ERCOT System Planning:

2012 West Texas Sensitivity Study Report

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Document Revisions

Date	Version	Description	Author(s)
09/17/2013	2.0	Final **Corrections:** On page 36: The facilities connecting West Stanton to Vealmoor are already in place and currently owned by ~~Xcel SPS~~ Sharyland Utilities. Upon the PUCT's approval of the Docket #41430, the facilities will be ~~owned by Sharyland Utilities and be~~ transferred to ERCOT from SPP.	Sun Wook Kang, Audrey Zhou, Naga Kota

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I. Executive Summary

The West Texas Sensitivity Study is the result of a coordinated planning process, performed by ERCOT Staff with extensive review and input by NERC registered Transmission Planners (TPs), Transmission Owners (TOs) and other stakeholders, which addresses reliability and economic transmission needs to meet the growing electric demand being driven by the oil and natural gas industry and the associated economic expansion in supporting residential, commercial and supporting industries in the ERCOT West and Far West weather zones.

The transmission improvements identified in the West Texas Sensitivity Study include several 69 kV and 138 kV line upgrades, and several 138/69 kV autotransformer upgrades, six new 345/138 kV autotransformers, three new 138 kV lines and a new 69 kV line. Table 1 summarizes the reliability and economic driven projects identified in the 2012 West Texas Sensitivity Study that are in addition to the 2012 Five-Year Transmission projects previously identified by ERCOT.

The project completion years stated in this West Texas Sensitivity Study were chosen to timely address reliability and economic needs. The TOs will attempt to meet these project completion dates, but lead times necessary to implement projects based on factors such as availability of construction clearances, time required to receive necessary regulatory or governmental approvals, time required to design the projects, equipment and land acquisition and resource constraints which may result in different project completion dates. It should be noted that the scope of the projects identified in this report with sufficient implementation lead time may change if further analysis by ERCOT and/or the TOs/TPs results in better alternatives or a need for modifying the projects due to a change in demand or generation assumptions in the West Texas study area is identified. Projects requiring Regional Planning Group (RPG) approval will be reviewed in future assessments (also where sufficient lead time exists), such as future ERCOT Regional Transmission Plans to make sure the identified system facilities are still needed. Conversely, projects may also need to be accelerated if system conditions require earlier in-service dates.

The TOs designated to complete these projects will provide ERCOT additional details on project scope, project cost, and an implementation schedule with completion date(s). This information from the TOs may be provided through further RPG review and/or Transmission Project Information Tracking (TPIT) updates in accordance with ERCOT Planning Guide Section 6.4.1.

Table 1: Reliability Driven Projects and Year Needed

Project Area	#	Project Name	2015	2017
Midland, Ector and Andrews Counties	**R1**	Construct a new 345/138 kV substation at or near the existing Gardendale substation	✓	✓
	R2	Loop the existing Moss-Midland East 345 kV line into the new 345/138 kV substation at or near the Gardendale substation	✓	✓
	R3	Install a new 500 MVA 345/138 kV transformer at the new 345/138 kV substation at or near Gardendale substation	✓	✓
	R4	Loop the existing double circuit 138 kV line (Grandview-Mockingbird and Texaco Tap-Ector Hillmont)	✓	✓
	R5	Construct a new 138 kV line from new 345/138 kV substation at or near Gardendale to Midessa (~7.2 miles)	✓	✓
	R6	Construct a new 345/138 kV substation adjacent to the existing Amoco-Arena 138 kV line in Andrews County	✓	✓
	R7	Connect a 345 kV line from the new 345/138 kV substation near Gardendale to the new 345/138 kV substation adjacent to the existing Amoco-Arena 138 kV line	✓	✓
	R8	Loop the existing Amoco-Arena 138 kV line into the new 345/138 kV substation	✓	✓
	R9	Install a new 500 MVA 345/138 kV transformer at the new 345/138 kV substation adjacent to the existing Amoco-Arena 138 kV line	✓	✓
	R10	Upgrade Midland East-Windwood 138 kV line	✓	✓
	R11	Upgrade Westover-Amoco South Foster 138 kV line	✓	✓
	R12	Upgrade Odessa North-Amoco South Foster 138 kV line	✓	✓
	R13	Upgrade Fullerton-Exxon Fullerton 69 kV line	✓	✓
	R14	Upgrade CRMWD 8 Tap-Glenhaven 138 kV line	✓	✓
	R15	Upgrade CRMWD 8 Tap-Midland Airport 138 kV line	✓	✓
	R16	Upgrade Odessa EHV Switch-Odessa 138 kV line	✓	✓
	R17	Install 36.8 Mvar capacitor bank at North Andrew 138 kV substation	✓	✓
Reagan and Crockett Counties	**R18**	Close the normally-open Powell Field-Powell Field Junction 69 kV line	✓	✓
	R19	Close the normally-open Illinois #4-Pandale 69 kV line	✓	✓
	R20	Maintain neutral or appropriate narrow bandwidth for the phase shifter at Big Lake during certain system conditions	✓	✓

	R21	Expand the existing Humble Tap (Powell Field Tap) 69 kV substation to accommodate new 138/69 kV facilities	✓	✓
	R22	Loop the existing Big Lake-North McCamey 138 kV line into the expanded Humble Tap substation	✓	✓
	R23	Install a new 138/69 kV transformer at the expanded Humble Tap substation	✓	✓
	R24	Upgrade the existing Big Lake-Kemper Exxon Tap 69 kV line	✓	✓
	R25	Upgrade the existing Kemper Exxon Tap-Humble Tap 69 kV line	✓	✓
	R26	Upgrade the existing Shell Powell Tap-Powell Field 69 kV line	✓	✓
Reeves, Winkler and Ward Counties	**R27**	Construct a new 138 kV substation adjacent to the existing Barilla-Musquiz 138 kV line	✓	✓
	R28	Loop the existing Barilla-Musquiz 138 kV line into the new 138 kV substation	✓	✓
	R29	Expand the existing Flat Top 69 kV substation to accommodate new 138/69 kV facilities	✓	✓
	R30	Install a new 138/69 kV transformer at Flat Top	✓	✓
	R31	Construct a new 138 kV line from the new 138 kV substation to Flat Top (~8.7 miles)	✓	✓
	R32	Upgrade the existing Barilla Draw Field Tap-Flat Top 69 kV line		✓
Crane County	**R33**	Upgrade the existing 138/69 kV transformer at Crane	✓	✓
	R34	Upgrade the existing 69 kV bus tie at Crane	✓	✓
Tom Green and Irion Counties	**R35**	Accelerate the construction of a new 138 kV line from Yucca to RingTail	✓	✓
	R36	Convert the existing 69 kV line from Barnhart Phillips Tap to Yucca 138 kV to 138 kV	✓	✓
	R37	Install a new 138/69 kV transformer at Barnhart Phillips Tap	✓	✓
	R38	Upgrade the existing 345/138 kV transformer at Twin Buttes		✓
	R39	Install a second new 345/138 kV transformer at Twin Buttes	✓	✓
	R40	Construct a new 138 kV line from Twin Buttes to Bluffs (~7.8 miles)	✓	✓
	R41	Upgrade the existing Bluffs-College Hills 138 kV line	✓	✓
	R42	Upgrade the existing 138/69 kV transformer at San Angelo North	✓	✓
	R43	Upgrade the existing 138/69 kV transformer at College Hill		✓
Menard and Mason Counties	**R44**	Expand the existing North Brady 69 kV substation	✓	✓
	R45	Construct a new 69 kV line from Mason Switch to North Brady (~25 miles)	✓	✓

Mitchell County	**R46**	Upgrade the existing Morgan Creek 138/69 kV transformer	✓	✓
	R47	Upgrade the two existing Morgan Creek-Barber Lake 138 kV lines		✓
Uvalde and Bandera Counties	**R48**	Upgrade the Utopia-Tarplery 69 kV line (Terminal Equipment)	✓	✓
	R49	Upgrade the existing Montell-Uvalde 69 kV line		✓
Llano County	**R50**	Upgrade Ferguson-Sandy Creek 138 kV line	✓	✓
Coke County	**R51**	Upgrade Cedar Hill 138/69 kV transformer	✓	✓
	R52	Install 12 Mvar capacitor bank at Spade Ranch 69 kV bus	✓	✓
	R53	Install 12 Mvar capacitor bank at Sterling City 69 kV bus	✓	✓
	R54	Add 12 Mvar capacitor bank to the existing capacitor bank at Cedar Hill 69 kV substation	✓	✓
Taylor County	**R55**	Upgrade Abilene South-Abilene West Texas Gulf 69 kV line	✓	✓
Borden, Howard and Mitchell Counties (N-1 & G-1 projects)	**R56**	Expand the existing Vealmoor 138 kV substation to accommodate 345/138 kV facilities		✓
	R57	Install a new 450 MVA 345/138 kV transformer at Vealmoor		✓
	R58	Connect 345 kV line from Vealmoor to Long Draw		✓
	R59	Connect W Stanton to Vealmoor (Northern Loop Project) *		✓
Reagan, Upton, Irion and Tom Green Counties (N-1 & G-1 projects)	**R60**	Construct a new 345/138 kV substation at the junction where the Bakers-Big Hill 345 kV line (CREZ line) and the Ringtail-Big Lake 138 kV line cross (50% of the Bakers-Big Hill 345 kV line, ~5 miles north of Ringtail 138 kV bus)		✓
	R61	Loop the Bakers-Big Hill 345 kV line into the new substation		✓
	R62	Loop the Big Lake-Ringtail 138 kV line into the new substation		✓
	R63	Install a new 345/138 kV transformer at the new substation		✓
	R64	Upgrade the existing 138 kV line from Ringtail to the new substation (~5 miles)		✓

***** The West Stanton to Vealmoor project was submitted for RPG review and comments in June 2013. Upon completion of the RPG review, the project was classified as a Tier 4 project.

Table 2: Economic Driven Projects and Year Needed

Project Area	#	Project Name	2015	2017
Andrews County	E1	Upgrade the existing 138/69 kV transformer # 1 at Andrews North		✓

II. Assumptions and Process

This report documents the West Texas Sensitivity Study performed by ERCOT System Planning in accordance with the ERCOT Planning Guide Section 3.

The West Texas Sensitivity Study is an addendum to the 2012 Five-Year Transmission Plan which addresses the project needs in the West and Far West weather zones to meet the projected load growth related to the oil and natural gas industry and the associated economic growth in residential, commercial and supporting industries. The West Texas Sensitivity Study analyzed the reliability and efficiency of the transmission system for the years 2015 and 2017 according to the NERC Reliability Standards and the ERCOT Planning Criteria. Upgrades identified for the years 2015 and 2017 need to be further reviewed by the appropriate TPs to determine the need for an earlier in-service year (2014 or 2016, respectively).

The scope for the West Texas Sensitivity Study was presented to the RPG. Study updates were given to and comments received by stakeholders during RPG monthly meetings in December 2012, May 2013, June 2013 and August 2013.

A. Tools

ERCOT utilized the following software tools while performing the 2012 Five-Year Transmission Plan:

- PSS/E version 32 was used to develop the conditioned cases and the AC reliability cases
- PowerWorld version 16 with SCOPF was used to create a security-constrained AC reliability case
- UPLAN version 8.12.0.9073 was used to perform security-constrained economic analysis

B. Assumptions

1. Demand

Demand for Reliability Analysis:

The 2012 Five-Year Transmission Plan final power flow cases for 2015 and 2017 (North, North Central, West and Far West were used as the start case for the West Texas Sensitivity reliability studies. The 2012 Five-Year Transmission Plan compared the ERCOT econometric 90/10 load

forecast versus the SSWG forecast and utilized the higher of the two demand forecasts for each weather zone for the reliability analysis. The load forecast used in the 2012 Five-Year Transmission Plan cases for years 2015 and 2017 are shown in Figure 1.

Weather Zone	SSWG Forecast		ERCOT Econometric 90/10 Forecast	
	2015	2017	2015	2017
NORTH	1683	1708	1851	1968
NORTH_CENTRAL	25215	26010	27605	29151
EAST	2632	2664	3245	3443
FAR_WEST	1843	1876	2079	2191
WEST	2090	2144	2274	2362
SOUTH_CENTRAL	13169	13810	12617	13659
COAST	24808	25347	23904	24697
SOUTH	6212	6474	6380	6715
ERCOT	77652	80033	79955	84186

Total using Highest Forecast	81411	84987

Figure 1: 2012 Five-Year Transmission Plan Demand Forecasts (MW)

Using the highest load forecast for each weather zone resulted in a simultaneous system demand greater than the amount of generation available to serve the load plus reserves for all of the base cases. For all study years the analysis of the system was split into two load variation regions, defined by weather zones: 1. North, North Central, West and Far West; 2. South, South Central, East and Coast. For each region studied, the corresponding weather zone demand was set to the higher of the two demand forecast highlighted in Figure 1. For the weather zones outside the study area the demand was set to the SSWG forecast. This was done to achieve a balance of load plus reserves and generation.

For the West Texas Sensitivity Study reliability cases, the load forecasts in the West and Far West weather zones were revised based on the latest normal load forecast provided by NERC registered Transmission Planners (TPs), Transmission Owners (TOs) and other stakeholders to account for revised load forecasts for the developments in the oil and natural gas industry and the associated residential, commercial and industrial expansion as of February 2013. The loads in the other weather zones remained at same level as the 2012 Five-Year Transmission Plan reliability cases.

Because the loads in this area have been rapidly increasing for this area ERCOT also requested that the TPs and TOs provide a forecast with additional load growth above the normal forecast to test the robustness of planned transmission improvements. The West Texas Sensitivity Study and

the 2012 Five-Year Transmission Plan (2012 5YTP) load forecasts for the West and Far West weather zones are shown in Figure 2.

	2015			2017		
	2012 5YTP	West Texas Sensitivity (Normal)	West Texas Sensitivity (High)	2017 (2012 5YP)	West Texas Sensitivity (Normal)	West Texas Sensitivity (High)
West	2273	2434	2551	2362	2585	2696
FAR West	2079	3227	3616	2192	3569	3944

Figure 2: West Texas Sensitivity Demand Forecasts (MW)

Demand for Economic Analysis:

The final 2015 and 2017 cases used for the economic analysis of the 2012 Five-Year Transmission Plan served as the start cases for the West Texas Sensitivity Study economic analysis. The 2012 Five-Year Transmission Plan used the ERCOT econometric 50/50 demand forecast for all weather zones. The ERCOT econometric 50/50 load forecast consists of an hourly demand profile for each year for each of eight weather zones representing the different climate-related weather patterns observed in the ERCOT Region. These eight hourly forecasts are summed by hour to produce the ERCOT forecast. The ERCOT econometric forecast is based on a "normalized" weather profile and economic predictions.

For the West Texas economic cases, the load forecasts in the West and Far West weather zones were revised based on the normal load forecast provided by the TPs and TOs and other stakeholders to account for revised load forecasts for the developments in the oil and natural gas industry and the associated residential, commercial and industrial expansion (shown in Figure 2). The loads in the other weather zones remained at same level as the 2012 Five-Year Transmission Plan economic cases.

2. Generation

The base cases used in the West Texas Sensitivity Study include all existing generation facilities and planned generation facilities modeled in the 2012 Five-Year Transmission Plan. These generating facilities were included in the 2012 Five-Year Transmission Plan cases to meet the Five-Year Transmission Plan study criteria:

- Stephens-Borlynn Wind Project, 360 MW, Borden County
- RRE Austin Solar, 80 MW, Travis County
- Panda Sherman Natural Gas Combined Cycle, 743 MW, Grayson County
- Panda Temple Natural Gas Combined Cycle, 1485 MW, Bell County

Hydro-electric power plants were also kept offline throughout the analysis since the future year availability of water was not known.

Mothballed generation units were placed in-service in the reliability analysis per the SSWG Procedure Manual Section 4.3.3.1. Because the analysis was divided into regions, the mothballed plants in a given region were not placed in-service when that region was being analyzed.

The generation output for all wind plants within the North and West region was set at zero and the Coastal region was dispatched at 10% for the reliability analysis.

3. Transmission Model

The 2012 Five-Year Transmission Plan final cases for 2015 and 2017 summer peak base cases posted in December 2012 were used as the starting point models for the transmission topology. These cases contain all 2012 Five-Year Transmission reliability and economic projects for all weather zones. The cases were updated to incorporate input from TOs and recently approved RPG projects. The key updates include the Atlas Load Integration Project (2015 and 2017 cases), the 138 kV line from Permian Basin to Culberson (modeled in 2017 case), the radial 138 kV line from Ringtail to Yucca (Tier 4 modeled in the 2017 case), and the ratings of several TNMP 69 kV facilities located in Reeves and Ward Counties (2015 and 2017 cases). More details can be found in Appendix E.

III. Reliability Driven Projects

The project completion years stated in this West Texas Sensitivity Study were chosen to timely address reliability and economic needs. The TOs will attempt to meet these project completion dates, but lead times necessary to implement projects based on factors such as availability of construction clearances, time required to receive required regulatory or governmental approvals, equipment availability, land acquisition and resource constraints may result in different project completion dates. It should be noted that the scope of the projects identified in this report may change if further analysis by ERCOT or the TOs and TPs finds better alternatives or a need for modifying the projects due to a change in demand or generation assumptions is identified. Projects requiring Regional Planning Group (RPG) approval will be reviewed in future assessments (where sufficient lead time exists), such as future ERCOT Regional Transmission Plans to make sure the identified system facilities are still needed.

