INTERCONNECTION FACILITIES STUDY REPORT

GEN-2016-069

IFS-2016-001-32

Published August 2019

By SPP Generator Interconnections Dept.

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION
7/10/2019	SPP	Initial draft report issued.
8/6/2019	SPP	Updated the costs for Table 3: Interconnection Customer Shared Network Upgrades and Table 6: Cost Summary.
8/12/2019	SPP	Final report issued.

CONTENTS

SUMMARY

INTRODUCTION

This Interconnection Facilities Study (IFS) for Interconnection Request GEN-2016-069/IFS-2016-001-32 is for a 31.35 MW generating facility located in Chaves County, New Mexico. The Interconnection Request was studied in the DISIS-2016-001 Impact Study for Network Resource Interconnection Service (NRIS) and Energy Resource Interconnection Service (ERIS). Then it was restudied in DISIS-2016-001-1, DISIS-2016-001-2, and DISIS-2016-001-3 Impact Restudies for Energy Resource Interconnection Service (ERIS). The Interconnection Customer's original requested Commercial Operation Date is 6/1/2018. The revised Commercial Operation Date in the Facility Study Agreement is 11/1/2020.

The interconnecting Transmission Owner, Southwestern Public Service Company (SPS), performed a detailed IFS at the request of SPP. The full report is included in Appendix A. SPP has determined that full Interconnection Service will be available after the assigned transmission owner interconnect facilities (TOIF), non-shared network upgrades, shared network upgrades, previously allocated, and affected system upgrades that are required for full interconnection service are completed.

The primary objective of the IFS is to identify necessary Transmission Owner Interconnection Facilities, Network Upgrades, other direct assigned upgrades, cost estimates, and associated upgrade lead times needed to grant the requested Interconnection Service.

PHASE(S) OF INTERCONNECTION SERVICE

It is not expected that Interconnection Service will occur in phases. However, full Interconnection Service will not be available until all Interconnection Facilities and Network Upgrade(s) can be placed in service.

CREDITS/COMPENSATION FOR AMOUNTS ADVANCED FOR NETWORK UPGRADE(S)

Interconnection Customer shall be entitled to compensation in accordance with Attachment Z2 of the SPP OATT for the cost of SPP creditable-type Network Upgrades, including any tax gross-up or any other tax-related payments associated with the Network Upgrades, that are not otherwise refunded to the Interconnection Customer. Compensation shall be in the form of either revenue credits or incremental Long Term Congestion Rights (iLTCR).

INTERCONNECTION CUSTOMER INTERCONNECTION FACILITIES

The Generating Facility is proposed to consist of eight (8) GE 3.8 MW and one (1) .95 GE solar inverters for a total generating nameplate capacity of 31.35 MW.

The Interconnection Customer's Interconnection Facilities to be designed, procured, constructed, installed, maintained, and owned by the Interconnection Customer at its sole expense include:

- 34.5 kV underground cable collector circuits;
- 34.5 kV to 115 kV transformation substation with associated 34.5 kV and 115 kV switchgear;
- One (1) 115/34.5 kV 21/28/35 MVA (ONAN/ONAF/ONAF) step-up transformer to be owned and maintained by the Interconnection Customer at the Interconnection Customer's substation;
- A less than one mile overhead 115 kV line to connect the Interconnection Customer's substation to the Point of Interconnection ("POI") at the 115 kV bus at existing Transmission Owner substation ("Chaves 115kV") that is owned and maintained by Transmission Owner;
- All transmission facilities required to connect the Interconnection Customer's substation to the POI;
- Equipment at the Interconnection Customer's substation necessary to maintain a composite power delivery at continuous rated power output at the high-side of the generator substation at a power factor within the range of 95% lagging and 95% leading in accordance with Federal Energy Regulatory Commission (FERC) Order 827. Additionally approximately 0.4 Mvars[1] of reactors will be required to compensate for injection of reactive power into the transmission system under no/reduced generating conditions. The Interconnection Customer may use inverter manufacturing options for providing reactive power under no/reduced generation conditions. The Interconnection Customer will be required to provide documentation and design specifications demonstrating how the requirements are met.

The Interconnection Customer shall coordinate relay, protection, control, and communication system configurations and schemes with the Transmission Owner.

[1] This approximate minimum reactor amount is needed for the current configuration of GEN-2016-069 as studied in the DISIS-2016-001 Impact Study and Restudies.

TRANSMISSION OWNER INTERCONNECTION FACILITIES AND NON-SHARED NETWORK UPGRADE(S)

To facilitate interconnection, the interconnecting Transmission Owner will perform work as shown below necessary for the acceptance of the Interconnection Customer's Interconnection Facilities.

Table 1 and **Table 2** lists the Interconnection Customer's estimated cost responsibility for Transmission Owner Interconnection Facilities (TOIF) and Non-Shared Network Upgrade(s) and provides an estimated lead time for completion of construction. The estimated lead time begins when the Generator Interconnection Agreement has been fully executed.

Table 1: Transmission Owner Interconnection Facilities (TOIF)

Transmission Owner Interconnection Facilities (TOIF)	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)	Estimated Lead Time
SPS Chaves 115kV Interconnection Substation: Construct (1) one 115 kV line terminal, line switches, dead end structure, line relaying, communications, revenue metering, line arrestor, and all associated equipment and facilities necessary to accept transmission line from Interconnection Customer's Generating Facility.	$617,437	100%	$617,437	18-24 Months
Total	**$617,437**	**100%**	**$617,437**	

Table 2: Non-Shared Network Upgrade(s)

Non-Shared Network Upgrades Description	Z2 Type[2]	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)	Estimated Lead Time
SPS Chaves 115kV Interconnection Substation: Install one (1) 115 kV 3000A circuit breakers, two (2) 3000A switches and one (1) 115 kV CCVT's, standard line relaying package, breaker failure relay, new electrical control enclosure, associated materials and labor cost to facilitate the GEN-2016-069 terminal, control panels, line relaying, acquire land, disconnect switches, structures, foundations, conductors, insulators, and all other associated work and materials.	Non-Creditable	$1,293,552	100%	$1,293,552	18-24 Months
Total		**$1,293,552**	**100%**	**$1,293,552**	

[2] Indicates the method used for calculating credit impacts under Attachment Z2 of the Tariff.

SHARED NETWORK UPGRADE(S)

The Interconnection Customer's share of costs for Shared Network Upgrades is estimated in **Table 3** below.

Table 3: Interconnection Customer Shared Network Upgrades

Shared Network Upgrades Description	Z2 Type	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)	Estimated Lead Time
AEPW: Border - Chisholm 345kV CKT 1: Build a portion of the new 25 mile 345 kV from Border (OKGE) - Chisholm (AEP) with a minimum normal/emergency rating of 1793 MVA	Creditable	$24,674,924	5.09%	$1,255,746	42 Months
OKGE: Border - Chisholm 345kV CKT 1: Build a portion of the new 25 mile 345 kV from Border (OKGE) - Chisholm (AEP) with a minimum normal/emergency rating of 1793 MVA	Creditable	$17,145,000	5.09%	$872,536	30 Months
SPS: New Crawfish Draw 345kV Substation & Crawfish Draw - Tolk 345kV CKT 1: Tap Border-TUCO 345kV and OKU-TUCO 345kV, build Crawfish Draw 345kV substation and build ~64 miles of 345kV from Crawfish Draw - Tolk 345kV with a minimum normal/emergency	Creditable	$129,349,036	8.62%	$11,152,783	TBD
AEPW: Oklaunion 345 kV High Voltages: Update relay settings (Refer to Stability Report for details)	Non-Creditable	$169,238	5.17%	$8,753	18 Months
AEPW: Oklaunion 345kV Capacitive Reactive Power Support: Install a minimum of +20Mvar Capacitor Bank(s) at Oklaunion 345kV	Creditable	$1,464,908	5.14%	$75,262	24 Months
AEPW: Shamrock 69kV Capacitive Reactive Power Support: Install a minimum of +10Mvar of Capacitor Bank(s) at Shamrock 69kV	Creditable	$1,465,657	5.53%	$81,048	24 Months
SPS: Tolk - Potter County 345kV CKT 1: Build approximately 115 miles of 345kV from Tolk - Potter County with minimum normal/emergency rating of 1195 MVA	Creditable	180,684,436	6.02%	$10,879,907	TBD
Total		**$354,953,199**		**$24,326,035**	

All studies have been conducted assuming that higher-queued Interconnection Request(s) and the associated Network Upgrade(s) will be placed into service. If higher-queued Interconnection Request(s) withdraw from the queue, suspend or terminate service, the Interconnection Customer's share of costs may be revised. Restudies, conducted at the customer's expense, will determine the Interconnection Customer's revised allocation of Shared Network Upgrades.

PREVIOUS NETWORK UPGRADE(S)

Certain Previous Network Upgrades are **currently not the cost responsibility** of the Interconnection Customer but will be required for full Interconnection Service.

Table 4: Interconnection Customer Previous Network Upgrade(s)

Previous Network Upgrade(s) Description	Current Cost Assignment	Estimated In-Service Date
Border Capacitive Reactive Power Support (OKGE): Install +100Mvar Capacitor Bank(s) at Border 345kV	$2,369,160	TBD
Deaf Smith - Plant X 230kV CKT 1 (SPS): Fix ~70 structures and two wavetraps at Plant X and Deaf Smith to achieve 953 amps (380 MVA) minimum	$4,500,000	TBD
Deaf Smith Capacitive Reactive Power Support (SPS): Install +60Mvar Capacitor Bank(s) at Deaf Smith 230kV	$1,679,950	TBD
Newhart - Plant X 230kV CKT 1 (SPS): Fix ~14 structures to achieve 1035 amps (413 MVA) minimum	$700,000	TBD
Oklaunion Capacitive Reactive Power Support (AEPW): Install +100Mvar Capacitor Bank(s) at Oklaunion 345kV	$2,369,160	TBD

Depending upon the status of higher- or equally-queued customers, the Interconnection Request's in-service date is at risk of being delayed or Interconnection Service is at risk of being reduced until the in-service date of these Previous Network Upgrades.

AFFECTED SYSTEM UPGRADE(S)

To facilitate interconnection, the Affected System Transmission Owner will be required to perform the facilities study work as shown below necessary for the acceptance of the Interconnection Customer's Interconnection Facilities. **Table 5** displays the current impact study costs provided as part of the Affected System Impact review. The Affected System facilities study could provide revised costs and will provide each Interconnection Customer's allocation responsibilities for the upgrades.

