ERCOT Independent Review of the Bearkat – North McCamey – Sand Lake 345-kV Transmission Line Addition Project

Final

Document Revisions

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Executive Summary

On April 12, 2022, LCRA Transmission Services Corporation (LCRA TSC), Wind Energy Transmission Texas (WETT), and Oncor jointly submitted the Bearkat – North McCamey – Sand Lake 345-kV Transmission Line Addition Project to the Regional Planning Group (RPG). This project is designed to meet the growing demand for electricity from increased oil and natural gas extraction activities in the Permian Basin region, specifically in the Delaware Basin.

ERCOT completed the Delaware Basin Load Integration Study[1] in December 2019, following review and input by the affected Transmission Service Providers (TSPs). This study, which identified the reliability needs of the region, provides a long lead time transmission improvement roadmap for the continued oil and gas load growth in the Delaware Basin area. This RPG project, as submitted by LCRA TSC, WETT, and Oncor, aligns with the Stage 2 upgrade identified in the Delaware Basin Load Integration Study. The study found that the addition of a double-circuit 345-kV line from Bearkat to North McCamey to Sand Lake (i.e., Stage 2 upgrade) is the recommended option to reliably serve load once the peak demand level of the Delaware Basin area exceeds 4,022 MW. More details of the Delaware Basin Load Integration Study can be found in Appendix A.

Although ERCOT confirmed the need for the Stage 2 upgrade in the Delaware Basin Load Integration Study, ERCOT also performed additional analysis in the Permian Basin Load Interconnection Study[2] completed in December 2021 to reconfirm the need for the Stage 2 upgrade using the 2030 study case. More details of the Permian Basin Load Interconnection Study can be found in Appendix B.

The average annual peak demand growth rate of the Far West Weather Zone is about 12% according to the historical load data from 2016 to 2021. Both 2021 Regional Transmission Plan (RTP) and ERCOT October 2021 Steady-State Working Group (SSWG) cases indicated that the load growth in the Delaware Basin area could exceed 4,022 MW by 2026 or earlier. ERCOT also reviewed and assessed the 2021 RTP and confirmed the need for the Stage 2 upgrade to improve the Delaware Basin load serving capability and address a potential voltage instability issue under N-1 condition in 2026.

Based on this independent review, ERCOT recommends the following project as jointly submitted by LCRA TSC, WETT, and Oncor:

- Build a new double-circuit 345-kV line from existing Bearkat Substation to existing North McCamey Substation (~71 miles), with normal and emergency ratings of at least 2,564 MVA
- Build a new double-circuit 345-kV line from existing North McCamey Substation to existing Sand Lake Substation (~94 miles), with normal and emergency ratings of at least 2,564 MVA
- Reconfigure each of the existing substations into a breaker-and-a-half substation (as a minimum configuration)

The recommended project is a Tier 1 project estimated to cost $477.6 Million. Certificate of Convenience and Necessity (CCN) filings will be required for this new transmission project (approximately 165 miles of new double-circuit 345-kV lines). The project is expected to be in-service by June 2026.

LCRA TSC, Oncor, and WETT have requested ERCOT designate the recommended project “critical” to the reliability of the system per PUCT Substantive Rule 25.101(b)(3)(D). Since there is a reliability need to have the project in place and significant uncertainty associated with predicting the timing of the need for the proposed project (see Section 8 for more details), ERCOT deems the project critical

[1] https://www.ercot.com/gridinfo/planning >> ERCOT Delaware Basin Load Integration Study Report
[2] https://www.ercot.com/gridinfo/planning >> ERCOT Permian Basin Load Interconnection Study Report

to reliability. LCRA TSC, Oncor, and WETT also indicated in the RPG submittal that they will work with ERCOT to implement Constraint Management Plans (CMPs) based on operational conditions as required. In addition, Oncor indicated in its response to the RPG comment that Oncor will work with the neighboring TSP in order to effectively and efficiently address other potential transmission system concerns that may arise from the recent influx of customer loads in the Far West region beyond those identified in the scope of the original Delaware Basin area review.

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1. Introduction

The Far West Weather Zone, which includes the Delaware Basin area, has experienced an average annual peak demand growth rate of approximately 12% from 2016 to 2021 due to significant growth in oil and natural gas industry demand. This growth rate is the highest of any weather zone in the ERCOT region. Figure 1.1 shows the primary oil basin resources in the Permian area.

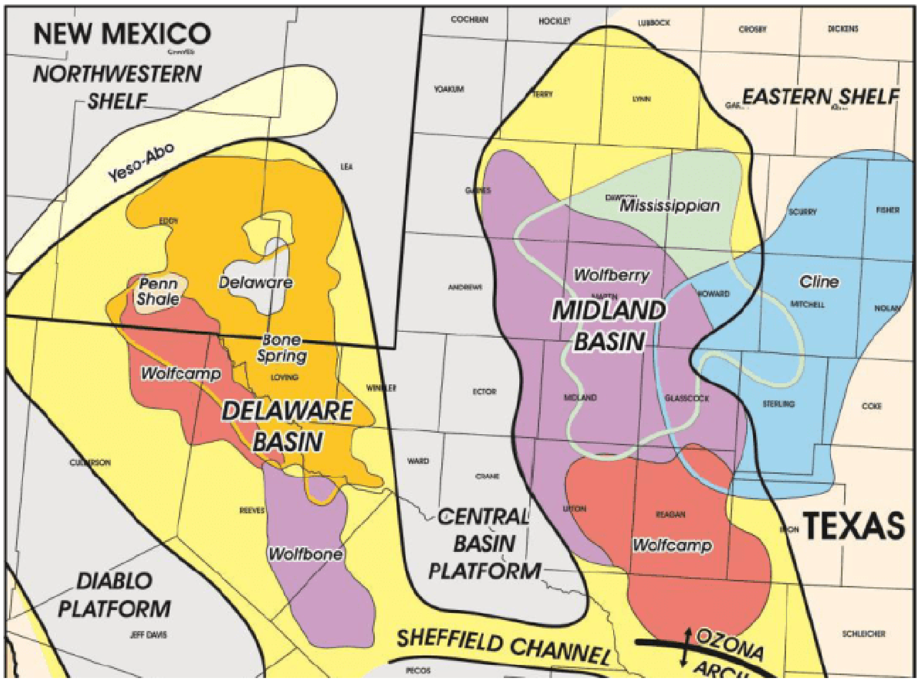

Figure 1.1 Map of Tectonic Subdivision of the Delaware Basin[3]

Several transmission upgrades, including the Far West Texas Project (FWTP), the Far West Texas Dynamic Reactive Devices (DRD) Project, and the Far West Texas Project 2 (FWTP2) have been completed in recent years to accommodate the significant and rapid load growth and to address the transmission needs in the area. Figure 1.2 shows the existing 345-kV transmission system map of the study area.

The rapid oil and gas development in the area has been and will continue to be a significant challenge for both transmission planning and system operations. The challenge originates from fundamental difference in planning horizons between major transmission improvements and oil and gas development. The oil and gas industry typically maintains a one or two year planning horizon, while transmission improvements, which include planning studies, routing analysis, regulatory approvals, route acquisition, design, and construction, can take on the order of four to six years. Because of the short planning horizon for oil and gas customers and resulting lack of long-term load commitments, transmission planning studies are able to accurately identify system needs only for one to two years in advance, which is not sufficient to plan and construct new transmission improvements to meet the rapid and significant load growth in the Permian Basin area.

[3] https://www.oilandgas360.com/ngl-energy-partners-adds-water-sources-for-oil-gas-operators-in-the-permian/

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland

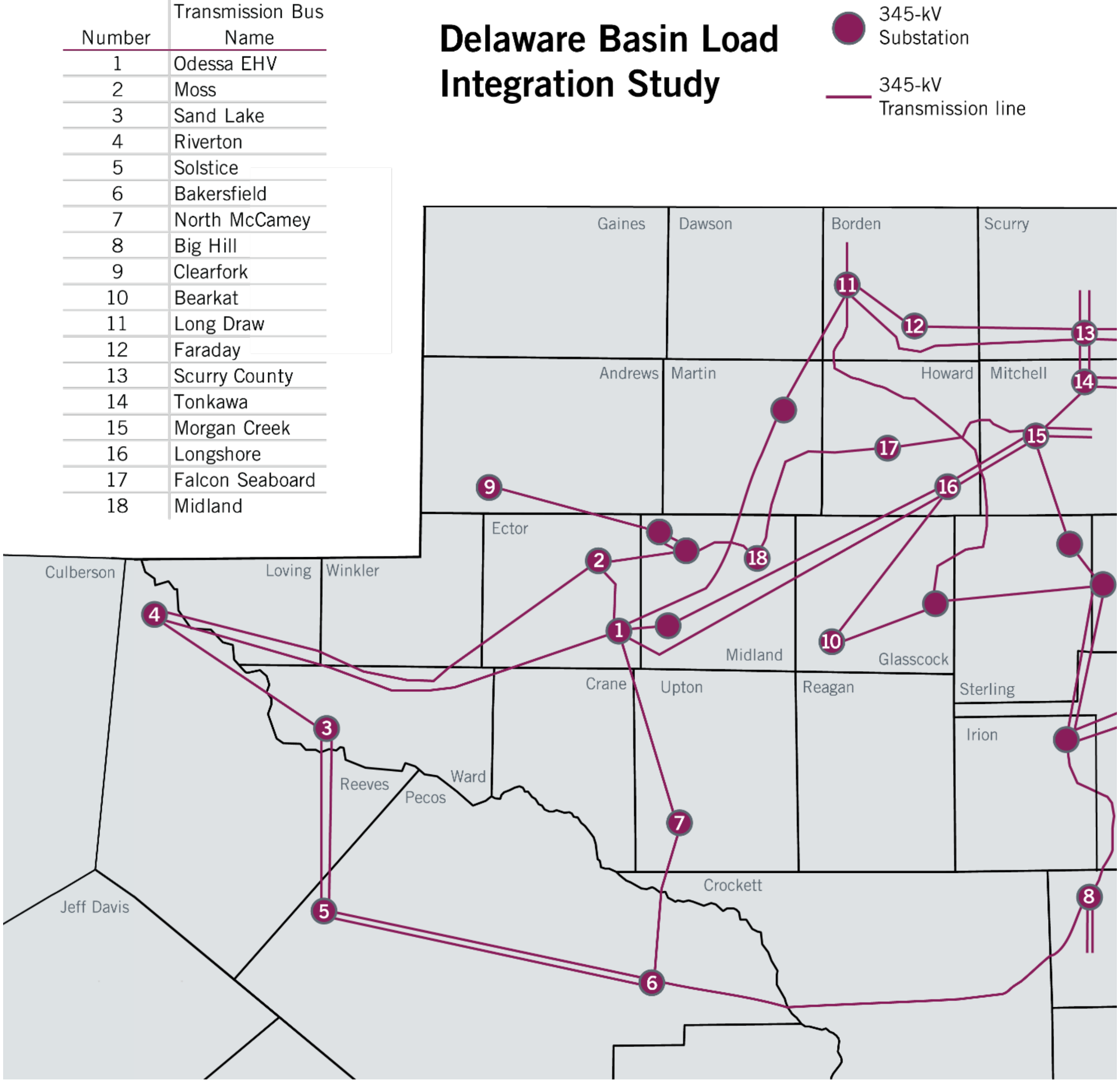

Figure 1.2 345-kV Transmission System Map of Study Area

As part of the continuing efforts to address the challenge, ERCOT completed the Delaware Basin Load Integration Study[1] in December 2019 and Permian Basin Load Interconnection Study[2] in December 2021 through extensive review and input by TSPs and stakeholders.

The Delaware Basin Load Integration Study identified potential long lead time transmission improvements (i.e., new 345-kV transmission lines) to accommodate the rapid oil and gas development. The study developed a roadmap of preferred system upgrades involving major new 345-kV lines to improve the capability to import power into the Delaware Basin area using a higher-than-forecasted (i.e., conceptual plus planned) load growth in the Delaware Basin area. The conceptual load growth assumed in the Delaware Basin Load Integration Study was provided by the TSPs in the area based on the surveys of their high-use oil and gas customers. Table 1.1 and Figure 1.3 show the roadmap of the five stages of transmission upgrades identified from the study. Among the upgrades in the roadmap, the Stage 1 upgrade was endorsed in June 2021 and is expected to be complete in 2023.

Table 1.1 Delaware Basin Transmission Upgrade Roadmap

Stage	Estimated Delaware Basin Load Level (MW)	Upgrade Element	Trigger
1	3,052	Add a second circuit on the existing Big Hill – Bakersfield 345-kV line	Import Needs
2	4,022	A new Bearkat – North McCamey – Sand Lake double-circuit 345-kV line	Import Needs
3	4,582	A new Riverton – Owl Hills single-circuit 345-kV line	Culberson Loop Needs
4	5,032	Riverton – Sand Lake 138-kV to 345-kV conversion and a new Riverton – Sand Lake 138-kV line	Culberson Loop Needs
5	5,422	A new Faraday – Lamesa – Clearfork – Riverton double-circuit 345-kV line	Import Needs

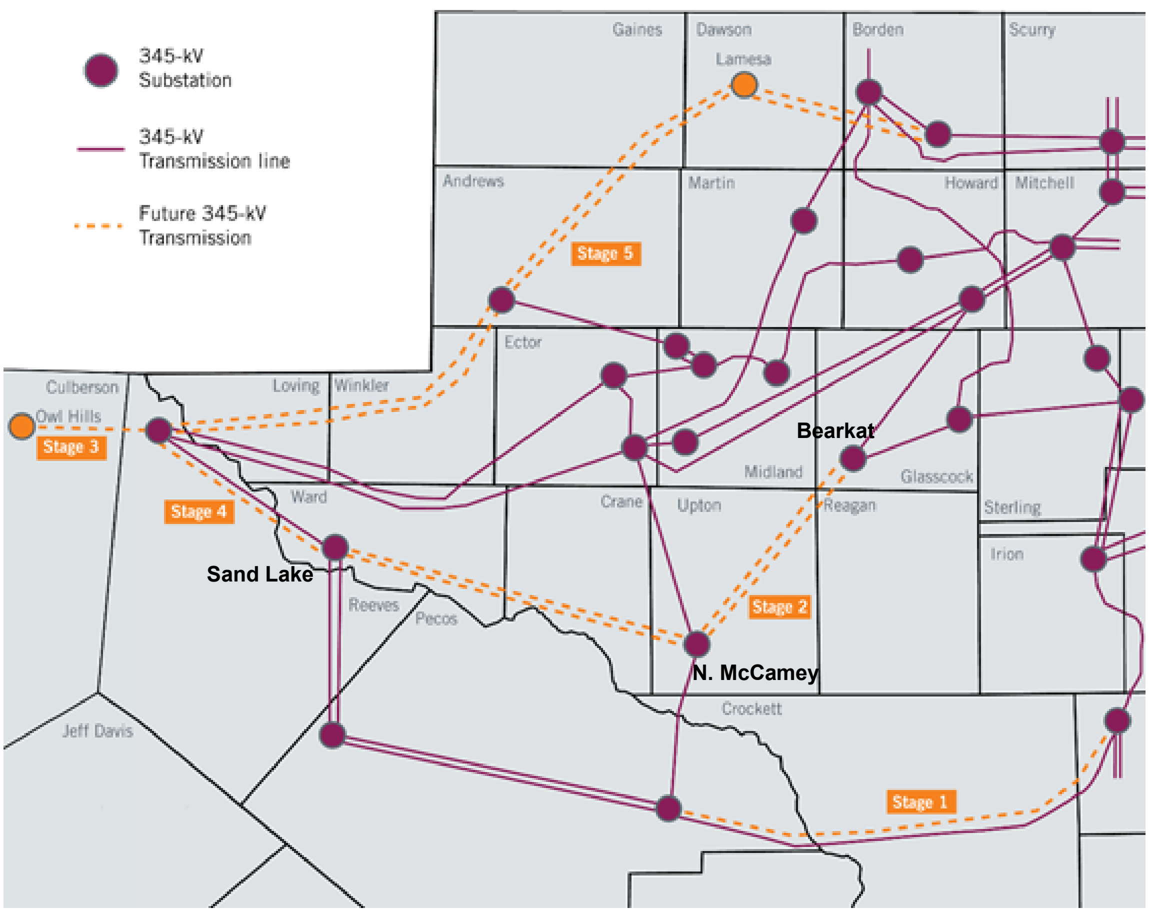

Figure 1.3 345-kV Transmission System Map of Study Area with Stage 1 – Stage 5 Upgrades

The Permian Basin Load Interconnection Study identified the reliability challenges and a set of transmission upgrades, especially long lead time transmission upgrades, to connect and reliably serve the existing and projected oil and gas loads in the Permian Basin area utilizing the demand forecast from the IHS Markit study[4]. The IHS Markit study is a customer demand study performed by IHS Markit, which provides an in-depth analysis of the oil and gas industry and provides an electricity demand forecast in the Permian area through 2030. According to the IHS Markit study report, the demand forecast was based on geology and resource assessment, industry intelligence, oil and gas expertise, commercial considerations, translations of historical and forecasted oil and gas activities into electric load demands in every single square mile in the Permian Basin area.

As shown in Appendix B, the Permian Basin Load Interconnection Study identified the preferred transmission upgrades. Among the preferred transmission upgrades, the Stage 2 upgrade was identified to maintain grid reliability under multiple P7 contingencies (i.e., N-1 conditions) in the 2030 study case. More details of the need for the Stage 2 upgrade are described in Section 3.

LCRA TSC, Oncor, and WETT jointly submitted the Bearkat – North McCamey – Sand Lake 345-kV Transmission Line Addition Project for RPG review to provide a new transmission import path into the Delaware Basin area that is necessary to accommodate significant and rapid load growth associated with oil and gas development and to address reliability needs in the Delaware Basin area. With the demand in the Delaware Basin area forecasted to exceed the Stage 2 trigger point (4,022 MW) in both the 2021 RTP (year 2026) and October 2021 SSWG cases (year 2024), LCRA TSC, Oncor, and WETT propose to implement the Stage 2 upgrade. This RPG project has an estimated cost of $477.6 Million and is classified as a Tier 1 project pursuant to Protocol Section 3.11.4.3. Certificate of Convenience and Necessity filings would be required for this project.

Since the Stage 2 upgrade has already been evaluated and proposed as part of the Delaware Basin Load Integration Study and Permian Basin Load Interconnection Study, ERCOT conducted the independent review of this RPG project by reviewing these study results and assumptions to check if any recent system changes would potentially alter or modify the projects recommended in these studies. In addition, ERCOT reviewed and compared the recent trends of demand growth in the Delaware Basin area. The subsequent sections describe the details of the study assumptions, methodology, and the results of the ERCOT Independent Review.

[4] https://www.ercot.com/files/docs/2020/11/27/27706_ERCOT_Letter_to_Commissioners_-_Follow-up_Status_Update_on_Permian....pdf

2. Study Assumptions and Methodology

ERCOT reviewed the RPG project jointly submitted by LCRA TSC, Oncor, and WETT and confirmed the submitted project aligns with the Stage 2 upgrade identified in the Delaware Basin Load Integration Study. As such, for this independent review, ERCOT utilized the study results from the Delaware Basin Load Integration Study and the 2021 Permian Basin Load Interconnection Study. Furthermore, ERCOT reviewed the 2021 RTP final reliability case to confirm the project need.

2.1. Study Assumptions and Methodologies

ERCOT conducted the Delaware Basin Load Integration Study in 2019 based on criteria contained in NERC reliability standard TPL-001-4 and the ERCOT Planning Guide.

Oil and gas loads in the Delaware Basin area were assumed to be constant throughout the year based on operational data. As such, potential high impact maintenance outages (including major 345-kV circuits) were included in the study in order to ensure adequate operational flexibility and reliability in the study area.

Due to the relatively constant demand from oil and gas customers in the Delaware Basin region, solar generation in the area was assumed to be offline to represent a stressed system condition. This solar dispatch assumption was extended to the entire Far West Weather Zone during the review of the 2021 RTP final reliability case.

The following sections describe the study assumptions of the review using the 2021 RTP final case.

2.1.1. Steady-State Study Base Case

The study area for this review included transmission facilities in the Far West Weather Zone.

2.1.1.1. Base Case

The steady-state study base case was constructed from the following final 2021 RTP case[5] posted on the MIS on December 23, 2022:

- 2021RTP_2026_SUM_WFW_12232021

2.1.1.2. Transmission Topology

All RPG-approved Tier 1, Tier 2, and Tier 3 transmission projects within the study area as well as the Tier 4 projects within the Delaware Basin area expected to be in-service by 2026 that were not in the base case were added to the study base case. Based on the ERCOT Transmission Project Information and Tracking (TPIT) report posted on October 1, 2021, the TPIT projects in Table 2.1 were added to the study base case.

Table 2.1 Transmission Projects Added to Study Base Case

TPIT Number	Project Name	County	Projected In-service Date	Planning Charter Tier
7124	Flat Iron – Barr Ranch – Pegasus South 138 kV Line Project	Midland	Dec-2023	Tier 2
63429	Adds TNMP Alamo Street Substation	Pecos	May-2022	Tier 4
63431	Adds TNMP Holiday Switching Station	Pecos	May-2022	Tier 4
63427	Adds TNMP Girvin Switching Station	Pecos	Jun-2022	Tier 4

[5] https://mis.ercot.com/secure/data-products/grid/regional-planning?id=PG3-2178-M

63433	Rebuilds AEP Creosote - TNMP Coyanosa138-kV line as double circuit	Reeves	Dec-2022	Tier 4
62728	Wink - Shifting Sands 69-kV Line Conversion to 138-kV	Winkler	Dec-2022	Tier 4

The Stage 2 upgrade was already modeled in the 2021 RTP 2026 reliability case to address the reliability violations. In this ERCOT Independent Review, the Stage 2 upgrade was removed from the 2021 RTP reliability case.

2.1.1.3. Generation

Based on the January 2022 Generator Interconnection Status (GIS) report posted on the ERCOT website in February 2021, generator additions planned to connect to the study area and meeting Planning Guide Section 6.9(1) for inclusion in the planning models that were not in the base case were added to the study base case. These generator additions are listed in Table 2.2. All the new battery generation units added to the case were dispatched consistent with the 2021 RTP methodology.

Table 2.2 Generation Units Added to Study Case

GINR Number	Project Name	County	Capacity (MW)	Fuel	Projected Commercial Operation Date
20INR0280	High Lonesome BESS	Crockett	51.06	Battery	06/01/2022
20INR0281	Queen BESS	Upton	51.06	Battery	05/31/2022
22INR0372	BRP Hydra BESS	Pecos	202.31	Battery	10/30/2022
22INR0384	BRP Pavo BESS	Pecos	176.85	Battery	07/11/2022

The status of the units either mothballed or retired were reviewed at the time of this study, and the following unit was removed from the study case:

- RAY OLINGER STG U1

2.1.1.4. Loads

The load level of the Far West Weather Zone remains the same as in the 2021 RTP case. The loads outside of the study weather zone, excluding the West and Far West Weather Zones, were adjusted necessary for power balance consistent with the 2021 RTP assumptions.

2.1.2. Economic Study Base Case

2.1.2.1. Base Case

The 2026 economic final case from the 2021 RTP was used to develop a study base case for congestion analysis.

2.1.2.2. Transmission Topology

All RPG-approved Tier 1, 2, and 3 transmission projects in the study area as well as the Tier 4 projects in the Delaware Basin area expected to be in-service by 2026 were added to the study base case. The ERCOT TPIT report posted on October 1, 2021, was used as reference. The added TPIT projects are listed in Table 2.1.

2.1.2.3. Generation

Planned generators in the ERCOT system that met Planning Guide Section 6.9(1) conditions for inclusion in the base cases (based on the 2022 January GIS report) were added to the study base case. The added generators are listed in Table 2.2.

The status of the units either mothballed or retired were reviewed at the time of this study and the following unit was removed from the study case:

- RAY OLINGER STG U1

2.1.2.4. Loads

Loads were maintained consistent with the 2021 RTP economic model for the year 2026.

2.2. Study Tool

ERCOT utilized the following software tools to perform this independent review:

- PowerWorld Simulator version 22 was used for security constrained optimal power flow (SCOPF) and steady state contingency analysis
- UPLAN version 11.4.0.27191 was used to perform the congestion analysis

3. Project Need

ERCOT conducted the review of the Delaware Basin Load Integration Study, Permian Basin Load Interconnection Study, and the 2021 RTP summer peak final reliability case based on the study assumptions and methodologies described in Section 2.

3.1. Review of the 2021 Regional Transmission Plan (RTP) Cases

ERCOT evaluated the 2021 RTP 2026 case based on the study assumptions and methodologies described in Section 2. The study results showed potential voltage instability under certain NERC Category P7 contingency (i.e., N-1 condition) and confirmed the reliability need of the Stage 2 upgrade.

Voltage instability was observed under the following NERC Category P7 contingency condition in 2026 case:

- REDACTED

The Stage 2 upgrade will address the potential voltage instability issue that may occur under N-1 condition of certain NERC Category P7 contingency.

Table 3.1 Delaware Basin Area Load Forecast in the 2021 RTP Cases

Year	MW
2026	4,347
2027	4,545

The trigger point of the Stage 2 upgrade (4,022 MW) was compared to the Delaware Basin area load in the 2021 RTP WFW 2026 and 2027 summer peak cases as shown in Table 3.1. The Delaware Basin area load in the 2021 RTP 2026 case exceeds the trigger point of the Stage 2 upgrade, indicating that the Stage 2 upgrade (i.e., a new Bearkat – North McCamey – Sand Lake double-circuit 345-kV line) is needed by summer 2026 or earlier.

3.2. Review of Delaware Basin Load Integration Study Results

The Delaware Basin Load Integration Study identified the addition of a new Bearkat – North McCamey – Sand Lake double-circuit 345-kV line as the Stage 2 upgrade to address the overload of the Longshore to Midessa South 345-kV line under certain critical N-1 contingency that may occur during the planned maintenance outage of the Odessa combined cycle train 1 when the Delaware Basin area load level exceeds 4,022 MW.

More details of the Delaware Basin Load Integration Study can be found in Appendix A.

3.3. Review of Permian Basin Load Interconnection Study Results

The Permian Basin Load Interconnection Study identified a set of transmission upgrades, especially long lead time local transmission upgrades, to connect and reliably serve the existing and projected oil and gas loads in the Permian Basin area utilizing the demand forecast from the IHS Markit study, which provides an in-depth analysis of the oil and gas industry and provides an electricity demand forecast in the Permian Basin area through 2030. Table 3.2 shows the 2025 and 2030 load levels in the Delaware Basin area studied in the Permian Basin Load Interconnection Study.

Table 3.2 Delaware Basin Area Load Forecast in the Permian Basin Load Interconnection Study

Year	MW
2025	3,789
2030	4,898

The results of the Permian Basin Load Interconnection Study reconfirmed the need of the Stage 2 upgrade to maintain grid reliability under multiple P7 contingencies (i.e., N-1 conditions) in the 2030 study case in which the Delaware Basin area load is 4,898 MW.

More details of the Permian Basin Load Interconnection Study can be found in Appendix B.

4. Project Alternatives and Recommended Project

4.1. Review of Delaware Basin Load Integration Study Results

ERCOT evaluated a number of options (as part of the Delaware Basin Study) to improve the capability to import power into the Delaware Basin area to resolve the identified reliability issues, including adding a second circuit on the existing Big Hill – Bakersfield 345-kV line (Stage 1 upgrade), a new Bearkat – North McCamey – Sand Lake double-circuit 345-kV line (Stage 2 upgrade, estimated cost: $371 Million in 2019 dollar and $477.6 Million in 2022 dollar, estimated new rights-of-way: 165 miles), and a new Faraday – Lamesa – Clearfork – Riverton double-circuit 345-kV line (Stage 5 upgrade, estimated cost: $444 Million in 2019 dollar, estimated new rights-of-way: 193 miles). The Stage 1 upgrade was endorsed by ERCOT in June 2021 and is expected to be implemented in 2023.

The estimated load serving capabilities are similar for the Stage 2 and Stage 5 upgrades as described in Sections 4 and 6 of the Delaware Basin Load Integration Study. The Stage 2 upgrade requires relatively less amount of new rights-of-way and is projected to cost less than the Stage 5 upgrade. As such, ERCOT proposed the new Bearkat – North McCamey – Sand Lake double-circuit 345-kV line as the Stage 2 upgrade in the Delaware Basin Load Integration Study.

4.2. Additional Alternatives Evaluation

ERCOT considered additional alternatives submitted by Garland Power and Light (GP&L) and Texas-New Mexico Power (TNMP) during the comments period of this RPG review. The alternatives are slightly different from the Stage 2 upgrade as shown in Figure 4.1.

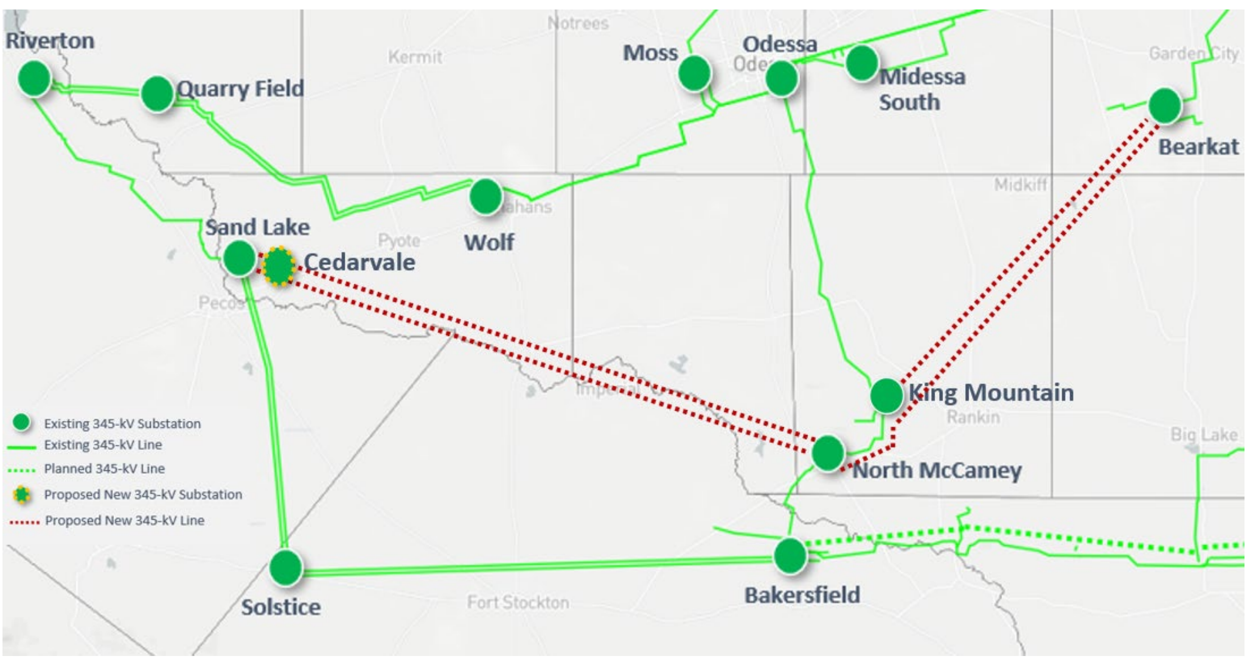

Figure 4.1 Additional Alternatives

GP&L's alternative slightly modifies the Stage 2 upgrade by terminating one of the new 345-kV circuits from Bearkat at King Mountain and making portion of the new Bearkat – North McCamey circuit share the same towers with the existing King Mountain to North McCamey circuit as shown in Figure 4.1.

ERCOT evaluated GP&L's alternative and determined that the proposed Stage 2 upgrade is more reliable than GP&L's alternative based on the following reasons:

- The Stage 2 upgrade provides one more outlet to North McCamey where two 800 MVA 345/138 kV transformers are located to serve the load and generation on the 138-kV system in the McCamey area, compared to GP&L's alternative.
- GP&L's alternative will leave only one circuit from Bearkat to North McCamey under the maintenance outage of the existing North McCamey to King Mountain circuit. ERCOT's steady-state analysis with the maintenance outage condition showed thermal overloads on some of the 138-kV lines in the McCamey area.
- Under GP&L's alternative, a NERC Category P7 contingency will remove both the existing North McCamey – King Mountain 345-kV line and the new North McCamey – Bearkat 345-kV line. ERCOT conducted a high-level stability study for GP&L's alternative, and the study indicated negative impact on the McCamey GTC limit under the prior outage of Noelke – Schneeman Draw or Cedar Canyon – Noelke 345-kV double circuits when compared to the Stage 2 upgrade.
- Extended construction outages or higher energized construction costs may be needed to add a second 345-kV circuit on the existing towers in GP&L's alternative.

TNMP's alternative slightly modifies the Stage 2 upgrade by looping the new North McCamey to Sand Lake double-circuit 345-kV line into a new Cedarvale 345-kV substation (~ 3.7 miles southeast of the existing Sand Lake substation) in order to accommodate potential large flexible loads in the area. According to the response to the TNMP comment, Oncor and TNMP agreed that the LCRA TSC, Oncor, and WETT Bearkat – North McCamey – Sand Lake 345kV Transmission Line Addition Project should move forward without delay as originally submitted. The response from the TSPs also indicated that "both Oncor and TNMP will remain committed to effectively and efficiently address transmission system concerns that arise from the recent influx of customer loads in the Far West region beyond that which was identified in the scope of the original Delaware Basin area review."

Since such loads are currently under review by Large Flexible Load Task Force, ERCOT also recommends moving forward with the proposed Stage 2 upgrade.

4.3. Recommended Project

Based on this independent review, the Delaware Basin Load Integration Study and Permian Basin Load Interconnection Study, ERCOT recommends the following project (Stage 2 upgrade):

- Build a new double-circuit 345-kV line from existing Bearkat Substation to existing North McCamey Substation (~71 miles), with normal and emergency ratings of at least 2,564 MVA
- Build a new double-circuit 345-kV line from existing North McCamey Substation to existing Sand Lake Substation (~94 miles), with normal and emergency ratings of at least 2,564 MVA
- Reconfigure each of the existing substations into a breaker-and-a-half substation (as a minimum configuration)

5. Impact of Stage 2 Upgrade on Dynamic Stability Analysis

ERCOT assessed the potential impact of the recommended project (Stage 2 upgrade) on the existing McCamey Generic Transmission Constraint (GTC). As the Stage 2 upgrade provides additional new 345-kV transmission outlets to the McCamey area, it is expected to improve system strength by reducing overall system impedances and reactive losses. Therefore, the Stage 2 upgrade is expected to improve the dynamic stability of the existing system in the McCamey area.

The Stage 2 upgrade, a new Bearkat – North McCamey – Sand Lake double-circuit 345-kV line, is not expected to require any extended transmission outages during construction. The McCamey GTC will continue to be reviewed and updated in the future Quarterly Stability Assessments (QSAs).

6. Sub-synchronous resonance (SSR) Assessment and Other Sensitivity Studies

A sub-synchronous-resonance (SSR) assessment was performed for the Stage 2 upgrade to identify any adverse impacts to the system in the study area. In addition, sensitivity studies were performed to identify the Stage 2 upgrade performance under certain sensitivity scenarios.

6.1. SSR Assessment

Pursuant to Nodal Protocol Section 3.22.1.3, ERCOT conducted an SSR screening for the Stage 2 upgrade and found no need to require further assessment per Nodal Protocol Section 3.22.

6.2. Planning Guide Section 3.1.3(4) Sensitivities

The Stage 2 upgrade is categorized as a Tier 1 project, pursuant to ERCOT Protocol 3.11.4.3. As required by Planning Guide Section 3.1.3(4), ERCOT performed generation and load sensitivity studies.

6.2.1. Generation Addition Sensitivity Analysis

ERCOT performed a generation addition sensitivity analysis based on Planning Guide Section 3.1.3(4)(a).

Based on a review of the January 2022 GIS report, the following generators in the study area shown in Table 6.1 have a signed interconnection agreement (IA) but have not met all the conditions for inclusion in the case pursuant to Section 6.9(1) of the Planning Guide.

Table 6.1 Generation Units with Signed IA

GINR	Project Name	County	Projected Commercial Operation Date	Fuel	Capacity (MW)
20INR0143	Soda Lake Solar 2	Crane	05/31/2023	Solar	202.99
20INR0249	Appaloosa Run Wind	Upton	03/01/2023	Wind	175
21INR0005	Hutt Wind	Midland	04/05/2023	Wind	336
21INR0021	Green Holly Solar	Dawson	03/31/2023	Solar	413.6
21INR0022	Red Holly Solar	Dawson	08/01/2023	Solar	260
21INR0029	Green Holly Storage	Dawson	08/01/2023	Battery	50
21INR0033	Red Holly Storage	Dawson	08/01/2023	Battery	50
21INR0268	Greyhound Solar	Ector	06/30/2023	Solar	608.7
22INR0363	Hayhurst Texas Solar	Culberson	02/15/2023	Solar	46.2
22INR0485	House Mountain 2 Batt	Brewster	02/01/2023	Battery	61.62
22INR0495	TIMBERWOLF BESS 2	Upton	02/17/2023	Battery	150

These potential renewable resources are located in the Far West Weather Zone. As discussed in Section 2, due to the relatively constant demand from oil and gas customers in the Delaware Basin area, solar generation in the Far West region was assumed to be offline to represent a stressed system condition. Therefore, inclusion of the potential solar resources in Table 6.1 will not change the reliability need.

Although inclusion of the potential wind and battery resources may slightly improve the load serving capability in the study area under normal system conditions if these renewable resources become materialized, it is not expected to be enough to address the reliability need in the study area. As shown in Table 6.1, there are 511 MW of potential new wind generation capacity in the Far West Weather

Zone. With the assumption of 9.55% wind generation dispatch inside the study region per 2021 RTP methodology, the potential new wind generation addition will be about 49 MW. The battery generation is assumed online to provide reactive power support only, i.e., zero MW output, based on the 2021 RTP methodology.

As such, these future renewable resources are not expected to have a material impact on the need of the Stage 2 upgrade.

6.2.2. Load Scaling Sensitivity Analysis

Planning Guide Section 3.1.3(4)(b) requires evaluation of the potential impact of load scaling on the criteria violations seen in this ERCOT independent review. ERCOT concluded that the load scaling would not have a material impact on the project need because of the following reasons:

- The Delaware Basin area is remotely located at the western most part of the ERCOT system relying on two major 345-kV import paths (i.e., Odessa/Moss – Wolf – Riverton and Bakersfield – Solstice).
- Significant and rapid oil and gas load additions were observed and projected in the Delaware Basin area. The load scaling outside the Delaware Basin area is not expected to have a material impact on the need of the Stage 2 upgrade.

7. Congestion Analysis

ERCOT conducted a congestion analysis to identify any potential impact on system congestion related to the addition of the Bearkat – North McCamey – Sand Lake double-circuit 345-kV line, using the 2021 RTP 2026 economic study case.

The results of the congestion analysis indicated no additional congestion in the area with the addition of the Stage 2 upgrade.

8. Load Growth Consideration

ERCOT compared the load forecasts related to the Delaware Basin area assumed in the 2021 RTP cases, the Permian Basin Load Interconnection Study completed in 2021, and the October 2021 ERCOT SSWG cases as shown in Table 8.1. The load forecasts assumed in the 2021 RTP cases and the Permian Basin Load Interconnection Study are based on the load forecast from the IHS Markit Study published in April 2020. The 2021 RTP cases indicate that the Delaware Basin area load is expected to exceed the trigger point of 4,022 MW for the Stage 2 upgrade prior to summer 2026. The 2021 SSWG cases indicate that the Delaware Basin area load will exceed the trigger point of the Stage 2 upgrade a few years earlier.

These discrepancies indicate the current uncertainty associated with predicting the timing of the need for the proposed project.

Table 8.1 Delaware Basin Area Load Forecasts Comparison

Year	2021 RTP (MW)	2021 Permian Basin Load Interconnection Study (MW)	October 2021 SSGW (MW)
2025	n/a*	3,789	4,515
2026	4,347	n/a**	4,543
2027	4,545	n/a**	4,556

Note:
* 2021 RTP study didn't include the case for year 2025.
** 2021 Permian Basin Load Interconnection Study included the cases for year 2025 and 2030. The load levels are 3,789 MW and 4,898 MW for 2025 and 2030 respectively.

In addition, ERCOT reviewed the historical oil and gas activities and load growth in the Far West region. As shown in Figure 8.1, oil and gas drilling activities in the Far West Texas region declined in early 2020 due economic factors and international oil markets but have been increasing since July 2020. As shown in Figure 8.2, historical peak demand in the Far West Weather Zone continues to grow.

