Sub Regional RTEP Committee
PJM West

March 9, 2018

Continue Feb. 14, 2018 SRRTEP slides (#65 - #112)

http://www.pjm.com/-/media/committees-groups/committees/srrtep-w/20180214/20180214-reliability-analysis-update.ashx

First Review

Baseline Reliability and Supplemental Projects

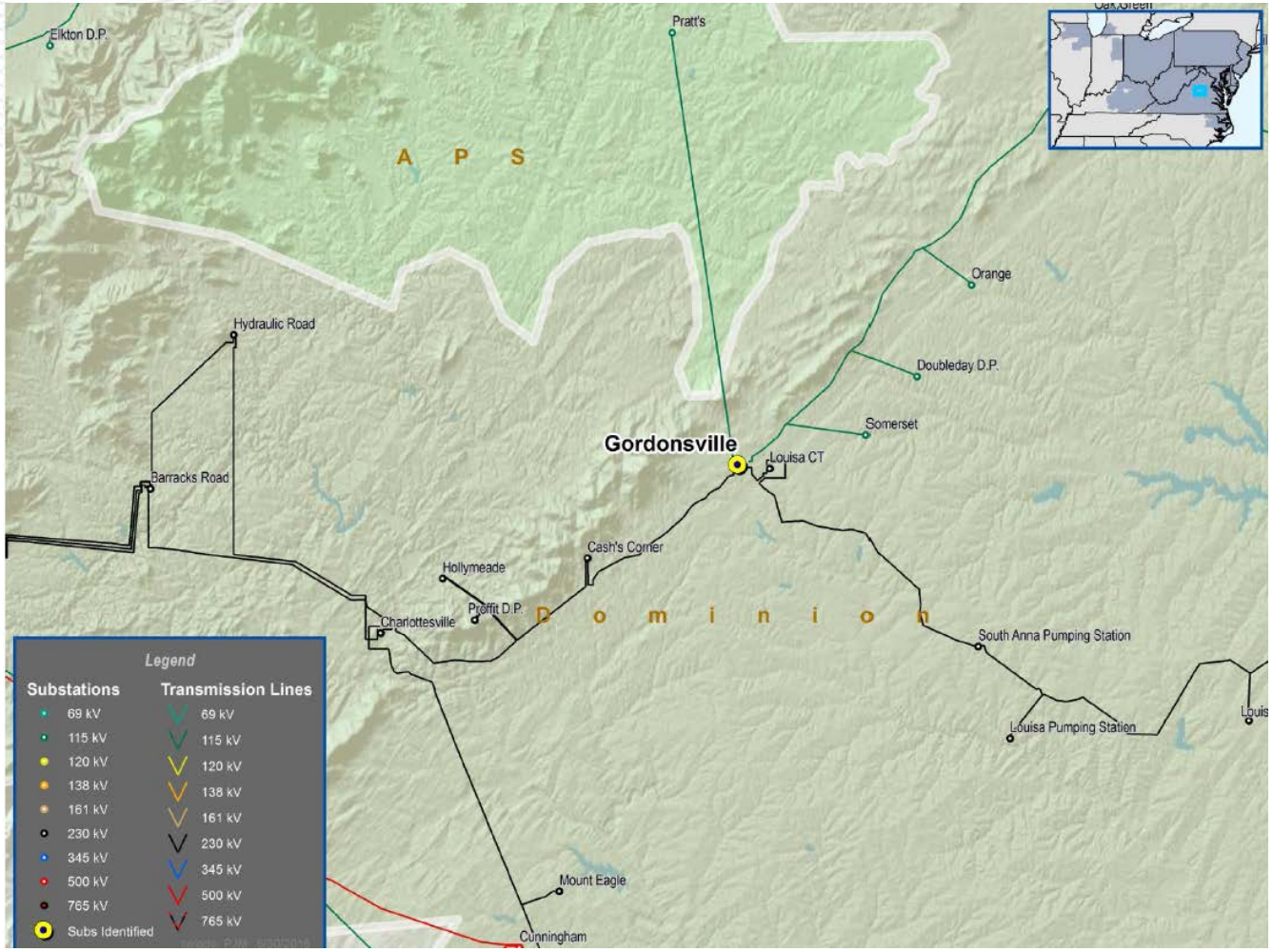
FE Scope for Dominion Baseline B2747

B2747: Install a Motor Operated Switch and SCADA control between Dominion's Gordonsville 115kV bus and FirstEnergy's 115kV line. (Presented in 7/26/2016 South SRRTEP)

FE Scope: Relocate the FirstEnergy Pratts 138 kV terminal CVTs at Gordonsville substation to allow for the installation of a new motor operated switch being installed by Dominion. (B2747.1)

Estimated Cost: $0.11M

Required In-service: 6/1/2018



RMU/ComEd Transmission Zone: Supplement
Twombly Road –West DeKalb-Glidden line

Problem Statement:

Rochelle Municipal Utilities (RMU) currently has two 138 kV lines serving its load; the TSS 169 (McGirr Road)/TSS 186 (Steward) – H440 (Caron Road) 138 kV line and the RMU H445 (Twombly) – Steward 138kV line. These lines are fairly close together and are electrically from the same source; they both run south to north. A severe storm could potentially take out both lines simultaneously, which would result in an unacceptably long outage during line reconstruction. For example, on Nov. 17th, 2013, a tornadic wind shear took down 22 poles on the transmission system at the same time a ComEd planned outage had RMU down to one line, resulting in a system interruption.

Potential Solution:

Construct a new line from the Twombly Road substation to a tap of the West DeKalb to Glidden 138 kV line just outside the West DeKalb 138 kV substation. The new 138 kV line would provide a diverse source to RMU and would also provide another path to ComEd for serving load in the DeKalb area.

Estimated Cost: $18M ($17M RMU & $1M ComEd)

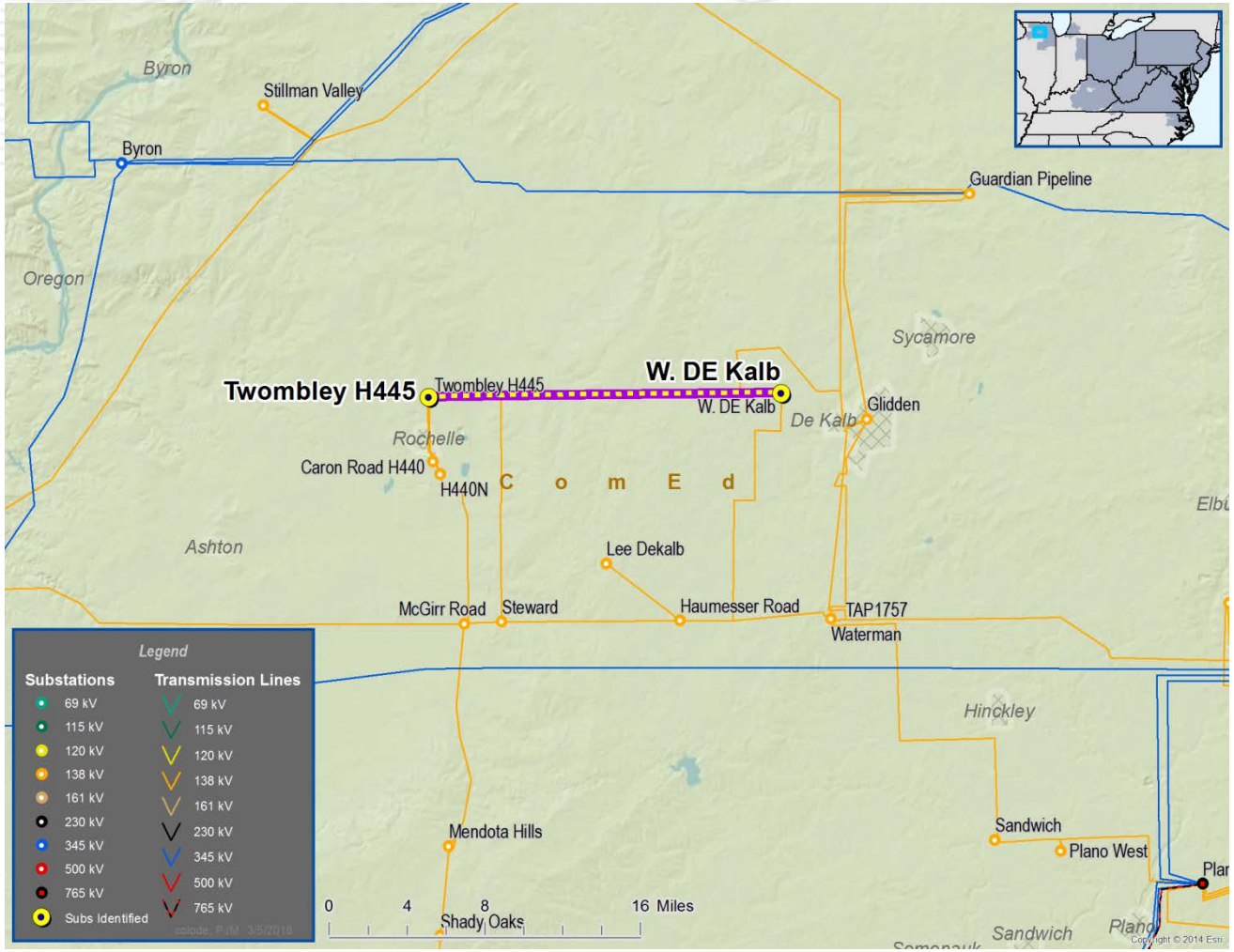
Alternatives:

There are a number of alternatives that have been evaluated. The new line would initiate from the RMU Twombly 138kV substation. Alternative terminations have been considered at a new tap on the Dixon – Stillman Valley 138kV line, the Waterman 138kV substation, and at a new substation located at the Guardian Pipeline 138kV tap.

Terminating the line at the Waterman substation would require more extensive substation expansion than the proposed solution. Terminating the line at the Dixon to Stillman Valley line would require construction of a new ring-bus substation. Each of these alternatives are much higher cost and have more development risks compared to the proposed solution.

Projected In-service: 10/1/2021

Project Status: Engineering



DEOK Transmission Zone: Supplemental
Beckjord and Redbank Replace 138 Circuit Breakers

Problem Statement:
The breakers at each end of a 138kV line connecting Beckjord and Red Bank are vintage 1973 and 1981 respectively, obsolete, oil filled breakers.

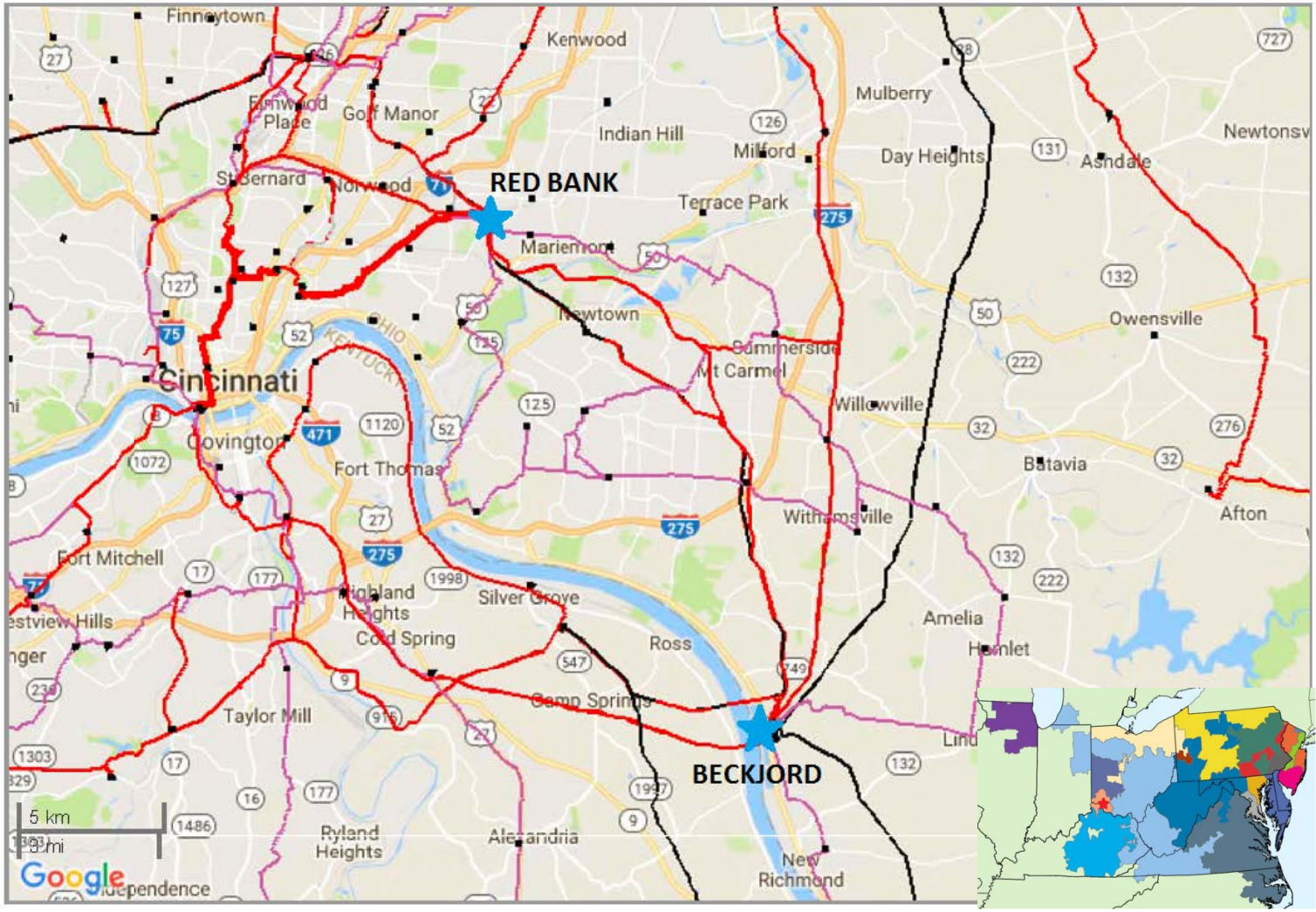
Potential Solution:
Replace the breakers, breaker disconnects, and metering equipment. Branch rating will increase to 340 MVA (conductor limited).
Driver : Equipment Condition, Performance and Risk
Estimated Cost: $1.86 M

Alternatives:

- None

Projected In-service: 12-31--2018

Project Status: Development



DEOK Transmission Zone: Supplemental
Dixie – Expand Substation

Problem Statement:
Load growth requires expanding Dixie substation.

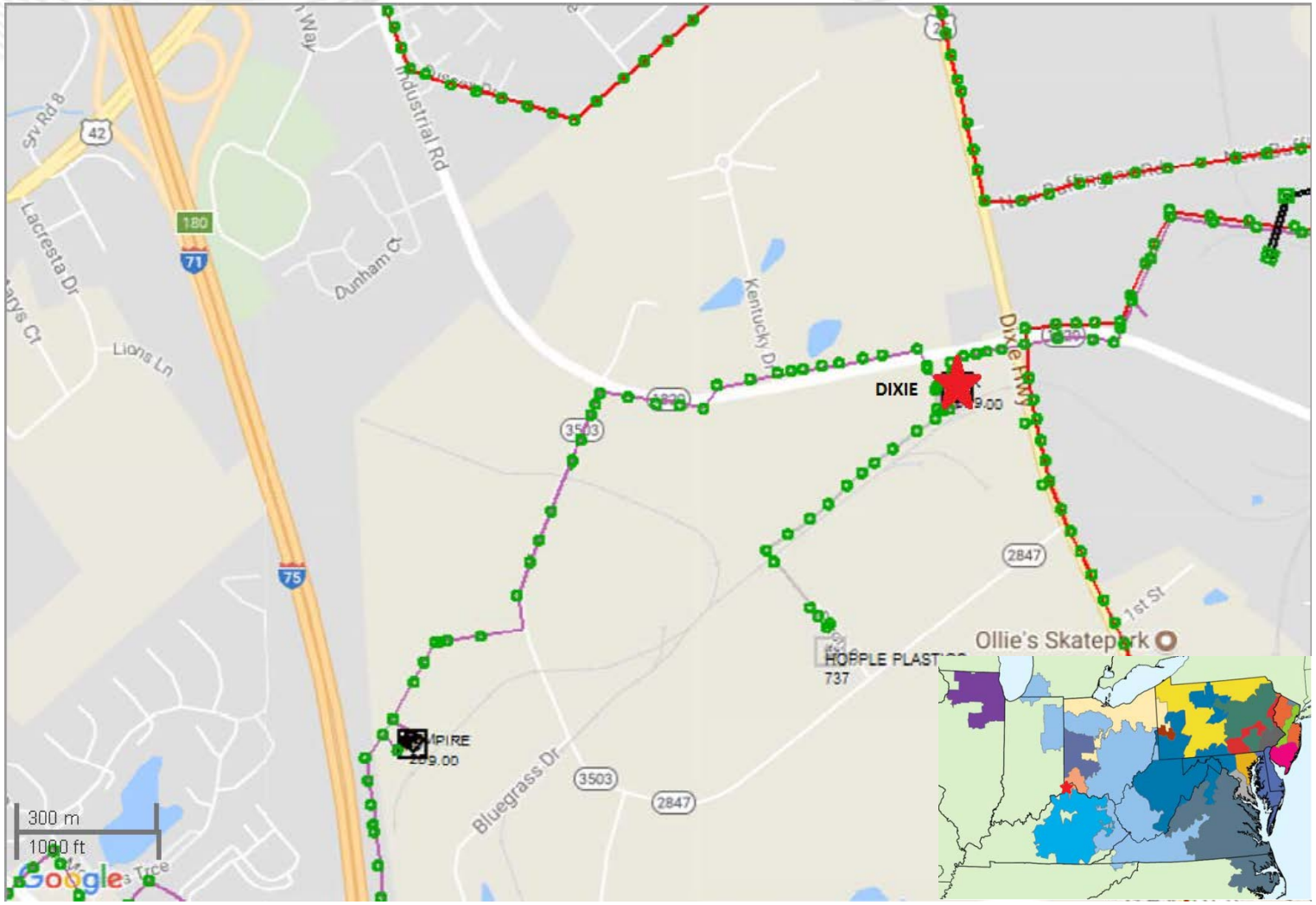
Potential Solution:
Install a 69/13 kV 10 MVA transformer, bus work and breakers to support two new distribution feeders.
Driver : Customer Service
Estimated Cost: $0 M

Alternatives:

- None

Projected In-service: 12-31--2018

Project Status: Development



DEOK Transmission Zone: Supplemental Ebenezer Replace Switchgear

Problem Statement:
The 13kV switchgear at Ebenezer is obsolete and in deteriorating condition. Space limitations for new gear requir 69/13kV TB4 to be moved.

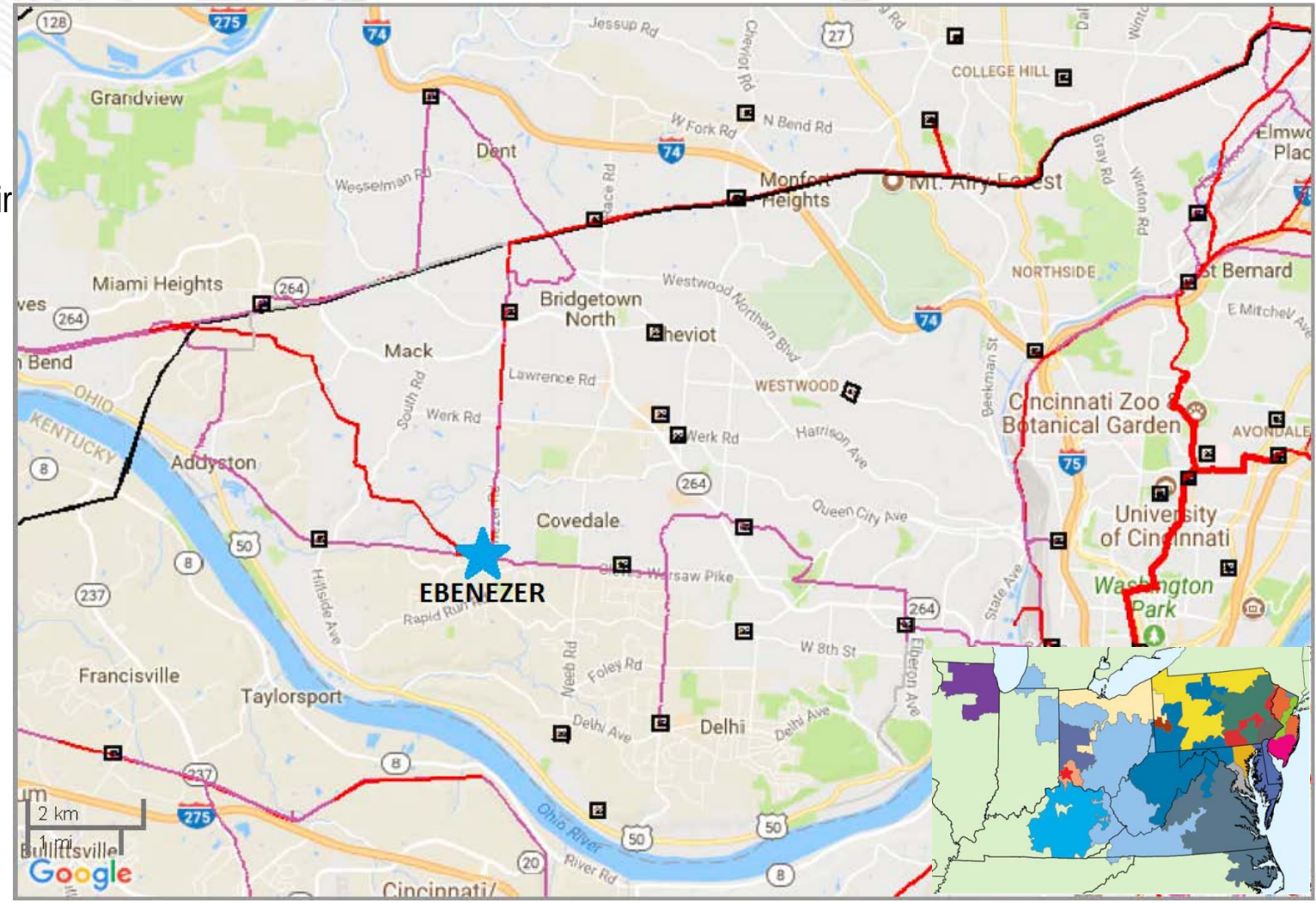
Potential Solution:
Replace the switchgear. Due to it's age, 50 years, and the expense of moving TB4, replace with a new transformer.
Driver : Equipment Condition, Performance and Risk
Estimated Cost: $0 M

Alternatives:

- None

Projected In-service: 12-31--2018

Project Status: Development



DEOK Transmission Zone: Supplemental
Evendale – Port Union 69 kV Feeder Rebuild

Problem Statement:
The 69 kV feeder between Evendale and Port Union substations is aged and in deteriorating condition (1950's era).

Potential Solution:
Rebuild 9.5 miles of feeder between Evendale and Port Union substations with new structures, hardware, switches and conductor. Capacity will increase from 97 MVA to 114 MVA (through bus limited).

Driver: Equipment Material Condition, Performance and Risk

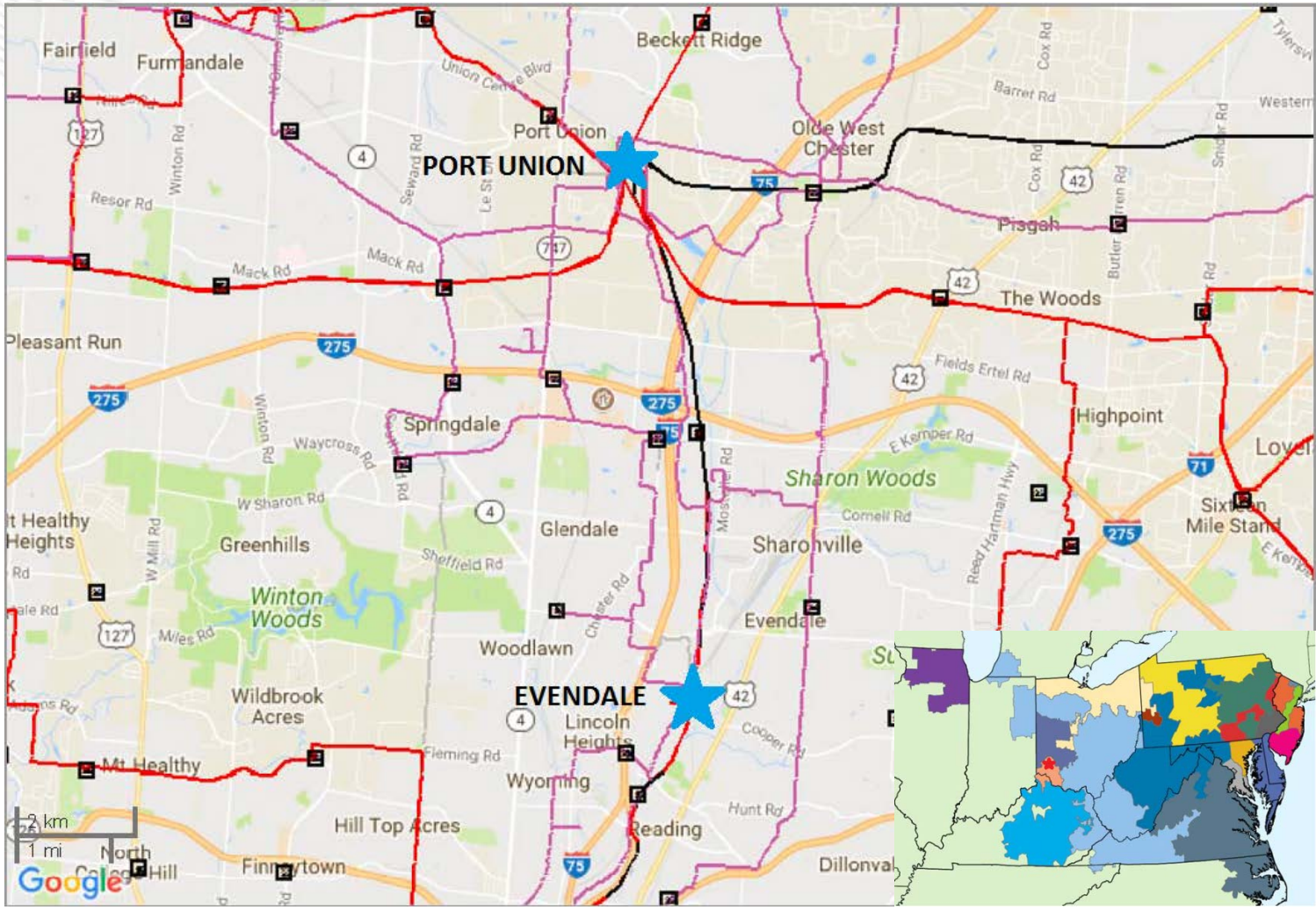
Estimated Cost: $10.8 M

Alternatives:

- none

Projected In-service: 12-1-2018

Project Status: Development



DEOK Transmission Zone: Supplemental Goodwin – New Distribution Substation

Problem Statement:
A distribution feeder suffers low voltage and overload when one of the two end sources is lost.

Potential Solution:
Build a new 69/13kV distribution substation separating the feeder into two segments. Install a 69/13 kV 10 MVA transformer, bus work and breakers to support the distribution feeders.
Driver : Customer Service

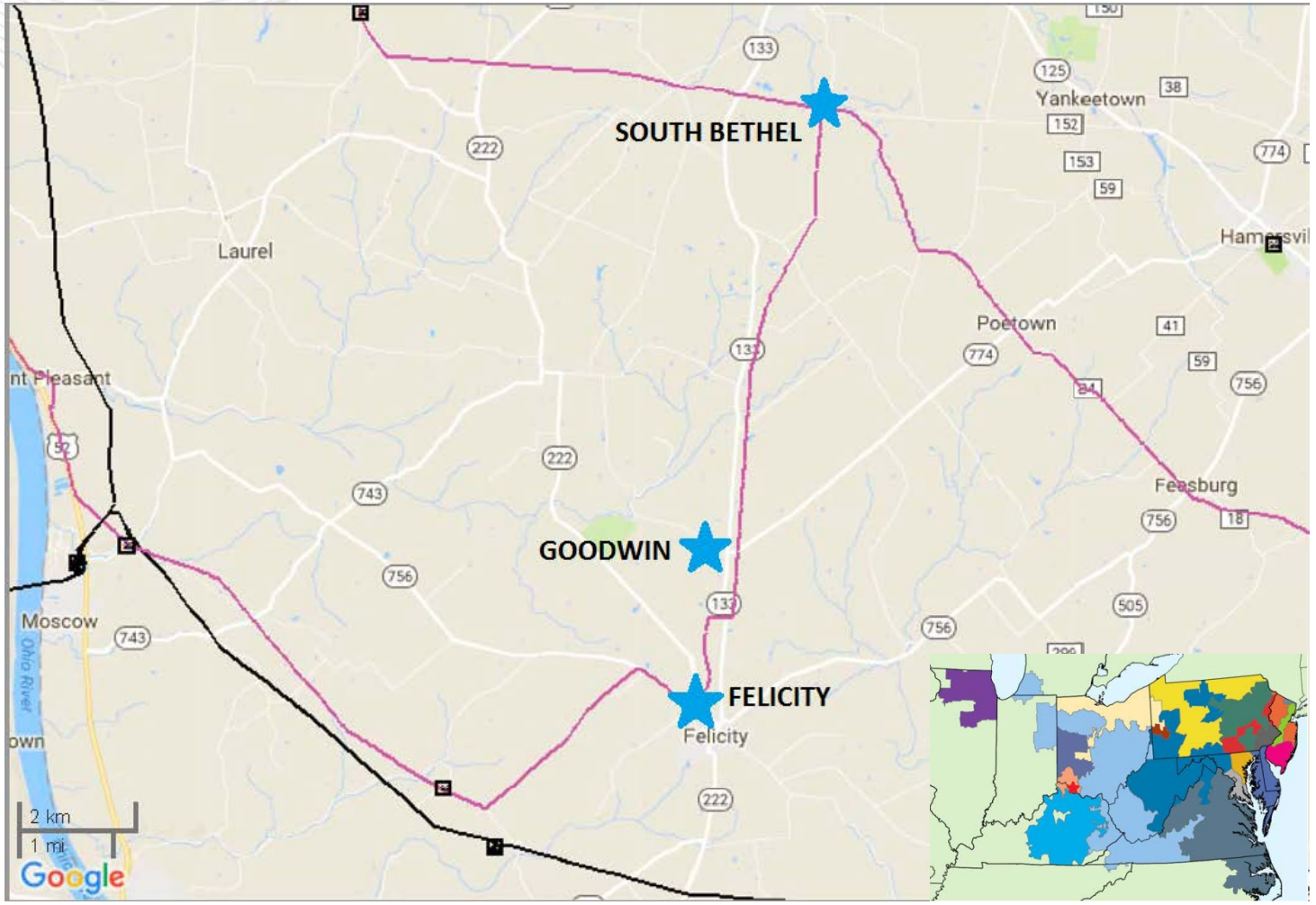
Estimated Cost: $0 M

Alternatives:

- None

Projected In-service: 12-31--2018

Project Status: Development



DEOK Transmission Zone: Supplemental Locust – Todd 69 kV Feeder Rebuild

Problem Statement:
The 69 kV feeder between Locust and Todd substations is aged and in deteriorating condition (1950's era).

Potential Solution:
Rebuild 6.4 miles of feeder between Locust and Todd substations with 54 new structures, hardware, and conductor. Capacity of the line will increase from 56 MVA to 117 MVA.
Driver: Equipment Material Condition, Performance and Risk

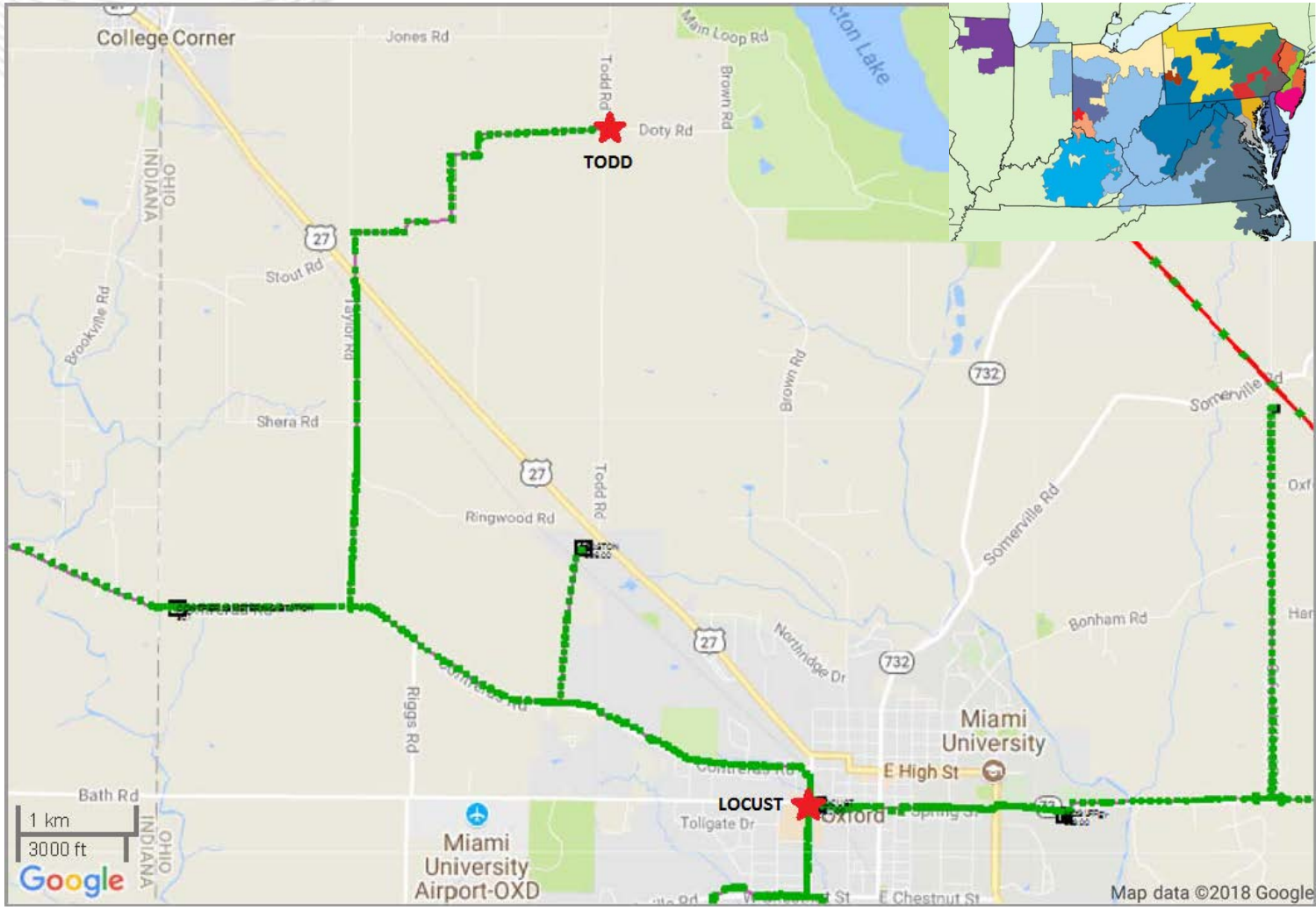
Estimated Cost: $7.5 M

Alternatives:

- none

Projected In-service: 12-1-2018

Project Status: Development



DEOK Transmission Zone: Supplemental
New Richmond – Expand Substation

Problem Statement:
There is high winter loading and low voltage on a New Richmond 13kV distribution feeder.

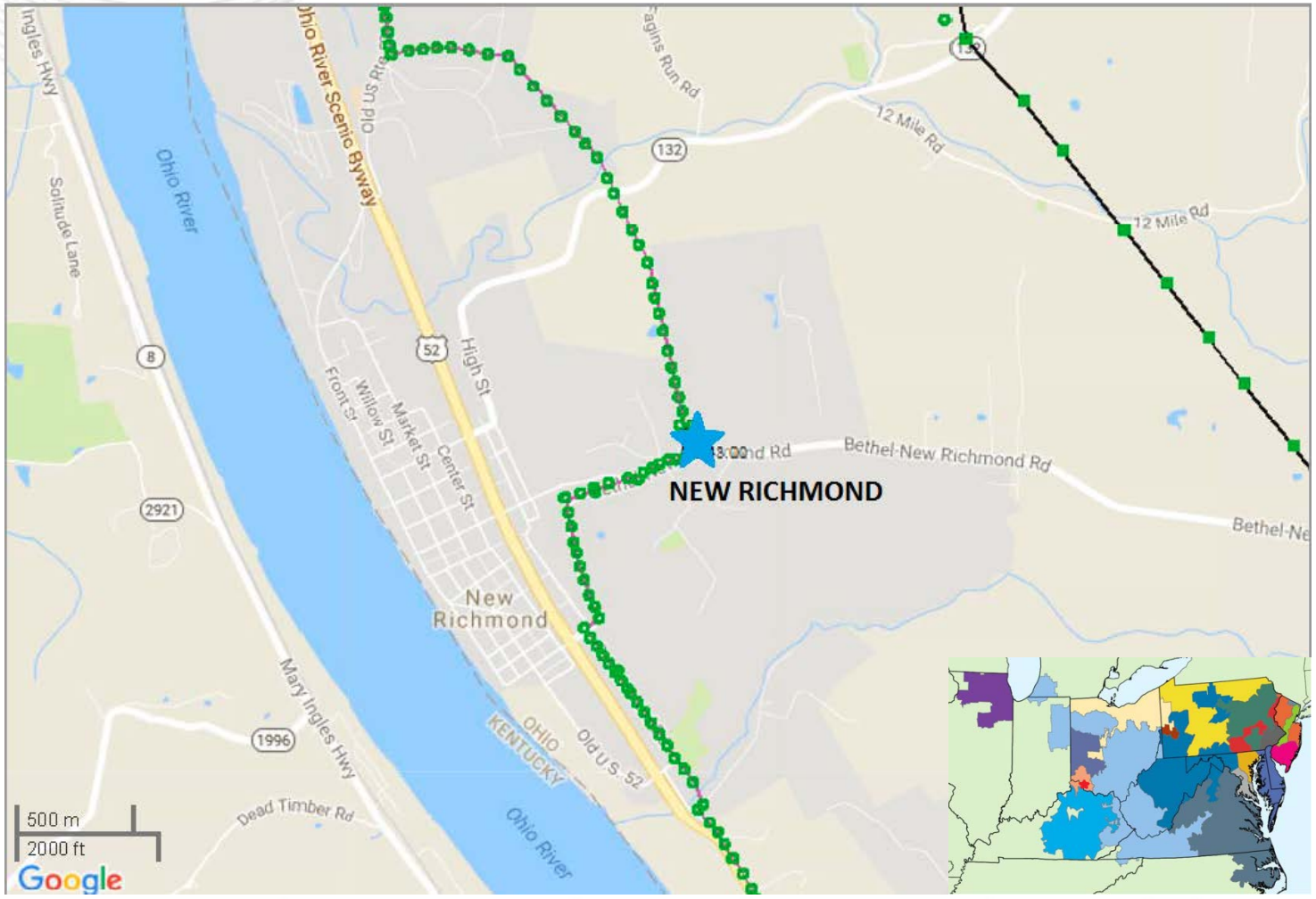
Potential Solution:
Split the feeder into three segments all terminating at New Richmond. Install a 69/13 kV 10 MVA transformer, bus work and breakers to support two new distribution feeders.
Driver : Customer Service
Estimated Cost: $0 M

Alternatives:

- None

Projected In-service: 12-31--2018

Project Status: Development



DEOK Transmission Zone: Supplemental
Oakbrook – Expand Substation

Problem Statement:
Distribution load at Oakbrook substation is predicted to grow due to new commercial development.

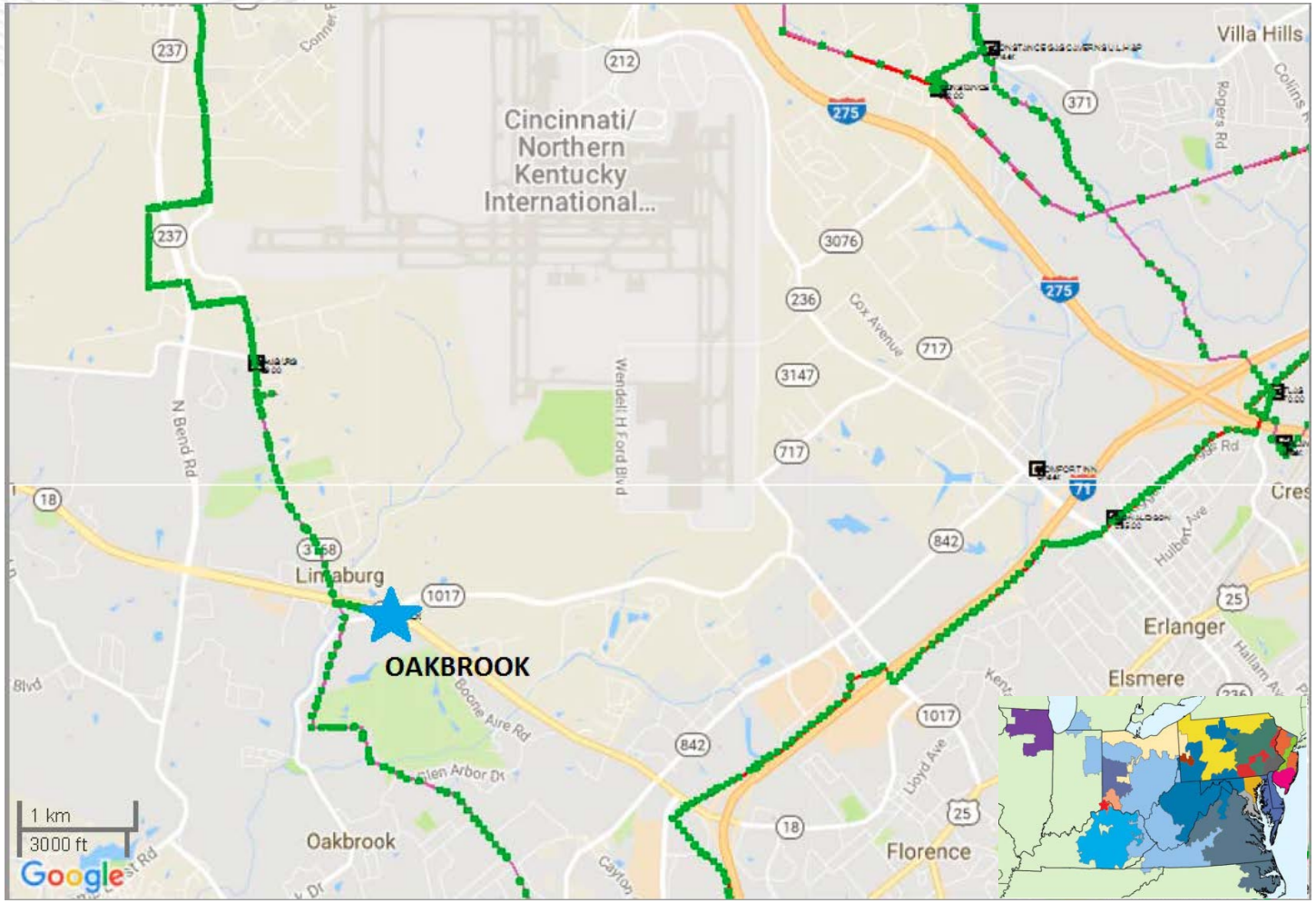
Potential Solution:
Install a 69/13 kV 10 MVA transformer, bus work and breakers to support two new distribution feeders.
Driver : Customer Service
Estimated Cost: $0 M

Alternatives:

- None

Projected In-service: 12-31--2018

Project Status: Development



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DEOK Transmission Zone: Supplemental
Red Bank Replace Tie Breaker

Problem Statement:
The tie breaker between Redbank 138kV buses one and two is a vintage 1975, obsolete, oil filled breaker and is stuck open (will not stay closed).

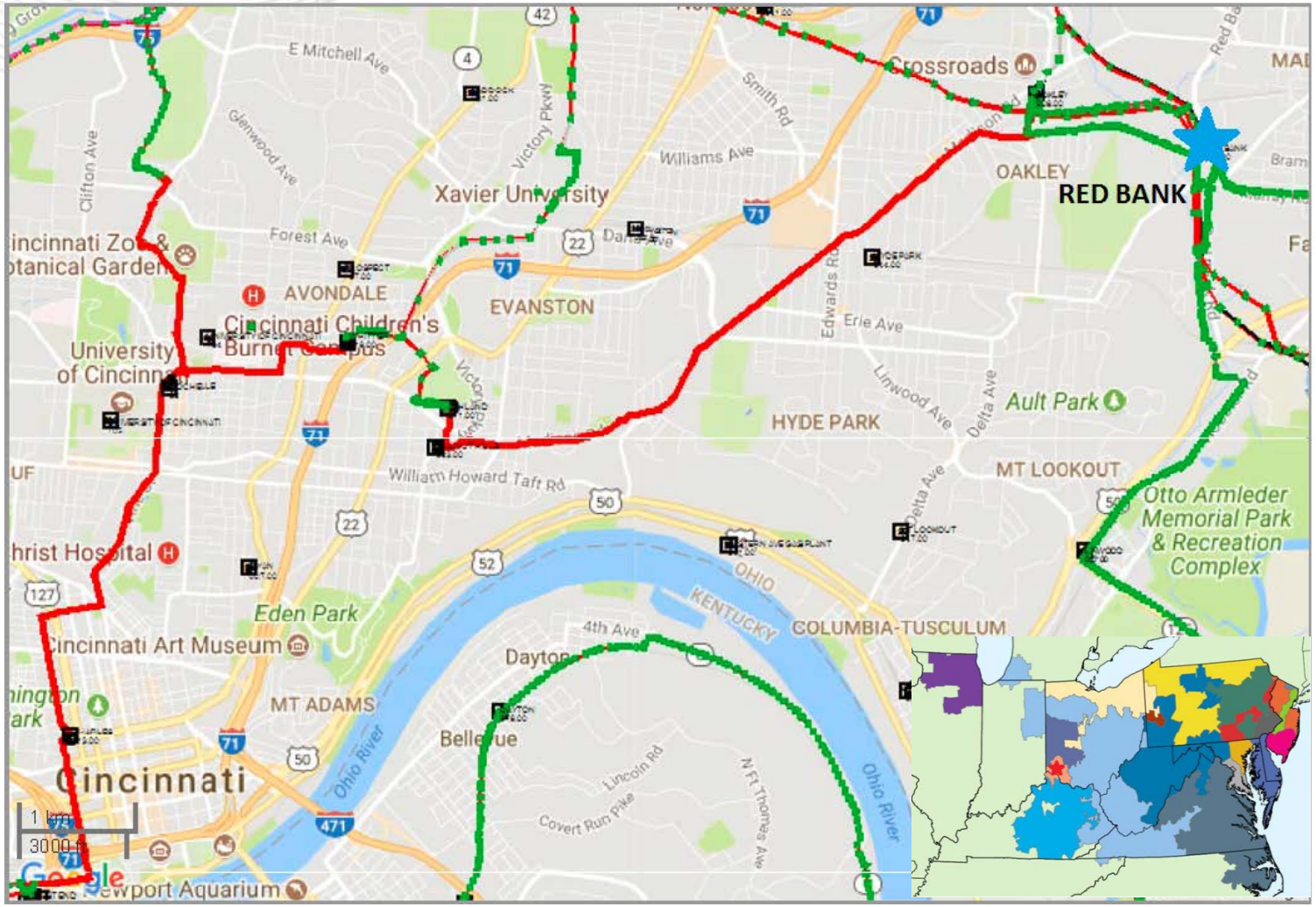
Potential Solution:
Replace the breaker
Driver : Equipment Condition, Performance and Risk
Estimated Cost: $1M

Alternatives:

- None

Projected In-service: 12-31--2018

Project Status: Development



DEOK Transmission Zone: Supplemental
Summerside – Senco 69 kV Feeder Rebuild

Problem Statement:
The 69 kV feeder between Summerside substation to the customer tap at Senco is aged and in deteriorating condition (1970's era).

