Sub Regional RTEP Committee
PJM West

March 27, 2018

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http://www.pjm.com/-/media/committees-groups/committees/srrtep-w/20180309/20180309-reliability-analysis-update.ashx

First Review

Baseline Reliability and Supplemental Projects

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

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

Driver: Equipment Material Condition, Performance and Risk

Potential Solution:
Rebuild 5.8 miles of feeder between Princeton and Port Union substations with 161 new structures, hardware, and conductor. Capacity of the line will increase from 99 MVA to 121 MVA (terminal eq. limited).

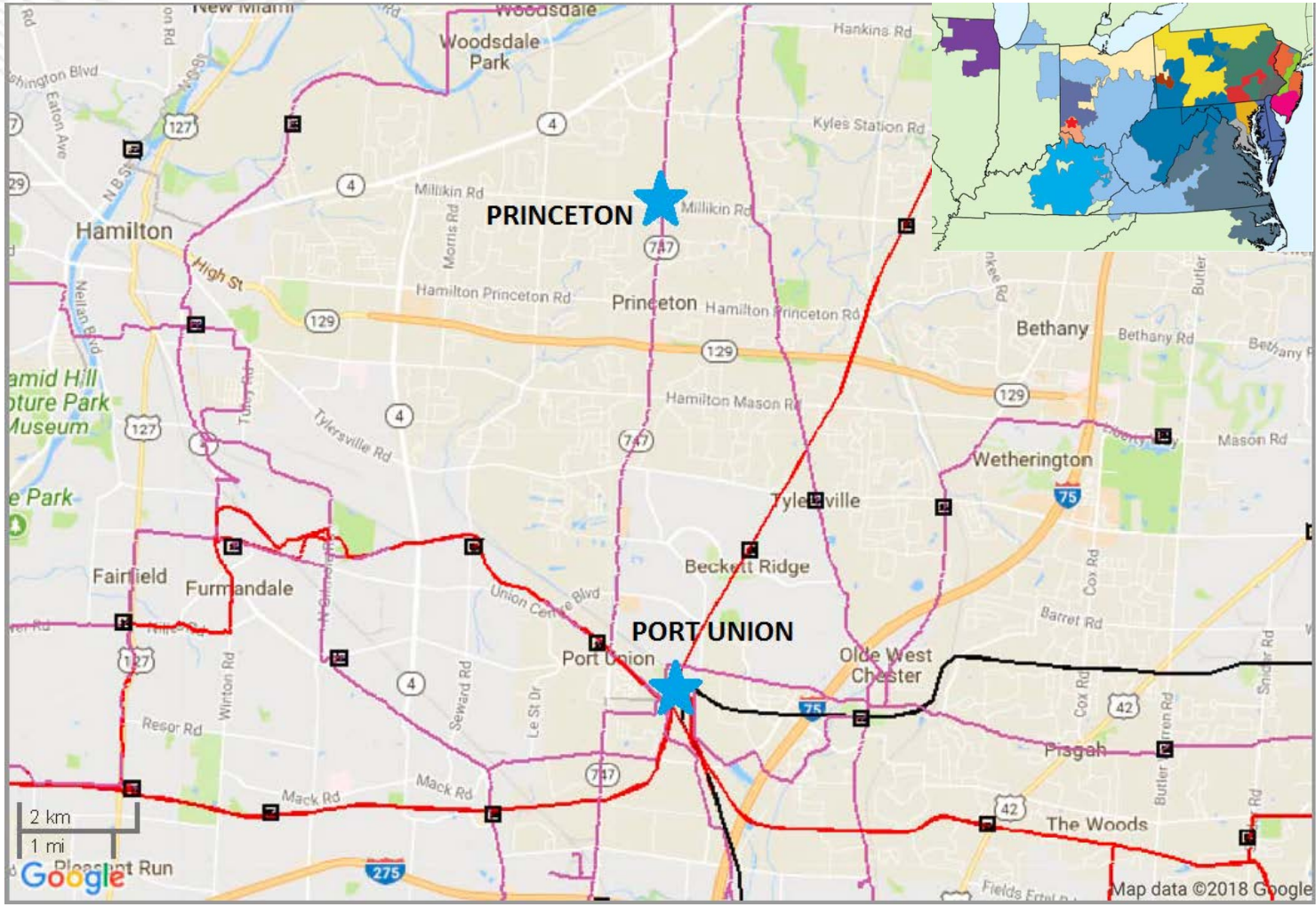
Estimated Cost: $7.5 M

Alternatives:

- none

Projected In-service: 12/1/2018

Project Status: Scoping



DUQ Transmission Zone: Supplemental Panther Hollow Cut in

Problem Statement (Scope):
The Oakland 138-23kV substation has exceeded its capacity to reliably serve the increased and projected distribution load growth in the area. The Oakland substation has a peak distribution load of 204MVA.

Drivers:
Customer Service, Operational Flexibility and Efficiency

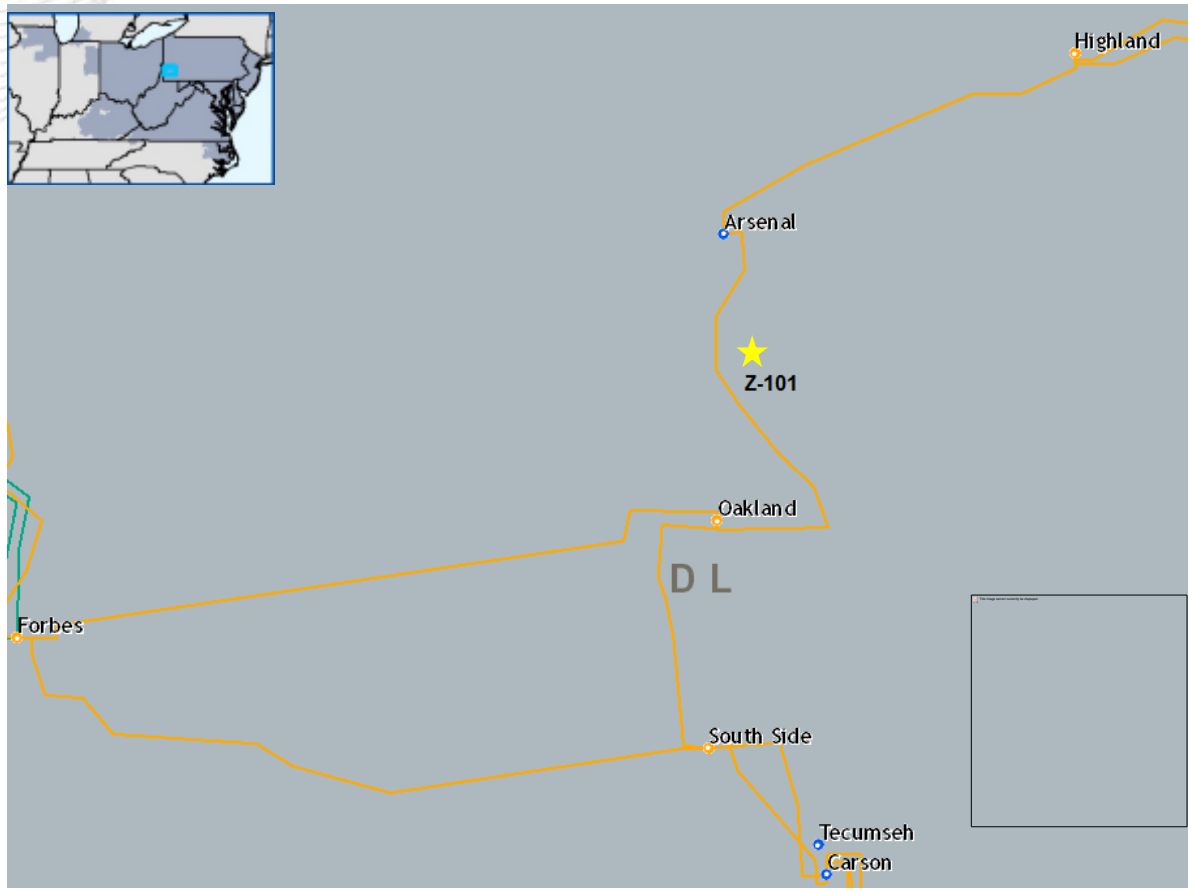
Potential Solution:
Establish a new 138-23kV substation (Panther Hollow) utilizing the existing Arsenal-Oakland (Z-101) 138kV circuit as a looped transmission source.

Alternatives Considered:
No cost effective alternatives.

Estimated Project Cost: $16.8M

Projected IS Date (Expected IS Date): 5/31/2020

Status: Conceptual



AEP Transmission Zone: Supplemental Auburn Breakers

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The Auburn 69 kV circuit breaker 'A' is a 600 A, GE 'FK' oil-filled breaker installed in 1956 and circuit breaker 'D' is a 1200 A, GE 'FK' oil-filled breaker installed in 1957. 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.

Potential Solution

At Auburn station, replace 69 kV breakers "A" and "D" with 40 kA, 3000 A, 69 kV circuit breakers.

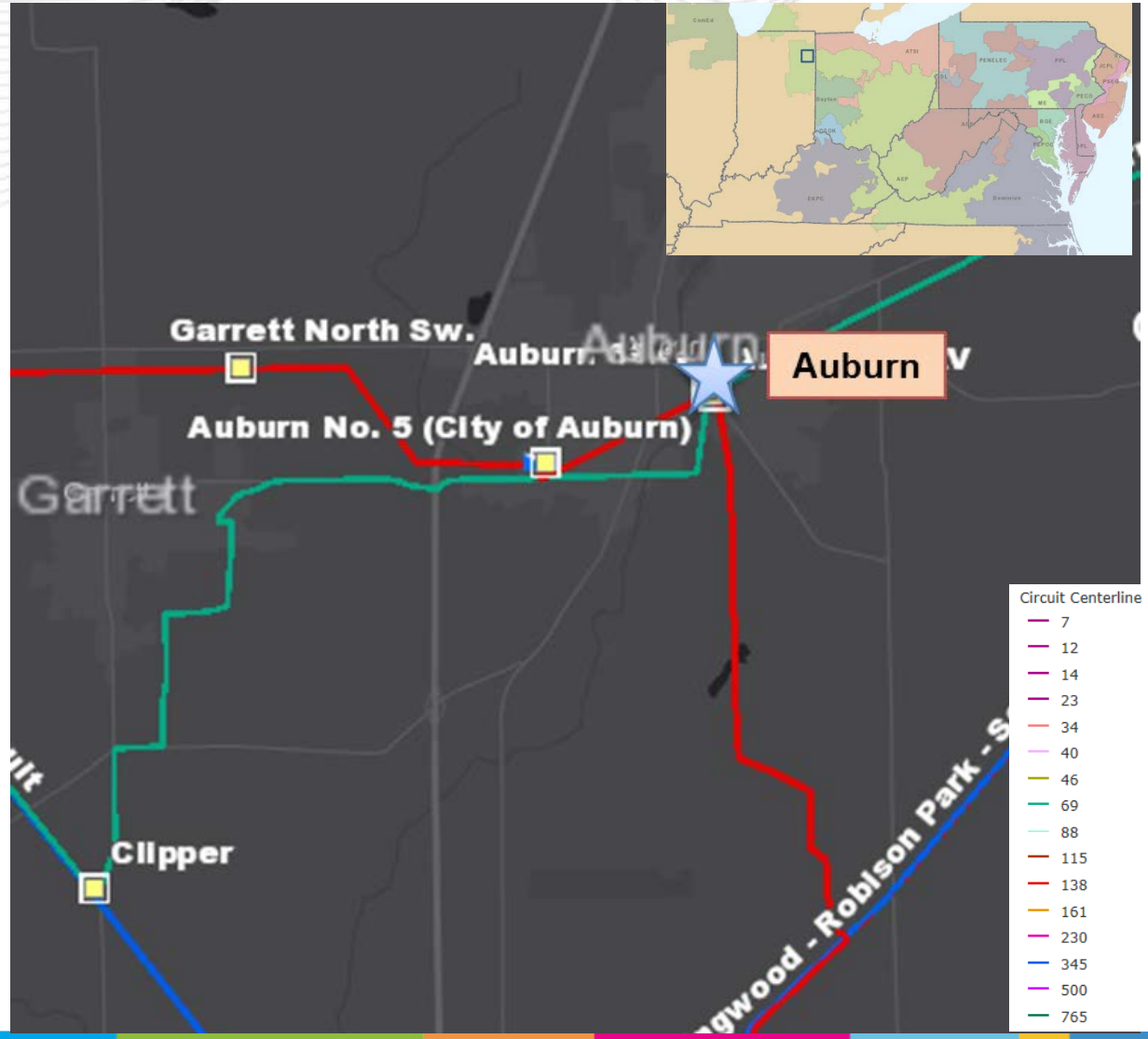
Estimated Cost: $1.6M

Alternatives:

No viable cost-effective transmission alternative was identified.

Projected In-service: 6/1/2019

Project Status: Scoping



AEP Transmission Zone: Supplemental Butler Station

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The Butler 69 kV circuit breaker 'A' is a 1200 A, GE 'FK' oil-filled breaker installed in 1957. In general, oil breakers have become increasingly difficult to maintain due to the oil handling associated with them. It has also operated through 68 fault operations, exceeding the manufacturer recommendation of 10. Oil spills are frequent with failures and routine maintenance which is also an environmental hazard. Capacitor Switchers "AA" and "BB" are Mark types which no longer work with modern relaying packages causing protection and coordination issues.

Operational Flexibility and Efficiency

Replace Butler station MOABs "X" and "Y" with 69 kV CBs to improve the reliability of the Auburn-Hamilton 69 kV circuit. Currently, Hamilton Station is fed radially out of Butler Station (along with two hard tapped customers) on a ~7.5 mile radial line which is susceptible to dropping load for faults on the Auburn-Butler 69 kV circuit momentarily due to existing MOAB line protection. In addition, customers served from Butler station will also benefit from the MOAB upgrades to circuit breakers at Butler Station, eliminating exposure to line faults.

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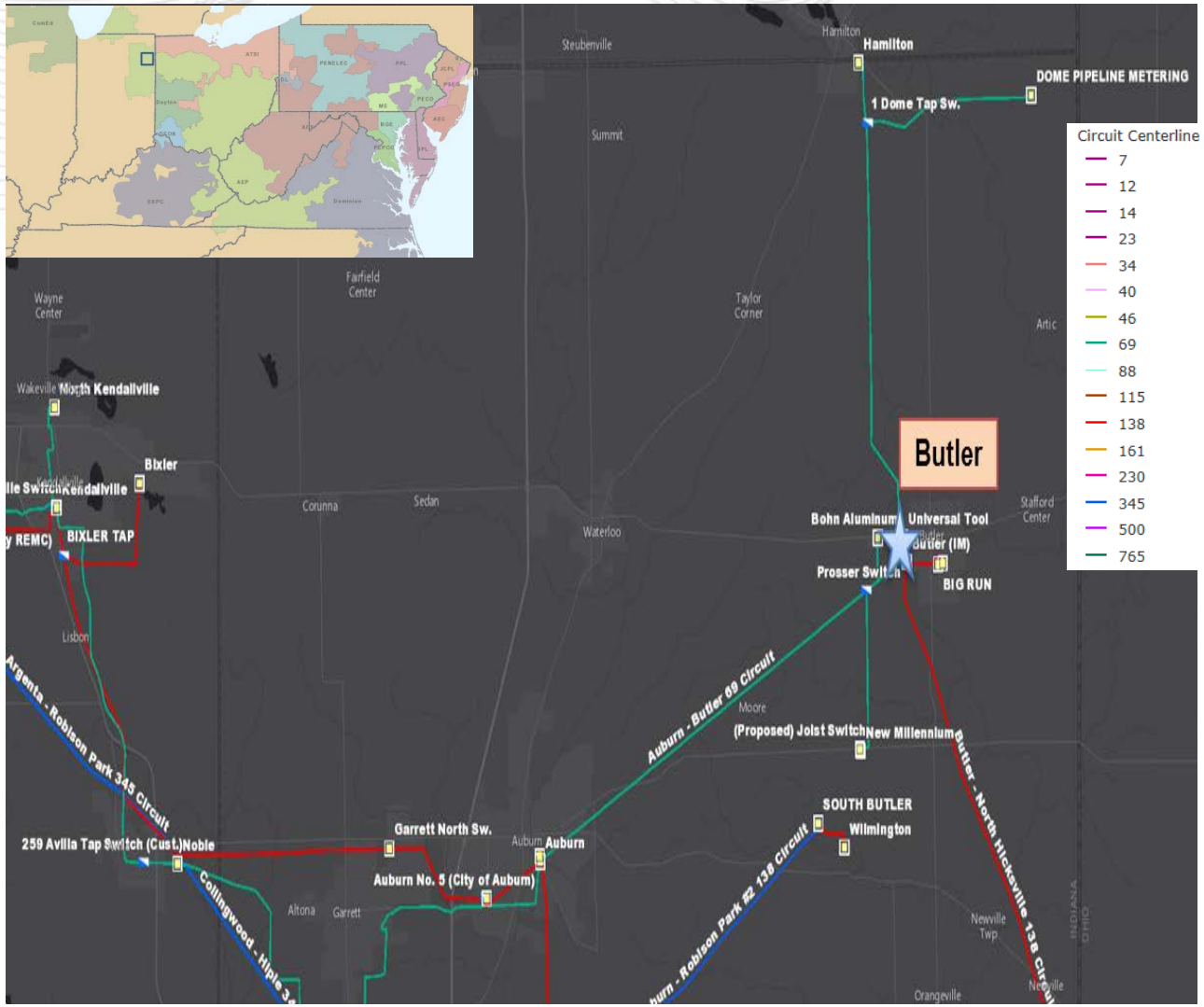

AEP Transmission Zone: Supplemental Butler Station

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Potential Solution

At Butler station, replace 69 kV breaker “A”, replace 69 kV MOABs “X” and “Y” with 69 kV breakers, replace 69 kV cap switchers “AA” and “BB” (S&C Mark V) with 3000 A, 40 kA circuit breakers.

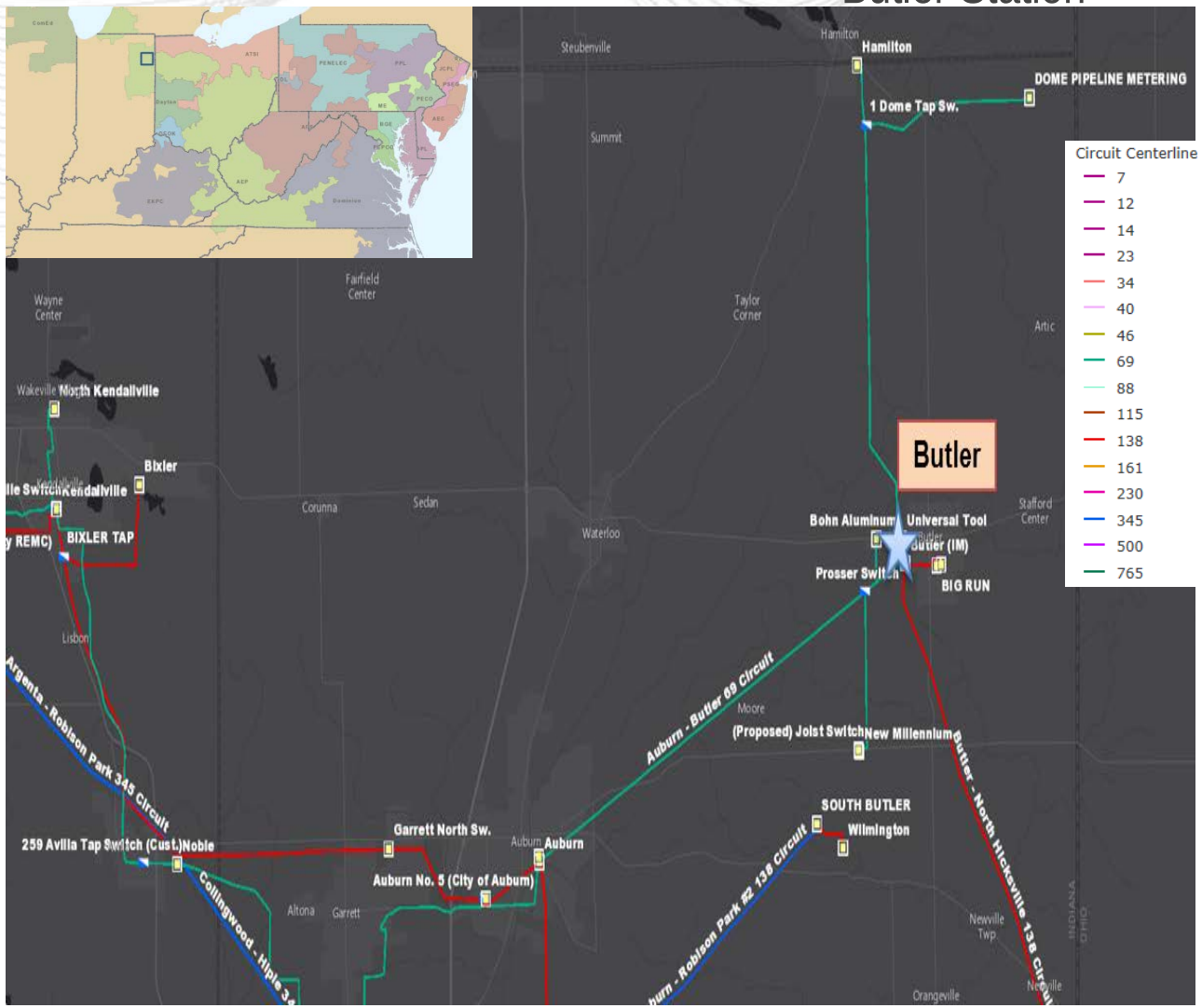
Estimated Cost: $2.5M

Alternatives:

No viable cost-effective transmission alternative was identified.

Projected In-service: 6/1/2019

Project Status: Scoping



AEP Transmission Zone: Supplemental
East Huntington Station

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The existing 34.5 kV circuit breakers “A”, “D”, “E”, “H”, and “I” at East Huntington are all 1800 A 27 kA FK oil type breakers that are all 46 years old. 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. Other drivers include damage to bushings and an excessive number of fault operations exceeding the recommendations of the manufacturer. East Huntington breakers “A”, “D”, “E”, “H”, and “I” have experienced 10, 13, 14, 16, and 10 fault operations respectively. The manufacturer’s recommendation for this type of breaker is 10.

Operational Flexibility and Efficiency

Circuit switchers will be added to the high side of transformers #1 and #4 at East Huntington station to separate dissimilar zones of protection.

A 138 kV bus-tie circuit breaker will be added at East Huntington to better sectionalize the four transformers currently off the single 138 kV bus.

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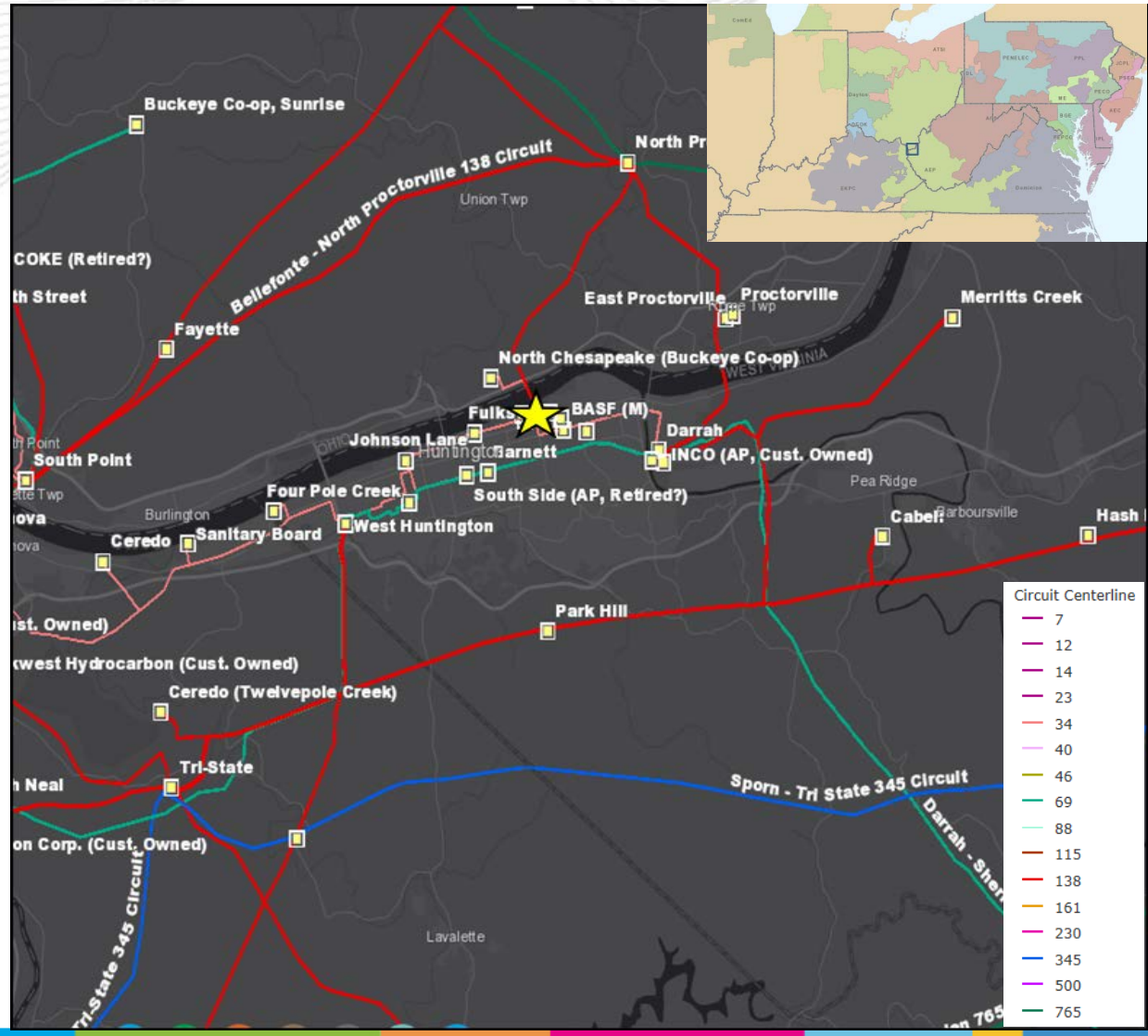

AEP Transmission Zone: Supplemental
East Huntington Station

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Potential Solution

At East Huntington station, replace 34.5 kV circuit breakers “A”, “D”, “E”, “H”, and “I” at East Huntington with new 3000 A 40 kA 34.5 kV circuit breakers. 3000 A 40 kA 138 kV circuit switchers will be added to the high side of East Huntington transformers #1 and #4 to replace the existing Ground Switch MOAB’s. A new 3000A 40 kA 138 kV circuit breaker will be installed to split the existing single 138 kV bus. A fuse will be added to the high side of the 34/12 kV transformer #2.

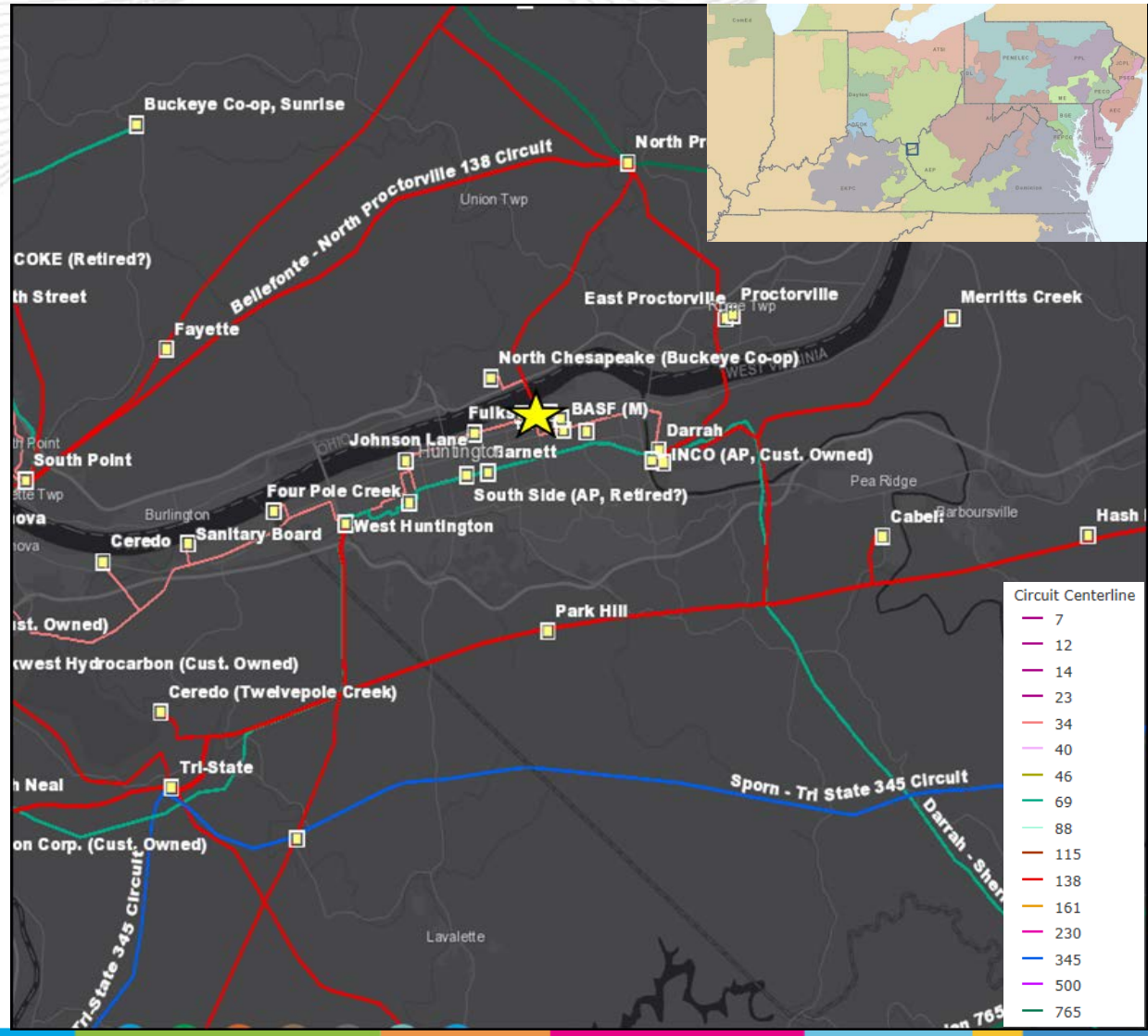
Estimated Cost: $4.5M

Alternatives:

No viable cost-effective transmission alternative was identified.

Projected In-service: 6/1/2020

Project Status: Scoping



AEP Transmission Zone: Supplemental Elkhart Network

Problem Statement:

Customer Service:

This is an AEP Distribution driven project. The Elkhart UG Network is presently served via 2-34.5 kV Feeders and 2- 4 kV feeders from Elkhart Hydro Station. The present arrangement and configuration is not in compliance with the AEP Distribution Network Planning Criteria regarding UG primary feeder separation and UG secondary replacement. Harrison Station and it's two 69/13.8 KV transformers is necessary to allow the redesign and reconfiguration of the UG Elkhart Network system by 12/2018. Specifically Harrison Station will provide 4-13.8 kV feeders which will allow the separation of the UG Primary and compliance with the AEP Distribution Network Planning Criteria. The reasoning behind this is as follows: The UG Elkhart system is being designed for mixed contingency operation, shall have the feeders arranged with no more than two feeders of the same network in common duct, manholes or vaults, and shall have the feeders connected so that loss of no single duct bank, manhole or vault causes an outage to any network customer, including the single-contingency portions all per AEP Distribution Network Planning Criteria and Distribution Network Systems Center of Excellence.

The current Harrison St station is fed from a radial 34.5kV sub transmission line which would need to be looped and rebuilt to provide a high level of reliability for the network. The decision was made to rebuild at 69kV to modernize the transmission into the Elkhart area and prepare for further revitalization plans by the city. The transmission work will also convert Lusher station to 69kV operation upgrade facilities at Dunlap and Concord stations. Elkhart Hydro will have all network facilities retired and distribution equipment replaced that is at the end of its engineered life.

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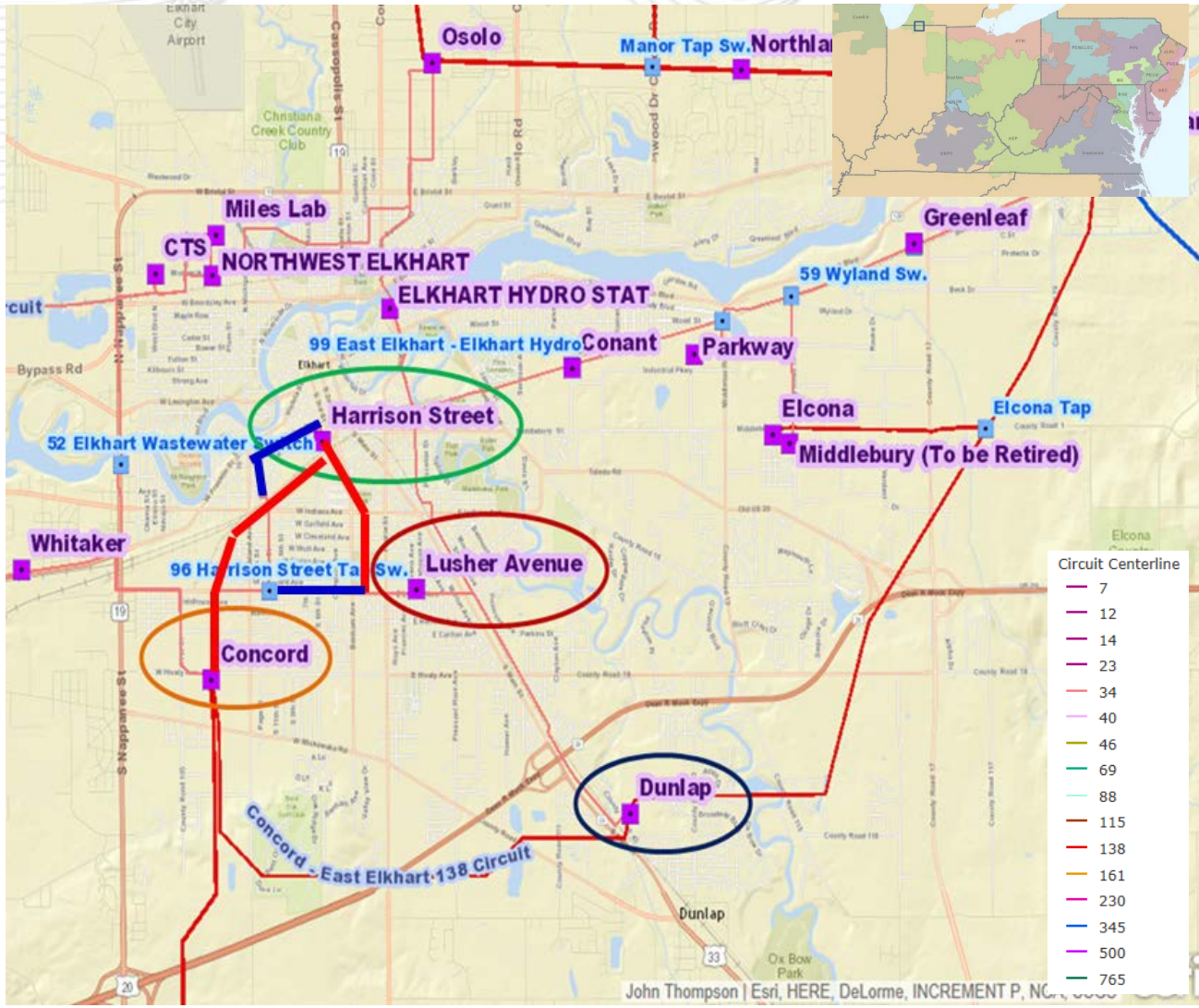

AEP Transmission Zone: Supplemental
Elkhart Network

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Equipment Material/Condition/Performance/Risk:

Elkhart Hydro is a station that presently supplies the Elkhart underground distribution network via two 1950's vintage 34.5/4 kV transformers. The 34.5/4 kV GSU transformer 1 at Elkhart Hydro Substation has high values of ethylene and carbon oxides that began increasing in 2004. The CO/CO2 ratio has been fluctuating between the warning and alarm limit since 2005 indicating that this unit has degraded paper insulation. Additionally, the interfacial tension and power factor are trending in a direction that shows degradation of the transformer oil. This unit has aged insulating materials. The 34.5/4kV transformer 2 at Elkhart Hydro Substation has low values of combustible gasses. The 34.5/12kV transformer 3 at Elkhart Hydro Substation has high values of hydrogen and carbon oxides that have been steadily rising since 1993. The hydrogen and carbon monoxide fluctuate in a similar manner and the unit has experienced partial discharge events. Additionally, the interfacial tension indicates that the oil is in poor quality and the moisture content is high. The transformer insulating system is degraded. Elkhart Hydro station 4 kV equipment is indoor, obsolete, characterized by very compact clearances, and has a vintage estimated in the 1920's. The 1975 vintage 34.5/12kV transformer 2 at Lusher Avenue Substation has an extremely high value for Ethane. This unit has experienced overheating faults which has deteriorated the paper insulation. The 1970 vintage 138/12kV transformer 1 and 1976 vintage transformer 2 at Dunlap Substation has high carbon dioxide values and the bushing dielectric data. The unit has low values of combustible gases.

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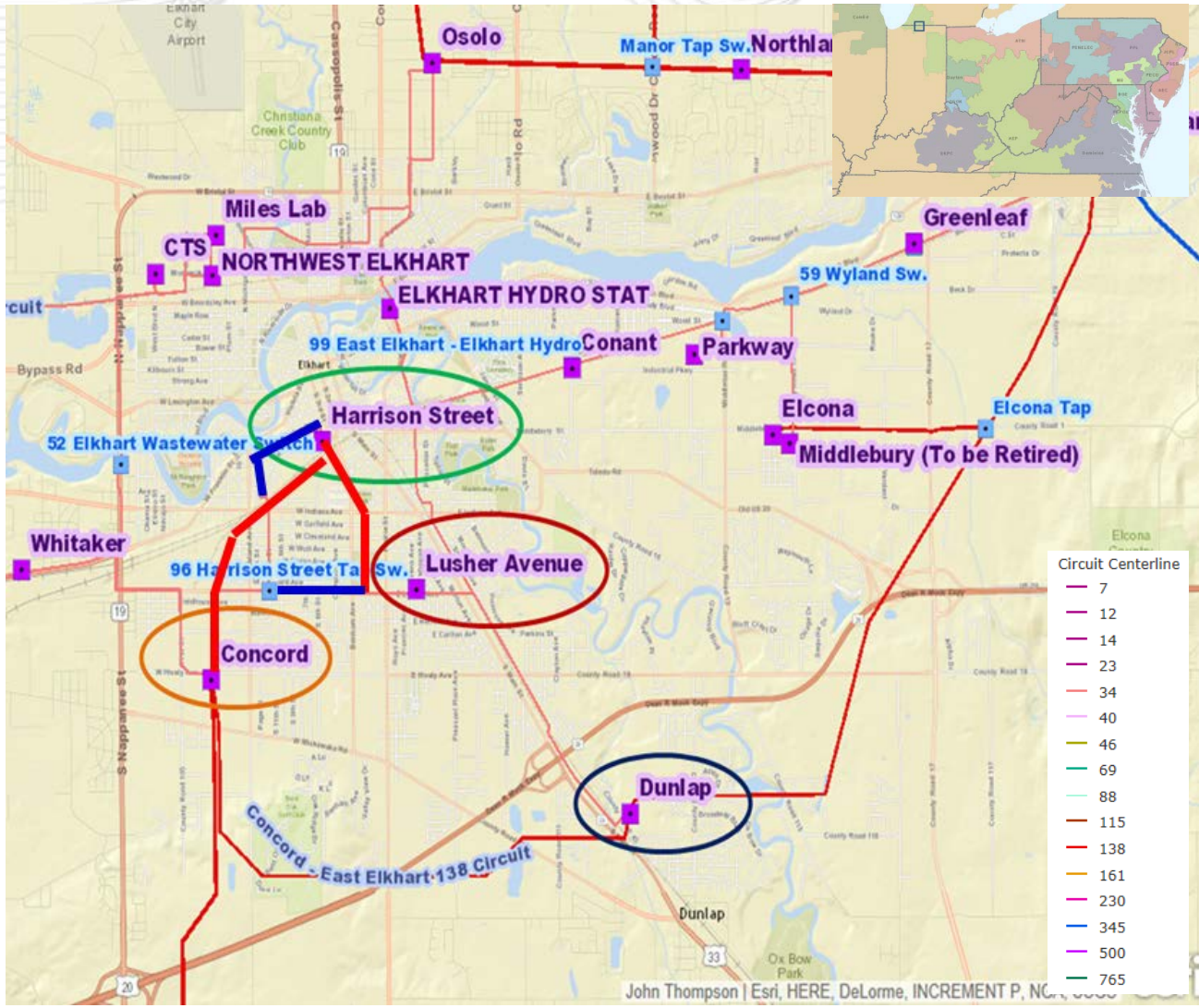

AEP Transmission Zone: Supplemental Elkhart Network

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The 1950's and 1960's vintage 34.5kV circuit breakers A, D, E, F, G, and H, at Elkhart Hydro Substation have operated through 38, 26, 30,18 & 4 fault operations. The 1987 vintage 34.5kV Cap Switcher J has operated through 44 fault operations. The 1952 vintage 34.5kV circuit breakers A and B at Lusher Avenue Substation have operated through 8 & 14 fault operations. The 1972 vintage 34.5kV circuit breakers H and J at Dunlap Substation have operated through 28 & 45 fault operations. These Circuit Breakers are oil filled FK-breakers without oil containment. These breakers have the following documented conditions: age; bushing problems; unavailability of spare parts; lifetime fault operations count; and high moisture readings. 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 can be an environmental hazard. All these circuit breakers are above the manufacturer recommended limit for full fault operations except the 34.5kV circuit breaker H at Elkhart Hydro and A & J at Lusher Avenue.

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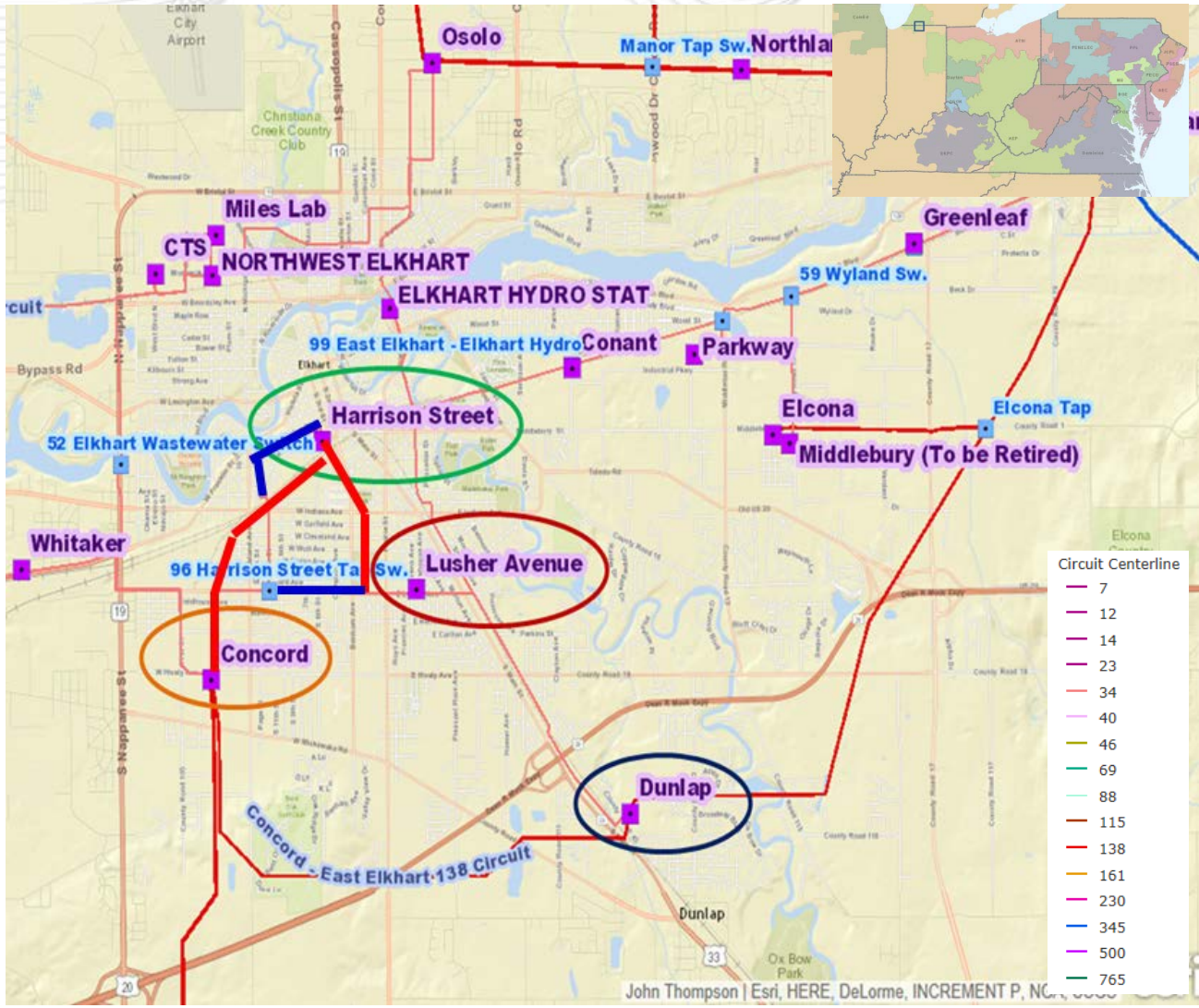

AEP Transmission Zone: Supplemental Elkhart Network

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Potential Solution

Rebuild Harrison Street station as a 69kV ring bus station using 3000A 40kA breakers. Estimated Cost: $4.2M

Rebuild Lusher Avenue as a 69kV station using a DT1 FK F1 3000A 40kA model bus tie breaker with 2 MOABS on the line exits. Estimated Cost: $1.8M

Install a 69kV 3000A 40kA breaker at Concord station toward Harrison Street. Install a 69kV (34.5kV operated) 3000A 40kA breaker at Concord station toward AE COMP. Estimated Cost: $2.3M

At Dunlap Station replace transformer 2 with a 138/69-34.5kV 90MVA transformer. The transformer will have a high side 3000A 40kA circuit switcher. Install two 138kV line breakers using 3000A 40kA breakers. Replace circuit breaker 'H' and 'J' with 69kV 3000A 40kA models. Estimated Cost: $11.6M

Rebuild Elkhart Hydro to 69kV standards but operate it at 34.5kV. Replace circuit breaker 'F' and 'A' with 3000A 40kA breakers. Install a 3000A 40 kA 69kV line breaker. Estimated Cost: $8.7M

Remove Harrison Street Tap Switch. Estimated Cost: $0.1M

Build ~1.5 miles of line from the existing Concord – Wolf de-energized 138kV line to Harrison Street at 69kV utilizing 795 ACSR (64 MVA rating). After this, retire the line portion from AE Comp – Harrison Street. Estimated Cost: $4.4M

Build ~1.5 miles from the Dunlap – Concord line to Harrison Street station. Rebuild .5 miles of the existing Dunlap – Lusher line to 69kV standards and retire the portion between Harrison Street Tap and the new line. All new line will utilize 795 ACSR (64 MVA rating). Estimated Cost: $5.8M

Total Estimated Transmission Cost: $38.9M

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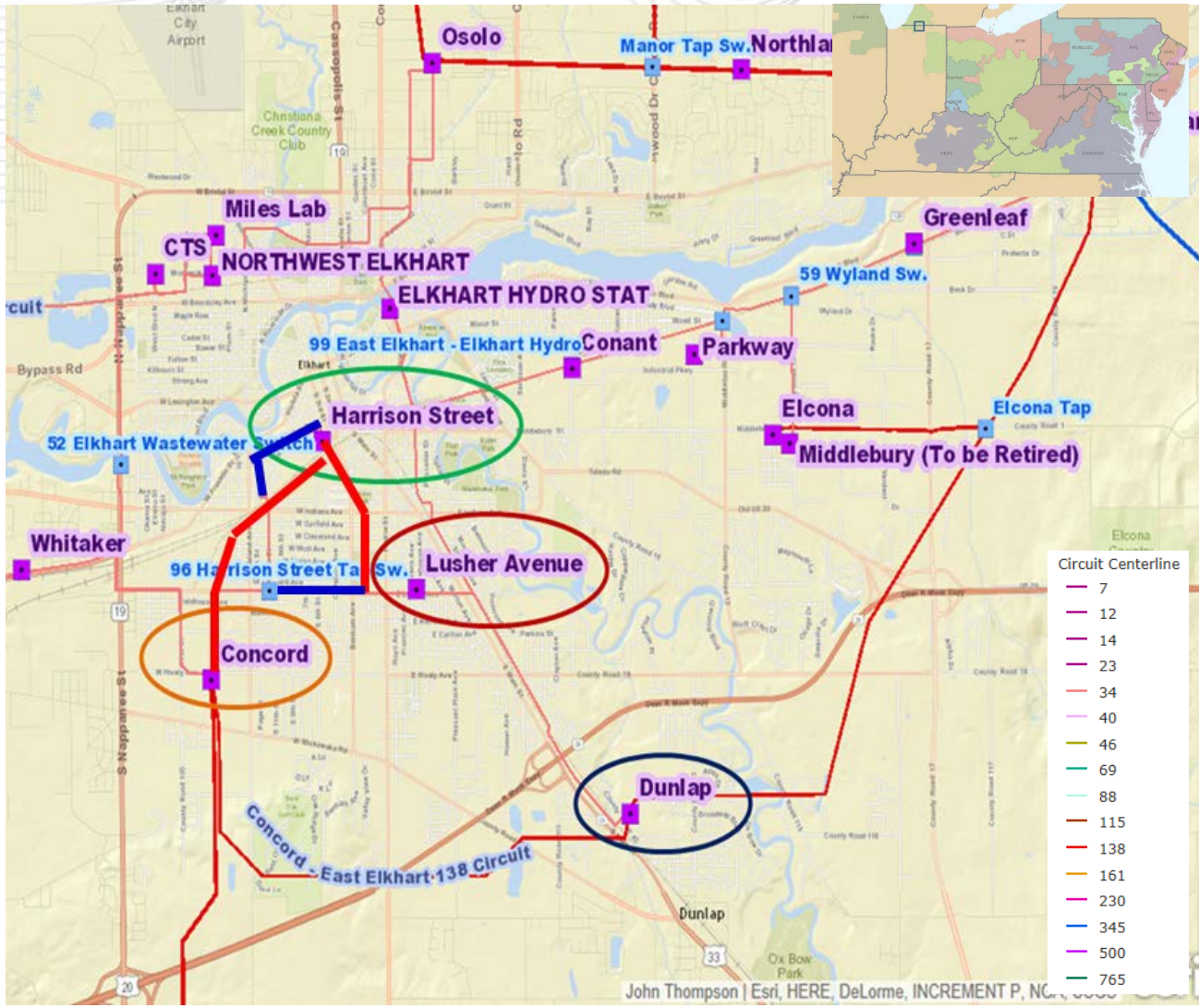

AEP Transmission Zone: Supplemental Elkhart Network

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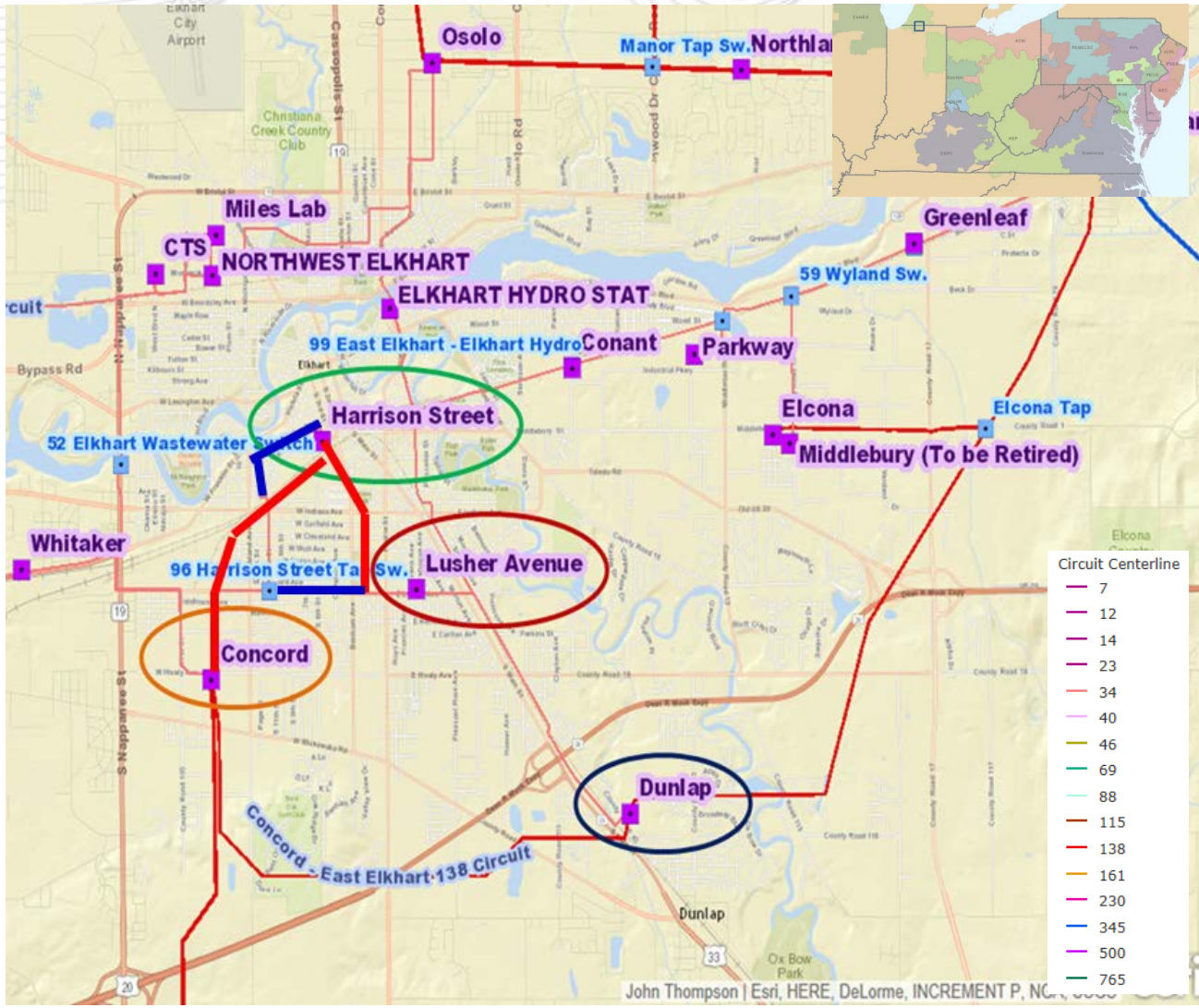
Alternatives:
Reconstruct approximately four miles of 69kV line as double circuit 138kV, extend single circuit 138kV to Harrison Street, reconstruct Harrison Street to 138kV standards, extend Concord – Wolf 138kV line to Harrison Street. Estimated cost: $40M

Projected In-service: 4/1/2019

Project Status: Scoping



AEP Transmission Zone: Supplemental
Berrien Springs

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Derby Station: The 69kV CBs F, G, and H and the 34.5kV CB K at Derby Substation are oil filled GE-FK breakers. Failure of these units generally results in fire and oil spillage within the substation. The units are severely rusted and the foundation is deteriorated. These breakers have significantly exceeded the designed number of full fault operations (10) with 40, 40, 49, and 53 fault operations, respectively.

