Transmission Planning Study

For

Addition of a 230 kV Big Sandy-Calhan Transmission Line

September 1, 2011

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Background

Power is presently delivered to Tri-State member MVEA through three transmission sources. From MVEA's southwestern boundary, MVEA is served through the Western Area Power Administration's Midway Substation and the Tri-State 115 kV Midway-Geesen line extending from that substation. From its western boundary, MVEA is served through the Colorado Springs Utilities' (CSU) 230 kV Jackson Fuller Substation and Tri-State's 230-115 kV 100 MVA transformer located there. From its northwestern boundary, MVEA is served through the CSU Monument interconnection. Although MVEA does own and operate a 69 kV line from Western's 115-69 kV Limon Substation to MVEA's 69 kV Simla Substation, this line is operated normally open due to its poor condition. (MVEA has confirmed that this line is normally de-energized, and is only used for temporary emergency service to Simla, Person, and Calhan.)

Tri-State and CSU entered into a Memorandum of Understanding (MOU), dated March 29, 1994, which established the point of interconnection at the Monument Substation, but which granted no transmission service to Tri-State over the CSU transmission system to Monument. Tri-State and CSU also entered into a MOU for the Fuller Substation Point of Interconnection, dated October, 1997. That MOU specifically states that neither party is providing transmission service to the other in connection with the Fuller project. Therefore, Tri-State and CSU do not have transmission service arrangements for either the Monument or Fuller interconnections, nor was it viewed as necessary to have transmission service agreements at the time the interconnections were negotiated.

The maximum delivery that Western can make available to Tri-State member loads at Midway is 93 MW; 43 MW of preference power and an additional 50 MW from the 100 MW exchange assigned to Tri-State from Colorado Ute's prior entitlement. The existing 115 kV Midway to Geesen line constitutes nearly the entirety of Tri-State's transmission into the MVEA service territory. Although presently limited by CT's to only 80 MVA capacity, this line's thermal capacity is not much higher (95 MVA), due to its 50°C rating and 477 ACSR conductor.

MVEA's system load in 2010 was 146 MW (winter peak) and 117 MW (summer peak). With only 93 MW of delivery capability at Midway, Tri-State presently relies on the CSU and Xcel transmission systems interconnected at Monument and Fuller to provide service to MVEA loads. For example, Tri-State relied on the CSU and Xcel transmission system for 53 MW (146 MW less 93 MW) at the time of the 2010 MVEA system peak. As MVEA's load growth continues, albeit at a much slower rate than its previous double digit growth prior to collapse of the housing market, Tri-State's reliance on these other transmission providers will increase.

A loss of any one of the three transmission sources to the MVEA load area places a strain on the remaining transmission and subtransmission system serving MVEA's customers. It should be

noted that all three of the transmission sources serving MVEA are located on the western side of its service territory and that the MVEA system lacks any direct transmission source to its eastern load area.

Previous Study Work

In 2008, Peak Power Engineering, Inc. was contracted by Tri-State to conduct a transmission planning study of the MVEA area for incorporation into the Long Range Plan of MVEA. Power flow analysis was completed on 2008, 2013, and 2018 cases using updated load and topology data for the systems of MVEA and CSU. Several transmission alternatives were analyzed for their performance with a 2018 high load growth scenario. Additional sensitivities were completed with winter load levels for 2013 and 2018 to get a better idea of the timing of proposed construction projects.

Besides proposing system upgrades for the MVEA subtransmission system, the Peak Power report identified the need to increase the thermal rating of the Big Sandy-Midway 230 kV line to 100° C, and the need to construct a new 230 kV line from Big Sandy into the Calhan load area. The specific project for Calhan included construction of a new 230 kV line from Big Sandy to a new 230-115kV substation at Tri-State's Road 125 site, located north of Calhan, and extending 115 kV lines west to Elbert and southwest to Calhan.

The Peak Power study identified the critical contingencies for the MVEA load area to be the loss of the Fuller 230-115 kV transformer and the loss of the Falcon-Fuller 115 kV line. These contingencies caused several overloads and low-voltages. The study concluded that a 230 kV source from Big Sandy alleviated the problems associated with these two critical contingencies and provided a stiff 230 kV source of voltage support for the area. It also relieved some other system problems. For example, overloads of CSU's Kettle Creek-Flying Horse 115 kV line were alleviated during an outage of the Fuller 230-115 kV transformer, and overloads of the Fuller 230-115 kV transformer were alleviated for a loss of the CSU Palmer Lake-Monument 115 kV line. The study concluded that construction of a new line from the Big Sandy 230 kV source greatly improved reliability for eleven of Mountain View's distribution substations.