1. Midland, Ector and Andrews County Reliability Project

The load in Midland and Ector Counties is served mainly by the 345/138 kV transformers at the Moss, Odessa EHV and Midland East substations through the 138 kV lines running between the transformers, while the load in Andrews County is supported mainly by the 138 kV and 69 kV lines from the Holt substation (Ector County), and the two long 138 kV lines from Lamesa (Dawson County) and Wink (Winkler County) substations.

Compared to the 2017 case built for the 2012 Five-Year Transmission Plan, the 2017 normal load case built for the West Texas Sensitivity Study has nearly 670 MW of additional load modeled in Midland, Ector and Andrews Counties. Primarily driven by the oil and gas business development and supporting commercial, industrial and residential development in the region, the significant load increase will cause wide spread overloads and low voltages under system intact and contingency conditions. The study result of the 2017 normal load case indicates the overload of roughly 83 miles of 138 kV lines, 11 miles of 69 kV lines and two existing 345/138 kV transformers at Moss and Midland East. In addition to the overload issues, 37 low voltage buses (100 kV and above) are found under either system intact or contingency conditions. The low voltage issues extend to some of the buses in Dawson County. These unacceptable system issues in the region precipitate the need for transmission reinforcement. Figure 3.1 illustrates the system issues in Midland, Andrews and Ector Counties.

Several options were tested to resolve the thermal and voltage issues identified in Figure 3.1, including the ones listed below:

- Option A: Major new 345 kV and 138 kV lines on new rights of way:
    - Construct a new 345 kV line from Midland East to Andrews North (~52 miles)
    - Expand the existing Andrews North 138 kV substation to accommodate new 345/138 kV facilities
    - Install a new 345/138 kV transformer at the Andrews North station
    - Construct a new 345/138 kV substation adjacent to the Quail-Longshore 345 kV line and install a new 345/138 kV transformer
    - Construct a new 138 kV line (~15 miles) from the new substation to Midessa

  - Construct a new 138 kV line from Midessa to Gardendale (bus number # 1183, ~7.2 miles)
- Option B: Switch existing line (from SPP) into ERCOT, convert from 230 kV operation to 138 kV operation, and construct a new 138 kV line on new right of way:
  - Tap the existing Midland East-Moss 345 kV line (~ 50% from each end) to construct a new 345/138 kV substation and install a new 345/138 kV transformer at the new substation
  - Connect the new 345/138 kV substation to Gardendale (bus number # 1183) at 138 kV
  - Construct a new 138 kV line from Midessa to Gardendale (~7.2 miles)
  - Tap the existing Amoco Three Bar tap-Arena 138 kV line and construct a new 138 kV substation,
  - Disconnect an existing 230 kV line that is currently connected to the Southwest Power Pool (SPP) System and connect it to the ERCOT System at 138 kV operation. Connect the new 138 kV substation in Andrews Counties and the new 345/138 kV substation near Gardendale through the Amoco Midland Farm Tap 138 kV substation (~ 40.2 miles) using this line.
- Option C: Switch existing line (from SPP) into ERCOT, convert from 230 kV operation to 345 kV operation, and construct a new 138 kV line on new right of way:
  - Construct a new 345/138 kV substation at or near the existing Gardendale substation
  - Loop the existing Moss-Midland East 345 kV line into the new 345/138 kV substation
  - Install a new 500 MVA 345/138 kV transformer at the new 345/138 kV substation at or near Gardendale
  - Loop the existing Grandview-Mockingbird and Texaco Tap-Ector Hillmont double circuit 138 kV line into the new 345/138 kV substation
  - Construct a new 138 kV line from the new substation at or near Gardendale to Midessa (~7.2 miles)
  - Construct a new 345/138 kV substation adjacent to the existing Amoco-Arena 138 kV line
  - Disconnect an existing 230 kV line that is currently connected to the SPP System and connect it to the ERCOT System at 345 kV operation. Connect the 345 kV line from the new 345/138 kV substation at or near Gardendale to the new 345/138 kV substation adjacent to the existing Amoco-Arena 138 kV line in Andrews County
  - Loop the existing Amoco-Arena 138 kV line into the new 345/138 kV substation
  - Install a new 500 MVA 345/138 kV transformer at the new 345/138 kV substation adjacent to the existing Amoco-Arena 138 kV line

Option A addresses most of the system issues and provides better system loss reduction than Option C. However, Option A requires significant new rights of way for the new 345 kV (~52 miles) and 138 kV (~22 miles) lines. Estimated by ERCOT, the capital cost of Option A is likely to be more than $200 million. Option B addresses most of the system issues, but it does not provide better system performance and system loss reduction compared to Option C. Therefore,

Option A and Option B were not selected based on system performance, system losses, public impact and construction cost.

Based on the evaluation of different options, Option C is selected as the preferred solution to address most of the system issues in the three counties:

#1 Construct a new 345/138 kV substation at or near the existing Gardendale substation
#2 Loop the existing Moss-Midland 345 kV line into the new 345/138 kV substation
#3 Install a new 500 MVA 345/138 kV transformer at the new 345/138 kV substation near Gardendale
#4 Loop the existing Grandview-Mockingbird and Texaco Tap-Ector Hillmont double circuit 138 kV lines into the new 345/138 kV substation
#5 Construct a new 138 kV line from the new substation near at or near Gardendale to Midessa (~7.2 miles). Minimum emergency rating applied for the new line is 394 MVA
#6 Construct a new 345/138 kV substation adjacent to the existing Amoco-Arena 138 kV line
#7 Disconnect an existing 230 kV line that is currently connected to the SPP System and connect it to the ERCOT System at 345 kV operation Connect the 345 kV line from the new 345/138 kV substation near Gardendale to the new 345/138 kV substation adjacent to the existing Amoco-Arena 138 kV line in Andrews County. Connect the 345 kV line from the new 345/138 kV substation near Gardendale to the new 345/138 kV substation adjacent to the existing Amoco-Arena 138 kV line in Andrews County. Minimum emergency rating applied for the line is 717 MVA per information provided by Sharyland Utilities
#8 Loop the existing Amoco-Arena 138 kV line into the new 345/138 kV substation
#9 Install a new 500 MVA 345/138 kV transformer at the new 345/138 kV substation adjacent to the existing Amoco-Arena 138 kV line

Option C addresses a number of overload issues, improves voltage in the region, provides operational flexibility during maintenance and construction, and reduces transmission losses significantly. A high-level loss analysis indicates roughly 34 MW of transmission loss reduction with the preferred project modeled in the 2017 West Texas base case.

Part of the project involves connecting the new 345/138 kV substation at or near Gardendale and the new 345/138 kV substation adjacent to the existing Amoco-Arena 138 kV line. The two new substations will be connected by an existing 230 kV transmission line that is currently connected in the SPP system. The line will be disconnected from the SPP system, connected to the ERCOT system, and converted from 230 kV to 345 kV operation. Recently, Xcel SPS and Sharyland Utilities have signed a purchase agreement so that Sharyland Utilities can acquire this existing 230 kV transmission line. The acquisition plan is subject to regulatory approval by the PUCT. The existing 230 kV line was originally constructed for up to 345 kV operation. Thus, relatively minimal effort is expected for the voltage conversion. If the Xcel SPS line is not acquired and integrated into ERCOT, transmission upgrades similar to those described in Option A may be necessary.

In addition to the line conversion, the project includes construction of a new 138 kV line from the new substation at or near Gardendale to Midessa (7.2 miles) to relieve the loadings on the 138 kV lines between Moss, Odessa EHV, and Midland East.

The project described above resolves most of the system issues in the region, but some local overload and low voltage issues remain. The remaining issues needs to be addressed by the following transmission reinforcements:

#1 Upgrade the Midland East-Windwood 138 kV line (3.3 miles, Minimum emergency rating assumed: 326 MVA)
#2 Upgrade the Westover-Amoco South Foster 138 kV line (0.6 mile, Minimum emergency rating assumed: 326 MVA)
#3 Upgrade the Odessa North-Amoco South Foster 138 kV line (4.3 miles, Minimum emergency rating assumed: 326 MVA)
#4 Upgrade the Fullerton-Exxon Fullerton 69 kV line (0.01 miles, Minimum emergency rating assumed: 109 MVA)
#5 Upgrade the CRMWD 8 Tap-Glenhaven 138 kV line (4.8 miles, Minimum emergency rating assumed: 326 MVA)
#6 Upgrade the CRMWD 8 Tap-Midland Airport 138 kV line (0.7 miles, Minimum emergency rating assumed: 326 MVA)
#7 Upgrade the Odessa EHV Switch-Odessa 138 kV line (2.3 miles, Minimum emergency rating assumed: 394 MVA, if 394 MVA is not achievable without rebuilding or reconductoring the line, the minimum target emergency rating of 652 MVA is recommended since the line is already rated at 326 MVA emergency in the 2017 West Texas base case)
#8 Install 36.8 Mvar capacitor bank at the Andrews North 138 kV substation

Both the aforementioned project and the local transmission upgrades are needed in order to meet the reliability criteria in the 2015 case.

Some of the projects above exist in the June-2013 TPIT report and are scheduled for completion in 2013, 2014 or 2015. The upgrade of the Fullerton-Exxon Fullerton 69 kV line was completed on 7/25/2013. The upgrade of the Odessa EHV-Odessa 138 kV line is scheduled for completion in December 2014. The upgrade of the Midland Airport-CRMWD 8 Tap-Glenhaven 138 kV line is scheduled for completion in May 2015. The projected completion date of the upgrade of the Westover-Amoco South Foster 138 kV line, and the Odessa North-Amoco South Foster 138 kV line is currently December 2015. Mitigation plan(s) will need to be developed if the projects cannot be completed before summer 2015.

The overload issues and the worst contingencies are listed in the table below. More details of the system problems can be found in Appendix A and B.

Table 3.1 Thermal overload issues in Midland, Ector and Andrews Counties

Overloaded Element	Worst Contingency	Percent Overload	
		2015	2017
Amoco South Foster - Odessa North 138 kV	Odessa EHV - Odessa 138 kV	125.22	142.02

Crmwd 8 Tap - Midland Airport 138 kV	Midland East 345/138 kV Xfmr	101.73	123.94
Fullerton - Exxon Fullerton 69 kV	Holt Switch - Emma Tap 69 kV	104.80	125.77
Glenhaven - Crmwd 8 Tap 138 kV	Midland East 345/138 kV Xfmr	102.32	124.54
Holt Switch - Emma Tap 69 kV	Holt Switch - Amoco Midland Farms Tap 138 kV	105.77	119.39
Midland East – Windwood 138 kV	Odessa EHV - Liquid Air 138 kV	137.74	156.81
Moss Switch 345/138 kV Xfmr	Midland East 345/138kV Xfmr	117.54	102.64
Odessa EHV - Odessa 138 kV	Moss Switch 345/138 kV Xfmr	100.93	115.85
Texas Junction Tap – Odessa Texas Instruments 138 kV	Odessa EHV - Liquid Air 138 kV	107.30	127.40
Westover - Amoco South Foster 138 kV	Odessa EHV - Odessa 138 kV	128.21	145.15
Permian Basin To Wink Switch 138 kV*	Permian Basin - Ward Gulf Tap 138 kV	113.24	114.02
Permian Basin - Ward Gulf Tap 138 kV*	Permian Basin To Wink Switch 138 kV	N/A	101.24
Midland East 345/138kV Xfmr	Odessa EHV – Liquid Air 138 kV	N/A	112.41
Odessa EHV- Liquid Air 138 kV	Midland East 345/138kV Xfmr	N/A	114.95
Midessa - Midland West 138 kV	Midland East 345/138kV Xfmr	N/A	107.95
Odessa Texas Instruments - Midessa 138 kV	Odessa EHV - Liquid Air 138 kV	N/A	111.25
Windwood - Midland West 138 kV	Odessa EHV - Liquid Air 138 kV	N/A	115.69
Odessa - Glen Haven 138 kV	Midland East 345/138kV Xfmr	N/A	110.18
Liquid Air - Odessa 138 kV	Midland East 345/138kV Xfmr	N/A	112.88
Holt Switch - Amoco Midland Farms Tap 138 kV	Lamesa - West Dawson 138 kV	N/A	102.92
Andrews North - Bakke Tap 69 kV	Holt Switch - Emma Tap 69 kV	N/A	102.24
Ector Hillmont - 1183 138 kV	Midland East - Goddard 138 kV	N/A	114.58
Moss – Ector Hillmont 138 kV	Midland East - Goddard 138 kV	N/A	129.99
Midland East - Goddard 138 kV	Moss – Ector Hillmont 138 kV	N/A	107.52

* Permian Basin-Wink and Permian Basin-Ward Gulf Tap 138 kV lines are located in Ward and Winkler Counties. However, these issues are noted in this section because the major project addresses the line overloads.

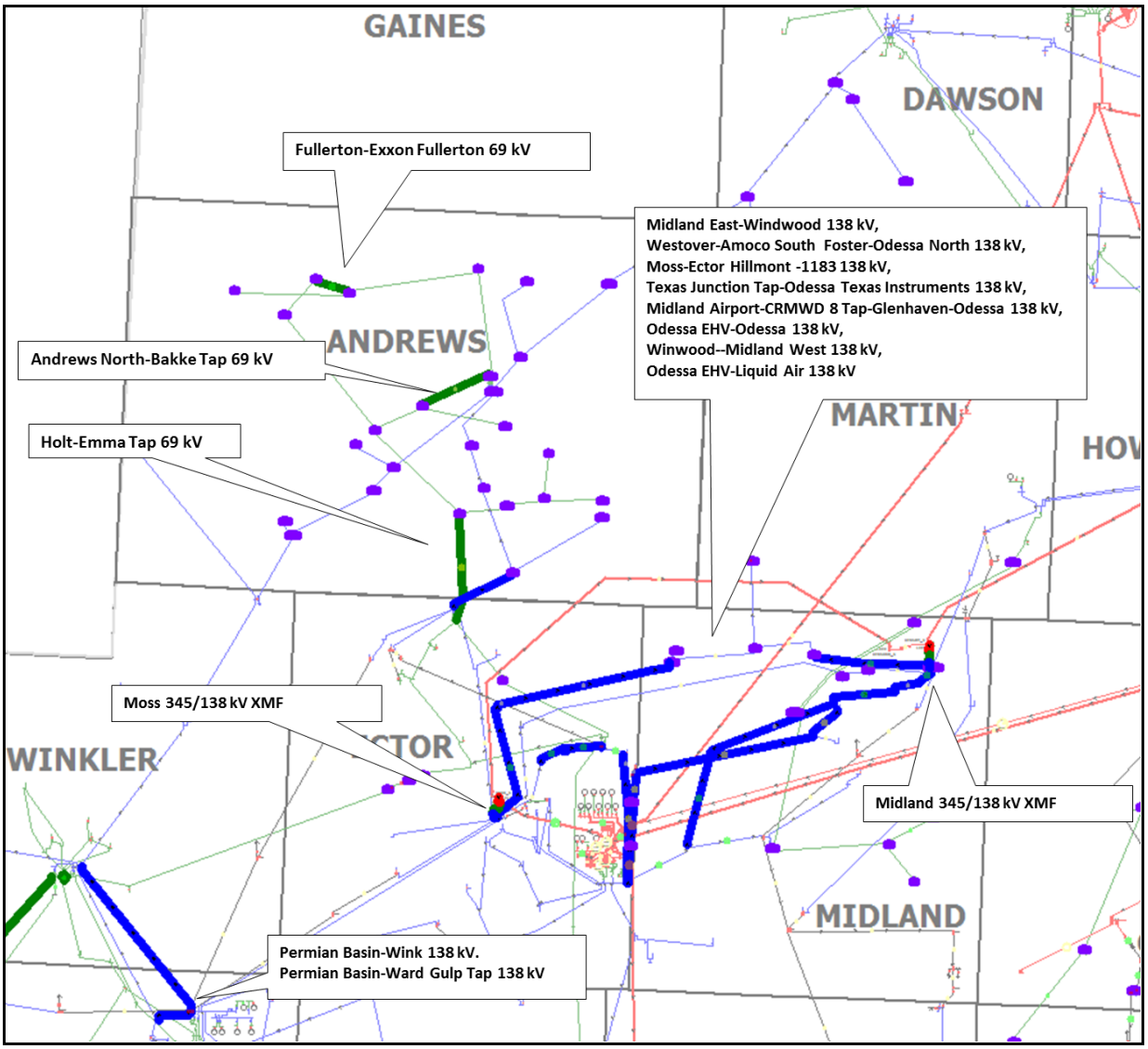


Figure 3.1 Map of system issues in Midland, Ector and Andrew Counties (2017 normal load condition)

2. Reagan and Crockett County Reliability Project

A significant increase in load is expected in Reagan and Crockett Counties. Compared to the 2017 case built for the 2012 Five-Year Transmission Plan, the 2017 normal load case has nearly 200 MW of additional load modeled in the counties.

The load in the area is currently served by the 138/69 kV transformers at Big Lake and Friend Ranch and through the 138 kV and 69 kV lines between the 138/69 kV substations. Due to the load increase, the existing transmission system in Reagan and Crockett Counties needs transmission reinforcement to address a number of overloads and low voltages under system intact and contingency conditions. The study result of the 2017 normal load case indicates the

overload of roughly 65 miles of 69 kV lines, 47 miles of 138 kV lines and two 138/69 kV transformers. In addition to the thermal issues, seven low voltage buses (100 kV and above) were found under system intact and contingency conditions.