The 138/69/34 transformer was commissioned in 1961 and is also in poor condition. This bank has experienced high energy faults and has ever increasing oil contamination.

Berrien Springs Station: The two transformers are approaching 70 years of service and are all in poor condition. Also, the 34.5 kV CB's are approaching 50 years of service and have experienced numerous faults and are all in poor condition. The 34.5 kV switch yard sits on an elevated concrete platform directly above the fish ladder and lacks oil containment or proper equipment grounding (safety concern). The deteriorated condition of this platform is of significant concern. Also, all drainage around the station goes directly to the river and with this station being located below the dam on the St. Joseph River, uncontained oil spills have direct access to Lake Michigan. There's no ability to expand the 34.5/12 kV system which is an already an atypical arrangement (one of only 3 in I&M) to which distribution has previously requested replacement. The control house lacks space and the equipment is outdated and unable to communicate with our current IED relays.

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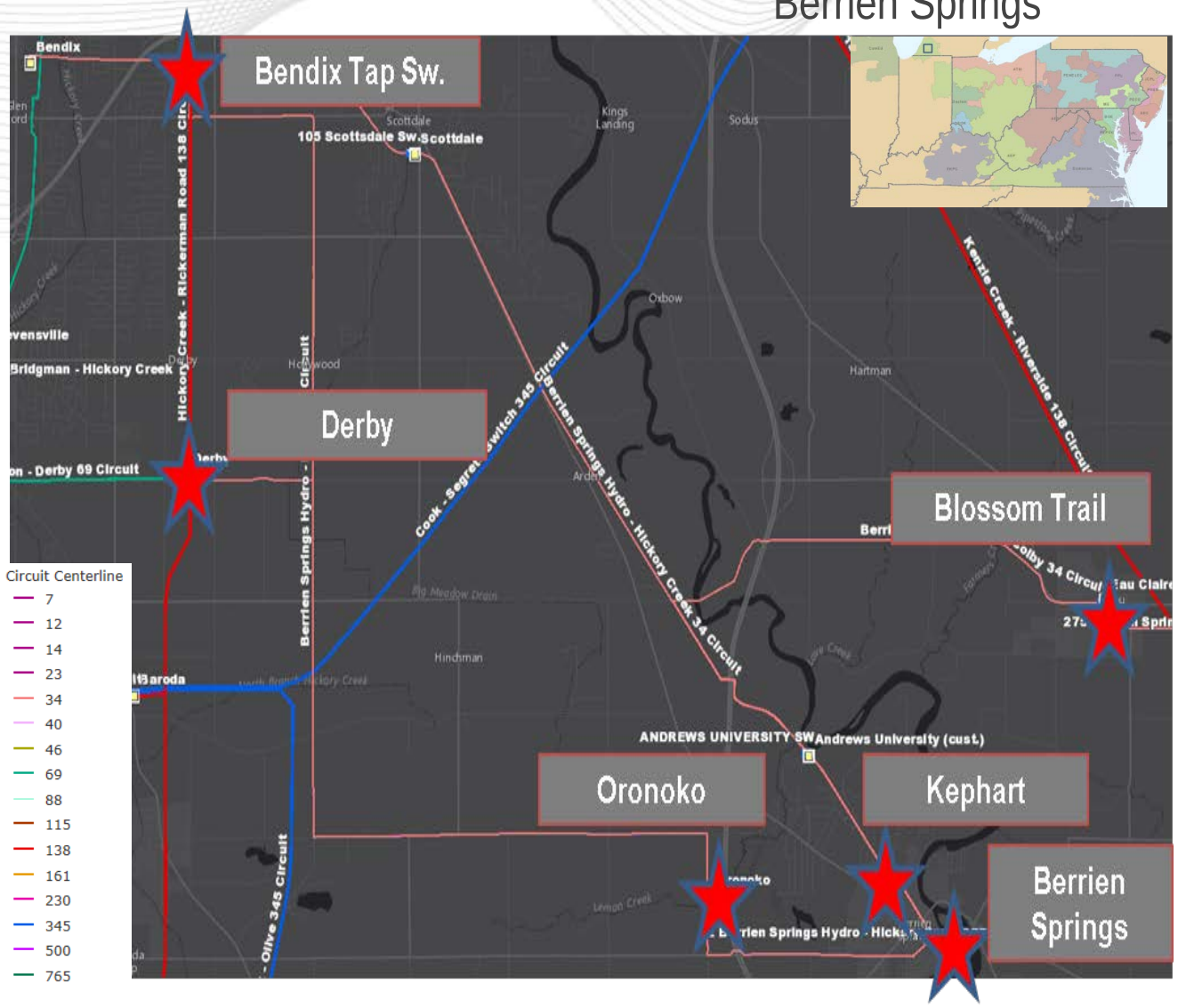

AEP Transmission Zone: Supplemental
Berrien Springs

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Oronoko Station: I&M Distribution has ongoing failures with the 34.5 kV underground terminations at Oronoko and Derby Stations. These cables are at the end of their expected life.

Line Assets: From 2014 to 2017 the Berrien Springs Hydro – Derby line was subject to 1,575,738 Customer Minutes of Interruption (CMI). The underground components of the Berrien Springs Hydro – Derby circuit were built in the 1970's. The cable manufacturing technology and insulating compounds produced during this time period results in contaminant levels far exceeding today's standard; this notion is accepted in the utility industry. Formation of cable tress inside the insulation layer leads to ever increasing risk of electrical breakdown and failure. The high end of life expectancy for cables of this vintage is generally predicted to be at 35-40 years of age. Additionally, the component that is part of the Derby Tap Line Asset is a non-standard size of the XLPE (cross-linked polyethylene) cable. In November of 2015, there was a failure on the phase 2 cable entrance at Oronoko which led to a 50 day outage. In April of 2016, there was a failure on the Phase 1 cable on the Derby Tap which resulted in a 79 day outage. The Berrien Springs Hydro – Derby circuit was built with wood structures and mostly 4/0 ACSR conductor. The total open conditions, 226, date from 2009 – 2017. Some of the structure conditions reported were broken and split cross arms, disconnected x-braces and rot. Currently, 119 of the 462 structures have at least one open condition.

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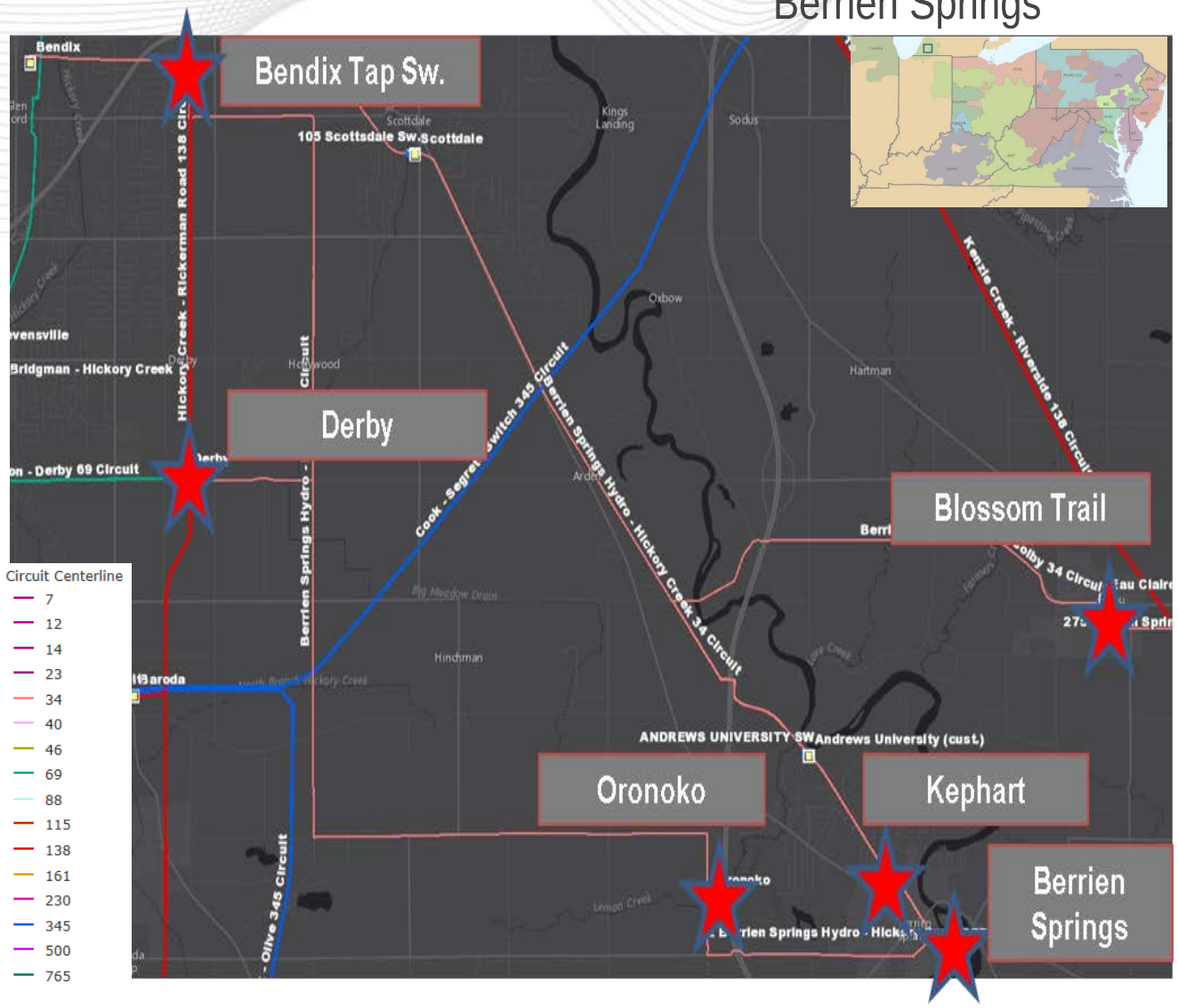

AEP Transmission Zone: Supplemental
Berrien Springs

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Operational Flexibility and Efficiency

Historically the loss of the Hickory Creek and Derby sources have resulted in low voltages and voltage instability. DDC has reported that the voltage switching transients during 34.5 kV operations are approaching 8 volts (on a 124 volt base) when a lose of Hickory Creek 34.5 kV is experienced. The remoteness of AEP's Berrien Springs Hydro generation from stronger 138 or 69 kV systems has long been an issue. The introduction of a new 138 kV source near Eau Claire, MI would provide the opportunity to strengthen the grid and restore stability to the area with 138/69/34.5 kV transformation. This project will also prepare our 34.5kV network for future 69kV conversions and will eliminate drop and pickup issues when transferring distribution loads.

The Berrien Springs Hydro – Derby line is a combination of underground and overhead cables. When underground and overhead are mixed, the circuit must be operated in manual reclose to protect the underground cable section from additional damage to the underground cable caused by reclosing into a fault. If for some reason a circuit is operated with automatic reclosing like an all overhead circuit, there is great risk to causing additional (catastrophic) damage to the cable if the fault is still present.

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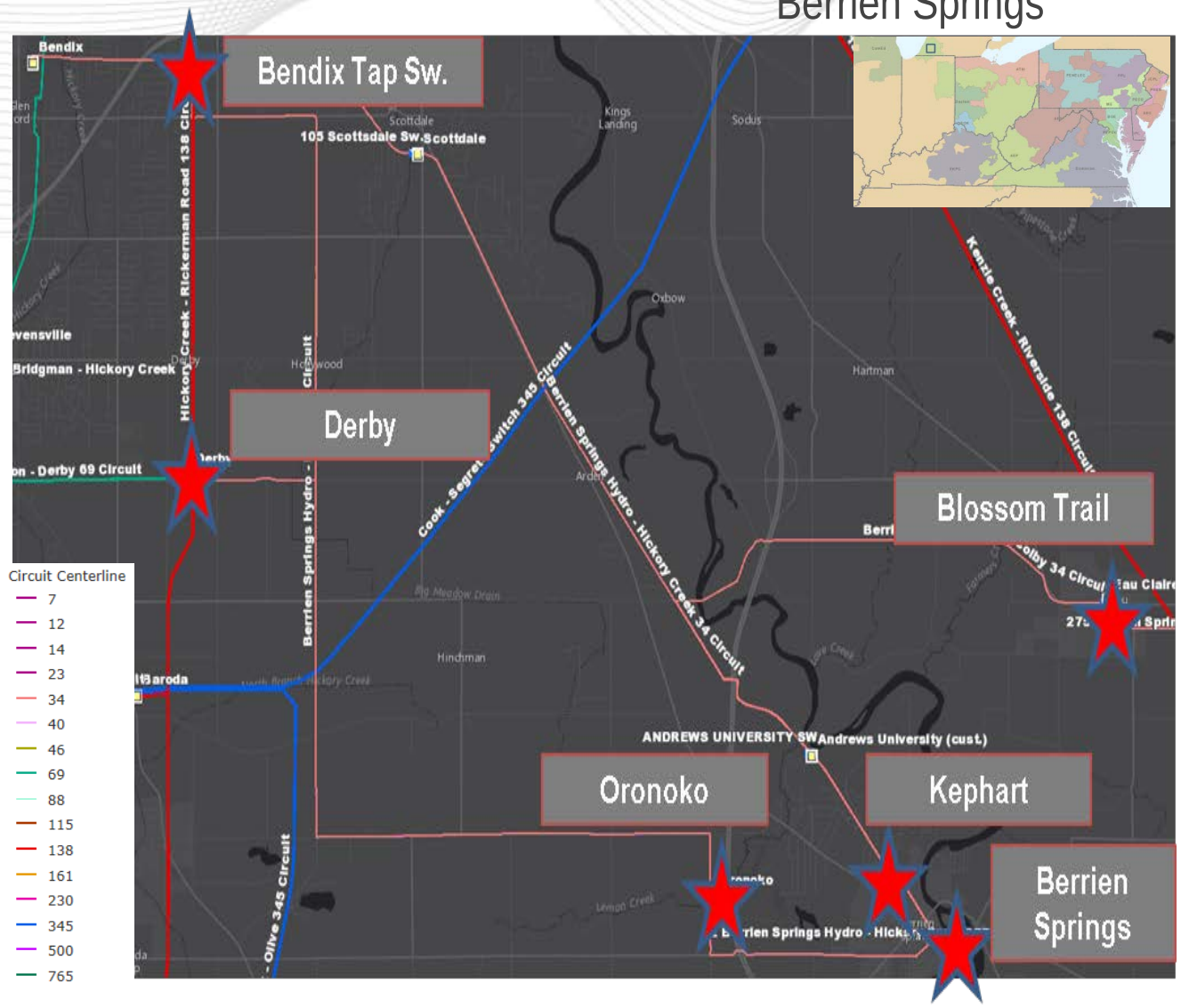

AEP Transmission Zone: Supplemental
Berrien Springs

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Potential Solution

Derby - Bendix: Relocate line exits and eliminate the need for underground 69/34kV lines at Derby. Replace Bendix Tap Sw. Pole. Estimated Cost: $2.5M

Berrien Springs Hydro - Oronoko - Hickory Creek 34.5kV: Eliminate UG 69kV section at Oronoko. Rebuild ~1.3mi of 34.5 kV as 69kV double circuit. Build line extension to the proposed site for Kephart station. Estimated Cost: $0.9M

Rebuild Derby station in the clear. Proposed station will have (2) 138kV CBs, (4) 69kV CBs, (1) 34.5 CB, (1) dual voltage 138-69/34.5kV transformer with a circuit switcher on the primary. Estimated Cost: $4.0M

Construct a new Kephart station with (2) 69kV CBs, (1) 34.5kV CB, (1) 69/12kV transformer, (1) 69/34.5kV transformer, and (3) 12kV CB's. Construct a 69kV yard that can accommodate 34.5kV and 69kV operation. Estimated Cost: $1.9M

At Berrien Springs, retire existing 34.5kV yard, concrete platform and associated transmission equipment. Install (2) 69kV CBs and replace 69kV CB "H" on the primary side of T1. Estimated Cost: $2.5M

At Blossom Trail, install (1) dual voltage 138-69/34.5kV transformer, (4) 138kV CBs, (1) 138kV CS, (1) 69kV CB , (1) 34.5 CB, and (1) 34.5 ground bank. Estimated Cost: $6.0M

Replace Bendix tap switch with 1200A 69kV phase over phase switch. Estimated Cost: $0.6M

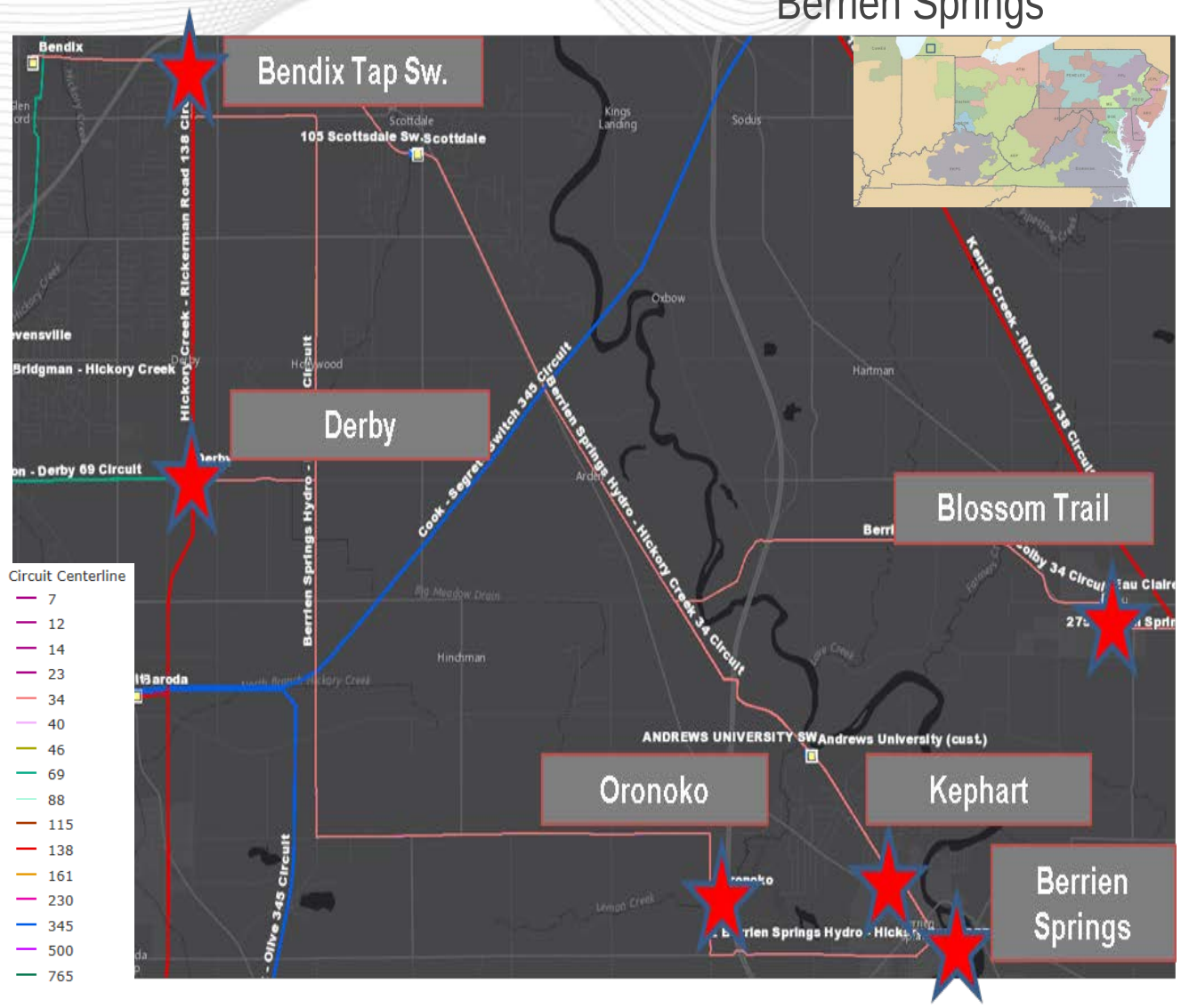
Total Estimated Transmission Cost: $18.4M

Alternatives:

An alternative considered to address the low voltage issues in the area is to bring a new line into Scottsdale 34.5kV station. However, Scottsdale is located in a congested urban area and would not be a cost effective solution.

Projected In-service: 6/1/2020

Project Status: Scoping



AEP Transmission Zone: Supplemental Brice Station

Problem Statement:

Customer Service:

AEP-Ohio has requested a new 138kV delivery point capable of serving 3-50 MVA transformers to address their concerns as listed below.

- Two Distribution circuits from Astor are nearing 90% capabilities. Load transfer options are exhausted.
- One Distribution circuit from Shannon is forecasted to exceed 90% capability in 2018 and 100% capability in 2019 with confirmed additions of block loads. Only temporary load transfers can be utilized as the forecasted loads for all feeders in the area would be exhausted.
- Reynoldsburg 34.5kV/13.2kV Station (served from Distribution line) is radially fed and has no method for recovery in the event of a full station outage. This area has a history of reliability problems and complaints.
- AEP Ohio has been approached numerous times about relocating Reynoldsburg Station by the City of Reynoldsburg for economic development purposes.
- Reynoldsburg and Pataskala areas along I-70 are active residential and commercial load growth centers. No appreciable capacity left on existing facilities.
- With load transfers from Shannon Station to this station, would have ability to utilize the freed up capacity on the Shannon circuits to pick up load from of the areas served by the northern circuits out of Bixby that are starting to have capacity issues.
- With the addition of the Brice Station, we would have sufficient facilities in a very marketable location to push economic development opportunities.

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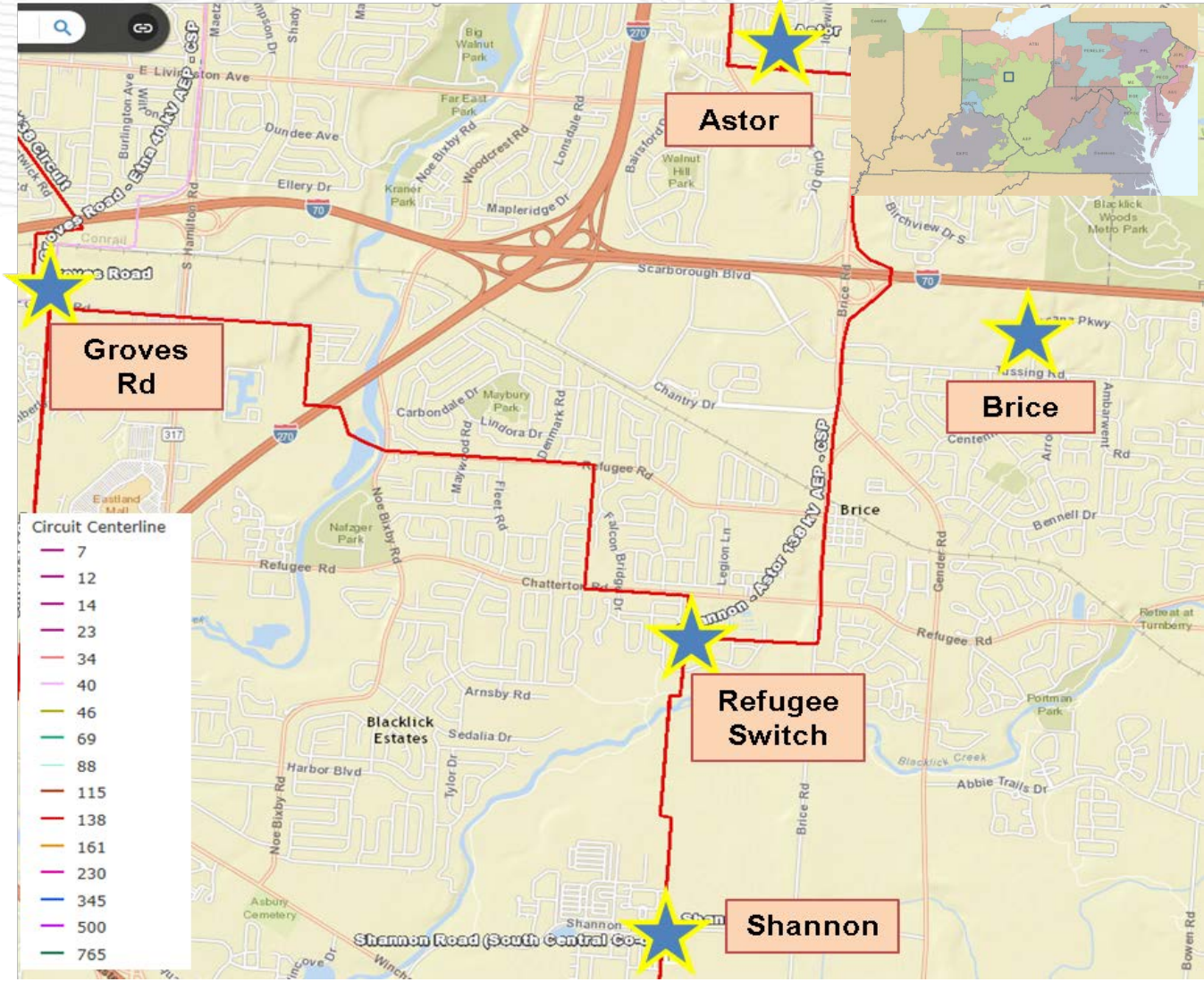

AEP Transmission Zone: Supplemental
Brice Station

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Operational Flexibility and Efficiency

Columbus is a large urban load center. AEP-Ohio routinely utilizes larger than average Distribution transformers in this area due to load density needs, distribution line routing difficulties, and other reasons. Use of such large Distribution transformers as well as unique combinations of transformer windings operated in parallel tends to put large amounts of customer load at risk. For this reason, circuit breakers will be installed at Brice.

Specifically, in the area of the new Brice station installation, the new station will cut into an existing 3 terminal line. A longer term solution will be required to address the 3 terminal line issue but, in the meantime, it is necessary to avoid increasing load and line exposure to this outdated configuration.

Potential Solution

Cut into existing Astor-Groves-Shannon 138kV circuit with 0.69 miles of new double circuit 795 ACSR (257 MVA rating). **Estimated Cost: $0.8M**

Construct a new Brice station as a ring bus laid out for breaker and a half. Install 3-138kV 3000A 40kA CB's. **Estimated Cost: $1.5M**

Total Estimated Transmission Cost: $2.3M ($4.0M for Distribution Cost)

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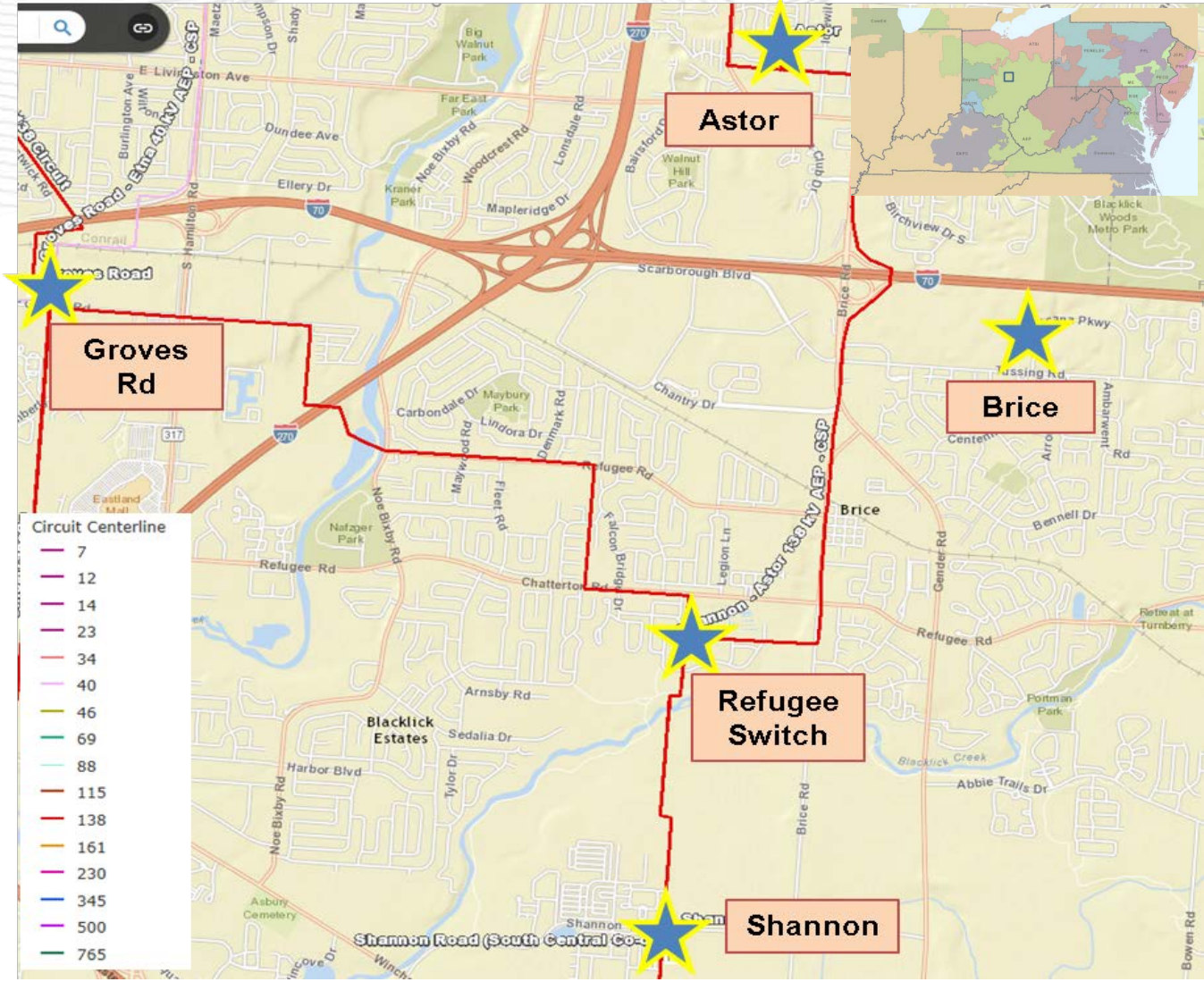

AEP Transmission Zone: Supplemental
Brice Station

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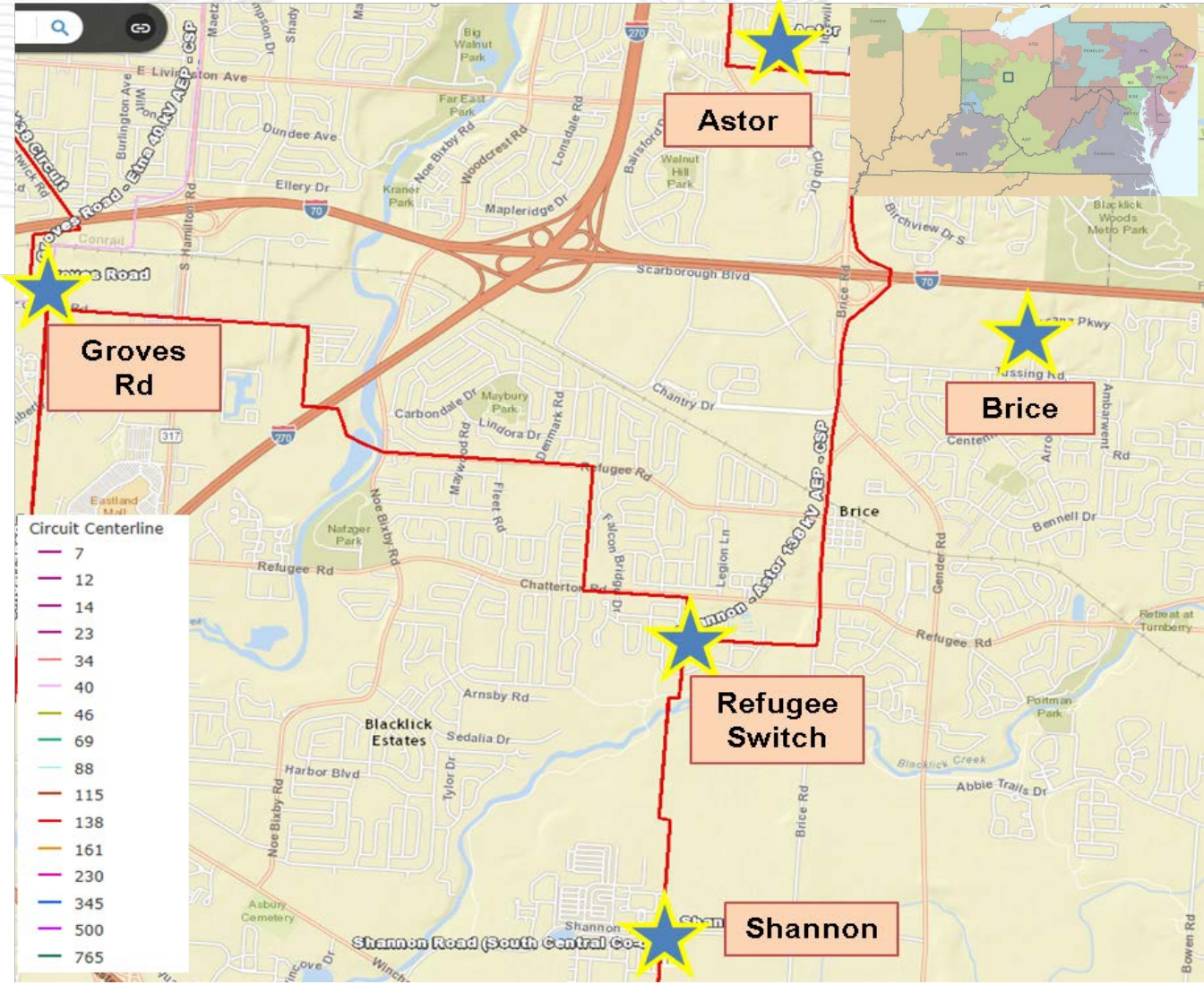
Alternatives:

Build a new 138kv/13.2kV 50MVA station near the intersection of Livingston Ave. and SR 256 (Huber Station) and construct 1.8 miles of double circuit 138kV transmission utilizing the distribution corridor along Livingston Ave. from Brice Rd. Construct two new distribution feeders, retire Reynoldsburg Station, and transfer/cascade loads to Astor and new Huber circuits. This option is feasible but not as desirable because the transmission route is longer and more constrictive. Also the distribution options are more limited and would not provide as much support to the stations south of I-70. Estimated Cost: $8.3M

Projected In-service: 10/21/2019

Project Status: Scoping



AEP Transmission Zone: Supplemental
Darrah Station

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The existing 34.5 kV circuit breakers “C”, “D”, “F”, “G”, “I”, “J”, and “N” at Darrah are all FK oil type breakers that are all between 45-70 years old. 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. Other drivers include damage to bushings and an excessive number of fault operations exceeding the manufacturers recommendations. Darrah breakers “C”, “D”, “F”, “G”, “I”, “J”, and “N” have experienced 12, 10, 85, 22, 1, 18, and 90 fault operations respectively. The manufacturer’s recommendation for this type of breaker is 10.

138 kV circuit breaker “T” at Darrah is a FGK oil type breaker that is close to 60 years old. These oil breakers share similar concerns to the FK types listed above. Darrah breaker “T” has experienced 23 fault operations, exceeding the manufacturer’s recommendation of 10.

Darrah’s 138/34.5 kV Transformer #1 (vintage 1949) and is showing dielectric breakdown (insulation), accessory damage (bushings/windings) and short circuit breakdown (due to amount of through faults).

Operational Flexibility and Efficiency

Circuit switchers will be added to the high side of transformers #1, #2, #3, and #4 at Darrah Station to separate dissimilar zones of protection. Installation of a circuit switcher was evaluated for transformer #5 at Darrah. It was determined a switcher could not be added without a complete relocation of the transformer and its low side bus work or a significant reconfiguration of the 138 kV bus at Darrah.

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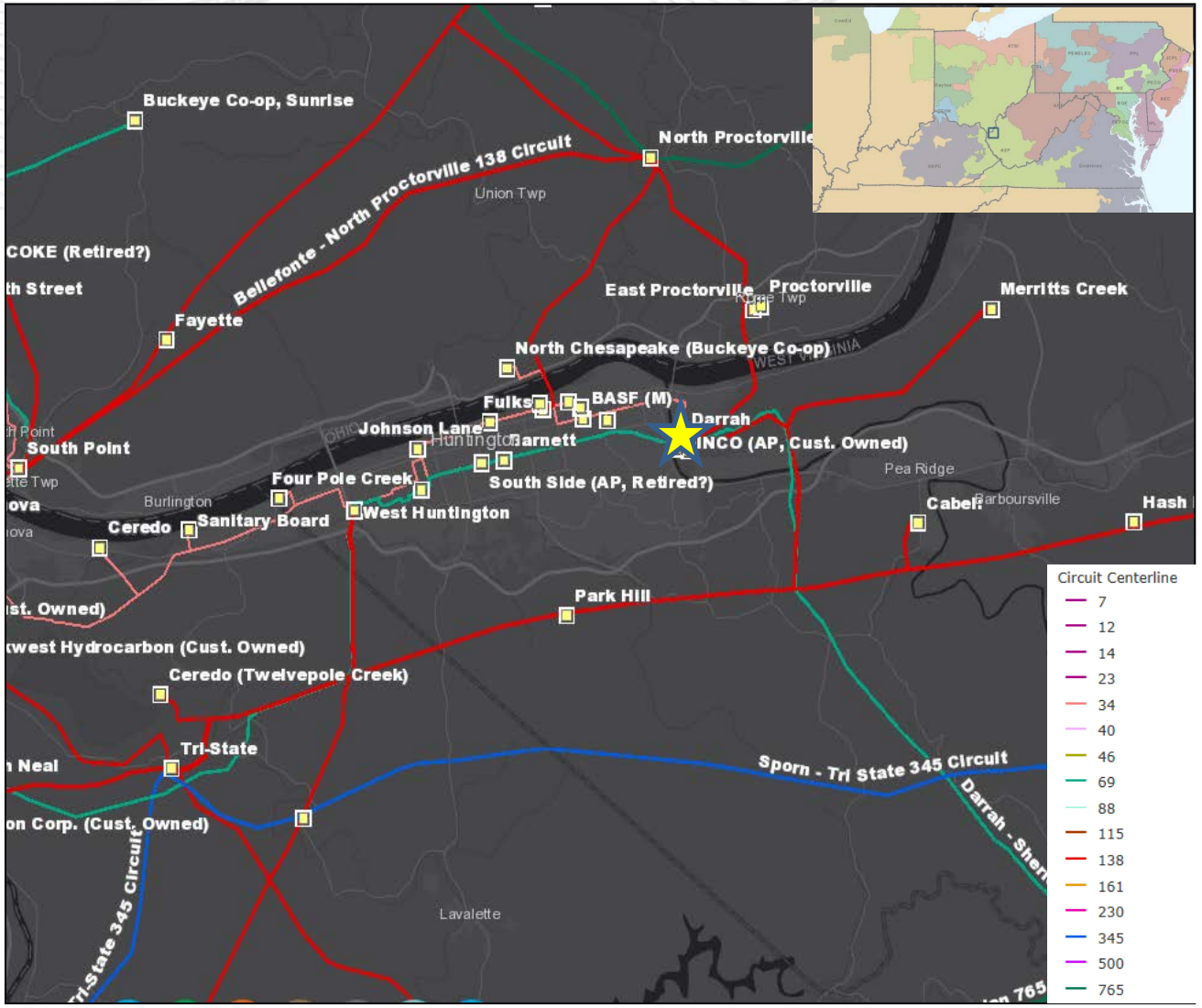

AEP Transmission Zone: Supplemental
Darrah Station

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Potential Solution

At Darrah station, replace the existing 1600 A 42 kA 138 kV circuit breaker "T" with a new 3000 A 40 kA 138 kV circuit breaker. Replace the existing 1200 A 17 kA 34.5 kV circuit breakers "C", "D", "F", and "I" with new 3000 A 40 kA 34.5 kV. Replace the existing 1800 A 27 kA 34.5 kV circuit breakers "J", "G", and "N" with new 3000 A 40 kA 34.5 kV circuit breakers. 138 kV circuit switchers will be added to the high side of Darrah transformers #1, #2, #3, and #4. The existing 45 MVA 138/34.5 kV transformer #1 will be replaced by 138/69/34.5 kV transformer with a 50 MVA tertiary.

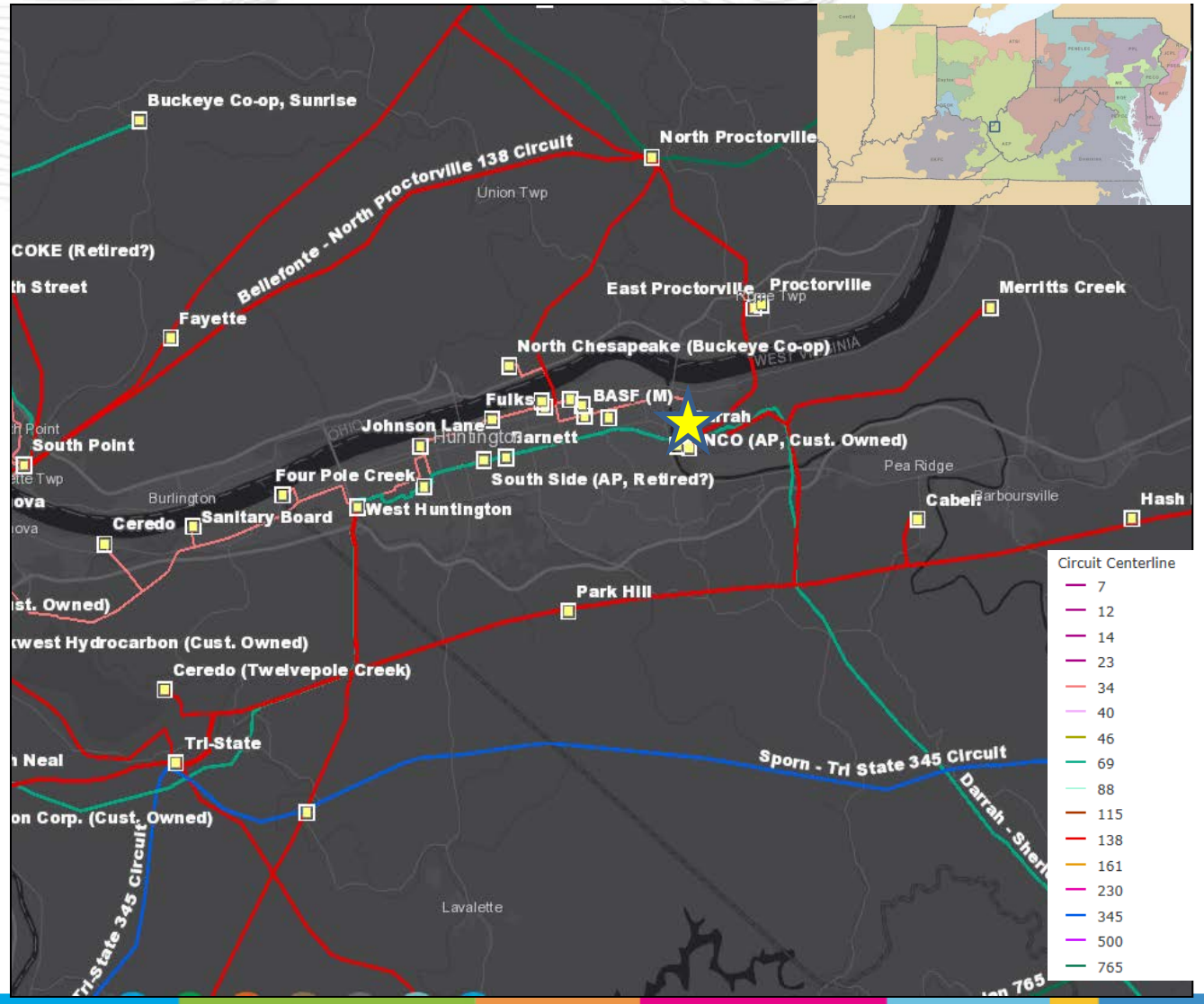
Estimated Cost: $11.5M

Alternatives:

Consolidating the 34.5 kV subtransmission transformers #1 and #2 was considered. Analysis showed 97% loading on T2 and overloads on the West Huntington-Johnsons Lane 34.5 kV lines. Consolidating T3 and T5 is not feasible due to furnace load on T5 causing potential power quality issues on the subtransmission network. Additionally, there is 34.5 kV transmission and distribution systems served from Darrah. The distribution system is a grounded-Y network whereas the transmission system is delta connected. These networks cannot be combined.

Projected In-service: 6/1/2020

Project Status: Engineering



AEP Transmission Zone: Supplemental Dearington Area

Problem Statement:

Equipment Material/Condition/Performance/Risk:

South Lynchburg station 69 kV circuit breakers 'D' & 'C' and Dearington station 69 kV circuit breakers 'L', 'K' & 'M' are oil type breakers without oil containment manufactured between 1959 and 1969. In general, oil breakers have become increasingly difficult to maintain due to the oil handling requirements. Oil spills are frequent with failures and routine maintenance. Other drivers include damage to bushings. South Lynchburg CB 'D' is also legacy oil-filled FK type breakers which have little to no replacement parts. 69KV circuit breaker 'C' is a EPB Gas Circuit Breaker with gas leaks, bushing failures, and CT gasket problems.

The 69 kV network lines in the area is currently protected with pilot wire technology. Copper pilot wire is a relatively obsolete technology, which makes it increasingly difficult to find suitable pilot wire cable and hardware parts. Consequently, we are avoiding like-kind replacement of pilot wire because the technology will be increasingly difficult to maintain.

At Dearington station the station battery voltage its being changed from 48 vdc to 125 vdc (AEP standard). Reusing Cap Switcher 'AA' would have required modifying the controls and motor to work with 125 vdc, which, is a very difficult and costly task. The CS can be a safety hazard as the gas sensor cannot be monitor remotely. One has to be standing in front of the CS to determine if adequate pressure is available to operate. This becomes a safety hazard if the gas is depleted and it is called on to operate.

Customer Service:

Dearington station serves critical loads in the Lynchburg, VA area. These customers include the Lynchburg General Hospital, Lynchburg College, EC Glass High School, and two nursing homes. Adding a bus tie breaker at Dearington station will limit the exposure to customers in the area.