Subsequent to the Peak Power study, Tri-State included projects in its Ten-Year Transmission Capital Construction Plan for the uprate of the Big Sandy-Midway 230 kV line and for construction of a new 230 kV line from Big Sandy to Calhan.

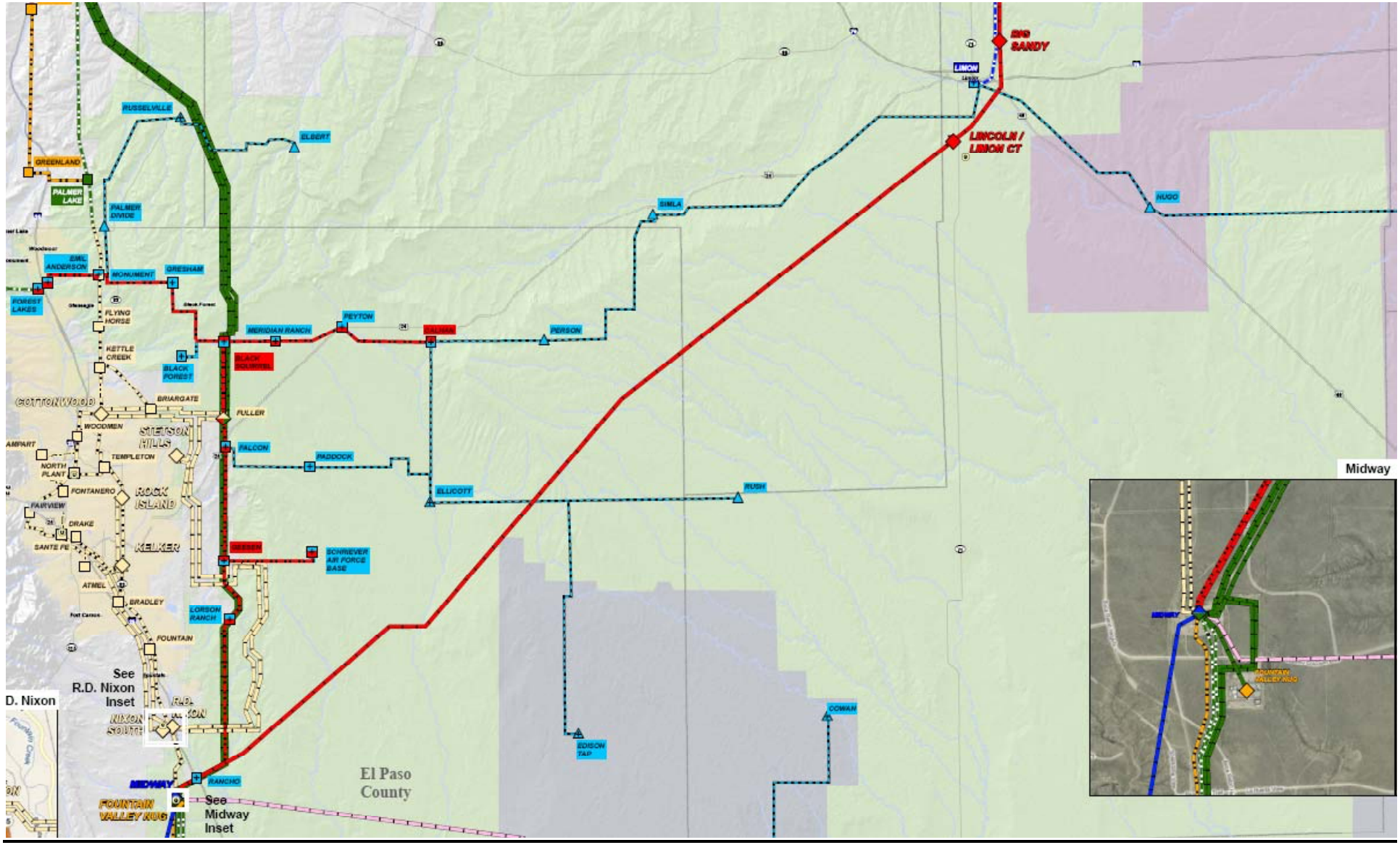

Figure 1: Mountain View Electric Association Regional Transmission Map in Central Eastern Colorado (1 of 2)