Based on this review of the historical and forecasted demand in the area, recent oil and gas drilling trends, and the evaluation of the 2021 RTP cases described in Section 3.3, ERCOT believes that this project will be needed prior to summer 2026. As such, ERCOT concurs with the schedule proposed by LCRA TSC, Oncor, and WETT, specifically that the project be completed prior to summer 2026.

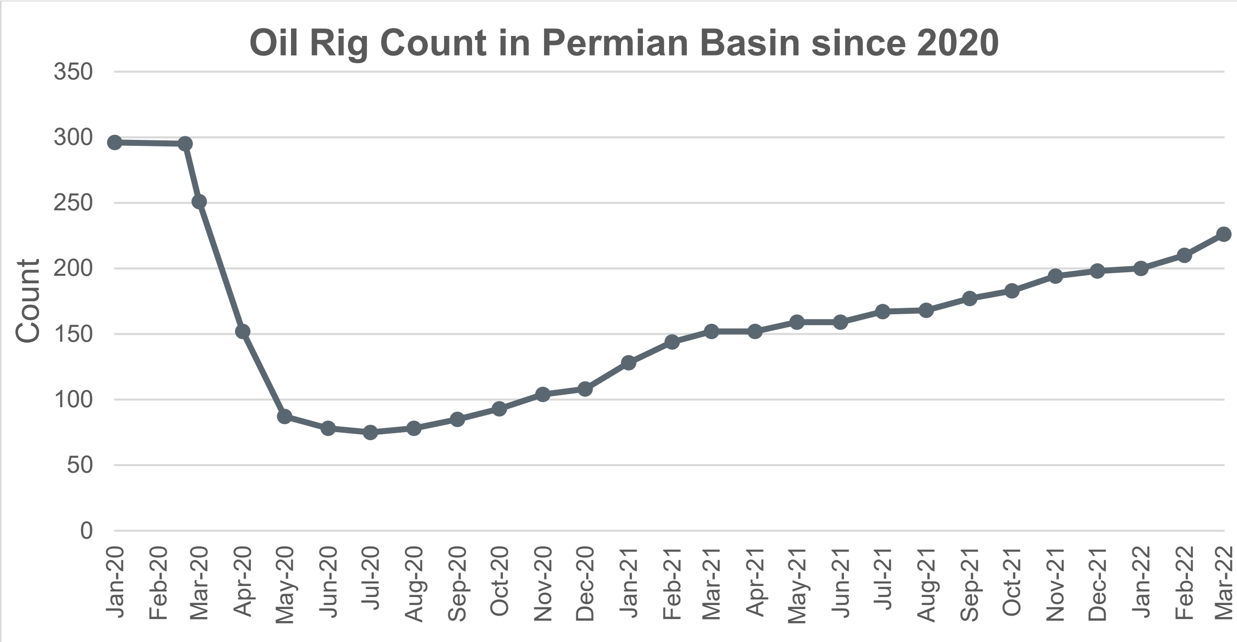

Figure 8.1 Oil Rig Counts in Permian Basin

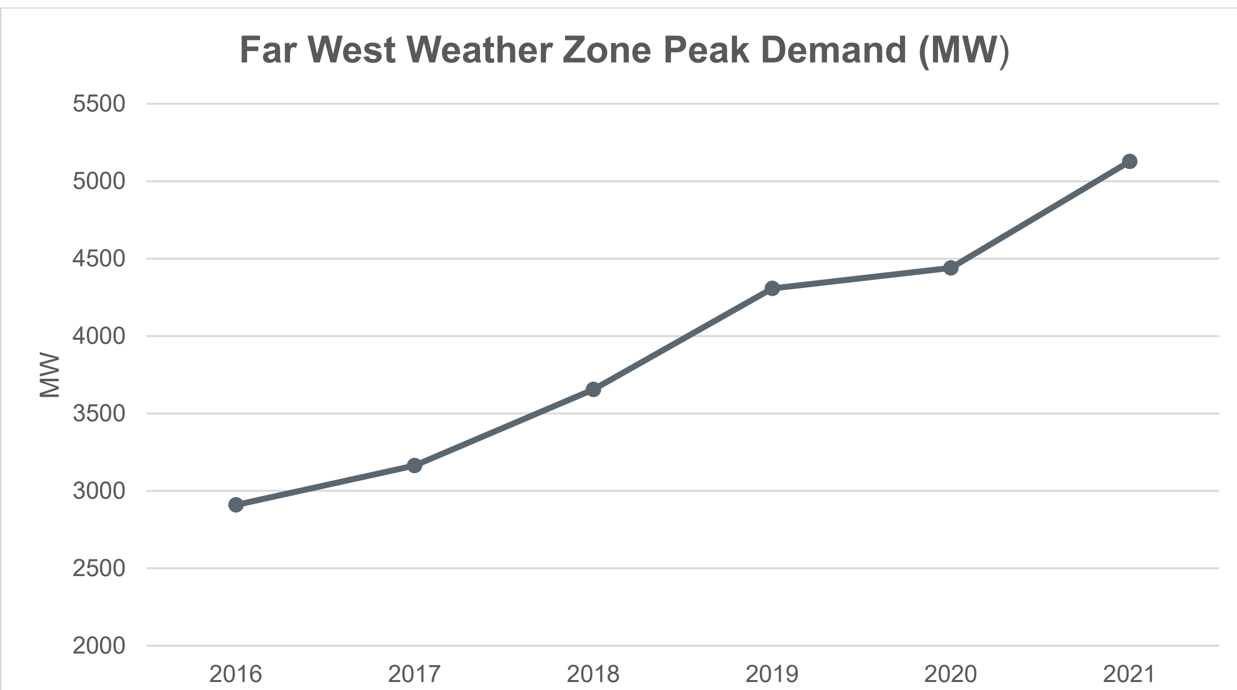

Figure 8.2 Far West Weather Zone Historical Peak Demand

9. Conclusion

This report describes the ERCOT evaluation of the Bearkat – North McCamey – Sand Lake 345-kV Transmission Line Addition Project jointly submitted by LCRA TSC, WETT, and Oncor. Based on the results of this independent review, ERCOT recommends this RPG project to address the reliability need to accommodate the significant and rapid load growth in the Delaware Basin area. The Bearkat – North McCamey – Sand Lake double-circuit 345-kV line addition Project is estimated to cost $477.6 Million and consists of the following upgrades:

- Build a new double-circuit 345-kV line from existing Bearkat Substation to existing North McCamey Substation (~71 miles), with normal and emergency ratings of at least 2,564 MVA
- Build a new double-circuit 345-kV line from existing North McCamey Substation to existing Sand Lake Substation (~94 miles), with normal and emergency ratings of at least 2,564 MVA
- Reconfigure each of the existing substations into a breaker-and-a-half substation (as a minimum configuration)

It is also recommended that this project be in-service by summer 2026.

LCRA TSC, Oncor, and WETT have requested ERCOT designate the recommended project "critical" to the reliability of the system per PUCT Substantive Rule 25.101(b)(3)(D). Since there is a reliability need to have the project in place and significant uncertainty associated with predicting the timing of the need for the proposed project (see Section 8 for more details), ERCOT deems the project critical to reliability.

10. Appendix

10.1. Appendix A: Delaware Basin Load Integration Study Report	ERCOT_Delaware_Basin_Load_Integratio
10.2. Appendix B: Permian Basin Load Interconnection Study Report	ERCOT_Permian_Basin_Load_Interconne

APPENDIX A

ERCOT Delaware Basin Load Integration Study

Final

Document Revisions

Date	Version	Description	Author(s)
12/23/2019	1.0	Final	Ying Li
		Reviewed by	Sun Wook Kang, Shun Hsien (Fred) Huang, Jeff Billo

Executive Summary

ERCOT, with extensive review and input by Transmission Service Providers (TSPs) and stakeholders, performed the Delaware Basin Load Integration Study. This report describes potential reliability transmission needs to meet higher-than-forecasted electric demand driven by the oil and natural gas industry and the associated economic expansion in the Delaware Basin area located in the ERCOT Far West Weather Zone. The Delaware Basin area spans the following eight counties: Brewster, Culberson, Jeff Davis, Loving, Pecos, Reeves, Ward, and Winkler.

The Far West Weather Zone, especially the Delaware Basin area, has the highest peak demand growth rate in the ERCOT system in recent years. The historical load data from 2013 to 2019 showed that the average annual peak load growth rate of the Far West Weather Zone is approximately 11%, well above the ERCOT system-wide average.

Several planned transmission projects, including the Far West Texas Project (FWTP), Far West Texas Dynamic Reactive Devices (DRD), and Far West Texas Project 2 (FWTP2), endorsed by the ERCOT Board of Directors in 2017 and 2018, are expected to be sufficient to meet the current load forecast for the Far West Weather Zone through 2024. As the oil and gas load in the Delaware Basin area continues to develop, ensuring that the necessary transmission improvements are in place in time to accommodate the rapid load growth will continue to be a challenge. The nature of the industry is such that oil and gas customers are not able to accurately project their demand needs more than one or two years ahead of time while transmission improvements can take up to six years to complete planning studies, routing analysis (if needed), regulatory approvals, route acquisition (if needed), design, and construction.

The main purpose of the study is to identify potential reliability needs and cost-effective bulk power system upgrades, particularly long lead time transmission improvements, which may be necessary if the load in the Delaware Basin area increases at a rapid pace. ERCOT performed a steady state reliability analysis using a higher-than-forecasted (i.e. conceptual plus planned) load growth in the Delaware Basin area. The total load assumed in the study area was 5,372 MW, which is double the area load (2,688 MW) assumed in the ERCOT 2019 Regional Transmission Plan (RTP) for year 2024.

To address the reliability needs for the assumed total load, four short-listed long lead time transmission alternatives and a set of common transmission upgrades were identified to reliably serve the assumed load in the study area under both normal and contingency conditions. As a result, ERCOT identified a roadmap for the long lead time transmission upgrades (i.e. new 345-kV transmission lines) and the associated triggers in terms of the load level in the Delaware Basin area. As the common transmission upgrades and the upgrade of existing 345-kV lines are expected to require relatively less lead time, they were not considered in the roadmap development. Rather, they were assumed to be completed prior to first trigger level. Table E.1 lists the details of transmission additions associated with each stage.

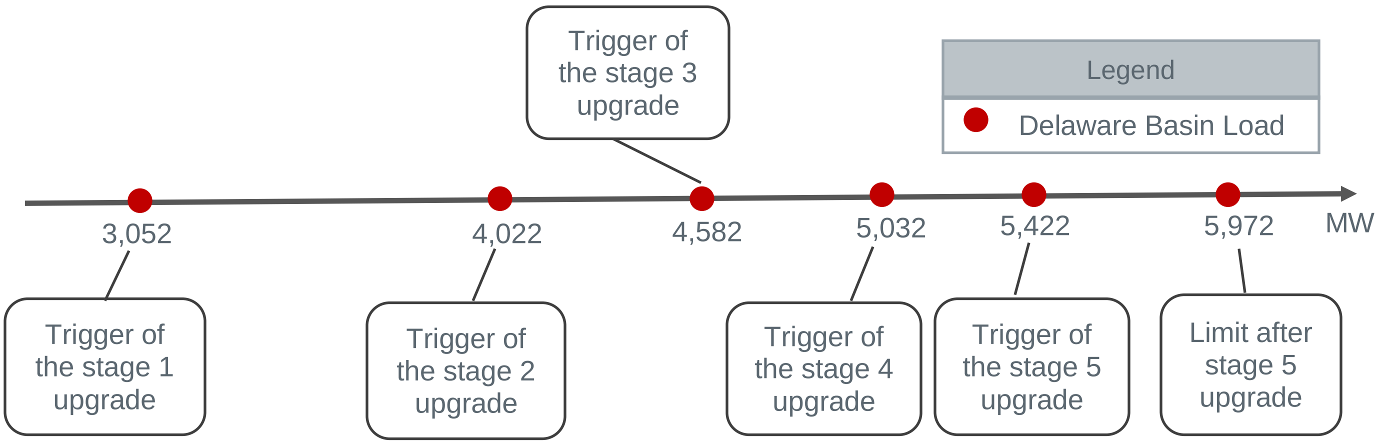

Figure E.1 Delaware Basin Transmission Upgrade Roadmap

Table E.1 Delaware Basin Transmission Upgrade Roadmap – Detailed Project List

Stage	Estimated Delaware Basin Load Level (MW)	Upgrade Element	Estimated Upgrade Cost ($M)	Trigger
1	3,052	Add a second circuit on the existing Big Hill - Bakersfield 345-kV line	69	Import Needs
2	4,022	A new Bearkat - North McCamey - Sand Lake double circuit 345-kV line	371	Import Needs
3	4,582	A new Riverton - Owl Hills single circuit 345-kV line	41	Culberson Loop Needs
4	5,032	Riverton - Sand Lake 138-kV to 345-kV conversion and a new Riverton - Sand Lake 138-kV line	56	Culberson Loop Needs
5	5,422	A new Faraday - Lamesa - Clearfork - Riverton double circuit 345-kV line	444	Import Needs

As noted above, all of the common transmission upgrades were included in the study while developing this roadmap. The addition of a second circuit on the existing structures of the Big Hill - Bakersfield 345-kV line, identified as Stage 1 upgrade, will be needed if the Delaware Basin load exceeds 3,052 MW. The Stage 2 upgrade, a new import path consisting of 345-kV circuits from Bearkat to North McCamey to Sand Lake, will be needed if the Delaware Basin load exceeds 4,022 MW. The Stage 2 upgrade is also expected to improve the existing Generic Transmission Constraints (GTCs) in the McCamey and Bearkat areas.

With Stage 1 and Stage 2 upgrades assumed in service, voltage instability was observed in the Culberson Loop when the Delaware Basin area load reaches 4,582 MW. Stage 3 and Stage 4 upgrades will be necessary to address the Culberson Loop voltage instability.

When the load in the Delaware Basin area exceeds 5,422 MW, the Delaware Basin area may need an additional new import path as shown in the Stage 5 upgrade.

Although the study year was 2024, it should not be assumed that all of the improvement projects are needed in 2024. The actual need for each project could be sooner or later than 2024 depending on the growth rate and location of the load in the Delaware Basin. Other factors that could affect the need for and timing of the upgrades include, but are not limited to, common transmission upgrade implementation, availability and dispatch of the generation in the study area, impedance of the new conductors, transmission upgrade cost estimates, and the results of dynamic stability analysis, which was not conducted as part of this study.

The TSPs and ERCOT will continue to study the Delaware Basin as part of their normal planning processes and recommend new transmission projects as necessary to address new customer interconnections, new generation development, and system needs.

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Disclaimer

It should be noted that the identified transmission improvements in this document are based on the assumptions used in this study. Assumptions that could change the results of this analysis include, but are not limited to, the following: actual load addition size, timing, and location; common transmission upgrade implementation; availability and dispatch of the generation in the study area; impedance of the new conductors; transmission upgrade cost estimates; and the results of dynamic stability analysis.

The primary focus of this study was to identify and to create a roadmap for long lead time transmission improvements, such as new extra high voltage transmission lines, to serve assumed conceptual and planned loads in the Delaware Basin study area. This study addressed transmission system thermal violations and steady state voltage stability issues identified during the analyses for the Far West Weather Zone.

A local reactive planning assessment was not completed as part of this study. The location and size of reactive devices were not optimized as part of this assessment.

1. Introduction

Over the past several years, the Far West Weather Zone, especially in the Delaware Basin area with significant oil and natural gas load, has had the highest peak demand growth rate in the ERCOT region. The average annual peak demand growth rate of the Far West Weather Zone was about 11% according to historic data between 2013 and 2019. The significant load growth rate was primarily driven by the oil and natural gas business development. Figure 1.1 shows the map of tectonic subdivision of the Delaware Basin area.

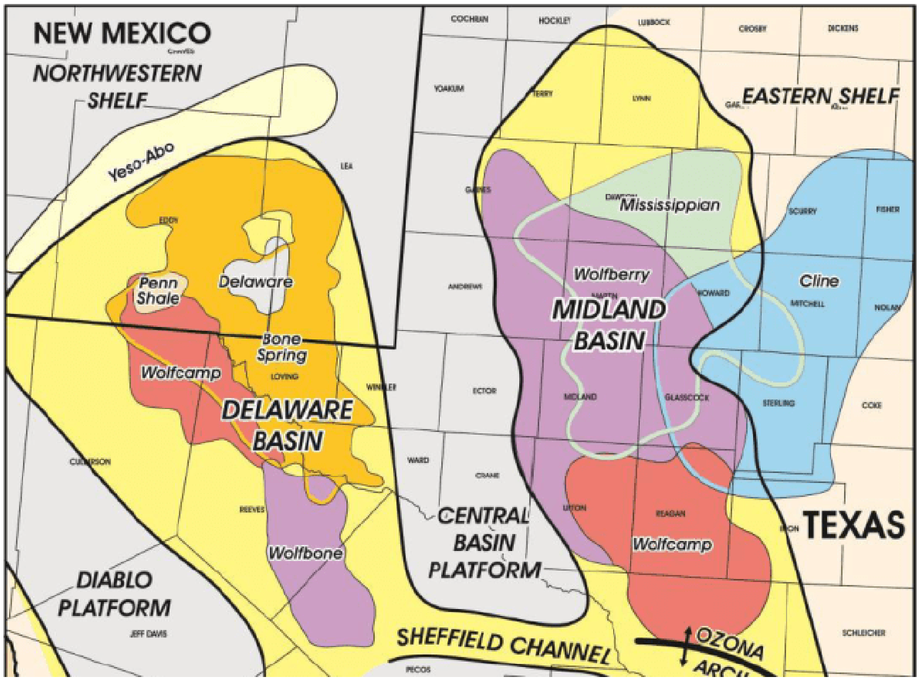


Figure 1.1 Map of Tectonic Subdivision of the Delaware Basin[1]

To accommodate the significant load growth and address the transmission needs in the area, the ERCOT Board endorsed the Far West Texas Project (FWTP), a Tier 1 transmission project in June 2017. In June 2018, the ERCOT Board endorsed the Far West Texas Dynamic Reactive Devices (DRD) Project and the Far West Texas Project 2 (FWTP2) to meet the projected contractually-confirmed load level in the Culberson Loop located in the Delaware Basin area. The FWTP, DRD, and FWTP2 projects, which include a new 345-kV double circuit transmission loop and multiple dynamic reactive devices, are scheduled to be completed by the end of 2020.

These projects along with other planned transmission upgrades are expected to be sufficient to meet the current forecasted load in the Delaware Basin area through 2024. However, if the load in the area develops faster than forecasted, it could outgrow the load serving capability of these planned upgrades. In addition, ensuring that the transmission improvements are in place in time to accommodate the rapid load growth will continue to be a challenge because the nature of the industry is such that oil and gas customers are not able to accurately project their demand needs more than one or two years ahead of time while transmission improvements can take up to six years to complete

[1] https://www.oilandgas360.com/ngl-energy-partners-adds-water-sources-for-oil-gas-operators-in-the-permian/

planning studies, routing analysis (if needed), regulatory approvals, route acquisition (if needed), design, and construction. Due to the nature of relatively short notice from the oil and gas customers providing financial commitment for new load additions, it is difficult to accurately forecast the load five years ahead during the typical planning studies.

Figure 1.2 shows the load comparison of five-year ahead load forecast in the ERCOT SSWG cases and actual historic load in the Delaware Basin area. In 2014, the projected 2019 summer peak demand in the SSWG case for the Delaware Basin area was 595 MW; the recorded peak demand in the Delaware Basin area in 2019 was 1,132 MW, which significantly exceeded the five-year out projected load from 2014. Figure 1.2 also shows substantial increase in the load forecast projected for year 2024. This is primarily due to a significant amount of conceptual loads added by TSPs to the Delaware Basin area.

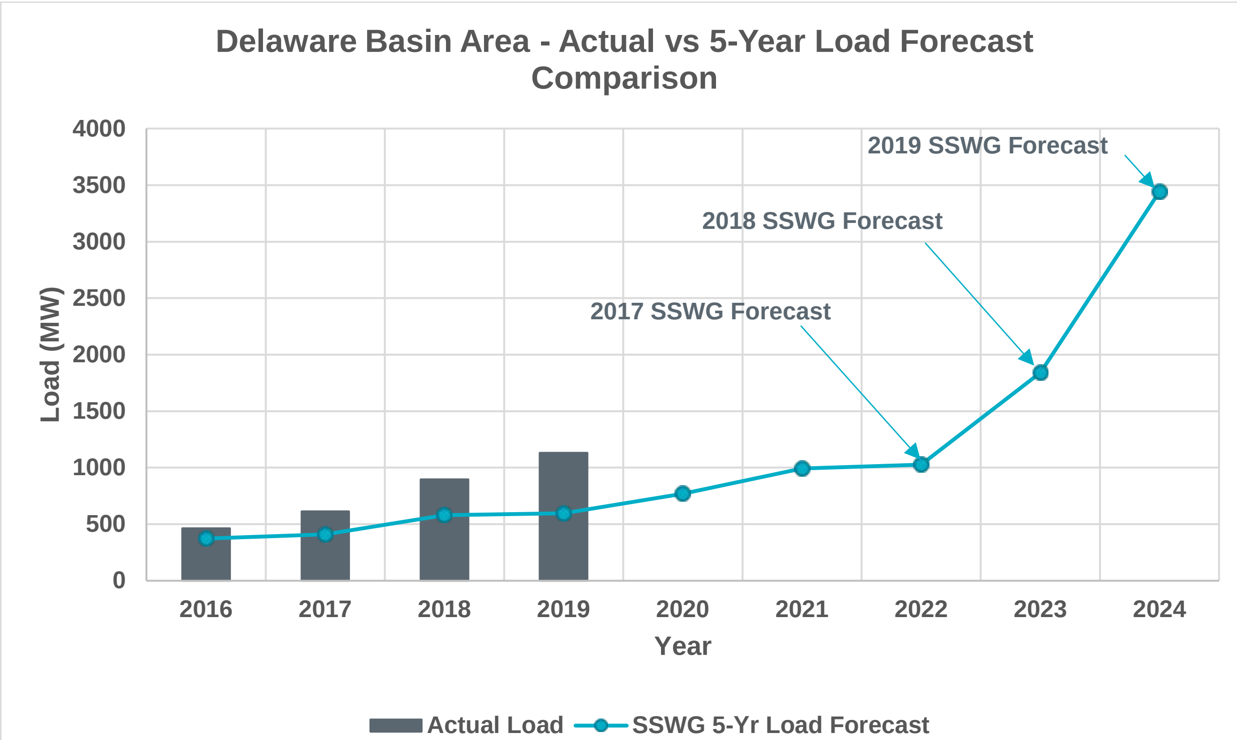


Figure 1.2 Actual and 5-year Load Forecast in the Delaware Basin Area

Given the challenges associated with uncertainties of the load growth in the Delaware Basin area, ERCOT initiated the Delaware Basin Load Integration Study to perform a reliability analysis for higher-than-forecasted load growth in the Delaware Basin area. ERCOT worked closely with TSPs and stakeholders throughout the study.

ERCOT performed steady state analyses using the updated case and identified both long-lead time transmission improvements and a set of common transmission upgrades to reliably serve the assumed load in this study. The common transmission upgrades include upgrading existing transmission facilities, adding new 138-kV transmission lines, and adding new reactive power devices. These common transmission upgrades were assumed to be in-service in the import path evaluation and the development of the long-lead-time-transmission-upgrade roadmap. It should be noted that these common transmission upgrades are expected to require relatively shorter lead time but will be highly dependent on the size and location of the new load additions. Additional studies such as dynamic stability analysis will need to be conducted to optimize the size, location and technology of the new reactive power devices identified as placeholders.

2. Criteria, Study Assumption and Methodology

The study criteria, assumptions, and methodology are described in this section.

2.1. Study Criteria and Monitored Area

The Delaware Basin area includes the following eight counties: Brewster, Culberson, Jeff Davis, Loving, Pecos, Reeves, Ward, and Winkler. Figure 2.1.1 shows the existing and planned 345-kV system map of the study area.

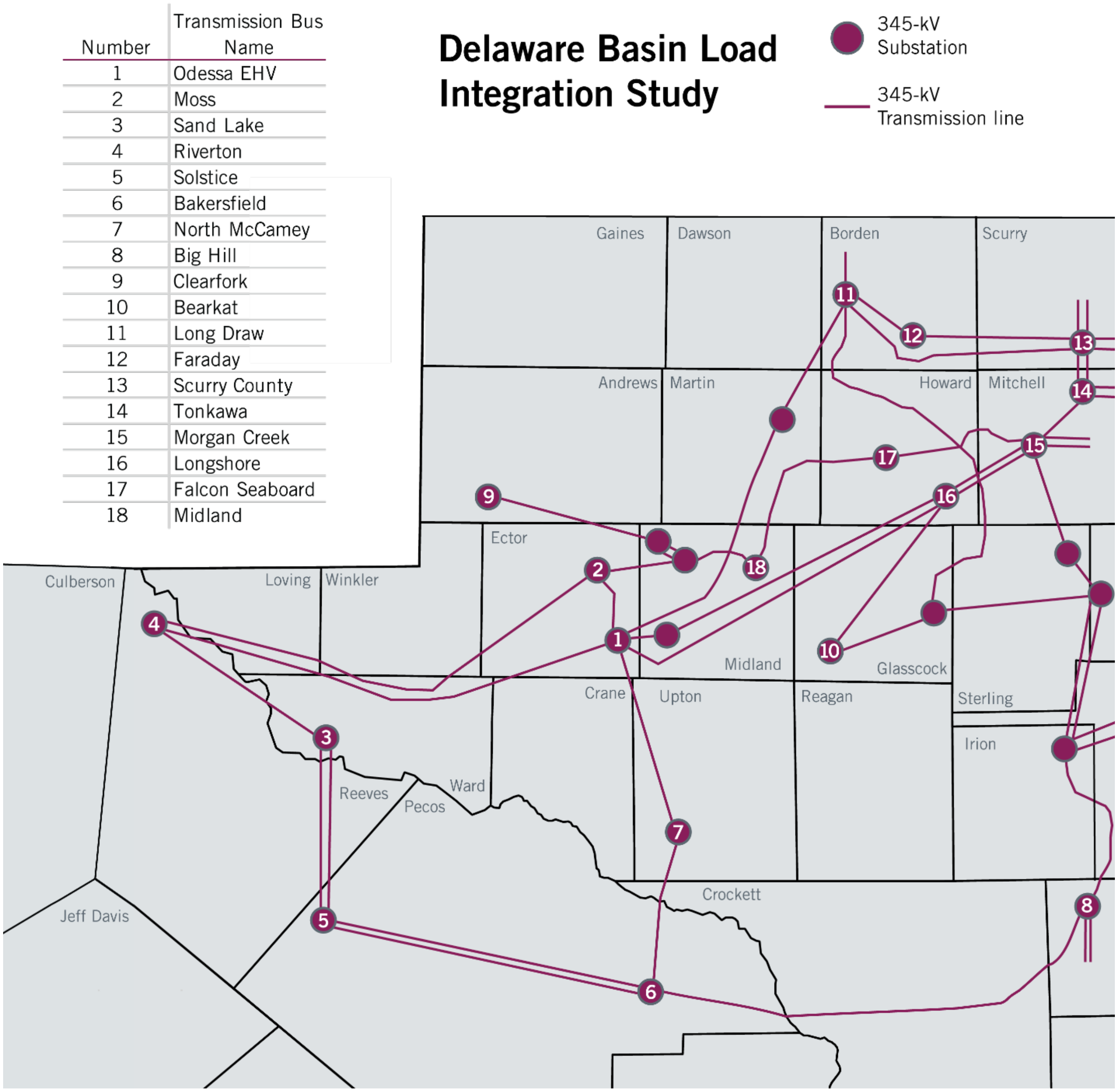


Figure 2.1.1 345-kV Transmission System Map of Study Area

The criteria applied for the AC power flow analyses were consistent with the requirements in the ERCOT Planning Guide 4.1.1.2 and the 2019 Regional Transmission Plan (RTP). As the main purpose of the study is to identify long lead time transmission improvements necessary to serve the assumed load in the study area, ERCOT mainly addressed identified transmission system thermal violations and steady state voltage stability issues in the Far West Weather Zone.

2.2. Study Assumption

2.2.1. Reliability Case

The following starting case was used in the study:

- The 2024 West/Far West (WFW) summer peak case from the 2018 RTP (posted in December 2018 on the ERCOT MIS site)

2.2.2. Study Case Loads

Initially, the Delaware Basin area loads in the starting case (i.e. 2018 RTP 2024 WFW case) were updated to match the area load with the load level (3,509 MW) in the February 2019 SSWG 2024 Summer Peak case as a significant amount of conceptual loads had already been added by TSPs to the Delaware Basin area in the February 2019 SSWG case.

Additionally, the Delaware Basin area loads were further updated by incorporating 1,863 MW of additional conceptual loads provided by the area TSPs (i.e. Oncor, AEP, TNMP, LCRA TSC, and GSEC) based on surveys of their high-use oil and gas customers to support this Delaware Basin Load Integration Study. The customers in the area supplied aggregated load information pertaining to size, schedule, type, and location for the year 2024 by assuming that there would be no capacity or schedule impediments to access electric service in the Delaware Basin. According to the TSPs, the types of the loads in the survey responses included, but were not limited to, the following: planned or projected new load, existing or new load with technology changes (e.g. conversion from self-serve generation to grid power), and load associated with uncompleted oil wells. The load survey samples included large customers that are expected to have a better load projection process and larger impact compared to smaller customers. ERCOT did not extrapolate the load levels provided by TSPs to attempt to account for the smaller customers that were not part of the survey. Using the aggregated load information from their customers, the TSPs established the 1,863 MW of additional conceptual loads projected for the year 2024.

As shown in Table 2.2.1, the load level modeled in this Delaware Basin Load Integration Study was approximately double the load in the same study area compared to the 2019 RTP.

Table 2.2.1 Delaware Basin Load Projection for Year 2024

2019 Regional Transmission Plan (based on Planning Guide Section 3.1.7)	2,688 MW
2019 February SSWG Case	3,509 MW
Delaware Basin Study (including higher than committed load)	5,372 MW

Figures 2.2.1 shows the distribution of the additional conceptual loads added to the study case in the Delaware Basin area.

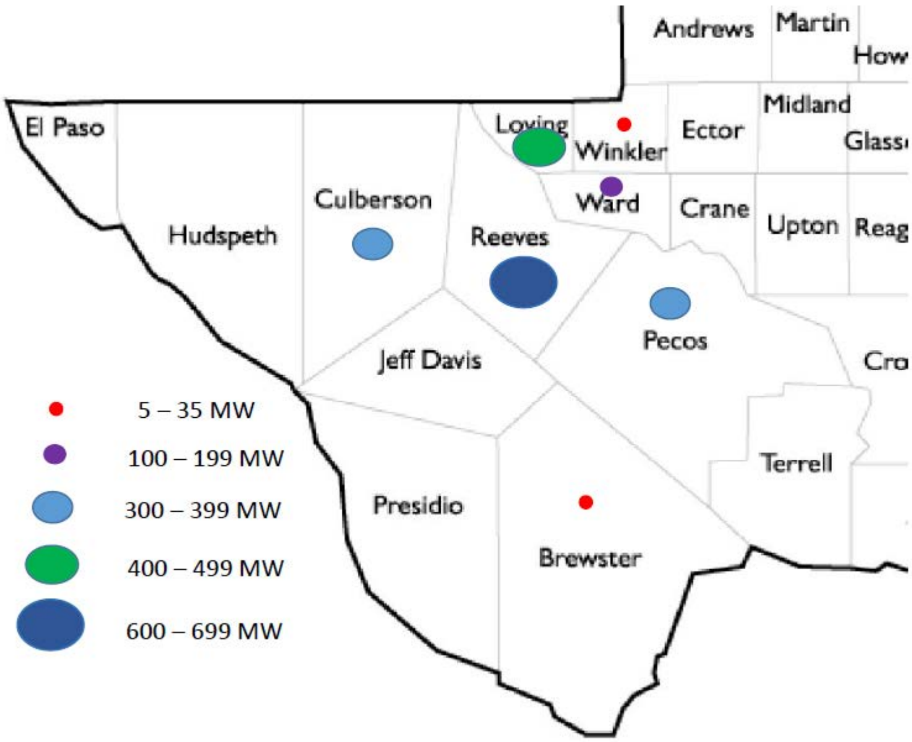


Figure 2.2.1 Distribution of Conceptual Loads Added to the System in the Delaware Basin Area

Figure 2.2.2 shows the load contour map of the total load in Delaware Basin area.

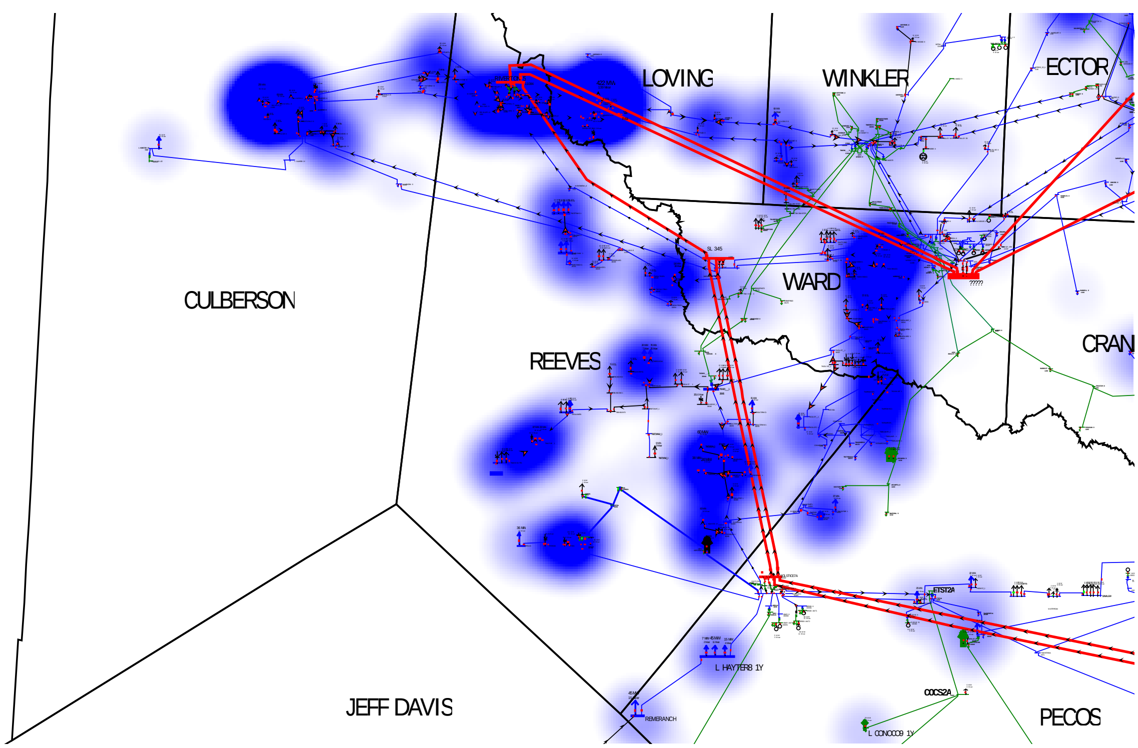


Figure 2.2.2 Load Contour Map of the Total Load in the Delaware Basin Area

2.2.3. Transmission Topology

The starting case was modified based on input from TSPs to include load additions and topological changes in the study area. TSPs provided upgrades and new circuits (if there were no existing transmission facilities in the area) necessary to interconnect the conceptual load additions.

2.2.4. Generation

Planned generators in the West and Far West weather zones that met Planning Guide Section 6.9 conditions for inclusion in the base cases (according to the 2019 April Generation Interconnection Status report) were added to the study case. The added generators are listed in Table 2.2.2.

Table 2.2.2 Added Generators that Met Planning Guide Section 6.9 Conditions (2019 April GIS Report)

GINR Number	Project Name	MW	Fuel	County	Weather Zone
16INR0019	BlueBell Solar	30	SOL	Coke	West
17INR0067	Sweetwater 1 repower	0	WIN	Nolan	West
17INR0068	Sweetwater 2 repower	7	WIN	Nolan	West
17INR0069	Trent repower	6	WIN	Nolan	West
18INR0033	Oveja Wind	300	WIN	Irion	West
18INR0038	Barrow Ranch	160	WIN	Andrews	Far West
18INR0068	Loraine Windpark Phase III	100	WIN	Mitchell	West
19INR0029	Phoebe Solar	250	SOL	Winkler	Far West
19INR0083	Oberon Solar	180	SOL	Ector	Far West
19INR0099a	Kontiki 1 Wind (ERIK)	255	WIN	Glasscock	Far West
19INR0099b	Kontiki 2 Wind (ERNEST)	255	WIN	Glasscock	Far West
19INR0174	Elbow Creek repower	0	WIN	Howard	Far West
19INR0184	Oxy Solar	16	SOL	Ector	Far West
20INR0011	Ranchero Wind	300	WIN	Crockett	Far West
14INR0009	WKN Amadeus Wind	246	WIN	Fisher	West
18INR0055	Long Draw Solar	225	SOL	Borden	Far West
19INR0038	High Lonesome W	450	WIN	Crockett	Far West
19INR0080	Whitehorse Wind	419	WIN	Fisher	West
19INR0102	Queen Solar	400	SOL	Upton	Far West
19INR0163	Sage Draw Wind	338	WIN	Lynn	Far West
19INR0185	Lapetus Solar 2	100	SOL	Andrews	Far West
20INR0054	Taygete Solar	254	SOL	Pecos	Far West

Solar generation in the Delaware Basin area was turned off to represent a stressed system condition since the oil and natural gas loads are assumed to operate as constant loads throughout the day and night. The dispatch of solar and wind generation outside of the Delaware Basin area were consistent with the 2019 RTP methodology. Gibbons Creek Unit 1 (470 MW) was turned off as it was retired permanently in October 2019.

2.2.5. Capital Cost Estimates

Capital costs estimates of each transmission upgrade identified were provided by the TSP relevant to each upgrade. ERCOT used the cost estimates provided by the TSPs to calculate total project cost estimates for various project options. For new transmission lines requiring new right of way, ERCOT assumed a routing adder of 20% to the straight distance between two end points. The cost estimates described in this report only include the capital costs of the 345-kV transmission upgrades.

2.3. Study Methodology

ERCOT evaluated various types of transmission upgrades such as adding long lead time extra high voltage (EHV) transmission lines (e.g. new 345-kV lines) and new 138-kV lines. Table 2.3.1 shows the types of upgrades considered in this study.

Table 2.3.1 Types of Upgrades Considered in this Study

Types of Upgrades Considered	Comments
Long lead time Extra High Voltage circuits (e.g. new 345-kV lines)	**Main focus of the study**
Existing 345-kV line upgrades	Included in the analysis
New 138-kV lines	Included in the analysis, but not optimized
Existing 138-kV and 69-kV line upgrades	Included in the analysis, but not optimized
Voltage support devices, static and dynamic	Included in the analysis, but stability analysis was not performed to optimize

The graphic in Figure 2.3.1 shows the study process and methodology used in this study.

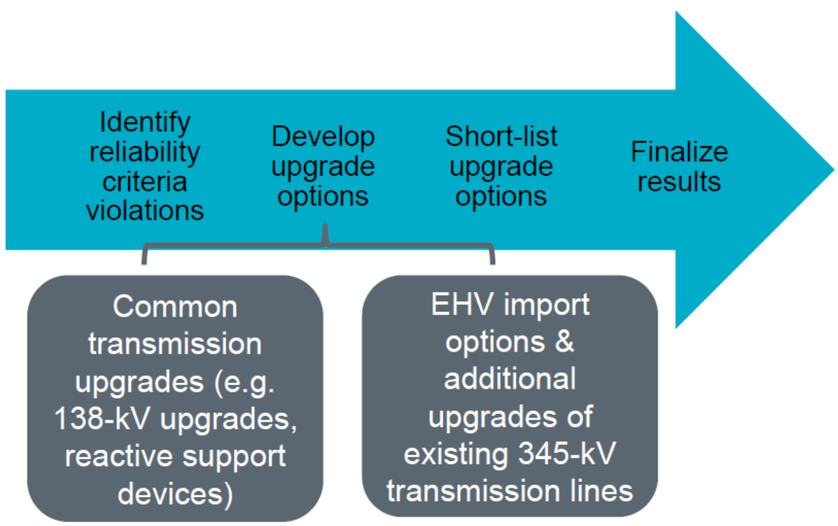


Figure 2.3.1 Study Process and Methodology

2.3.1. Tools

ERCOT utilized the following software tools for the Delaware Basin Load Integration Study:

- PowerWorld Simulator version 20 was used for SCOPF and steady state contingency and voltage stability analysis
- UPLAN version 10.4.0.22733 was used to perform security-constrained economic analysis

2.3.2. Contingencies

All of the NERC P1, P2-1, and P7 contingencies in the West and Far West weather zones were evaluated for the AC power flow analyses. ERCOT also evaluated G-1+N-1 and X-1+N-1 contingencies in the study area.

