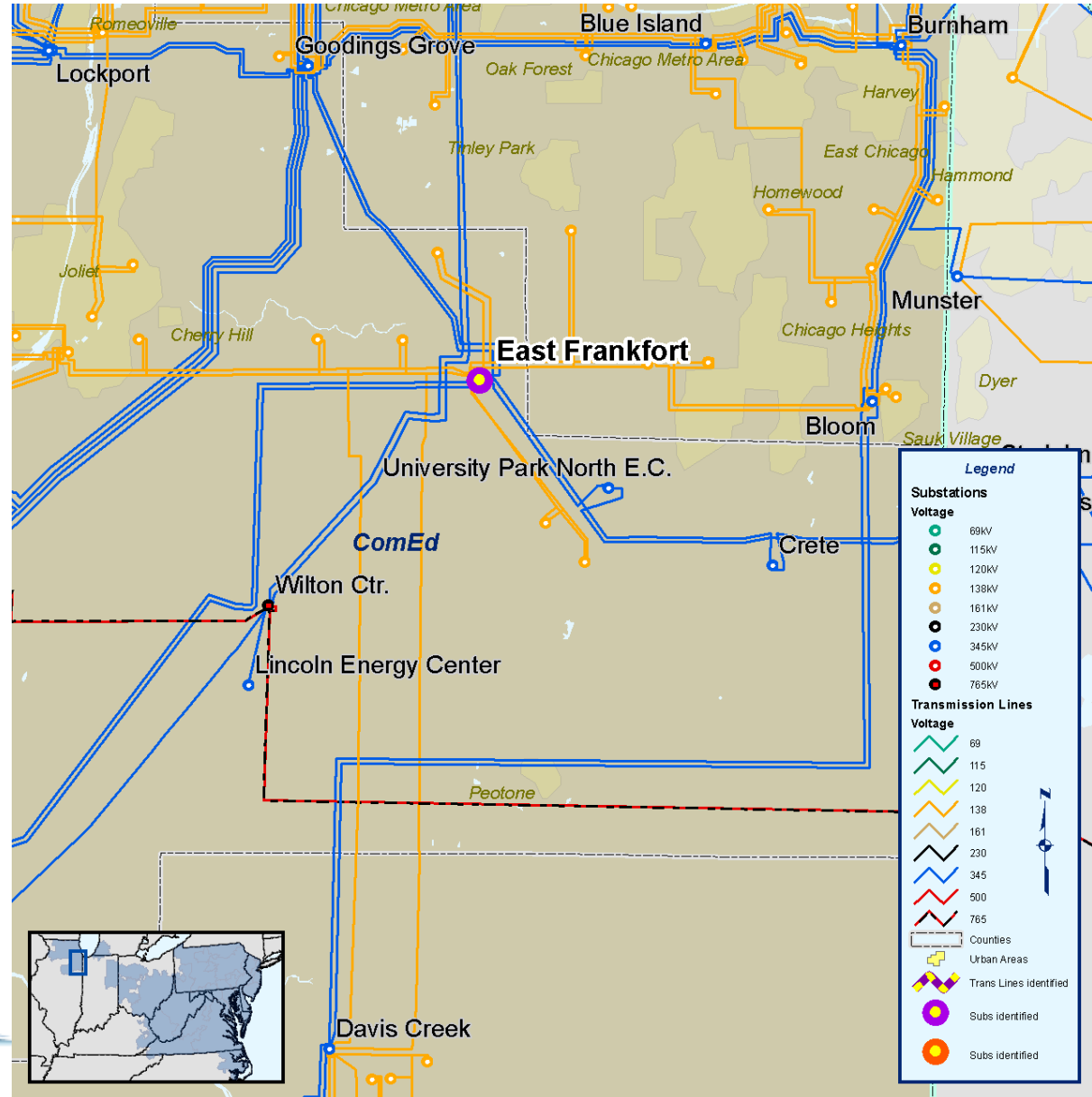
# ComED Baseline Upgrades

## PJM Load Deliverability and CE Dynamic Voltage Criteria & Voltage Stability Criteria

- Potential solution to add a 300 MVAR SVC at Elmhurst 138 kV on the “Red” and “Blue” system and install switched capacitors at the following locations:
  - East Frankfort 138 kV
  - Lisle 138 kV Red
  - Lisle 138 kV Blue
  - McCook 138 kV Red
  - McCook 138 kV Blue
  - Wayne 138 kV Blue
  - Wayne 138 kV Red
  - Crawford 138 kV Blue
  - Crawford 138 kV Red
  - Bedford 138 kV Blue
  - Bedford 138 kV Red
  - Wolfs 138 kV (57.6 MVAR)

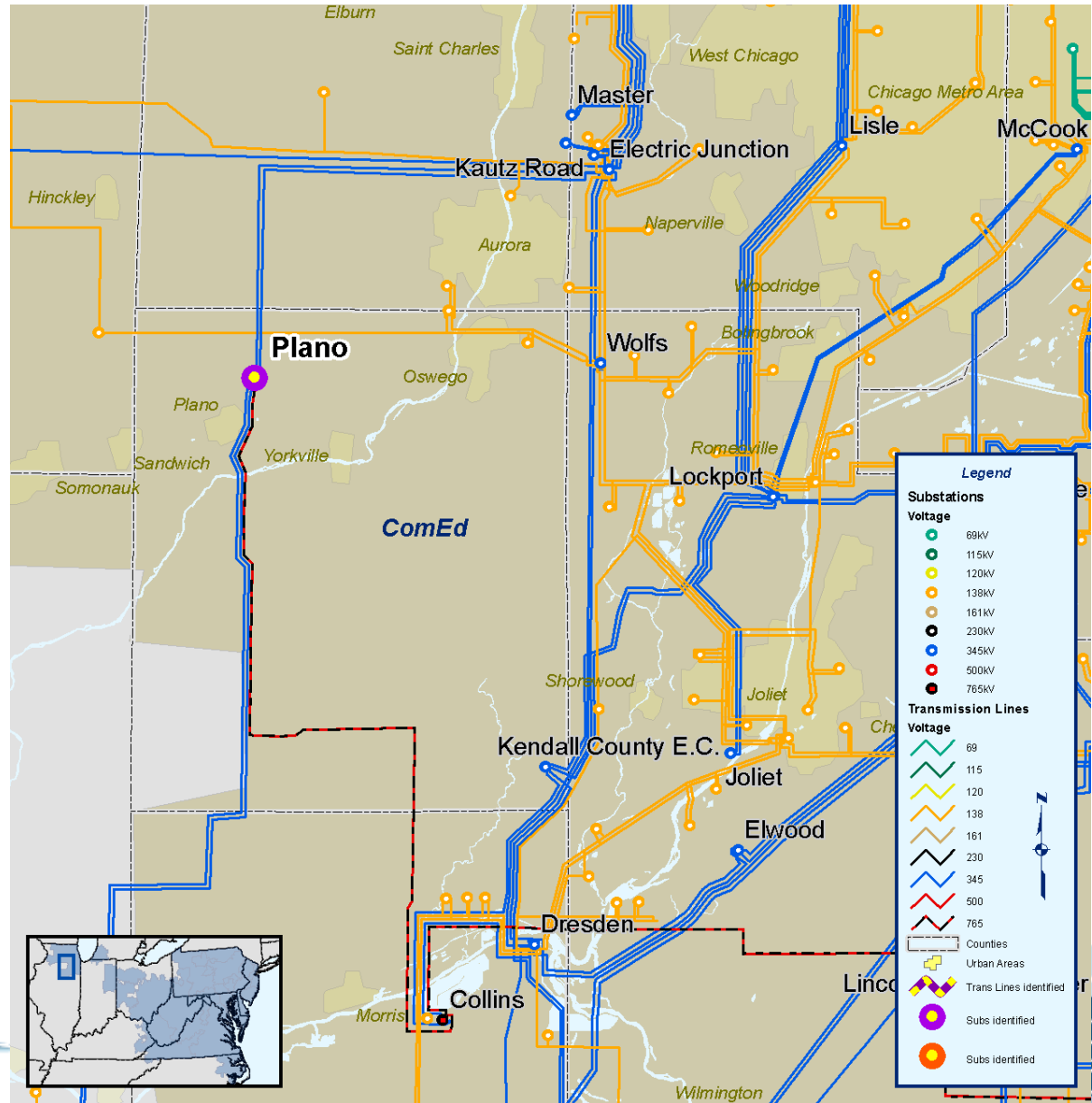


- Thermal Overload of East Frankfort – Goodings Grove 345 kV “Red” for the generation deliverability and load deliverability test
- Potential solution to add a 2nd East Frankfort 345 / 138 kV Autotransformer
- IS Date: June 2013
- Cost Estimate: TBD

