



Reliability Analysis Update

Transmission Expansion Advisory
Committee
July 11, 2019

- The following definitions explain the basis for excluding flowgates and/or projects from the competitive planning process and designating projects to the incumbent Transmission Owner.
- Flowgates/projects excluded from competition will include the underlined language on the corresponding slide.
 - Immediate Need Exclusion: Due to the immediate need of the violation (3 years or less), the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity. - Operating Agreement, Schedule 6 § 1.5.8(m)
 - Below 200kV Exclusion: Due to the lower voltage level of the identified violation(s), the driver(s) for this project are excluded from the competitive proposal window process. As a result, the local Transmission Owner will be the Designated Entity - Operating Agreement, Schedule 6 § 1.5.8(n)
 - FERC 715 (TO Criteria) Exclusion: Due to the violation need of this project resulting solely from FERC 715 TO Reliability Criteria, the driver(s) for this project are excluded from the competitive proposal window process. As a result, the local Transmission Owner will be the Designated Entity - Operating Agreement, Schedule 6 § 1.5.8(o)
 - Substation Equipment Exclusion: Due to identification of the limiting element(s) as substation equipment, the driver(s) for this project are excluded from the competitive proposal window process. As a result, the local Transmission Owner will be the Designated Entity - Operating Agreement, Schedule 6 § 1.5.8(p)



2019 RTEP Analysis Update



Short-term Project Proposal Window

		# of FGs posted	# of FGs Open to Window
Light load	Basecase Analysis Voltage	15	13
	Gen Deliv	23	6
Winter	Basecase Analysis Thermal	9	0
	Basecase Analysis Voltage Mag	2	0
	N-1-1 Voltage Mag	16	6
	N-1-1 Voltage Drop	25	10
	Gen Deliv	26	6
Summer	Basecase Analysis Thermal	9	6
	Basecase Analysis Voltage Mag	19	19
	Basecase Analysis Voltage Drop	24	22
	N-1-1 Thermal	71	3
	N-1-1 Voltage Mag	29	13
	N-1-1 Voltage Drop	13	0

Dominion End of Life Criteria

Recommended Solution

Baseline Reliability Projects



Dominion Transmission Zone: Baseline 230kV Line #254 Rebuild (End of Life Criteria)

Process Stage: Recommended Solution

Criteria: End of Life

Assumption Reference: FERC 715

Model Used for Analysis: 2018 Series 2023 Summer RTEP

Proposal Window Exclusion: FERC 715 (TO Criteria)

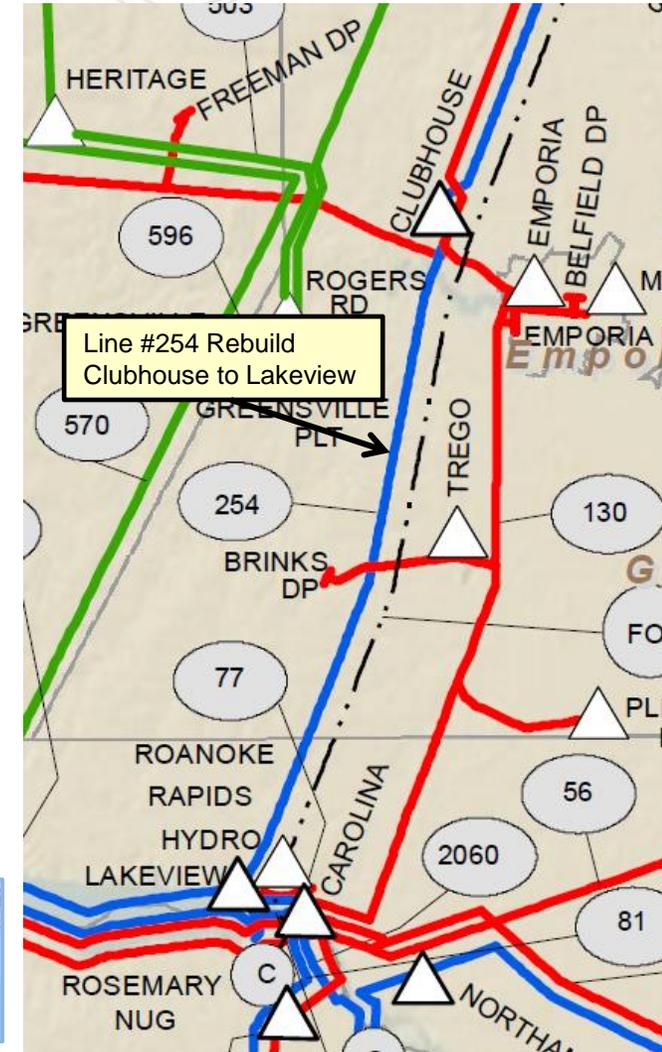
Problem Statement:

The 230kV Line #254, from Clubhouse to Lakeview, is approximately 18 miles long and was constructed on wooden H-frame structures in 1962. Industry guidelines indicate equipment life for wood structures is 35-55 years, conductor and connectors are 40-60 years and porcelain insulators are 50 years.

Reliability studies indicate that retiring Line #254 will result in thermal overloads in accordance with P1, P2, P4, P6, and P7 NERC criteria violations. There is also an operational performance need for Line #254, as generator AB2-100 would be left unserved if the line were retired.

Existing Facility Rating: 399 MVA STE

Preliminary Facility Rating: 1047 MVA STE



COLOR	VOLTAGE	TRANSMISSION LINE NUMBER
Green	500 KV.	500 thru 599
Blue	230 KV.	200 thru 299 & 2000 thru 2099
Red	115 KV.	1 thru 199
Orange	138 KV.	AS NOTED
Cyan	69 KV.	AS NOTED



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Dominion Transmission Zone: Baseline 230kV Line #254 Rebuild (End of Life Criteria)

Recommended Solution:

Rebuild 230kV Line #254 with single-circuit wood pole equivalent structures at the current 230kV standard with a minimum rating of 1047 MVA. (b3121)

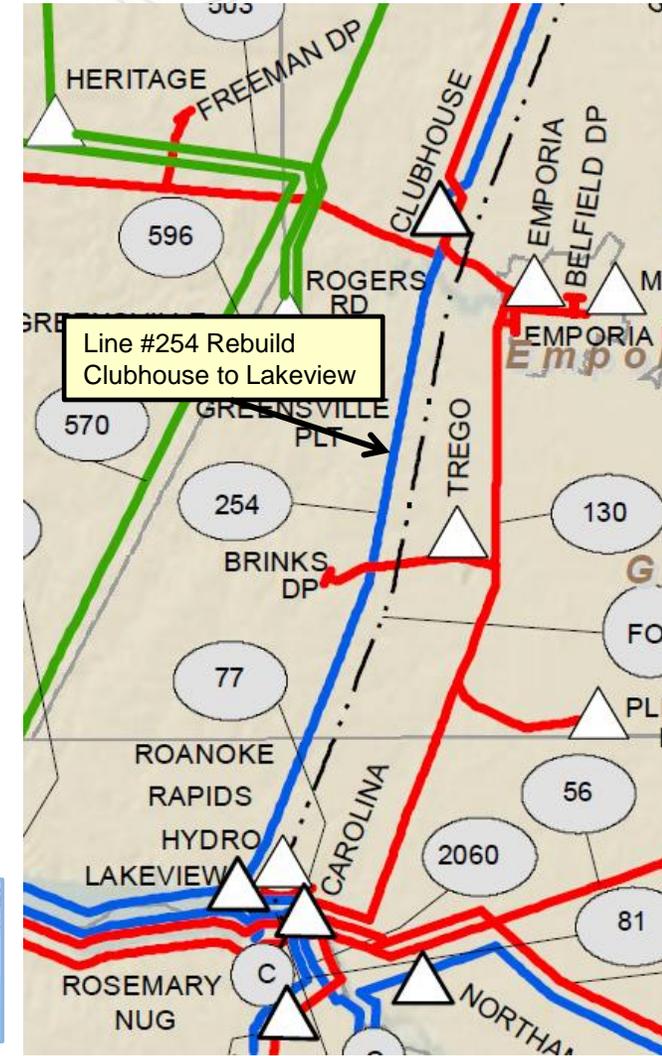
- **Estimated Cost:** \$27.0 M

Required In-Service: Immediate Need

Projected In-Service: 12/31/2024

Project Status: Conceptual

Previously Presented: 6/13/2019 TEAC



COLOR	VOLTAGE	TRANSMISSION LINE NUMBER
Green	500 KV.	500 thru 599
Blue	230 KV.	200 thru 299 & 2000 thru 2099
Red	115 KV.	1 thru 199
Orange	138 KV.	AS NOTED
Cyan	69 KV.	AS NOTED



Process Stage: Recommended Solution

Criteria: End of Life

Assumption Reference: FERC 715

Model Used for Analysis: 2018 Series 2023 Summer RTEP

Proposal Window Exclusion: FERC 715 (TO Criteria)

Problem Statement:

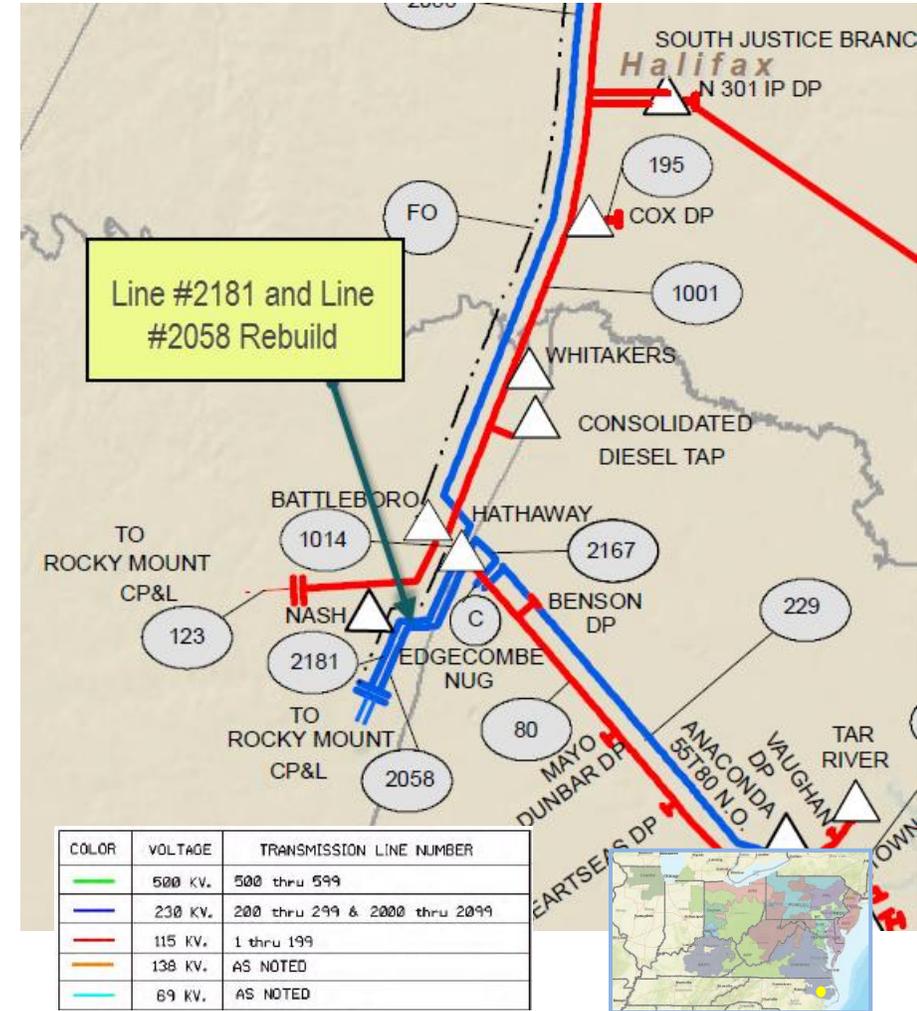
The 230kV Line #2181 and Line #2058 Hathaway – Rocky Mount (Duke Energy Progress) was constructed on Cor-ten lattice-type double circuit towers in the 1960s for approximately 4.1 miles. These towers have been shown to have inherent corrosion problems that continuously deteriorate the steel members. These lines have been identified to be rebuilt as part of Dominion’s End of Life criteria.

The Line #2181 provides service to Nash and City of Rocky Mount #4 substations with approximately 16 MW and 54 MW tapped load.

With Lines #2181 and #2058 removed from service, N-1 loss of Line #218 Everetts – Greenville (Duke Energy Progress) overloads Line #123 Battleboro – Rocky Mount (Duke Energy Progress) (NERC Category P1 – Single Contingency).

Existing VACAR South Operating Limits Procedure identifies these tie-lines between Dominion and Duke Energy Progress as possible overloads under certain system conditions.

Continued on next slide...





Dominion Transmission Zone: Baseline 230kV Line #2181 and 230kV Line #2058 Rebuild (End of Life Criteria)

Existing Facility Ratings: 478 MVA STE

Preliminary Facility Rating: Hathaway - Nash: 1047 MVA STE Line #2181

Nash – City of Rocky Mount: 478 MVA STE (Limited by Duke) Line #2181

Hathaway – City of Rocky Mount: 478 MVA STE (Limited by Duke) Line #2058

Recommended Solution:

Rebuild 230kV Line #2181 and Line #2058 Hathaway – Rocky Mount (Duke Energy Progress) with double circuit steel structures using double circuit conductor at current 230kV standards with a minimum rating of 1047 MVA. (b3122)

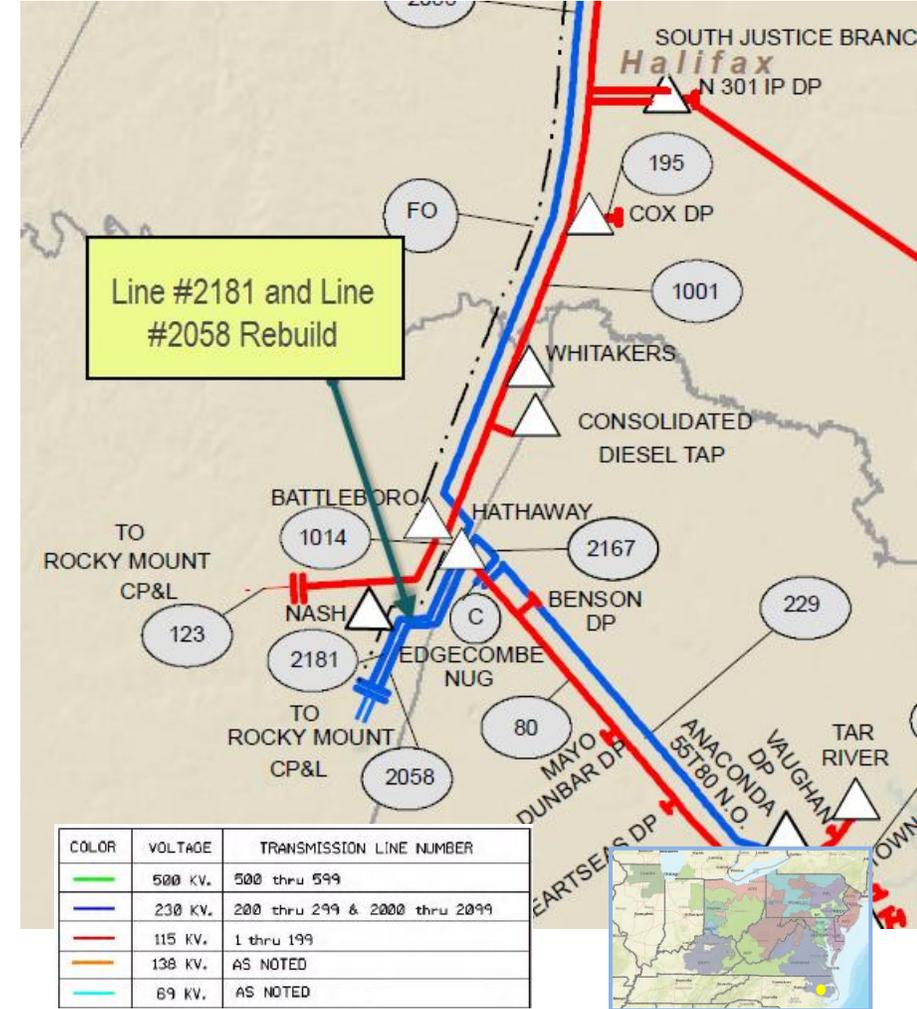
- **Estimated Cost:** \$13.0 M

Required In-Service: Immediate Need

Projected In-Service: 12/31/2024

Project Status: Conceptual

Previously Presented: 6/13/2019 TEAC



Short Circuit Projects

Baseline Reliability: Immediate Need Exclusion

Problem Statement: Short Circuit

- The Whitpain 230kV breaker "125" is overdutied.

Significant Driver:

- Case Correction – Whitpain 230kV breaker "125" was incorrectly modeled as a 63kA breaker when it was a 50kA breaker in the field.

Recommended Solution:

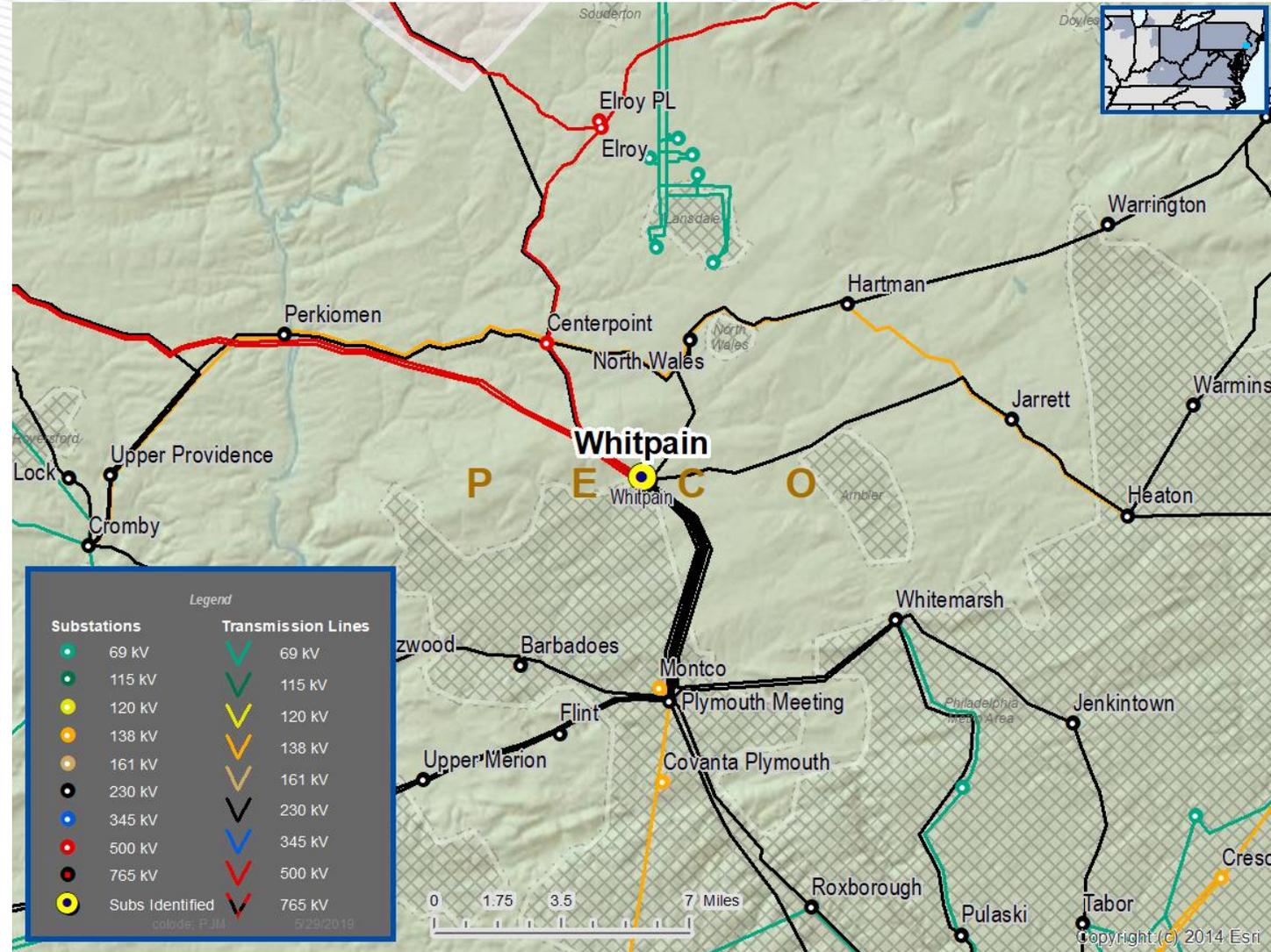
- Replace the Whitpain 230kV breaker "125" with a 63kA breaker (b3120)

Estimated Project Cost: \$0.60 M

Required In-service Date: Immediate Need

Projected In-service Date: 6/1/2021

Project Status: Conceptual



- Review proposals as they are provided
- Review possible solutions
- Continue stability analysis

Questions?



2019

- TEAC meetings are the following Thursdays in 2019
- **1/10, 2/7, 3/7, 4/11, 5/16, 6/13, 7/11, 8/8, 9/12, 10/17, 11/14, 12/12.**

- V1 – 07/03/2019 – Original slides posted
- V2 – 07/08/2019 – Added slide # 4, Short-term Project Proposal Window



Appendix: Previously Reviewed Baseline Upgrade Recommendations for the July 2019 PJM Board Review



Mid Atlantic Region

Cancellation of the B1690 (MCRP) project:

- The B1690 project (Build a new third 230 kV line into the to Red Bank 230 kV substation) was initially proposed in 2011 to resolve voltage violations identified in the Red Bank area
- The project will be canceled due to recent proceedings
- The project will be removed from the all 2019 RTEP cases
- PJM and First Energy are working on alternative solutions and will provide update in the future

Three Mile Island 1 deactivation - 802.8 MW

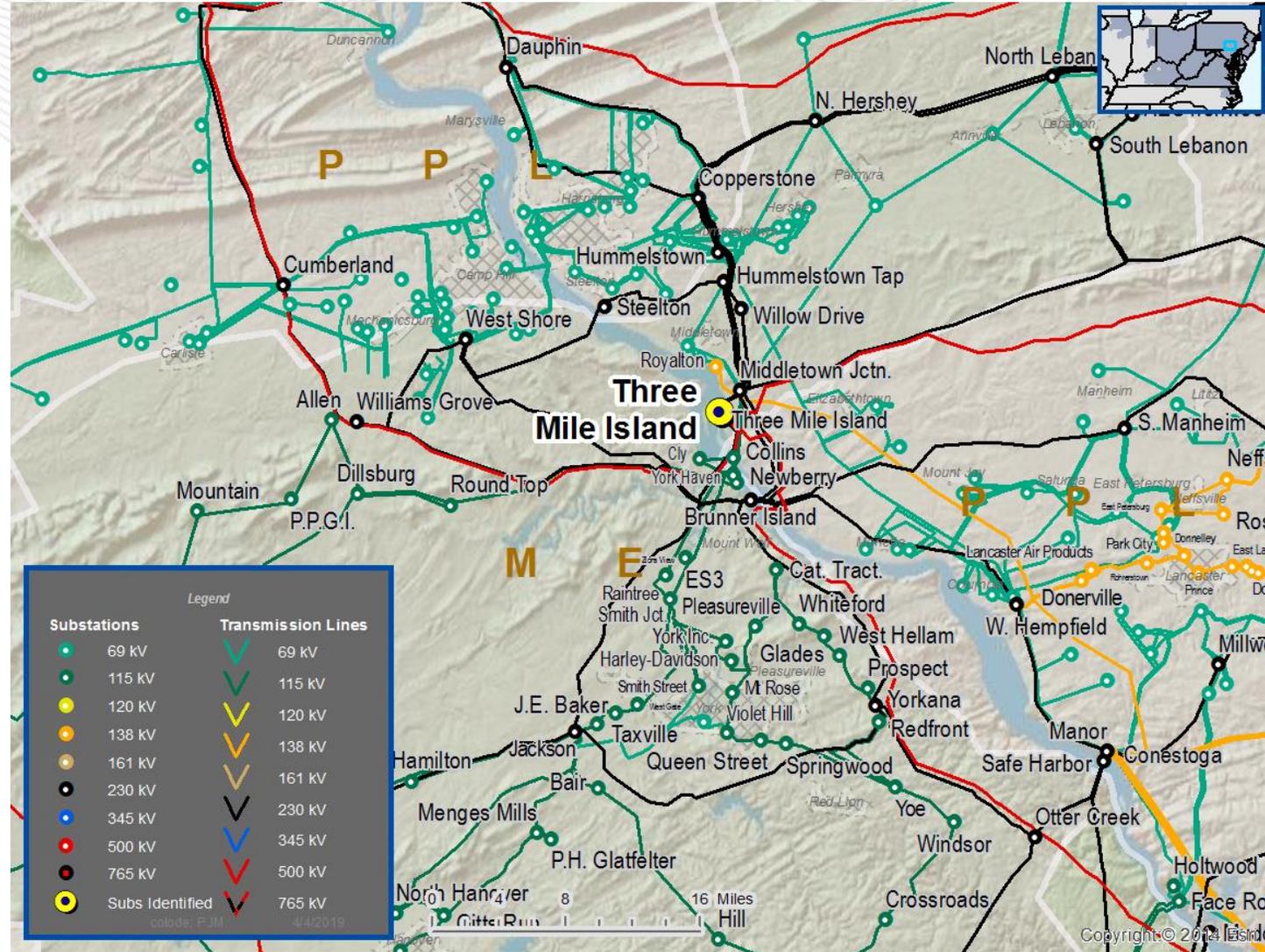
- PJM received the deactivation request on 05/30/2017.
- The projected deactivation date is 09/30/2019.
- No impacts were identified and the result was presented on 07/13/2017.
- FE recently informed of the necessary substation work associated with deactivating the unit.

B3115 - Provide new station service to control building from 230 kV bus (served from plant facilities presently).

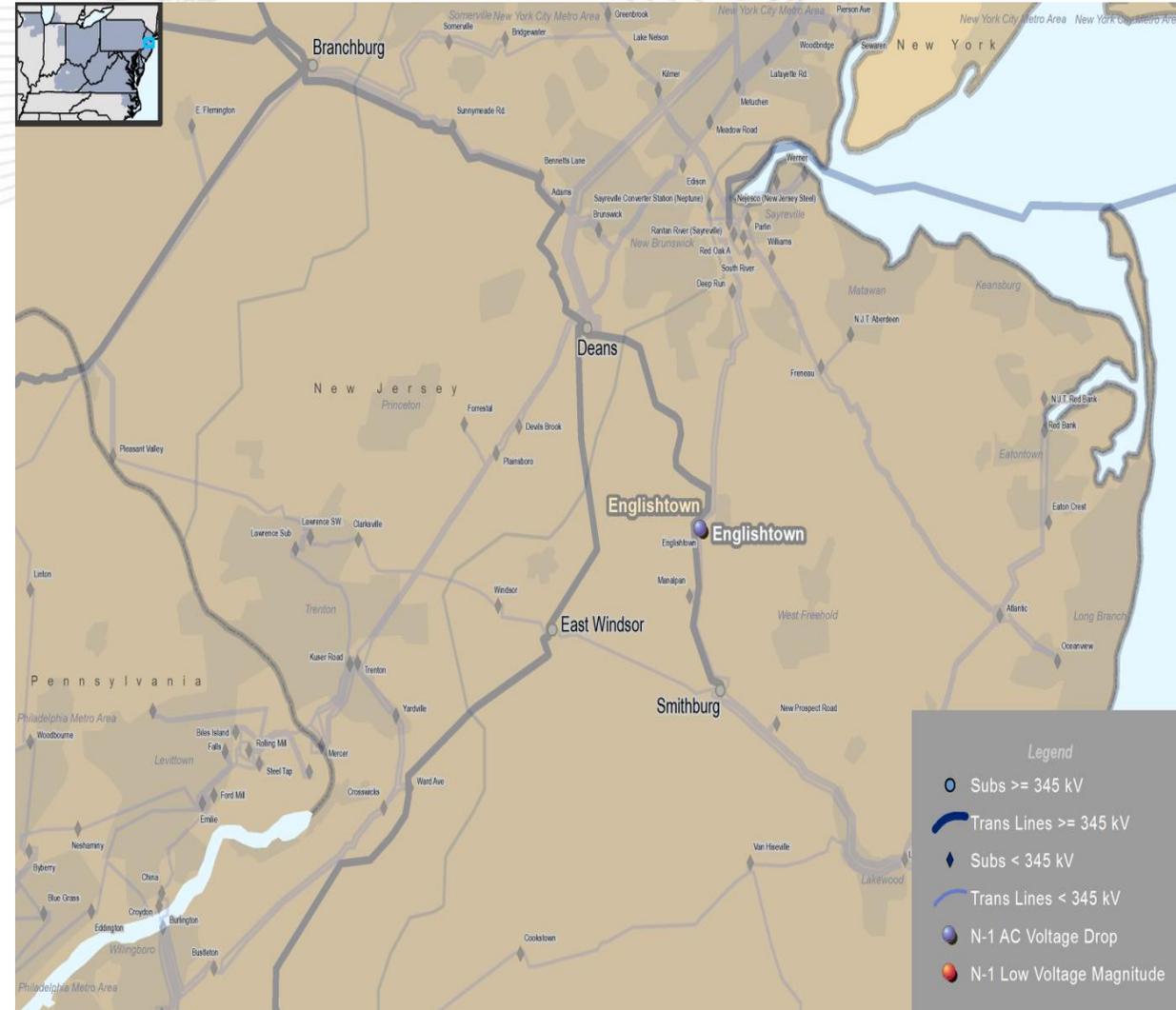
Estimated Project Cost: \$1.5M

Required IS Date: 09/30/2019

Projected IS Date: 09/30/2019



- Cancellation of the B2676 project:
- The B2676 (Install one 72 MVAR fast switched capacitor at Englishtown 230 kV) was identified to mitigate voltage violation at Englishtown substation for N-1-1 condition in 2015.
- The upgrade is no longer required due to a lower load forecast and other Englishtown area upgrades.
- PJM performed all required analysis without the Englishtown 230 kV fast switched capacitor and didn't identify any issue.