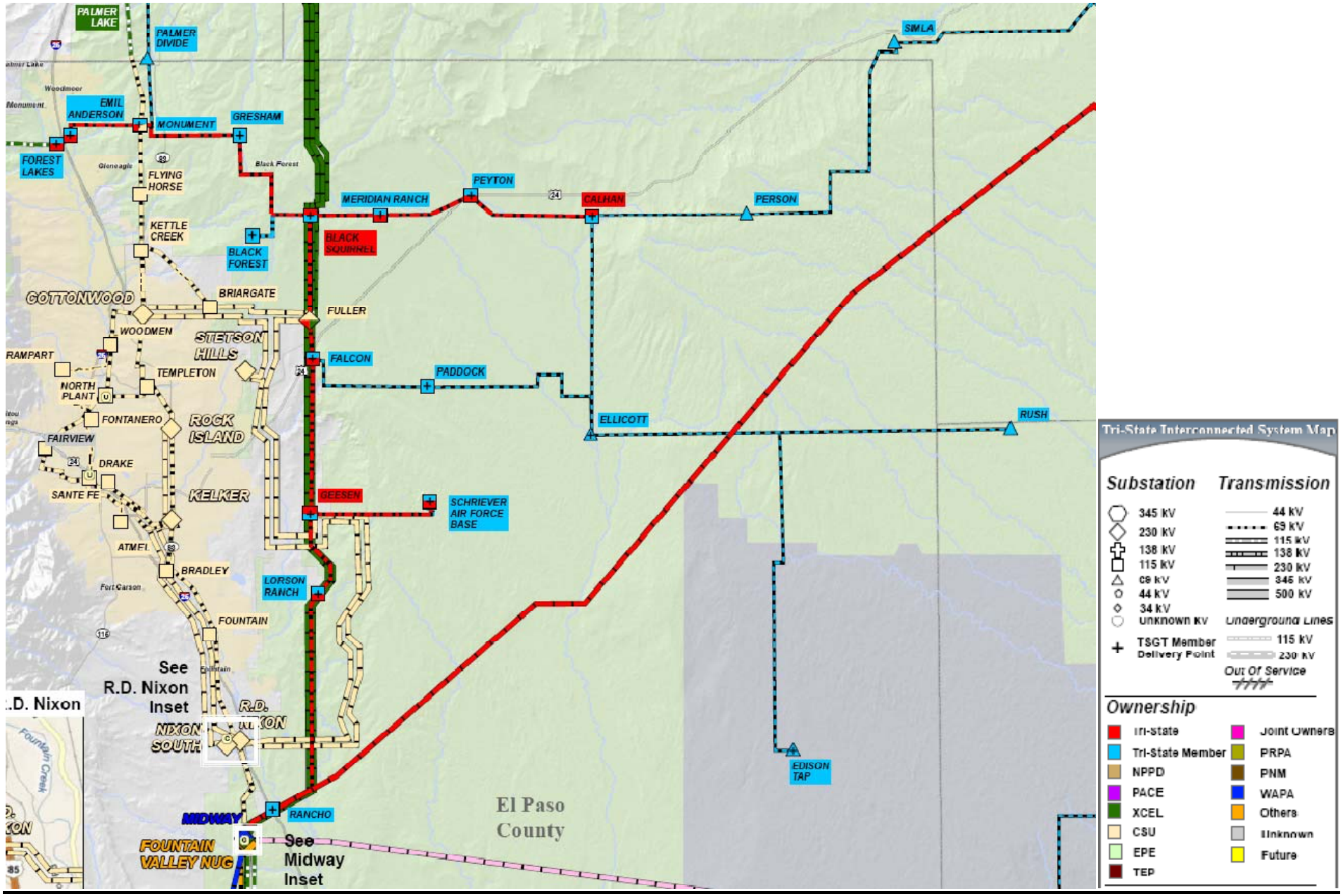

Figure 2: Mountain View Electric Association Regional Transmission Map in Central Eastern Colorado (2 of 2)

Study Objectives

Tri-State has prepared this transmission planning study to evaluate previously identified load-serving deficiencies, to identify any additional regional transmission system deficiencies that may exist in the southern Front Range or eastern Colorado regions, and to evaluate transmission project alternatives for improving the reliability and load serving capability to MVEA. The known load-serving deficiencies (present and future) include constraints associated with serving MVEA's load through the bottleneck of the 115 kV Midway-Geesen line and the 230-115 kV transformer at Fuller.