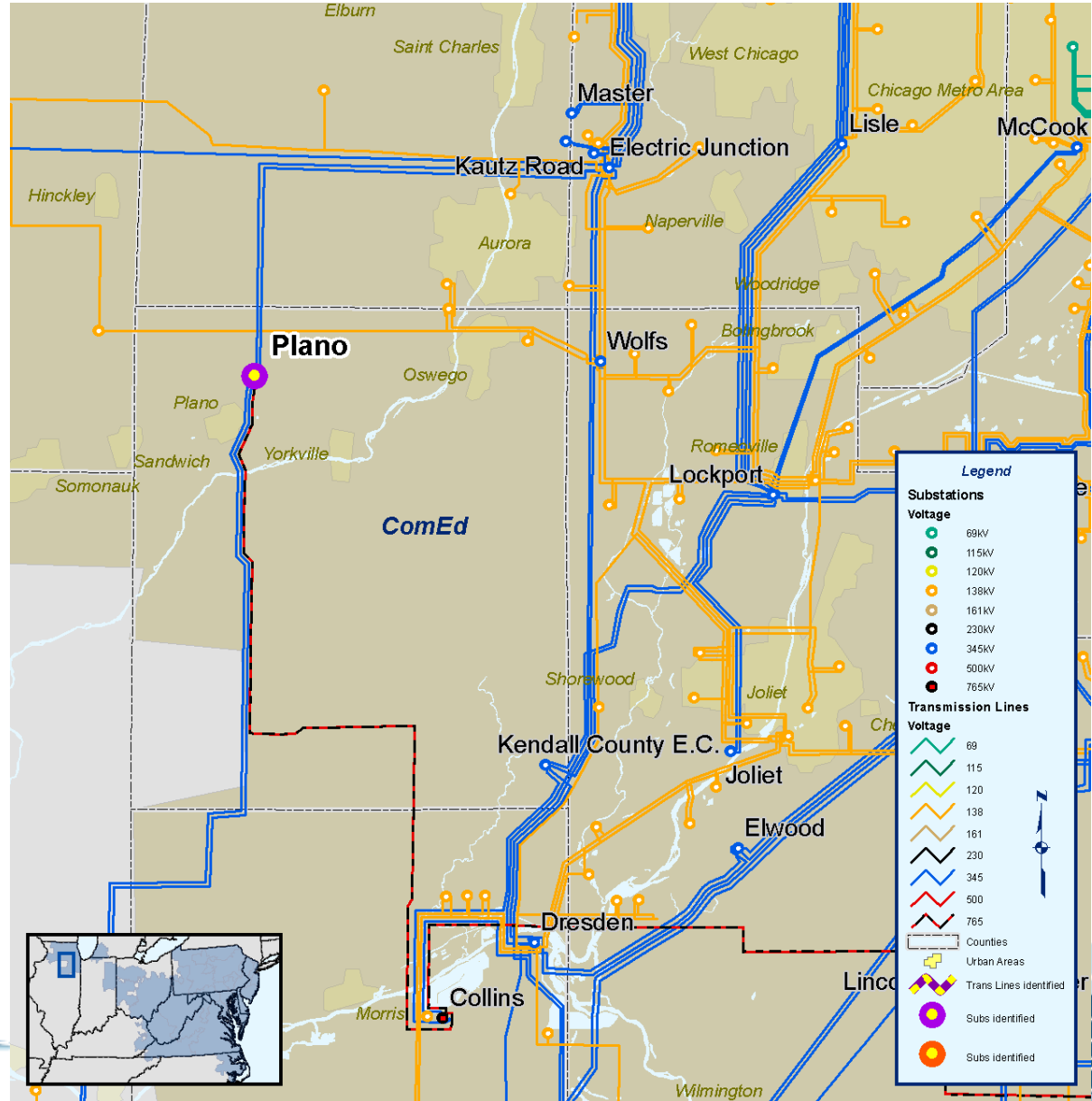




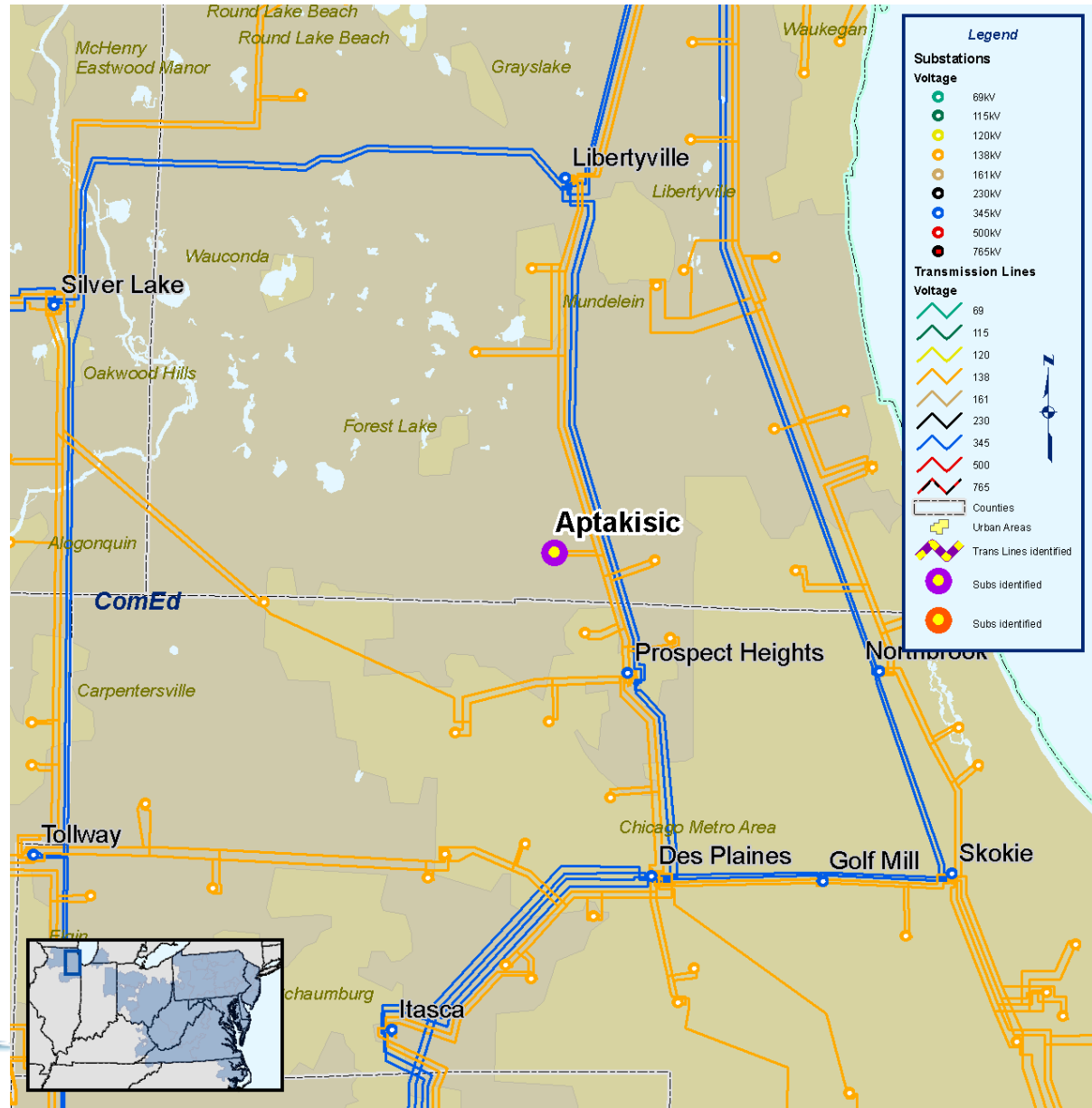
- Generator Deliverability violation
- Thermal overload of Wolfs 345/138 kV “Red” transformer and Wolfs – Oswego 138 kV
- Preliminary solution involves replacing the existing baseline upgrade to install a 2<sup>nd</sup> Wolfs 345/138 kV transformer. The replacement project is a 345/138 kV transformer at Plano
- Estimated Project Cost: \$TBD
- IS Date: June 2013