Western Region

Problem Statement: N-1-1 thermal

Hyatt - Maliszewski 138 kV line is overloaded for the following contingency scenarios:

- Loss of Hyatt 345/138 kV 1A & 1B transformers followed by the loss of Hyatt - Maliszewski #2 138 kV.
- Loss of Marysville 765/345 kV #2 transformer followed by Hyatt - Maliszewski #2 138 kV.

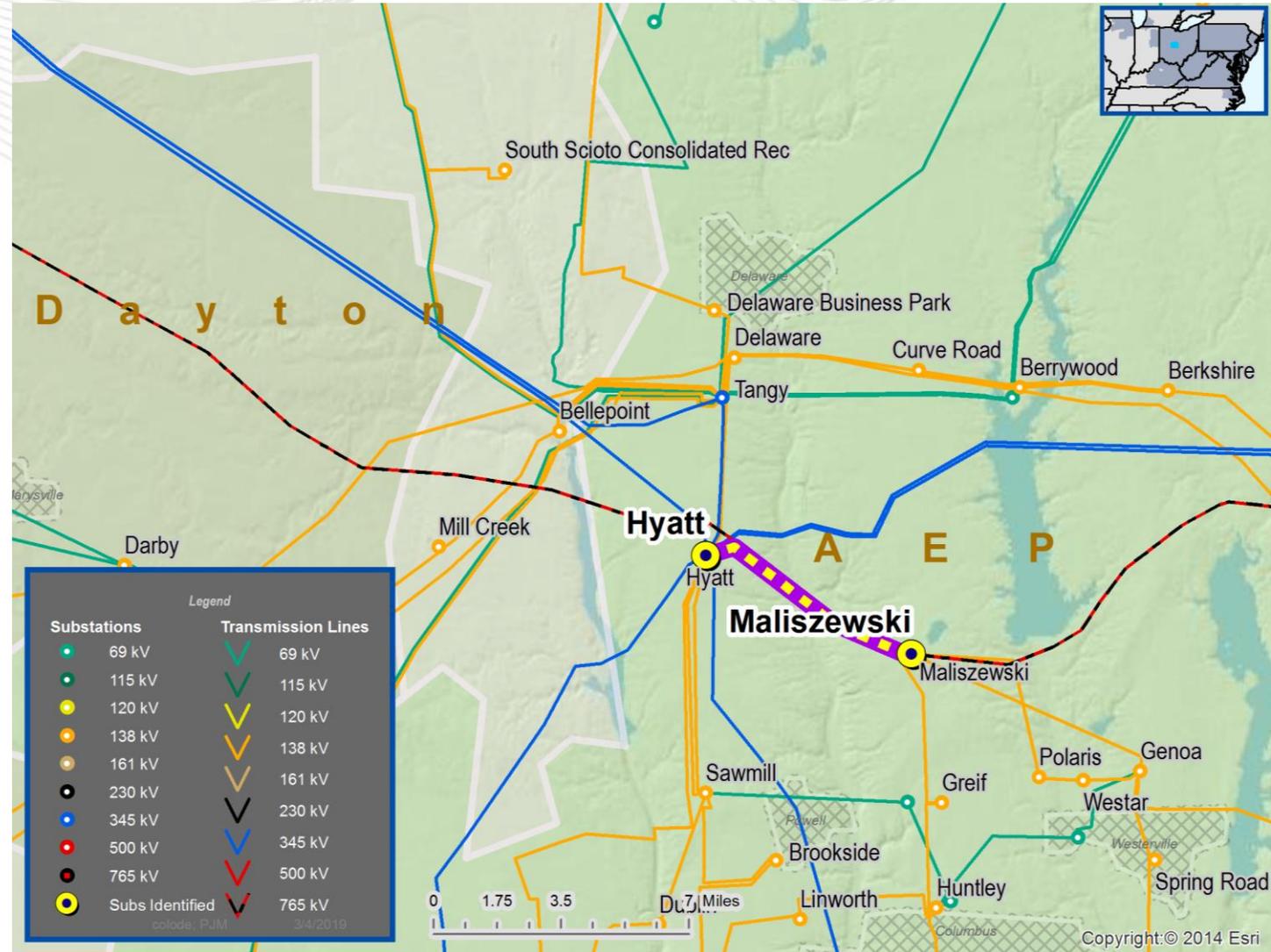
Recommended Solution:

- B3106: Perform a sag study (~ 6.8 miles) to increase the Summer Emergency rating.
- Current rating: SN 223 MVA / SE 226 MVA
- New rating: SN 257 MVA / SE 310 MVA

Estimated Project Cost: \$ 0.5M

Required IS Date: 06/01/2020

Projected IS Date: 06/01/2020



Problem Statement: N-1-1 thermal

Polaris - Westerville 138 kV line is overloaded for the following contingency scenarios:

- Loss of Vassel - Vassel TR1 Lead 345 kV followed by the loss of Genoa - Maliszewski #2 138 kV.
- Loss of Vassel 765/345 kV transformer followed by the loss of Genoa - Maliszewski ckt 2 138 kV.
- Loss of Genoa - Maliszewski #2 138 kV followed by loss of Vassel - Vassel TR1 Lead 345 kV.
- Loss of Genoa - Maliszewski #2 138 kV followed by loss of Vassel 765/345 kV transformer.

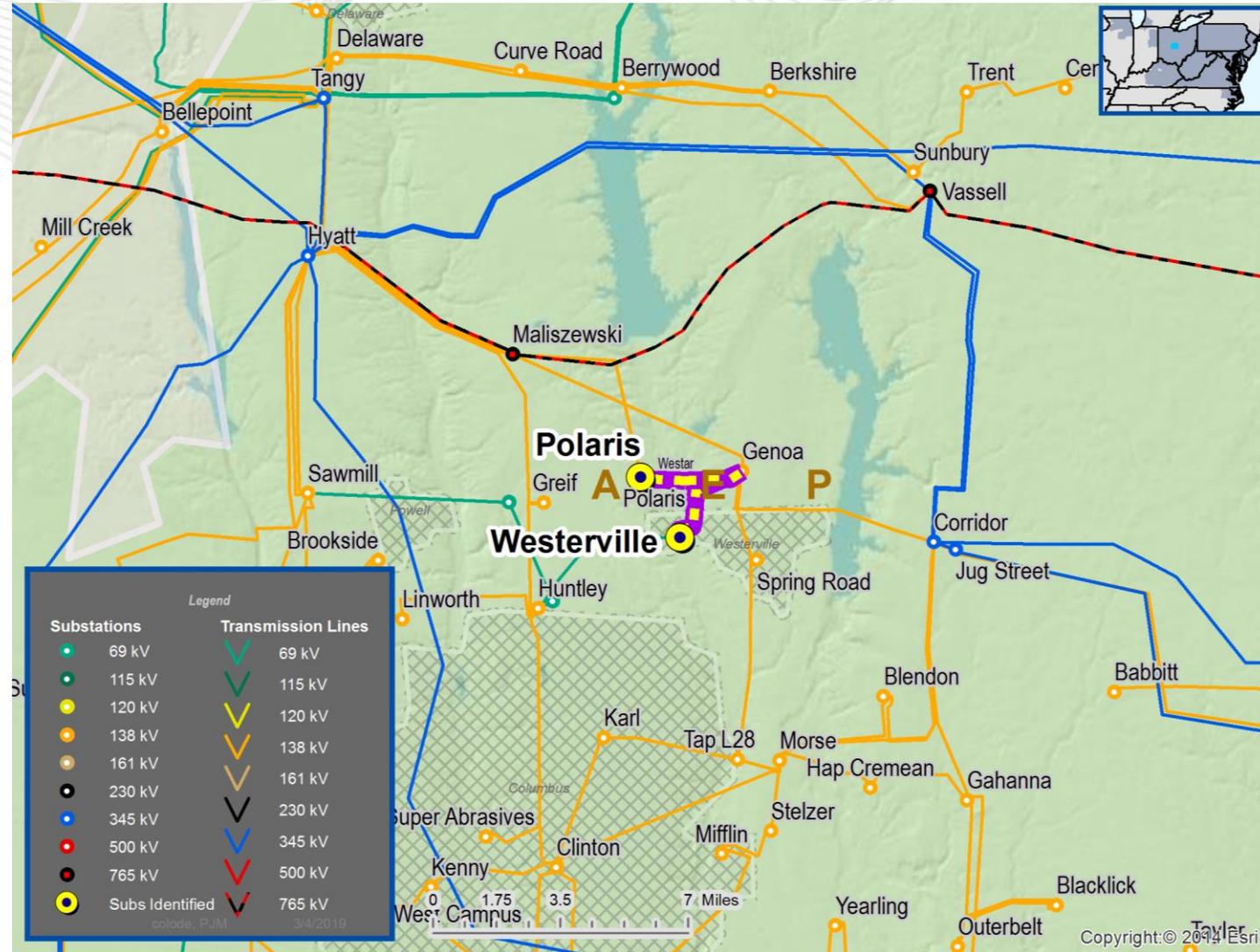
Recommended Solution:

- B3104: Perform a sag study (~ 3.6 miles) to increase the Summer Emergency rating to 310 MVA.
- Current rating: SN 223 MVA / SE 226 MVA
- New rating: SN 223 MVA / SE 310 MVA

Estimated Project Cost: \$ 0.5M

Required IS Date: 06/01/2020

Projected IS Date: 06/01/2020



Problem Statement: N-1-1 thermal

Delaware - Hyatt 138 kV line is overloaded for the following contingency scenarios:

- Loss of Delaware - Vassel 138 kV (N-1-0)
- Loss of Vassel 345/138 kV transformer (N-1-0)

Recommended Solution:

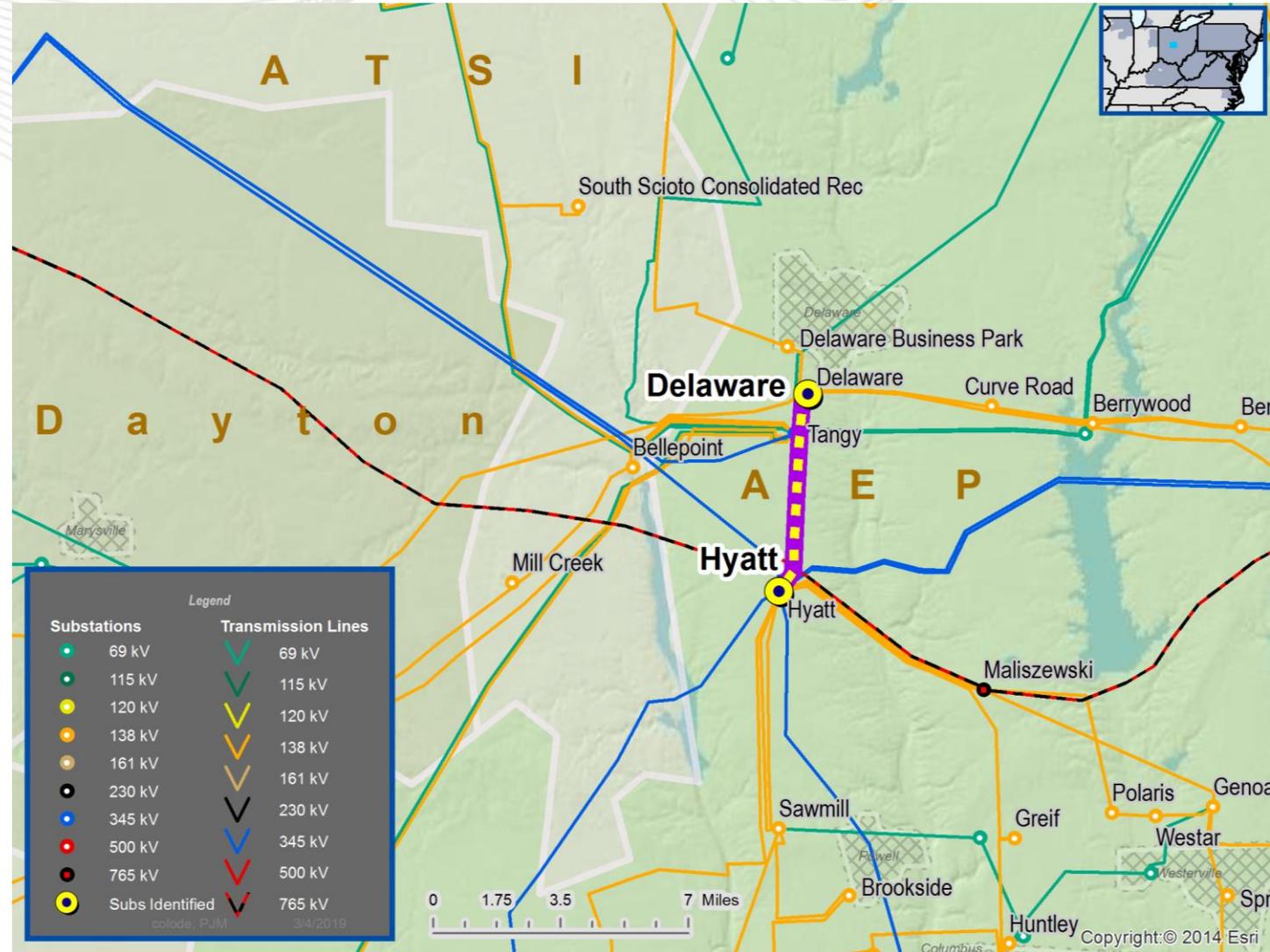
- B3105: Rebuild the Delaware – Hyatt 138 kV line (~ 4.3 miles) along with replacing conductors at both Hyatt and Delaware substations.
- Current rating: SN 223 MVA / SE 330 MVA
- New rating: SN 256 MVA / SE 360 MVA

Estimated Project Cost: \$ 16M

Required IS Date: 06/01/2020

Projected IS Date: 06/01/2022

* Operating measures identified to mitigate reliability impacts in interim



Dayton High Voltage Issues During Light Load

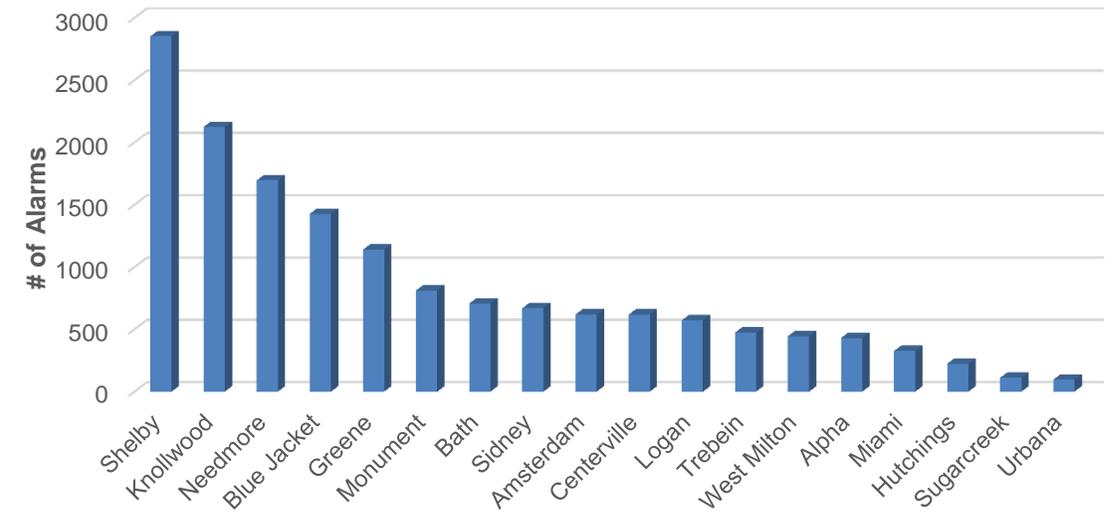
- **Excessive Amount of High Voltage Alarms for Dayton**

- Approximately 19,000 operational alarms logged in 2017-2018 (including 327 alarms at 345kV buses).
- Logged more High Voltage Alarms in 2018 with fewer Minimum Load Hours in comparison to 2017.
 - High Voltage Alarm to Minimum Load Hour Ratio Almost Doubled from 2017 to 2018.

- **Limited Means to Control High Voltage**

- Total loss of ~ 600MVAR of reactive absorption capability in the Dayton Zone Killen & Stuart Retirements (2018) + Hutchings Retirements (2015)
- After exhausting all typical operating procedures, Dayton is frequently forced to switch out equipment to avoid long-term damage from high voltage exposure. This practice of switching out equipment is not a sustainable operating practice and does not effectively solve the high voltage issues.
- As a result of retirements, there are only Peaking Plants Left in Zone
- No existing or planned SVC's, Statcoms, Reactors, etc.

Alarms by 138kV Substation 1/2017 -12/2018



- PJM planners worked closely with Dayton planners to determine what operational and planning changes area available
 - Reviewed EMS snapshots of high voltage conditions to confirm issues
 - Examined impact of planned, approved reactive upgrades
- Outcome of the investigation resulted in the proposed addition of three new 100 MVAR 138 kV reactors on the Dayton system with a 12/31/2021 projected in-service date
- Immediate Need exclusion
- Recommended Solution:
 - **B3108.1:** Install 100 MVAR reactor at Miami 138 kV substation (\$5M)
 - **B3108.2:** Install 100 MVAR reactor at Sugarcreek 138 kV substation (\$5M)
 - **B3108.3:** Install 100 MVAR reactor at Hutchings 138 kV substation (\$5M)



DAYTON/AEP Transmission Zone

Cost updates and New Sub ID needed for AEP portion of work for B1570, previously presented on 5/12/2011, 9/8/2011 TEAC

Original Project Description:

- B1570: Add a 345/69kV transformer at AEP Marysville 345kV bus
- B1570.1: Add/Reconductor Marysville 69kV – Darby 69kV
- B1570.2: Add/Reconductor Marysville 69kV – Union REA 69kV
- B1570.3: Reconductor Union REA 69kV – Honda MT 69kV

Original Total Project Cost: \$16 M

New Project Description:

- B1570: Add a 345/69kV transformer at Dayton’s Peoria 345kV bus
- B1570.1: Add/Reconductor Peoria 69kV – Darby 69kV
- B1570.2: Add/Reconductor Peoria 69kV – Union REA 69kV
- B1570.3: Reconductor Union REA 69kV – Honda MT 69kV

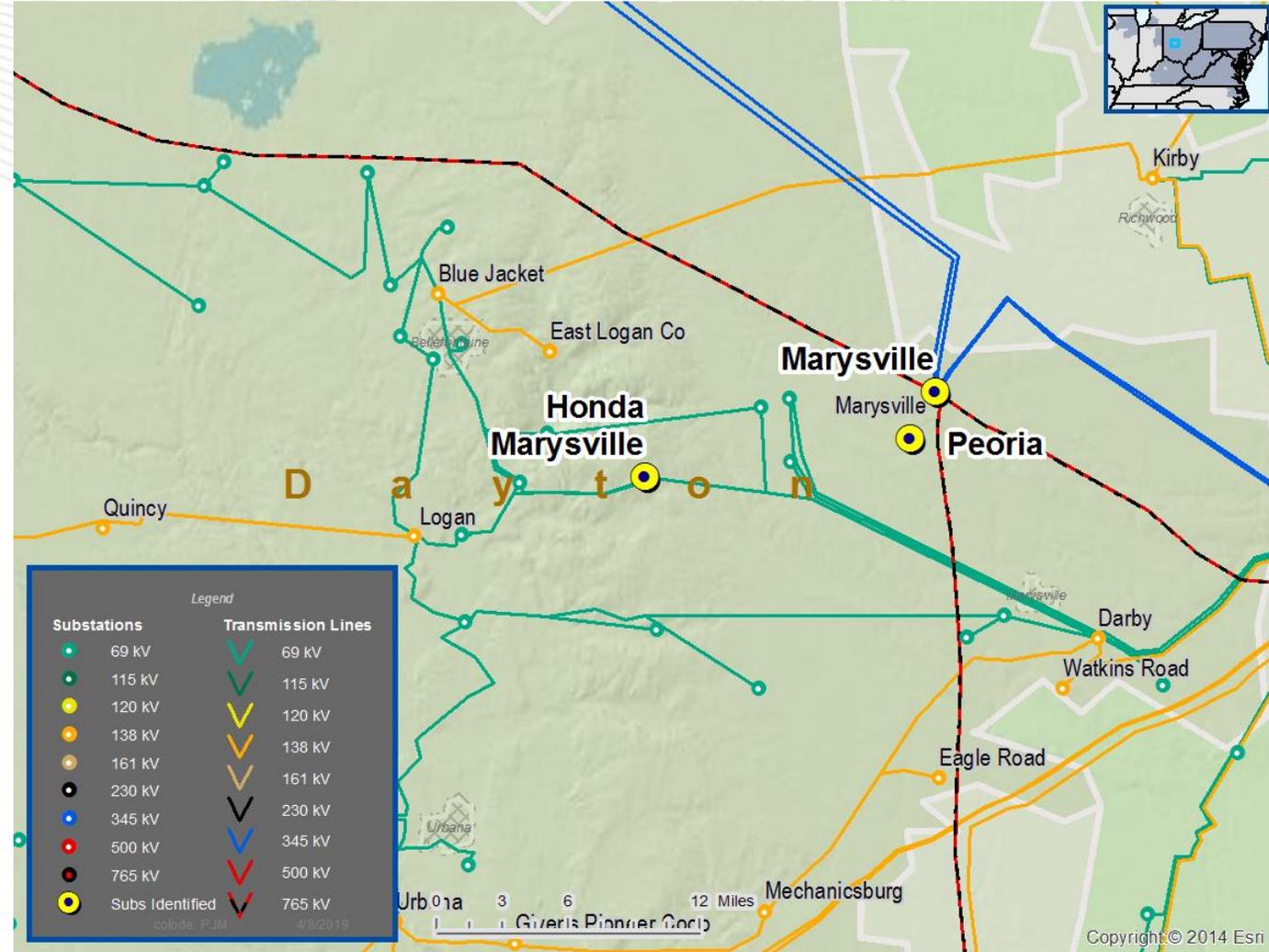
New Sub ID for AEP portion of work:

B1570.4: Add a 345kV breaker at Marysville 345kV station and a 0.1 mile 345kV line extension from Marysville to the new 345/69kV Dayton transformer Estimated Cost: **\$4.1M**

Note: No additional scope, it was part of the original B1570, but not broken-out into a separate Sub ID

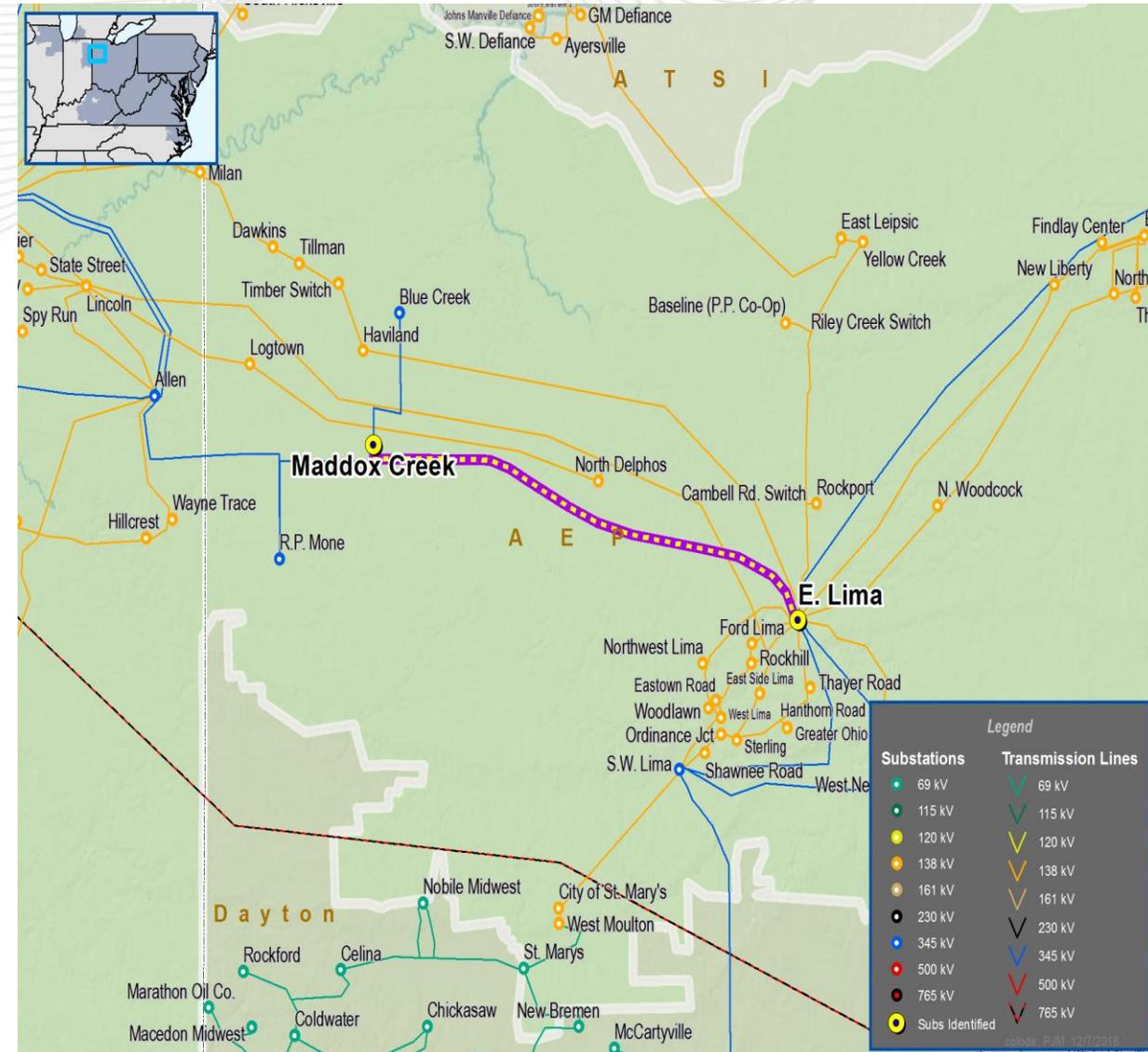
Updated cost for B1570, B1570.1, B1570.2 and B1570.3 is **\$16M**