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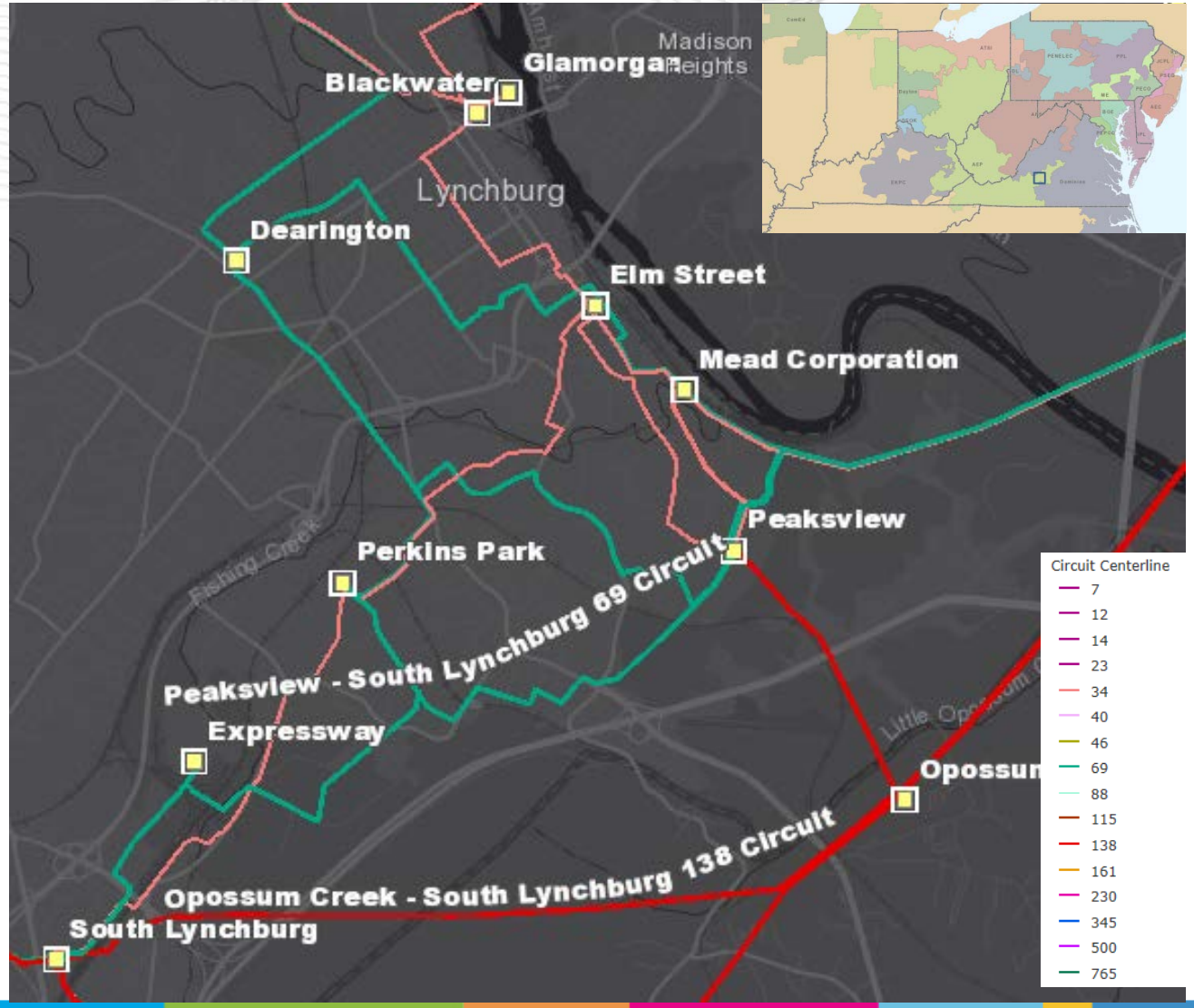

AEP Transmission Zone: Supplemental Dearington Area

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Potential Solution

At South Lynchburg station, replace the existing 69 kV/1200 A/21 kA CB "C" and the 69 kV/1200 A/11.3 kA CB "D" with 3000 A/40 kA circuit breakers. Install new control relays for breakers. Retire pilot wire from the Peaksview and Skimmer 69 kV line relays and install new line relays. Estimated Cost: $1.3M

At Peaksview station, retire pilot wire from the Dearington #1 & #2 and South Lynchburg 69 kV lines and install new line relays. Install a 20' building expansion to accommodate new relays and RTU. Estimated Cost: $1.9M

At Dearington station, replace the existing 69 kV/1200 A/21 kA CB 's "L", "M", and "K" with 3000 A/40 kA circuit breakers. Install a new 69 kV/3000 A/40 kA bus tie breaker. Retire pilot wire from the Peaksview #1 & #2 and Reusens lines and install new line relays. Replace existing 69 kV/400 A/40 kA circuit switcher "AA" with a new 420 A/18 kA circuit switcher. Install new DICM to accommodate all new relays and RTU. Estimated Cost: $0M

At Perkins Park station, retire pilot wire from the Dearington and Peaksview lines and install new line relays. Install high side circuit switcher on distribution transformer. Install new RTU. Estimated Cost: $0M

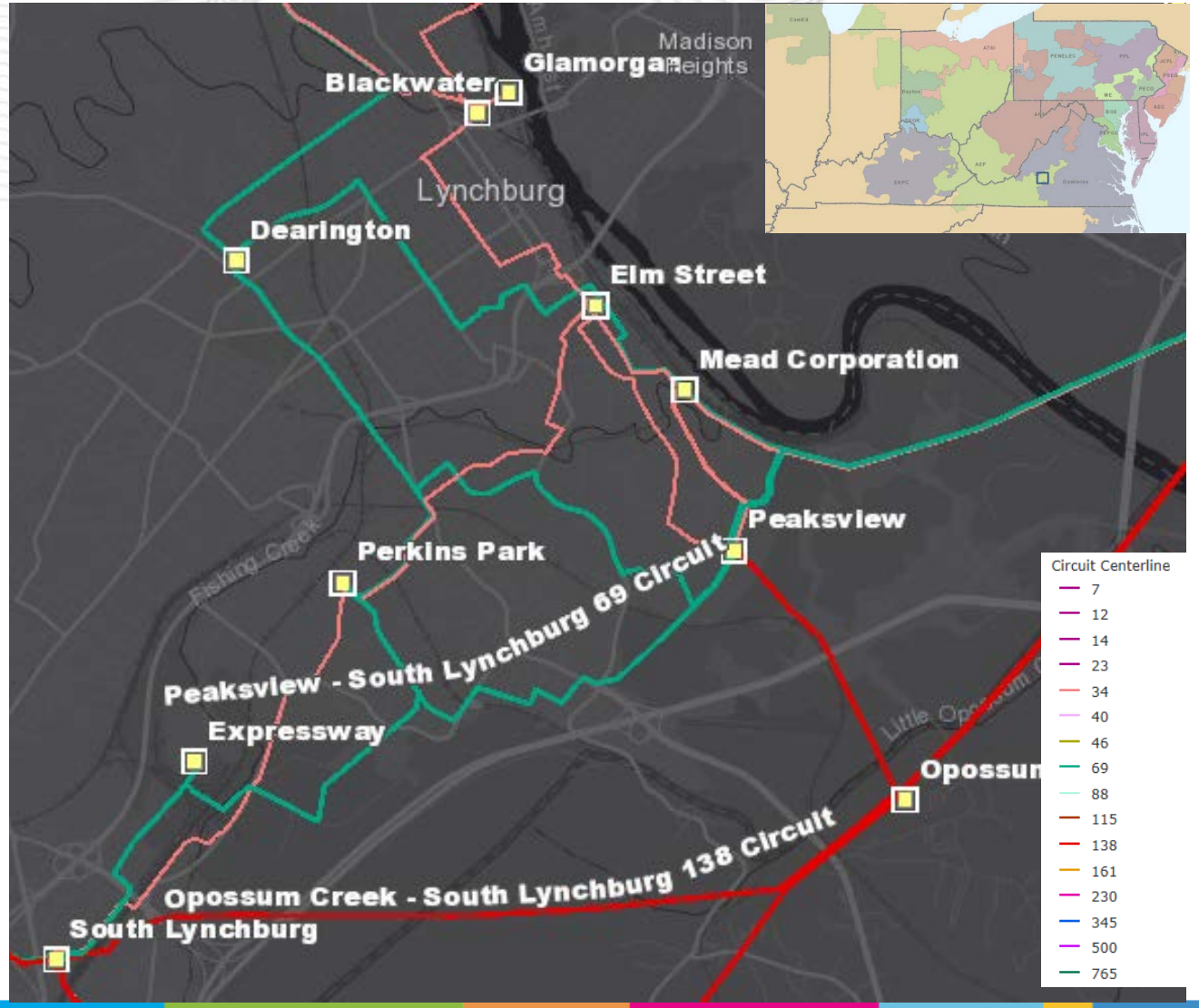
Total Estimated Transmission Cost: $3.2M

Alternatives:

No viable cost-effective transmission alternative was identified.

Projected In-service: 8/31/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental East Logan

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The East Logan 69 kV circuit breakers “M” and “N” are showing signs of deterioration. These breakers are 1969 vintage oil 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 can become an environmental hazard. The drivers for replacement of these breakers are age, bushing damage, number of fault operations, and a lack of available repair parts. Circuit breaker “M” and “N” have fault operations of 185 and 69 respectively. Circuit switcher AA is a Mark type switcher 1970 vintage. Mark switchers are being recommended for replacement due to their inability to coordinate with modern relaying packages. 54 of the 57 relays at East Logan are either electromechanical or static type. 33 of these are Transmission. The new line relays needed CCVT’s to be installed . Cable and trenching was needed to connect these to the DICM which is in a different location because of space constraints. A backup station service was needed for the 69 kV as there was none at the station currently.

Customer Service:

The rehab upgrades are being done to align with AEP Ohio work. They will be replacing their 69/12 kV transformer, installing a new feeder, constructing a new 12 kV bus, upgrading 12 kV circuit breakers, installing a 69 kV circuit switcher, installing feeder regulators, installing a DICM and replacing outdated equipment.

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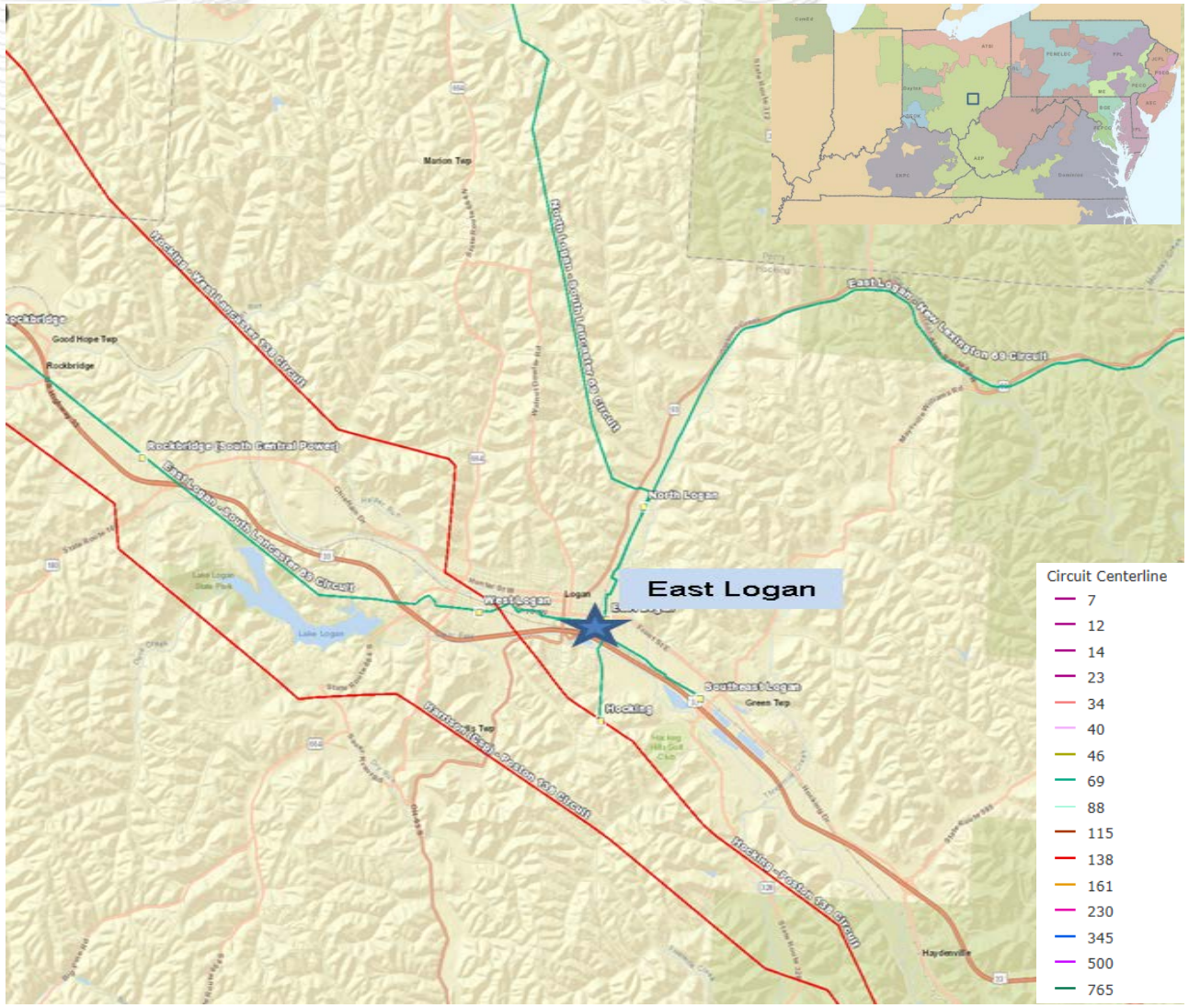

AEP Transmission Zone: Supplemental
East Logan

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Potential Solution

At East Logan station, replace 69 kV circuit breakers “M” and “N”. Replace the 69 kV capacitor bank. Install 15 69 kV CCVT’s. Replace 33 electromechanical relays. Install cable and trenching to connect CCVTs to the DICM. Install station backup service.

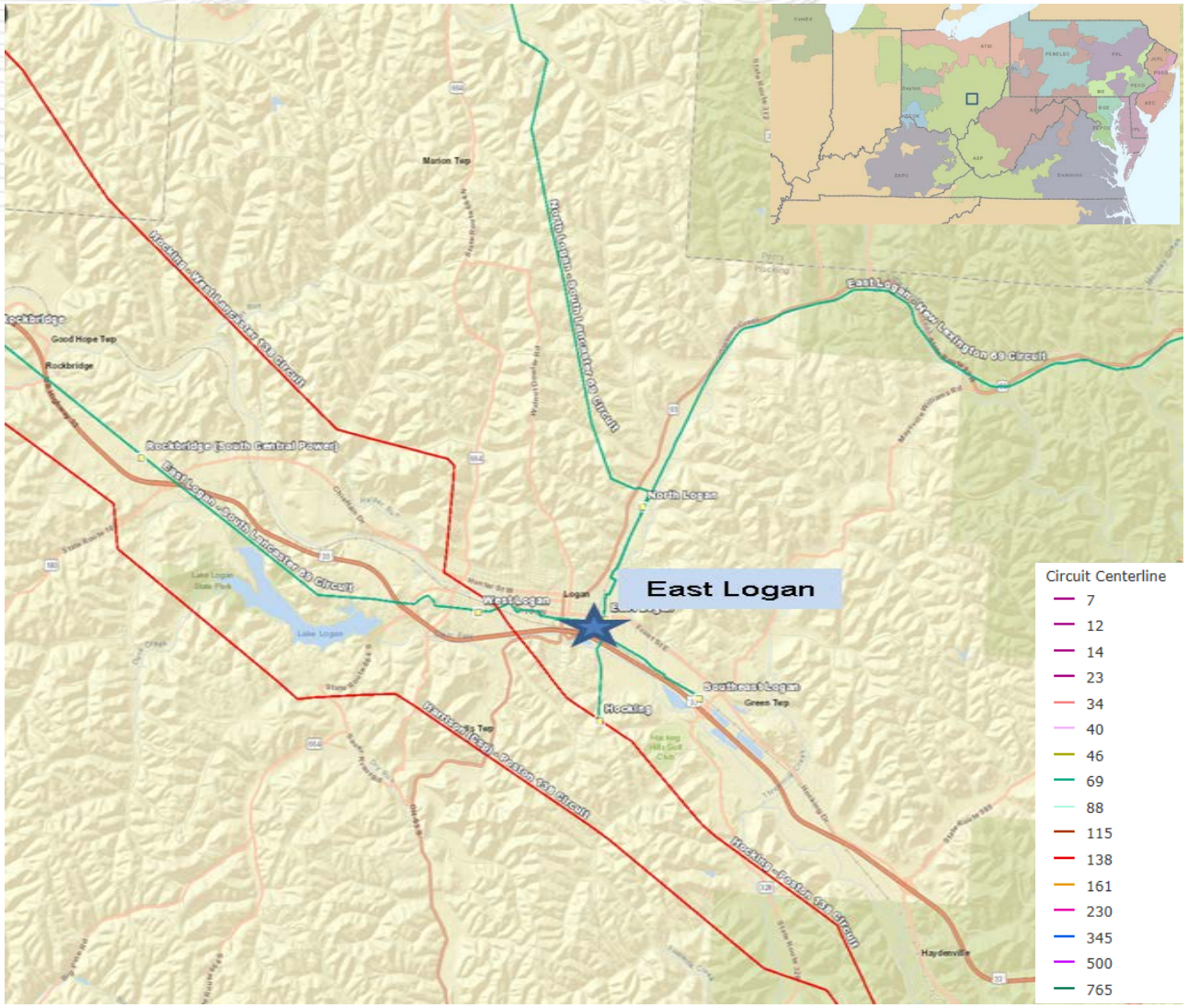
Estimated Cost: $4.0M

Alternatives:

Build East Logan Station in the clear. Overall project cost would be higher due to property purchase and line re-routes. The existing site is in a congested area making these items difficult. Estimated Cost: $6-8M

Projected In-service: 5/1/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental Hancock

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Hancock station 138 kV circuit breakers 'A', 'B' & 'C', 69 kV circuit breakers 'CA', 'M' and 'N', 34 kV circuit breakers 'J', 'I', 'P', 'R' & 'S' are oil type breakers without oil containment. In general, oil breakers have become increasingly difficult to maintain due to the oil handling requirements. Oil spills are frequent with failures and routine maintenance which is also an environmental hazard. Other drivers include damage to bushings. CBs 'A', 'B', 'C', 'CA', 'N', 'J', 'I' & 'P' are also legacy oil-filled FK type breakers which have little to no replacement parts. 69KV circuit breaker 'Q' is a EPB Gas Circuit Breaker with gas leaks, bushing failures and CT gasket problems.

Hancock 138/69/34.5 kV Transformer #2, 1951 vintage, is currently in a poor physical and operational condition. All three single phase transformers are showing short circuit strength breakdown caused through fault events, gassing of the unit, and a significant number of overheating events. There is an upward trending of oil moisture content resulting in downward trending to the oil dielectric strength. Increasing moisture content is a resultant of water ingress through aged gaskets, tank or pump leaks, or a breakdown of paper insulation of the transformer windings. In the Phase 1 tank, the most current reading for ethylene is at IEEE Condition 3 and has been steadily rising over the bank's lifetime. In the Phase 2 and 3 tanks, the most current reading for carbon dioxide is at IEEE Condition 3 and 2, respectively, and has recently been on the rise.

Circuit Switcher BB is an Mark V which is no longer supported by the manufacturer and parts are not available. We have to scavenge for parts during maintenance. These are older designed circuit switchers with old controls that no longer coordinate well with modern relaying.

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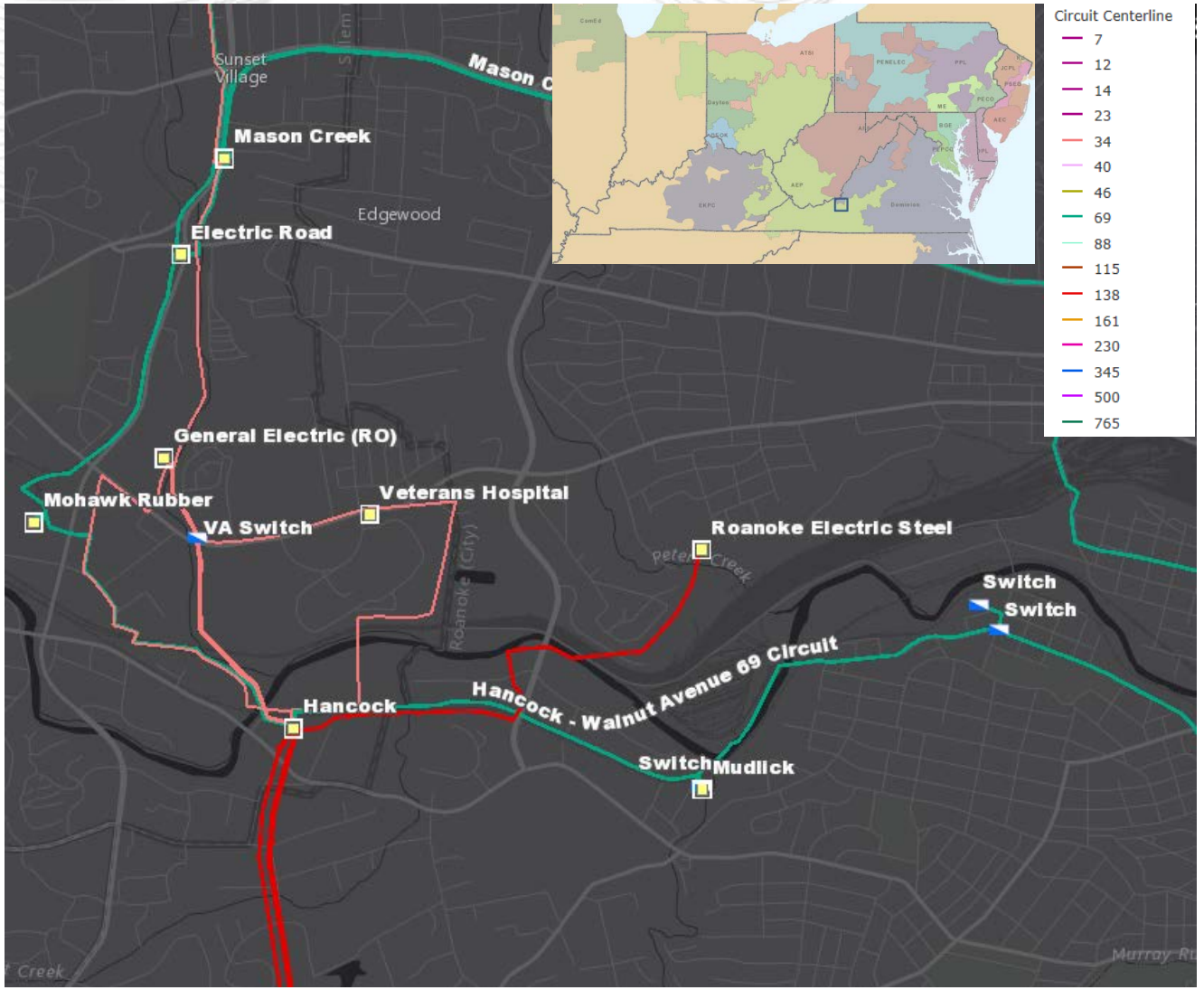

AEP Transmission Zone: Supplemental Hancock

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69 kV Mason Creek and Walnut Ave. 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 will be increasingly difficult to maintain.

<u>Operational Flexibility and Efficiency</u>

The breaker and half configuration will break the three dissimilar zones of protection (138 kV bus #2, transformer #1 and transformer #2), increase reliability, and allow for shorter maintenance outages. With the current configuration we are susceptible to a station outage with a breaker failure of 138 kV bus tie breaker "F".

<u>Customer Service:</u>

Hancock is a critical station for customers in the area. It feeds Roanoke Electric Steel, VA Hospital, General Electric and City of Salem.

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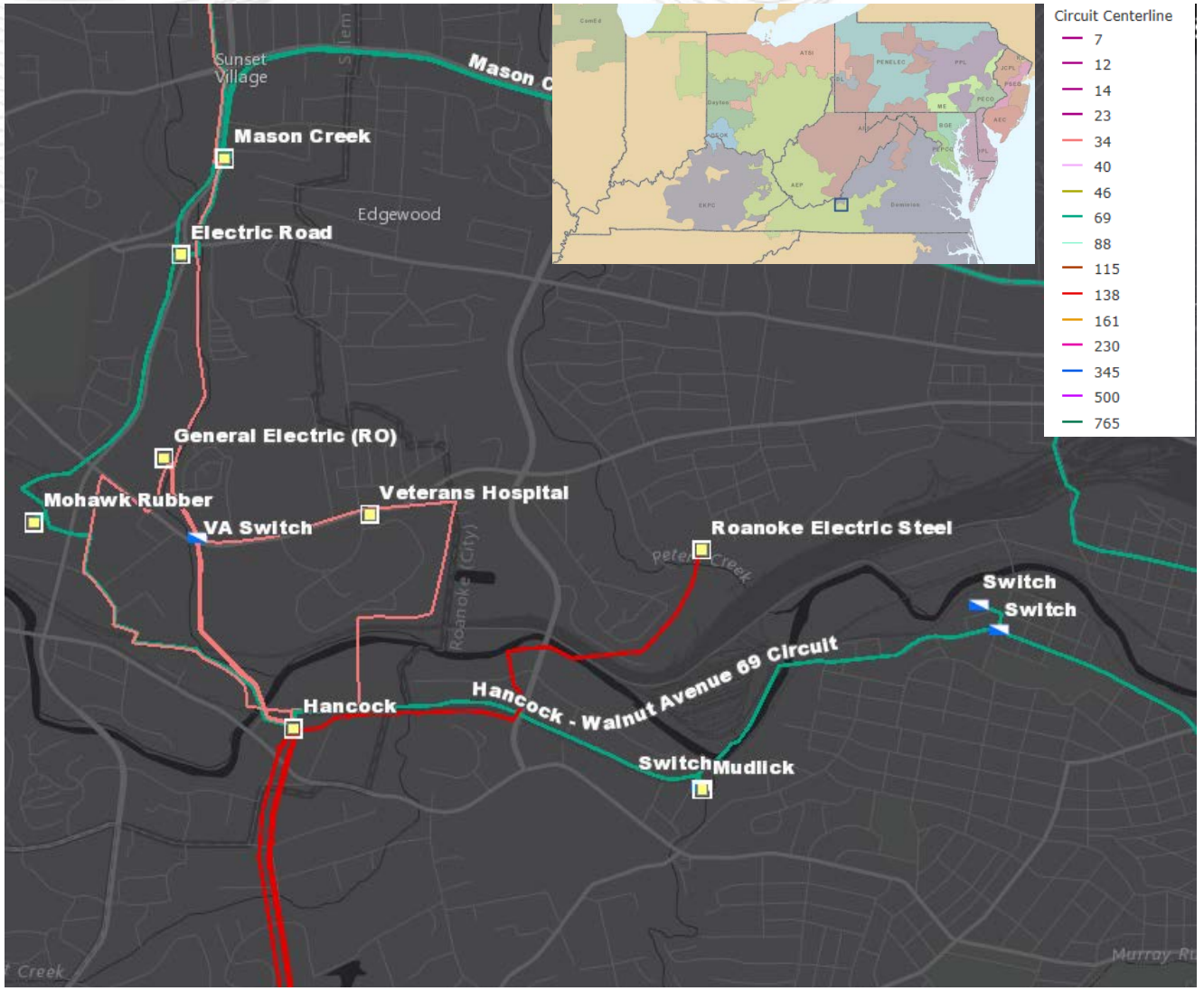

AEP Transmission Zone: Supplemental Hancock

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Potential Solution

At Hancock station, build a new 138 kV breaker and half configuration with 3 strings. Install 9 new 3000 A/40 kA circuit breakers. Replace the existing 69 kV/27 kA/1800 A CB “N” and “CA”, 1200 A/21 kA CB “M” and 2000 A/31.5 kA CB “Q” with 3000 A/40 kA circuit breakers. Replace the existing 34.5 kV/560 A/12 kA CB “R” and “S”, 1200 A/16.8 kA CB “I” with 1200 A/25 kA circuit breakers. Install new DICM. Replace 138/34 45 MVA Transformer #2 with new 138/69/34.5kV 130MVA. Add new 138/34.5 kV 30 MVA Transformer #3 with high side Circuit Switcher (3000 A, 40 kA). Replace the existing 138 kV 1200 A/61 kA Circuit Switcher “BB” with new 650A, 31.5 kA CS. Replace 138kV Bus #1, 34.5kV Bus #1 and 34.5kVBus #2 CCVT’s. Replace 34.5 kV Circuit Breakers “P” and “J” with new 34.5 kV, 3000 A, 40 kA CB’s. Replace 34.5 kV Capacitor Bank Circuit Switcher “AA” with new 40 kA CS. Install Bus Regulators on 34.5kV Bus #3. Replace remote end line relaying. Estimated Cost: $30.0M

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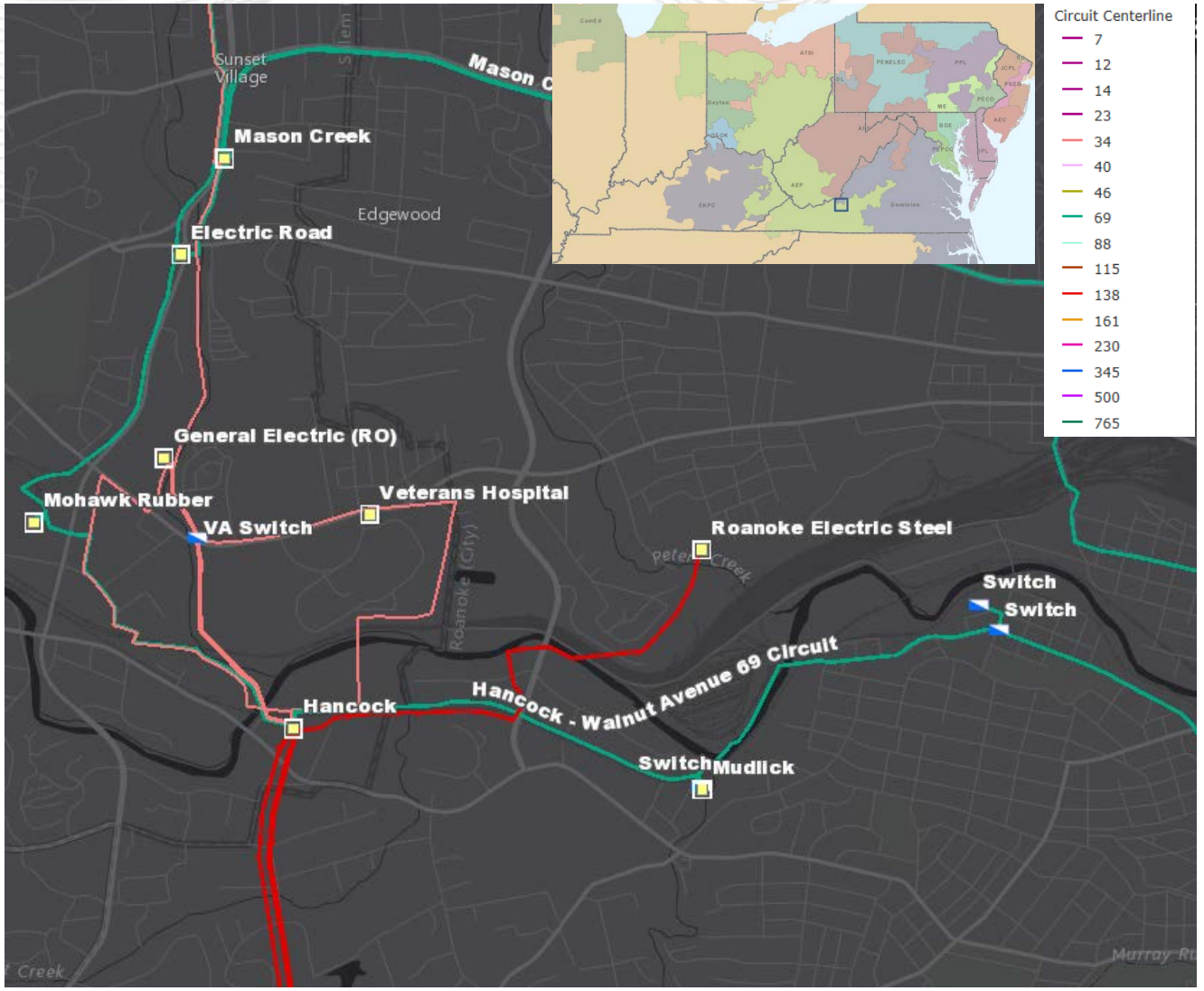

AEP Transmission Zone: Supplemental Hancock

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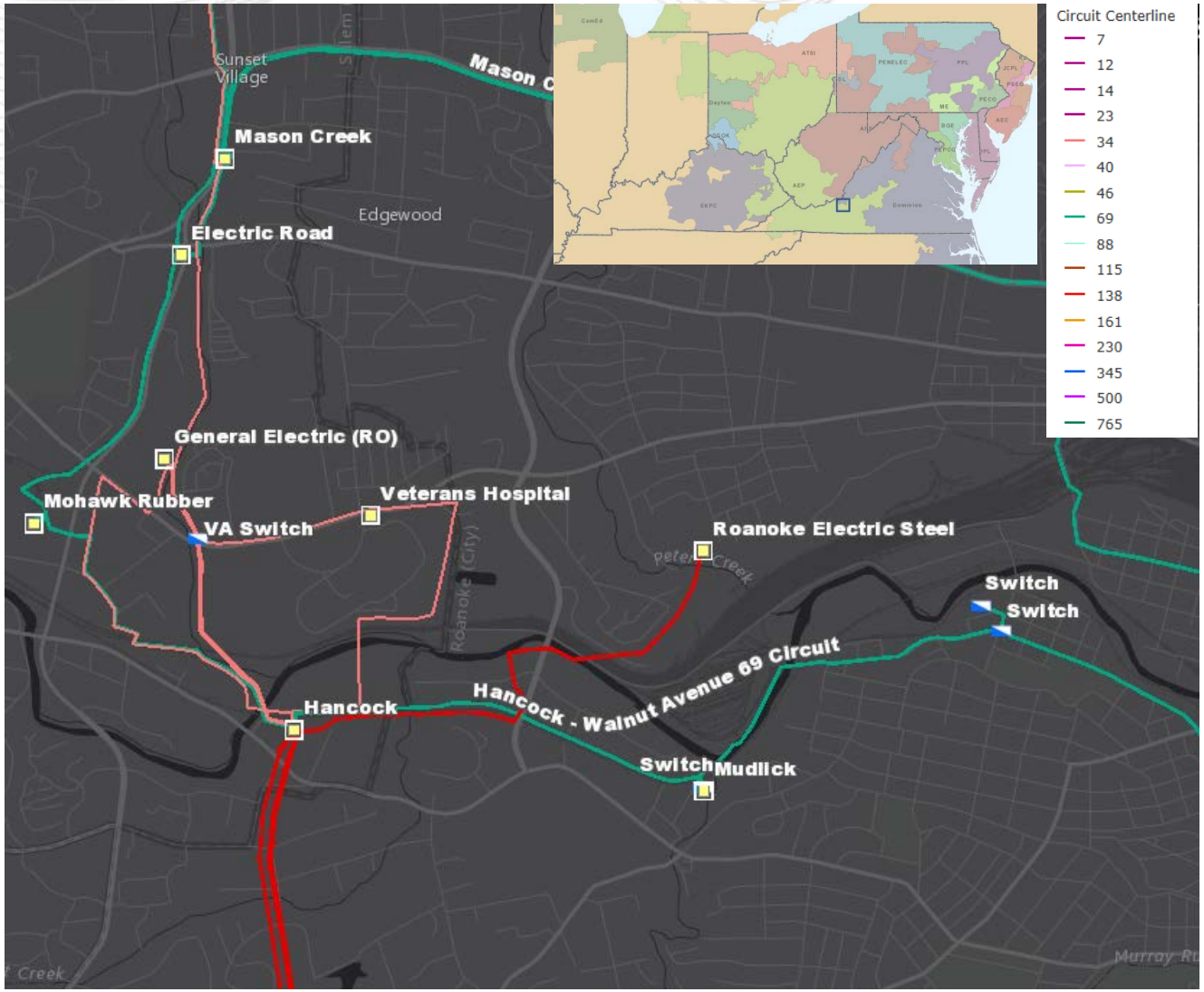
Alternatives:

Use existing 138 kV structures, replace 138 kV circuit breakers in place, add 138 kV breaker on Roanoke Electric Steel line, add a 138 kV bus tie breaker between 138/69/34 transformer #1 and 138/34 kV transformer #2. Replace 138/34 kV transformer #2 with new 138/69/34 kV 130 MVA transformer and install high side circuit switcher. Install 138 kV circuit switcher on 138/69/34 transformer #1. Install a new 138/34 kV 30 MVA transformer and move 34.5 kV distribution load here. Adding the second bus tie breaker was going to require to reinforce the existing 138 kV structures. Long outages on the 138 kV would have necessary to accomplish this. Due to the customers in the area it was going to be difficult to coordinate and get approval for an outage of this magnitude. With the second 138 kV bus tie breaker Hancock Station would have had three 138 kV buses and still open to a loss of all transformers with a breaker failure scenario. The 138 kV breaker and half scheme has proven to be the most reliable configuration and gives flexibility for performing maintenance without affecting customers.

Estimated Cost: $18M

Projected In-service: 12/18/2021

Project Status: Scoping



AEP Transmission Zone: Supplemental Hillsboro-Hutchings Rebuild

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The 36 miles of transmission line sections from Hillsboro to Hutchings Tap were constructed in 1943 using wood pole structures with 477 ACSR conductor (185 MVA rating). There are 1,098 open conditions on this line, including rotten cross-arms, burnt/broken insulators, and loose/broken conductor hardware.

Operational Flexibility and Efficiency

In the event there is a failure of the line between Hillsboro and Hutchings, the driving time can be approximately 1-2 hours from the Chillicothe Service Center to Middleboro Switch. A MOAB will allow for automatic sectionalizing.

Potential Solution

The path between Hillsboro and Hutchings Tap has two 138kV transmission lines in a common corridor. For the first 17 miles west from Hillsboro, AEP owns both lines. This section will be rebuilt as double circuit construction. The 19-mile AEP segment from Middleboro to Hutchings Tap will be constructed as a single circuit line. Beyond Hutchings Tap, DP&L owns the 15 miles of line to Hutchings. That line was built in 1965 and has a higher capacity; as such DP&L is not electing to upgrade their portion of the line at this time. Duke Energy owns the other portions of the Portsmouth-Trenton line. They have plans to rebuild sections of their line for operation at 300 MVA; the AEP line will match that rating using 954 ACSR conductor. Estimated Cost: $113.1M

The 1200 A switch at Middleboro will be upgraded to 2000 A. The new switch will have SCADA control, auto sectionalizing and loop opening/line dropping capability. Estimated Cost: $1.5M

Total Estimated Transmission Cost: $114.6M

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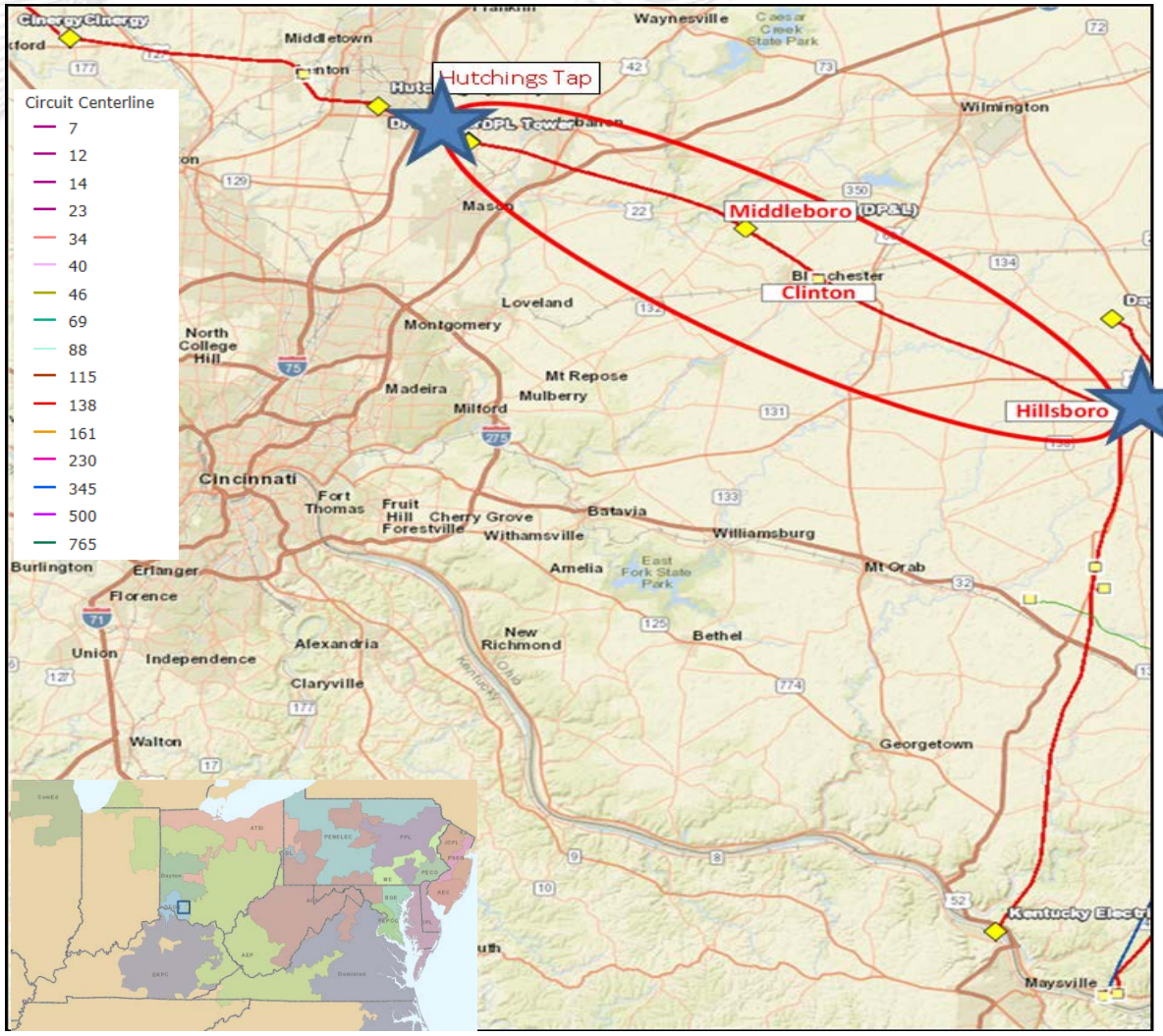

AEP Transmission Zone: Supplemental Hillsboro-Hutchings Rebuild

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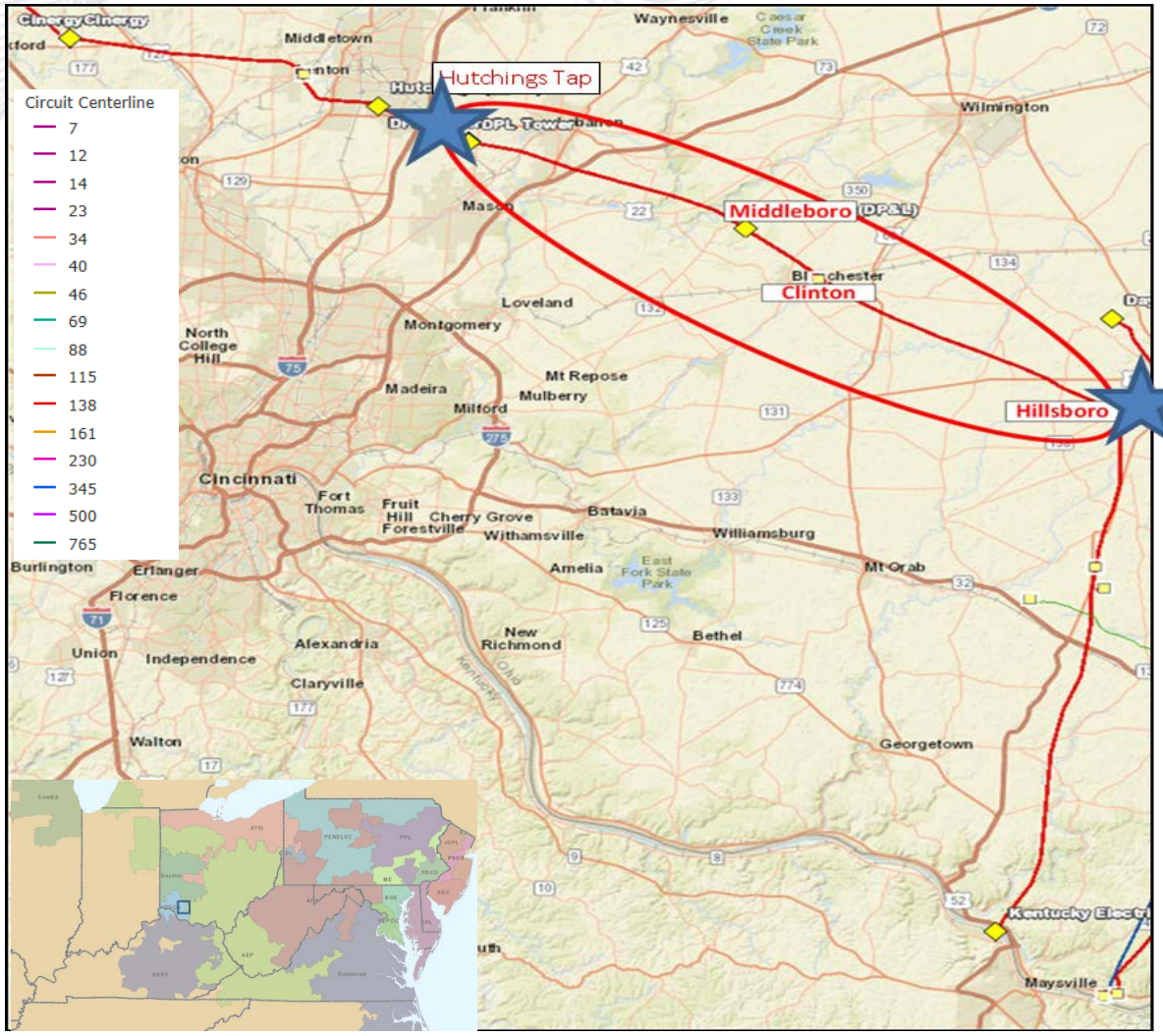
Alternatives:

An alternate design to this project would be to rebuild both lines independently as isolated, single-circuit lines, as they are today. The advantage of this design would be a reduction in outages needed when maintaining the lines. The alternate design would also reduce the risk of losing both lines due to a single structure failure. Estimated Cost: $133M

Another alternative would be to rebuild the entire line as one single circuit, then install a new 138kV three-breaker ring substation near Clinton that would tie the two lines together, connecting Clinton, Middleboro and Hillsboro. The cost savings changing from the double-circuit to single-circuit design for the Hillsboro-Clinton section did not offset the cost of a new substation. The total cost would be slightly higher than the proposed solution and was not preferred. Estimated Cost: $119.3M

Projected In-service: 12/01/2021

Project Status: Scoping



AEP Transmission Zone: Supplemental
IGC Beckley

Problem Statement:

Customer Service:

ICG Beckley request to serve projected 1.5 MW of load on the Bradley – Tams Mtn. 46 kV line. Obligation to serve customer.

Potential Solution

Tap the Bradley-Tams Mountain 46 kV line and install a 69 kV, 1200A 3-way switch. Install low side metering.

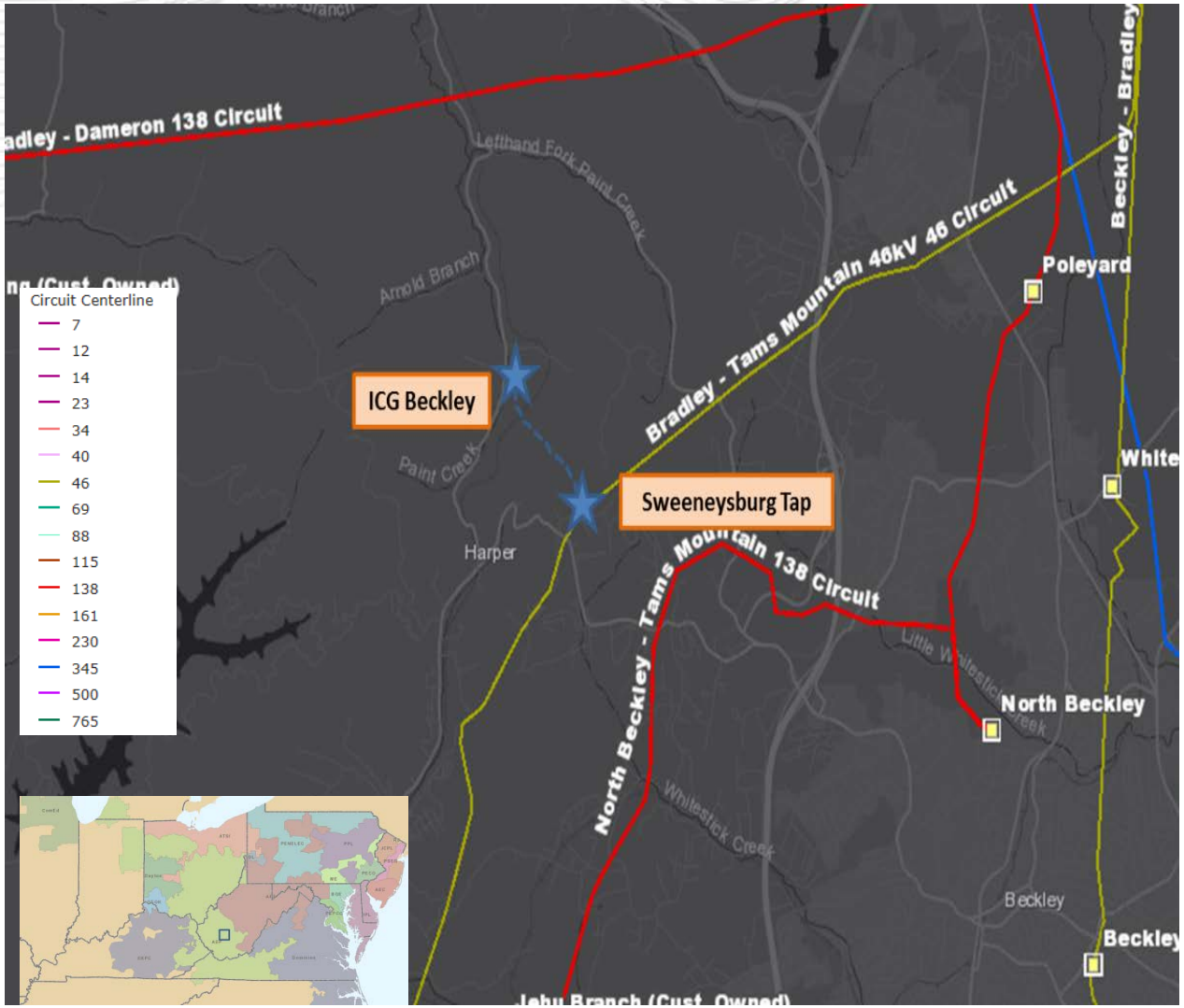
Estimated Transmission Cost: $0.5M

Alternatives:

No viable cost-effective transmission alternative was identified.

Projected In-service: 06/01/2019

Project Status: Scoping



AEP Transmission Zone: Supplemental Johnsons Lane

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The existing 34.5 kV circuit breakers “E”, “F”, and “W” at Johnsons Lane are all FK oil type breakers. Breaker “E” was manufactured in 1955 with breakers “F” and “W” manufactured in 1971. 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. Other drivers include damage to bushings.

Operational Flexibility and Efficiency

Appalachian Power Distribution is currently working on a project to convert the 4 kV distribution out of Johnsons Lane to 34.5 kV. Once complete, the existing 34.5/4 kV transformer at the station will no longer be required and will be retired. After the 34.5/4 kV transformer is retired the 34.5 kV bus tie circuit breaker will be retired and a new 34.5 circuit breaker will be installed on the high side of transformer #1 to separate dissimilar zones of protection.

Potential Solution

Retire the existing 1200 A 17 kA 34.5 kV bus tie circuit breaker “E” at Johnsons Lane. Install a new 3000 A 40 kA 34.5 kV circuit breaker on the high side of transformer #1. Replace the existing 1800 A 27 kA 34.5 kV circuit breakers “F” and “W” at Johnsons Lane with new 3000 A 40 kA 34.5 kV circuit breakers.

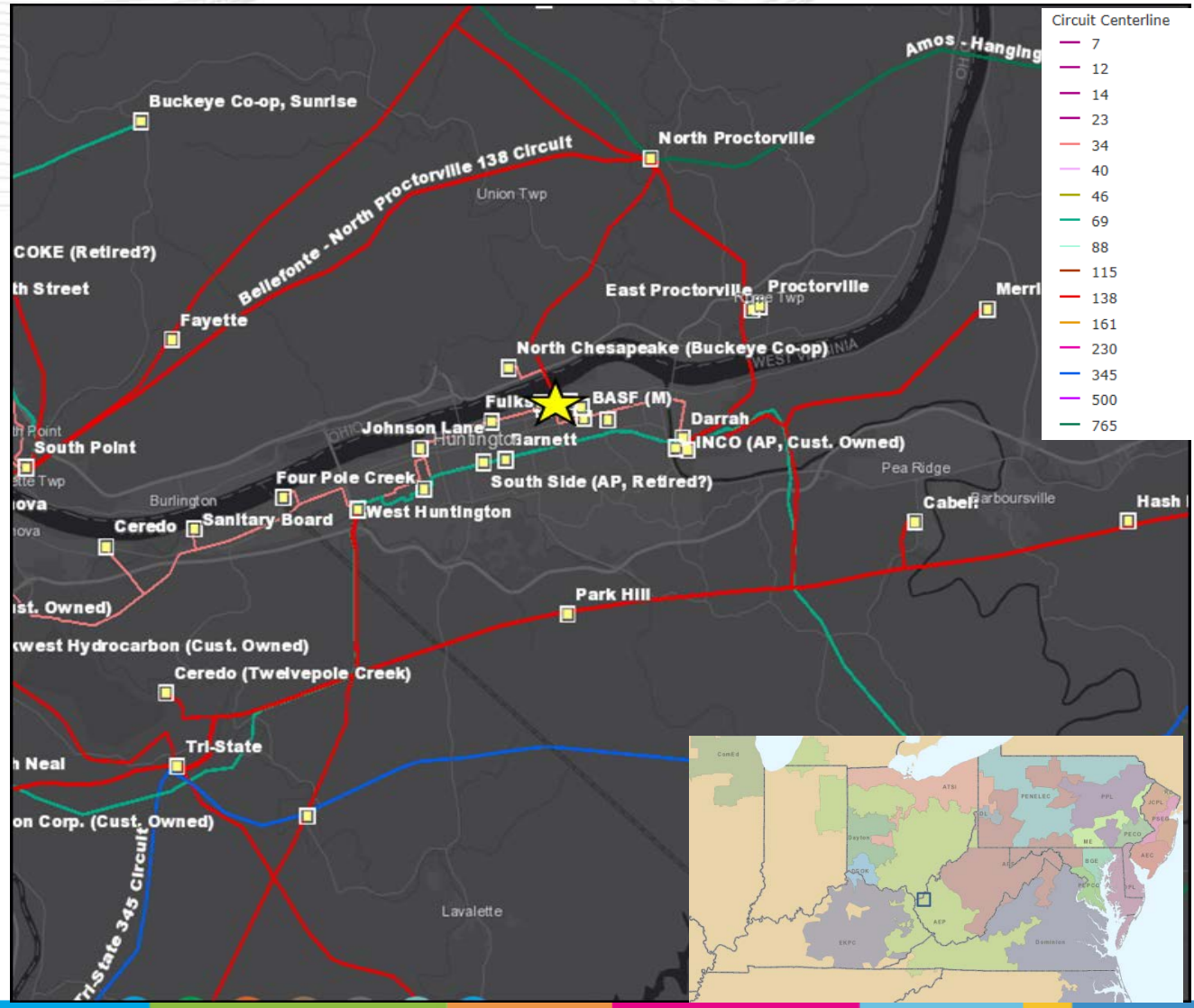
Estimated Transmission Cost: $0M

Alternatives:

No viable cost-effective transmission alternative was identified.