Among the overloaded 69 kV lines, the power flows on the Big Lake-Kemper Exxon Tap-Powell Field Tap 69 kV lines and the Shell Powell Tap-Powell Field 69 kV line exceed the line ratings under system intact condition. The two long 138 kV lines to Big Lake from North McCamey and from Twin Buttes are either overloaded or experience heavy flow under contingency conditions. The existing 138/69 kV transformers at Big Lake are also susceptible to overload under contingency conditions. Figure 3.2 illustrates the system issues of the region.

Several options were tested to resolve the thermal and voltage issues, including the ones listed below:

- Option A
  - Close the normally-open Powell Field-Powell Field Junction 69 kV line
  - Close the normally-open Illinois #4-Pandale 69 kV line
  - Maintain neutral or appropriate narrow bandwidth for the phase shifter at Big Lake during certain system conditions
  - Expand the existing Humble Tap (Powell Field Tap) 69 kV substation to accommodate new 138/69 kV facilities
  - Loop the existing Big Lake-North McCamey 138 kV line into the expanded Humble Tap substation
  - Install a new 138/69 kV transformer at the expanded Humble Tap substation
  - Upgrade the existing Big Lake-Kemper Exxon Tap 69 kV line (5.6 miles)
  - Upgrade the existing Kemper Exxon Tap-Humble Tap (Powell field Tap) 69 kV line (0.3 mile)
  - Upgrade the existing Shell Powell Tap-Powell Field 69 kV line (5 miles)
- Option B:
  - Close the normally-open Powell Field-Powell Field Junction 69 kV line
  - Close the normally-open Illinois #4-Pandale 69 kV line
  - Maintain neutral or appropriate narrow bandwidth for the phase shifter at Big Lake during certain system conditions
  - Upgrade the two existing 138/69 kV transformers at Big Lake
  - Upgrade the existing Big Lake-Kemper Exxon Tap 69 kV line (5.6 miles)
  - Upgrade the existing Kemper Exxon Tap-Humble Tap (Powell field Tap) 69 kV line (0.3 mile)
  - Upgrade the existing Shell Powell Tap-Powell Field 69 kV line (5 miles)

Although Option B addresses most of system issues, there are still remaining low voltage and overload issues under contingency conditions such as the loss of the 69 kV lines from Big Lake toward Kemper Exxon Tap. Thus, Option B is not selected as the potential solution.

Based on the evaluation of different options, Option A is selected as the preferred solution to address the system issues:

#1 Close the normally-open Powell Field-Powell Field Junction 69 kV line
#2 Close the normally-open Illinois #4-Pandale 69 kV line

#3 Maintain neutral or appropriate narrow bandwidth for the phase shifter at Big Lake during certain system conditions
#4 Expand the existing Humble Tap (Powell Field Tap) 69 kV substation to accommodate new 138/69 kV facilities
#5 Loop the existing Big Lake-North McCamey 138 kV line into the expanded Humble Tap substation
#6 Install a new 138/69 kV transformer at the expanded Humble Tap substation (Minimum emergency rating assumed: 143 MVA)
#7 Upgrade the existing Big Lake-Kemper Exxon Tap 69 kV line (5.6 miles, Minimum emergency rating assumed: 109 MVA)
#8 Upgrade the existing Kemper Exxon Tap-Humble Tap (Powell field Tap) 69 kV line (0.3 mile, Minimum emergency rating assumed: 109 MVA)
#9 Upgrade the existing Shell Powell Tap-Powell Field 69 kV line (5 miles, Minimum emergency rating assumed: 109 MVA)

All of the projects selected above are needed in order to meet the reliability criteria in the 2015 case.

Part of the projects involves appropriately operating the existing phase shifter at Big Lake. The angle of the phase shifter will need to be maintained at neutral or a very narrow bandwidth to avoid potential overload or heavy flow on the transformers at Big Lake or the 138 kV line toward the new 345/138 kV substation (new substation driven by G-1+N-1) near Ringtail in anticipation of a contingency under peak load condition.

Originally, several new capacitor banks were considered as part of the potential project set to obtain acceptable voltage levels. However, they were removed due to voltage support provided by the new 345/138 kV project near Ringtail proposed for the G-1+ N-1 system issue (Ref: Section for G-1-N-1 Reliability Project for Reagan, Upton, Irion and Tom Green Counties).

The overload issues and the worst contingencies are listed in the table below. More details of the system problems can be found in Appendix A and B.

Table 3.2 Thermal overload issues in Reagan and Crockett Counties

Overloaded Element	Worst Contingency	Percent Overload	
		2015	2017
Big Lake - Big Lake Philips Tap 69 kV	Friend Ranch 138/69 kV Xfmr	156.26	165.3
Big Lake 138/69 kV Xfmr	Big Lake 138/69 kV2Xfmr	134.35	131.82
Big Lake 138/69 kV Xfmr	Big Lake 138/69 kV Xfmr	135.13	132.61
Cactus - Iraan 69 kV	West Yates - Air Products Tap 69 kV	N/A	101.07
Friend Ranch - Ozona 69 kV	Temprank4A - North McCamey 138 kV (2017) Twin Buttes - Schkade & Big Lake 138 kV (2015)	108.53	119.02
Humble Tap- Atlantic Best Tap 69 kV	Friend Ranch 138/69 kV Xfmr	N/A	107.62

Temprank4A - North McCamey 138 kV	Twin Buttes - Schkade & Big Lake 138 kV	N/A	102.7
Midway Lane - Ozona 69 kV	Friend Ranch 138/69 kV Xfmr	133.74	137.01
Big Lake Philips Tap - Strauss Rea 69 kV	Friend Ranch 138/69 kV Xfmr	155.56	164.52
Powell Field Tap - Midway Lane 69 kV	Strauss Rea - Powell Field Tap 69 kV	150.62	159.03
Big Lake - Temprank4A 138 kV	Twin Buttes - Schkade & Big Lake 138 kV	N/A	102.84
Midway Lane - Ozona 69 kV	Friend Ranch 138/69 kV Xfmr	133.74	N/A
Powell Field Tap - Strauss Rea 69 kV	Friend Ranch 138/69 kV Xfmr	150.49	N/A
Strauss Rea - Powell Field Tap 69 kV	Friend Ranch 138/69 kV Xfmr	150.49	N/A

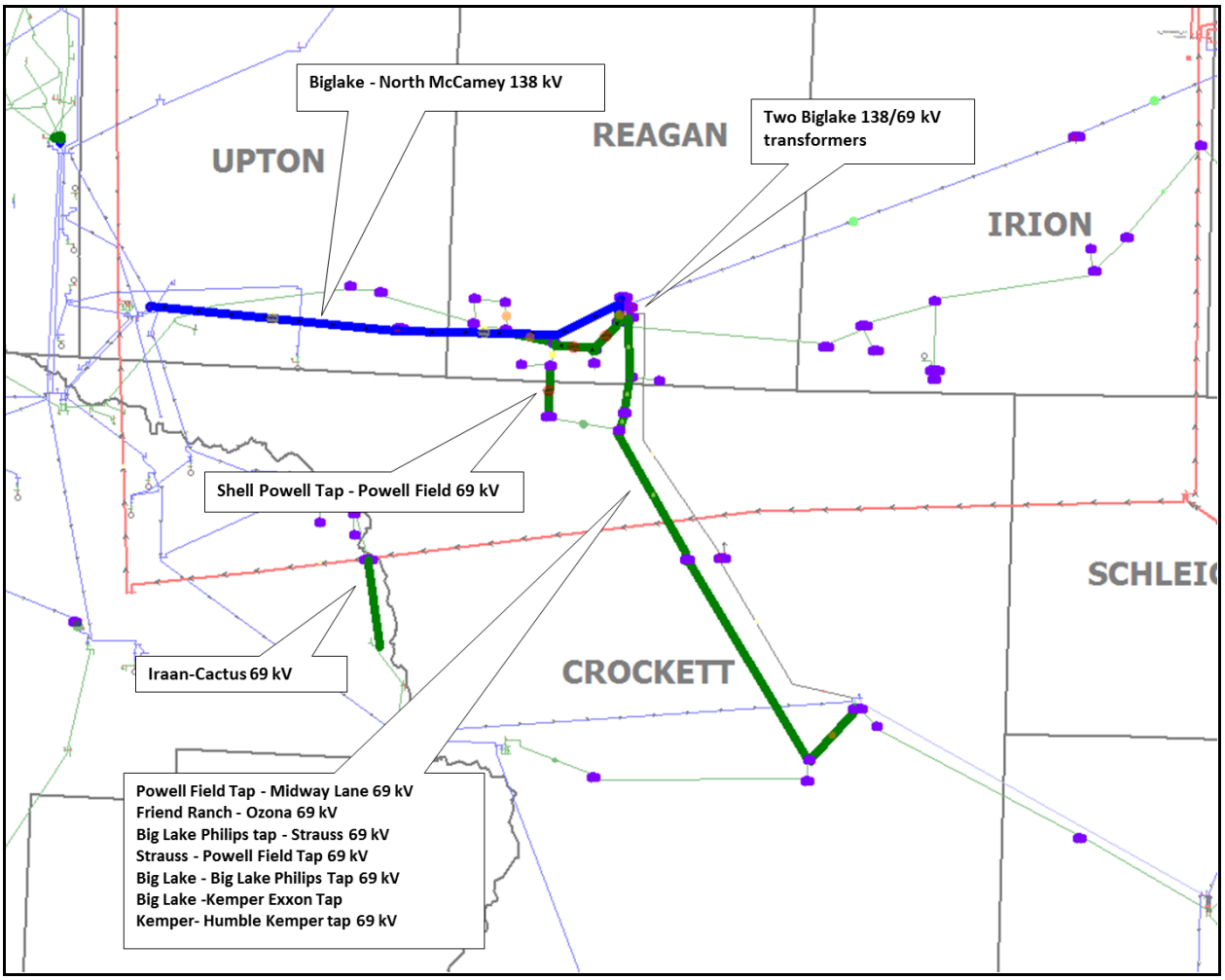


Figure 3.2 Map of system issues in Reagan and Crockett Counties (2017 normal load condition)

3. Reeves, Winkler and Ward County Reliability Project

The load in Reeves, Winkler and Ward Counties is served mainly through the lengthy 69 kV lines out of the Wink and TNP Wink 138/69 kV substations. Approximately 41 MW of additional load is expected in the counties by 2017, compared to the 2017 case built for the 2012 Five-Year Transmission Plan.

The study result of the 2017 normal load case indicates the overload of roughly 15 miles of 69 kV lines, including the Wink-TNP Wink 69 kV line and the TNP Wink-AA Pipeline-TNP Lonestar Tap 69 kV lines under contingency conditions.

The options listed below were tested to resolve the thermal issues identified in Figure 3.3.

- Option A:
  - Construct a new 138 kV line from a tap off of the existing Barilla-Musquiz 138 kV line to Pecos (27.7 miles)
  - Install a new 138/69 kV transformer at Pecos
- Option B: Rebuilding the TNMP Wink-Lone Star Tap-Barstow Tap-Pecos 69 kV lines (33 miles)
- Option C:
  - Construct a new 138 kV substation adjacent to the existing Barilla-Musquiz 138 kV line
  - Loop the existing Barilla-Musquiz 138 kV line into the new 138 kV substation
  - Expand the existing Flat Top 69 kV substation to accommodate new 138/69 kV facilities
  - Install a new 138/69 kV transformer at Flat Top
  - Construct a new 138 kV line from the new substation (#1) to Flat Top (~8.7 miles)
  - Upgrade the existing Barilla Draw Field Tap-Flat Top 69 kV line (5.7 miles)

Although Option A addresses the system issues, it requires 28 miles of new right of way for a new 138 kV line while it leaves 18 miles of existing 69 kV line from IH-20 toward Flat Top as a radial line serving the load at Barilla Draw Field Tap and Flat Top. Option B addresses the system issues except the overload of the Wink-Wink TNP 69 kV line. Provided by TNMP, the estimated capital costs of Option A and Option B are roughly $25 million and $15 million, respectively. Option C addresses the system issues, provides a network service to Flat Top and Barilla Draw Tap, and is expected to cause relatively less public impact because the new 138 kV line will use 8.7 miles of existing unused 69 kV line right of way. The estimated capital cost of Option C is about $16.5 million. Based on the cost, public impact and system performance, Option C is the best option.

Based on the evaluation of different options, the following potential project, Option C, is needed for the area to resolve the overload issues in Figure 3.3:

#1 Construct a new 138 kV substation adjacent to the existing Barilla-Musquiz 138 kV line
#2 Loop the existing Barilla-Musquiz 138 kV line into the new 138 kV substation
#3 Expand the existing Flat Top 69 kV substation to accommodate new 138/69 kV facilities
#4 Install a new 138/69 kV transformer at Flat Top

#5 Construct a new 138 kV line from the new substation (#1) to Flat Top (~8.7 miles, Minimum emergency rating assumed: 326 MVA)
#6 Upgrade the existing Barilla Draw Field Tap-Flat Top 69 kV line (5.7 miles, Minimum emergency rating assumed: 109 MVA)

The potential project addresses the overload issues, provides a network service to the radially-served Flat Top and Barilla Draw Field Tap 69 kV substations, and provides operational flexibility during maintenance or construction.

Except upgrading the Barilla Draw Field Tap-Flat Top 69 kV line, the projects listed above are needed in order to meet the reliability criteria in the 2015 case. The existing Barilla Draw Field Tap-Flat Top 69 kV line is slightly overloaded in 2017 due to the new 138 kV injection into the Flat Top station under contingency condition. Thus, upgrading the Flat Top-Barilla Draw Field Tap 69 kV line is needed by 2017.

The overload issues and the worst contingencies are listed in the table below. More details of the system problems can be found in Appendix A and B.

Table 3.3 Thermal overload issues in Reeves, Winkler and Ward Counties

Overloaded Element	Worst Contingency	Percent Overload	
		2015	2017
AA Pipeline TNP - Lonestar Tap TNP 69 kV	Wink TNP - Bonesprings Tap 69 kV	N/A	107.62
Wink TNP - AA Pipeline TNP 69 kV	Wink TNP – Bonesprings Tap 69 kV	N/A	107.67
Wink Sub - Wink TNP 69 kV	Wink Sub - Wink TNP 138 kV	117.42	125.14

Note that the Permian Basin-Wink and Permian Basin-Ward Gulf Tap 138 kV line overload issues were already listed in the table in Section 1 (Midland, Ector, Andrews Counties) since the line overloads were relieved by the new 345/138 kV project in the section.

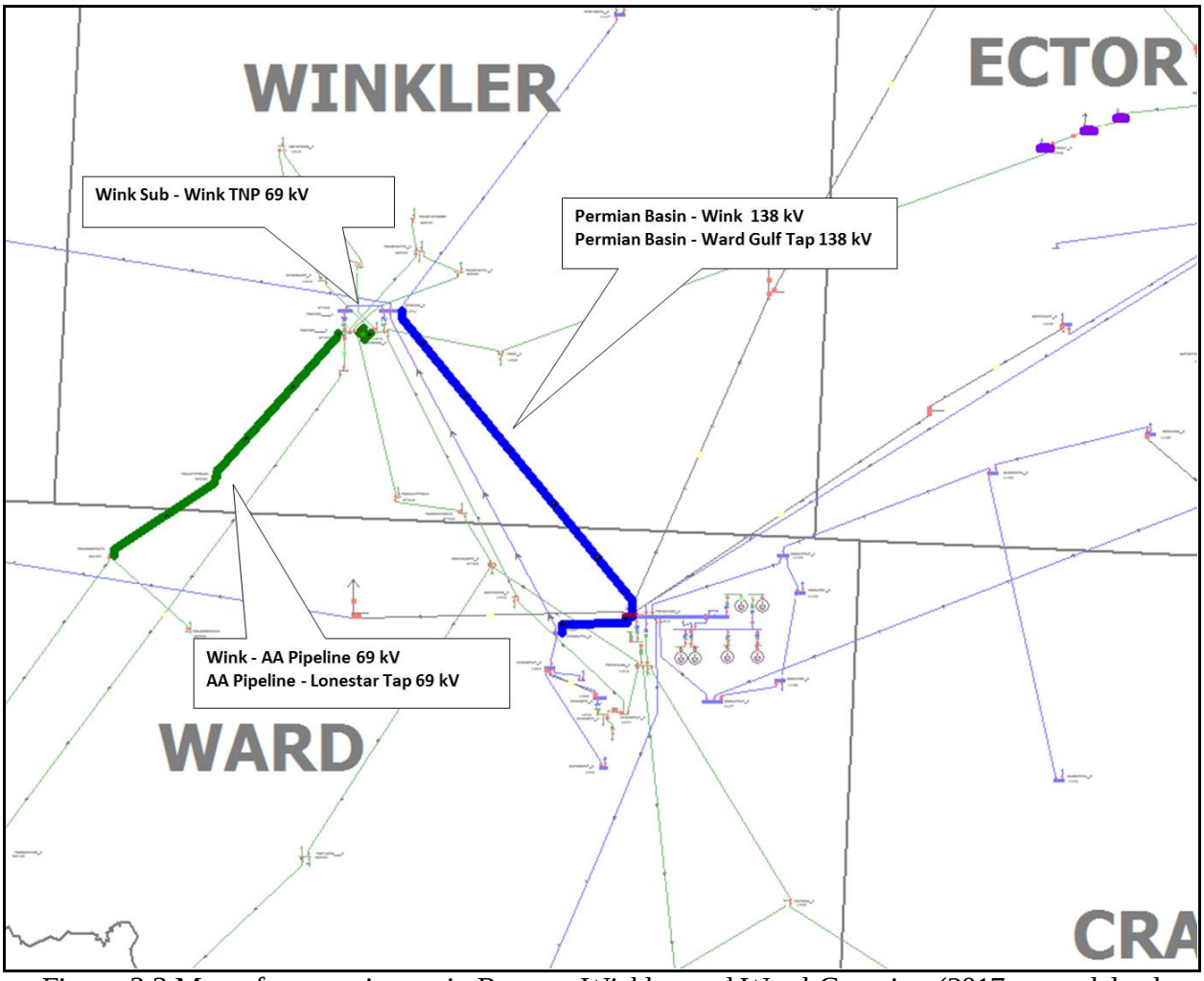


Figure 3.3 Map of system issues in Reeves, Winkler and Ward Counties (2017 normal load condition)

4. Crane County Reliability Project

Approximately 40 MW of additional load is expected in Crane County by 2017, compared to the 2017 case built for the 2012 Five-Year Transmission Plan. The load in the area is mainly served by the two existing 138/69 kV transformers at Crane. One transformer is rated at 143 MVA (AEP) and the other is rated at 84 MVA (ONCOR). The study result indicates the overload of the 84 MVA transformer and the Crane 69 kV bus tie for the loss of the 143 MVA transformer.