Updated Total Project Cost: \$20.1M



Cost increase for B2833, previously presented on 1/12/2017 TEAC

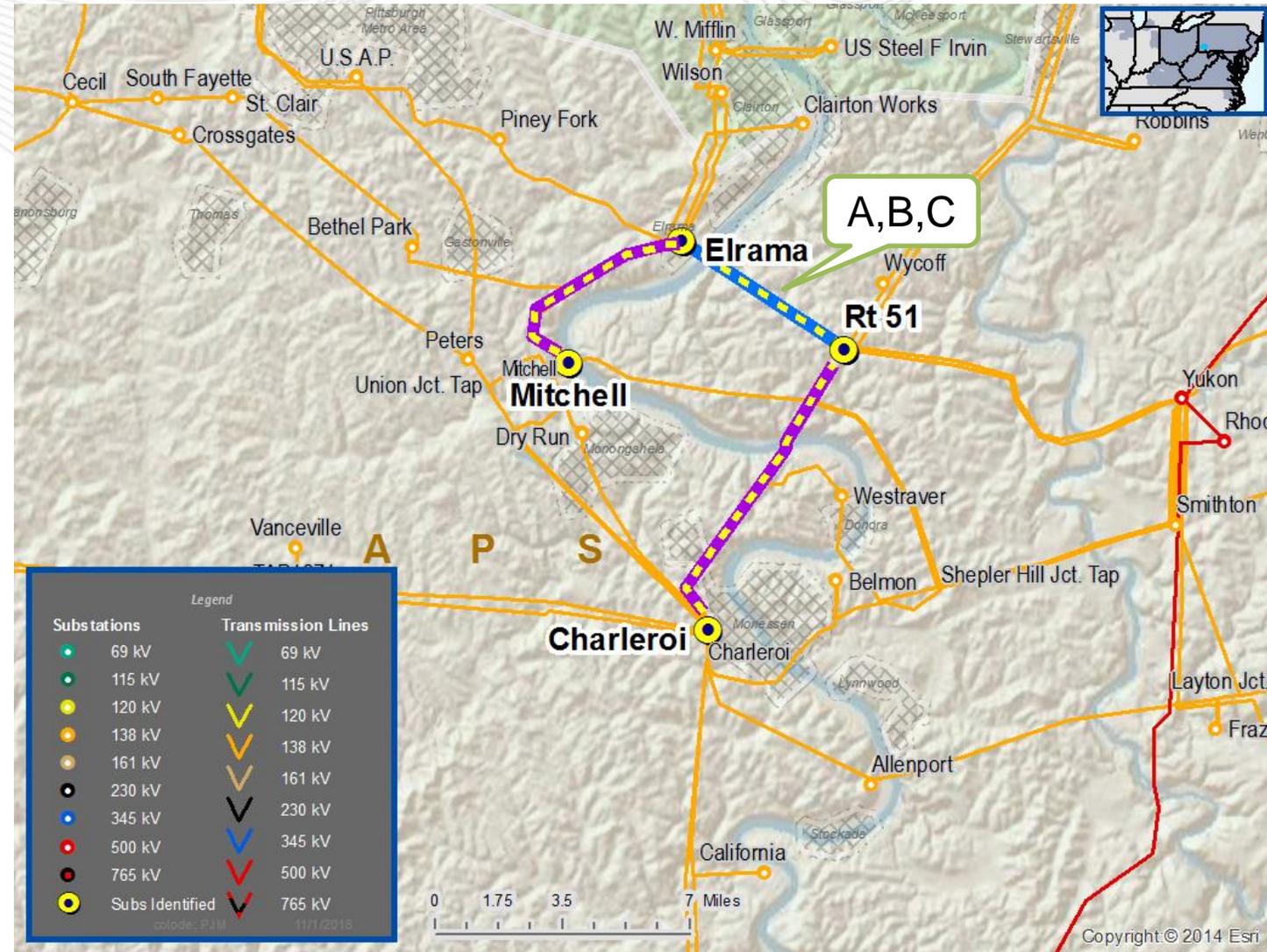
- B2833: Reconductor the Maddox Creek to East Lima 345 kV circuit with 2-954 ACSS Cardinal conductor. (2016_3-4D)
- **Driver:**
 - Winter Generator Deliverability (FG# 123) in 2016 proposal window 3: Maddox Creek to East Lima 345 kV circuit is overloaded for single contingency loss of the Marysville – Sorenson 765 kV circuit.
- **Alternatives considered:**
 - 2016_3-3A (\$ 5.95 M)
 - 2016_3-4D (\$ 18.2 M)
 - 2016_3-4F (\$ 67.7 M)
 - 2016_3-4G (\$ 69.3 M)
 - 2016_3-7A (\$ 55.9 M)
- **Original Estimated Cost: \$18.2M**
- **New Estimated Cost : \$ 30.5M**
- **Reason for the Cost Increase:**
 - Access cost increased \$6M. Detailed project development and access plan review showed a much higher cost would be expected if traditional access roads were used to perform construction. Helicopter construction will be used as the more cost-effective approach to reduce need for mitigation of access roads and impact to property owners.
 - Labor and material cost for tower and hardware assemblies were updated, resulting in a \$6.3M increase.
- **Required IS Date: 12/1/2021**



Scope Change for B3012

Scope History

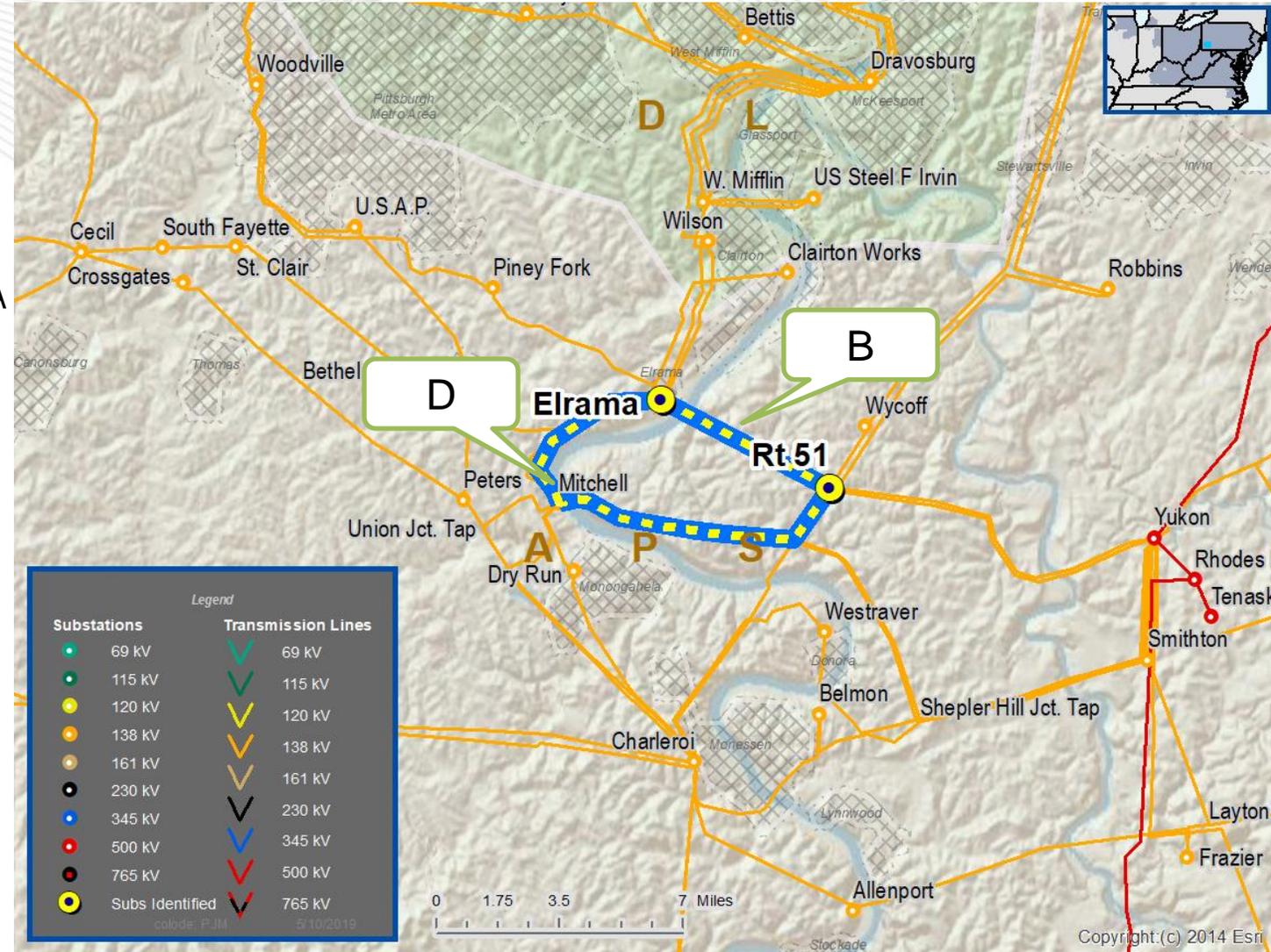
- A. June 7, 2018 TEAC: Initial scope for constructing two new 138 kV ties between Elrama and Route 51 using double circuit construction.
 - Driven by FENOC (nuclear) deactivations
 - Estimated cost: \$9.2M
- B. November 5, 2018: PJM receives FE construction acceptance for b3012
 - FE revised cost and scope to \$23.1M due to detailed estimate;
 - Estimated cost: \$27.7M (FE: \$23.1M; DLCO: \$4.6M)
- C. November 8, 2018 TEAC: Scope revised for additional FES Coal deactivations
 - Separate the two new Elrama – Route 51 circuits onto separate structures to alleviate common structure contingency overloads on the Mitchell - Elrama 138 kV and Route 51 - Charleroi 138 kV #1 and #2 lines.
 - New Estimated cost: \$45.7M (FE: \$41.1M, DLCO:\$4.6M)



Scope Change for B3012 – Continued

Revised Scope (Combine previous B with new D scope)

- B. Construct two new 138 kV tie lines using double circuit construction
 - Estimated cost: \$27.7M (FE: \$23.1M; DLCO: \$4.6M)
- D. Construct new Elrama – Route 51 138 kV #3 line (SN 789 MVA / SE 908 MVA).
 - Reconductor ~4.7 miles of the existing double circuit Shepler Hill Jct. – Mitchell 138 kV line (FE). Line will be six-wired.
 - Construct ~1.5 miles of new double circuit 138 kV line from Route 51 to the reconducted portion of the Shepler Hill Jct. – Mitchell 138 kV line (FE). Line will be six-wired.
 - Cut the existing Shepler Hill Jct. – Mitchell 138 kV line at two locations
 - Cut the Mitchell – Elrama line and connect to the former Shepler Hill Jct. – Mitchell 138 kV line. Establishes new tie line in place of the existing Elrama – Mitchell 138 kV line (DLCO).
 - Install one new terminal at FE's Route 51 substation (FE).



Scope Change for B3012 – Continued Revised Scope (Combine previous B with new D scope)

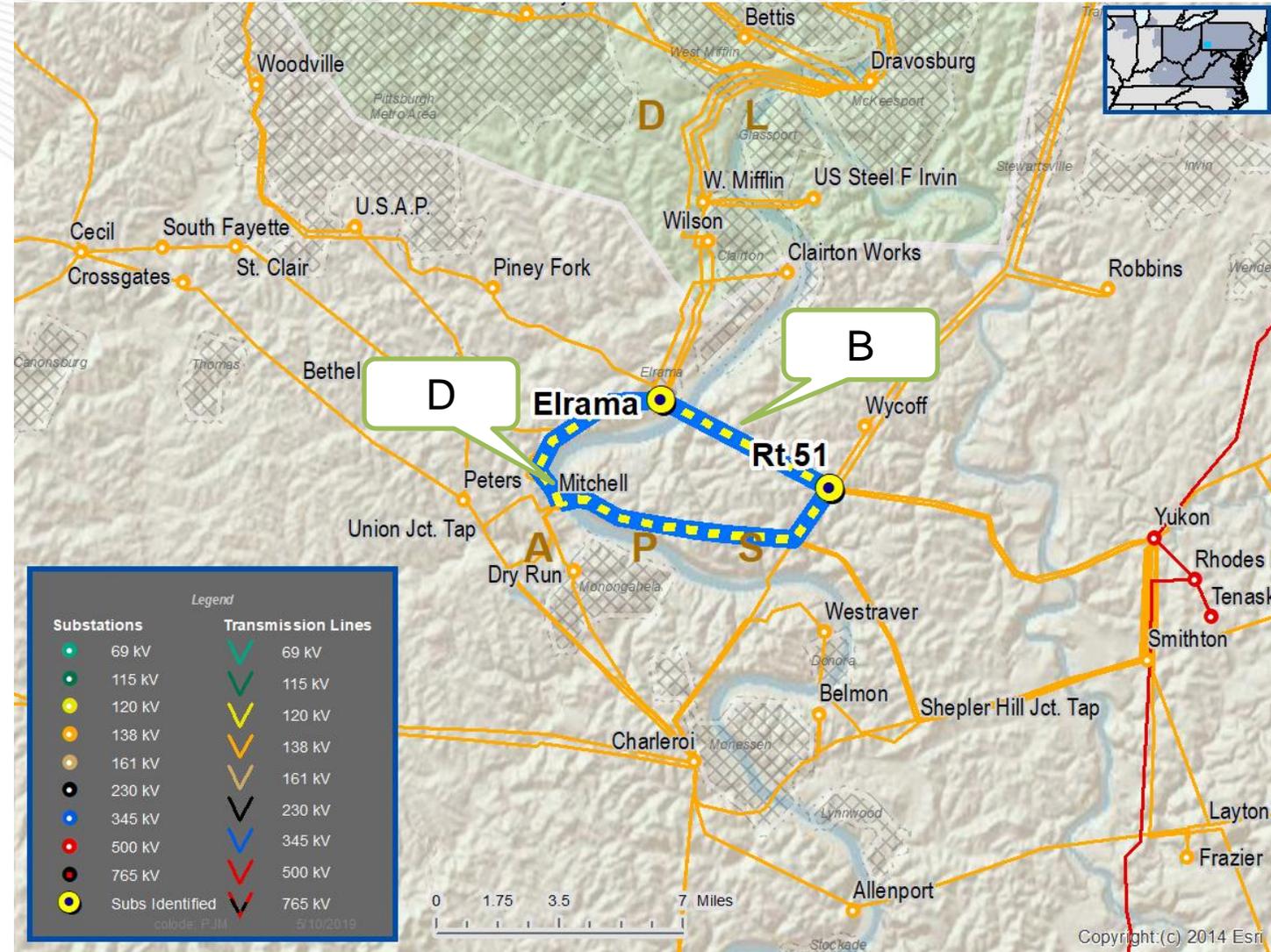
- This project eliminates the need for b2966, which reconductors Yukon - Smithton - Shepler Hill Jct, and replace line disconnect switch at Yukon.
 - o Estimated cost: \$6.7M.

D project cost: \$19.1 (FE: \$18.1M, DLCO:\$1M)

B & D combined cost: \$46.8M

Required IS Date: 06/01/2021

Projected IS Date: 06/01/2021



Revised Scope Change for B3012 – Benefit: \$5.6M

Work Description	Original Scope	Revised Scope
Construct new double circuit 138 kV tie lines (b3012 scope B)	Not Required	\$27.7M
Construct new circuits on separate structures (b3012 scope C)	\$45.7M	Not Required
Construct a new Elrama – Route 51 138 kV #3 line (b3012 scope D)	Not Required	\$19.1M
Reconductor Yukon - Smithton - Shepler Hill Jct (b2966)	\$6.7M	Not required
Total Estimated Cost	\$52.4M	\$46.8M

B2970 Project Update:

PJM identified the B2970 to resolve violations identified in the 2017 RTEP study year and was presented at the 11/2/2017 TEAC.

Immediate Need Exclusion

Recommended Solution :

- Install two new 230 kV positions at Ringgold for 230/138 kV transformers. **(B2970.1)**
- Install new 230 kV position for Ringgold – Catoctin 230 kV line. **(B2970.2)**
- Install one new 230 kV breaker at Catoctin substation. **(B2970.3)**
- Install new 230 / 138 kV transformer at Catoctin substation.
- Convert Ringgold-Catoctin 138 kV Line to 230 kV operation. **(B2970.4)**

Estimated Project Cost: \$ 13.33 M

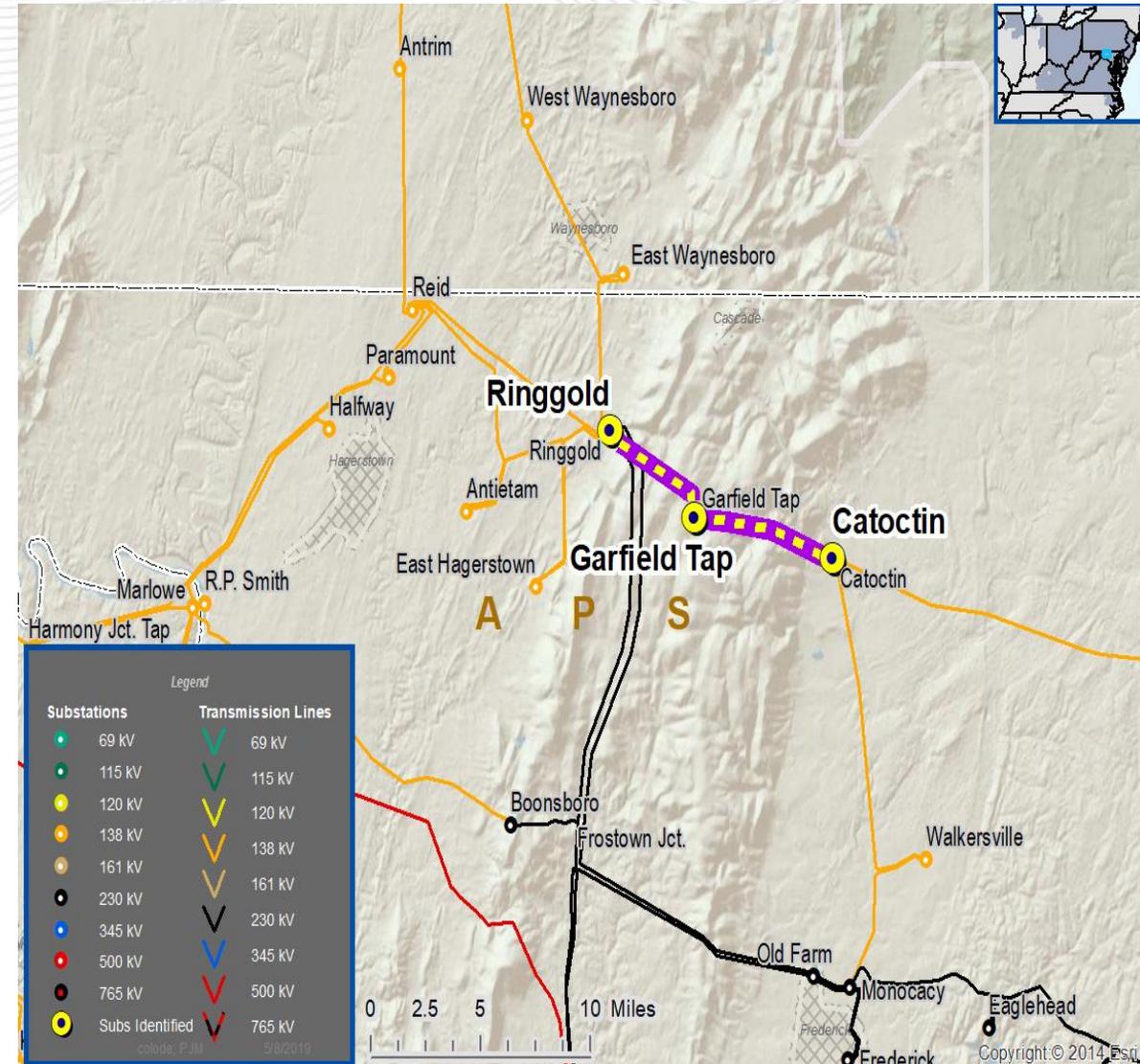
Required IS date: 6/1/2020

• There is a 138/12.5 kV station (Garfield) tapped on the Ring Gold – Catoctin 138 kV circuit that should be converted to 230 kV as part of the B2970 project, but was missed from the original scope and cost estimate. Update the scope of the B2970 to reflect the additional work needed to convert the Garfield 138/12.5 kV to 230/12.5 kV.

• **B2970.5** → Convert Garfield 138/12.5 kV substation to 230/12.5 kV.

Estimated Project Cost: \$ 2.2 M

Total Estimated Project Cost: \$15.53 M



Problem Statement:

Elwyn Z-70 line breaker at Dravosburg 138 kV substation is overdutied. Generation deactivation driven system upgrades (b3011.1 -6) is the driver.

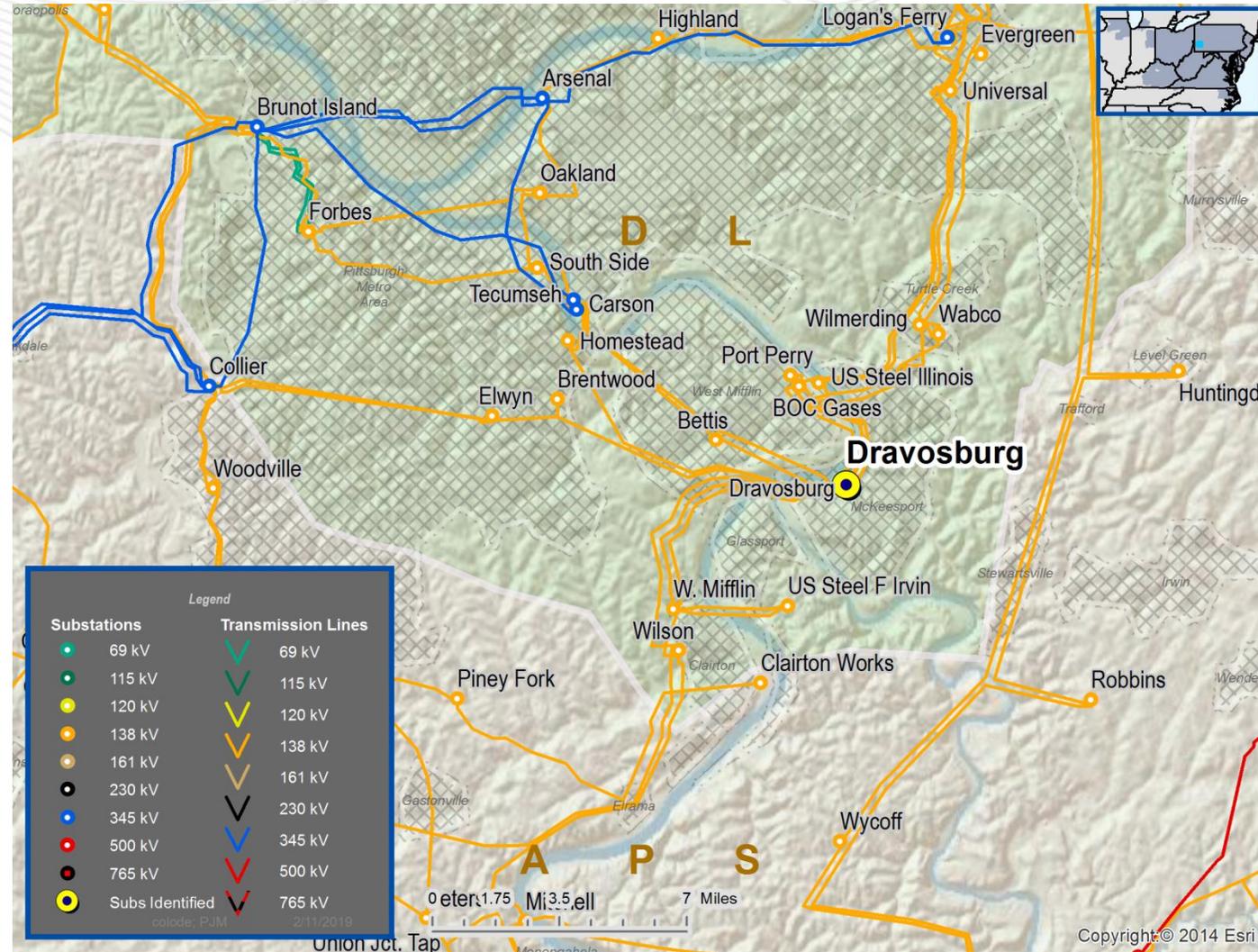
Selected Solution: Replace the line terminal equipment and line breaker #85 at Dravosburg 138 kV substation in the Elwyn Z-70 line position/bay, with the breaker duty as 63KA. (b3011.7)

Estimated Cost: \$ 0.9M

Required In-service: 6/1/2021

Projected In-service: 6/1/2021

Project Status: Planning





Basecase Analysis and N-1-1 Violation

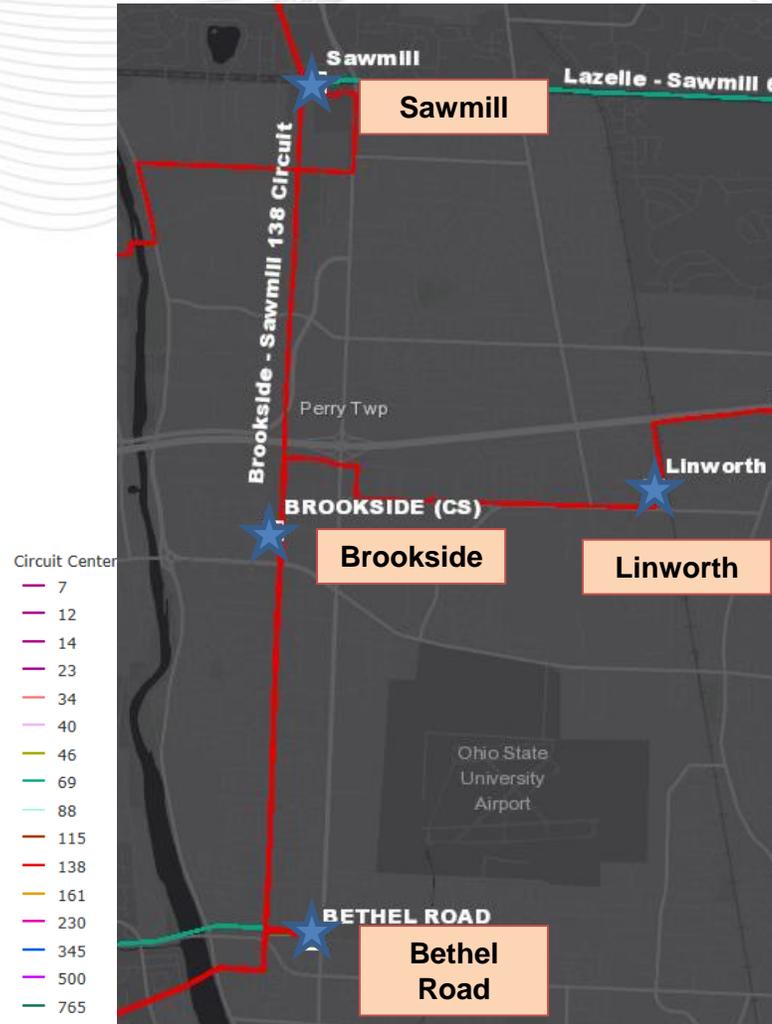
Problem Statement:

The Bethel – Brookside - Sawmill 138 kV line was derated due to the results of a sag study performed on the line, which identified existing encroachments on the line that resulted in the derate. (Summer Normal/Emergency ratings from 216/216 MVA to 151/151MVA)

The Bethel – Brookside line section is overload about 102% for the loss of the 345kV tower lines between Robert and Hayden. It is also shown overloaded in N-1-1 test.

The Brookside – Sawmill line section is overloaded up to 128% for multiple N-1 contingencies and N-1-1 pairs.

AEP has received requests for increased demand in the Dublin area. Newly connected customer loads are scheduled to ramp up, significantly contributing to area thermal concerns.



Proposed Solution:

- Rebuild 5.2 mile Bethel-Sawmill 138kV line. 1590 ACSR 54/19 Falcon conductor is recommended pending engineering verification. Include new ADSS.
- Upgrade risers and relaying at Brookside, Bethel, Sawmill, and Linworth stations.
- Mitigate any ROW encroachments found as needed.
- Upgrade Brookside 1,200A line switches to 3,000A ratings.
- Upgrade risers at Bethel station. **(b3109)**

Alternatives:

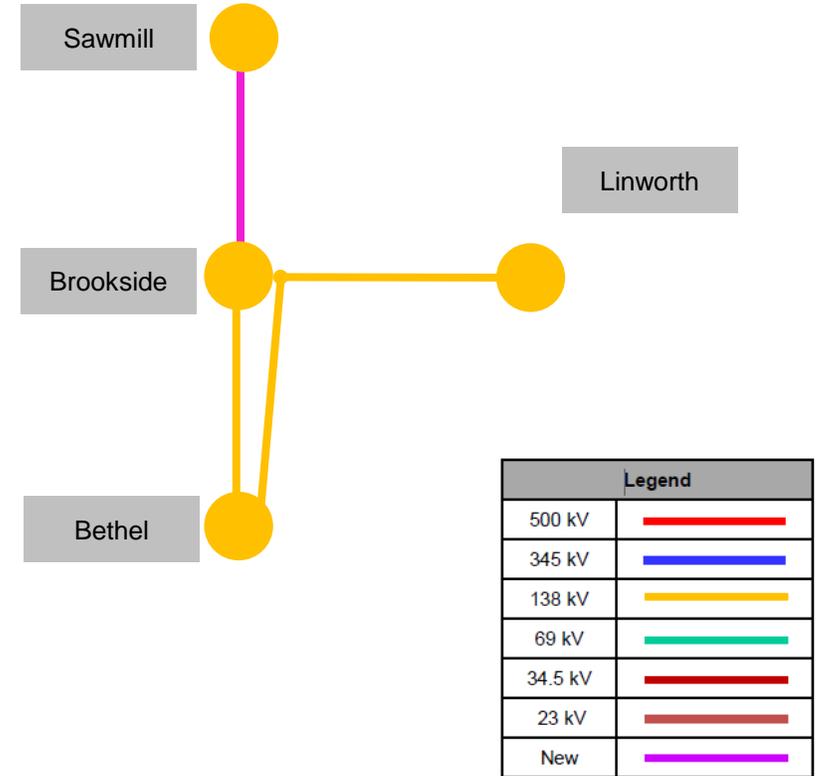
- Various alternatives were investigated but there are no viable alternatives to upgrading this line rating via rebuild.

Total Estimated Transmission Cost: \$34.54M

Required IS Date: 6/1/2019

Projected IS Date: 6/1/2020

Project Status: Engineering



TO Planning Criteria Violation(Previously Presented: 1/11/2019 SRTEP)

Problem Statement:

In the 2022 PJM Winter RTEP, a TO Criteria violation was identified due to exceeding the thermal emergency rating (106% of the 66 MVA thermal emergency rating) on Chemical transformer #2 under a N-1-1 contingency condition involving the loss of the Chemical transformer #6 (which includes the loss of XFR #4, Chemical – Turner 138 kV line and Chemical – Ortin 138 kV, due to the loss of 138 kV bus #1) paired with the loss of the Capitol Hill – Chemical 138 kV line (which includes the loss of XFR #1, due to it's existing configuration on the line).