Table 5: Interconnection Customer Affected System Upgrade(s)

Affected System Upgrades Description	Total Cost Estimate ($)	Allocated Share (%)	Allocated Cost Estimate ($)
None	$0	N/A	$0
Total	**$0**		**$0**

CONCLUSION

After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 31.35 MW can be granted. Full Interconnection Service will be delayed until the transmission owner interconnect facilities (TOIF), non-shared network upgrades, shared network upgrades, previously allocated, and affected system upgrades that are required for full interconnection service are completed. The Interconnection Customer's estimated cost responsibility is summarized in the table below.

Table 6: Cost Summary

Description	Allocated Cost Estimate
Transmission Owner Interconnection Facilities	$617,437
Network Upgrades	$25,619,587
Total	**$26,237,024**

A draft Generator Interconnection Agreement will be provided to the Interconnection Customer consistent with the final results of this IFS report. The Transmission Owner and Interconnection Customer will have 60 days to negotiate the terms of the GIA consistent with the SPP Open Access Transmission Tariff (OATT).

APPENDICES

A: TRANSMISSION OWNER'S INTERCONNECTION FACILITIES STUDY REPORT AND NETWORK UPGRADES REPORT(S)

See next page for the Transmission Owner's Interconnection Facilities Study Report and Network Upgrades Report(s).

Facilities Study For
Southwest Power Pool (SPP)

Andrews Co., Texas

GEN-2016-015

Total Output: 100 MW

Solar Generation Facilities

Transmission Planning South
Xcel Energy Services

Updated July 2019

Executive Summary

Interconnection Customer (IC) requested an interconnection of a solar energy facility located in Andrews Co., Texas approximately 5.75 miles east-southeast of Eunice, NM to the Southwestern Public Service Company (SPS) transmission network. This solar generating facility has a net capacity of 100 MW. SPS will construct a new 230 kV terminal to connect the IC's solar generating facility to the SPS transmission system at Andrews Substation. The proposed Interconnection Customer's 230 kV line from their collector substation to the new 230 kV terminal at Andrews Substation shall be designed for 345 kV system but will be operated at 230 kV as a condition of this Interconnection Service.

The Southwest Power Pool (SPP) evaluated the request (GEN-2016-015) to interconnect the solar generation facility to the SPS transmission system in a Definitive Interconnection System Impact Study (DISIS-2016-001-3). The Interconnection Customer will build and will be responsible for their transmission line from their solar farm collector substation to the interconnection point at the existing Andrews Substation. The IC will be required to maintain a Power Factor between 0.95 lagging and 0.95 leading at the high-side of the generator substation.

SPP requires that each generator shall implement automatic Under Frequency Load Shedding (UFLS) according to the SPP UFLS Plan for SPS found in the Xcel Energy Interconnection Guidelines For Transmission Interconnected Producer-Owned Generation Greater Than 20 MW at the following link:

http://www.transmission.xcelenergy.com/staticfiles/microsites/Transmission/Files/PDF/Interconnection/Interconnections-POL-TransmissionInterconnectionGuidelineGreat20MW.pdf.

To fulfill this requirement, coordination with Xcel Energy is required during the under-frequency relay-setting phase for the generation. The Interconnection Customer is required to report their generation off-nominal frequency tripping relay settings to SPP and SPS. SPS specifies that generators shall not trip at frequencies above 58.5 Hz unless exceptions in the Transmission Provider Criteria are met. The Interconnection Customer agrees that the energy generating units installed at this interconnection will not be tripped for under-frequency conditions above 58.5 Hz in compliance with Transmission Provider criteria. This means that the generation subject to this Interconnection Agreement may not trip for under-frequency conditions on the transmission system until all under-frequency load shedding relays have operated. SPS will also require that the Interconnection Customer be in compliance with all applicable criteria, guidelines, standards, requirements, regulations, and procedures issued by the North American Electric Reliability Corporation (NERC), SPP, and the Federal Energy Regulatory Commission (FERC) or their successor organizations.

The Hobbs Plant to Andrews Substation transmission line is built and designed for 345 kV systems but currently operated at 230 kV. It will be converted to 345kV at a later date to accommodate various reliability needs. The 230 kV bus will be converted to 345 kV operations. The Interconnection Customer is required by this study to design their transmission line facility for 345 kV systems from their collector substation to the SPS Andrews Substation. The Interconnection Customer will be responsible for all the cost of the Interconnection Facilities, installation of the Direct Assigned Interconnection Facilities; inclusive of all construction required for the customer owned transmission line from customer collector substation to the SPS's Andrews Substation before and after operating voltage is converted from 230 to 345 kV. The shared network upgrades will be determined at a later date by SPP and may impact the total overall costs for interconnection for the Interconnection Customer.

It is anticipated that the entire process to build the necessary upgrades identified in this report will require approximately 18-24 months to complete after an Interconnection Agreement is signed and an authorization to proceed is received. The cost of these upgrades, inclusive of the Interconnection Customer's cost for the interconnection of this Solar Farm facility, is shown below in Table 1, with the detailed description of the cost shown in Table 2.

Table 1, Cost Summary

Shared Network Upgrades	**See DISIS Report**
Network Upgrades:	**$5,432,736**
Transmission Owner Interconnection Facilities:	**$1,193,127**
Total:	**$6,625,863**

General Description of SPS[a] Facilities

1. Construction: SPS will build a new 230 kV breaker terminal position at Andrews Substation: See Appendix A, Figure A-1 for general vicinity location map.

1.1. Location: Customer will build a new 230 kV line from their collector substation to the Interconnection Point at the existing SPS Andrews Substation. The customer shall design this line for 345 kV system but will be operated at 230 kV voltage. Appendix A, Figure A-2, shows the one-line of Andrews 230/115 kV Substation and the change of Ownership at the Point of Interconnection is shown on Appendix A, Figure A-3.

1.2. Bus Design: The existing three breaker terminals at the 230 kV yard at Andrews Substation will be converted to breaker and a half scheme in order to accommodate the output from the solar energy facility. Four (4) new 345 kV breakers, seven (7) 3000A switches and two (2) 230 kV CCVT's will be required to convert to breaker and a half arrangement. This is shown in Appendix A, Figure A-2.

1.3. Line Terminals: The 230 kV line and static wire breaker terminal, maximum per phase tension, shall be verified by the IC prior to termination of any IC line to the Point of Interconnection (POI). The SPS substation engineering department can provide guidance on the design tension for this breaker terminal and any specifics required of the IC.

1.4. Control House: The existing control house will accommodate the new metering, protective relaying and control devices, terminal cabinets, and any fiber-optic cable terminations, etc. for the 230 kV line breaker terminals.

1.5. Relay and Protection Scheme: The new line terminal primary protection to the interconnection customer 230 kV transmission line will use line current differential relaying over optical fiber installed in the static of the customer's 230 kV transmission line. Secondary relaying will use mirrored bit, Permissive Overreaching Transfer Trip (POTT) over the optical fiber. An SEL 411L and an SEL 311C will be used as primary and secondary relays, respectively. The SEL 411L will be used for line/bus SCADA closing conditions for the 230 kV breakers. Also, a SEL 351S will be used for breaker failure.

An SEL 411L will display the bus voltage, GCB amps, MW, MVAR, and fault location. A communication relay will be installed and for other functions as required.

1.6. Revenue Metering: An individual billing meter will be installed at Andrews Substation on the 230 kV line terminal from the Interconnection Customer's substation, which meets the standards: ANSI C12.1 accuracy class 0.2 (3-PT's IEEE C57.13 accuracy class 0.3 and 3-CT's IEEE C57.13 accuracy class 0.15) for full 3-phase 4-wire metering. Pulses out of the primary billing meter will be sent via SCADA to the Transmission Owner's Control Center in Amarillo, Texas.

1.7. Disturbance Monitoring Device: A Disturbance Fault Recorder (DFR), capable of recording faults, swings, and long term trending, will be installed to monitor and record conditions in the substation and on the transmission lines. The disturbance equipment shall also be equipped with a GPS time

[a] All modifications to SPS facilities will be owned, maintained and operated by SPS.

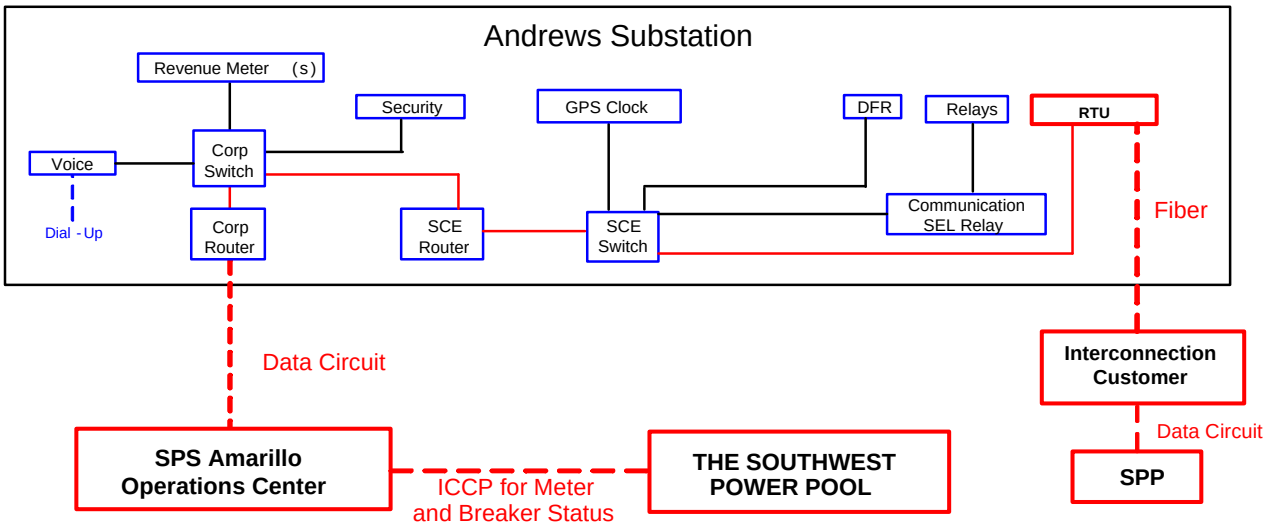
synching clock. This equipment will have communication capability with a dedicated communication circuit. The disturbance equipment will have its own dedicated communications circuit.

1.8. **Remote Terminal Unit (RTU):** A Communication SEL Relay will be installed for relay communications and other functions as required; these costs will be directly assigned to the IC. The IC will provide and install an RTU for metering and telemetry at the IC's facility as required by the latest Xcel Energy Interconnection Guidelines.

1.9. **Communications:** To meet its Communications obligations, the Interconnection Customer shall be responsible for making arrangements with the local phone company to provide a communication circuit as required by the Transmission Owner. Transmission Owner equipment may include, but is not limited to the following: relay communication equipment, RTU, and disturbance monitoring equipment at Carlisle. Prior to any construction, the IC is required to contact the Transmission Owner substation-engineering department for all communication details and provide detail of the method to be used in communication.