The present study updates load and resource data for the MVEA area in order to appropriately time the need for transmission additions. The present study effort builds on the conclusions of the previous study work and was performed primarily to verify the performance of the system with an electrical interconnection to Big Sandy substation. The study objectives are to:

1. Verify the performance of the transmission and subtransmission system with the proposed interconnection to Big Sandy substation. Determine the best voltage for that interconnection. Identify the timing.
2. Mitigate the projected overloads of Tri-State's 100 MVA 230-115 kV Fuller transformer.
3. Increase Tri-State's ability to deliver planned Tri-State resources in southeastern Colorado to the MVEA load area.
4. Provide a bulk transmission connection (strong voltage source) to the eastern side of MVEA's load area.

Scope

The study region evaluated and monitored in the power flow analysis conducted for this report encompassed the central eastern Colorado transmission system, including the bulk transmission system from Big Sandy to Midway, Midway to Jackson Fuller, and Jackson Fuller to Monument. It also included MVEA's entire load serving transmission system.

This study analyzed five alternatives to mitigate known existing and future transmission system deficiencies, and to improve Tri-State's ability to deliver planned Tri-State resources in southeastern Colorado to the MVEA load area.

A power flow contingency analysis of the central eastern Colorado region was conducted to determine the system performance both with, and without, each of the five transmission system alternatives for the 2015 HS, 2016 HW, 2018 HW, and 2021 HS cases. The outage list included all single transmission elements in Areas 70 and 73. All buses, lines, and transformers in this study region were monitored for criteria violations, as specified below.

Study Assumptions

Base Case

Two heavy winter and heavy summer base cases were selected for evaluating the study alternatives. Each case included the planned eastern 115 kV loop in MVEA's service territory (originally scheduled to be in service as early as 2012, but since delayed). The 2015 heavy summer (HS) case was built from the 2015_FAC009_LGIP_TriState_4-8-11.sav case, with review and modifications by Tri-State Power System Planning. The 2016 heavy winter (HW) case was built from the 2016 HW WECC case 16hw2a1p.sav case. The 2018 HW case was similarly created from the 2018 HW WECC case 18hw1sa1p.sav case. The 2021 HS case was created from the 2021 HS WECC case 21hs1a1p.sav. The major modifications that were made to all of these starting cases to create the base cases used in this study appear in Appendix K.

Methodology

Analysis Technique

Using Multiple AC Contingency (MACC) reports and following up with selected additional single outage analysis, each combination of base case and alternative was studied. Contingency analysis was performed for each of the four study base cases, and for each alternative included with each of the four cases.

Acceptable voltages for all buses in the study area are between 0.95 and 1.05 per unit under system normal conditions. According to Tri-State's *Engineering Standards Bulletin-Criteria for System Planning and Service Standards*, acceptable loading on any transmission line is less than 80 percent of its continuous rating, and less than 100 percent of its maximum nameplate rating for transformers. System adjustments during solution were allowed, including shunt capacitor switching and LTC tap adjustments. Area interchanges and phase shifter adjustments were not utilized.

Tri-State's *Engineering Standards Bulletin* state's that the 80 percent system normal line loading criteria applies to Tri-State owned transmission lines. This criterion was established in recognition of the high losses, high voltage drop, and possible steady-state stability problems associated with a line loaded above 80% of its static thermal rating. For lines owned by other entities, loading above this limit was noted, but no facility upgrades were required until the loading reached 100 percent of their continuous ratings under system normal conditions.

In the case of single contingency conditions, acceptable voltages for all buses in the study area are between 0.90 and 1.10 per unit. Acceptable loading for all transmission lines and transformers is below 100 percent of their continuous ratings or any applicable emergency ratings as specified by the owner of a particular element. No applicable emergency ratings were identified for this study. System adjustments during solution were not allowed, including shunt capacitor switching, LTC tap adjustments, area interchanges and phase shifter adjustments.

Proposed Alternatives

The study evaluates various design/routing alternatives that may improve the future reliability, capacity and load serving capability of the transmission system in the south central and eastern Colorado region. The study area includes the transmission system serving the southern Front Range suburban communities around Colorado Springs and Monument, and the rural areas to the east, all of which are served by MVEA. Following is a discussion of the transmission system alternatives that were included in this study.