Potential Solution:

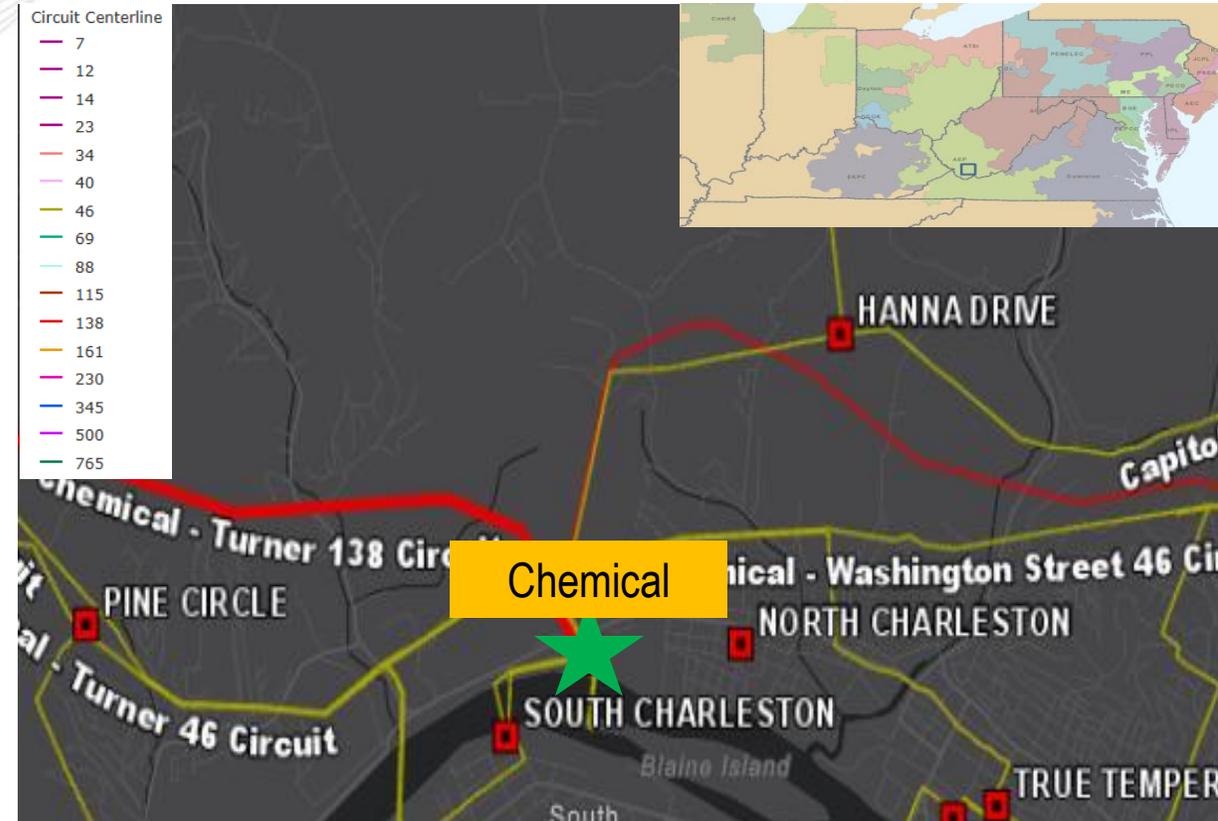
Replace 138kV MOAB switch “YY” with a new 138kV circuit switcher on the high side of Chemical XFR #6. (B3100)

Estimated Transmission Cost: \$0.7M

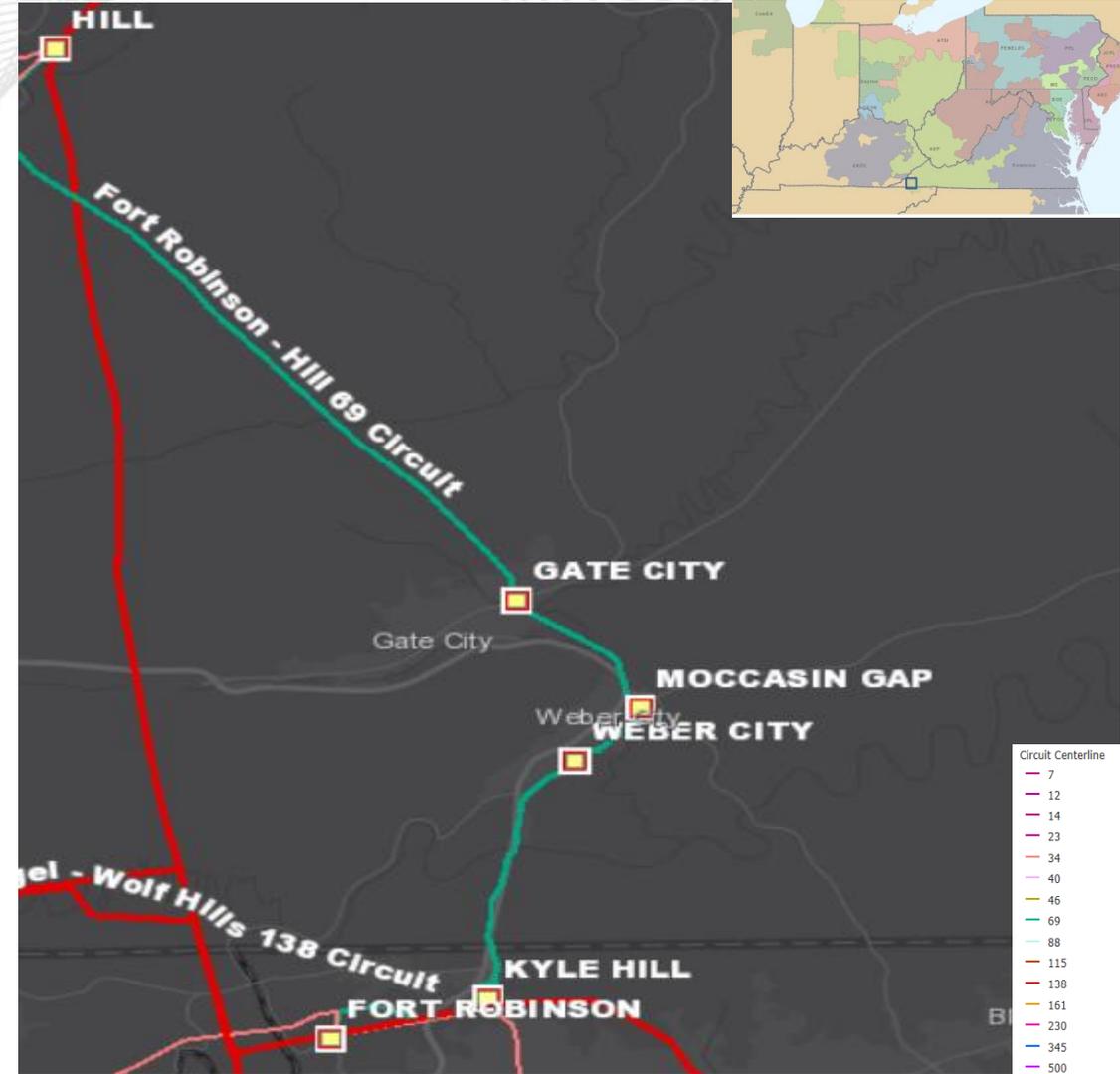
Required In-service: 12/1/2022

Projected In-service: 12/1/2022

Project Status: Scoping



Fort Robinson – Moccasin Gap 69 kV Line Section Replacements



TO Planning Criteria Violation(Previously Presented: 1/11/2019 SRRTEP)

Problem Statement:

The Fort Robinson – Moccasin Gap 69 kV line section (~5 miles) will load to 105% (2023 RTEP) of its winter emergency rating (48 MVA) for the loss of the Hill – Gate City 69 kV line section.

The line will also overload for loss of the Hill 138/69/34.5 kV transformer or the Clinch River – Nagel 138 kV circuit

Selected Solution:

Rebuild the 1/0 Cu. conductor sections (~1.5 miles) of the Fort Robinson - Moccasin Gap 69 kV line section (~5 miles) utilizing 556 ACSR conductor and upgrade existing relay trip limit (WN/WE: 63 MVA , line limited by remaining conductor sections). (B3101)

Estimated Cost: \$3.0 M

Required IS Date: 12/1/2023

Projected In-service: 9/1/2022

Project Status: Scoping

TO Planning Criteria Violation (Previously Presented: 1/11/2019 SR RTEP)

Problem Statement:

The existing Fremont 138/69 kV transformers #1 and #2 (both 1957 vintage) will overload to ~120% (2022 RTEP) of their winter emergency rating (70 MVA) for loss of the Garden Creek – Clinch River 138 kV circuit paired with a loss of one of the aforementioned 138/69 kV transformers at Fremont.

The existing Fremont 138/69 kV transformers #1 and #2 (both 1957 vintage) will overload to ~111% (2022 RTEP) of their winter emergency rating (70 MVA) for loss of the Clinchfield 138/69 kV transformer paired with a loss of one of the aforementioned 138/69 kV transformers at Fremont.

Selected Solution:

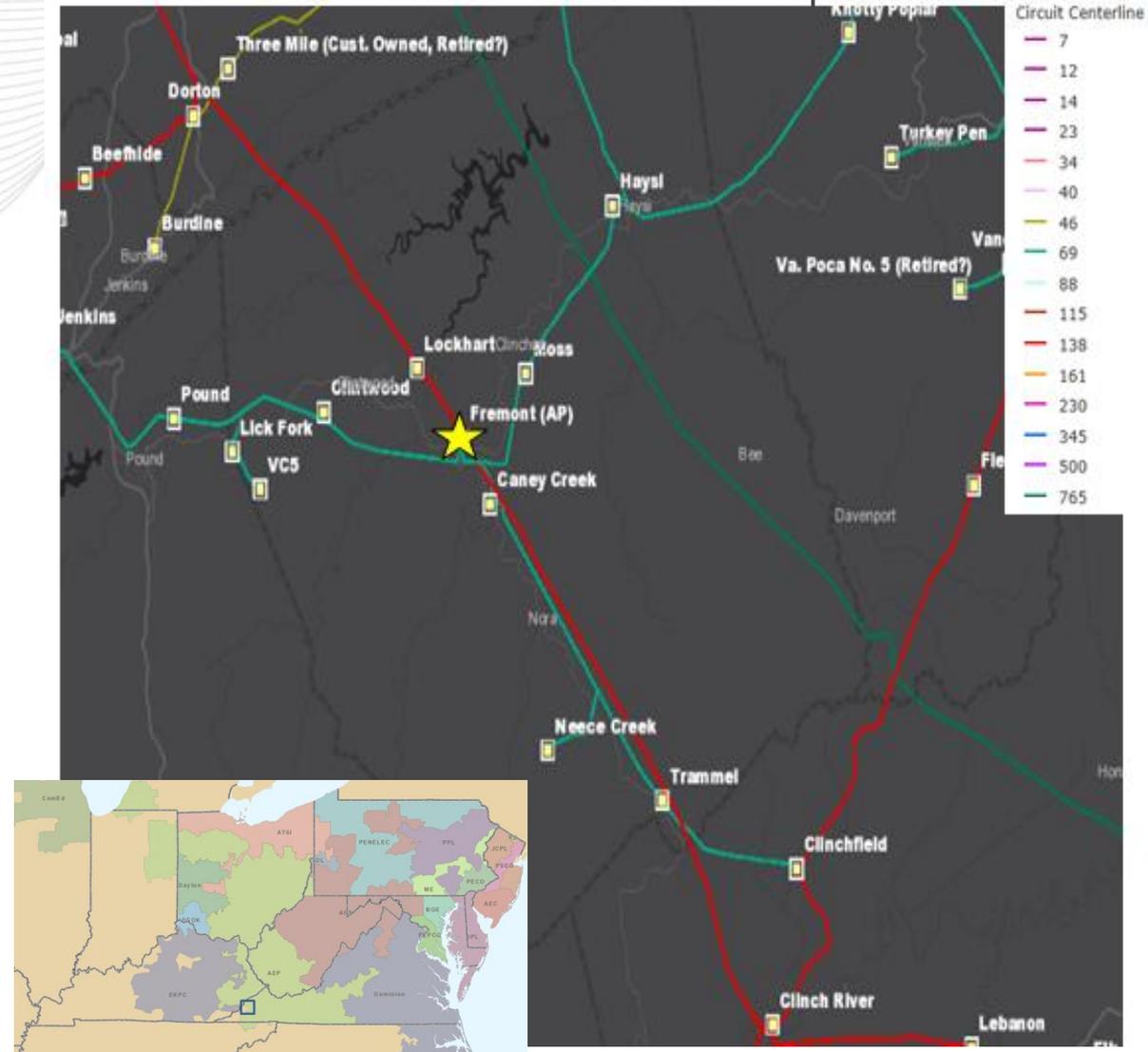
Replace existing 50 MVA 138/69 kV transformers #1 and #2 (both 1957 vintage) at Fremont station with new 130 MVA 138/69 kV transformers. **(B3102)**

Estimated Cost: \$4.1 M

Required In-service: 12/1/2022

Projected In-service: 12/1/2020

Project Status: Scoping



TO Planning Criteria Violation (Previously Presented: 1/11/2019 SR RTEP)

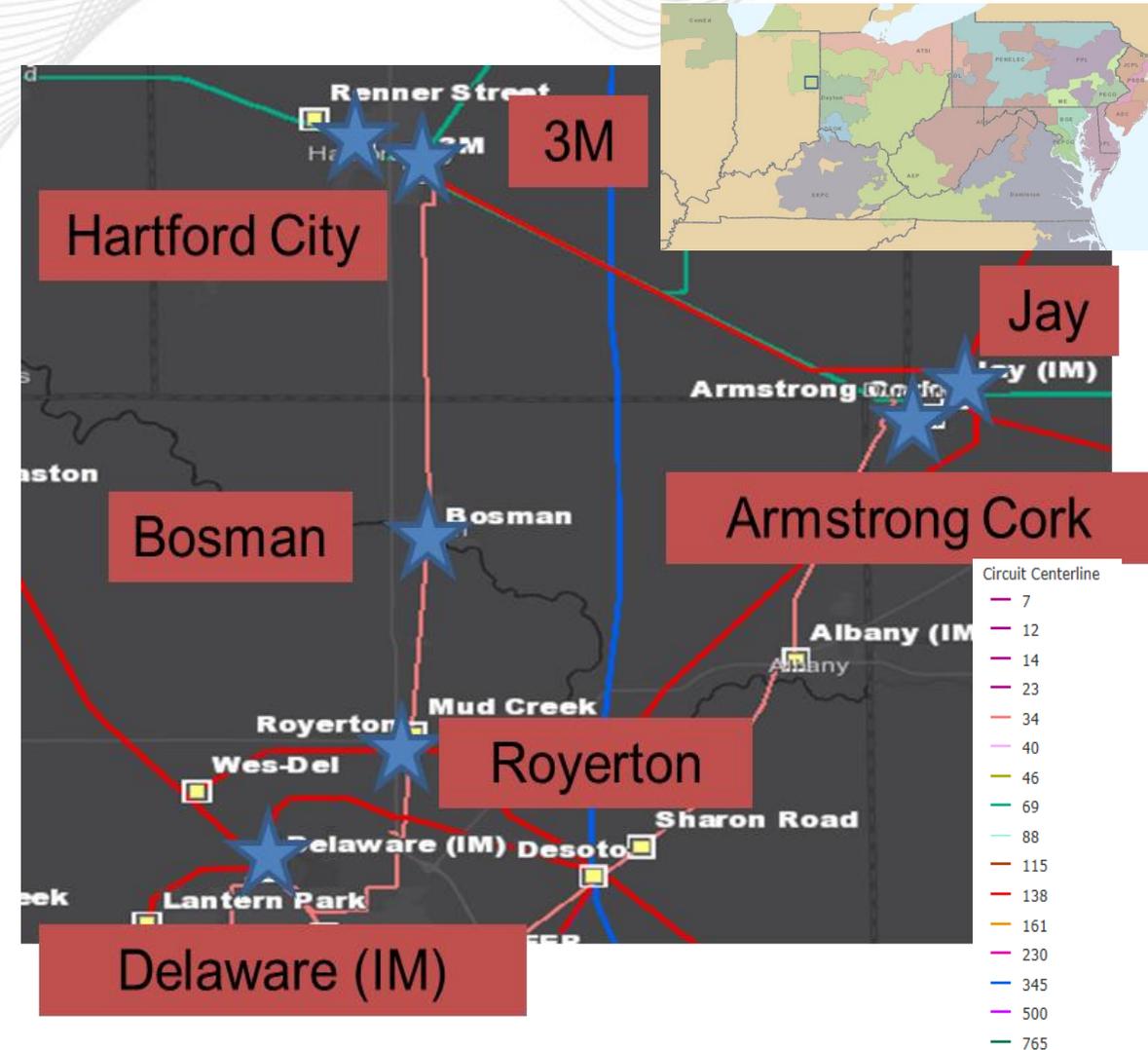
Problem Statement

The following overloads were identified in the 2022 and 2023 RTEP Summer case with corrected Armstrong Cork load model (about 10MW more).

For loss of the Jay and Deer Creek 138/69/34.5kV banks, the following overloads occur.

- Delaware – Bosman 34.5kV: 147% overload of the 23MVA 3/0 CU conductor and 125% overload of the 27MVA 4/0 CU conductor
- Bosman – Hartford 34.5kV: 105% overload of the 23MVA 3/0 CU conductor.
- Upon loss of Deer Creek 138/69/34.5kV transformer and Bosman – Delaware 34.5kV line, the following overloads occur:
 - Armstrong Cork – Fulkerson 69kV line overloads 113% past it's 46MVA 3/0 CU and 103% past its 50MVA 4/0 ACSR ratings.
 - Fulkerson – 3M 104% past its 46MVA 3/0 CU rating
- This issue has been verified by the high amount of PCLLRW's in the area. This area has received PCLLRW's on 2/26/2018 (2 different instances this day due to Deer Creek 138/69/34.5kV transformer being out.), 2/6/2018, 1/9/2018, 7/24/17, 7/14/17 for loss of Jay transformer with several of these PCLLRW's lasting multiple days.

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Selected Solution :

Royerton : Install a 138/69kV transformer. Install a 69kV bus with one 69kV breaker toward Bosman station. Rebuild the 138kV portion into a ring bus configuration built for future breaker and a half with 4 138kV breakers **(B3103.1) Estimated Trans Cost: \$10.251M**

Bosman/Strawboard: Rebuild this station in the clear across the road to move it out of the flood plain and bring it up to 69kV standards. **(B3103.2) Estimated Trans Cost: \$4.474M**

Delaware: Retire Breaker L and re-purpose M for the Jay line. **(B3103.3) Estimated Trans Cost: \$0.176M**

Hartford City: Retire all 34.5kV equipment. Re-purpose breaker M for the Bosman line 69kV exit. **(B3103.4) Estimated Trans Cost: \$0.875 M**

Jay: Rebuild the 138kV portion of this station as a 6 breaker, breaker and a half station re-using the existing breakers “A”, “B” and “G”. Rebuild the 69kV portion of this station as a 6 breaker ring bus re-using the 2 existing 69kV breakers. Install a new 138/69kV transformer. **(B3103.5) Estimated Trans Cost: \$18.732 M**

Hartford City – Jay: Rebuild the 69kV Hartford City – Armstrong Cork line but instead of terminating it into Armstrong Cork, terminate it into Jay station. **(B3103.6) Estimated Trans Cost: \$21.12M**

Armstrong Cork – Jay #2: Build a new 69kV line from Armstrong Cork – Jay station. **(B3103.7) Estimated Trans Cost: \$2.347M**

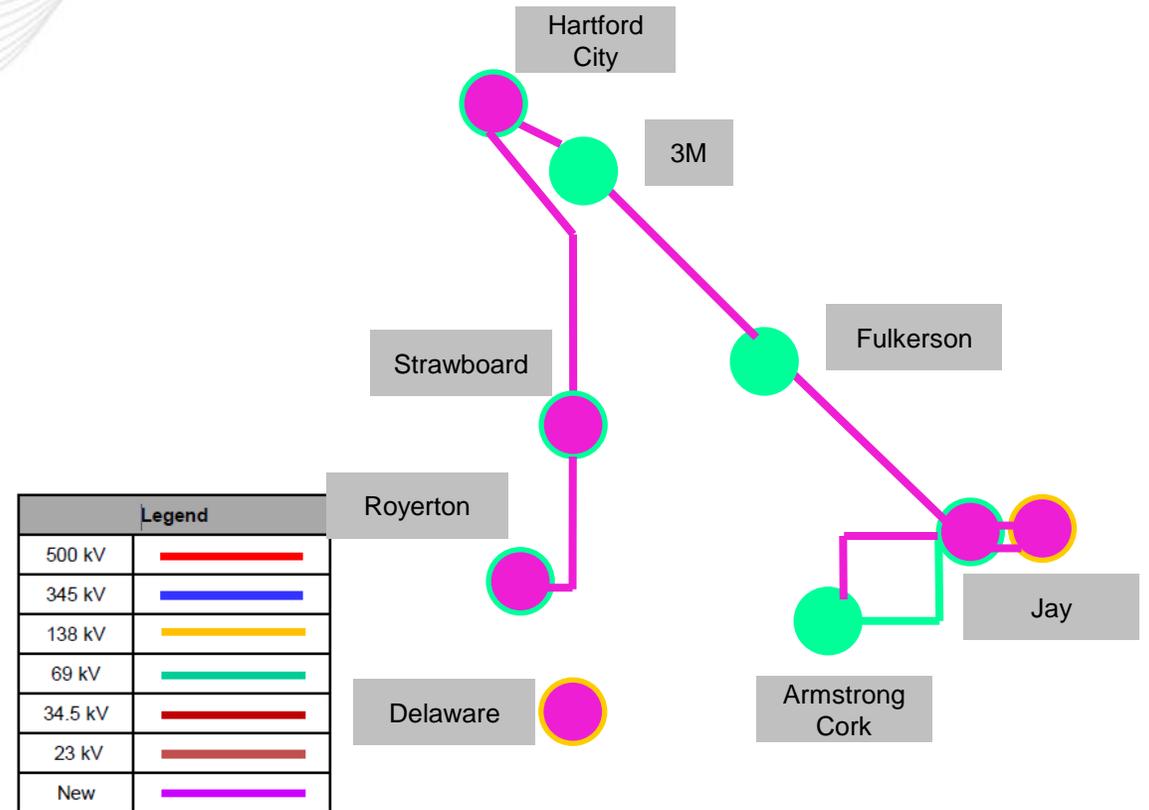
Delaware – Bosman: Rebuild the 34.5kV Delaware – Bosman line as the 69kV Royerton – Strawboard line. Retire from Royerton – Delaware station. **(B3103.8) Estimated Trans Cost: \$12.78 M**

Total Estimated Transmission Cost: \$70.75M

Required IS Date: 6/1/2022

Projected IS Date: 6/1/2022

Project Status: Scoping



TO Planning Criteria Violation (Previously Presented: 1/11/2019 SR RTEP)

Problem Statement:

In the 2022 PJM Summer Case, TO criteria thermal violations exist in the Kingsport 34.5 kV sub-transmission network for the outage of the 138/34.5 kV transformer #5 at Holston paired with the loss of the Nagel – Reedy Creek 138 kV circuit:

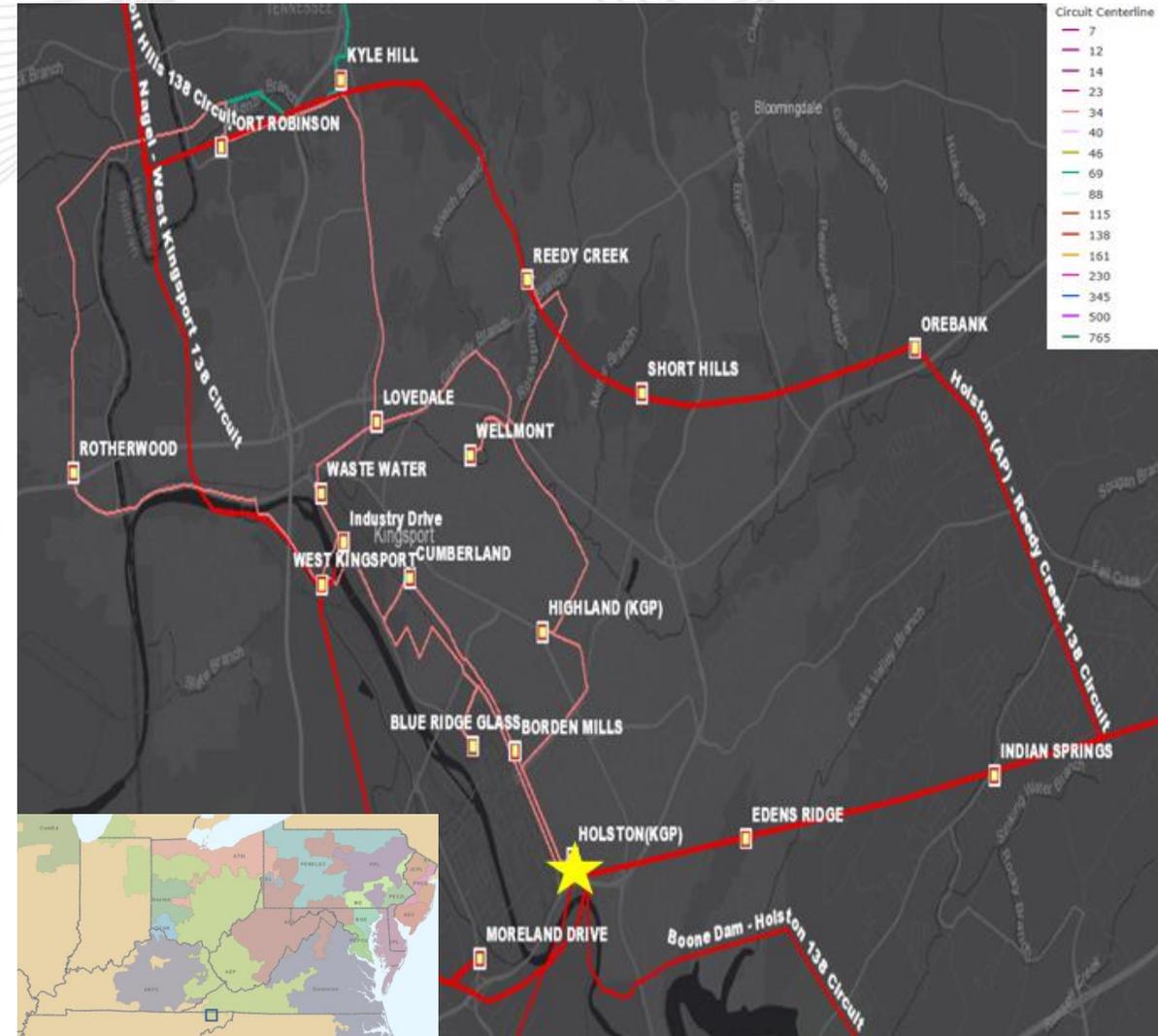
- The Holston – Highland 34.5 kV line section (~2.5 mi.) will load to 130% of its summer emergency rating (27 MVA).
- The Lovedale – Arbutus S.S. 34.5 kV line section (~1.8 mi.) will load to 154% of its summer emergency rating (35 MVA).
- The Lovedale – Waste Water 34.5 kV line section (~1.0 mi.) will load to 115% of its summer emergency rating (30 MVA).
- The Lovedale – Kyle Hills Sw. 34.5 kV line section (~2.2 mi.) will load to 106% of its summer emergency rating (35 MVA).
- The Reedy Creek – Arbutus S.S. 34.5 kV line section (~1.6 mi.) will load to 177% of its summer emergency rating (37 MVA).
- The West Kingsport – Waste Water 34.5 kV line section (~ 0.7mi.) will load to 116% of its summer emergency rating (30 MVA).
- The West Kingsport 138/34.5 kV transformer #1 will load to 106% of its summer emergency rating (60 MVA).
- The Reedy Creek 138/69/34.5 kV transformer #1 will load to 106% of its summer emergency rating (39 MVA).

Voltage Magnitude issues are also observed for the same contingency pair at the following stations in the area: Orebank (0.63 pu), Short Hills (0.63 pu), and Reedy Creek 69 kV (0.71 pu)

Voltage Deviation issues are also observed for the same contingency pair at the following stations in the area: Orebank (44%), Short Hills (44%), Reedy Creek 69 kV (40%), Highland (13%), Wellmont (16%), Lovedale (11%), and Waste Water (10%)

The contingency pair listed above resulted in a non-convergence scenario within the 2022 Winter Case.