The potential projects to address the overload issues identified in Figure 3.4 are

#1 Upgrade the existing smaller 138/69 kV transformer at Crane (Minimum emergency rating assumed: 143 MVA)

#2 Upgrade the existing 69 kV bus tie at Crane (Minimum emergency rating assumed: 124 MVA)

The projects are needed in order to meet the reliability criteria in the 2015 case.

The overload issues and the worst contingencies are listed in the table below. More details of the system problems can be found in Appendix A and B.

Table 3.4 Thermal overload issues in Crane County

Overloaded Element	Worst Contingency	Percent Overload	
		2015	2017
Crane 69 kV bus tie	Crane 138/69 kV Xfmr (AEP)	144.41	150.27
Crane 138/69 kV Xfmr (ONCOR)	Crane 138/69 kV Xfmr (AEP)	110.55	116.71

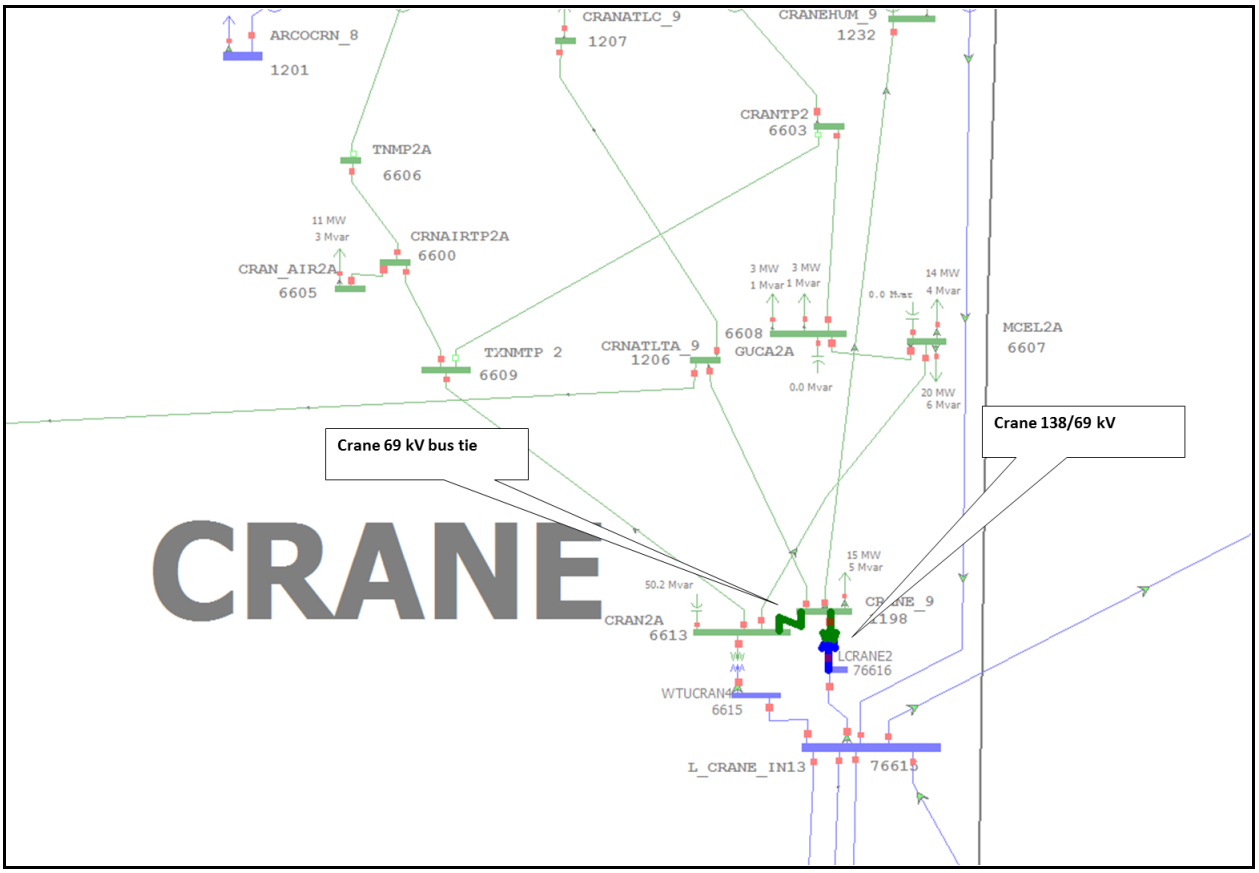


Figure 3.4 Map of system issues in Crane County (2017 normal load condition)

5. Tom Green and Irion County Reliability Project

Compared to the 2017 case built for the 2012 Five-Year Transmission Plan, approximately 132 MW of additional load is modeled in Tom Green and Irion Counties for the 2017 normal load case. Approximately half of the area load is served through the 138 kV lines running between the 345/138 kV transformers at Red Creek and Twin Buttes. The rest of the load is served by the 69 kV lines connecting the 138/69 kV transformers located at San Angelo Concho, San Angelo North, San Angelo College Hills and San Angelo Power Station.

Due to the load increase in the area, the study result of the 2017 normal case indicates the overloads of multiple transmission facilities:

- One of the two existing 345/138 kV transformers at San Angelo Red Creek
- Roughly 16 miles of 138 kV lines from San Angelo Red Creek to Highland Street and from San Red Creek to Paul Ann
- Roughly 10.3 miles of a 69 kV line from San Angelo Concho to Mathis Field
- Existing 138/69 kV transformer at San Angelo North

Based on the inputs from AEP, several options were developed and tested to resolve the system issues identified in Figure 3.5:

- Option A:
  - Construct a new Little Hill Station on the San Angelo Power Station (SAPS) to Eldorado Live Oak 138 kV line
  - Install a new 345/138 kV autotransformer at Little Hill
  - Construct a 345 kV line between Big Hill and Little Hill (~0.7 miles)
  - Loop the Santiago-Live Oak 138 kV line into Little Hill
  - Upgrade the SAPS to Little Hill 138 kV line (~26 miles)
  - Upgrade the Eldorado Live Oak to Little Hill 138 kV line (~12 miles)
  - Rebuild the Red Creek to Concho 138 kV line (~9.7 miles)
  - Construct a new 138 kV line from Ringtail to Yucca (13.5 miles, Note: this line is already modeled in the 2017 West Texas base case as a radial line serving Yucca from Ringtail, but not in the 2015 West Texas base case)
  - Convert the existing 69 kV line from Barnhart Phillips Tap to Yucca 138 kV to 138 kV (~12 miles)
  - Install a new 138/69 kV transformer at Barnhart Phillips Tap
- Option B:
  - Upgrade the existing Twin Buttes 345/138 kV transformer
  - Install a second 345/138 kV transformer at Twin Buttes
  - Construct a Grape Creek Tap 138 kV bus
  - Removes the College Hills to Grape Creek Tap 69 kV line
  - Construct a new Grape Creek Tap to Twin Buttes 138 kV line (~9.7 miles)
  - Construct a new Bluffs to Twin Buttes 138 kV line (~7.8 miles)
  - Upgrade the Bluffs -College Hills 138 kV line (~0.7 mile)
  - Install a new 138/69 kV transformer at Grape Creek Tap
  - Construct a new 138 kV line from Ringtail to Yucca (13.5 miles, Note: this line is already modeled in the 2017 West Texas base case as a radial line serving Yucca from Ringtail, but not in the 2015 West Texas base case)
  - Convert the existing 69 kV line from Barnhart Phillips Tap to Yucca 138 kV to 138 kV (~12 miles)
  - Install a new 138/69 kV transformer at Barnhart Phillips Tap
- Option C:
  - Upgrade the existing 345/138 kV transformer at Twin Buttes
  - Install a second new 345/138 kV transformer at Twin Buttes
  - Construct a new 138 kV line from Twin Buttes to Bluffs (~7.8 miles)
  - Upgrade the existing Bluffs-College Hills 138 kV line (~0.7 mile)

- Upgrade the existing 138/69 kV transformer at San Angelo North
- Upgrade the existing 138/69 kV transformer at College Hill
- Construct a new 138 kV line from Ringtail to Yucca (13.5 miles, Note: this line is already modeled in the 2017 West Texas base case as a radial line serving Yucca from Ringtail, but not in the 2015 West Texas base case)
- Convert the existing 69 kV line from Barnhart Phillips Tap to Yucca 138 kV to 138 kV (~12 miles)
- Install a new 138/69 kV transformer at Barnhart Phillips Tap

Both Option A and Option B cause other thermal issues calling for additional transmission upgrades in the region. The capital costs of Option A and Option B without the common element associated with Ringtail, Yucca and Barnhart are roughly $42 million and $56 million, respectively. Option C addresses the system issues and the capital cost of Option C without the common element associated with Ringtail, Yucca and Barnhart is roughly $28 million. Based on the system performance and the cost, Option A and Option B were not selected as the preferred solution for the region.

Based on the evaluation of different options, the following project, Option C, is selected as the preferred solution to address the system issues in these counties:

#1 Convert the existing 69 kV line from Barnhart Phillips Tap to Yucca 138 kV to 138 kV (Minimum emergency rating assumed: 345 MVA)
#2 Install a new 138/69 kV transformer at Barnhart Phillips Tap (Minimum emergency rating assumed: 99 MVA)
#3 Upgrade the existing 345/138 kV transformer at Twin Buttes (Minimum emergency rating assumed: 852 MVA)
#4 Install a second new 345/138 kV transformer at Twin Buttes (Minimum emergency rating assumed: 852 MVA)
#5 Construct a new 138 kV line from Twin Buttes to Bluffs (~7.8 miles, Minimum emergency rating assumed: 966 MVA)
#6 Upgrade the existing Bluffs-College Hills 138 kV line (~0.7 mile, Minimum emergency rating assumed: 966 MVA)
#7 Upgrade the existing 138/69 kV transformer at San Angelo North (Minimum emergency rating assumed: 143 MVA)
#8 Upgrade the existing 138/69 kV transformer at College Hill (Minimum emergency rating assumed: 143 MVA)
#9 Construct a new 138 kV line from Ringtail to Yucca (13.5 miles, Minimum emergency rating assumed: 345 MVA, Note: this line is already modeled in the 2017 West Texas base case as a radial line serving Yucca from Ringtail, but not in the 2015 West Texas base case. This is included as part of the project since it needs to be accelerated to meet the reliability criteria in the 2015 case)

The projects are needed in order to meet the reliability criteria in the 2015 case, except upgrading the existing 345/138 kV transformer at Twin Buttes and upgrading the existing 138/69 kV transformer at College Hill, These two items are needed to meet the reliability criteria in the 2017 case.

As noted in the project description, the new 138 kV line from Ringtail to Yucca is already modeled in the 2017 West Texas Sensitivity Study base case, serving the load at Yucca radially from Ringtail (March-12-2013-TPIT, 16TPIT0031, 16TPIT0032, and in-service year of 2016 as Tier 4). The study result of the 2015 base case indicates the overload of the 69 kV lines in Irion County under contingency conditions. Therefore, the projected in-service year of the new 138 kV line from Ringtail to Yucca should be accelerated to 2015. Upon completion of the conversion of the existing 69 kV line from Barnhart Phillips Tap to Yucca to 138 kV, the new 138 kV line from Ringtail to Yucca will become one of the key outlets of a new 345/138 kV injection proposed for the G-1+N-1 issue in the region. More details of the new 345/138 kV injection can be found in the section of the G-1+N-1 Reliability Project for Reagan, Upton, Irion and Tom Green Counties. These projects will provide a network service to Yucca and Barnhart and improves the voltages at the 69 kV buses in Irion County.

The overload issues and the worst contingencies are listed in the table below. More details of the system problems can be found in Appendix A and B.

Table 3.5 Thermal overload issues in Tom Green and Irion County

Overloaded Element	Worst Contingency	Percent Overload	
		2015	2017
Big Lake - Barnhart Tap 69 kV	San Angelo Concho - San Angelo Mathis Field 69 kV	116.89	N/A
Mertzon - Barnhart Philips Tap 69 kV	Big Lake - Barnhart Tap 69 kV	106.94	N/A
Mertzon - Mertzon Tap 69 kV	Big Lake - Barnhart Tap 69 kV	113.23	N/A
San Angelo Mathis Field – Tankersley 69 kV	Big Lake - Barnhart Tap 69 kV	137.38	N/A
Tankersley – Mertzon 69 kV	Big Lake - Barnhart Tap 69 kV	129.03	N/A
San Angelo Concho - San Angelo Mathis Field 69 kV	Big Lake - Barnhart Tap 69 kV	145.18	103.88
San Angelo North 138/69 kV Xfmr	San Angelo Concho 138/69 kV Xfmr	104.29	105.37
San Angelo Coke Street - Sa Highland Street 138 kV	Twin Buttes 345/138 kV Xfmr	105.23	107.16
San Angelo Red Creek - San Angelo Coke Street 138 kV	Twin Buttes 345/138 kV Xfmr	113.51	116.67
San Angelo Red Creek 345/138 kV Xfmr #1	San Angelo Red Creek 345/138 kV Xfmr #2	107.57	115.37
San Angelo Red Creek – Paul Ann 138 kV	San Angelo Red Creek – San Angelo Coke Street 138 kV	N/A	101.93

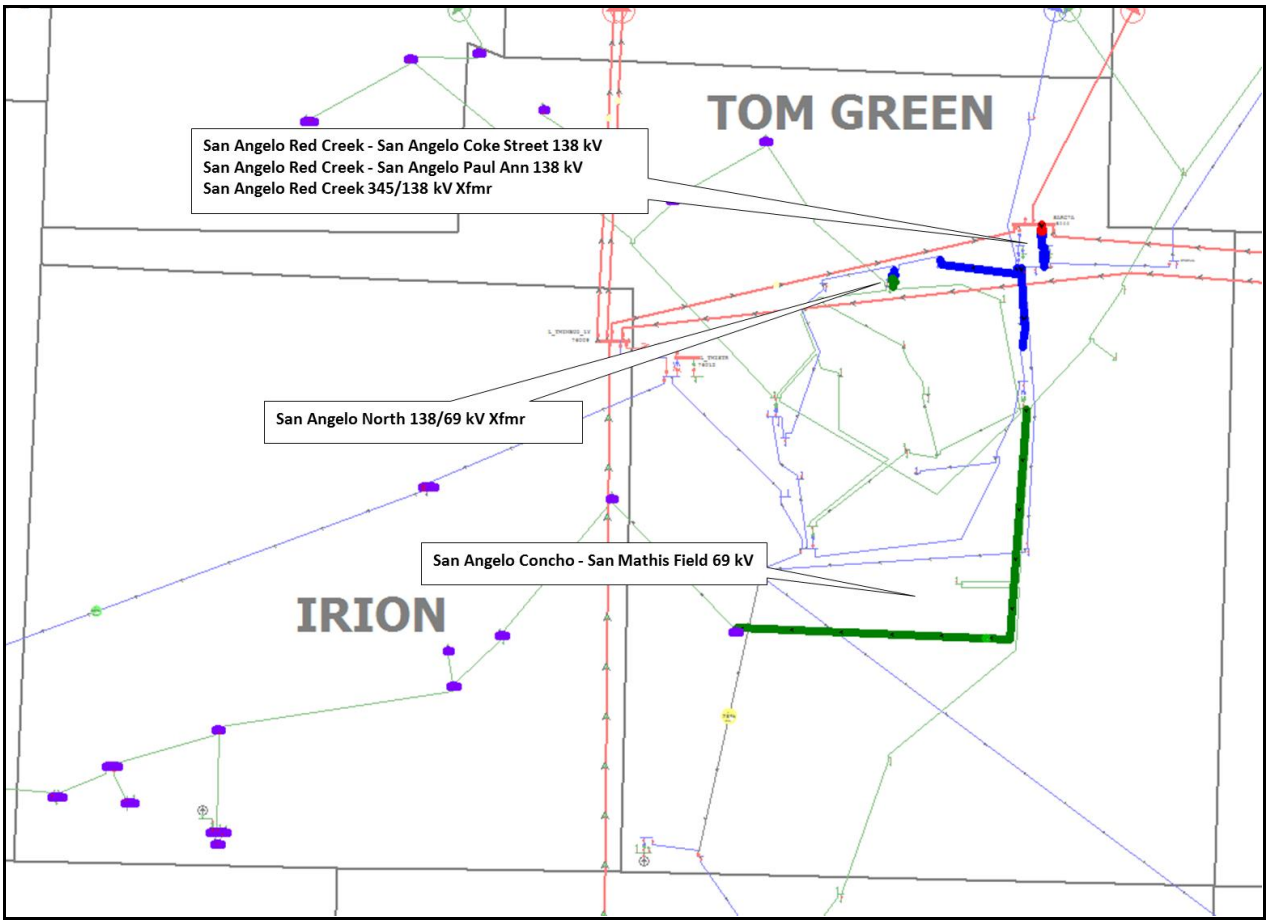


Figure 3.5 Map of system issues in Tom Green and Irion Counties (2017 normal load condition)

6. Menard and Mason County Reliability Project

The loads in McCulloch and the south of Concho Counties are being served by 69 kV lines from Yellow Jacket in Menard County and TNC Mason in Mason County. Compared to the 2017 case built for the 2012 Five-Year Transmission Plan, the 2017 normal load case has roughly 18 MW of additional load modeled in the region.