Potential Solution:
Rebuild 2.9 miles of feeder between Summerside substation and the Senco tap with 54 new structures, hardware, and conductor. Capacity of the line will increase from 99 MVA to 160 MVA.

Driver: Equipment Material Condition, Performance and Risk

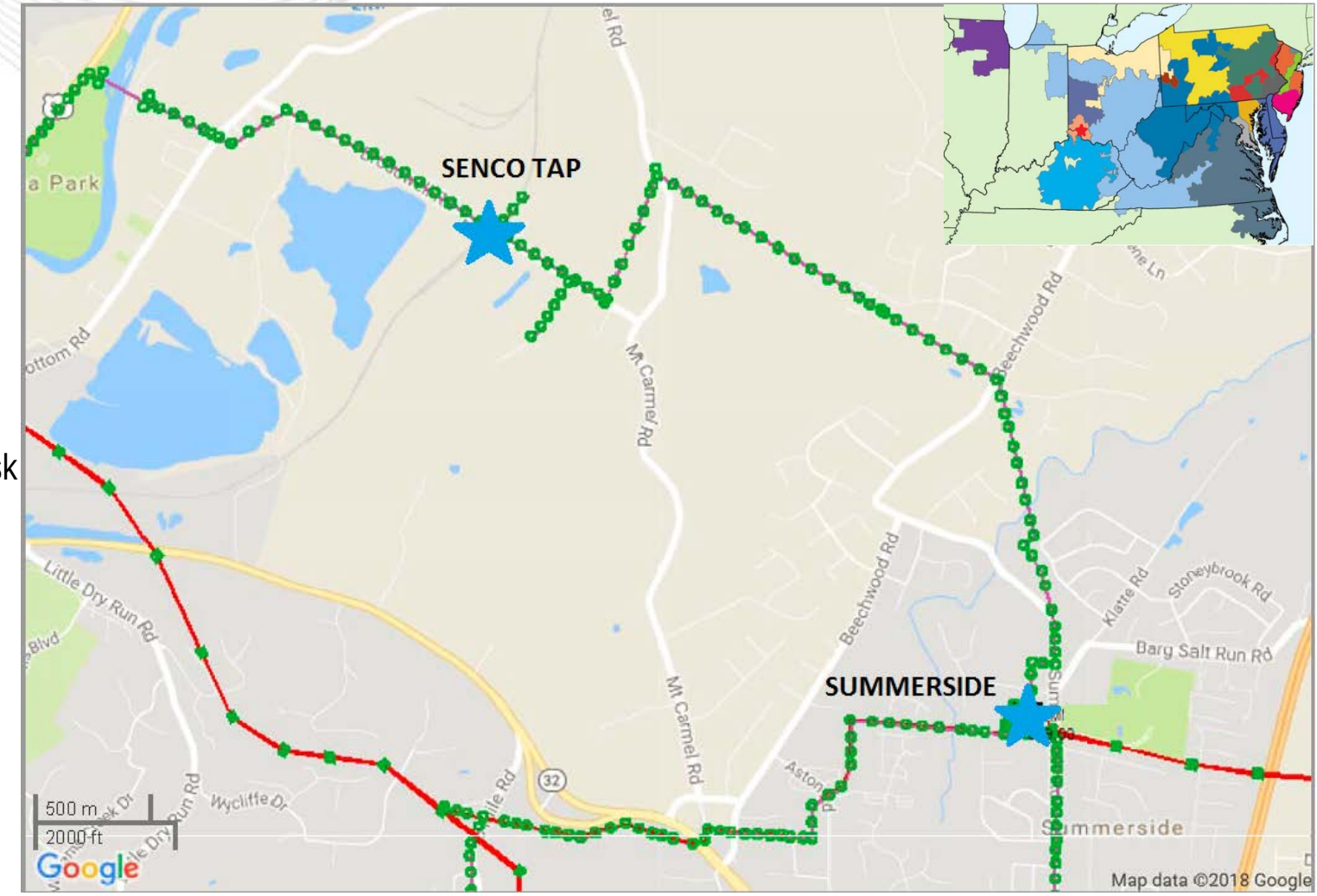
Estimated Cost: $2.95 M

Alternatives:

- none

Projected In-service: 12-1-2018

Project Status: Development



DEOK Transmission Zone: Supplemental Terminal Replace 138/69 kV Transformer

Problem Statement:
Terminal TB2 is a 100 MVA 138/69 kV transformer. It was taken out of service due to oil pump failure. After the pump replacement the transformer would not hold vacuum. During inspection is was found to have multiple leaks, shifted windings and spacers, broken spacers, broken bolts, and insulation and other material was dispersed throughout the tank. Due to the found condition the transformer will not be put back into service. TB2 is 67 years old and was being considered for replacement depending on condition on what was then the future inspection.

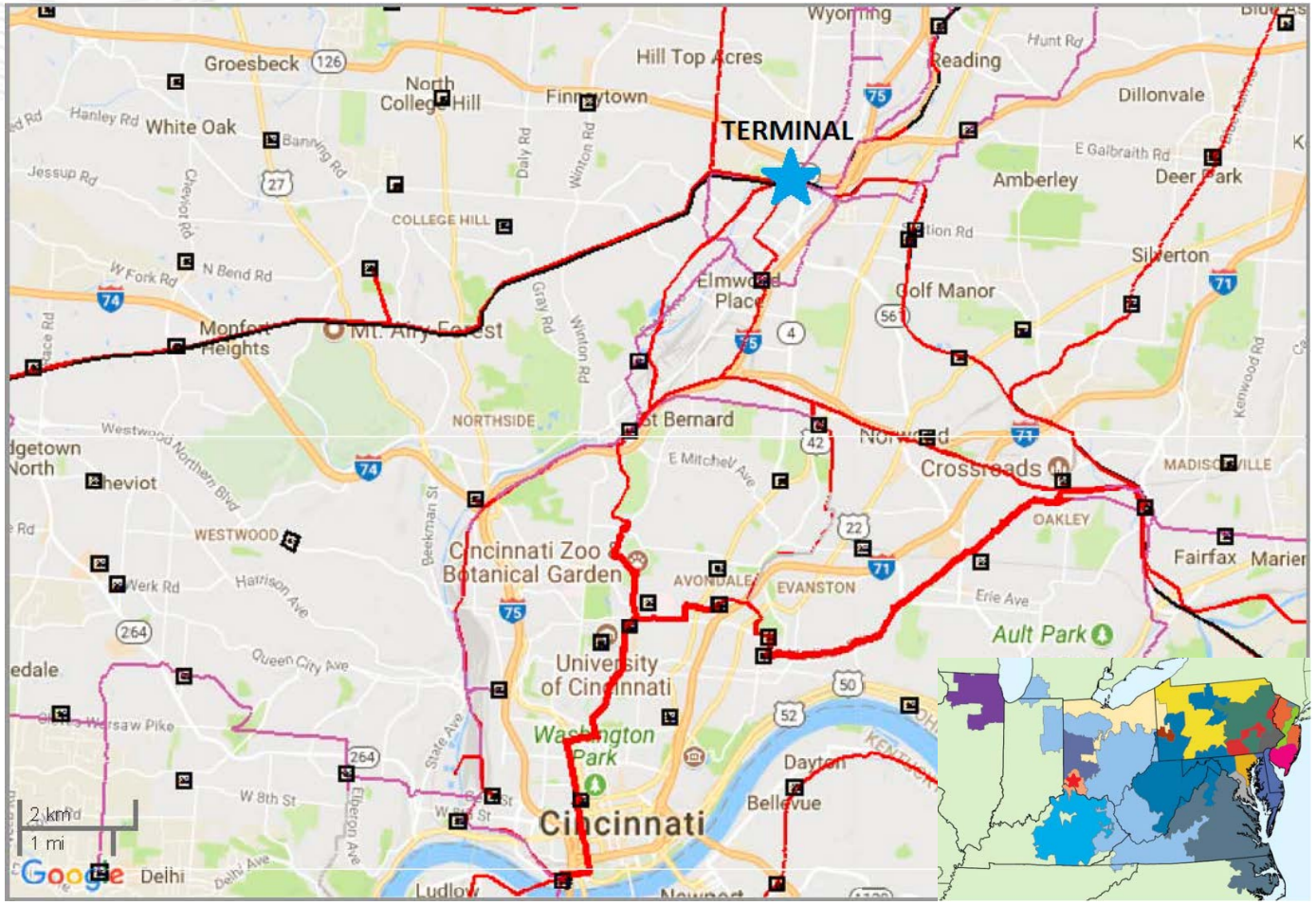
Potential Solution:
Replace the transformer with an existing 100 MVA spare from the Indiana system.
Driver : Equipment Condition, Performance and Risk
Estimated Cost: $1.6 M

Alternatives:

- Replace with 168 MVA Ohio system spare
- Order and wait for replacement (estimated 1 yr lead time). Install 78 MVA mobile; sunk cost of temporary solution, mobile would impede installation of replacement.

Projected In-service: 4-30-2018

Project Status: Engineering



AEP Transmission Zone: Supplemental Boone Breakers

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Boone 46 kV CB's "A", "B", and "C" (vintage 1972) are 1200A 20 kA oil filled circuit breakers without oil containment. Oil breakers have become more difficult to maintain due to the required oil handling. There is an increased potential for oil spills during routine maintenance and failures with these types of breakers. These circuit breakers have operated for 135, 177, and 58 faults respectively. The manufacturers recommended number of fault operations is 10.

Potential Solution

Replace three existing 1200 A 20 kA 46 kV circuit breakers "A", "B", and "C" with new 3000 A 40 kA 69 kV circuit breakers.

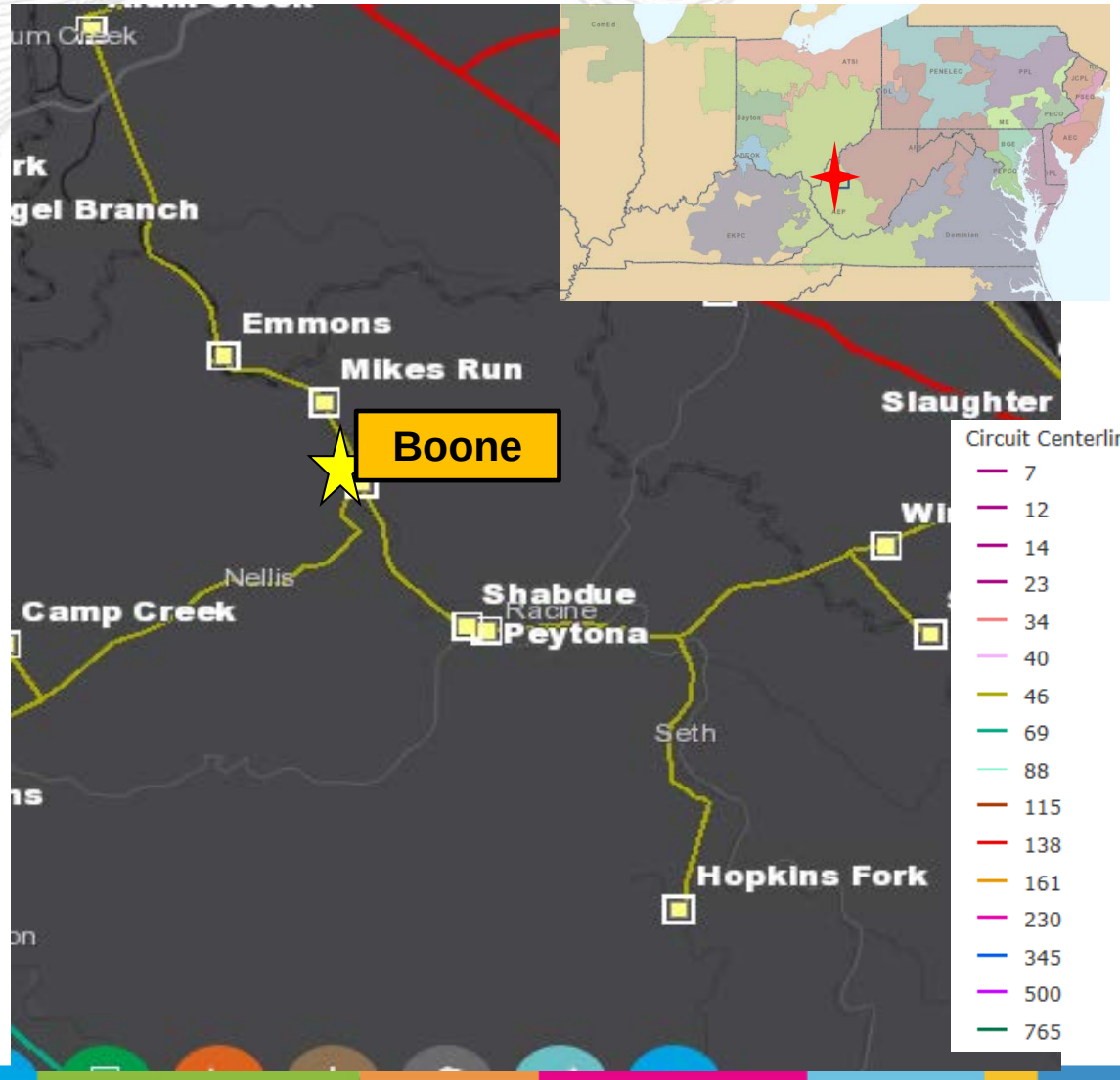
Estimated Cost: $1.5M

Alternatives:

A ring bus configuration was considered, however the existing bus/steel is not showing any signs of deterioration and did not warrant being replaced. Re-configuring the station into a ring configuration would have been cost prohibitive.

Projected In-service: 11/1/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental Heath Breakers

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Several 69 kV circuit breakers at Heath station are showing signs of deterioration. These breakers are all 1200 A 20 kA oil breakers manufactured in 1962 and 1973. Oil breaker maintenance has become more difficult due to the oil handling required to maintain them. Oil spills are frequent with breaker failures and routine maintenance and can become an environmental hazard. The 69 kV circuit breakers “A”, “B”, “C” and “D” have fault operations of 16, 28, 58 and 70 respectively.

Potential Solution

Replace 69 kV circuit breakers “A”, “B”, “C” and “D” with 2000 A 40 kA circuit breakers. Expand the DICM. Remove the 138/34.5 kV 25 MVA transformer #5.

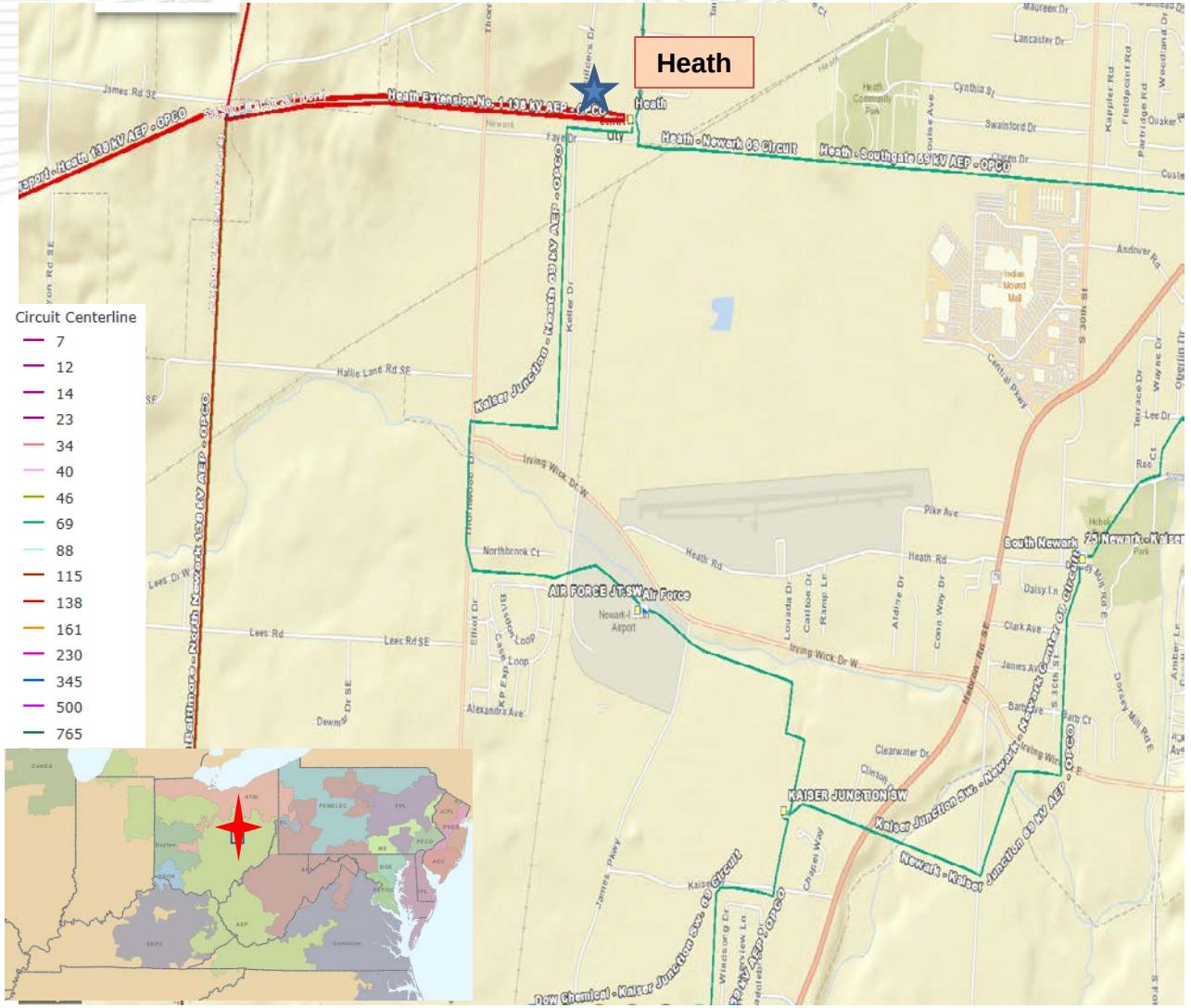
Estimated Cost: $3.9M

Alternatives:

No viable cost-effective alternatives could be identified.

Projected In-service: 06/01/2021

Project Status: Engineering



AEP Transmission Zone: Supplemental
Leslie Station

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The 161/69 kV transformer at Leslie is 36 years old and shows an upward trending of oil moisture content resulting in downward trending to the oil dielectric strength. Increasing moisture content is a result of water ingress and break down of paper insulation of TF windings. Short circuit strength breakdown caused by through fault events has lead to gassing of the unit, and carbonization of the insulating paper. All of this indicates that the transformer is in need of replacement. A spare transformer (non-switchable) for the station is also being purchased as this is the sole 161/69 kV transformer on AEP's eastern footprint.

161 kV circuit breaker "K" at Leslie station is a HVB242 type breaker. HVB's have a history of slow reclosing due to documented issues associated with their air receivers and control valves. Currently there are only nine breakers of this type in service on the AEP system. Parts for the breaker are hard to come by and are no longer available through the manufacturer. The breaker in question has external rust issues which resulted in a failure to reclose properly in the past. The breaker has experienced 141 fault operations exceeding the manufacturer recommendation number of 10.

Potential Solution

Replace existing 90 MVA 161/69 kV transformer with a new 130 MVA 161/69 kV transformer. A second 161/69 kV transformer will be purchased as a non--switchable spare on site. 161 kV 3000 A 50 kA circuit breaker "K" will be replaced with a new 3000 A 40 kA 161 kV circuit breaker.

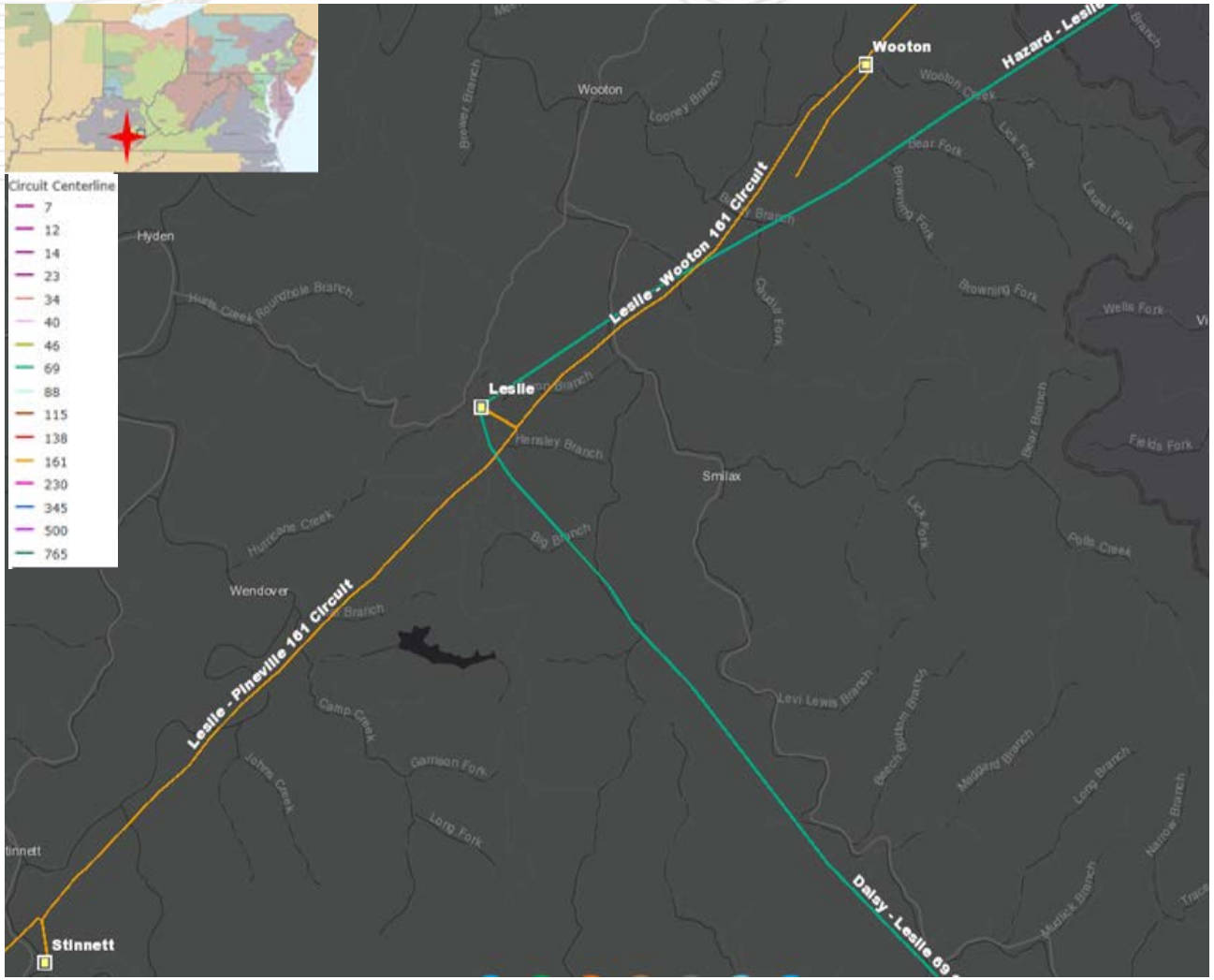
Estimated Cost: $6.3M

Alternatives:

No viable cost-effective alternatives could be identified.

Projected In-service: 08/01/2020

Project Status: Engineering



AEP Transmission Zone: Supplemental
Notre Dame Station

Problem Statement:

Customer Service:

The University of Notre Dame (UND) has requested a service upgrade to accommodate an increase in load and upgrades to its current station. UND currently has (2) 138/4 kV transformers and it will be upgrading its station and adding (2) additional 138/12 kV transformers. To accommodate the customer upgrades and reduce the customer exposure to 138 kV line faults, AEP proposes the installation of a bus tie breaker and in-and-out service.

Potential Solution

Remove Notre Dame's 3 way switch and build the station into an in and out configuration with a bus tie 138kV 3000A 40kA breaker

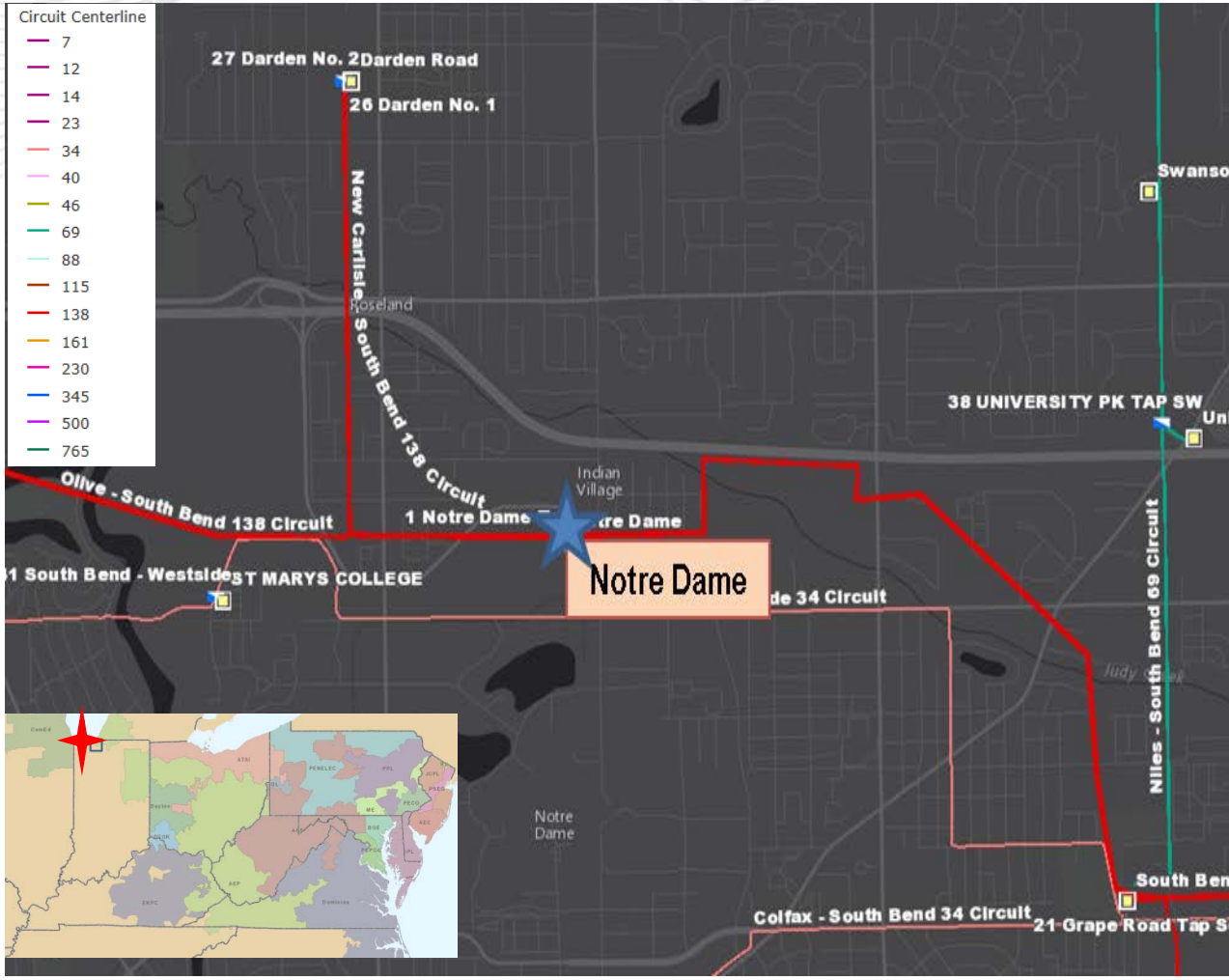
Estimated Cost: $3.1M

Alternatives:

No viable cost-effective alternatives could be identified.

Projected In-service: 10/01/2018

Project Status: Scoping



AEP Transmission Zone: Supplemental
Osolo Area

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Transformer #1 138/69/34.5kV 50 MVA at East Elkhart Station manufactured in 1968 and transformer #1 138/69/34.5kV 50 MVA at Osolo Station manufactured in 1961 will be replaced because of breakdown in dielectric strength (winding insulation), short circuit strength (winding short circuit strength breakdown due to magnitude of short circuit fault events), oil quality issues and accessory problems (bushings, pumps etc.). Transformer Grounding banks manufactured in 1956 and 1961 will be replaced at both East Elkhart and Osolo Station.

34.5 kV 1200A 1500MVA Circuit Breaker N at East Elkhart Station, manufactured in 1965, has experienced 33 fault operations. 34.5 kV 1200A 1500 MVA Circuit Breakers A and B at Osolo Station, manufactured in 1950, have experienced 45 and 38 fault operations respectively. These Circuit Breakers are oil filled Breakers and oil filled breaker maintenance has become more difficult due to the oil handling required to maintain them. Oil spills are frequent with breaker failures and routine maintenance and can become an environmental hazard. The breakers have numerous issues related to age, bushing damage, maintenance issues and no repair part availability. They also have numerous fault operations. The 138 kV Circuit Breakers and Circuit Switcher on the high side of the 138/69/34.5 kV transformer #1 will be installed at Osolo Station to get rid of the three terminal line and provide improved reliability to the 40 MVA Distribution load.

Operational Flexibility and Efficiency

Operational bus tie switches cause the protection scheme to be split which leads to mis-operations. Because of this, AEP will be addressing these whenever entering a station. In this case, a breaker is required to take the place of the bus tie switch to ensure the load's recoverability for a bus outage.

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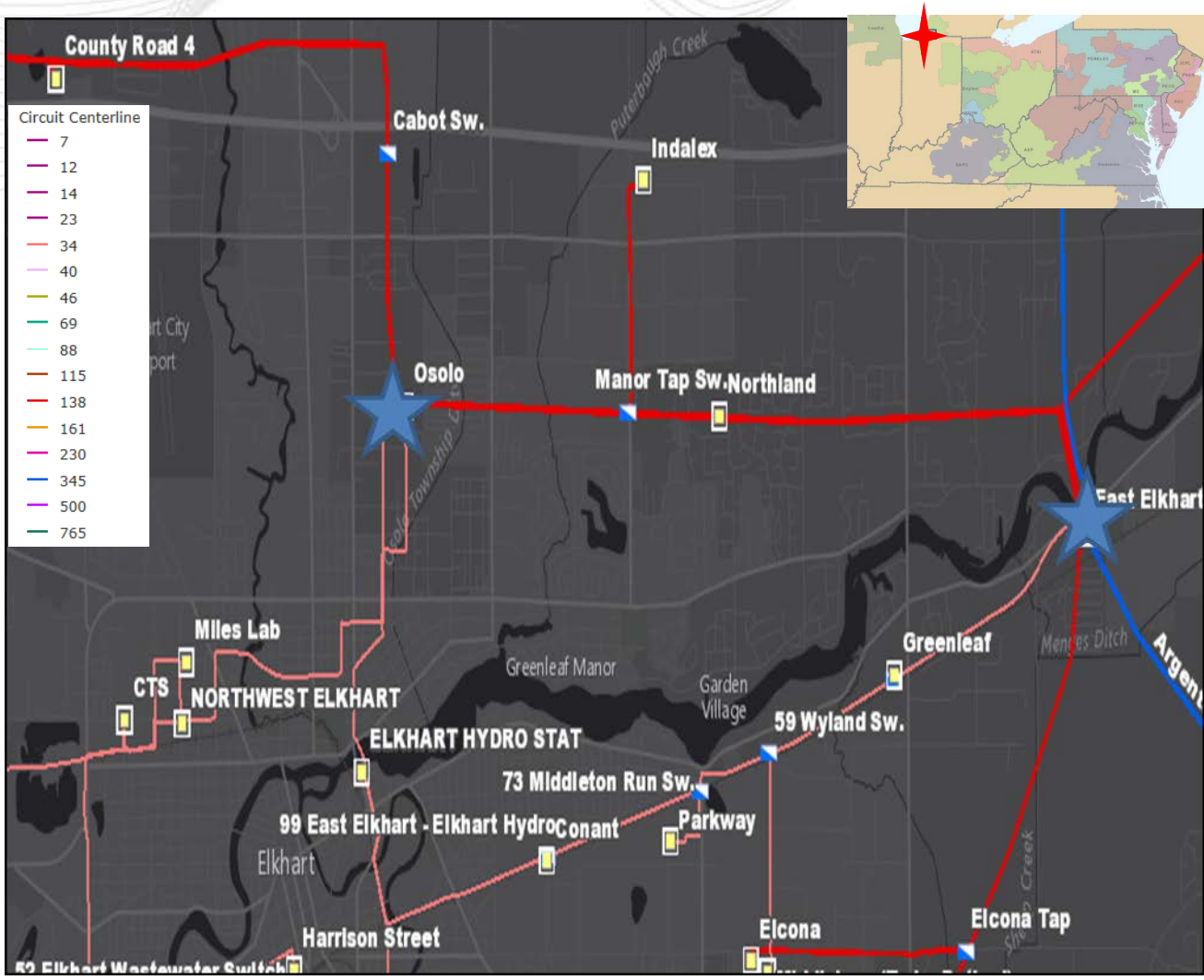

AEP Transmission Zone: Supplemental
Osolo Area

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Potential Solution

At Osolo station, replace 34.5kV breakers “A” and ”B” with Alstom 1200A 69kV 40kA breakers. Replace transformer 1 with a 138/69/34.5 75 MVA unit and install a high side circuit switcher. Install two line breakers and a bus tie breaker in between the two loads utilizing 3000A 138kV 40kA breakers.

Estimated Cost: $7.6M

At East Elkhart station, replace transformer 2 with a 138/69/34.5kV 75MVA transformer Replace breaker “N” with a 3000A 40kA 69kV breaker.

Estimated Cost: $4.5M

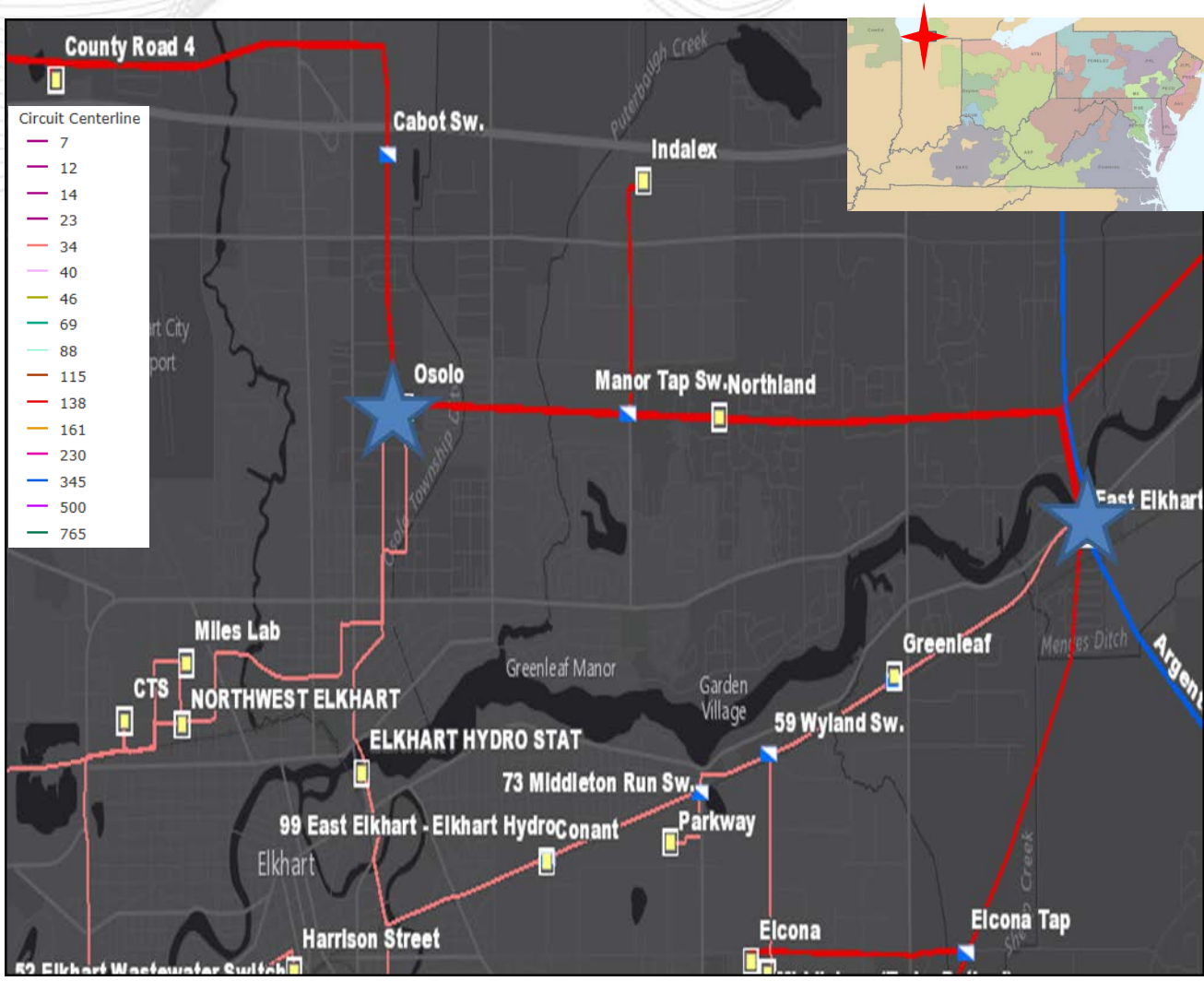
Total Estimated Transmission Cost: $12.1M

Alternatives:

Installing a five breaker ring bus at Osolo station is an alternate but because of Distribution constraints this option was not considered.

Projected In-service: 04/10/2020

Project Status: Scoping



AEP Transmission Zone: Supplemental
Tulip Road-West Side Rebuild

Problem Statement:

Equipment Material/Condition/Performance/Risk:

On the Tulip Road-West Side 34.5 kV line is estimated to be around 1934 vintage, constructed with 4/0 copper and 336 aluminum conductor (27 MVA rating). It is constructed from wood poles which are currently subject to 160 conditions including but not limited to, broken conductor hardware; broken, top rotted, split and twisted crossarms; broken and missing ground lead wires; damaged insulator; and damaged, leaning, rotted and split poles;

Operational Flexibility and Efficiency

Grandview is currently hard tapped on the Tulip Road – West Side line. This means that any time AEP wants to maintain this line, the Grandview interconnection would have to be disconnected. While this project does not eliminate the tap, it sets the line up so that it can be replaced with a switching structure in a future project while simultaneously reducing the length of the line exposed to the hard tap.

Potential Solution

Rebuild from Tulip Road to Grandview station utilizing 7.4 miles of single circuit 765 ACSR (64 MVA rating) built to 69kV but energized at 34.5kV. From Grandview – West Side, build 1.2 miles of double circuit 795 ACSR built to 69kV but operated at 34.5kV. Remove the emergency switch toward Bendix station. Remove the Grandview hard tap and feed the station radially from West Side.

Estimated Cost: $17.2M

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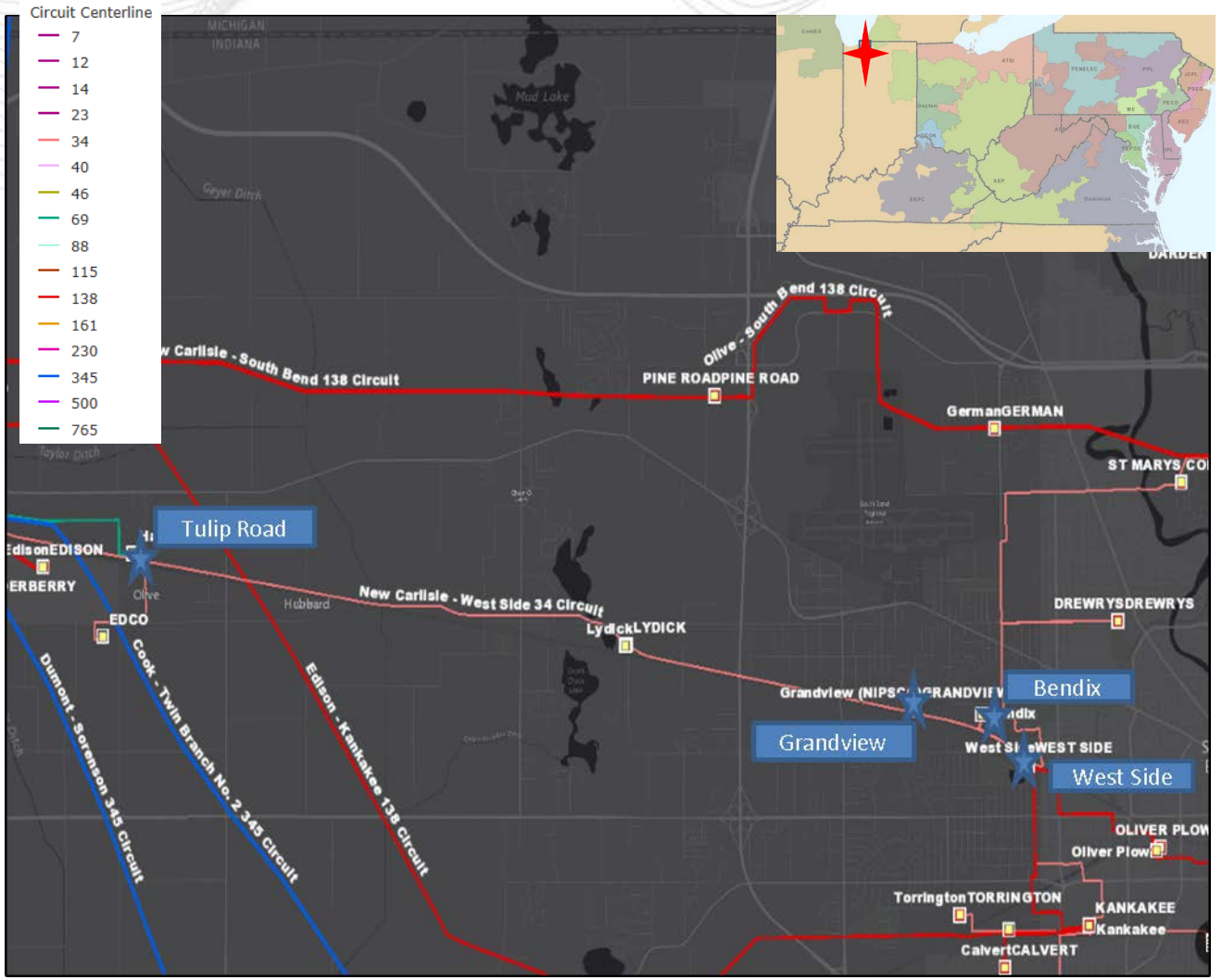

AEP Transmission Zone: Supplemental
Tulip Road-West Side Rebuild

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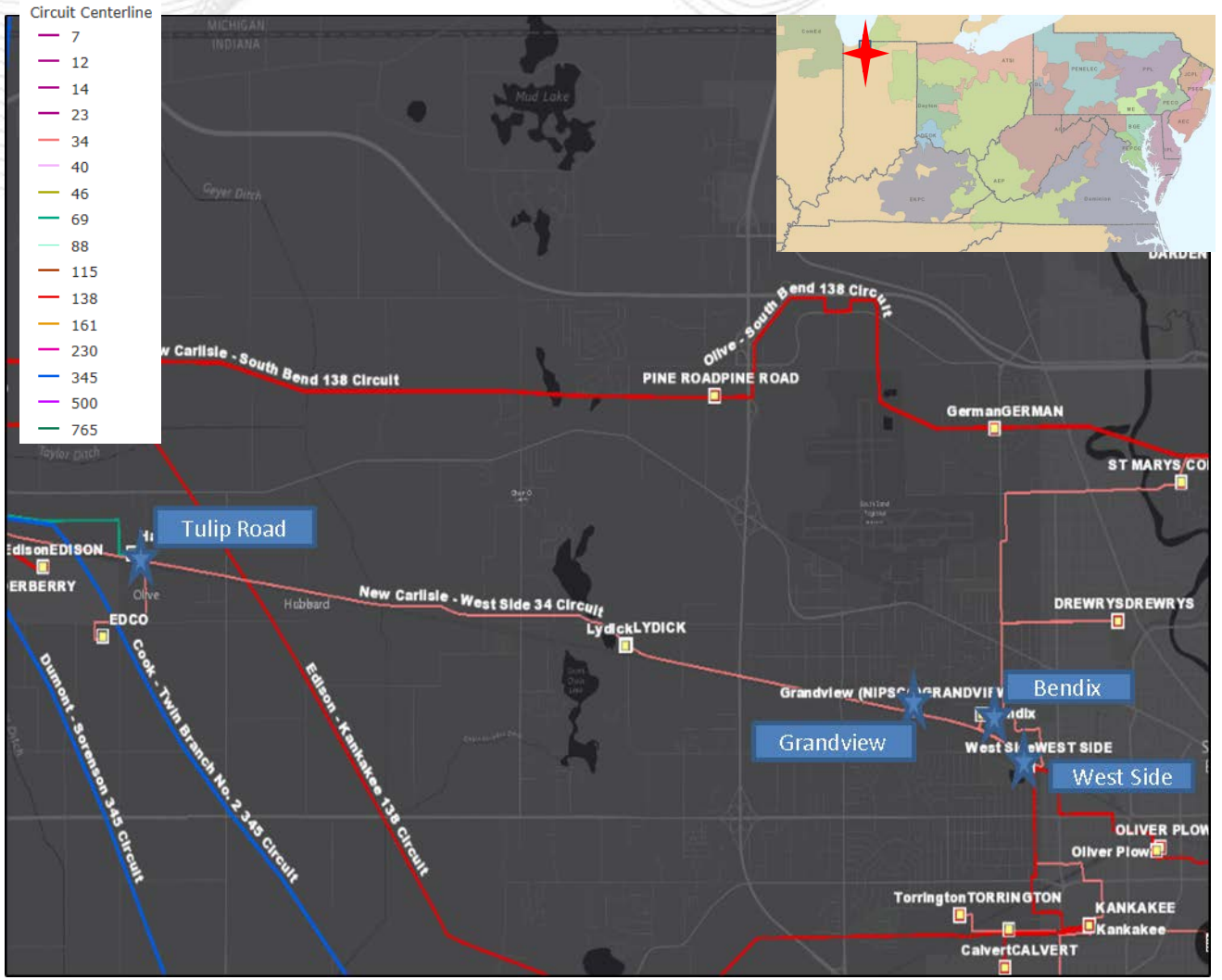
Alternatives:

Build roughly .1 miles of line to bring the Grandview tap into Bendix station. While this would eliminate the three terminal line, Bendix station is located in the middle of an industrial park and would not be able to add another line exit cost effectively. Due to this, and due to the fact that the NIPSCo tie is already normally open, this option was not chosen. This option also does not address the needs on the line.

Build line in the clear to reduce outages. Due to ability to take outages on this line, and the increased right of way cost associated with building in the clear, this is not recommended.