The following communications schematic diagram, which includes communication equipment information for the IC, Transmission Provider (Southwest Power Pool) and Transmission Owner (Southwestern Public Service), is provided to assist the Parties as a template.

A schematic outlining the proposed communications is provided below:



Interconnection Customer shall be responsible for providing fiber optic communication circuit installed in the overhead transmission line static wire from the customer substation to Andrews Substation for protective relaying and for transmitting metering and status data to SPS. Utilizing this fiber optic connection, SPS will establish a direct connection to the IC's RTU.

SPS will not serve as a proxy for communication from the IC to SPP.

2. Transmission Work:

2.1. The Interconnection Customer will construct, own, operate, and maintain any customer owned 230 kV transmission line from the Interconnection Customer's substation to the Interconnection Point at SPS's new 230 kV Switching Station. This line is shown in Appendix A, Figure A-1. **The SPS transmission design group prior to any construction by the Interconnection Customer or its contractor on any customer 230 kV transmission lines, or doing work in close proximity to any SPS transmission line, will require an engineering review of the customer's design. It is the Interconnection Customer's responsibility to initiate the design review in a timely manner before construction of any transmission line begins. If the review has not been made or the design at any of the aforementioned locations is deemed inadequate, the crossing(s) and or termination into the interchange will be delayed until the matters are resolved. SPS will not be held responsible for these delays.**

3. Right-Of-Way:

3.1. **Permitting**: The interconnection customer will be responsible for any permitting and right of way of their substation and the 230 kV transmission line from their substation to the Interconnection Point at the existing Andrews Substation.

4. Construction Power and Retail Service:

4.1. It is the sole responsibility of the Interconnection Customer to make arrangements for both construction and station power, which may be required for the Interconnection Customer's solar farm facility. **Additionally, if the Interconnection Customer's substation(s) and/or construction site(s) are located outside of the SPS service area, SPS cannot provide station power (retail service) and the Interconnection Customer needs to make arrangements for retail service from the local retail provider. Retail provider and Customer will be responsible for making any necessary Interconnection Service arrangements as required under the SPP OATT.**

5. Project and Operating Concerns:

5.1. **Collaboration of Work**: Close work between the Transmission group, the Interconnection Customer's personnel and local operating groups will be imperative in order to meet any in-service date that has been established.

5.2. **Reactive Power Requirements:** The Interconnection customer will be required to maintain a Power Factor between 0.95 lagging and a 0.95 leading at the high-side of the generator substation. All capacitors required will be installed on the low side at the customer's substation. This is required to maintain acceptable dynamic voltage rise as per latest revision of the Xcel Energy Interconnection Guidelines for Transmission Interconnection Producer-Owned Generation Greater than 20 MW. The capacitor banks need to be switched in stages where the voltage rise is less than 3%.

6. Fault Current Study:

The IC will coordinate with the System Protection Engineering (SPE) department at SPS on the available fault current at the interconnection location following the acceptance of the Generator Interconnection Agreement (GIA) and prior to final design on the IC's facilities.

7. Estimated Construction Costs

The projects required for the interconnection of 100 MW Solar Generation facilities consist of the projects summarized in the table below. These costs are estimates and can change based on future reviews by SPS.

Table 2, Required Interconnection Projects

Project	Description	Estimated Cost
	Shared Network Upgrades: (TBD at a later date)	
1	(at the Interconnection Customer's expense)	See DISIS Report
	Network Upgrades	
2	Install four (4) 345 kV 3000A circuit breakers, seven (7) 3000A switches and two (2) 230 kV CCVT's. Breaker Failure Relay will be Installed.	$ 5,432,736
	Subtotal:	**$5,432,736.00**
	Transmission Owner Interconnection Facilities (at the Interconnection Customer's expense)	
3	Communications [b]	
4	Install two (2) 345 kV Deadend Structures, one (1) 345 kV Switch, three (3) 230 kV CT/PT Metering Units, Line Relaying, Line Arrestors, Revenue Metering and Other Related Items.	$ 1,193,127
	Subtotal:	**$1,193,127**
	Total Cost	**$6,625,863.00**

8. Engineering and Construction:

An engineering and construction schedule for this project is estimated at approximately 18-24 months. Other factors associated with clearances, equipment delays and work schedules could cause additional delays. This is applicable after all required agreements are signed and internal approvals are granted.

All additional cost for work not identified in this study is the sole responsibility of the Interconnection Customer unless other arrangements are made.

[b] It is the Requester's responsibility to provide both the data circuit and communication circuits, see Section 1.8.

Appendix A

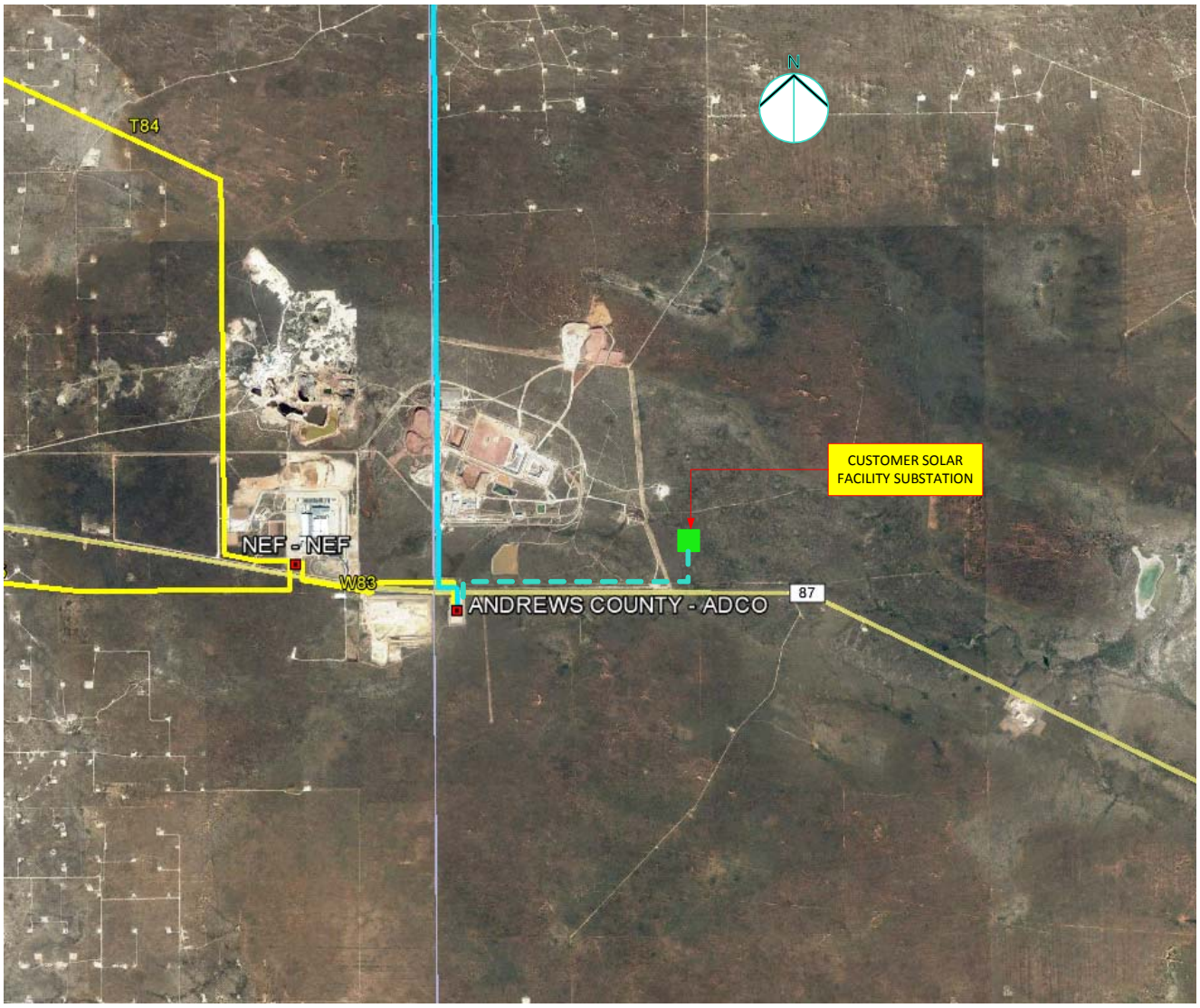


Figure A- 1, Andrews Co. Substation vicinity location and approximate location of Customer Owned Solar Farm 230 kV Substation.