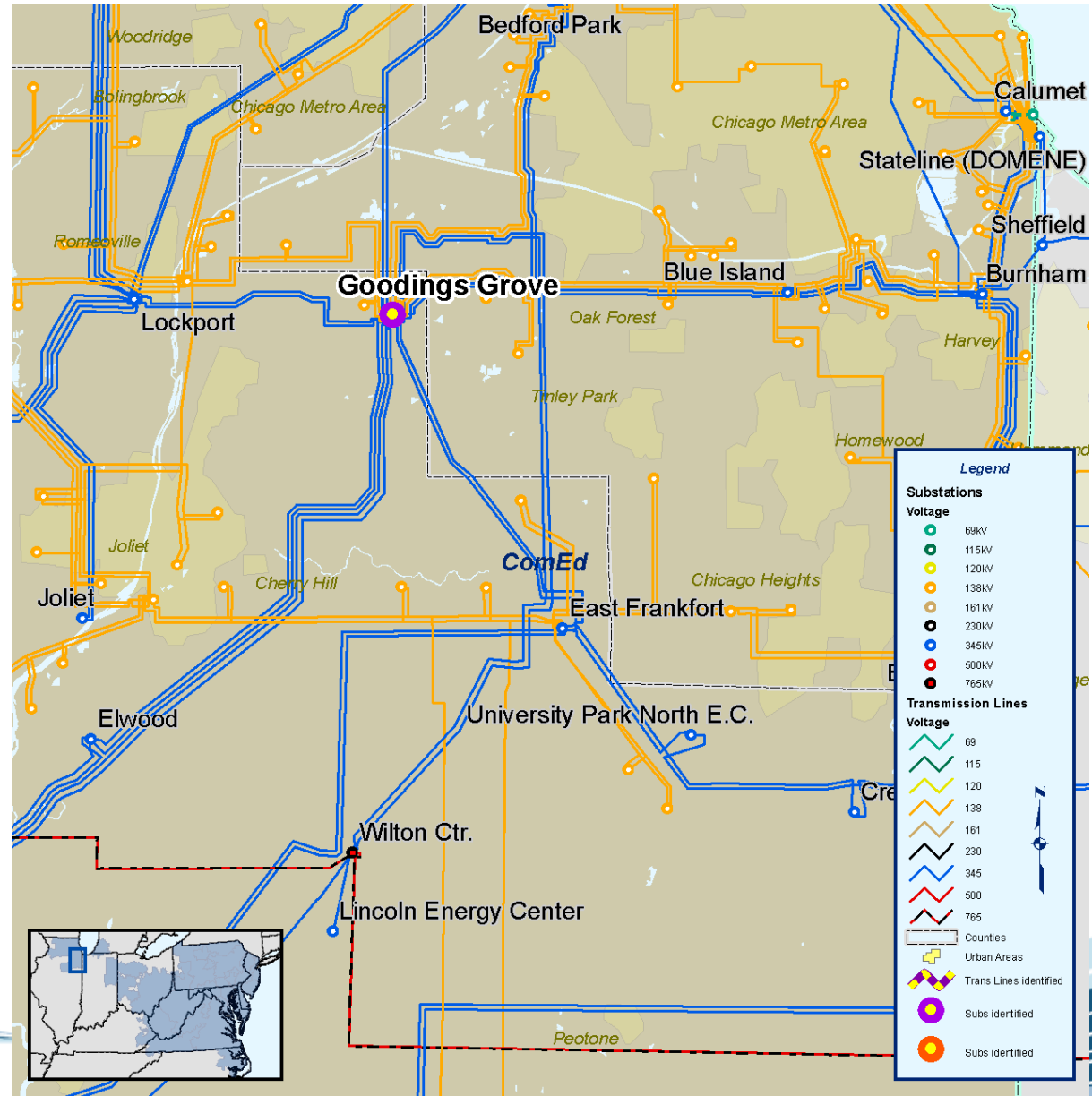
- Generator deliverability violation
- Thermal overload of Plano – Electric Junction 345 kV “Red” for the loss of the parallel circuit
- Potential Solution: Install a second 345/138 kV transformer at Plano
- Estimated Project Cost: \$TBD
- IS Date: June 2013



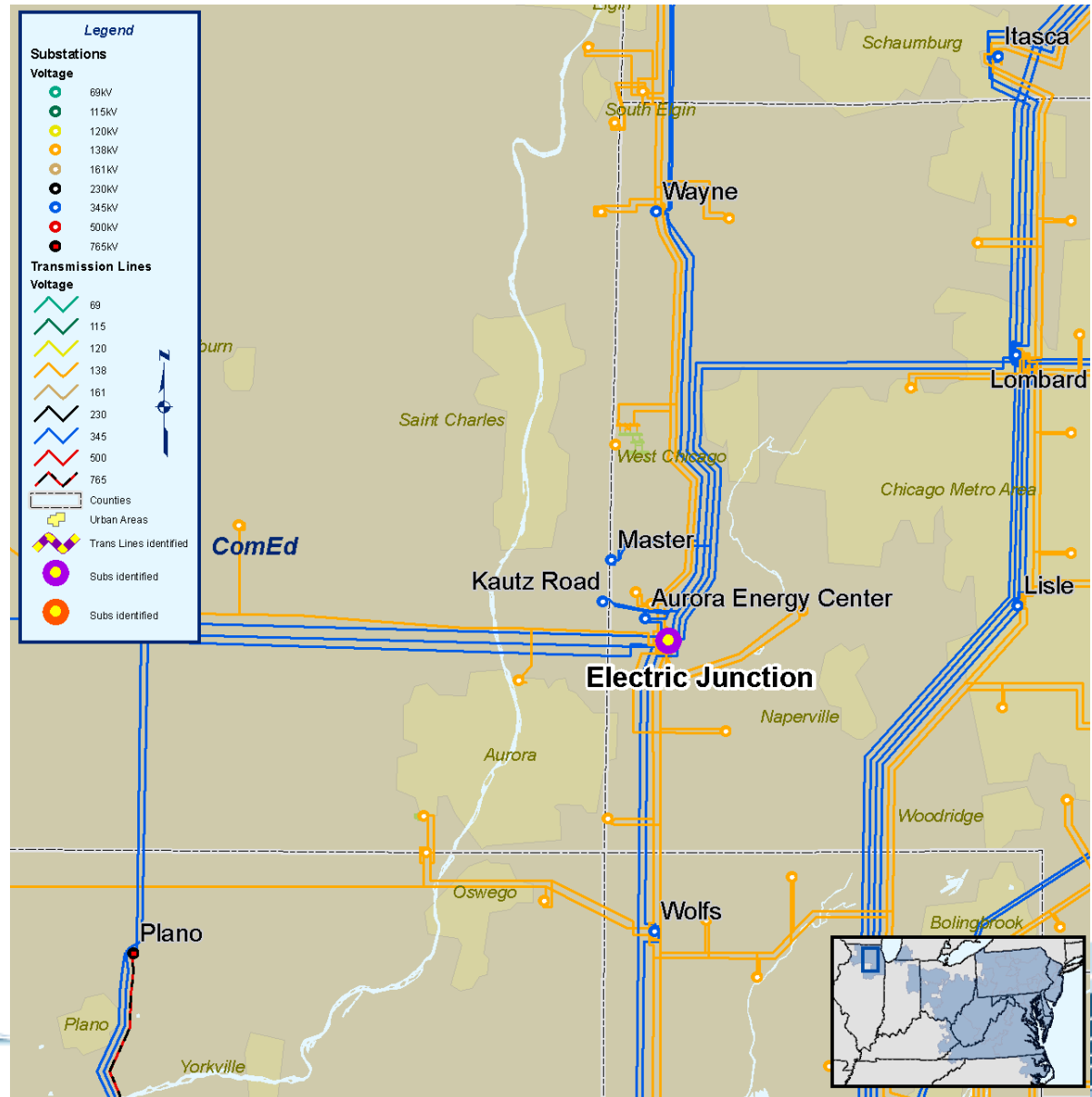
- Load Deliverability violation
- Thermal overload of Prospect Heights 345/138 kV “Red” transformer for the loss of Prospect Heights – Leighton 138 kV line 11708
- Preliminary solution to add a breaker at Aptakistic 138 kV to split the line in two for the 11708 contingency
- Expected IS Date: 6/01/2013
- Cost estimate: TBD