Projected In-service: 12/1/2020

Project Status: Scoping



AEP Transmission Zone: Supplemental Limberlost

Problem Statement:

Customer Service

Distribution customers served by the South Berne – Geneva circuit experience frequent outages. Contributing to the number of interruptions is significant amount of distribution line exposure between the load center and South Berne Station. One large customer, Red Gold, has experienced 447 minutes of interruption in the last 3 years. Due to the current distribution circuit configuration, there are limited recovery options for this circuit. A station outage at South Berne Station results in 7 MVA of unrecoverable load until repairs are made or a mobile substation can be set. Also due to current circuit configuration, load transfers for routine maintenance are limited. Customers served off Berne-Portland 69 kV circuit experience frequent outages due to lack of sectionalizing along the line. In addition to this, the Berne – Portland line currently has 1,000,000+ CMI. In order to reduce the complexity of the protection scheme and to reduce fault exposure, AEP recommends installing a new "Limberlost" station off the Berne-Portland 69 kV circuit. Installing two MOABs at Limberlost would put four MOABs in series on this line. AEP's current practices and standards do not recommend more than three MOABs in series, so adding circuit breaker facing Portland station and a MOAB facing Berne station is recommended in order to resolve reliability issues and decrease the number of MOABs in series. This project is resulting from a request from I&M distribution.

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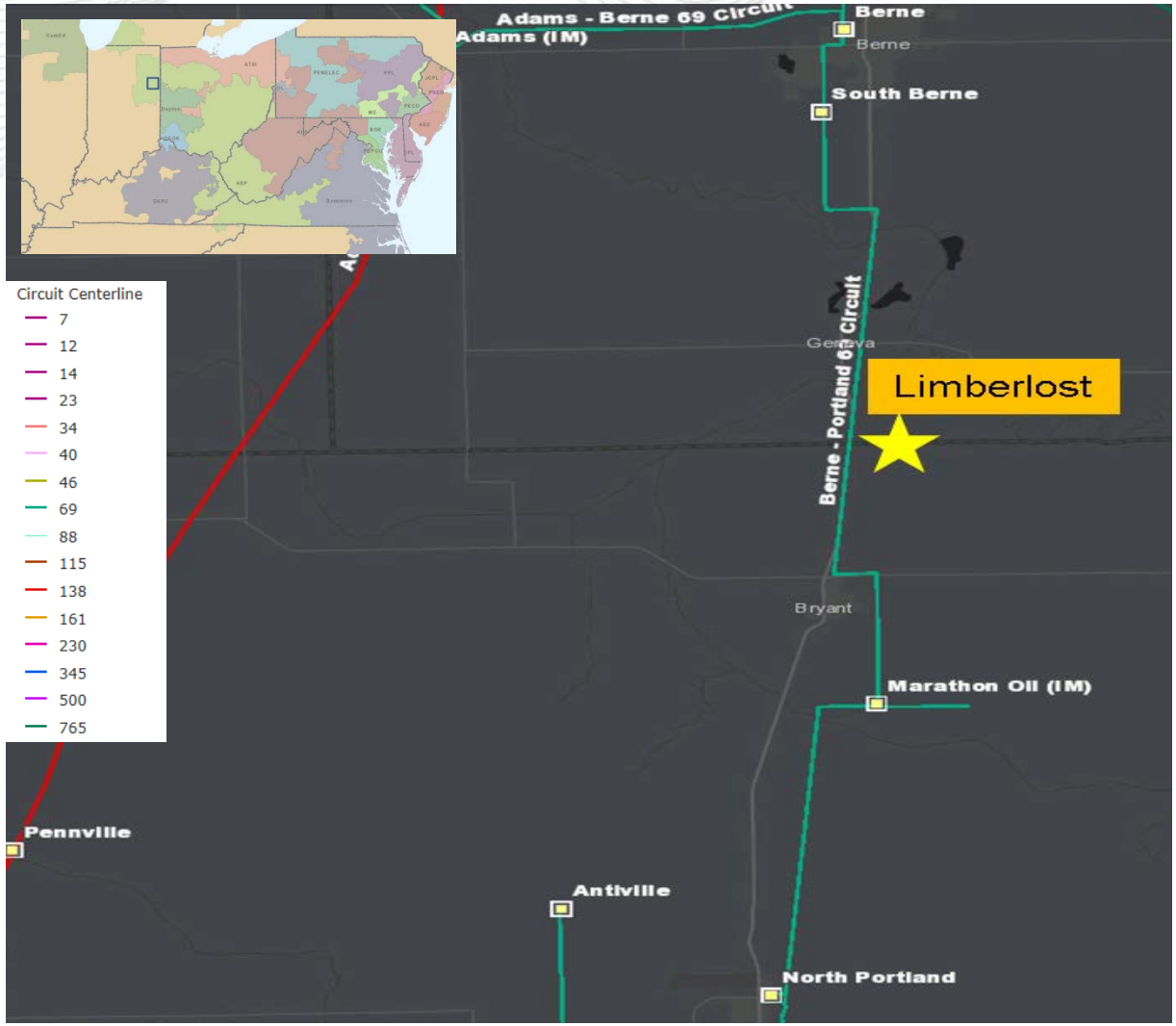

AEP Transmission Zone: Supplemental Limberlost

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Potential Solution

Cut the Berne-Portland 69 kV line into a new substation called Limberlost. Establish new Limberlost station by installing a 69 kV breaker and MOAB along with a 69/12 kV transformer and two 12 kV feeders.

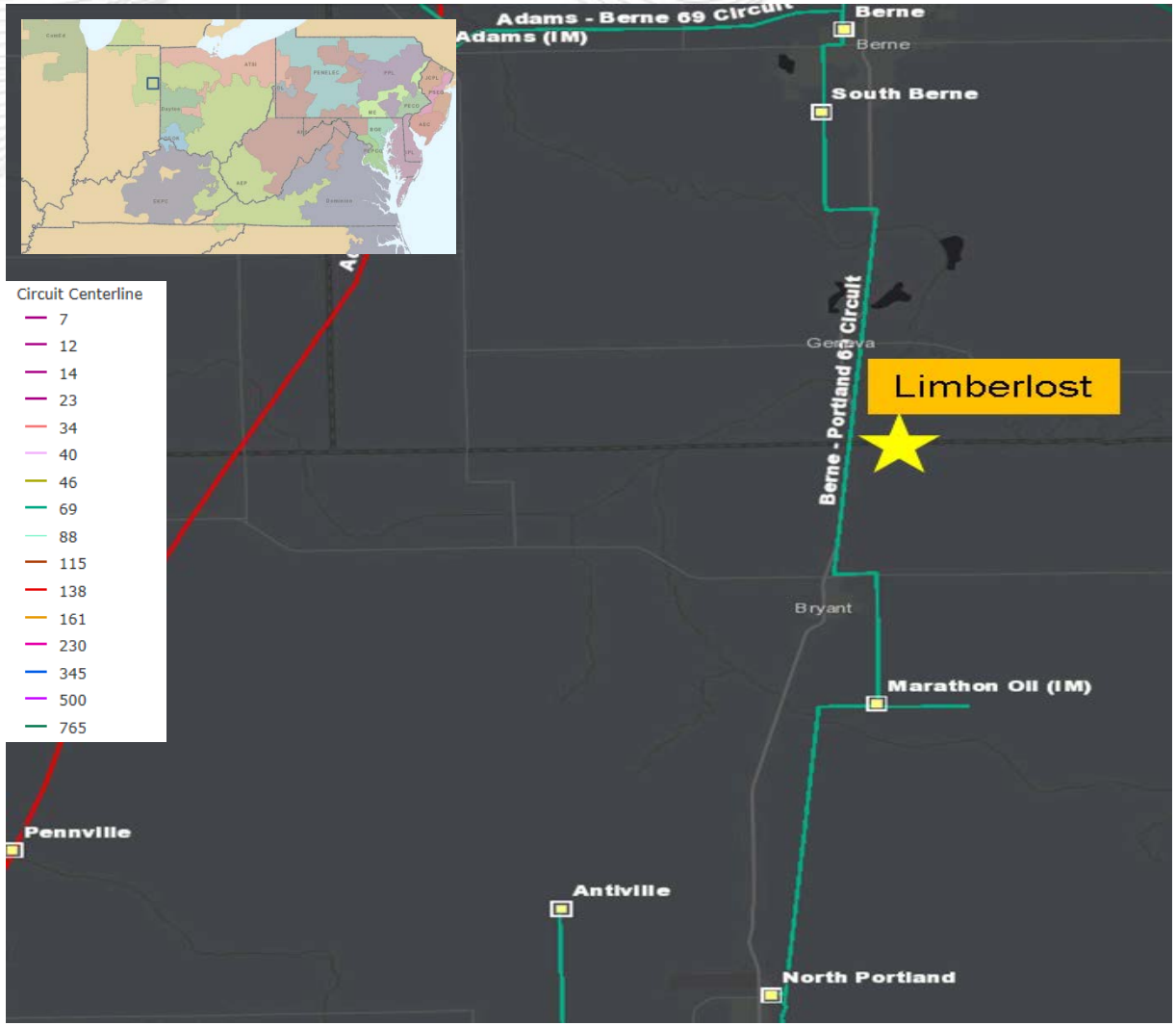
Estimated Cost: $4.0M

Alternatives:

Install breakers at South Berne. This would not effectively reduce the miles of exposure the line would see for a potential fault. This option also does not diversify the distribution load which would result in lower impact of interruptions. Placing the breaker at Limberlost not only separates the mileage and load, but also protects both Limberlost and South Berne from the customer owned REMC tap line. Installation of the distribution transformer and two 12 kV feeders diversifies the customer base among these feeders and increases the operation flexibility in the area. **Estimated Cost:** $2.9M

Projected In-service: 12/1/2018

Project Status: Scoping



AEP Transmission Zone: Supplemental Madison

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The transformer at Madison is a vintage from 1964. The CO/CO2 ratio is above the warning threshold and the interfacial tension is trending downward. This data shows that the units insulation is degrading and should be addressed. Additionally, the unit has experienced serious leaking issues since 2015. Due to the mentioned notices, AEP recommends the replacement of transformer 1. The 1964 vintage 34.5kV circuit breaker's B, C, E, and H at Madison Substation are oil filled FK-breakers without oil containment. Additionally, all of the breakers, are in deteriorating condition and breakers B and C have fault operations beyond the manufacturers recommended limit. AEP recommends the replacement of all circuit breakers mentioned due to the stated conditions. Breakers B and C have 17 and 11 fault operations respectively. Currently the foundations of the 34.5kV yard are severely deteriorated and need to be addressed.

Potential Solution

Replace Breaker 'B', 'H' and 'C' with new 34.5kV 25kA 1200A models. Remove Breaker 'E'. Replace the 138/34.5kV transformer with a new 138/34.5kV 75MVA model with a high side switcher. Remove bus 1 and reroute all lines to the rebuilt bus 2.

Estimated Cost: $5.7M

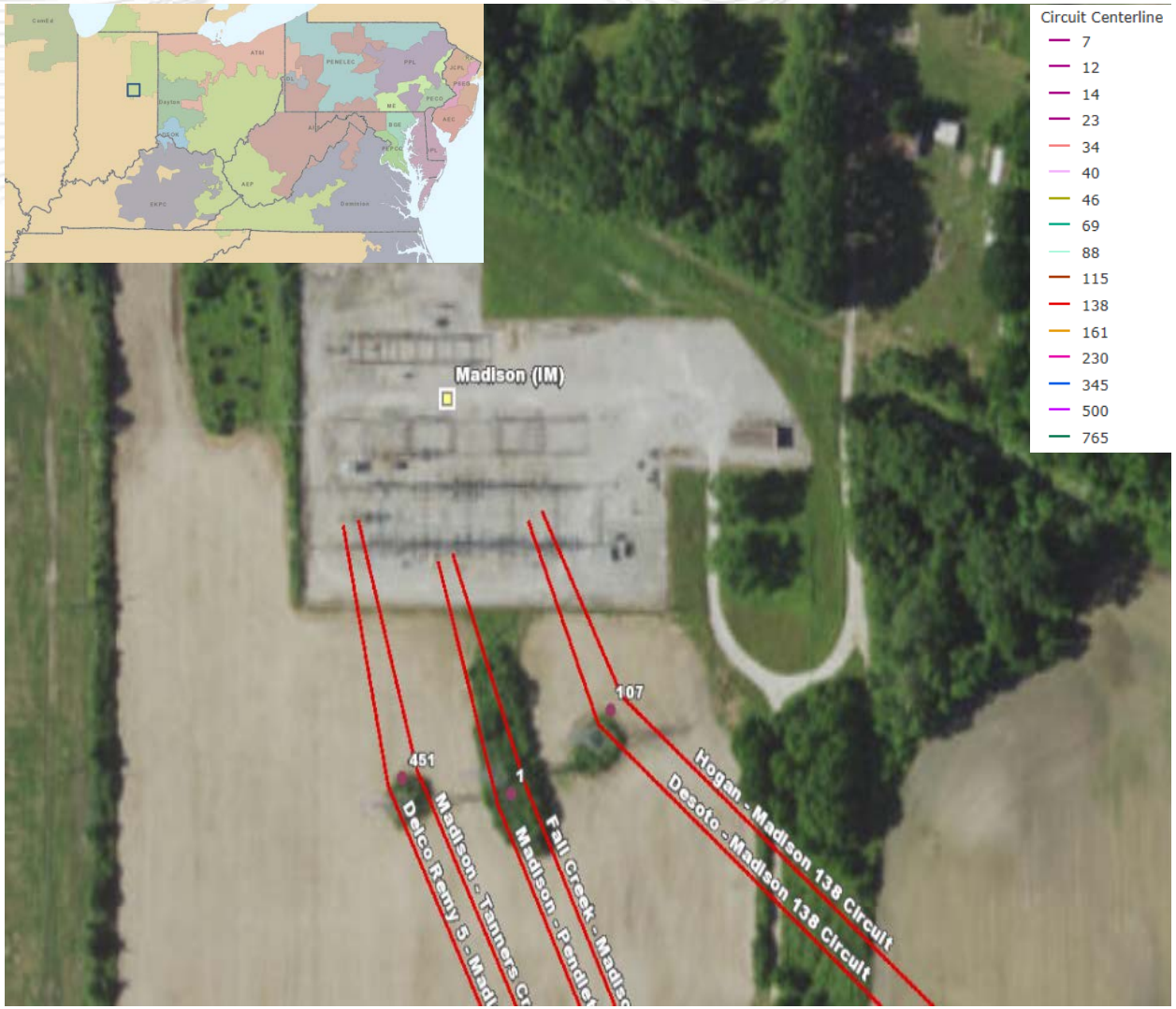
Alternatives:

Replace the 34.5kV equipment with 69kV rated equipment.

The end goal is for this station to be exclusively feeding the IMPA system. IMPA has shown no interest in upgrading their system voltage and so building for future voltage conversion isn't prudent nor recommended.

Projected In-service: 12/30/2019

Project Status: Scoping



AEP Transmission Zone: Supplemental Oneida-Pekin

Problem Statement:

Equipment Material/Condition/Performance/Risk:

This project is an extension of the adjacent Malvern-Oneida 69kV rebuild, which resolves thermal overloads (PJM Baseline #B2796). This Supplemental project will rebuild the remaining 3.5 miles of the circuit to Pekin, as well as replace the aging Pekin circuit breaker. After the associated Baseline line rebuild (B2796), this 3.5 mile section is loaded to 94% SE for the worst N-1-1 contingency pair (51 MVA loading/54 MVA rating, leaving only 3 MVA of margin for future area load growth). This area has had large block load additions from industrial customers, 3 MVA is not enough margin for long-term planning.

The T-Line was built in the early 1960's on wood poles that are in poor condition; it utilizes 4/0 copper conductor (54 MVA rating) and 11/32" copperweld shield wire, both of which are no longer stocked in storerooms, making it difficult to perform field repairs & public relocations, potentially leading to higher O&M costs and outage restoration times. Note that the actual copper conductor dates to 1922 and has become brittle (assuming it was re-used through the decades). The T-Line section has the following open condition count: A2- 10 (broken braces, ground-leads, insulators; burned insulators); A3- 1 (broken ground-lead); B- 1 (leaning pole); Forestry concerns- 7; for a total count of 19 concerns. A stretch of 21 structures are built in the style of having 3 crossarms with conductor & insulators only on one side, where the unequal weighting and style of the knee braces has lead to numerous maintenance calls in recent years.

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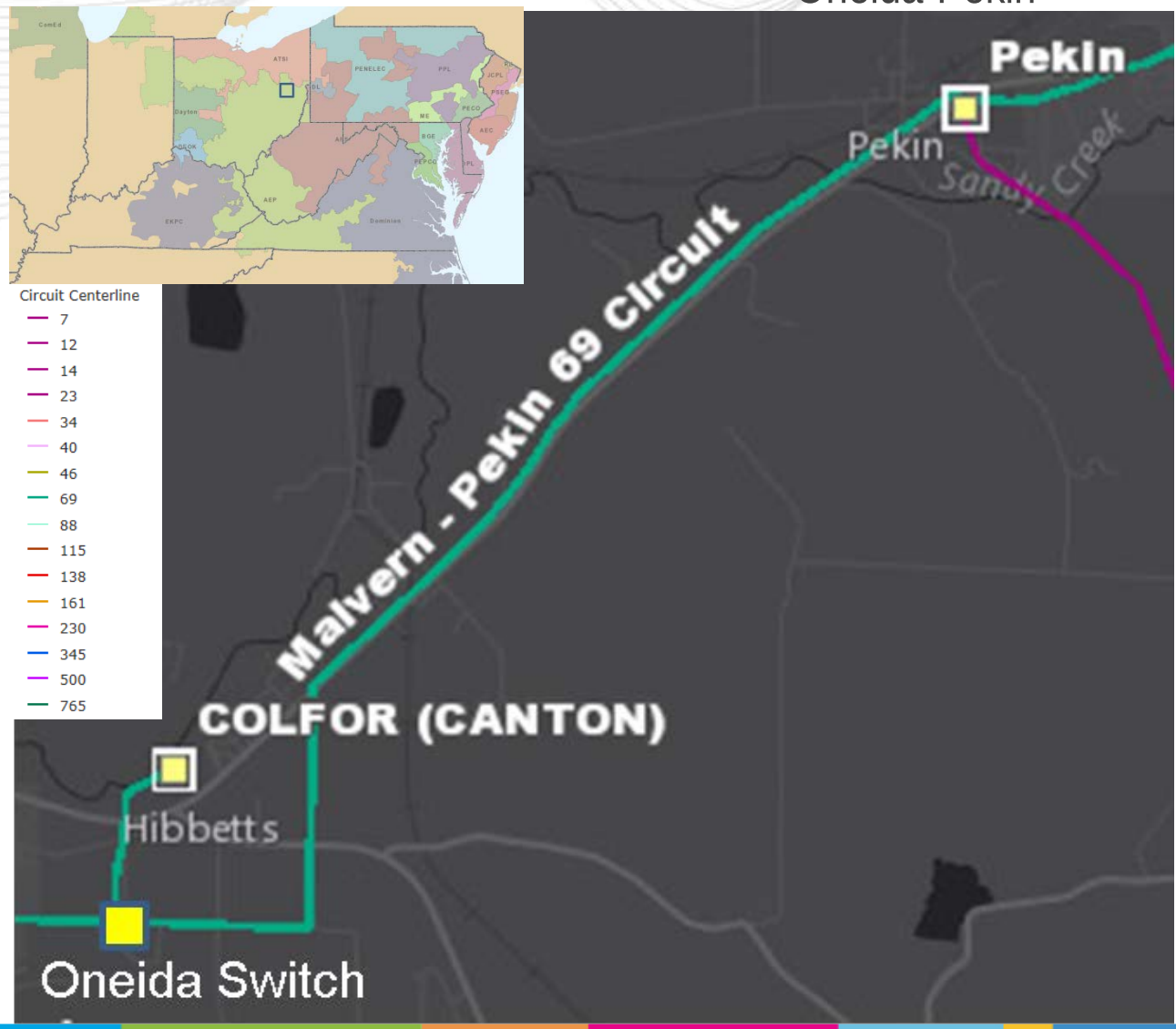

AEP Transmission Zone: Supplemental Oneida-Pekin

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In the 2013-2017 timeframe, the Malvern-Pekin 69KV circuit has experienced 9 momentary outages and 7 sustained outages, with an average outage duration of 7.1 hours. The circuit currently serves 3- Buckeye Power co-op stations and one large industrial company. The outages have been due to vegetation fall-in, storms, animal contact, and broken cross-arms.

Circuit breaker 'A', at Pekin, is an 'FK' oil breaker that is 52 years old; it is recommended for replacement due to age, lack of spare parts, and number of fault operations: 111 fault operations in its lifetime, versus a manufacturer recommendation of 10.

The associated controls and relays will need upgraded to coordinate with AEP's fiber-based protection scheme.

Potential Solution

Rebuild 69kV transmission line from Oneida Switch to Pekin (3.5 miles) with 795 ACSR (125 MVA rating). Update & modify right-of-way to accommodate the rebuild. Remove the old T-Line. Estimated Cost: $5.4M

At Pekin station, replace 69kV oil breaker 'A' with an SF6 gas breaker (40kA unit). Upgrade relays for circuit protection to June Road. Replace 69kV disconnect switch (line side of breaker A). Upgrade breaker risers to exceed ampacity of new T-Line. Estimated Cost: $0.5M

Total Estimated Transmission Cost: $5.9M

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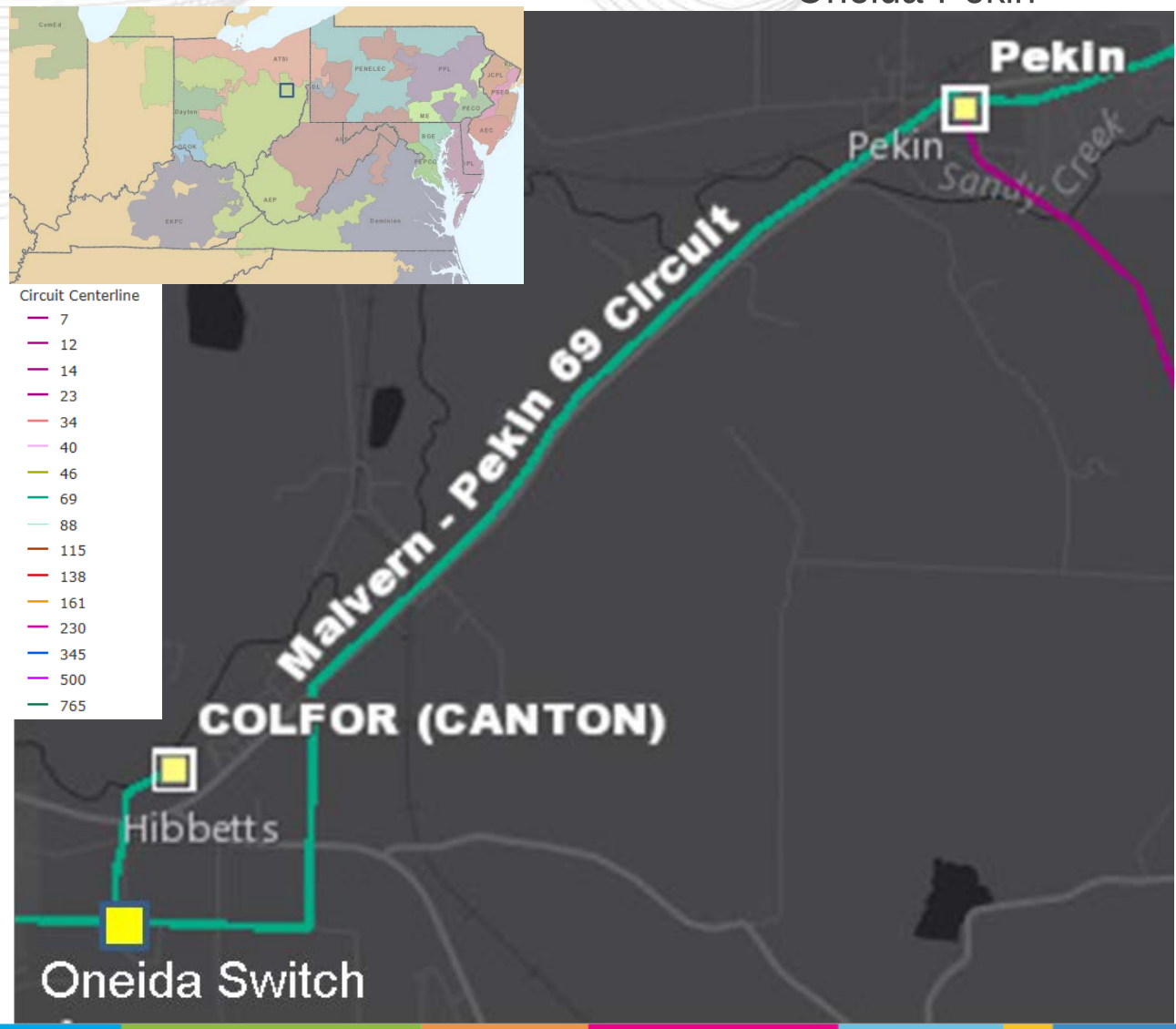

AEP Transmission Zone: Supplemental Oneida-Pekin

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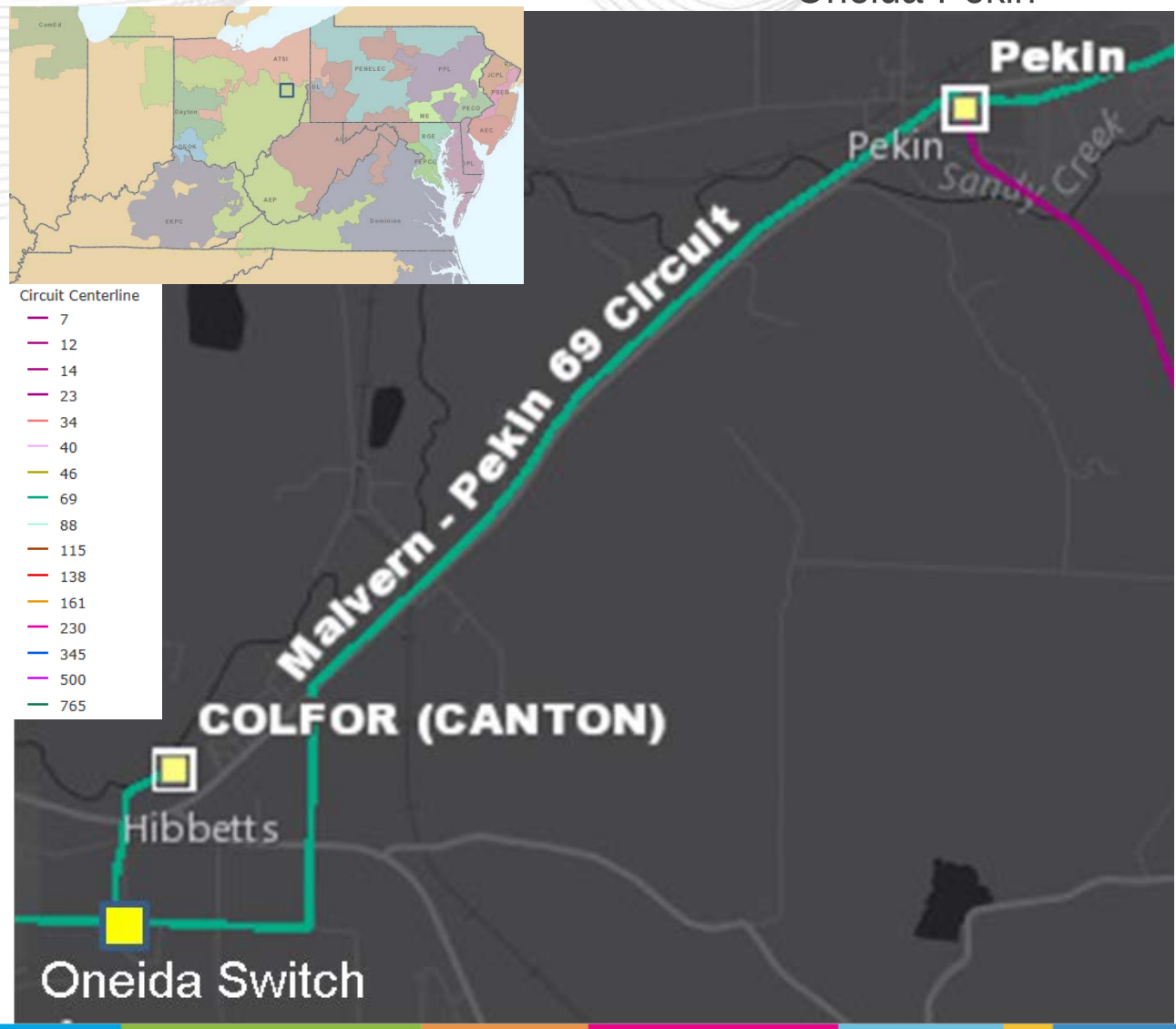
Alternatives:

Rather than do the Baseline & Supplemental 69kV line rebuild of June Road-Pekin, construct a new 138-69kV source substation near Augusta or Summitville (where FE ATSI's 138kV lines cross our 69kV). However, this is much more expensive (~$10-12 million for both utilities), and did little to reduce the overloads on June Road-Pekin 69kV; nor did the alternative option address the aging infrastructure on this T-Line (copper conductor and rotting poles).

Projected In-service: 12/1/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental Provident Switch

Problem Statement:

Customer Service:

This project will directly improve system reliability for AMP wholesale customer (St. Clairsville), by eliminating hard tap configuration. Also improves area reliability for AEP Ohio distribution customers (served via the following stations on the 3-terminal line: Highland Terrace, St. Clairsville, Pleasant Grove, Bannock Road, Flushing) and South Central Co-op customers (at Shepherdstown), all of which could otherwise be affected by the Glencoe-Bannock-Robyville 69kV 3-terminal line misoperations.

Operational Flexibility and Efficiency:

The new station eliminates a 28-mile 3-terminal line which is inherently unreliable (Glencoe-Bannock-Robyville 69kV). It aligns the area's 69kV circuit protection (Glencoe-Robyville + Flushing-Smyrna 69kV), which will all be fiber-based, as a result of other projects in the works. Also, today there are 4- MOAB auto-sectionalizing switches in series on this circuit, which is no longer permitted protection-wise, due to the likelihood of miscoordination. Installing breakers will split the circuit, to have 2 MOAB's on each branch.

In addition, 400 feet from the existing Provident Switch pole, St. Clairsville Municipal's Hess station is connected via a 'hard tap' (lacks proper line sectionalizing switches). This causes St Clairsville to take an outage whenever T-Line maintenance work must be done nearby, and also has a negative impact on transmission system sectionalizing and outage restoration.

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AEP Transmission Zone: Supplemental Provident Switch

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In the past 5 years, the Glencoe-Robyville 69kV 2-terminal circuit has experienced 20 momentary outages and 7 sustained outage events (with an average duration for customers of 19.1 hours). A significant number of the outages have been due to protection misoperation and station equipment issues, which will only worsen once the circuit becomes a 3-terminal circuit in 2021 (by connecting the radial circuits via the Flushing-Smyrna project). Installing this new ring bus station will greatly improve operational flexibility and reduce the frequency and duration of transmission outage events.

The protective relays and controls at Bannock station cannot be adequately upgraded to match the remote-ends at Provident and Flushing (which will utilize fiber-based microprocessor relays). There is no control house, and the site is not suitable for a new control house. 69kV MOAB switches are reasonable in this case to provide adequate reliability for the distribution station. Today the basic overcurrent protection is adequate on the radial line to Flushing, but once Flushing is networked to Smyrna, the protection is not adequate (not capable of 2-way protection).

Potential Solution

Re-route Glencoe-Robyville-Flushing 69kV circuit to connect to new Provident Switch station. Estimated Cost: $0.5M

Construct a new 4-breaker 69kV ring bus station called Provident; provide service to St Clairsville Muni's Hess station. Update relay settings at remote-ends. Retire 69kV breaker at Bannock station. Install 2- 69kV MOAB switches with auto-sectionalizing. Install new revenue metering at Hess station. Coordinate protection with Provident Station. Estimated Cost: $3.1M

Total Estimated Transmission Cost: $3.6M

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AEP Transmission Zone: Supplemental Provident Switch

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Alternatives:

Leave the system as is, with a new 3-terminal 69kV circuit between Glencoe-Flushing-Robyville 69kV (line exposure of roughly 28 miles on a 3-terminal line). In addition the Bannock 69kV breaker & protection would need removed, due to not having space to upgrade the protection equipment. This would be a net reliability decrease for the area's customers, by creating a larger area of customers that would be affected by a system fault. As we seek to improve the customer experience and reliability, this is not a recommended course of action. It would also leave 4- MOAB switches in series, which is difficult to properly protect. Estimated Cost: $0.8M (for modifications to Bannock, and upgrading P&C at remote terminals)

Build a new 138-69kV station 1.5 miles west of Provident, by interconnecting to FirstEnergy's 138kV circuits between Holloway and Nottingham stations. This would upgrade the western side between this new station and Flushing, but would still leave a 3-terminal line to the east, toward Glencoe/Provident/Robyville. Furthermore, this expensive of an alternative is not warranted at this time, since another source to the 69kV system is not needed. It would still leave 4- MOAB switches in series, which is difficult to properly protect. Estimated Cost: $20 million (new 138-69kV station, including transformer, interconnection costs with FirstEnergy, etc.)

Projected In-service: 12/1/2021

Project Status: Scoping

AEP Transmission Zone: Supplemental Reaver

Problem Statement:

Customer Service:

AEP-Ohio's transformer loads at Briggsdale are at 93% capacity with no physical space for expansion. A relatively large load increase is anticipated in the area in the near term. Area distribution circuits are loaded so that adequate relief with adequate backup redundancy is not available. As a result, AEP-Ohio has requested a new 138kV delivery point, named Reaver, that is expandable to serve up to 4-50 MVA transformers worth of distribution load.

Operational Flexibility and Efficiency:

The only two delivery points currently served from the Wilson-McComb 40kV system are Briggsdale and Phillipi. Briggsdale is the AEP-Ohio distribution station and Phillipi is a customer owned station that has been designed for easy conversion to 138kV in the future. Working with AEP-Ohio and the customer at Phillipi, an area plan has been developed to convert these loads to 138kV and retire all of the local 40kV system. The next step in this plan is to transfer the Briggsdale load to a new 138kV sourced distribution station named Reaver. This will allow one of the two 40kV circuits to be de-energized. The elimination of Briggsdale station is necessary to properly plan for the rehab needs at Wilson station, the remaining 40kV to 138kV conversion of Phillipi station, and an increase in available distribution capacity at McComb due to freeing up the currently reserved transmission capacity on the existing transformers.

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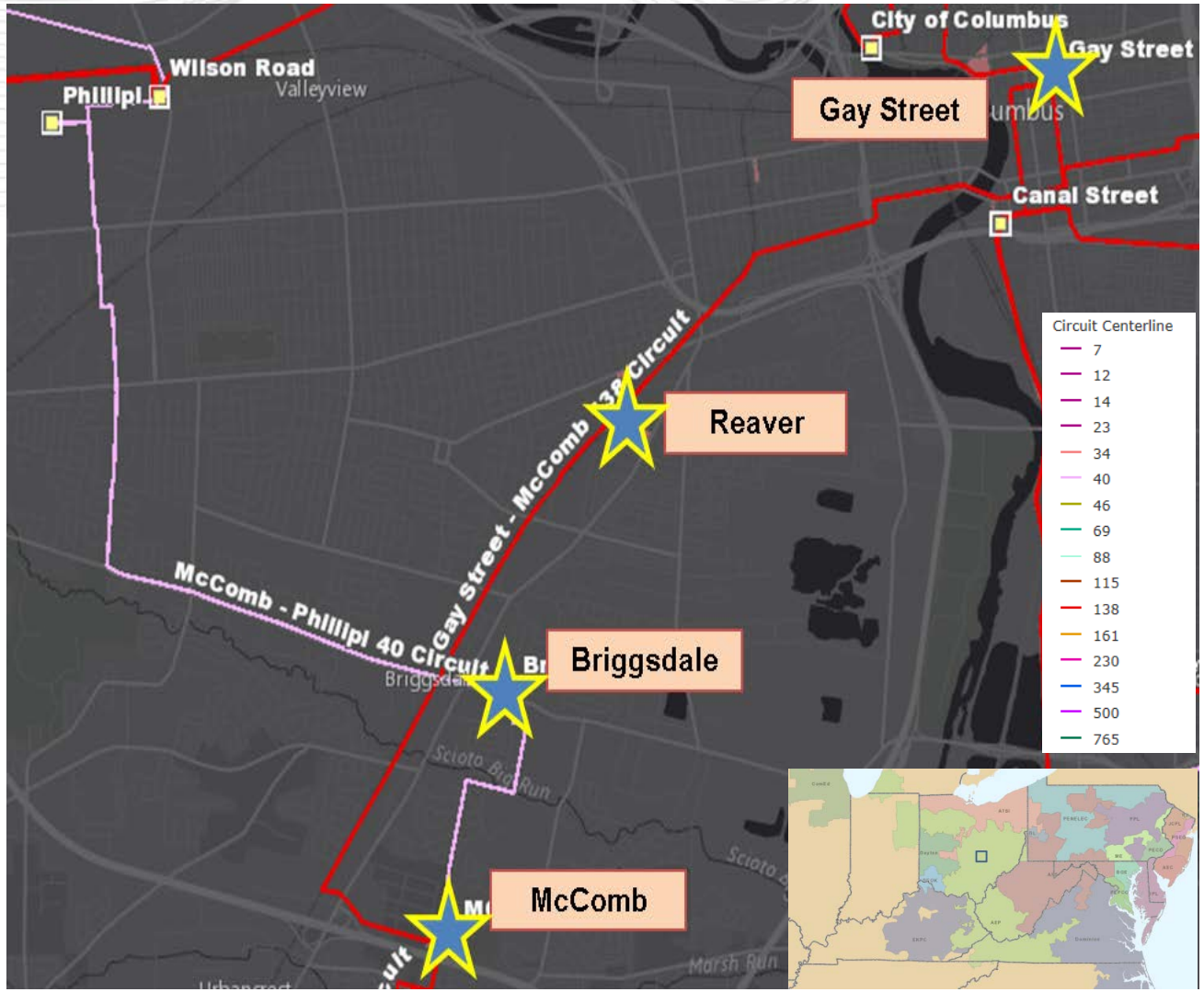

AEP Transmission Zone: Supplemental Reaver

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Equipment Material/Condition/Performance/Risk:

The majority of equipment at Wilson station is in need of rehab driven replacement. The 40kV system between Wilson and McComb is antiquated, obsolete, and in poor condition. Significant portions of this system are in the process of being converted to 69kV with the final solution to completely eliminate the 40kV system.

138kV CB's 101E & 101C are both oil type and approx. 50 years old, and both have exceeded the recommended number fault operations.

Potential Solution

Construct a new 138/13kV station (Reaver) with 2-3,000A 40kA 138 kV CB's. Estimated Cost: $2.4M

Retire and remove Briggsdale station. Estimated Cost: $0.2M

At McComb station, replace 2-138kV 1600A 40kA CB's 101C & 101E and disconnect switches with 3,000A 40kA CB's. Estimated Cost: $1.3M

Cut Reaver station into existing Gay Street-McComb 138kV circuit with very short construction of 636 ACSR 26/7 Grosbeak conductor (223 MVA rating). Estimated Cost: $0.7M

Total Estimated Transmission Cost: $4.6M

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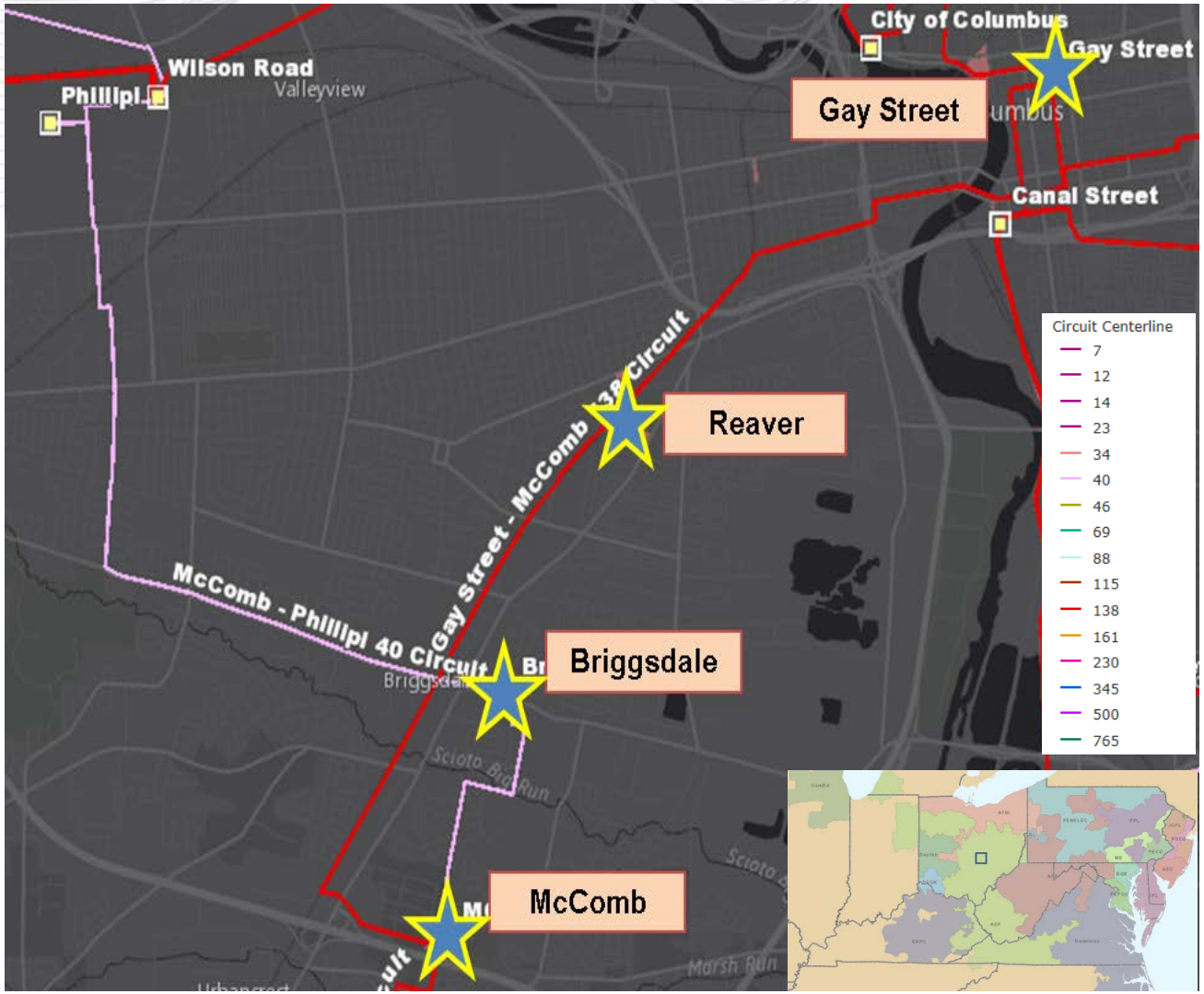

AEP Transmission Zone: Supplemental Reaver

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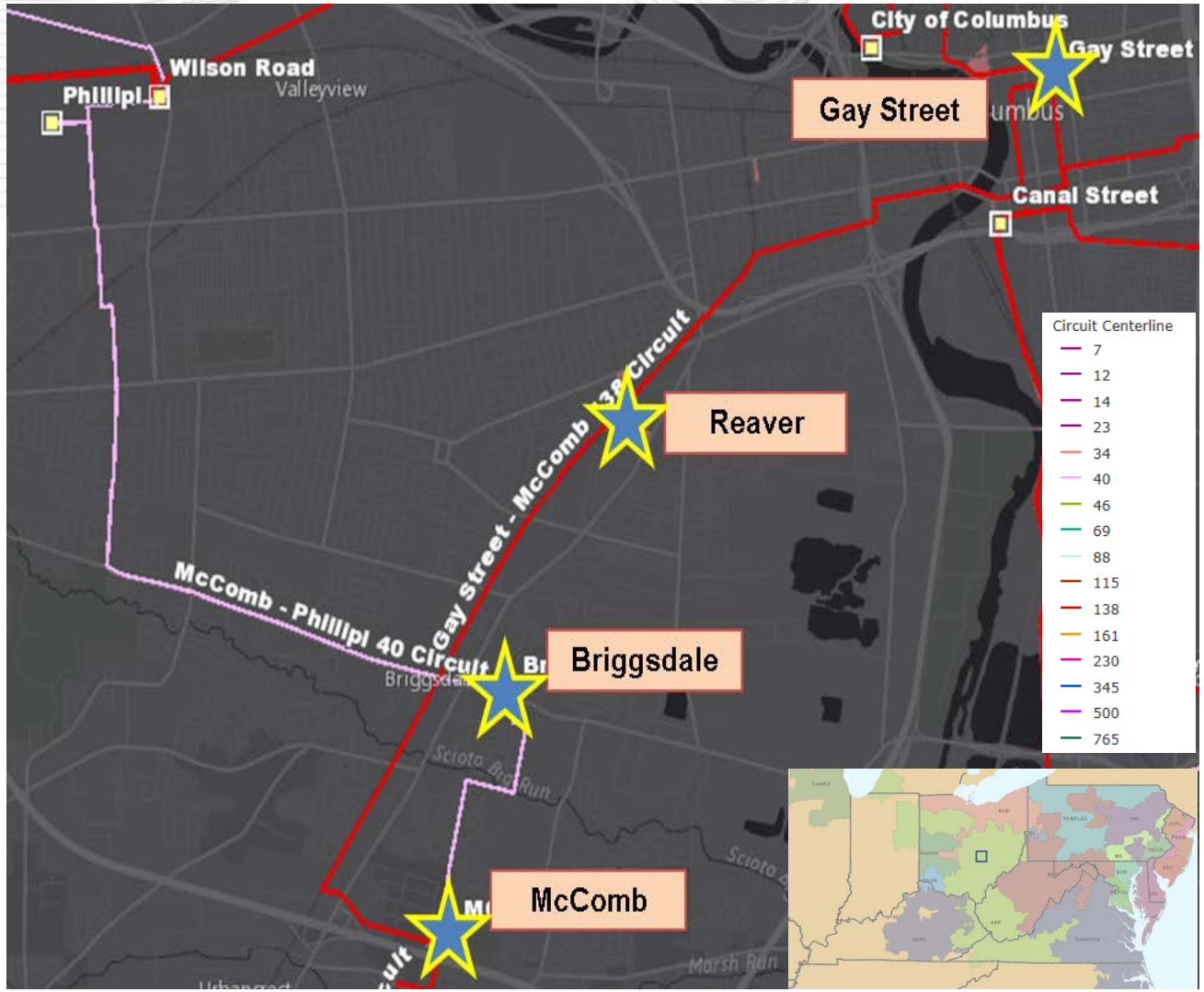
Alternatives:

- Other sites were briefly investigated to replace Briggsdale besides the chosen Reaver station site. AEP purchased the Reaver station site in the 1970's for the express purpose of building a future 138/13kV station and the site has been deemed acceptable for this purpose.
- Briggsdale station is served from both Wilson and McComb at 40kV through a 40kV line in poor condition.
- Wilson station has extensive rehab replacement needs. Eliminating the 40kV before undertaking these upgrades will significantly ease the operational, design, cost, and space constraints of making these replacements on future projects.
- AEP-Ohio distribution currently shares transformation with AEP transmission via the tertiary transformer windings at Wilson and McComb stations. This arrangements limits the availability of capacity for both parties. By eliminating the 40kV system, all 13kV transformation capacity will be fully available to AEP-Ohio since AEP Transmission will no longer have a need for the transformers. This will further free up the ability of AEP-Ohio to replace the existing transformers as rehab or capacity needs may require. AEP Transmission will, in turn, eliminate the need to maintain and plan for the obsolete 40kV system.
- The Wilson-McComb 40kV system is targeted for elimination due to condition, obsolete equipment and antiquated technology, unavailability of spare/replacement parts, and a lack of operational flexibility as it is entirely surrounded by 138kV facilities.



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AEP Transmission Zone: Supplemental Reaver

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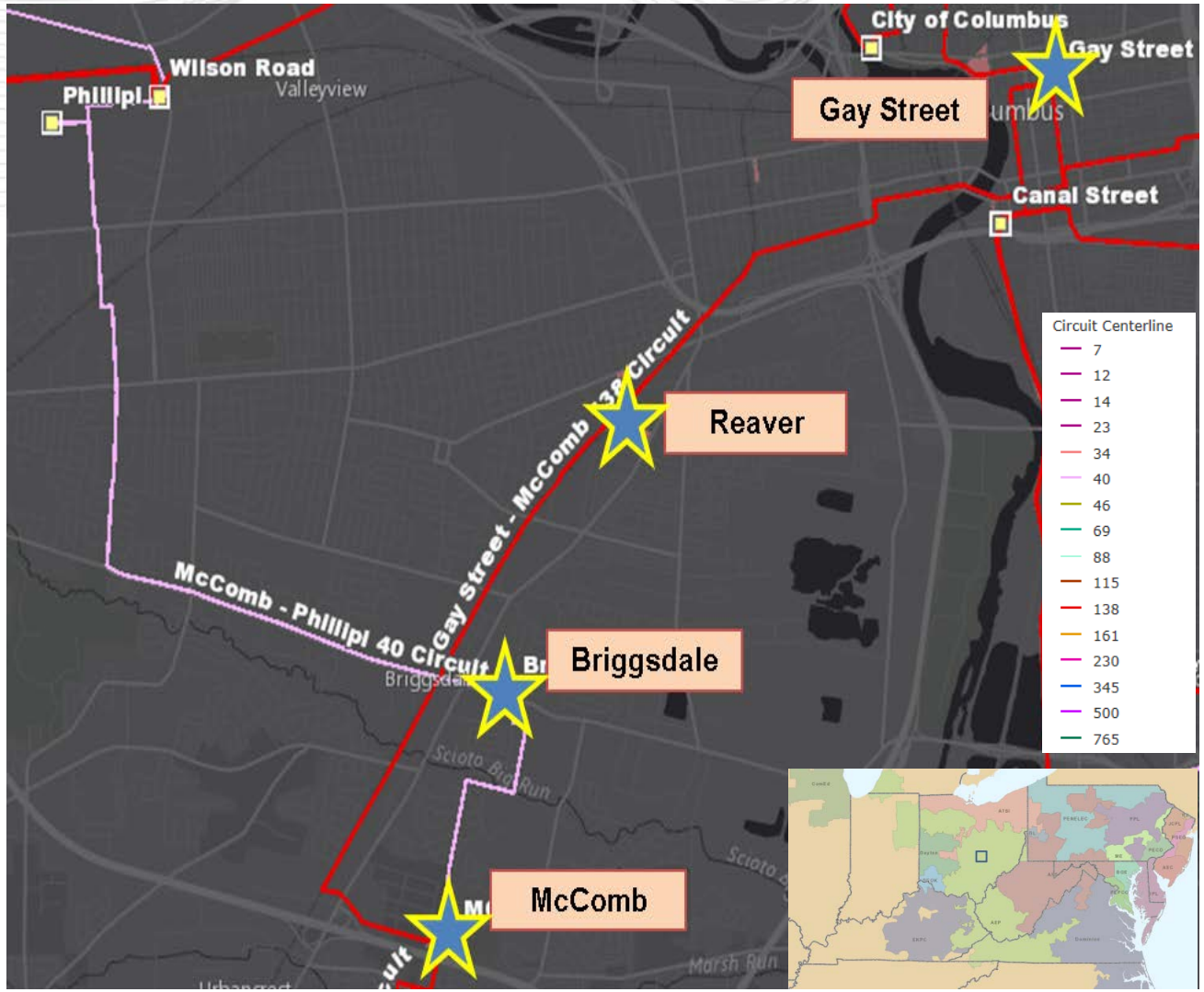
- AEP-Ohio continues to experience growth in the Briggsdale area with only minimal margin and no station expansion prospects. Conversion to 138kV on the existing site is not feasible due to space limitations.
- The McComb-Briggsdale 40kV line has experienced ROW encroachments over the years that will be very difficult to mitigate and continue to serve the existing Briggsdale footprint. Upgrade to 138kV on certain parts of the route would be exceedingly difficult.
- Phillipi is the only other customer served from this local 40kV system and is already designed to easily transition to 138kV on a future project. All other facilities served from the local 40kV system (far removed to the west) are in the process of being converted to 69kV.
- Based on the above discussion, there is no feasible alternative

Projected In-service: 12/1/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental Reusens

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Reusens Station: The 138 kV CB “AB” is a PK air blast breaker, which currently require hearing protection be used for personnel within the substation. PK air blast breakers have a tendency to fail catastrophically, which, cause sharp pieces of porcelain from their bushings are typically expelled causing potential safety hazard to field personnel. In addition, the ability to get spare parts for these breakers is becoming increasingly difficult. The Manufacturers recommended number of fault operations is 10. CB “AB” has experienced 118 operations. 69 kV circuit breaker “AA”, “BB” & “CC” are 1962 vintage oil type breakers without oil containment. 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. CB “AA” has experienced 60 operations, “BB” has experienced 103 operations, and “CC” has experienced 51 operations.