Projected In-service: 11/30/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental Conesville-Cyclops

Problem Statement:

Equipment Material/Condition/Performance/Risk:

This project is an extension of the adjacent Ohio Central-Conesville 69kV transmission line rebuild (11.8 miles) and Ohio Central 138-69KV transformer upgrade, which resolve thermal overloads (PJM Baseline #B2797). This project will rebuild the remaining 1.8 miles of the 69kV circuit between Conesville-Cyclops. After the associated Baseline line rebuild, this 1.8 mile section is loaded to 96% SE for the worst contingency (70 MVA loading/73 MVA rating, leaving only 3 MVA of margin for future area load growth). Cyclops station serves a stainless steel plant.

Customers served from this circuit (2- AEP distribution stations and 1- rural co-op station) experienced 2.02 million minutes of interruption (CMI) over the 2014-16 time period, or equivalently 8 hours of outage-duration per customer.

This 1.8 mile line section was built in 1948 on wood poles that are in poor condition with 336 ACSR conductor (73 MVA rating). The T-line currently has five reported conditions. Proactively upgrading this 1.8-mile line section at the same time as the adjacent Baseline rebuild results in construction and outage-scheduling synergies.

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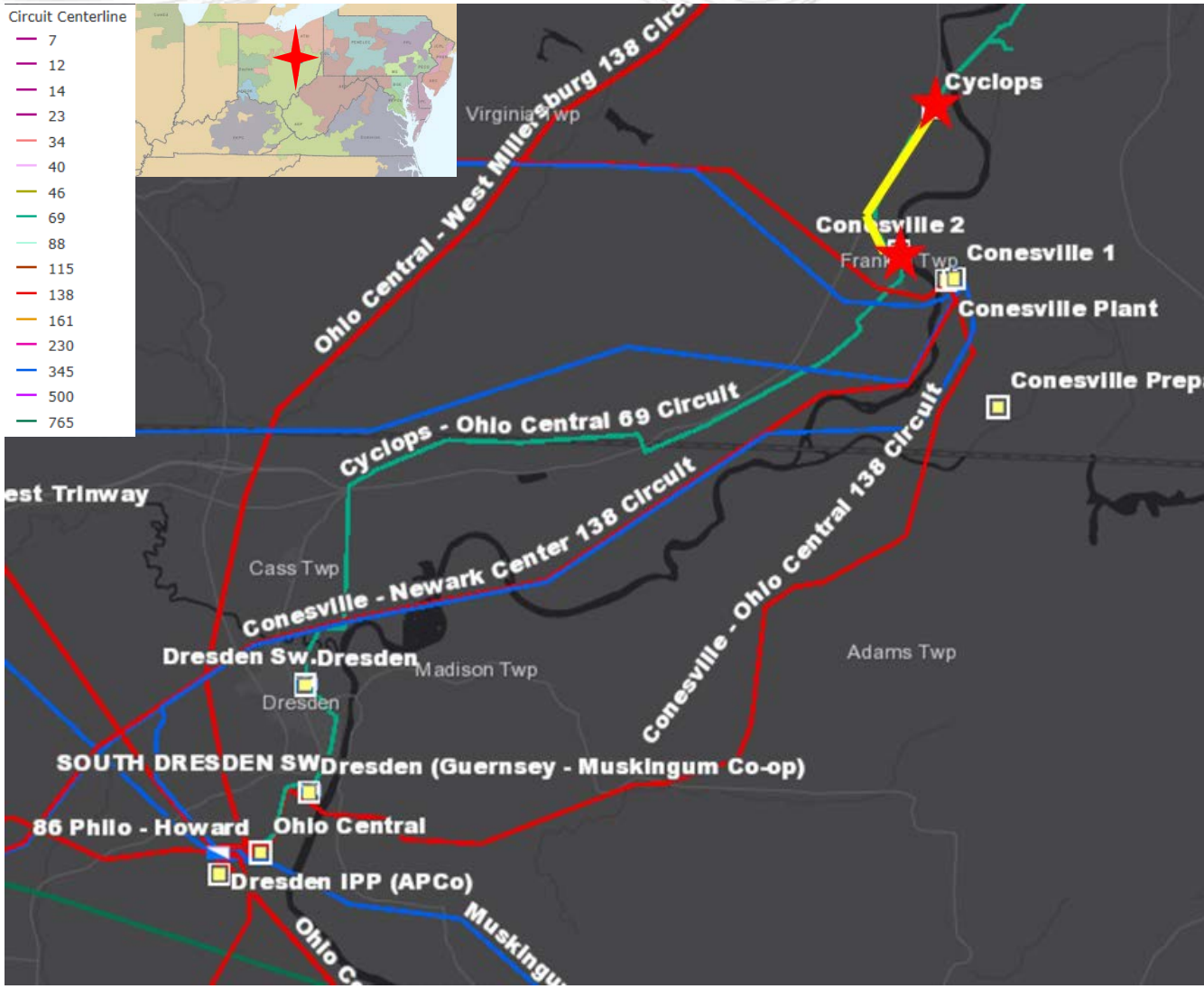

AEP Transmission Zone: Supplemental Conesville-Cyclops

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Potential Solution

Rebuild 69kV transmission line from Conesville station to Cyclops station (1.8 miles) with 795 ACSR conductor (125 MVA rating). Update & modify right-of-way to accommodate the rebuild. Remove the old T-Line.

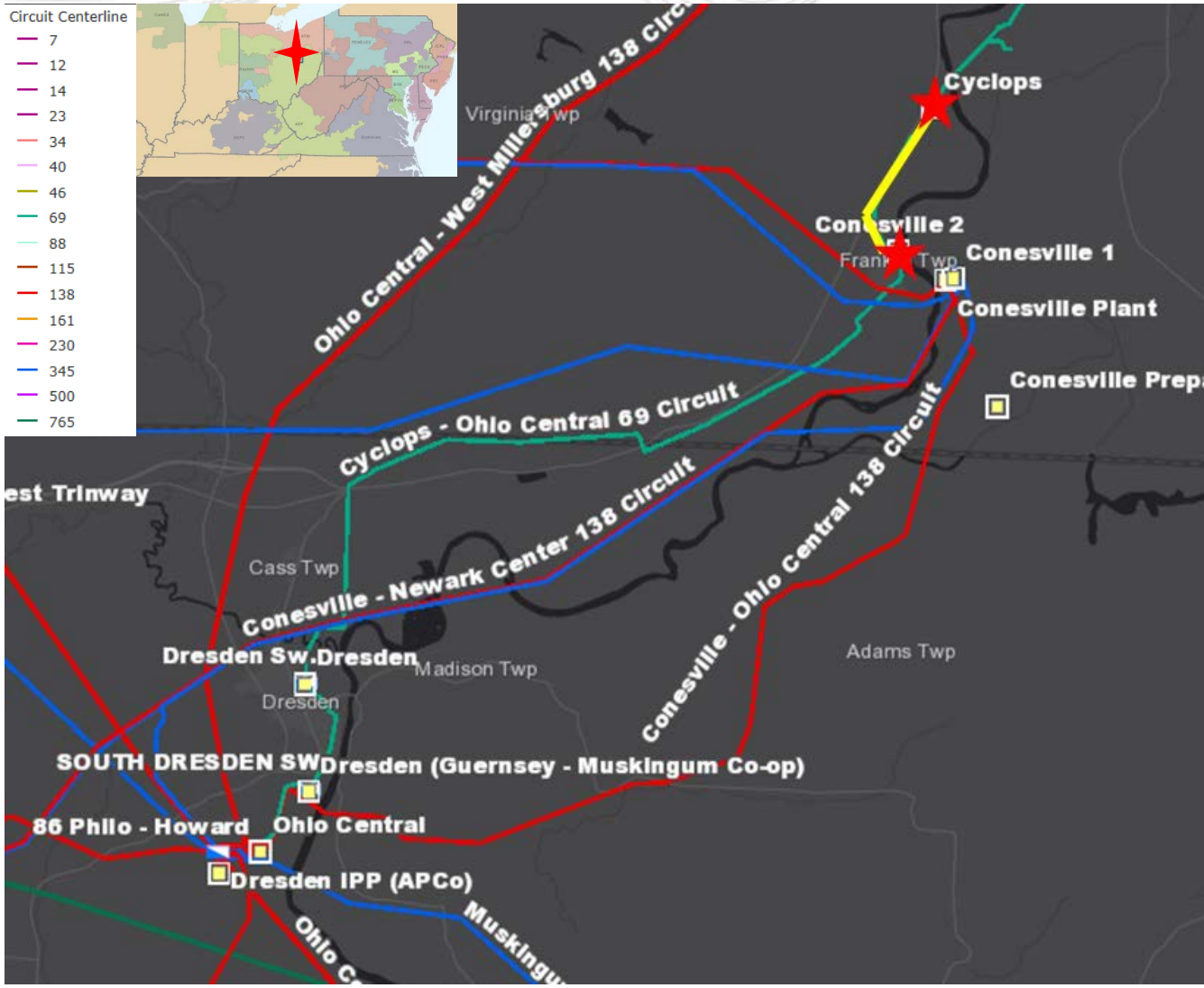
Estimated Cost: $2.2M

Alternatives:

No viable cost-effective alternatives could be identified.

Projected In-service: 12/01/2019

Project Status: Engineering



Second Review

Baseline Reliability and Supplemental Projects

From December 2017 Slide Deck

AEP Transmission Zone: Supplemental
Anchor Hocking - Price Rebuild

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

From 2013-2016, this circuit has had 3 permanent outages mainly due to T-Line related issues and accumulated 215,119 CMI. Due to the historical performance of this line, replacement of the 6.5 mile section is recommended.

This line has a vintage of 1951, is wood pole construction with 4/0 ACSR conductor (50 MVA rating), and has 20 open conditions. The original poles, crossarms and support braces are undersized in terms of both height and strength with respect to current standards, and may not be able to sustain higher wind speeds. In addition, many of the poles are constructed using crossarms with suspension insulator assemblies which have proven to be susceptible to failures across AEP footprint and are not part of AEP's current standards. The life expectancy of these crossarms is far less than the poles and requires constant replacement. The line currently uses 3#8 Copperweld shield wire which is also obsolete and very difficult to repair and splice due to lack of availability. Finally, the line is currently only grounded at every other pole, which increases safety risk to personnel and general public.

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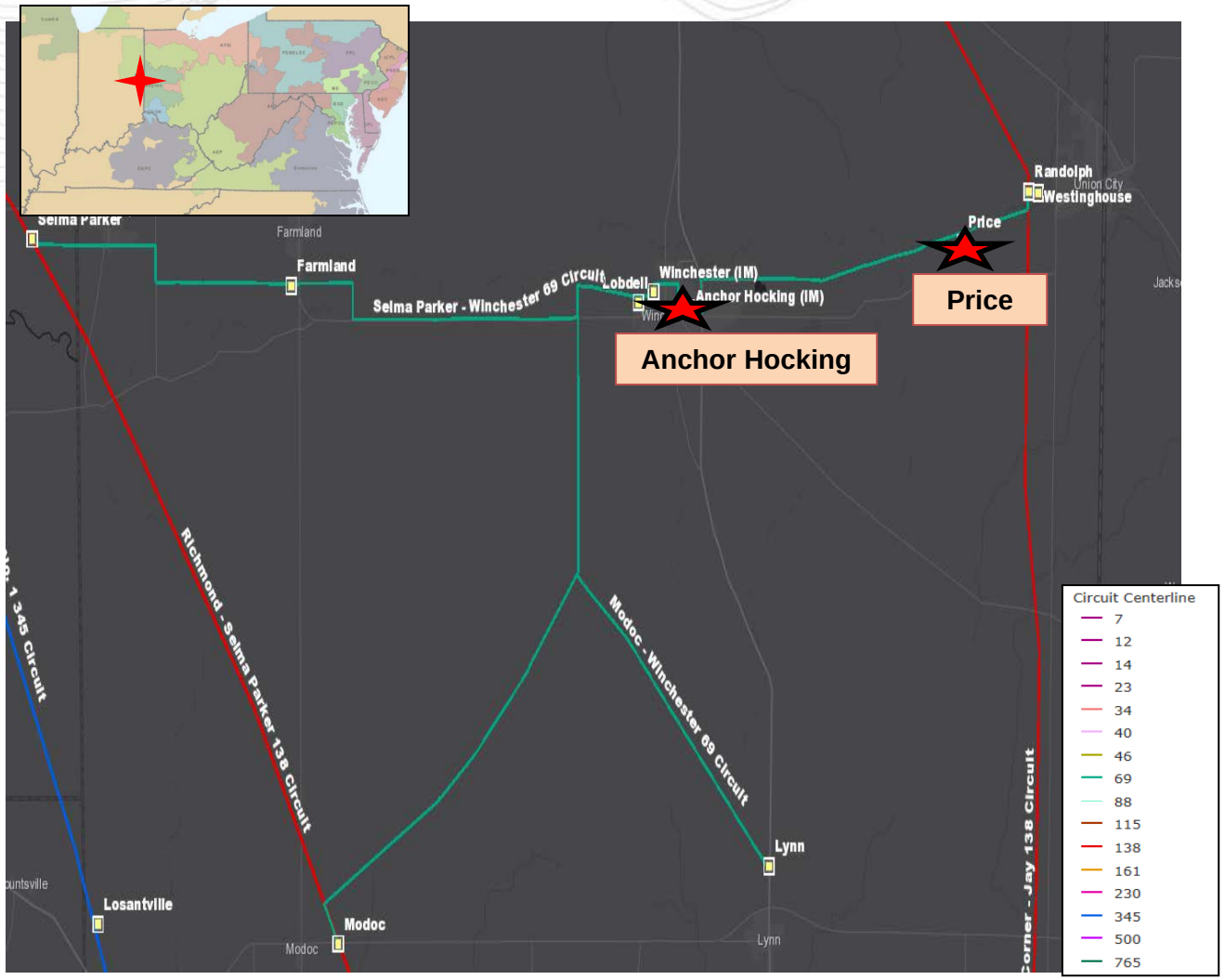


AEP Transmission Zone: Supplemental
Anchor Hocking - Price Rebuild

Continued from previous slide…

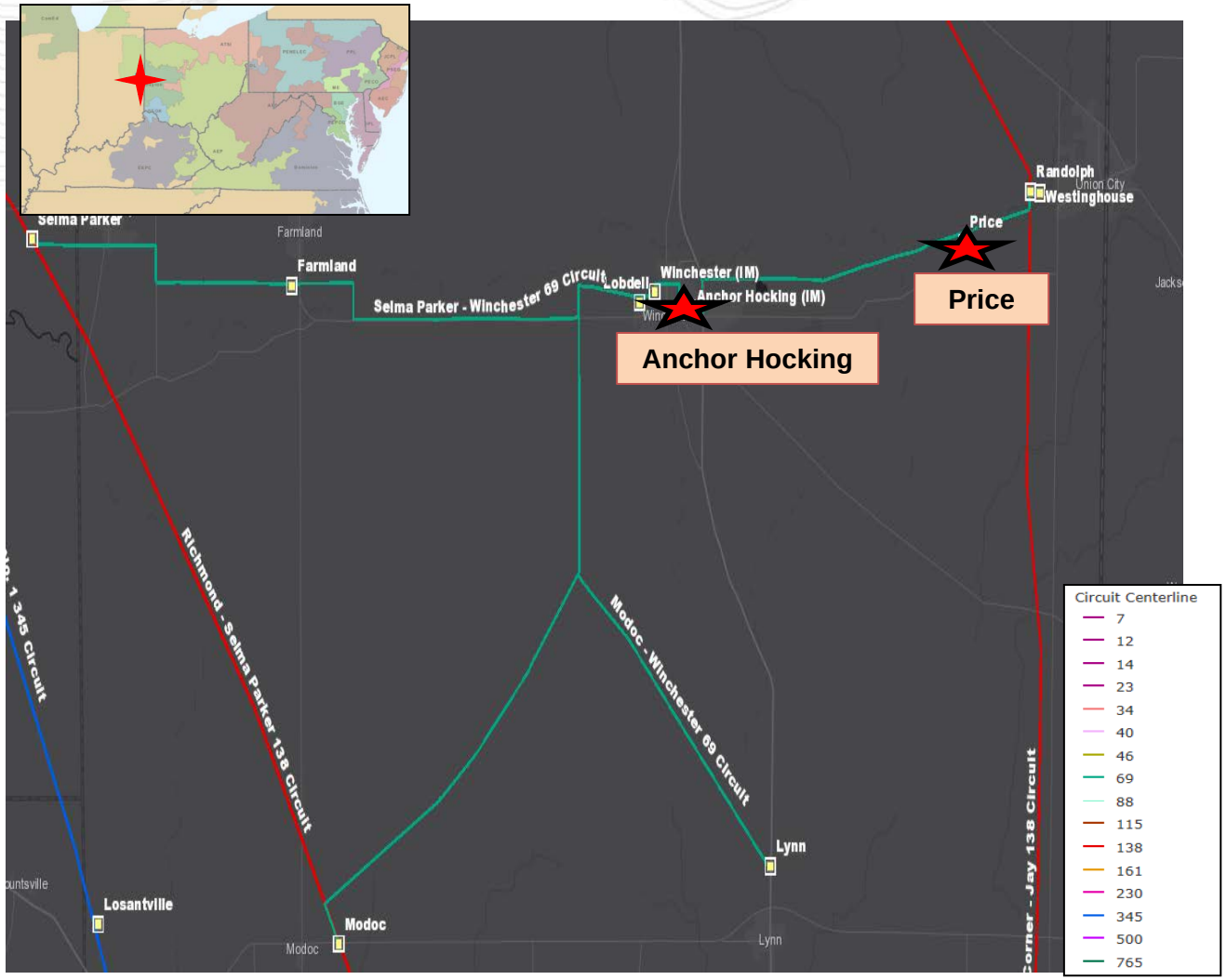
Selected Solution:

Rebuild from Structure 1 near Anchor Hocking Station to structure 139A near Price station (~6.5 miles) using 556.5 ACSR 26/7 (SN:102 SE:141 WN:129 WE:159) (S1508)

Total Estimated Transmission Cost: $10.6M

Projected In-service: 12/01/2019

Project Status: Scoping



AEP Transmission Zone: Supplemental
Carbondale - Tower 117 Rebuild

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

From 2013 – 2016 the Carbondale – Tower 117 69 kV (vintage 1938) circuit has experienced 23 permanent and 8 momentary outages resulting in over 3.4M customer minutes of interruption. 5.6 miles of this line has no shielding, which leaves it susceptible to outages due to lightening. AEP's Transmission Line Engineering group has determined shielding cannot be added to the existing structures In addition, the 9.8 miles we are rebuilding (out of a total of 21.1 miles) have 23 current open A conditions on 79 structures of single circuit wood pole construction. These conditions consist of rotted/broken poles, rotted/broken crossarms, damaged shield wires, burnt poles, and woodpecker/insect damage. The conductor on the sections being rebuilt varies in size from 3/0 ACSR, 4/0 ACSR, and 556 ACSR (44 MVA rating). The original conductor over the course of its 79 year life has endured multiple contacts and severe weather conditions.

The existing 600 A phase over phase (P.O.P.) switch will be replaced with a 1200 A P.O.P. due to the line rebuild at Gauley Mountain.

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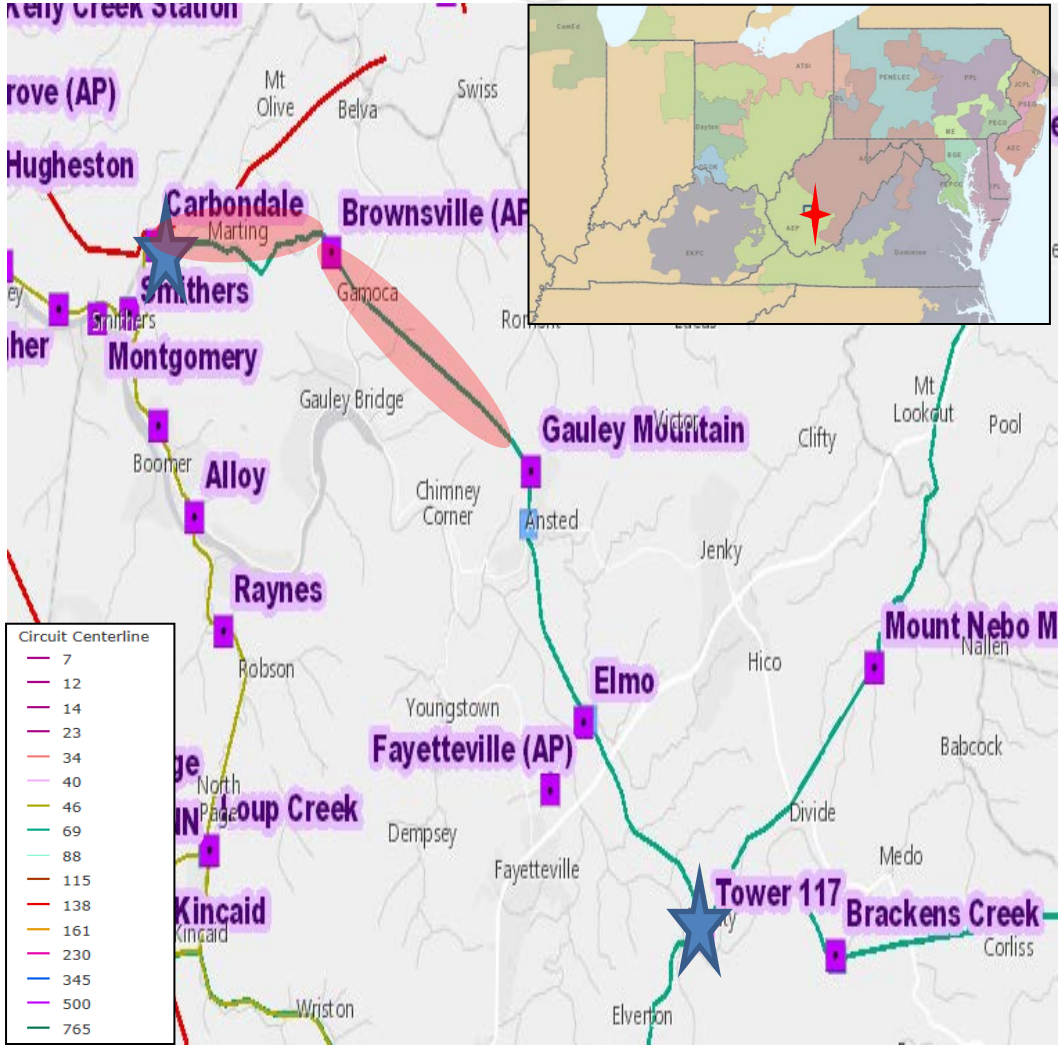


AEP Transmission Zone: Supplemental
Carbondale - Tower 117 Rebuild

Continued from previous slide…

Selected Solution:

Rebuild ~4 miles of the Carbondale – Brownsville 69 kV line utilizing 795 ACSR conductor (125 MVA rating) at 69 kV standards with steel equivalent H frame structures. Rebuild ~5.6 miles of the Brownsville – Gauley Mountain 69 kV line utilizing 795 ACSR conductor at 69 kV standards with steel equivalent H frame structures. Rebuild 0.1 miles of the Elmo – Tower 117 69 kV line over route 19 with 795 ACSR conductor at 69 kV standards. (S1509.1)

Estimated Cost: $25.5M

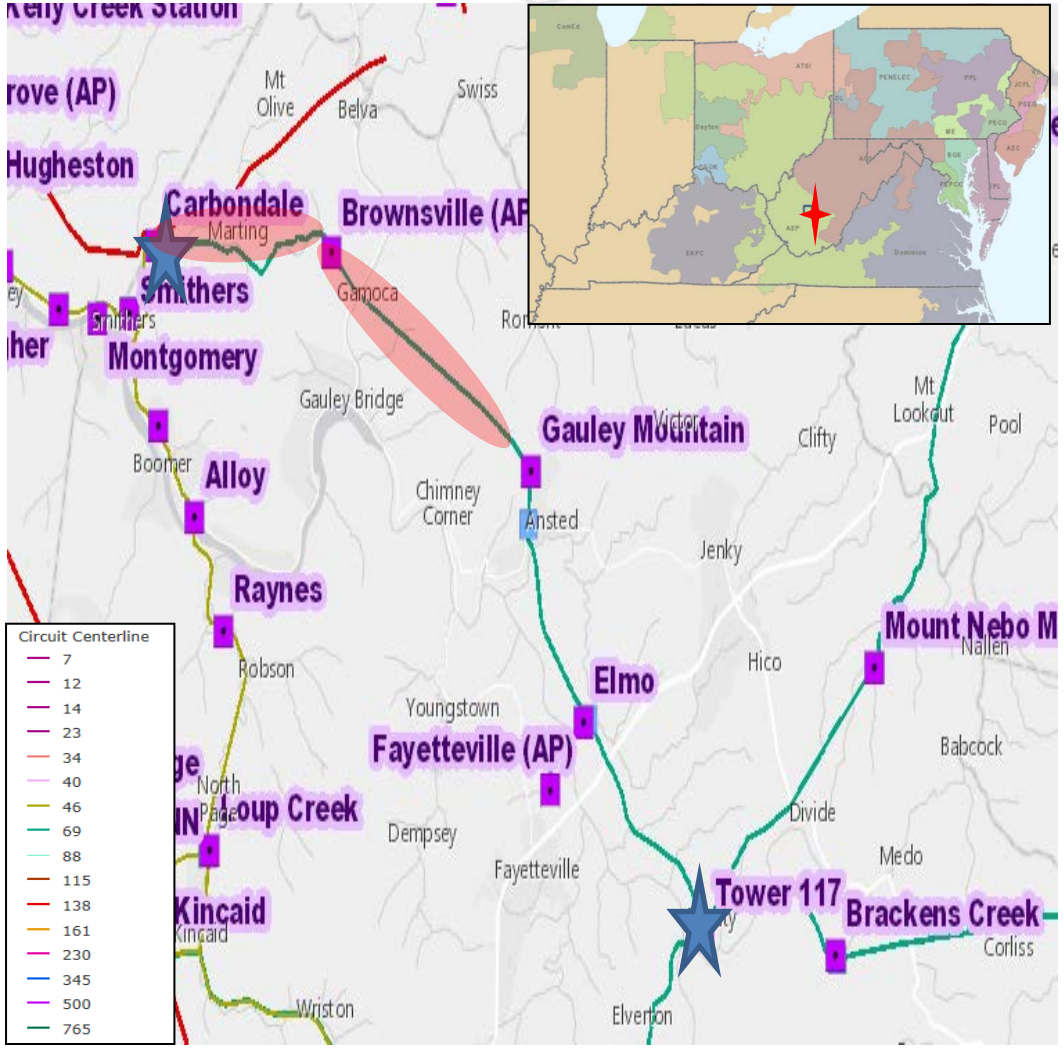
Replace Gauley Mountain switches with a new 3 way motorized Phase Over Phase structure. (S1509.2)

Estimated Cost: $0.5M

Total Estimated Transmission Cost: $26.0 M

Projected In-service: 12/01/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental
Kirk Rehab and Upgrades

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Several circuit breakers at Kirk station are showing signs of deterioration. These breakers are all (with the exception of CB 106N) oil breakers installed in 1975. Oil breaker maintenance has become more difficult due to the oil handling required to maintain them. Oil spills are frequent with breaker failures and routine maintenance and can become an environmental hazard. CB 106N is an SF-6 breaker manufactured in 1986. To maximize cost effectiveness, CB 106N will be replaced at the same time. The drivers for replacement of these breakers are bushing damage, no repair part availability, number of fault operations, system impact scoring, and trouble report scoring. The following CB's will be replaced: 102S, 102C, 106S, 106C, & 106N. CB 102N will be retired.

Transformers 1 and 4 are also showing signs of deterioration. Drivers for Transformer 1 replacement include accessory damage (bushings), dielectric strength breakdown (winding insulation), and short circuit strength breakdown (due to the amount of through fault events). Drivers for Transformer 4 replacement include those same drivers associated with Transformer 1 with the addition of high temperature scoring (winding thermal condition).

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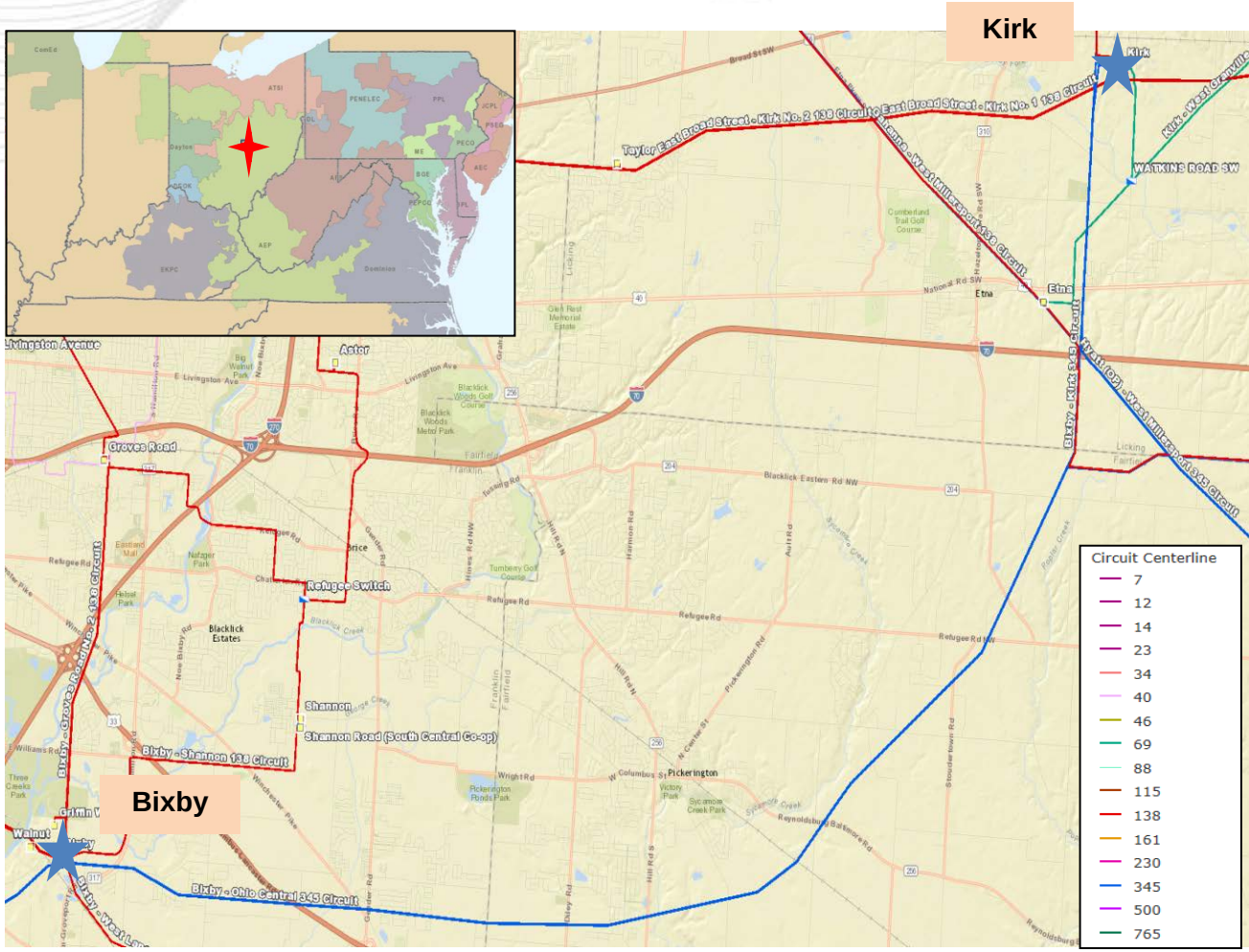

AEP Transmission Zone: Supplemental Kirk Rehab and Upgrades

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Operational Flexibility and Efficiency:

Transformer #4's high side lead and the 345kV bus #1 are combined into the same protection zone such that a XF#4 fault intermittently outages all three of the 345kV lines until MOAB X4 opens (this is undesirable for EHV).

In order to protect a XF#4 fault condition involving a breaker failure scenario on any of the three 345kV breakers, a high speed ground switch on the 345kV (Z4) is required. Intentionally putting faults on the 345kV system is not desirable and non-standard.

The 345kV XF#4 high side lead differential relays limit the WE rating of all three 345kV lines. This is not desirable for a relay thermal to limit EHV lines and the condition cannot be improved without replacing the relays.

A fault in XF#1 or XF#2 or the 138kV high side lead, will outage both XF#1 and XF#2 since their protection zones are combined. By separating them, a fault in XF#1 will no longer affect XF#2 and vice versa. The current scheme requires a ground switch in order to clear low side XF#1 faults with the combined transformer configuration. There is currently only one relay system providing protection for the 138kV lead between CB-106N/106C and the XF high sides (non-standard). At 138kV our current standard calls for redundant systems. It is also difficult to do maintenance on this single relay system without taking outages on XF#1 and XF#2 which is also undesirable.

A breaker failure on CB-102C, CB-102N, CB-E, CB-D, or CB-C will outage all of Kirk's 345kV. This is not desirable as Kirk is a critical station in the East Columbus area.

East Broad St. circuit #2 and West Hebron circuit are radially fed from the 103S and 105C CB's respectively. Reliability and circuit breaker flexibility for these circuits and the 138kV yard as a whole will be improved by adding CB's and completing the through path strings.

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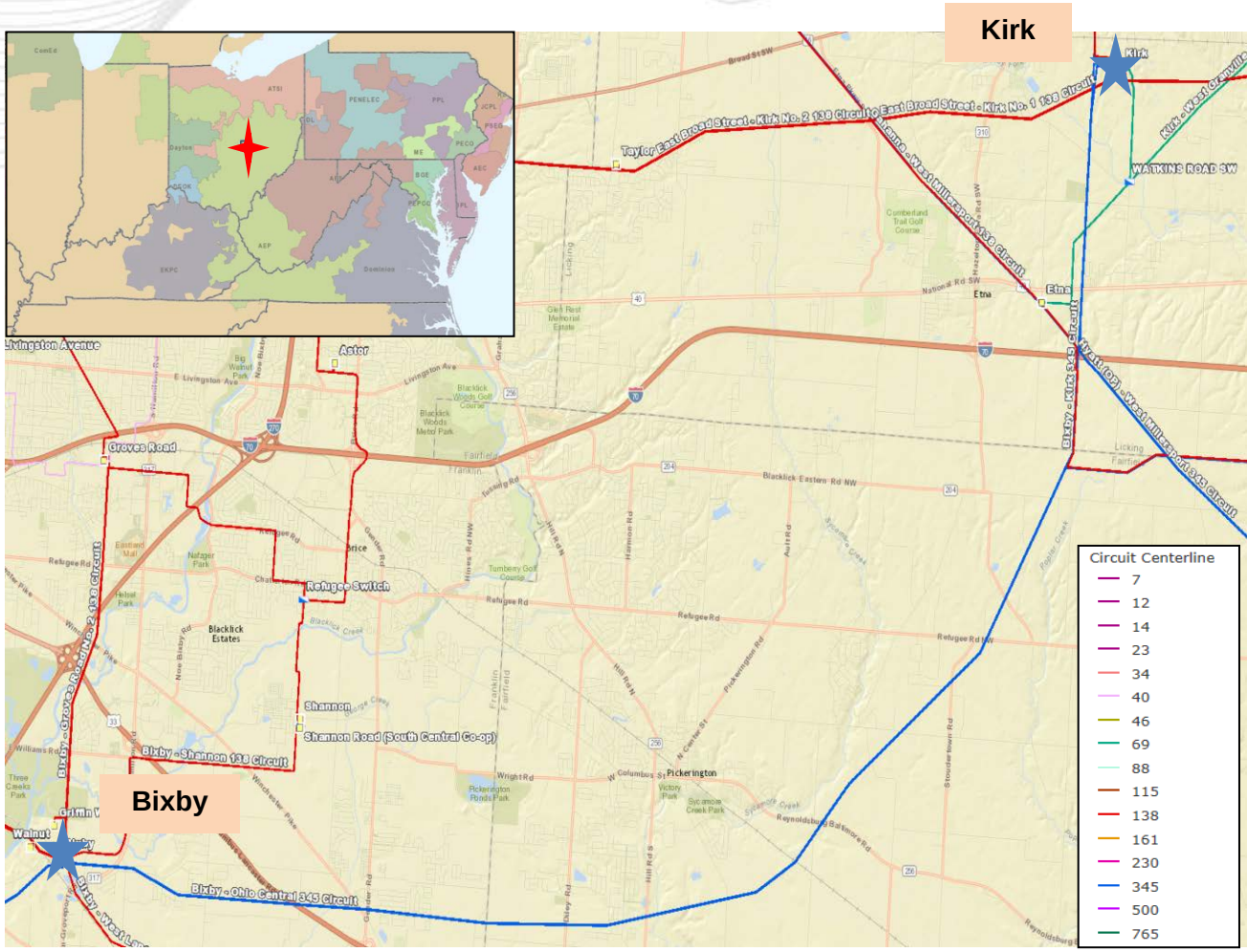

AEP Transmission Zone: Supplemental
Kirk Rehab and Upgrades

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Kirk-Bixby 345kV line is limited by various line risers at Kirk and Bixby as well as thermal relay limits at Kirk. Relaying and line risers at Kirk will be replaced with the replacement of transformer #4 and the new 345kV CB's. Line risers at Bixby also need to be replaced under the same line outage to maximize the benefit of the outage. The next limiting factor for the circuit is a line switch at Bixby. Replacing this switch now further increases the SN line capability by approx. 49 MVA and allows for a potentially larger rating increase without an additional outage if a future sag study is done on the line.

Transmission operations requested upgrading the Kirk 345kV yard to breaker and a half, completing the 138kV strings, and separating T1 & T2 for the reason of improved operational and maintenance flexibility.

Customer Service:

AEP-Ohio has agreed with separating the Distribution transformer lead and the 138/69kV transformer lead as well as the replacement of T#1 and CB's 50 & 51. They have also asked for disconnect switches for a future Distribution transformer.

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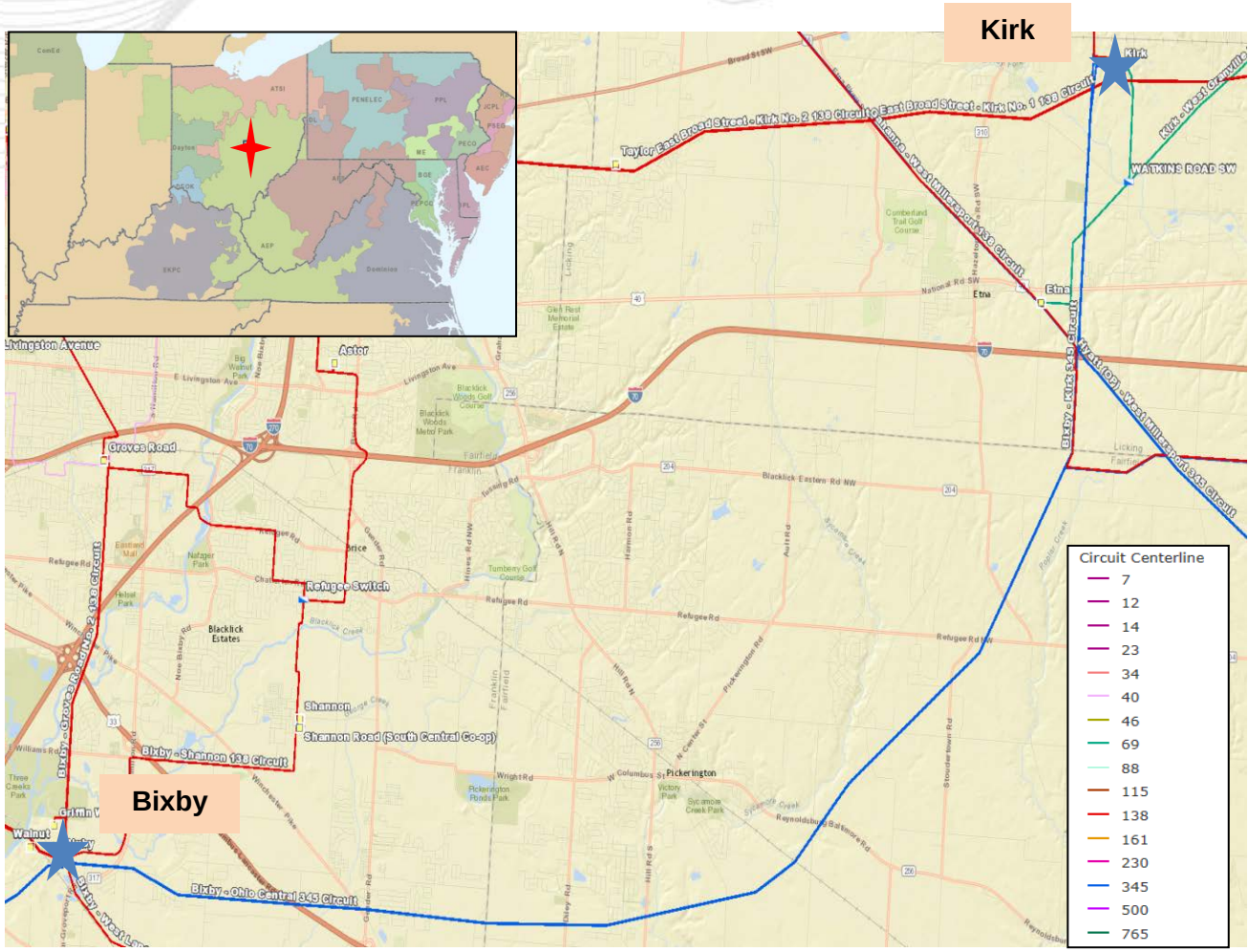

AEP Transmission Zone: Supplemental
Kirk Rehab and Upgrades

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Selected Solution:

At Kirk, Install 4-345kV 3,000A CB's & end bus and complete the 345kV breaker and a half configuration. Replace 345/138kV XF with 675 MVA unit. Connect in different 345kV bay and on new 138kV string before removing old unit. Upgrade 2-138kV 4,000A CB's & retire 1 CB on 102 string. Install 2-138kV 4,000A CB's on new 104 string. Install 3 new 3,000A 138kV CB's and complete 103 & 105 strings. Upgrade 3-138kV CB's with 3,000A on 106 string. Separate 138/69 & 138/34kV XF connections and install 1-138kV ckt switcher on distribution bank.

Replace 138/34kV XF and 2-34kV CB's. (S1510.1) Estimated Cost: $19.7M

At Bixby, replace Kirk 345kV line risers and line switch and upgrade relaying (S1510.2) Estimated Cost: $1.9M

Upgrade relaying at Jug Street (S1510.3) Estimated Cost: $0.4M

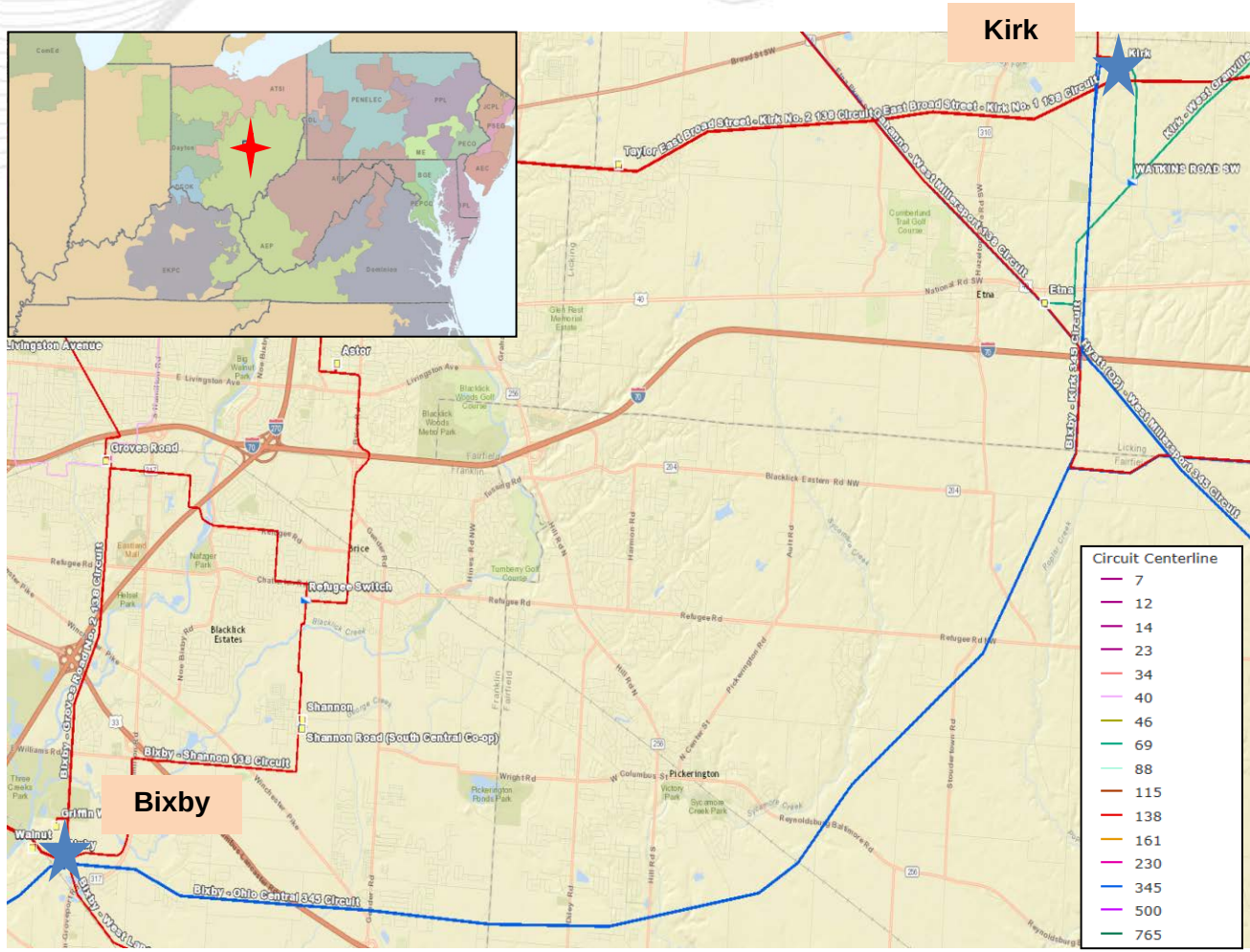
Upgrade relaying at West Millersport (S1510.4) Estimated Cost: $0.8M

Upgrade relaying at West Hebron (S1510.5) Estimated Cost: $0.2M

Total Estimated Transmission Cost: $23.0M

Projected In-service: 12/01/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental
LuK USA and Madisonburg Loop

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Customer Service:

LuK USA, LLC has requested a new 69kV delivery point (Clutch Switch) to serve a peak demand of 11 MVA, as their load growth has outgrown the local distribution in the area. LuK USA, LLC in Wooster, OH performs sales, design, development and manufacturing of clutch systems and torque converters for the automotive industry. A fully executed Letter of Commitment (LOC) has been established with the customer.

Equipment Material/Condition/Performance/Risk:

North Wooster has two long radial circuits (7.5 miles & 5 miles) serving three Holmes-Wayne Co-Op delivery points, two AEP Ohio substations, and LuK USA. These radials were constructed in the 1940s with a mix of 556 ACSR, 4/0 AL, #2 CU, and 1/0 ACSR (37 MVA rating) and have roughly 100 open category A conditions combined. The total peak summer load connected to these radials will be approximately 35 MW. These radials serve the largest shopping area for the Wooster community, four different medical offices, Green Local Schools and the Wayne County Vocational school. Any extended outage on these radials not only negatively impacts a large number of customers in numerous industries, it is harmful in the eyes of the customer and Holmes-Wayne/AEP Ohio's public image suffers because of it.