For the G-1+N-1 analyses, the following generator outages were considered to represent the most significant G-1 conditions in the study area:

- Permian Basin all five units (340 MW)
- Odessa Combined Cycle Train 1 (497 MW)

For the X-1+N-1 analyses, the following 345/138-kV transformers were considered to represent the most significant X-1 conditions for the study area:

- Riverton 345/138-kV transformer 1
- Sand Lake 345/138-kV transformer 1
- Wolf 345/138-kV transformer 1
- Quarry Field 345/138-kV transformer 1
- Solstice 345/138-kV transformer 1
- Megan 345/138-kV transformer 1

The oil and gas loads were assumed to be constant loads throughout the year. Because of this, it can be challenging to schedule maintenance outages of equipment without operating in a state such that the contingency of another facility causes thermal or voltage limit exceedances. To give due consideration for such operational flexibility and reliability in the study area, potential high impact maintenance outages which include major single-circuit 345-kV circuit and dynamic reactive devices in the Delaware Basin area were analyzed and are listed below.

- Odessa - Wolf 345-kV line
- Wolf - Quarry Field 345-kV circuit 1
- Faraday - Clearfork 345-kV circuit 1 (potential new line)
- Clearfork - Riverton 345-kV circuit 1 (potential new line)
- Bearkat - North McCamey 345-kV circuit 1 (potential new line)
- North McCamey - Megan 345-kV circuit 1 (potential new line)
- North McCamey - Sand Lake 345-kV circuit 1 (potential new line)
- Riverton - Sand Lake 345-kV circuit 1
- Solstice - Megan 345-kV circuit 1
- Megan - Sand Lake 345-kV circuit 1
- Bakersfield - Solstice 345-kV circuit 1
- Noelke - Bakersfield 345-kV line

- Queen Solar - North McCamey 345-kV line
- Rando DRD (250 Mvar)
- Horse Shoe DRD (250 Mvar)
- IH-20 SVC (190 Mvar)

3. Case Development for Long Lead Time Upgrade Identification

The existing and planned transmission system was not sufficient to serve the studied load of 5,372 MW in the Delaware Basin area. In fact, the study case demonstrated voltage instability under N-0 conditions. To identify the long lead time upgrades, which were the primary focus of the study, the reliability issues under N-0 that would be expected to be addressed through local transmission upgrades were first identified through the steps described in Appendix A. These transmission upgrades, summarized in Table 3.1, were necessary to address the voltage instability and thermal violations under N-0 condition. ERCOT also identified local transmission upgrades under N-1 in section 4. These transmission upgrades under N-0 and N-1 were collectively referred to as the common transmission upgrades. The full list of the common transmission upgrades is included in the Appendix B.

Table 3.1 Common Transmission Upgrades under N-0

Transmission Upgrades/Addition	Length (miles)	Normal and Emergency Ratings (RATE A/B) (MVA) Modeled in Study Case
Tap the new 345-kV Wolf station to the Odessa/Moss – Riverton 345-kV double-circuit lines and add two 345/138-kV transformers at Wolf station (TPIT 46094, Tier 3, Dec 2020)		750/750 (transformer Ratings)
Reactive device at Clearfork		300 Mvar
Reactive device at Riverton		300 Mvar
Reactive device at Wolf		300 Mvar
Reactive device at Barilla Draw		300 Mvar
Reactive device at Faulkner		300 Mvar
Reactive device at Coalson Draw (DRD)		250 Mvar
Capacitors at Owl Hills		110 Mvar
Convert 69-kV line Barrilla - Hoefs Road - Verhalen - Saragosa to 138-kV	33.8	483/483
Convert 69-kV line Yucca - Royalty - Coyanosa - Wolfcamp to 138-kV	46.9	614/614
Tap the Wolf - Riverton 345-kV double circuit at Quarry Field, and add two 345/138-kV transformer at Quarry Field station		750/750 (transformer Ratings)
Upgrade Quail Switch - Odessa EHV Switch 345-kV ckt 1	0.9	1521/1784
Upgrade the Solstice - Hayter - Remeranch 138-kV	15.7	614/614

Besides the common transmission upgrades, a placeholder project of a new single circuit 345-kV import path (Bearkat - Wolf - Sand Lake) was also added in the case development to address the voltage instability under N-0. This placeholder project will be evaluated and replaced by alternatives in section 4.

4. Initial Import Path Options

The study case development in Section 3 indicated that a new import path was needed to serve the assumed Delaware Basin load with solar generation offline in the area. ERCOT initially evaluated various import path options and the study results are summarized in this section.

4.1. Descriptions of the Initial Import Path Options

An initial set of import path options was developed by considering the following factors in the area: reliability criteria violations in the study case, potential generating capacity growth, the existing stability constraints (maintained in operations as Generic Transmission Constraints (GTCs)) in the region, and the ERCOT 2018 Long-Term System Assessment[2]. Table 4.1.1 summarizes the initial import path options. The maps of these ten initial Import path options are available in Appendix C.

Table 4.1.1 Descriptions of the Initial Import Options

Import Options	Estimated New Right of Way (ROW) (miles)	Cost Estimates ($M)
Option 1: add a second circuit on the existing Big Hill - Bakersfield - North McCamey - Odessa 345-kV line and a new North McCamey - Megan double circuit 345-kV line	78	311
Option 2: a new Faraday - Lamesa - Clearfork - Riverton single circuit 345-kV line	193	380
Option 3: a new Bearkat - North McCamey - Megan single circuit 345-kV line	149	278
Option 4: a new Faraday - Lamesa - Clearfork - Riverton double circuit 345-kV line	193	444
Option 5: a new Bearkat - North McCamey - Megan double circuit 345-kV line	149	343
Option 6: a new Bearkat - North McCamey - Sand Lake double circuit 345-kV circuit	164	371
Option 7: a new Red Creek - North McCamey - Megan double circuit 345-kV circuit	216	490
Option 8: a new 1,200 MW HVDC line (VSC) from Abernathy to Riverton	240	906
Option 9: a new 1,200 MW HVDC line (VSC) from Howard Road to Bakersfield and a new double circuit 345-kV line from North McCamey to Megan	380	2,119
Option 10: a new single circuit 765-kV line from Howard Road to Bakersfield, two new 765/345-kV transformers at both Howard Road and Bakersfield stations, and a new double circuit 345-kV line from North McCamey to Megan	380	2,014

[2] https://mis.ercot.com/pps/tibco/mis/Pages/Grid+Information/Long+Term+Planning/

4.2. Results of Reliability Analysis for the Initial Import Path Options

4.2.1. Results of N-1 contingency analysis

Among the initial ten options evaluated, ERCOT found that five options did not meet the N-1 reliability criteria. The results of the study showed unsolved contingencies (i.e. potential voltage collapse) for Options 1, 2, 3, 7, and 8 at the assumed load of 5,372 MW in Delaware Basin area, and these five options alone were not evaluated further but were combined with other import path options for further evaluation.

Steady state voltage stability assessment under N-1 contingency conditions was conducted to estimate the load serving capability of the ten initial import path options and the results are summarized in Table 4.2.1. As an estimate, the load serving capability of each option was calculated by a 100 MW step change based on the assumed load of 5,372 MW under P1, P2-1, and P7 contingency events.

Table 4.2.1 Estimated Load Serving Capability of Ten Initial Import Options (NERC P1, P2-1 and P7)

Import Options	Estimated New ROW (miles)	Estimated Load Serving Capability (MW)
Option 1: add a second circuit on the existing Big Hill - Bakersfield - North McCamey - Odessa 345-kV line and a new North McCamey - Megan double circuit 345-kV line	78	~ 4,972
Option 2: a new Faraday - Lamesa - Clearfork - Riverton single circuit 345-kV line	193	~ 4,972
Option 3: a new Bearkat - North McCamey - Megan single circuit 345-kV line	149	~ 4,972
Option 4: a new Faraday - Lamesa - Clearfork - Riverton double circuit 345-kV line	193	~ 5,372
Option 5: a new Bearkat - North McCamey - Megan double circuit 345-kV line	149	~ 5,372
Option 6: a new Bearkat - North McCamey - Sand Lake double circuit 345-kV circuit	164	~ 5,372
Option 7: a new Red Creek - North McCamey - Megan double circuit 345-kV circuit	216	~ 5,272
Option 8: a new 1,200 MW HVDC line (VSC) from Abernathy to Riverton	240	~ 5,272
Option 9: a new 1,200 MW HVDC line (VSC) from Howard Road to Bakersfield and a new double circuit 345-kV line from North McCamey to Megan	380	~ 5,472
Option 10: a new single circuit 765-kV line from Howard Road to Bakersfield, two new 765/345-kV transformers at both Howard Road and Bakersfield stations, and a new double circuit 345-kV line from North McCamey to Megan	380	~ 5,472

The results in Table 4.2.1 show that Options 4, 5, 6, 9, and 10 are capable of serving the assumed Delaware Basin load under N-1 conditions without voltage instability, and additional local transmission upgrades are needed to address the local N-1 steady state reliability criteria violations. These additional local transmission upgrades are listed in Table 4.2.2. As shown in the table, most of the upgrades are needed to serve the local load independent of the import options. The full list of the transmission upgrades are available in Appendix B.

Table 4.2.2 Additional Local Transmission Upgrades in the Initial Import Path Options

Transmission Upgrades	Estimated Length (miles)	Normal and Emergency Ratings (RATE A/B) (MVA) Modeled in Study Case	Import Options Requiring Local Upgrades
Build a new 345/138-kV Owl Hills station with two 345/138-kV transformers, and add a new single circuit 345-kV line from Riverton to Owl Hills station	20.3	750/750 (transformer Ratings) 2988/2988 (Line Ratings)	Common[3]
Tap the new Megan station to the Solstice - Sand Lake double circuit 345-kV line, and install two new 345/138-kV transformers at the new Megan station		750/750 (transformer Ratings)	Common
Build a new 138-kV line from Saragosa to Faulkner	18.0	614/614	Common
Rio Pecos to Fort Stockton Upgrade: Upgrade the 138-kV lines from Rio Pecos to Lynx to TNMP 16th St to Fort Stockton	74.6	483/483	Common
Convert the existing stations at Fort Stockton and Conoco Comp and Conoco Rgec 69-kV line to be 138-kV. Move the 138/69-kV transformer from Fort Stockton to Conoco Comp	25.1	614/614	Common
Build a new 138-kV line from Conoco Rgec to TNMP 16th street	22.0	483/483	Common
Build a new 138-kV line from Remeranch to Saragosa	26.5	483/483	Common
Upgrade the existing Morgan Creek - Tonkawa 345-kV line	21.3	1792/1792	Common
Upgrade the existing Morgan Creek - Longshore 345-kV line	36.5	1792/1792	Options 5 & 6
Upgrade the existing Midland East - Falcon Seaboard 345-kV line	48.4	1792/1792	Common
Upgrade the existing Saddleback - Salt Draw Tap 138-kV line	0.5	717/717	Option 5
Upgrade the existing Salt Draw Tap - IH20 138-kV line	4.9	717/717	Option 5
Build a new double circuit 138-kV line from the new Megan station to Saddleback	6.2	614/614	Common
Build a new double circuit 138-kV line from the new Megan station to Faulkner	24.2	614/614	Common
Upgrade the existing Morgan Creek - Falcon Seaboard 345-kV line	36.2	1792/1792	Options 9 & 10
Upgrade the existing Longshore - Midessa 345-kV line	48.0	1792/1792	Options 9 & 10
Upgrade the existing Midland East - Midland County NW 345-kV line	17.2	1792/1792	Option 10

[3] Common means the project is needed regardless of import options

4.2.2. Results of G-1+N-1, X-1+N-1, and N-1-1 contingency analysis

Import Options 4, 5, 6, 9, and 10 were further evaluated for G-1+N-1, X-1+N-1, and N-1-1. Tables 4.2.3 – 4.2.5 show the study results.

Table 4.2.3 Steady State Voltage Stability Analysis Results under G-1+N-1 for Options 4, 5, 6, 9, and 10

G-1 Scenario	Option 4	Option 5	Option 6	Option 9	Option 10
Permian Basin all five units	Voltage Collapse	Voltage Collapse	Voltage Collapse	Voltage Collapse	Voltage Collapse
Odessa Combined Cycle Train 1	No Voltage Collapse	No Voltage Collapse	No Voltage Collapse	No Voltage Collapse	No Voltage Collapse

Table 4.2.4 Largest Thermal Violations under X-1+N-1 for Options 4, 5, 6, 9, and 10

Element	Contingency	Option 4	Option 5	Option 6	Option 9	Option 10
Quarry Field 345/138-kV	Riverton - Quarry Field 345-kV double; Quarry Field 345/138-kV	< 100%	108.5%	104.7%	109.8%	108.2%
Riverton 345/138-kV	Owl Hill - Riverton 345-kV; Riverton 345/138-kV	100.4%	< 100%	< 100%	< 100%	< 100%
Megan 345/138-kV	Megan - Sand Lake 345-kV double; Megan 345/138-kV	< 100%	118.7%	< 100%	119.0%	120.7%
Wolf 345/138-kV	Wolf - Quarry Field 345-kV double; Wolf 345/138-kV	< 100%	107.8%	105.4%	111.0%	107.0%

Table 4.2.5 Steady State Voltage Stability Analysis Results under N-1-1 for Options 4, 5, 6, 9, and 10

	Option 4	Option 5	Option 6	Option 9	Option 10
N-1-1 Scenario	Voltage Collapse	Voltage Collapse	Voltage Collapse	Voltage Collapse	Voltage Collapse

As shown in Table 4.2.3 and Table 4.2.5, potential voltage collapse issues were observed for all five options under the G-1+N-1 and N-1-1 contingency conditions. As described in section 5, ERCOT further modified these import options to identify the additional upgrade needs to serve the assumed load in the Delaware Basin area. Option 10 which requires a new 765-kV line was not selected for the further evaluation as substantial new transmission additions will be required to satisfy the reliability criteria under the N-1-1 maintenance condition.

5. Modified Import Options

5.1. Description of the Modified Import Options

Twelve ERCOT modified Import Options based on the selected Import Options 4, 5, 6, and 9 and some of the transmission components in the initial ten import path options were developed to address the G-1+N-1 and N-1-1 reliability violations. These modified import options are referred as Options 4a, 4b, 4c, 4g, 5d, 5e, 5f, 6a, 6e, 6f, 6g, and 9e. Table 5.1.1 summarizes these twelve modified import options. The maps of these twelve options are provided in the Appendix B.

Table 5.1.1 Summary of the Twelve Modified Import Options

Options	Estimated New ROW (miles)	Cost Estimates[4] ($M)
Option 4a: a new Faraday - Lamesa - Clearfork - Riverton double circuit 345-kV line, and add a second circuit on the existing Big Hill - Bakersfield - North McCamey -Odessa 345-kV line	193	573
Option 4b: a new Faraday - Lamesa - Clearfork - Riverton double circuit 345-kV line, add a second circuit on the existing Big Hill - Bakersfield 345-kV line, and a new North McCamey - Megan double circuit 345-kV line	271	695
Option 4c: a new Faraday - Lamesa - Clearfork - Riverton double circuit 345-kV line and a new Bearkat - North McCamey - Megan single circuit 345-kV line	342	722
Option 4g: a new Faraday - Lamesa - Clearfork - Riverton double circuit 345-kV line, add a second circuit on the existing Big Hill - Bakersfield 345-kV line, convert the Sand Lake - Riverton 138-kV to 345-kV, and add a new 138-kV line from Sand Lake to Riverton	193	569
Option 5d: a new Bearkat - North McCamey - Megan double circuit 345-kV line, and a new Clearfork - Riverton double circuit 345-kV line	231	525
Option 5e: a new Bearkat - North McCamey - Megan double circuit 345-kV line, add a second circuit on the existing Big Hill - Bakersfield 345-kV line, and a new Clearfork - Riverton double circuit 345-kV line	231	594
Option 5f: a new Bearkat - North McCamey - Megan double circuit 345-kV line, and a new Faraday - Lamesa - Clearfork - Riverton single circuit 345-kV line	342	723
Option 6a: a new Bearkat - North McCamey - Sand Lake double circuit 345-kV line, and add a second circuit on the existing Big Hill - Bakersfield - North McCamey - Odessa 345-kV line	164	440
Option 6e: a new Bearkat - North McCamey - Sand Lake double circuit 345-kV line, add a second circuit on the existing the Big Hill - Bakersfield 345-kV line, and a new Clearfork - Riverton double circuit 345-kV line	246	622
Option 6f: a new Bearkat - North McCamey - Sand Lake double circuit 345-kV line, and a new Faraday - Lamesa - Clearfork - Riverton single 345-kV line	357	751
Option 6g: a new Bearkat - North McCamey - Sand Lake double circuit 345-kV line, add a second circuit on the existing Big Hill - Bakersfield 345-	164	496

[4] Cost estimates do not include the local transmission upgrades.

kV line, convert the Sand Lake - Riverton 138-kV to 345-kV, and add a new 138-kV line from Sand Lake to Riverton		
Option 9e: add a new 1,200 MW HVDC line (VSC) from Howard Road to Bakersfield, a new North McCamey - Megan double circuit 345-kV line, add a second circuit on the existing Big Hill - Bakersfield 345-kV line, and a new Clearfork - Riverton double circuit 345-kV line	462	2,370

5.2. Results of Reliability Analysis for the Modified Import Options

ERCOT conducted the N-1-1 analysis for these twelve options. Table 5.2.1 shows the study results.

Table 5.2.1 Steady State N-1-1 Results for Options 4a, 4b, 4c, 4g, 5d, 5e, 5f, 6a, 6e, 6f, 6g, and 9e

Option 4a	Option 4b	Option 4c	Option 4g	Option 5d	Option 5e	Option 5f	Option 6a	Option 6e	Option 6f	Option 6g	Option 9e
Voltage Collapse	No Voltage Collapse	No Voltage Collapse	Voltage Collapse	Voltage Collapse	No Voltage Collapse	No Voltage Collapse	Voltage Collapse	No Voltage Collapse	No Voltage Collapse	No Voltage Collapse	No Voltage Collapse

Voltage collapse issues were observed in Options 4a, 4g, 5d, and 6a under the N-1-1 contingency condition. As a result, ERCOT performed additional studies for Options 4b, 4c, 5e, 5f, 6e, 6f, 6g, and 9e as no voltage collapses were observed under the N-1-1 contingency condition. Focusing on thermal violations, ERCOT evaluated these eight options under the N-1-1, X-1+N-1 and G-1+N-1 conditions. The results are summarized in Tables 5.2.2 – 5.2.4.

Table 5.2.2 Largest Thermal Violations under N-1-1 for Options 4b, 4c, 5e, 5f, 6e, 6f, 6g and 9e

Element	Miles	Option 4b	Option 4c	Option 5e	Option 5f	Option 6e	Option 6f	Option 6g	Option 9e
Morgan Creek - Falcon Seaboard 345-kV	36.2	< 100%	< 100%	105.0%	101.0%	104.0%	< 100%	< 100%	< 100%
Telephone Road - Clearfork 345-kV	32.8	< 100%	< 100%	103.6%	< 100%	102.7%	< 100%	< 100%	< 100%
Midland East - Midland County NW 345-kV	17.2	< 100%	< 100%	100.3%	< 100%	< 100%	< 100%	< 100%	103.3%
Odessa - Wolf 138-kV	44.4	< 100%	< 100%	< 100%	102.4%	< 100%	< 100%	107.6%	< 100%

Table 5.2.3 Largest Thermal Violations under X-1+N-1 for Options 4b, 4c, 5e, 5f, 6e, 6f, 6g, and 9e

Element	Option 4b	Option 4c	Option 5e	Option 5f	Option 6e	Option 6f	Option 6g	Option 9e
Quarry Field 345/138-kV	< 100%	< 100%	< 100%	< 100%	< 100%	< 100%	< 100%	< 100%
Riverton 345/138-kV	< 100%	< 100%	< 100%	< 100%	< 100%	< 100%	< 100%	< 100%
Megan 345/138-kV	< 100%	< 100%	114.2%	< 100%	< 100%	< 100%	< 100%	116.5%
Wolf 345/138-kV	< 100%	< 100%	< 100%	< 100%	< 100%	< 100%	< 100%	< 100%

Table 5.2.4 Largest Thermal Violations under G-1+N-1 for Options 4b, 4c, 5e, 5f, 6e, 6f, 6g, and 9e

Element	Option 4b	Option 4c	Option 5e	Option 5f	Option 6e	Option 6f	Option 6g	Option 9e
Morgan Creek - Falcon Seaboard 345-kV	< 100%	< 100%	103.3%	< 100%	103.0%	< 100%	< 100%	< 100%
Telephone Road - Clearfork 345-kV	< 100%	< 100%	< 100%	< 100%	< 100%	< 100%	< 100%	102.6%
Odessa - Wolf 138-kV	< 100%	< 100%	< 100%	< 100%	< 100%	< 100%	108.4%	< 100%

The N-1-1, G-1+N-1, and X-1+N-1 study results in Tables 5.2.2 – 5.2.4 indicate that Options 4b, 4c, 6f, and 6g performed the best among the options tested. There are no additional 345-kV thermal violations for Options 4b, 4c, 6f, and 6g under the N-1-1, G-1+N-1, or X-1+N-1 contingency conditions. Since the overload of the existing Odessa - Wolf 138-kV line was identified under N-1-1 condition in Option 6g, ERCOT included the upgrade of the overload existing 138-kV line as part of Option 6g during the further evaluation of the selected four short-listed options.

6. Short-listed Options

The results of the N-1-1, G-1+N-1, and X-1+N-1 analyses in Section 5 indicate that Options 4b, 4c, 6f, and 6g would provide the best performance among the eight selected modified options. For these four short-listed options, ERCOT conducted power transfer analysis, congestion analysis, and cost comparison.

6.1. Power Transfer Analysis

A power transfer analysis was conducted from a steady state voltage stability perspective for the four short-listed options. The load in the Delaware Basin area was proportionally increased, and NERC P1, P2-1, and P7 contingency events in the study area were tested to identify estimated maximum load serving capability. The results are listed in Table 6.1.1; all four short-listed options would be capable of serving a load level above the assumed Delaware Basin load.

Table 6.1.1 Power Transfer Analysis for Options 4b, 4c, 6f, and 6g

Option	Estimated New ROW (miles)	Estimated N-1 Load Serving Capability (MW)
4b	291	5,982
4c	362	6,062
6f	378	6,042
6g	185	5,772

6.2. Congestion Analysis

Although the Delaware Basin Load Integration Study was focused on reliability needs, ERCOT also conducted a congestion analysis to compare the relative performance of each of the short-listed options in terms of production cost savings.

The 2024 economic case built for the 2019 RTP was used as the starting case. The common 345-kV transmission upgrades together with the recently approved RPG projects in the Delaware Basin area were added to the starting case to create the study base case. The load in the congestion analysis remained the same as in the 2019 RTP. ERCOT then modeled each of the four short-listed import options and performed production cost simulations for the year 2024. The annual production cost under each select option was compared to the option yielding the highest annual production cost in order to obtain a relative annual production cost difference for each option.

As shown in Table 6.2.1, the results indicated that the annual production cost differences for Options 4b, 4c, and 6f were approximately $0.4 million, $3.1 million, and $3.1 million, respectively, when compared to Option 6g. The results indicated none of the options provided significantly better production cost savings than others. The study also indicated no significant change in system congestion on the ERCOT transmission grid for each short-listed option.

Table 6.2.1 Relative Annual Production Cost Differences (Referenced to Option 6g) in $ Million

Option	Option 4b	Option 4c	Option 6f	Option 6g
Relative Annual Production Cost Differences (referenced to Option 6g)	0.4	3.1	3.1	Reference

6.3. Cost Estimates

All four short-listed import options require some additional existing 345-kV transmission line upgrades. The cost estimate of each short-listed import option in Table 6.3 also includes the cost of upgrading the existing 345-kV lines. Since the main focus of this study was to identify cost-effective long lead time transmission improvements to reliably serve the assumed load, the costs of the transmission upgrades with voltage 138-kV and below were not considered in the cost comparison. Table 6.3.1 summarizes the cost estimates for the four short-listed options. Note all values are rough order magnitude (ROM) quality estimates and do not include uncertain factors that may be revealed during a more detailed routing study/CCN-level cost estimate (e.g. environmental/cultural components, etc.)

Table 6.3.1 Cost Estimates for the Short-Listed Options in $ Million

Option	Transmission Element	Cost Estimate ($M)	Total Cost Estimates ($M)
4b	A new Faraday - Lamesa - Clearfork - Riverton double circuit 345-kV line	444	753
	Add a 2nd circuit on the existing Big Hill - Bakersfield 345-kV line	69	
	A new North McCamey - Megan double circuit 345-kV line	182	
	A new Riverton - Owl Hills single circuit 345-kV line	41	
	Upgrade the existing 345-kV lines from Quail Switch to Odessa and from Morgan Creek to Tonkawa	17	
4c	A new Faraday - Lamesa - Clearfork - Riverton double circuit 345-kV line	444	816
	A new Bearkat - North McCamey - Sand Lake double circuit 345-kV line	278	
	A new Riverton - Owl Hills single circuit 345-kV line	41	
	Upgrade the existing 345-kV lines from Quail Switch to Odessa, from Morgan Creek to Tonkawa, and from Midland to Falcon Seaboard	53	
6f	A new Bearkat - North McCamey - Sand Lake double circuit 345-kV line	371	873
	A new Faraday - Lamesa - Clearfork - Riverton single circuit 345-kV line	380	
	A new Riverton - Owl Hills single circuit 345-kV line	41	
	Upgrade the existing 345-kV lines from Quail Switch to Odessa, from Morgan Creek to Tonkawa, from Midland to Falcon Seaboard, and from Morgan Creek to Longshore	81	
6g	A new Bearkat - North McCamey - Sand Lake double circuit 345-kV line	371	618
	Add a 2nd circuit on the existing Big Hill - Bakersfield 345-kV line	69	
	Sand Lake - Riverton 138-kV to 345-kV conversion and a new Sand Lake - Riverton 138-kV line	56	
	A new Riverton - Owl Hills single circuit 345-kV line	41	
	Upgrade the existing 345-kV lines from Quail Switch to Odessa, from Morgan Creek to Tonkawa, from Midland to Falcon Seaboard, and from Morgan Creek to Longshore	81	

7. Roadmap of Long Lead Time Upgrades

Based on the study results of the four short-listed import options described in Section 6 and the consideration of uncertainty of conceptual load growth in the Delaware Basin area, ERCOT developed a roadmap identifying different upgrade stages to accommodate the load growth in the Delaware Basin area. The transmission upgrades at each stage in the roadmap only include the long lead time transmission improvements (new 345-kV lines). As the upgrades of the existing 345-kV lines can be implemented in a relatively short time frame, they were not included in the roadmap development. The common 138-kV transmission upgrades and the reactive devices were also assumed to be in-service prior to Stage 1 to serve the local loads in the area.

Figure 7.1 shows the triggers of the transmission upgrades at each stage in terms of the load level in the Delaware Basin area. Table 7.1 lists the details of the transmission additions associated with each stage in the developed roadmap. The triggers and limits are based on either thermal or steady state voltage stability under the N-1, G-1+N-1, X-1+N-1, and N-1-1 contingency conditions.

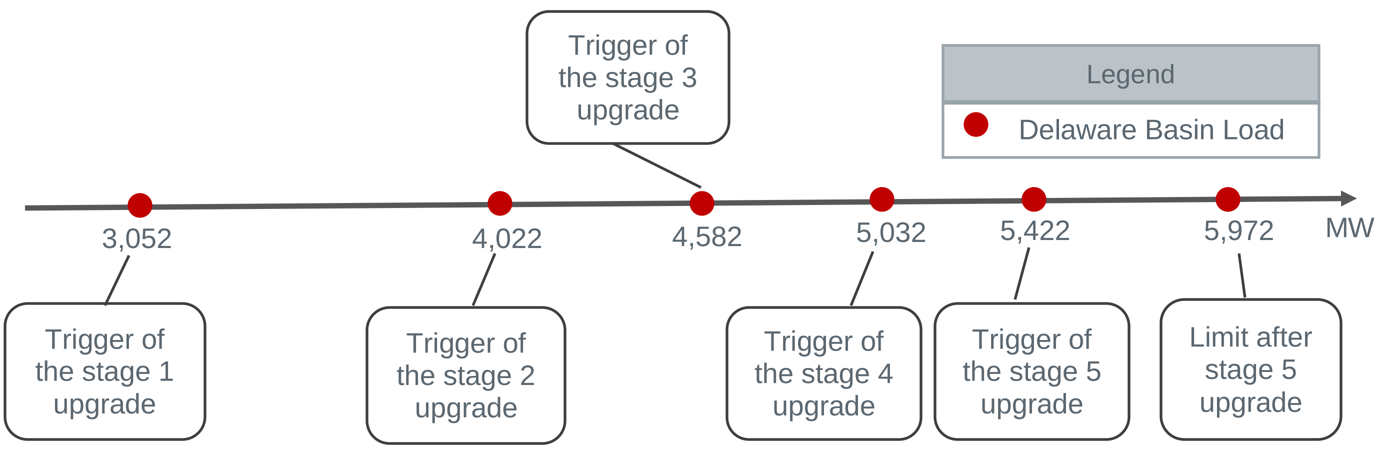


Figure 7.1 Delaware Basin Transmission Upgrade Roadmap

Table 7.1 Delaware Basin Transmission Upgrade Roadmap – Detailed Project List

Stage	Estimated Delaware Basin Load Level (MW)	Upgrade Element	Estimated Upgrade Cost ($M)	Trigger
1	3,052	Add a second circuit on the existing Big Hill - Bakersfield 345-kV line	69	Import Needs
2	4,022	A new Bearkat - North McCamey - Sand Lake double circuit 345-kV line	371	Import Needs
3	4,582	A new Riverton - Owl Hills single circuit 345-kV line	41	Culberson Loop Needs
4	5,032	Riverton - Sand Lake 138-kV to 345-kV conversion and a new Riverton - Sand Lake 138-kV line	56	Culberson Loop Needs
5	5,422	A new Faraday - Lamesa - Clearfork - Riverton double circuit 345-kV line	444	Import Needs

Figure 7.2 shows the existing and planned 345-kV system map of the study area together with the Stage 1 – Stage 5 transmission upgrades.

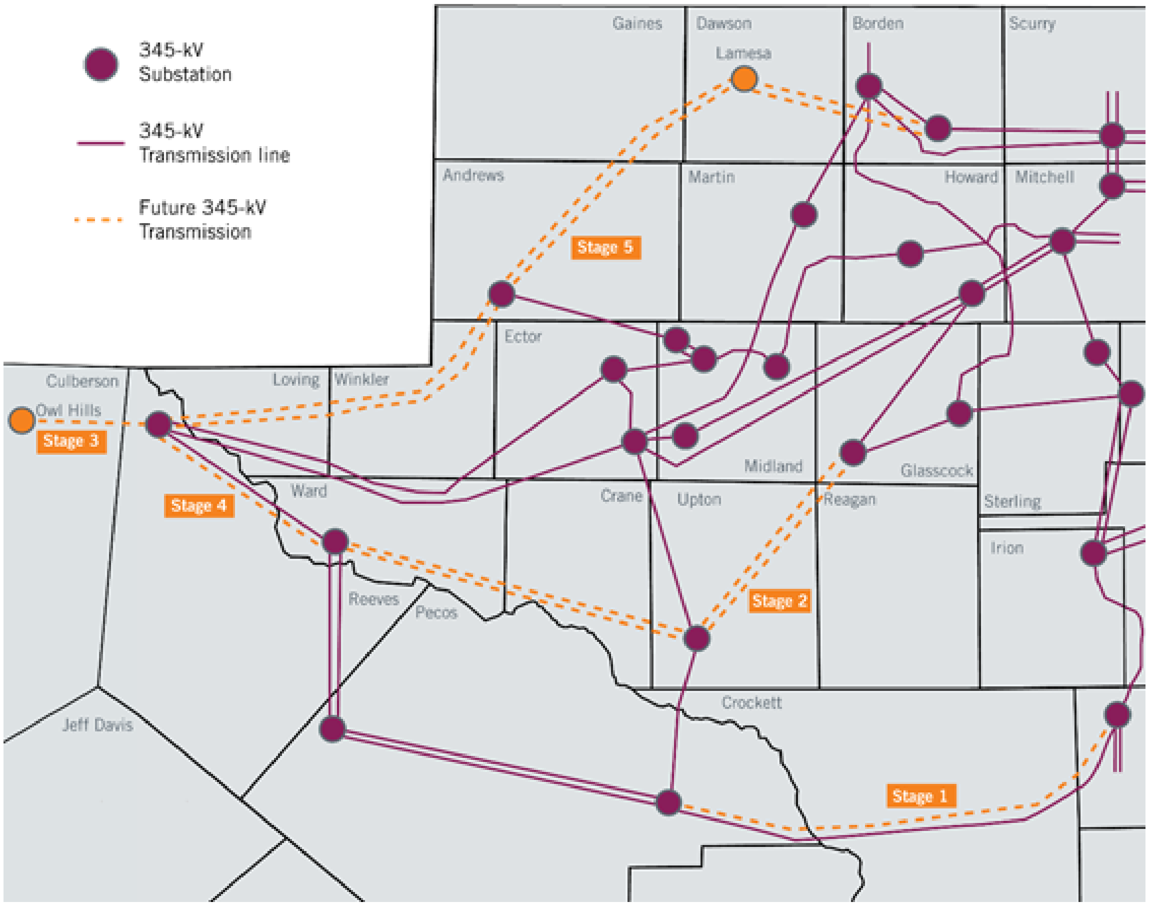


Figure 7.2 345-kV Transmission System Map of Study Area with Stage 1 – Stage 5 Upgrades

Although the study year was 2024, it should not be assumed that all of the improvement projects are needed in 2024. The actual need for each project could be sooner or later than 2024 depending on the growth rate and location of the load in the Delaware Basin. Other factors that could affect the need for and timing of the upgrades include, but are not limited to, common transmission upgrade implementation, availability and dispatch of the generation in the study area, impedance of the new conductors, transmission upgrade cost estimates, and the results of dynamic stability analysis, which was not conducted as part of this study.

7.1. Roadmap – Stage 1 Upgrade

Transmission overload is expected to occur under N-1-1 contingency condition when the Delaware Basin load level reaches 3,052 MW. The addition of the second circuit on the existing Big Hill - Bakersfield 345-kV line was identified as the stage 1 upgrade to address the transmission overload. The cost estimate of the Stage 1 upgrade is $69 million. With the stage 1 upgrade, the load serving capability in the Delaware Basin was estimated to increase to 4,022 MW.

In addition to benefiting the Delaware Basin area, this circuit would be expected to provide stability benefits for the export of wind and solar power out of the McCamey area and West Texas overall. As of November 2019, there were more than 3,500 MWs of generation connected in the Bakersfield and McCamey area, including approximately 2,400 MWs connected directly to the existing Big Hill - Bakersfield 345-kV line. Furthermore, there are existing stability constraints (managed in operations by the Bakersfield GTC and McCamey GTC). The addition of a second circuit on the Big Hill - Bakersfield 345-kV line would improve these stability constraints and lead to less congestion. ERCOT did not quantify these benefits as part of this study.

7.2. Roadmap – Stage 2 Upgrade

When the Delaware Basin load reaches 4,022 MW, additional transmission overload is expected to occur under G-1+N-1 contingency condition, which indicates the need for an additional import path. The addition of a new 345-kV double circuit line from Bearkat to North McCamey to Sand Lake was identified to address the transmission overload. The Stage 2 upgrade is estimated to cost $371 million, requiring approximately 164 miles of new right of way. With the Stage 2 upgrade, the load serving capability in the Delaware Basin area would increase to 4,582 MW.

The addition of a new 345-kV double circuit line from Bearkat to North McCamey to Sand Lake would also improve the existing stability constraints at Bakersfield and McCamey. ERCOT did not quantify these benefits as part of this study.

7.3. Roadmap – Stage 3 and Stage 4 Upgrades

Local voltage collapse issues under N-1 contingency conditions were observed when the area load reached 4,582 MW. The addition of a new 345-kV single circuit line from Riverton to Owl Hills was identified to address this local voltage collapse issue. The Stage 3 upgrade requires approximately 20 miles of new right of way and is estimated to cost $41 million.

When the Delaware Basin load reaches 5,032 MW, a different local voltage collapse was observed under N-1-1 contingency conditions. To address this additional local voltage collapse, ERCOT proposes the Stage 4 upgrade include the conversion of the Riverton - Sand Lake 138-kV line to 345-kV line and the addition of the new 138-kV line from Riverton to Sand Lake to serve the local load. The cost estimate of the Stage 4 upgrade is about $56 million.

The transmission upgrade identified in Stage 3 is to serve the projected load in the Owl Hills area along the Culberson loop. The need of this transmission upgrade is dependent on local load growth. Given the recent rapid load growth in the Owl Hills area, this transmission upgrade may need to be accelerated according to the TSP.

7.4. Roadmap – Stage 5 Upgrade

With the Stage 1 – Stage 4 upgrades assumed in place, the load serving capability in the Delaware Basin was found to increase to 5,422 MW. If the load in the Delaware Basin area reaches to 5,422 MW, another import path will be needed. A new Faraday - Lamesa - Clearfork - Riverton 345-kV double circuit line was identified as a placeholder import path option to further increase the load serving capability. The Stage 5 upgrade requires about 193 miles of new right of way and is estimated to cost $444 million. With the stage 5 upgrade, the load serving capability of the system in the Delaware

Basin area could reach 5,972 MW. The load serving capability may be further improved if additional reactive power support is implemented.

8. Conclusion

The purpose of the Delaware Basin Load Integration Study was to identify potential system constraints and transmission upgrade needs to potentially accommodate significant load growth in the Delaware Basin area. The results provide a roadmap for the long lead time transmission upgrades to the ERCOT stakeholders that include the upgrade needs and the associated triggers in terms of load level in the Delaware Basin area. In addition, a set of transmission upgrades will also be needed to address local issues and load connections in the area.

It should be noted that the identified improvements were based on the assumptions used in the steady state analysis in this study. Should these assumptions change, the results of this analysis will need to be updated which could yield a different set of transmission improvements or trigger points.

Figure 8.1 shows the load comparison of five-year ahead load forecast in the ERCOT SSWG cases and actual historic load in the Delaware Basin area together with the trigger points of the long lead time transmission upgrades identified in the roadmap.