- Generator Deliverability violation
- Thermal overload of Goodings Grove 345/138 kV “Red” transformer for the loss of Blue Island – Alsip 138 kV
- Potential solution to install a third 345/138 kV transformer at Goodings Grove “Red”
- IS Date: June 2013
- Cost Estimate: TBD



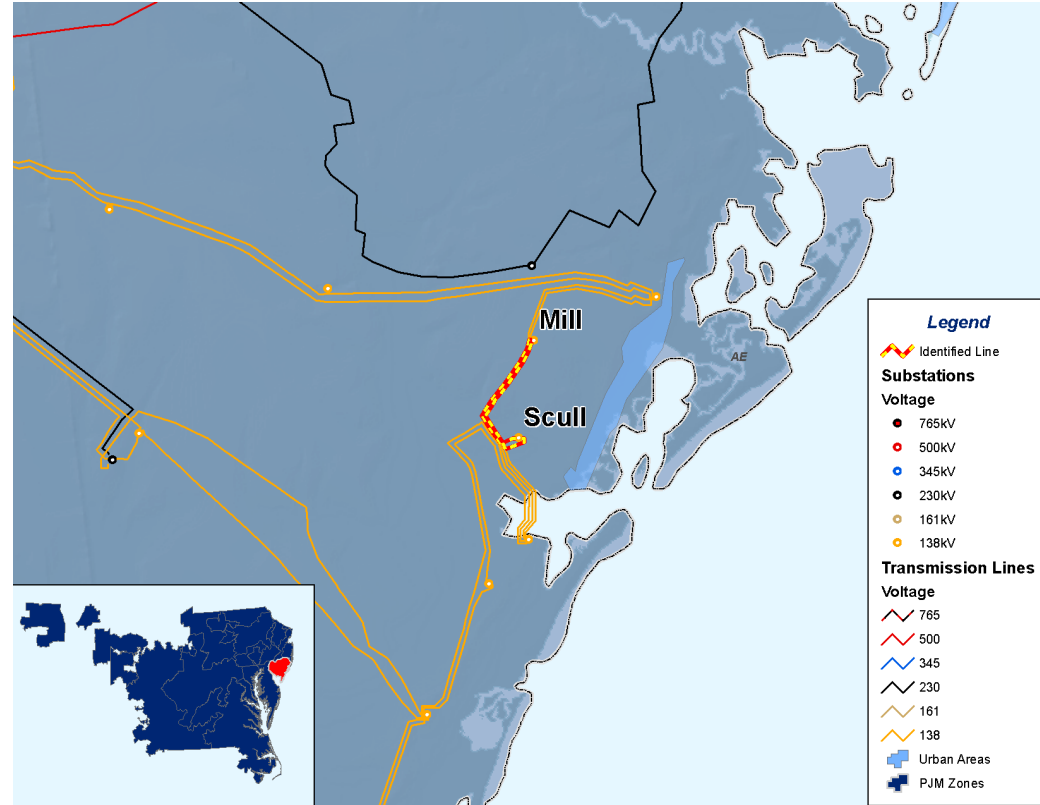
- Provide new service to a new customer west of Electric Junction on lines 11104 & 11106
- Supplemental Project
- Expected IS Date: 6/01/2013
- Cost Estimate: TBD



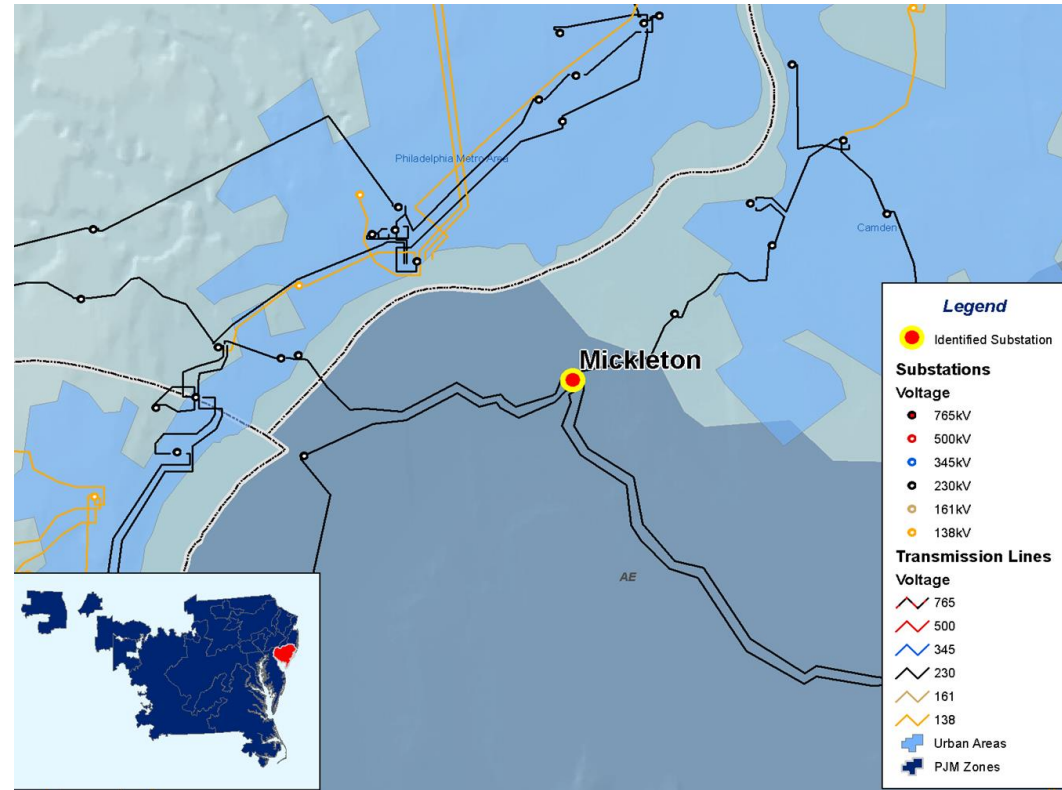


# Atlantic Electric Baseline Upgrades

- Scull #2 – Mill #2 138 kV line / Loss of the other circuit (Single)
- Recommended Solution: Upgrade a strand bus at MILL
- Estimated cost: \$0.2M
- Expected in-service date: June 1, 2013



- Mickleton 230/69 kV transformer #4 / loss of the Mickleton 230/69kV transformer #1
- Recommended Solution: Move the Monroe 230/69 kV transformer to Mickleton
- Estimated cost: \$1.24 M
- Expected in-service date: June 1, 2013