The study result of the 2017 normal load case indicates the overload of the TNC Mason-Katemcy 69 kV line (16.8 miles) for the loss of the Yellow Jacket-Eden 69 kV line, and the overload of the Yellow Jacket-Eden-Eden Rea Tap 69 kV lines (24.5 miles) for the loss of the TNC Mason-Katemcy 69 kV line.

Based on the inputs from AEP, several options were developed and tested to resolve the system issues identified in Figure 3.6:

- Option A:
  - Expand the existing North Brady 69 kV substation
  - Construct a new 69 kV line between North Brady and Mason Switching Station (~25 miles)

- Option B:
  - Construct a new Katemcy Station on the Mason to North Brady 69 kV line
  - Upgrade the Yellow Jacket-Eden 69 kV line (~20 miles)
  - Upgrade the Katemcy-Mason 69 kV line (~17 miles)
  - Install two 7.2 Mvar capacitor banks at Eden
- Option C:
  - Construct a new 69 kV line between Yellow Jacket and North Brady (~35 miles)

All these options address the system issues. It is also expected that Option A and Option C would provide operational flexibility for maintenance outage conditions on the existing system in the area due to the new 69 kV line on a new right of way required under both options. The capital cost of each option is $32 million for Option A, $39 million for Option B and $41 million for Option C. Thus, Option A is the best option as the least cost project.

Based on the evaluation of different options, the following project, Option A, is selected as the preferred solution to address the overload issues and to provide better operational flexibility to the system:

#1 Expand the existing North Brady 69 kV substation
#2 Construct a new 69 kV line from Mason Switch to North Brady (~25 miles, Minimum emergency rating assumed: 242 MVA)

The projects are needed in order to meet the reliability criteria in the 2015 case.

The overload issues and the worst contingencies are listed in the table below. More details of the system problems can be found in Appendix A and B.

Table 3.6 Thermal overload issues in Menard and Mason Counties

Overloaded Element	Worst Contingency	Percent Overload	
		2015	2017
TNC Mason Sub - Katemcy 69 kV	Yellow Jacket - Eden 69kV	NA	104.83
Yellow Jacket – Eden 69kV	TNC Mason Sub – Katemcy 69 kV	101.97	109.77
Eden-Mcec Tap 69 kV	TNC Mason Sub – Katemcy 69 kV	N/A	103.21

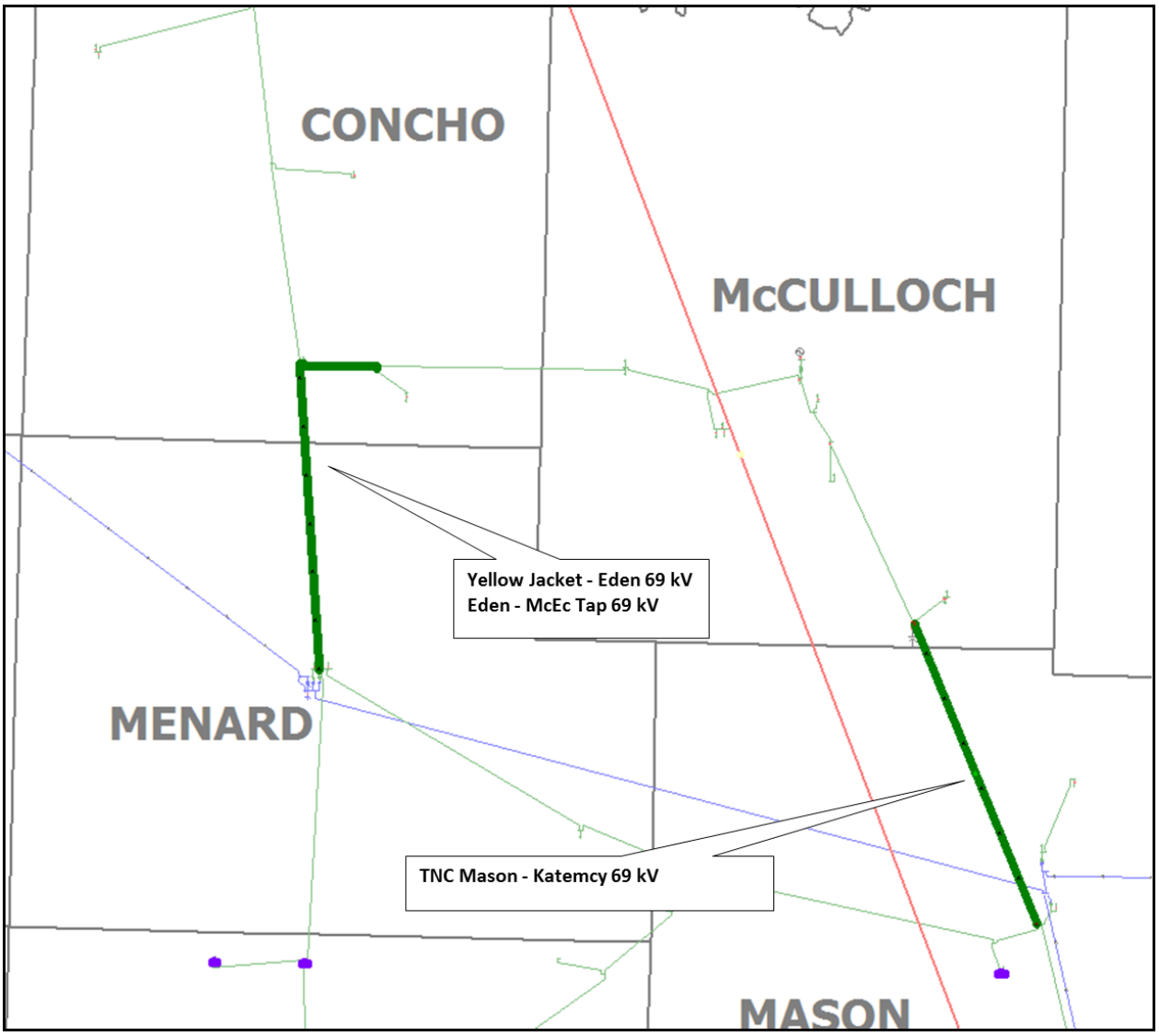


Figure 3.6 Map of system issues in Menard and Mason Counties (2017 normal load condition)

7. Mitchell County Reliability Project

The transmission system around Morgan Creek in Mitchell County is electrically close to the system in the neighboring counties such as Scurry, Howard and Nolan. For these counties, approximately 117 MW of additional load is modeled in the 2017 case compared to the 2017 case built for the 2012 Five-Year Transmission Plan.

Under various contingency conditions, the Morgan Creek 138/69 kV transformer is overloaded. The worst contingency causing the transformer overload is the loss of the 345 kV line from Scurry County South to Long Draw. There are two 138 kV lines out of Morgan Creek running toward Barber Lake. The loss of any one of the two 138 kV lines causes the overload of the remaining 138 kV line.

The following potential projects address the overload of the 138 kV lines and the 138/69 kV transformer at Morgan Creek identified in Figure 3.7:

#1 Upgrade the two existing Morgan Creek-Barber Lake 138 kV lines (6.3 miles, Minimum emergency rating assumed: 326 MVA)
#2 Upgrade the existing Morgan Creek 138/69 kV transformer (Minimum emergency rating assumed: 125 MVA)

The upgrade of the existing Morgan Creek 138/69 kV transformer is needed in order to meet the reliability criteria in the 2015 case, and the upgrades of the two 138 kV lines are needed in order to meet the reliability criteria in the 2017 case.

The overload issues and the worst contingencies are listed in the table below. More details of the system problems can be found in Appendix A and B.

Table 3.7 Thermal overload issues in Mitchell County

Overloaded Element	Worst Contingency	Percent Overload	
		2015	2017
Morgan Creek Unit 138/69 kV Xfmr	Eskota 138/69 kV Xfmr (2015) Scurry County - Long Draw & Faraday 345 kV (2017)	108.63	113.58
Morgan Creek – Barber Lake 138 kV #2	Morgan Creek – Barber Lake 138 kV #1	NA	113.61
Morgan Creek – Barber Lake 138 kV #1	Morgan Creek – Barber Lake 138 kV #2	NA	113.61

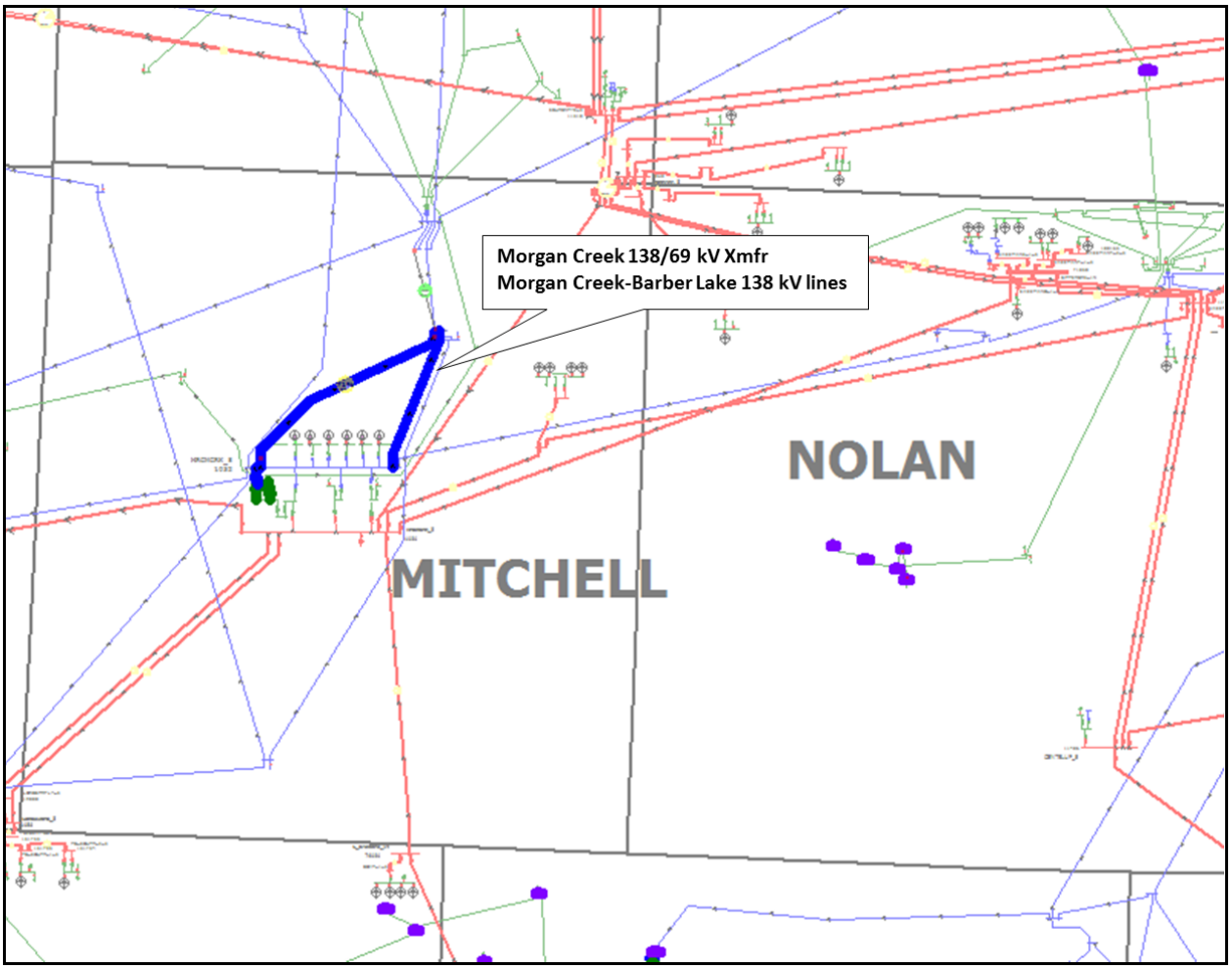


Figure 3.7 Map of system issues in Mitchell County (2017 normal load condition)

8. Uvalde and Bandera County Reliability Project

The load in Real, Uvalde and Bandera Counties is served by the lengthy and lossy 69 kV lines connecting the 138/69 kV transformers at the Bandera and Uvalde substations. Compared to the 2017 case built for the 2012 Five-Year Transmission Plan, an additional seven MW of load is modeled in the 2017 normal load case.

The study result of the 2017 normal load case indicates the overload of 56 miles of 69 kV lines under contingency conditions. The Uvalde-Montell-Campwood 69 kV line is overloaded for the loss of the Leakey-Utopia-Tarpley-Bandera 69 kV line. The Utopia-Tarpley 69 kV line is overloaded for the loss of the Montell-Uvalde 69 kV line. The Hondo-Hondo Creek 69 kV line is slightly overloaded for the loss of Moore-Downie 69 kV line.

To address the overload issues identified in Figure 3.8, the following potential projects need to be done:

#1 Upgrade the existing Montell-Uvalde 69 kV line (25.8 miles, Minimum emergency rating assumed: 109 MVA)
#2 Upgrade the Utopia-Tarplery 69 kV line (Terminal Equipment, 16 miles, Minimum emergency rating assumed: 64 MVA)

The Utopia-Tarplery 69 kV line upgrade is needed in order to meet the reliability criteria in the 2015 case, and the Montell-Uvalde 69 kV line upgrade is needed in order to meet the reliability criteria in the 2017 case.

The overload issues and the worst contingencies are listed in the table below. More details of the system problems can be found in Appendix A and B.

Table 3.8 Thermal overload issues in Uvalde and Bandera Counties

Overloaded Element	Worst Contingency	Percent Overload	
		2015	2017
Tarpley - Utopia 69 kV	Utopia 138/69 kV Xfmr (2015) Montell - Uvalde 69 kV (2017)	100.00	102.11
Hondo Creek - Hondo Sub 69 kV	Moore Sub - Downies Sub 138 kV	NA	100.43
Montell - Campwood 69 kV	Bandera - Tarpley - Utopia - Leakey 69 kV	NA	111.45
Uvalde - Montell 69 kV	Bandera - Tarpley - Utopia - Leakey 69 kV	NA	119.33

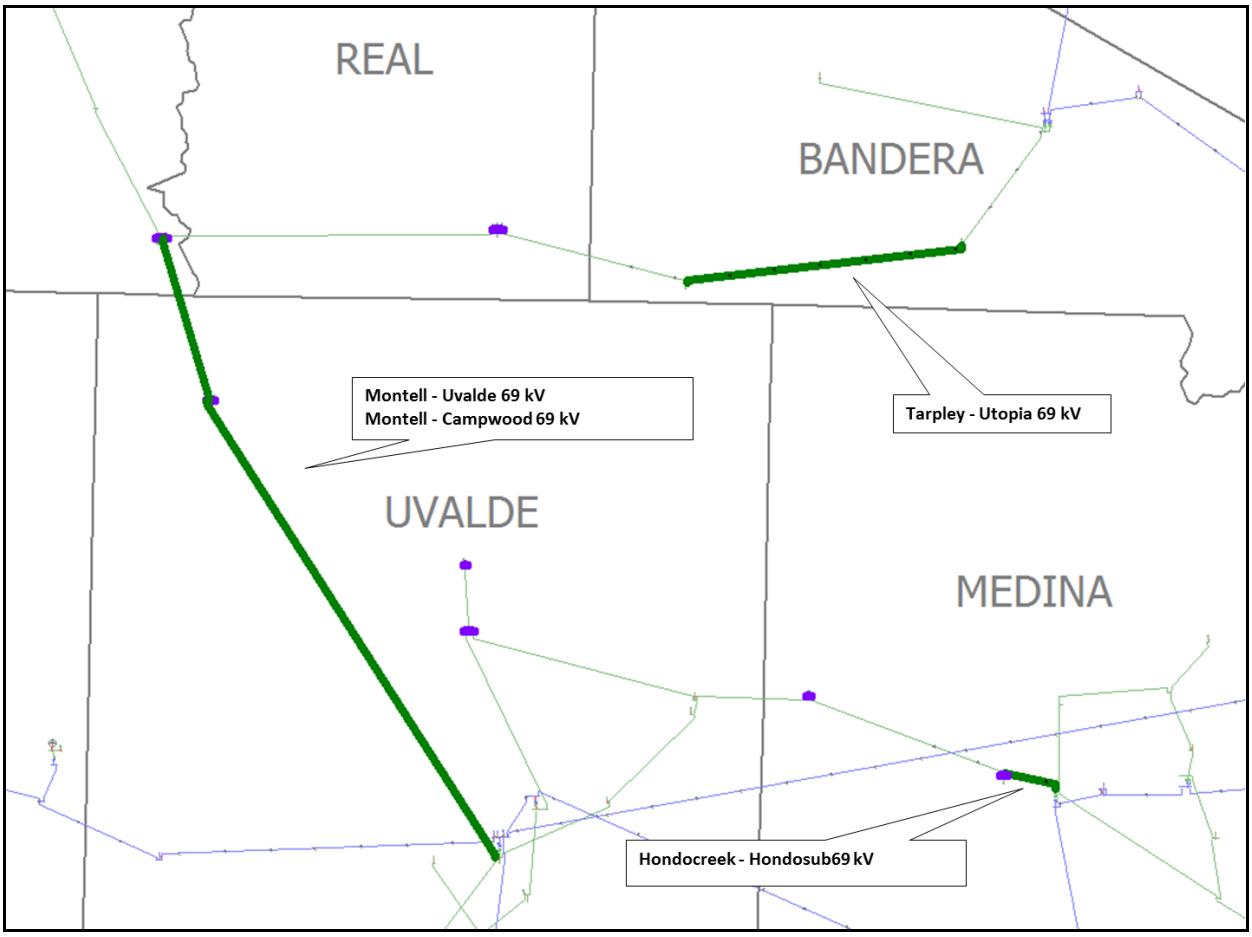


Figure 3.8 Map of system issues in Uvalde and Bandera Counties (2017 normal load condition)

9. Llano County Reliability Project

No additional load was modeled in the 2017 normal case for Llano County which is located at the far eastern edge of the study area. The study result indicates the overload of the Ferguson-Sandy Creek 138 kV line under various contingency conditions. The worst critical contingency causing the line overload is the loss of the Ferguson-Horseshoe Bay and Ferguson-Gillespie 138 kV lines.