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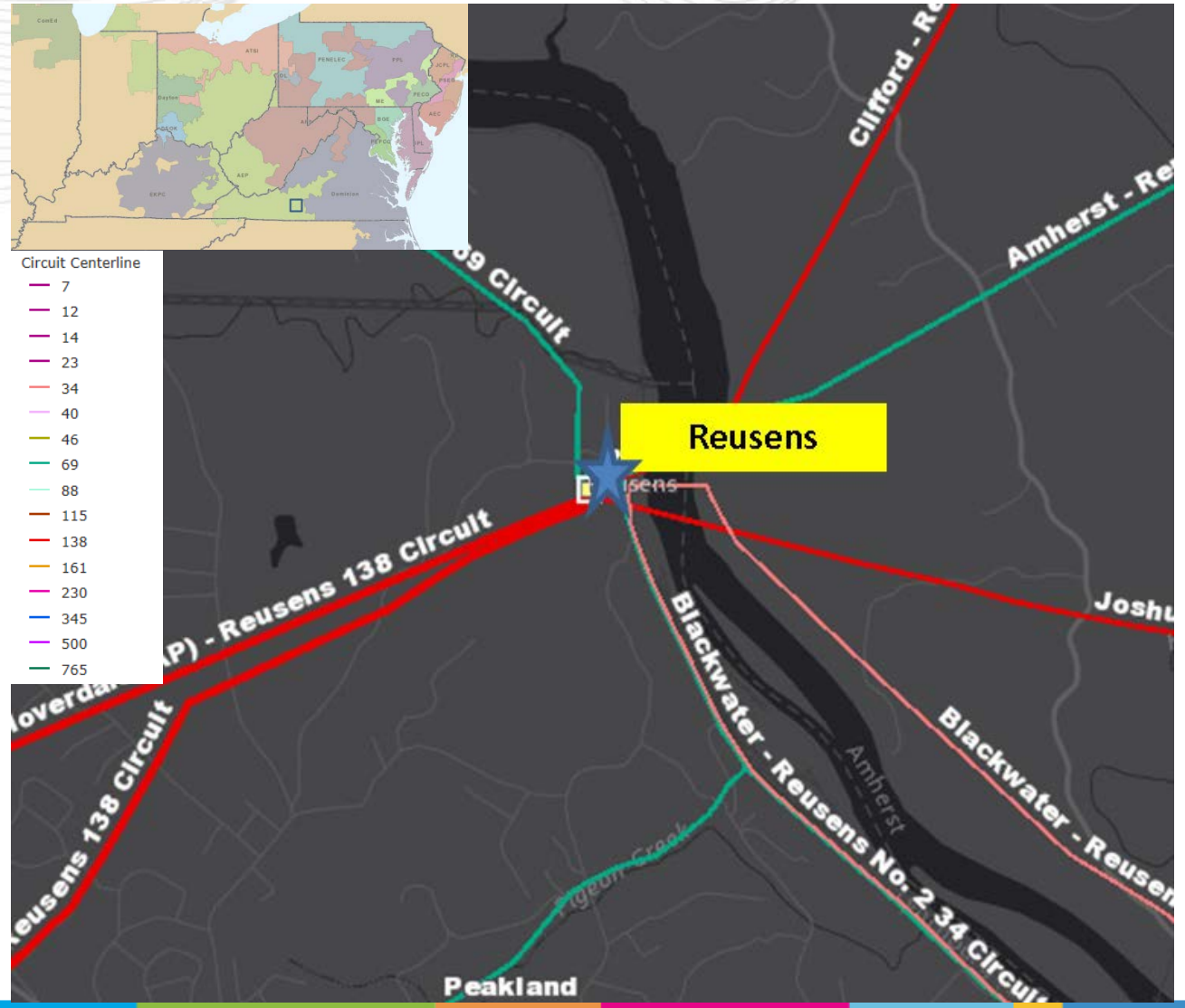

AEP Transmission Zone: Supplemental Reusens

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138 kV 3000 A 50 kA CB “D” is a vintage 1980 GA gas mechanical two pressure air blast breaker no longer supported by the manufacturer. These breakers require extensive maintenance to keep them from leaking air. Due to their excessive leaks, we had a program some years back to maintain/rebuild all GA breakers. The rebuild required 400 man-hours per breaker to rebuild. From AEP’s experience, we determined that it was more cost effective to replace these breakers which will eventually leak again. CB “D” has experienced 52 operations. The existing Transformer #1, vintage 1951, has seen major through fault events which has contributed to extremely elevated levels of combustible gases and carbonization of insulating paper. The existing Transformer # 2, vintage 1954, has also seen numerous major through fault events causing significant gassing of the unit and upward trending moisture content in the oil. The high side circuit switchers is being installed on Transformer #1, #2, and # 3 will break up dissimilar zones of protection, which causes over tripping and miss-operations. In addition, this current lack of sectionalizing makes it difficult to perform routine maintenance work. Circuit switcher “DD” is an VMB type, which, is no longer supported by the manufacturer and parts are difficult to obtain. This CS is a poor cold weather performer due to the use of fiberglass parts in the interrupter which expand and contract with the weather causing miss operations. Due to their age and design we are seeing increased contact resistance on most units. Circuit Switcher “AC “ is a Mark III which the manufacturer no longer makes parts for. We have to scavenge for parts to do routine maintenance. These are older designed circuit switchers with old controls that no longer coordinate well with modern relaying.

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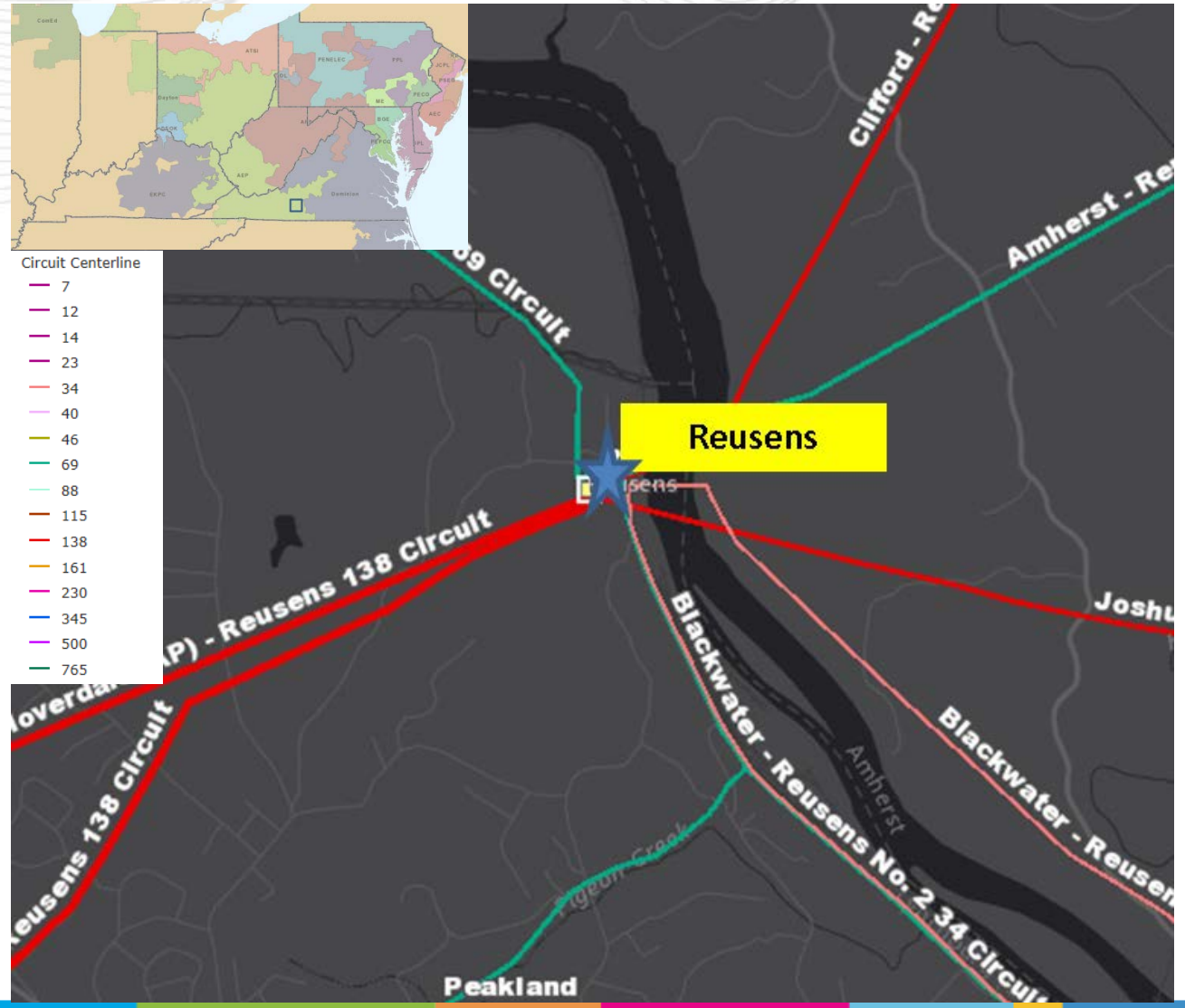

AEP Transmission Zone: Supplemental Reusens

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Moseley Station: The addition of CB "B" & Transformer # 1's high side circuit switcher are being installed to break up dissimilar zones of protection on the 138 kV system, which causes misoperations and over tripping. The 138 kV CB "A" is 1959 vintage oil filled breaker without oil containment and has experienced 176 operations. The 69 kV CB "E", which feeds the Town of Bedford, is a 1967 vintage oil filled breaker without oil containment and has experienced 101 operations. 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.

Clifford Station: The 138 kV CB "F" and Transformer #1's high side CB "XT1" are being added to break up dissimilar zones of protection on the 138kV, which could cause misoperations and over tripping.

Operational Flexibility and Efficiency:

Ground switch MOAB's are being replaced to prevent intentional induce a faults on the system, tripping remote breakers for a transformer fault, reducing the life of the transformer and increasing relay coordination complexity for the transformer protection.

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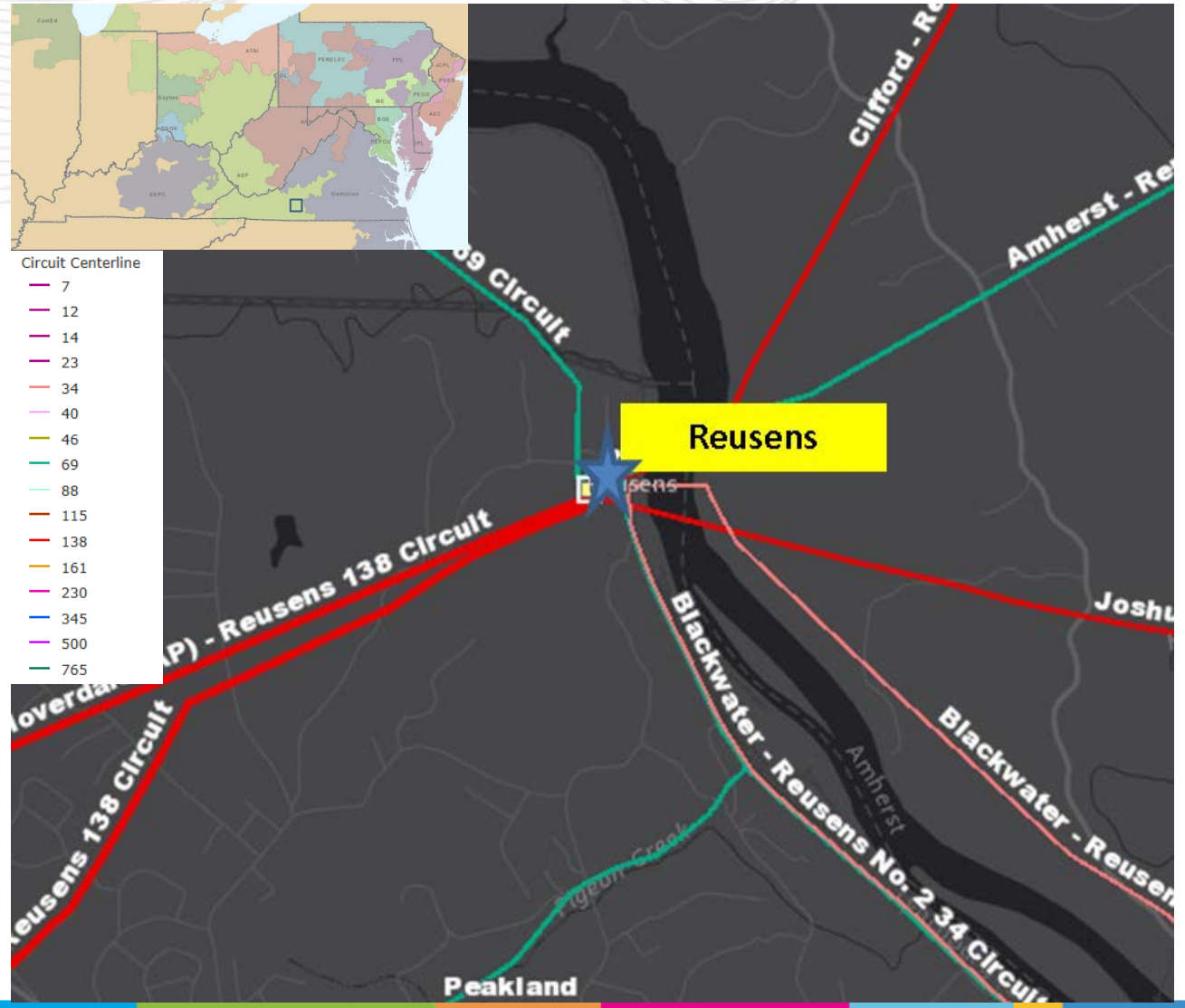

AEP Transmission Zone: Supplemental Reusens

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Potential Solution

At Reusens station, replace existing 3000 A 40 kA 138 kV CB's "AB" & "D" with new 3000 A 40 kA CB. Replace existing 138/34.5 kV 130 MVA XF's #1 & XF #2 with new 138/34.5 kV 130 MVA XF's. Add new 3000 A 40 kA 138 kV circuit switchers "XT1"," XT2", "XT4" on the high side of their respective transformers. Replace existing 1200 A 61 kA 138 kV cap switcher "AC" with new 650 A 31.5 kA cap switcher. Replace existing 300 A 12.5 kA 69 kV cap switcher "DD" with new 420 A 15 kA cap switcher. Install a new 3000 A 40 kA 69 kV CB "XB4L" to the low side of XF #4. Replace existing 1200 A 69 kV CBs "AA", "BB", & "CC" with new 3000 A 40 kA CB's. The 138/69 kV 60 MVA XF #4 failed and was replaced with a new 138/70.5/13 kV 130 MVA transformer. Estimated Cost: $12.6M

At Mosely station, replace existing 800 A 17.5 kA 138 kV CB "A" with new 3000 A 40 kA CB. Add a new 3000 A 138 kV 40 kA line CB "B" on the Roanoke exit. Replace existing 1200 A 69 kV CB "E" with new 3000 A 40 kA CB. Replace the existing 1200 A 61 kA grounding switch MOAB "Z1" with new 3000 A 40 kA circuit switcher "XT1". Estimated Cost: $4.7M

At Clifford station, Replace existing MOAB "Y" with new 3000 A 40 kA 138 kV CB "F" on the Boxwood line exit. replace grounding switch MOAB "Z1" with new 3000 A 40 kA circuit switcher "XT1". 138/46 kV Transformer #3 ground switch MOAB will be retired on a separate baseline project. Estimated Cost: $3.4M

Total Estimated Transmission Cost: $20.7M

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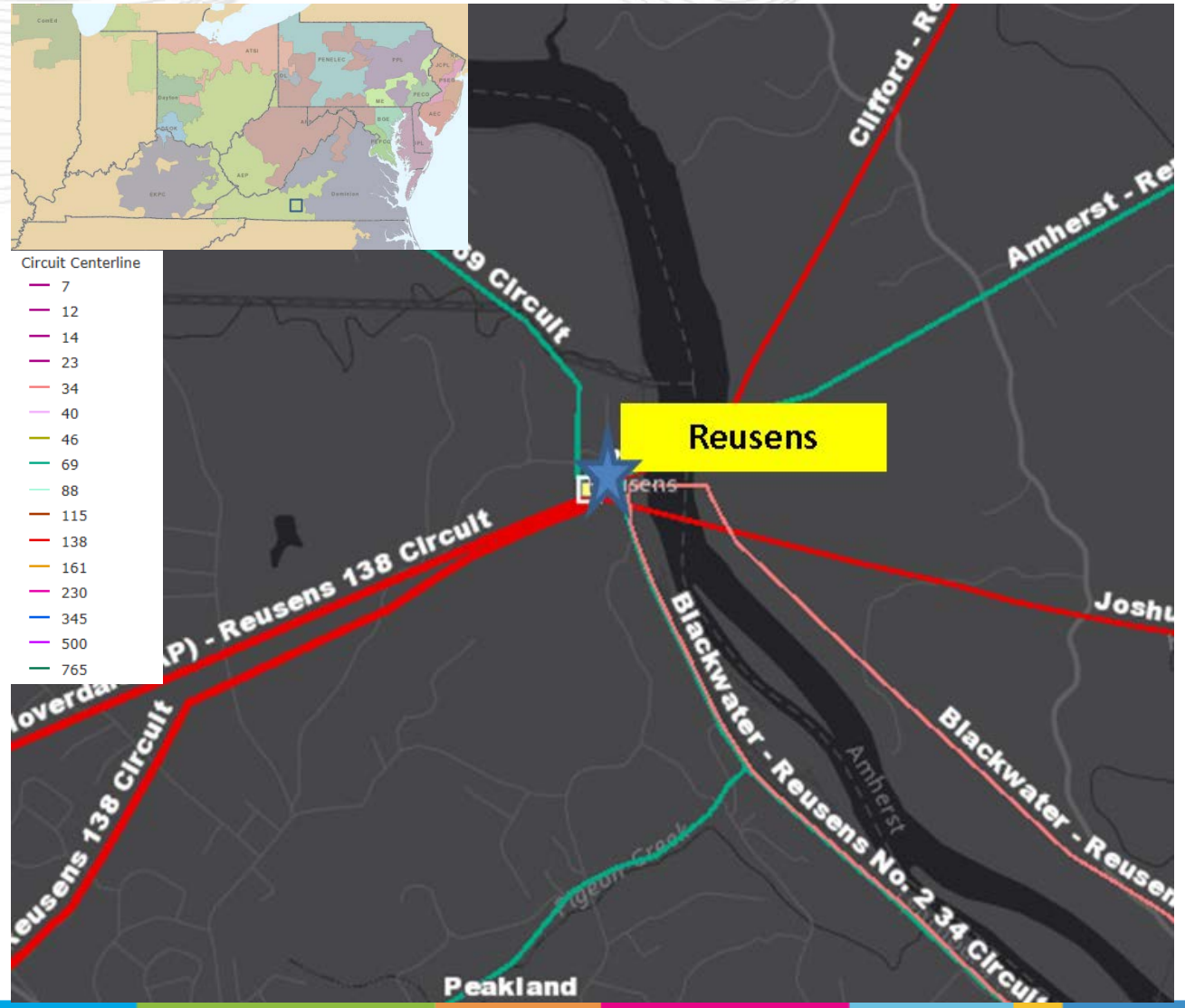

AEP Transmission Zone: Supplemental Reusens

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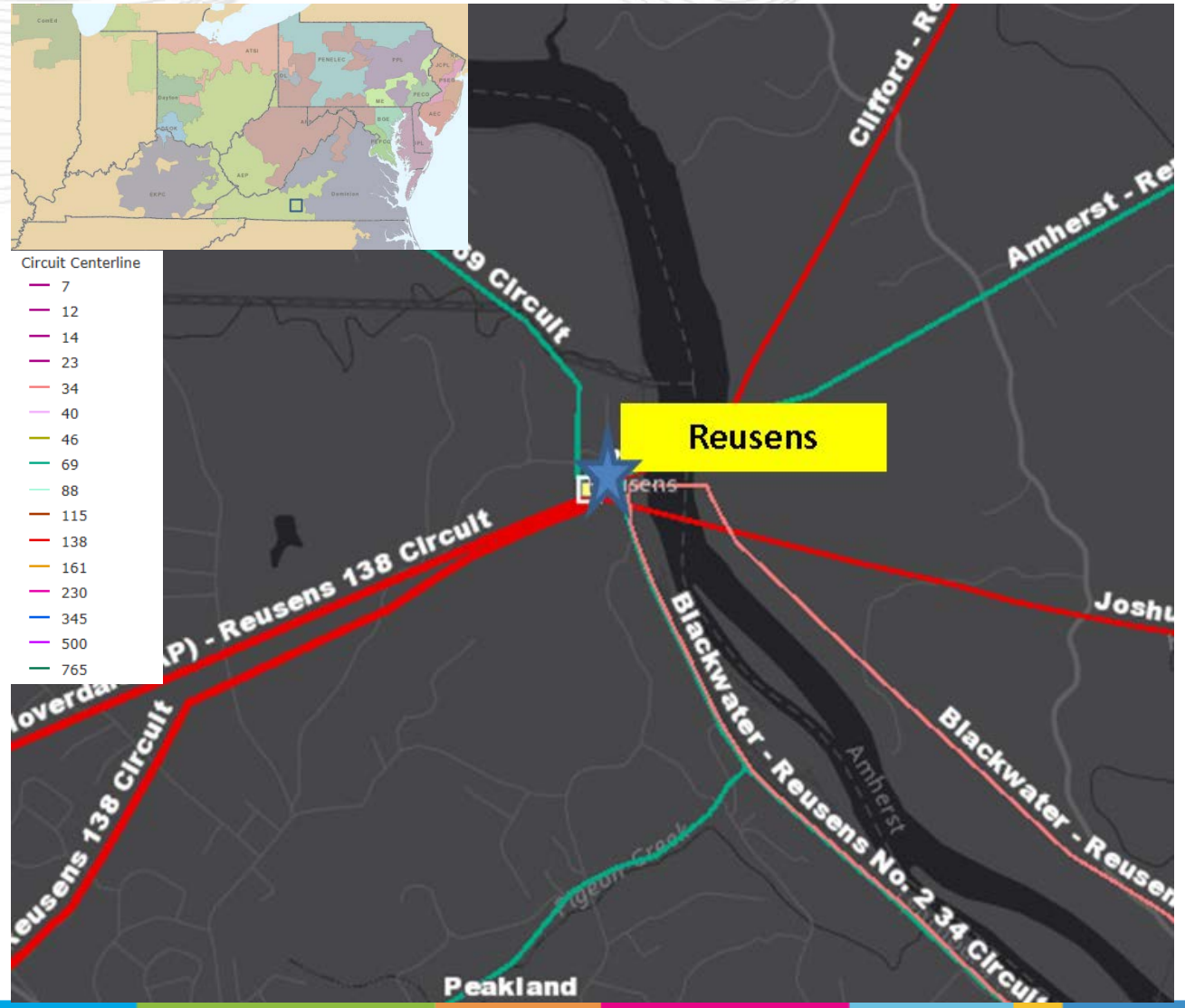
Alternatives:
No viable cost-effective transmission alternative was identified.

Projected In-service: 6/29/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental Haviland-West Van Wert

Problem Statement:

Equipment Material/Condition/Performance/Risk:

There are 332 open conditions on the Haviland – S. Van Wert circuit, the majority of which are on the Haviland – W. Van Wert line section.

The subject 69 kV line in Van Wert County, Ohio was originally constructed in 1955. The vast majority of the original-vintage poles are 55 ft. class 4 wood poles. These original vintage poles are far undersized in terms of both height and strength when compared to today's AEP Transmission standards.

Since January 1, 2002 there have been at least eight (8) instances of cascading pole failures during adverse weather, each resulting in a long-duration sustained transmission line outage which interrupted the transmission source to two (2) AEP Ohio distribution stations (South Convoy and Ohio City) and one (1) Paulding-Putnam Electric Cooperative substation (Convoy). These two AEP Ohio distribution stations supply approximately 1350 retail customers. In addition to the cascading pole failure events there have been other sustained outages due to broken insulators, broken crossarms, and broken shield wires.

The majority of the original-vintage tangent wood poles are insulated with 66 kV rated brown porcelain horizontal post insulators. This type of insulator is no longer standard on the AEP system. AEP's experience has shown that this size and type of insulator is subject to base and end fitting separation from the porcelain body when subjected to climatic thermal cycling. They are also prone to electrical backflash.

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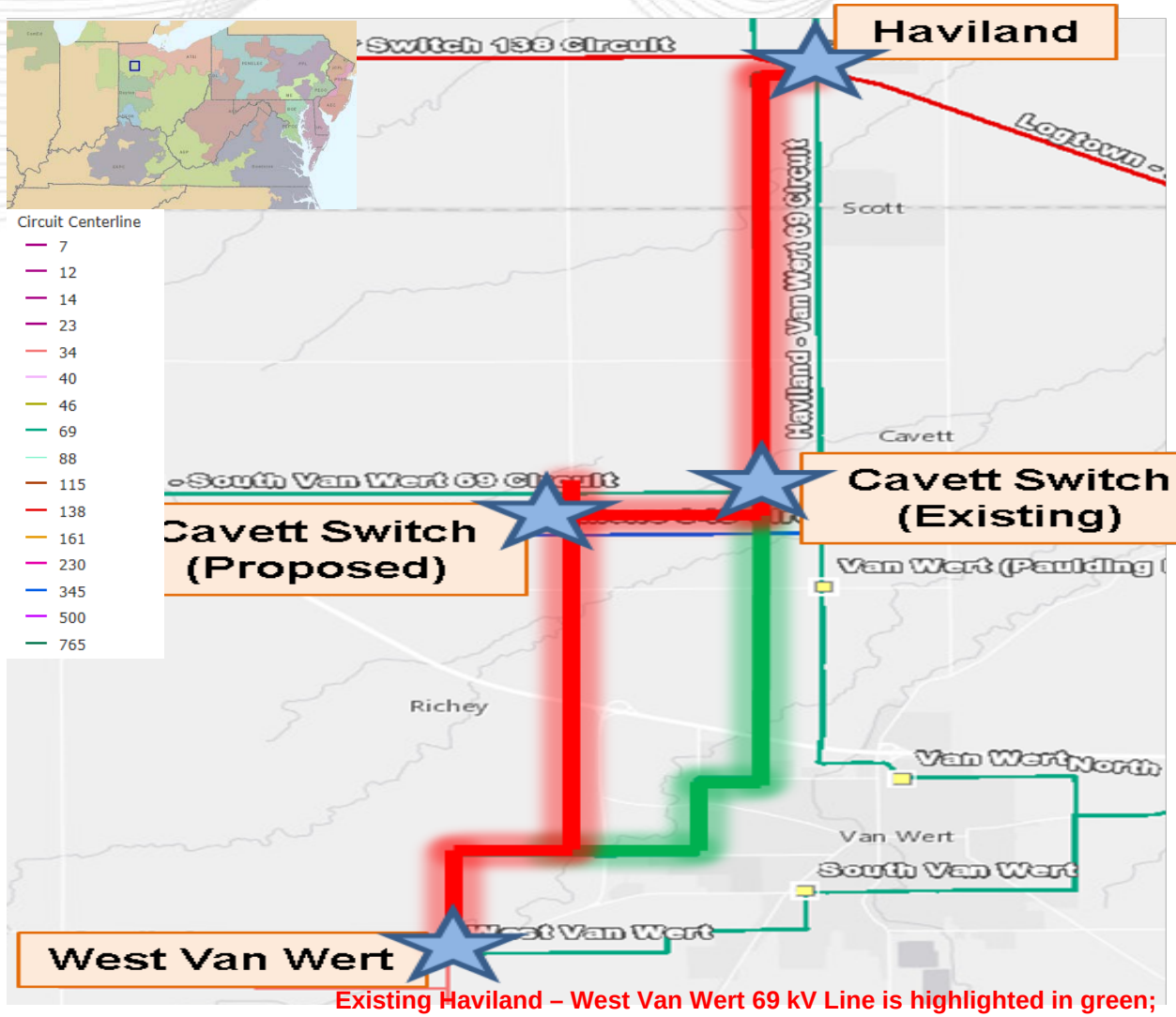

Existing Haviland – West Van Wert 69 kV Line is highlighted in green; Proposed rebuild is highlighted in red.

AEP Transmission Zone: Supplemental Haviland-West Van Wert

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Some original vintage poles utilize wood crossarm construction with either vertical post insulators or suspension insulator strings. The life expectancy of wood crossarms is far less than that of wood poles, meaning the required timing of the replacement of the major structural components is not synchronized. This results in the inspection failure rate of crossarms being higher than the inspection failure rate of poles. The cost to access poles in an environmentally responsible way to replace defective crossarms can result in the decision being made to prematurely replace older poles too, prior to the poles actually being judged as defective. Construction types that do not utilize crossarms resolve this issue.

Crossarms and support braces of this vintage are typically undersized, more closely resembling distribution crossarm assemblies. End splitting and suspension insulator string fallout is an elevated risk.

A portion of the line utilizes 4/0 copper phase conductors (50 MVA rating). This size and type of conductor is obsolete on the AEP system, meaning it can be difficult to splice and repair due to lack of available stock materials.

The majority of the shield wire on the line is either 5/16" EHS steel or No. 1 copper 3-strand. Both of these shield wire sizes and types are obsolete on the AEP system, meaning they can be difficult to splice and repair due to lack of available stock materials.

Many of the original-vintage wood poles utilize non-standard crossarm-type bay-o-nets extending from the pole top to support the shield wire. Bay-o-nets decay at the same rate as wood crossarms, meaning bay-o-net replacement is typically required prior to the pole itself needing to be replaced. Bay-o-net top rot and splitting also poses the risk of dropping the shield wire into the top or center phase conductor, and resulting sustained outage to the circuit.

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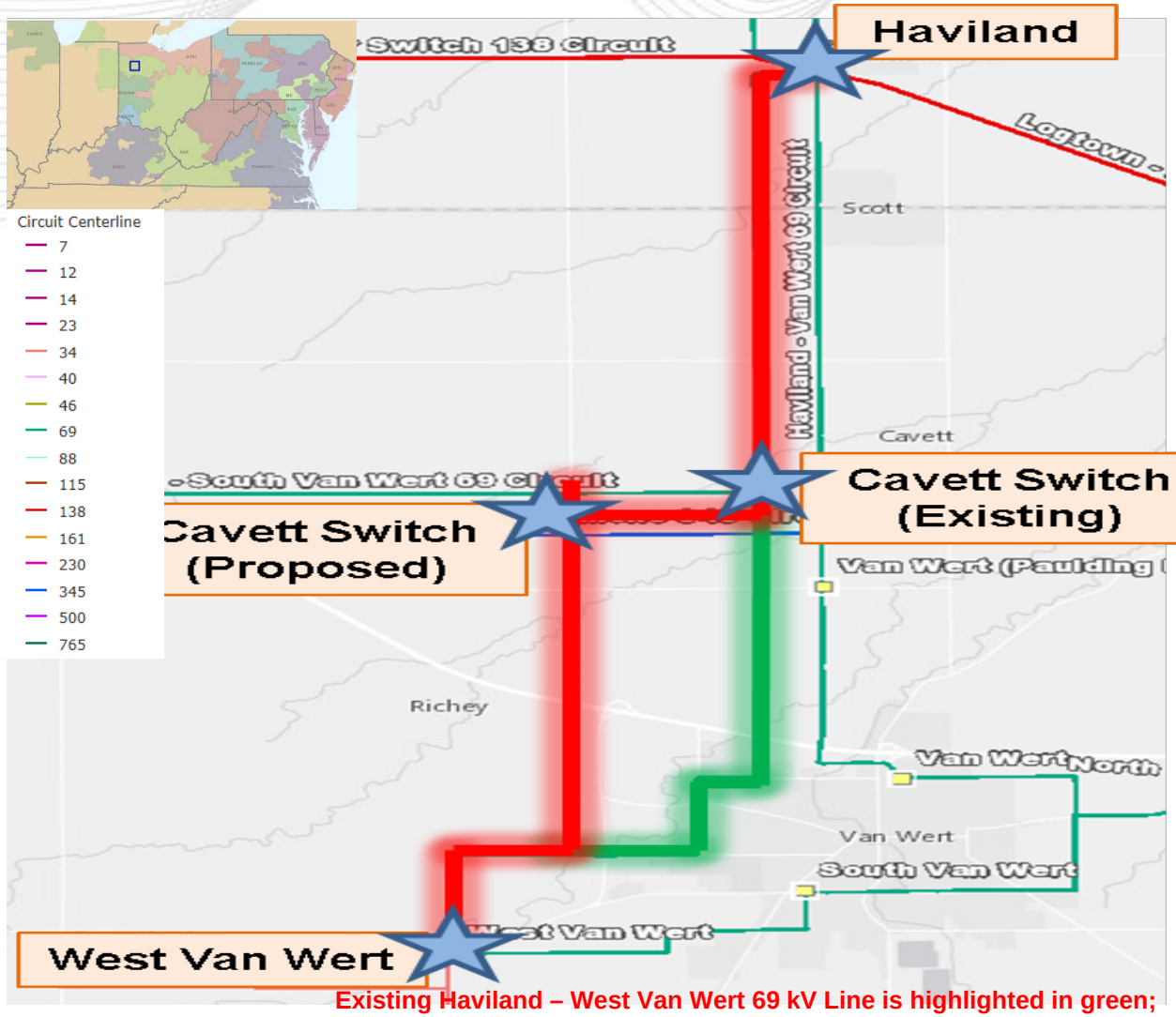

Existing Haviland – West Van Wert 69 kV Line is highlighted in green; Proposed rebuild is highlighted in red.

AEP Transmission Zone: Supplemental Haviland-West Van Wert

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Existing grounding is only every other structure. This is not the current AEP standard. Grounding electrodes are typically a butt-wrap, which can be high impedance and less effective than driven rods.

Some of the line has distribution underbuilt. Distribution underbuilt mechanical loads consume pole strength, adding to the risk of future cascading pole failure events.

Legacy underlying land rights for a line of this vintage are typically inadequate by present day AEP standards, offering less-than-desired protective rights for encroachment control and vegetation management.

Operational Flexibility and Efficiency

The FOI calculation justifies a MOAB at Cavett Switch facing toward West Van Wert.

Potential Solution

Retire existing Cavett 2-way line switch. Replace with 3-way line switch on new route with MOAB facing West Van Wert. Estimated Cost: $0.3M

Rebuild existing Haviland–West Van Wert 69 kV line asset (~14.6 miles) with 795 ACSR conductor (68 MVA rating, non-conductor limited), including partial line reroute. Remove old 211.6 ACSR, 4/0 Copper, and 336.4 ACSR conductor. Estimated Cost: $15.7M

Total Estimated Transmission Cost: $16.0M

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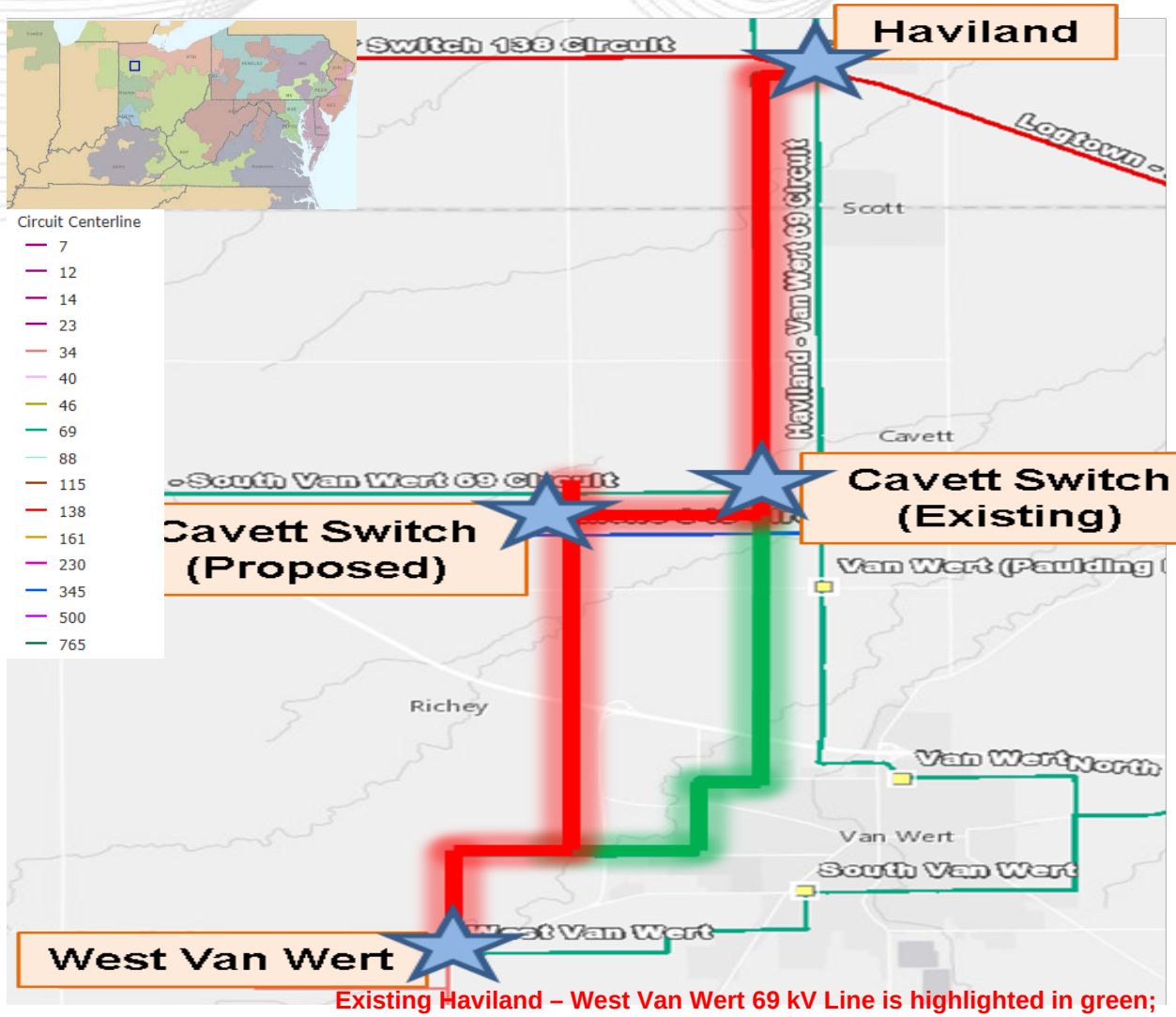

Existing Haviland – West Van Wert 69 kV Line is highlighted in green; Proposed rebuild is highlighted in red.

AEP Transmission Zone: Supplemental Haviland-West Van Wert

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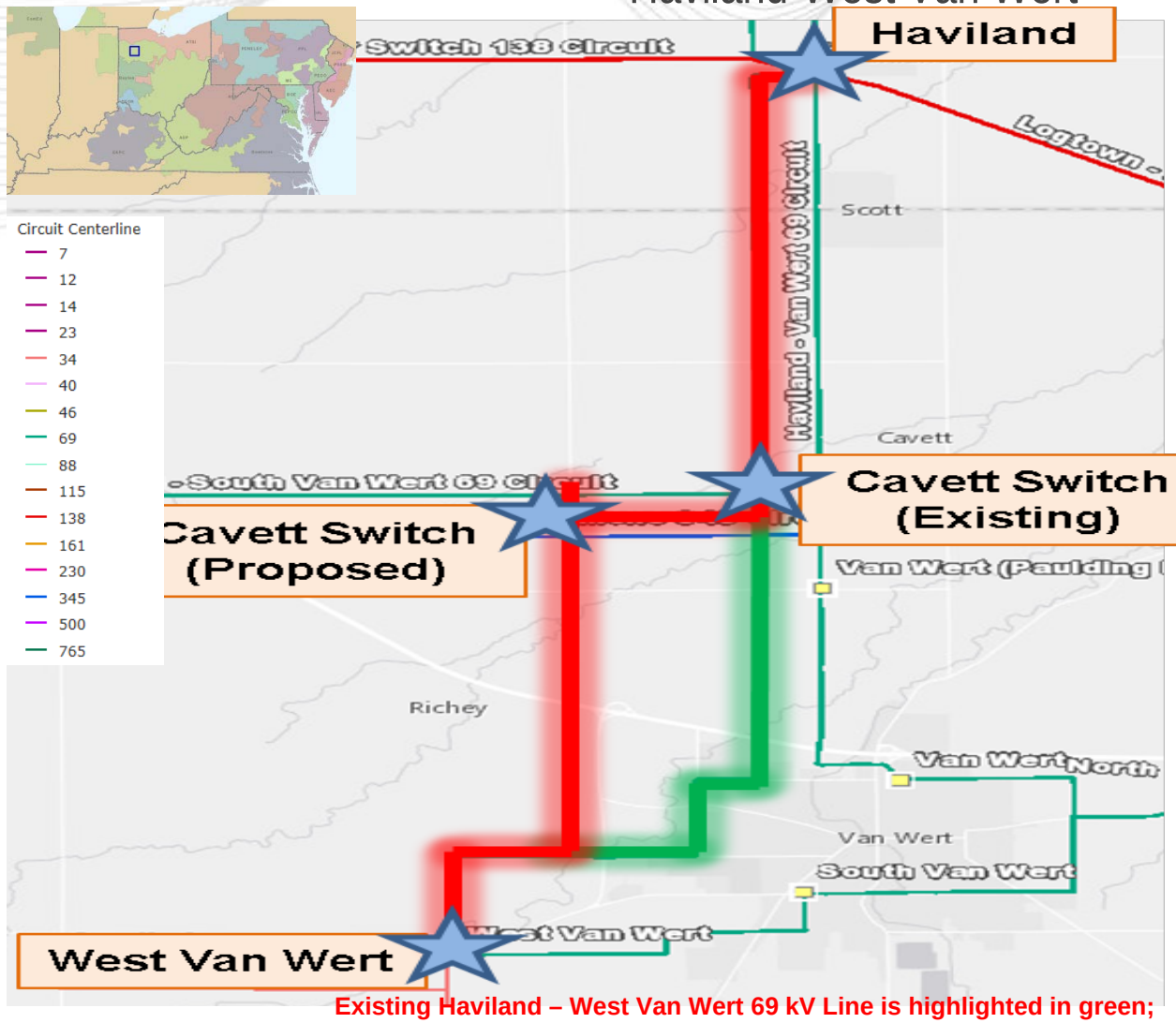
Alternatives:

Rebuild line along existing ROW. Proximity to Van Wert County Airport increases risk and difficulty of work on existing route. Because of the minimal distance of the reroute and the potential for project complications with schedule or requests for underground rebuild from the airport, the cost for this alternative is estimated to be comparable to the cost of the proposed reroute. Estimated Cost: $16M

Projected In-service: 12/31/2020

Project Status: Engineering



Existing Haviland – West Van Wert 69 kV Line is highlighted in green; Proposed rebuild is highlighted in red.

AEP Transmission Zone: Supplemental Sardinia

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The existing 11.9 mile, 69 kV radial line section between Seaman and Sardinia was constructed in 1938 using wood pole structures with 336 ACSR conductor (60 MVA rating). There are 363 open A conditions on the entire 20.3-mile line from Adams to Seaman including the radial to Sardinia. The 11.9-mile section has approximately 60% of those (217). The conditions include rotten cross-arms, burnt/broken insulators, and loose/broken conductor hardware.

Operational Flexibility and Efficiency

AEP Ohio Stations Sardinia and Wildcat have transfer capability between them. Installing 138 kV circuit breakers will help keep customers in service.

Potential Solution

Build a 4.5-mile 138kV double circuit line from Sardinia Station to tap point on the Kenton – Wildcat 138kV circuit, capable of 200 MVA. Once complete, remove the 11.9-mile 69kV Seaman-Sardinia transmission line and associated 69kV equipment at the Seaman and Sardinia substations.

Estimated Cost: $14.0M

Install 138 kV bus and two 138 kV circuit breakers at Sardinia station.

Estimated Cost: $3.0M

Total Estimated Transmission Cost: $17.0M

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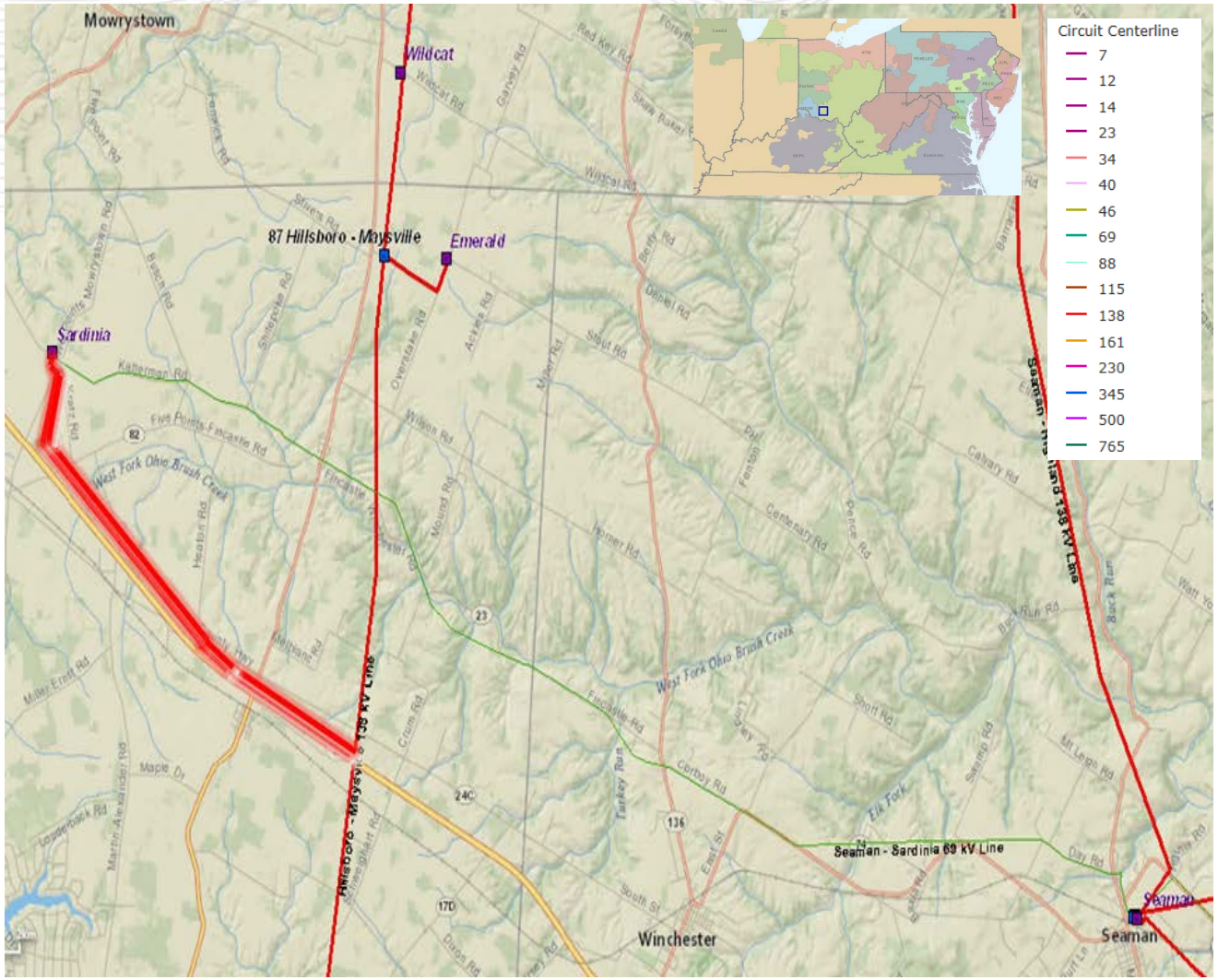

AEP Transmission Zone: Supplemental Sardinia

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Alternatives:

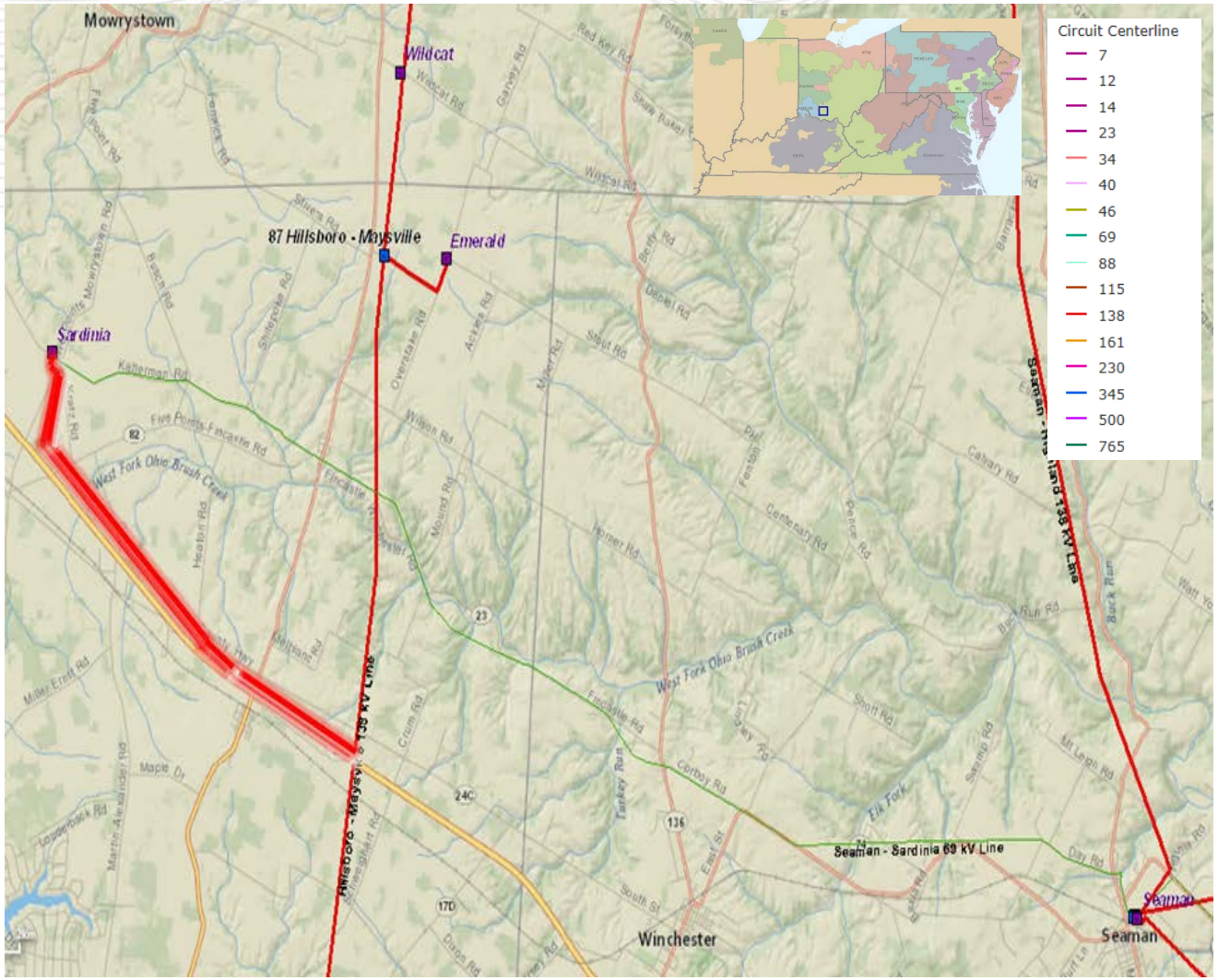
Rebuild the 11.9 mile line from Seaman as a 69 kV double circuit. This alternate would provide the town of Sardinia with a redundant circuit, similar to the proposed project. This alternate eliminates the rehab issue, but would take significant outages to accomplish. There are a large number of encroachments that would need to be removed to correct ROW clearances. $26M

To increase reliability the Sardinia extension can be designed with two independent lines looping into Sardinia. Build ~4 miles of new single circuit 138 kV line from the North near Emerald to Sardinia, and continue the loop to a new tap point near SR-32. Then retire the 138kV line between the new tap points along with the 69 kV line. $26M

Build approximately 4.5 miles of new double circuit 138 kV line from Wildcat substation. Wildcat could be expanded to terminate the Sardinia circuits with circuit breakers and retire the Seaman-Sardinia 69 kV line. $23M

Projected In-service: 12/1/2021

Project Status: Scoping



AEP Transmission Zone: Supplemental South Point Bus Reconductor

Problem Statement:

Operational Flexibility and Efficiency

The South Point-Millbrook Park Line was loaded to 96% of the 107 MVA rating as recently as Sept 22, 2017. Low ratings on the 138kV South Point-Millbrook Park and South Point-Apple Grove lines will cause delays in outage scheduling for construction and maintenance to avoid overloads.