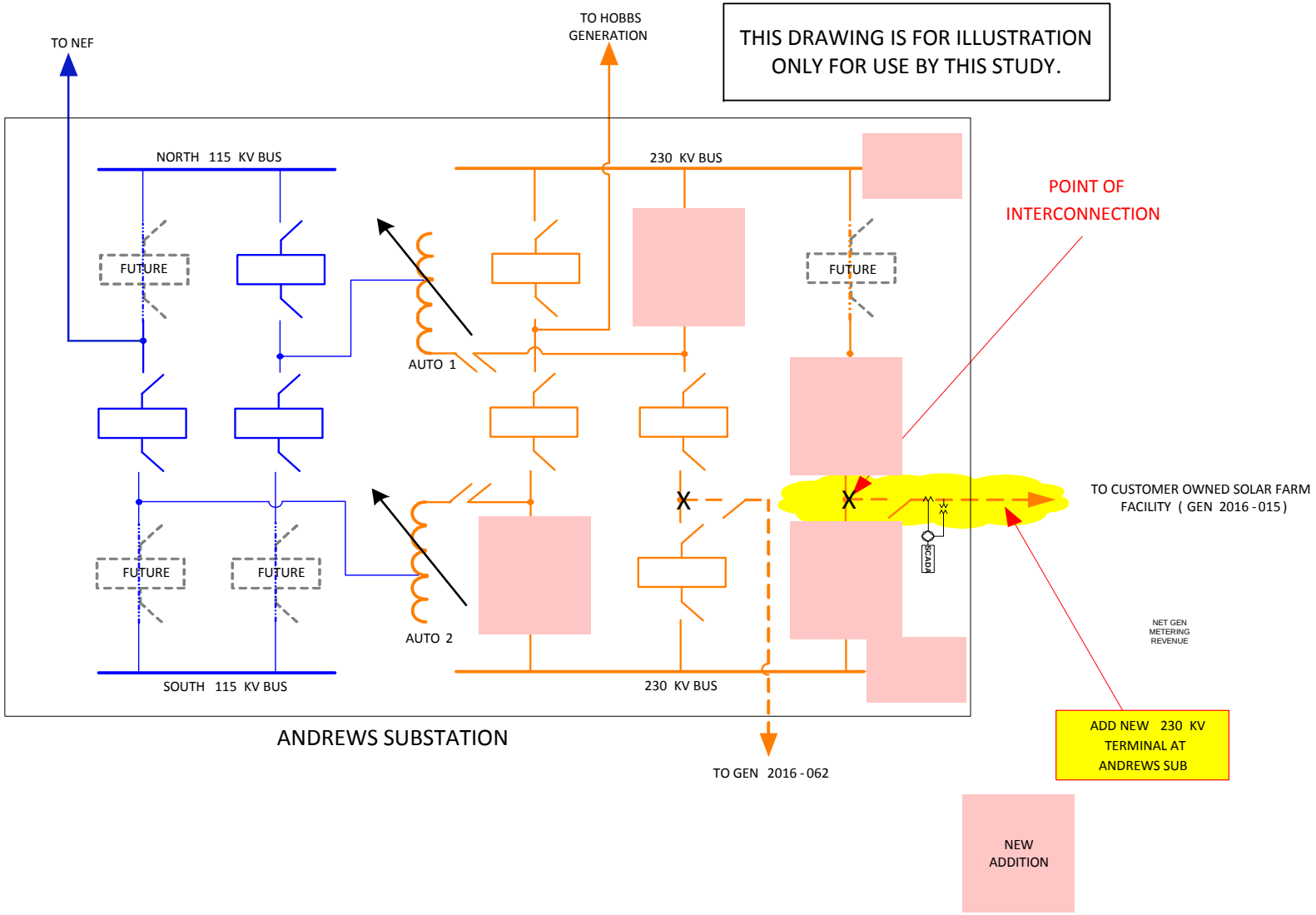


Figure A- 2, One-line Diagram of Existing Andrews Substation

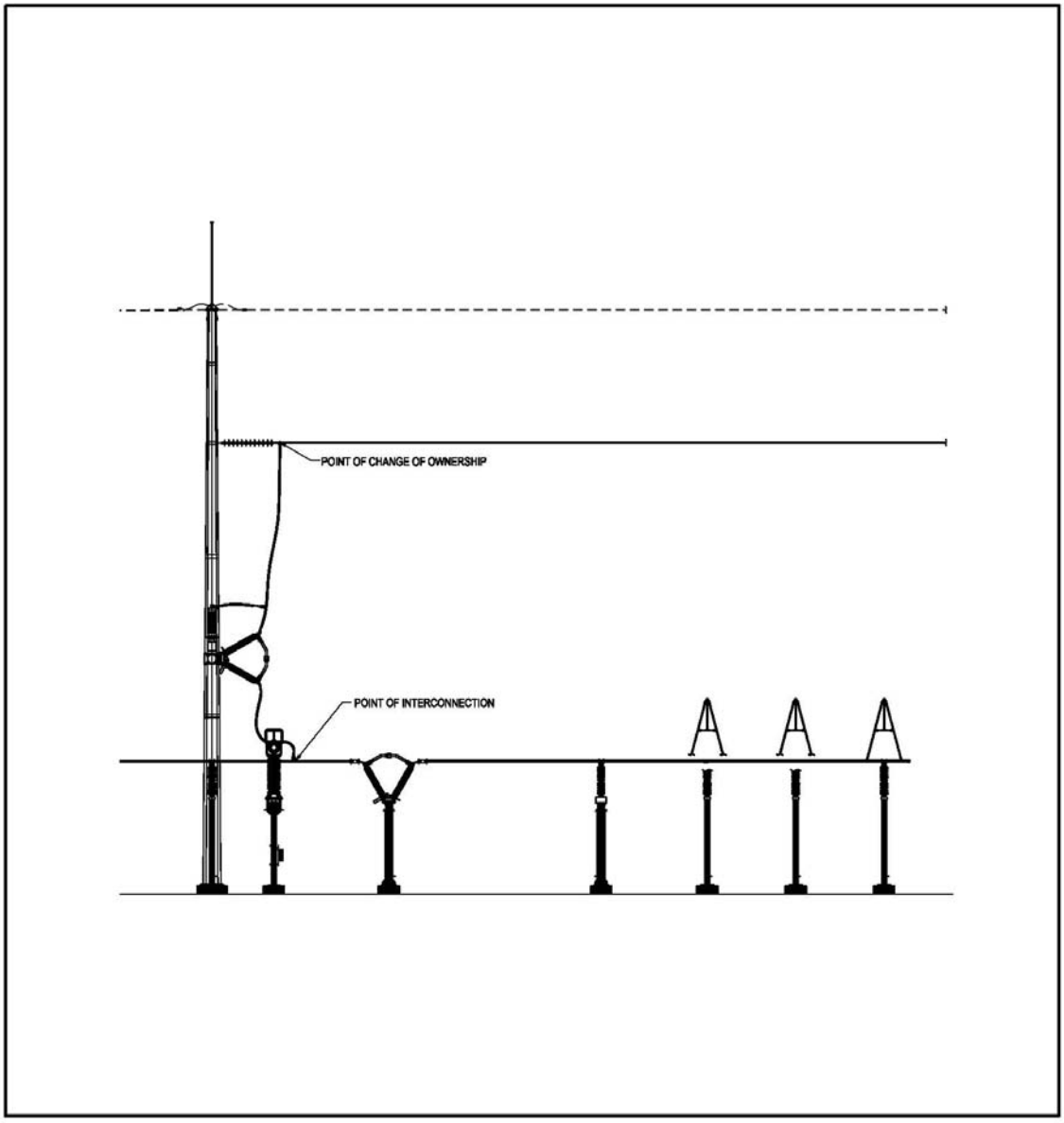


Figure A-3 Point of Interconnection & Change of Ownership (Typical)

– END OF REPORT –

BOUNDLESS ENERGY℠

Interconnection Facilities Study for GI Cluster Impact Re-study DISIS-2016-001-3 Chisholm – Border 345 kV Line Network Upgrade

August 2019

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Summary

American Electric Power Southwest Transmission Planning (AEP) performed the following study at the request of the Southwest Power Pool (SPP) for SPP Generation Interconnection request DISIS-2016-001-03. Per the SPP Generator Interconnection Procedures (GIP), SPP requested that AEPW perform an Interconnection Facilities Studies (IFS) for Network Upgrade(s) in accordance with the Scope of Interconnection Facilities Study in GIP 8.10 and the Interconnection Facilities Study Procedures in accordance with GIP 8.13 for the following Network Upgrades:

- Chisholm - Border 345 kV
    - Build 12.5 miles of new 345 kV with a minimum normal/emergency rating of 1793 MVA

Interconnection Facilities (See Figures 1 and 2)

Chisholm 345kV Substation

AEP will build 12.5 miles of 345 kV transmission line from the AEP Chisholm station to the halfway point of the new 345 kV line to OGE Border station. In addition, a 345 kV line terminal will be added at the AEP Chisolm station that will include a circuit breaker, disconnect switches, bus work, relaying, and other associated terminal equipment to accommodate the new interconnection.

The design and construction of the new terminal will meet all AEP specifications for stations. Bus work and disconnect switches will be designed to accommodate the loading requirements, and circuit breakers will be rated to ensure adequate load and fault interrupting capability. AEP will own, operate and maintain the station.

Short Circuit Fault Duty Evaluation

It is standard practice for AEP to recommend replacing a circuit breaker when the current through the breaker for a fault exceeds 100% of its interrupting rating with recloser de-rating applied, as determined by the ANSI/IEEE C37.5-1979, C37.010-1979 & C37.04-1979 breaker rating methods.

In the AEP system, no breakers were found to exceed their interrupting capability after the addition of the generation and related facilities. Therefore there are no short circuit upgrade costs associated with the DISIS-2016-001-3 interconnections.

Interconnection Costs

Listed below are the associated costs.

SYSTEM IMPROVEMENT	COST (2019 DOLLARS)
Build 12.5 miles of 345 kV transmission line from the AEP Chisholm station to the OGE Border station. In addition, a 345 kV line terminal will be added at the AEP Chisolm station that will include a circuit breaker, disconnect switches, bus work, relaying, and other associated terminal equipment	$24,674,924.00
TRANSMISSION INTERCONNECTION FACILITY TOTAL COSTS	$24,674,924.00

TABLE 1

Project Lead Time

Project in-service date is projected to be 42 months after the issuance of a NTC from the Southwest Power Pool.

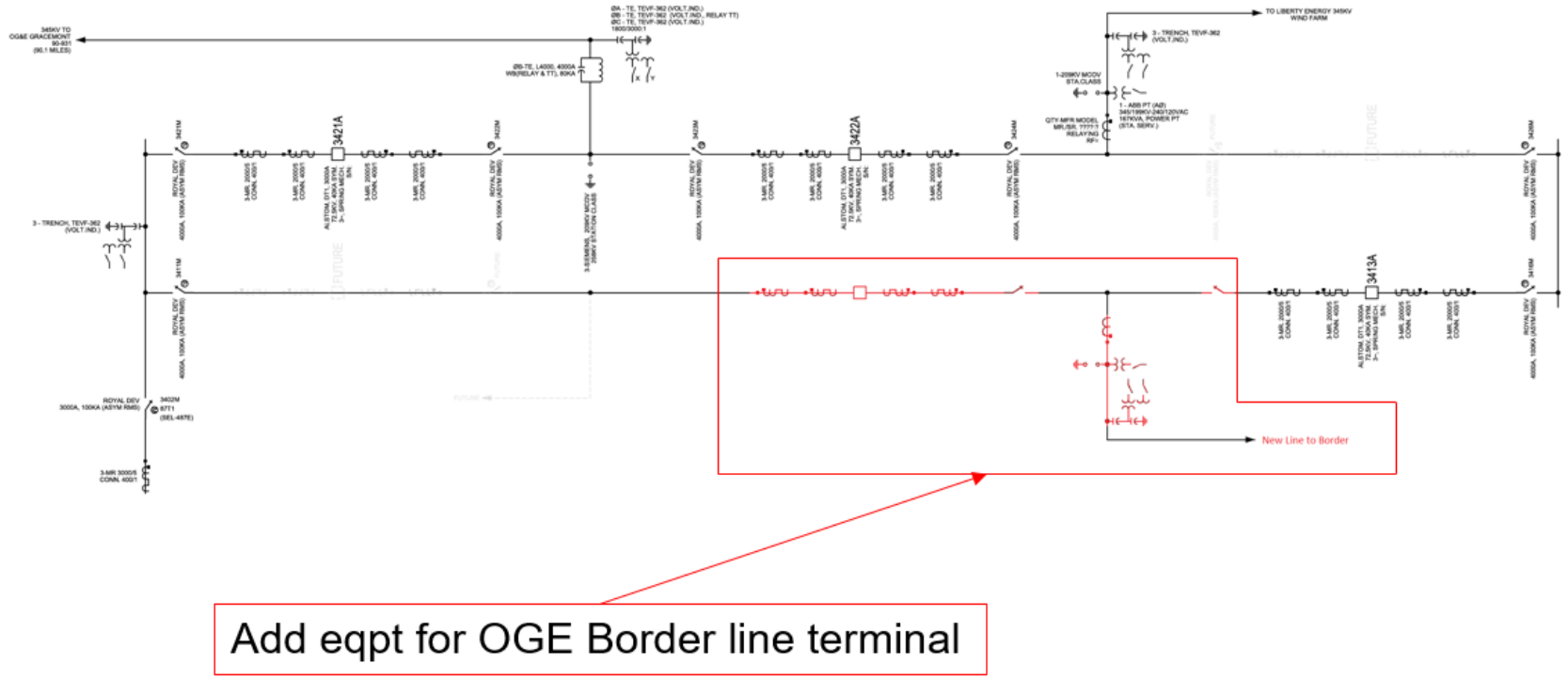
345KV TO OG&E GRACEMONT 90-8311 (90.1 MILES)
ØA - TE, TEVF-362 (VOLT.IND.)
ØB - TE, TEVF-362 (VOLT.IND., RELAY TT)
ØC - TE, TEVF-362 (VOLT.IND.)
1800/3000:1
ØB-TE, L4000, 4000A W/B(RELAY & TT), 80KA
TO LIBERTY ENERGY 345KV WIND FARM
3 - TRENCH, TEVF-362 (VOLT.IND.)
1-200KV MODV BTA CLASS
1 - ABB PT (AØ) 345/199KV-240/120VAC 167KVA, POWER PT (BTA, SERV.)
3421A
3422A
3413A
3 - TRENCH, TEVF-362 (VOLT.IND.)
ROYAL DEV 3000A, 100KA (ASTM R665)
3-MR 3000/5 CONN. 4031
3402M
6771
(SEL-487E)
New Line to Border
Add eqpt for OGE Border line terminal