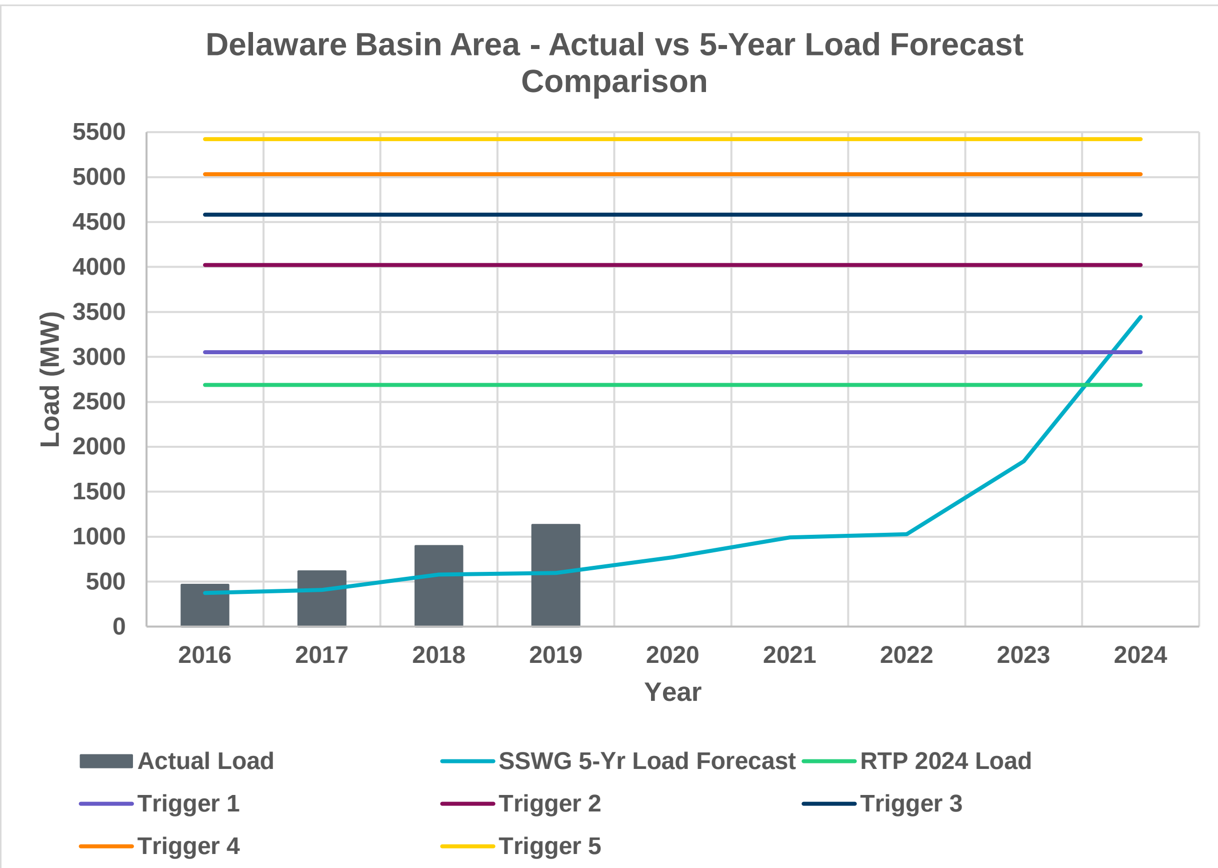


Figure 8.1 Actual and 5-year Load Forecast in the Delaware Basin Area

9. Appendix

9.1. Appendix A: Steps to Develop the Common Upgrades under N-0	Steps to develop the N-0 common up
9.2. Appendix B: List of Upgrades Identified in This Study	TransmissionUpgrades_DelawareBasinS
9.3. Appendix C: Options Diagrams	Appendix - Options Maps_v3.pdf

APPENDIX A

ERCOT Delaware Basin Load Integration Study

The existing and planned transmission system was not sufficient to serve the studied load of 5,372 MW in the Delaware Basin area. In fact, the study case demonstrated voltage instability under N-0 conditions. To identify the long lead time upgrades, which were the primary focus of the study, the reliability issues that would be expected to be addressed through local transmission upgrades were first identified through the steps described below.

Step 1

With the higher-than-forecasted load (5,372 MW), power flow of the starting case was not solved even if solar generation in the Delaware Basin area (~1,160 MW) was assumed online. The following updates were applied to just make the case solve under the N-0 condition:

- Tapped the new 345-kV Wolf station to the Odessa/Moss - Riverton 345-kV double circuit lines, and add two transformers 345/138-kV transformers at Wolf station (TPIT 46094, Tier 3, Dec 2020)
- Added total 1,860 Mvar reactive devices

Table 1 shows the locations and capacity of these 1,860 Mvar reactive devices. As stated in the study methodology, the focus of this study is to identify long lead time transmission upgrades. The reactive devices will need additional evaluation such as dynamic stability analysis to optimize the sizes, locations, and technology of reactive devices.

Table 1 Locations and Capacity of the Added Reactive Devices

Bus Number	Bus Name	kV	Capacity (Mvar)
79650	Clearfork	345	300
11084	Riverton	345	300
21013	Wolf	345	300
38124	Faulkner	138	300
38065	Barilla Draw	138	300
11078	Coalson Draw	138	250
11090	Owl Hills	138	110

Step 2

The upgrades identified in step 1 were able to solve the study base case, and a number of thermal violations which are listed in Table 2 were observed under N-0 condition and solar generation in the study area were assumed online.

Table 2 Thermal Overloads under N-0 with Online Solar Generation in the Delaware Basin Area

Element	Length (miles)	Thermal Overloading
Wolf Switching Station - Wickett 138-kV ckt 1	5.8	111.2%
Yucca Drive - Royalty 69-kV ckt 1	10.3	116.2%
Royalty - Coyanosa 69-kV ckt 1	10.3	151.1%
Barrilla - Hoefs Road 69-kV ckt1	8.2	116.1%
Barrilla 138/69-kV transformer		111.4%
Quail Switch - Odessa EHV Switch 345-kV ckt 1	0.9	107.9%
Riverton 345/138-kV transformer 1		109.7%
Riverton 345/138-kV transformer 2		109.7%

Wink - AA Pipeline Tap 69-kV ckt1	0.7	121.6%
Wickett - Pyote 138-kV ckt 1	12.9	107.7%
Pyote - Reward Tap 138-kV ckt 1	12.3	103.6%
Barilla Draw - Flat Top 138-kV ckt 1	5.8	124.8%
Flat Top - Pig Creek 138-kV ckt 1	8.9	128.6%
Gemsbok - Gemsbok Autonomous Crypto 138-kV ckt 1	1.4	110.5%
AA Pipeline Tap - AA Pipeline Meter Station 69-kV ckt 1	0.2	103.2%

To address the thermal overloads listed in Table 2, additional transmission upgrades were identified and added to the study case. Table 3 shows the additional transmission upgrades added in Step 2. The upgrades identified in step 1 and step 2 were needed to address the voltage instability and thermal violations under N-0 condition assuming the solar generation in the study area were online.

Table 3 Additional Transmission Upgrades in Step 2

Transmission Upgrades/Addition	Length (miles)
Convert AEP 69-kV line Barrilla - Hoefs Road - Verhalen - Saragosa to 138-kV	33.8
Convert TNMP 69-kV system from Winks to IH20 to 138-kV	(a recent RPG-approved Tier 2 project)
Convert ONCOR 69-kV line Yucca - Royalty - Coyanosa - Wolfcamp to 138-kV	46.9
Tap the Wolf - Riverton 345-kV double circuit at Quarry Field, and add two 345/138-kV transformer at Quarry Field	
Upgrade Quail Switch - Odessa EHV Switch 345-kV ckt 1	0.9
Upgrade the Solstice - Hayter - Remeranch 138-kV	15.7

Step 3

Based on the study assumption, the solar generation in the Delaware Basin area were turned off to represent a stressed system condition. The study results showed that turning off the solar generation in the Delaware Basin area would result in voltage collapse mainly because of the loss of reactive power support from the solar generation. To address the voltage collapse issue, one new single circuit 345-kV import path (Bearkat - Wolf - Sand Lake) was considered as a placeholder project.

The upgrades identified in the abovementioned steps were needed to address the voltage instability and thermal violations under N-0 condition when solar generation in the study area were assumed offline.

APPENDIX B

ERCOT Delaware Basin Load Integration Study

	Project	Project Description	From Bus	To Bus	From TSP	To TSP	Minimum Summer Normal and Emergency Ratings (RATE A/B) (MVA) Modeled in Study Case	Assumed Miles	Common = Project is needed regardless of import options	Reliability Need
Upgrades for N-0										
1	Added 1,860 Mvar reactive devices	Dynamic Reactive Devices such as SVC, STATCOM and Syncronous Condenser at Clearfork	79650		ONCOR_ED		300 Mvar		Common	Voltage Collapse
		Dynamic Reactive Devices such as SVC, STATCOM and Syncronous Condenser at Riverton	11084		ONCOR_ED		300 Mvar		Common	Voltage Collapse
		Dynamic Reactive Devices such as SVC, STATCOM and Syncronous Condenser at Wolf	21013		ONCOR_ED		300 Mvar		Common	Voltage Collapse
		Dynamic Reactive Devices such as SVC, STATCOM and Syncronous Condenser at Barilla Draw	38065		TNMP_TSP		300 Mvar		Common	Voltage Collapse
		Dynamic Reactive Devices such as SVC, STATCOM and Syncronous Condenser at Faulkner	38124		TNMP_TSP		300 Mvar		Common	Voltage Collapse
		Owl Hills 138-kV Capacitors	11090		ONCOR_ED		110 Mvar		Common	Voltage Collapse
		Coalson Draw with DRD	11078		ONCOR_ED		250 Mvar		Common	Voltage Collapse
2	Tapped the new 345-kV Wolf station to the Odessa/Moss - Riverton 345-kV double circuit lines (TPIT 46094, Tier 3, Dec 2020)	New Wolf 345/138-kV substation	21013		ONCOR_ED		2988/2988 (Line Ratings)		Common	Voltage Collapse
		Two 345/138-kV Xfrms at Wolf	21013		ONCOR_ED		750/750		Common	Voltage Collapse
3	345-kV import path is also needed for N-0.		n/a	n/a	n/a	n/a			Common	Voltage Collapse
4	Convert AEP 69-kV line Barrilla - Hoefs Road - Verhalen - Saragosa to 138-kV		60385	60716	AEP_TNC	AEP_TNC	483/483	33.78	Common	Voltage Collapse
5	Convert TNMP 69-kV system from Wink to IH20 to 138-kV.				TNMP_TSP	TNMP_TSP			Common	Approved Tier 2 RPG project.
6	Convert ONCOR 69-kV line Yucca - Royalty - Coyanosa - Wolfcamp to 138-kV		1009	1242	ONCOR_ED	ONCOR_ED	614/614	46.90	Common	Yucca - Royalty - Coyanosa 69-kV
7	Upgrade the Gemsbok to Gemsbok Autonomous Crypto 138-kV line		38107	38109	TNMP_TSP	TNMP_TSP	614/614	1.35	Common	Gemsbok to Gemsbok Autonomous Crypto 138-kV
8	Tap the Wolf - Riverton 345-kV double circuit at Quarry Field, and add two 345/138-kV autotransformer at Quarry Field	Quarry Field 345-kV station	11188		ONCOR_ED				Common	Both Riverton 345/138-kV transformers
		Two 345/138-kV Xfrms at Quarry Field	11188		ONCOR_ED		750/750		Common	
9	Upgrade Quail Switch - Odessa 345-kV line		11016	11028	ONCOR_ED	ONCOR_ED	1521/1784	0.90	Common	Quail Switch - Odessa 345-kV
10	Upgrade the Solstice - Hayter 138-kV line		60385	78925	AEP_TNC	AEP_TNC	614/614	1.50	Common	Solstice - Hayter 138-kV
Upgrades for N-1										
11	Build a new 345/138-kV OwlHill station with two 345/138-kV transformers, and add a new single circuit 345-kV line from Riverton to 345-kV OwlHill station	OwlHill 345/138-kV station	211090		ONCOR_ED		2988/2988 (Line Ratings)		Common	Riverton 345/138-kV transformer1/transformer2; There're also unsolved contingencies along the Riverton - OwlHill area
		Two 345/138-kV Xfrms at OwlHill	211090		ONCOR_ED		750/750		Common	
		Single 345-kV line from Riverton to OwlHill	11084	211090	ONCOR_ED	ONCOR_ED	2988/2988	20.27	Common	

12	Tap the new Megan station to the Solstice - Sand Lake 345-kV double-circuit lines, and install two new 345/138-kV transformers at the new Megan station	New 345/138-kV Megan station	38083		TNMP_TSP		2988/2988 (Line Ratings)		Common	Voltage Collapse
		Two 345/138-kV Xfrms at new Megan station	38083		TNMP_TSP		750/750		Common	
13	Build a new 138-kV line from Saragosa to Faulkner		60716	38124	AEP_TNC	TNMP_TSP	614/614	18.00	Common	a. IH20 - SALT DRAW TAP TNP - SADDLEBACK 138-kV b. TNMP Pecos - Reeves Tap 138-kV
14	Upgrade the 138-kV line from Hayter to Remeranch		78925	99900	AEP_TNC	AEP_TNC	614/614	14.15	Common	Hayter - Remeranch 138-kV
15	Rio Pecos to Fort Stockton Upgrade: Upgrade the 138-kV lines from Rio Pecos - Lynx - TNMP 16th St - Fort Stockton	Rio Pecos - Lynx 138-kV Ckt2	6601	60400	AEP_TNC	AEP_TNC	483/483	1.91	Common	a. 16TH STREET TNP - WOODWARD 2 138-kV b. Fort Stockton - AIRPORT TNP 138-kV c. 16TH STREET TNP - AIRPORT TNP 138-kV d. Fort Stockton - TOMBSTONE 138-kV
		Lynx - Tombstone - Fort Stockton 138-kV	60400	6630	AEP_TNC	AEP_TNC	483/483	35.31	Common	
		Lynx - 16th Street TNP 138-kV	60400	38310	AEP_TNC	TNMP_TSP	483/483	31.78	Common	
		16th Street TNP - Airport TNP 138-kV	38310	38340	TNMP_TSP	TNMP_TSP	483/483	2.78	Common	
		Airport TNP 138kV - Fort Stockton 138-kV	38340	6630	TNMP_TSP	AEP_TNC	483/483	2.80	Common	
16	Convert the existing Fort Stockton - Conoco Comp station - Conoco Rgec 69-kV line to 138-kV. Move the 138/69-kV transformer from Fort Stockton to Conoco Comp station	Fort Stockton-Conoco Comp	6628	6663	AEP_TNC	AEP_TNC	614/614	13.97	Common	Voltage Collapse
		Conoco Comp-Conoco Rgec	6663	76663	AEP_TNC	LCRA TSC	614/614	11.12	Common	
17	Build a new 138-kV line from Conoco Rgec to TNMP 16th street		76663	38310	LCRA TSC	TNMP_TSP	483/483	22.00	Common	Voltage Collapse
18	Build a new 138-kV line from Remeranch to Saragosa		99900	6652	AEP_TNC	AEP_TNC	483/483	26.50	Common	Voltage Collapse
19	Upgrade Morgan Creek - Tonkawa 345-kV line		1030	11048	ONCOR_ED	ONCOR_ED	1792/1792	21.30	Common	Morgan Creek - Tonkawa 345-kV line
20	Upgrade Morgan Creek - Longshore 345-kV line		1030	1058	ONCOR_ED	ONCOR_ED	1792/1792	36.50	Needed for an option with new Bearkat - North McCamey line	Morgan Creek - Longshore 345-kV line
21	Upgrade Midland East - Falcon Seaboard 345-kV		1021	1025	ONCOR_ED	ONCOR_ED	1792/1792	48.40	Common	Midland East - Falcon Seaboard 345-kV
22	Upgrade Saddleback - Salt Draw Tap 138-kV		38058	38080	TNMP_TSP	TNMP_TSP	717/717	0.50	Option 5	Saddleback - Salt Draw Tap 138-kV
23	Build new 138-kV double circuit from the new Megan station to Saddleback		38080	38055	TNMP_TSP	TNMP_TSP	614/614	6.20	Common	Needed to connect the new Megan 345-kV source to the 138-kV system
24	Upgrade Salt Draw Tap - IH20 138-kV		38055	38045	TNMP_TSP	TNMP_TSP	717/717	4.90	Option 5	Salt Draw Tap - IH20 138-kV
25	Build new 138-kV double circuit from the new Megan station to Faulkner		38080	38124	TNMP_TSP	TNMP_TSP	614/614	24.20	Common	Needed to connect the new Megan 345-kV source to the 138-kV system
26	Upgrade Morgan Creek - Falcon Seaboard 345-kV		1030	1025	ONCOR_ED	ONCOR_ED	1792/1792	36.20	Needed for Options 5 & 9	Morgan Creek - Falcon Seaboard 345-kV
27	Upgrade Longshore - Midessa 345-kV		1058	1125	ONCOR_ED	ONCOR_ED	1792/1792	48.00	Needed for Option 9	Longshore - Midessa 345-kV
28	Upgrade Midland East - Midland County NW 345-kV		1022	1185	ONCOR_ED	ONCOR_ED	1792/1792	17.20	Needed for Options 5 & 9	Midland East - Midland County NW 345-kV
29	2nd 345-kV Circuit from Big Hill to Bakersfield		76003	76002	LCRA TSC	LCRA TSC	1521/1784	111.42	**Option 1**	
	2nd 345-kV Circuit from Bakersfield to North McCamey		76002	76000	LCRA TSC	LCRA TSC	1521/1784	16.27		
	2nd 345-kV Circuit from North McCamey to Odessa		76000	11028	LCRA TSC	ONCOR_ED	1521/1784	58.72		
	North McCamey - Megan 345-kV Double Ckt		76000	38083	LCRA TSC	TNMP_TSP	2564/2564	78.00		

30	Faraday - Lamesa 345-kV Single Ckt		59905	991163	WETT	ONCOR_ED	2564/2564	34.20	**Option 2**	
	Lamesa - Clearfork 345-kV Single Ckt		991163	79650	ONCOR_ED	ONCOR_ED	2564/2564	76.80		
	Clearfork - Riverton 345-kV Single Ckt		79650	11084	ONCOR_ED	ONCOR_ED	2564/2564	82.00		
31	Faraday - Lamesa 345-kV Double Ckt		59905	991163	WETT	ONCOR_ED	2564/2564	34.20	**Option 4**	
	Lamesa - Clearfork 345-kV Double Ckt		991163	79650	ONCOR_ED	ONCOR_ED	2564/2564	76.80		
	Clearfork - Riverton 345-kV Double Ckt		79650	11084	ONCOR_ED	ONCOR_ED	2564/2564	82.00		
32	Bearkat - North McCamey 345-kV Single Ckt		59903	76000	WETT	LCRA TSC	2564/2564	70.80	**Option 3**	
	North McCamey - Megan 345-kV Single Ckt		76000	38083	LCRA TSC	TNMP_TSP	2564/2564	78.00		
33	Bearkat - North McCamey 345-kV Double Ckt		59903	76000	WETT	LCRA TSC	2564/2564	70.80	**Option 5**	
	North McCamey - Megan 345-kV Double Ckt		76000	38083	LCRA TSC	TNMP_TSP	2564/2564	78.00		
34	Bearkat - North McCamey 345-kV Double Ckt		59903	76000	WETT	LCRA TSC	2564/2564	70.80	**Option 6**	
	North McCamey - Sand Lake 345-kV Double Ckt		76000	11096	LCRA TSC	ONCOR_ED	2564/2564	93.60		
35	North McCamey - Megan 345-kV Double Ckt		76000	38083	LCRA TSC	TNMP_TSP	2564/2564	78.00	**Option 7**	
	Red Creek - North McCamey 345-kV Double Ckt		6444	76000	AEP_TNC	LCRA TSC	2564/2564	138.00		
36	1,200 MW HVDC line (VSC) from Abernathy to Riverton		79506	11084	ONCOR_ED	ONCOR_ED	1200	240.24	**Option 8**	
37	1,200 MW HVDC line (VSC) from Howard Road to Bakersfield		5056	76002	CPS_TSP	LCRA TSC	1200	302.00	**Option 9**	
	North McCamey - Megan 345-kV Double Ckt		76000	38083	LCRA TSC	TNMP_TSP	2564/2564	78.00		
38	Howard Road - Bakersfield 765-kV Single Ckt + Transformers	Howard Road - Bakersfield 765-kV single Ckt line	5056	76002	CPS_TSP	LCRA TSC	3975/3975	302.00	**Option 10**	
		Two 765/345-kV Xfrms at Howard Road	5056		CPS_TSP		1500/1500			
		Two 765/345-kV Xfrms at Bakersfield		76002		LCRA TSC	1500/1500			
	North McCamey - Megan 345-kV Double Ckt		76000	38083	LCRA TSC	TNMP_TSP	2564/2564	78.00		
39	Build a new 138-kV line from Elcor to Faulkner		11198	38124	ONCOR_ED	TNMP_TSP	614/614	36.00	Common	Customer Needs
40	Convert Riverton - Sand Lake 138-kV to 345-kV		11084	11096	ONCOR_ED	ONCOR_ED	2988/2988		Option 6g	
41	Build a new Riverton - Sand Lake 138-kV line		11083	11097	ONCOR_ED	ONCOR_ED	765/765	40		
42	Upgrade Odessa - Wolf 138-kV		1027	1013	ONCOR_ED	ONCOR_ED	614/614	44.4	Needed for Option 6g	Odessa - Wolf 138-kV

APPENDIX C

ERCOT Delaware Basin Load Integration Study

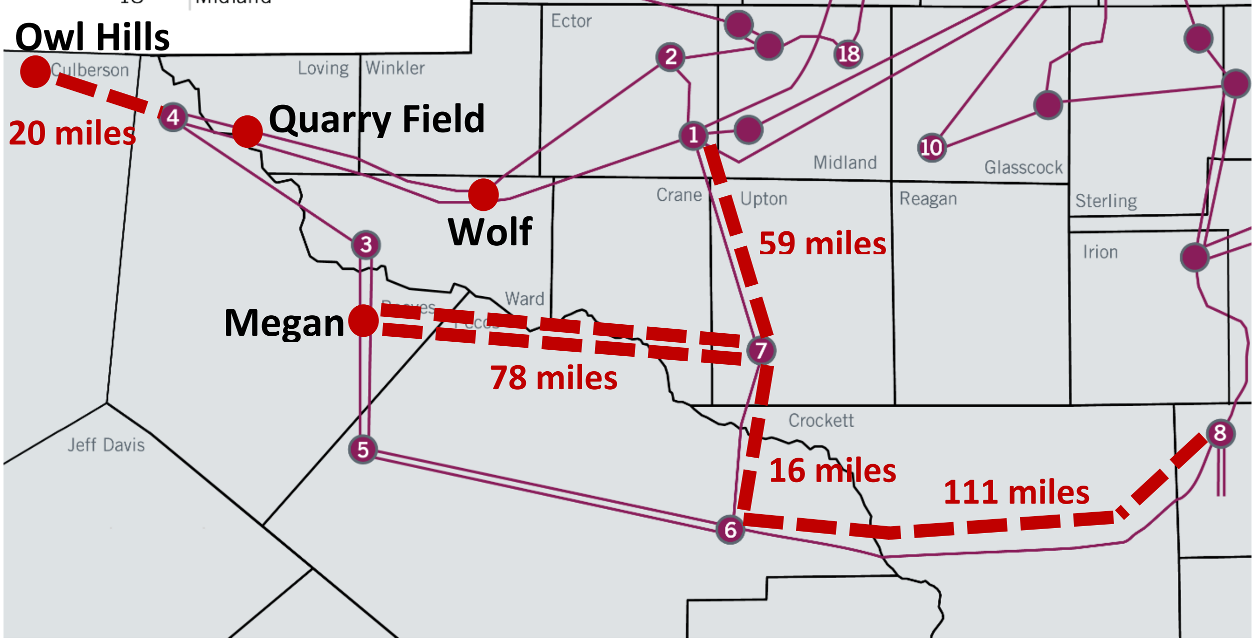
Option 1: Add a second circuit for the Big Hill – Bakersfield – North McCamey – Odessa 345-kV line, and new North McCamey – Megan double-circuit 345-kV line (shown in dash lines)

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland

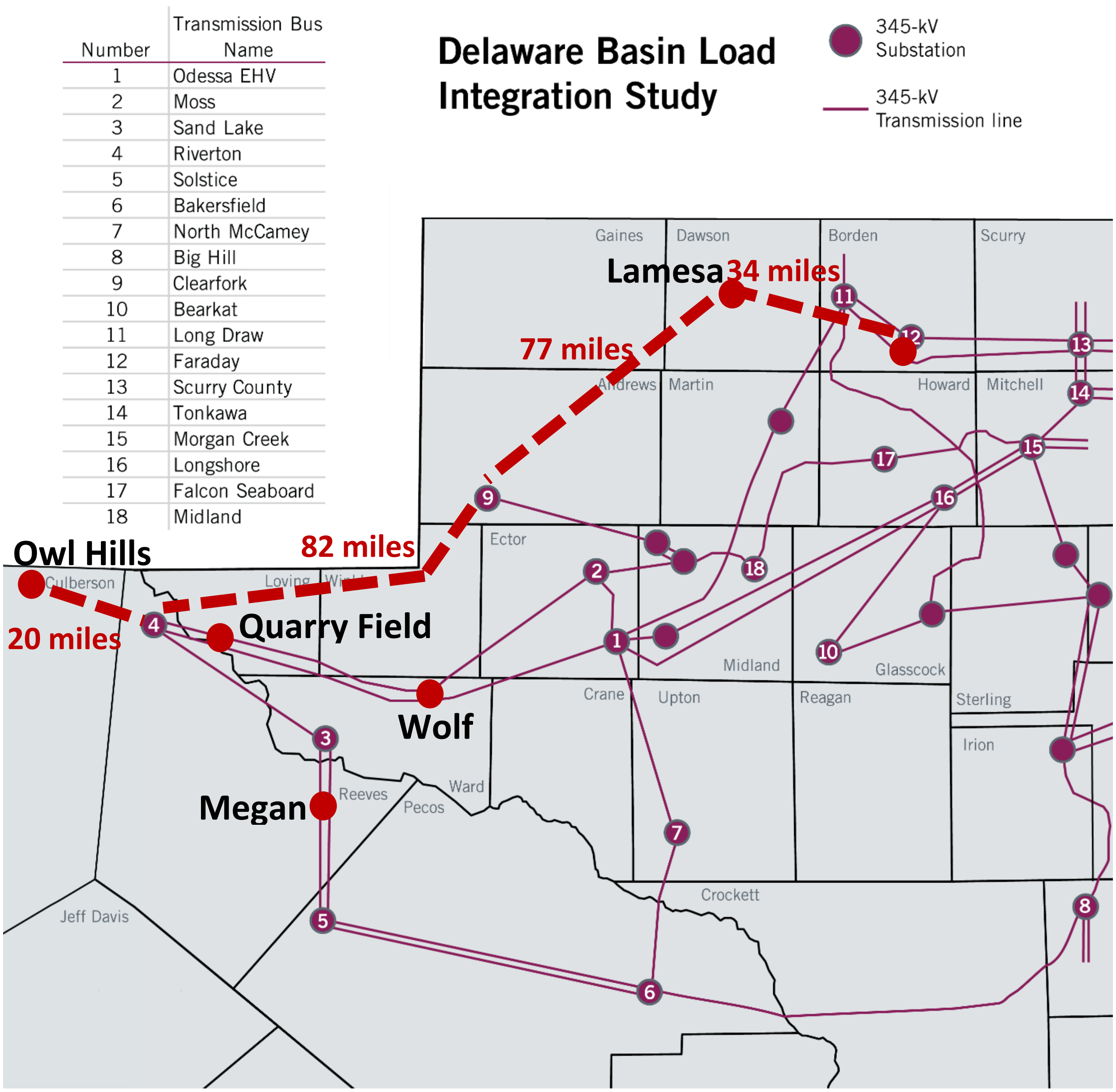
Delaware Basin Load Integration Study

345-kV Substation

345-kV Transmission line

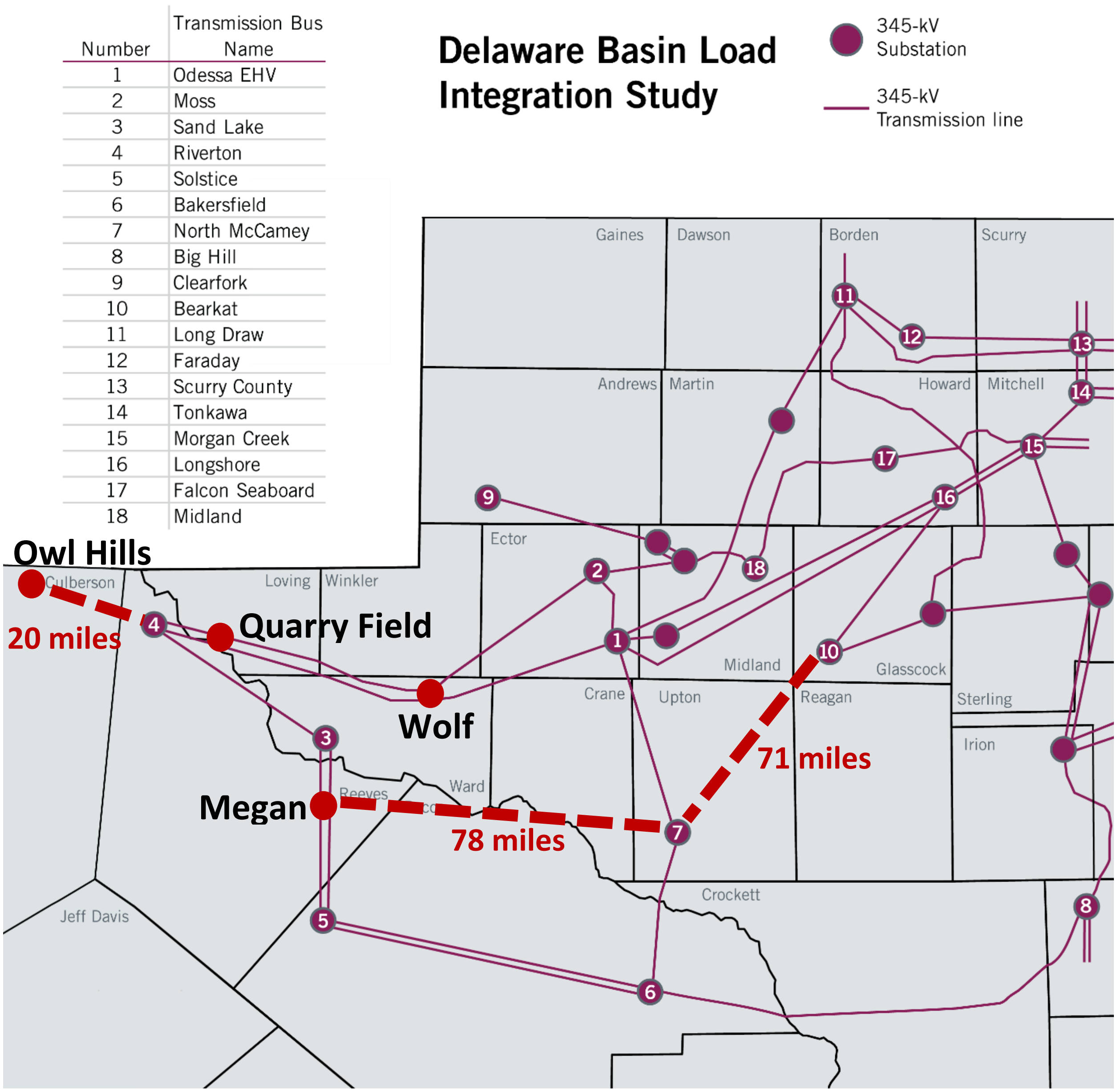


Option 2: Faraday – Lamesa - Clearfork – Riverton 345-kV single circuit (shown in dash lines)

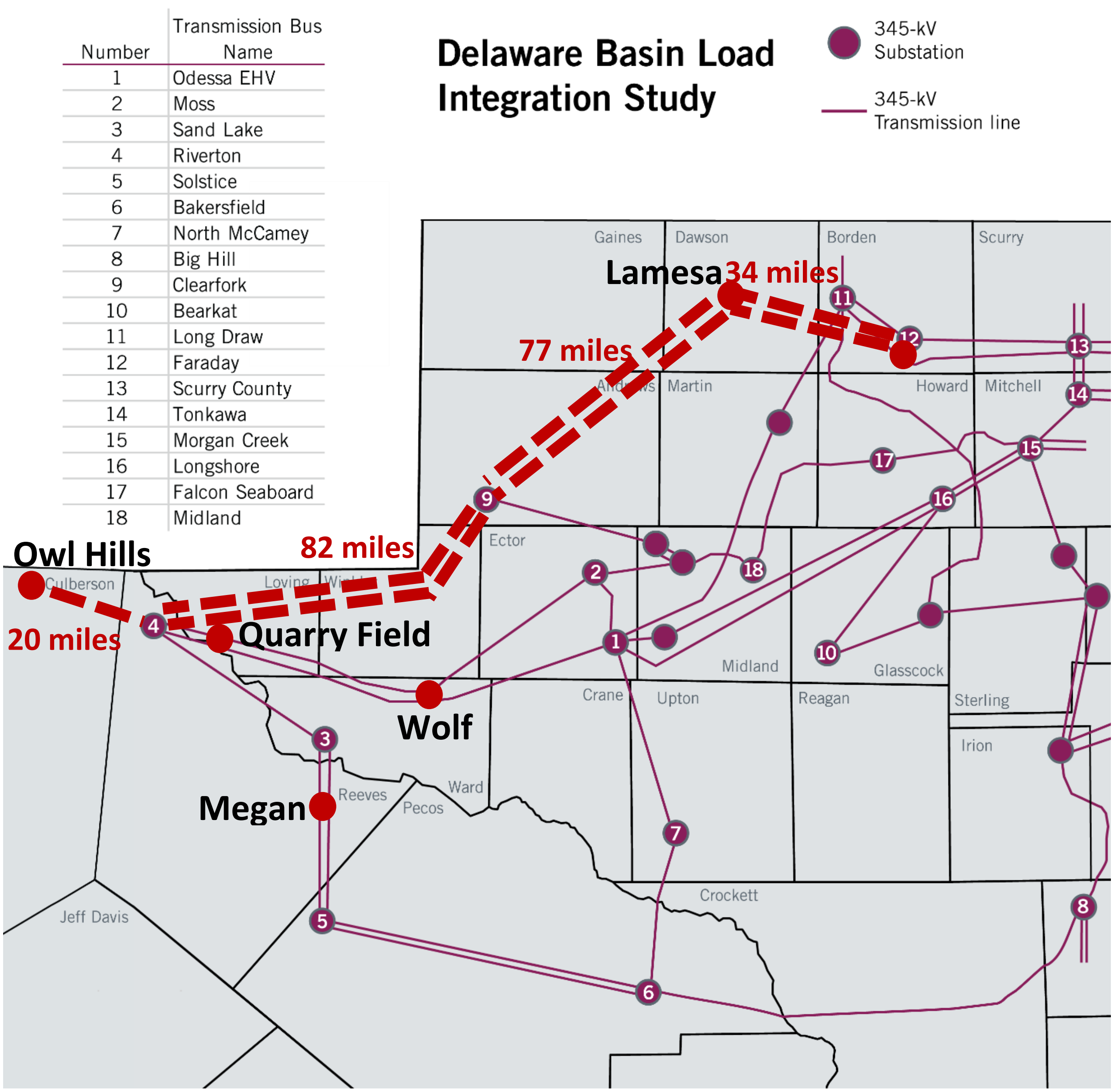


Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland

Option 3: Bearkat – North McCamey – Megan 345-kV single circuit (shown in dash lines)

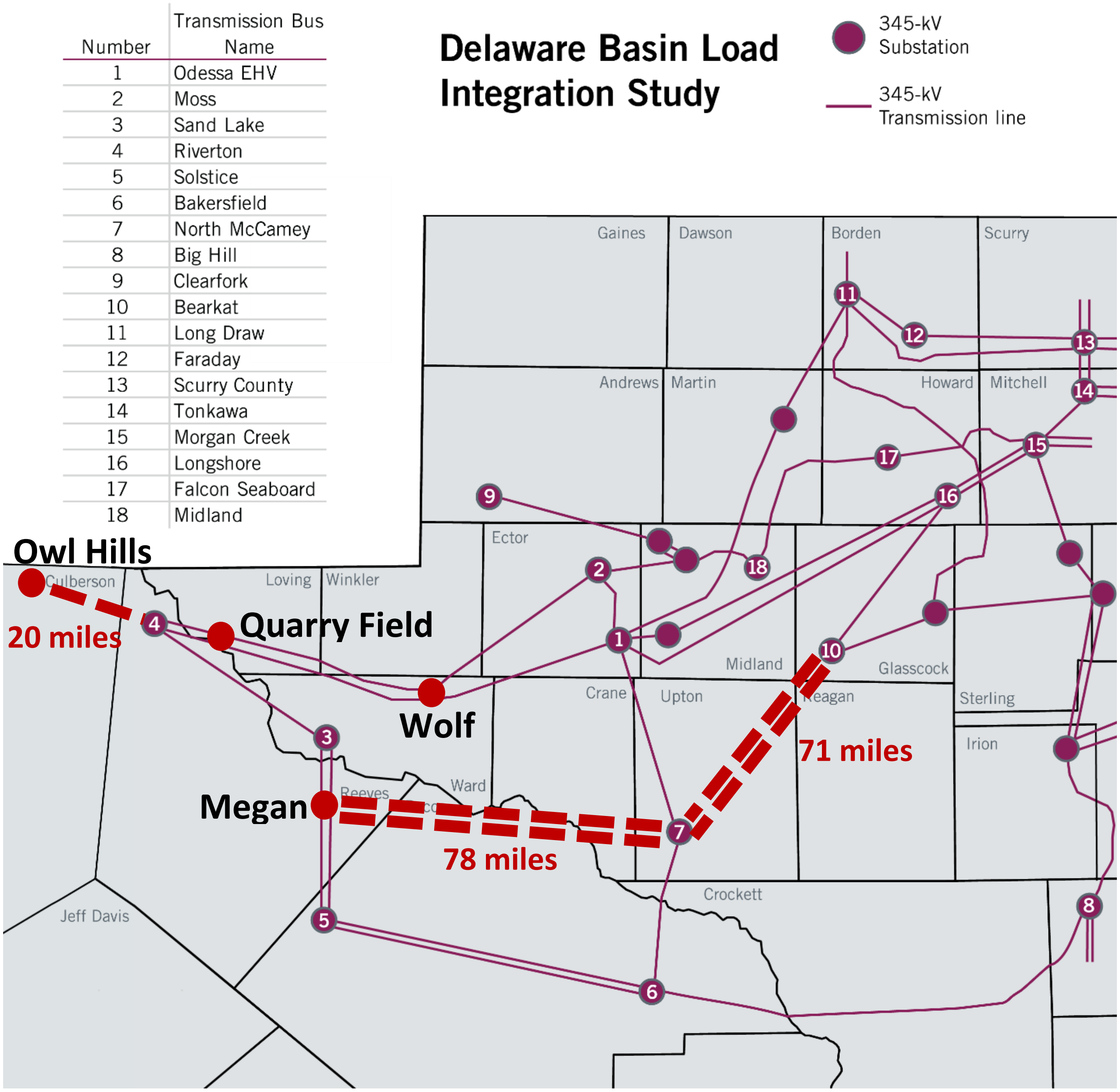


Option 4: Faraday – Lamesa - Clearfork – Riverton 345-kV double circuit (shown in dash lines)



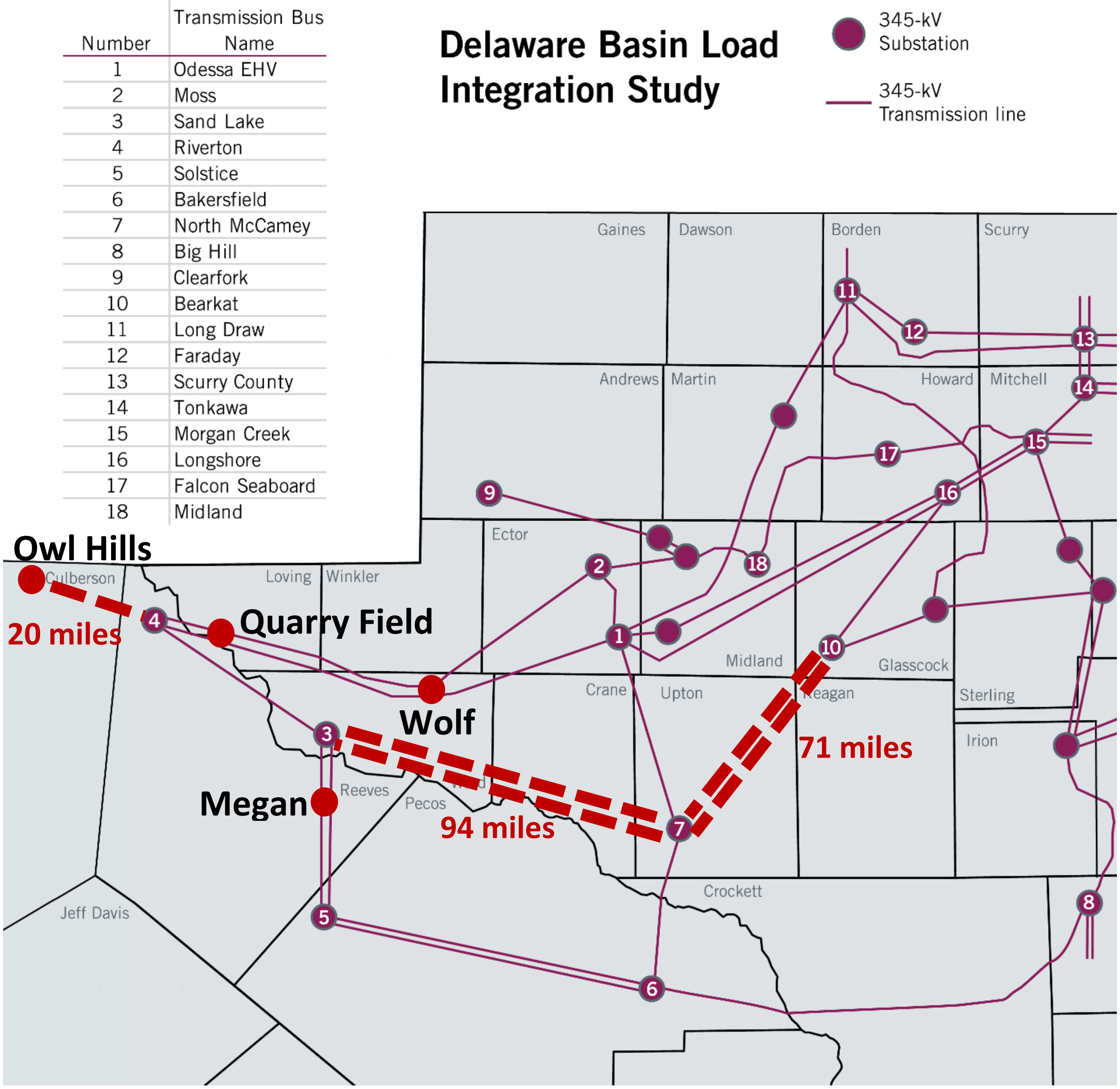
Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland

Option 5: Bearkat – North McCamey – Megan 345-kV double circuit (shown in dash lines)

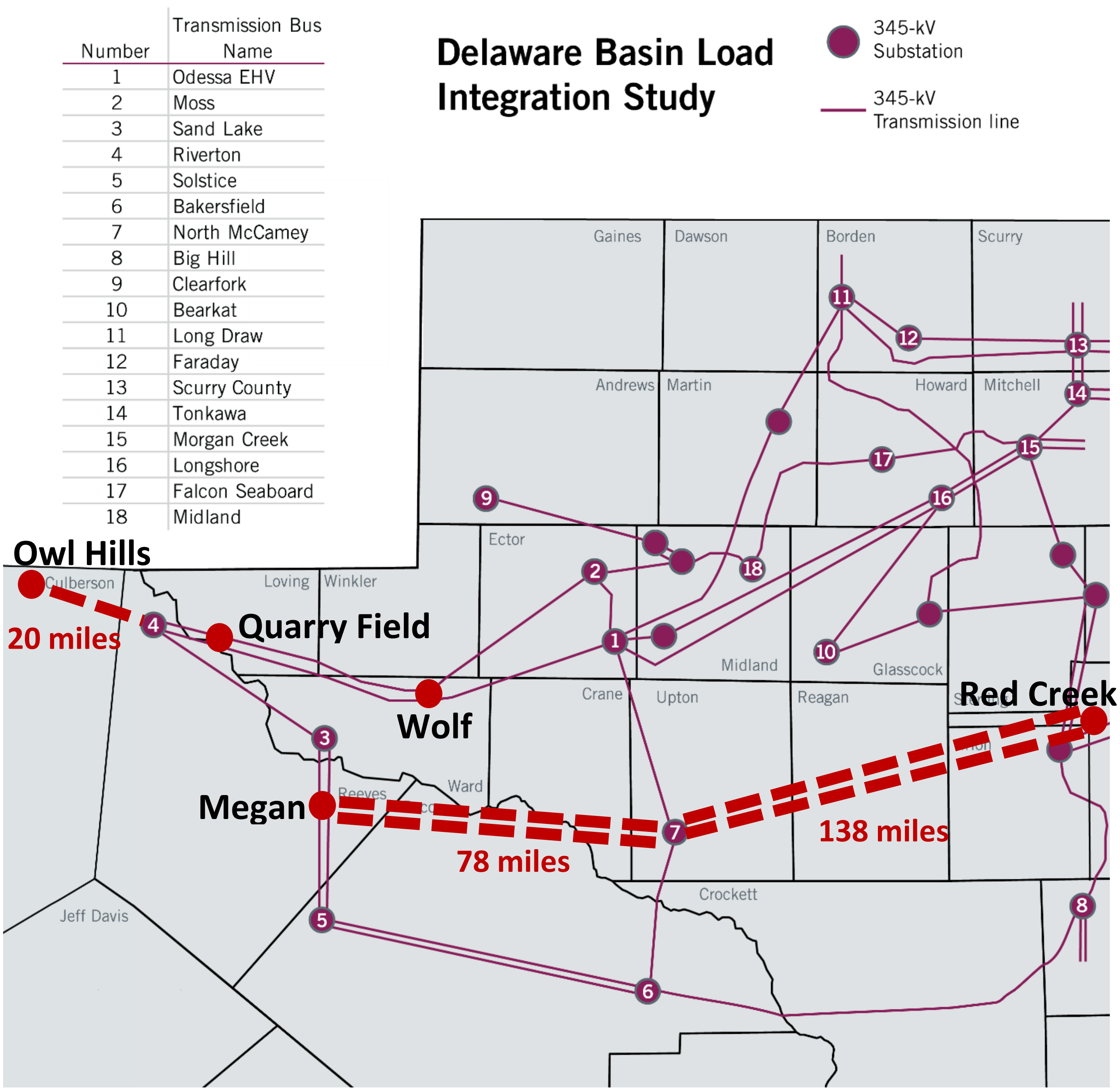


Option 6: Bearkat – North McCamey – Sand Lake 345-kV double circuit (shown in dash lines)

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland

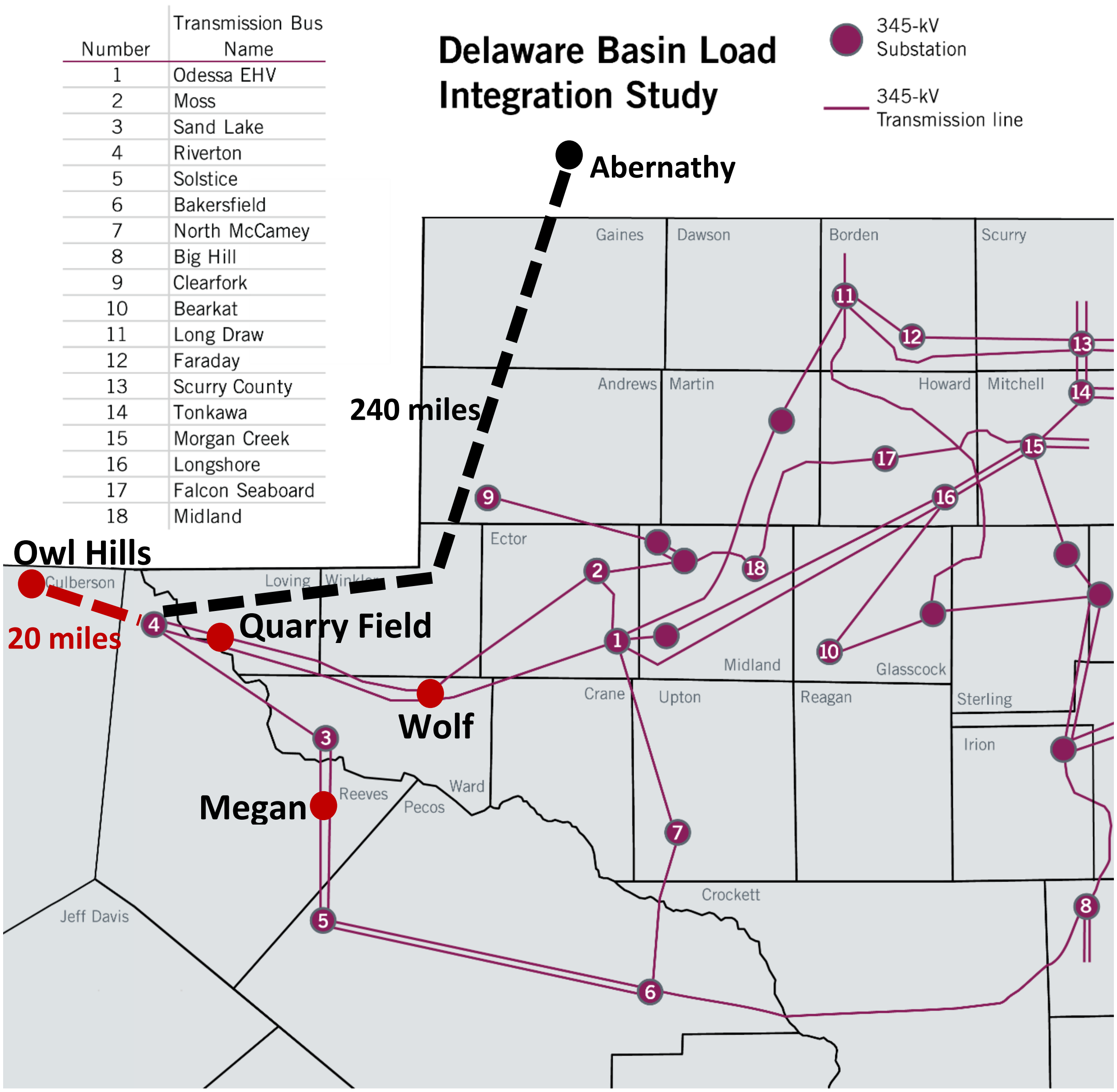


Option 7: Red Creek – North McCamey – Megan 345-kV double circuit (shown in dash lines)



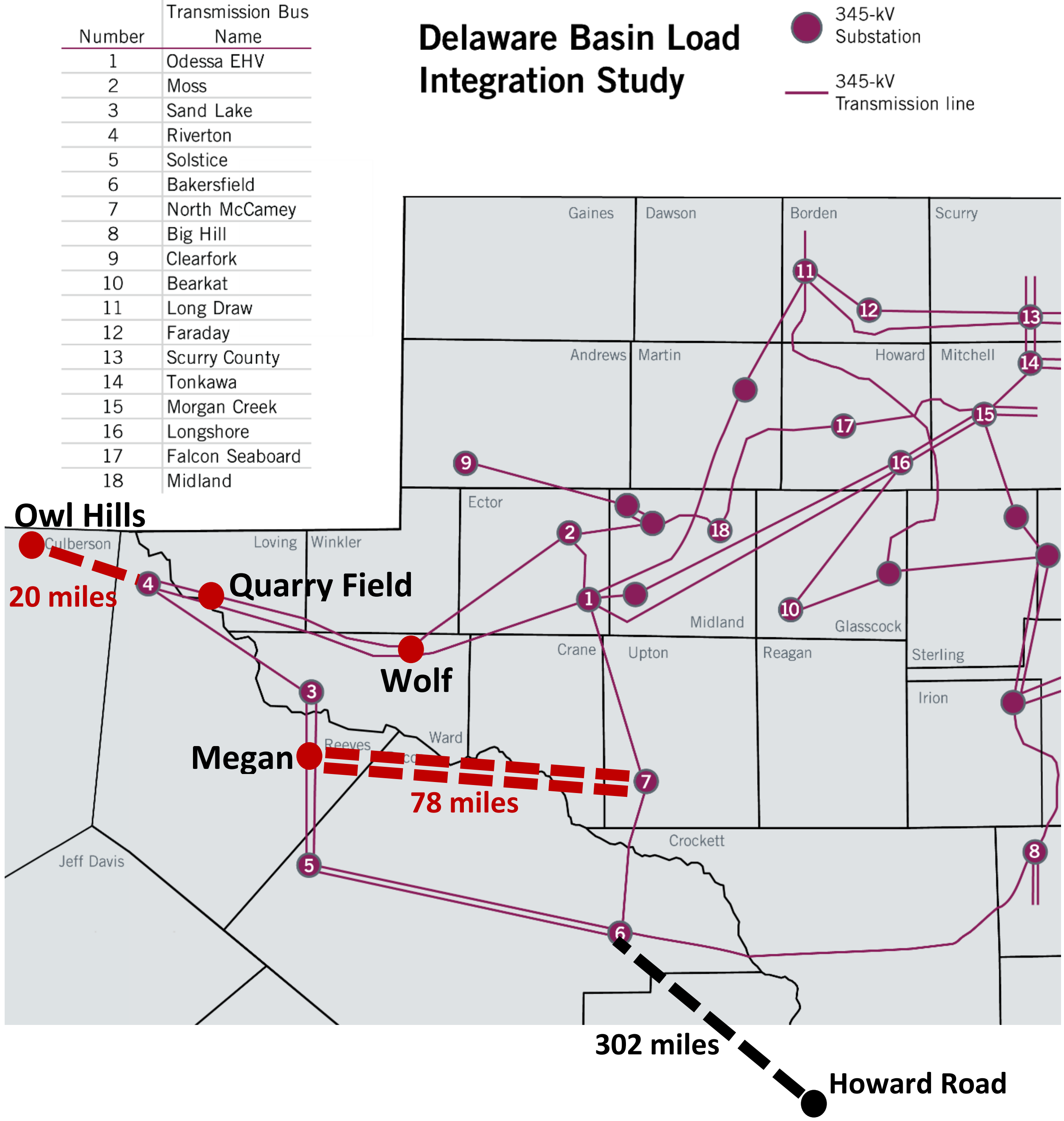
Option 8: 1,200 MW HVDC line (VSC) from Abernathy to Riverton (shown in dash lines)

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland



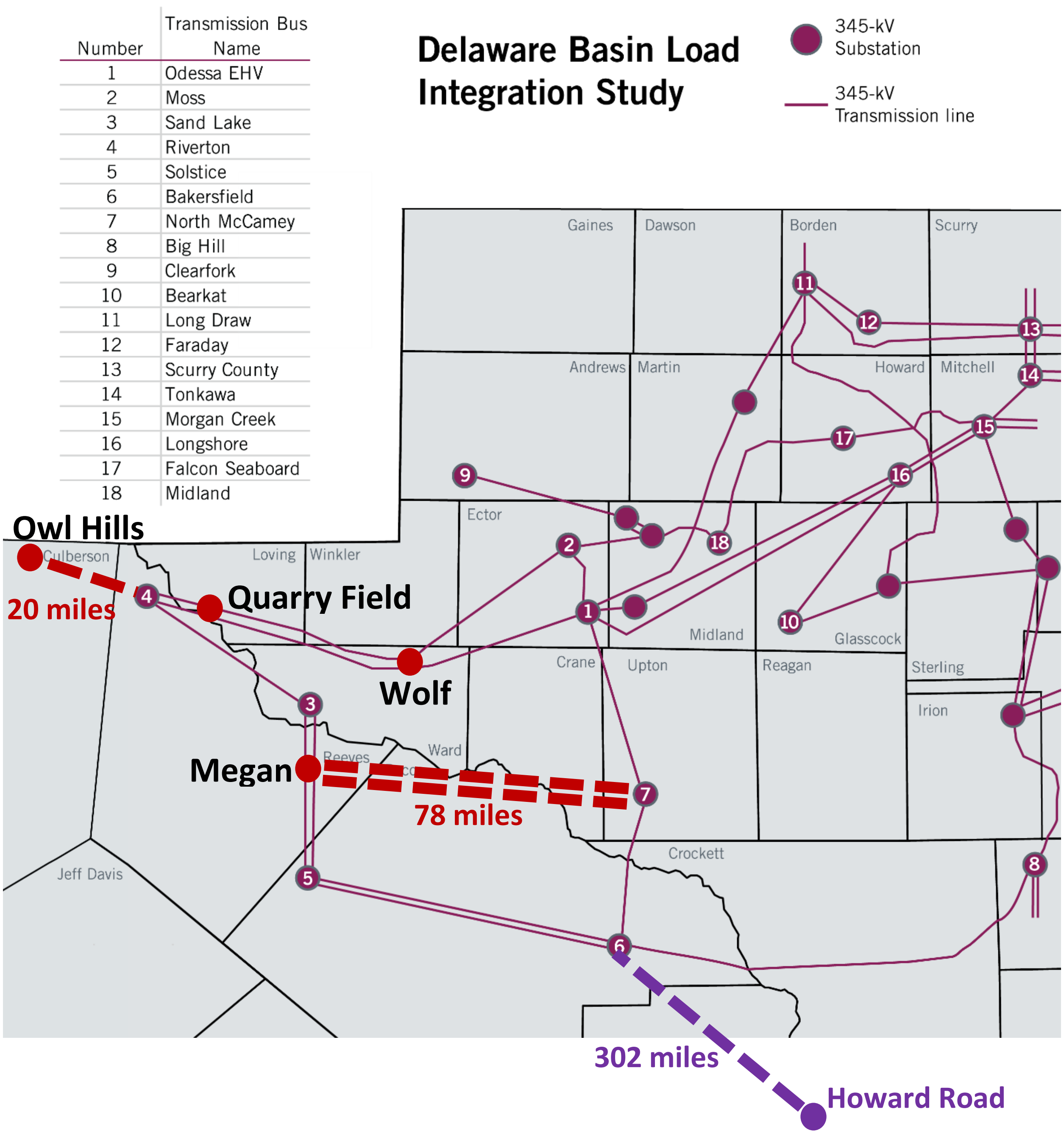
Option 9: 1,200 MW HVDC line (VSC) from Howard Road to Bakersfield, and new 345-kV double-circuit line from North McCamey to Megan (shown in dash lines)

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland

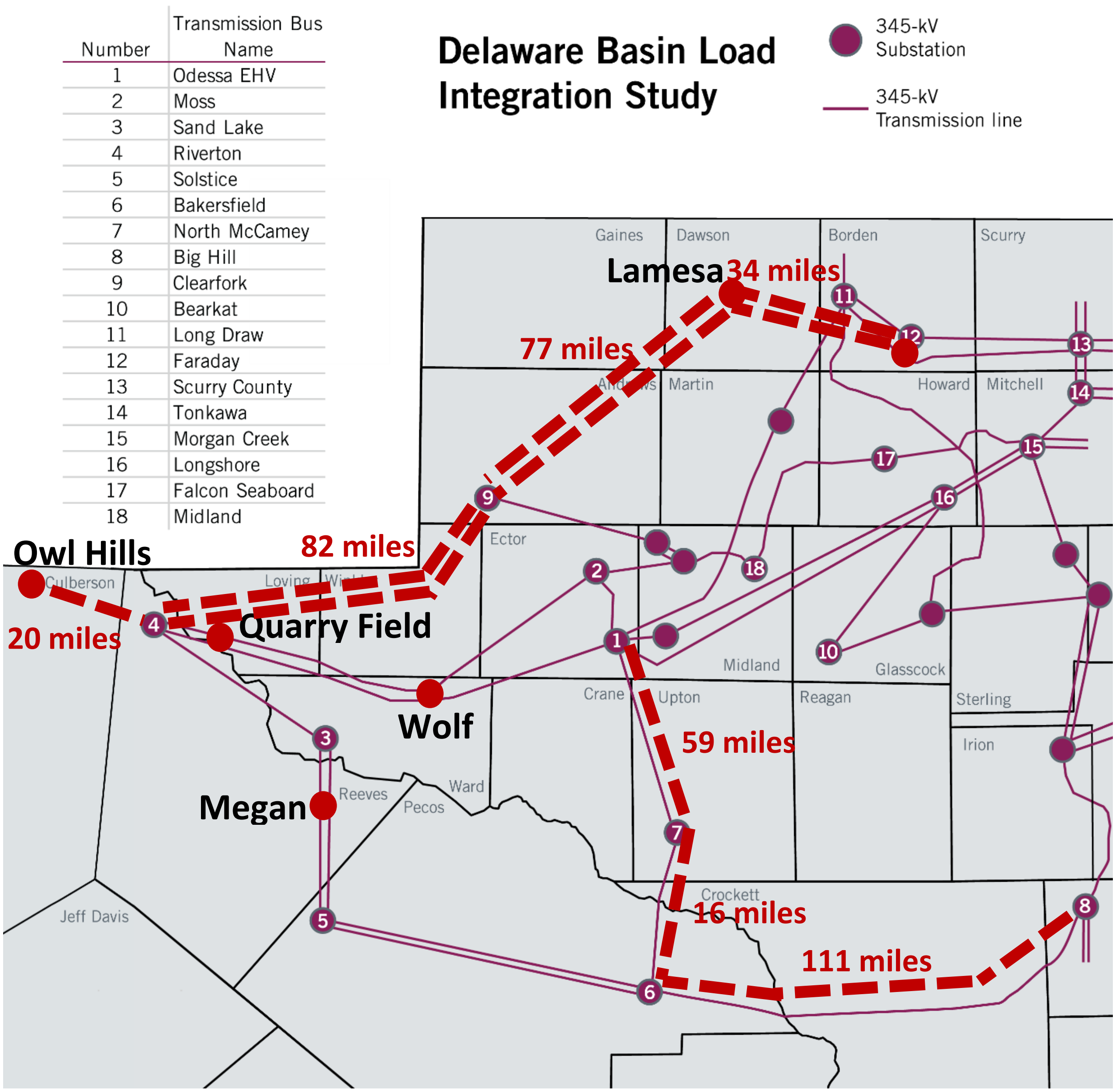


Option 10: Howard Road – Bakersfield 765-kV single-circuit line, and new 345-kV double-circuit line from North McCamey to Megan (shown in dash lines)

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland

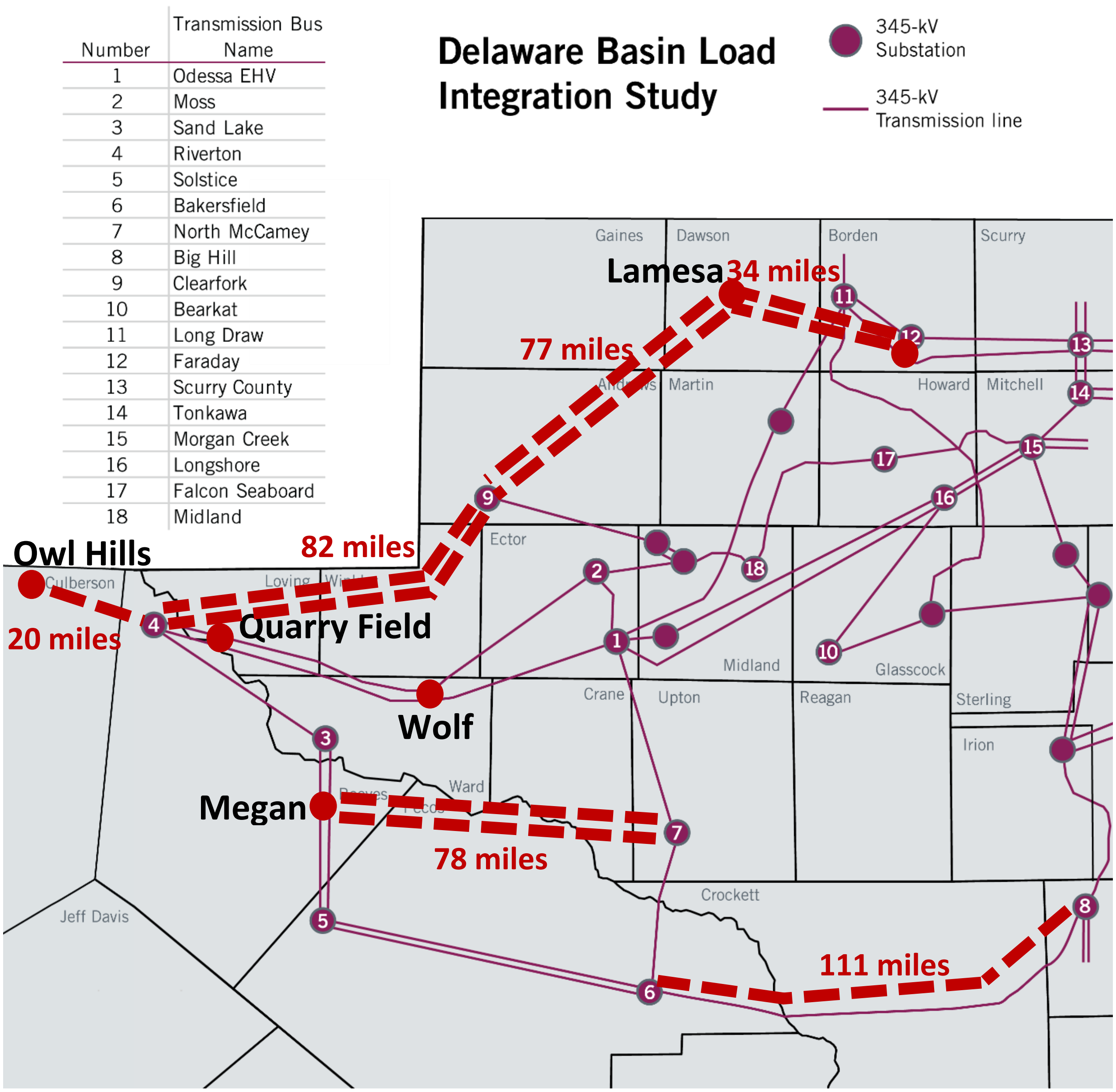


Option 4a: Faraday – Lamesa - Clearfork – Riverton 345-kV double circuit, a second circuit for the Big Hill – Bakersfield – North McCamey – Odessa 345-kV line (shown in dash lines)



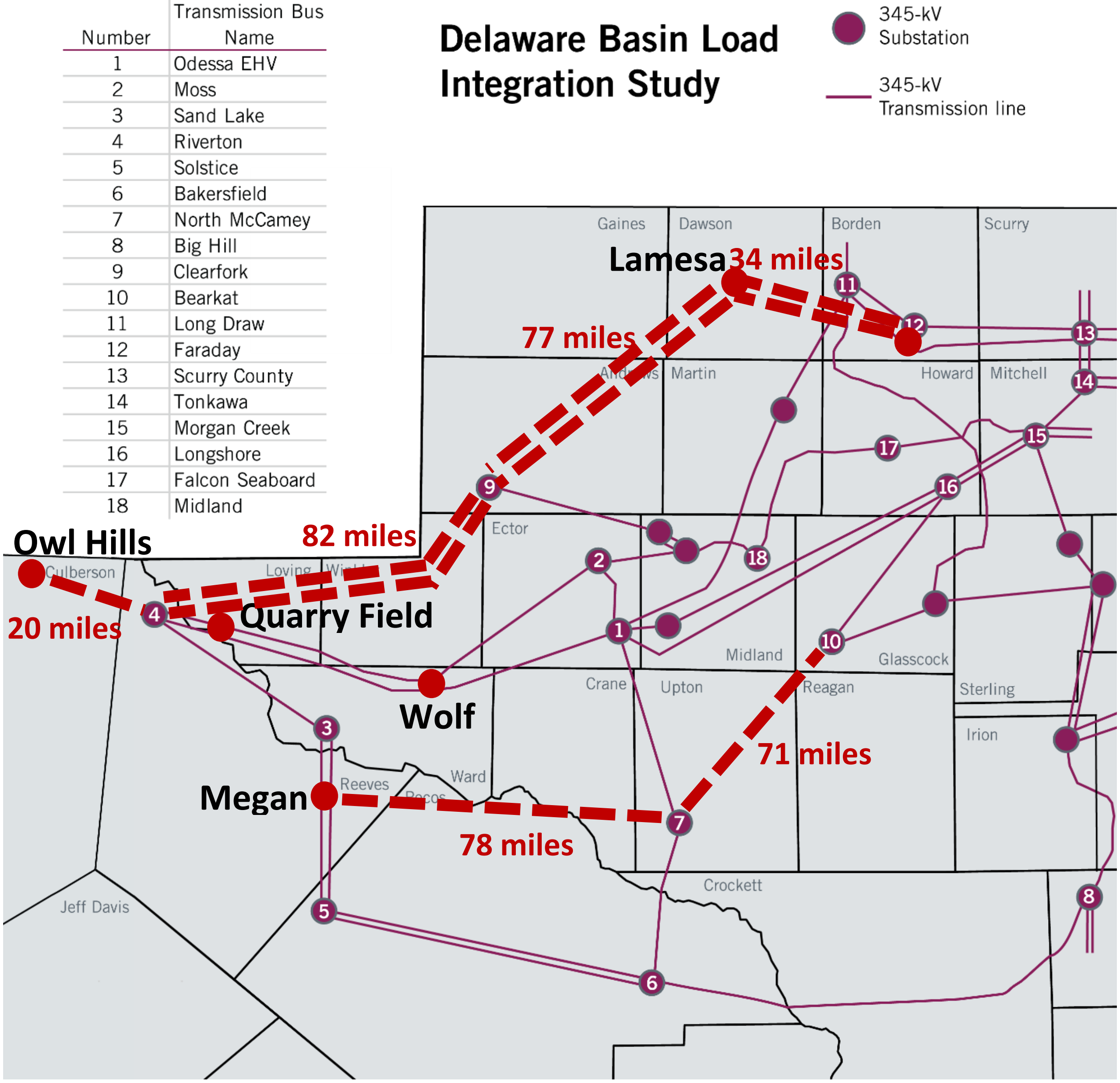
Option 4b: Faraday – Lamesa - Clearfork – Riverton 345-kV double circuit, a second circuit for the Big Hill – Bakersfield 345-kV line, North McCamey – Megan 345-kV double circuit (shown in dash lines)

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland

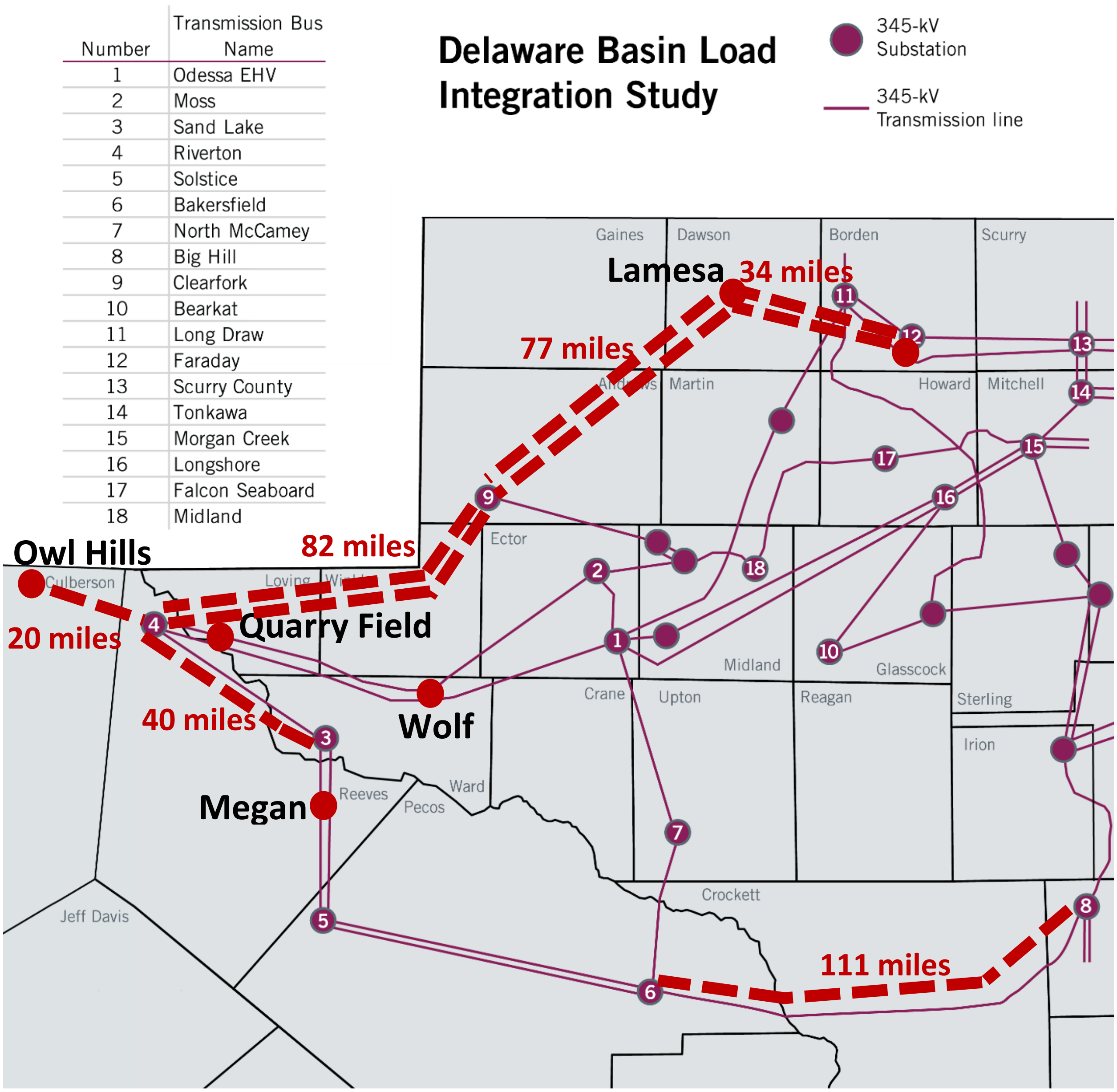


Option 4c: Faraday – Lamesa - Clearfork – Riverton 345-kV double circuit, Bearkat - North McCamey – Megan 345-kV single circuit (shown in dash lines)

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland



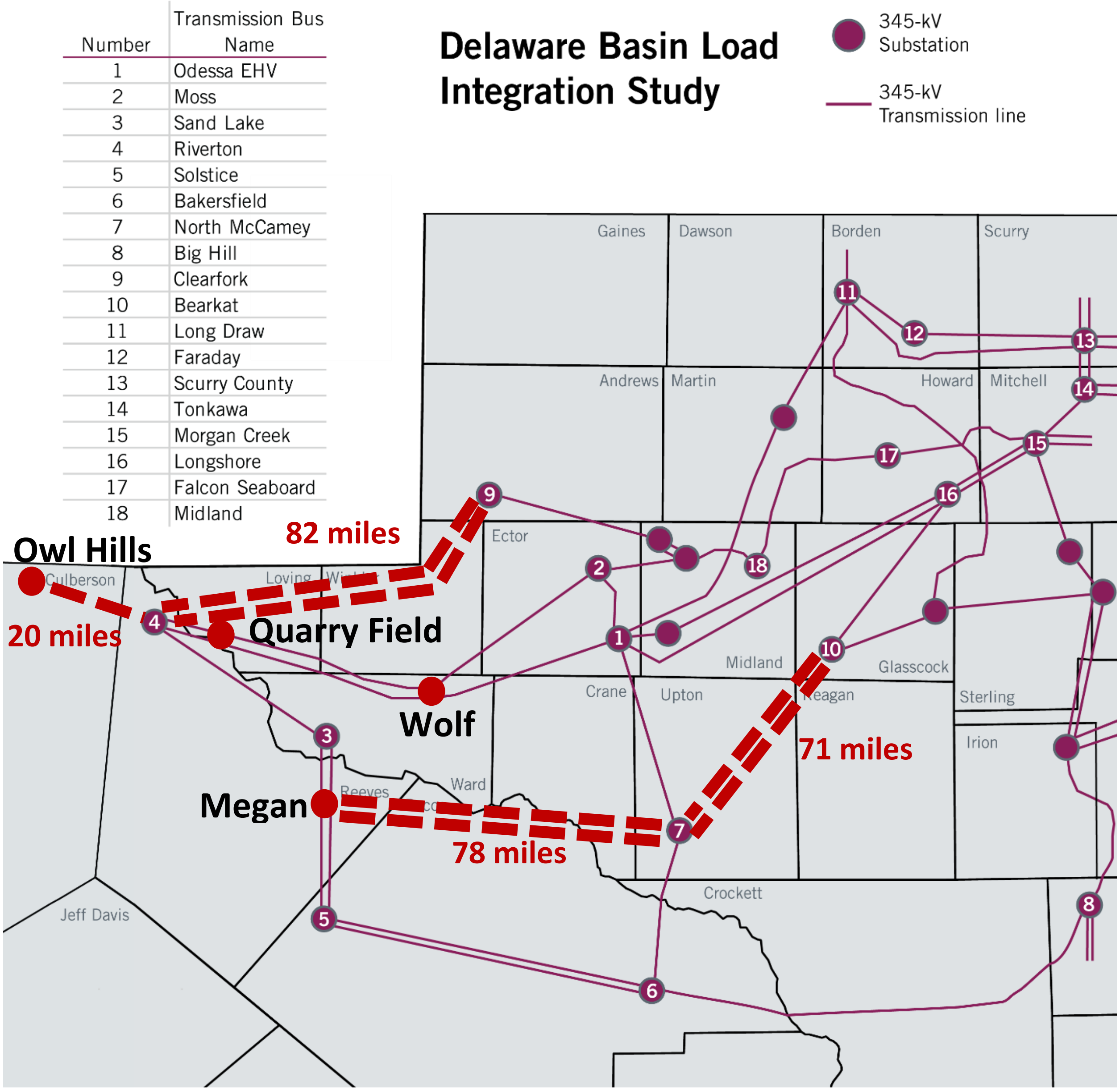
Option 4g: Faraday – Lamesa - Clearfork – Riverton 345-kV double circuit, a second circuit for the Big Hill – Bakersfield 345-kV line, Convert the Sand Lake – Riverton 138-kV to 345-kV and add a new 138-kV line from Sand Lake to Riverton (shown in dash lines)



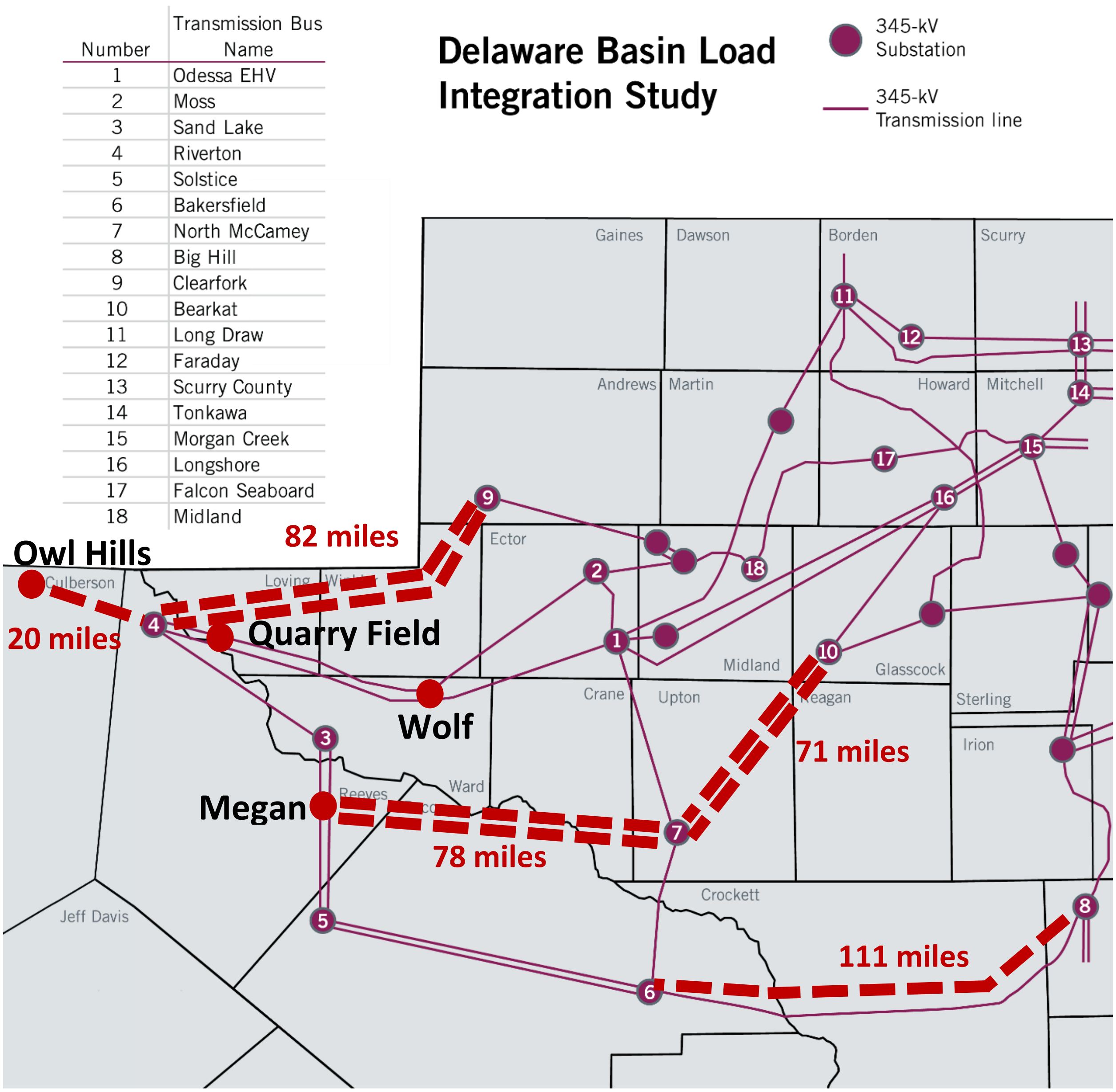
Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland

Option 5d: Bearkat – North McCamey – Megan 345-kV double circuit, Clearfork – Riverton 345-kV double circuit (shown in dash lines)

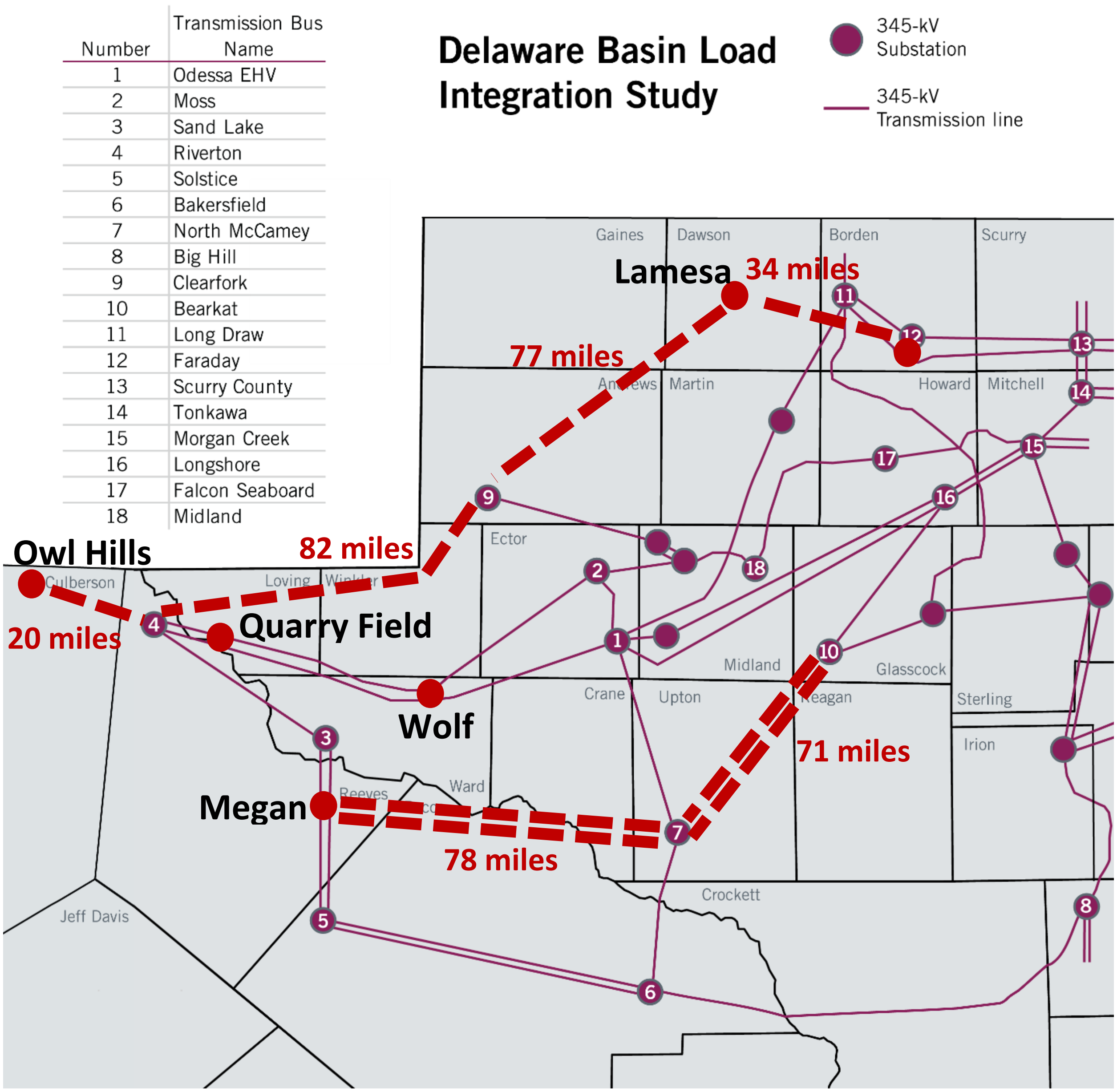
Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland



Option 5e: Bearkat – North McCamey – Megan 345-kV double circuit, a second circuit for the Big Hill – Bakersfield 345-kV line, Clearfork – Riverton 345-kV double circuit (shown in dash lines)

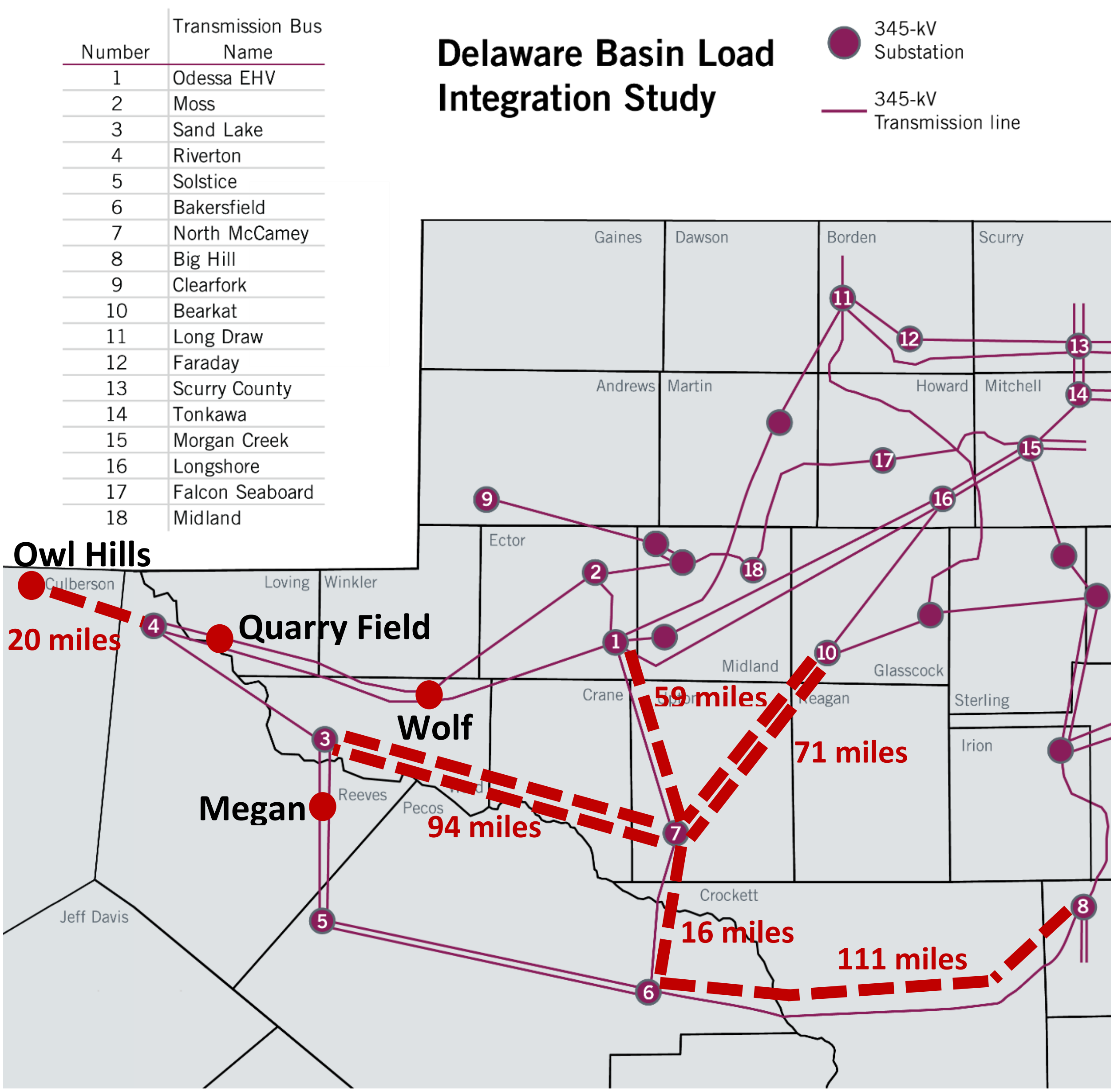


Option 5f: Bearkat – North McCamey – Megan 345-kV double circuit, Faraday – Lamesa - Clearfork – Riverton 345-kV single circuit (shown in dash lines)



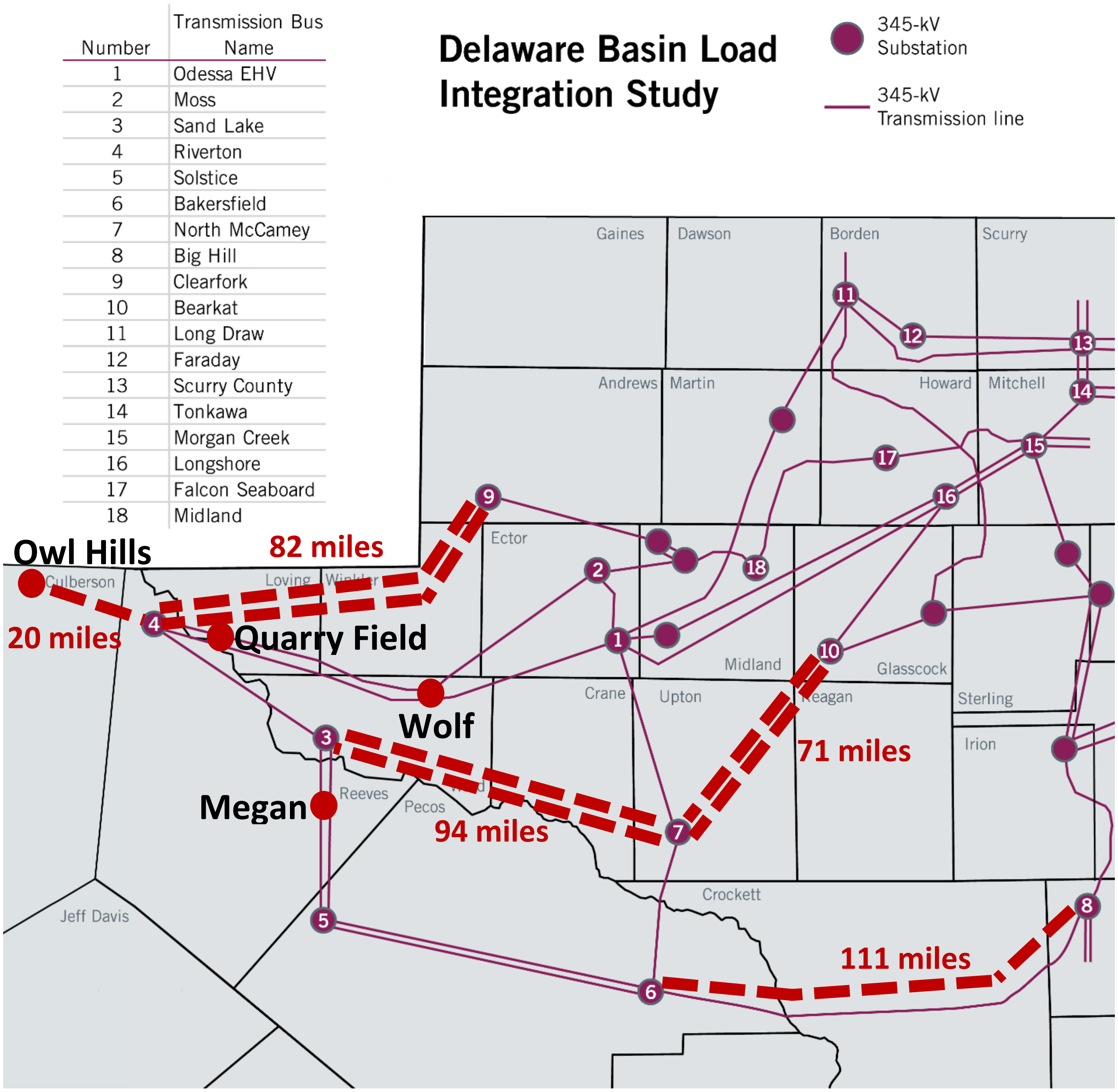
Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland

Option 6a: Bearkat – North McCamey – Sand Lake 345-kV double circuit, a second circuit for the Big Hill – Bakersfield – North McCamey – Odessa 345-kV line (shown in dash lines)

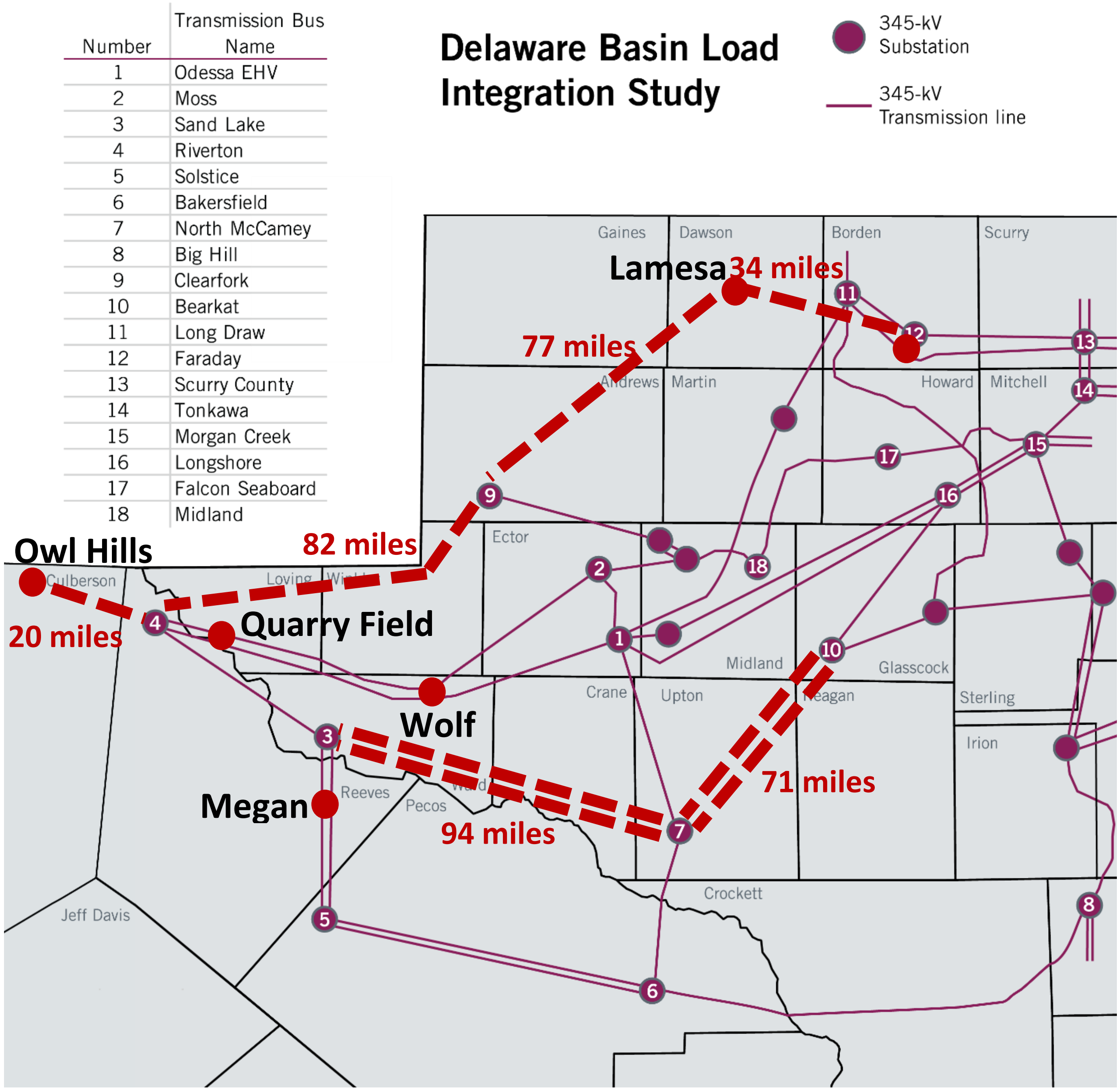


Option 6e: Bearkat – North McCamey – Sand Lake 345-kV double circuit, a second circuit for the Big Hill – Bakersfield 345-kV line, Clearfork – Riverton 345-kV double circuit (shown in dash lines)

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland

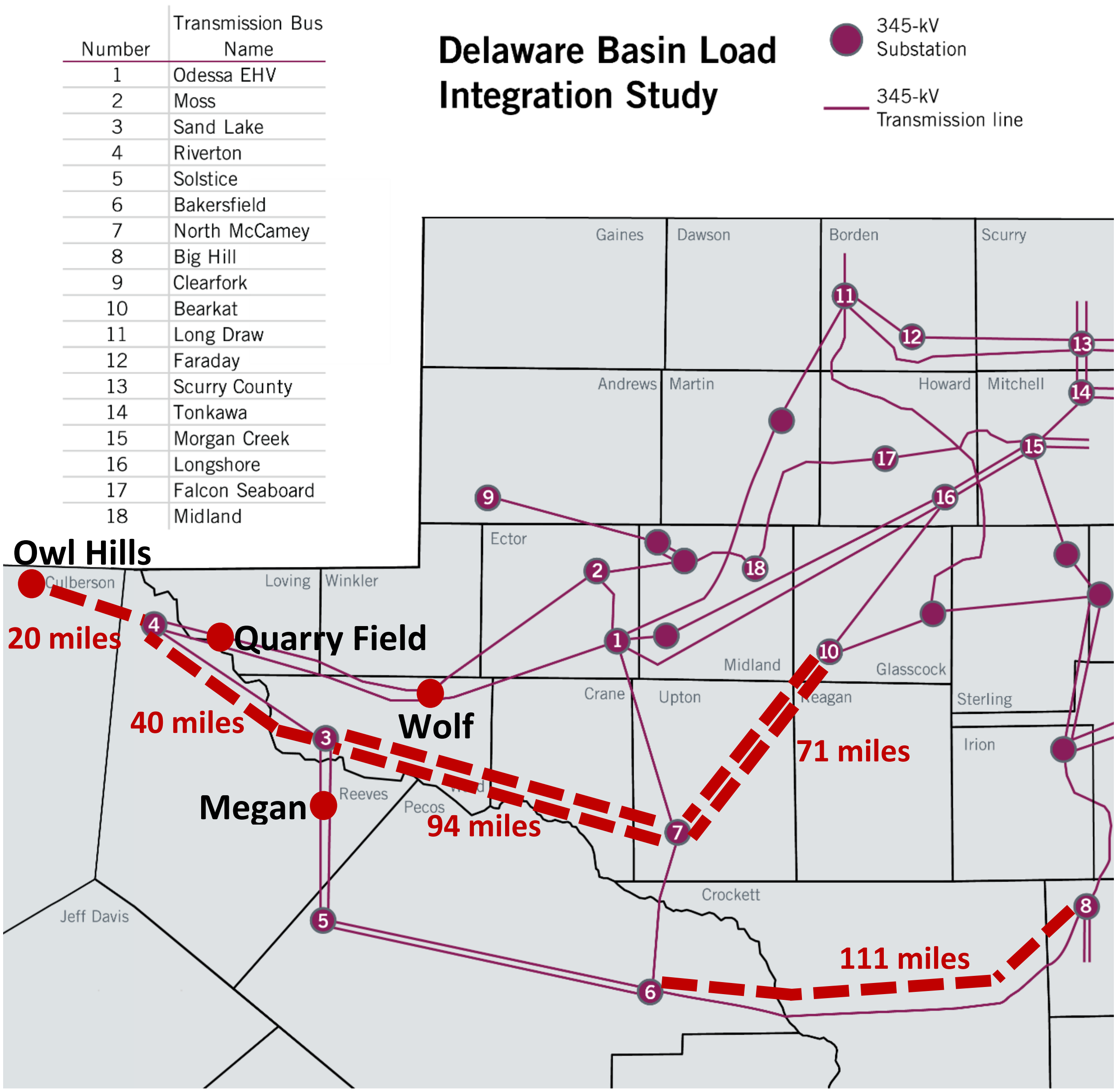


Option 6f: Bearkat – North McCamey – Sand Lake 345-kV double circuit, Faraday – Lamesa - Clearfork – Riverton 345-kV single circuit (shown in dash lines)

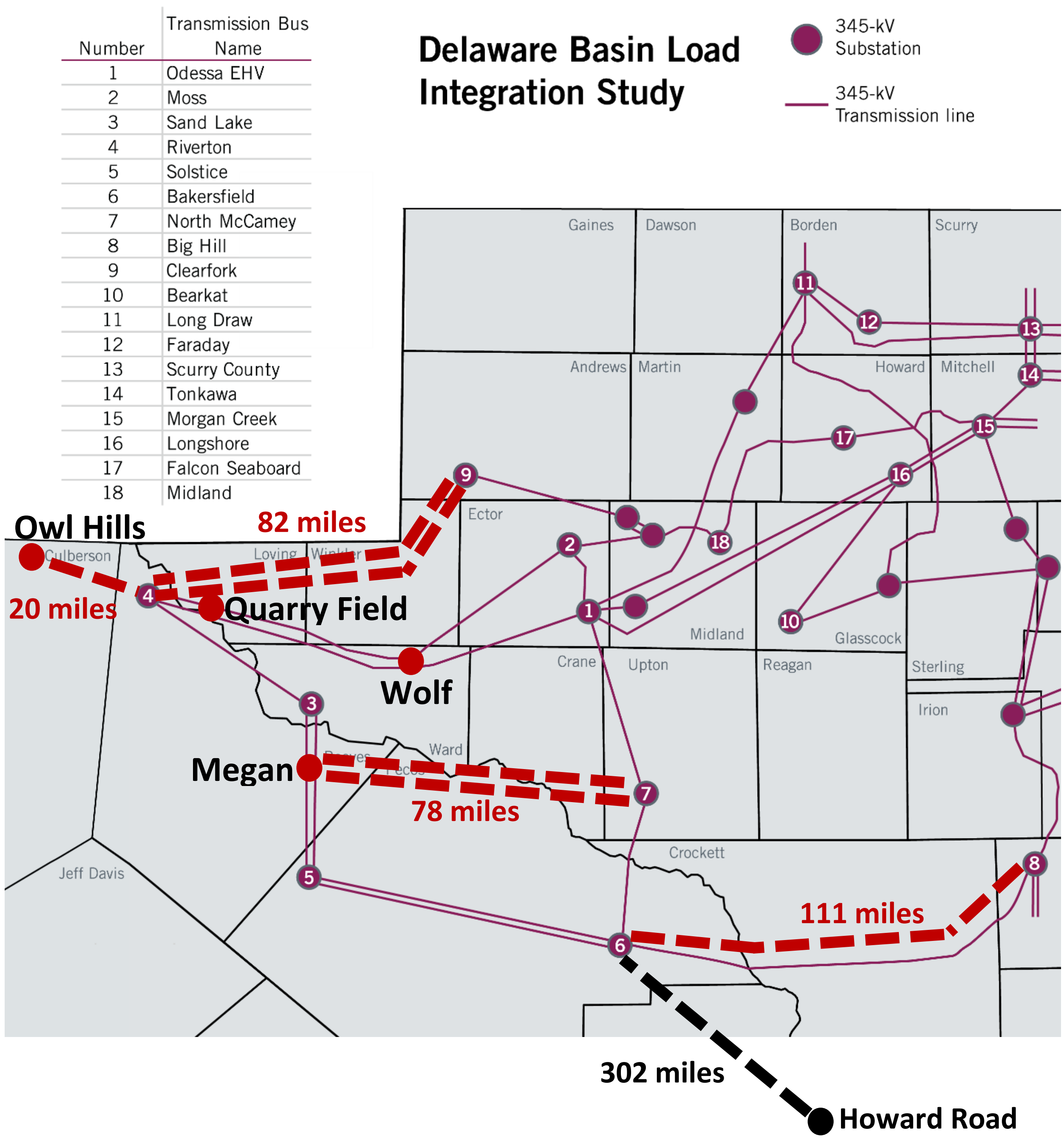


Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland

Option 6g: Bearkat – North McCamey – Sand Lake 345-kV double circuit, a second circuit for the Big Hill – Bakersfield 345-kV line, convert the Sand Lake – Riverton 138-kV line to 345-kV and add a new Sand Lake – Riverton 138-kV line (shown in dash lines)



Option 9e: 1,200 MW HVDC line (VSC) from Howard Road to Bakersfield, new 345-kV double-circuit line from North McCamey to Megan, a second circuit for the Big Hill – Bakersfield 345-kV line, and Clearfork – Riverton 345-kV double circuit (shown in dash lines)



APPENDIX B

ERCOT Permian Basin Load Interconnection Study

Final

December 2021

Document Revisions

Date	Version	Description	Author(s)
December 8, 2021	1.0	Final	Ying Li
		Reviewed by	Sun Wook Kang, Shun Hsien (Fred) Huang

Executive Summary

ERCOT, with extensive review and input by the affected Transmission Service Providers (TSPs) and stakeholders, performed the Permian Basin Load Interconnection Study and identified transmission upgrades, especially long lead time transmission upgrades, necessary to reliably serve the existing and projected oil and gas loads in the Permian Basin area. This report describes the identified potential reliability needs and details of the transmission upgrades to meet the electric demand driven by the oil and natural gas industry and the associated economic expansion in the Permian Basin area. The Permian Basin area includes the Delaware Basin, Midland Basin, and Central Basin Platforms which covers most of the counties in the Far West Weather Zone plus five adjacent counties in the West Weather Zone.

The Far West Weather Zone has experienced an average annual peak demand growth rate of approximately 12% from 2016 to 2021 due to significant growth in oil and natural gas industry demand. This growth rate is the highest of any weather zone in the ERCOT region. Due to the short-term planning horizons of the oil and gas industry resulting in lack of long-term load commitments, ensuring that necessary transmission improvements are in place in time to accommodate the rapid oil and gas development continues to be a challenge. As part of the efforts to address the challenge, several transmission upgrades, including the Far West Texas Project (FWTP), the Far West Texas Dynamic Reactive Devices (DRD) Project, and the Far West Texas Project 2 (FWTP2) have been completed in recent years. In addition, ERCOT completed the Delaware Basin Load Integration Study[1] in December 2019 and developed the roadmap involving major new 345-kV lines to improve load serving capability to import power into the Delaware Basin area. The Stage 1 upgrade in the roadmap was endorsed in June 2021 and is expected to be complete in 2023.

Given the challenges associated with the rapid load growth in the Permian Basin area, TSPs serving the Permian Basin area have also made significant efforts to better understand the underlying dynamics of oil and gas development throughout the region. This effort led to the completion of a customer demand study by IHS Markit, which provides an in-depth analysis of the oil and gas industry and provides more granular and detailed electricity demand forecast in the Permian Basin area through 2030. According to the IHS Markit study report[2] published in April 2020, the electricity needs of the Permian Basin is projected to be nearly double by 2030 compared to 2019, based on a detailed examination of the key drivers underlying power demand associated with recent and ongoing growth of oil and gas activities in the Midland Basin, Delaware Basin, Central Basin Platform, and Fringe regions of the Permian Basin. ERCOT and the TSPs relevant to the area reviewed the demand forecast from the IHS Markit study and deemed that the forecast is reasonable and appropriate to be used for the local transmission/load interconnection study of the Permian Basin area.

As a result, ERCOT with significant support from the relevant TSPs performed steady state analyses utilizing the demand forecast through 2030 (8,450 MW in 2025 and 9,970 MW in 2030) and identified a set of transmission improvements to connect and reliably serve the projected oil and gas loads in the Permian Basin area. As summarized in Section 5 of this report, ERCOT identified both preferred and placeholder transmission upgrades. If the preferred upgrades identified in this study are submitted to Regional Planning Group (RPG) for review, ERCOT may use this study report as part of ERCOT Independent Review. The placeholder projects may require further review. Table E.1 lists the details of the preferred upgrades identified in this study. The total cost of the preferred transmission upgrades is estimated to be approximately $1.5 Billion. Capital cost estimates of each transmission upgrade

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[1] https://www.ercot.com/gridinfo/planning

[2] https://www.ercot.com/files/docs/2020/11/27/27706_ERCOT_Letter_to_Commissioners_-_Follow-up_Status_Update_on_Permian....pdf

were provided by the TSPs relevant to each upgrade. ERCOT used the cost estimates provided by the TSPs to calculate total project cost estimates for various projects.

Table E.1 Preferred Reliability Upgrades

Project ID	Preferred Transmission Upgrades (Note: Assumed ratings can be found in Section 6)	Year of Study Case with Reliability Need Starting to Appear	Approximate Cost Estimate ($M)
1	Rebuild existing Morgan Creek – Tonkawa 345-kV line using double-circuit capable structures and add a 2nd circuit	2025	100.58
2	Rebuild existing Midland East – Falcon Seaboard 345-kV line using double-circuit capable structures and add a 2nd circuit	2025	196.47
2	Rebuild existing Morgan Creek – Falcon Seaboard 345-kV line using double-circuit capable structures and add a 2nd circuit	2030	
2	Rebuild existing Midland East – Midland County NW 345-kV line using double-circuit capable structures and add a 2nd circuit	2025	
3	Upgrade existing Morgan Creek – Longshore 345-kV line	2030	393.88
3	Upgrade existing Morgan Creek – Longshore Fly 345-kV line	2025	
3	Establish a new 345/138-kV substation at Consavvy with two new 345/138-kV transformers; Loop existing Longshore – Midessa South 345-kV line into Consavvy and upgrade Longshore – Consavvy 345-kV line; Loop existing South Midland – Pronghorn 138-kV line and Midland East – Spraberry 138-kV line into Consavvy	2025	
3	Upgrade Consavvy – Midessa South 345-kV line	2025	
3	Upgrade existing Longshore Fly – Quail 345-kV line	2025	
3	Loop existing Grelton – Odessa EHV 345-kV line into Consavvy	2025	
3	Upgrade existing Midessa South – Odessa EHV 345-kV line	2025	
3	Upgrade existing Quail – Odessa EHV 345-kV line	2025	
3	Upgrade existing Midessa South 345/138-kV transformer and add a 2nd Midessa South 345/138-kV transformer	2025	
18	Add Verhalen – New Load 90108 138-kV line	2025	6.60
24	Establish a new IH20 345-kV Substation and install two new 345/138-kV transformers	2030	65.55
24	Loop existing Solstice – Sand Lake 345-kV double-circuit line at the new IH20 345-kV Substation	2030	
25	Establish a new 345/138-kV Reiter Substation with two new 345/138-kV transformers; Establish a new 345-kV Quail East Substation; Add a new Quail East – Reiter 345-kV double-circuit line	2025	104.65
31	Add Quarry Field – New Load 90004 138-kV line	2025	80.23
31	Add New Load 90004 – New Load 90007 – New Load 90015 – New Load 90066 – Keystone 138-kV line	2025	
31	Add capacitor bank (90 Mvar) at new load bus 90004	2025	
33	Add ONC90005_TAP – New Load 90005 138-kV line	2025	67.25
33	Add New Load 90005 – New Load 90111 – New Load 90023 - New Load 90012 138-kV line	2025	

33	Add capacitor bank (90 Mvar) at new load bus 90012	2025	
34	Add New Load 90012 – New Load 90021 138-kV line	2030	29.6
35	Add Faulkner – New Load 90038 – New Load 90021 138-kV line	2025	33.8
35	Add capacitor bank (90 Mvar) at new load bus 90021	2030	
36	Add Faulkner – New Load 90108 138-kV line	2030	17.55
42	Add Bearkat – North McCamey 345-kV double-circuit line (Stage 2 upgrade)	2030	392.41
42	Add North McCamey – Sand Lake 345-kV double-circuit line (Stage 2 upgrade)	2030	

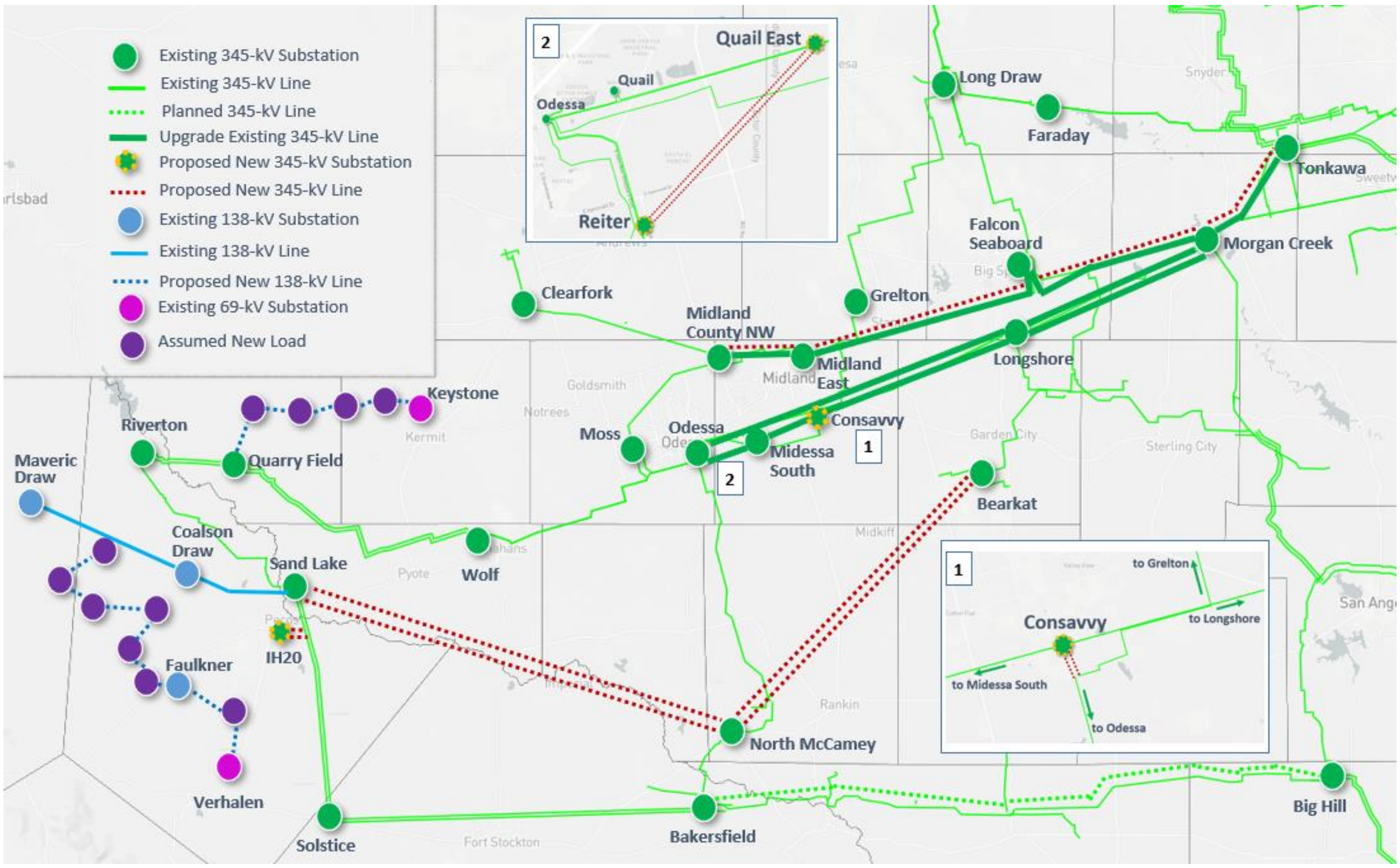

Figure E.1 Preferred Reliability Upgrades for 2030

Table of Contents

1. Introduction

Over the past several years, the Far West Weather Zone, which includes the Delaware Basin, Midland Basin, and Central Basin Platform, has experienced an average annual peak demand growth rate of approximately 12% from 2016 to 2021 due to significant growth in oil and natural gas industry demand. Figure 1.1 shows the primary oil basin resources in the Permian area.

Ensuring that necessary transmission improvements are in place in time to accommodate the rapid oil and gas development in the Permian Basin area has been and will continue to be a significant challenge for both transmission planning and system operations. The challenge originates from fundamental difference in planning horizons between major transmission improvement and oil and gas development. Due to the nature of the oil and gas industry, it is extremely difficult to accurately forecast their electricity demand more than one to two years. On the other hand, transmission improvements, which include planning studies, routing analysis, regulatory approvals, route acquisition, design, and construction, generally can take up to six years. Because of lack of long-term load commitments from the oil and gas industry, transmission planning studies are able to accurately identify system needs only for one to two years in advance, which is not sufficient to plan and construct new transmission improvements for the rapid and significant load growth in the Permian Basin area.

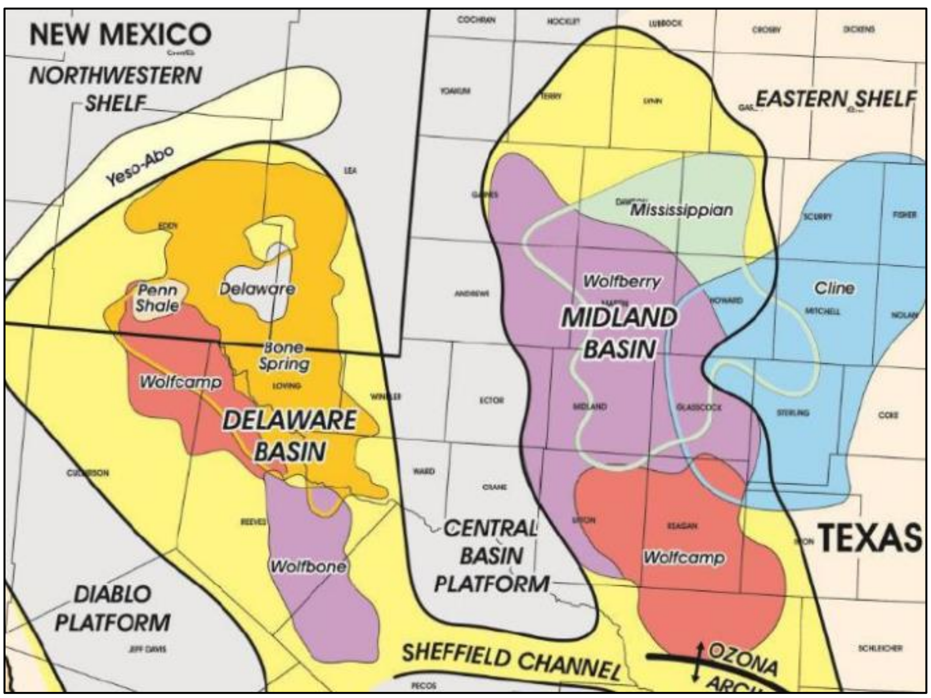

Figure 1.1 Map of Tectonic Subdivision of the Permian Basin[3]

As part of the efforts to address the challenge, several transmission upgrades, including the Far West Texas Project (FWTP), the Far West Texas Dynamic Reactive Devices (DRD) Project, and the Far West Texas Project 2 (FWTP2) have been completed in recent years to accommodate the significant and rapid load growth and address the transmission needs in the Delaware Basin area. In December 2019, ERCOT completed the Delaware Basin Load Integration Study to identify potential long lead

[3] https://www.oilandgas360.com/ngl-energy-partners-adds-water-sources-for-oil-gas-operators-in-the-permian/

time transmission improvements (i.e., new 345-kV transmission lines) to accommodate the rapid oil and gas development. The study developed a roadmap involving major new 345-kV lines to improve the capability to import power into the Delaware Basin area using a higher-than-forecasted (i.e. conceptual plus planned) load growth in the Delaware Basin area. The conceptual loads assumed in the Delaware Basin Load Integration Study were provided by the TSPs in the area based on the surveys of their high-use oil and gas customers. The Stage 1 upgrade in the roadmap was endorsed in June 2021 and is expected to be complete in 2023.

The TSPs serving the load in the Permian Basin area have also made significant efforts to better understand the underlying dynamics of oil and gas development throughout the region. This effort led to the completion of a customer demand study by IHS Markit, which provides an in-depth analysis of the oil and gas industry and provides an electricity demand forecast in the Permian area through 2030. According to the IHS Markit study report, the demand forecast was based on geology and resource assessment, industry intelligence, oil and gas expertise, commercial considerations, translations of historical and forecasted oil and gas activities into electric load demands in every single square mile in the Permian Basin area.