Potential Solution

Replace 4/0 Copper risers that are the limiting elements on the South Point 138kV transmission lines to Millbrook Park and Apple Grove. There are also two section of 300 Cu on the bus ends which will be upgraded to match the bus thermal rating. The electromechanical relays for the bus diff and capacitor will upgraded during the project.

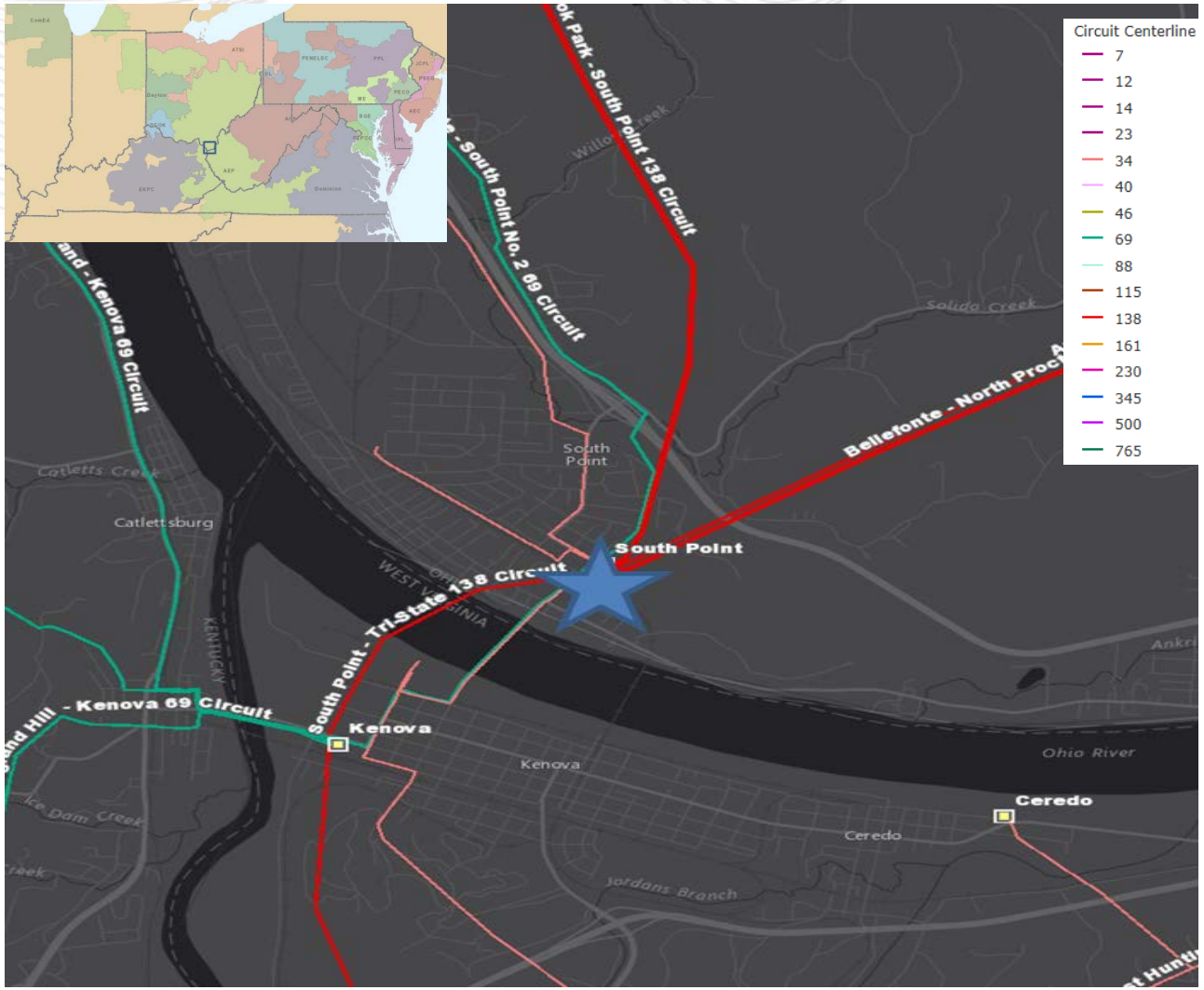
Estimated Cost: $0.5M

Alternatives:

No viable cost-effective transmission alternative was identified.

Projected In-service: 5/31/2018

Project Status: Scoping



AEP Transmission Zone: Supplemental
Stadium Park

Problem Statement:

Customer Service:

The NFL Hall of Fame (HOF) in Canton, Ohio has a major expansion in the works for 2017 through 2020. The Pro Football Hall of Fame Village will be an $800 million mixed-use development, including the museum, expanded stadium, hotels, apartments, and other features. There will be a large amount of new load forecasted, which is above the capacity of the existing Stadium Park 69-12kV distribution transformer. In addition, the HOF needs additional land, which is occupied by AEP's distribution station. AEP will be relocating the station further to the west.

Equipment Material/Condition/Performance/Risk:

West Canton 69kV breaker 'S' is a CF oil breaker made in 1970 (47 years old). It is recommended for replacement, due to age, lack of spare parts, and breaker-failure system impact to other facilities. Since the year 2000, the breaker has experienced 25 fault operations (lifetime count of 45), above the recommended limit of 10. The breaker lacks modern gas & moisture-monitoring capabilities. In general, oil breakers have become increasingly difficult to maintain due to the oil handling and environmental hazards associated with them. The breaker itself is rusting, along with heavy rust on the supporting structure and foundations.

During the time that the 69kV circuit protection is being upgraded, it makes sense to also replace this breaker, so as to reduce engineering/construction costs and utilize outage-windows, by doing it all in one project.

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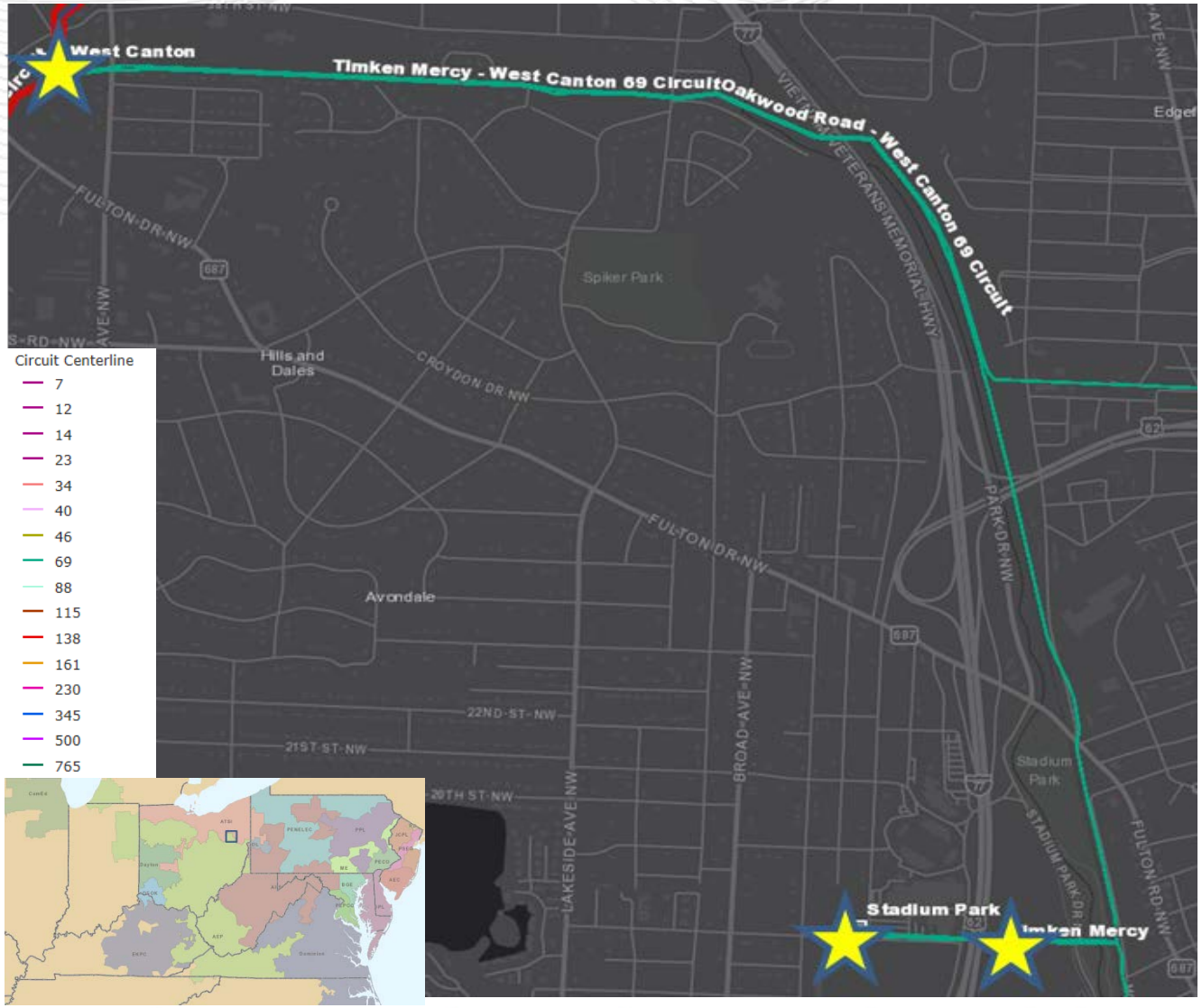

AEP Transmission Zone: Supplemental
Stadium Park

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Operational Flexibility and Efficiency

Two new 20 MVA 69-12kV Distribution (AEP Ohio) transformers will be installed at the greenfield station. Due to the existing and future load growth, 2- 69KV circuit breakers will be installed. The addition of the Stadium Park 69kV circuit breakers will prevent a distribution fault at Stadium Park from causing an outage to the hospital served from Timken Mercy Hospital station.

The 69kV capacitor bank will be retired due to space constraints. This retirement was studied in conjunction with AEP Operations, and no concerns were found.

Potential Solution

Distribution (AEP Ohio) will be relocating their station to the west, to facilitate the needed station upgrades to address capacity overloads. Transmission will install 2- 69kV circuit breakers and relaying. The 69kV cap bank will be retired.
Estimated Cost: $2.1M

At the 69kV remote-end of West Canton, upgrade protection to coordinate with Stadium Park; replace 69kV oil breaker 'S'. **Estimated Cost: $0.8M**

At the 69kV remote-end of Timken Mercy, upgrade protection to coordinate with Stadium Park; install CCVT's. **Estimated Cost: $0.8M**

Extend West Canton-Stadium Park-Timken Mercy 69kV double-circuit loop to new Stadium Park station location, approximately 300 ft. to the west. **Estimated Cost: $0.3M**

Total Estimated Transmission Cost: $4.0M

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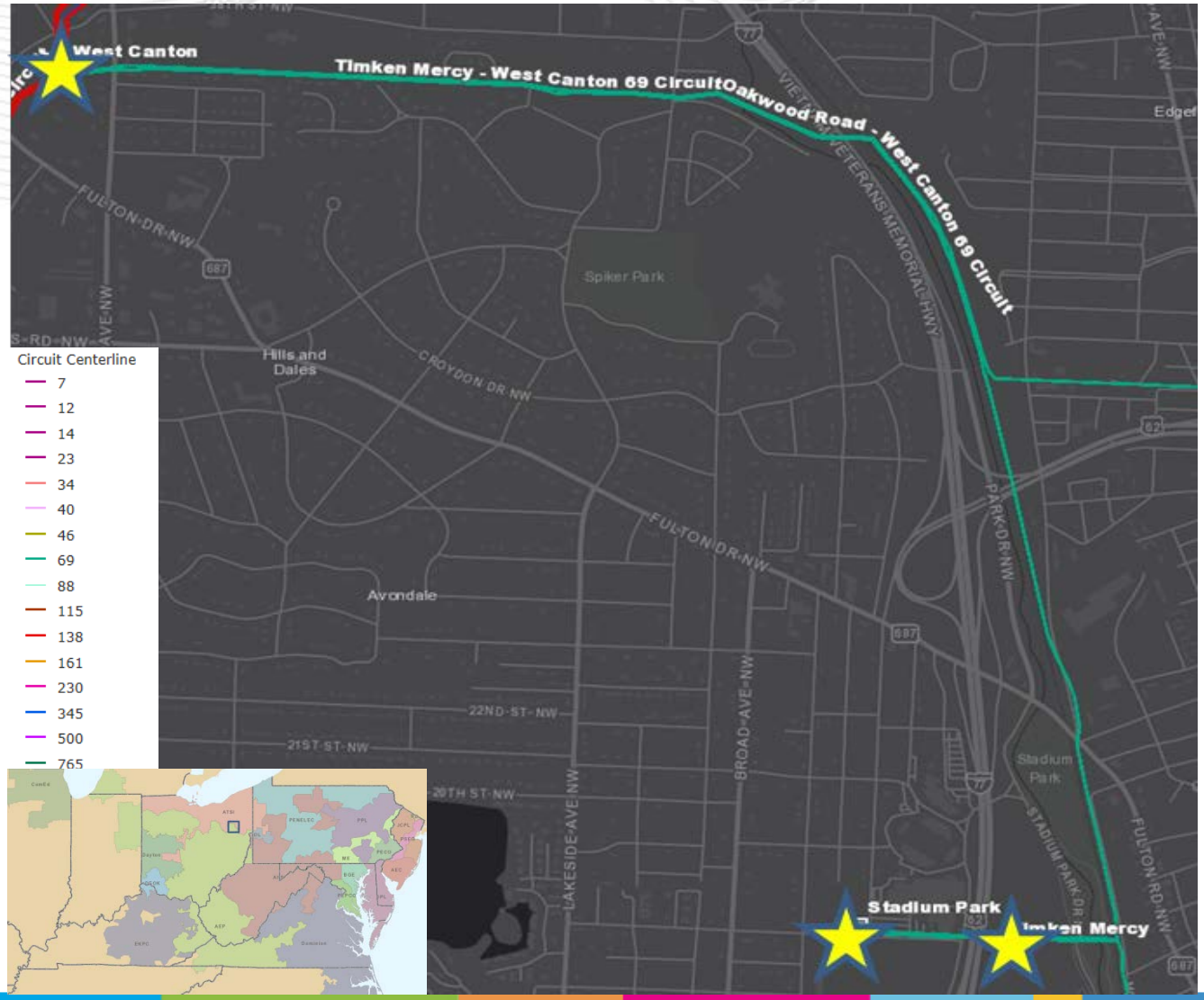

AEP Transmission Zone: Supplemental Stadium Park

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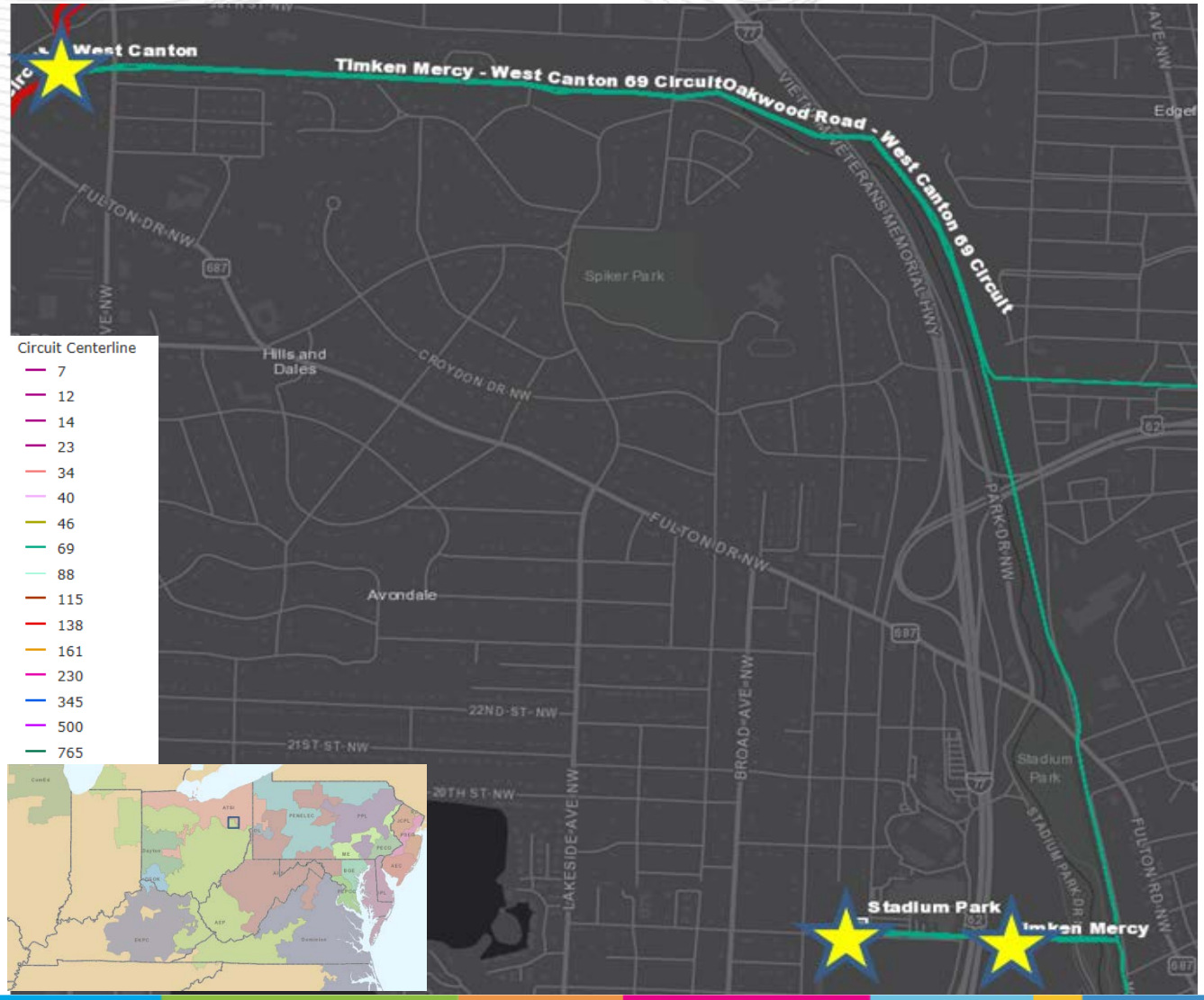
Alternatives:

Add transformer capacity at other distribution stations in the area and configure load transfers where possible, in order to serve the increased loads of the customer. However, this would be a less efficient solution, as Stadium Park station is located adjacent to the customer. Serving the Hall of Fame loads from other stations in Canton would result in increased distribution line losses (and in turn, transformer losses), reducing the performance of the system. In addition, it would have been a less reliable configuration, due to the mileage involved. Upgrading the adjacent Stadium Park station will ensure a reliable source for all local customers for years to come. Estimated Cost: $15M

Projected In-service: 12/31/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental Tidd Station

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The 5- remaining 1600A 50 kA 138kV 'ATB' air-blast breakers at Tidd were manufactured in 1966. These units are overall in poor condition and a safety hazard to field personnel, due to the violent manner in which they tend to fail. Air-blast breakers are being replaced across the AEP system due to their catastrophic and violent failures. Sharp pieces of porcelain from their bushings are typically expelled from the breakers and can be a potential safety hazard to field personnel. Other factors driving the replacement are age (52 years), scarce availability of spare parts, and system impact upon failure. The breakers lack real-time condition monitoring, but instead require a de-energized test for evaluation

The existing control house is in poor condition and has experienced flooding in the basement, placing protection and telecom equipment at risk numerous times. There are various safety concerns in the deteriorating building, including lighting and heating/cooling issues. The DC system in the building has failed due to degraded cables.

The majority of the relays being replaced are electromechanical or solid-state units, which are aging and prone to failure; these also lack modern fault-location and event-recording functionality. The 138kV bus PT's are rusting and leaking oil, along with deteriorated foundations. The 138kV bus-work utilizes cap-and-pin insulators, which are prone to failure.

The 138kV switches are in a hard-to-access location, due to the station being retrofitted from double-bus double-breaker to breaker-and-a-half over the years. Any work on the 12- incoming T-Line entrances or Transformer leads requires a full bus outage due to necessary safety clearances over the bus extensions. The placement of the current switches is very complex (in a stacked arrangement on the bus), which can lead to switching errors by field personnel or safety issues.

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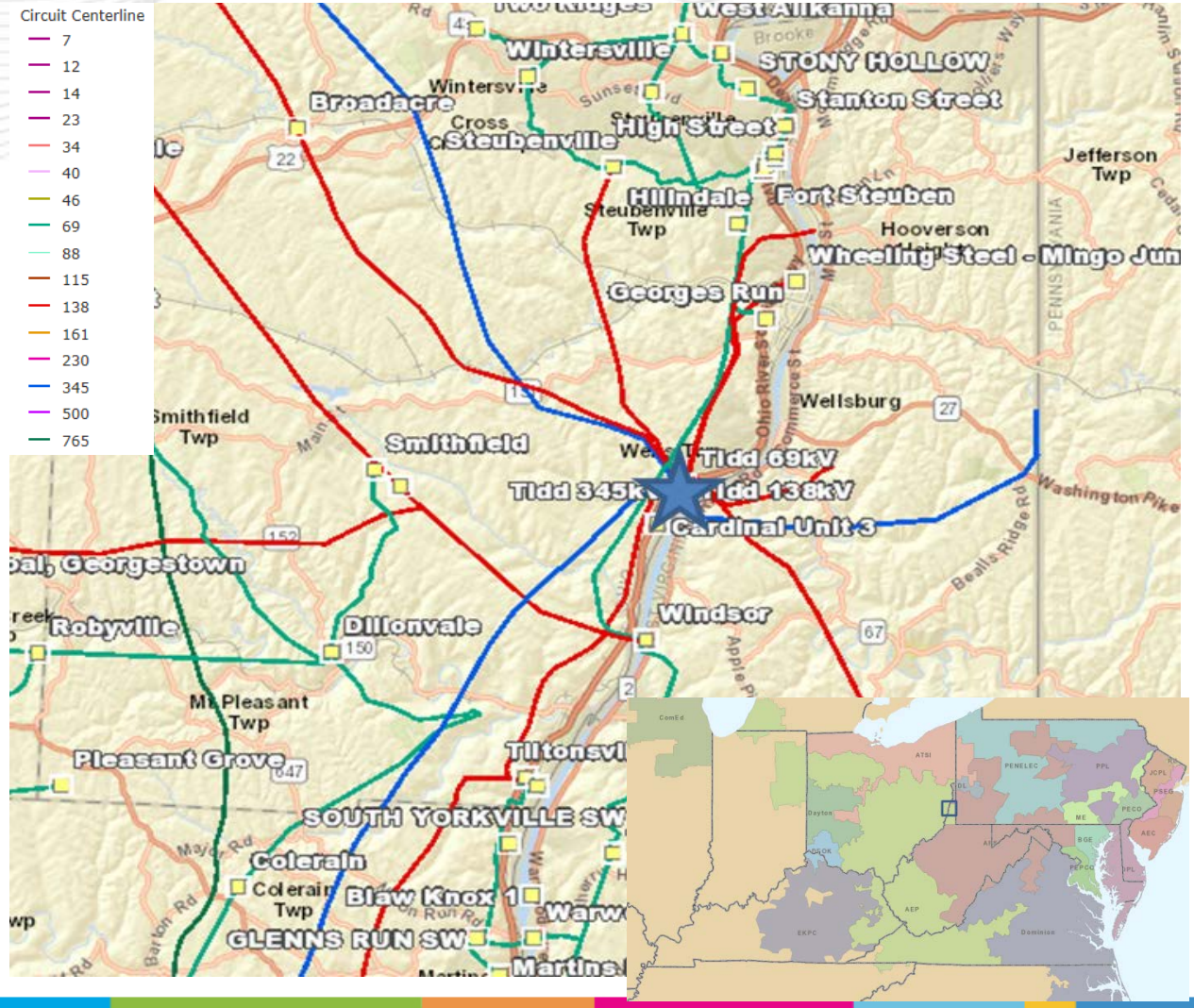

AEP Transmission Zone: Supplemental
Tidd Station

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Operational Flexibility and Efficiency

Currently, the two 138kV straight buses at Tidd have significantly more than the recommended amount of connected breakers. A fault on Bus 1 requires the tripping of 9 breakers and the loss of a source of station service power. A fault on Bus 2 requires the tripping of 9 breakers, the loss of an 86 MVAR cap bank, and the loss of a source of station service power. Furthermore, when either bus must be taken out of service for maintenance or project commissioning, it takes significantly longer than necessary to isolate the bus. AEP's general recommendation is to limit the amount of breakers tripped for a bus fault to 6 or less. To remedy the situation, two 138kV bus-tie breakers will be installed, to split the two buses into four.

The area around Tidd has a significant amount of industrial load, such as power plant scrubbers, steel-making, and shale gas processing loads. The addition of a 2nd 138kV capacitor bank will provide operational flexibility, by providing needed voltage support capability, especially for times when any of the Cardinal power plant generators may be offline or if there are performance problems with the single existing 138kV cap bank.

In addition, SCADA indication/control & metering capability will be added to parts of the 138kV station where it is currently lacking (e.g., 6- circuit breakers).

Customer Service:

Tidd provides two direct 138kV feeds to a steel-making customer, which will benefit from the Tidd station reliability improvements. This customer has significant expansion plans in the future.

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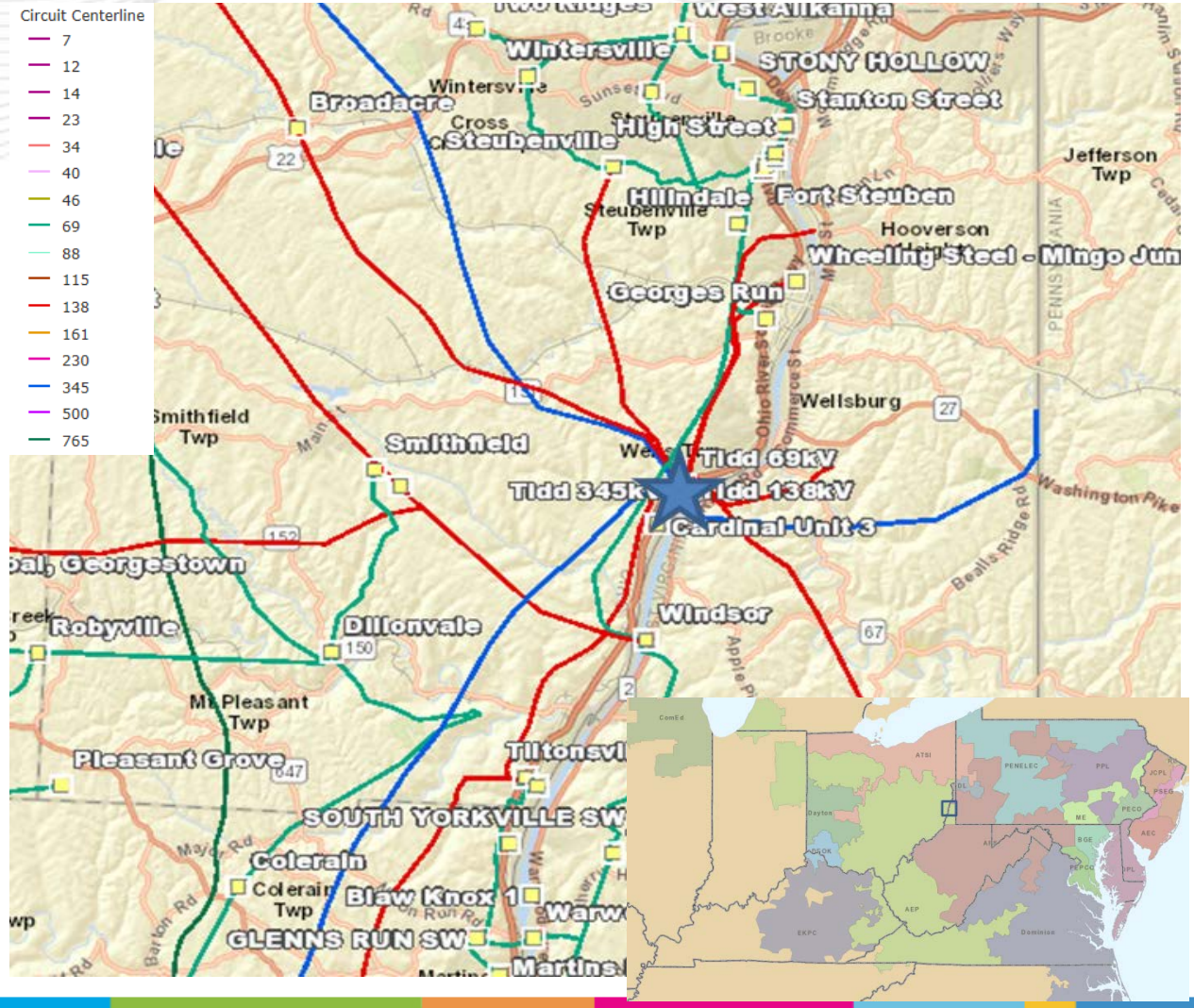

AEP Transmission Zone: Supplemental Tidd Station

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Potential Solution

At the Tidd 138kV station, replace the 5 remaining 'ATB' air-blast circuit breakers with new 4000A 63kA units. Install 2- 138kV bus-tie breakers. Install new protection & communications equipment in a new DICM (drop-in control module) and demolish the old control house. Install a 58 MVAR cap bank. To address safety hazards, replace and relocate a number of manual disconnect switches throughout the station.

Estimated Cost: $9.1M

Alternatives:

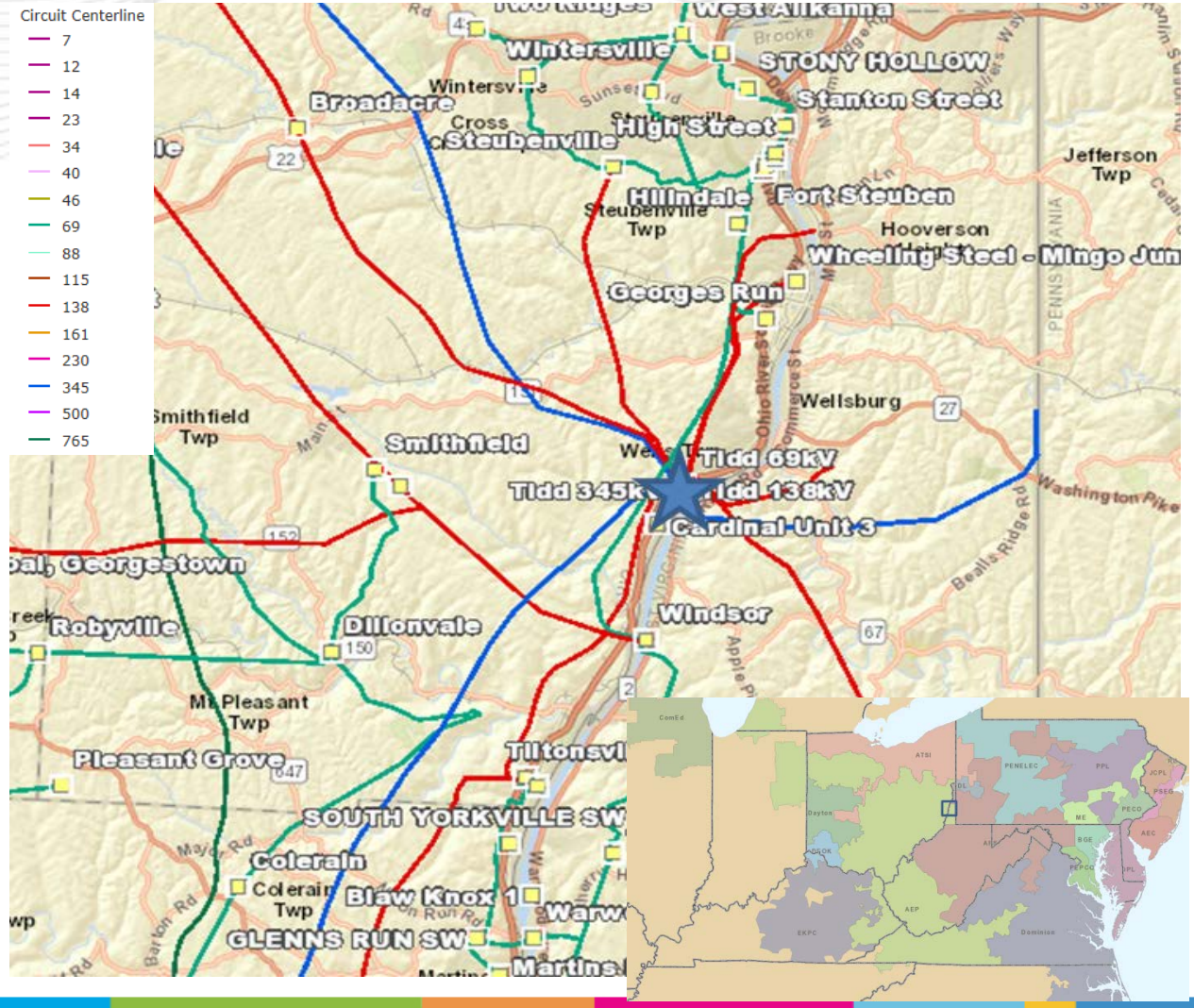
Various options have been explored to upgrade the aging Tidd station, which serves as a critical 345/138/69kV transmission hub in the area. Rebuilding the station on greenfield property in the clear was considered; however, due to the hilly terrain, the Ohio River, and an adjacent highway, plus the high cost of relocating the many transmission lines, this was not a cost-effective solution.

Replacing the 5- remaining air-blast breakers (out of 26 total), while upgrading the station's protection & SCADA connectivity, was deemed to be the more cost-effective solution. This will ensure enhanced transmission system reliability for years to come.

Estimated Cost: $50-100 million for complete station relocation and greenfield rebuild

Projected In-service: 12/01/2020

Project Status: Engineering



AEP Transmission Zone: Supplemental Newbery Station

Problem Statement:

Customer Service:

PUCO obligation to serve a new 138kV service to a 56 MVA PRO-TEC facility, with a typical steady state load of 40MVA.

Operational Flexibility and Efficiency

FOI calculations (21.47) have determined that at a minimum MOABs should be installed. With Pro-Tec's existing service from Yellow Creek containing breakers, to maintain consistent practice and reliable service, due to the critical and sensitive nature of Pro-Tec's steel production processes, and requests from operations for breakers, breakers will be installed.

Potential Solution

New ~0.75 mile double-circuit 138kV line extension to a new substation to serve a new PRO-TEC facility by cutting the existing East Leipsic-Yellow Creek 138kV circuit (Yellow Creek Extension). Match existing conductors on new line extension, which are 1033 ACSR Curlew.

Estimated Cost: $0.9M

New 2-breaker, 3000A, 40kA, 138kV in and out station (Newbery), with two line exits (East Leipsic & Yellow Creek) and one tap to a PRO-TEC transformer. **Estimated Cost**: $6.0M

Total Estimated Transmission Cost: $6.9M

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AEP Transmission Zone: Supplemental Newbery Station

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Alternatives:

Build Newbery station as a ring bus. This alternative is no longer in consideration because the customer specifically requested a duplicate design of their service from their existing Yellow Creek Substation. Estimated Cost: $10.8M

Construct Newbery station with two transformers in an in-and-out configuration. This alternative was ruled out by the customer because rather than having a second transformer for backup they're going to utilize a 34.5kV distribution backup source to serve plant critical load in the event of an emergency. Estimated Cost: $8.8M

Projected In-service: 12/31/2018

Project Status: Engineering

AEP Transmission Zone: Supplemental Buckeye Pipe Line

Problem Statement:

Customer Service:

Buckeye Pipe Line, LP has requested a new 34.5kV service for a new customer owned station to be installed adjacent to the existing Cygnet Buckeye Pipe Line station. Their peak diversified demand will be 2.5MW with a requested in service date of 3/1/18, although we have worked with the customer on a more realistic ISD of Q2 2018.

The new load and station is needed to move new refined petroleum east to Pennsylvania. The existing Cygnet Buckeye Pipe Line station will become fully owned and operated by Sunoco Pipeline LP. No significant changes are expected with the existing Cygnet Buckeye Pipe Line station.

Operational Flexibility and Efficiency

FOI calculations (8.96) justify a MOAB on this circuit. With the circuit being radial, it is recommended to install a MOAB towards the remaining portion of the radial. This will enable AEP to remotely isolate any problems further down the radial, retaining service to Buckeye Pipe Line as well as all other customers served from the radial line.

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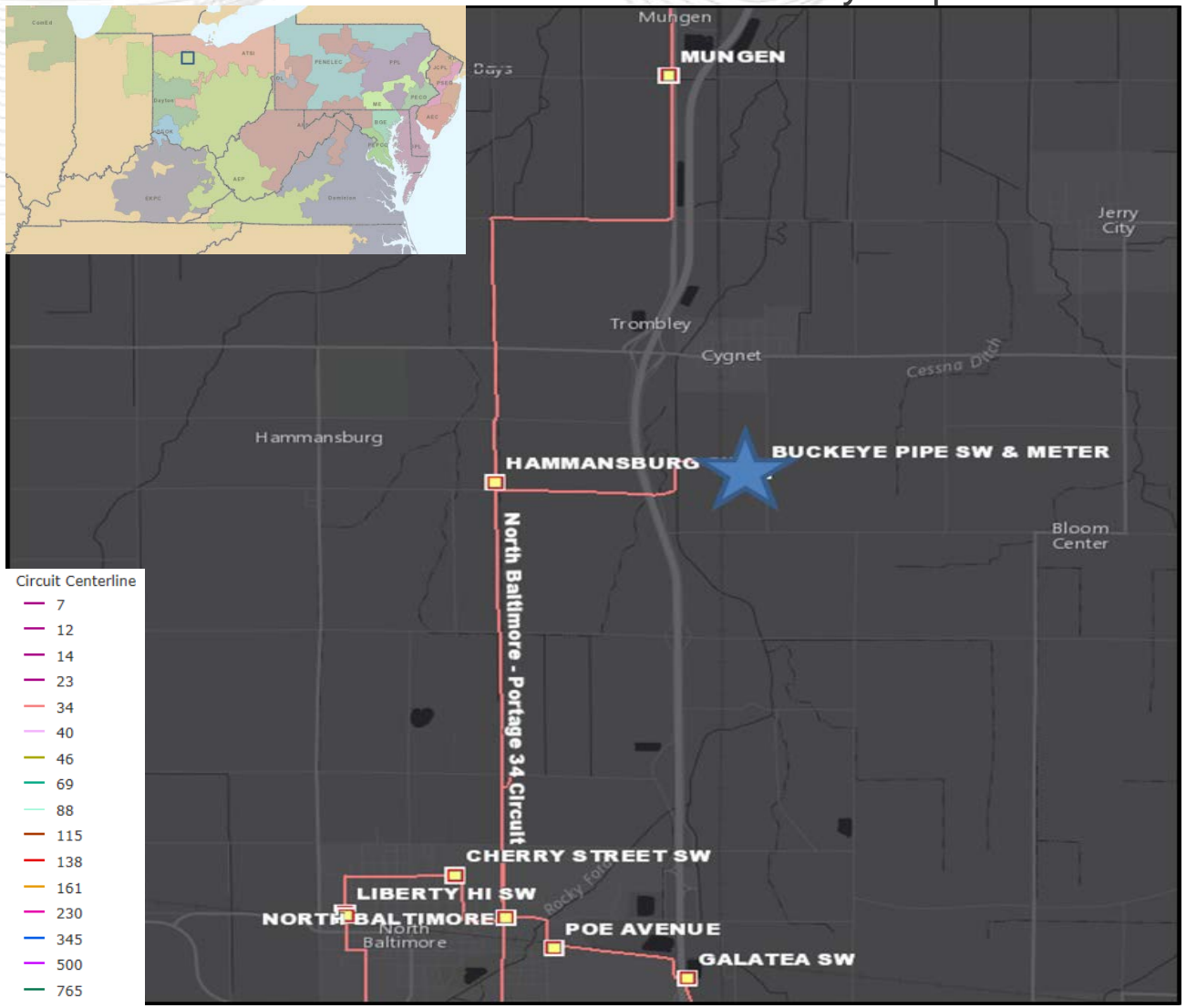

AEP Transmission Zone: Supplemental Buckeye Pipe Line

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Potential Solution

New 69kV (energized at 34.5kV) POD Box Bay (Hoiles Switch), with one MOAB towards the former customer station, Cygnet. Relaying upgrades at North Baltimore station. **Estimated Cost: $0.9M**

Cut existing line into new station, matching existing conductors of 4/0 ACSR (25 MVA rating).**Estimated Cost: $0.5M**

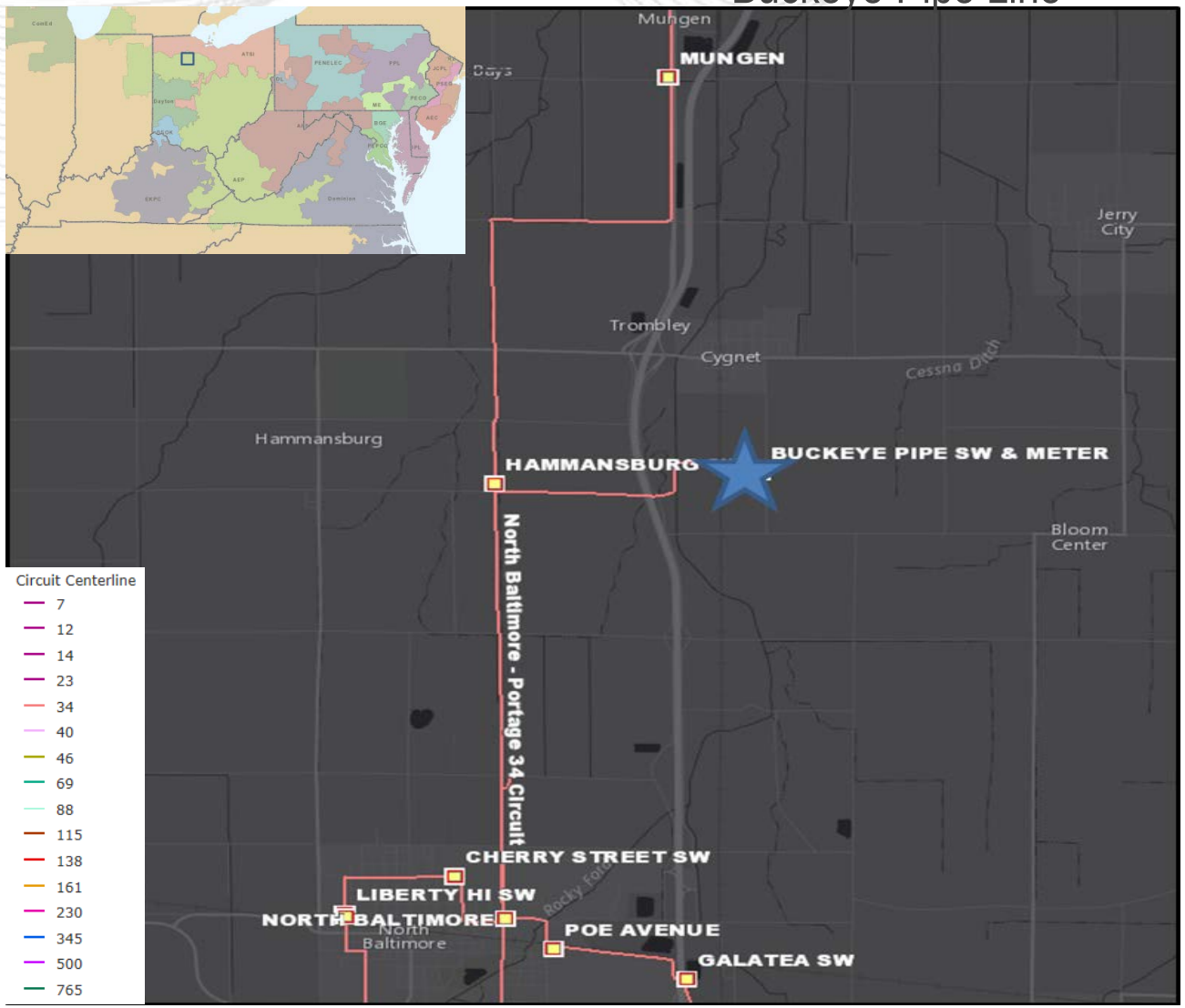
Total Estimated Transmission Cost: $1.4M

Alternatives:

Install a PH/PH switch to serve customer instead of POD structure. This alternative was ruled out due to the lack of available space. Installing a PH/PH switch will force the need for a 2nd metering structure, whereas installing a POD structure enables AEP to install the switching as well as the metering instrument transformers directly inside of the POD structure, saving ~50' of space. Installing a PH/PH switch would require more Transmission Line work as well as extended outages to the existing pipeline facility to reconfigure the positioning of the radial. Estimated Cost: $1.3M

Projected In-service: 6/30/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental Zuber

Problem Statement:

Customer Service:

AEP-Ohio requested service for a 2nd 138/13kV 50 MVA transformer with 2 additional distribution circuits to address expected overloads on existing distribution as early as 2018. Ultimate station design will include up to 4-138/13kV 50 MVA transformers.

Operational Flexibility and Efficiency

The Zuber distribution station is designed to eventually serve 4-50 MVA transformers. AEP-Ohio now plans to install the 2nd of these transformers. Due to the load density of the Columbus area, Distribution utilizes 50MVA transformers. Transmission is recommending installation of 138kV circuit breakers due to the large size of these banks and the amount of load served.

AEP Transmission is anticipating serving a large customer in the area which would drive the need for a second circuit between Beatty and Harrison. It is desirable to both maximize reliability of the station in it's proposed configuration and to minimize future outages for the future circuit to be cut into Zuber.

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AEP Transmission Zone: Supplemental Zuber

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Potential Solution

Expand Zuber station bus to a ring design with 3,000A 40kA CB's.

Estimated Cost: $3.9M

Reterminate Harrison-Beatty 138kV line on new bus work.

Estimated Cost: $0.7M

Total Estimated Transmission Cost: $4.6M

Alternatives:

Install 2nd 138/13kV 50 MVA transformer at White Road with 2 additional distribution circuits. AEP-Ohio didn't choose this alternative because Zuber station is closer to and more strategic for serving the necessary load increases and required distribution transfers. Estimated Cost: $13.0M

Projected In-service: 12/1/2019

Project Status: Engineering

AEP Transmission Zone: Supplemental Central South Bend Improvements

Problem Statement:

Equipment Material/Condition/Performance/Risk:

AEP has identified multiple rehab needs at Colfax, Drewry's and Saint Mary's stations. Colfax station is a cubicle switch gear type construction, is obsolete, and spare parts are unavailable. Mobile transformer can't be installed on site due to physical space limitations and complete station outage can only be taken during off-peak months (Sep-May). The 34.5 kV CB C and D at Colfax Station are GE FK oil-filled breakers manufactured in 1950s, have operated through 12 and 20 fault operations, exceeding the manufacturer recommendation of 10. These breakers are oil 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. The drivers for replacement of these breakers are age, number of fault operations, and a lack of repair parts. The 34.5/12 kV Transformer at Colfax was manufactured in 1974 and is also showing significant signs of deterioration. It has a load tap changer (LTC) and therefore distribution voltage regulation is difficult. Drivers for replacement of the transformer include dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), and accessory damage (bushings).

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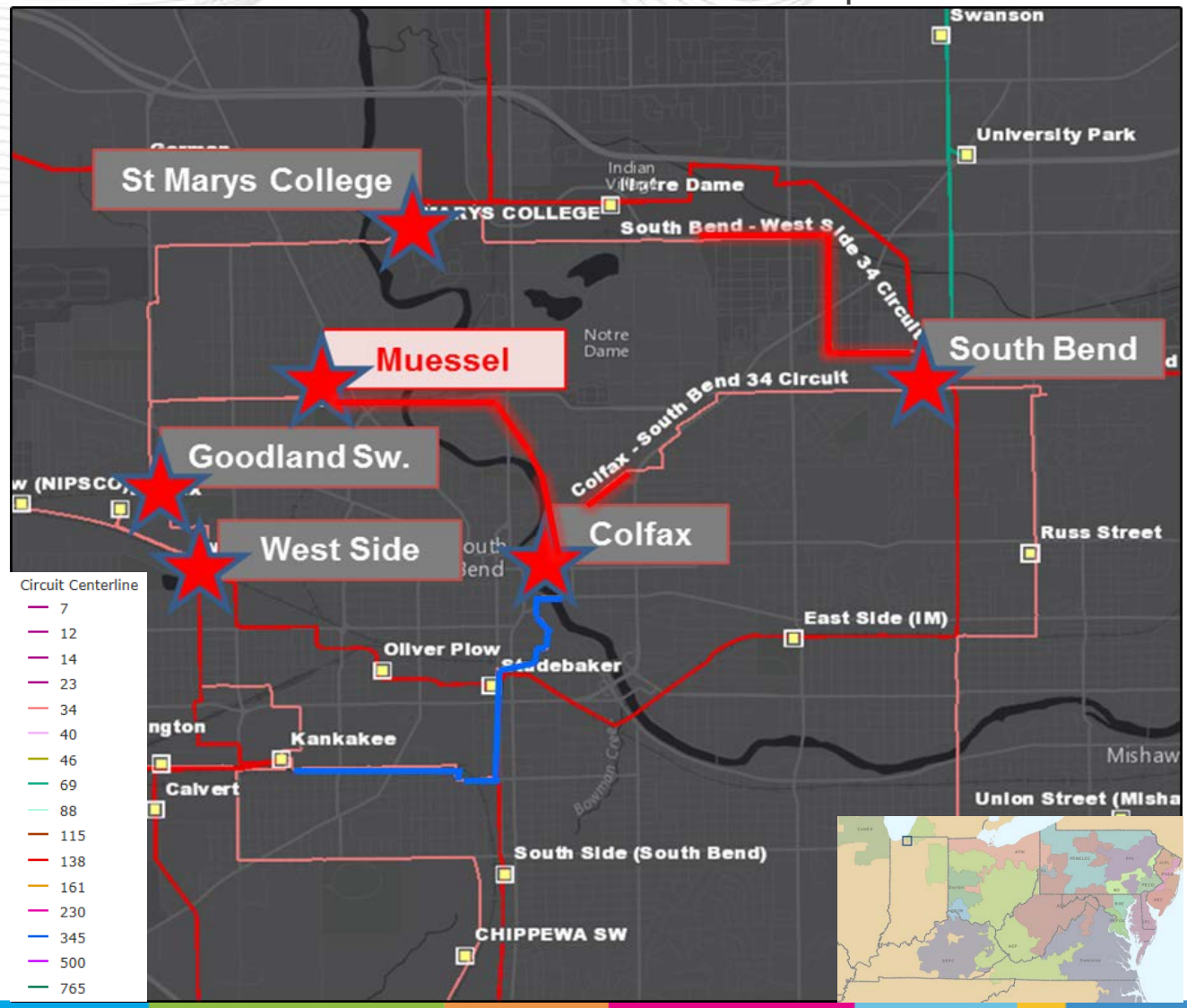

AEP Transmission Zone: Supplemental Central South Bend Improvements

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Drewry's Station is very congested and is located adjacent to Muessel Grove public park. On site mobile transformer can't be installed due to physical space limitations. Station transformers do not meet present day electrical clearance standards. Transformer high side ground switches can't be replaced with circuit switchers and low side breakers can't be installed due to physical space limitations. There is no control house present and 14 out of 20 relays are electromechanical and are obsolete. Station drive path is not available and poses additional maintenance and safety challenges. Station foundations and steel on 12 kV structures are beginning to show signs of deterioration. 12 kV circuit breaker A,B,C & D at Drewry's are 2000 vintage but have severely exceeded the life expectancy of full fault operations. The 34.5/12kV Transformer#2 was manufactured in 1963 and the steady increase in ethylene, methane, and carbon dioxide over the years show that there has been heating of the Transformer #2 at Drewry's which has deteriorated its insulation. Additionally, the LTC is not operating properly.

The 34.5/4kV Transformer at Saint Mary's Station was manufactured in 1952 and is also showing significant signs of deterioration. Drivers for replacement of the transformer include dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), and accessory damage (bushings).