1) Alternative 0: 230 kV Big Sandy-Calhan Line

This alternative consists of acquiring MVEA's right-of-way for its 69 kV Limon-Simla-Person-Calhan line to construct a new 230 kV Big Sandy-Calhan line. A new 230 kV substation, including a new 230-115 kV transformer, would be constructed as an addition to the existing Calhan Substation. The 230 kV ring bus at Big Sandy Substation would be expanded to accommodate the new line termination. The 230 kV line would be constructed with 1272 mcm ACSR conductor with a maximum design temperature of 100 degrees C, and would possess a rating of 613 MVA (1538 amperes). For the purpose of this study (but not the estimate), two new 230 kV delivery point tap substations were assumed, one to serve Person, and the other to serve Simla. However, there are numerous other transmission and distribution alternatives that could be considered for either retaining 69 kV service, or providing new 24.9 kV service to Person, for these MVEA customers. To retain 69 kV service, either the new 230 kV Big Sandy-Calhan line could be constructed as a double circuit, 230/69 kV line from Calhan to Simla, or else a new 230-69 kV delivery point substation could be constructed at Simla, in which case that portion of line between Simla and Person would be constructed as double circuit 230/69 kV.

2) Alternative 1: Double Circuit 115 kV Big Sandy-Calhan Line

This alternative consists of acquiring MVEA's right-of-way for its 69 kV Limon-Simla-Person-Calhan line to construct a new double circuit 115 kV Big Sandy-Calhan line. The existing 115 kV Calhan Substation would be expanded to accommodate the additional two line terminations. The double circuit 115 kV line would be constructed with 795 mcm ASCR conductor with a maximum design temperature of 100 degrees C, and would possess a rating near 464 MVA (2334 amperes). For the purpose of this study, it was assumed that one circuit would serve two new delivery point tap substations to be constructed, one to serve Person, and the other Simla. However, there are other distribution alternatives that could be considered providing new 24.9 kV service to Person, for these MVEA customers.

3) Alternative 2: Road 125 Substation

This alternative is essentially a variant on Alternative 0, in that it consists of a new 230 kV line from Big Sandy-Calhan, but by way of an additional interconnection and sectionalizing switching station at Road 125. This new 230 kV line would be constructed across new right-of-way from Big Sandy to Road 125, and then south to a new substation site for serving Simla, at which point the 230 kV line would utilize MVEA's right-of-way for its 69 kV Simla-Person-Calhan line to reach Calhan Substation. A new 230 kV substation, including a

new 230-115 kV transformer, would be constructed as an addition to the existing Calhan Substation. The 230 kV ring bus at Big Sandy Substation would be expanded to accommodate the new line termination. The new Road 125 switching station would be constructed on property already owned by Tri-State with a new 230 kV breaker and a half scheme to accommodate a possible future line extension to Xcel's 230 kV Missile Site Substation. The 230 kV line would be constructed with 1272 mcm ACSR conductor with a maximum design temperature of 100 degrees C, and would possess a rating of 613 MVA (1538 amperes). For the purpose of this study (but not the estimate), two new 230 kV delivery point tap substations were assumed, one to serve Person, and the other to serve Simla.

4) Alternative 3: Tap 230 kV Lincoln-Midway Line and Build New 230 kV North Rush Road-Calhan Line

This alternative consists of constructing an interconnection switching station, called North Rush Road, to sectionalize the 230 kV Lincoln-Midway line southeast of Person adjacent to MVEA's 69 kV Calhan-Person-Simla line. From this point, a new 230 kV line would be built to MVEA's 69 kV line, which would then be reconstructed as a double circuit 230/69 kV line, the 230 kV line would then continue on to Calhan. A new 230 kV substation, including a new 230-115 kV transformer, would be constructed as an addition to the existing Calhan Substation.

5) Alternative 4: Add 2nd 100 MVA 230-115 kV Transformer at Jackson Fuller Substation

This alternative consists of the installation of a second, 100 MVA, 230-115 kV transformer at Jackson Fuller Substation to supplement the existing 100 MVA, 230-115 kV transformer owned by Tri-State. Fuller is the key load serving source from CSU's 230 kV system for MVEA, but as noted previously, Tri-State has no transmission rights to the high side of Fuller. The installation of a second transformer at Fuller would alleviate potential overloads of the existing transformer.