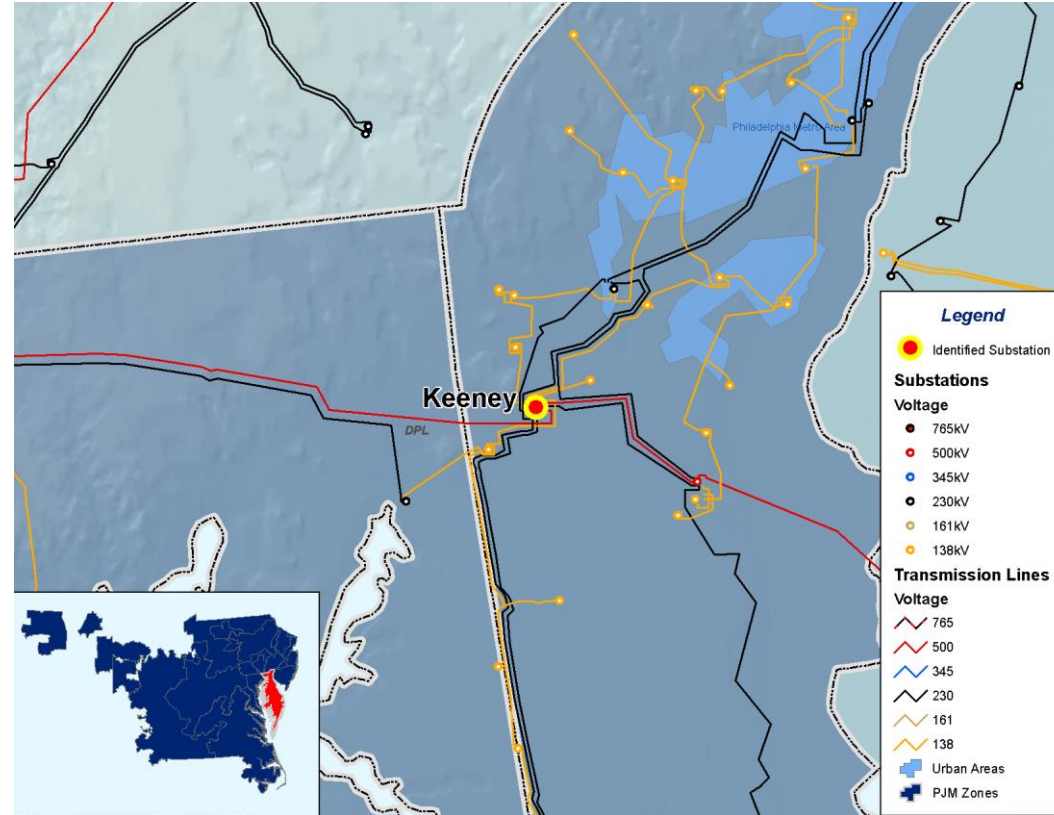




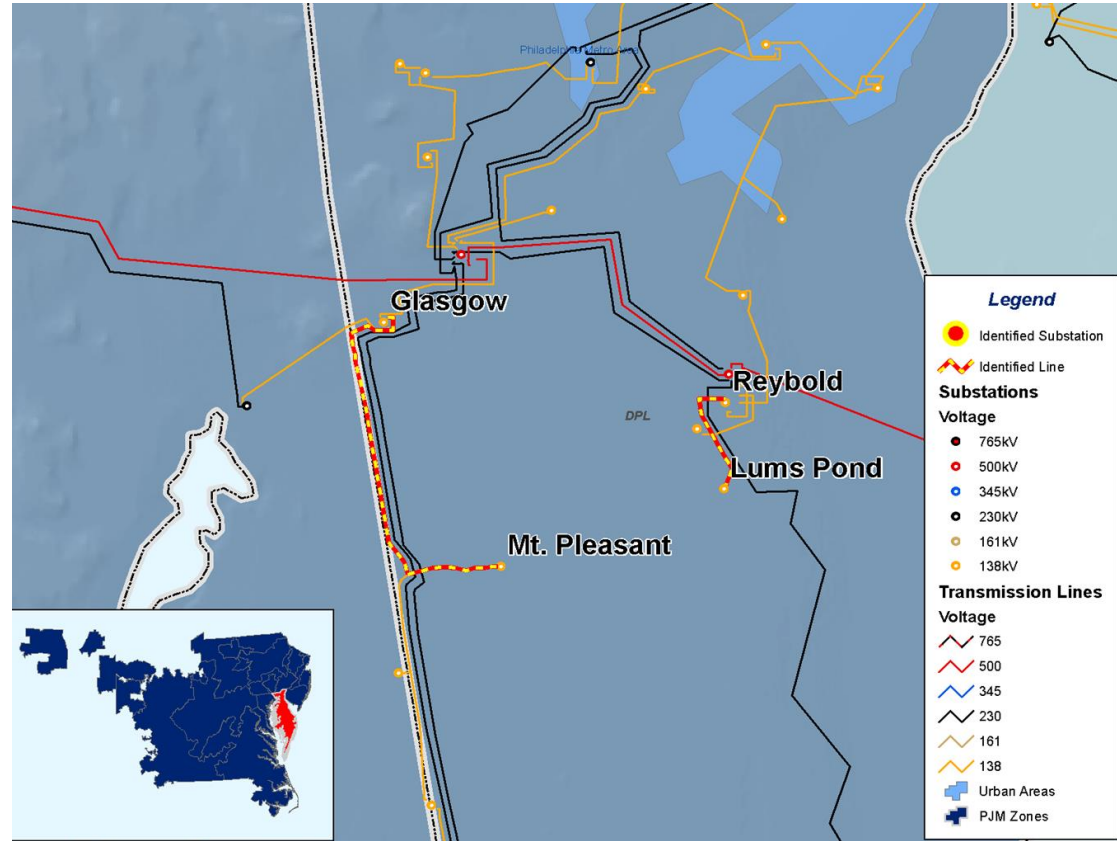


# Delmarva Baseline Upgrades

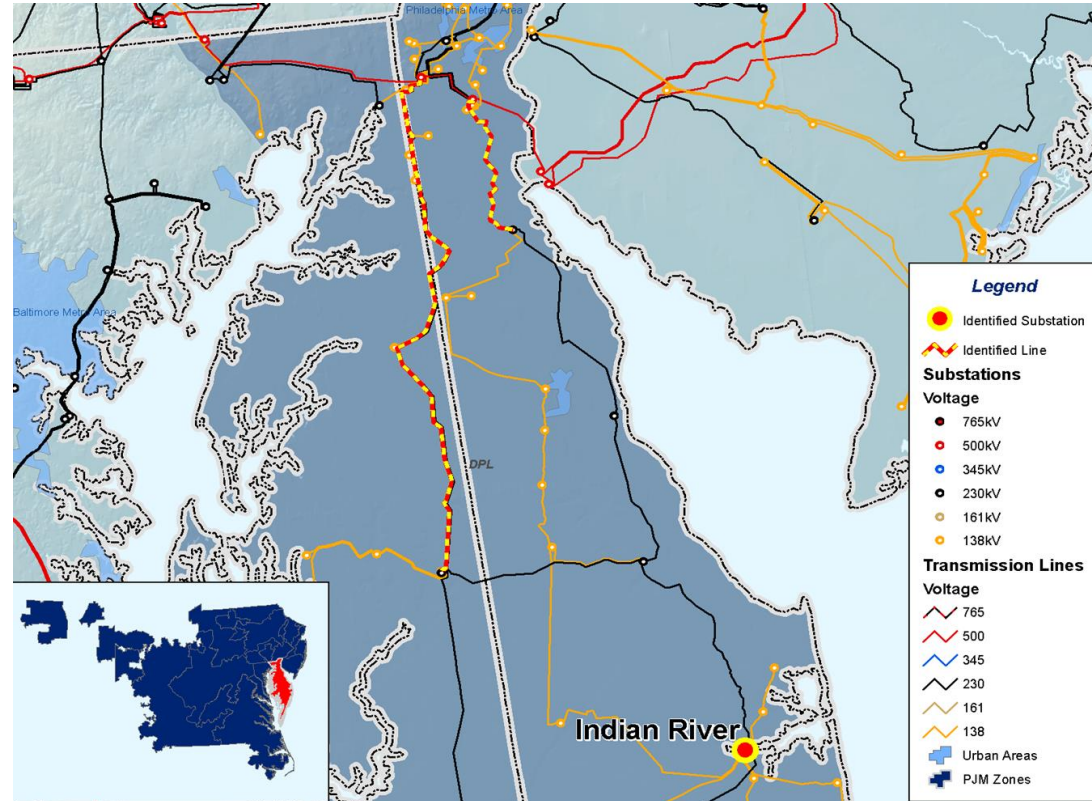
- Keeney 500/230 kV transformer CKT 1 / Loss of Keeney – Red Lion + Keeney 500/230 kV transformer CKT 2 (Line\_FB)
- Keeney 500/230 kV transformer CKT 2 / Loss of Keeney – Red Lion + Keeney 500/230 kV transformer CKT1 (Line\_FB)
- PHI is investigating solutions.