ERCOT and the TSPs relevant to the area reviewed the demand forecast projected in the IHS Markit study and deemed that the forecast is reasonable and appropriate to be used for the local transmission/load interconnection study of the Permian Basin area. More details of the projected demand forecast from the IHS Markit study can be found in Section 2.2 of this report. ERCOT with significant support from the relevant TSPs completed this Permian Basin Load Interconnection Study in 2021 utilizing the demand forecast from the IHS Markit study to identify the reliability challenges and a set of transmission improvements to connect and reliably serve the existing and projected oil and gas loads in the Permian Basin. This report describes the study assumptions, methodology and the results of ERCOT's assessment.

ERCOT also reviewed the historical oil and gas activities and load growth in the Far West region. As shown in Figure 1.2, the oil rig count data showed that the oil and gas drilling activities in the Permian Basin area have been increasing since July 2020 although the activities temporarily declined in early 2020 due to COVID-19 and international oil markets. Figure 1.3 shows the historical peak demand in the Far West Weather Zone which also indicates the resumed rapid load growth in the area.

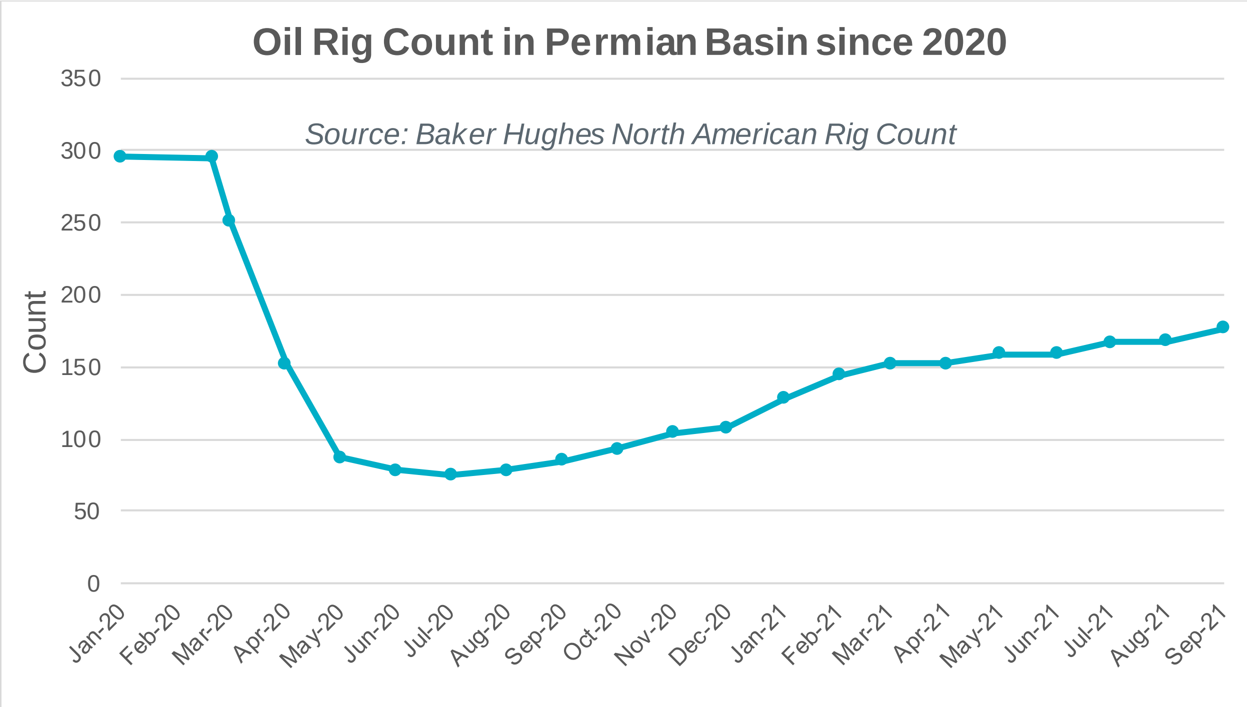

Figure 1.2 Oil Rig Counts in Permian Basin

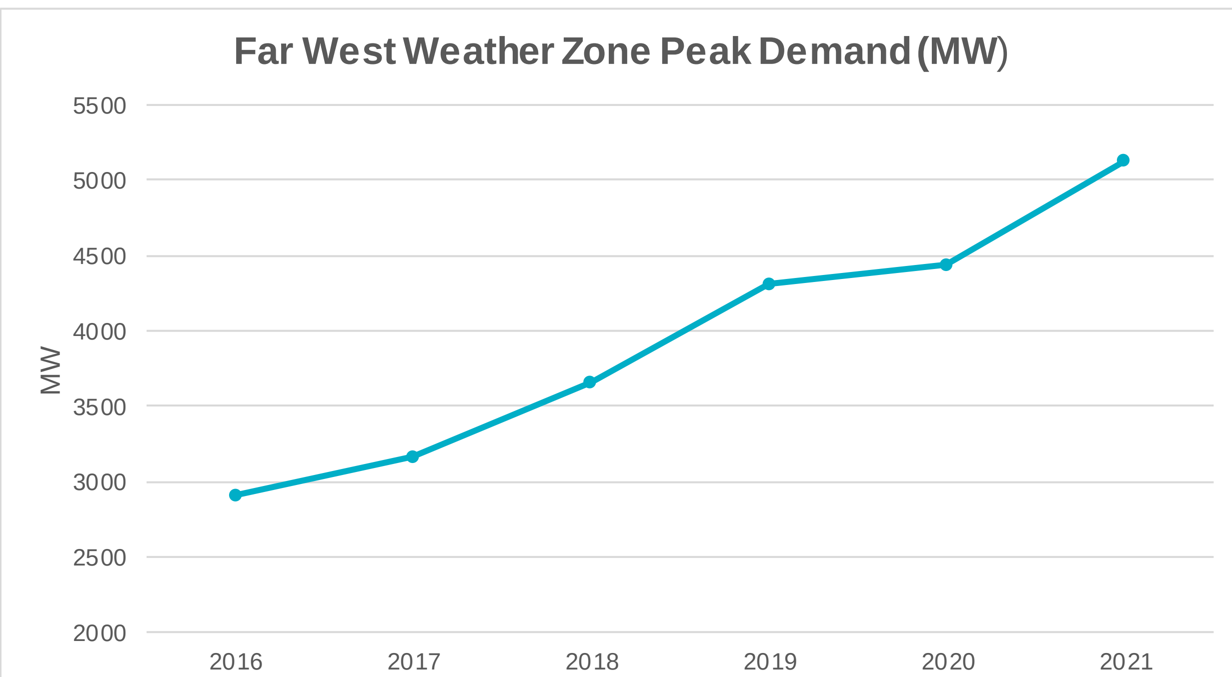

Figure 1.3 Far West Weather Zone Historical Peak Demand

2. Study Assumptions and Methodology

This section describes study assumptions and methodology employed in the Permian Basin Load Interconnection Study.

2.1. Study Area

The Permian Basin area spans most of the counties in the Far West Weather Zone plus five adjacent counties in the West Weather Zone. Table 2.1 shows the counties included in the study area in this study.

Table 2.1 Counties in the Study Area

County	Weather Zone
Andrews	Far West
Borden	Far West
Crane	Far West
Crockett	Far West
Culberson	Far West
Dawson	Far West
Ector	Far West
Glasscock	Far West
Howard	Far West
Irion	West
Loving	Far West
Martin	Far West
Midland	Far West
Mitchell	West
Pecos	Far West
Reagan	Far West
Reeves	Far West
Schleicher	West
Scurry	West
Sterling	West
Upton	Far West
Ward	Far West
Winkler	Far West

2.2. Study Assumption

2.2.1. Reliability Case

The following starting case was used to develop study cases for year 2025 and 2030 in the study:

- The 2025 West/Far West (WFW) summer peak case[4] from the 2020 RTP (posted in October 2020 in the ERCOT MIS site)

[4] https://mis.ercot.com/secure/data-products/grid/regional-planning?id=PG7-173-M

2.2.2. Study Case Loads

The IHS Markit study provides an in-depth analysis of the oil and gas industry and provides an electricity demand forecast in the Permian Basin area through 2030.

As described in Section 1, ERCOT and the TSPs relevant to the area reviewed the demand forecast from the IHS Markit study and deemed that the forecast is reasonable and appropriate to be used in this study. The TSPs made a joint effort and mapped the granular load forecast data to the substation level. The substation level load includes the load connecting to the existing substations and the projected new loads that require new interconnections to the existing transmission grid. Figure 2.1 and Figure 2.2 show the geographic locations of the projected new loads for the year 2025 and 2030.

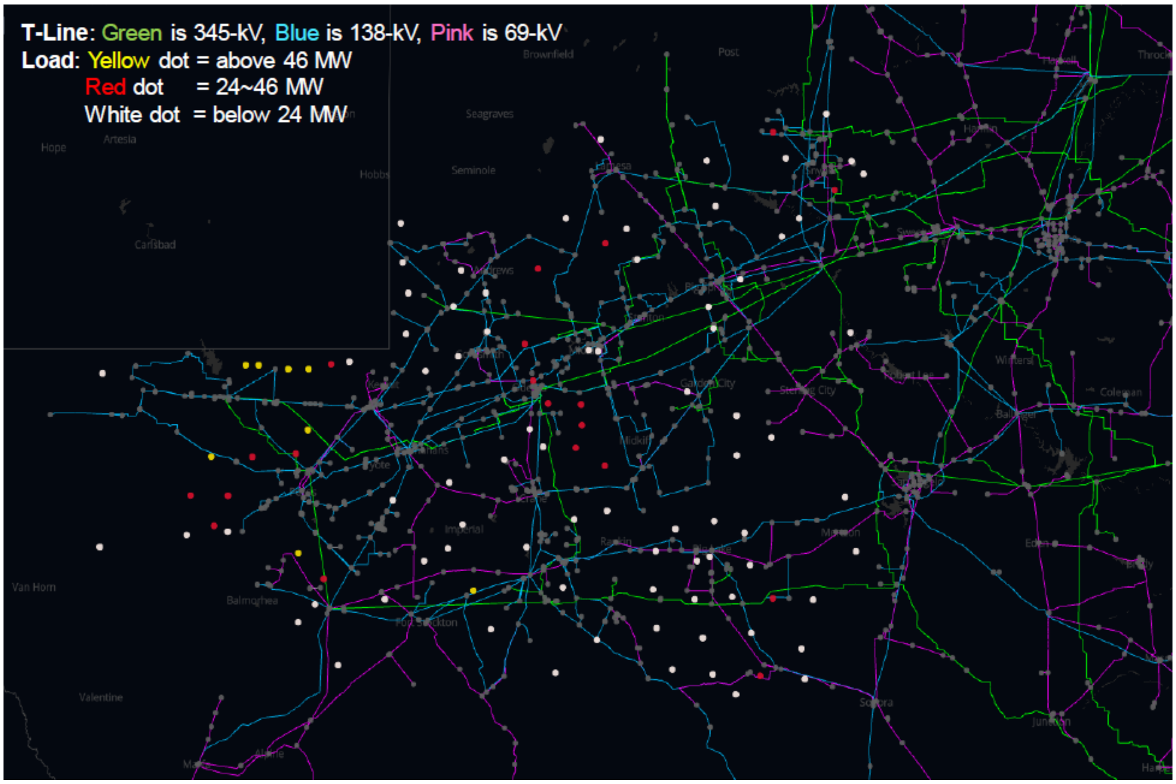

Figure 2.1 Approximate Locations of Projected New Loads for Year 2025

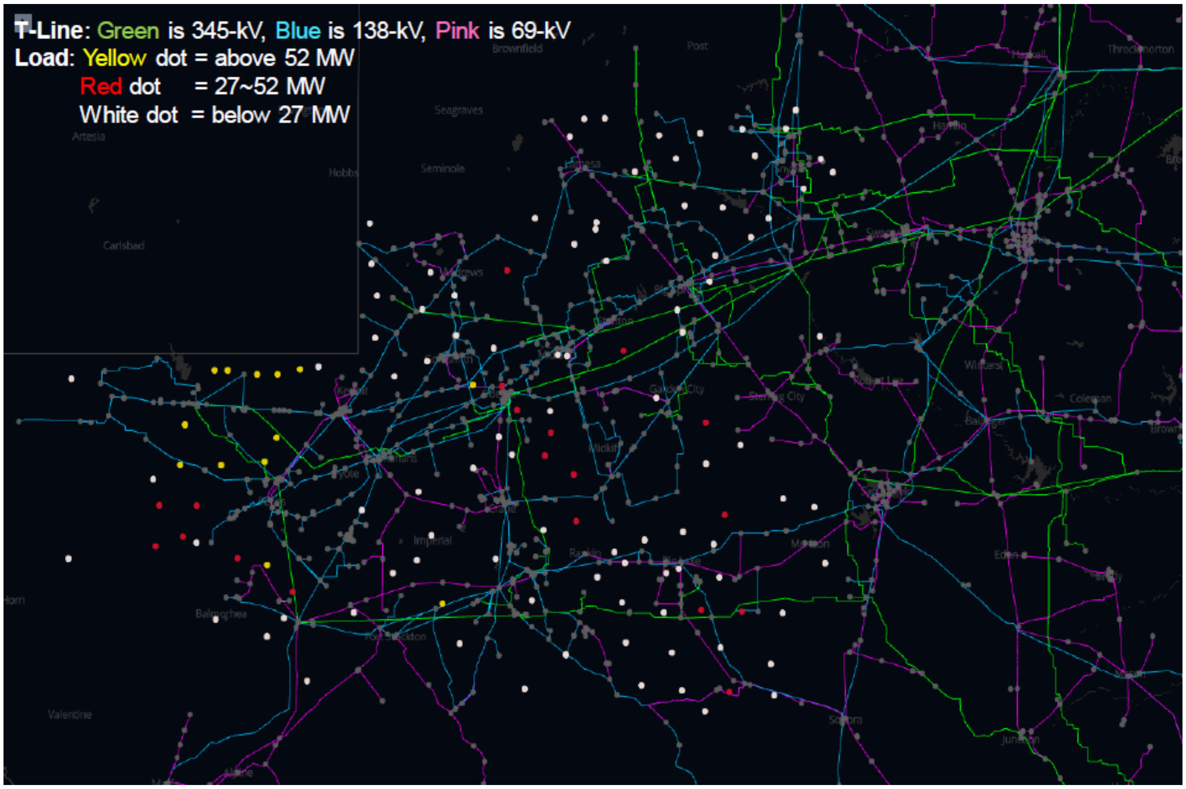

Figure 2.2 Approximate Locations of Projected New Loads for Year 2030

The load in the Permian Basin area in the starting case was updated with the substation level load derived from the demand forecast in the IHS Markit study to develop the study base case. Certain placeholder transmission interconnection projects were assumed to connect the projected new loads into the study base case. Table 2.2 summarizes the load level modeled in this Permian Basin Load Interconnection Study compared to the load in the 2020 RTP case.

Table 2.2 Permian Basin Load Projection for Year 2025 and 2030 in the Study

Permian Basin Load	IHS Load Forecast (MW)		2020 RTP (MW)
	2025 Load	2030 Load	2025 Load
Total Load at Existing Substations	6,601	7,402	8,343
Total Load Requiring New Transmission Interconnections	1,850	2,568	n/a
Total Load	**8,450**	**9,970**	**8,343**

Table 2.3 shows the load projection by the locations in the study base cases.

Table 2.3 IHS Load Projection by Locations for Year 2025 and 2030

Area	2025 Load (MW)	2030 Load (MW)
Delaware Basin	3,789	4,898
Far West (Excluded Delaware Basin)	4,128	4,533
West (Included Five Counties)	532	539
Total	**8,450**	**9,970**

The reactive consumption of the projected new oil and gas load was assumed based on historical operational performance of existing oil and gas load in the Permian Basin area. Based on the review of the historical performance and inputs from the relevant TSPs, 0.97 power factor was used in this study for the projected new oil and gas loads. For the loads at the existing substations, the power factors were assumed the same as in the 2020 RTP case.

2.2.3. Transmission Topology

All RPG-approved Tier 1, 2, and 3 and all Tier 4 transmission projects expected to be in-service within the study area by the respective years were added to the corresponding study base cases based on the review of the ERCOT Transmission Project Information and Tracking (TPIT) report posted in October 2020. During the study, additional transmission projects expected to be in-service within the study area were also added to the study base cases based on the review of the June 2021 TPIT report. Table 2.4 lists the transmission projects added to the study base cases.

Table 2.4 Transmission Additions for Year 2025 and 2030

ERCOT Project #	Project Title	Projected In-Service Date (Month/Year)	Planning Charter Tier
54255	Rebuild Rio Pecos – Lynx Ckt 2 (1926 ACSS)	Dec-20	Tier 4
55372	Conversion of TNMP Gomez to 138-kV service.	Dec-20	Tier 4
57173	TNMP Soaptree Switching Station	Dec-20	Tier 4
52311	Add Gardendale 345-kV Switch	Dec-20	Tier 4
52295	Natural Dam 138-kV Switch	May-21	Tier 4
57797	Athey: Build 138-kV Station	Sep-21	Tier 4
55367	Wolfcamp: Build 138-kV box bay	Nov-21	Tier 4
52322	Establish Courtney Creek Switch	Dec-21	Tier 4
58540	Rebuild 16th St – Soaptree	Dec-21	Tier 4
6719	Twelvemile Substation Addition	Sep-22	Tier 4
55470	Bison to Ozona: Rebuild 69-kV line	Nov-22	Tier 4
51788	Amos Creek Circuit Breaker Addition	Nov-20	Tier 4
52464	Alamito Creek to Ft. Davis: Rebuild 69-kV line	May-23	Tier 4
60489	Adds Leon Creek Switching Station and Tarbush Tie	Sep-21	Tier 4
60491	Rebuild 16th Street-Airport with 1926 ACSS	Mar-22	Tier 4
59402	Add Midland East Switch 345/138-kV Autotransformer #2	Dec-22	Tier 3
62728	Wink – Shifting Sands 69-kV Line Conversion to 138-kV	May-22	Tier 4
63491, 63493, 63495, 63497	Bakersfield to Big Hill 345-kV Second Circuit Addition Project	Summer 2023	Tier 2

ERCOT also included the Stage 2 upgrade (adding a new Bearkat – North McCamey – Sand Lake 345-kV double-circuit line) identified in the Delaware Basin Load Integration Study in the 2030 study case since the load level in the Delaware Base area in the 2030 study case exceeded the trigger point of the Stage 2 upgrade as shown in Table 2.5. It indicates the need of a new transmission import path to the Delaware Basin area in the 2030 study case. More details about the Stage 2 upgrade were described in Section 4.3.

Table 2.5 Delaware Basin Transmission Upgrade Roadmap

Stage	Estimated Delaware Basin Load Level (MW)	Upgrade Element	Trigger
1	3,052	Add a second circuit on the existing Big Hill – Bakersfield 345-kV line	Import Needs
2	4,022	A new Bearkat – North McCamey – Sand Lake 345-kV double-circuit line	Import Needs
3	4,582	A new Riverton – Owl Hills 345-kV single-circuit line	Culberson Loop Needs
4	5,032	Riverton – Sand Lake 138-kV to 345-kV conversion and a new Riverton - Sand Lake 138-kV line	Culberson Loop Needs
5	5,422	A new Faraday – Lamesa – Clearfork – Riverton 345-kV double-circuit line	Import Needs

2.2.4. Generation

Planned generators in the West and Far West Weather Zones that met Planning Guide Section 6.9(1) requirements for inclusion in the base cases were added to the study cases based on the 2020 December Generation Interconnection Status (GIS) report posted on January 4, 2021. The added generators are listed in Table 2.6.

Table 2.6 Added Generators for Year 2025 and 2030

GINR	Project Name	County	Projected COD	Fuel	Capacity (MW)
17INR0052	Horse13 CallD Repower	Taylor	12/31/2020	WIND	44
17INR0061	Capricorn IV Repower	Sterling	12/31/2020	WIND	9
18INR0079	Woodward I Repower	Pecos	12/31/2020	WIND	0
19INR0121	Galloway Solar	Concho	10/01/2021	SOLAR	250
20INR0046	Maverick Creek II W	Concho	03/23/2021	WIND	118.8
21INR0357	SP TX-12B BESS	Upton	10/31/2021	STORAGE	22.68
21INR0365	Bat Cave Energy Storage	Mason	06/01/2021	STORAGE	100.49
21INR0431	Galloway 2 Solar	Concho	04/01/2022	SOLAR	110
21INR0449	Panther Creek III Repower	Howard	02/02/2021	WIND	15.96

Solar generation in the study area was assumed to be offline to represent a stressed system condition since the oil and natural gas loads are assumed to operate as constant loads throughout the day and night. The dispatch of Energy Storage Resource (ESR) and wind generation as well as solar generation outside of the study area were consistent with the 2020 RTP methodology. Generation retired, indefinitely mothballed, or to be decommissioned was turned off if it was not already offline in the case.

2.2.5. Capital Cost Estimates

Capital cost estimates of each transmission upgrade identified in this study were provided by the TSPs relevant to each upgrade. ERCOT used the cost estimates provided by the TSPs to calculate total project cost estimates for various projects. For new transmission lines requiring new rights of way, ERCOT assumed a routing adder of 20% to the straight distance between two end points.

2.3. Study Methodology

The existing transmission system in some local area was not sufficient to serve the assumed load, especially with the new load interconnections in the Delaware Basin area. In fact, the voltage instability issues were identified in the initial 2025 and 2030 study cases under system intact (i.e., N-0) conditions. The following local transmission upgrade was identified to address the voltage instability issues and applied to the study cases during the case development. This upgrade was assumed in-service during the reliability need analysis.

- Convert existing Barrilla Loop to 138-kV: Barrilla – Hoefs Road – Verhalen – Cherry Creek – Saragosa 69-kV line to 138-kV

ERCOT evaluated various transmission upgrade options and identified a set of transmission upgrades to address the reliability criteria violations in the study area. These transmission upgrades were then categorized as ERCOT preferred upgrades or placeholder upgrades.

Various transmission load interconnection upgrades were considered to connect the projected new loads in Figure 2.3. For example, a radial line from the nearest substation was considered as placeholder to connect the relatively smaller loads (e.g., white dots). For most of the bigger loads (e.g., red and yellow dots), the transmission interconnections were initially modeled based on the inputs from the TSPs as the placeholder. For Area 1, further detailed analysis was performed as described below.

Among the new loads in Figure 2.3, ERCOT and the relevant TSPs focused relatively more on Area 1 in the Delaware Basin area to identify proper local transmission load interconnection projects based on the following considerations:

- A large amount of projected new loads (e.g., red and yellow dots) are concentrated in Area 1 compared to other areas. Area 1 is in the Delaware Basin area which is the most profitable area for the oil and gas development in the Permian Basin according to the IHS Markit study report.
- Compared to other areas in the Permian Basin, Area 1 has limited existing transmission infrastructures.

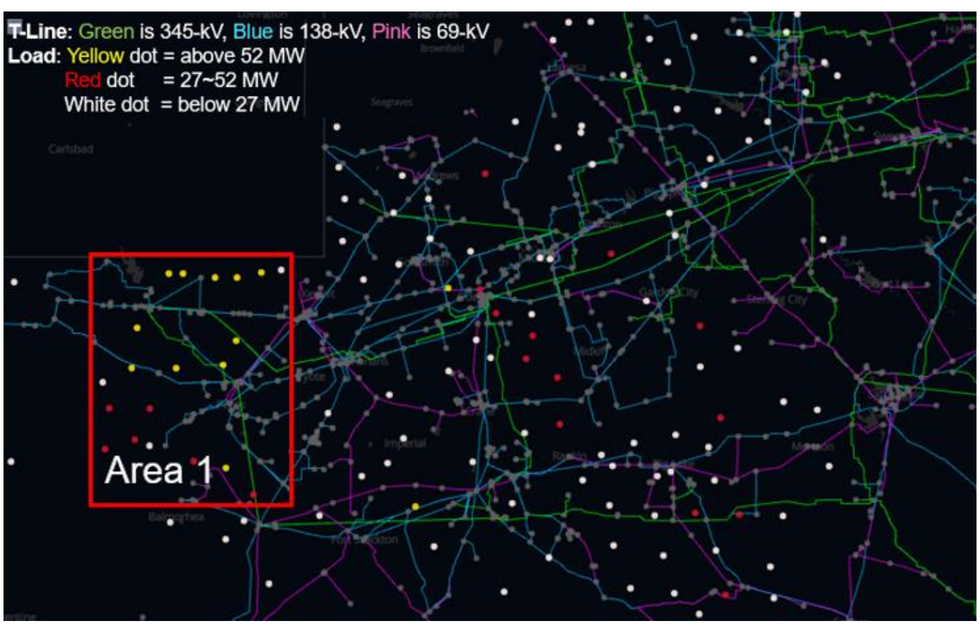

Figure 2.3 Focused Area for New Transmission Interconnection

2.3.1. Tools

ERCOT utilized the following software tool in this study:

- PowerWorld Simulator version 21 was used for SCOPF and steady state contingency and voltage stability analysis

2.3.2. Contingencies

All the NERC P1, P2-1, and P7 contingencies in the West and Far West Weather Zones were evaluated for the AC power flow analyses. ERCOT also evaluated G-1+N-1 and X-1+N-1 contingencies in the study area.

For the G-1+N-1 analyses, the following generator outages were considered to represent the anticipated significant G-1 conditions in the study area:

- Permian Basin all five units (340 MW)
- Odessa Combined Cycle Train 1 (497 MW)

For the X-1+N-1 analyses, the following 345/138-kV transformers were considered to represent the anticipated significant X-1 conditions for the study area:

- Riverton 345/138-kV transformer 1
- Sand Lake 345/138-kV transformer 1
- Wolf 345/138-kV transformer 1
- Quarry Field 345/138-kV transformer 1
- Solstice 345/138-kV transformer 1
- Odessa EHV 345/138-kV transformer 1

2.3.3. Criteria

The reliability assessment was performed based on NERC Reliability Standard TPL-001-4, ERCOT Nodal Protocol and Planning Criteria.

3. Reliability Need

The 2025 and 2030 study base cases were evaluated to determine if system improvements would be necessary to meet the projected demand forecast in the Permian Basin area. The reliability assessment results revealed that both thermal overloads and voltage instability would occur without system improvements. Table 3.1 summarizes the reliability analysis results under N-0, N-1, G-1+N-1, and X-1+N-1 contingencies for the 2025 and 2030 study base cases. No cascading issues were identified in this study. More details of the reliability analysis results were described in the subsequent sections. Transmission upgrades were identified in Section 4 to address these reliability criteria violations.

Table 3.1 Summary of the Reliability Violations

Reliability Needs	2025 Case	2030 Case
Number of Unsolvable Contingencies	2	17
Transmission Line Overloads	~ 196 miles of 345-kV line ~ 347 miles of 138-kV line ~ 127 miles of 69-kV line	~ 269 miles of 345-kV line ~ 366 miles of 138-kV line ~ 177 miles of 69-kV line
Transformer Overloads	Three 345/138-kV transformers Four 138/69-kV transformers	Seven 345/138-kV transformers Six 138/69-kV transformers

3.1. Reliability Needs Inside Delaware Basin Area

The Delaware Basin area mainly includes six counties in Far West Weather Zone: Culberson, Loving, Pecos, Reeves, Ward, and Winkler. The total loads in the Delaware Basin area in the study base cases are 3,789 MW and 4,898 MW in 2025 and 2030 respectively.

Several transmission upgrades, including both the 345-kV and 138-kV upgrades, have been completed in recent years to accommodate the rapid load growth in the Delaware Basin area. The newly built 345-kV lines, Odessa EHV/Moss – Wolf – Quarry Field – Riverton – Sand lake – Solstice – Bakersfield recommended in FWTP and FWTP2, extended the extra high voltage transmission system in the Far West to the Delaware Basin area and formed a loop to serve the underlying system. These 345-kV lines are connected to the 138-kV transmission facilities distributing power flows through the newly added Wolf, Quarry Field, Riverton, Sand Lake, and Solstice 345/138-kV transformers. These 345-kV upgrades together with other 138-kV upgrades such as the Horseshoe Springs Switch – Riverton Switch 138-kV Second Circuit Project and the Ward/Winkler Transmission Improvement Project are sufficient to meet projected near-term load forecast in the Delaware Basin area. However, with the IHS projected load level up to 2030 in this study, the existing transmission system in the Delaware Basin area could experience significant reliability criteria violations without additional transmission upgrades.

The reliability study results showed that there is no unsolvable contingency in the 2025 case, but ten unsolvable contingencies in the 2030 case. Besides the unsolvable consistencies, thermal overloads were also observed in the Delaware Basin area as shown in Table 3.2.

Table 3.2 Summary of the Reliability Violations Inside Delaware Basin Area

Reliability Needs	2025 Case	2030 Case
Number of Unsolvable Contingencies	0	10
Transmission Line Overloads	~ 18 miles of 138-kV line ~ 7 miles of 69-kV line	~ 20 miles of 138-kV line ~ 29 miles of 69-kV line
Transformer Overloads	none	Four 345/138-kV transformers Two 138/69-kV transformers

The following sections describe the details of the thermal violations in those six counties in the Delaware Basin area.

3.1.1. Reliability Needs in Culberson, Loving, and Winkler Counties

The existing transmission overloads in Culberson, Loving, and Winkler Counties were all occurred in the 2030 case as shown in Table 3.3.

Table 3.3 Thermal Overloads in Culberson, Loving, and Winkler Counties

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Wink – California Tnp 69-kV line	Base Case	< 100	123.7
Wink Tnp 138/69-kV transformer 1	Wink Tnp 138/69-kV transformer 2	< 100	106.5
Wink Tnp 138/69-kV transformer 2	Wink Tnp 138/69-kV transformer 1	< 100	106.5
Riverton 345/138-kV transformer 1	Quarry Field 345/138-kV transformer 1 + Riverton 345/138-kV transformer 2	< 100	104.2
Riverton 345/138-kV transformer 2	Quarry Field 345/138-kV transformer 1 + Riverton 345/138-kV transformer 1	< 100	104.0

3.1.2. Reliability Needs in Reeves and Ward Counties

Reeves County has the highest load projection in the study area, 1,430 MW in 2025 and 1,824 MW in 2030. With the projected load level in the 2030 case, both thermal overloads and voltage instability issues were observed in this area. Table 3.4 lists the thermal overloads.

Table 3.4 Thermal Overloads in Reeves and Ward Counties

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Caymus TNP – Gas Pad 138-kV line	Base Case	< 100	130.7
Sand Lake – Cochise TNP 138-kV ckt 1	Sand Lake – Cochise TNP 138-kV ckt 2	< 100	109.7
Sand Lake – Cochise TNP 138-kV ckt 2	Sand Lake – Cochise TNP 138-kV ckt 1	< 100	109.7
Sand Lake 345/138-kV transformer 2	Sand Lake 345/138-kV transformer 1	< 100	105.8
Sand Lake 345/138-kV transformer 1	Sand Lake 345/138-kV transformer 2	< 100	105.5

3.1.3. Reliability Needs in Pecos County

All the identified reliability needs in Pecos County are all related to the thermal overloads of the existing 69-kV and 138-kV lines. Table 3.5 lists the thermal overloads in Pecos County.

Table 3.5 Thermal Overloads in Pecos County

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Fort Stockton – Leon Creek TNP 138-kV line	Lynx – Tombstone 138-kV line	125.4	125.8
Wolfcamp Tap – Coyanosa 69-kV line	Base Case	101.4	121
Wolfcamp – Coyanosa 69-kV line	Base Case	101.4	121
Wolfcamp Tap – Courtney Creek 69-kV line	Base Case	< 100	119.9
16th Street – Fort Stockton TNP 69-kV line	Base Case	108.1	109.4
Yucca – Royalty 69-kV line	Base Case	< 100	103.8
Lynx – Tombstone 138-kV line	Base Case	100.0	101.1

3.2. Reliability Needs Outside Delaware Basin Area

The reliability needs outside of the Delaware Basin area are mainly divided into the following three regions:

- Dawson, Borden, and Scurry Counties
- Ector, Midland, Howard, and Mitchell Counties
- Upton, Reagan, and Irion Counties.

Table 3.6 summarizes the reliability violations outside of the Delaware Basin area.

Table 3.6 Summary of the Reliability Violations Outside Delaware Basin Area

Reliability Needs	2025 Case	2030 Case
Number of Unsolvable Contingencies	2	7
Transmission Line Overloads	~ 196 miles of 345-kV line ~ 329 miles of 138-kV line ~ 120 miles of 69-kV line	~ 269 miles of 345-kV line ~ 346 miles of 138-kV line ~ 148 miles of 69-kV line
Transformer Overloads	Three 345/138-kV transformers Four 138/69-kV transformers	Three 345/138-kV transformers Four 138/69-kV transformers

The following sections describe the details of thermal violations outside of the Delaware Basin area.

3.2.1. Reliability Needs in Dawson, Borden, and Scurry Counties

The existing 138-kV transmission systems in Dawson, Borden, and Scurry Counties are relatively old and have low normal and emergency ratings. The power flow from the Willow Valley 345-kV source goes through the 138-kV transmission system to serve the load in the area, causing the thermal overloads shown in Table 3.7.

Table 3.7 Thermal Overloads in Dawson, Borden, and Scurry Counties

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Lamesa – Jim Payne – Dawson – Alkali Lake 138-kV line	Vealmoor – Long Draw 345-kV line	110.2	131.0
Scurry – Kndrsacrc – Knapp 138-kV line	Scurry County South – Long Draw/Faraday 345-kV double-circuit line	109.3	124.7
Lamesa – Key Sub – Gail Sub – Willow Valley Switch 138-kV line	Base Case	128.8	117.3
Knapp – Bluff Creek Switch – Exxon Sharon Ridge 138-kV line	Scurry County South – Long Draw/Faraday 345-kV double-circuit line	< 100	109.2
Deep Creek Sub – Sacroc 138-kV line	Odessa Combined Cycle Train 1 + Dermott – Scurry County South 345-kV double-circuit line	< 100	104.9
Howard Switch – Vealmoor 138-kV line	Odessa Combined Cycle Train 1 + Buzzard Draw – Koch Tap 138-kV line	< 100	102.9

3.2.2. Reliability Needs in Ector, Midland, Howard, and Mitchell Counties

The Morgan Creek – Odessa EHV 345-kV path includes the existing Morgan Creek – Longshore – Quail/Odessa EHV 345-kV double-circuit line and the Morgan Creek – Falcon Seaboard – Midland East – Midland County NW 345-kV single-circuit line. The Morgan Creek – Odessa EHV 345-kV path is one of the major backbone transmission systems in the area, and the path is connected to a number of 138-kV transmission facilities distributing power flows through multiple 345/138-kV transformers located along the path. In addition, since the newly built FWTP and FWTP2 extended the 345-kV transmission lines from Moss and Odessa EHV to the Delaware Basin area, more power is expected to flow through the Morgan Creek – Odessa EHV 345-kV path toward the newly built 345-kV lines as the load in the Delaware Basin area continues to grow.

The study results indicated that the existing system can no longer reliably serve the projected demand in the area without upgrading the existing 345-kV lines along the path. Table 3.8 lists the 345-kV level thermal overload issues along the Morgan Creek – Odessa EHV path. Table 3.9 shows the summary of the thermal overloads of the 138-kV and 69-kV systems in the area.

Table 3.8 345-kV Thermal Overloads on the Morgan Creek – Odessa EHV Path

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Morgan Creek – Tonkawa 345-kV line	Morgan Creek – Champion Creek/Bitter Creek 345-kV double-circuit line	115.0	164.2
Consavvy – Midessa South 345-kV line	Quail – Odessa EHV 345-kV line	129.0	127.0
Quail – Odessa EHV 345-kV line	Consavvy – Midessa South 345-kV line	124.8	122.8
Morgan Creek – Longshore 345-kV line	Bakersfield – Cedar Canyon 345-kV double-circuit line	< 100	122.5
Midland East – Falcon Seaboard 345-kV line	Morgan Creek – Longshore – Consavvy 345-kV double-circuit line	109.3	121.2
Consavvy 345/138-kV transformer	Consavvy – Midessa South/Quail 345-kV double-circuit line	124.2	119.2
Odessa EHV 345/138-kV transformer 2	Odessa EHV – Moss/Wolf 345-kV double-circuit line	112.8	116.1
Morgan Creek – Falcon Seaboard 345-kV line	Morgan Creek – Longshore – Consavvy 345-kV double-circuit line	< 100	106.6
Longshore Fly – Consavvy 345-kV line	Permian Basin Five Units + Big Hill – Schneeman Draw 345-kV double-circuit line	101.4	106.2
Longshore – Consavvy 345-kV line	Odessa Combined Cycle Train 1 + Bakersfield – Cedar Canyon 345-kV double-circuit line	115.5	104.8
Midessa South 345/138-kV transformer	Odessa Combined Cycle Train 1 + Consavvy – Quail & Odessa EHV – Midessa South 345-kV double-circuit line	101.2	104.8
Morgan Creek – Longshore Fly 345-kV line	Odessa Combined Cycle Train 1 + Bakersfield – Cedar Canyon 345-kV double-circuit line (2025); Morgan Creek – Longshore 345-kV line (2030)	105.4	101.8
Midessa South – Odessa EHV 345-kV line	Quail – Odessa EHV 345-kV line	104.0	101.1

Table 3.9 138-kV and 69-kV Thermal Overloads in Ector, Midland, Howard, and Mitchell Counties

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Stanton East – Spraberry 69-kV line	Spraberry 138/69-kV transformer	152.0	165.3
Midkiff 138/69-kV transformer	Spraberry 138/69-kV transformer	117.6	136.3
China Grove – Getty Tap 138-kV line	Vealmoor – Long Draw 345-kV line	105.4	116.4
General Tire Switch – Edwards Tap – Judkins 138-kV line	Permian Basin Five Units + Wolf – Moss/Odessa EHV 345-kV double-circuit line	112.3	110.0
Morgan Creek – McDonald 138-kV line	Base Case	119.6	109.0
Sterling City – Sterling County 69-kV line	Bakersfield – Cedar Canyon 345-kV double-circuit line	< 100	108.4
Odessa EHV – Yarbrough Sub – Wolf 138-kV line	Permian Basin Five Units + Wolf – Moss/Odessa EHV 345-kV double-circuit line	115.8	107.7
Getty Tap – Big Spring 138-kV line	Vealmoor – Long Draw 345-kV line	< 100	106.7
Odessa North – Odessa 138-kV line	Permian Basin Five Units + Odessa EHV – Moss/Wolf 345-kV double-circuit line	108.0	106.5
Stanton East 138/69-kV transformer	Spraberry 138/69-kV transformer	100.1	106.2
Spraberry 138/69-kV transformer	Midkiff – Reagan Shell Tap 69-kV line	105.9	105.8
Odessa EHV – Big Three Odessa Tap – Odessa Southwest 138-kV line	Odessa EHV – Moss/Wolf 345-kV double-circuit line	104.7	105.1

3.2.3. Reliability Needs in Upton, Reagan, and Irion Counties

The study results indicated that some of the existing 69-kV and 138-kV lines are no longer able to reliably serve the projected demand even under the N-0 contingency condition. Table 3.10 summarizes the thermal overloads in this area.

Table 3.10 Thermal Overloads in Upton, Reagan, and Irion Counties

Overloaded Element	Limiting Contingency	Percent Overload	
		2025	2030
Big Lake – Barnhart 69-kV line	Barnhart – Cassava 69-kV line	< 100	129.6
Rio Pecos – McCamey – Rankin4 69-kV line	Base Case	116.0	126.4
Cassava – San Angelo Mathis Field 69-kV line	Bakersfield – Cedar Canyon 345-kV double-circuit line	105.4	120.9
Rio Pecos 138/69-kV transformer 1	Rio Pecos 138/69-kV transformer 2	100.4	110.4
Jerry – Big Lake 138-kV line	Odessa Combined Cycle Train 1 + Big Hill – Schneeman Draw 345-kV double-circuit line	< 100	106.3
Twin Buttes – Hargrove – Pumpjack – Jerry 138-kV line	Bakersfield – Cedar Canyon 345-kV double-circuit line (2025); Base Case (2030)	128.5	104.0

4. Project Evaluation

Multiple transmission projects were evaluated in this section to address the reliability violations identified in Section 3.