Operational Flexibility and Efficiency:

On the 20 miles of 69kV in North Wooster, only two automatic sectionalizing devices exist to support the four AEP Ohio substations and three Holmes-Wayne Co-Op delivery points. Most outages on the 69kV network would thus require manual operation of switching devices, which leads to longer outage times for sensitive customers (shopping centers, medical facilities, and local schools).

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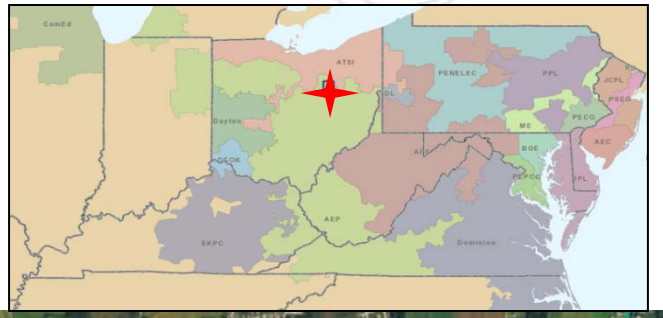
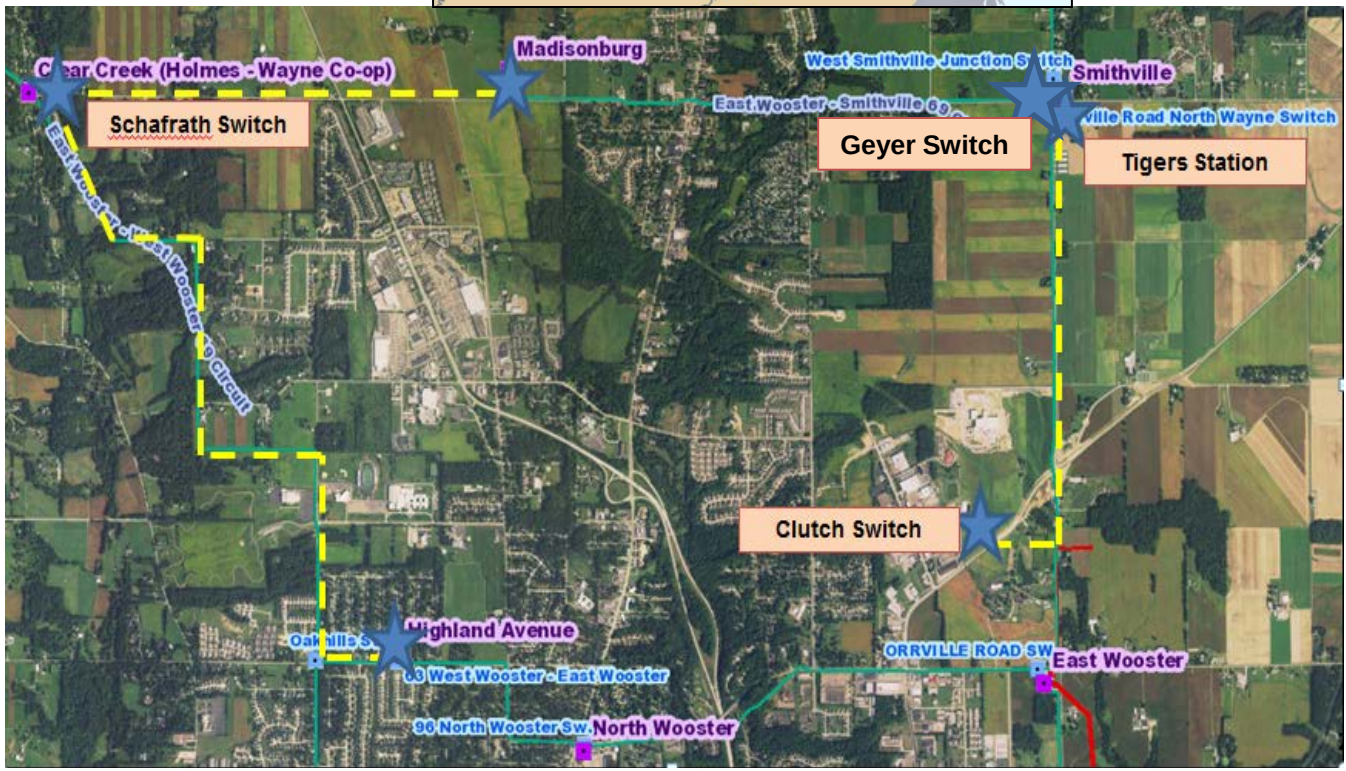




AEP Transmission Zone: Supplemental LuK USA and Madisonburg Loop

Continued from previous slide…

Selected Solution:

Construct double-circuit line extension to Clutch Switch (0.5 miles) (S1511.1) Estimated Cost: $1.6M

Construct a single circuit line to close the loop between Schafrath Sw and Madisonburg (2 miles) (S1511.2) Estimated Cost: $3.1M

Rebuild Clutch Switch to Tigers as single circuit (1.5 miles) (S1511.3) Estimated Cost: $3.7M

Rebuild from Schafrath Sw to Oakhills Switch (3.0 miles single circuit) and from Oakhills to Highland (0.4 miles double circuit) (S1511.4) Estimated Cost: $8.5M

Establish a new station to serve customer (Clutch) (S1511.5) Estimated Cost: $3.4M

Establish a new station at Schafrath Switch to eliminate hard tap and loop lines (S1511.6) Estimated Cost: $1.0M

Expand Madisonburg station to establish new line exit to Schafrath (S1511.7) Estimated Cost: $1.4M

Construct new station at Tigers to eliminate hard tap and replace Smithville station (S1511.8) Estimated Cost: $4.6M

Install new phase-over-phase switch at Geyer Switch (S1511.9) Estimated Cost: $0.8M

Retire Oakhills Switch and establish a new box bay at Highland Avenue for the double circuit line (S1511.10) Estimated Cost: $5.2M

Retire Orrville Road Switch (S1511.11) Estimated Cost: $0.1M

Upgrade relaying at West Wooster (S1511.12) Estimated Cost: $0.8M

Upgrade relaying at East Wooster (S1511.13) Estimated Cost: $0.8M

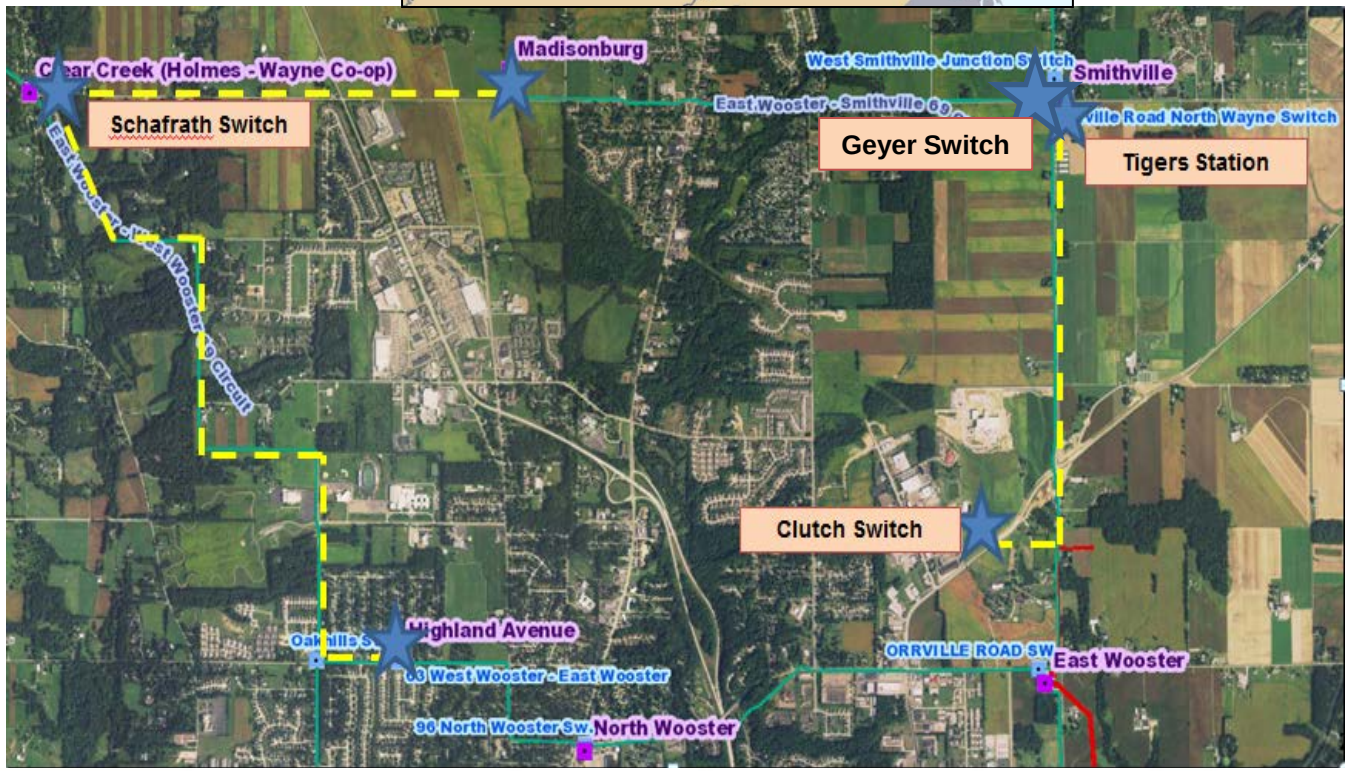
Retire Smithville station (S1511.14) Estimated Cost: $0.4M

**Note: AEP already owns 99% of Right of Way (ROW) in sections where loops will be closed. All new line construction will be 69kV with 556 ACSR conductor (126 MVA rating)*

Total Estimated Transmission Cost: $35.4M

Projected In-service: 12/31/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental Mid-Vol Station

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Customer Service:

Mid-Vol Coal request to serve 8 MW of load on the Jim Branch – Switchback 138 kV line. Obligation to serve customer request.

Selected Solution:

Tap the existing Jim Branch – Switchback 138 kV line. (S1512.1)

Estimated Customer Cost: $0.52M

Estimated Transmission Cost: $0.0M

Establish the new Thorpe Switching Station and install a new 2000 A 138 kV phase-over-phase switch and install necessary 138 kV metering equipment. (S1512.2)

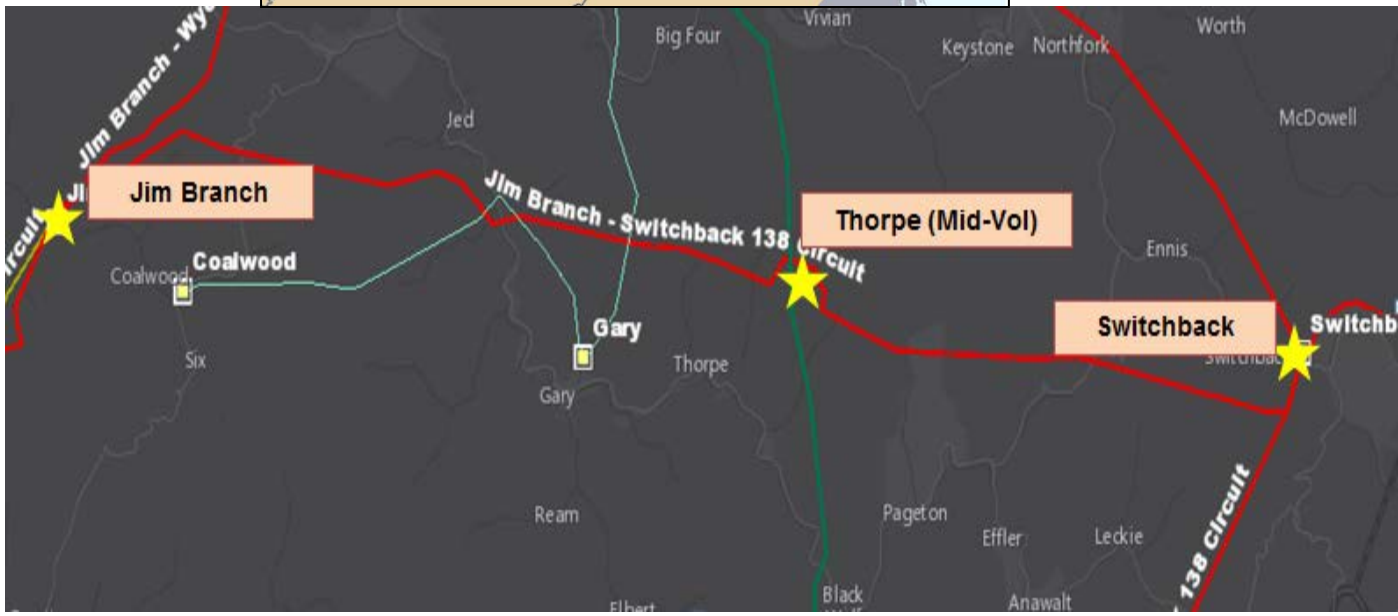
Estimated Customer Cost: $0.95M

Estimated Transmission Cost: $0.0M

Total Estimated Transmission Cost: $0 M

Projected In-service: 4/16/2018

Project Status: Scoping



AEP Transmission Zone: Supplemental
Morgan Rd Switching Station

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Operational Flexibility and Efficiency:

Newcomerstown – North Coshocton 34.5 kV circuit is approximately 27.61 miles long. Many of the structures were replaced in 1989. This circuit currently has 218,976 customer minute interruptions. The Newcomerstown – North Coshocton 34.5 kV circuit serves approximately 14.67 MW. The customer minute interruptions can be reduced by either rebuilding the line or improving sectionalizing. Installing circuit breakers is more cost effective than rebuilding to reduce the CMI.

Selected Solution:

Establish Morgan Run Switch and install three 69 kV (to be operated at 34.5 kV) circuit breakers 2000 A 40 kA in a ring bus layout as a breaker and a half standard. (S1513.1)

Estimated Cost: $4.7M

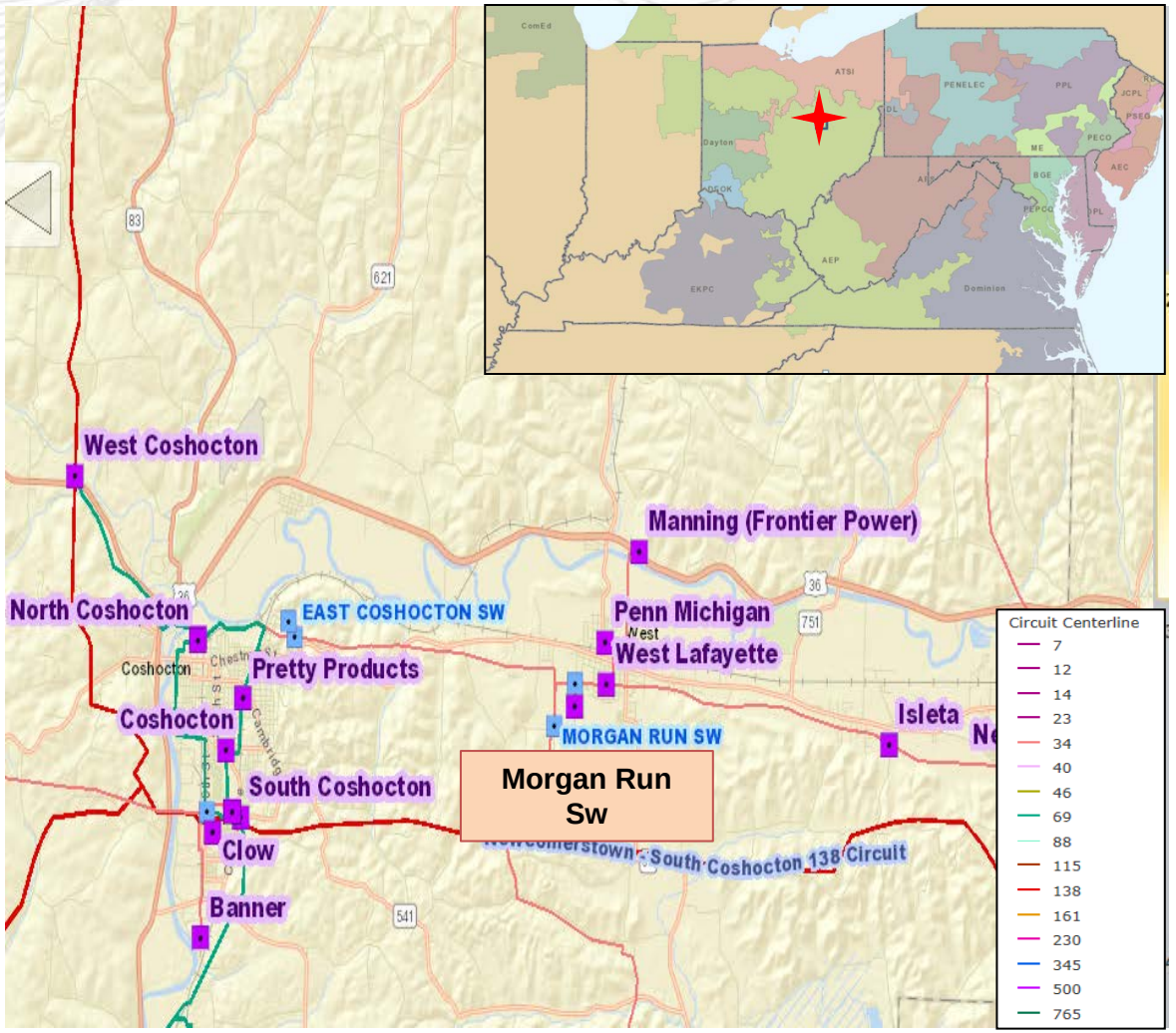
Relocate Morgan Run – Alleghany 34.5 kV line to accommodate the new circuit breakers. (S1513.2)

Estimated Cost: $1.1M

Total Estimated Transmission Cost: $5.8 M

Projected In-service: 12/15/2020

Project Status: Scoping



AEP Transmission Zone: Supplemental
Mt Sterling – Zanesville 69 kV Circuit

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Mount Sterling – South Fultonham 69kV line is a 7.22-mile radial line serving ~8 MW of peak demand. This line was built in 1959 and has 47 open A-type conditions. The line has contributed to 2.4 million customer minutes of interruptions (CMI) between 2013 and 2016.

The Zanesville 69 kV circuit breakers "J", "K" and "L" are FK oil type circuit breakers. Oil breaker maintenance has become more difficult due to the oil handling required to maintain them. Oil spills are frequent with breaker failures and routine maintenance and can become an environmental hazard. They have fault operations of 43, 45 and 47 respectively, higher than the manufacturer recommended number of 10 fault operations.

Selected Solution:

Build a new 5.7-mile 69 kV line from Mount Sterling to Zanesville station with 556.5 ACSR (102 MVA rating) to close the radial loop. (S1514.1) Estimated Cost: $8.1M

Zanesville – Linden Avenue 69 kV structure removal. (S1514.2) Estimated Cost: $0.8M

Mount Sterling – Zanesville 69 kV fiber cable. (S1514.3) Estimated Cost: $0.3M

At Zanesville station, install a 69 kV 40 kA 2000A circuit breaker. Replace 69 kV breakers J, K, and L. Install a 138 kV high side circuit breaker and a 69 kV low side circuit breaker for the 138/69 kV transformer. (S1514.4) Estimated Cost: $4.3M

At Mount Sterling station, install two 69 kV 40 kA 2000A circuit breakers in a box bay configuration. (S1514.5) Estimated Cost: $3.0M

Total Estimated Transmission Cost: $16.5M

Projected In-service: 12/15/2019

Project Status: Engineering

AEP Transmission Zone: Supplemental
Napier (Lakeland Hospital) Station

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Customer Service:

Lakeland Memorial Hospital has requested AEP Transmission provide a new dual feed point of service to their current location. The hospital is currently served from the Distribution system but construction is underway to expand their facilities to add 4 MW of additional loading to their current location. The customer has expressed sensitivity to any potential reliability issues and will install two transformers for the dual feeds.

Selected Solution:

Create an in & out from the existing Hickory Creek – Main Street No. 2 34.5 kV circuit (S1515.1) Estimated Cost: $1.7M

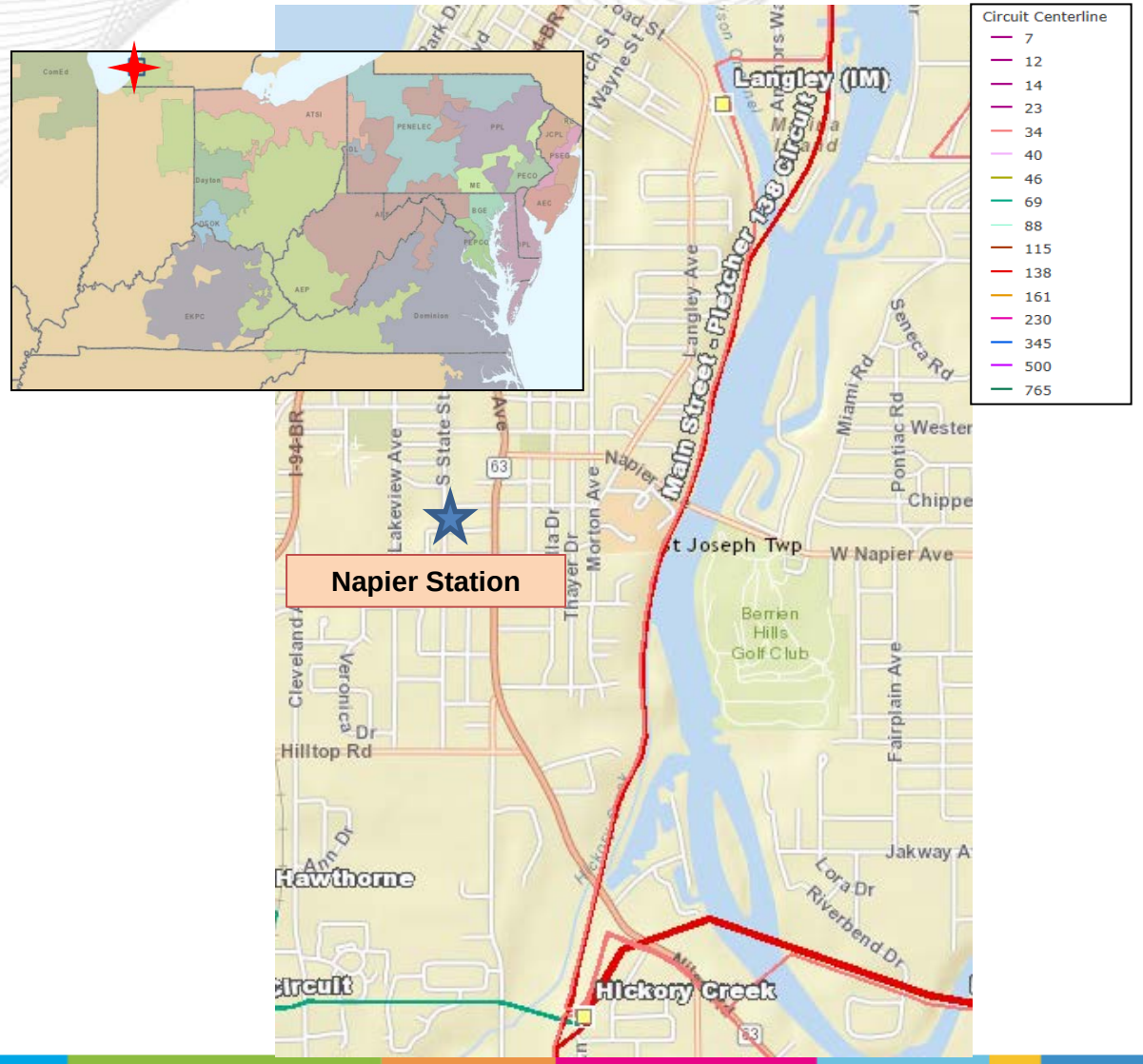
Construct a new Napier station with a single circuit breaker between two customer feeds. The two feeds will serve two customer owned transformers. (S1515.2)

Estimated Cost: $2.9M

Total Estimated Transmission Cost: $4.6 M

Projected In-service: 06/30/2019

Project Status: Scoping



AEP Transmission Zone: Supplemental
North Bristol CB Replacement

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

North Bristol 138 kV circuit breakers A and B (vintage 1975) are type Air Blast breakers. Air blast breakers are being replaced across the AEP system due to reliability concerns, intensive maintenance, and their tendency to catastrophically fail. During failures, sharps pieces of porcelain from their bushings are typically expelled, which can be a potential safety hazard to field personnel. In addition, the ability to get spare parts for these breakers is becoming increasingly difficult. Circuit breaker B has exceeded (40 operations) the manufacturers recommended number of fault interruption (10 operations).

Selected Solution:

North Bristol 138 kV: Replace existing 3000 A 50 kA 138 kV circuit breakers 'A' and 'B' with new 3000 A 40 kA 138 kV circuit breakers. (S1516)

Total Estimated Transmission Cost: $2.5 M

Projected In-service: 11/1/2019

Project Status: Engineering

AEP Transmission Zone: Supplemental
Parlett Switching Station

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Operational Flexibility and Efficiency

The Blackhawk-Dillonvale-Sparrow 69kV circuit is a 24-mile 3-terminal line. This circuit has experienced frequent mis-operations, power quality events, and customer outages over the last several years, due to a non-standard 3-terminal protection configuration. These events resulted in severe effects on industrial customers' operations, especially for those in the Utica shale midstream gas processing industry.

The Markwest-Hopedale plant in Harrison County, Ohio has experienced significant impacts due to momentary outages and voltage dips caused in part by protection mis-operations on AEP's local area 69kV system. Their plant is served from the Blackhawk 69kV substation, which was placed in-service in 2013, and serves as a critical hub for the area midstream processing operations. These momentary interruptions force the customer into 12-24 hour restart cycles resulting in significant monetary and production losses. AEP met with the customer to address the customer's concerns and, as a result, has developed a plan to improve area reliability including a project to upgrade Parlett Switch. Parlett is currently part of a 3-terminal 69kV circuit ("Blackhawk-Dillonvale-Sparrow 69kV"), which is especially difficult to protect, due to having 3 sources of power.

Customer Service:

Marathon/Markwest has started a relatively new production plant at Blackhawk station with a sensitive load that is very critical to many of regional gas-pipeline processes. Recent momentary outages with extensive recovery times have resulted in considerable losses .

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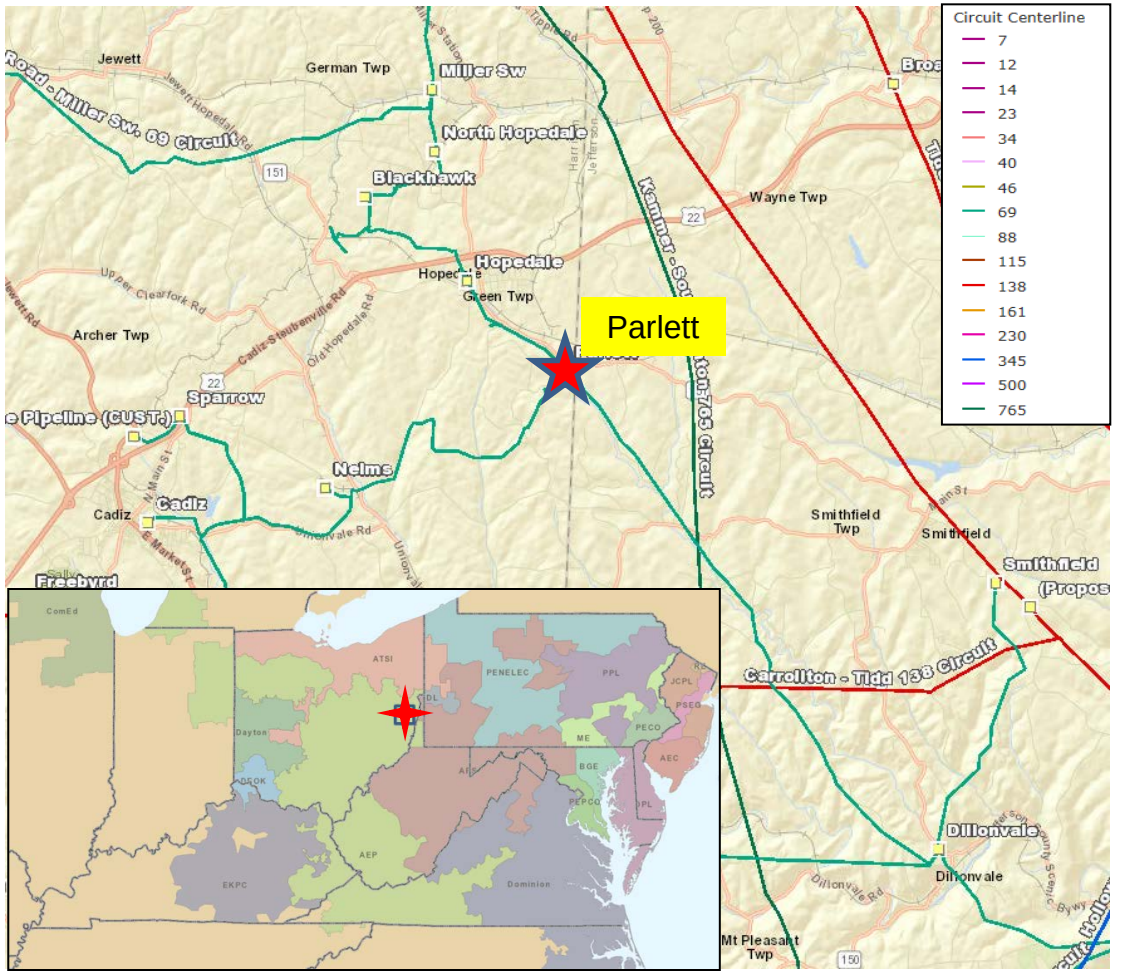


AEP Transmission Zone: Supplemental
Parlett Switching Station

Continued from previous slide…

Selected Solution:

Construct 138kV-rated 4-breaker ring bus, with a 14.4 MVAR cap bank; station to be operated at 69kV until area is converted to 138kV. (S1517.1) Estimated Cost: $12.3M

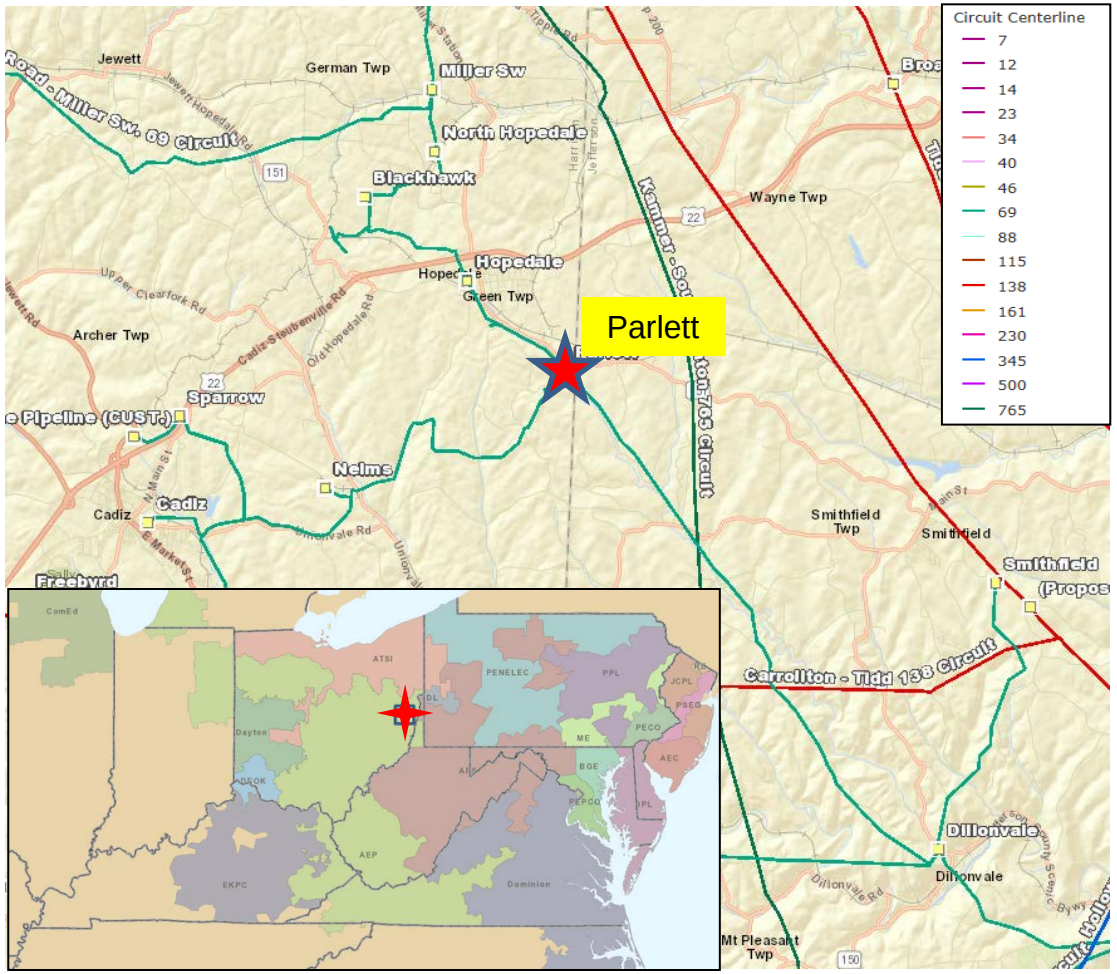
Reroute the 3- 69kV lines to enter Parlett station. (S1517.2) Estimated Cost: $1.6M

Retire Parlett 69kV switch (S1517.3) Estimated Cost: $0.1M

Total Estimated Transmission Cost: $14.0 M

Projected In-service: 12/01/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental
Riggs Station

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Other:

Obligation to serve new customer request. Summer projected load 14 MVA, Winter Projected load 23 MVA.

Selected Solution:

Tap the Holston – Sullivan Gardens 138kV circuit. (S1518.1)

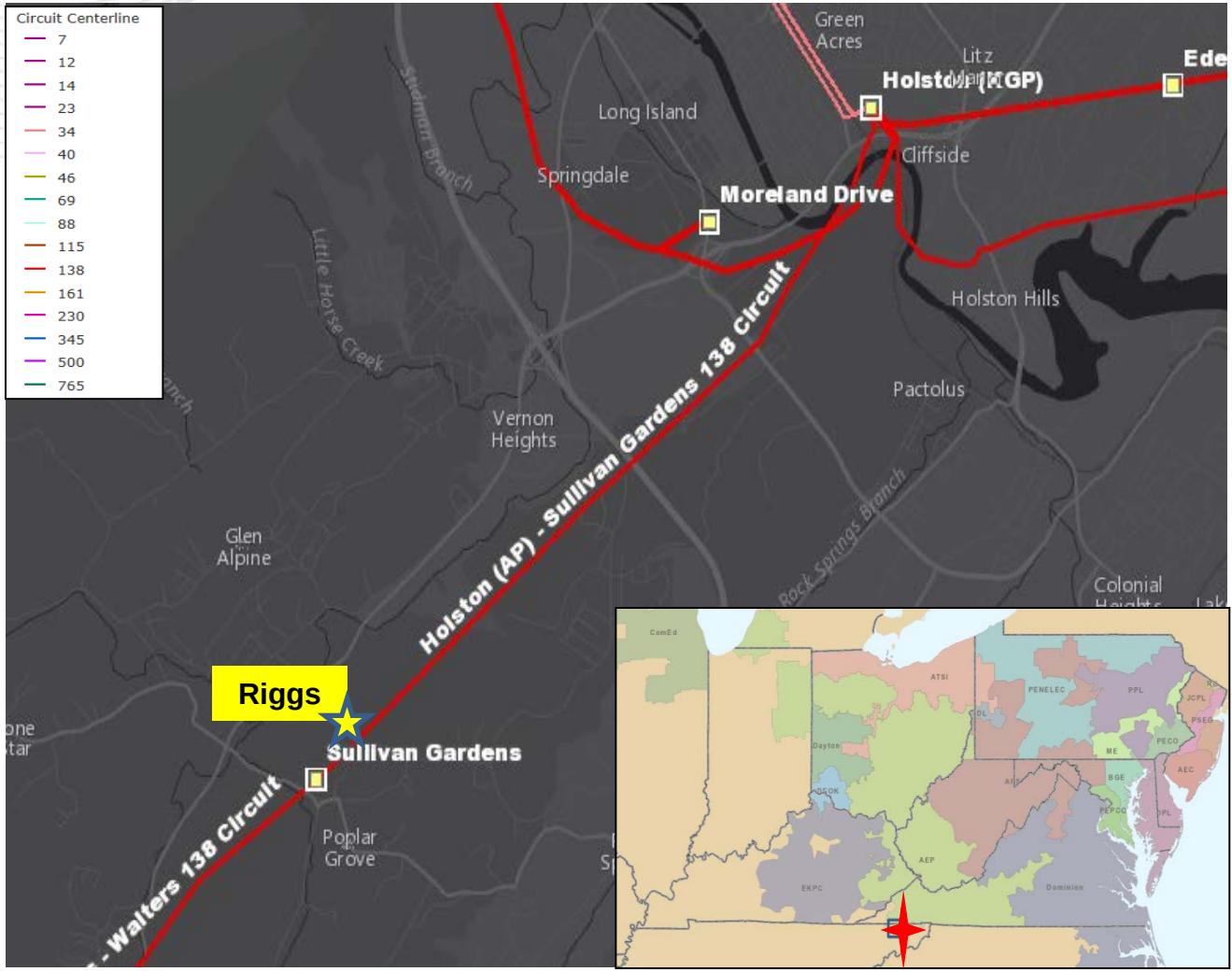
Estimated Cost: $0.4M

Construct a 138/34.5kV distribution station (Riggs). Install a new 138/34.5 kV 30 MVA, two 3000 A 100kA 138 kV MOABs and a 3000 A 40 kA 138 kV circuit switcher. (S1518.2) Estimated Cost: $0.0M

Total Estimated Transmission Cost: $0.4M

Projected In-service: 12/31/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental
Roberts Rehab & Upgrades

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Transformer 2 (560 MVA unit) at Roberts station is 43 years old with dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), and accessory damage (bushings). The ratings on Transformer 1 are currently limited by equipment in the 138 kV yard. Replacing this equipment will allow both transformers to operate at their full capabilities.

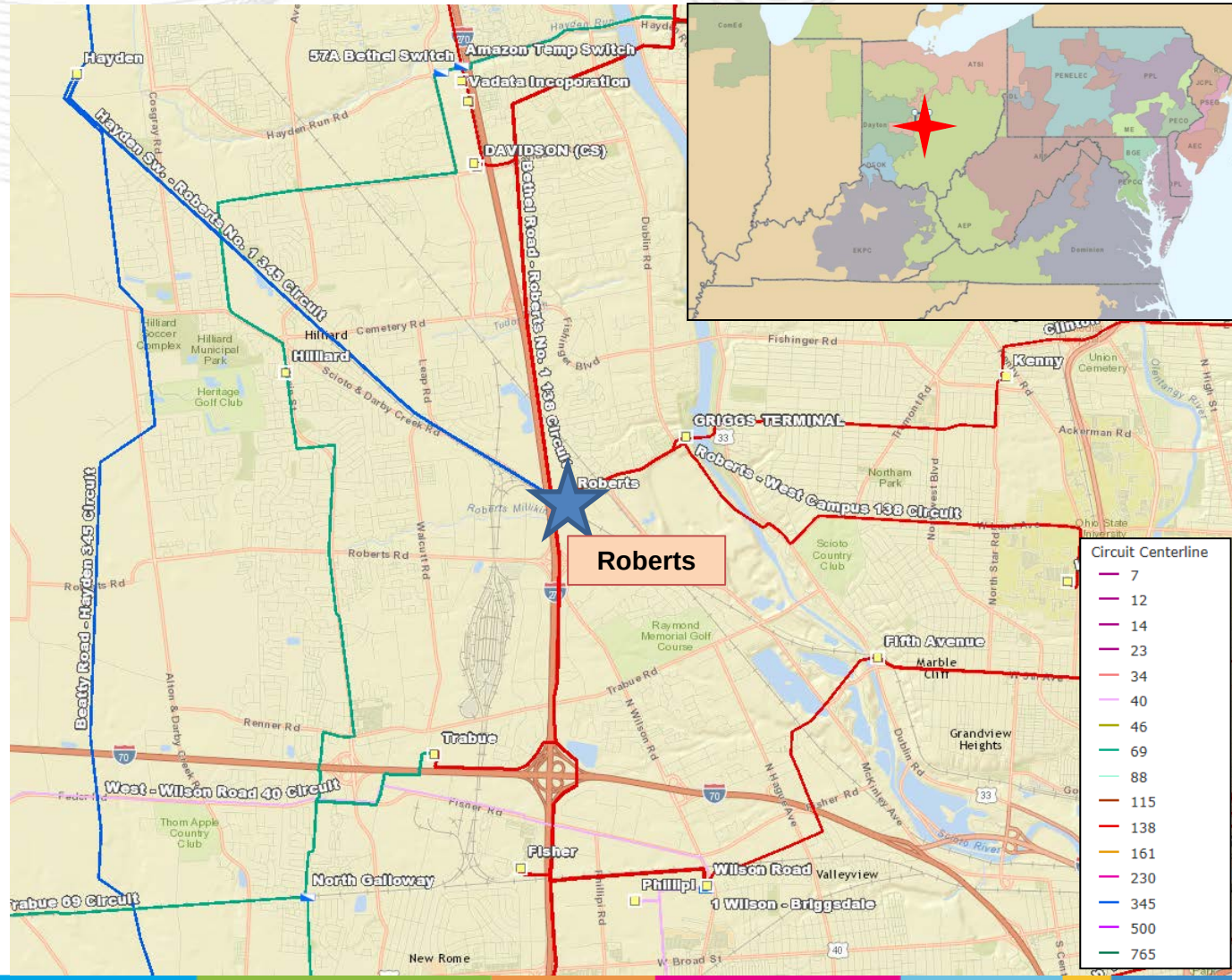
Selected Solution:

Replace XF#2 with a 675 MVA 345/138kV unit and upgrade all XF#2 risers and XF#2 138kV lead to 4,000A ratings. Add 138kV 4,000A XF#2 switch. Upgrade XF#1 risers to 4,000A ratings. (S1519)

Estimated Transmission Cost: $8.4M

Projected In-service: 12/01/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental Rockwell Mining

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Customer Service:

Rockwell Mining request to serve a new 6 MW load on the Bim – Skin Fork 46 kV line.

Selected Solution:

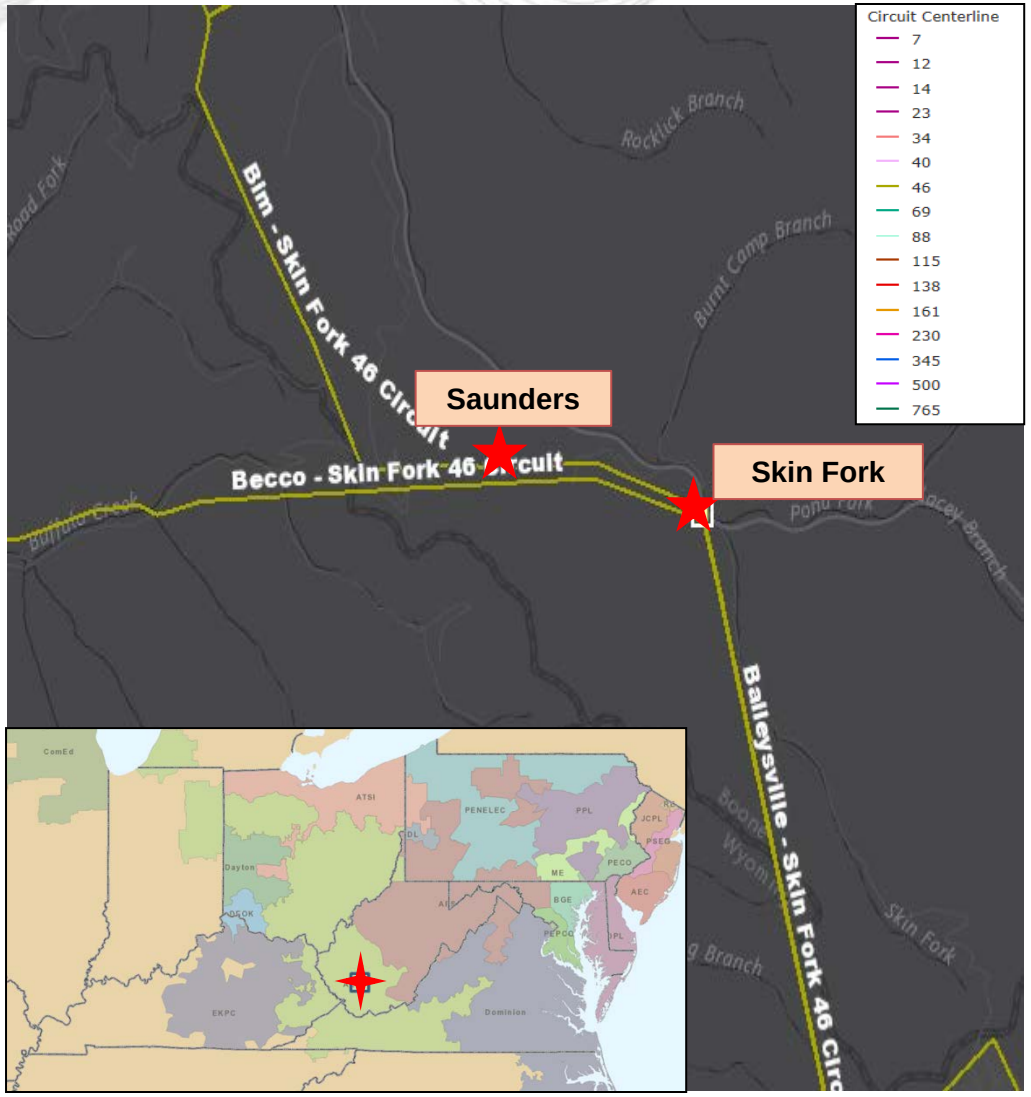
Tap existing Bim – Skin Fork 46 kV line and re-enforce structures for the new delivery point and switch installation. (S1520.1) Estimated Cost: $0.3M

Install a 1200 A 3-way phase-over-phase switch on Bim – Skin Fork 46 kV circuit at newly established Saunders Switching Station. (S1520.2) Estimated Cost: $0.0M

Total Estimated Transmission Cost: $0.3M

Projected In-service: 10/01/2018

Project Status: Scoping



AEP Transmission Zone: Supplemental
Somerset 69 kV Switching Station

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Operational Flexibility and Efficiency

The New Lexington – South Fultonham 69 kV circuit serves 6.74 MW of load. In three years the New Lexington – South Fultonham 69 kV circuit has experienced customer minute interruptions of 1,732,378. Much of this line was rebuilt in 2013. CMI can be reduced by either rebuilding the line or improving sectionalizing. Installing circuit breakers is more cost effective.

Selected Solution:

Relocate three lines to the new Somerset Switching Station. (S1521.1)

Estimated Cost: $2.7M

Install four 69 kV circuit breakers in a ring bus configuration at Somerset Switch. (S1521.2) Estimated Cost: $5.7M

Total Estimated Transmission Cost: $8.4 M

Projected In-service: 12/15/2020

Project Status: Engineering

AEP Transmission Zone: Supplemental Vicksburg – Schoolcraft Improvements

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Vicksburg – Schoolcraft 69kV is a 5 mile 1970's vintage radial line that currently has 22 structures with open conditions affecting 36% of the total number of structures. With our current system configuration this line cannot be addressed as it will result in significant outages to Vicksburg station, which cannot be recovered from a backup facility.