To address the system issue identified in Figure 3.9, the following potential project needs to be done:

#1 Upgrade Ferguson-Sandy Creek 138 kV line (9 miles, Minimum emergency rating assumed: 326 MVA)

The upgrade is needed in order to meet the reliability criteria in the 2015 case.

The overload issues and the worst contingencies are listed in the table below. More details of the system problems can be found in Appendix A and B.

Table 3.9 Thermal overload issues in Llano County

Overloaded Element	Worst Contingency	Percent Overload	
		2015	2017
Ferguson - Sandy Creek Switchyard 138 kV	Ferguson - Gillespie & Ferguson - Horseshoe Bay 138 kV	108.97	107.67

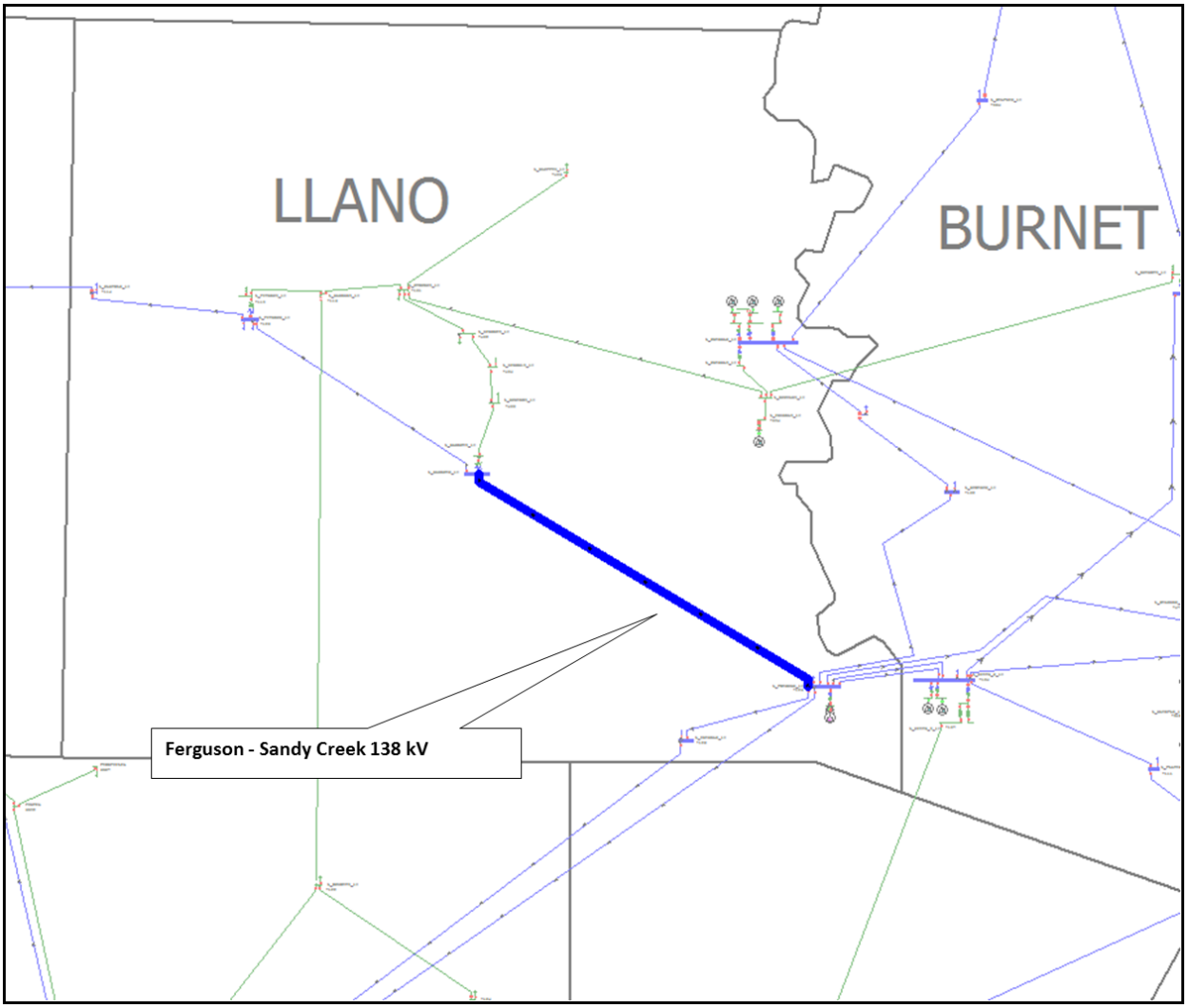


Figure 3.9 Map of system issues in Llano County (2017 normal load condition)

10. Coke County Reliability Project

Much of the load in Coke and Sterling Counties is being served by the 138/69 kV transformer at Cedar Hill through the long 69 kV lines running toward Sterling and Runnels Counties. Compared to the 2017 case built for the 2012 Five-Year Transmission Plan, roughly 42 MW of additional load is modeled for the area in the 2017 normal load case.

The study result of the 2017 normal load case indicates the overload of the Cedar Hill 138/69 kV transformer under system intact and contingency conditions, and a low voltage issue at the Cedar Hill 138 kV bus for the loss of the Cedar Hill-Oak Creek 138 kV line.

To address the thermal and voltage issues identified in Figure 3.10, the following potential projects need to be done:

#1 Upgrade Cedar Hill 138/69 kV transformer (Minimum emergency rating assumed: 143 MVA)
#2 Install 12 Mvar capacitor bank at Spade Ranch 69 kV bus
#3 Install 12 Mvar capacitor bank at Sterling City 69 kV bus
#4 Add 12 Mvar capacitor bank to the existing capacitor bank at Cedar Hill 69 kV substation

The projects are needed in order to meet the reliability criteria in the 2015 case.

The overload issues and the worst contingencies are listed in the table below. More details of the system problems can be found in Appendix A and B.

Table 3.10 Thermal overload issues in Coke County

Overloaded Element	Worst Contingency	Percent Overload	
		2015	2017
Cedar Hill 138/69 kV Xfmr	Base Case	N/A	107.8
Cedar Hill 138/69 kV Xfmr	Big Spring - Big Spring Gulf Tap 69 kV	104.53	112.73

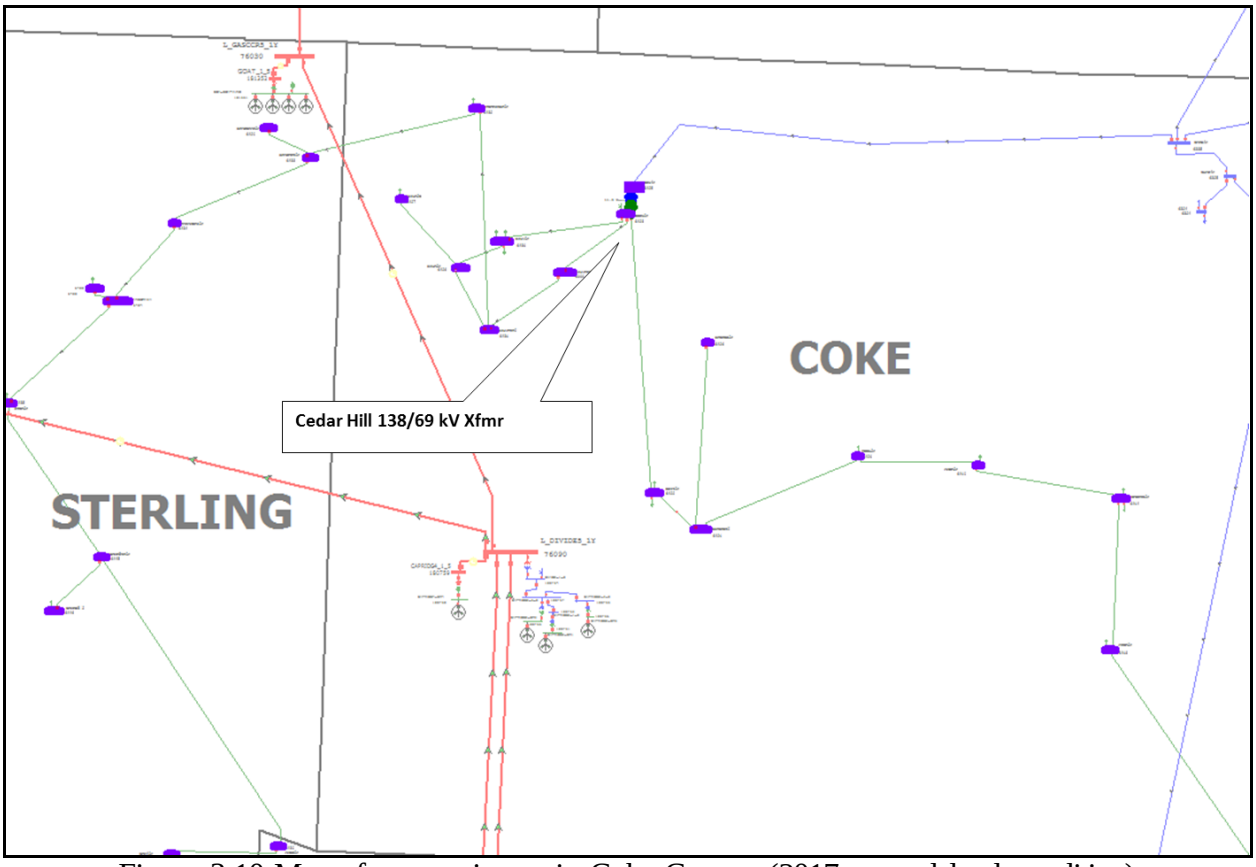


Figure 3.10 Map of system issues in Coke County (2017 normal load condition)

11. Taylor County Reliability Project

Approximately 111 MW of additional load is modeled for Taylor County in the 2017 normal load case compared to the 2017 case built for the 2012 Five-Year Transmission Plan. The area load is served by the 138/69 kV transformers located at Abilene South, Abilene East, Abilene North West and Abilene Elm Creek through the 69 kV lines in the region. The study result of the 2017 normal load case indicates the overload of the Abilene South-Abilene West Texas Gulf 69 kV line under various contingency conditions. The worst contingency causing the overload is the loss of the Abilene East-Abilene Plant 69 kV line.

To address the thermal issue identified in Figure 3.11, the following project needs to be done:

#1 Upgrade Abilene South-Abilene West Texas Gulf 69 kV line (2.2 miles, Minimum emergency rating assumed: 109 MVA)

The project is needed in order to meet the reliability criteria in the 2015 case.

The overload issues and the worst contingencies are listed in the table below. More details of the system problems can be found in Appendix A and B.

Table 3.11 Thermal overload issues in Taylor County

Overloaded Element	Worst Contingency	Percent Overload	
		2015	2017
Abilene South - Abilene West Texas Gulf Tap 69 kV	Abilene East - Abilene Plant 69 kV	102.67	112.36

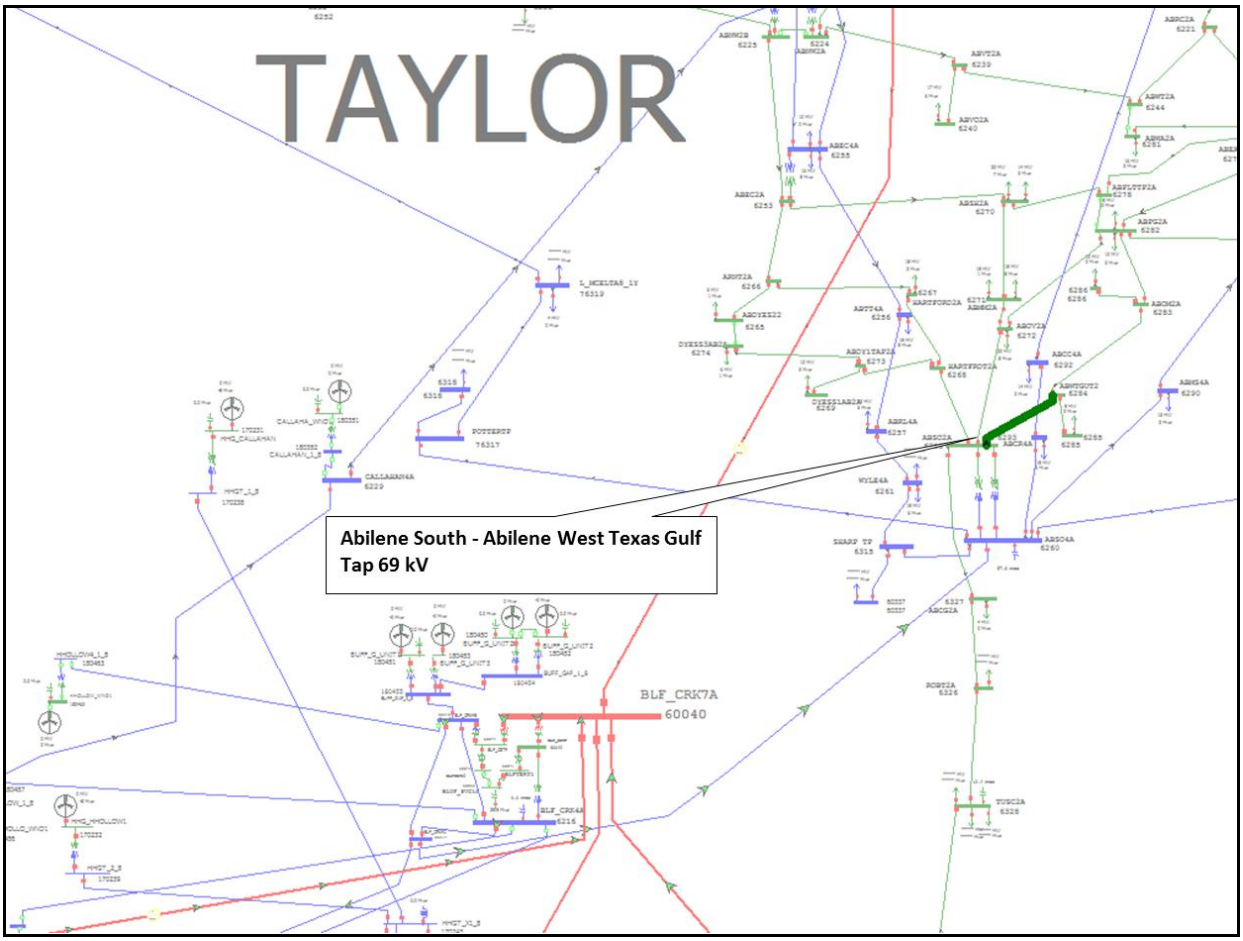


Figure 3.11 Map of system issues in Taylor County (2017 normal load condition)

12. G-1+N-1 Reliability Project for Borden, Howard and Mitchell Counties

With the entire set of preferred projects identified in Section 3.1 through 3.11 modeled in the base cases, a reliability analysis was performed under the prior outage of generation.