4.1. Transmission Upgrades Inside Delaware Basin Area

The transmission upgrades inside the Delaware Basin area are divided into the following three areas:

- Culberson, Loving, and Winkler Counties
- Reeves and Ward Counties
- Pecos County

4.1.1. Culberson, Loving, and Winkler Counties

The conversion of the TNMP Wink – California – Wickett 69-kV line to 138-kV was identified to address the overloads of the Wink - California Tnp 69-kV line and Wink Tnp 138/69-kV transformers in the 2030 study case under NERC P0 and P1 contingencies. More details of the reliability needs are available in Table 3.3.

The four new loads #4, #7, #15, and #66 (total of 233 MW in 2030) shown in Figure 4.1 need new connections to the existing transmission grid. ERCOT evaluated the following two options to interconnect these new loads into the system.

- Option A: Add new 138-kV lines to connect the new loads #4, #7, #15, and #66 to 138-kV Kyle Ranch Substation
- Option B: Add new 138-kV lines to connect the new loads #4, #7, #15, and #66 to 138-kV Quarry Field Substation, and connect new load #66 to Keystone Substation to form a 138-kV loop

Connecting the new load #4 to Kyle Ranch (~ 4 miles) in Option A has a shorter distance compared to connecting it to Quarry Field (~ 10 miles) in Option B. However, Option A is expected to result in negative impact on the loading of the Riverton 345/138-kV transformer 2. The loading on the existing Riverton 345/138-kV transformer 2 is expected to be close to its emergency rating under the critical G-1+N-1 contingency condition in Option A. Therefore, ERCOT recommends Option B, shown in Figure 4.1, as the preferred option to connect the new loads in Loving and Winkler Counties.

According to the June 2021 TPIT report, the existing Keystone 69-kV Substation conversion to 138-kV in Option B is scheduled to be in-service by summer 2022 as part of the Tier 4 project TPIT # 62728: Wink - Shifting Sands (i.e., Keystone) 69-kV line conversion to 138-kV.

In summary, the following two transmission upgrades were identified in Culberson, Loving, and Winkler Counties.

- Convert existing TNMP Wink – California – Wickett 69-kV line to 138-kV (identified in 2030 study case)
- Add new 138-kV lines to connect the new loads #4, #7, #15, and #66 to 138-kV Quarry Field Substation, and then connect new load #66 to Keystone Substation to form a 138-kV loop (identified in 2025 study case)

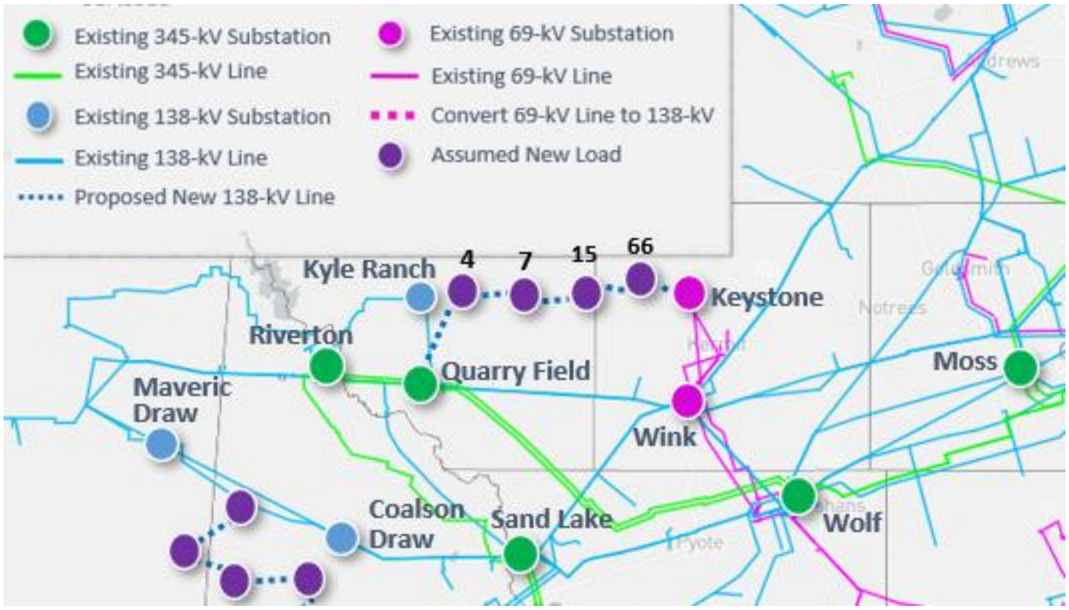

Figure 4.1 Loving and Winkler County Transmission Interconnection

4.1.2. Reeves and Ward Counties

Reeves County has the highest load projection in the study area, 1,430 MW in 2025 and 1,824 MW in 2030. Among these total load projections, 362 MW in 2025 and 566 MW in 2030 are related to new loads requiring new connections to the existing transmission grid. In addition to the new load connection projects, upgrades associated with existing transmission facilities were also identified to address the reliability needs in Reeves and Ward Counties listed in Section 3.1.2.

4.1.2.1 New Load Connection Projects

Figures 4.2 and 4.3 show the transmission interconnections to the new loads in 2025 and 2030. There are seven new loads in Reeves County which need connections to the existing transmission grid in 2030 as shown in Figure 4.3.

Below are the identified new 138-kV transmission lines to interconnect these new loads into the system in 2025:

- Tap a new 138-kV station on existing Coalson Draw – Maveric Draw 138-kV line, about 7.3 miles away from Coalson Draw
- Add new 138-kV lines to connect the new loads #5, #111, #23, and #12 to the new station on the Coalson Draw – Maveric Draw 138-kV line
- Add new 138-kV lines to connect the new loads #38 and #21 to Faulkner Substation

In 2030, the following additional new transmission lines are needed to form a 138-kV loop to reliably serve the projected load in this area:

- Add a new 138-kV line to connect the new load #108 to Verhalen Substation. This new load appears in 2030
- Add a new 138-kV line to connect the new loads #12 and #21 to form a 138-kV loop in 2030
- Add a new 138-kV line to connect the new load #108 to Faulkner to form a 138-kV loop in 2030

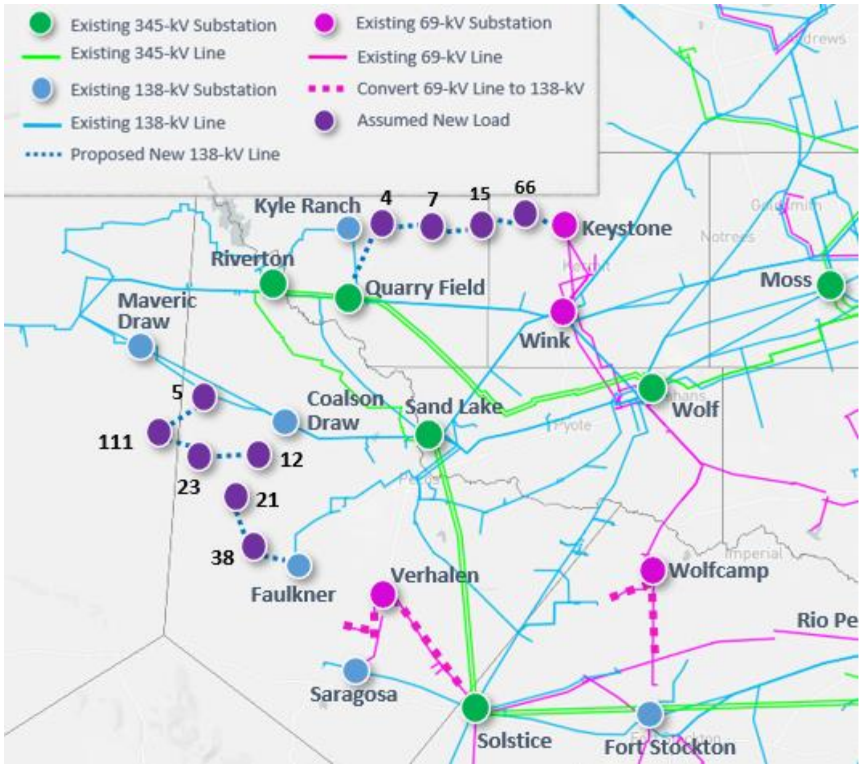

Figure 4.2 Reeves County Transmission Interconnection in 2025

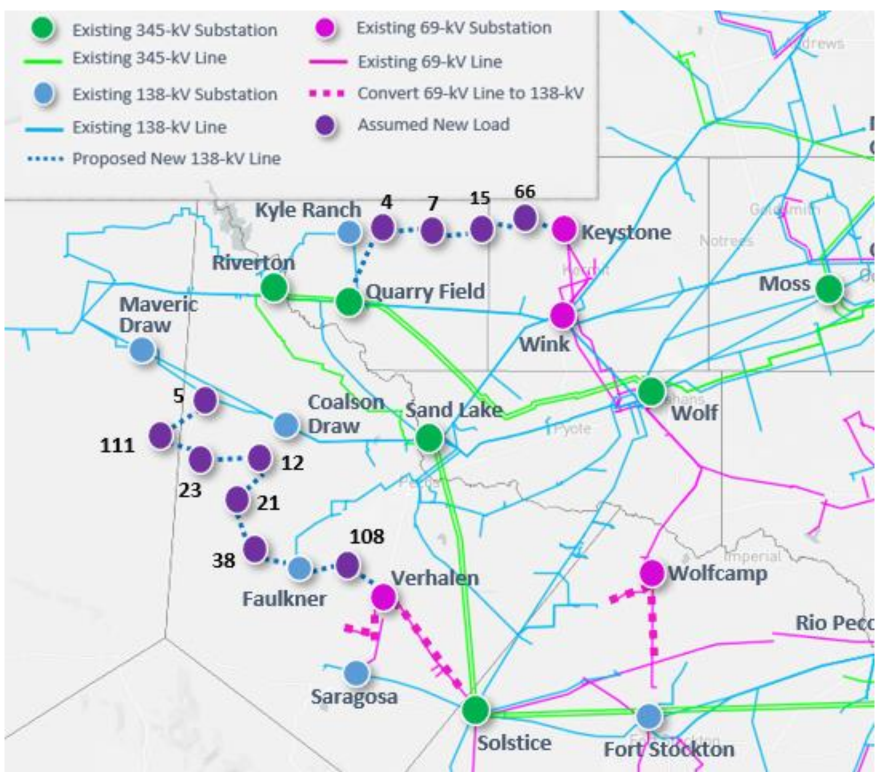

Figure 4.3 Reeves County Transmission Interconnection in 2030

4.1.2.2 Upgrades Associated with Existing Transmission Facilities

The conversion of the Barrilla Loop to 138-kV was identified to address the voltage instability issues in Reeves County.

As shown in Table 3.4 in Section 3, thermal overloads of the Sand Lake 345/138-kV transformers and Sand Lake – Cochise 138-kV double-circuit line were observed in the 2030 case under NERC P1 (N-1) contingencies. The overloads of the Sand Lake 345-kV transformers are substantially higher under the critical X-1+N-1 contingency conditions. This indicates that additional 345/138-kV transformation capacity is needed in this area to serve the projected load. ERCOT tested the following three options that involve looping the existing Solstice – Sand Lake 345-kV line into the 138-kV system with two new 345/138-kV transformers near the existing IH20 138-kV Substation to address the reliability needs.

- Option A: Loop Solstice – Sand Lake 345-kV double-circuit line at IH20 Substation
- Option B: Loop Solstice – Sand Lake 345-kV double-circuit line at Collie Field Substation
- Option C: Loop Solstice – Sand Lake 345-kV double-circuit line at Saddleback Substation

Option A resolves all the violations without any additional upgrades. Option A also has more 138-kV outlets compared to Option B and Option C.

Option B and Option C also resolve the violations but need additional upgrades. Option B needs to upgrade additional 2.95 miles of existing 138-kV line from Collie Field Tap to IH20. Option C needs to upgrade additional 4.88 miles of existing 138-kV line from Saddleback to IH20.

Based on the comparison, ERCOT recommends Option A as the preferred option to address the reliability need in the area.

Details of the identified transmission upgrades associated with the existing transmission facilities in Reeves and Ward Counties are described below:

- Convert existing Barrilla Loop to 138-kV: Barrilla – Hoefs Road – Verhalen – Cherry Creek – Saragosa 69-kV line to 138-kV (identified in 2025 study case)
- Establish a new IH20 345-kV Substation and install two new 345/138-kV transformers and loop the existing Solstice – Sand Lake 345-kV double-circuit line into the new IH20 Substation (identified in 2030 study case)
- Terminal equipment upgrade associated with existing Caymus TNP - Gas Pad 138-kV line (identified in 2030 study case)

4.1.3. Pecos County

All the identified reliability issues in Pecos County are related to the thermal overloads of the existing 69-kV and 138-kV lines. The following transmission upgrades were identified in the 2025 study case to address the reliability needs in Table 3.5:

- Convert existing Yucca – Wolfcamp – Courtney Creek 69-kV line to 138-kV
- Upgrade existing Lynx – Tombstone – Fort Stockton138-kV line
- Upgrade existing Fort Stockton – Leon Creek 138-kV line
- Upgrade existing 16th Street – Fort Stockton TNP 69-kV line

4.2. Transmission Upgrades Outside Delaware Basin Area

The transmission upgrades outside of the Delaware Basin area are mainly in three areas:

- Dawson, Borden, and Scurry Counties

- Ector, Midland, Howard, and Mitchell Counties
- Upton, Reagan, and Irion Counties

4.2.1. Dawson, Borden, and Scurry Counties

As shown in Table 3.7, thermal overloads were observed in Dawson, Borden, and Scurry Counties, and the following transmission upgrades were identified to address the reliability needs:

- Upgrade existing Sacroc – Deep Creek Sub – Snydrs 138-kV line (identified in 2030 study case)
- Upgrade existing Scurry – Kndrsacrc – Knapp 138-kV line (identified in 2025 study case)
- Upgrade existing Knapp – Bluff Creek Switch – Willow Valley Switch 138-kV line (identified in 2030 study case)
- Upgrade existing Lamesa - Key Sub – Gail Sub – Willow Valley Switch 138-kV line (identified in 2025 study case)
- Upgrade existing Lamesa – Jim Payne – Dawson – Alkali Lake 138-kV line (identified in 2025 study case)

4.2.2. Ector, Midland, Howard, and Mitchell Counties

Majority of the thermal overloads, especially the 345-kV transmission level, were occurred in Ector, Midland, Howard, and Mitchell Counties. This section describes the details of the transmission upgrades identified to address the reliability needs in this area.

4.2.2.1 345-kV Transmission Upgrades

The following transmission upgrades were identified in 2025 study case and recommended by ERCOT.

- Upgrade #1: Rebuild existing Morgan Creek – Tonkawa 345-kV line using double-circuit capable structures and add a 2nd circuit
- Upgrade #2: Rebuild existing Morgan Creek – Falcon Seaboard – Midland East – Midland County NW 345-kV line using double-circuit capable structures and add a 2nd circuit
- Upgrade #3: Upgrade existing Morgan Creek – Longshore – Odessa EHV 345-kV double-circuit line
- Upgrade #4: Establish a new 345/138-kV substation at Consavvy with two new transformers; Loop existing Longshore – Midessa South 345-kV line into Consavvy; Loop existing Grelton – Odessa EHV 345-kV line into Consavvy; Loop existing South Midland – Pronghorn 138-kV line and Midland East – Spraberry 138-kV line into Consavvy
- Upgrade #5: Upgrade existing Midessa South 345/138-kV transformer and add a 2nd Midessa South 345/138-kV transformer
- Upgrade #6: Establish a new 345/138-kV substation at Reiter (~ 3 miles south of Odessa EHV 345-kV Substation) with two new transformers, and loop existing Odessa EHV – Moss/Wolf 345-kV double-circuit line into Reiter; Establish a new 345-kV substation at Quail East (~ 2.5 miles east of Quail 345-kV Substation), and loop existing Odessa EHV – Midessa South 345-kV and Quail – Longshore Fly 345-kV line into Quail East; Add a new Quail East - Reiter 345-kV double-circuit line (~ 2.5 miles)

Among the six upgrades, Upgrades #1, #2, #3, and #5 are the upgrades of existing transmission facilities to address some of the reliability needs identified in Table 3.8. Upgrades #4, #5, and #6 are related to adding new transmission facilities to address the remaining reliability needs in Table 3.8. Details of Upgrades #4 and #6 including option evaluations were discussed below.

Upgrade #4 is needed to serve the load in Midland County. As shown in Table 3.8, under certain P7 contingency related to the segment of the Morgan Creek – Longshore – Odessa EHV 345-kV double-circuit line, all the flow from the Morgan Creek to Odessa EHV path redirected to Consavvy resulted in the overload of the Consavvy 345/138-kV transformer. Several options were evaluated to address the reliability need, and the performance of each option was compared in Table 4.1.

Table 4.1 Options to Address Consavvy Transformer Overload

Option	Option Description	Percent Loading	
		2025	2030
Option 1	Establish a new 345/138-kV substation at Consavvy with two new 345/138-kV transformers; Loop existing Longshore – Midessa South 345-kV line into Consavvy	102.7	89.3
Option 2	Establish a new 345/138-kV substation at Consavvy with two new 345/138-kV transformers; Loop existing Longshore – Midessa South 345-kV line into Consavvy; Loop existing Grelton – Odessa EHV 345-kV line into Consavvy	78.7	76.7
Option 3	Establish a new 345/138-kV substation at Consavvy with two new 345/138-kV transformers; Loop existing Longshore – Midessa South and Longshore Fly – Quail 345-kV double-circuit line into Consavvy; Loop existing Grelton – Odessa EHV 345-kV line into Consavvy	92.2	93.3

As shown in Table 4.1, Option 2 adds a new Consavvy 345-kV source to serve the load in Midland County while relieving the overload on the Consavvy transformer under X-1+N-1 contingency condition of one Consavvy 345/138-kV transformer and the related P7 contingency. Based on the study results, ERCOT recommends Option 2 as the preferred solution.

Odessa EHV 345/138-kV transformer 2 is overloaded in both 2025 and 2030 cases. According to the TSP, upgrading the existing Odessa EHV transformer or adding additional transformer at Odessa EHV are not feasible options due to the space constraints and based on TSP's practice. As such, four transmission upgrade options were evaluated to address this overload issue. The details of the options and performance were compared in Table 4.2.

Table 4.2 Options to Address Odessa EHV Transformer 2 Overload

Option	Option Description	Percent Loading	
		2025	2030
Option 1	Add a new Midessa South – Moss 345-kV single-circuit line (~20 miles)	96.1	98.1
Option 2	Establish a new 345/138-kV substation at Reiter with two new 345/138-kV transformers, and loop existing Odessa EHV – Moss/Wolf 345-kV double-circuit line into Reiter; Establish a new 345/138-kV substation at Quail East with two new 345/138-kV transformers, and loop existing Odessa EHV – Midessa South 345-kV and Quail – Longshore Fly 345-kV double-circuit line into Quail East; Add a new Quail East – Reiter 345-kV double-circuit line (~2.5 miles)	64.8	64.7
Option 3	Establish a new 345/138-kV substation at Reiter with two new 345/138-kV transformers, and loop existing Odessa EHV – Moss/Wolf 345-kV double-circuit line into Reiter;	80.4	80.6

	Establish a new 345-kV substation at Quail East, and loop existing Odessa EHV – Midessa South 345-kV and Quail – Longshore Fly 345-kV double-circuit line into Quail East; Add a new Quail East – Reiter 345-kV double-circuit line (~2.5 miles)		
Option 4	Establish a new 345/138-kV substation at Reiter with two new 345/138-kV transformers, and loop existing Odessa EHV – Moss/Wolf 345-kV double-circuit line into Reiter; Add a new Reiter – Midessa South 345-kV double-circuit line (~6 miles)	89.5	91.7

The study results showed that Options 2 and 3 performed better than Options 1 and 4. Option 3 is less costly than Option 2 since Option 3 does not require the new 138-kV Quail East Substation and two new 345/138-kV transformers. As such, ERCOT recommends Option 3 as the preferred upgrade.

4.2.2.2 138-kV and 69-kV Transmission Upgrades

Besides the 345-kV level upgrades, the following 138-kV and 69-kV transmission upgrades were identified to address the reliability needs in Table 3.9:

- Upgrade existing China Grove – Getty Tap 138-kV line (identified in 2025 study case)
- Upgrade existing Getty Tap – Big Spring 138-kV line (identified in 2020 study case)
- Upgrade existing Morgan Creek – McDonald 138-kV line (identified in 2025 study case)
- Upgrade existing Odessa EHV – Big Three Odessa Tap – Odessa Southwest 138-kV line (identified in 2025 study case)
- Upgrade existing Sterling City – Sterling County 69-kV line (identified in 2030 study case)
- Convert existing Spraberry – Midkiff 69-kV line to 138-kV (identified in 2025 study case)
- Upgrade existing Salt Flat – Pronghorn – Consavvy 138-kV line (identified in 2025 study case)
- Upgrade existing Odessa EHV – Rexall – General Tire Switch – Edwards Tap – Judkins – Sandhills Tap – Wolf 138-kV line (identified in 2025 study case)
- Upgrade existing Moss – Wolf 138-kV line (identified in 2025 study case)
- Upgrade existing Odessa North – Odessa 138-kV line (identified in 2025 study case)
- Upgrade existing Odessa EHV – Yarbrough Sub – Wolf 138-kV line (identified in 2025 study case)
- Upgrade existing Holt – Scharbauer POI 138-kV line (identified in 2025 study case)

4.2.3. Upton, Reagan, and Irion County Projects

The following transmission upgrades were identified in the 2025 study case to address the reliability needs in Table 3.10.

- Upgrade existing Twin Buttes – Hargrove – Pumpjack – Big Lake 138-kV line
- Convert existing Rio Pecos – Big Lake 69-kV line to 138-kV
- Convert existing Big Lake – San Angelo Concho 69-kV line to 138-kV

Since the new loads in Upton, Reagan, and Irion Counties are relatively smaller and sparse compared to other loads in the Delaware Basin or Midland area, these transmission upgrades are considered as placeholders. Further review of these upgrades will be required if submitted for RPG review.

4.3. Stage 2 Upgrade

ERCOT completed the Delaware Basin Load Integration Study in December 2019 and identified a roadmap of preferred system upgrades to meet future demand growth in the Delaware Basin area and improve the capability to import power into the Delaware Basin area. The roadmap involves five stages of the long lead time 345-kV upgrades as shown in Table 2.5. Among the upgrades, the Stage 1 upgrade which adds a second circuit on the existing Big Hill – Bakersfield 345-kV line was endorsed by ERCOT in June 2021 and is expected to be implemented in 2023.

As described in Section 2.2.3, the load level associated with the Delaware Base area in the 2030 study case is expected to exceed the trigger point of the Stage 2 upgrade (i.e., a new Bearkat – North McCamey – Sand Lake 345-kV double-circuit line). Although ERCOT conducted the detailed analysis of the need for the Stage 2 upgrade in the Delaware Basin Load Integration Study, ERCOT performed additional analysis in this Permian Basin Load Interconnection Study to reconfirm the need for the Stage 2 upgrade. The additional analysis was performed using the 2030 study case without the Stage 2 upgrade, and the results showed voltage instability under multiple P7 contingencies (i.e., N-1 conditions).

As described in Sections 4, 5, and 6 of the Delaware Basin Load Integration Study, ERCOT evaluated a number of import path options as alternatives to the Stage 2 upgrade, including a new Faraday – Lamesa – Clearfork – Riverton 345-kV double-circuit line (i.e., the Stage 5 upgrade). Due to more mileages of new rights-of-way and higher project costs of those alternatives, ERCOT proposed the addition of a new Bearkat – North McCamey – Sand Lake 345-kV double-circuit line as the Stage 2 upgrade in the Delaware Basin Load Integration Study.

Based on the results of the Delaware Basin Load Integration Study and this Permian Basin Load Interconnection Study, ERCOT recommends the Stage 2 upgrade as a new transmission import path to the Delaware Basin area in the 2030 study case:

- Stage 2 upgrade: add a new Bearkat – North McCamey – Sand Lake double-circuit 345-kV line (~164 miles), with the minimum normal and emergency rating of at least 2564 MVA

5. Summary of the Transmission Upgrades

As discussed in Section 4, various transmission upgrades were developed to address the reliability criteria violations identified in the Permian Basin Load Interconnection Study. The long lead time transmission upgrades (e.g., RPG Tier 1 and Tier 2 projects) and the new load connections in the Delaware Basin area which form a 138-kV loop are considered as preferred projects. The remaining transmission upgrades are considered as placeholder projects and may require further review. The placeholder projects include the transmission upgrades that are expected to be potential RPG Tier 3 and Tier 4 projects as well as the transmission upgrades in Upton, Reagan, and Irion Counties which are at the border of the Permian Basin study area. Table 5.1 summarizes the transmission upgrades identified in this study. The total cost of the preferred transmission upgrades is estimated to be approximately $1.5 Billion.

Table 5.1 Summary of the Identified Transmission Upgrades in 2025 and 2030

Reliability Upgrades	Unit	Project Consideration
New 345-kV Line	~ 295 miles	Preferred
Existing 345-kV Line Upgrade	~ 211 miles	Preferred
New 345-kV Substation	4	Preferred
New 345/138-kV Transformer	7	Preferred
New 138-kV Line	~ 128 miles	Preferred
Existing 138-kV Line Upgrade	~ 449 miles	Placeholder
69-kV line to 138-kV Conversion	~ 313 miles	Placeholder
Reactive Support Need	~ 400 MVAR	Placeholder

Table 5.2 lists the details of the preferred transmission upgrades identified in this study. Figures 5.1 and 5.2 show the maps of the preferred reliability upgrades identified in the 2025 and 2030 cases.

Table 5.2 List of the Preferred Transmission Upgrades

Project ID	Preferred Transmission Upgrades	Assumed Rate A/B (MVA) in Study Case	Year of Study Case with Reliability Need Starting to Appear	Approximate Cost Estimate ($M)
1	Rebuild existing Morgan Creek – Tonkawa 345-kV line using double-circuit capable structures and add a 2nd circuit	2988/2988	2025	100.58
2	Rebuild existing Midland East – Falcon Seaboard 345-kV line using double-circuit capable structures and add a 2nd circuit	1792/1792	2025	196.47
2	Rebuild existing Morgan Creek – Falcon Seaboard 345-kV line using double-circuit capable structures and add a 2nd circuit	1792/1792	2030	
2	Rebuild existing Midland East – Midland County NW 345-kV line using double-circuit capable structures and add a 2nd circuit	1792/1792	2025	
3	Upgrade existing Morgan Creek – Longshore 345-kV line	1792/1792	2030	393.88
3	Upgrade existing Morgan Creek – Longshore Fly 345-kV line	1792/1792	2025	
3	Establish a new 345/138-kV substation at Consavvy with two new 345/138-kV transformers; Loop existing Longshore – Midessa South 345-kV line into Consavvy and upgrade Longshore – Consavvy line;	1792/1792	2025	

	Loop existing South Midland – Pronghorn 138-kV line and Midland East – Spraberry 138-kV line into Consavvy			
3	Upgrade Consavvy – Midessa South 345-kV line	1792/1792	2025	
3	Upgrade existing Longshore Fly – Quail 345-kV line	1792/1792	2025	
3	Loop existing Grelton – Odessa EHV 345-kV line into Consavvy	1723/1723	2025	
3	Upgrade existing Midessa South – Odessa EHV 345-kV line	1792/1792	2025	
3	Upgrade existing Quail – Odessa EHV 345-kV line	1792/1792	2025	
3	Upgrade existing Midessa South 345/138-kV transformer and add a 2nd Midessa South 345/138-kV transformer	600/600	2025	
18	Add Verhalen – New Load 90108 138-kV line	483/ 483	2025	6.60
24	Establish a new IH20 345-kV Substation and install two new 345/138-kV transformers	700/750	2030	65.55
24	Loop existing Solstice – Sand Lake 345-kV double-circuit line at the new IH20 345-kV Substation	2988/2988	2030	
25	Establish a new 345/138-kV Reiter Substation with two new 345/138-kV transformers; Establish a new 345-kV Quail East Substation; Add a new Quail East – Reiter 345-kV double-circuit line	2988/2988	2025	104.65
31	Add Quarry Field – New Load 90004 138-kV line	614/614	2025	80.23
31	Add New Load 90004 – New Load 90007 – New Load 90015 – New Load 90066 – Keystone 138-kV line	614/614	2025	
31	Add capacitor bank (90 Mvar) at new load bus 90004		2025	
33	Add ONC90005_TAP – New Load 90005 138-kV line	617/617	2025	67.25
33	Add New Load 90005 – New Load 90111 – New Load 90023 – New Load 90012 138-kV line	614/614	2025	
33	Add capacitor bank (90 Mvar) at new load bus 90012		2025	
34	Add New Load 90012 – New Load 90021 138-kV line	617/617	2030	29.6
35	Add Faulkner – New Load 90038 – New Load 90021 138-kV line	617/617	2025	33.8
35	Add capacitor bank (90 Mvar) at new load bus 90021		2030	
36	Add Faulkner – New Load 90108 138-kV line	617/617	2030	17.55
42	Add Bearkat – North McCamey 345-kV double-circuit line	2564/2564	2030	392.41
42	Add North McCamey – Sand Lake 345-kV double-circuit line	2564/2564	2030	

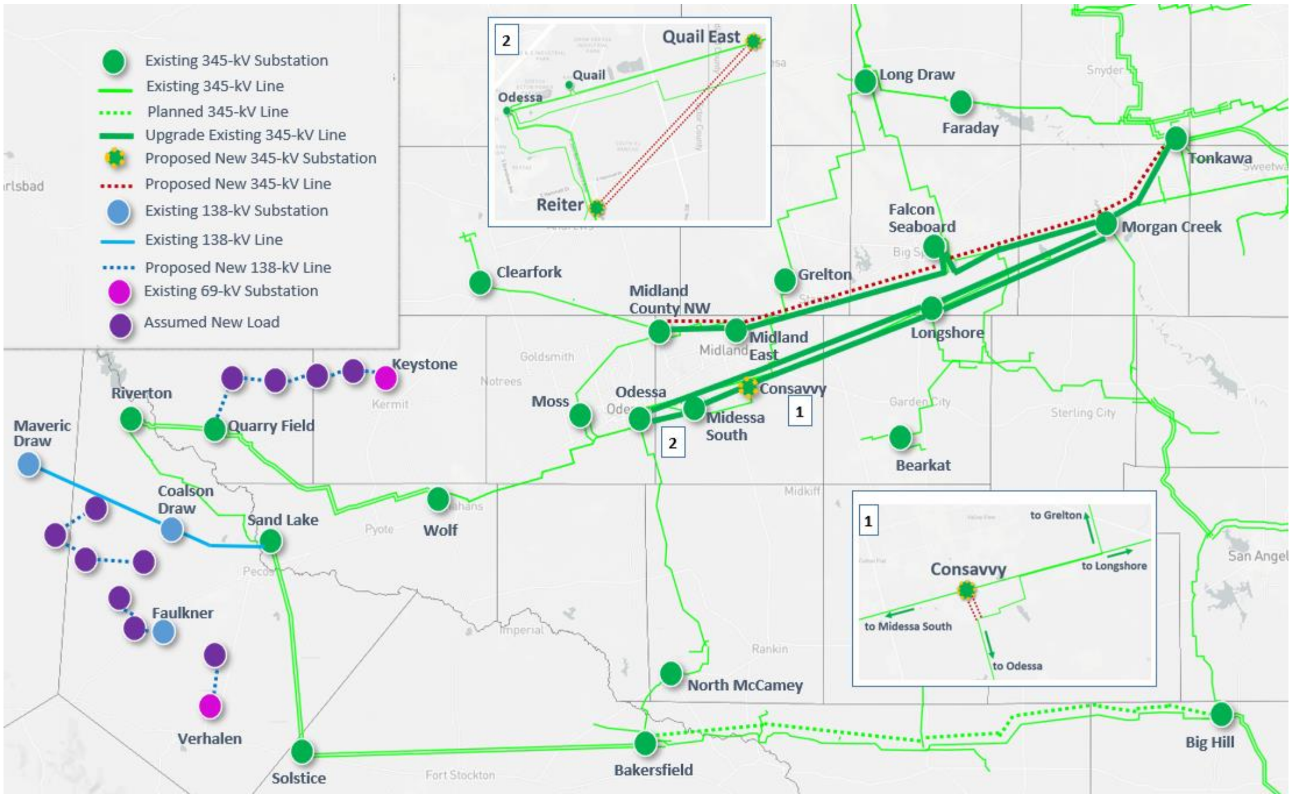

Figure 5.1 Preferred Reliability Upgrades for 2025

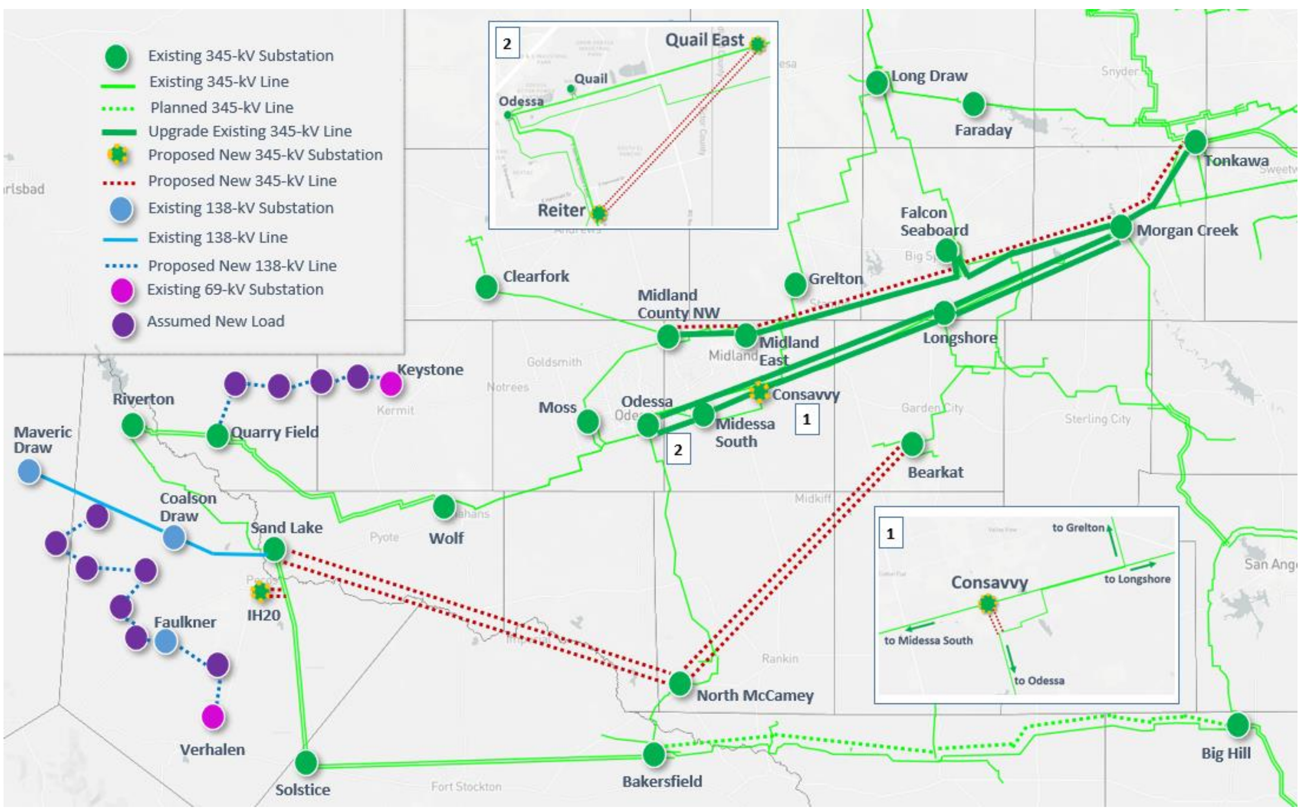

Figure 5.2 Preferred Reliability Upgrades for 2030

Table 5.3 lists the placeholder transmission upgrades identified in this study.

Table 5.3 List of the Placeholder Transmission Upgrades

Project ID	Placeholder Transmission Upgrades	Year of Study Case with Reliability Need Starting to Appear	Approximate Cost Estimate ($M)
4	Upgrade existing Sacroc – Deep Creek Sub – Snydrs 138-kV line	2030	24.23
5	Upgrade existing Scurry – Kndrsacrc – Knapp 138-kV line	2025	19.44
6	Upgrade existing Knapp – Bluff Creek Switch 138-kV line	2030	46.02
6	Upgrade existing Bluff Creek Switch – Willow Valley Switch 138-kV line	2030	
7	Upgrade exisitng Lamesa – Key Sub – Gail Sub – Willow Valley Switch 138-kV line	2025	45.09
8	Upgrade existing Lamesa – Jim Payne – Dawson – Alkali Lake 138-kV line	2025	28.98
9	Upgrade existing China Grove – Getty Tap 138-kV line	2025	56.86
10	Upgrade existing Getty Tap – Big Spring 138-kV line	2030	20.63
11	Upgrade existing Morgan Creek – McDonald 138-kV line	2025	46.66
12	Upgrade existing Odessa EHV – Big Three Odessa Tap – Odessa Southwest 138-kV line	2025	21.16
13	Upgrade existing Lynx – Tombstone – Fort Stockton 138-kV line	2025	38.60
14	Upgrade existing Fort Stockton – Leon Creek 138-kV line	2025	3.58
15	Upgrade existing Twin Buttes – Hargrove – Pumpjack – Big Lake 138-kV line	2025	65.05
16	Upgrade existing Sterling City – Sterling County 69-kV line	2030	2.48
17	Upgrade existing 16th Street – Fort Stockton TNP 69-kV line	2025	0.75
18	Convert existing Barrilla Loop 69-kV line to 138-kV	2025	46.81
18	Add Verhalen – New Load 90008 138-kV line	2025	
18	Add Hoefs Road – New Load 90026 138-kV line	2025	
18	Add capacitor bank (90 Mvar) at new load bus 90008	2025	
19	Convert existing Yucca – Wolfcamp – Courtney Creek 69-kV line to 138-kV	2025	75.50
20	Convert existing Big Lake – San Angelo Concho 69-kV line to 138-kV	2025	61.24
21	Convert existing Rio Pecos – Big Lake 69-kV line to 138-kV	2025	114.00
22	Convert existing Spraberry – Midkiff 69-kV line to 138-kV	2025	6.84
23	Convert existing TNMP Wink – California – Wickett 69-kV to 138-kV	2030	14.46
26	Upgrade existing Odessa EHV – Rexall – General Tire Switch – Edwards Tap – Judkins – Sandhills Tap – Wolf 138-kV line	2025	62.74
27	Upgrade existing Moss – Wolf 138-kV line	2025	39.30
28	Upgrade existing Odessa North – Odessa 138-kV line	2025	15.76

29	Upgrade existing Odessa EHV – Yarbrough Sub – Wolf 138-kV line	2025	63.11
30	Upgrade existing Holt – Scharbauer POI 138-kV line	2025	10.46
32	Add Kyle Ranch – New Load 90001 – New Load 90006 138-kV line	2025	3.97
35	Add New Load 90021 - New Load 90032 138-kV line	2025	17.0
37	Add ONC90002_TAP – New Load 90002 138-kV line	2025	18.37
37	Add capacitor bank (24 Mvar) at new load bus 90002	2030	
38	Add Three Mile Draw Switch – New Load 90106 138-kV line	2030	13.54
39	Add ONC90009_TAP – New Load 90009 138-kV line	2025	14.53
41	Increase the capacitor bank at bus 1323 to 18.4 Mvar from 9.2 Mvar	2030	0.50
44	Upgrade existing Salt Flat – Pronghorn – Consavvy 138-kV line	2025	15.70
45	Terminal equipment upgrade for existing Caymus TNP – Gas Pad 138-kV line	2030	0.50

6. Conclusion

The purpose of this Permian Basin Load Interconnection Study was to identify transmission upgrades that are necessary to connect projected oil and gas loads in the Permian Basin area.

This study identified a list of the transmission upgrades, including both the preferred and placeholder projects, required by 2025 and 2030 to address the identified reliability criteria violations in the study area.

The preferred projects may be endorsed by ERCOT based on the results of this Permian Basin Load Interconnection Study if they are submitted for RPG review. The total cost of the preferred transmission upgrades is estimated to be approximately $1.5 Billion. The placeholder projects are expected to require further analysis if submitted for RPG review.

7. Appendix

Maps of All Transmission Upgrades	Maps of All Transmission Upgra