FIGURE 1

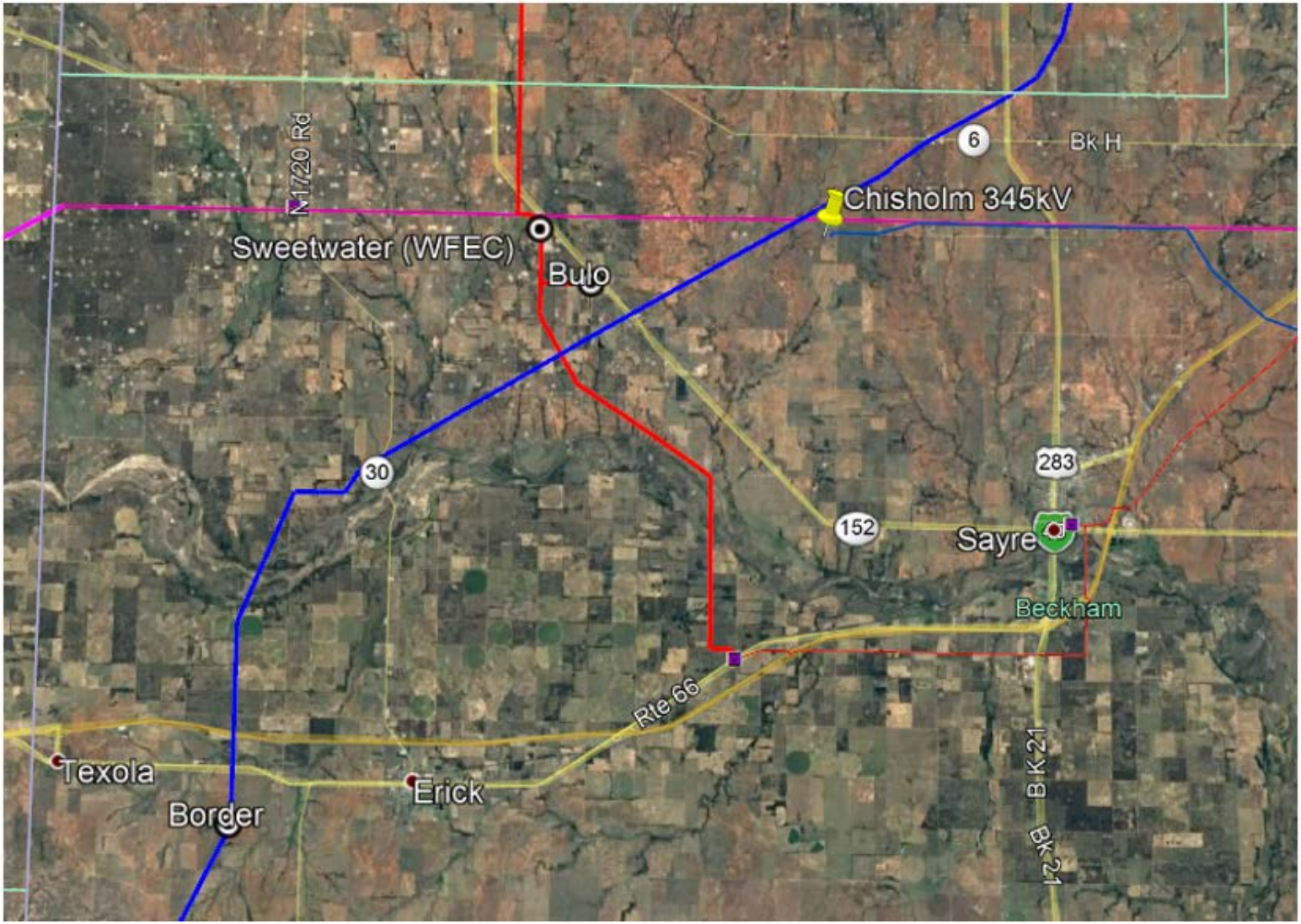
M17/20 Rd
6
Bk H
Chisholm 345kV
Sweetwater (WFEC)
Bulo
30
283
152
Sayre
Beckham
Rte 66
Texola
Erick
Border
B K 21
Bk 21

FIGURE 2

FACILITY STUDY

for

IFS-2016-001-3 Network Upgrades
For
DISIS-2016-001-3

New Beaver County to Clark County 345kV Circuit 1
and
New Border to Chisholm 345kV Circuit 1
In Beaver and Beckham Counties,
Oklahoma

June 12, 2019

Daryl Huslig, P.E.
Lead Engineer
Transmission Planning
OG&E Electric Services

Summary

Pursuant to the tariff and at the request of the Southwest Power Pool (SPP), Oklahoma Gas and Electric (OG&E) performed the following Facility Study for Network Upgrades to satisfy the Facility Study Agreement executed by the requesting customers included in SPP DISIS-2016-001-3. The request for interconnection was placed with SPP in accordance SPP's Open Access Transmission Tariff, which covers new generation interconnections on SPP's transmission system. The requirements for the Network Upgrades are to build a new line terminal and 345kV line reactor at Beaver County substation for a new 125-mile 345kV circuit from Beaver County to Clark County (ITC) substation located in southwestern Kansas, and a new line terminal at Border substation for a new 25-mile 345kV circuit from Border to Chisholm (AEP) substation, and associated relay and control equipment at Beaver County and Border substations. The total cost for OKGE to complete these upgrades is $91,765,100.

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Introduction

The Southwest Power Pool has requested a Facility Study for Network Upgrades within the service territory of OG&E Electric Services (OKGE) in Beaver and Beckham Counties in Oklahoma. The proposed Network Upgrade Facilities are to build a new line terminal and 345kV line reactor at Beaver County substation, half the distance of a new 125-mile 345kV circuit from Beaver County to Clark County (ITC) substation located in southwestern Kansas, a new line terminal at Border substation, half the distance of a new 25-mile 345kV circuit from Border to Chisholm (AEP) substation, and associated relay and control equipment at Beaver County and Border substations.

Network Constraints in the Southwest Public Service (SPS), American Electric Power West (AEPW), OKGE, Western Farmers Electric Cooperative (WFEC) and ITC Holdings systems may be verified with a transmission service request and associated studies.

Network Upgrade Facilities

The primary objective of this study is to identify network upgrades. The requirements for this Network Upgrade consist of installing a new line terminal and 345kV line reactor at Beaver County substation, half the distance of a new 125-mile 345kV circuit from Beaver County to Clark County (ITC) substation located in southwestern Kansas, a new line terminal at Border substation, half the distance of a new 25-mile 345kV circuit from Border to Chisholm (AEP) substation, and associated relay and control equipment at Beaver County and Border substations on the OG&E transmission system to accommodate generator interconnection requests identified in SPP-GI DISIS-2016-001-3. These 345kV network upgrades shall be constructed and maintained by OKGE.

The total cost for OKGE to build 62.5 miles of single-circuit 345kV transmission line and install 1-345kV breaker, 2-345kV switches, 345kV line reactor, dead end structure, and associated relay and control equipment at Beaver County substation is estimated at $74,620,100.

The total cost for OKGE to build 12.5 miles of single-circuit 345kV transmission line and install 1-345kV breaker, 2-345kV switches, dead end structure, and associated relay and control equipment at Border substation is estimated at $17,145,000.

The total cost for all OKGE facilities included in IFS-2106-001-3 is estimated at $91,765,100.

This Facility Study does not guarantee the availability of transmission service necessary to deliver the additional generation to any specific point inside or outside the Southwest Power Pool (SPP) transmission system. The transmission network facilities may not be adequate to deliver the additional generation output

to the transmission system. If the customer requests firm transmission service under the SPP Open Access Transmission Tariff at a future date, Network Upgrades or other new construction may be required to provide the service requested under the SPP OATT.

The costs of network upgrades to the OKGE transmission system are listed in Table 1.

Short Circuit Fault Duty Evaluation

It is standard practice for OG&E to recommend replacing a circuit breaker when the current through the breaker for a fault exceeds 100% of its interrupting rating with re-closer de-rating applied, as determined by the ANSI/IEEE C37.5-1979, C37.010-1979 & C37.04-1979 breaker rating methods.

For this Network Upgrade, no breakers were found to exceed their interrupting capability after the addition of the transmission lines and related substation facilities. OG&E found no breakers that exceeded their interrupting capabilities on their system. Therefore, there is no short circuit upgrade costs associated with this DISIS-2016-001-3 Network Upgrade.