The study result indicates that the Barber Lake-China Grove 138 kV lines and the Morgan Creek-Cosden 138 kV line are overloaded if certain contingencies occur when a combined cycle unit (498 MW) at Odessa is out of service. The following potential projects need to be done to resolve the thermal issues identified in Figure 3.12:

#1 Expand the existing Vealmoor 138 kV substation to accommodate 345/138 kV facilities

#2 Install a new 345/138 kV transformer at Vealmoor (Minimum emergency rating assumed: 450 MVA)
#3 Connect 345 kV line from Vealmoor to Long Draw (18 miles, Minimum emergency rating assumed: 1084 MVA), which requires voltage conversion of an existing 230 kV line to 345 kV.
#4 Connect Vealmoor to West Stanton (Sharyland Northern Loop Project)
    a. Vealmoor-Koch Tap (8.37 miles, Minimum emergency rating assumed: 176 MVA)
    b. Koch Tap-Koch (2 miles, Minimum emergency rating assumed: 271 MVA)
    c. Koch Tap-Brown (5.73 miles, Minimum emergency rating assumed: 176 MVA)
    d. Brown-Grady (20.18 miles, Minimum emergency rating assumed: 271 MVA)
    e. Grady- West Stanton (14.27 miles, Minimum emergency rating assumed: 176 MVA)

The projects are needed in order to meet the reliability criteria in the 2017 case.

Part of the projects involves connecting Vealmoor to Long Draw (~18 miles). Similar to the 230 kV line discussed in Section 3.1, the transmission line is already in place and connected to the SPP system. The line needs conversion from 230 kV to 345 kV operation and to be switched from the SPP system to the ERCOT system. The existing 230 kV line was originally constructed for up to 345 kV operation. Thus, relatively minimal effort is expected for the voltage conversion. This line is also part of the acquisition plan between Sharyland Utilities and Xcel SPS, which is subject to regulatory approval by the PUCT. If the Xcel SPS line is not acquired and integrated into ERCOT, other transmission upgrade alternatives will need to be evaluated.

To address the transmission system issues, part of the project also connects West Stanton to Vealmoor at 138 kV. This 138 kV line connection is one of the options in the report submitted by Sharyland Utilities to RPG to resolve their distribution system issues:

- The existing distribution system in the area does not provide a reliable service at the Grady, Koch and Brown substations which have experienced significant load growth due to the oil and gas business development.
- An extended power outage of the Vealmoor and Fairview stations is likely to occur if there is a fault on the 30-mile circuit supported by aging wood poles between Vealmoor and Salem.

The facilities connecting West Stanton to Vealmoor are already in place and currently owned by Sharyland Utilities. Upon the PUCT's approval of the Docket #41430, the facilities will be transferred to ERCOT from SPP. The West Stanton to Vealmoor project was submitted for RPG review and comments in June 2013. Upon completion of the RPG review, the project was classified as a Tier 4 project.

The overload issues and the worst contingencies are listed in the table below. More details of the system problems can be found in Appendix A and B.

Table 3.12 Thermal overload issues (G-1-N-1, Borden, Howard and Mitchell Counties)

Overloaded Element	Worst Contingency	Percent Overload	
		2015	2017
Barber Lake- China Grove 138 kV	Willow Valley - Faraday 345 kV	NA	110.80
China Grove - China Grove 138 kV	Willow Valley - Faraday 345 kV	NA	110.74
Morgan Creek - Cosden 138 kV	DCKT Odessa EHV - Quail Switch & Long Shore Switch 345 kV	NA	100.88

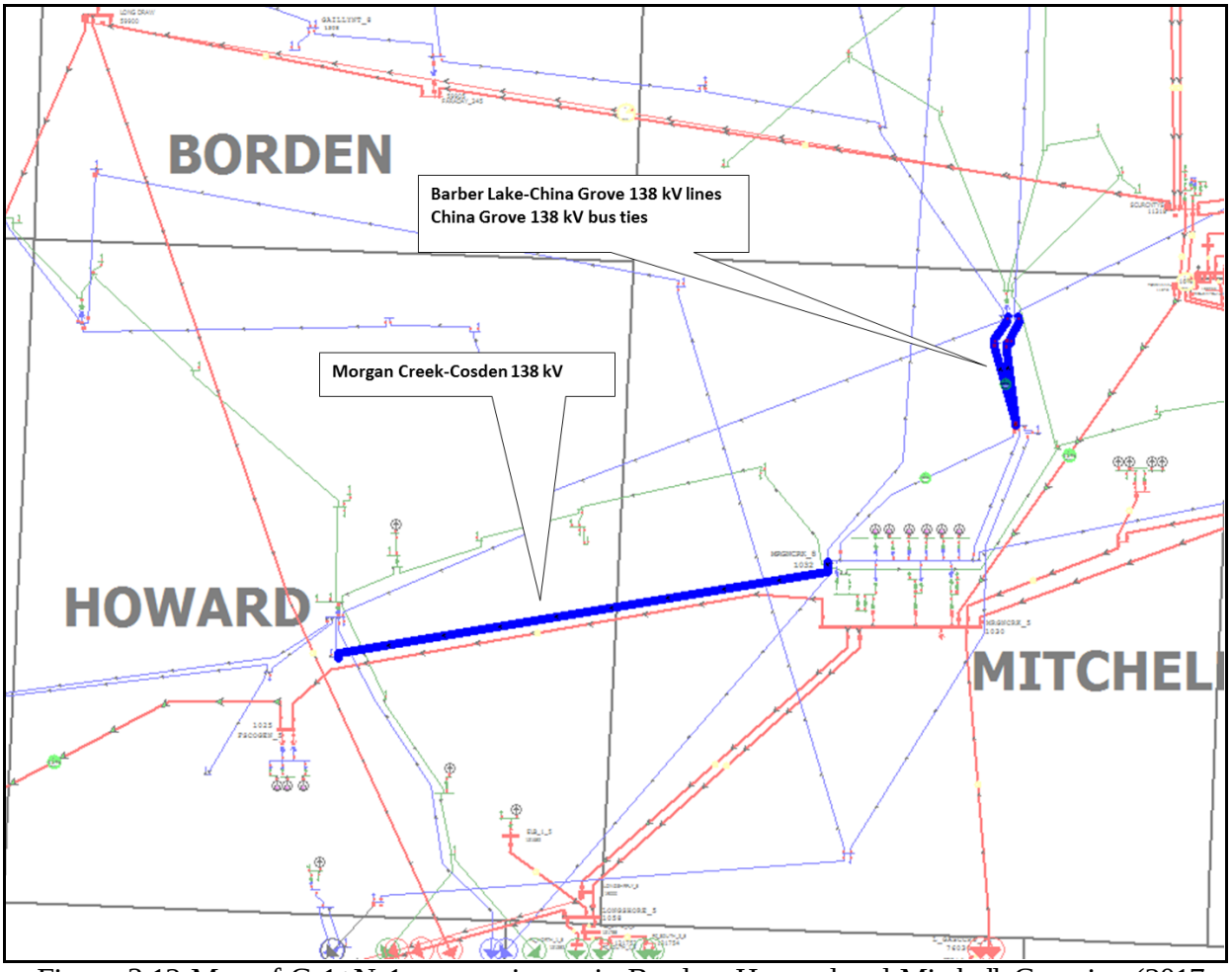


Figure 3.12 Map of G-1+N-1 system issues in Borden, Howard and Mitchell Counties (2017 normal load condition)

13. G-1+N-1 Reliability Project for Reagan, Upton, Irion and Tom Green Counties

The G-1+N-1 study result indicates the overload of the Big Lake-Twin Buttes 138 kV line and the San Angelo Concho-San Angelo Mathis 69 kV line for the loss of certain transmission line

under the prior outage of either the combined cycle units (498 MW) at Odessa or the combined cycle units (250 MW) at Quail.

To address the thermal issues identified in Figure 3.13, the following projects need to be done:

#1 Construct a new 345/138 kV substation at the junction where the Bakers Field-Big Hill 345 kV line (CREZ line) and the Ringtail-Big Lake 138 kV line cross (50% of the Bakers Field-Big Hill 345 kV line, 5 miles north of Ringtail 138 kV bus in 2017 case)

#2 Loop the Bakers Field-Big Hill 345 kV line into the new substation

#3 Loop the Big Lake-Ringtail 138 kV line into the new substation

#4 Install a new 345/138 kV transformer at the new substation (Minimum emergency rating assumed: 500 MVA)

#5 Upgrade the existing 138 kV line from Ringtail to the new substation (~5 miles, Minimum emergency rating assumed: 326 MVA)

The projects are needed in order to meet the reliability criteria in the 2017 case.

The 345 kV source injected to the region improves the voltage of the 138 kV and 69 kV buses such as Big Lake, Ringtail, Yucca and Barnhart Phillips Tap. It also relieves the heavy flow on the 138 and 69 kV lines such as the North McCamey-Big Lake -Twin Buttes 138 kV lines.

The overload issues and the worst contingencies are listed in the table below. More details of the system problems can be found in Appendix A and B.

Table 3.13 Thermal overload issues (G-1-N-1, in Reagan, Upton, Irion and Tom Green Counties)

Overloaded Element	Worst Contingency	Percent Overload	
		2015	2017
San Angelo Concho - San Mathis Field 138 kV	Big Lake - Tempbltb4a 138 kV	NA	103.57
Big Lake - Tempbltb4a 138 kV	Temprank4A - North McCamey 138 kV	NA	102.06
Twin Buttes - Tempbltb4a 138 kV	Temprank4A - North McCamey 138 kV	NA	102.06

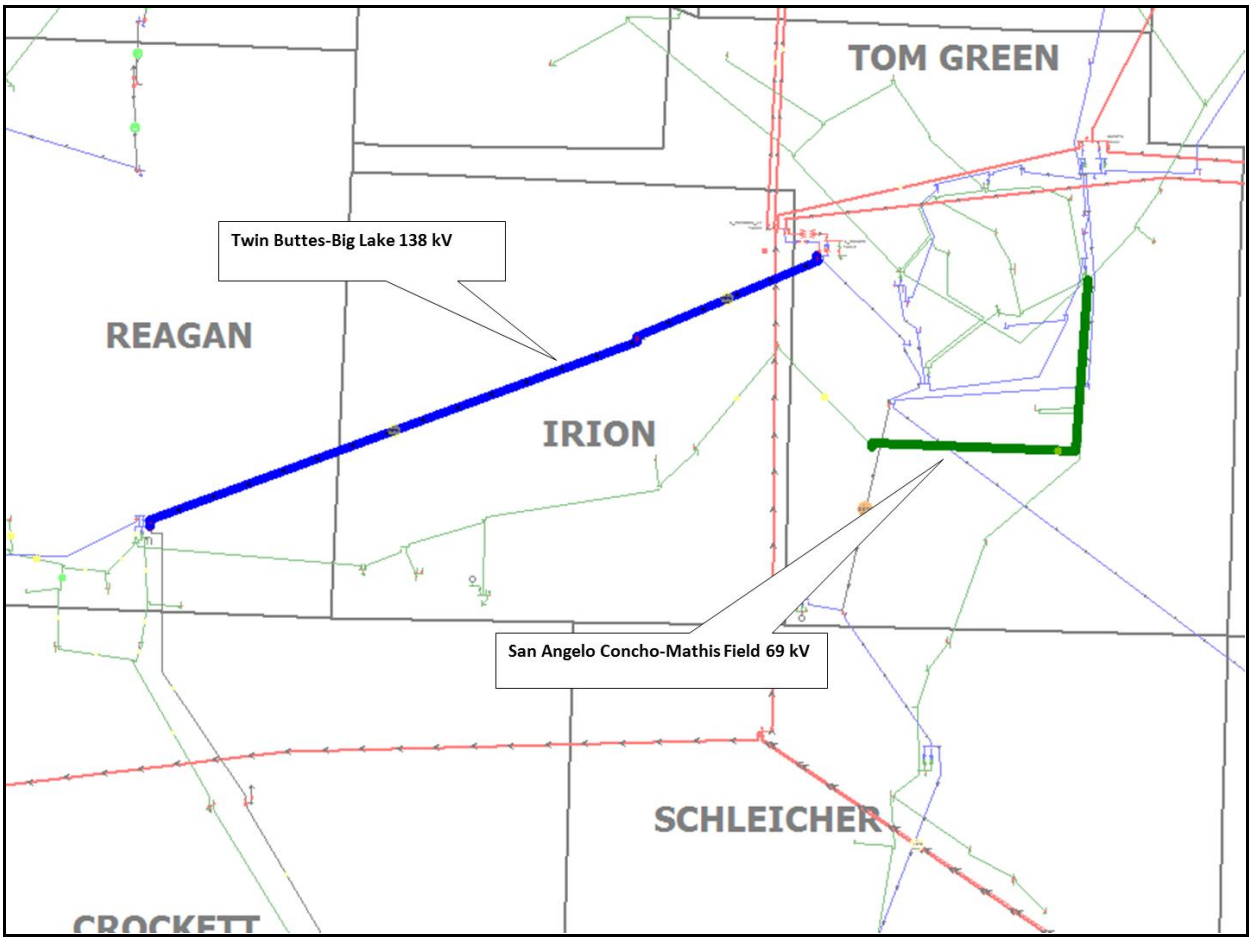


Figure 3.13 Map of G-1+N-1 system issues in Reagan, Upton, Irion and Tom Green Counties (2017 normal load condition)

IV. Sensitivity Analysis of 2017 High Load Condition

As part of the West Texas Sensitivity Study, ERCOT also conducted a sensitivity analysis of the 2017 West Texas high load case. The main purposes of testing the high load condition are to:

- Check the strength of the preferred projects identified for the system issues in the 2017 West Texas Sensitivity Study normal load case.
- Determine if any significant modification needs to be made to the preferred projects of the 2017 West Texas Sensitivity Study normal load case

The 2017 high load base case was built based on the high load forecast of the year 2017 provided by each load serving entity. As shown in Table 4.1, significant amount (486 MW) of additional load is modeled in the 2017 high load case compared to the 2017 normal load case. In addition to the additional load, all the potential projects in Section III (Reliability Project of 2017 normal load case) were modeled to build the 2017 high load base case.

Table 4.1 Comparison of the total MW load of the study area

Total MW Load of each Weather zone in Study Area	2017 (Normal Load)	2017 (High Load)
WEST	2585	2696
FAR WEST	3569	3944
TOTAL	6154	6640

As a result of the sensitivity analysis using the 2017 high load case, it is concluded that the system issues of the high load case would not cause any significant impact on the potential projects found for the system issues of the 2017 normal load case. The study result indicates that the system issues of the 2017 high load case occur in local areas, and can be addressed by incremental transmission reinforcement on top of the potential projects of the 2017 normal load case. The incremental reinforcement may include upgrading the existing lines, upgrading the existing transformers, installing capacitor banks and constructing a new 138 kV line. Potential options addressing the system issues of the high load condition are not discussed in this report based on the study purpose.

Divided by three geographical regions of the study area, the system issues of the 2017 high load base case are summarized in the following sections. More details of the system issues can be found in Appendix C.

1. System Issue in Northwest Region of Study Area

Figure 4.1 illustrates the system issue in the northwest region of the study area. Due to additional load modeled in the 2017 high load case, the system in the area is depressed, particularly the 69 kV transmission system owned by Oncor and 138 kV transmission system owned by Sharyland Utilities in the Midland, Glasscock, Upton and Reagan Counties area. The key issues in the area are the overloads of

- Skywest-Driver Tap1-Driver- Driver Tap2-Midkiff 138 kV lines
- Pembrook-Stiles and St. Lawrence-E. Stiles 138 kV lines
- Spraberry-Peck Tap 69 kV line
- Glasscock-Reagan Shell-Pembrook-Midkiff 69 kV line
- Garden City-Tex Harvey 69 kV line

The worst contingency causing the overload of the 138 kV lines is the loss of the 138 kV line(s) out of the Einstein 345/138 kV substation. The 69 kV lines are susceptible to overload under various contingency conditions such as the loss of the Midkiff 138/69 kV transformer and the loss of the 69 kV line out of Spraberry.