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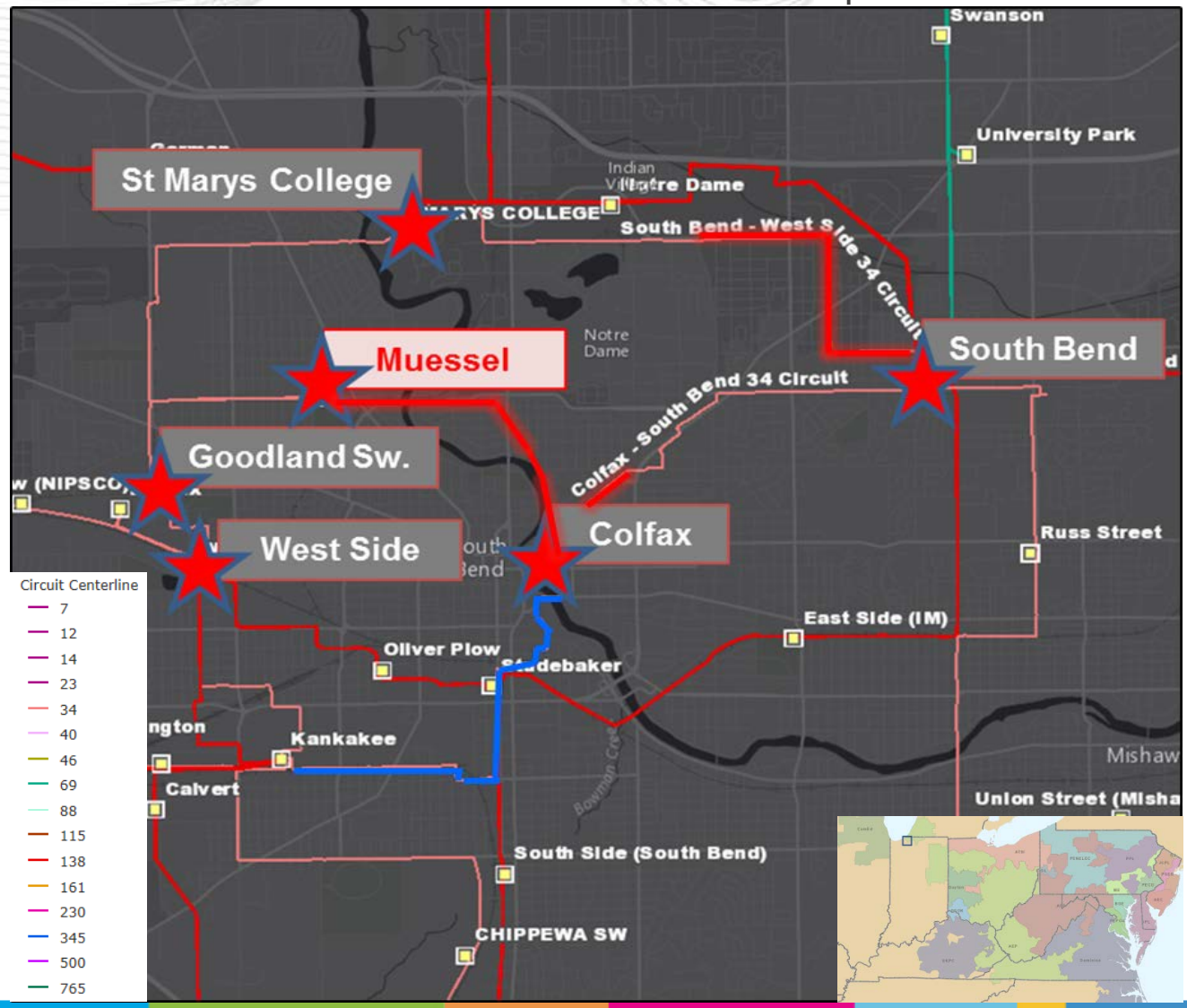

AEP Transmission Zone: Supplemental
Central South Bend Improvements

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On the Colfax-Kankakee 34.5 kV circuit, the overhead portion is ~1.5 miles while the underground section is ~1.3 miles. The overhead portion utilizes wood poles cross arm construction which is not a current AEP transmission standard. The overhead portion of this circuit is suspension insulator type construction with smaller cross-section distribution-type cross arms and braces. Historical experience with these types of wood cross arms is a higher frequency of required proactive replacement and occasional failure resulting in forced outages. The underground portion of the line occupies a manhole and conduit system that was not designed for transmission use. The underground portion occupies 33 manholes. Over half of the manholes contain transmission cable splices. An underground transmission cable system of this length should require no more than 4-7 manholes in order to minimize the number of cable splices required. Due to the number of manholes, the required number of cable splices is very excessive. Industry experience is that cable system components such as splices are a far more common failure cause than the transmission cables themselves. Almost all of the manholes are physically undersized for transmission cable system occupation, making splicing very difficult to accomplish. Many conduits are clay tile ducts installed in the 1930s. Since 2009 there have been at least seven documented failures, primarily on cable system components (splices and terminations). Cable testing performed in September 2013 and the cables passed the testing however, nine days later a cable failure occurred, causing the circuit to trip from service.

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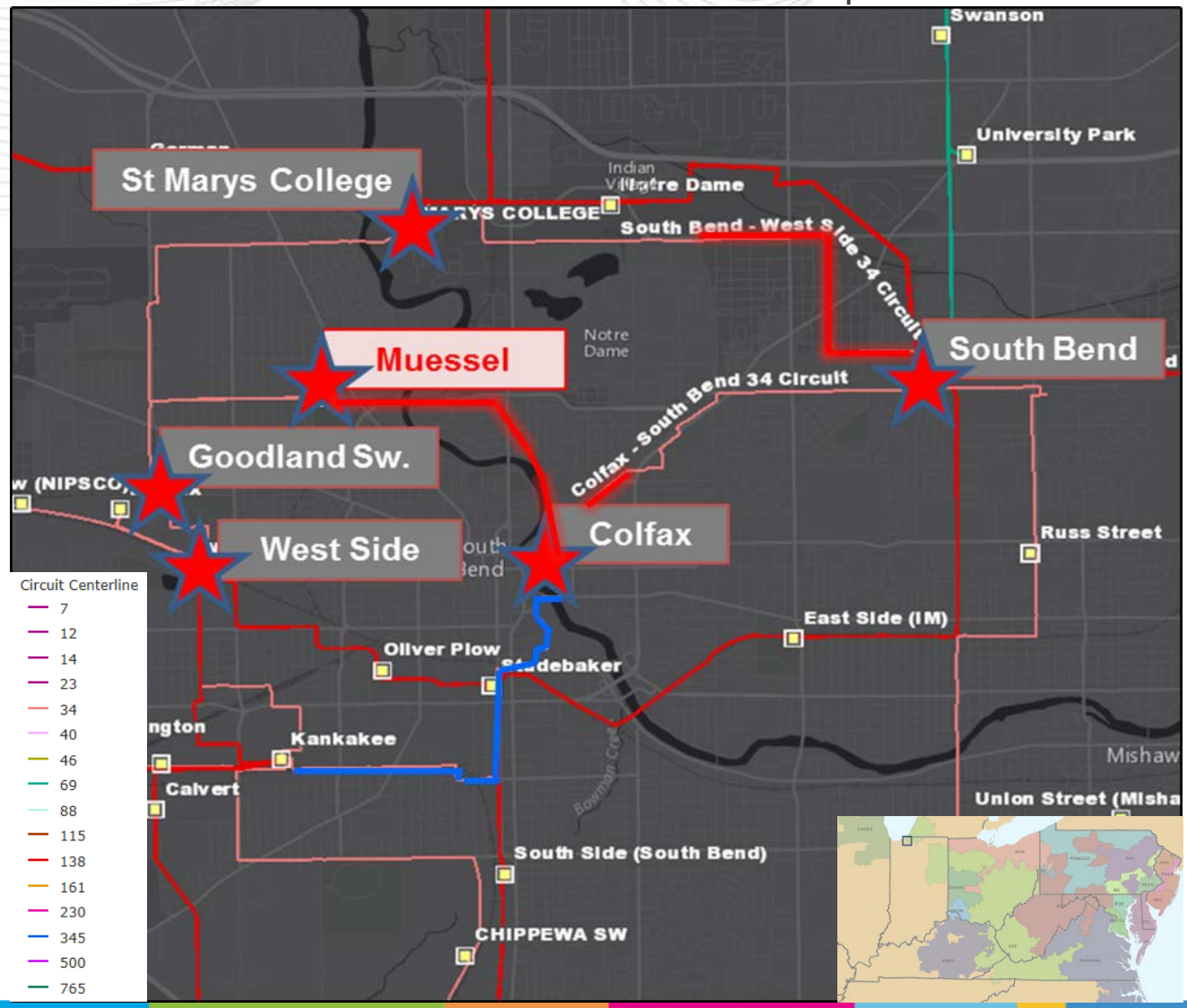

AEP Transmission Zone: Supplemental Central South Bend Improvements

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Operational Flexibility and Efficiency:

Colfax station backs up a portion of distribution load from the South Bend station. South Bend is a 138 kV station while Colfax is 34.5 kV which results in a load drop and pick issue. On average there are between 3 to 5 drop and pick cycles per year that are experienced by Colfax and Drewry's customers. Drewry's station is served by a double circuit transmission line which traverses through residential areas and a gravel pit. An outage involving the double circuit lines results in a complete station outage and the station peak load is not recoverable from an alternate source. Colfax station serves central South Bend load and is presently served from two 34.5 kV sources, South Bend and Kankakee. Kankakee source has an underground line section which is near its useful life and has been forced out multiple times in the recent past. The new Colfax – Drewery 34.5kV Line will be an additional source to Drewry's and Colfax Station. The transformer high side protection at Drewry's and Saint Mary's station is via high side ground switch scheme which is not a standard practice in modern installations. South Bend-West Side 34.5 kV circuit is ~11 miles and serves three stations (Goodland, Drewry's, and St Mary's College). There are two series MOBs each at Drewry's and St Mary's College. Having 4 MOAB in series is an undesirable configuration as it introduces coordination challenges related to P&C.

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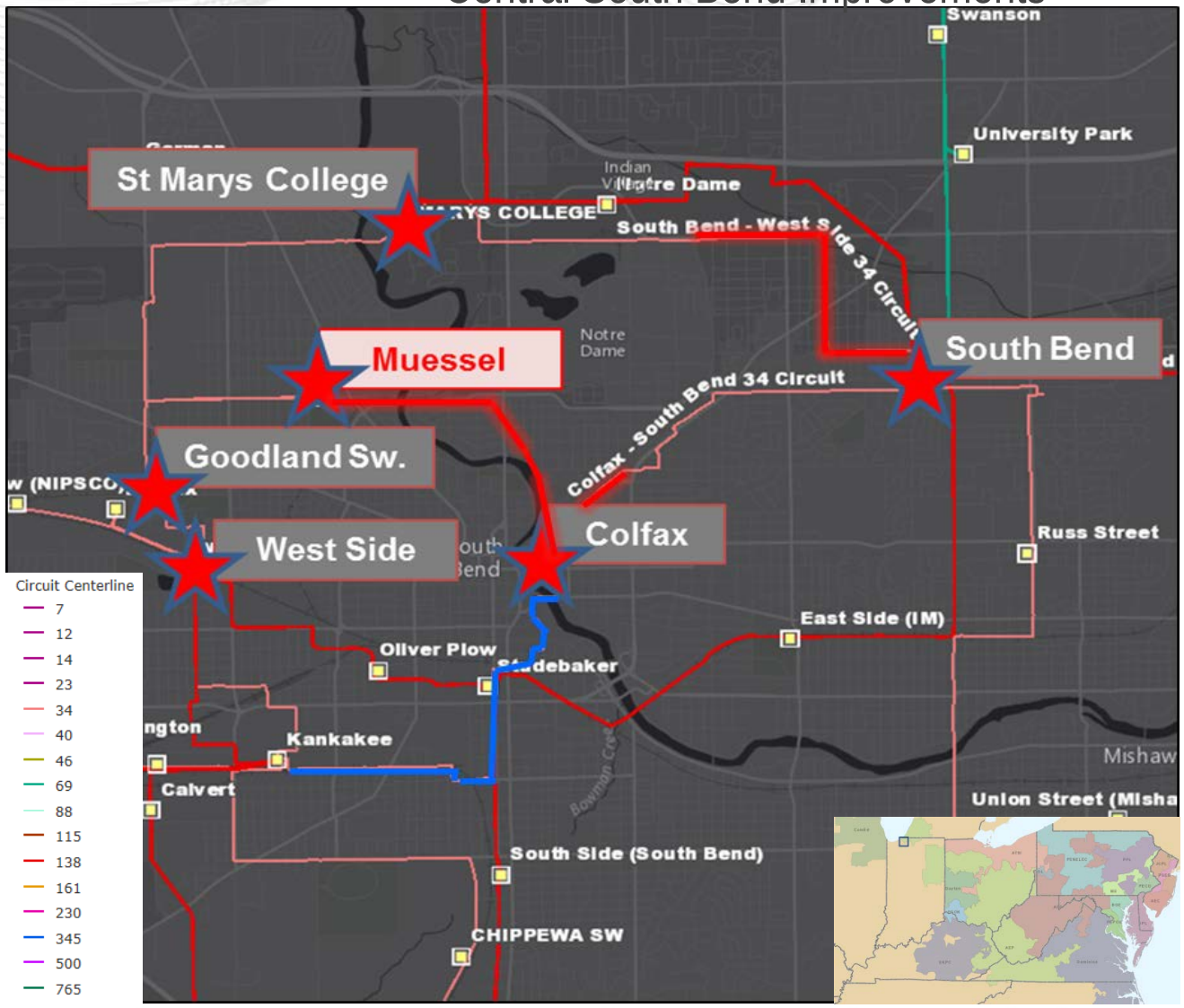

AEP Transmission Zone: Supplemental
Central South Bend Improvements

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Potential Solution

Construction of approximately 2.5 mile 69 kV underground line between Colfax and Muessel using 1750KCMIL Copper XLPE Conductor. Estimated Cost: $20.1M

Install Drewry's Extension 34.5kV. Estimated Cost: $0.7M

Retire Kankakee – Colfax (UG) 34kV Line. Estimated Cost: $0.6M

Rebuild .33 miles of the South Bend - Colfax UG line using 1750KCMIL Copper XLPE Conductor. Estimated Cost: $4.1M

Rebuild 1.9 miles of the South Bend – West Side Line using 795 ACSR (64 MVA rating). Estimated Cost: $3.7M

Bendix – Kankakee 34.5kV Line Work. Estimated Cost: $0.2M

South Bend station work to set up 69kV energization. Estimated Cost: $0.6M

West Side station work to set up 69kV energization. Estimated Cost: $0.5M

Completely rebuild Colfax station. Install a 69kV CB towards Muessel Station. Replace 34kV CB D with a 69kV CB towards South Bend Station. Install a 69kV SWR, 69/12kV TR#1 and (4) 12kV CB's. All 69kV CB's are 40kA breakers. Estimated Cost: $1.8M

Completely rebuild Drewrys station as Muessel station in the clear. Install (3) 69kV line CB's, (1) Bus Tie CB, (2) 69kV SWR's, (2) 69/12kV TR's and (7) 12kV CB's.All 69kV CB's are 40kA breakers. Estimated Cost: $5.0M

At St. Mary's College, install 69kV circuit switcher. Replace 69/12kV TR and (2) 69kV switches. Estimated Cost: $2.0M

Relocate Goodland Sw to West Side – Bendix 34kV Line. Estimated Cost: $1.0M

Kankakee: Remove breaker I. Estimated Cost: $0.1M

Total Estimated Transmission Cost: $40.4M

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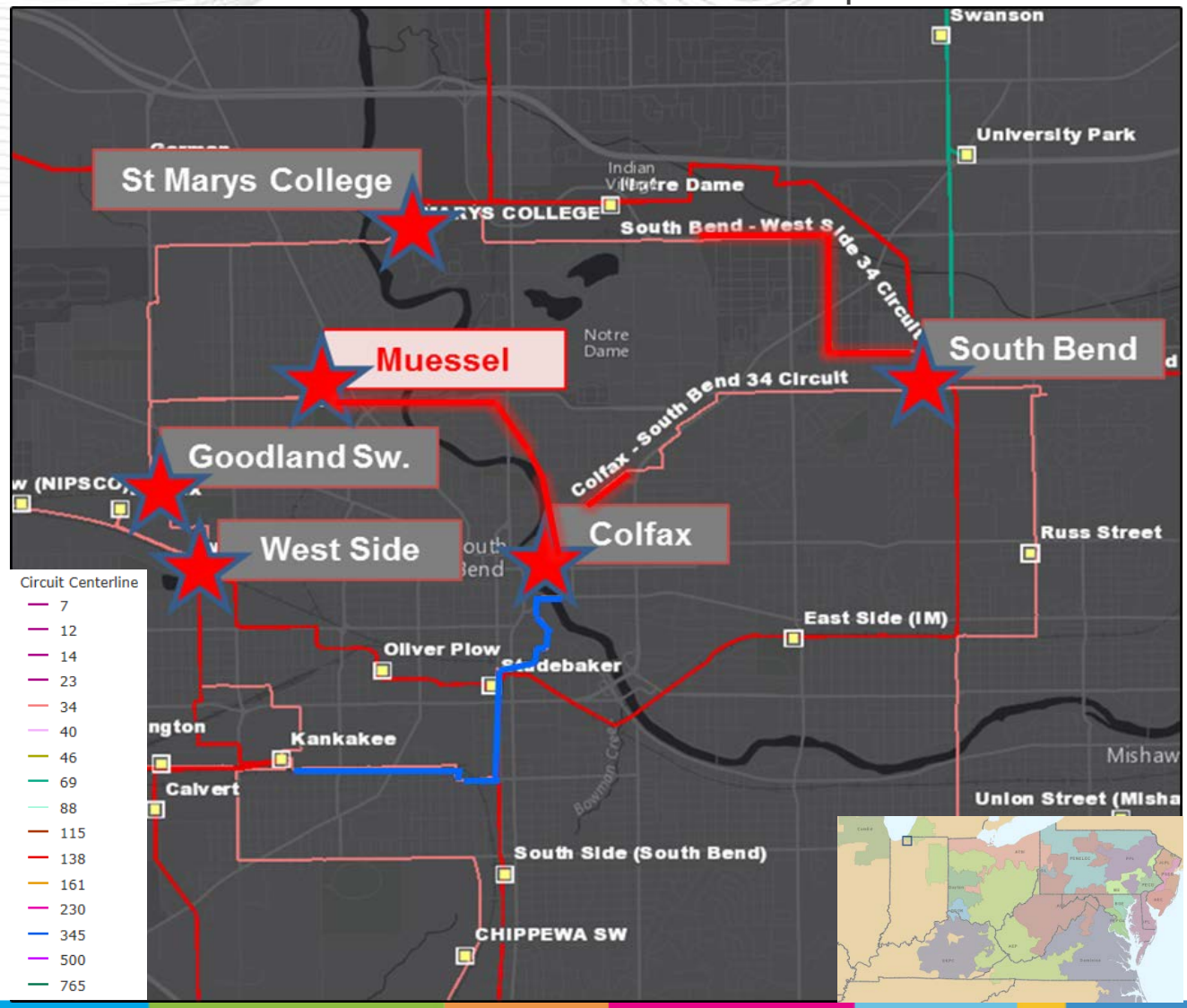


AEP Transmission Zone: Supplemental
Central South Bend Improvements

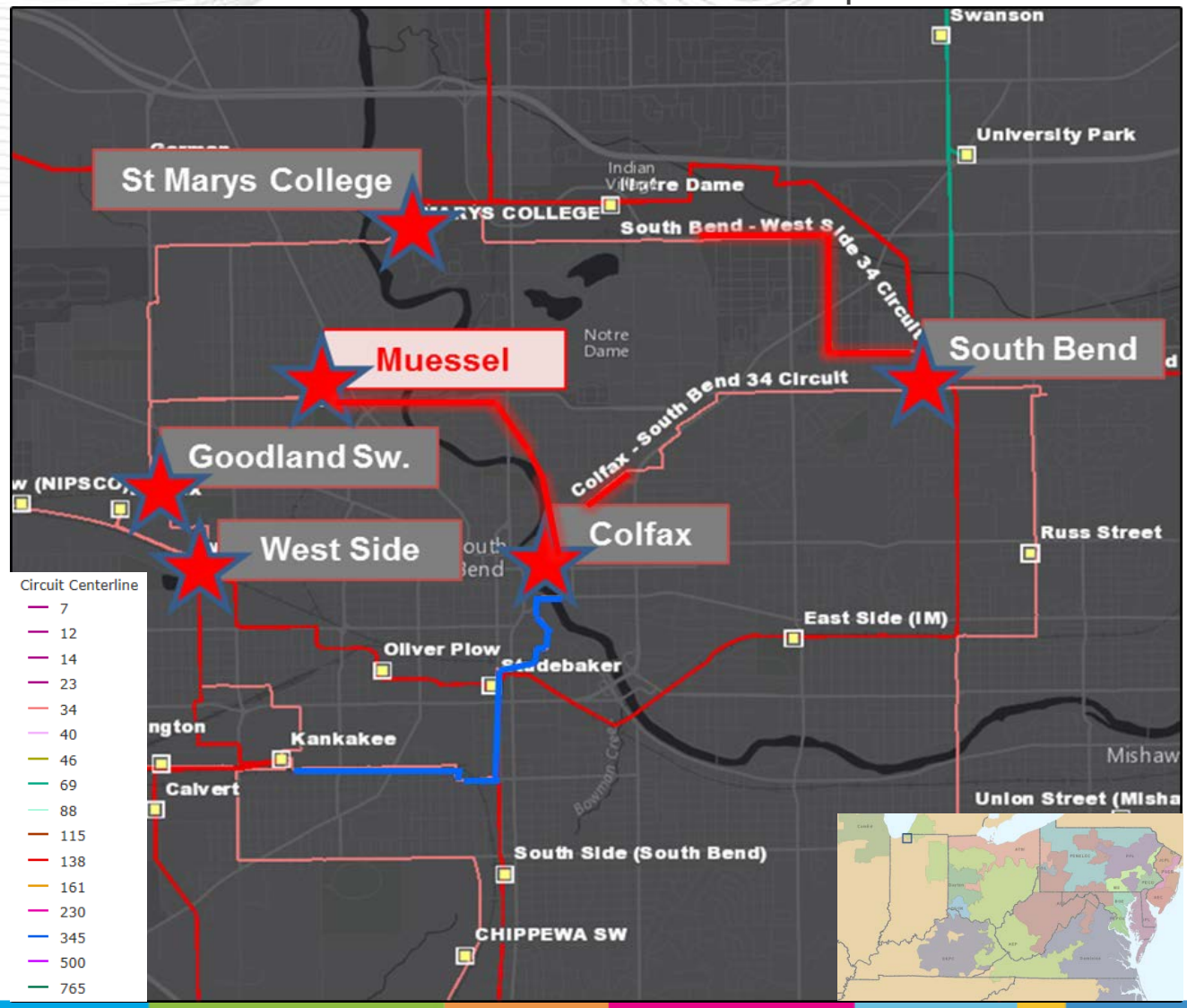
Continued from previous slide…

Alternatives:

Rebuild Colfax – Kankakee 34.5kV Circuit, consisting of ~1.5 miles overhead and additional ~1.8 miles underground section. This is not recommended as rebuilding the 2.5 mile long section toward Muessels enables the full retirement of this line. Estimated cost: $25M

Projected In-service: 5/10/2020

Project Status: Scoping



Second Review

Baseline Reliability and Supplemental Projects

Previously Presented: 3/9/2018 SRRTEP

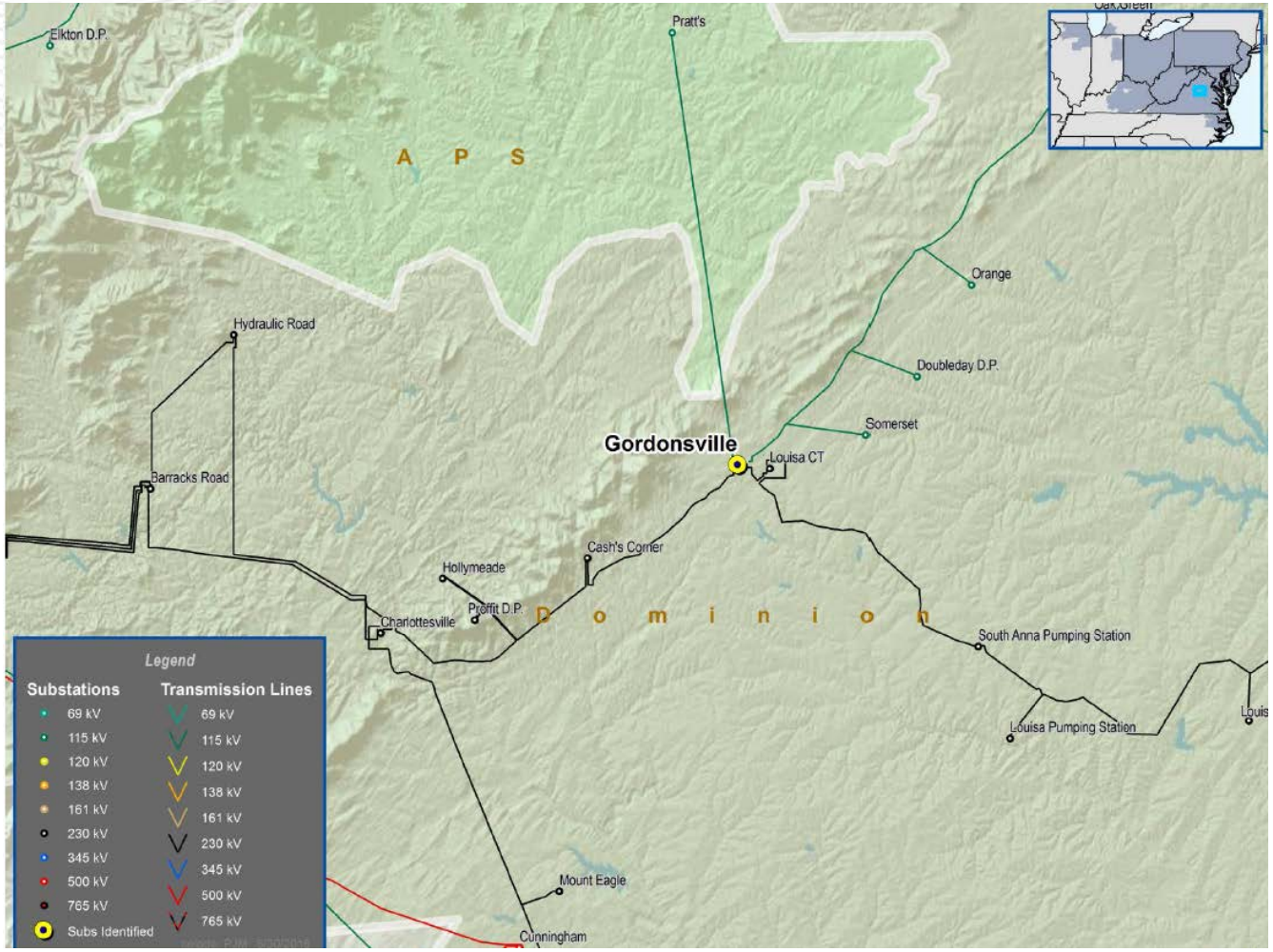
FE Scope for Dominion Baseline B2747

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
Twombley Road –West DeKalb-Glidden line

Previously Presented: 3/9/2018 SRRTEP

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 (Twombley) – 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.

Selected Solution:

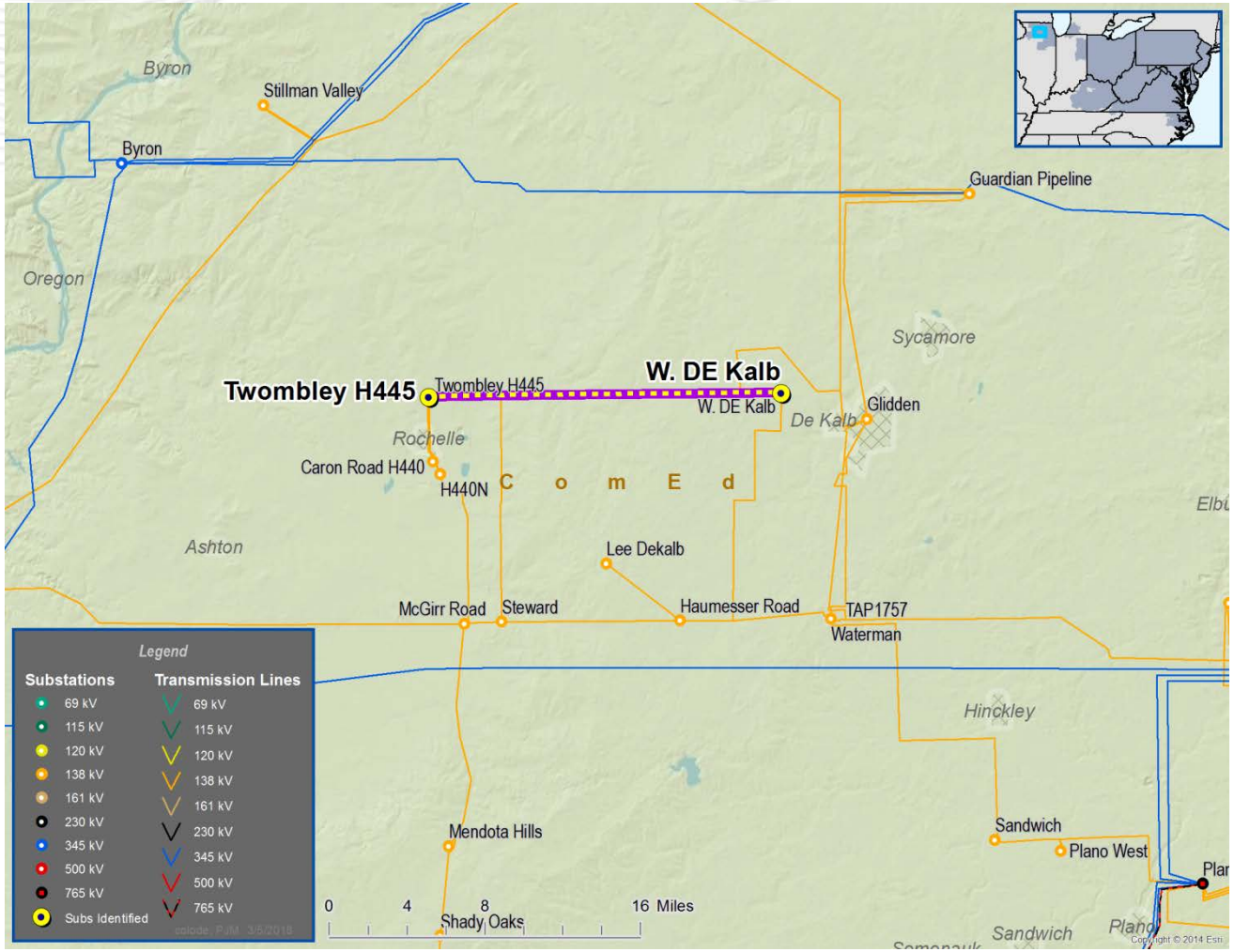
Construct a new line from the Twombley Road substation to a tap of the West DeKalb to Glidden 138 kV line just outside the West DeKalb 138 kV substation. (S1533.1)

ComEd side work at West DeKalb to accommodate the Connection. (S1533.2)

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

Projected In-service: 10/1/2021

Project Status: Engineering



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

Previously Presented: 3/9/2018 SRRTEP

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.

Driver : Equipment Condition, Performance and Risk

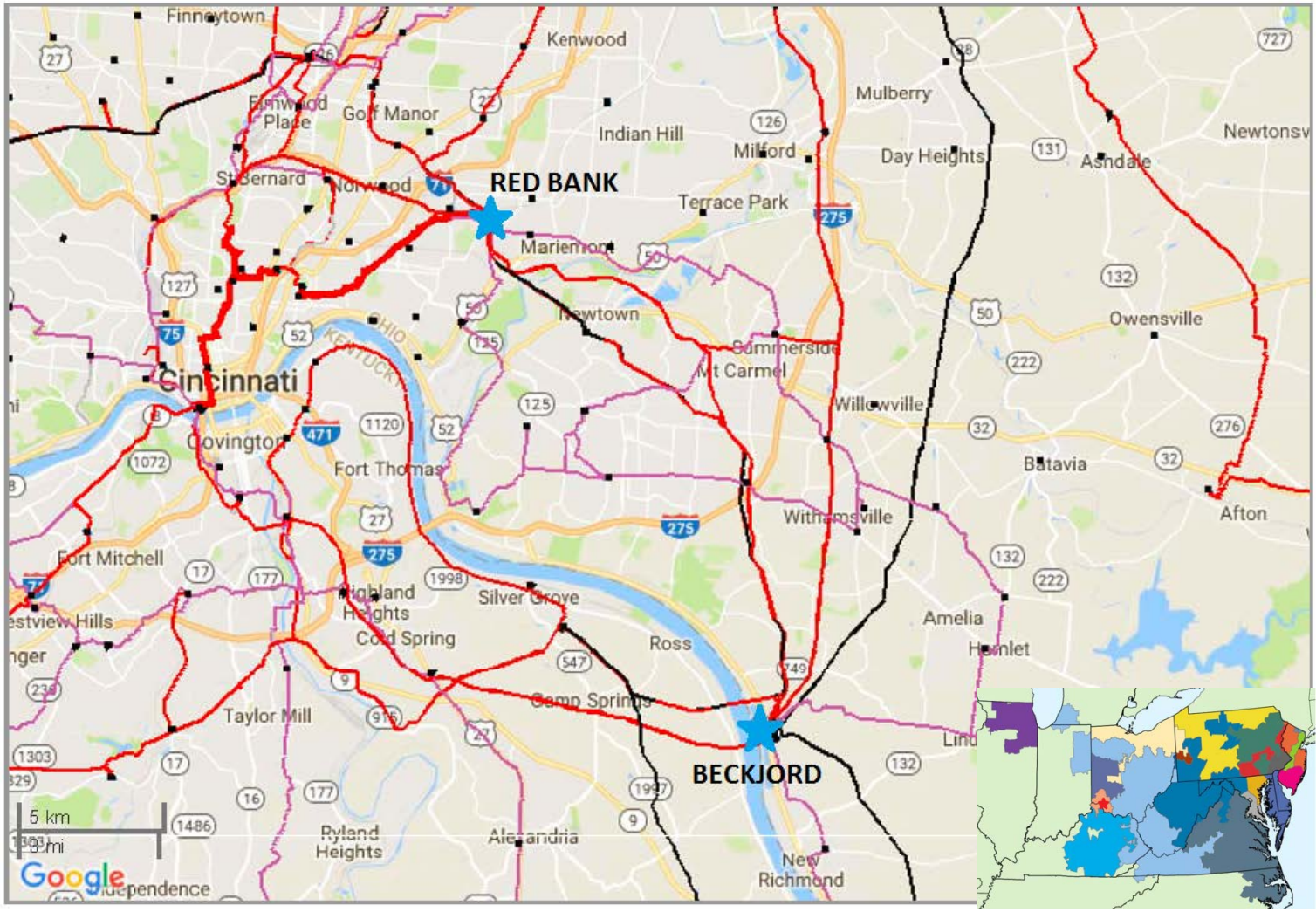
Selected Solution:

Replace the breakers, breaker disconnects, and metering equipment at Beckjord and Redbank 138kV. The Beckjord – Red Bank 138KV Branch rating will increase to 340 MVA (conductor limited). (S1534)

Estimated Cost: $1.86 M

Projected In-service: 12/31/2018

Project Status: Scoping



DEOK Transmission Zone: Supplemental
Dixie – Expand Substation

Previously Presented: 3/9/2018 SRRTEP

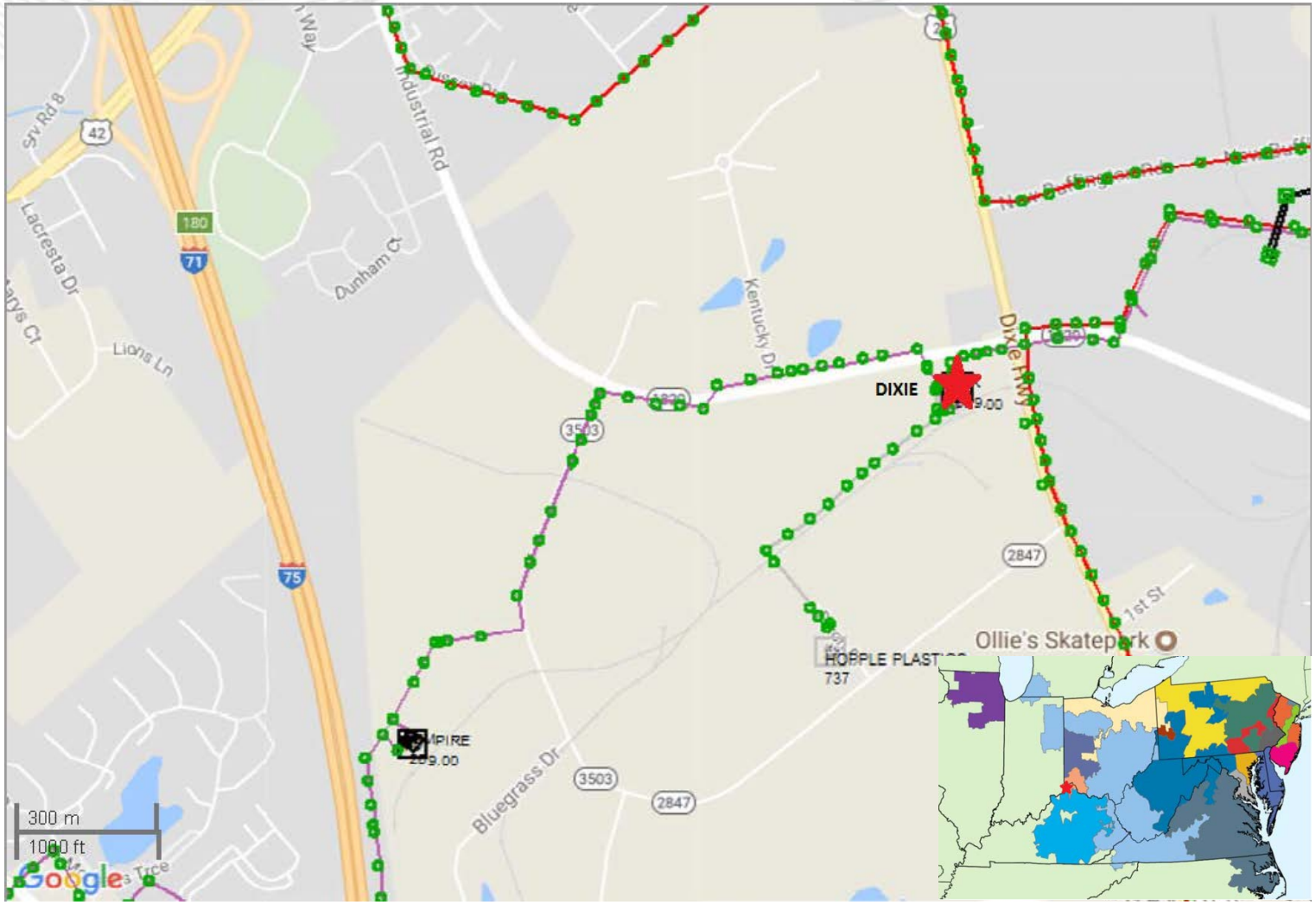
Problem Statement:
Load growth requires expanding Dixie substation.
Driver : Customer Service

Selected Solution:
Install a 69/13 kV 10 MVA transformer, bus work and breakers at Dixie 69KV substation to support two new distribution feeders. (S1535)

Estimated Cost: $0 M

Projected In-service: 12/31/2018

Project Status: Scoping



DEOK Transmission Zone: Supplemental Ebenezer Replace Switchgear

Previously Presented: 3/9/2018 SRRTEP

Problem Statement:

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

Driver : Equipment Condition, Performance and Risk

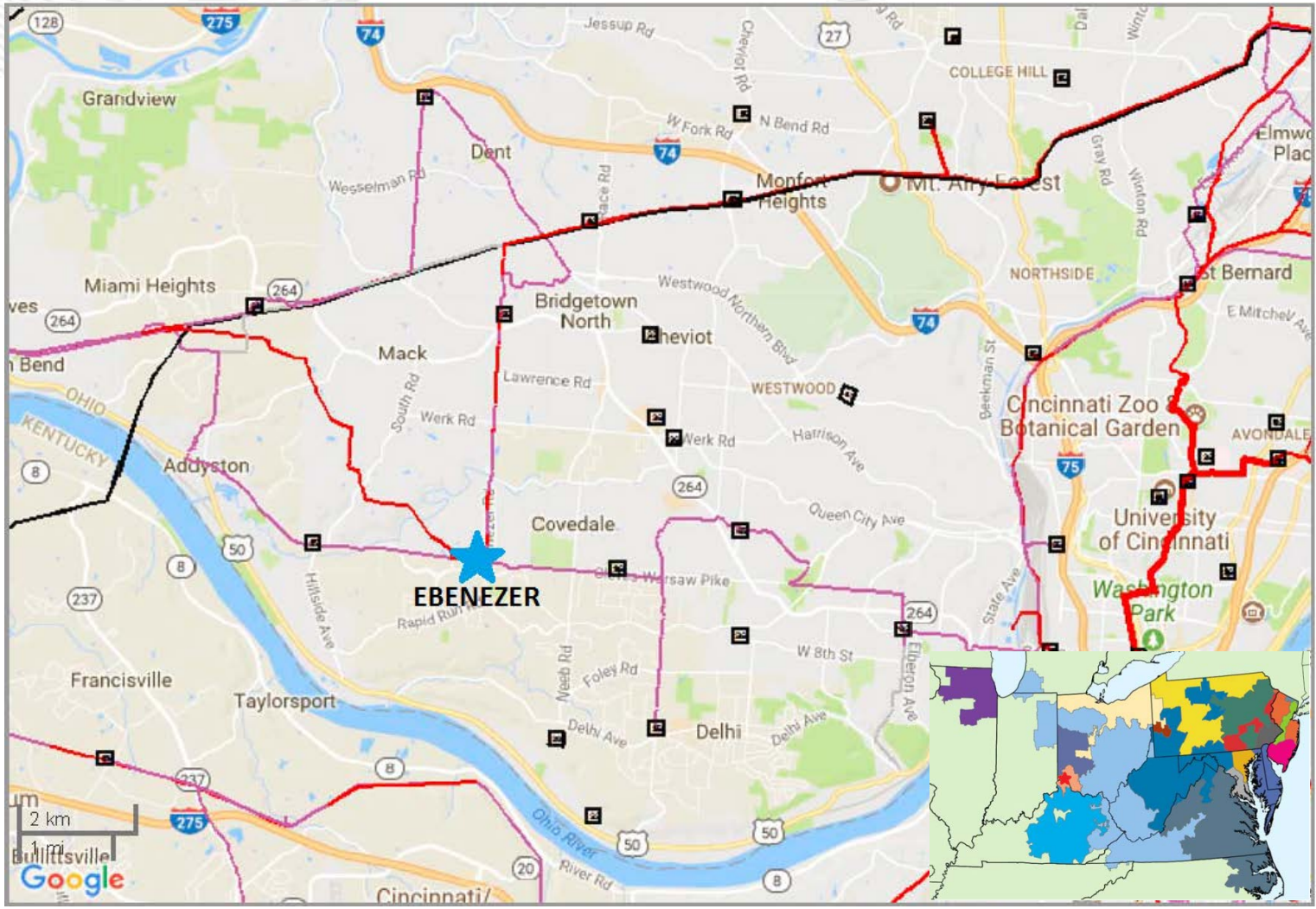
Selected Solution:

Replace the 13kV switchgear at Ebenezer and 69/13kV TB4 with a new transformer. (S1536)

Estimated Cost: $0 M

Projected In-service: 12/31/2018

Project Status: Scoping



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

Previously Presented: 3/9/2018 SRRTEP

Problem Statement:

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

Driver: Equipment Material Condition, Performance and Risk

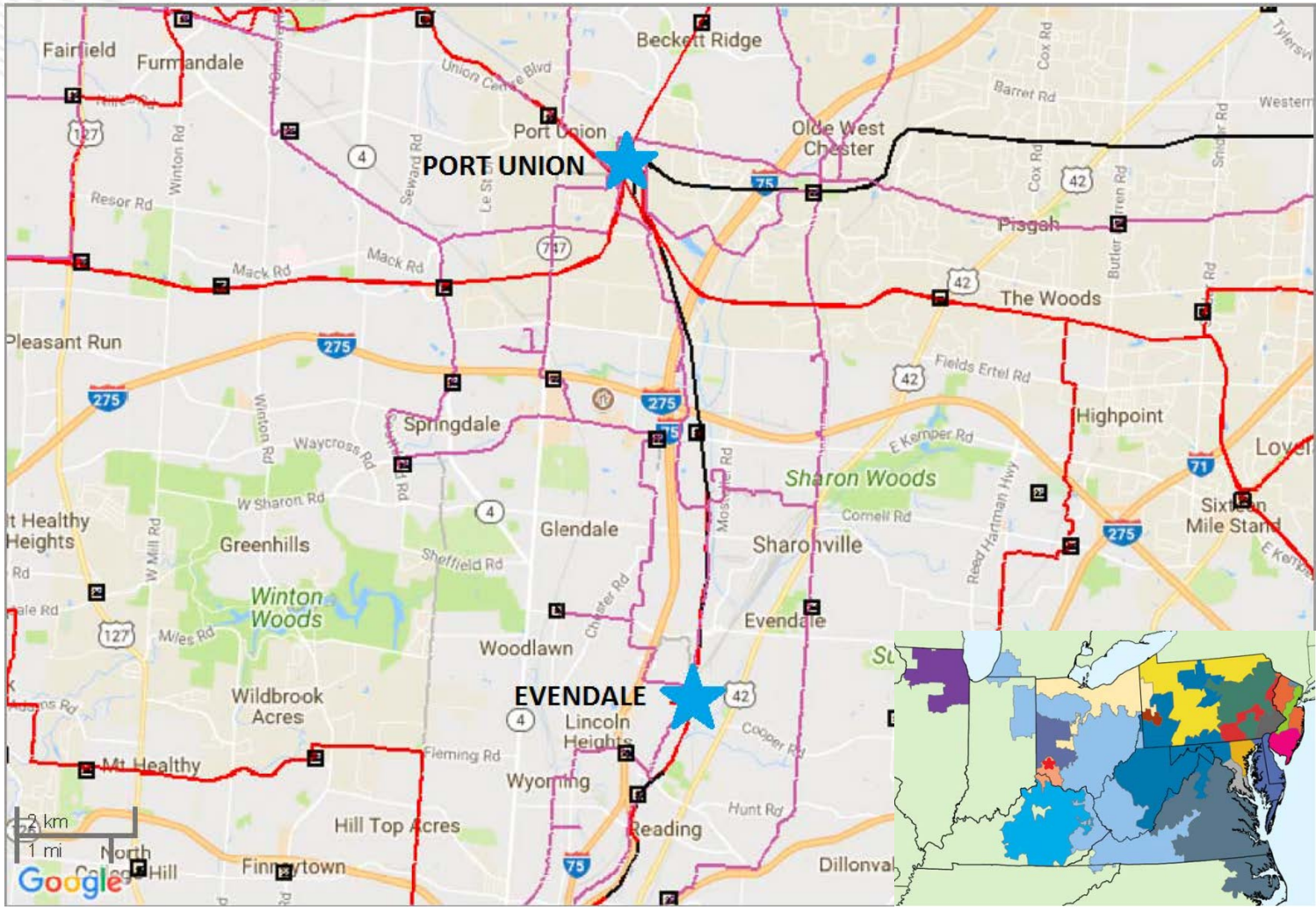
Selected Solution:

Rebuild 9.5 miles of feeder between Evendale and Port Union 69kV substations with new structures, hardware, switches and conductor. Capacity will increase from 97 MVA to 114 MVA (through bus limited). (S1537)

Estimated Cost: $10.8 M

Projected In-service: 12/1/2018

Project Status: Scoping



DEOK Transmission Zone: Supplemental Goodwin – New Distribution Substation

Previously Presented: 3/9/2018 SRRTEP

Problem Statement:

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

Driver : Customer Service

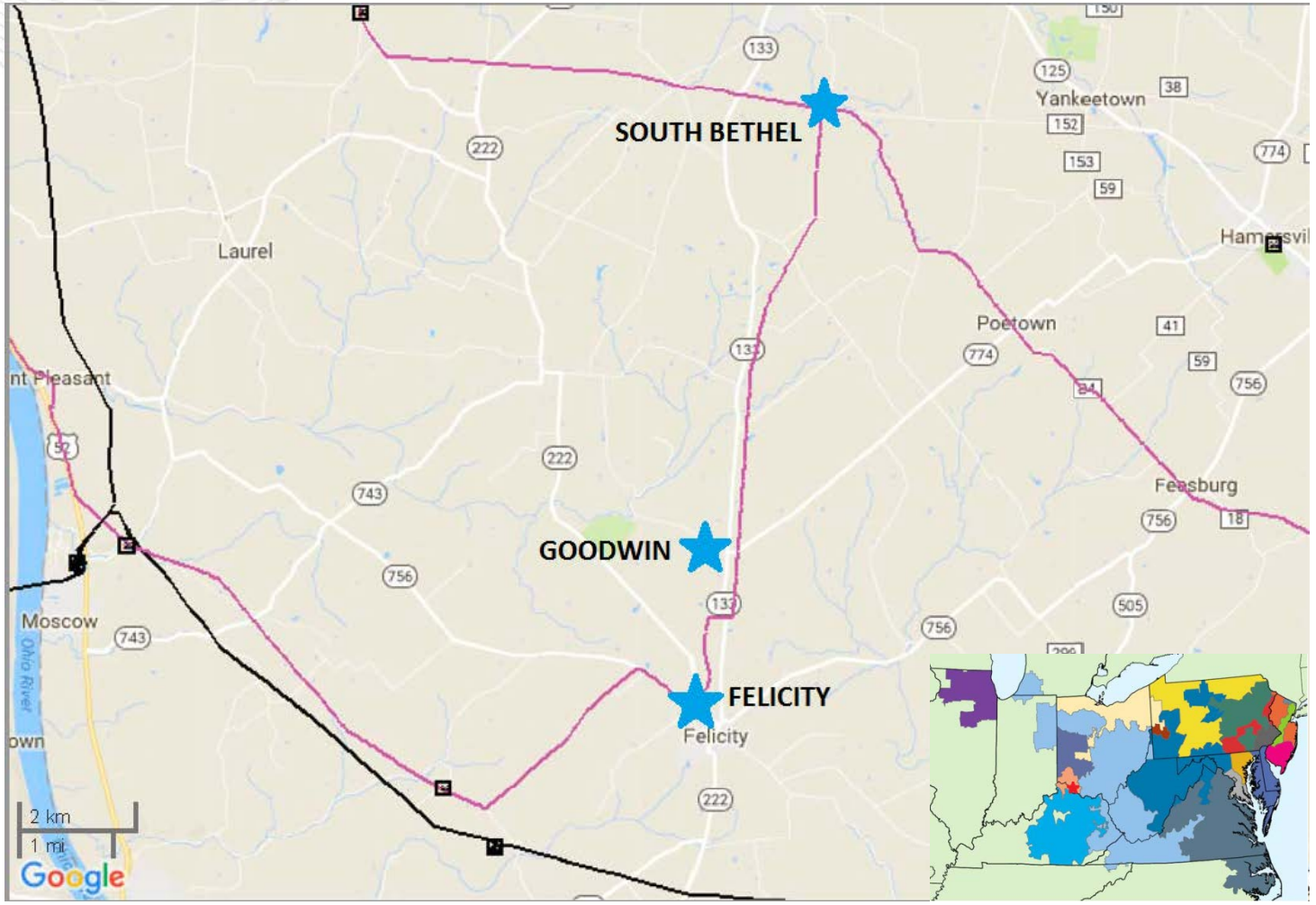
Selected Solution:

Build a new 69/13kV distribution Goodwin substation separating the South Bethel – Felicity 69KV feeder into two segments. Install a 69/13 kV 10 MVA transformer, bus work and breakers to support the distribution feeders. (S1538)