Table 1: Required Interconnection Network Upgrade Facilities

Facility	ESTIMATED COST (2019 DOLLARS)
OKGE – **Network Upgrades (Beaver County)** Expand substation site to north to accommodate new line reactors. Add a single 345kV line terminal to an existing EHV substation. Install 1-345kV 5000A 40kA breaker, 1-345kV 5000A breaker disconnect switch, 1-345kV 3000A line disconnect switch, dead end structure, line relaying, revenue metering including CTs and PTs and associated equipment. Install 345kV line reactors on the new transmission line.	$5,870,100.
OKGE – **Transmission Line (Beaver County to Clark County 345kV)** Steel monopole, bundled 1590 ACSR, 3382A, OPGW shield wire, 62.5 miles to interconnection point.	$68,750,000
OKGE – **Network Upgrades (Border)** Expand substation site to add a single 345kV line terminal to an existing EHV substation. Install 1-345kV 5000A 40kA breaker, 1-345kV 5000A breaker disconnect switch, 1-345kV 3000A line disconnect switch, dead end structure, line relaying, revenue metering including CTs and associated equipment.	$3,395,000
OKGE – **Transmission Line (Border to Chisholm 345kV)** Steel monopole, bundled 1590 ACSR, 3382A, OPGW shield wire, 12.5 miles to interconnection point.	$13,750,000
Total	$91,765,100

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June 12, 2019

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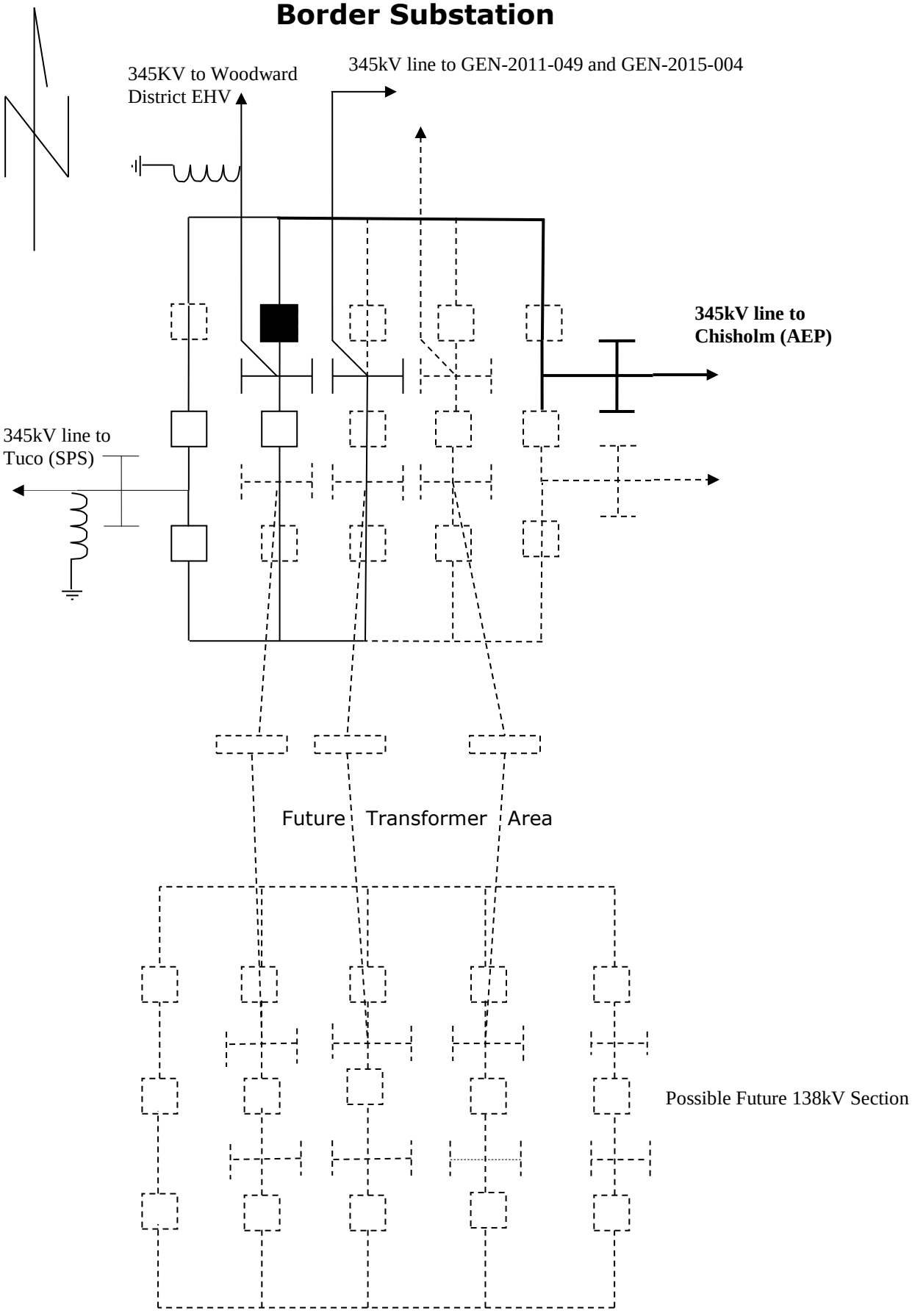
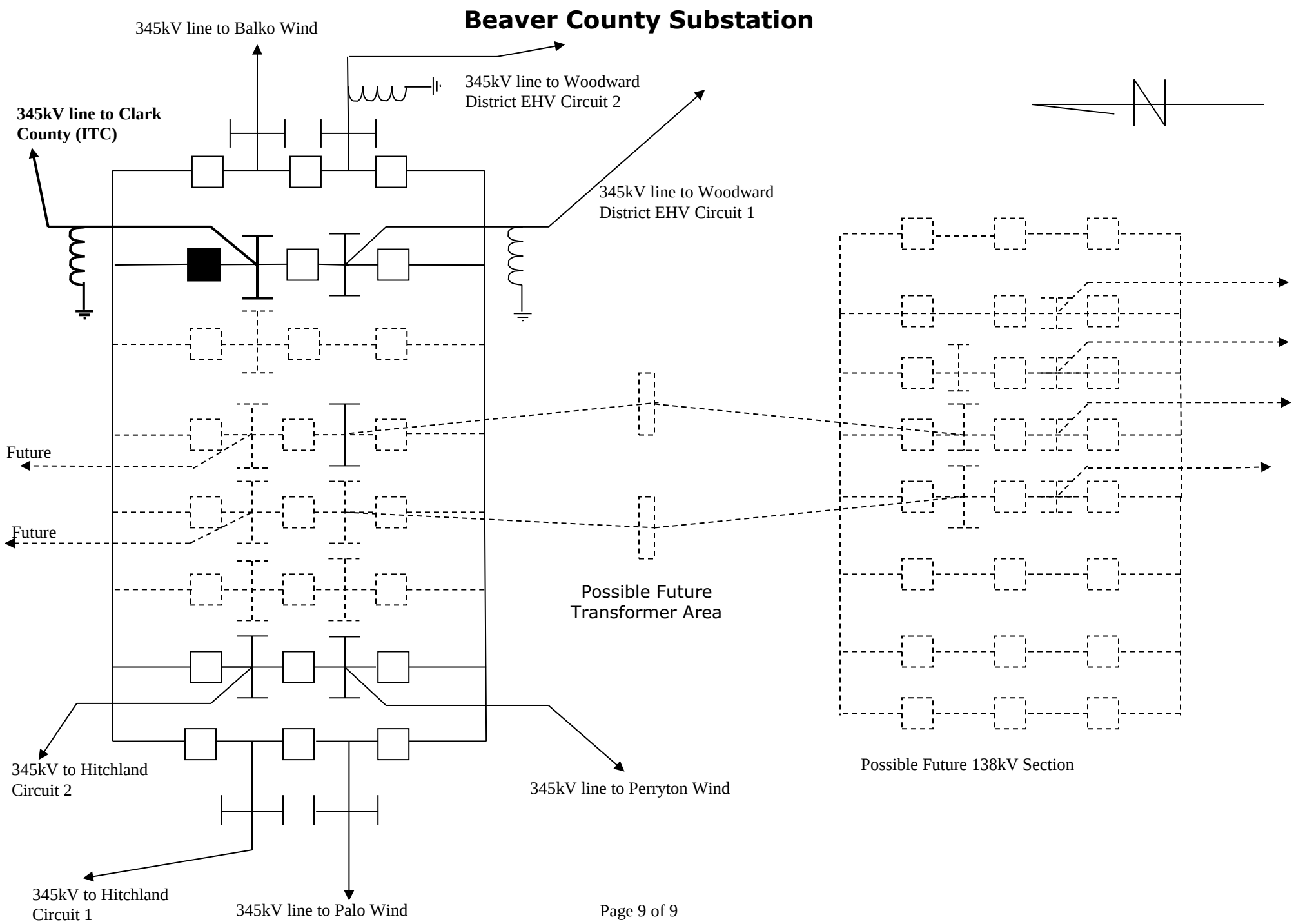
Border Substation



Beaver County Substation



BOUNDLESS ENERGY℠

Interconnection Facilities Study for GI Cluster Impact Re-study Shamrock 69 kV Capacitor Network Upgrade

June 2019

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Summary

American Electric Power Southwest Transmission Planning (AEP) performed the following study at the request of the Southwest Power Pool (SPP) for SPP Generation Interconnection request DISIS-2016-001-03. Per the SPP Generator Interconnection Procedures (GIP), SPP requested that AEPW perform an Interconnection Facilities Studies (IFS) for Network Upgrade(s) in accordance with the Scope of Interconnection Facilities Study in GIP 8.10 and the Interconnection Facilities Study Procedures in accordance with GIP 8.13 for the following Network Upgrades:

- Shamrock 69 kV
    - Install a minimum of + 10 MVAR of capacitor banks

Interconnection Facilities (See Figures 1 and 2)

Shamrock Station 69 kV Substation

A new 69 kV, 14.4 MVAR capacitor bank will be added at Shamrock Station for the generation interconnections. This will consist of one 69 kV capacitor bank and its associated microprocessor relays, circuit disconnects, and other associated equipment.

The design and construction of the new terminal will meet all AEP specifications for stations. Bus work and disconnect switches will be designed to accommodate the loading requirements, and circuit breakers will be rated to ensure adequate load and fault interrupting capability. AEP will own, operate and maintain the station.

Short Circuit Fault Duty Evaluation

It is standard practice for AEP to recommend replacing a circuit breaker when the current through the breaker for a fault exceeds 100% of its interrupting rating with recloser de-rating applied, as determined by the ANSI/IEEE C37.5-1979, C37.010-1979 & C37.04-1979 breaker rating methods.

In the AEP system, no breakers were found to exceed their interrupting capability after the addition of the generation and related facilities. Therefore there are no short circuit upgrade costs associated with the DISIS-2016-001-3 interconnections.

Interconnection Costs

Listed below are the associated costs.