Other overload issues found in this region are

- Odessa EHV 345/138 transformer #2 and Odessa EHV- Liquid Air-Odessa 138 kV line

- Wink-Vest-Midway 69 kV line
- Sandridge-Odessa Basin 69 kV line
- Permian-Wink and Permian-Ward Gulf Tap 138 kV lines

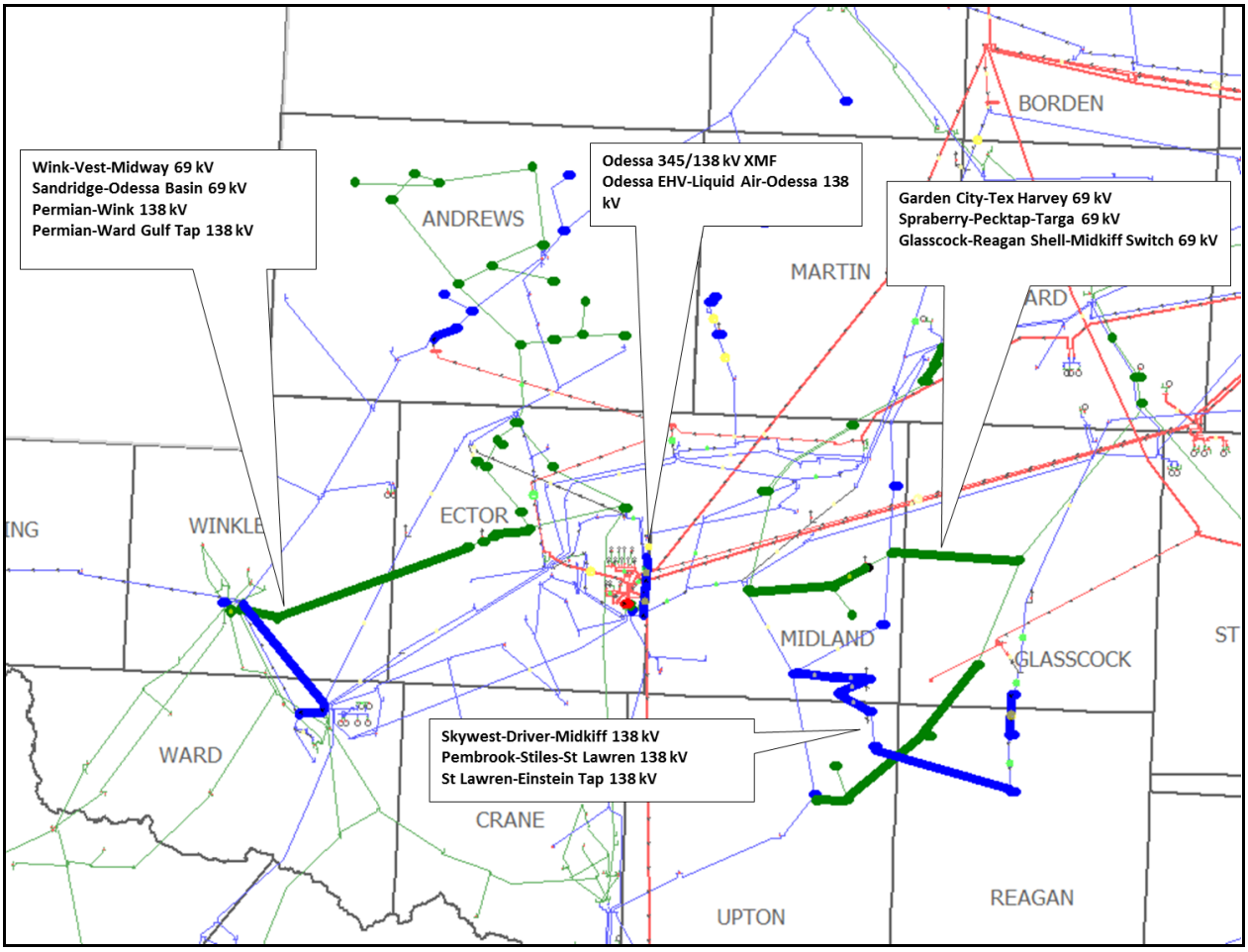


Figure 4.1 System issues in the northwest region of the study area (2017 high load condition)

2. System Issue in South Region of Study Area

As shown in Figure 4.2, relatively few system issues were found in the southern region of the study area under contingency conditions. The portion of the Big Lake-Ringtail 138 kV line is overloaded under various contingency conditions such as the loss of the Bakers Field-North McCamey 345 kV line. The Big Lake-Barnhart 69 kV line is slightly overloaded for the loss of the Yucca-Ringtail 138 kV line. There are no other major issues in the region.

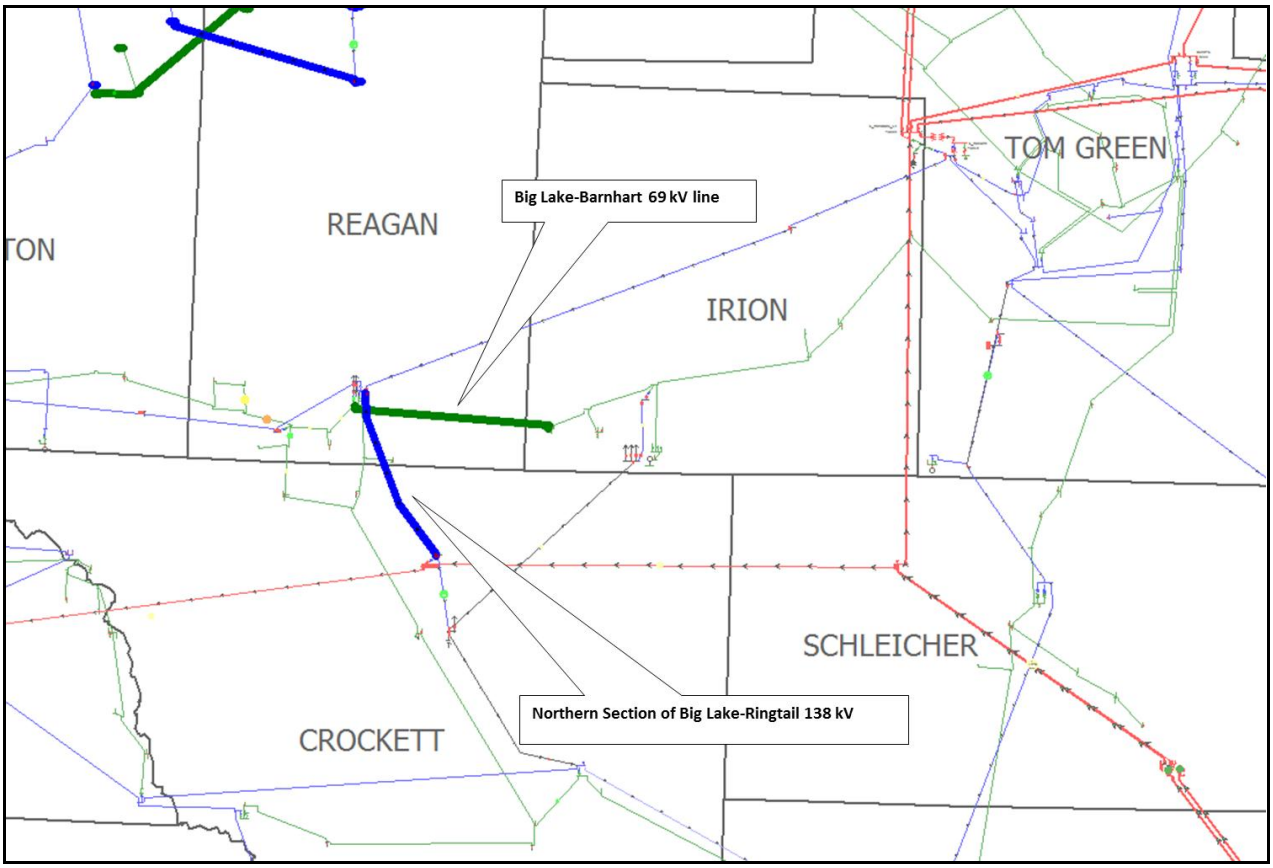


Figure 4.2 System issues in the south region of the study area (2017 high load condition)

3. System Issue in Northeast Region of Study Area

As shown in Figure 4.3, several local transmission system issues were found in the northeast region of the study area. The local issues are the overloads of

- Ennis Creek 138/69 kV transformer
- Morgan Creek 345/138 kV transformer #2
- Barber Lake-China Grove 138 kV lines
- Abilene NW-Ely Rea Tap 69 kV line

Among them, the Ennis Creek 138/69 kV transformer at the northeast of Scurry County is overloaded under system intact condition. The Morgan Creek 345/138 kV transformer #2 is overloaded for the loss of the Morgan Creek 345/138 kV transformer #1. The 138 kV line from Barber Lake to China Grove is also overloaded for the loss of one of the two 138 kV lines. The Abilene N.W.-Ely Rea Tap 69 kV line in Taylor County is overload for the loss of the Eskota 138/69 kV transformer in Nolan County.

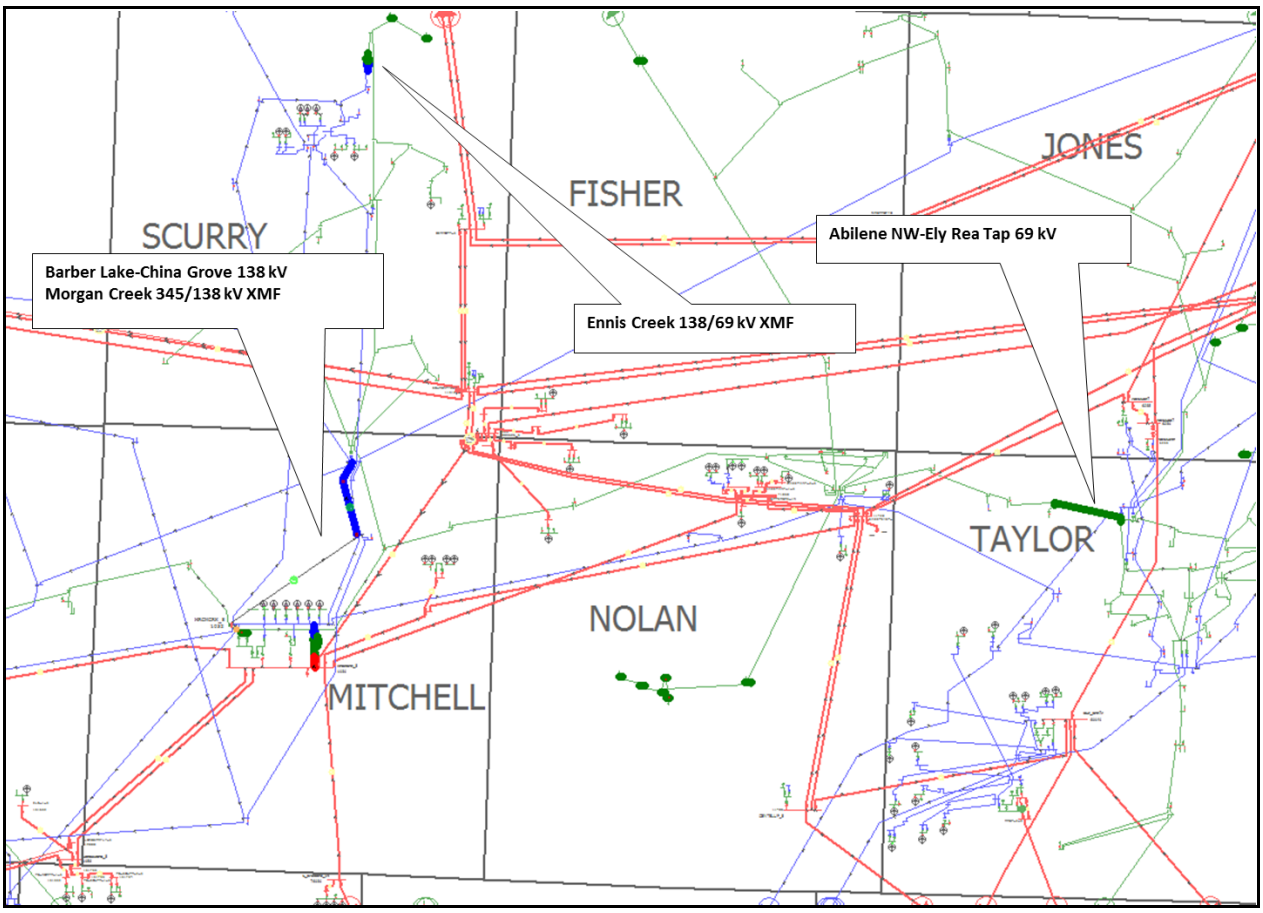


Figure 4.3 System issues in the northeast region of the study area (2017 high load condition)

V. Sensitivity Analysis of A-1+N-1 Condition

A high-level contingency analysis was performed under a prior outage of the new 345/138 kV transformer identified as the potential project. The main purpose of the study is to check if a need of any significant modification to the potential project exists due to the system issues under contingency following the outage of a 345/138 kV transformer.

The result of the A-1+N-1 analysis showed no significant system issues that require modification of the potential projects identified for the 2017 normal load case. It is found that the system issues due to A-1+N-1 can be addressed by either installing a second 345/138 kV transformer or bringing an additional 345 kV source from a different direction. A detailed A-1+N-1 analysis will be deferred until ERCOT performs a system wide analysis as part of the 2014 Regional Transmission Plan.

VI. Economic Project

For years 2015 and 2017 an economic analysis was conducted by performing production cost simulation. Where congestion was identified, projects were tested by comparing the simulation results for models with and without the projects. If the project met the economic planning criteria per ERCOT Protocol Section 3.11.2 (5), Planning Criteria it was recommended. If the production cost savings equals or exceeds the annual revenue requirement for the project, the project is economic from a societal perspective and will be recommended. In this study, it is assumed that the first year annual revenue requirement for the transmission project is approximately one sixth (1/6) of the total transmission project cost. Oftentimes the cost to implement a transmission project outweighs the cost of the congestion it is designed to solve. If a project did not meet the economic planning criteria the projected congestion will remain on the system.

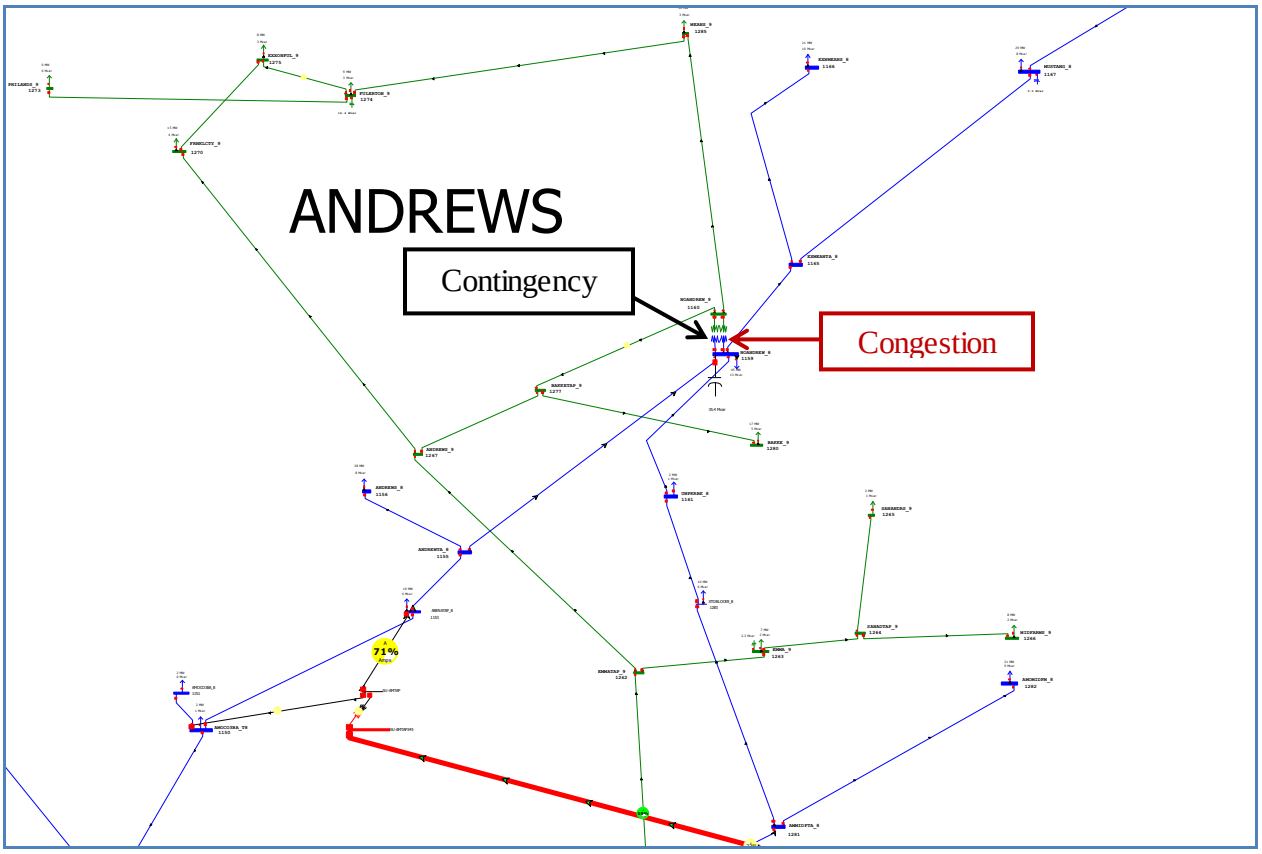
1. Andrews North 138/69 kV transformer upgrade

Currently the emergency ratings of the two Andrews North 138/69 kV transformers were 41 MVA and 84 MVA respectively. The Andrews North 138/69 kV transformer #1 with 41 MVA was congested 5.15% of the hours in 2017 under the contingency loss of the Andrews North 138/69 kV transformer #2. The congested element is marked on the map below.

To relieve the congestion, the Andrews North 138/69 kV transformer #1 was upgraded to a new emergency rating of 84 MVA. The estimated capital cost to upgrade this transformer is estimated to cost $5 million. The result of the annual production cost saving including the upgrade for 2017 is shown in the table below.

Year	Annual Production Cost Saving ($M)	Capital Cost / Saving
2017	12	< 1

The simulation result showed that upgrading the Andrews North 138/69 kV transformer 1 would reduce the annual production cost in 2017. Since the annual production cost saving in 2017 exceeded the corresponding project capital cost, the upgrade was recommended to be in service by 2017. There currently is a project in TPIT to replace this transformer in 2015.



VII. Appendices

Appendix A: AC Contingency Result of 2015 Normal Load Case	 WT 2015 Normal Load Base Case - Cor
Appendix B: AC Contingency Result of 2017 Normal Load Case	 WT 2017 Normal Load Base Case - Cor
Appendix C: AC Contingency Result of 2017 High Load Case with All Normal Load Projects in Service	 WT 2017 High Load Base Case with all No
Appendix D: Project Log (Projects and System Issues)	 West Texas Study_NL_Projects Lc
Appendix E: Transmission Model Updates	 WT Topology Updates.xlsx