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Selected Solution:

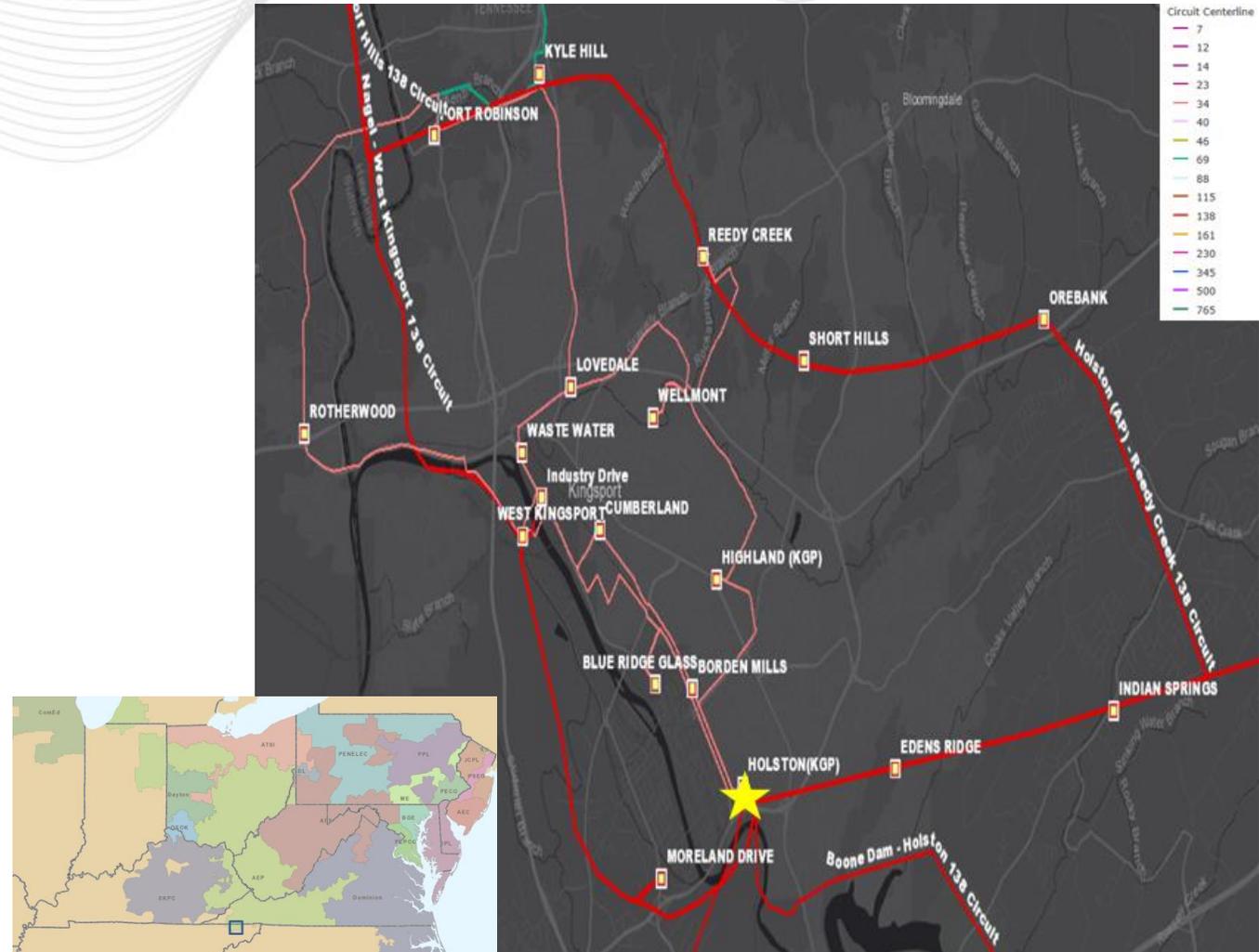
Install a 138 kV 3000A 40 kA circuit switcher on the high side of the existing 138/34.5 kV transformer #5 at Holston station. (B3099)

Estimated Cost: \$0.7 M

Required In-service: 6/1/2022

Projected In-service: 6/1/2022

Project Status: Scoping



Previously Presented on 2/20/2019 SR RTEP

TO Criteria Violation

Problem Statement:

Instability at TSS 946 University Park E.C. for a 3-phase-to-ground fault at the 80% of 138kV line L6603 from E. Frankfort 138kV blue bus w/ delayed clearing at E. Frankfort 138kV blue bus.

Selected Solution:

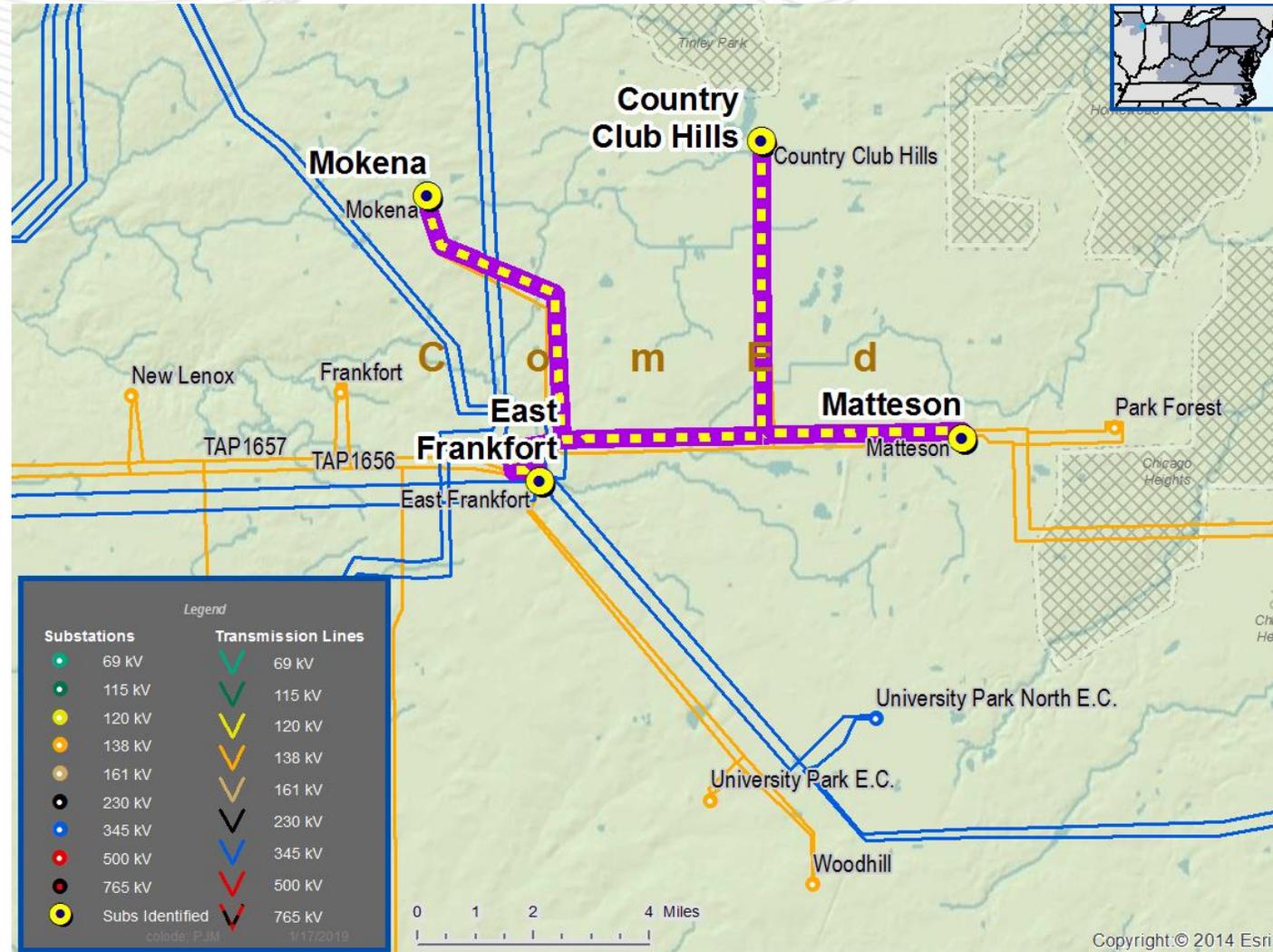
Installing high-speed backup clearing scheme on the E. Frankfort – Matteson 138kV line (L6603) **(B3111)**

Estimated Project Cost : \$0.5M

Required IS Date: 6/1/2020

Projected IS date: 6/1/2020

Status: Planning

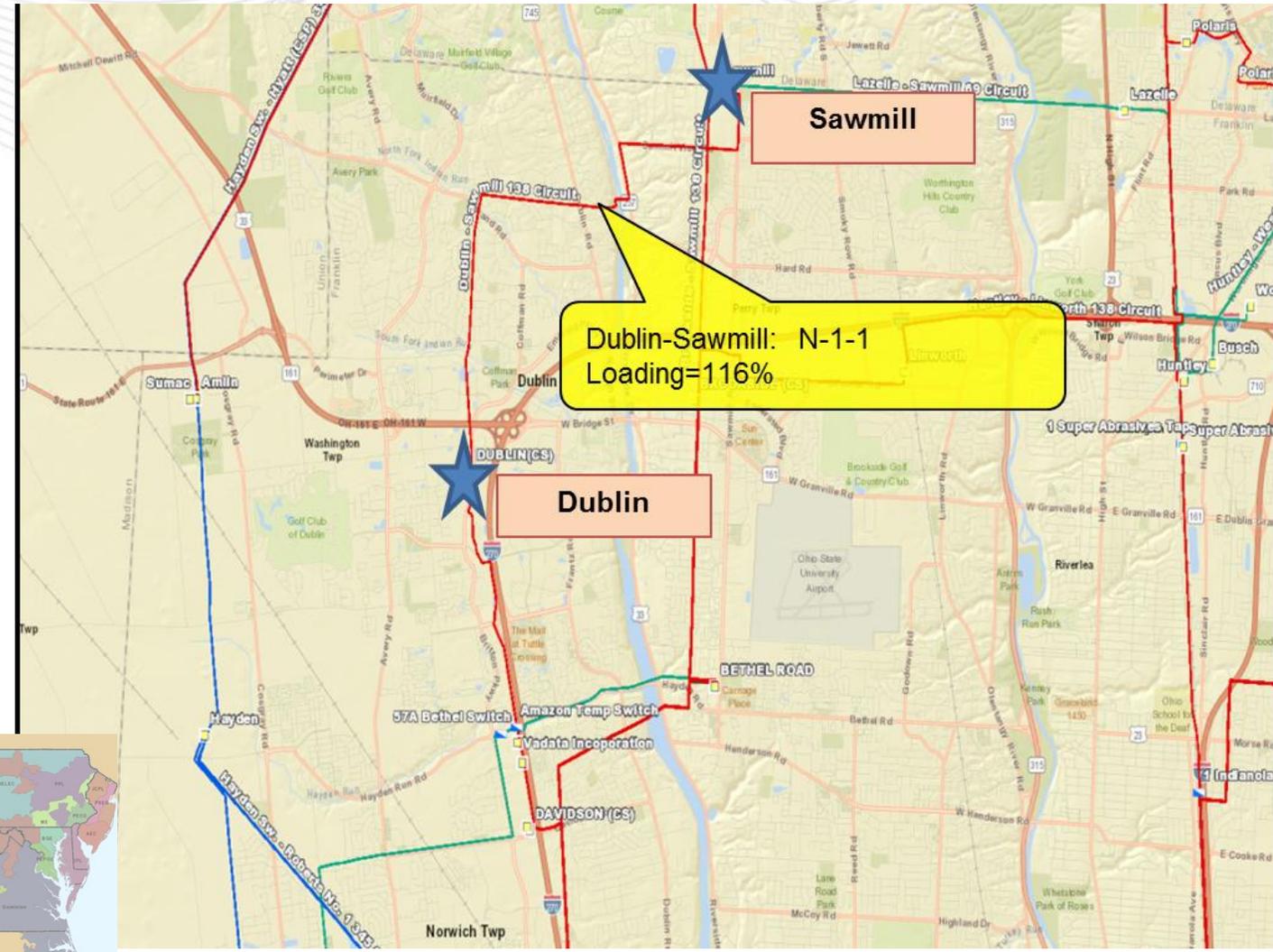


Previously Presented on 2/20/2019 SRRTEP TO Criteria Violation

Problem Statement:

Due to load increase in the area (Jug Street, Sumac, and Britton), the Dublin-Sawmill 138 kV circuit will be overloaded to 116% under N-1-1 conditions involving the loss of Bethel-Davidson 138 kV & Davidson-Roberts 138 kV circuits starting in 2022.

Additionally, AEP-Ohio has requested a third 138 kV source to Dublin station to maintain acceptable reliability levels for the load at risk. Dublin Station serves 75 MVA of peak demand with minimal load transfer capability. Dublin station serves some critical loads.



Selected Solution:

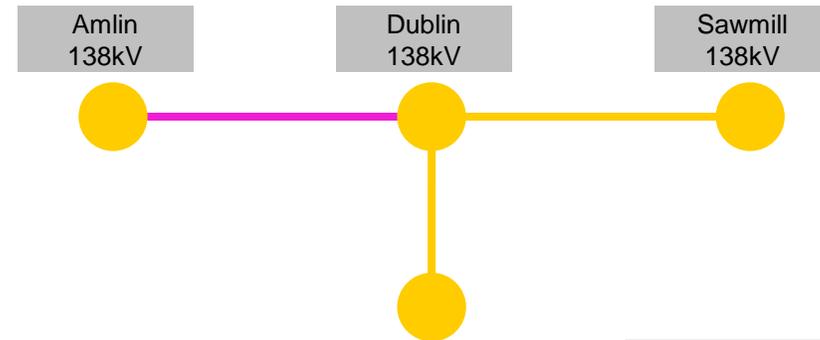
Construct a single circuit 138 kV line (~3.5 miles) from Amlin to Dublin using 1033 ACSR Curlew (296 MVA SN), convert Dublin Station into a ring configuration, and re-terminating the Britton UG cable to Dublin Station. **(B3112)**

Total Estimated Transmission Cost: \$39.29M

Required IS Date: 6/1/2022

Projected IS Date: 6/1/2020

Project Status: Scoping/Engineering



Legend	
500 kV	
345 kV	
138 kV	
69 kV	
34.5 kV	
23 kV	
New	

B2761.1 – Scope Clarification /Cost Update

Previously Presented: 10/6/2016 SRRTEP

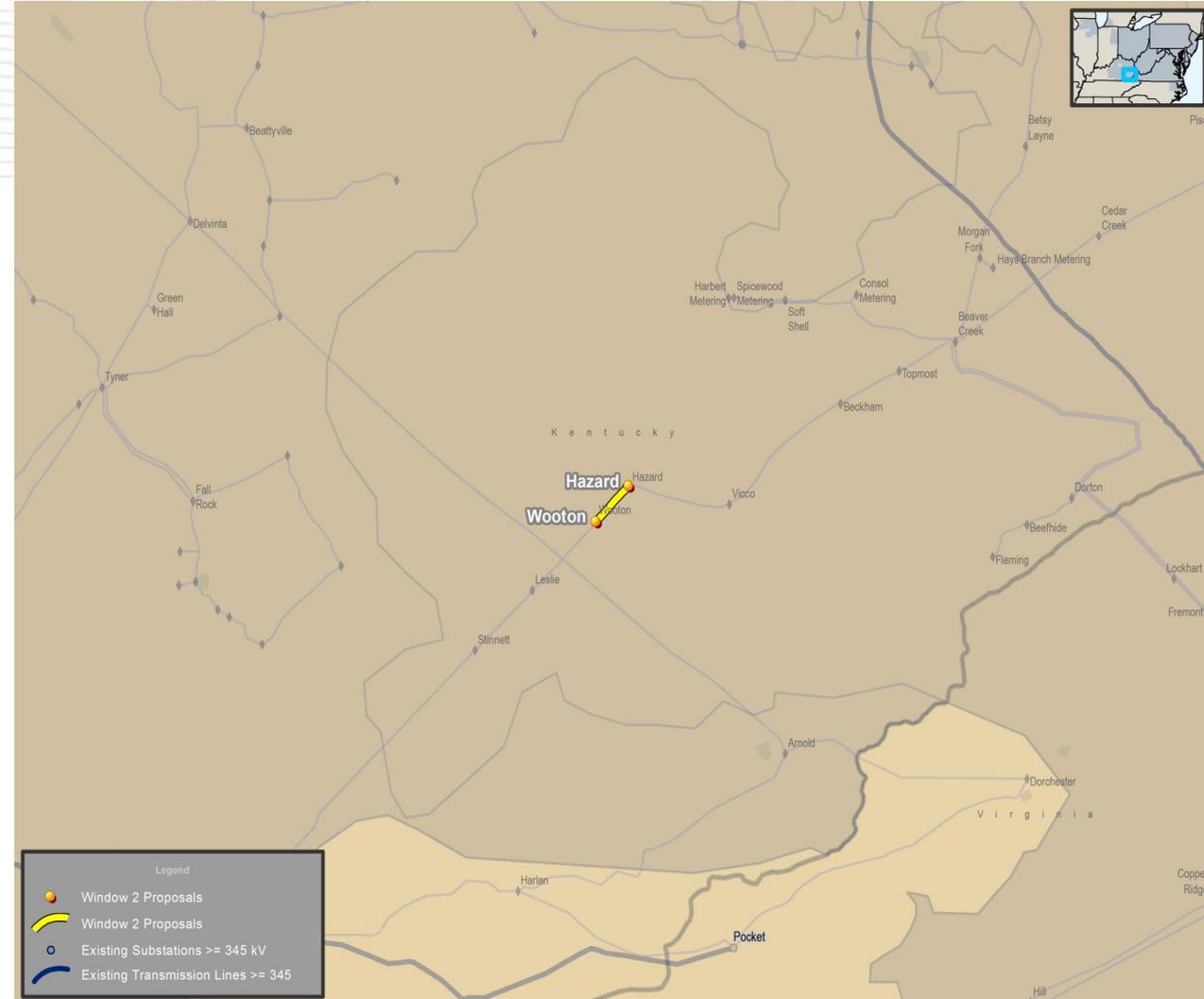
Original Scope Description: Replace the Hazard 161/138 kV Transformer

Original Estimated Cost: \$2.3 M

New Scope Description: Replace **and relocate** the Hazard 161/138 kV Transformer **and circuit breaker ‘M’**. Upgrade protection scheme on the new Transformer including installation of low side breaker.

New Estimated Cost: \$ 3.8 M

Required IS Date: 6/1/2021



B2761.3 –Scope Clarification/Cost Update
Previously Presented: 9/11/2017 SR RTEP

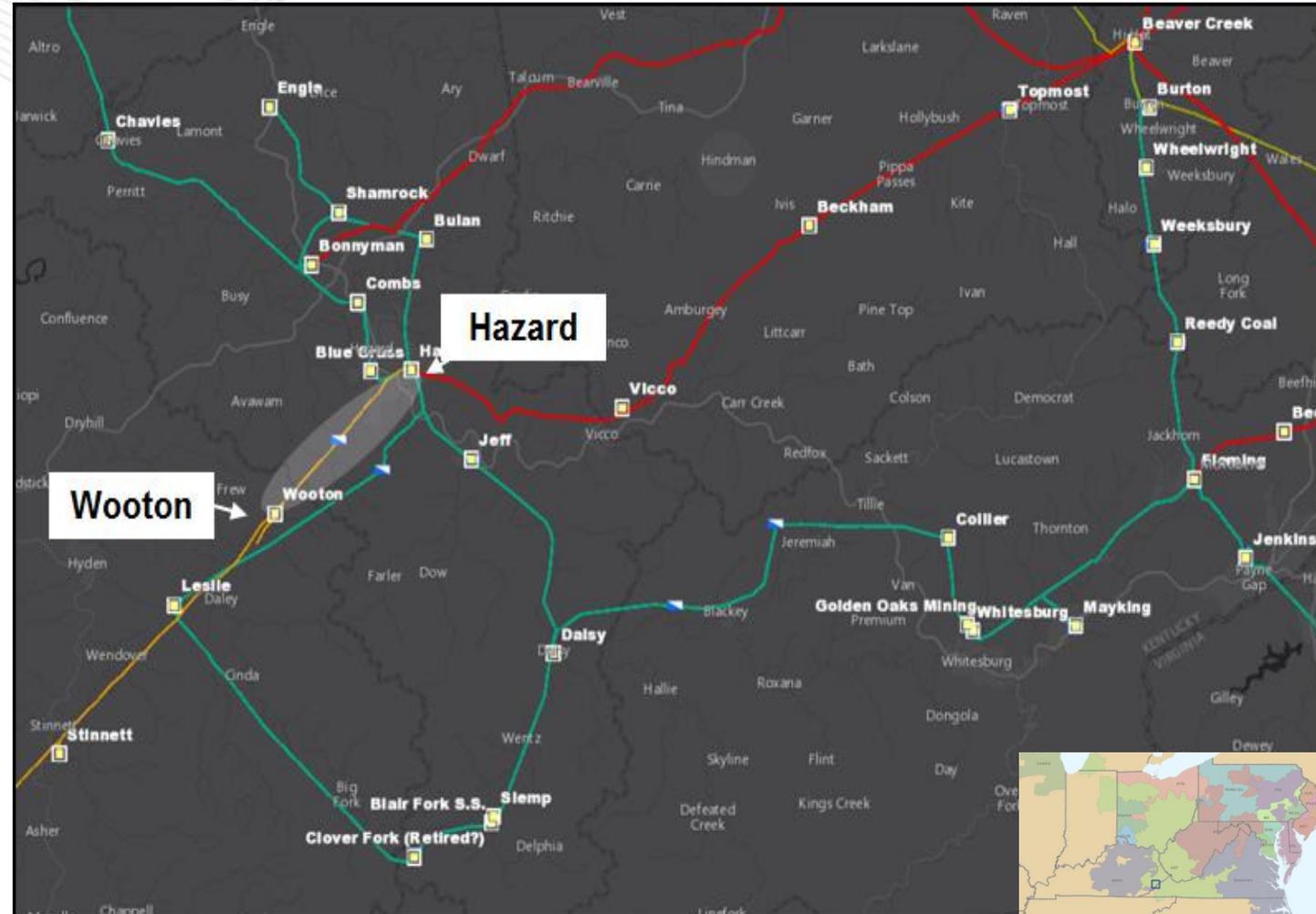
Original Scope Description: Rebuild the Hazard – Wooton 161 kV line utilizing 795 26/7 ACSR conductor (300 MVA rating).

Original Estimated Cost: \$16.48 M

New Scope Description: Rebuild the Hazard – Wooton 161 kV line utilizing 795 26/7 ACSR conductor (300 MVA rating). **Replace line relaying and associated termination equipment .**

New Estimated Cost: \$16.8 M

Required In-service: 6/1/2021



Previously Presented on 2/20/2019 SRRTEP

TO Criteria Violation (FERC 715 (TO Criteria) Exclusion)

Problem Statement:

In the 2022 PJM Winter RTEP, TO Criteria violation due to exceeding thermal emergency rating (105% of the 35 MVA thermal emergency rating) on Mullens 138/46 kV transformer #4 under N-1-1 contingency condition involving the loss of the Bradley – Jehu Branch 138 kV line plus the loss of the Tams Mountain – Mullens 138 kV line.

Selected Solution:

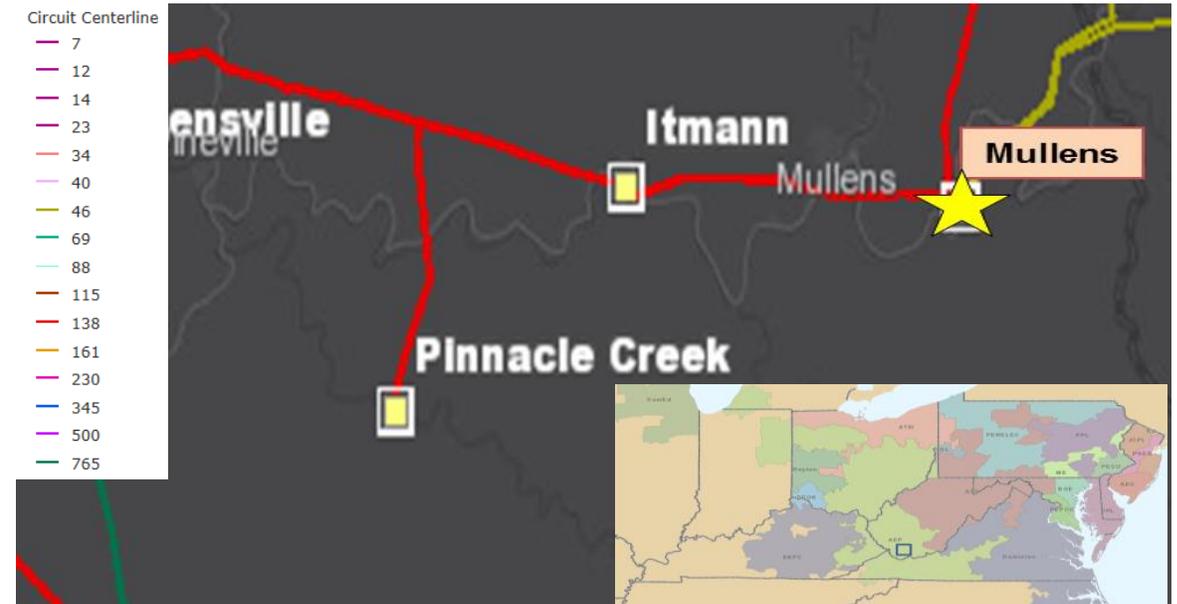
Replace existing Mullens 138/46kV 30 MVA transformer #4 and associated protective equipment with a new 138/46 kV 90 MVA transformer and associated protective equipment. (b3116)

Total Estimated Transmission Cost: \$3.0M

Required In-service Date: 12/1/2022

Projected In-service Date: 6/1/2022

Project Status: Scoping



Previously Presented on 2/20/2019 SRRTEP

TO Criteria Violation (FERC 715 (TO Criteria) Exclusion)

Problem Statement:

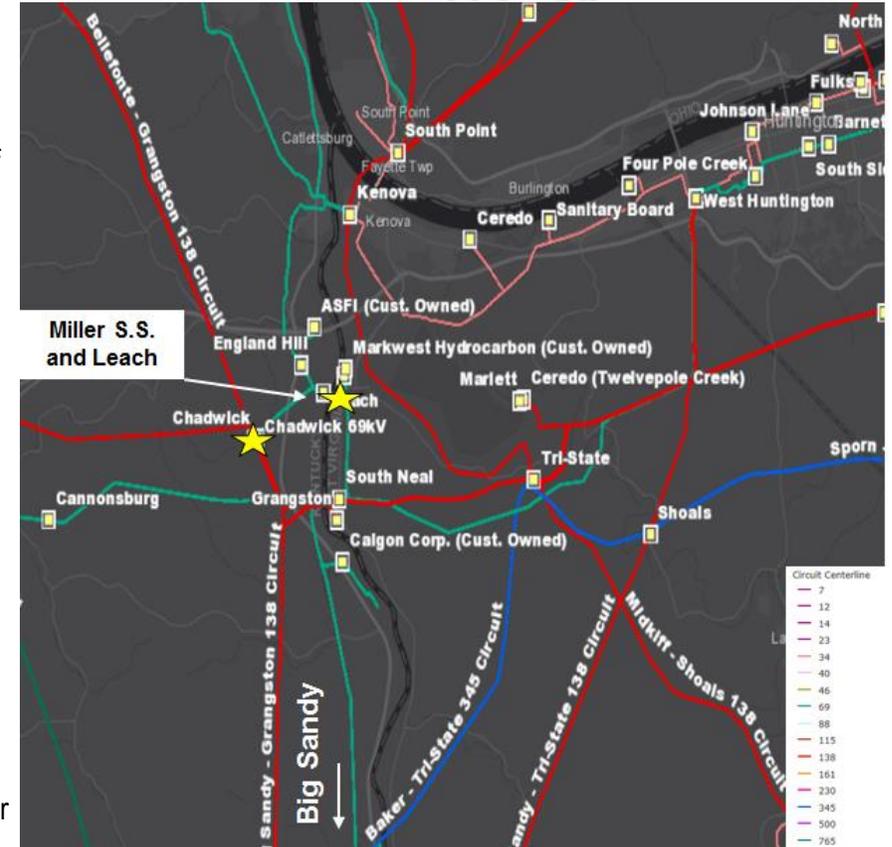
In the 2022 PJM Summer RTEP case, both thermal and voltage TO criteria violations were identified.

- The Leach – Miller S.S 69 kV line section (~0.5 mi.) will load to 113% of its summer emergency rating (75 MVA) for loss of the Big Sandy 138/69 kV transformer and Tri-State – West Huntington 138 kV circuit.
- For the loss of the 138/69 kV transformers at Chadwick and Kenova:
 - The Leach – Miller S.S 69 kV line section (~0.5 mi.) will load to 219% of its summer emergency rating (75 MVA) (127% of its largest conductor).
 - The South Neal – Miller S.S 69 kV line section (~1.5 mi.) will load to 205% of its summer emergency rating (82 MVA) (113% of its largest conductor).
 - The South Neal – West Huntington 69 kV line (~9.3 mi.) will load to 136% of its summer emergency rating (75 MVA) (100% of its largest conductor).
 - Voltage Magnitude issues at: South Neal (.91pu), Miller S.S. (.89pu), Leach (.89pu), England Hill (.88 pu), and ASFI (.88pu)
 - Voltage Deviation issues at: South Neal (8%), Miller S.S. (9%), Leach (9%), England Hill (10%), and ASFI (10%)
- Similar issues are observed for loss of the Chadwick 138/69 kV transformer followed by the loss of the Kenova – England Hill 69 kV or Tri State – South Point 138 kV circuits.