Study Results

Steady State Analysis

The study results are summarized below and in Tables 1 and 2. Detailed outage results can be found in Appendix H for the 2011 HS case, Appendix I for the 2018 HW case, and Appendix J for the 2021 HS case. Only the MACC results for the 2018 HW and 2021 HS case are indicated in the tables since, upon further evaluation of the 2015 HS and 2016 HW cases, neither of those cases possessed sufficient load growth to exceed the capacity of the existing 230-115 kV Fuller transformer, which is the operating limitation that these alternatives were intended to alleviate.

1. 2018 HW Base Case

Past Large Generator Interconnection Procedures (LGIP) study work has identified operating conditions where the existing Jackson Fuller 100 MVA, 230-115 kV transformer becomes overloaded before the winter of 2018, even with the dramatically reduced 2010 load forecast. The most critical single contingency outage for the heavy winter 2018 case, as confirmed by this study, is a loss of the 230 kV Midway-RD Nixon line, which overloads the existing Jackson Fuller 230-115 kV transformer. During this outage, the Fuller 100 MVA transformer is overloaded by a full 20 MVA, or 20% above its nameplate rating. The second most severe single contingency outage was for the 115 kV Cottonwood North-Kettle Creek line, owned by Colorado Springs Utilities (CSU), which caused a 5.7% overload on the 115 kV Briargate-Cottonwood South line (also owned by CSU).

During peak summer loading conditions, there were essentially no other significant overloads of transmission system elements in the MVEA area. The closest overload was only a 0.7% overload of the 115 kV Midway-R.D. Nixon line for a single contingency outage of the 230 kV Midway-R.D. Nixon line. Both of these elements are owned by CSU, and are therefore beyond the scope of this study to evaluate further.

2. 2021 HS Base Case

By the summer of 2021, there are more overloads within the regional transmission system serving MVEA, although the overload of the Jackson Fuller transformer is reduced. For the 2021 heavy summer base case, the worst single contingency outage causing an overload of the Fuller transformer is a loss of the 115 kV Kettle Creek-Flying Horse line, which results in a 10% overload (10 MVA) of the Fuller transformer. In contrast to the 2018 heavy winter base case, the most critical single contingency outage is for the 115 kV Cottonwood North-Kettle Creek line, which causes a 14.3% overload of the 115 kV Briargate-Cottonwood South line.

All five alternatives provide very similar improvements to system performance, such as alleviating the 230 kV bottleneck of the Fuller transformer. For example, given construction of Alternative 0 (230 kV Big Sandy-Calhan line), for the 2021 heavy summer case, the loading on the Fuller transformer under normal system operation was reduced by 40% (40 MVA) of its nameplate rating (100 MVA), from 79 MVA to only 39 MVA. Such a dramatic improvement (reduction) in the loading on the Fuller transformer (79% to only 39%) also has a cumulative positive effect upon the reduction in loading on adjacent transmission system elements as well. This is due to the shift in flow from western bulk transmission sources owned by Xcel and CSU to the eastern bulk transmission source of Big Sandy, owned Tri-State, and from which Tri-State resources can be supplied to serve MVEA's load.

Each of the first four alternatives provide transmission service from Tri-State transmission sources to MVEA's system loads and all of the alternatives performed well under normal system operating conditions. There was, however, one slight overvoltage noted that could occur at the jointly owned (TSGT/MVEA) 115 kV substations at Emil Anderson and Forest Lakes. Voltages rose to approximately 1.16 p.u. for the base case and all the alternatives for the single contingency outage of the 115 kV Emil Anderson-Monument line. This overvoltage is easily remedied by switching out

the 15 MVAR capacitor bank at Emil Anderson that is scheduled for installation in the next several years, depending upon the magnitude of MVEA's load growth.