Estimated Cost: $0 M

Projected In-service: 12/31/2018

Project Status: Scoping



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

Previously Presented: 3/9/2018 SRRTEP

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

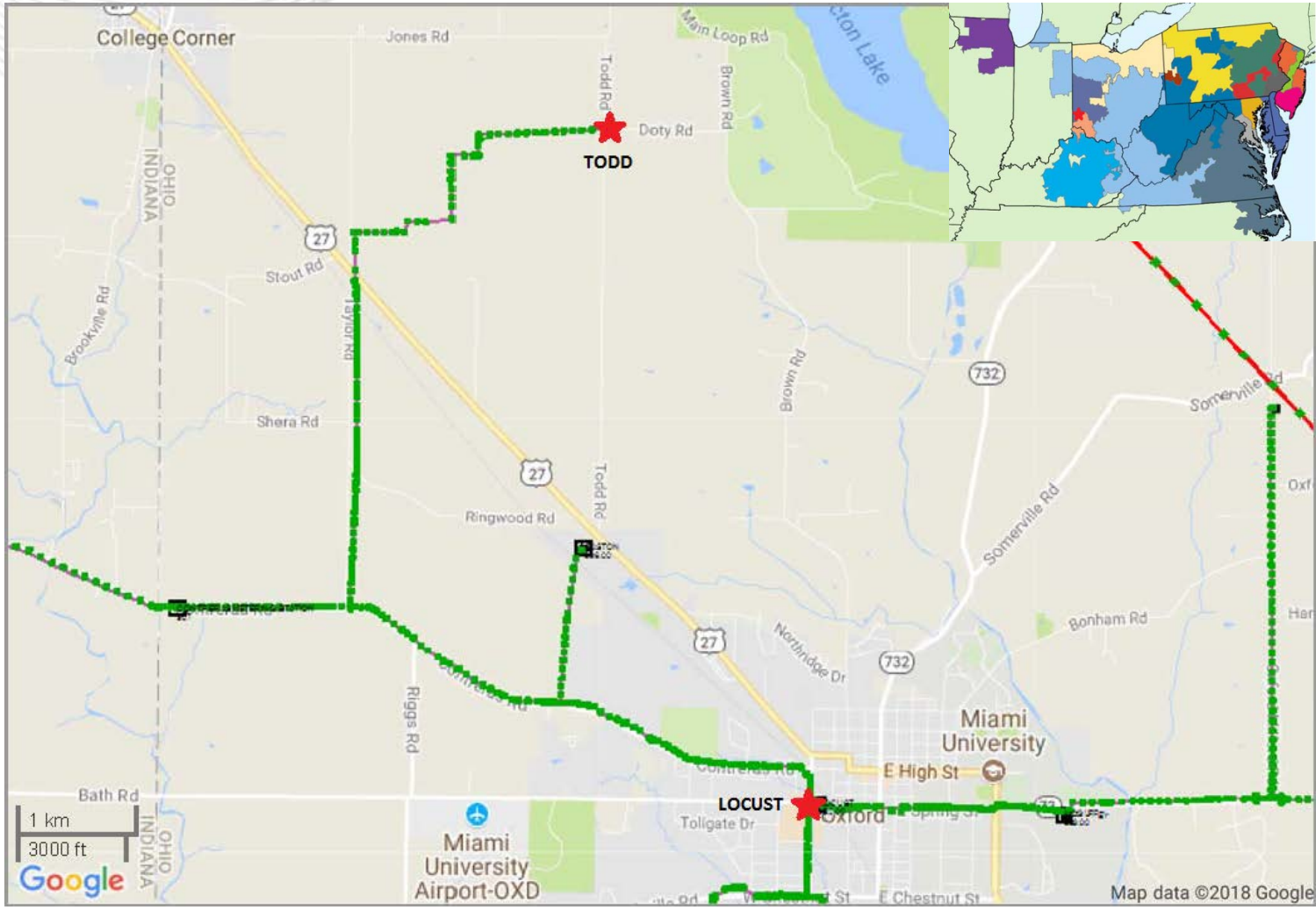
Driver: Equipment Material Condition, Performance and Risk

Selected Solution:
Rebuild 6.4 miles of69kV 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. (S1539)

Estimated Cost: $7.5 M

Projected In-service: 12/1/2018

Project Status: Scoping



DEOK Transmission Zone: Supplemental
New Richmond – Expand Substation

Previously Presented: 3/9/2018 SRRTEP

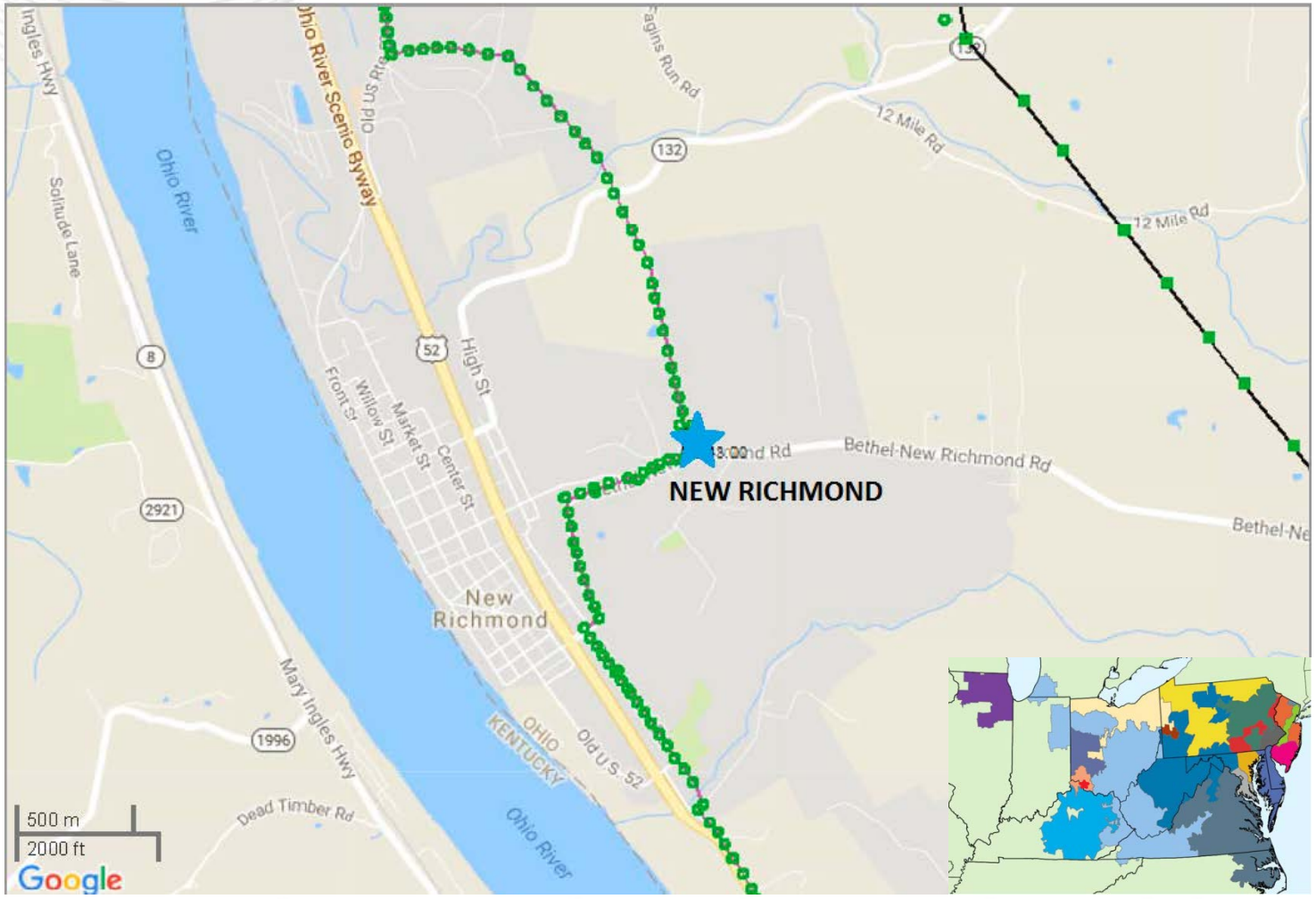
Problem Statement:
There is high winter loading and low voltage on a New Richmond 13kV distribution feeder.
Driver : Customer Service

Selected Solution:
Split the feeder into three segments all terminating at New Richmond 69KV substation. Install a 69/13 kV 10 MVA transformer, bus work and breakers to support two new distribution feeders. (S1540)

Estimated Cost: $0 M

Projected In-service: 12/31/2018

Project Status: Scoping



DEOK Transmission Zone: Supplemental
Oakbrook – Expand Substation

Previously Presented: 3/9/2018 SRRTEP

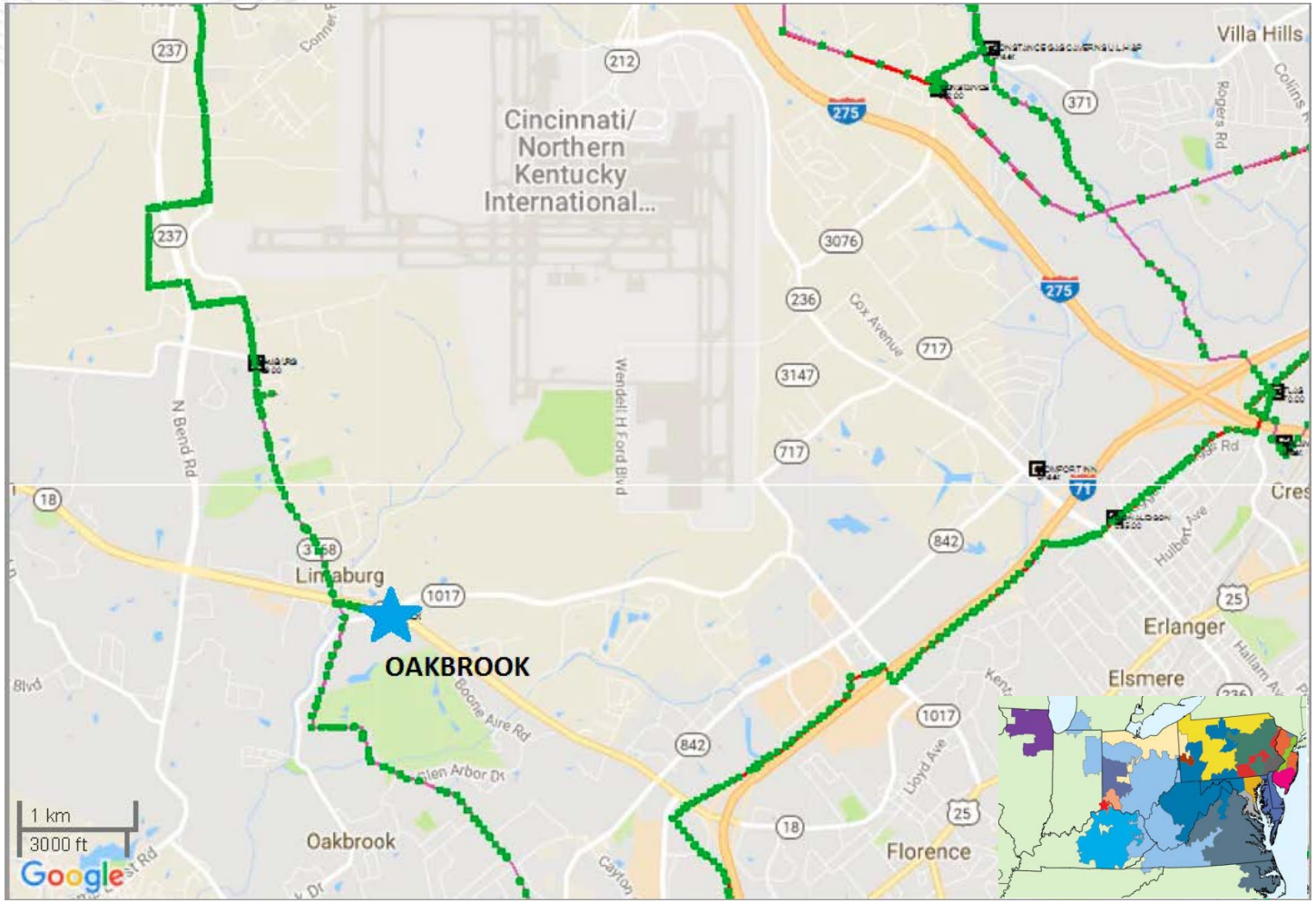
Problem Statement:
Distribution load at Oakbrook substation is predicted to grow due to new commercial development.
Driver : Customer Service

Selected Solution:
Install a 69/13 kV 10 MVA transformer, bus work and breakers at Oakbrook to support two new distribution feeders. (S1541)

Estimated Cost: $0 M

Projected In-service: 12/31/2018

Project Status: Scoping



DEOK Transmission Zone: Supplemental
Red Bank Replace Tie Breaker

Previously Presented: 3/9/2018 SRRTEP

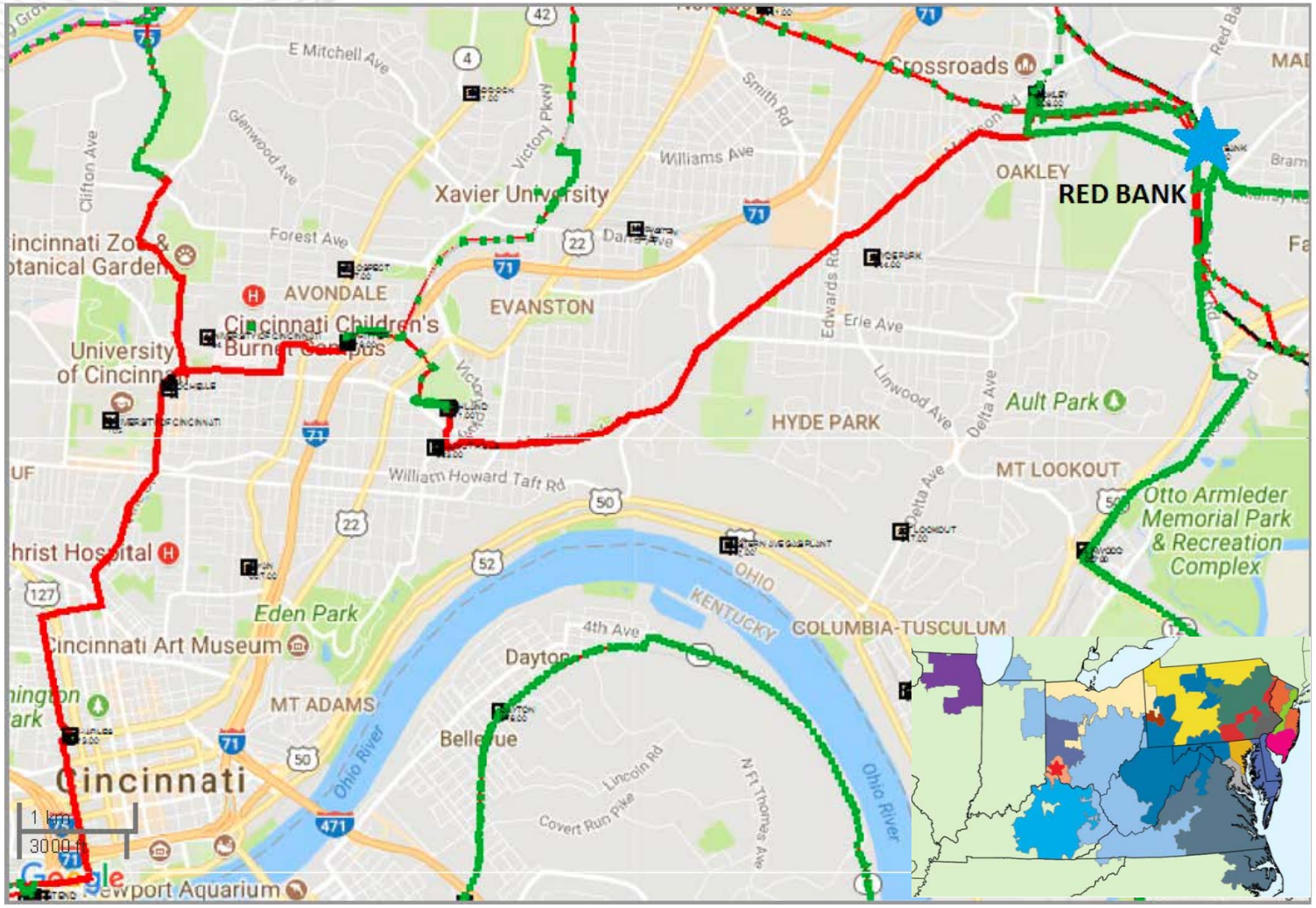
Problem Statement:
The tie breaker between Redbank 138kV buses one and two is a vintage 1975, obsolete, oil filled breaker and is stuck open (will not stay closed).
Driver : Equipment Condition, Performance and Risk

Selected Solution:
Replace the tie breaker between Redbank 138kV buses . (S1542)

Estimated Cost: $1M

Projected In-service: 12/31/2018

Project Status: Scoping



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

Previously Presented: 3/9/2018 SRRTEP

Problem Statement:

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

Driver: Equipment Material Condition, Performance and Risk

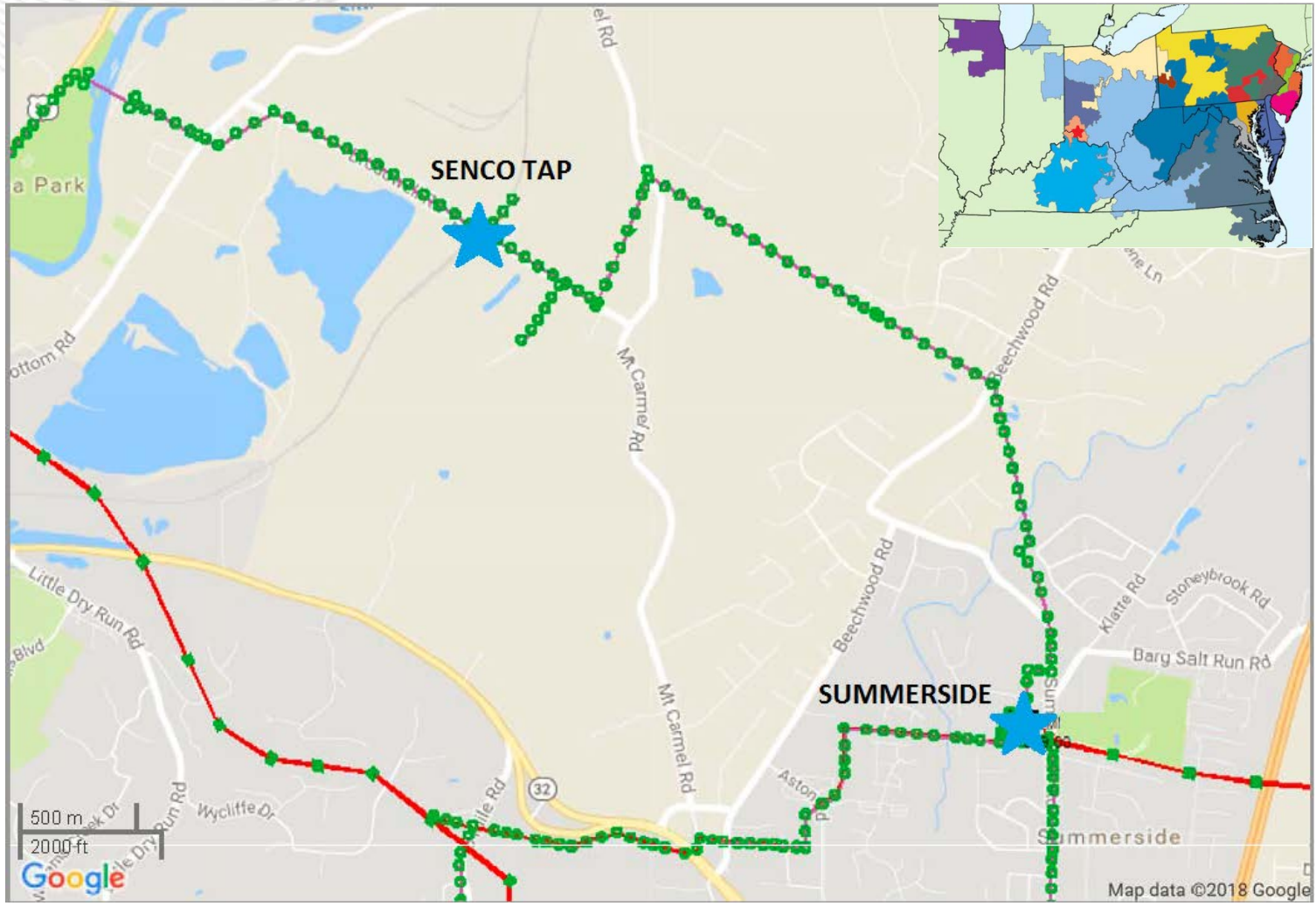
Selected Solution:

Rebuild 2.9 miles of 69kV 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. (S1543)

Estimated Cost: $2.95 M

Projected In-service: 12/1/2018

Project Status: Scoping



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

Previously Presented: 3/9/2018 SRRTEP

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.

Driver : Equipment Condition, Performance and Risk

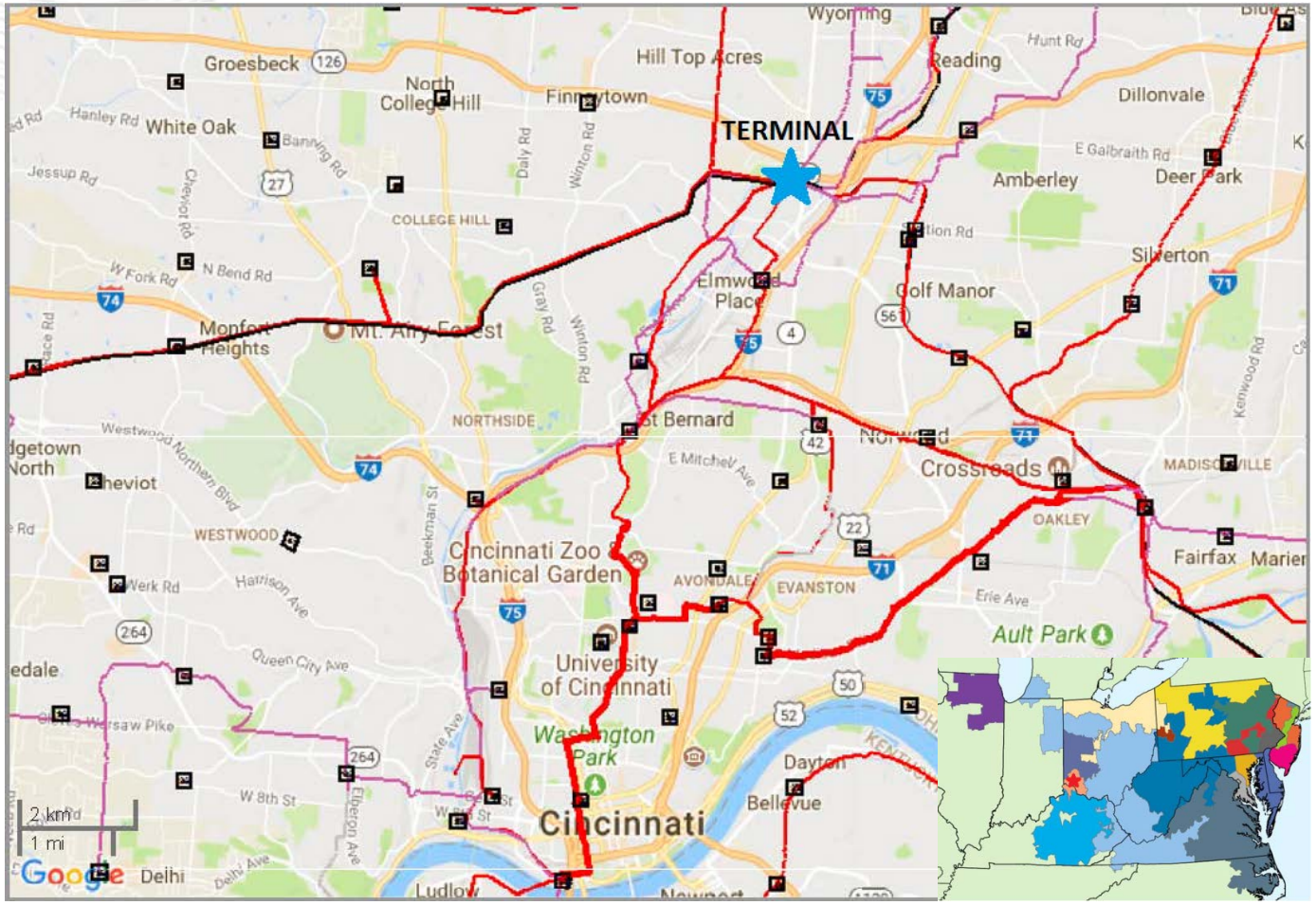
Selected Solution:

Replace the Terminal 138/69kV transformer TB2 with an existing 100 MVA spare from the Indiana system. (S1544)

Estimated Cost: $1.6 M

Projected In-service: 4/30/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental Boone Breakers

Previously Presented: 3/9/2018 SRRTEP

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.

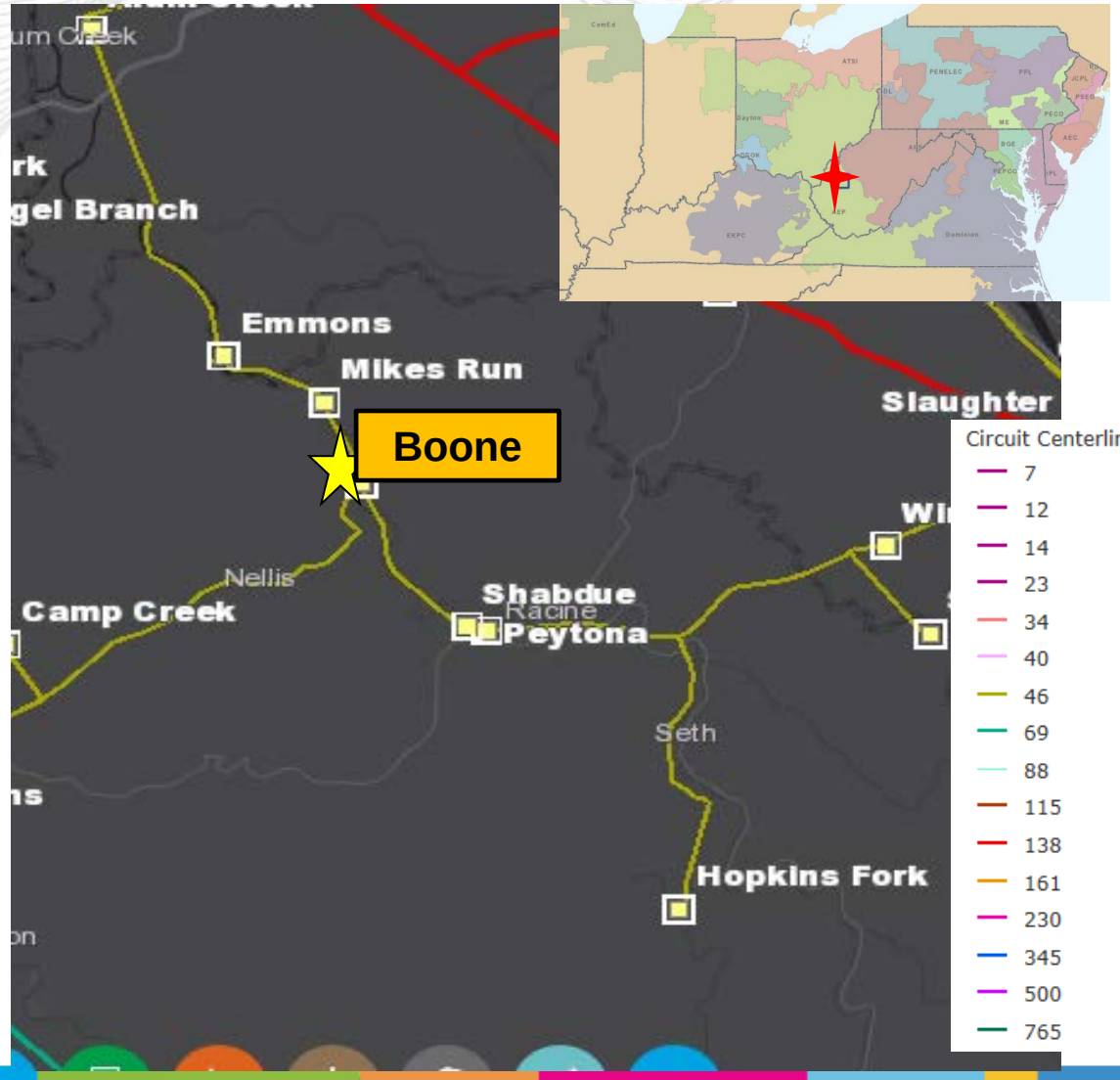
Selected Solution

Replace three existing 1200 A 20 kA 46 kV circuit breakers "A", "B", and "C" at Boone with new 3000 A 40 kA 46 kV circuit breakers. (S1545)

Estimated Cost: $1.5M

Projected In-service: 11/1/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental Heath Breakers

Previously Presented: 3/9/2018 SRRTEP

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.

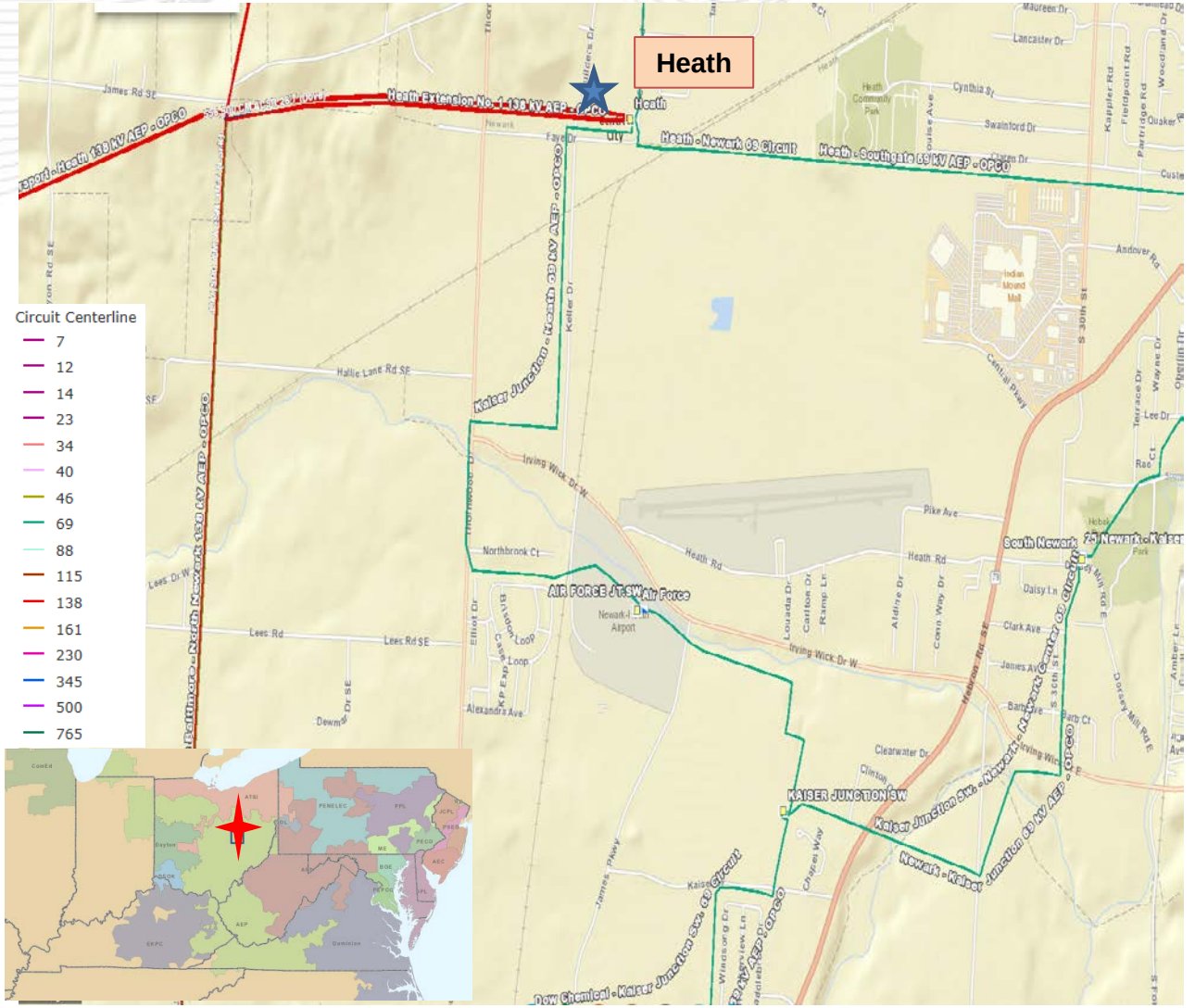
Selected Solution

Replace 69 kV circuit breakers “A”, “B”, “C” and “D” at Heath station with 2000 A 40 kA circuit breakers. Expand the DICM. Remove the 138/34.5 kV 25 MVA transformer #5. (S1546)

Estimated Cost: $3.9M

Projected In-service: 06/01/2021

Project Status: Engineering



AEP Transmission Zone: Supplemental Leslie Station

Previously Presented: 3/92018 SRRTEP

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.

Selected Solution

Replace existing 90 MVA Leslie 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. Replace Leslie 161 kV 3000 A 50 kA circuit breaker "K" with a new 3000 A 40 kA 161 kV circuit breaker. (S1547)

Estimated Cost: $6.3M

Projected In-service: 08/01/2020

Project Status: Engineering

Previously Presented: 3/9/2018 SRRTEP

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.

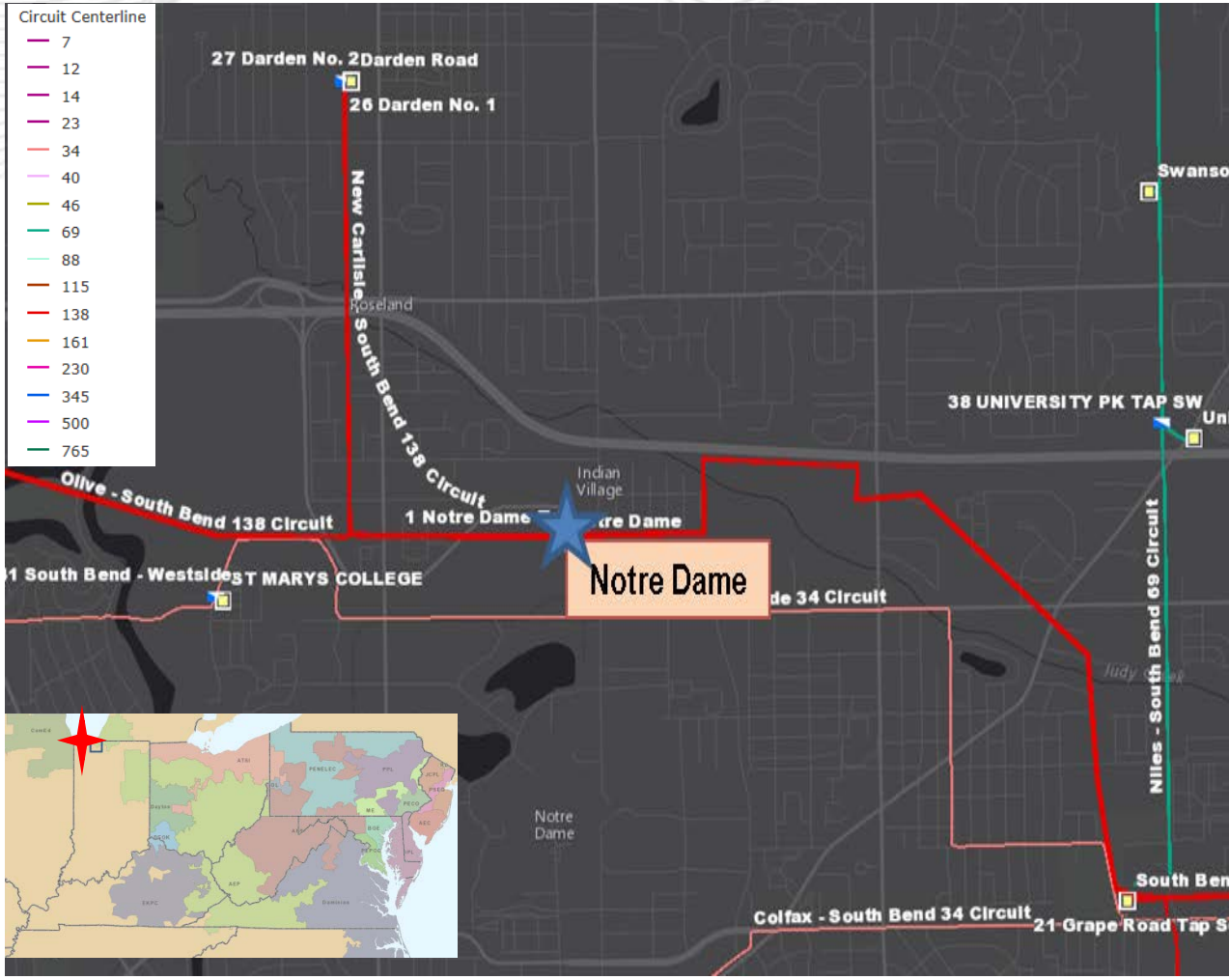
Selected Solution

Remove Notre Dame's 3 way switch and build the Notre Dame 138kV station into an in and out configuration with a bus tie 138kV 3000A 40kA breaker. (S1548)

Estimated Cost: $3.1M

Projected In-service: 10/01/2018

Project Status: Scoping



Previously Presented: 3/9/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

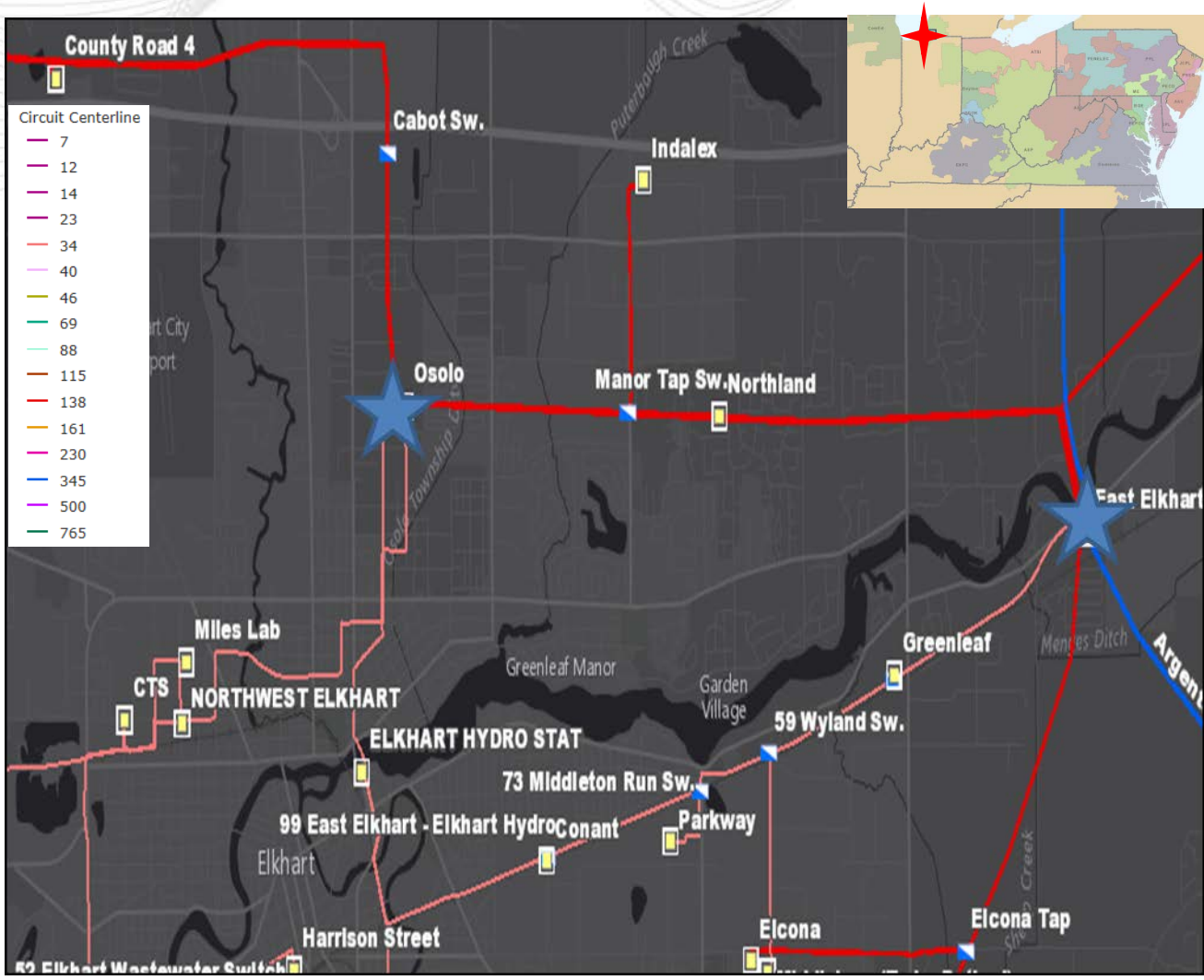
Transformer #1 138/69/34.5kV 50 MVA at East Elkhart Station manufactured in 1968 and transformer #1 138/69/34.5kV 50 MVA at Osolo Station manufactured in 1961 will be replaced because of breakdown in dielectric strength (winding insulation), short circuit strength (winding short circuit strength breakdown 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.

Continued on next slide…



AEP Transmission Zone: Supplemental
Osolo Area

Continued from previous slide…

Selected 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. (S1549.1)

Estimated Cost: $7.6M

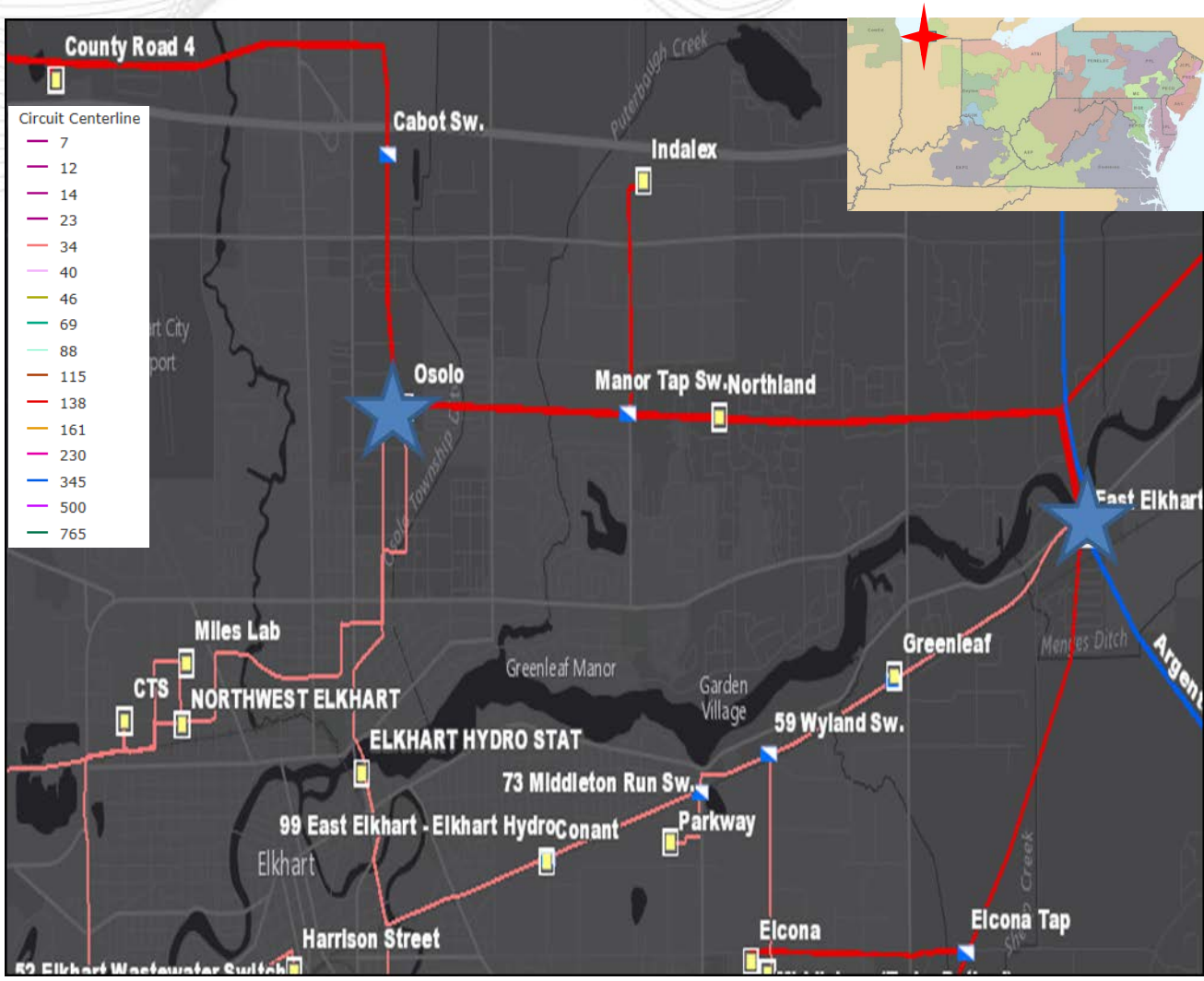
At East Elkhart station, replace transformer 2 with a 138/69/34.5kV 75MVA transformer Replace breaker “N” with a 3000A 40kA 69kV breaker. (S1549.2)

Estimated Cost: $4.5M

Total Estimated Transmission Cost: $12.1M

Projected In-service: 04/10/2020

Project Status: Scoping



AEP Transmission Zone: Supplemental
Tulip Road-West Side Rebuild

Previously Presented: 3/9/2018 SRRTEP

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.

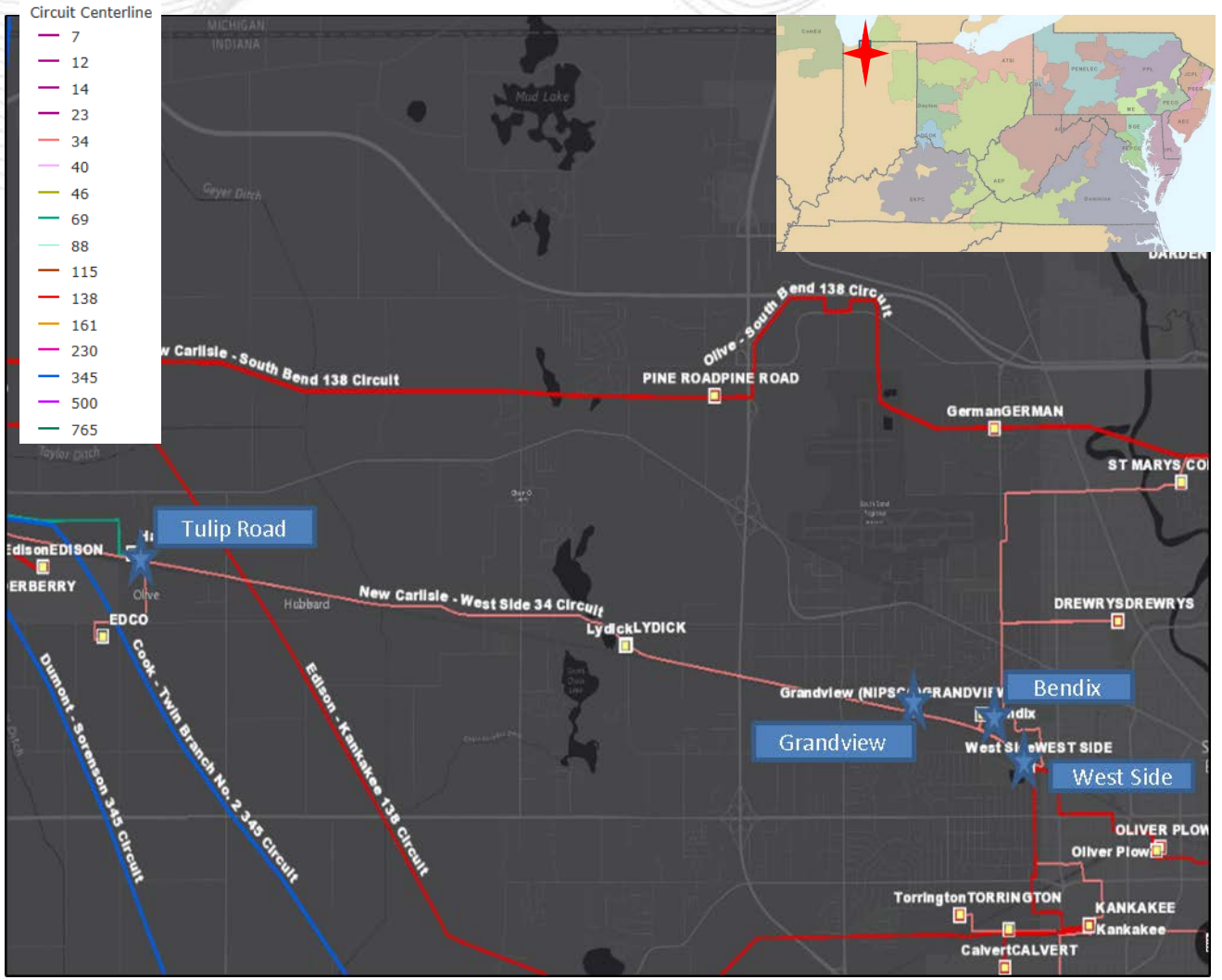
Selected Solution

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. (S1550)

Estimated Cost: $17.2M

Projected In-service: 11/30/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental Conesville-Cyclops

Previously Presented: 3/9/2018 SRRTEP

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.

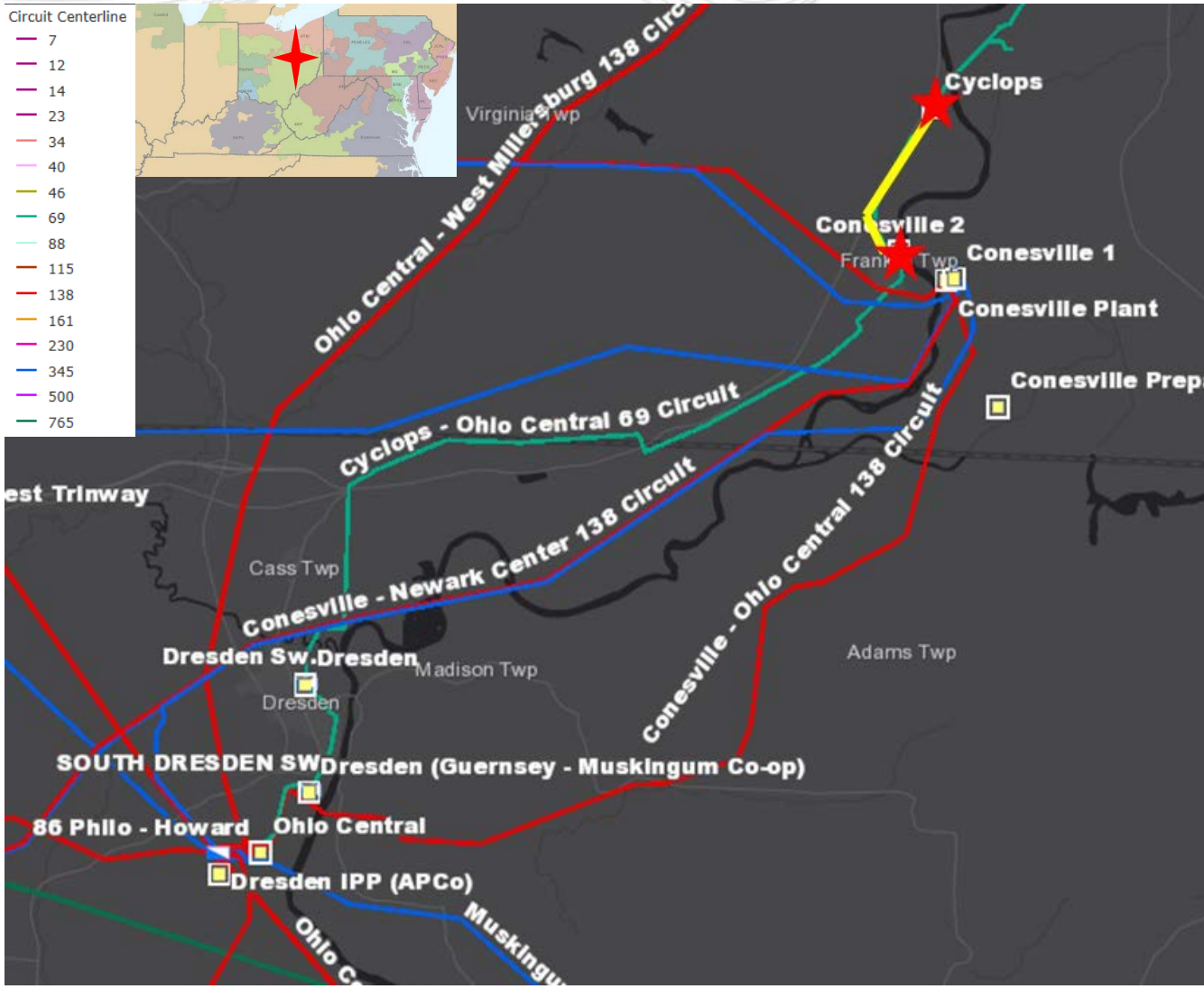
Selected Solution:

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. (S1551)

Estimated Cost: $2.2M

Projected In-service: 12/01/2019

Project Status: Engineering



Next Steps

Upcoming Western SRRTEP Dates

West	Start	End
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

6/26/2018 – V3 – Slide #24: Add description of alternation solution considered
– Slide #25: Add year of manufacture to breakers. Corrected breaker reference from “Q” to “C”
– Slide #35: Change project cost from $0M to $0.5M
– Slide #37: Change driver to “Customer Service” and note that customer was I&M distribution
– Slide #44: Add paragraph about line protection
– Slide #53: Add estimated cost of project components

4/05/2018 – V2 – Slide #5: Add “Panther Hollow Cut in” to the tittle
– Slide #21: Add Distribution Cost
– Slide #49: Add conclusion—there is no feasible alternative

3/21/2018 – V1 – Original version posted to pjm.com