Additionally, high loading observed for the following circuits:

- The Big Sandy – Inco Burnaugh 69 kV line section (~6.6 mi.) will load to 99% of its summer emergency rating (102 MVA) (99% of its largest conductor).
- The Chadwick – England Hill 69 kV circuit loads to 97% of its summer emergency rating (148 MVA) of its largest conductor for the loss of the Kenova – England Hill 69 kV and Chadwick – Leach 69 kV circuits.
- The South Neal – Miller S.S 69 kV line section (~1.5 mi.) will load to 99.5% of its summer emergency rating (82 MVA) for loss of the Big Sandy 138/69 kV transformer and Tri-State – West Huntington 138 kV circuit.
- The Chadwick – Leach 69 kV circuit loads to 99.6% of its summer emergency rating (148 MVA) of its largest conductor for the loss of the Kenova – England Hill 69 kV and Chadwick – England Hill 69 kV circuits.

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Selected Solution:

Chadwick station: Expand existing Chadwick station and install a second 138/69 kV transformer at a new 138 kV bus tied into the Bellefonte – Grangston 138 kV circuit. The 69 kV bus will be reconfigured into a ring bus arrangement to tie the new transformer into the existing 69 kV via installation of four 3000A 63 kA 69 kV circuit breakers. (b3118.1)

Estimated Conceptual Trans. Cost: \$9.3M

Grangston Station: Remote end will be required at Grangston station. (b3118.2)

Estimated Conceptual Trans. Cost: \$0.5M

Bellefonte Station: Remote end will be required at Bellefonte station. (b3118.3)

Estimated Conceptual Trans. Cost: \$0.5M

Chadwick – Leach 69 kV: Relocate the Chadwick – Leach 69 kV circuit within Chadwick station. (b3118.4)

Estimated Conceptual Trans. Cost: \$0.5M

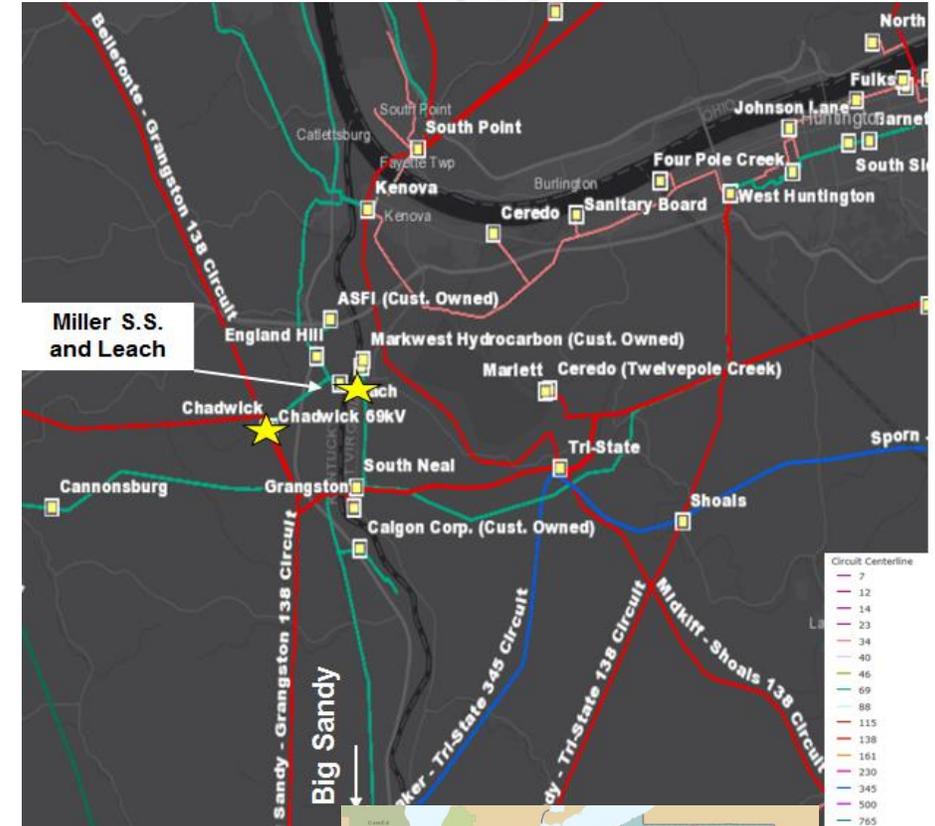
Bellefonte Grangston 138 kV circuit: The Bellefonte – Grangston 138 kV circuit currently spans over top of Chadwick station, but does not terminate. Work will be completed to bring the circuit into Chadwick station at the newly established 138 kV bus. (b3118.5)

Estimated Conceptual Trans. Cost: \$1.1M

Chadwick – Tri-State #2 138 kV circuit: The existing Chadwick – Tri-State #2 138 kV circuit will be reconfigured within the station to terminate into the newly established 138 kV bus #2 at Chadwick due to constructability aspects. (b3118.6)

Estimated Conceptual Trans. Cost: \$0.1M

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Chadwick – Leach and Chadwick – England Hill 69 kV circuits (share same structures for majority of circuits):

Reconductor circuits with 795 ACSS conductor. A LIDAR survey and a sag study will need to be performed to confirm that the reconducted circuits would maintain acceptable clearances. (b3118.7)

Estimated Conceptual Trans. Cost: \$3.3M

South Neal Station:

Replace line risers towards Leach station. Replace 20 kA 69 kV circuit breaker 'F' with a new 3000A 40 kA 69 kV circuit breaker (b3118.8)

Estimated Conceptual Trans. Cost: \$0

Leach – Miller S.S. 69 kV line section:

Rebuild 336 ACSR portion of Leach - Miller S.S 69 kV line section (~0.3 miles) with 795 ACSS conductor. (b3118.9)

Estimated Conceptual Trans. Cost: \$1.5M

Leach Station:

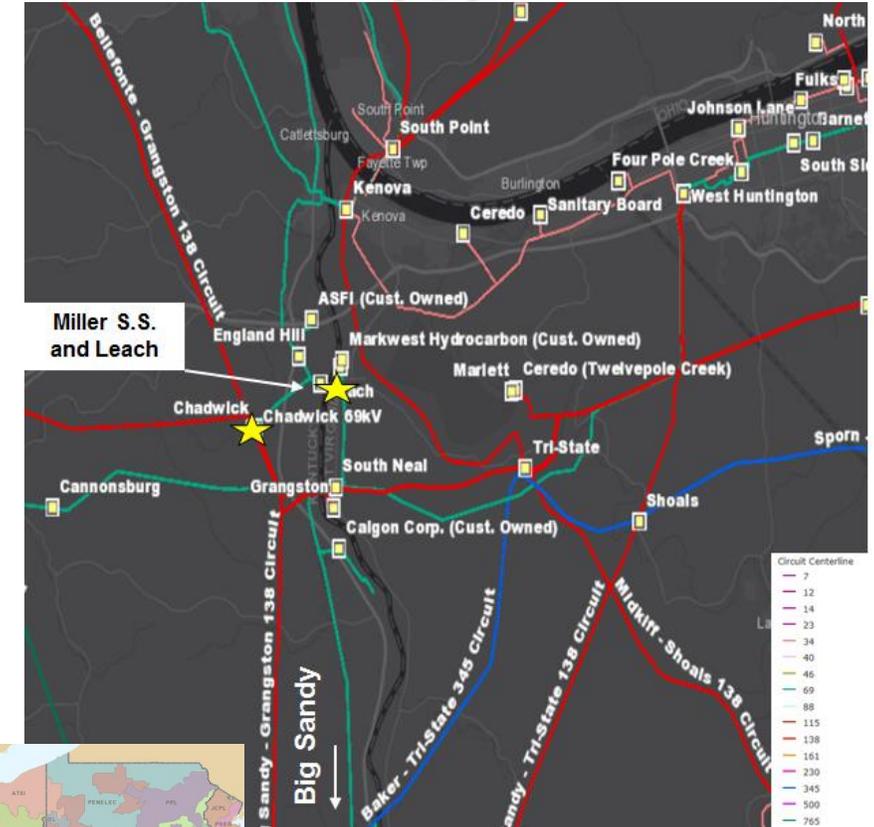
Replace line risers towards Chadwick station. (b3118.10)

Estimated Conceptual Trans. Cost: \$0.1M

Required In Service Date: 6/1/2022

Projected In Service Date: 10/1/2020

Project Status: Scoping



Previously Presented on 2/20/2019 SRRTPEP

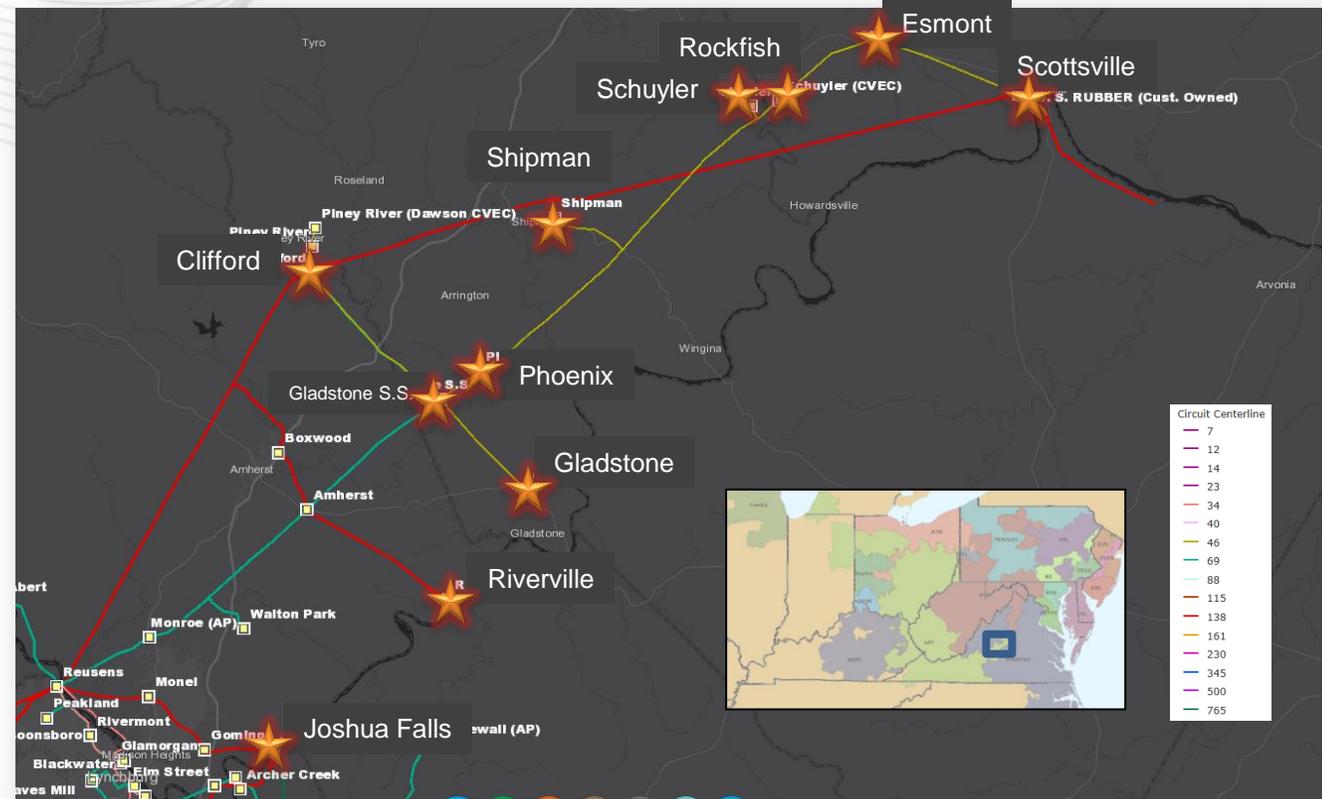
TO Criteria Violation (FERC 715 (TO Criteria) Exclusion)

Problem Statement:

In the 2022 PJM Winter RTEP case, both thermal and voltage T.O. planning criteria violations were identified.

For the loss of both transformers at Scottsville (138/46 kV T#1 & T#2 in parallel and 138/46 kV T#5 or the failure of breaker T) the Clifford 138/69-46 kV T#1 tertiary exceeds its emergency rating of 26 MVA by 229% and the Clifford-Gladstone Tap 46 kV (42 MVA) and Gladstone Tap-Phoenix 46 kV (42 MVA) line sections exceed their emergency ratings by 115% and 100% respectively. In addition, all the 46 kV bus voltages served by the Clifford-Scottsville 46 kV circuit experienced extreme low voltage magnitude and drop violations resulting a voltage collapse scenario. The 46 kV bus voltages violations include Scottsville, Esmont, Rockfish, Schuyler, Shipman, Phoenix, Gladstone, Clifford and Piney River.

Also, for the loss of both transformers at Clifford (138/69-46 kV T#1 and 138/46 kV T#3) the Scottsville 138/46 kV T#5 exceeds its emergency rating of 30 MVA by 187% and the same 46 kV bus voltages served by the Clifford-Scottsville 46 kV circuit experience extreme low voltage magnitude and drop violations resulting in per unit voltages of 0.83 p.u. and below.



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Selected Solution:

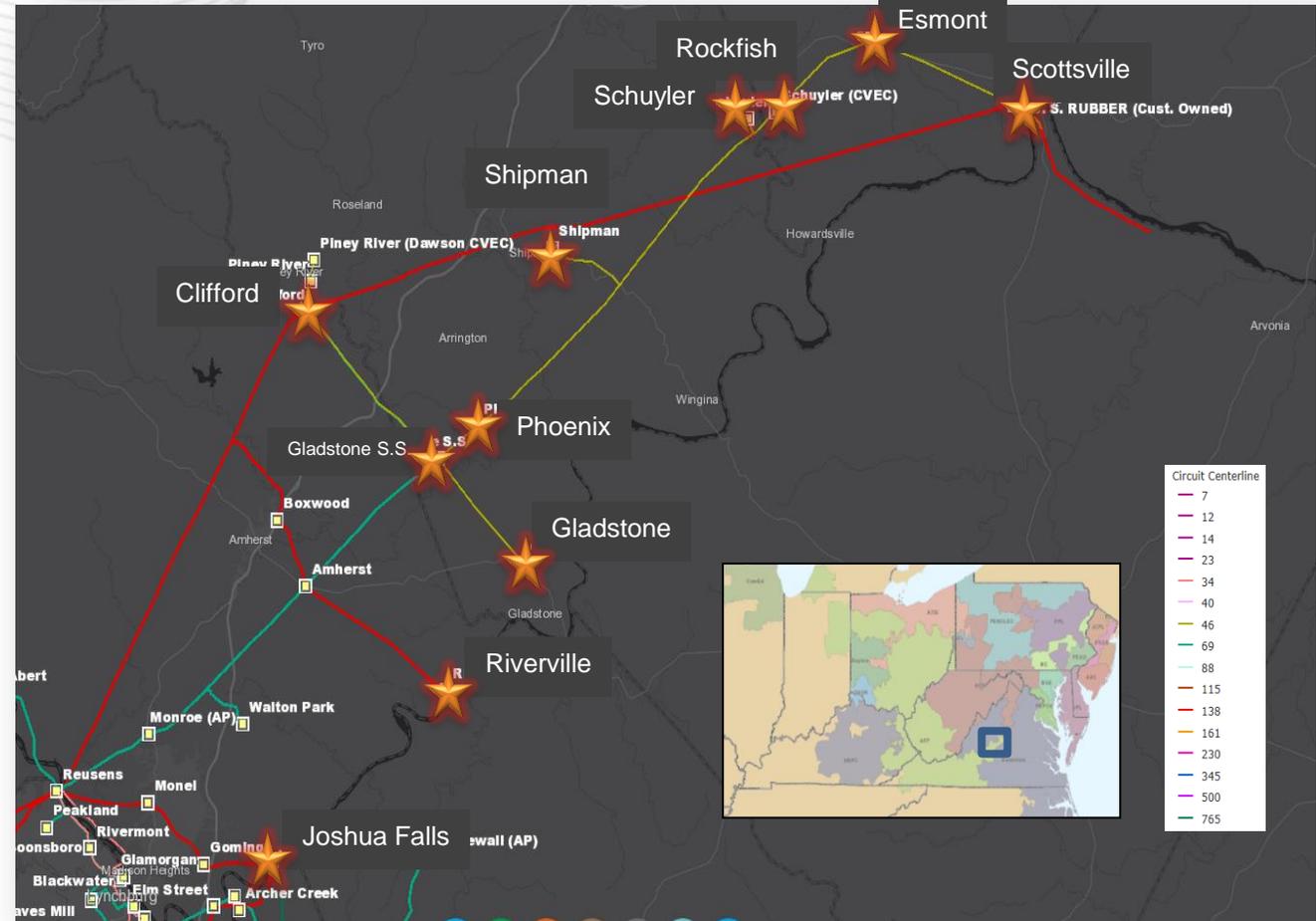
Retire approximately 38 miles of the 44 mile Clifford-Scottsville 46 kV circuit. Build new 138 kV “in and out” to two new Distribution stations to serve the load formerly served by Phoenix, Shipman, Schuyler (AEP), and Rockfish stations. Construct new 138 kV lines from Joshua Falls-Riverville (~10 mi.) and Riverville-Gladstone (~5 mi.). Install required station upgrades at Joshua Falls, Riverville and Gladstone stations to accommodate the new 138 kV circuits. Rebuild Reusen – Monroe (~4 mi.) (b3208)

Total Estimated Transmission Cost: \$85 M

Required In-service Date: 12/1/2022

Projected In-service: 12/1/2022

Project Status: Scoping





AEP Transmission Zone: Baseline Decatur, Indiana

Previously Presented on 4/23/2019 SRTEP
TO Criteria Violation (FERC 715 (TO Criteria) Exclusion)

Problem Statement:

In 2022 and 2023 RTEP cases, the following issues were observed:
Upon loss of Magley – Decatur 69 kV and Lincoln 138/69/34.5 kV XF,
Berne – Monroe 69 kV circuit overloads to 154% of the 50 MVA 4/0
ACSR; Monroe – South Decatur 69 kV circuit overloads to 137% of the 50
MVA 4/0 ACSR.
Additionally, Decatur – Berne 69 kV line is 1966 vintage wood pole line.

Selected Solution:

Rebuild the 10.5 mile Berne – South Decatur 69 kV line using 556 ACSR
in order to alleviate the overload and address a deteriorating asset.
(b3209)

Estimated Transmission Cost: \$16.6 M

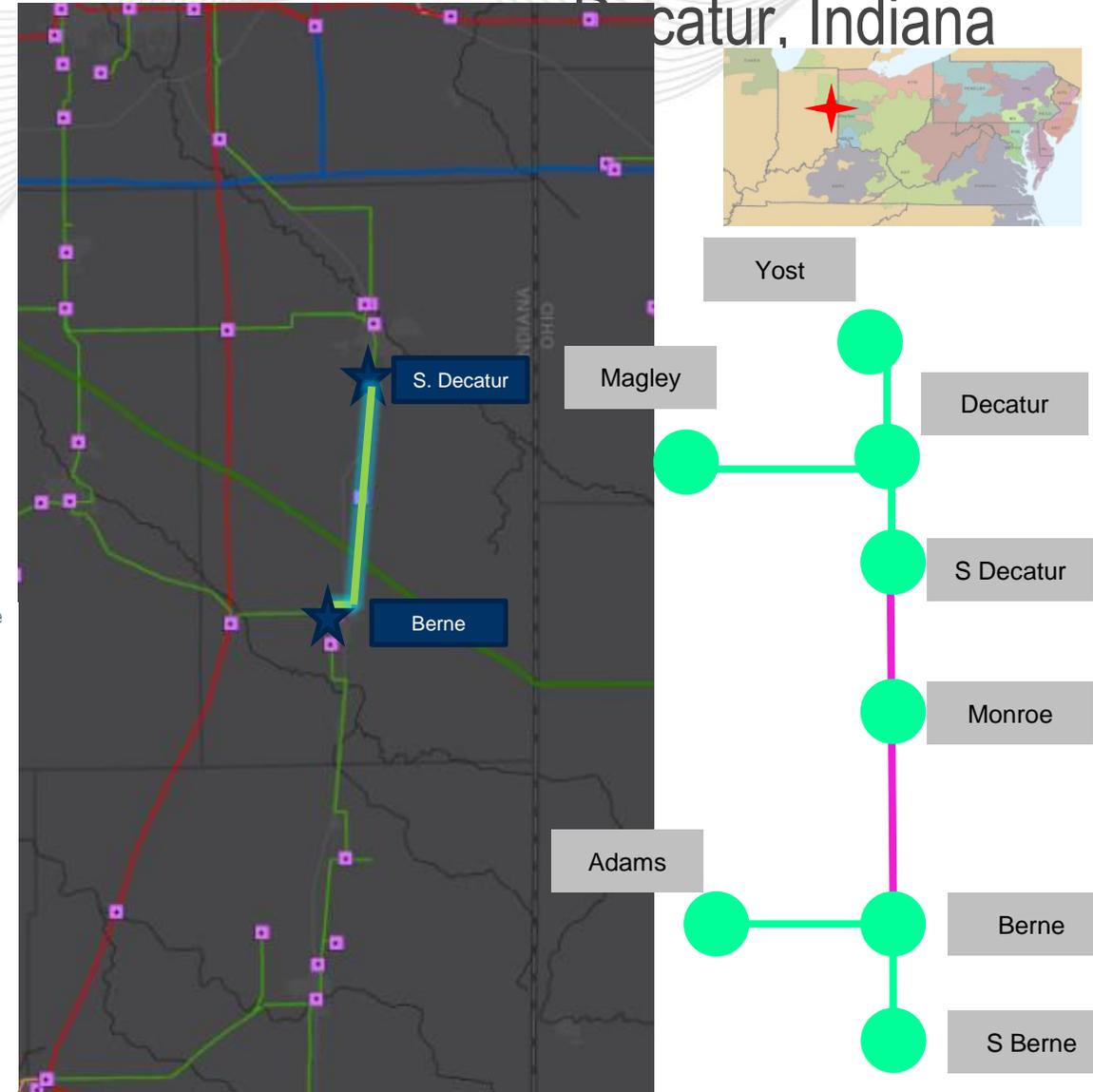
Required IS Date: 6/1/2022

Projected IS Date: 6/1/2022

Project Status: Scoping

Legend	
500 kV	
345 kV	
138 kV	
69 kV	
34.5 kV	
23 kV	
New	

Circuit Centerline	
7	
12	
14	
23	
34	
40	
46	
69	
88	
115	
138	
161	
230	
345	
500	
765	



West Mifflin 138kV Breaker “Z-94”, “Z-74”, “Z-14” and “Z-13” Replacements

Baseline Reliability: Generator Deactivation

*This project inherits the exclusion of its parent project.

Problem Statement: Short Circuit

The West Mifflin 138kV breakers “Z-94”, “Z-74”, “Z-14”, and “Z-13” are overdutied.

Significant Driver:

b3064: Expand Elrama 138 kV substation to loop in the existing USS Steel Clariton - Piney Fork 138 kV line (Generator Deactivation Reinforcement, previously presented on 11/8/2018 TEAC)

Recommended Solution:

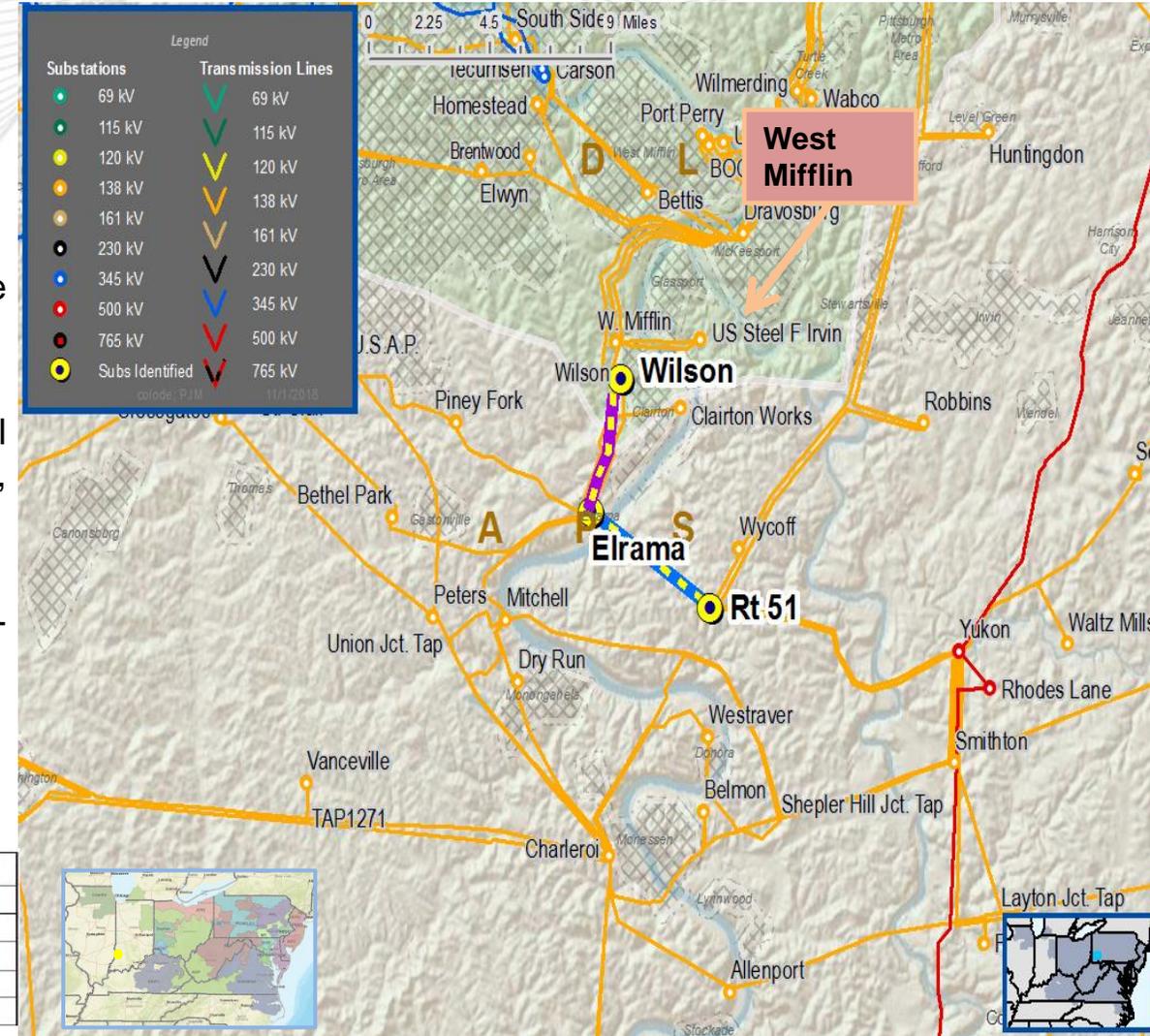
Replace the West Mifflin 138kV breakers “Z-94” (\$0.7M), “Z-74” (\$0.8M), “Z-14” (\$0.8M), and “Z-13” (\$0.8M) with 63kA breakers (**b3064.2**)

Estimated Project Cost: \$3.1 M

Required In-service Date: 6/1/2021

Projected In-service Date: 6/1/2021

Project Status: Conceptual



COLOR	VOLTAGE	TRANSMISSION LINE NUMBER
Green	500 KV.	500 thru 599
Blue	230 KV.	200 thru 299 & 2000 thru 2099
Red	115 KV.	1 thru 199
Orange	138 KV.	AS NOTED
Cyan	69 KV.	AS NOTED



Southern Region



Dominion Transmission Zone: Baseline Line #2008 Partial Rebuild, Line #265 Cut-In & Line #156 Retirement

Recommended Solution: (Continued):

Line #156 from Loudoun to Bull Run (8.44 miles) will be retired. In order to avoid a thermal violation for an N-1-1 contingency, cut and loop 230kV Line #265 (Clifton – Sully) into Bull Run Substation. Add three (3) 230kV breakers at Bull Run to accommodate the new line and upgrade the substation.