SYSTEM IMPROVEMENT	COST (2019 DOLLARS)
Install a minimum of +10Mvar of Capacitor Bank(s) at Shamrock 69kV Including all metering, protection, and SCADA	$1,465,657.32
TRANSMISSION INTERCONNECTION FACILITY TOTAL COSTS	**$1,465,657.32**

TABLE 1

Project Lead Time

Project in-service date is projected to be 24 months after the issuance of a NTC from the Southwest Power Pool.

1. **Shamrock** – Install minimum +10 MVAR,69 kV capacitor bank

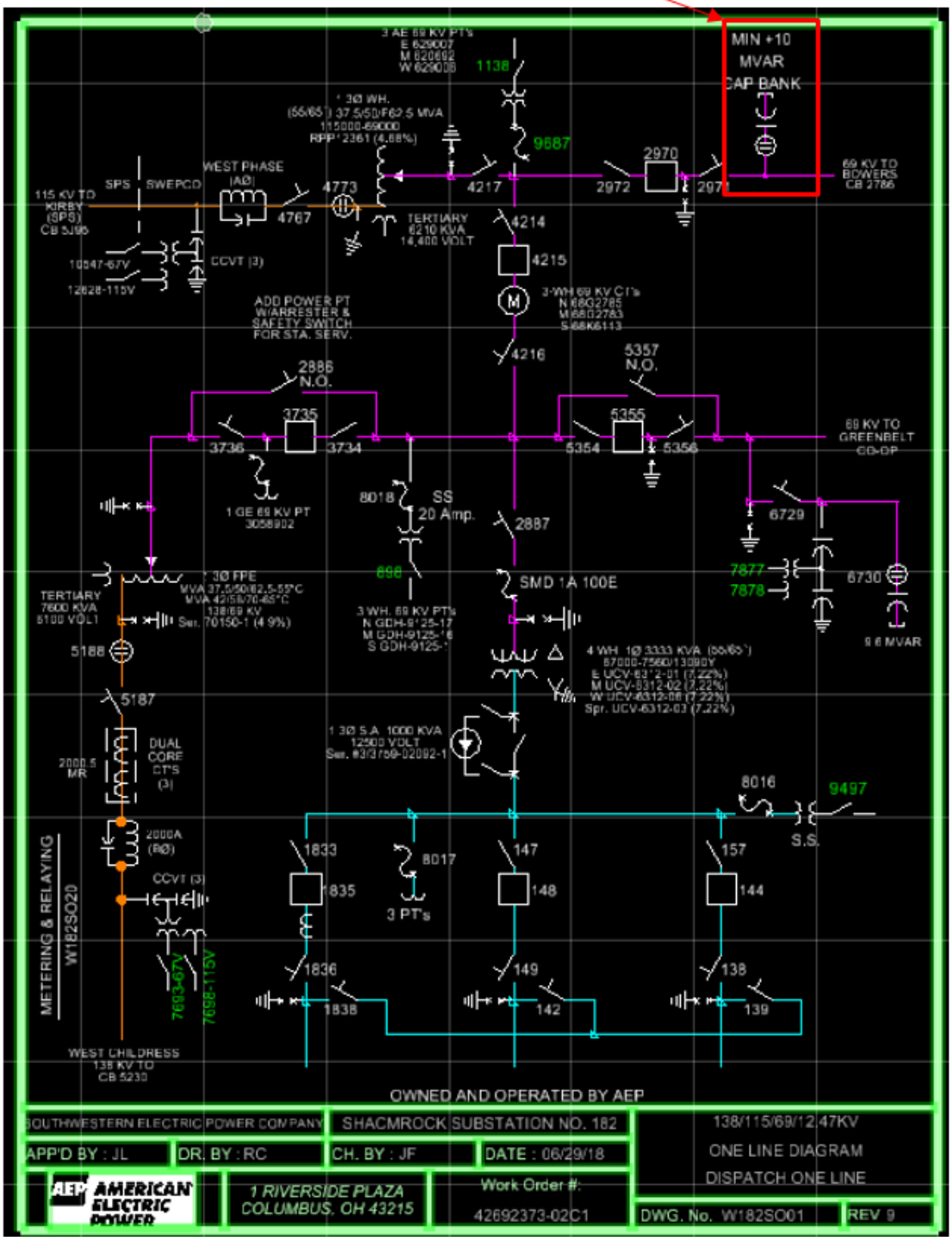

FIGURE 1

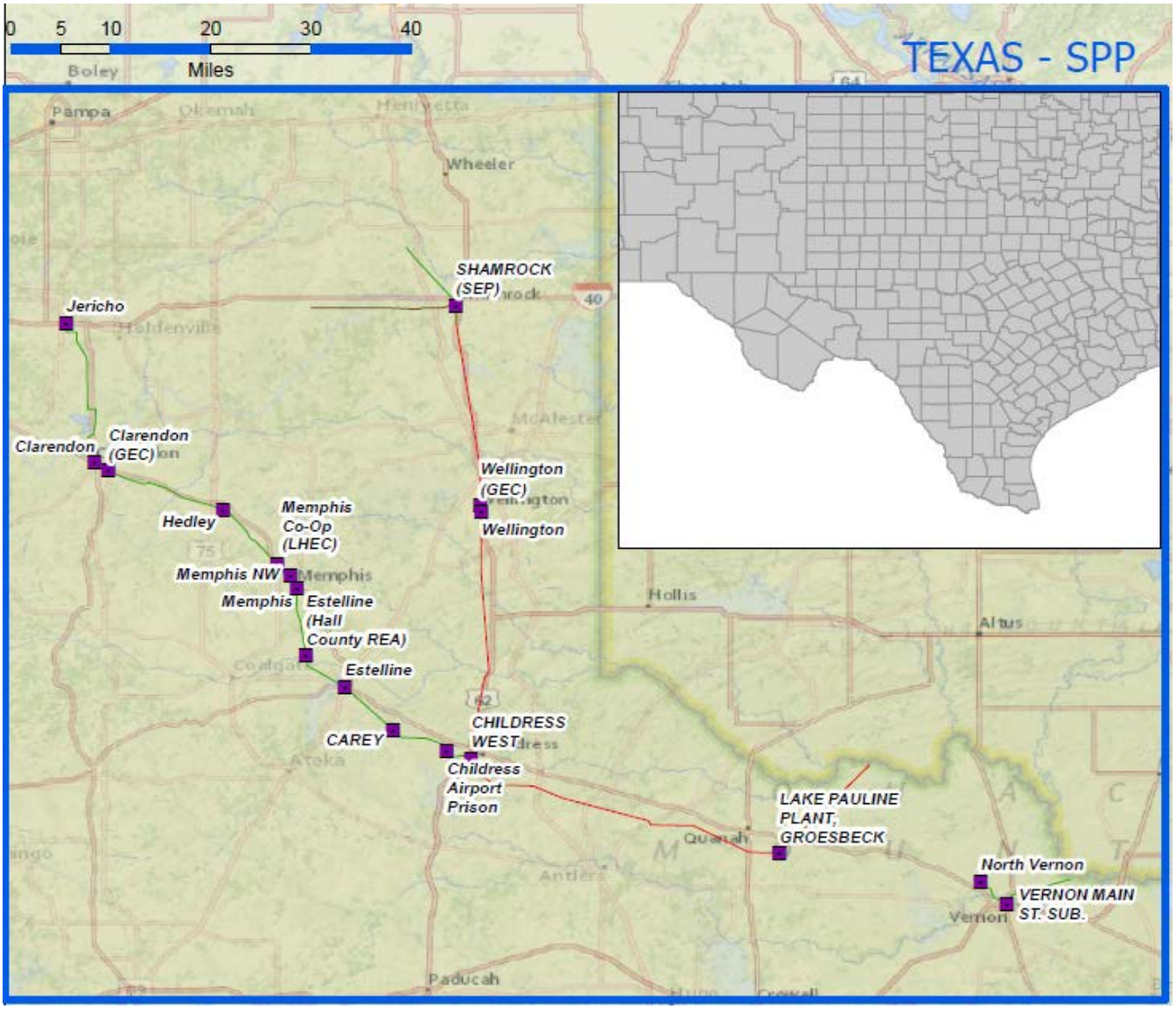
TEXAS - SPP
0 5 10 20 30 40
Miles
Boley
Pampa
Wheeler
SHAMROCK (SEP)
Jericho
Clarendon
Clarendon (GEC)
Hedley
Memphis Co-Op (LHEC)
Memphis NW
Memphis
Memphis
Estelline (Hall County REA)
Estelline
CAREY
CHILDRESS WEST
Childress Airport Prison
Wellington (GEC)
Wellington
Hollis
Altus
LAKE PAULINE PLANT, GROESBECK
North Vernon
VERNON MAIN ST. SUB.
Vernon
Quanah
Paducah

FIGURE 2

BOUNDLESS ENERGY℠

Interconnection Facilities Study for GI Cluster Impact Re-study DISIS-2016-001-3 Oklaunion 345 kV High Voltage Network Upgrade

June 2019

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Summary

American Electric Power Southwest Transmission Planning (AEP) performed the following study at the request of the Southwest Power Pool (SPP) for SPP Generation Interconnection request DISIS-2016-001-03. Per the SPP Generator Interconnection Procedures (GIP), SPP requested that AEPW perform an Interconnection Facilities Studies (IFS) for Network Upgrade(s) in accordance with the Scope of Interconnection Facilities Study in GIP 8.10 and the Interconnection Facilities Study Procedures in accordance with GIP 8.13 for the following Network Upgrades:

- Oklaunion 345 kV
    - Update relays and settings due to transient voltage recovery violations (high voltage) observed at the Oklaunion 345 kV substation following the three-phase fault on the Oklaunion to Lawton Eastside 345 kV line.

Interconnection Facilities

A dedicated SEL-451 relay will be installed for the over voltage protection due to addition of total 120 MVARs of capacitance.

Interconnection Costs

Listed below are the associated costs.

SYSTEM IMPROVEMENT	COST (2019 DOLLARS)
Oklaunion Relay Upgrades	$169,238.00
TRANSMISSION INTERCONNECTION FACILITY TOTAL COSTS	**$169,238.00**

Table 1

Project Lead Time

Project in-service date is projected to be 18 months after the issuance of a NTC from the Southwest Power Pool.