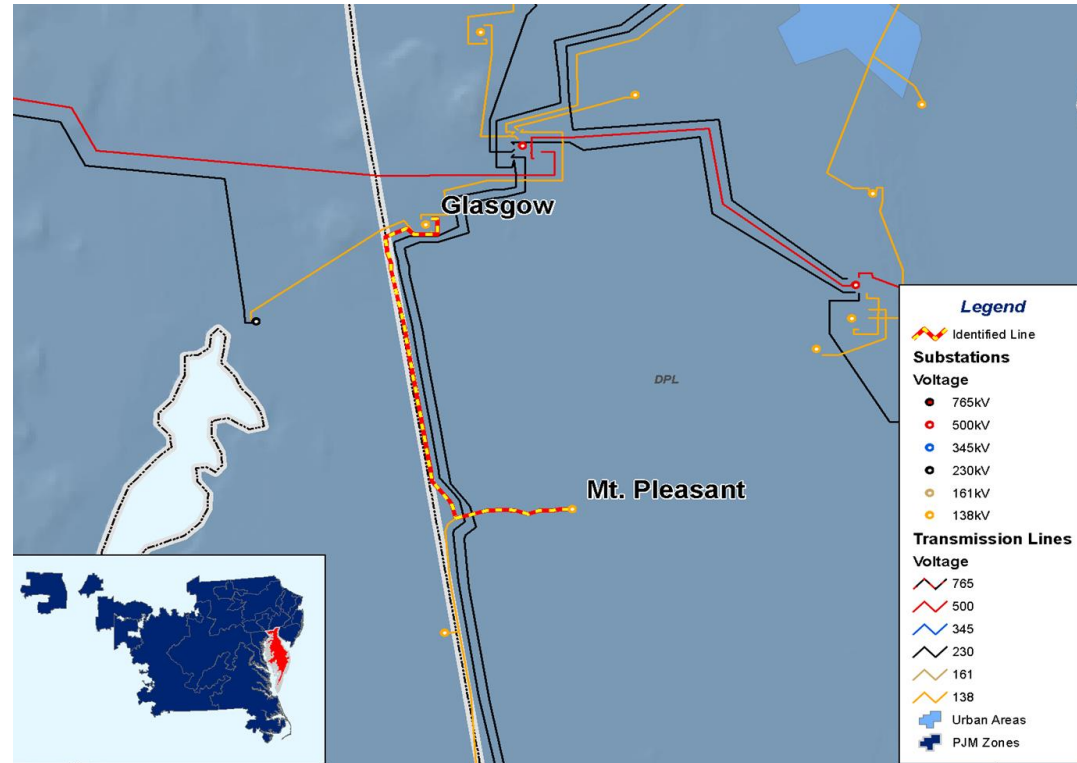
- Reybold – Lums Pond 138 kV line for the loss of Glasgow – Keeney 138 kV line
- Recommended Solution: Replace two circuit breakers to bring the emergency rating up to 348 MVA
- Estimated cost: \$1.0M
- Expected in-service: June 1, 2013
- Glasgow – Mt. Pleasant 138 kV line for the loss of Lums Pond – Reybold 138 kV line
- Recommended Solution: Rebuild 10 miles of Glasgow to Mt. Pleasant 138 kV line to bring the normal rating to 298 MVA and the emergency rating to 333 MVA
- Estimated cost: \$5.7 M
- Expected in-service: June 1, 2013



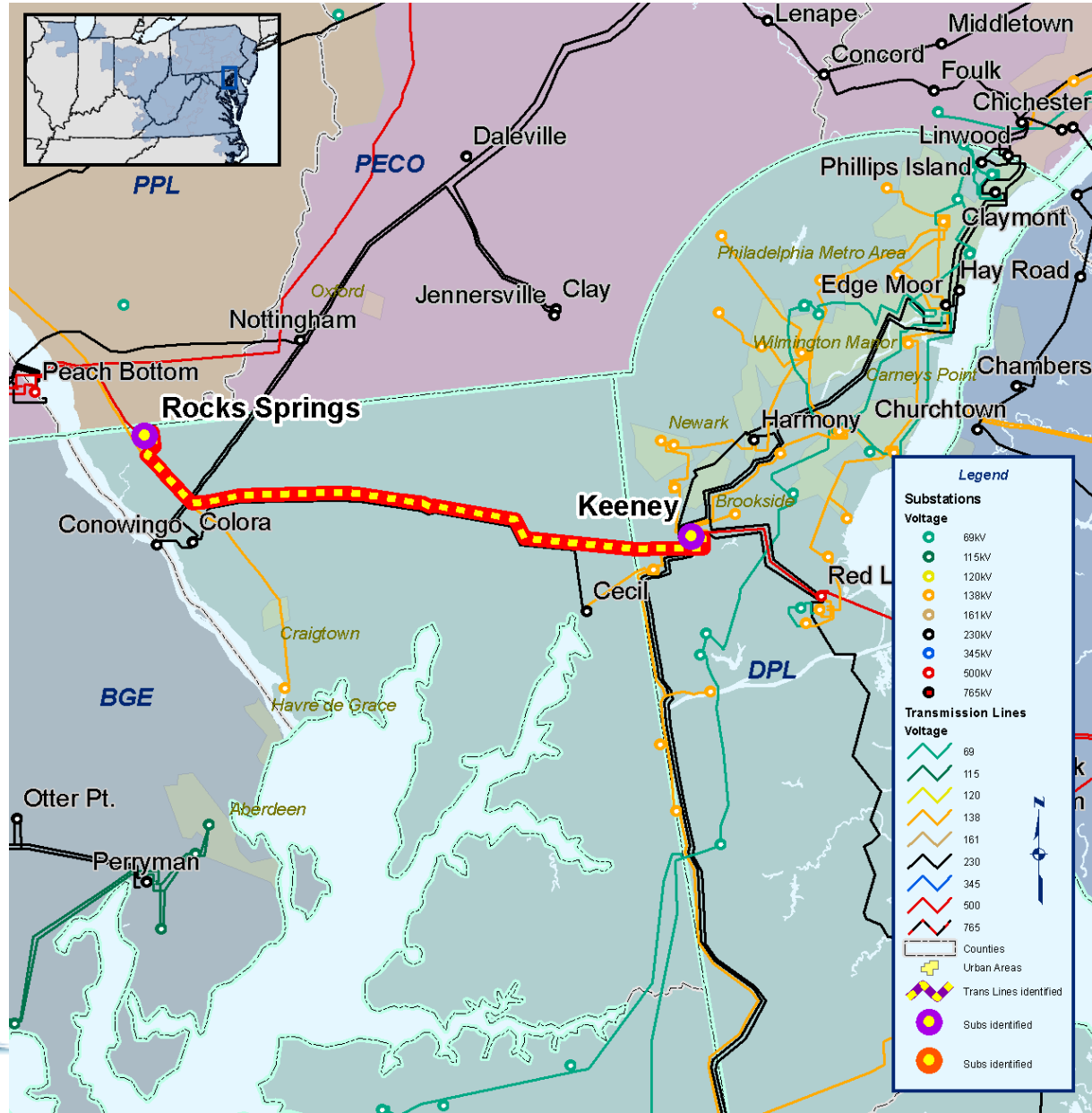
- Voltage collapse / loss of Indian River unit 3
- Voltage collapse / loss of Cedar Creek - Red Lion 230 kV line
- Voltage collapse / loss of Keeney - Steele 230 kV line
- Potential Solution: Convert the 138 kV network path from Vienna to Loretto to Piney Grove to 230 kV and add 230/138 kV transformer at Loretto 230 kV station
- Estimated cost: TBD
- Expected in-service date: June 1, 2013



- Glasgow - Mt. Pleasant 138 kV line / loss of Lums Pond - Reybold 138 kV line
  - See solution for the same line on Delmarva load deliverability violation slide
- Delmarva South load deliverability test also has same voltage violations as Delmarva load deliverability as well as several issues on the underlying 138 kV and 69 kV
  - See solution for the same voltage issues on Delmarva load deliverability violation slide