Line #2008 will share the same structures as existing Line #2173 which is currently on double circuit structures currently with an empty arm. The structures currently carrying Line #2008 and Line #156 will be retired and removed. Two 230/115kV transformers and a 115kV capbank at Loudoun Substation and a 115kV capbank at Bull Run Substation will also be removed. Additionally, a 230kV line switch from existing Line #295 in Bull Run Substation will also be removed. **(b3110)**

Alternative:

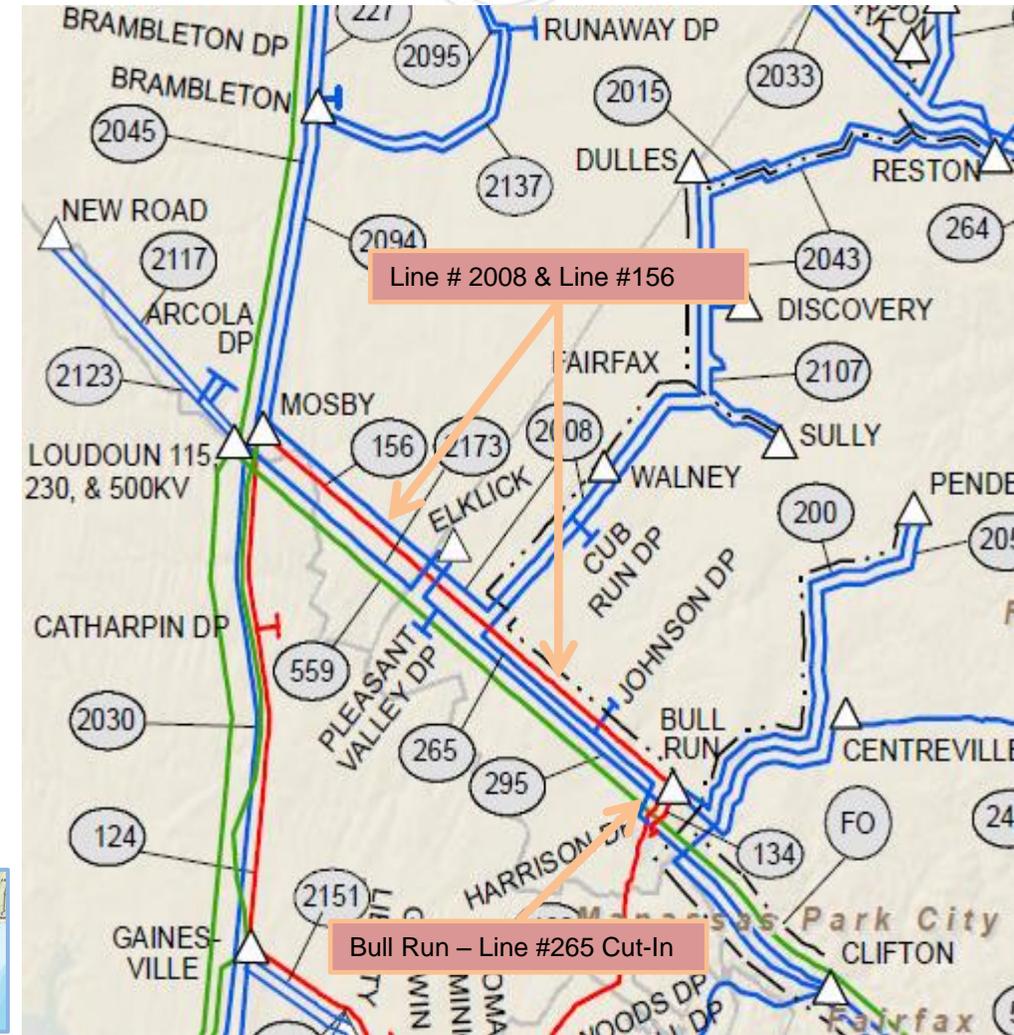
Rebuild partial Line #2008 and Line #156 between Loudoun to Dulles Junction with double circuit steel structures using double circuit conductors at current 230kV northern Virginia standards with minimum summer emergency ratings of 1200 MVA. Operate Line #156 at 115kV. Estimated cost: \$16 M

Estimated Project Cost: \$14 M

Projected In-service Date: 12/31/2023

Project Status: Conceptual

COLOR	VOLTAGE	TRANSMISSION LINE NUMBER
Green	500 KV.	500 thru 599
Blue	230 KV.	200 thru 299 & 2000 thru 2099
Red	115 KV.	1 thru 199
Orange	138 KV.	AS NOTED
Cyan	69 KV.	AS NOTED





Dominion Transmission Zone: Baseline Project

Date Project Last Presented: 03/09/2017 TEAC

Problem Statement: Short Circuit

- Seven of the Mt. Storm 500kV breakers are overstressed

Immediate Need:

- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

Alternatives Considered:

- Due to the immediate need of the project no alternatives were considered.

Recommended Solution:

- Recertify four Mt. Storm 500kV breakers with 50kA nameplate; 57272, G3TSX1, SX172, Y72 (b2842, b2845, b2846, b2847)
- Cancel three Mt. Storm 500kV breaker upgrades; G2TY, G2TZ, Z72 (b2843, b2844, b2848)

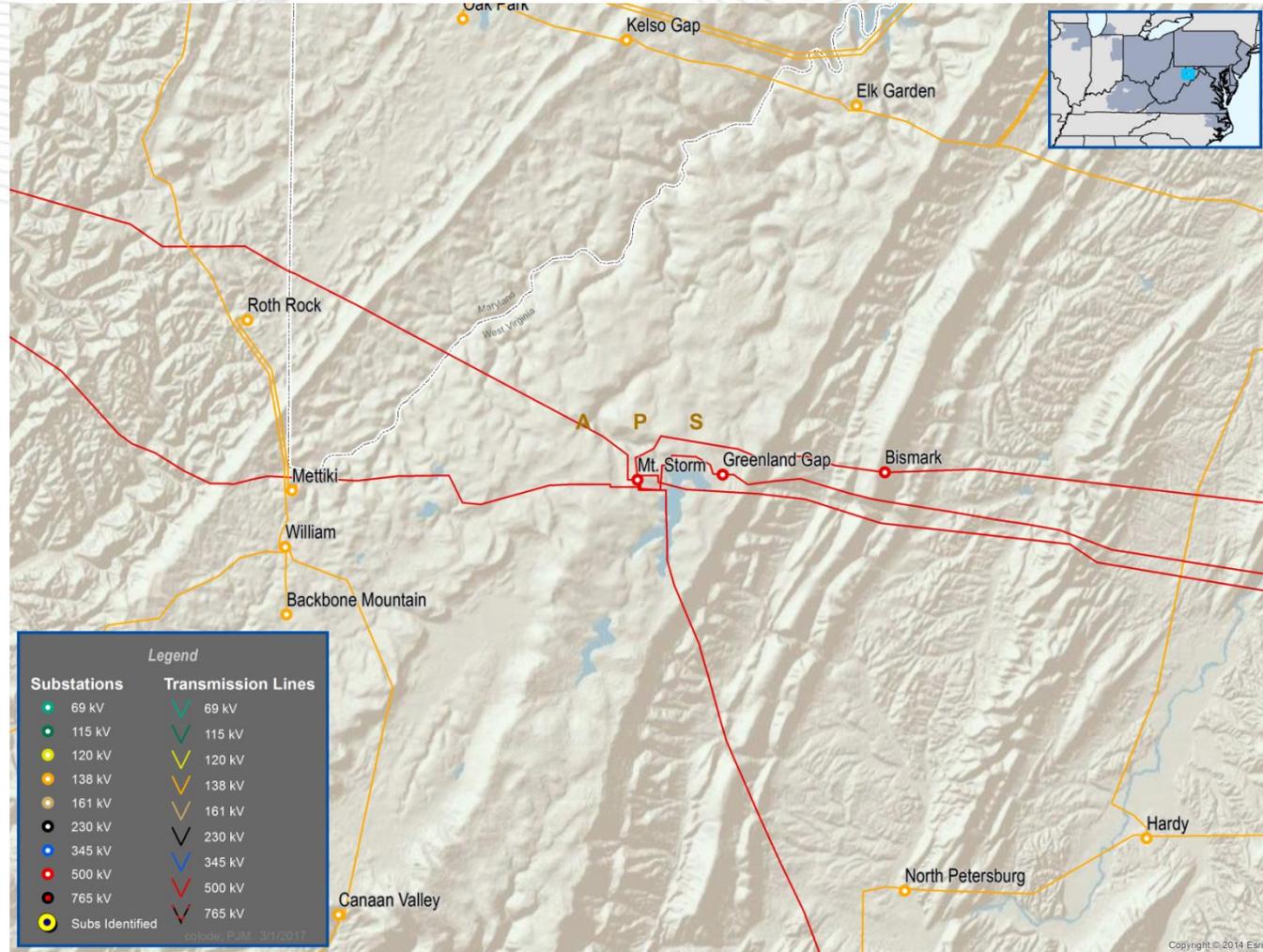
Original Project Cost: \$2.708 M (total)

Revised Project Cost: \$0.008 M (total)

Required IS Date: June 1, 2019

Project Status: Engineering / **Cancelled**

Reason Cancelled: Breaker manufacturer has indicated these three existing breakers are capable of 44kA. Overduity condition is mitigated.



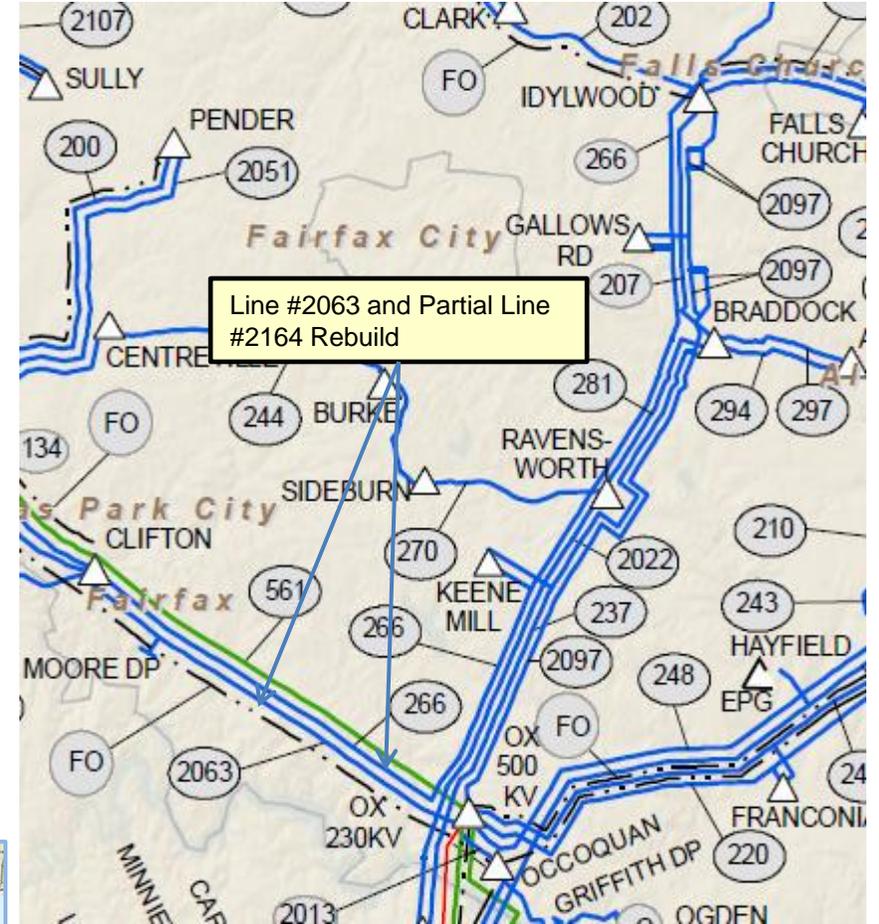
Baseline Reliability: TO Criteria Violation (FERC 715 (TO Criteria) Exclusion)

Problem Statement: Dominion “End of Life Criteria”

The 230kV Line #2063 from Clifton to Ox is roughly 7.16 miles long and was constructed on Cor-ten lattice-type double circuit towers in the 1960s. A roughly 7.1 mile long section of 230kV Line #2164 (currently Line #266) between Clifton and Keene Mill is on the same structures as Line #2063. These towers have been shown to have inherent corrosion problems that continuously deteriorate the steel members. These lines have been identified to be rebuilt as part of Dominion’s End of Life criteria.

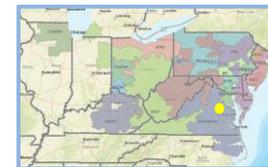
Line #2164 is part of the network feed to Idylwood Substation supplying over 100 MW of load that is required to meet Dominion’s Transmission Planning Criteria. It has tapped load at Keene Mill Substation and Gallows Road Substation totaling 118 MW.

Line #2063 is the only source for the tapped load at Moore D.P.



Continued on next slide...

COLOR	VOLTAGE	TRANSMISSION LINE NUMBER
Green	500 KV.	500 thru 599
Blue	230 KV.	200 thru 299 & 2000 thru 2099
Red	115 KV.	1 thru 199
Orange	138 KV.	AS NOTED
Cyan	69 KV.	AS NOTED





Dominion Transmission Zone: Baseline 230kV Line #2063 and Partial 230kV Line #2164 Rebuild

Recommended Solution:

Rebuild 230kV Line #2063 and Partial 230kV Line #2164 with double circuit steel structures using double circuit conductor at current 230kV northern Virginia standards with a minimum rating of 1200 MVA. **(b3096)**

Alternative:

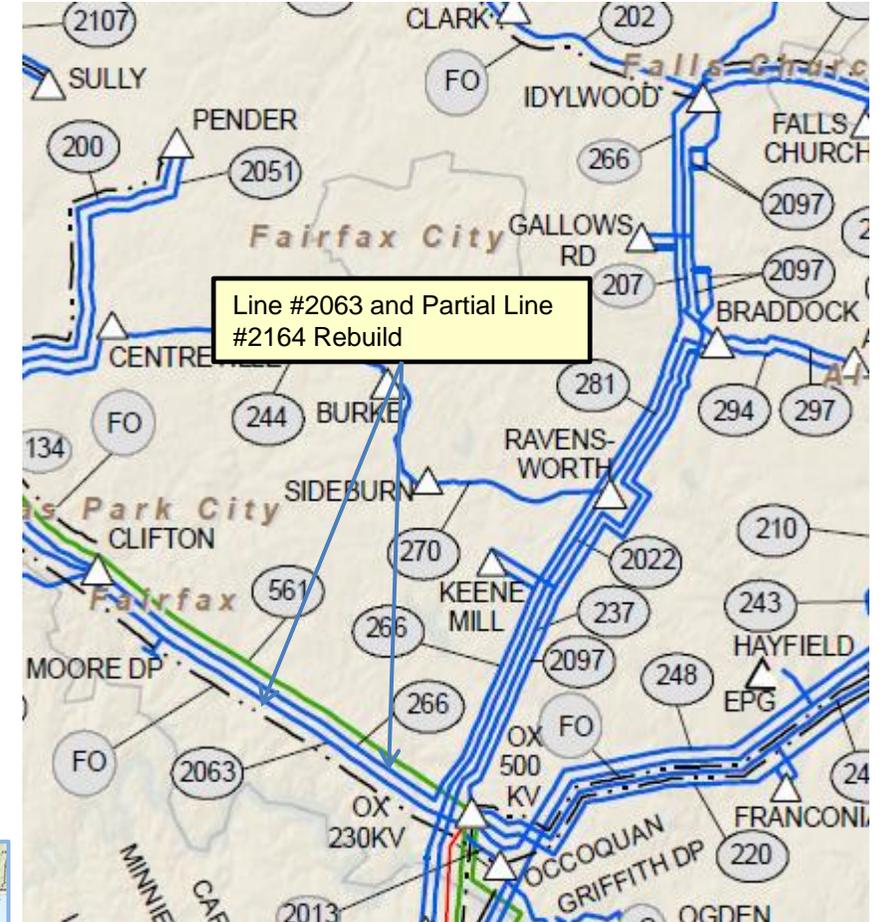
No feasible alternatives.

Estimated Project Cost: \$22.0 M

Required In-service Date: Immediate Need

Projected In-service Date: 12/31/2024

Project Status: Conceptual



COLOR	VOLTAGE	TRANSMISSION LINE NUMBER
Green	500 KV.	500 thru 599
Blue	230 KV.	200 thru 299 & 2000 thru 2099
Red	115 KV.	1 thru 199
Orange	138 KV.	AS NOTED
Cyan	69 KV.	AS NOTED





Dominion Transmission Zone: Baseline Bull Run 230kV Breaker “200T244” and “200T295” Replacements

Baseline Reliability: TO Criteria Violation (FERC 715 (TO Criteria) Exclusion)

*This project inherits the exclusion of its parent project.

Problem Statement: Short Circuit

- The Bull Run 230kV breakers “200T244” and “200T295” are overdutied.

Significant Driver:

- b3110:** Rebuild Line #2008 between Loudoun to Dulles Junction. Retire Line #156 from Loudoun to Bull Run. Cut and loop Line #265 (Clifton – Sully) into Bull Run Substation. Add three (3) 230kV breakers at Bull Run to accommodate the new line and upgrade the substation. (Dominion “End of Life Criteria”)

Recommended Solution:

- Replace the Bull Run 230kV breakers “200T244” and “200T295” with 63kA breakers (**b3110.2**)

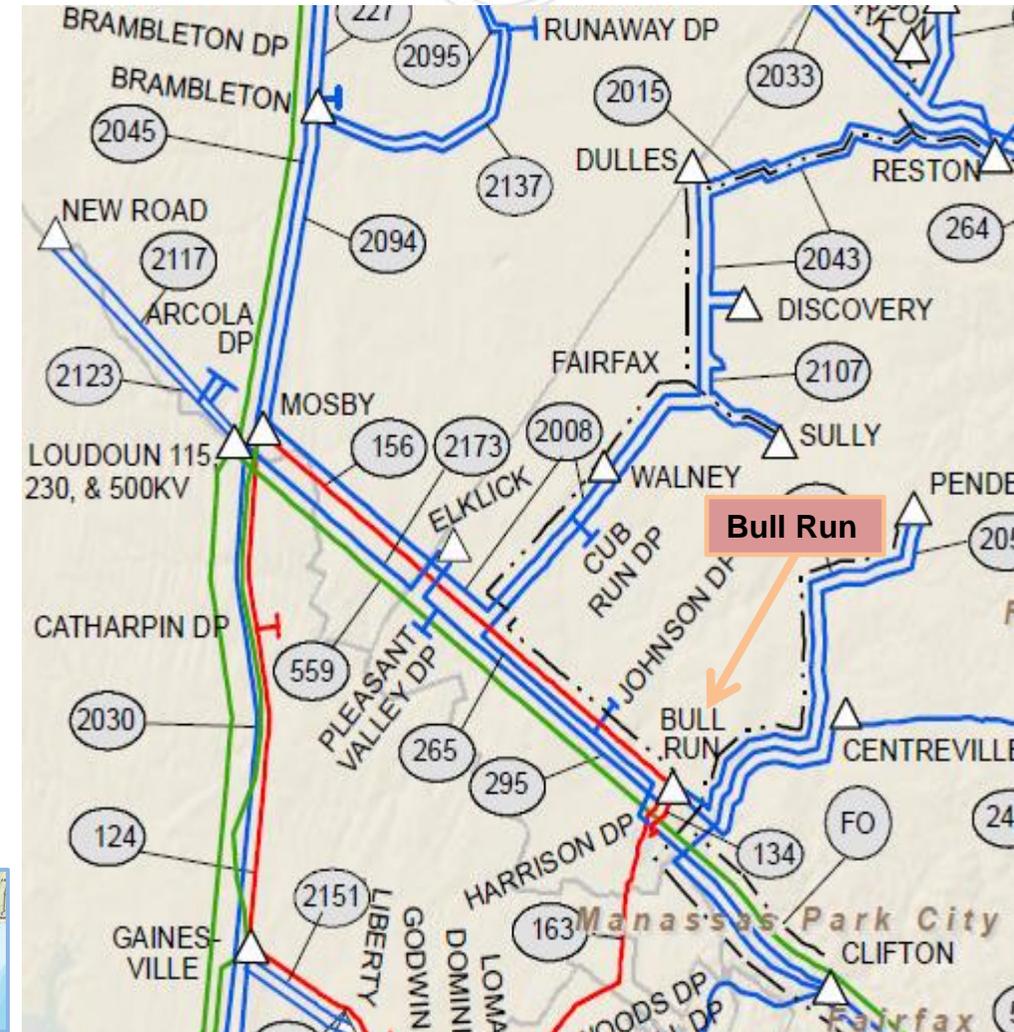
Estimated Project Cost: \$0.54 M

Required In-service Date: Immediate Need

Projected In-service Date: 12/31/2023

Project Status: Conceptual

COLOR	VOLTAGE	TRANSMISSION LINE NUMBER
Green	500 KV.	500 thru 599
Blue	230 KV.	200 thru 299 & 2000 thru 2099
Red	115 KV.	1 thru 199
Orange	138 KV.	AS NOTED
Cyan	69 KV.	AS NOTED





Dominion Transmission Zone: Baseline Remington CT 230kV Breaker "2114T2155" Replacement

Baseline Reliability: Immediate Need Exclusion

Problem Statement: Short Circuit

- The Remington CT 230kV breaker "2114T2155" is overdutied.

Significant Driver:

- **b2686.1:** Build a 230 kV line from Remington Substation to Gordonsville Substation utilizing existing ROW

Recommended Solution:

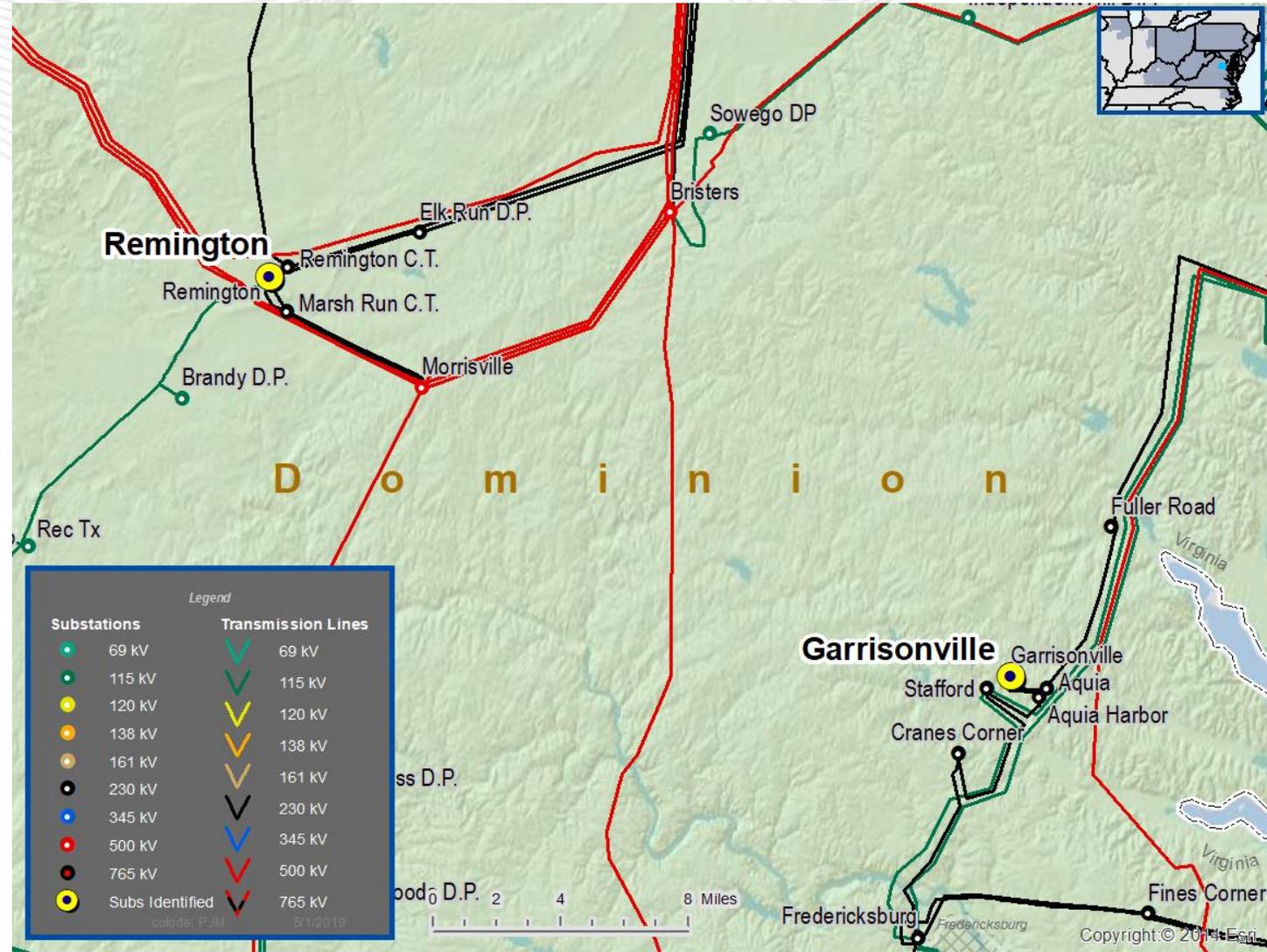
- Replace the Remington CT 230kV breaker "2114T2155" with a 63kA breaker (**b2686.4**)

Estimated Project Cost: \$0.30 M

Required In-service Date: 6/1/2019

Projected In-service Date: 6/1/2020

Project Status: Conceptual





Dominion Transmission Zone: Baseline 115kV Line #141 & #28 Rebuild

Baseline Reliability: TO Criteria Violation (FERC 715 (TO Criteria) Exclusion)

Problem Statement: Dominion “End of Life Criteria”

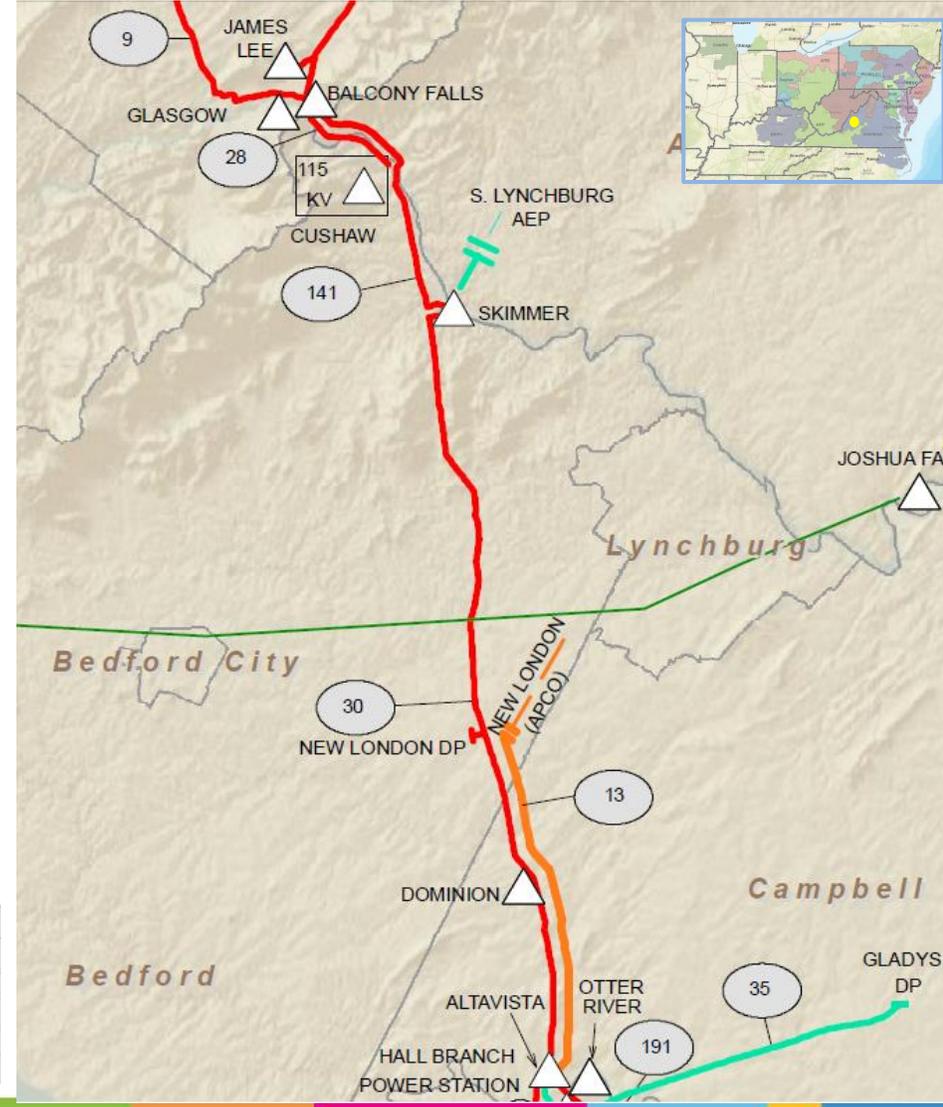
115kV Line #141 extends 9.8 miles between Balcony Falls and Skimmer. For 3.8 miles this line heads south out of Balcony Falls and is constructed on a combination of double circuit Blaw Knox structures it shares with 115kV Line #28 and single circuit wood H-frame structures. Line #28 terminates at Cushaw substation where it connects to a hydroelectric generator. Line #141 continues south on a combination of wood H-frame and Blaw Knox towers for 5.4 of the remaining 6 miles to Skimmer.

The Blaw Knox structures between Balcony Falls and Skimmer were constructed in the 1920’s, are showing deterioration, and are reaching the end of their useful service life. Wood H-frame structures for both lines are experiencing ground line deterioration, cracking, splitting, or woodpecker holes and have been identified for replacement.