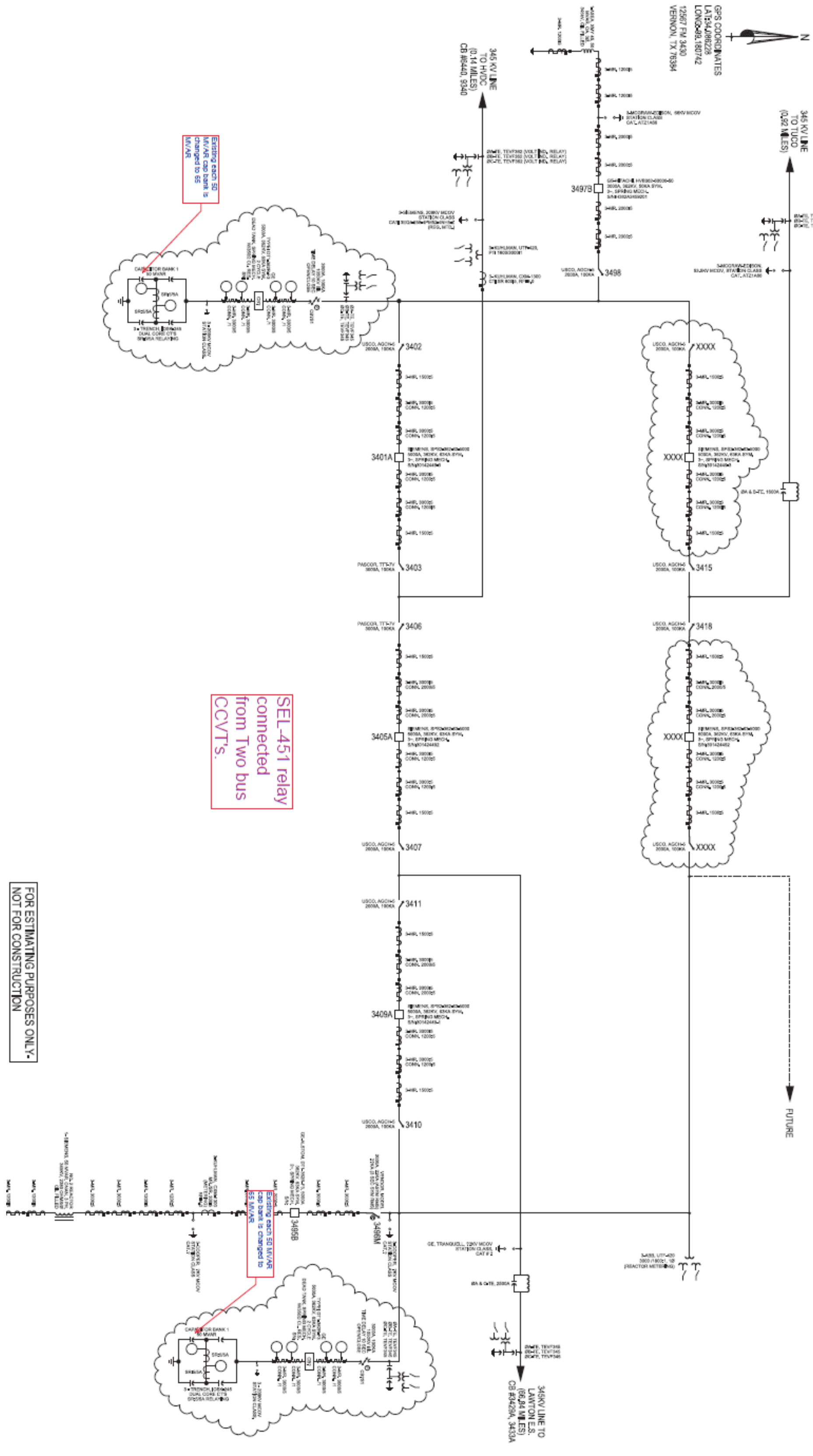
345 KV LINE TO TUCO (0.92 MILES)
345 KV LINE TO HVDC (0.14 MILES) CB #6440, 9340
Existing each 50 MVAR cap bank is changed to 65 MVAR
SEL-451 relay connected from Two bus CCVT's.
Existing each 50 MVAR cap bank is changed to 65 MVAR
FOR ESTIMATING PURPOSES ONLY-NOT FOR CONSTRUCTION
FUTURE
345KV LINE TO LAWTON E.S. CB #3420A, 3430A

Figure 1

BOUNDLESS ENERGY℠

Interconnection Facilities Study for GI Cluster Impact Re-study DISIS-2016-001-3 Oklaunion 345 kV Capacitors Network Upgrade

June 2019

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Summary

American Electric Power Southwest Transmission Planning (AEP) performed the following study at the request of the Southwest Power Pool (SPP) for SPP Generation Interconnection request DISIS-2016-001-03. Per the SPP Generator Interconnection Procedures (GIP), SPP requested that AEPW perform an Interconnection Facilities Studies (IFS) for Network Upgrade(s) in accordance with the Scope of Interconnection Facilities Study in GIP 8.10 and the Interconnection Facilities Study Procedures in accordance with GIP 8.13 for the following Network Upgrades:

- Oklaunion 345 kV
    - Install a minimum of + 20 MVAR of capacitor banks

Interconnection Facilities

Oklaunion 345kV Substation

AEP will install at 20 MVARs of capacitor banks and all associated equipment in addition to the 100 MVAR of capacitor banks that were previously required in DISIS-2015-002.

The design and construction of the new equipment will meet all AEP specifications for stations. Bus work and disconnect switches will be designed to accommodate the loading requirements, and circuit breakers will be rated to ensure adequate load and fault interrupting capability. AEP will own, operate and maintain the station.

Short Circuit Fault Duty Evaluation

It is standard practice for AEP to recommend replacing a circuit breaker when the current through the breaker for a fault exceeds 100% of its interrupting rating with recloser de-rating applied, as determined by the ANSI/IEEE C37.5-1979, C37.010-1979 & C37.04-1979 breaker rating methods.

In the AEP system, no breakers were found to exceed their interrupting capability after the addition of the generation and related facilities. Therefore there are no short circuit upgrade costs associated with the DISIS-2016-001-3 interconnections.

Interconnection Costs

Listed below are the associated costs

SYSTEM IMPROVEMENT	COST (2019 DOLLARS)
Oklaunion 345kV additional 20 MVAR of Capacitor Banks	$1,464,907.72
TRANSMISSION INTERCONNECTION FACILITY TOTAL COSTS	**$1,464,907.72**

Table 1

Project Lead Time

Project in-service date is projected to be 24 months after the issuance of a NTC from the Southwest Power Pool.

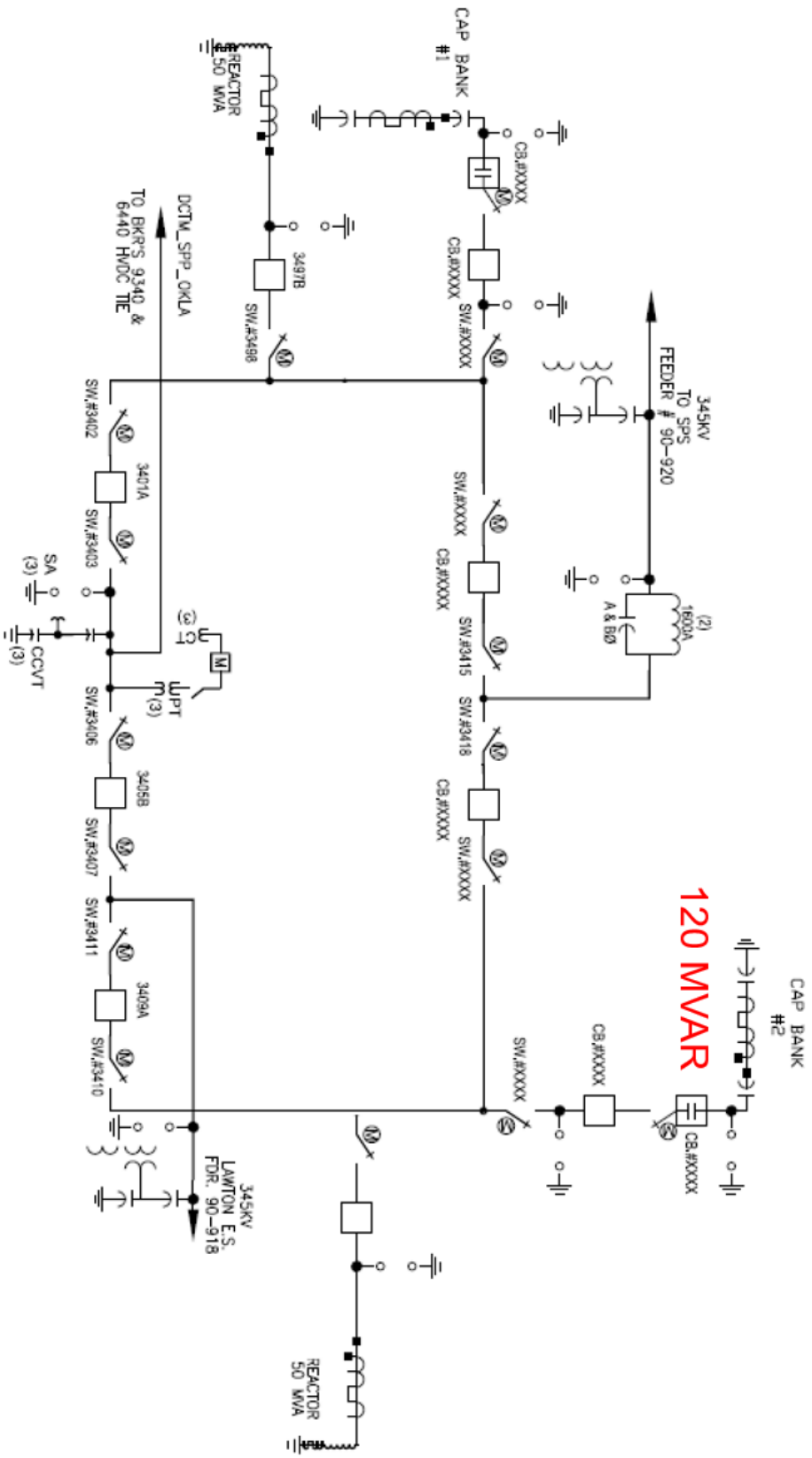
CAP BANK #1
REACTOR 50 MVA
CB,#XXXX
SW,#XXXX
345KV TO SPS FEEDER # 90-920
(2) 1600A A & B Ø
CAP BANK #2
120 MVAR
CB,#XXXX
SW,#XXXX
345KV LAWTON E.S. FDR. 90-918
REACTOR 50 MVA
DCTM_SPP_OKLA
TO BKR'S 9340 & 6440 HVDC TIE
3497B
SW,#3498
3401A
SW,#3402
SW,#3403
SA (3)
CCVT (3)
CT (3)
M
PT (3)
SW,#3406
3405B
SW,#3407
SW,#3411
3409A
SW,#3410
SW,#3415
SW,#3418

Figure 1