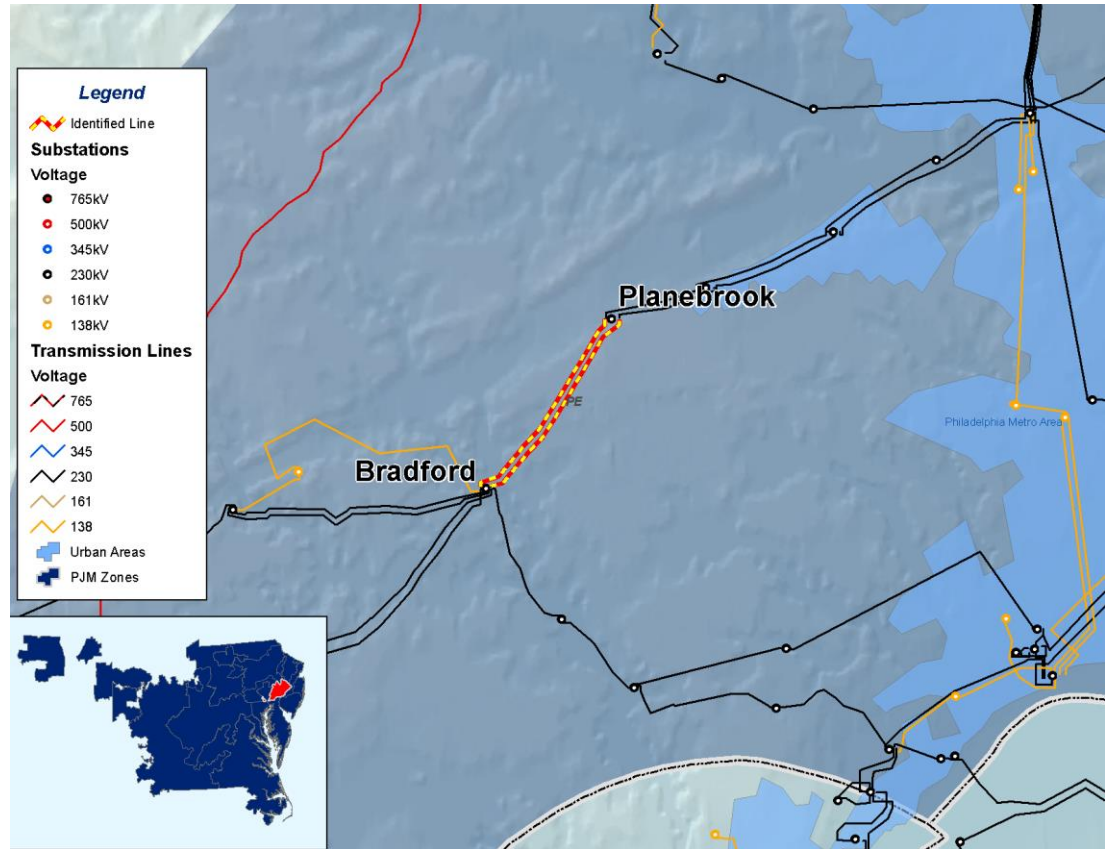
- Rock Springs – Keeney 500 kV line / basecase
- Rock Springs – Keeney 500 kV line for the loss of Peach Bottom to Limerick 500 kV line
- Recommended solution replace the wave trap/potential transformer at Rock Springs
- Expected in-service date: June 1, 2013
- Cost: TBD





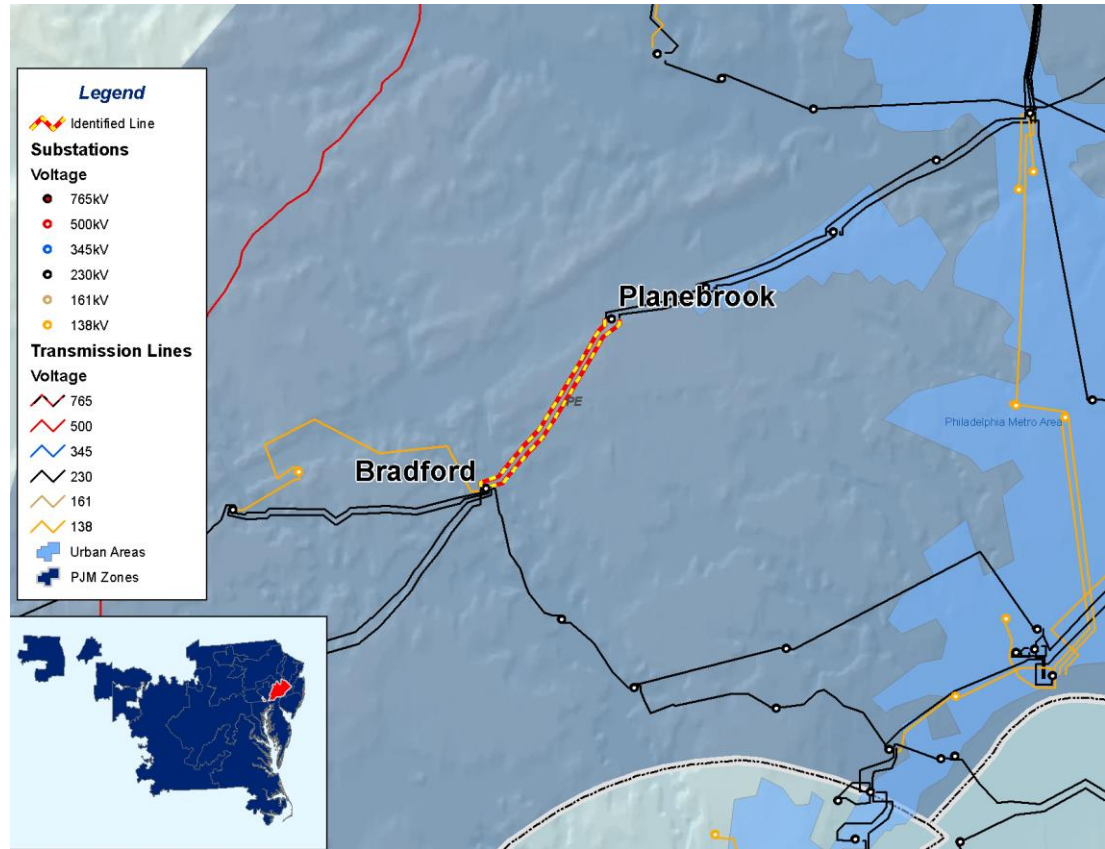
# PECO Baseline Upgrades

- Bradford – Planebrook 230 kV line CKT 220-02 / Loss of the other 230 kV line (Single)
- Recommended Solution: Reconductor the line to provide a normal rating of 677 MVA and an emergency rating of 827 MVA
- Expected in-service: June 1, 2013
- Estimated cost: \$7.0 M





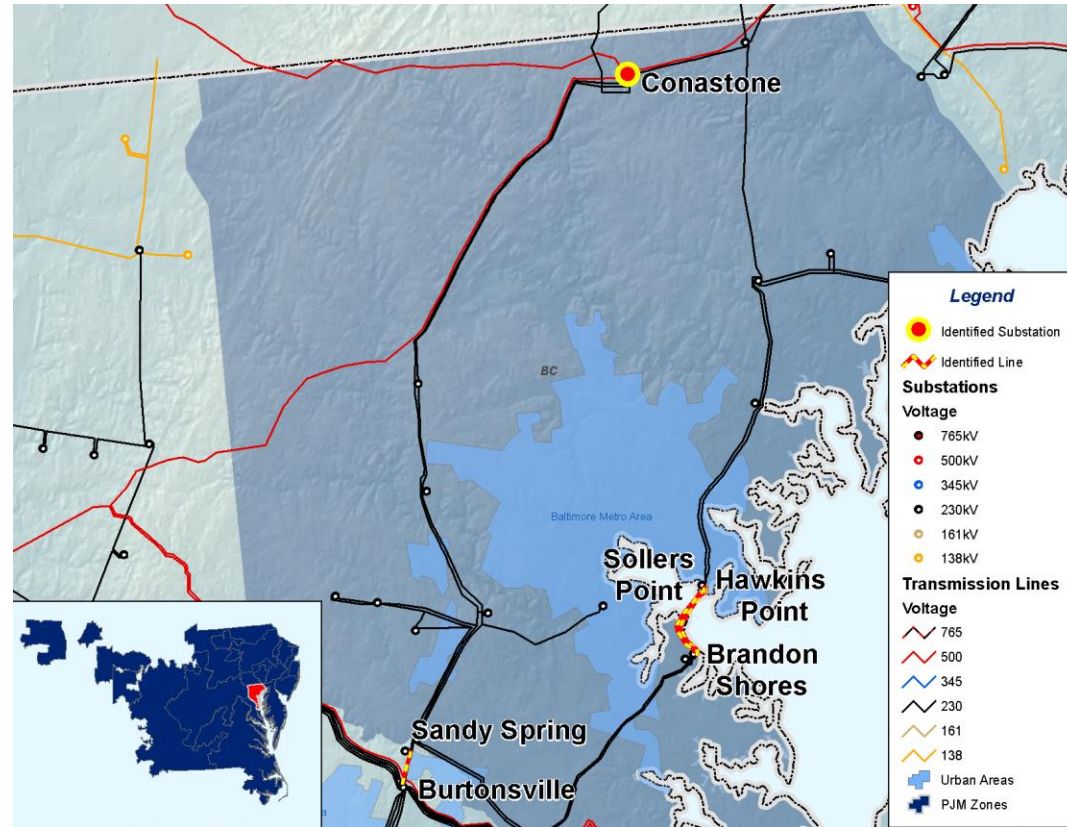
- Bradford – Planebrook 230 kV line CKT 220-31 / Loss of Bradford – Planebrook 230 kV line + Bradford CB 220 failed (Line\_FB)
- Recommended Solution: Reconductor the line to provide a normal rating of 677 MVA and an emergency rating of 827 MVA
- Expected in-service: June 1, 2013
- Estimated cost: \$7.5 M