Schoolcraft station equipment is mostly 1970s vintage. The 1967 vintage 69kV circuit breaker A at Schoolcraft Substation is an oil filled FK-breaker without oil containment. It has also operated through 175 fault operations, exceeding the manufacturer's recommendation of 10. In general, oil breakers have become increasingly difficult to maintain due to the oil handling associated with them. Oil spills are frequent with failures and routine maintenance which is also an environmental hazard.

Schoolcraft substation currently deploys 17 relays, implemented to ensure the adequate protection and operation of the substation. Currently, 9 of the relays are of the electromechanical type which have significant limitations with regards to fault data collection and retention.

Operational Flexibility and Efficiency:

The Moore Park – Schoolcraft 69kV line has averaged 5 million customer minutes of interruption per year over the last three years. For the past 10 years this line has experienced a total of 23 momentary outages, and 7 permanent outages.

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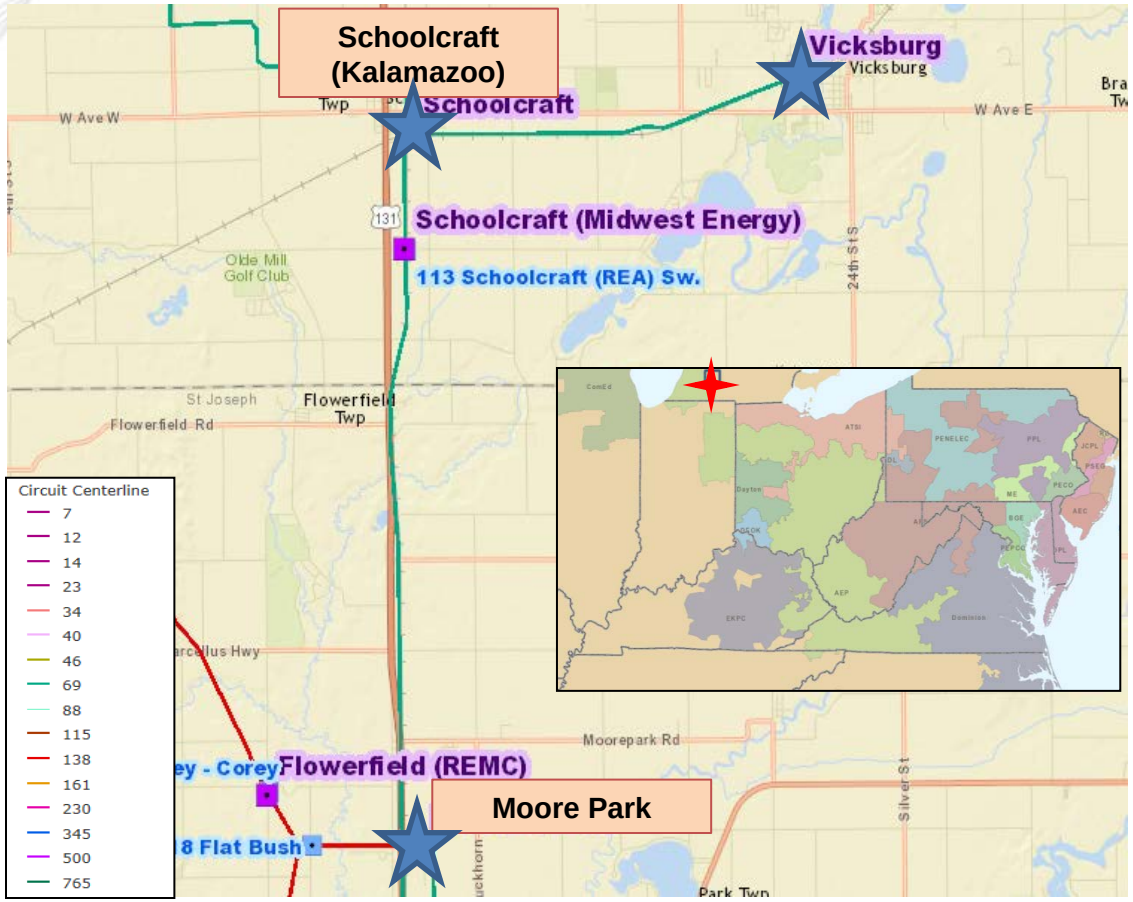

AEP Transmission Zone: Supplemental Vicksburg – Schoolcraft Improvements

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Vicksburg 69kV station, with a projected load of 14MW, is currently being served radially. Also, the current configuration at Schoolcraft station combines 3 elements into one protection zone. This protection scheme exposes the only transformer at Schoolcraft and both transformers at Vicksburg to line faults and increases the probability of relay mis-operations. This has been a historical issue to the customers in the Schoolcraft area because there is zero distribution recoverability or load transferability between Schoolcraft and Vicksburg station.

Customer Service:

In addition to the transmission facilities, I&M Distribution has identified switchgear replacements at Schoolcraft. Historically, 12 kV switchgear distribution facilities like the one at Schoolcraft are very problematic due to the many complications associated to maintenance and repairs. The cost of the switchgear is not a part of the scope as it is a distribution asset.

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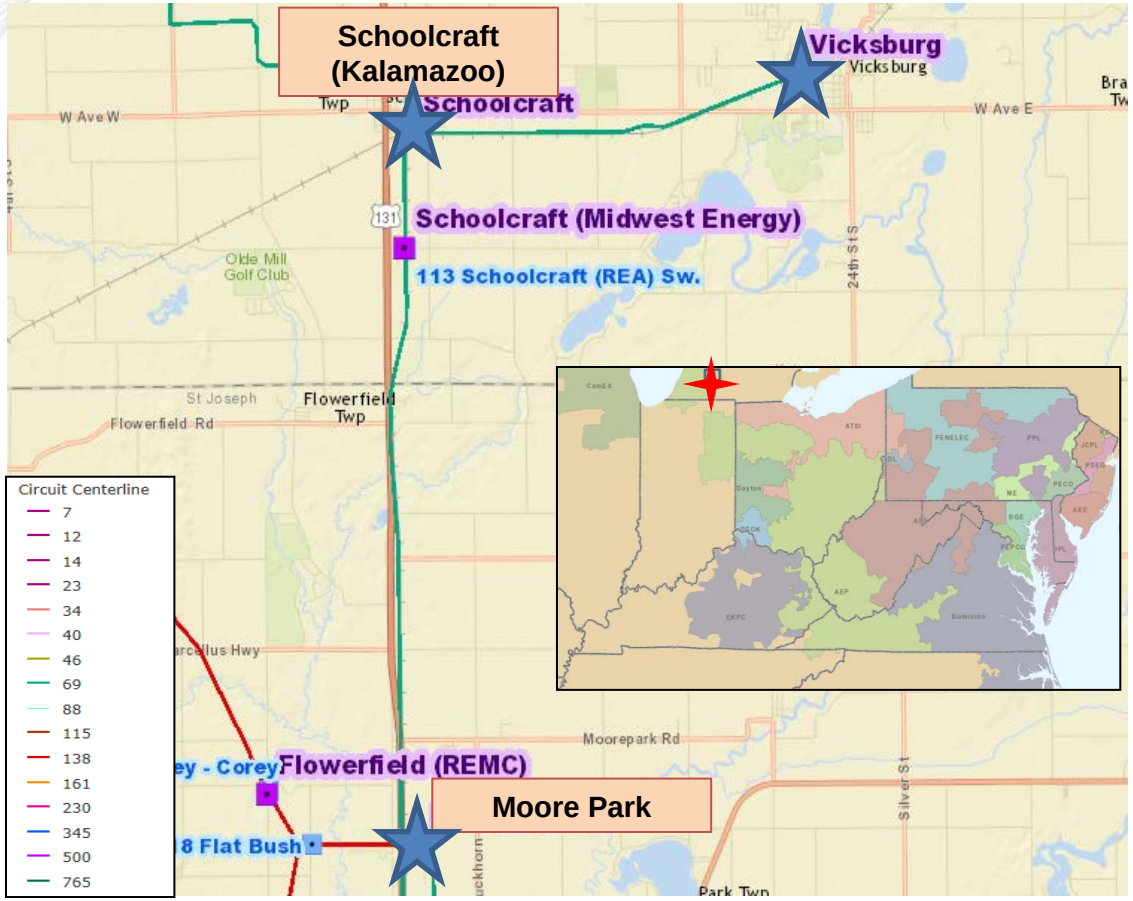

AEP Transmission Zone: Supplemental Vicksburg – Schoolcraft Improvements

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Selected Solution:

Rebuild Schoolcraft 69kV station as Kalamazoo 69kV station in the clear. Kalamazoo station will have a breaker and half configuration with (6) 69kV CBs , (2) 69/12kV transformers, 12kV bus with associated feeders, and a 14.4MVAR cap bank. One transformer will be transferred from the existing Schoolcraft station and the second will be new. (S1523.1) Estimated Cost: $5.2M

Install (2) 69kV CBs and install DICM at Vicksburg to accommodate the new, second line. (S1523.2) Estimated Cost: $1.5M

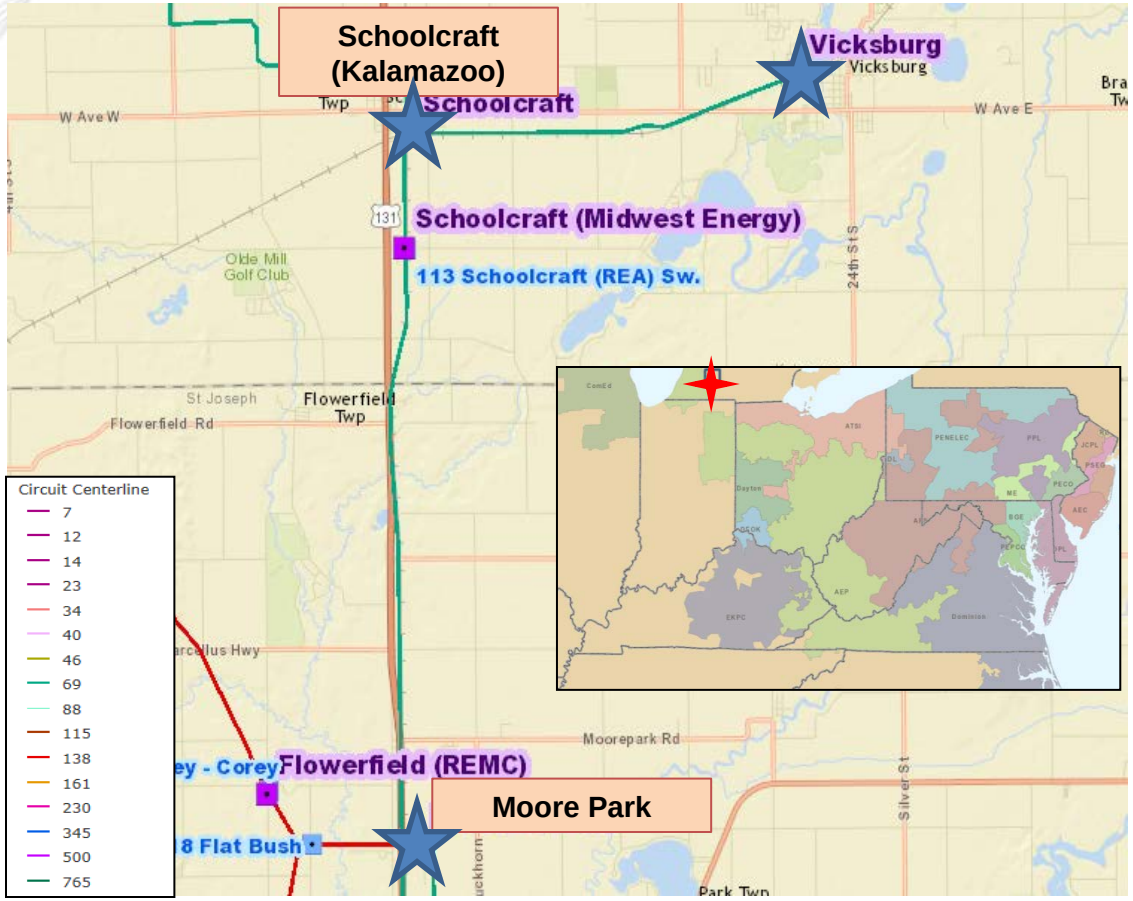
Construct a new 5 mile 69kV line between Kalamazoo and Vicksburg stations with 336.4 ACSR conductor (73 MVA rating). Install Fiber between Kalamazoo and Vicksburg Station. Extend Moore Park-Schoolcraft line into Kalamazoo. (S1523.3)

Estimated Cost: $12.5M

Total Estimated Transmission Cost: $19.2 M

Projected In-service: 12/01/2018

Project Status: Scoping



AEP Transmission Zone: Supplemental
Thelma Station

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Thelma Station 69 kV circuit breaker 'D' (vintage 1965) and 46 kV circuit breaker 'B' (vintage 1961) are both showing signs of deterioration. Circuit breaker 'B' is an oil type FZO Allis-Chalmers type that has historically presented AEP with catastrophic failures which have resulted in AEP targeting them for replacement. Circuit breaker 'D' is a GE FK oil type that was installed without oil containment and are prone to failure. This risk of contamination upon a failures has driven AEP to target them for replacement. In addition, the manufacturers recommended number of fault operations is 10. Breaker 'B' has experienced 260 operations and breaker 'D' has experienced 45 operations.

Circuit switcher BB is a MARK V unit. Mark III's, IV's and V's do no longer work with modern relaying packages and are recommended to be replaced.

Selected Solution:

Replace existing 1200 A 12.5 kA 46 kV circuit breaker 'B' with a new 3000 A 40 kA 46 kV circuit breaker. Replace existing 1200 A 21 kA 69 kV circuit breaker 'D' with a new 3000 A 40 kA 69 kV circuit breaker. Replace existing 1200 A 30 kA 138 kV cap switcher 'BB' with a new 650 A 31.5 kA 138 kV cap switcher. (S1524)

Estimated Transmission Cost: $1.7 M

Projected In-service: 06/07/2018

Project Status: Engineering

AEP Transmission Zone: Supplemental
Van Buren – Liberty Center Rebuild

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The Liberty Center – Van Buren line currently is subject to 44 open conditions including broken and damaged conductor; broken ground wire; and broken and damaged shield wire. The circuit was built in 1959 and 1968 using wooden poles. From 2013-2016 there have been five permanent outages with the majority cause being T-Line.

The existing line was constructed predominantly using shorter poles with wood crossarms and vertical post insulators. This type of construction is not a current AEP standard. Many of the crossarms are smaller cross-section, typical of those used for less resilient distribution construction. End splitting and bowing are common reasons for crossarms failing to pass periodic visual inspection, carrying an elevated risk of failure and line outages. In addition, crossarm construction results in a poor shielding angle, leading to a higher frequency of lightning strikes and momentary interruptions during lightning activity. Design standards from 1950s do not meet modern standards for strength, resilience, and horizontal and vertical clearances for safety for these poles.

Original conductors between Van Buren and Warren, and between Bluffton and Liberty Center were re-conductored with 4/0 ACSR conductors (50 MVA rating) in 1963. A 5/16" EHS steel shield wire was added in 1963. To avoid changing poles, most poles were retrofitted with a crossarm-type "bay-o-net" attached to the pole tops to support the shield wire addition. Bay-o-nets are prone to inspection rejection and occasional failure and are no longer an acceptable method of supporting a shield wire attachment.

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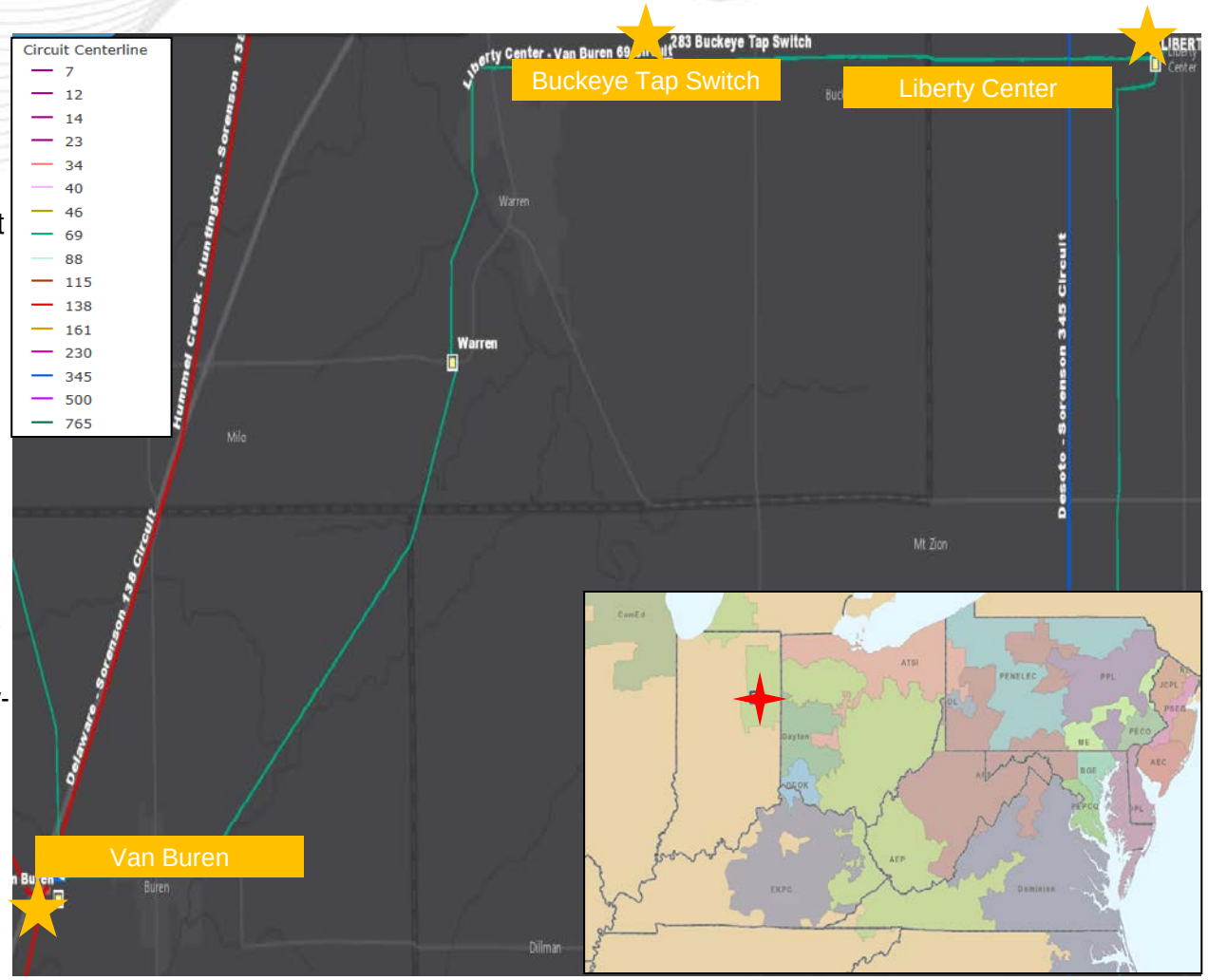

AEP Transmission Zone: Supplemental
Van Buren – Liberty Center Rebuild

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Existing grounding is only every other structure, at best, which is not the current AEP standard and may contribute to a higher frequency of momentary interruptions during lightning activity.

Legacy underlying land rights, where they exist, are typically inadequate by present day AEP Transmission standards. Some sections of the lines were originally constructed within public road rights-of-way with no easement rights acquired on the adjacent private properties. The lack of easement rights provides no ability to properly manage non-conforming land uses. Where easement rights do exist, the ability to control building encroachments and intrusive vegetation were often not included in the language of the original easements.

These wood pole transmission lines have exceeded their original life expectancy. Age and normal deterioration of the lines warrant their complete replacement.

As the Buckeye Switch Tap is part of the line, the switching structure will have to be replaced.

<u>Operational Flexibility and Efficiency</u>

The Liberty Center – Bluffton, Liberty Center – Montpelier, Montpelier – Hartford City and the Hartford City – Bosman all are either built using 795 ACSR or are being built using 795 ACSR. If anything less than 795 ACSR is installed on this line, it will effectively limit the network

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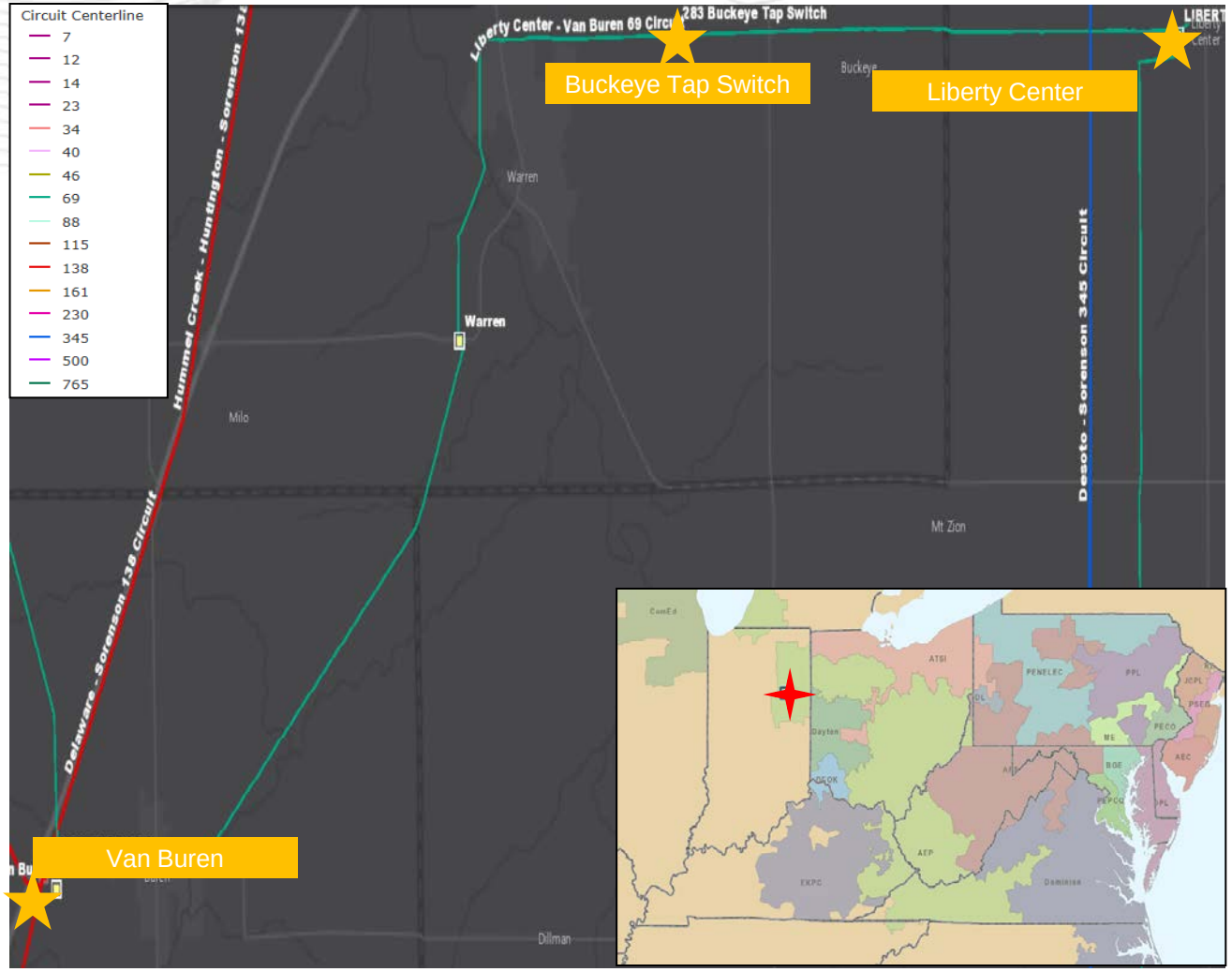

AEP Transmission Zone: Supplemental
Van Buren – Liberty Center Rebuild

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Selected Solution:

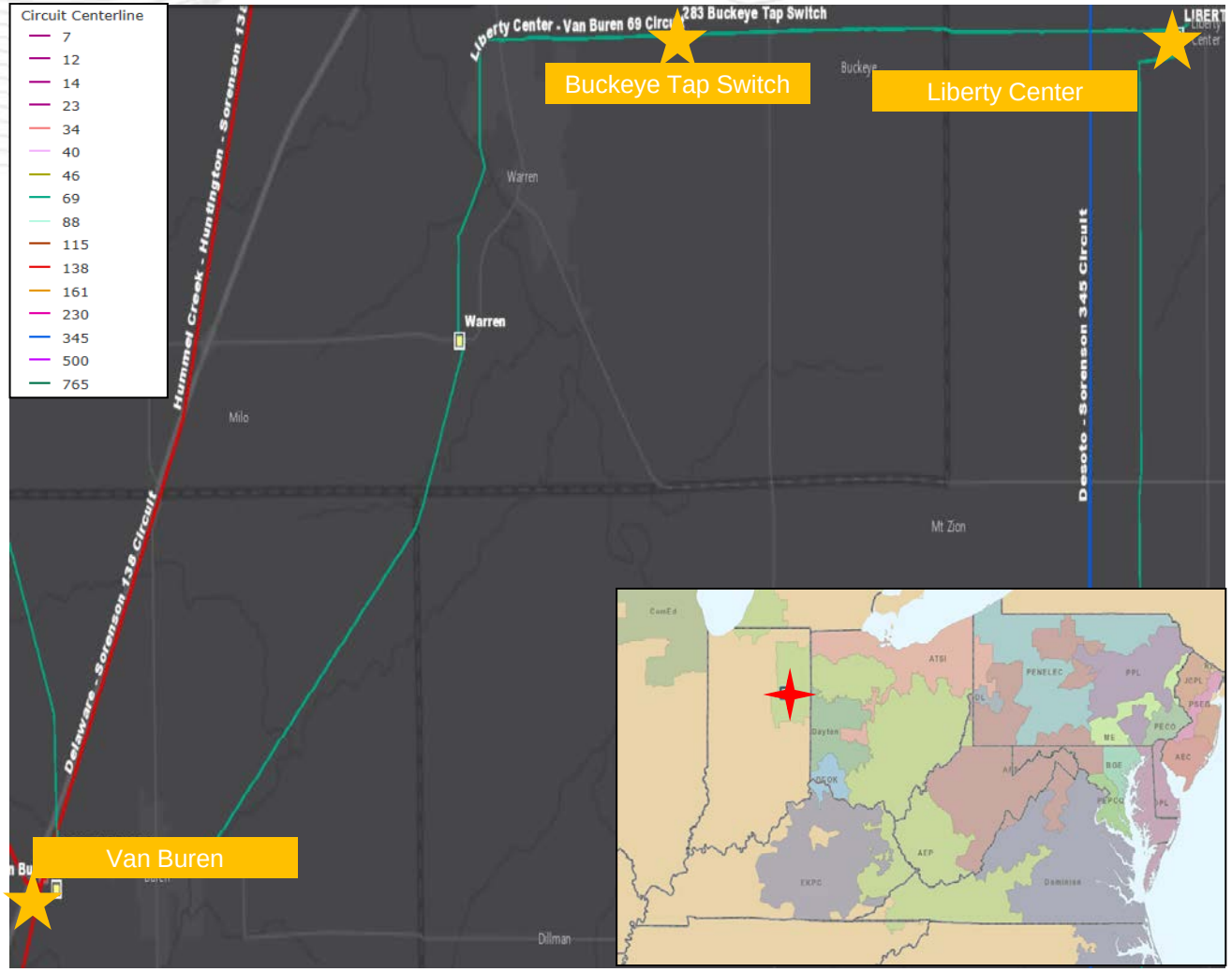
Rebuild 16.3 miles of the Van Buren – Liberty Center line utilizing 795 ACSR (129 MVA rating) (S1525.1) Estimated Cost: $22.1M

Install a new 3-way phase-over-phase 1200A steel switching structure at the Buckeye Tap Switch. (S1525.2) Estimated Cost: $0.3M

Total Estimated Transmission Cost: $22.4 M

Projected In-service: 06/05/2019

Project Status: Engineering



Second Review

Baseline Reliability and Supplemental Projects

From February 14, 2018 Slide Deck

ComEd Transmission Zone: Supplement
Glidden Hardening

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Glidden substation does not comply with ComEd standards
Single breaker failure will trip the entire station.
Transformer failure trips two transformers.
Transformer maintenance requires de-energization of the 138kV bus and two transformers

Selected Solution:

Expand Glidden substation from a straight bus to a ring bus
Install seven 138kV breakers to create a ring bus
Install four transformer high side breakers. (S1552)

Estimated Cost: $21M

Projected In-service: 12/31/2020

Project Status: Engineering

ComEd Transmission Zone: Supplement
Lisle 345-138kV Transformer Tertiary Cap bank Replacement

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Tertiary cap banks no longer installed on tertiary windings. Tertiary cap bank failures stress the 345-138kV transformers and have caused transformer failures in the past.

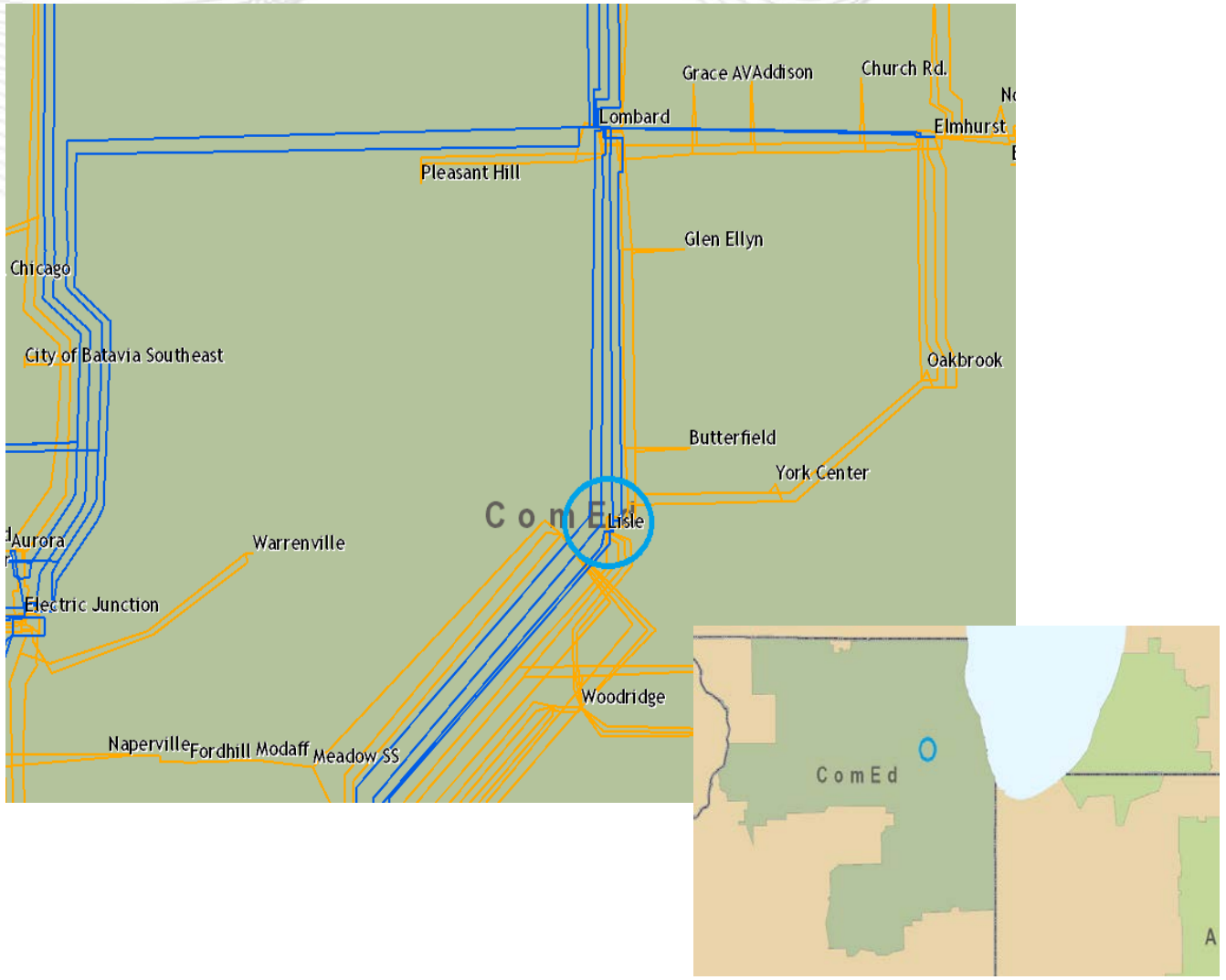
Selected Solution:

Remove Lisle tertiary capacitor banks and install 138 kV capacitor banks; Increase the thermal capability of the 345-138kV autotransformer. (S1553)

Estimated Cost: $6M

Projected In-service: 12/31/2018

Project Status: Engineering



ComEd Transmission Zone: Supplement
Ameren's Corbin Switching Station

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Ameren (MISO) is retiring the Oglesby substation

- Oglesby is currently tapped off of 138kV line 7713
  - Line 7713 is a three terminal line

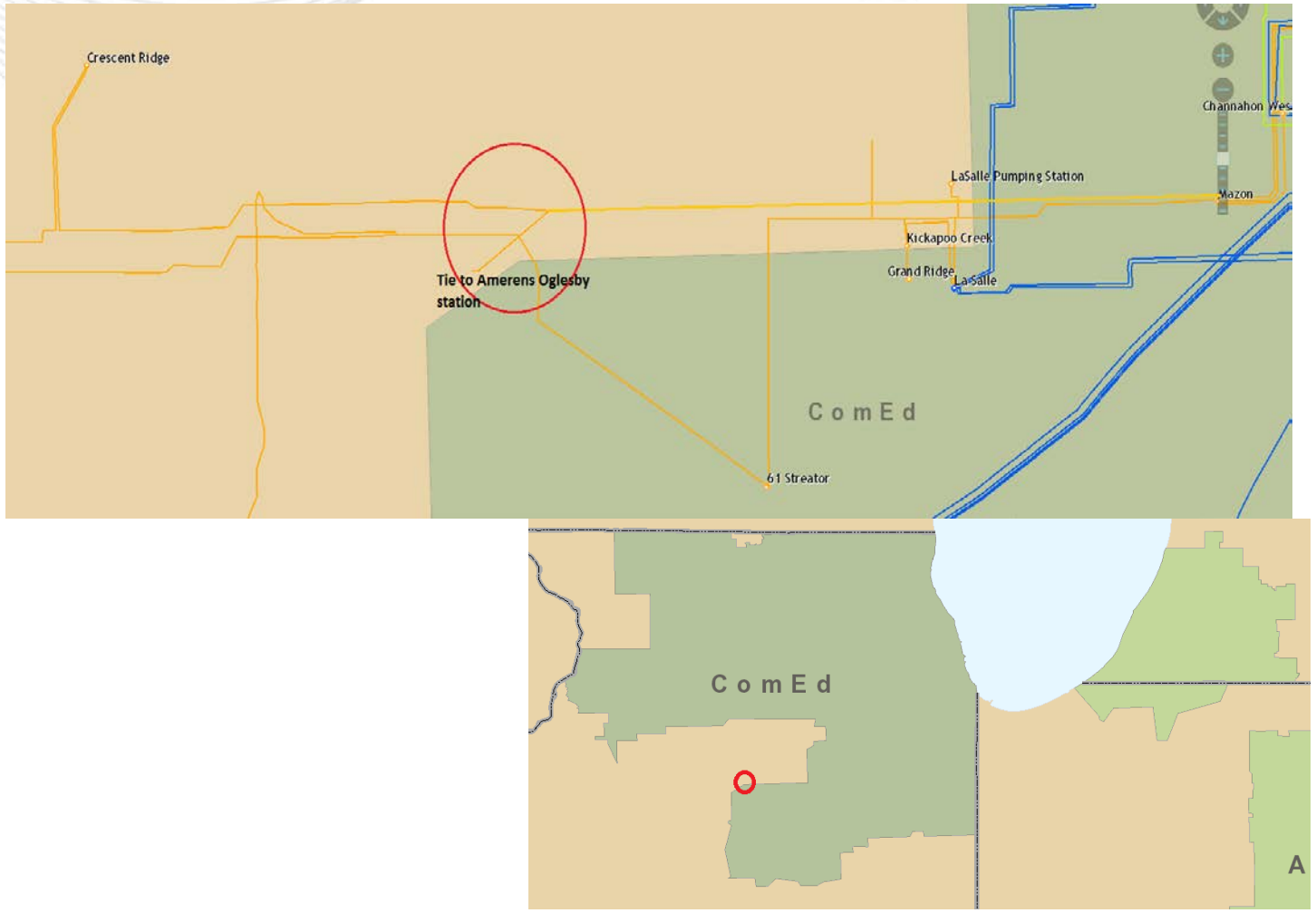
Selected Solution:

Cut 138kV line 7713 (Crescent Ridge- Mazon - Oglesby) in and out of the new Ameren Oglesby substation (Requires additional structures to facilitate the installation of the new substation and the cutting in and out of the existing 138kV line 7713) (S1554)

Estimated Cost: $1M for ComEd

Projected In-service: 12/31/2021

Project Status: Conceptual



ComEd Transmission Zone: Supplement
Modernize 138kV Relays

Previously presented on 2/14/2018 SRRTEP

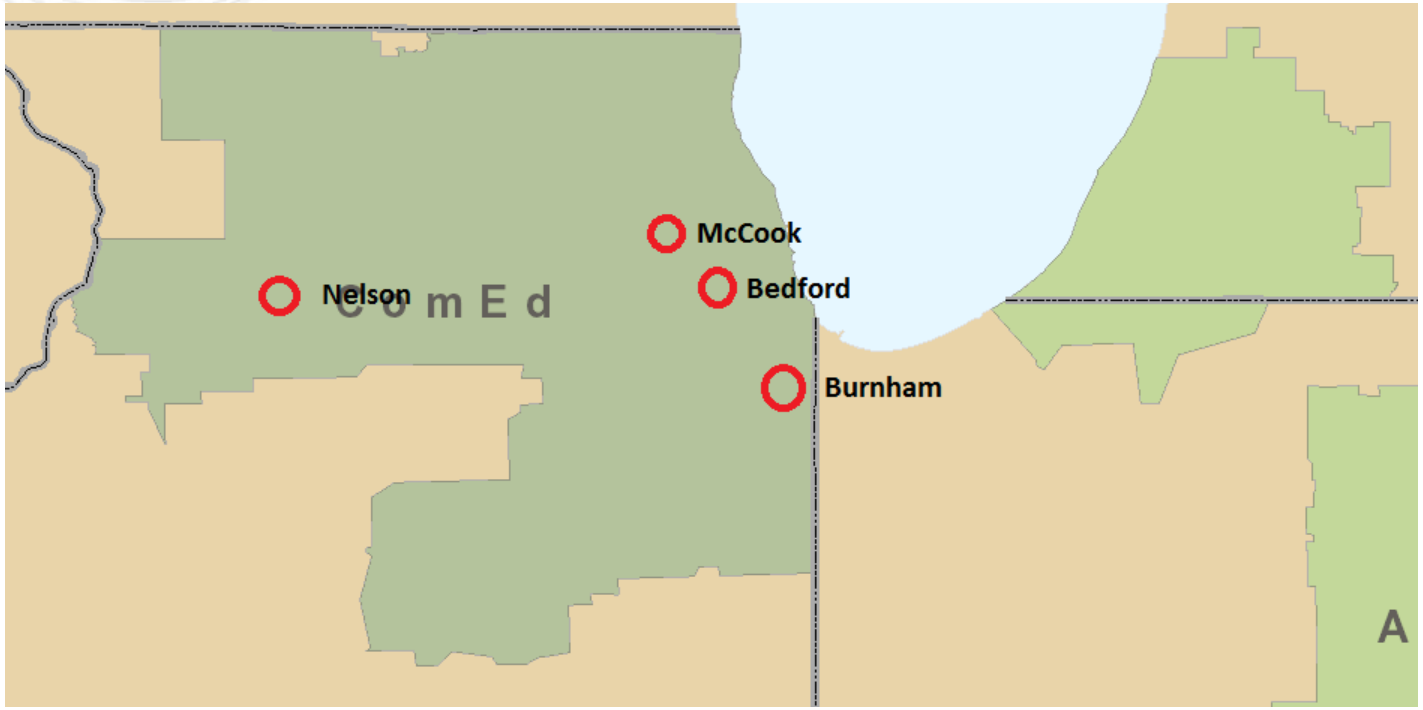
Problem Statement:

Replacing obsolete electromechanically relays with microprocessor relays

- Improved performance
- Add SCADA connectivity
- Allow real time data gathering of Transmision events

Selected Solution:

- Update relay packages at Nelson and Rockfalls on the 138kV line 15518 (Nelson-Rockfalls-Garden Plain) - $0.64M (S1555.1)
- Update relay packages at Bedford Park and Argonne on the138kV line 5104 (McCook-Bedford Park-Burr Ridge) - $0.64M (S1555.2)
- Update relay packages at Burnham and Chicago Heights on the 138kV line 7307 (Burnham-Chicago Heights) -$0.64M (S1555.3)



Estimated Cost: Transmission $320K per terminal

Projected In-service: 12/31/2018

Project Status: Engineering

ComEd Transmission Zone: Supplement
138kV line 17712 Wave Trap Replacement

Previously presented on 2/14/2018 SRRTEP

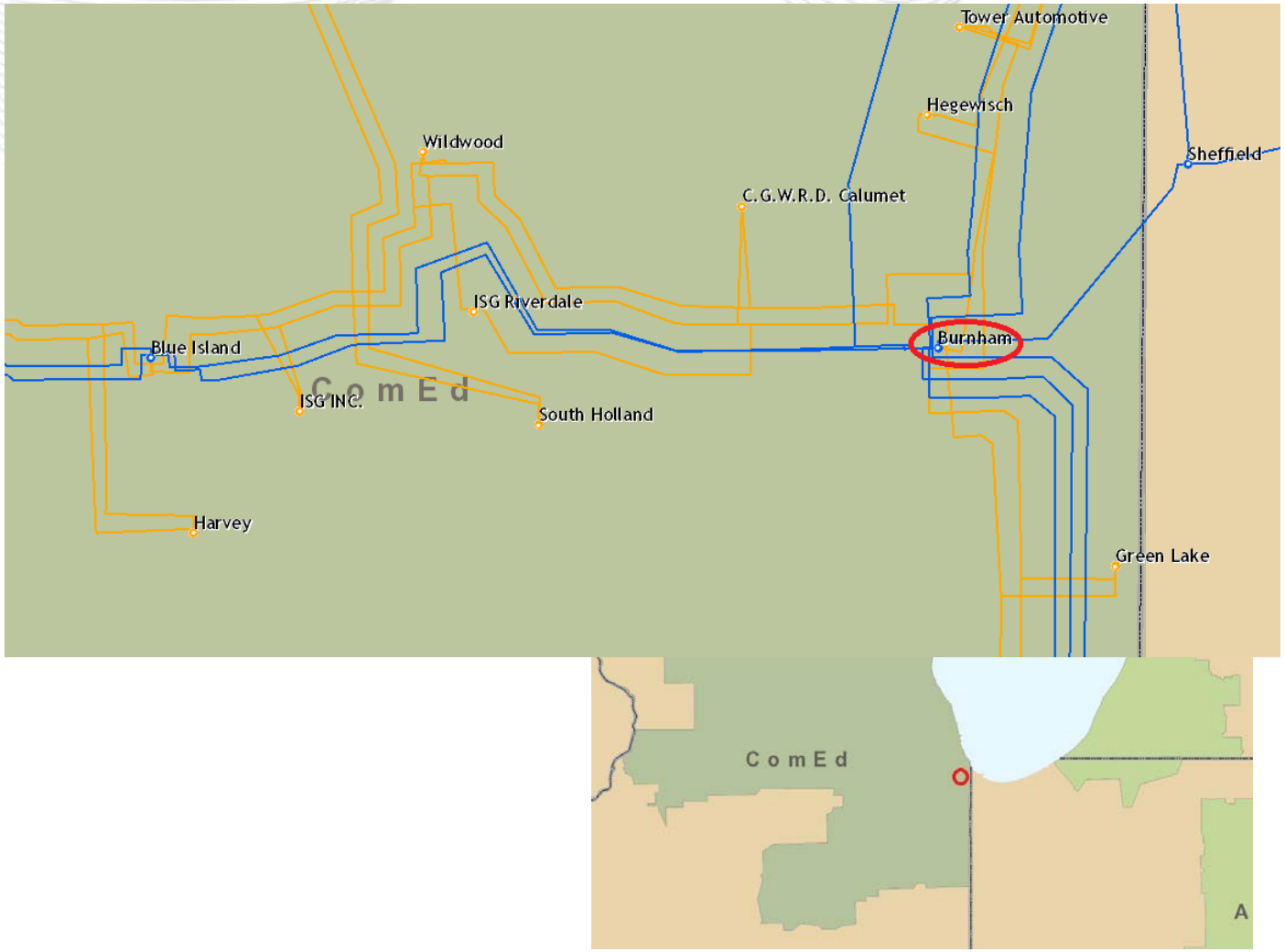
Problem Statement:
138kV line 17712 wave trap needs to be replaced due to material condition.

Selected Solution:
Replace the wave trap at the Burnham substation for 138kV line 17712 (Wildwood – Burnham-Hegewisch) (S1556)

Estimated Cost: $50K

Projected In-service: 12/31/2018

Project Status: Engineering



DUQ Transmission Zone: Supplemental Wilmerding Breaker Replacement

Previously presented on 2/14/2018 SRRTEP

Problem Statement

The Wilmerding #86 and #88 138kV breakers were installed in 1968. The #88 breaker feeds a transmission customer and has the potential to remove this customer from service if not replaced. The lifespan of these breakers have been optimized and each are now at the end of their useful lives based on material condition and performance.