Approximately 9.2 miles of Line #141 and 3.9 miles of Line #28 have 4/0 ACSR conductor that was installed in the 1920’s. Industry guidelines indicate equipment life for wood structures is 35-55 years, conductor and connectors are 40-60 years, and porcelain insulators are 50 years.

- Removing Line #141 from service creates a 29 mile radial line from Skimmer and Altavista that violates Dominion’s 700 MW-Mile planning criteria.
- Not rebuilding Line #28 will strand the generation at Cushaw.

COLOR	VOLTAGE	TRANSMISSION LINE NUMBER
Green	500 KV.	500 thru 599
Blue	230 KV.	200 thru 299 & 2000 thru 2099
Red	115 KV.	1 thru 199
Orange	138 KV.	AS NOTED
Cyan	69 KV.	AS NOTED





Dominion Transmission Zone: Baseline 115kV Line #141 & #28 Rebuild

Recommended Solution:

Rebuild 9.2 miles of Line #141 between Balcony Falls and Skimmer and 3.8 miles of Line #28 between Balcony Falls and Cushaw to current standards with a minimum rating of 261 MVA. (b3098)

Alternative:

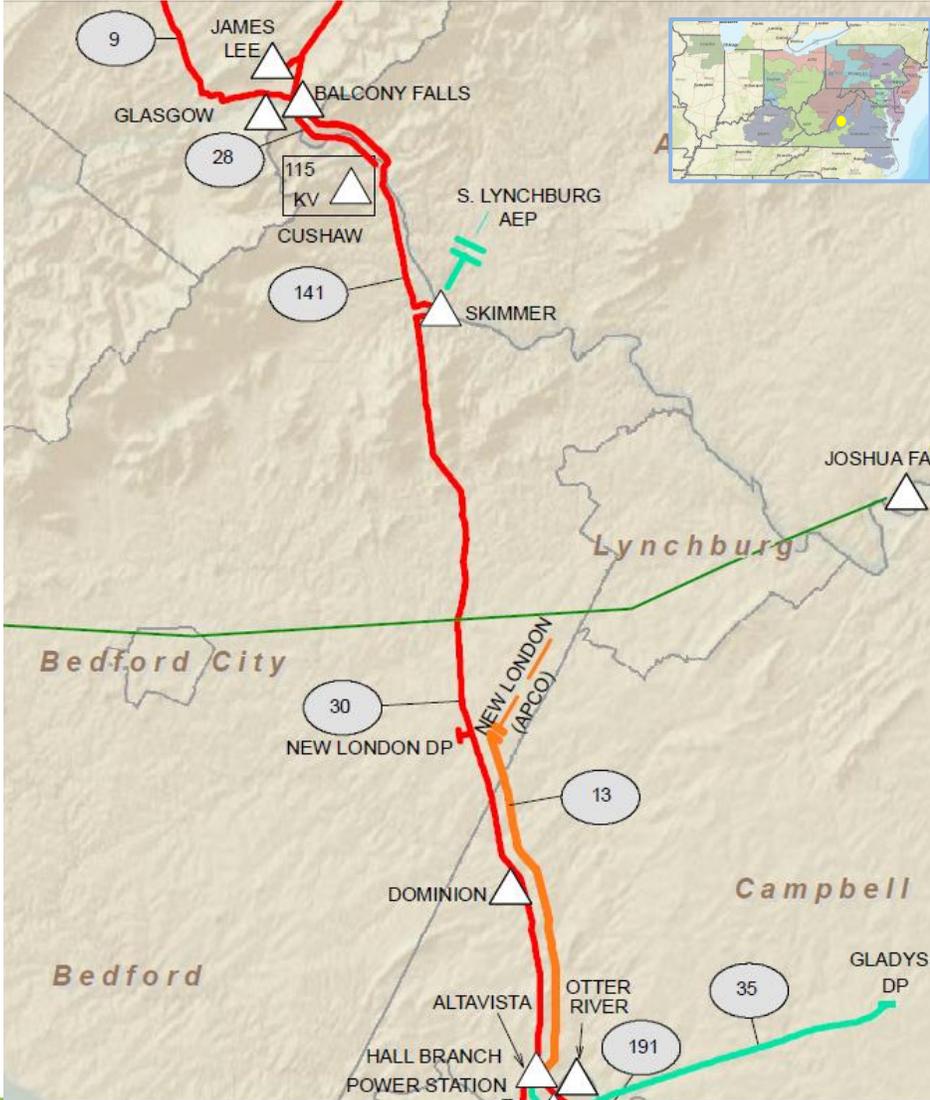
No feasible alternatives.

Estimated Project Cost: \$20 M

Required In-service Date: Immediate Need

Projected In-service Date: 12/31/2023

Project Status: Conceptual



COLOR	VOLTAGE	TRANSMISSION LINE NUMBER
Green	500 KV.	500 thru 599
Blue	230 KV.	200 thru 299 & 2000 thru 2099
Red	115 KV.	1 thru 199
Orange	138 KV.	AS NOTED
Cyan	69 KV.	AS NOTED

Baseline Reliability: TO Criteria Violation (FERC 715 (TO Criteria) Exclusion)

Problem Statement: Dominion “End of Life Criteria”

Approximately 1 mile of 115 kV Line #72 (Plaza – Chesterfield) and 115 kV Line #53 (Kevlar – Chesterfield) was constructed in 1956 on double circuit 3 pole wood H-frame structures. This line section has ACSR conductor and 3/8” steel static. Industry guidelines indicate equipment life for wood structures is 35-55 years, conductor and connectors are 40-60 years, and porcelain insulators are 50 years. This 1 mile line section has been identified for rebuild based on the company’s End of Life criteria.

Line #72 provides service to National Cylinder Gas, Bellwood, Brown Boveri, Kingsland and Reymet substations with a total load of 21.5 MWs. Brown Boveri substation is tapped from the identified 1-mile line section to be rebuilt.

Solution:

Rebuild approximately 1 mile of 115 kV Line #72 and #53 to current standards with a minimum summer emergency rating of 393 MVA. The resulting summer emergency rating of Line #72 segment from Brown Boveri to Bellwood is 180 MVA. There is no change to Line #53 ratings.

(b3113)

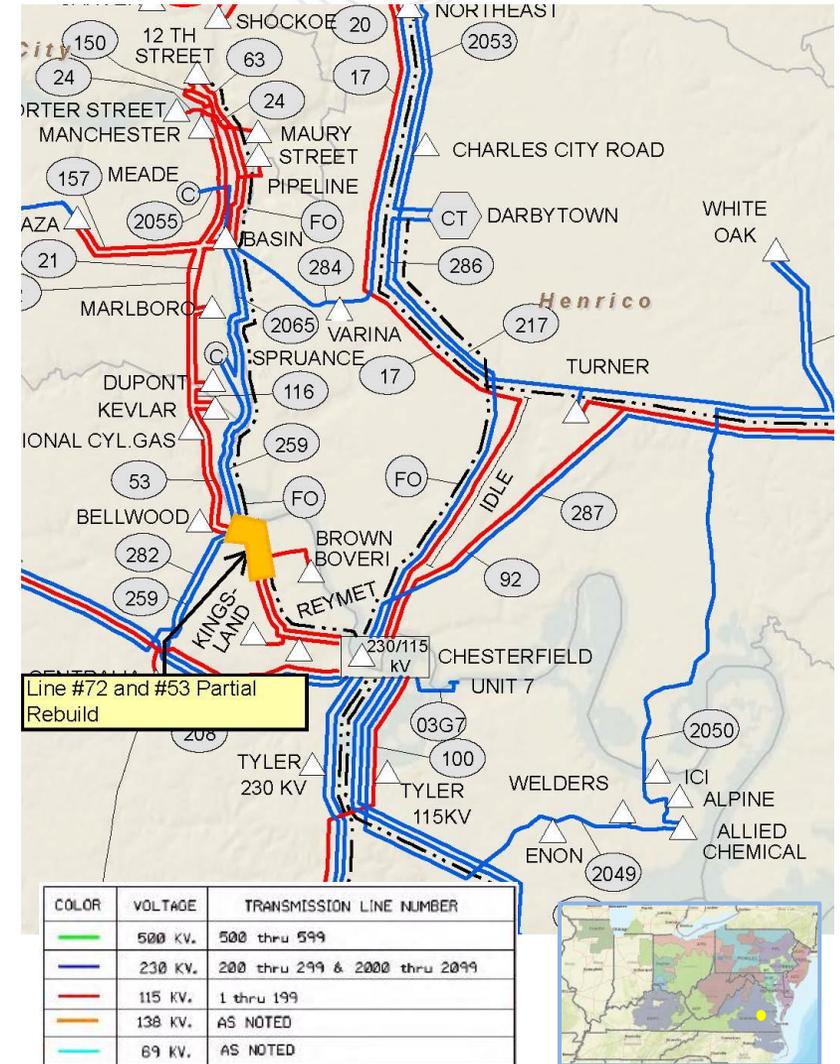
Alternative: No feasible alternatives.

Estimated Project Cost: \$3 M

Required In-service Date: Immediate Need

Projected In-service Date: 12/31/2019

Project Status: Conceptual



115 kV Line #81 and 230 kV Line #2056 Partial Rebuild

Baseline Reliability: TO Criteria Violation (FERC 715 (TO Criteria) Exclusion)

Problem Statement: Dominion “End of Life Criteria”

115 kV Line #81 extends 21.6 miles from Carolina to South Justice Branch and serves 3 delivery points: Roanoke Rapids DP, Darlington DP, and Hornertown. The 18.6 mile section between Carolina and the tap to South Justice Branch is mostly wood H-frames constructed in 1959. There are two sections, 1.7 miles total, within the 18.6 mile section that have double circuit structures that are V series Corten. 115 kV Line #81 and 230 kV Line #2056 are on these double circuit structures. The conductor on this line is ACSR and the static wire is 3/8 inch steel. Industry guidelines indicate equipment life for wood structures is 35-55 years, conductor and connectors are 40-60 years, and porcelain insulators are 50 years.

The 3 mile double circuit tap, 115 kV Lines #81 and #1001, to South Justice Branch was constructed in 2015.

Solution:

Rebuild the 18.6 mile section of 115 kV Line #81 which includes 1.7 miles of double circuit Line #81 and 230 kV Line #2056. This segment of line of 81 will be rebuilt to current standards with a minimum rating of 261 MVA. Line 2056 rating will not change. **(b3114)**

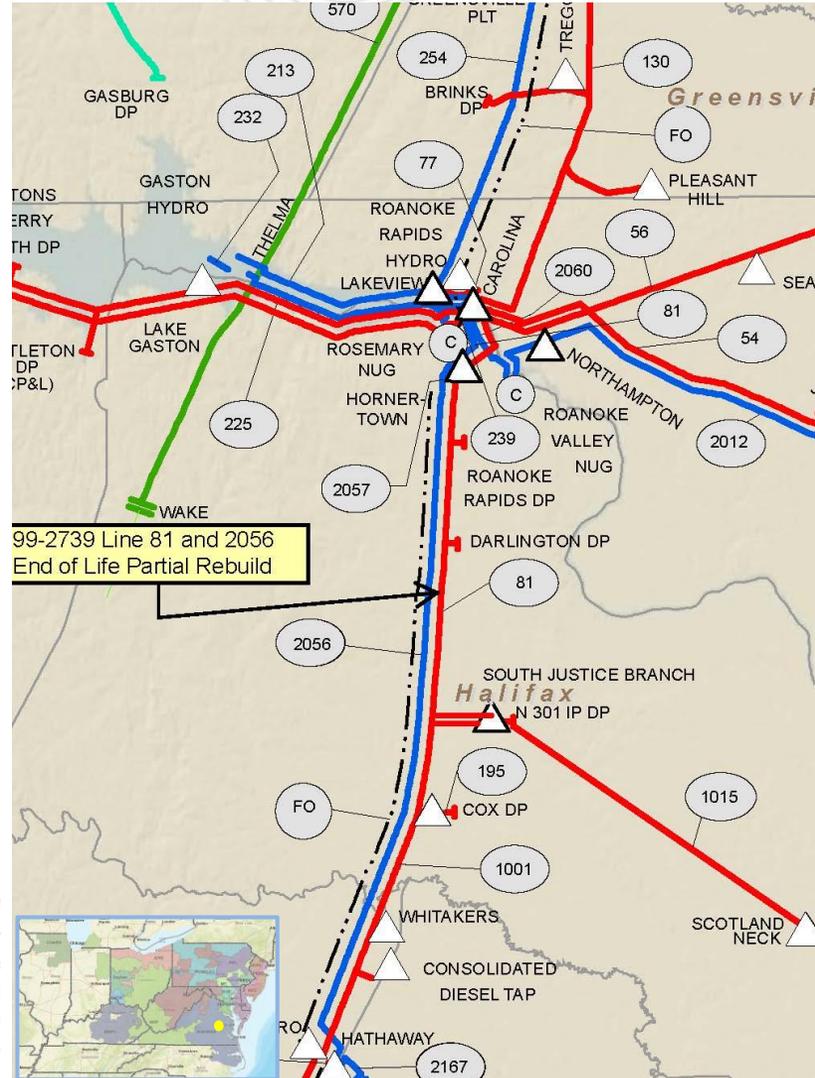
Alternative: No feasible alternatives.

Estimated Project Cost: \$25M

Required In-service Date: Immediate Need

Projected In-service Date: 12/31/2025

Project Status: Conceptual



COLOR	VOLTAGE	TRANSMISSION LINE NUMBER
Green	500 KV.	500 thru 599
Blue	230 KV.	200 thru 299 & 2000 thru 2099
Red	115 KV.	1 thru 199
Orange	138 KV.	AS NOTED
Cyan	89 KV.	AS NOTED



Dominion Transmission Zone: Baseline Line #34 and Line #61 (Partial) Skiffes to Yorktown Rebuild

Existing b2626 Scope and Cost Modification

Original: Baseline Project: Line #34 and Line #61 (Partial) Skiffes to Yorktown Rebuild

Revised: Line #34 and Line #61 (Partial) Skiffes to Yorktown Rebuild and Fort Eustis Tap Rebuild

Problem Statement:

- The 13 mile 115kV line #34 from Skiffes Creek – Yorktown was built on wood H-frames in the 1940's and 1950's. The first 4.5 miles out of Yorktown is on 3 pole double circuit wood H-frames with the line #61. The line #34 and the double circuit portion of the line #61 have been identified for rebuild based on the company's End of Life criteria.

Date Originally Presented: 03/09/2015 (SRTEP)

Original Proposed Solution

- Rebuild the line #34 and the double circuit portion of the line #61 to current standards. **(Est. cost \$24M)**

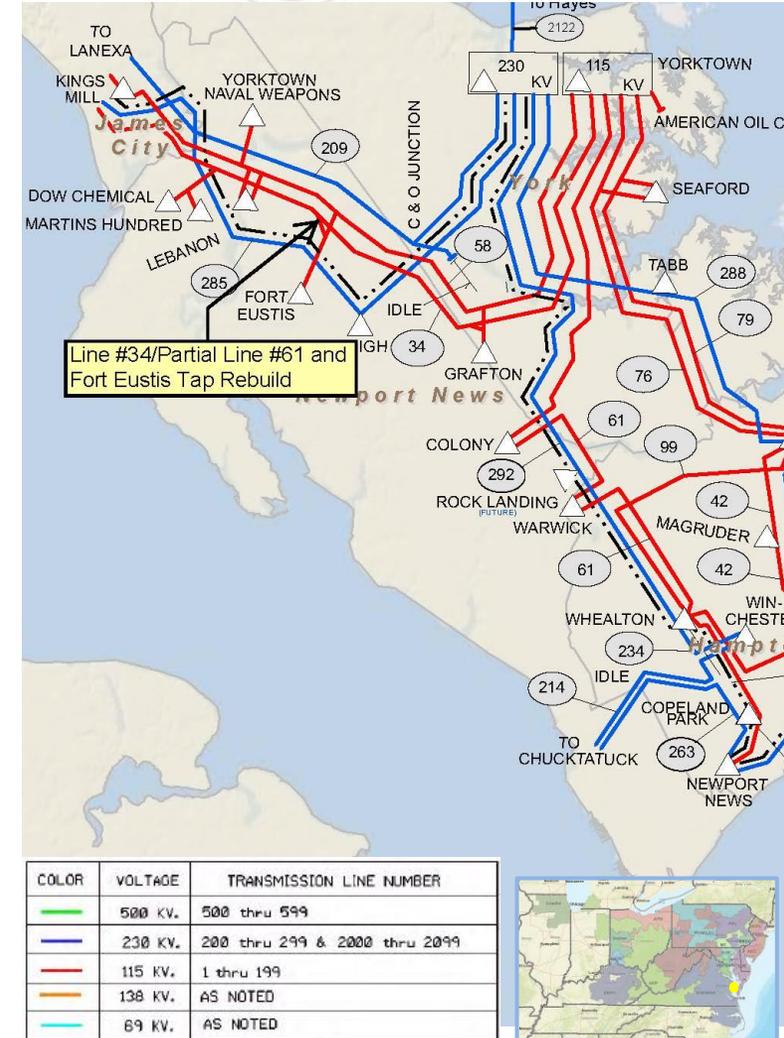
Additional Driver:

- Fort Eustis is served from a 2.5 mile radial line tapped off of line #34. The first 1.6 miles from the tap point is of similar vintage as parts of the main line #34. The remaining 0.9 miles of the tap line was built on wood poles in late 1960s. This tap line is at or approaching it's end of life and has been identified for rebuild.

Revised Proposed Solution

- (Same as original solution)** Rebuild the main line #34 and the double circuit portion of the line #61 to current standards. **(Est. cost \$24M)**
- Based on the company's FIR requirement for a tap line longer than 1 mile, rebuild the 2.5 mile tap line to Fort Eustis as Double Circuit line to loop line #34 in and out of Fort Eustis station to current standard with a summer emergency rating of 393 MVA at 115kV. Install a 115kV breaker in line #34 at Fort Eustis station. **(Est. cost \$11.7M)**

(Continued Next Page)





Dominion Transmission Zone: Baseline Line #34 and Line #61 (Partial) Skiffes to Yorktown Rebuild

Existing b2626 Scope and Cost Modification

Original: Baseline Project: Line #34 and Line #61 (Partial) Skiffes to Yorktown Rebuild

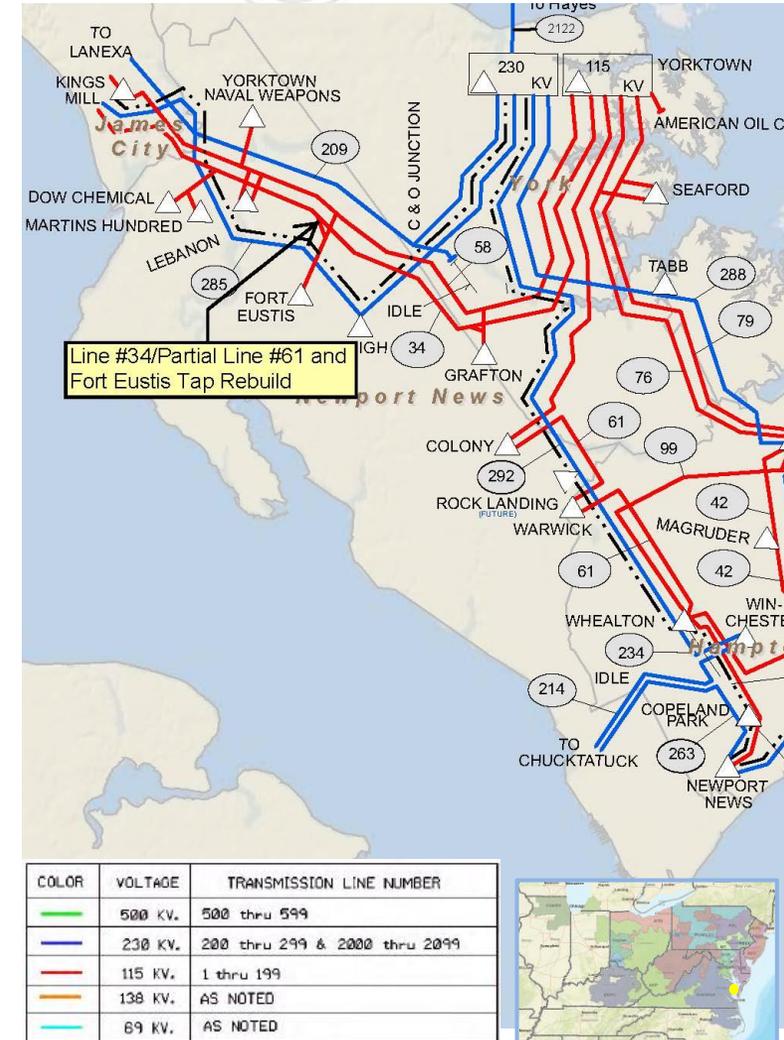
Revised: Line #34 and Line #61 (Partial) Skiffes to Yorktown Rebuild and Fort Eustis Tap Rebuild

Alternatives

- **(Same as original solution)** Rebuild the main line #34 and the double circuit portion of the line #61 to current standards. **(Est. cost \$24M)**
- Based on the company's FIR requirement for a tap line longer than 1 mile, build a 3-breaker ring bus station in line #34 at Fort Eustis tap point. Rebuild the 2.5 mile tap line to Fort Eustis as Single Circuit line to current standards with a summer emergency rating of 393 MVA at 115kV. **(Est. cost \$16.4M)**

Projected IS Date: 12/31/2023

Project Status: Conceptual





Dominion Transmission Zone: Baseline 115kV Line #29 Fredericksburg to Aquia Harbor End of Life

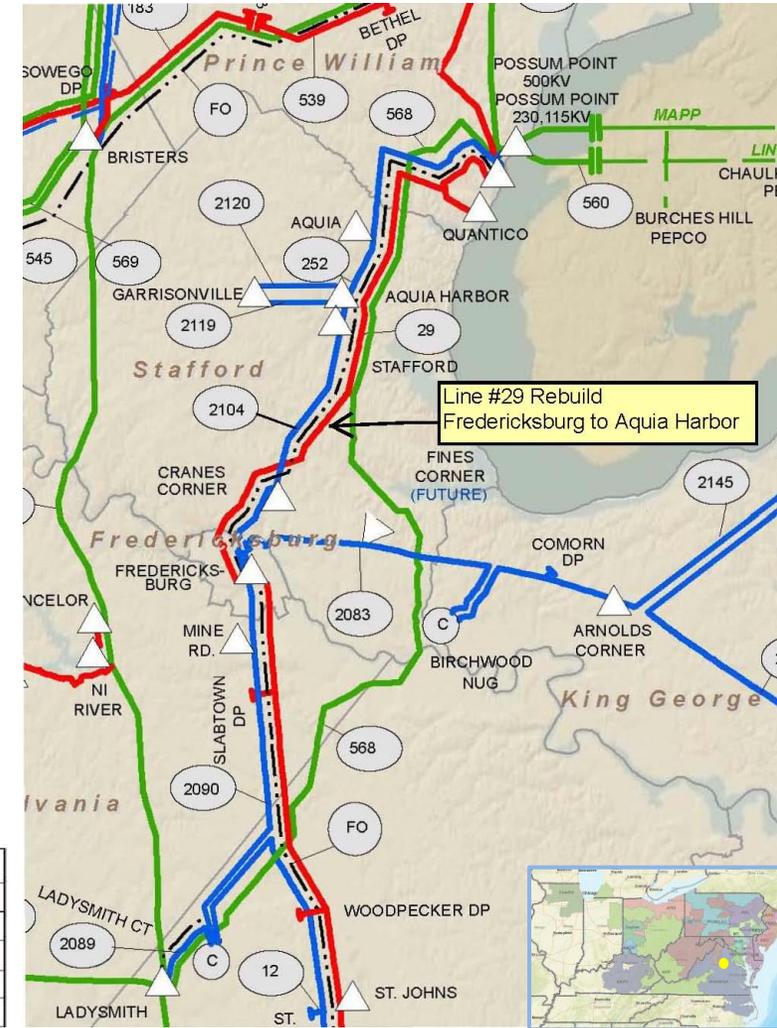
Existing b2981 Cost Increase

Date Project Last Presented: 12/18/2017 SR RTEP

Original Problem Statement: DOM “End of Life Criteria”

- Total line length of 115kV Line #29 is 24.4 miles and runs between Fredericksburg Substation and Possum Point Power Station. The proposed rebuild segment of the 115kV Line #29 between Fredericksburg and Aquia Harbor is approximately 12 miles long and was constructed on wood H-frame structures in 1957. Existing conductor in the proposed rebuild segment is a combination of 1109 ACAR, 2-721 ACAR and 795 ACSR with a summer rating of 239 MVA. The remaining 12 miles of Line #29 is on a common 230kV lattice structure with Line #252 (with the exception of the tap to Quantico) with a summer conductor rating of 361 MVA at 115kV.
- This line provides service to Quantico Substation with a total of 440 customers including the Quantico USMC Base. Quantico Substation is connected to Line #29 with a 1.7 mile 115kV tap off the main line.
- Rebuilding this 12 mile segment of Line #29 to current 230kV standards (with continued operation at 115kV) would be consistent with the Company’s practice of containing or converting 115kV load in the Northern Virginia area and would support the future conversion of the entire Line #29 to 230kV with the remaining 12 miles already installed on 230kV structures.

COLOR	VOLTAGE	TRANSMISSION LINE NUMBER
Green	500 KV.	500 thru 599
Blue	230 KV.	200 thru 299 & 2000 thru 2099
Red	115 KV.	1 thru 199
Orange	138 KV.	AS NOTED
Cyan	69 KV.	AS NOTED





Dominion Transmission Zone: Baseline 115kV Line #29 Fredericksburg to Aquia Harbor End of Life

Recommended Solution: (no change)

Rebuild Line #29 segment between Fredericksburg and Aquia Harbor to current 230kV standards (operating at 115kV) with a normal continuous summer rating of 524 MVA at 115kV (1047 MVA at 230kV). (b2981)

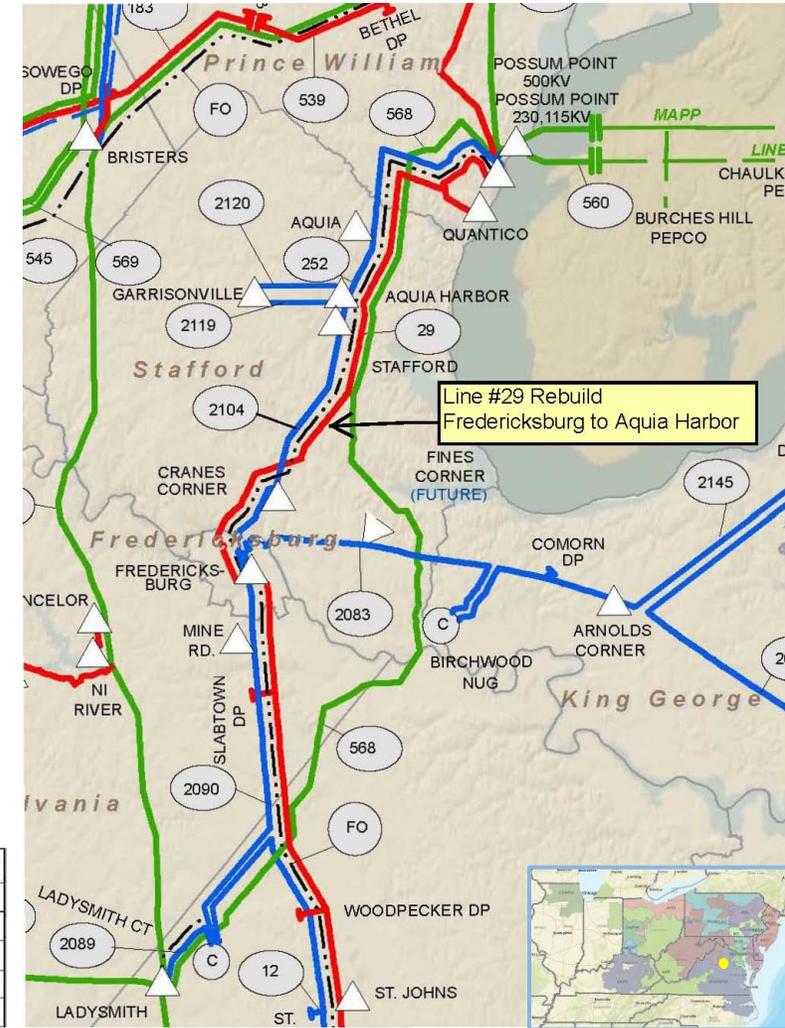
Conceptual Project Cost: \$12.5M

Revised Detailed Project Cost: \$20.0M

Reason for Cost Increase: Detailed versus conceptual cost estimate.

Projected In-service Date: 12/31/2022

Project Status: Engineering



COLOR	VOLTAGE	TRANSMISSION LINE NUMBER
Green	500 KV.	500 thru 599
Blue	230 KV.	200 thru 299 & 2000 thru 2099
Red	115 KV.	1 thru 199
Orange	138 KV.	AS NOTED
Cyan	69 KV.	AS NOTED