Table 1: 2018 H W Results

Contingency Element	From Bus	#	73391	73413	73413
		Name	Cttnwd N	MidwayBR	MidwayBR
		kV	115	230	230
	To Bus	#	73410	73419	73419
		Name	Kettleck	RD_Nixon	RD_Nixon
		kV	115	230	230
Monitored Element	From Bus	#	73389	73412	73477
		Name	Briargat	MidwayBR	Fuller
		kV	115	115	230
	To Bus	#	73393	73417	73481
		Name	Cttnwd S	RD_Nixon	Fuller
		kV	115	115	115
	Rating	(MVA)			
Case Scenario Evaluation of Monitored Element Loading For Worst Case Violations	Base Case	%	105.7%	-	119.9%
		(MVA)	159	-	120
	Alt 1	%	-	-	-
		(MVA)	-	-	-
	Alt 2	%	-	-	-
		(MVA)	-	-	-
	Alt 3	%	-	-	-
		(MVA)	-	-	-
	Alt 4	%	-	100.7%	-
		(MVA)	-	198	-
	Alt 0	%	-	-	-
		(MVA)	-	-	-

Table 2: 2021 HS Results

Contingency Element	From Bus	#	73391	73408	70601	73410	70601	70601
		Name	Cttnwd N	Kelker E	DanielPk	KettleCk	DanielPk	DanielPk
		kV	115	115	345	115	345	345
	To Bus	#	73410	73446	70654	73576	70654	70654
		Name	Kettleck	Kelker S	Comanche	FlyHorse	Comanche	Comanche
		kV	115	230	345	115	345	345
Monitored Element	From Bus	#	73389	73391	73413	73477	72427	72427
		Name	Briargat	Cttnwd N	MidwayBR	Fuller	N Rush Rd	N Rush Rd
		kV	115	115	230	230	230	230
	To Bus	#	73393	73410	73531	73481	73413	73531
		Name	Cttnwd S	Kettleck	LincolnNT	Fuller	MidwayBR	LincolnT
		kV	115	115	230	115	230	230
	Rating	(MVA)						
Case Scenario Evaluation of Monitored Element Loading	Base Case	%	114.3%	102.6%	109.2%	110.0%	-	-
		(MVA)	174	187	370	110	-	-
	Alt 1	%	106.7%	-	119.9%	-	-	-
		(MVA)	162	-	407	-	-	-
	Alt 2	%	106.8%	-	122.60%	-	-	-
		(MVA)	163	-	417	-	-	-
	Alt 3	%	-	-	-	-	133.1%	104.0%
		(MVA)	-	-	-	-	452	343
	Alt 4	%	108.1%	100.0%	108.9%	-	-	-
		(MVA)	164	266	369	-	-	-
	Alt 0	%	104.3%	-	125.4%	-	-	-
		(MVA)	159	-	426	-	-	-

Comparison of Alternatives

Alternative 4 (the addition of a second 100 MVA 230-115 kV transformer at Fuller) does not meet the study objectives of increasing Tri-State's ability to deliver planned Tri-State resources in southeastern Colorado to the MVEA load area, or of providing a bulk transmission connection (strong voltage source) to the eastern side of MVEA's load area. Therefore, Alternative 4 was eliminated.

Alternative 1 (a double circuit 115 kV Big Sandy-Calhan line) was eliminated on the combined basis of its ranking as the most expensive option, with no sufficient offsetting advantage over either of the 230 kV alternatives (#0 and #3). Compared to Alternative 0 (a 230 kV Big Sandy-Calhan line), Alternative 1 costs roughly $22.13 million more due to the costs required for double circuit steel structures over wooden H-frame structures. Although the double circuit 115 kV line could be considered somewhat more reliable than a single circuit 230 kV line, it is not sufficient to offset the greater cost and less thermal capacity obtained with Alternative 0.

Perhaps the only significant benefit of Alternative 1 over Alternative 0 is the savings associated with Tri-State only having to purchase one or two 115-12.5 kV transformers to serve MVEA's delivery point(s) at Simla (and possibly Person), as opposed to 230-12.5 kV transformers. However, that savings pales in comparison to the far larger costs associated with the structures. Consequently, Alternative 1 was eliminated as well.

Alternative 0 (a new 230 kV line from Big Sandy to Calhan) and Alternative 2 (a 230 kV Big Sandy-Road 125-Calhan line) provide the same benefit to MVEA and Tri-State in terms of enhancing the transmission capacity to serve MVEA's load. The substantive difference between the alternatives is the additional line expense for constructing the 230 kV line section from Big Sandy to Simla by way of Tri-State's Road 125 site instead of following MVEA's existing 69 kV line. Thus there is an additional cost of approximately $14.29 million over Alternative 0. As a result, barring any other need for Tri-State to route the new 230 kV Big Sandy-Calhan line through the Road 125 site, Alternative 0 is the better choice.