Drivers: Equipment Material Condition, Performance and Risk

Selected Solution:

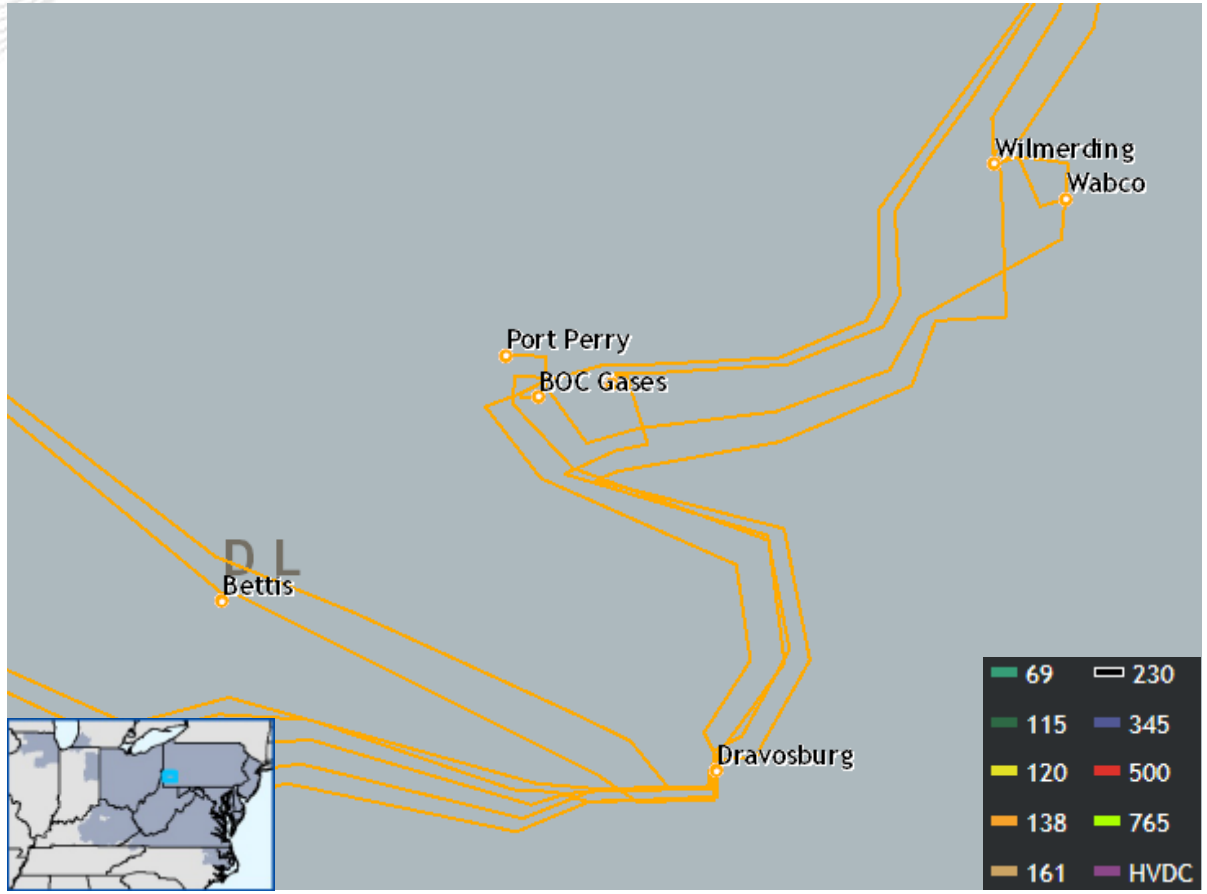
Replace Wilmerding SS - #86 138kV Breaker (Present rating: 37.1kA, Future rating: 50kA). (S1573.1)

Replace Wilmerding SS - #88 138kV Breaker(Present rating: 37.9kA, Future rating: 50kA). (S1573.2)

Estimated Project Cost: $0.38M each

Projected IS Date (Expected IS Date): 9/30/2018

Status: Engineering



AEP Transmission Zone: Supplemental
Ambler Ridge Station

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Operational Flexibility and Efficiency:

Currently AEP serves three critical customers from Thorofare Creek Switching Station. Due to physical limitations, AEP is unable to install circuit breakers at the Thorofare Creek Station. Therefore, by installing two 138 kV line breakers at Ambler Ridge Station, these critical customers will have line fault exposure reduced by 14 miles.

Customer Service:

Obligation to serve distribution customer request at a new station. Ambler Ridge station will serve approximately 6 MVA of load, transferred from Clendenin station.

Selected Solution

Construct a 138/34.5kV distribution station (Ambler Ridge). Install a new 138/34.5 kV 30 MVA transformer, two 3000 A 138 kV MOAB's and a 3000 A 40 kA 138 kV circuit switcher. (S1526.1) Estimated Cost: $0.0M

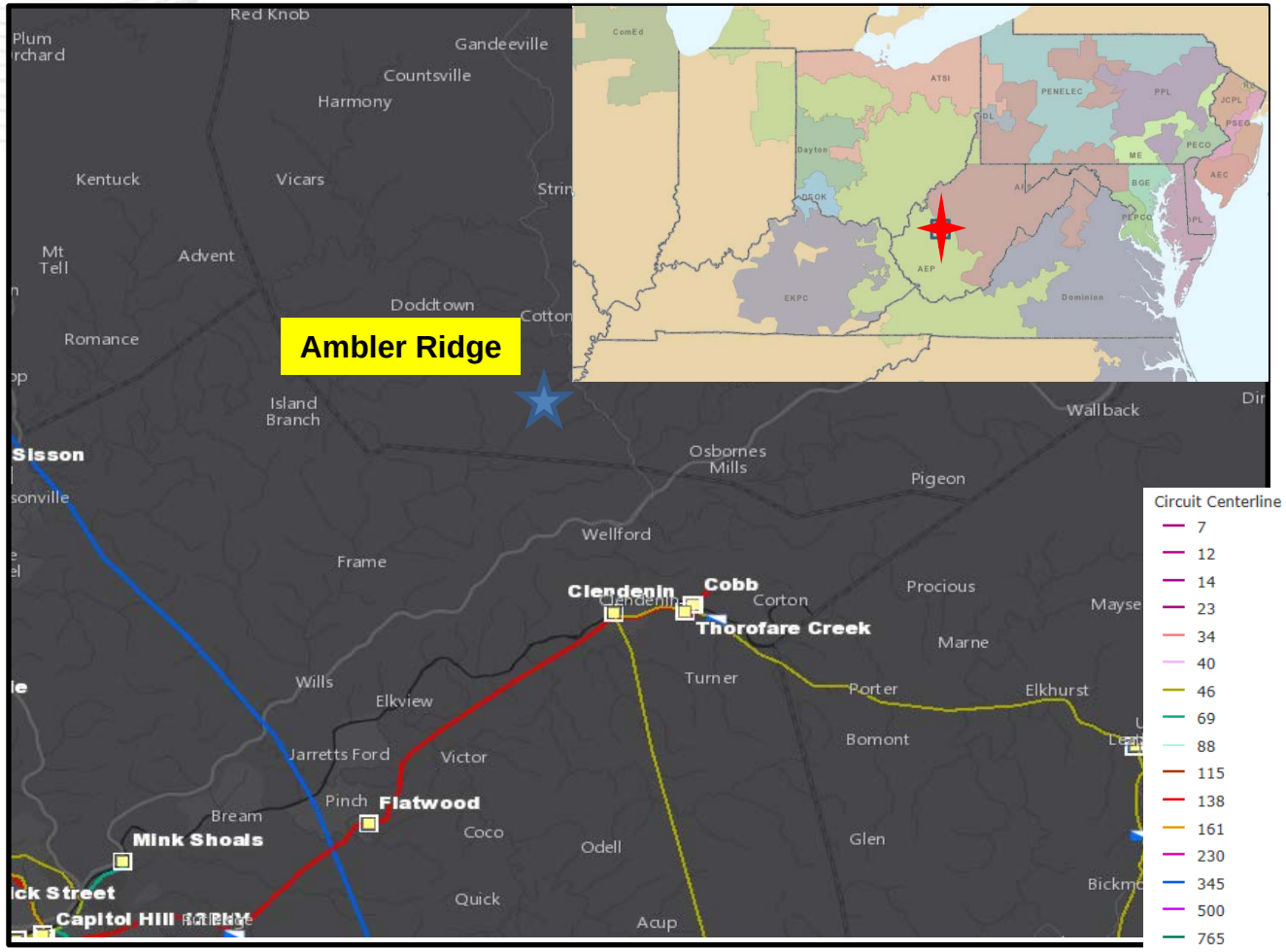
Route the Thorofare – Chloe 138 kV in and out to Ambler Ridge Station. (S1526.2)

Estimated Cost: $0.0M

Total Estimated Transmission Cost: $0.0M

Projected In-service: 6/1/2019

Project Status: Scoping



AEP Transmission Zone: Supplemental
West Huntington Station Rehab

Previously presented on 2/14/2018 SRRTEP

Problem Statement:
138 kV circuit breaker 'D' at West Huntington has been identified by PJM as exceeding its rated interrupting capabilities due to supplemental project S1377.1 -.11, which was presented on 11/2/2018 and 12/18/2017 SRRTEP

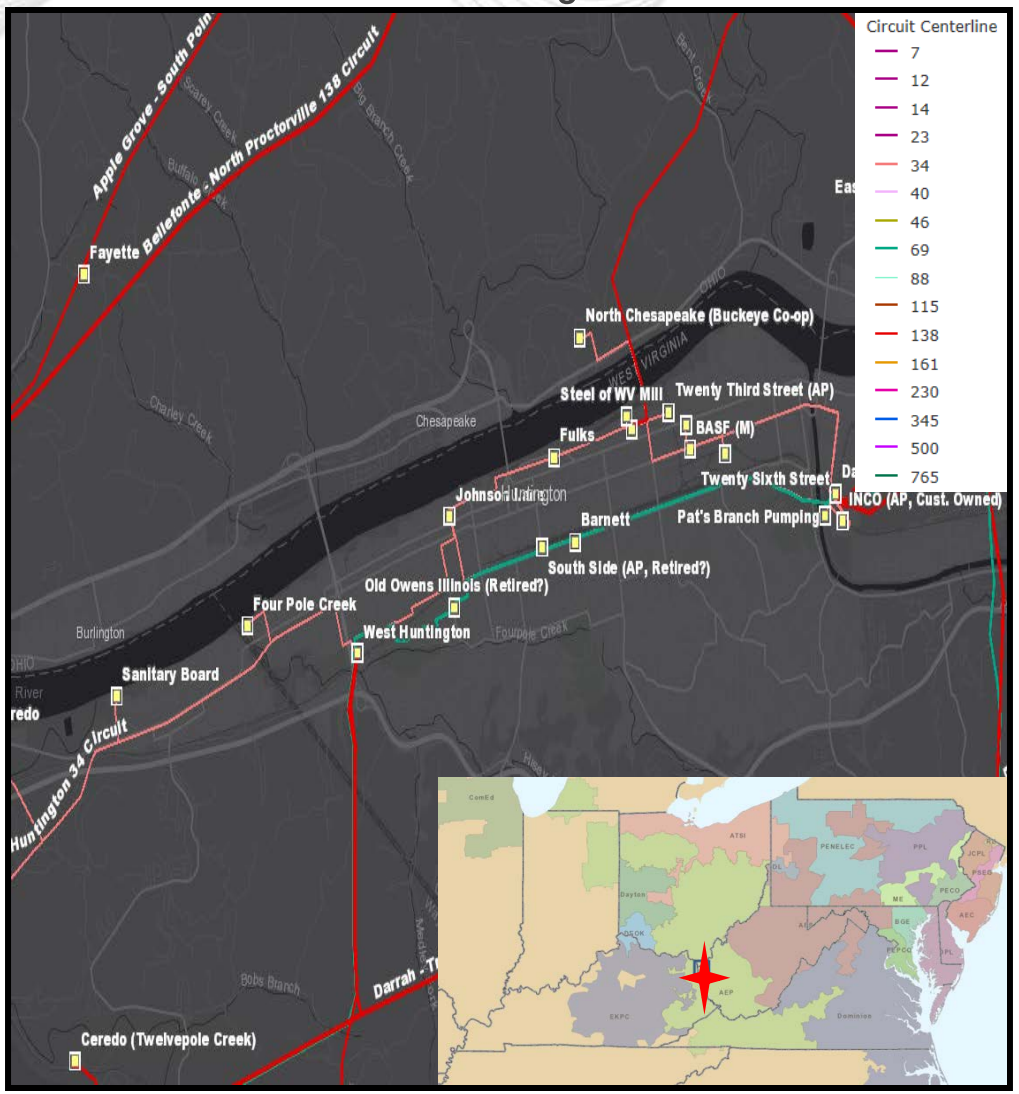
Equipment Material/Condition/Performance/Risk:
138 kV circuit breakers "D" at West Huntington is FK type breaker that is over 67 years old. It is oil breakers that have become more difficult to maintain due to the required oil handling. There is an increased potential for oil spills during routine maintenance and failures with these types of breakers. Other drivers include PCB content, damage to bushings and number of fault operations exceeding the recommendations of the manufacturer. West Huntington breakers "D" & "E" have experienced 89 and 18 fault operations. The manufacturer's recommendation for this type of breaker is 10.

Selected Solution:
Replace the existing 1200A 20 kA 138 kV circuit breaker 'D' with a new 3000A 40 kV 138 kV circuit breaker at West Huntington station. (S1377.12)

Estimated Cost: $0.6M

Projected In-service: 5/1/2018

Project Status: Under Construction



AEP Transmission Zone: Supplemental
West Huntington Station Rehab

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

138 kV circuit breaker "E" at West Huntington is FK type breakers that are both over 67 years old. It is oil breaker that has become more difficult to maintain due to the required oil handling. There is an increased potential for oil spills during routine maintenance and failures with these types of breakers. Other drivers include PCB content, damage to bushings and number of fault operations exceeding the recommendations of the manufacturer. West Huntington breaker "E" have experienced 89 and 18 fault operations. The manufacturer's recommendation for this type of breaker is 10.

69 kV circuit breaker "C" and 34.5 kV circuit breaker "J" at West Huntington are FK type oil breakers that are over 46 years and share the same concerns listed for the 138 kV breakers above. Circuit Breakers "C" & "J" have experienced 23 and 40 fault operations. The manufacturer's recommendation for this type of breaker is 10.

Capacitor switcher "AA" at West Huntington is a VBM type switcher. Joslyn Varmaster VBM-34's have a double stack interrupter design requiring simultaneous operation for rated current interruption; any delay between the two stacks would cause the full electrical stress of the operation to be placed on one stack. This could lead to capswitcher and/or cap bank failure. Like Mark V switchers, new control integration is difficult.

Operational Flexibility and Efficiency

138 kV circuit breakers will be added to the high side of the transformers at West Huntington to separate dissimilar zones of protection.

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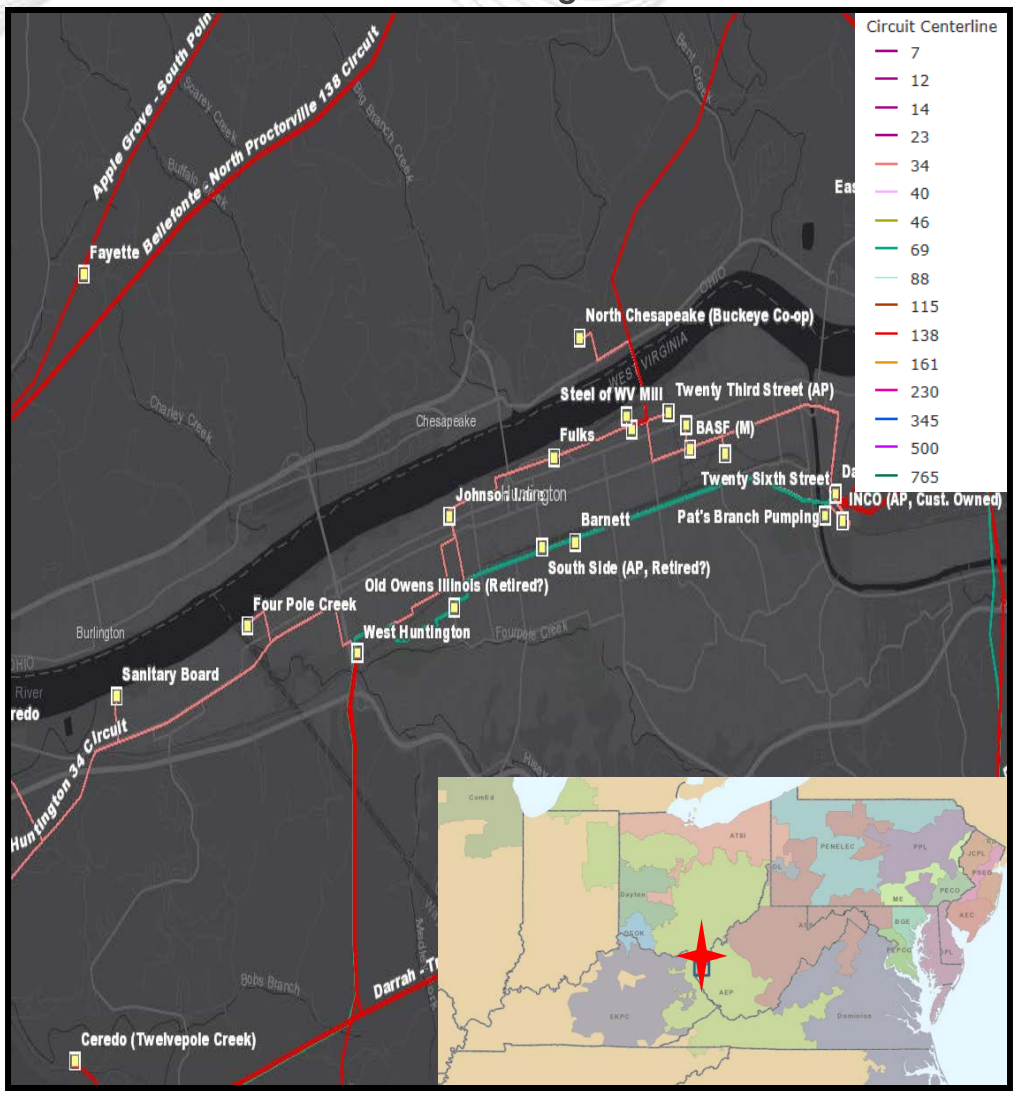

AEP Transmission Zone: Supplemental West Huntington Station Rehab

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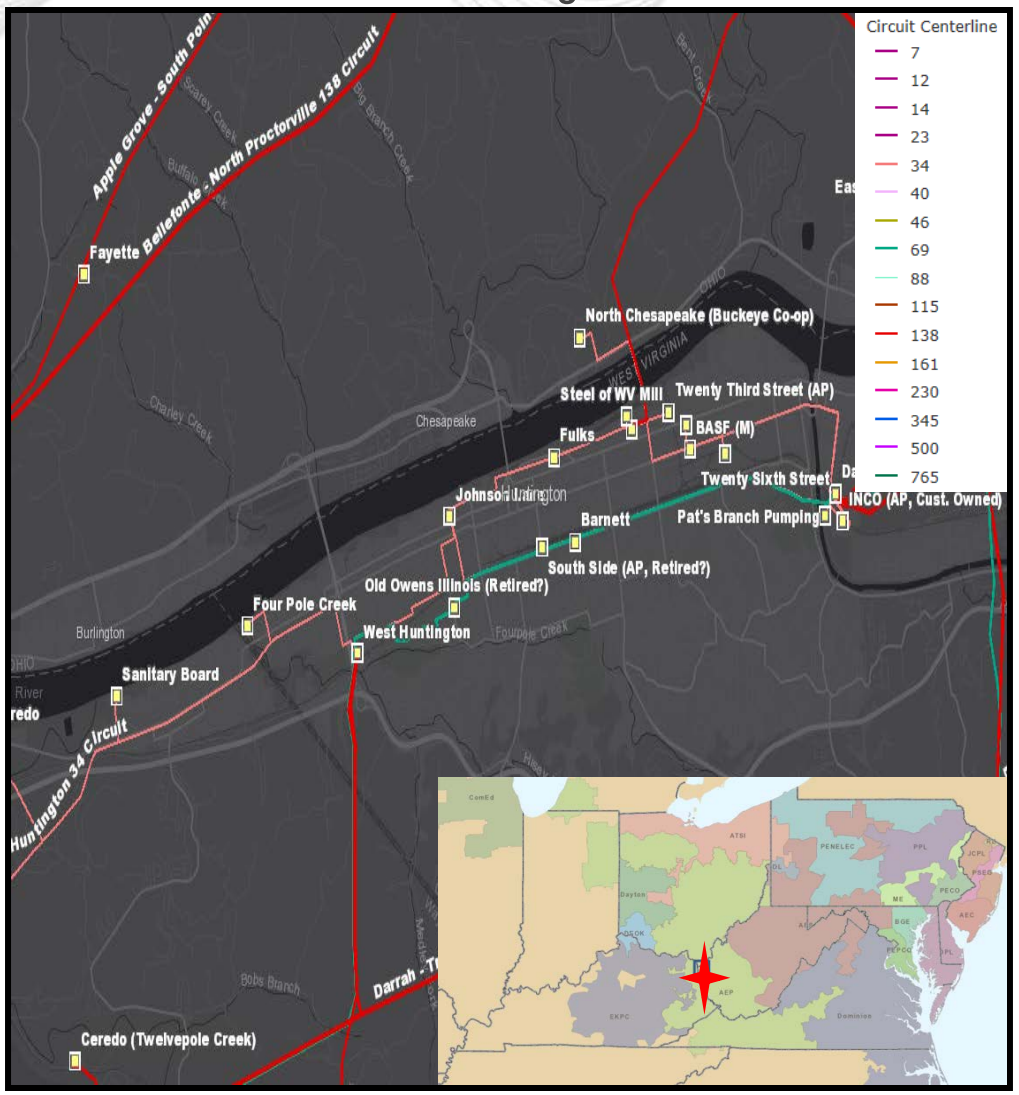
Selected Solution:

Replace the existing 1200A 20 kA 138 kV circuit breaker 'E' with a new 3000A 40 kV 138 kV circuit breaker. Install three 138 kV 3000 A 40 kA circuit breakers on the high side of the three transformers at West Huntington. Replace the existing 1800A 27 kA 69 kV circuit breaker 'C' with a new 3000 A 40 kA 69 kV circuit breaker. Replace the existing 1800A 27 kA 34.5 kV circuit breaker 'J' with a new 3000A 40 kA 34.5 kV circuit breaker. Replace the existing capacitor switcher 'AA' with a new circuit switcher. (S1527)

Estimated Cost: $3.9M

Projected In-service: 5/1/2018

Project Status: Under Construction



AEP Transmission Zone: Supplemental
Mount Vernon-Howard 69 kV Line Rebuild

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The Lexington – North Bellville – North Liberty Switch section of the Mount Vernon – Howard 69 kV line has conductor sizes of #1 Copper (31 MVA rating, originally built in 1917) and 1/0 ACSR (34 MVA rating, built in 1959). The line has 75 open conditions that pose risk of failure. Since 2013, the line has experienced over 2.9 M customer minutes of interruptions.

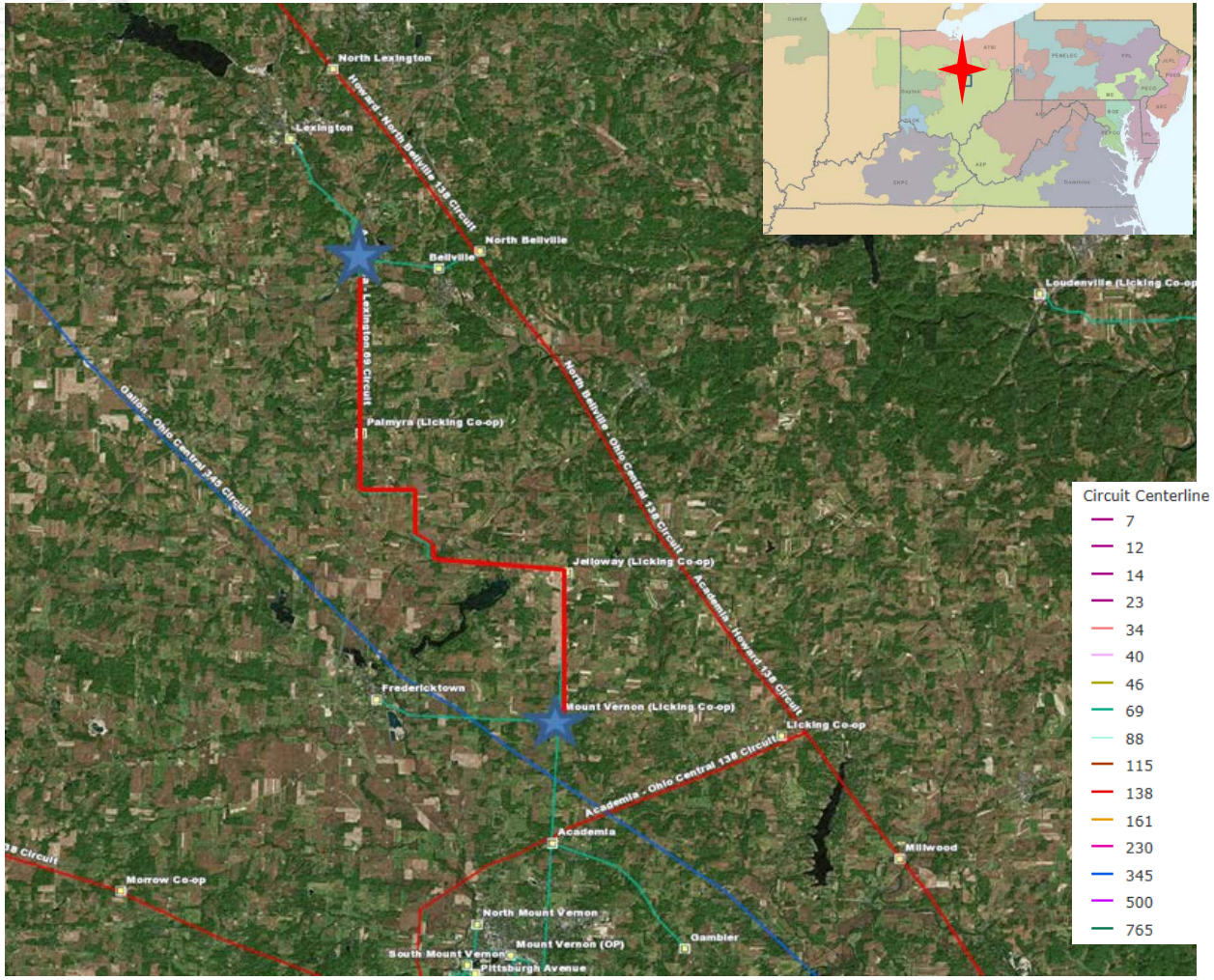
Selected Solution:

Rebuild the North Liberty Sw – West Bellville Sw section (12 miles) of the Mount Vernon – Howard 69 kV line with the conductor size 959.6 ACSR/TW (141 MVA rating). (S1557)

Estimated Cost: $8.5M

Projected In-service: 6/1/2018

Project Status: Under Construction



Previously presented on 2/14/2018 SRRTEP

Baseline & Supplemental Project

Problem Statement:

Planning Criteria Violations (TO criteria violation):

For N-1 loss of the Reedurban 138-69kV transformer (or the South Canton-West Canton #2 138kV circuit), the following summer peak overloads are observed: Torrey-S. Gambrinus Switch 69kV (117% SE); S. Gambrinus Switch-Gambrinus Road 69kV (106% SE). The circuit sections are overloaded due to 4/0 Copper conductor (rated at 54 MVA SE).

Equipment Material/Condition/Performance/Risk:

The existing 2.7 mile, 69 kV line section between Torrey and Bliss Park was originally constructed in 1922 using wood pole structures with 4/0 Copper conductor (54 MVA rating). The majority of the existing structures date to 1963 or earlier (55 years old), with the conductor dating to 1922. In addition, there is a 400 foot underground cable section that is in poor condition.

This 69kV line section has experienced 1.25 million minutes of customer interruption (CMI) in the past three years.

There are 17 open Category A conditions on this line section and 3 Category B items of concern. These issues include: rotted poles, damaged splices, and stolen ground-wire leads.

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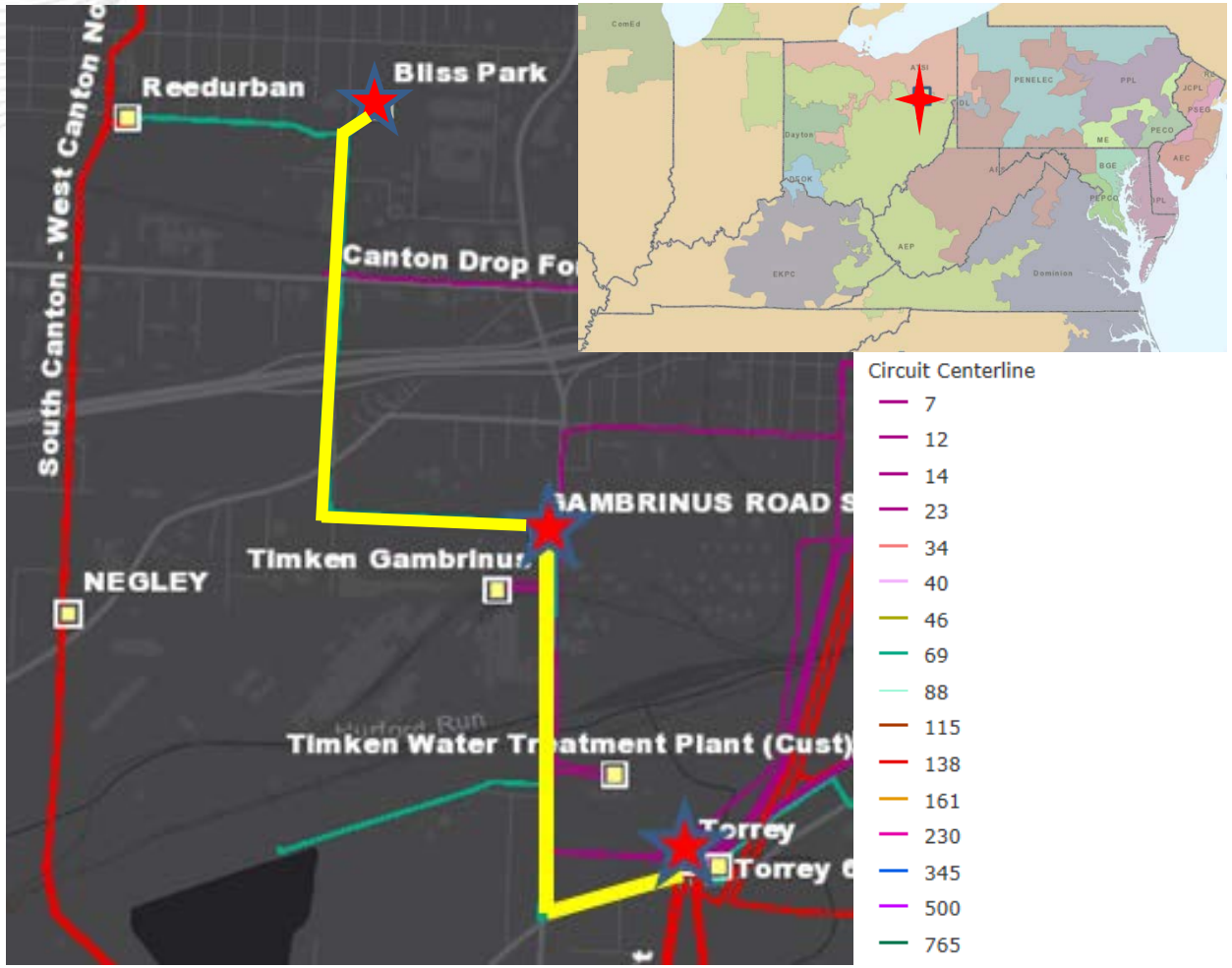

AEP Transmission Zone: Baseline and Supplemental
Torrey-Bliss Park 69kV Line Rebuild

Continued from previous slide…

Operational Flexibility and Efficiency:

This 69kV line section provides service to a large oil refinery, which has sensitive electrical equipment. Proactively replacing this aging asset will ensure a high level of reliability for years to come. In addition, the existing capacity constraints hinder future customer expansion plans.

The circuit has experienced numerous local PCLLRW warnings in 2016-17, due to the real-time loads being above the N-1 capability of the circuit.

In addition, the Bliss Park-Gambrinus 69kV section loads to 51 MVA (94% of its 54 MVA SE rating), for an N-1 contingency of the Torrey 138-69KV transformer fault or a Torrey 69kV bus fault. The 3 MVA of margin on this line may be used up quickly due to the large industrial customers on the circuit (oil refinery and scrap metal yard).

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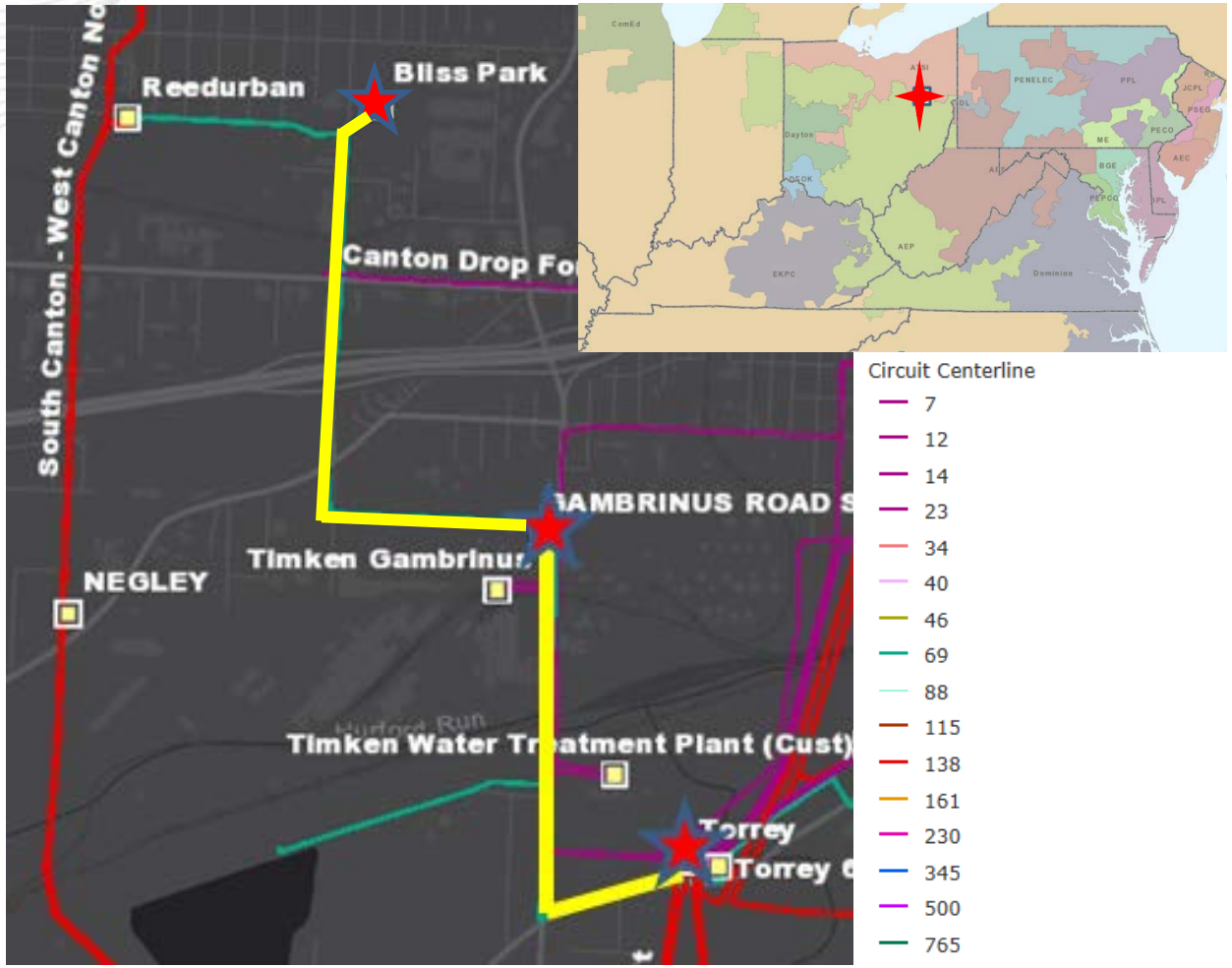


AEP Transmission Zone: Baseline and Supplemental
Torrey-Bliss Park 69kV Line Rebuild

Continued from previous slide…

Selected Solution:

Baseline:

Rebuild the Torrey – South Gambrinus Switch – Gambrinus Road 69kV line section (1.3 miles) with 1033 ACSR 'Curlew' conductor and steel poles. (B2993)

Estimated Baseline Cost: $2.8M

Required In-service: 6/01/2018

Projected In-service: 12/01/2018

Supplemental:

Rebuild the Gambrinus Road – Bliss Park 69kV line section (1.4 miles) with 1033 ACSR 'Curlew' conductor and steel poles. (S1558)

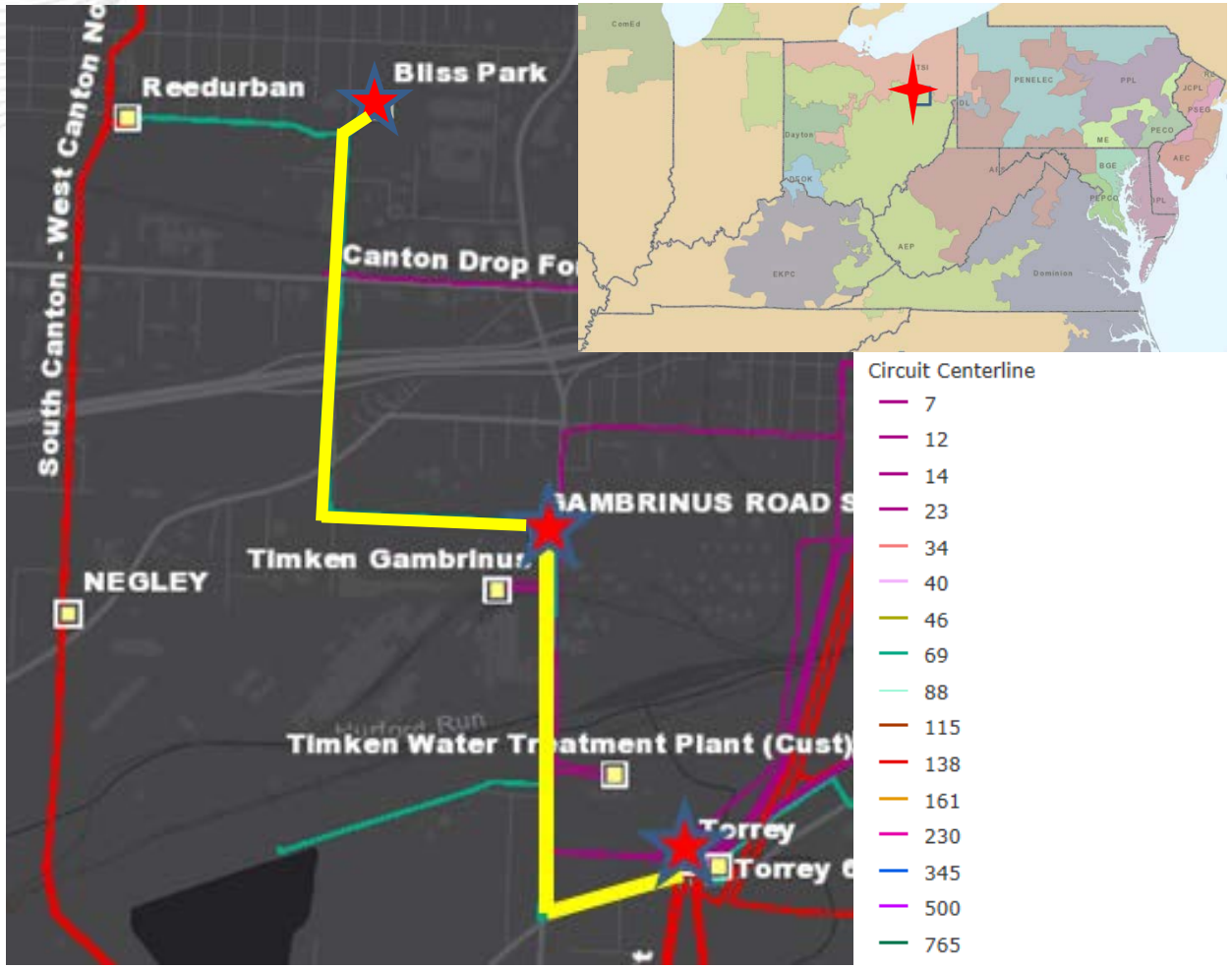
Estimated Supplemental Cost: $3.0M

Total Estimated Cost: $5.8M

[This conductor size was chosen due to the location of the major oil refinery that has discussed potential major load increases with AEP in recent years; in addition, this conductor is one of the most common in the Canton area, resulting in procurement/warehousing/spare-part cost savings.]

Projected In-service: 12/01/2018

Project Status: Engineering



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AEP Transmission Zone: Supplemental
Buckskin-Highland 69 kV Rebuild

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The Buckskin – Highland line was installed in 1926 with 4/0 ACSR conductor (50 MVA rating), with the majority of the line (96%) still from that vintage. There were 651 open conditions found during the most recent inspection of the Buckskin-Highland line, which was completed in 2015. Outages on this circuit are attributed to broken pole tops, floating phases, broken poles, and weather.

Petersburg Switch has been identified as a safety concern due to the terrain around the switch handles and the height at which the handles are installed. It has been recognized that when a switch person is switching, there is a tripping hazard due to the steep elevation change at the base of the pole where the GOAB handles are located: the switch handle is at head level at the high end of the terrain and is above the head when completely open. Switches on wood poles also have issues with the blades seating properly during switching, requiring additional outage and switching time from Transmission Dispatch. The existing wood pole switch will be replaced with a steel pole switch across the road from the existing location to allow for better footing, proper seating of the switch blades reducing outage and switching time, and safer operation of the switch. The FOI outage metric is 19.2, sufficient for the justification of MOAB switch installation.

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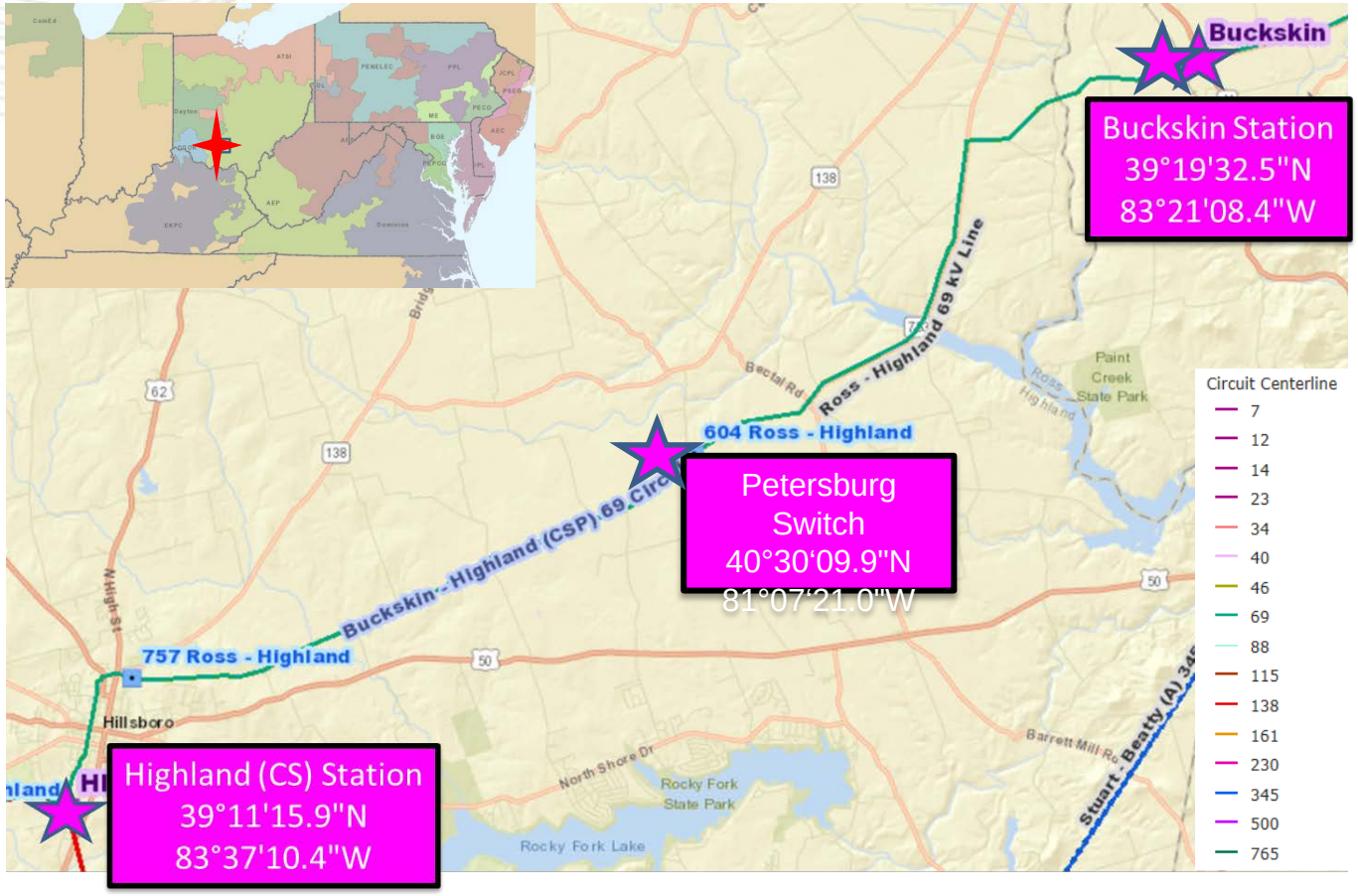

AEP Transmission Zone: Supplemental
Buckskin-Highland 69 kV Rebuild

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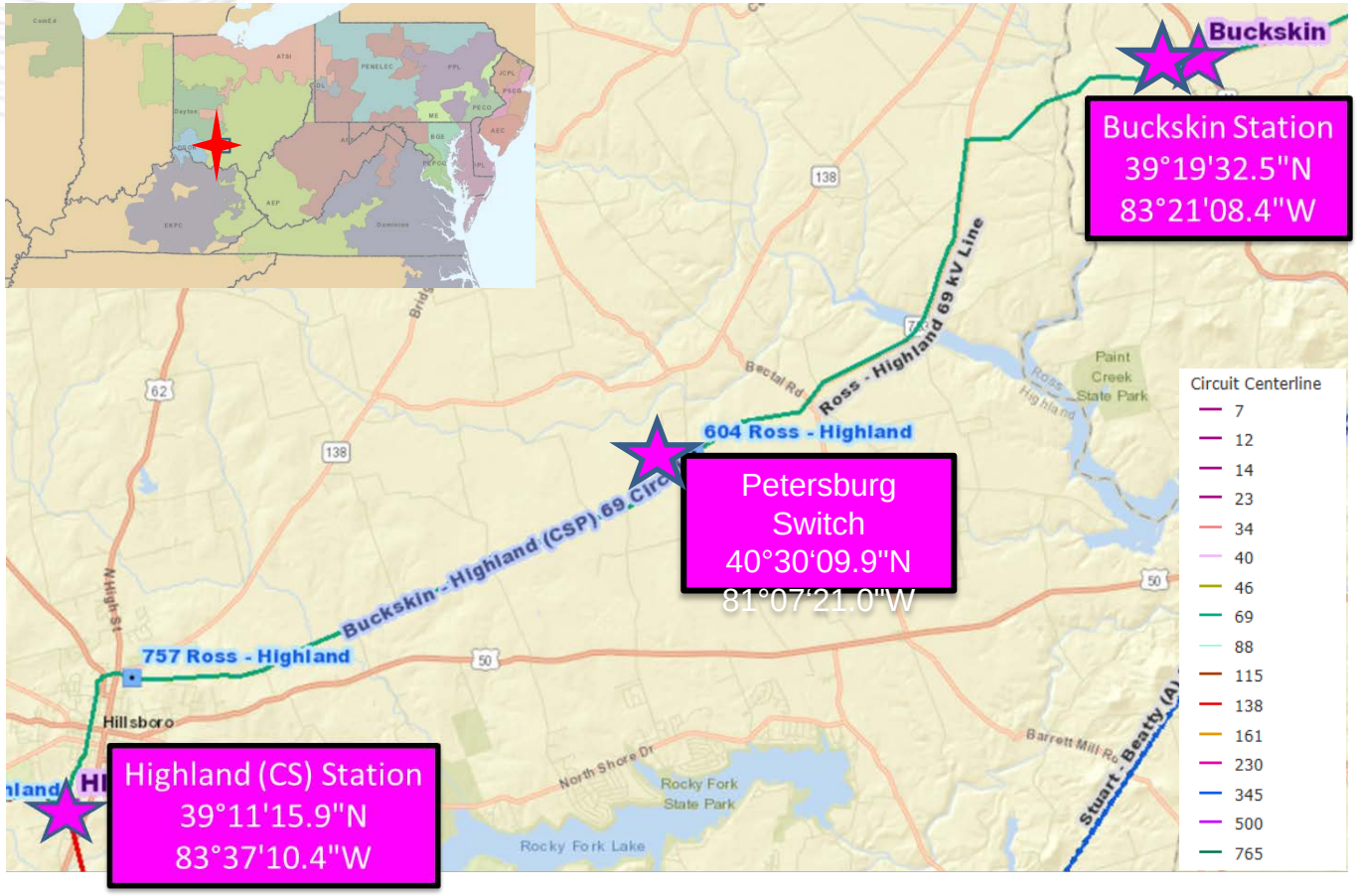
Selected Solution:
Rebuild ~18.7 miles of the Ross – Highland 69kV Line using 795 ACSR conductor (128 MVA rating) and 69kV Self Supporting steel with partial reroute around Hillsboro. (S1559.1)
Estimated Cost: $20.7M

Replace Petersburg Switch (S1559.2)
Estimated Cost: $0.3M

Total Estimated Transmission Cost: $21.0M

Projected In-service: 12/01/2019

Project Status: Engineering



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AEP Transmission Zone: Supplemental
Cabin Creek – Clendenin Rebuild

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

From 2014-2016, the Cabin Creek – Clendenin 46 kV circuit (~ 26 miles) has experienced 8 permanent and 14 momentary outages resulting in approximately 750,000 customer minutes interrupted. The 17 mile Kelly Creek – Clendenin 46 kV line section that is to be rebuilt currently has 49 category A conditions along 114 structures of single circuit wood pole construction. These conditions include damaged/rotted poles and damaged guy wires, cross arms and contribute to the amount of momentary and permanent outages seen on the circuit. The majority of this circuit utilizes 1960s and 1970s wood structures as well as some 1910s lattice structures with a mix of 3/0 ACSR, 4/0 Copper and 3/0 Copper conductor (29 MVA rating).