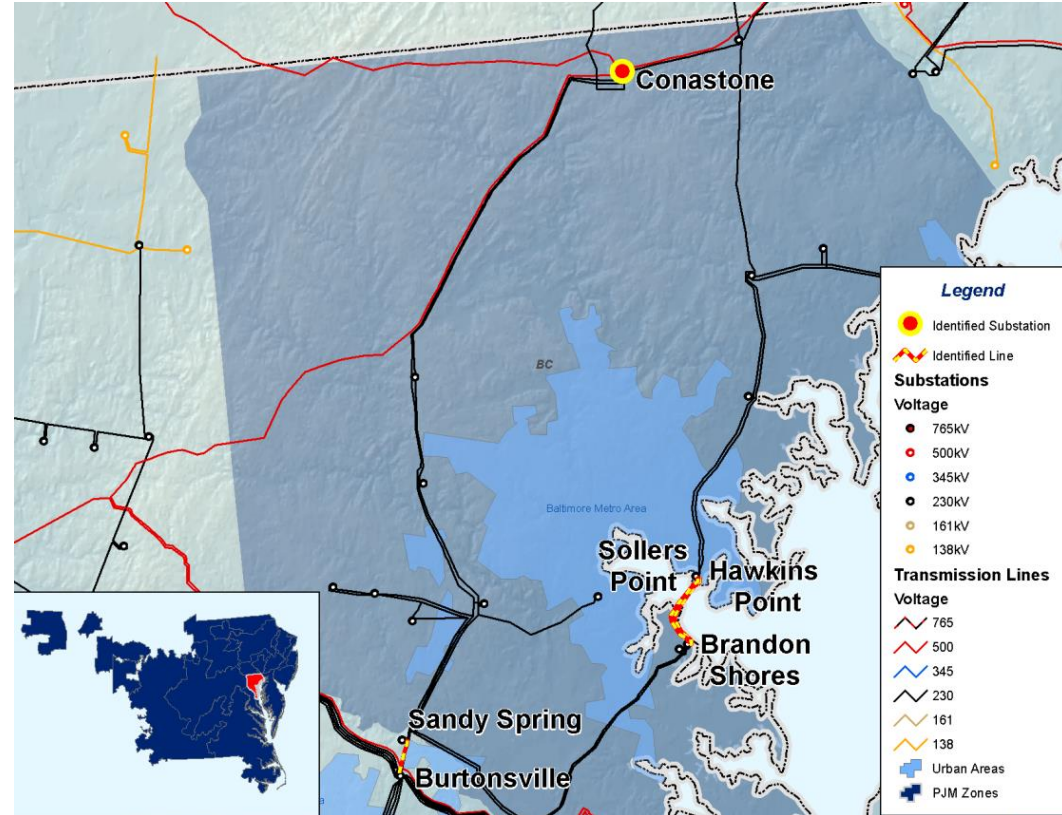


# BGE Baseline Upgrades

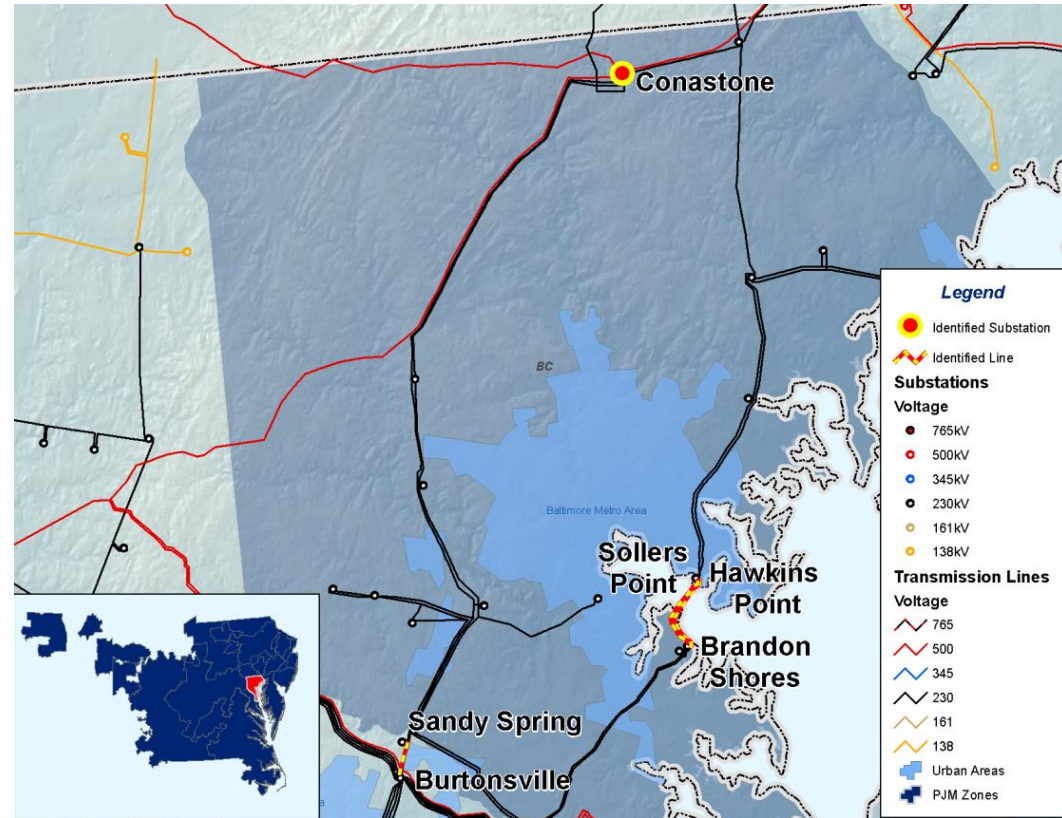
- Brandon Shores – Hawkins Point Terminal 230 kV line / Loss of Brandon Shores – Hawkins Point Terminal – Sollers Point Terminal (#2344) 230 kV line and Brandon Shores 5T Breaker failed (Line\_FB)
- Sollers Point Terminal – Riverside 230 kV line CKT 2345 / Loss of Brandon Shores – Hawkins Point Terminal – Sollers Point Terminal (#2344) 230 kV line and Brandon Shores 5T Breaker failed (Line\_FB)
- Recommended Solution: Replace 230 kV breaker and associated CTs at Riverside on 2345 line. Replace all dead-end structures at Brandon Shores, Hawkins Point, Sollers Point and Riverside. Install a second conductor per phase on the spans entering each station. Brandon Shores – Hawkins Point N/E = 1243/1386 MVA. Sollers Pt. – Brandon Shores N/E = 1174/1386 MVA
- Expected service date: June 1, 2013
- Estimated Cost \$1.5 M



- Conastone 500/230 kV transformer CKT 1 / Loss of Conastone – Peach Bottom 500 kV line + Conastone 500/230 kV transformer CKT 2 (Line\_FB)
  - The limitation on the transformer is associated bus
  - The bus will be replaced as part of the transformer replacement (B0298)



- Burtonsville – Sandy Spring 230 kV line CKT #2314 / Loss of High Ridge – Sandy Springs – Burtonsville CKT # 2334 (Single)
- Burtonsville – Sandy Spring 230 kV line CKT #2334 / Loss of High Ridge – Sandy Springs – Burtonsville CKT # 2314 (Single)
- Recommended Solution: Rebuild each line (0.2 miles each) to increase the normal rating to 968 MVA and the emergency rating to 1227 MVA
- Expected in-service: June 1, 2013
- Estimated cost: \$0.27 M per line





# PEPCO Baseline Upgrades

- Station H – Quince Orchard  
230 kV line / Loss of Dickerson – Quince Orchard DCTL
- Recommended Solution:  
Upgrade circuit to 3,000 amps  
using the ACCR
- Expected in-service date:  
June 1, 2013
- Estimated cost: \$6.252M