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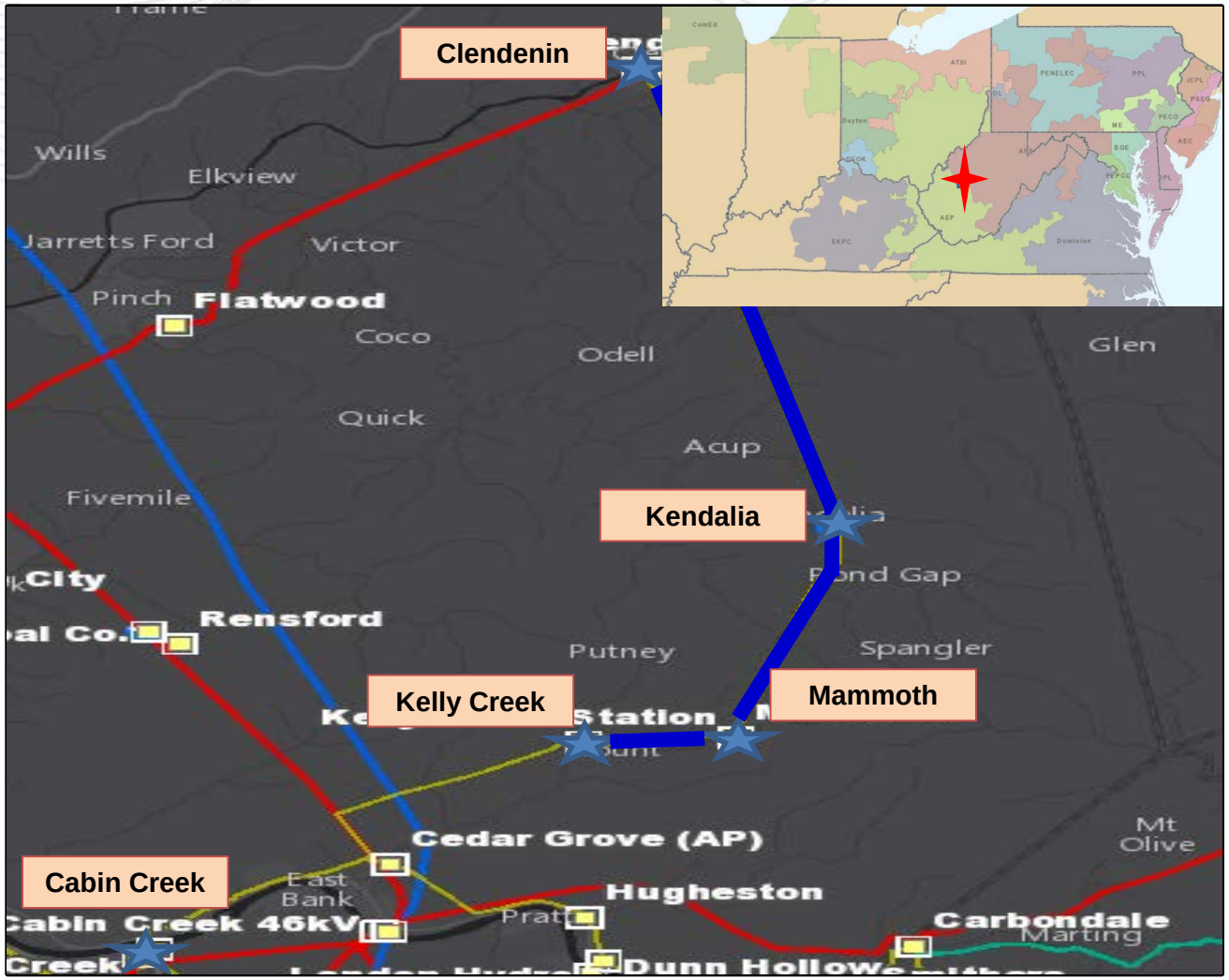

AEP Transmission Zone: Supplemental
Cabin Creek – Clendenin Rebuild

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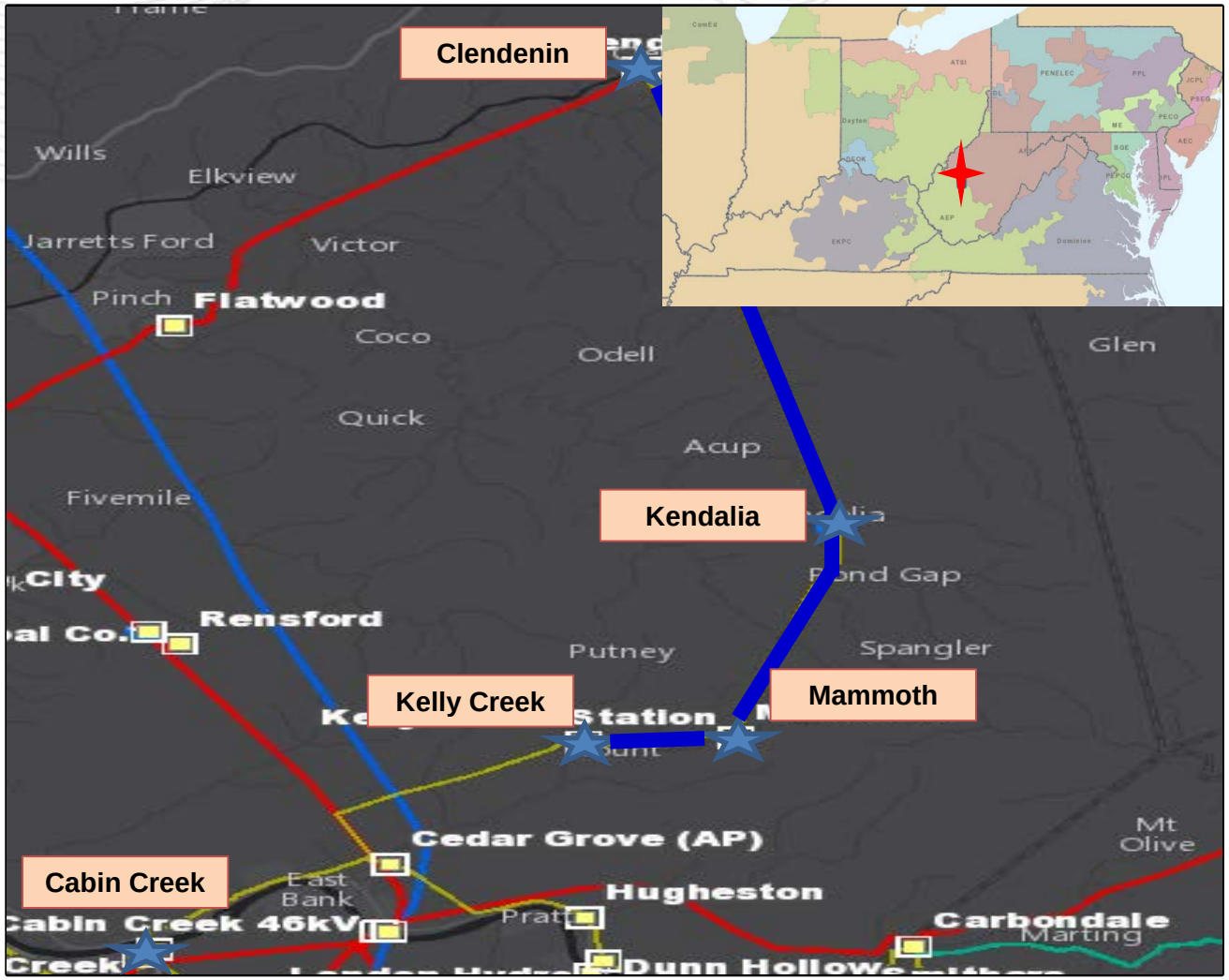
Selected Solution:
Rebuild approximately 17.5 miles of the Clendenin –Kelly Creek 46kV line to 69kV standards (energized at 46kV) utilizing 556 ACSR (68 MVA rating).
Retire Kendalia switch. (S1560.1)
Estimated Cost: $29.3M
At Kelly Creek retire the switching structure and replace it with a 1200 A 3 way Phase Over Phase (POP) motorized switching structure. (S1560.2)
Estimated Cost: $0.7M
At Mammoth station install a 1200 A 3 way POP motorized switching structure. (S1560.3)
Estimated Cost: $0.7M

Total Estimated Transmission Cost: $30.7M

Projected In-service: 12/04/2020

Project Status: Engineering



AEP Transmission Zone: Supplemental Darwin Bypass

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Darwin station (NIPSCO) was built to connect Sugar Creek IPP (Mirant station) into the PJM market. Sugar Creek IPP no longer has the rights or intention to sell power into PJM. In December 2016, the electrical connection between Mirant and Darwin stations was removed. This reduces Darwin into a mere switching station between Sullivan and Eugene. There are no grid needs to have Darwin station present between Sullivan and Eugene. Therefore, bypass and retirement of AEP owned assets at Darwin station is proposed. AEP owned assets at Darwin include 345 kV relays and metering. This project will assist to reduce AEP O&M costs and responsibilities.

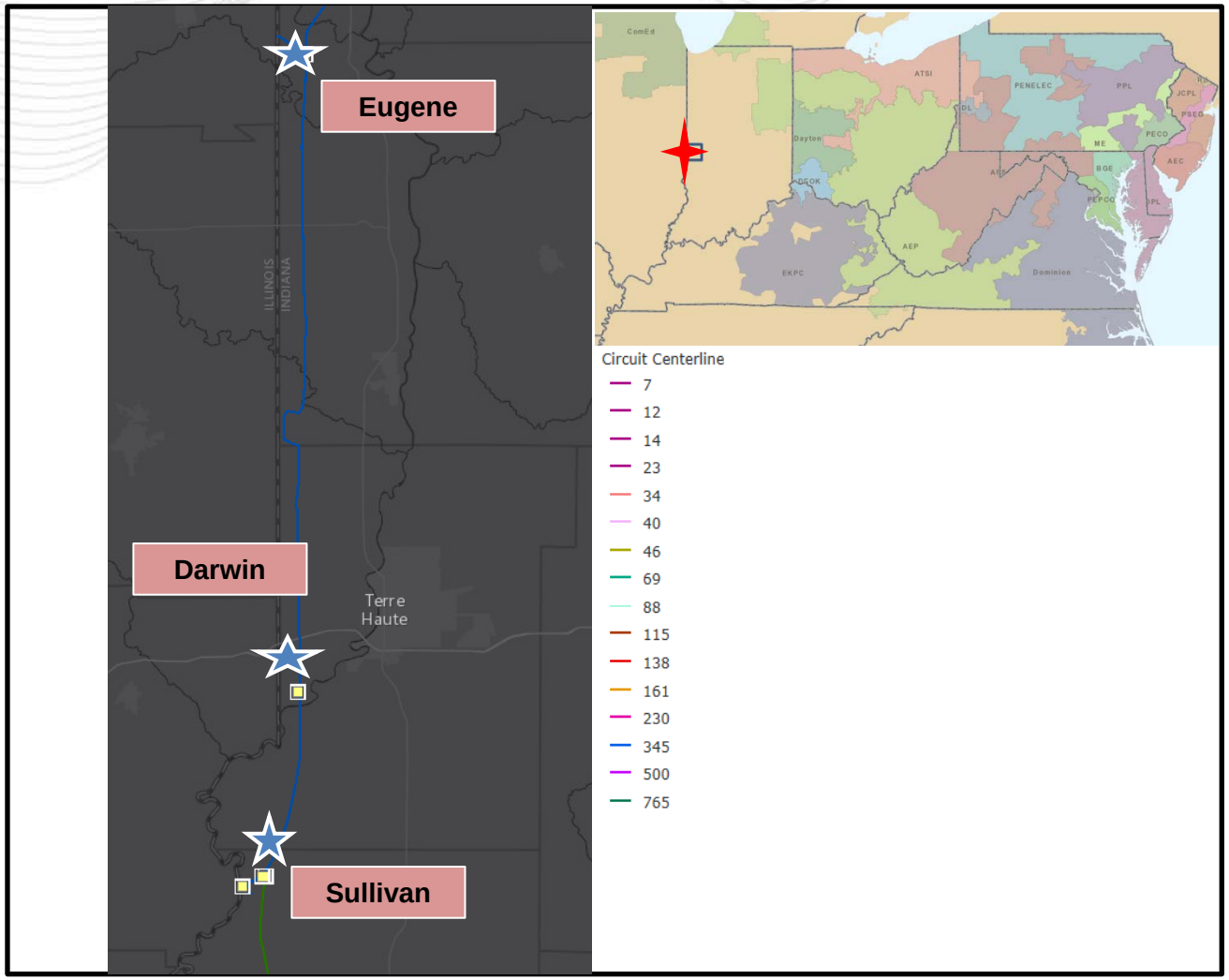
Selected Solution:

Disconnect Darwin station from the Eugene – Sullivan line and retire all AEP owned equipment at Darwin. (S1561)

Total Estimated Trans Cost: $0.9M

Projected In-service: 05/01/2018

Project Status: Engineering



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Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Dorton's 138/46 kV Transformer #1 is 1956 vintage and is showing dielectric breakdown (insulation), accessory damage (bushings/windings) and short circuit breakdown (due to amount of through faults).

Operational Flexibility:

There are three overlapping zones of protection on the 46 kV bus – the transformer, bus, and line exits.

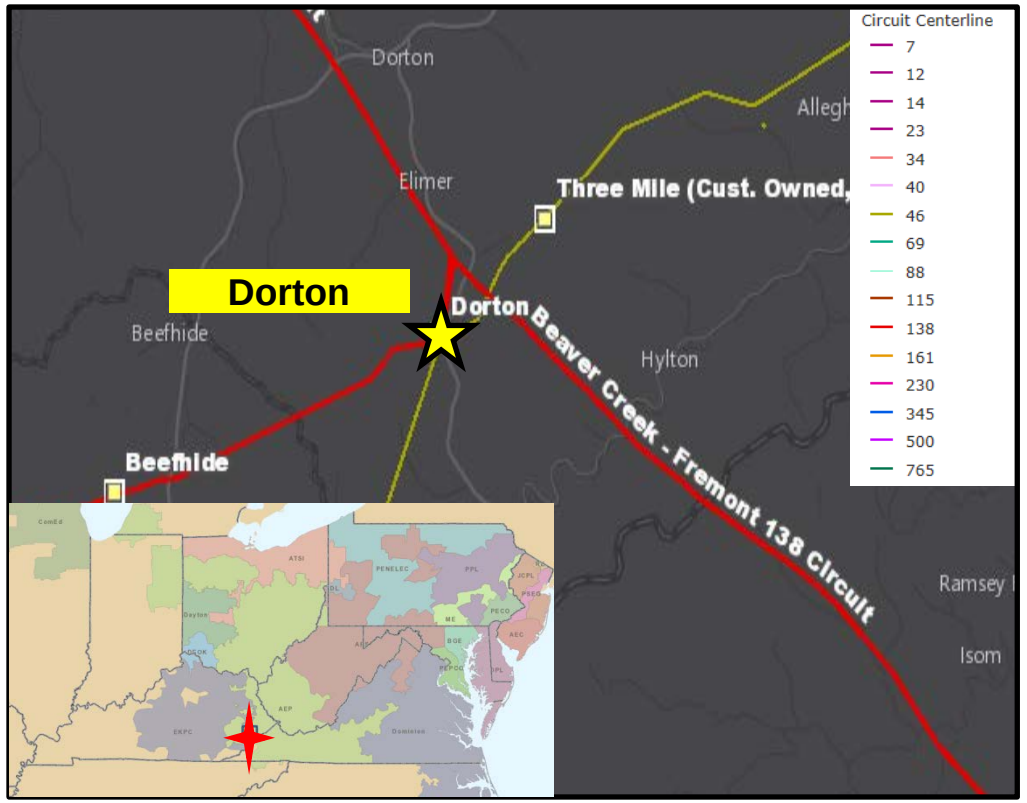
Selected Solution:

Replace the existing 138/46 kV 45 MVA transformer bank with a new 138/69/46 kV 90 MVA transformer bank at Dorton Station. A lowside 69 kV circuit breaker (operated at 46 kV) will be added to the transformer. (S1562)

Total Estimated Transmission Cost: $2.5 M

Projected In-service: 08/01/2019

Project Status: Scoping



Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The East Lima – Haviland 138kV line was originally constructed in 1925 with lattice towers and 397 ACSR conductor (167 MVA rating). The double circuit sectios of the line being rebuilt is approximately 30 miles long on the path from Haviland – North Delphos – Rockhill. There are 99 total open conditions along the line. There are numerous issues with the conductor and conductor hardware on this line. Armor grip suspension assemblies were installed during routine maintenance periods in an attempt to restore the strength of the conductor. However, crews have found many cases of broken conductor strands under these armor grip assemblies. In addition, the conductors' steel core has been found to be deteriorated in sections due to corrosion, which is a cause for concern as the mechanical strength of the wire can be compromised. Many insulators have lost their outer glaze, allowing contaminant buildup, compromised electrical integrity and growing risk of electrical failure. As this line was originally built in 1925, its design standards do not meet modern standards for strength, resilience, galloping and horizontal and vertical clearances for safety. Also, the easement conditions present sections with undefined width and have several encroachments.

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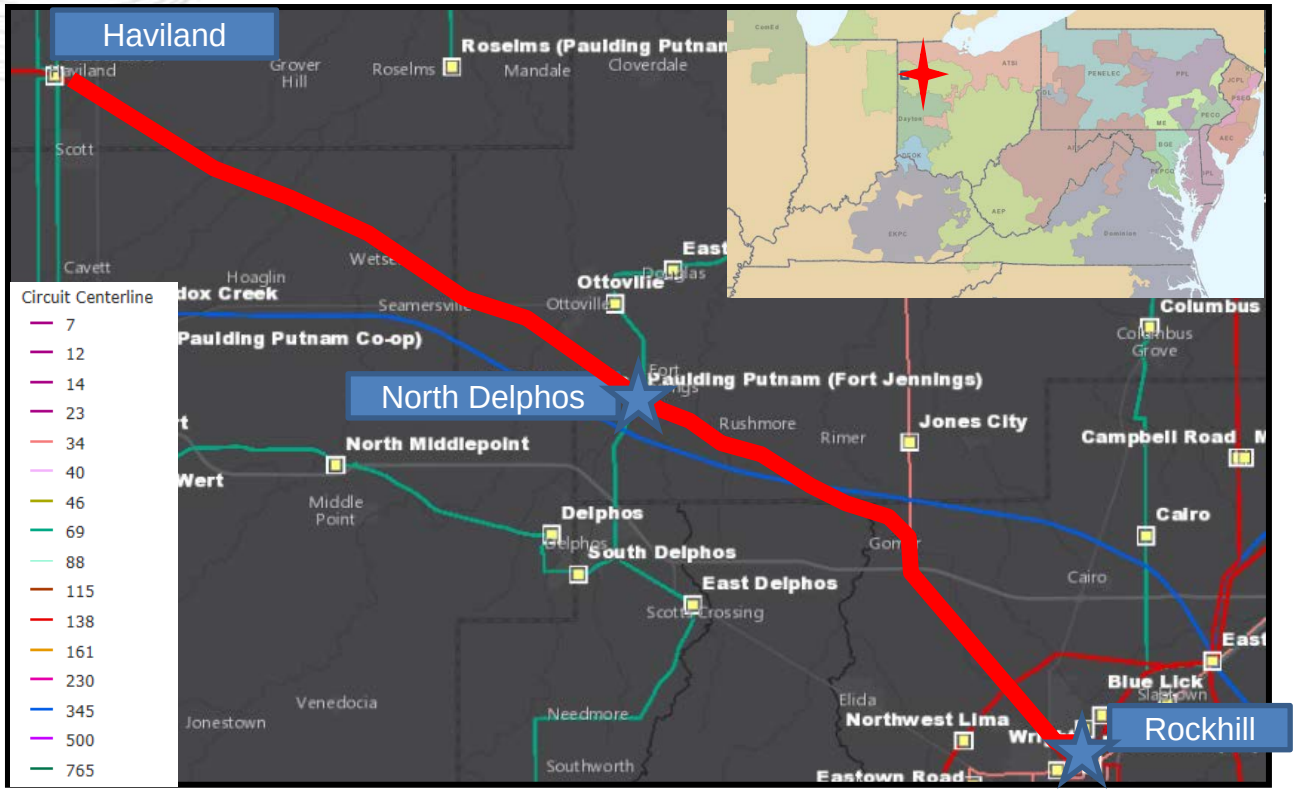

AEP Transmission Zone: Supplemental
East Lima – Haviland 138kV

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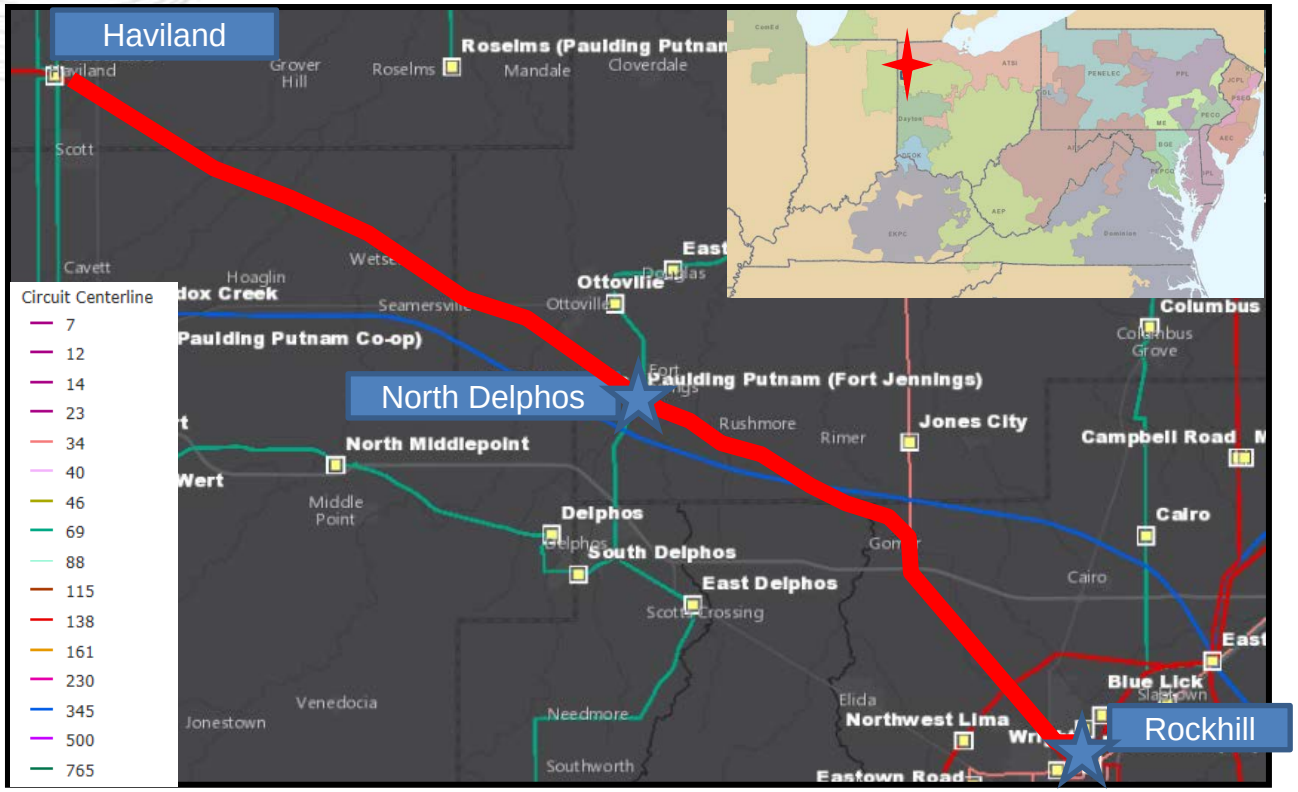
Selected Solution:
Haviland – North Delphos 138kV: Rebuild 15.6 miles of double circuit 138kV line utilizing 1033 ACSR conductor (296 MVA rating) (S1563.1)
Estimated Cost: $24.3M
North Delphos – Rockhill 138kV: Rebuild 15.4 miles of double circuit 138kV line utilizing 1033 ACSR 1033 ACSR conductor (296 MVA rating) (S1563.2)
Estimated Cost: $24.5M

Total Estimated Cost: $48.8M

Projected In-service: 12/18/2020

Project Status: Engineering



AEP Transmission Zone: Supplemental
Harpster – Waldo 69 kV Rehab

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The Harpster – North Waldo 69 kV circuit was built between 1946 - 1969 and is almost entirely wood poles with 132 A and 214 B open conditions distributed along the entire circuit. Almost the entire line is cross arm construction with vertical post insulators (not a current AEP standard).These cross arms and braces typically fail to pass inspection. Maintenance has become increasingly difficult due to the in availability of material for repair as the existing line is primarily 1/0 copper (35 MVA rating). The existing wood pole structures have bay-o-nets supporting the shield wire, with poor grounding at every other structure (currently not to AEP standard) contributing to poor momentary outage performance. Much of the line has distribution underbuilt whose mechanical loads consume pole strength. Some of these underbuilt is owned by Ohio Edison (a First Energy subsidiary). Furthermore, the present easement rights for this vintage line is inadequate by present day AEP Transmission standards.

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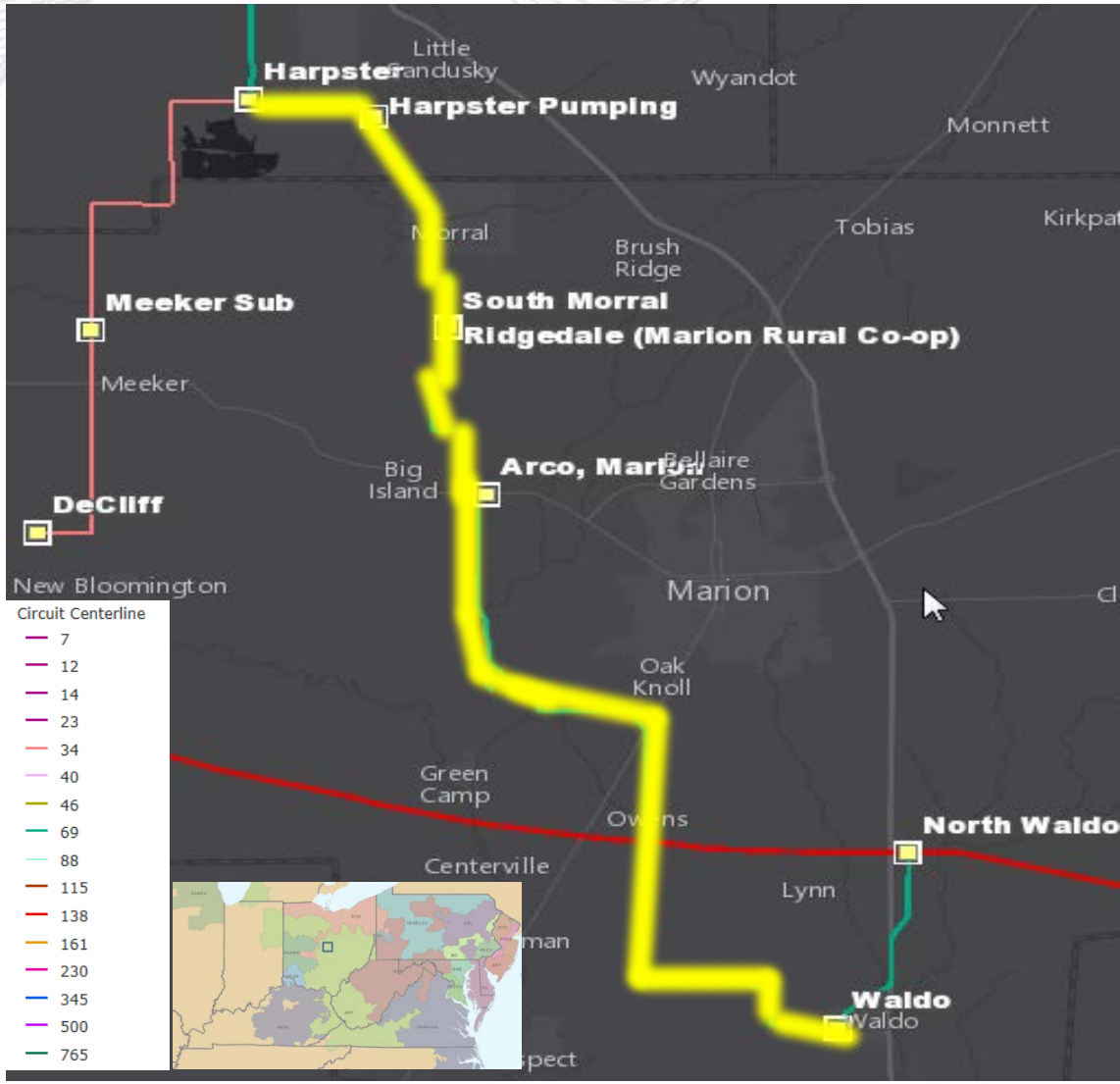

AEP Transmission Zone: Supplemental
Harpster – Waldo 69 kV Rehab

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Selected Solution:

Rebuild ~27.7 miles from Harpster 69 kV Station to Waldo 69 kV Station utilizing 795 ACSR conductor (SN 129 MVA rating) (S1564.1)
Estimated Trans Cost: $30.0M

Replace existing 600 A two way switch at Harpster Pump station with 1200 A three way switch. (S1564.2)
Estimated Transmission Cost: $0.91M

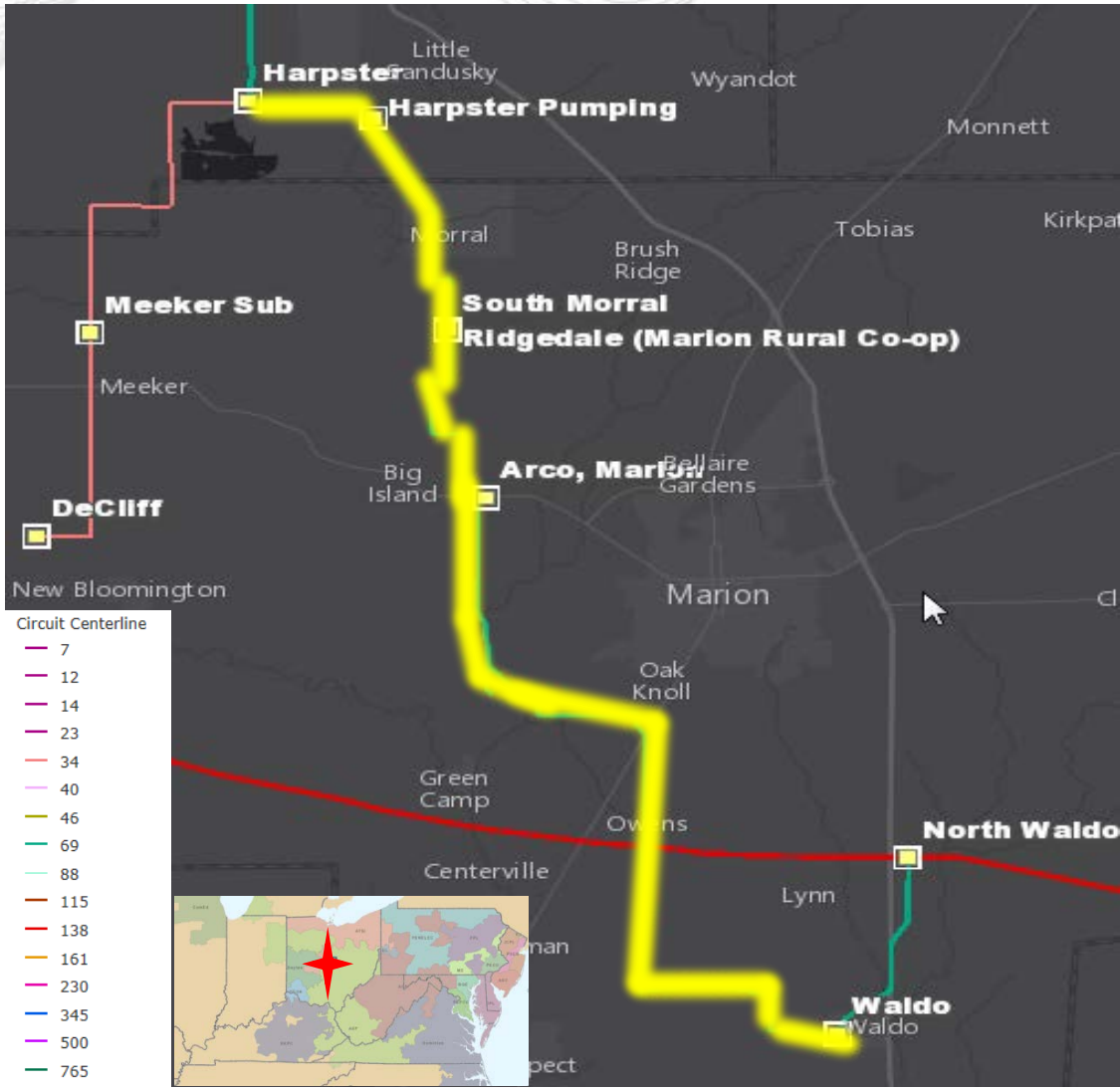
Install a one way 1200 A phase over phase switch (Goodnow Road SW) just north of Ridgedale (Marion Rural Co-op) (S1564.3)
Estimated Transmission Cost: $0.17M

Remove station West Marion SW. (S1564.4)
Estimated Transmission Cost: $0.08M

Total Estimated Transmission Cost: $31.2 M

Projected In-service: 06/04/2021

Project Status: Engineering



AEP Transmission Zone: Supplemental
Johns Creek Station Rehab

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Transformer Bank #1 (1980 vintage) has bad high side internal CTs which are not field replaceable. Given the faulty internal CT and the current maintenance issues, the bank is being replaced. Drivers for replacement include short circuit strength breakdown, bushing damage and dielectric strength breakdown (winding insulation). In order to move the 34.5 kV distribution load off the tertiary winding of the existing 138/69/34.5 kV transformer, a new 138/34.5 transformer is being installed along with the new 138/69/34.5 kV transformer.

Circuit Breaker 'A' is an oil breaker that is leaking oil. In addition the breaker has surpassed the manufacturer's recommended fault operations of 10 (135 fault operations).

Capacitor switcher 'AA' does not have pre-insertion inductor and has caused customer protection equipment in the area to trip off line due to voltage surges.

Capacitor switcher 'BB' is a Mark V model which no longer supports modern relaying packages. Mark V's have been historically prone to mechanism failures and are being replaced system wide where possible.

The MOAB/ground switch will be replaced. MOAB/ground switch combinations induce a fault on the system, tripping remote breakers for a transformer fault, reducing the life and increasing relay coordination complexity for the transformer protection.

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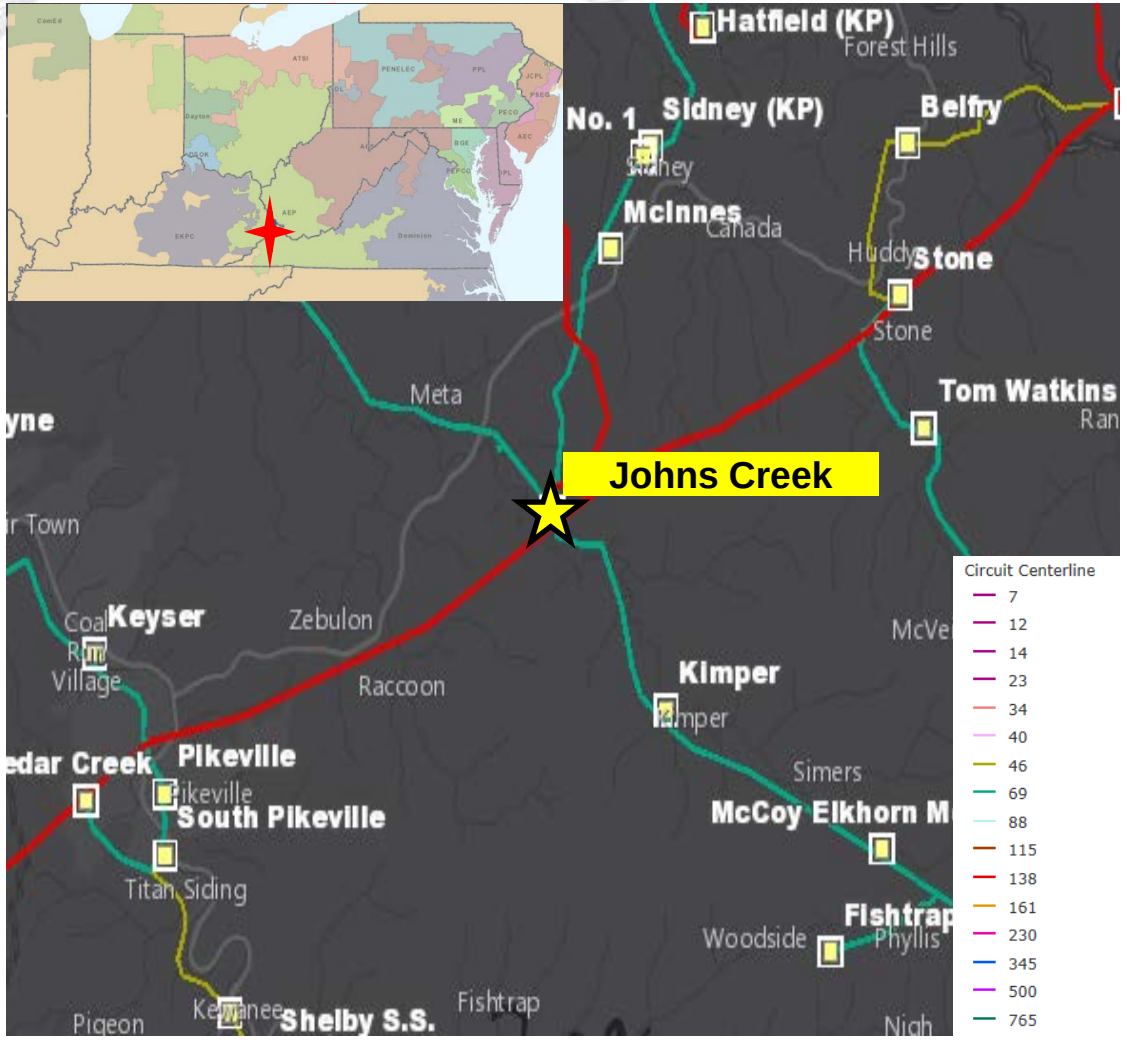


AEP Transmission Zone: Supplemental
Johns Creek Station Rehab

Continued from previous slide…

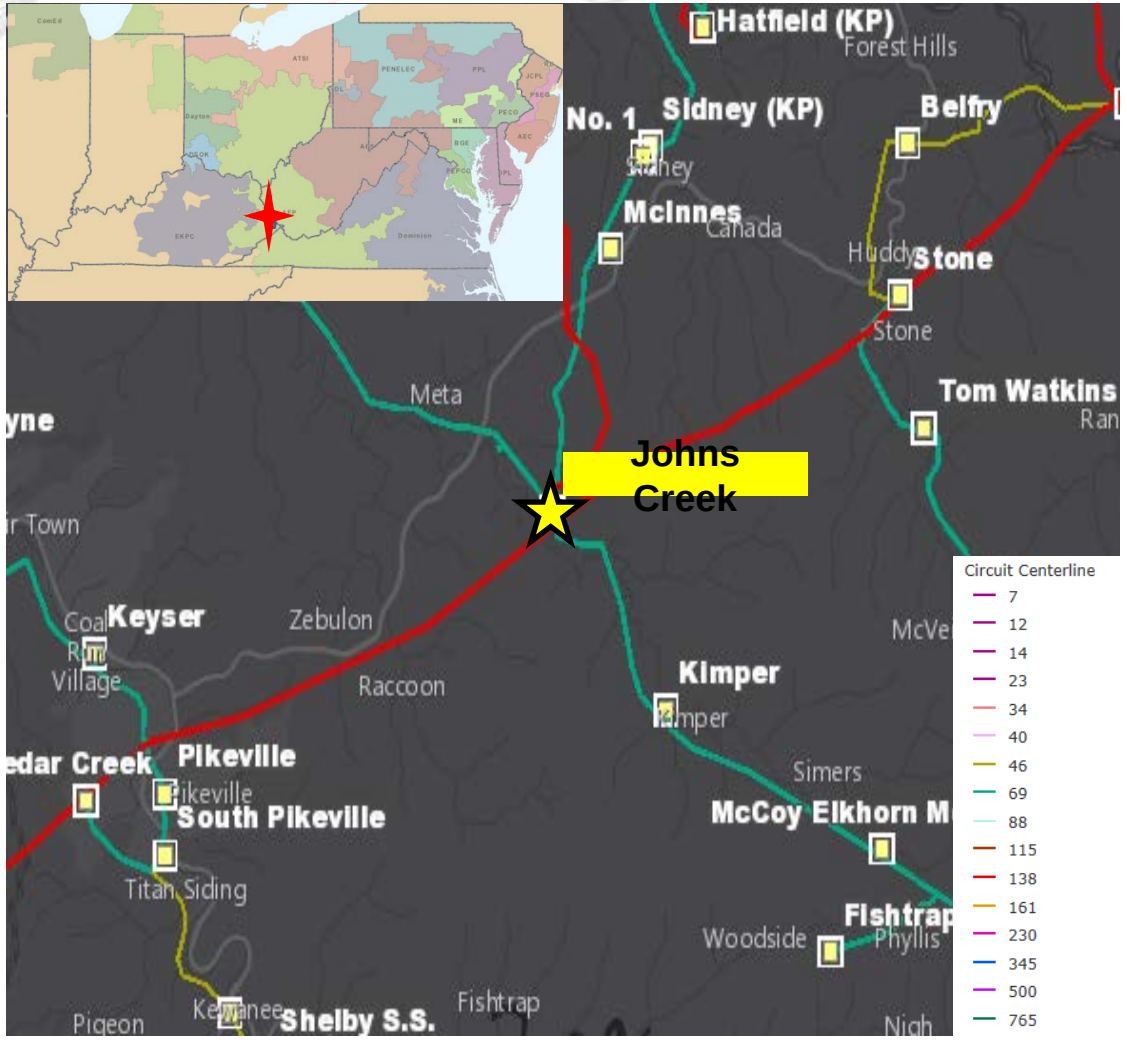
Selected Solution:

At Johns Creek Station, replace existing 69 kV circuit breaker 'A' with a new 3000 A 40 kA circuit breaker. Replace the existing 138/69/34.5 kV 90 MVA transformer #1 with a new 90 MVA 138/69/34.5 kV transformer. Install a new 20 MVA 138/34.5 kV transformer to remove the distribution load from the tertiary of transformer #1. Install a new 2000 A 40 kA high side circuit switcher on the 138/34.5 kV Transformer. Replace existing capacitor switcher 'AA' with a new 3000 A 40 kA switcher and existing capacitor switcher 'BB' with new 3000 A 40 kA switcher. (S1565)

Total Estimated Transmission Cost: $7.4 M

Projected In-service: 07/01/2019

Project Status: Scoping



AEP Transmission Zone: Supplemental
Layland – McClung Line Rebuild

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

From 2013-2016 the Layland – McClung 69 kV line (~20 miles) has experienced 13 momentary and 14 permanent forced outages resulting in over 3.6M customer minutes of interruption. The line consists of 169 structures of single circuit 69 kV wood pole construction built in the 1930s. There are currently 45 structures with category A open conditions along the line. These conditions include damaged/rotted poles and cross arms. This line does not currently have shielding and is not designed to physically support a shield wire. The conductor for this line is 3/0 ACSR 6/1 Pigeon (16.5 miles) and 4/0 ACSR 6/1 Penguin (3.5 miles).

Selected Solution:

At Meadow Bridge station, replace the 600 A 2 way Phase over Phase Switch with 1200 A 2 way Phase over Phase Switch (motorized). (S1566.1)
Estimated Cost: $0.6M

Rebuild approximately 20 miles of the Layland – McClung 69 kV line with 556.5 ACSR conductor. (S1566.2)
Estimated Cost: $34.4M

Total Estimated Transmission Cost: $35 M

Projected In-service: 12/04/2020

Project Status: Scoping

AEP Transmission Zone: Supplemental Newcomerstown Line Conversion and Transformer

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Newcomerstown 138/69/12 kV transformer #1 was installed in 1966. The transformer is showing signs of deterioration due to dielectric strength breakdown (winding insulation), accessory damage (bushings) and short circuit strength breakdown (due to the high number of through fault events).

Customer Service:

The Newcomerstown 138/69/12kV transformer overloaded for several contingencies when considering a large shale load increase in this area. The transformer is a 50 MVA unit with distribution load served off the tertiary winding. The transformer loaded to 101% of Summer Emergency (SE) for a breaker-failure contingency at West New Philadelphia and to 116% of SE for the single contingencies of Kammer – South Canton 765 kV and West New Philadelphia – Newcomerstown 138 kV circuit.

The Newcomerstown – Sugarcreek Terminal 34.5 kV line is already built to 69 kV standards. As part of this project, we are converting the line to operate at 69 kV in collaboration with customers presently served off the line. After the Newcomerstown – Sugarcreek Terminal circuit is converted to 69 kV, Sugarcreek Terminal – Belden 34.5 kV will be the only 34.5 kV connected to the Sugarcreek Terminal. There is not much 34.5 kV in the area or sources thus the N-1-1 outage of the Newcomerstown 69/34.5 kV transformer in conjunction with Sugarcreek Terminal 69/34.5 kV transformer would take out the Newcomerstown – Sugarcreek Terminal 34.5 kV and all its customers.

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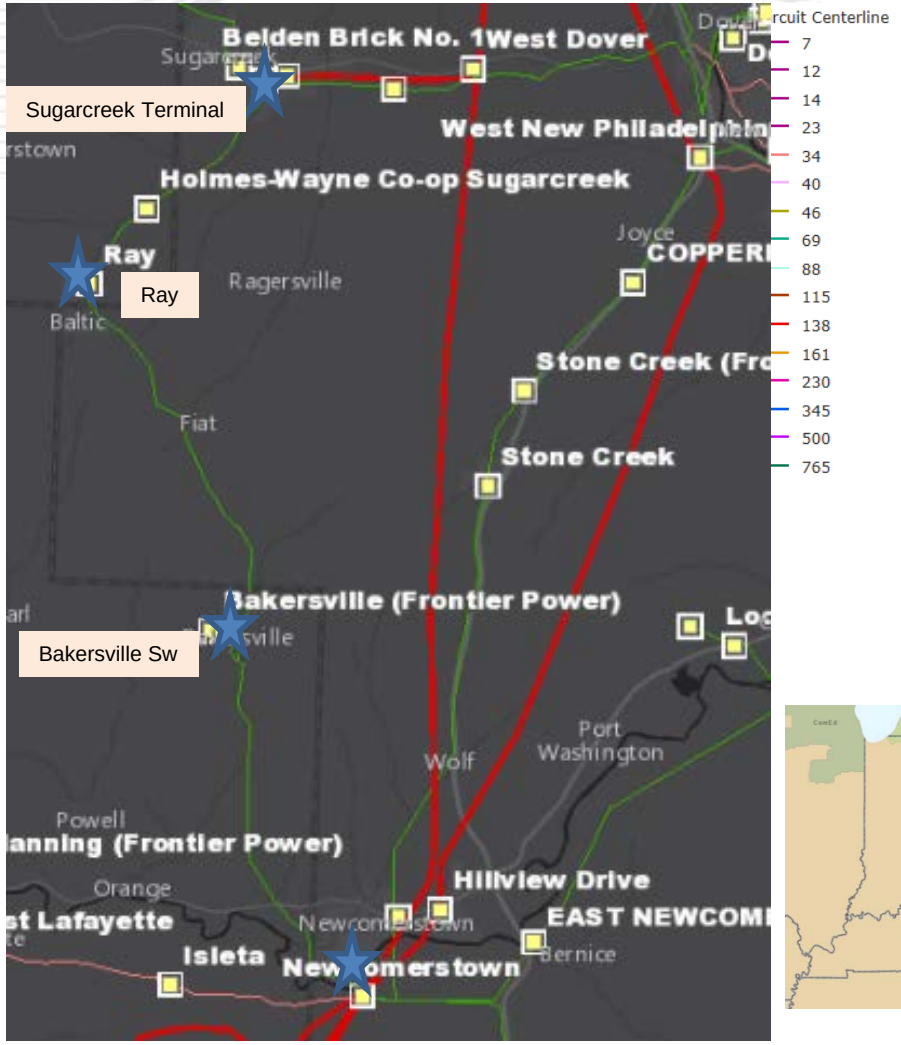

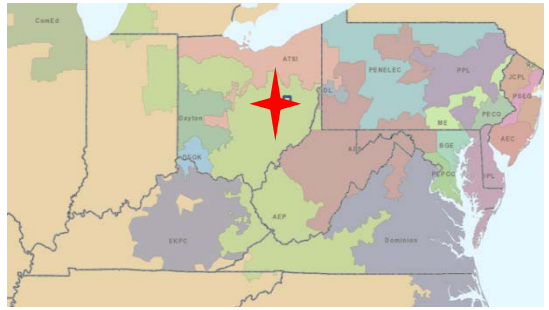

AEP Transmission Zone: Supplemental Newcomerstown Line Conversion and Transformer

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Selected Solution:

Relocate the Newcomerstown-Ray line to the 69 kV bay at Newcomerstown station. (S1567.1)
Estimated Cost: $0.1M

At Newcomerstown station, install a new 69kV 3000 A 40 kA circuit breaker for the Sugarcreek Terminal line exit. Remove the 34.5 kV Circuit Breaker "I". Replace the 50 MVA transformer with a 90 MVA transformer and install a high side and low side circuit breaker. (S1567.2)
Estimated Cost: $10.7M

At Ray station, install a 69 kV 3000 A 40 kA bus tie circuit breaker and transformer circuit switchers. Install a 69/34.5 kV transformer to serve the existing customers. (S1567.3)
Estimated Cost: $0.7M

At Bakersville switch, remove existing and install new PTs due to the 34.5kV to 69kV conversion. (S1567.4)
Estimated Cost: $0.3M

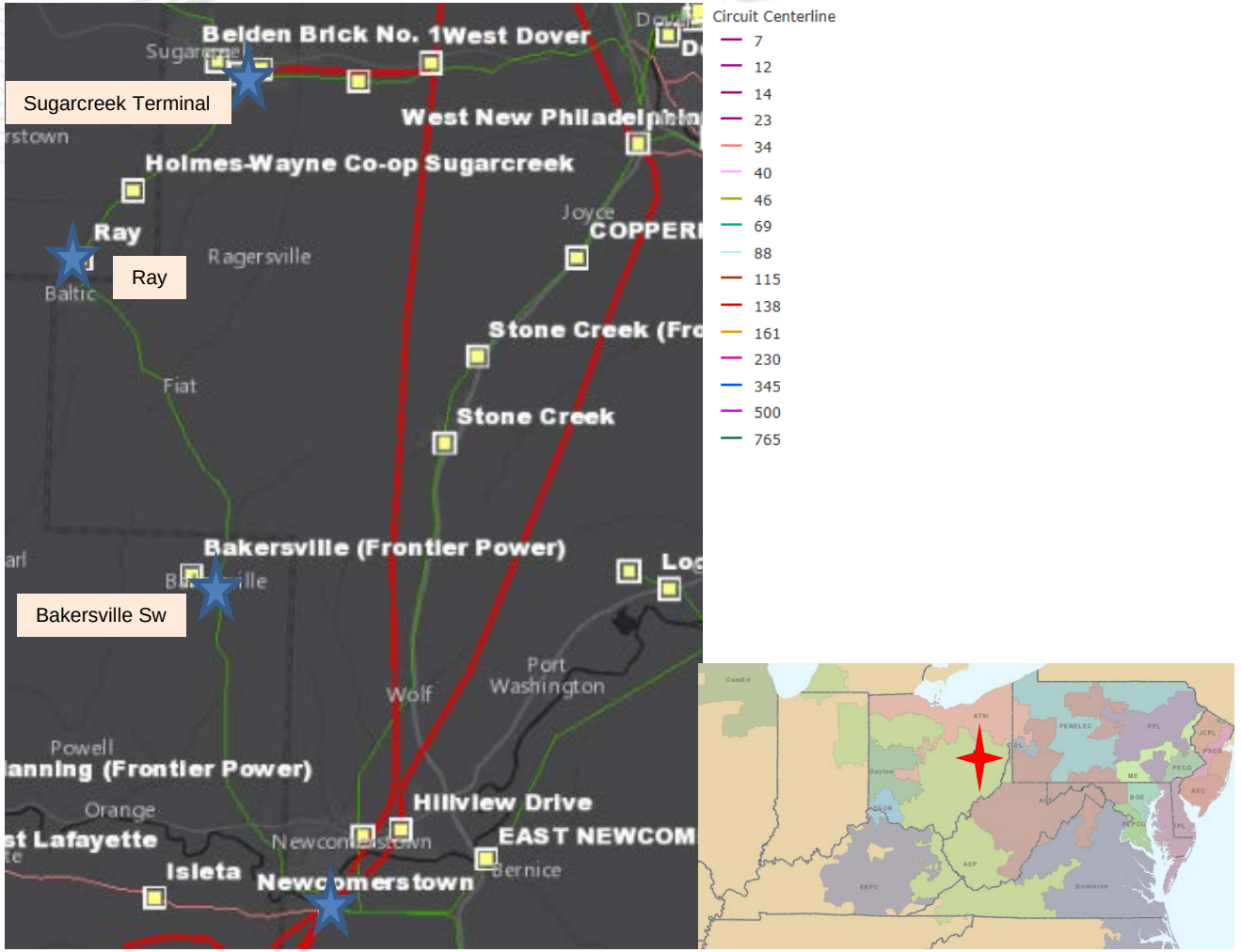
At Sugarcreek Terminal station, install a 69kV 3000 A 40 kA circuit breaker "F" for the Newcomerstown line exit. Remove 34.5 kV breaker "L." (S1567.5)
Estimated Cost: $0.7M

Relocate Ray-Sugarcreek 69 kV line to 69 kV bay at Sugarcreek Terminal. (S1567.6)
Estimated Cost $0.1M

Total Estimated Transmission Cost: $12.6M

Projected In-service: 12/16/2018

Project Status: Engineering



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AEP Transmission Zone: Supplemental
South Hicksville to Mark Center 69 kV Line

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The Mark Center-South Hicksville line was originally constructed in 1957 with 336 ACSR conductor (73 MVA rating). There are 119 open conditions on this 8.8 mile long circuit. The existing line is almost entirely crossarm construction with suspension insulator assemblies, which is not the current AEP standard; the existing crossarms and braces are typical for distribution construction, not transmission construction. End splitting and failure is an elevated risk. Many arms fail periodic inspection; quantity failing inspection is abnormally high. Undersized braces are prone to end fittings becoming separated and arms rotating. Some existing wood pole structures have bay-o-nets supporting the shield wire. At least once in the last year the line experienced a cascading failure of multiple poles in a row. Existing grounding is only every other structure. The line is double-circuit construction for several spans near South Hicksville Station. Structure failures in the double-circuit section jeopardize system stability in the Hicksville, OH area, elevating the risk of an area-wide outage. Some of the line has distribution underbuild, which mechanically consumes pole strength. Legacy underlying easement rights for a line of this vintage are typically inadequate by present day AEP Transmission standards.

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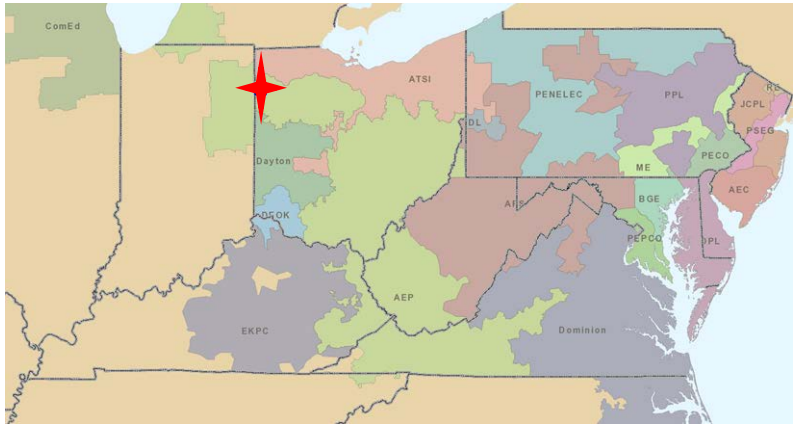
Existing Mark Center – South Hicksville 69 kV Line is highlighted in green;
Proposed rebuild is highlighted in red.



AEP Transmission Zone: Supplemental
South Hicksville to Mark Center 69 kV Line

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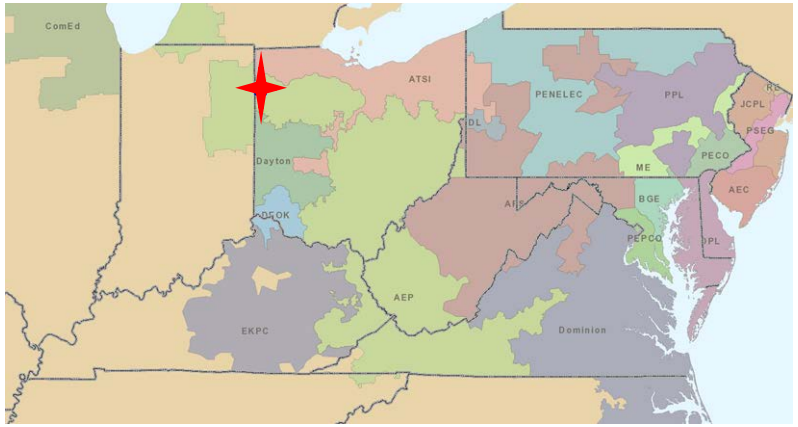
Selected Solution:
Rebuild existing South Hicksville – Mark Center Switch 69 kV line (~7.89 miles) with 795 ACSR (128 MVA rating), including a partial reroute to parallel the existing 138 kV line in the area. (S1568)

Estimated Cost: $8.2 M

Projected In-service: 5/31/2019

Project Status: Engineering

Existing Mark Center – South Hicksville 69 kV Line is highlighted in green;
Proposed rebuild is highlighted in red.



AEP Transmission Zone: Supplemental
Sunbright Station Rehab

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

34.5 kV circuit breakers “A” & “B” at Sunbright and “F” & “G” at Hill Stations are all FK type breakers (vintage 1950’s). These are oil breakers that have become more difficult to maintain due to the required oil handling. In general, oil spills occur often during routine maintenance and failures with these types of breakers. Other drivers include PCB content, damage to bushings and number of fault operations exceeding the recommendations of the manufacturer. Sunbright breakers “A” & “B” have experienced 25 and 26 fault operations respectively, which exceeds the manufactures recommended number of operations (10). Hill breakers “F” & “G” have experienced 74 and 35 fault operations respectively, which exceeds the manufactures recommended number of operations (10).

The 34.5/12 kV transformer at Sunbright is 61 years old and has experienced short circuit strength breakdown caused by a large amount of high temperature through fault events. This has led to minor gassing of the unit, and carbonization of the insulating paper. In addition, there is an upward trending of oil moisture content which will begin resulting in downward trending to the oil dielectric strength. Increasing moisture content is a resultant of water ingress through worn gaskets, leaks from the tank, or a breakdown of paper insulation of transformer windings.

Customer Service:

Obligation to serve distribution customer. The load on the Sunbright #1 transformer is projected to reach 124 % of its 8.5 MVA capability by winter 2017/18. The increase in loading is due to a 2 MVA addition to the Duffield Industrial Park in 2017. The Sunbright – Hill double circuit is already built to 69 kV standards.

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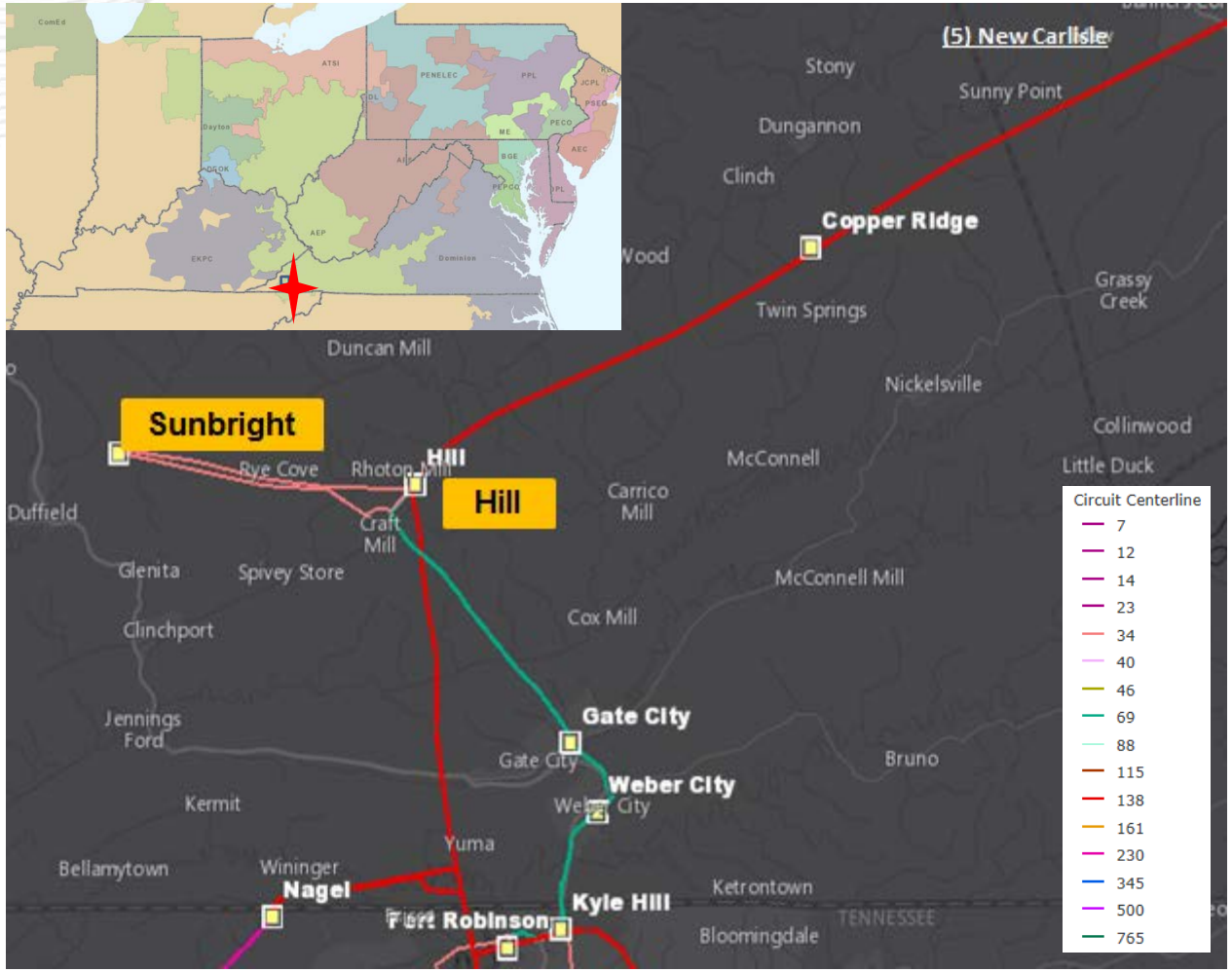

AEP Transmission Zone: Supplemental
Sunbright Station Rehab

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Selected Solution:

Convert Hill – Sunbright 34.5 kV circuits #1 and #2 to 69 kV. These lines were built to 69 kV standards. (S1569.1)

Estimated Cost: $0.0M

At Hill station, replace 34.5 kV circuit breakers “F” and “G” with new 3000 A 40 kA 69 kV circuit breakers to accommodate the conversion of the Hill – Sunbright circuit to 69 kV. A 69 kV circuit breaker will also be installed on the low side of the transformer 69 kV winding. (S1569.2)

Estimated Cost: $1.4M

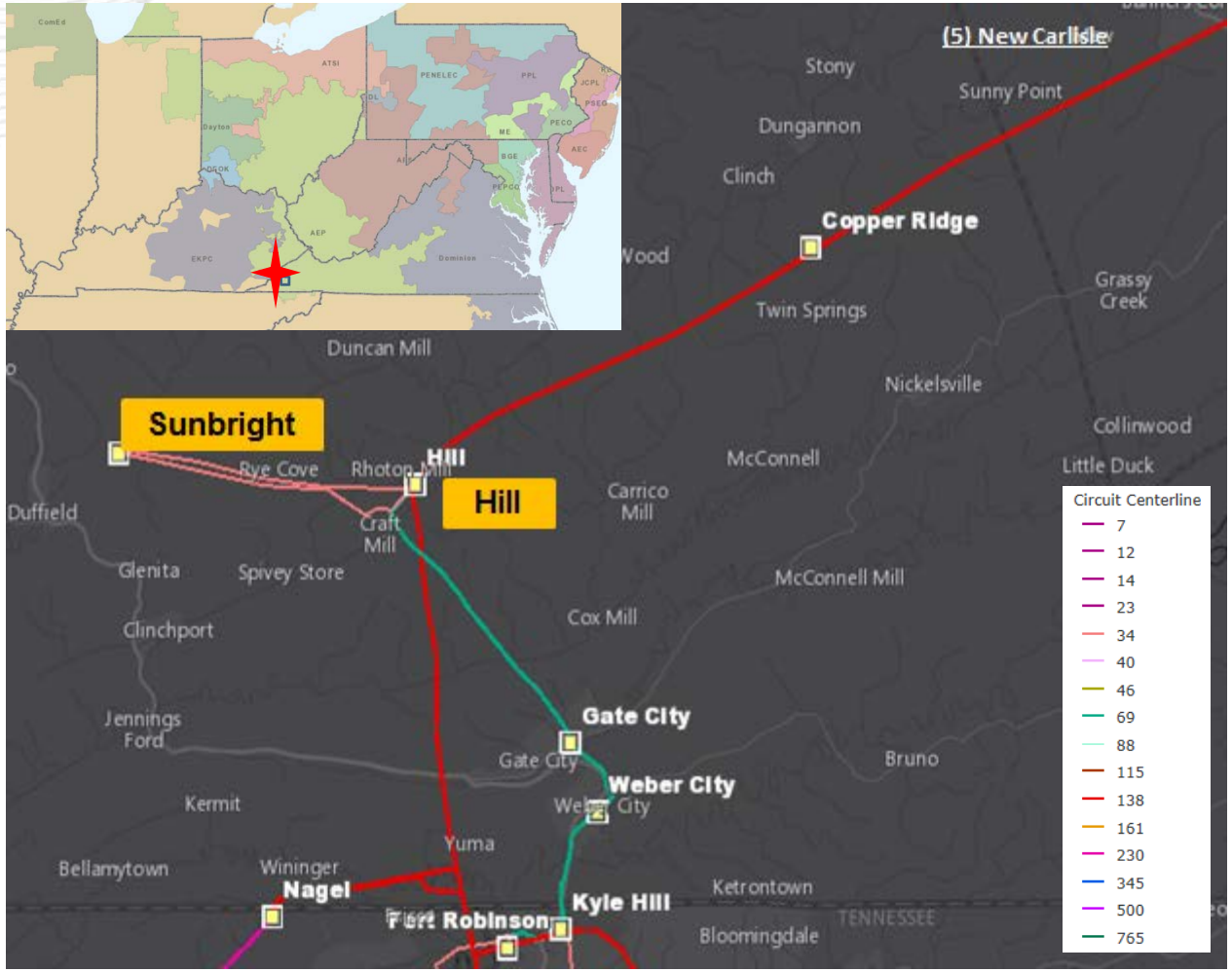
At Sunbright station, replace the existing 34/12 kV 5 MVA transformer with a new 69/12 kV 25 MVA transformer. Replace existing 34 kV 1200 A 17 kA circuit breakers with new 3000 A 40 kA 69 kV circuit breakers. (S1569.3)

Estimated Cost: $0.0M

Total Estimated Cost: $1.4 M

Projected In-service: 5/1/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental
Martinsville Station

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Martinsville 138 kV CB “C”, 69 kV CB “A” & “B” are oil type breakers without oil containment. These are oil breakers have become more difficult to maintain due to the required oil handling. In general, oil spills occur often during routine maintenance and failures with these types of breakers. Other drivers include PCB content and damage to bushings. CBs “A” & “B” are also legacy GE, oil-filled FK type breakers which have little to no access to replacement parts. CB “A” has experienced 27 fault operations, CB “B” has experiences 64 fault operations, and CB “C” has experienced 38 fault operations. The 138/34.5 kV transformer #1 has seen short circuit strength breakdown caused by excessive through fault events, some in excess of 700°C, which, has lead to an increased gassing of the unit. This transformer type (ME Co. auto banks) have frequent failures due to loose windings caused by thru faults. This transformer is needing a major overhaul to repair or replace safety and maintenance items (fans, pumps, paint, gasket, leaks). The 138/34.5 kV transformer #2B has an upward trending of oil moisture content resulting in decreasing oil dielectric strength. Increasing moisture content is a result of water ingress and/or break down of paper insulation of TF windings. The moisture content has since decreased without improvement to the dielectric strength. Short circuit strength breakdown caused by the amount of thermal through fault events, mostly in excess of 700°C, has lead to major gassing of the unit and carbonization of the insulating paper. The 138/34.5 kV transformer #2A is showing short circuit strength breakdown and high temperature health contributions due to the amount of thermal through fault events, with a majority in excess of 700°C . There are elevated levels of ethylene, methane, carbon monoxide, and carbon dioxide caused by these numerous through fault events. The CO/CO2 ratio has mostly been sustained at or above the warning level, and at times nearing the alert level. Carbonization of the insulating paper has begun which indicative of a transformer near the end of it useful life. 34.5 kV Martinsville – Morris Novelty #1 & #2 lines have pilot wire line relaying. Copper pilot wire is a relatively obsolete technology, and since the telephone companies almost never use it anymore, it is increasingly difficult to find suitable pilot wire cable and hardware. Consequently, we are avoiding like-kind replacement of pilot wire because the technology is increasingly difficult to maintain.

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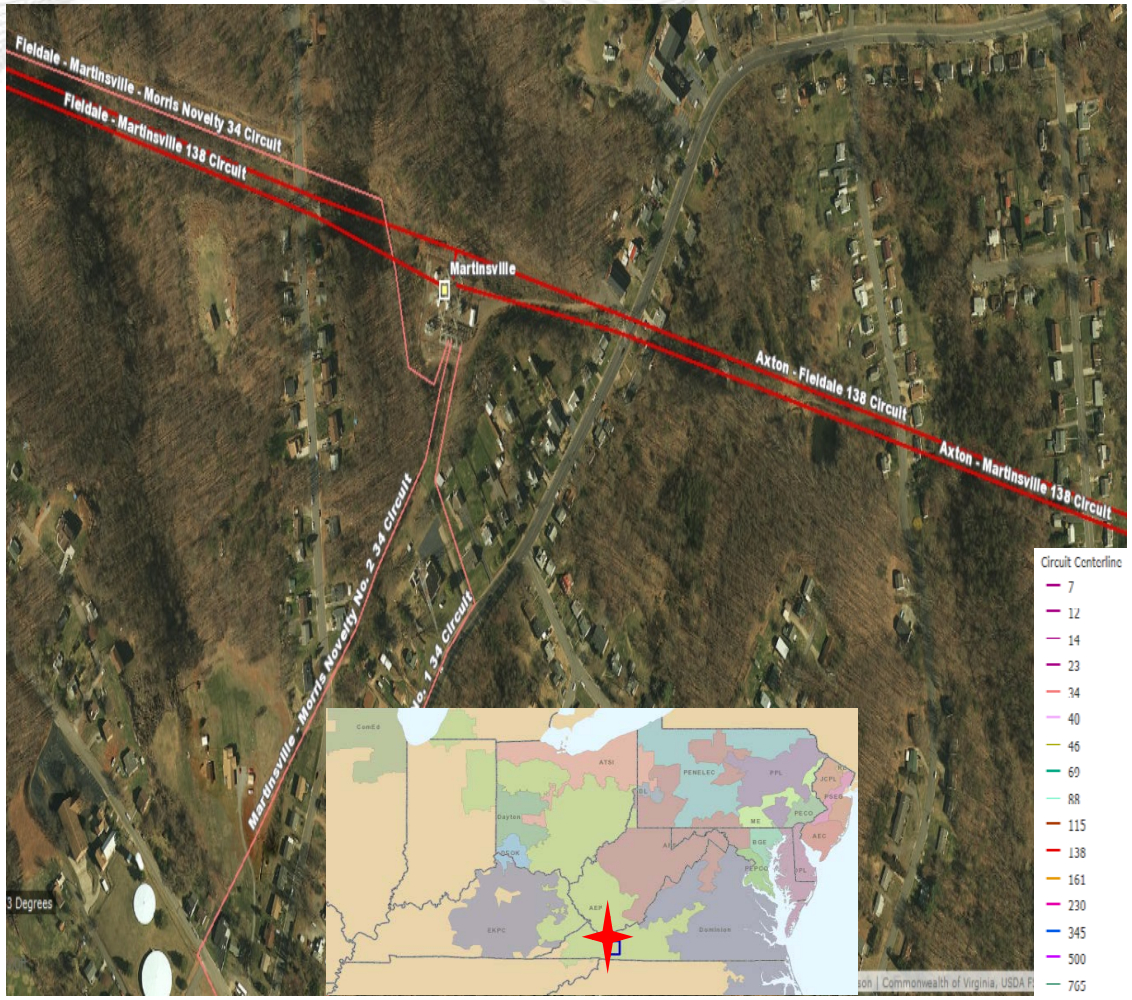

AEP Transmission Zone: Supplemental Martinsville Station

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Operational Flexibility and Efficiency:

The addition of Martinsville 138 kV line breaker (towards Fieldale) is going to break up three dissimilar zones of protection (line, bus and transformer) at Martinsville Station.

Infrastructure Resilience:

The existing control house at Martinsville Station has no room for additional relay panels. A new DCIM will be installed to accommodate new relay panels.

Customer Service:

The Martinsville substation is used as a back up to the Patriot Center Substation. The Patriot Center substation serves the largest industrial park in Henry county with over 25 business and the Patrick Henry Community College. With the current configuration both sources are going to experience outages with line or station faults. The breaker will isolate the sources during faults, allowing us to provide Patriot Centre with an increased reliability. Martinsville substation also serves all of the Southern Finishing accounts with is a large industrial customer with over 2.4 mw of load. This is a very power quality sensitive customer.

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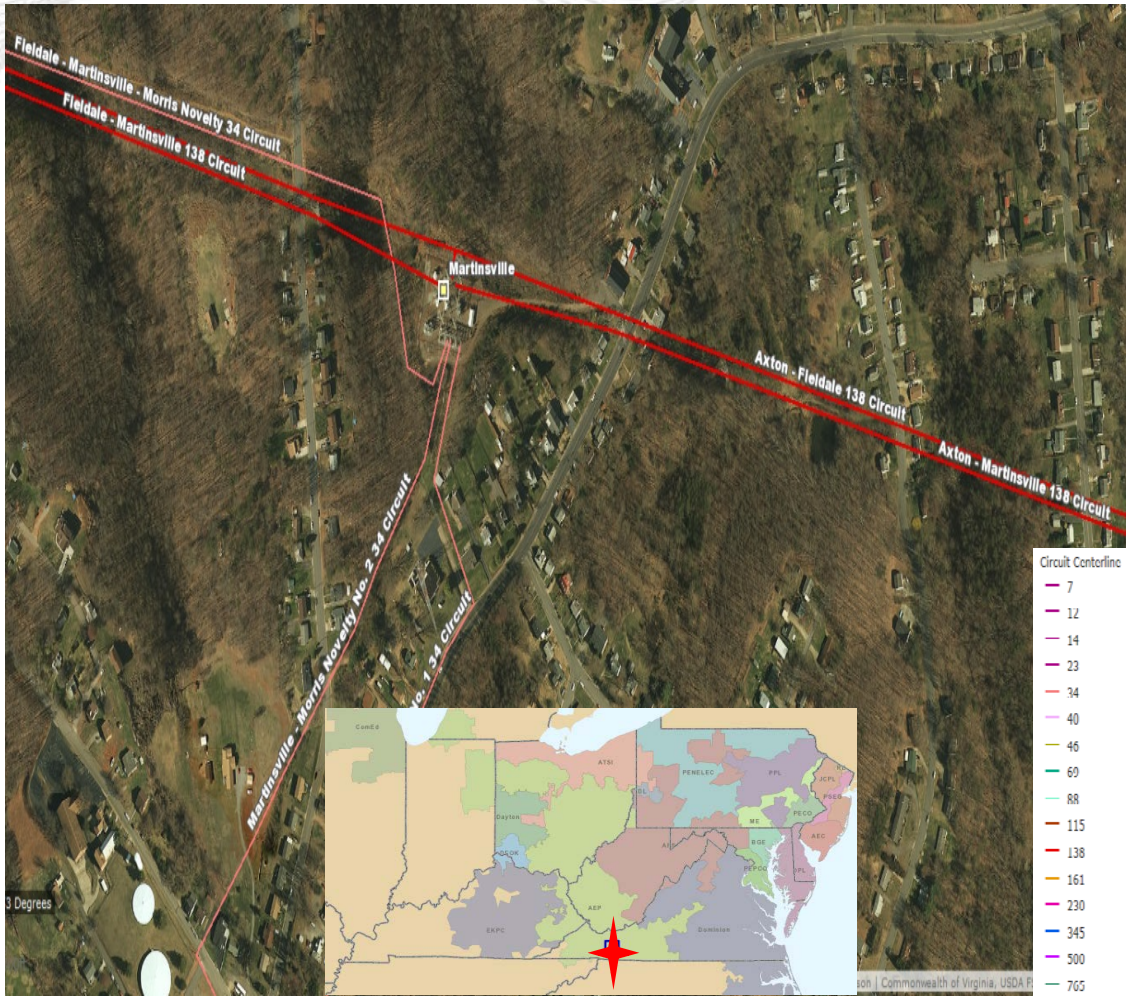

AEP Transmission Zone: Supplemental Martinsville Station

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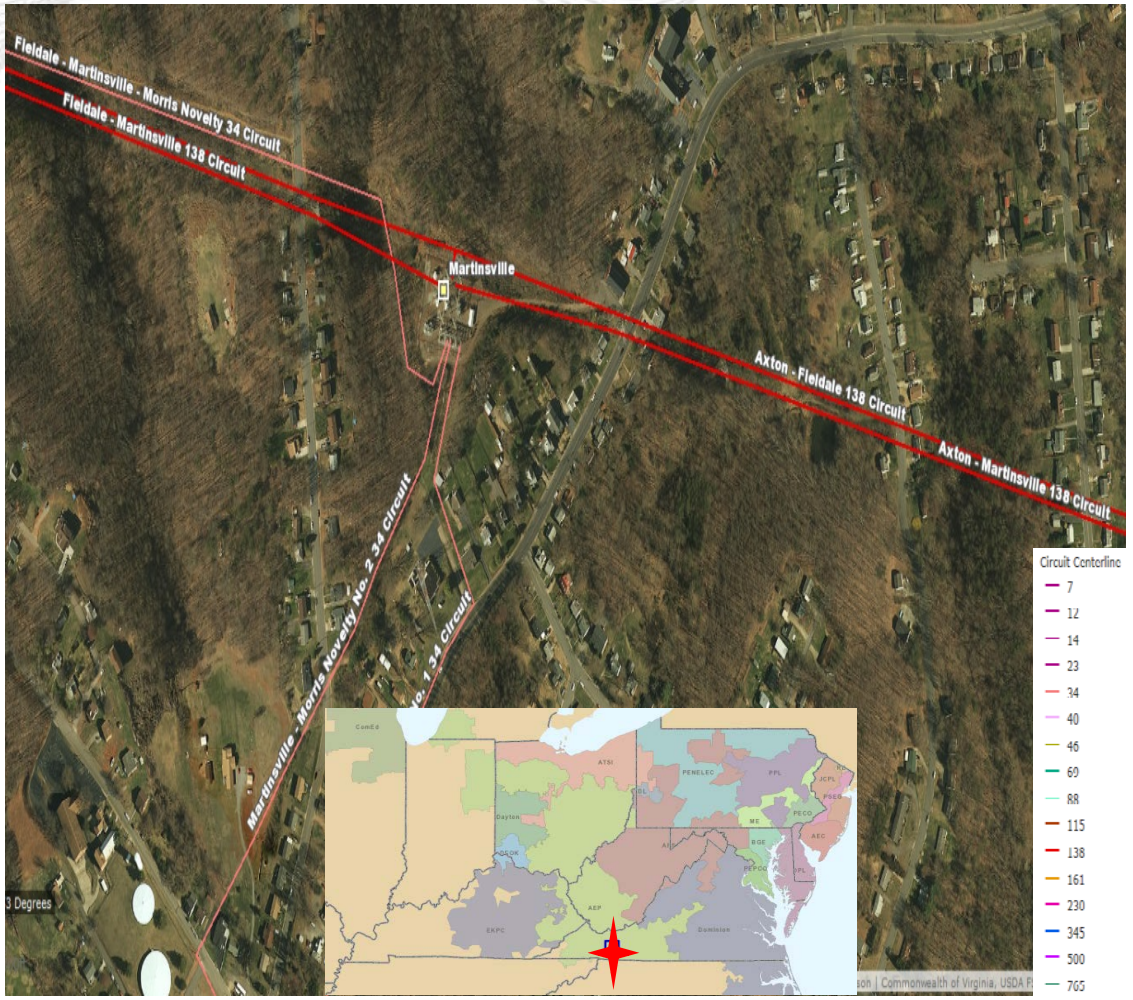
Selected Solution:

Replace the existing 138 kV/40 kA/3000A CB “C” at Martinsville Station and install new 138 kV/40 kA/3000A circuit breaker towards Fieldale. Relaying associated with the lines will be upgraded and new station equipment will be installed to support new relaying. Install a new Drop In Control Module (DICM). Replace 138/34 kV 30 MVA parallel transformers #2A and #2B with new 138/69/34 kV 90 MVA transformer. Install 138 kV/650 A/31.5 kA circuit switcher on both transformer #2 & #3. Retire 138/34 kV 128 MVA transformer #1. Retire 34 kV oil circuit breakers “A” and “B”. Replace pilot wire relays on Martinsville – Morris Novelty #1 & #2. (S1570)

Estimated Cost: $2.8M

Projected In-service: 6/1/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental
West Carroll Station

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Customer Service:

Obligation to serve distribution customer request at a new station. West Carroll station will serve approximately 17 MVA of load.

Selected Solution:

Construct a new 138/34.5kV distribution station (West Carroll). Install a new 138/34.5 kV 30 MVA, two 3000 A 138 kV MOABs, and a 3000 A 40 kA 138 kV circuit switcher. (S1571.1)

Estimated Cost: $0.0M

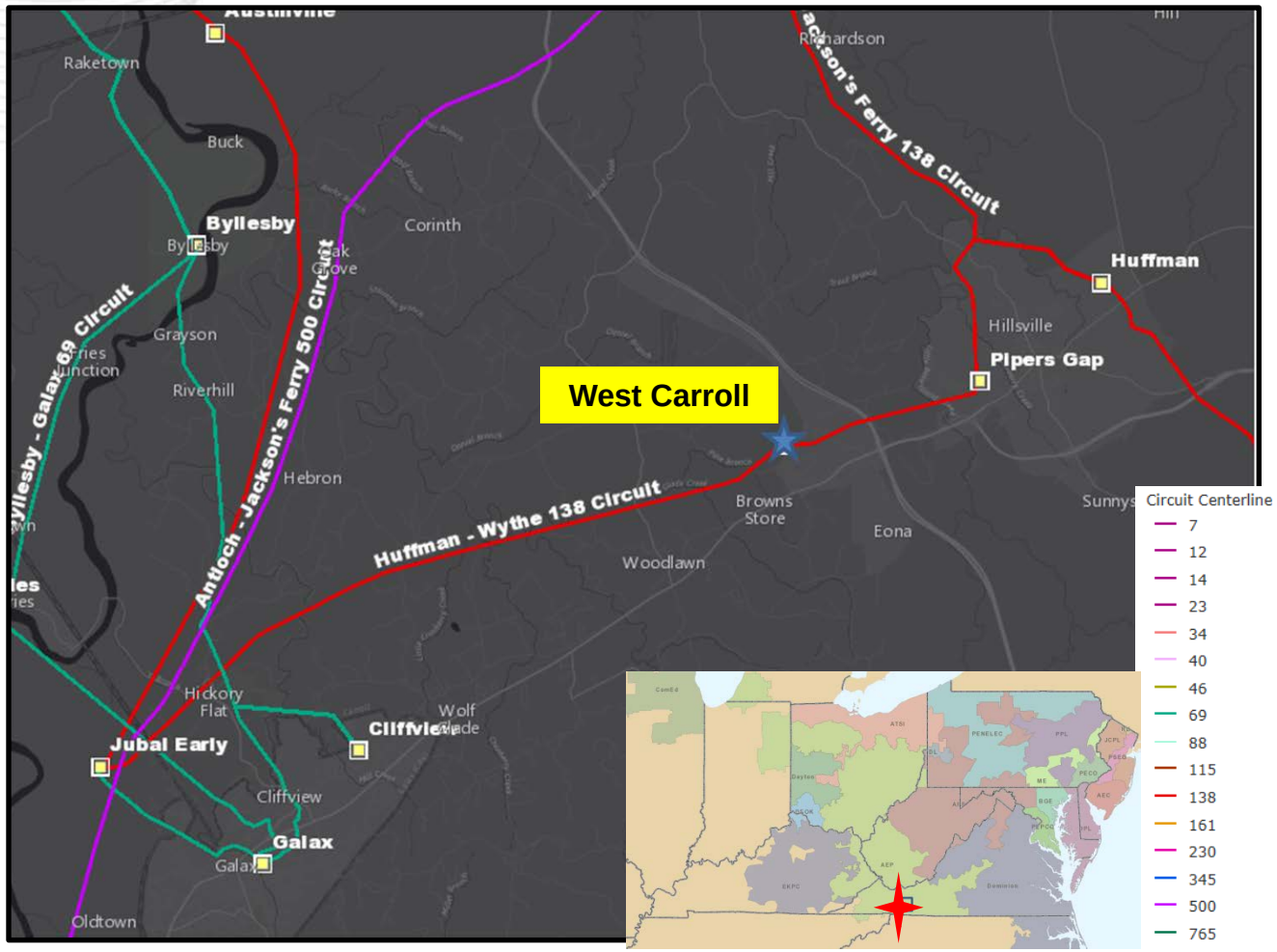
Tap the Huffman – Wythe 138kV circuit into West Carroll station. (S1571.2)

Estimated Cost: $0.6M

Total Estimated Transmission Cost: $0.6M

Projected In-service: 12/1/2019

Project Status: Scoping



AEP Transmission Zone: Supplemental Stone Station

Previously presented on 2/14/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The 138/69/46 kV 50 MVA transformer at Stone station has failed beyond repair and requires replacement.

Circuit breaker “A” and “B” at Stone (vintage 1966) are 1200A, 21 kA CF-48 type breakers. These are oil breakers that have become more difficult to maintain due to the required oil handling. There is an increased potential for oil spills during routine maintenance and failures with these types of breakers. In addition, these breakers also have bushing damage, and they are experiencing mechanical breakdown associated with its contacts and resistors. Both breakers have exceeded the amount of fault operations recommended by the manufacturer of 10. Breaker “A” and “B” have experienced 84 and 101 fault operations respectively.

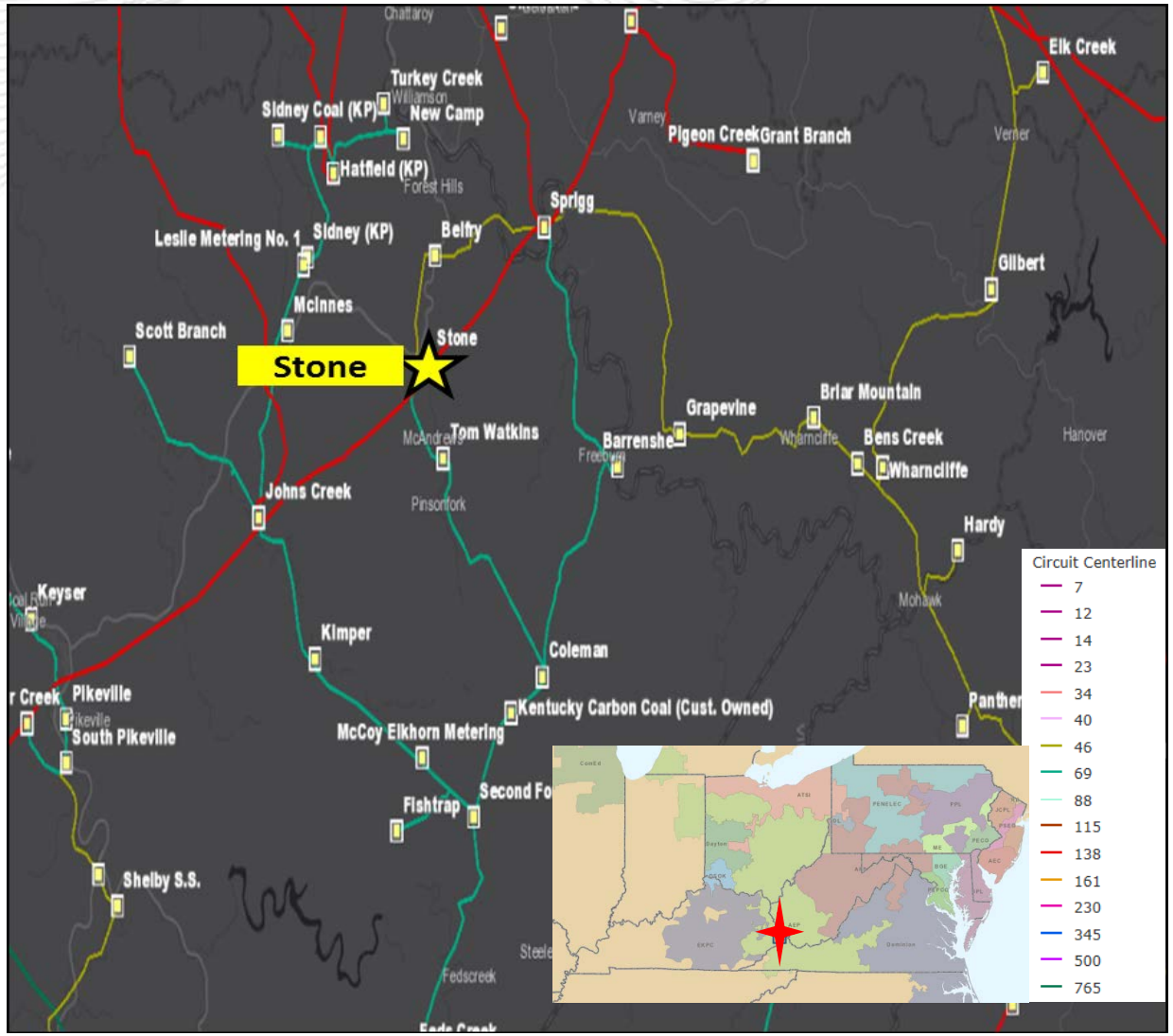
Selected Solution:

Replace the failed 138/69/46 kV 50 MVA transformer bank at Stone station with a new 138/69/46 kV 90 MVA transformer bank. Replace circuit breaker “A” with a new 69 kV 3000 A 40 kA circuit breaker. Replace circuit breaker “B” with a new 69 kV 3000 A 40 kA circuit breaker. (S1572)

Total Estimated Transmission Cost: $3.3M

Projected In-service: 12/1/2018

Project Status: Engineering



Next Steps

Upcoming Western SRRTEP Dates

West	Start	End
3/27/2018	12:00	4:00
5/30/2018	12:00	4:00
7/27/2018	12:00	4:00
9/28/2018	12:00	4:00
11/29/2018	12:00	4:00

Questions?

or

RTEP@pjm.com

Revision History

3/2/2018 – V1 – Original version posted to pjm.com

3/8/2018 – V2 – Slide #5-18: Update maps by adding the locator maps

3/12/2018 – V3 – Slide #57: Change Feb. 24 to Feb. 14

- Slide #14: Delete
- Slide #18: Change 46KV to 69kV
- Slide #43: Project IS date change
- Slide #20: Map update
- Slide #38: Update the cost estimates

3/13/2018 – V4 – Slide #58 - #99: Add S# or B#; Change “Potential Solution” to “Selected Solution”; Remove Alternatives

- Slide #72: Leave blank --Content is combined with Slide #71
- Slide #75: Leave blank --Content is combined with Slide #74
- Slide #79: Leave blank --Content is combined with Slide #78
- Slide #90: Leave blank --Content is combined with Slide #89