Having eliminated Alternatives 1, 2, and 4, only Alternative 3 (a North Rush Road interconnection of the 230 kV Lincoln-Midway line, and a new 230 kV line from there to Calhan) remains to be compared with Alternative 0 to determine which is the preferred transmission solution. In evaluating these two alternative transmission solutions, a review of the study results reveals that both alternatives produced similar and acceptable results. Both provide an eastern transmission source and looped transmission service to MVEA's expanding load serving network. Both alternatives performed equivalently well when evaluated for Category B single event contingencies, with only a slight difference in the 4% overload of CSU's 115 kV Briargate-Cottonwood South line in the 2021 HS case (refer to Table 2) for Alternative 0, where no such overload was recorded for Alternative 3. Both alternatives alleviate the loading on the Fuller transformer and both reduce the magnitude of import flows into the MVEA load area from third party transmission providers (CSU through Fuller, Western through Rancho, and Xcel through Monument/Forest Lakes).

Alternative 0 (a new 230 kV line from Big Sandy to Calhan) is approximately $16.7 million more than Alternative 3 due to its longer line length, but provides an improvement in transmission capacity that Alternative 3 does not. For example, Alternative 3, which interconnects and sectionalizes the 230 kV Lincoln-Midway line, necessarily utilizes existing transmission capacity in the 230 kV Big Sandy-Midway line. Therefore, Alternative 3 relies on the existing transmission path between Big Sandy and Midway to source the Calhan area loads and does not provide an additional or new transmission source into the area. An outage between Big Sandy and North Rush Road would remove Tri-State's ability to source both the Midway and Calhan loads.

Alternative 0, in contrast, provides a new 230 kV transmission source independent of the Big Sandy to Midway path. It connects the Big Sandy Substation directly to the Calhan area and provides the benefit of another transmission path (in addition to the Big Sandy-Midway path) to supply Tri-State resources to MVEA. A tie directly to the Big Sandy Substation can be considered an independent transmission source since Tri-State's plans include future 345 kV into the Big Sandy Substation as part of the Lamar-Front Range Project. A general summary of available transmission capacity by line segment for each alternative is included in Table 3.

Another benefit to Alternative 0 over Alternative 3 is the possibility of future transmission interconnections at locations such as Missile Site (via Road 125), Fuller, or Midway. Such transmission interconnections with either alternative would further strengthen the bulk transmission system. However, if Alternative 3 were constructed, then each of the possible future interconnections would again rely on the existing Big Sandy to Midway transmission path.

For informational purposes, a 230 kV interconnection between Midway and Calhan (utilizing the system configuration of Alternative 0) was modeled and is included in Appendix N.

A final benefit to Alternative 0 is its proposed construction along existing MVEA right-of-way between Limon-Simla-Person-Calhan. Alternative 3 requires acquisition of new right-of-way.

Table 3

Comparison of Available Transmission Capacity (ATC) For Alternative 0 vs Alternative 3 Configuration

Alternative 0: Build 230 kV Big Sandy-Calhan Line

	Path Segment (MW)
	Big Sandy-Calhan
TTC	613
ETC	0
TRM	0
ATC	**613**

Alternative 3: Sectionalize 230 kV Lincoln-Midway line at North Rush Road & Build 230 kV line to Calhan*

		Path Segment (MW)			
		Big Sandy-Lincoln	Lincoln-N Rush Rd	N Rush Rd-Midway	N Rush Rd-Calhan
TTC		613	613	613	613
ETC		-	-	-	-
1)	Xcel (MEAN/ARPA)	-43	-43	-43	-
2)	ARPA Firm 3 MW Path	-3	-3	-3	-
3)	LAP-Big Sandy	-33	-33	-33	-
4)	LAP-Big Sandy to CSU	-60	-60	-60	-
5)	TSGT PM 75 MW Reservation	-	-75	-75	-
6)	RMRG Reserve Delivery	-	-63	-63	-
TRM		0	0	0	0
ATC		**474**	**336**	**336**	**613**

***Assumes that the 50°C to 100°C uprate for the 230 kV Big Sandy-Lincoln-Midway line has been completed before 2018.**

Load Serving Analysis

Tri-State's native load-serving obligation in southeastern Colorado consists of transmission service to San Isabel Electric Association (SIEA) and Southeast Colorado Power Association (SECPA), as well as to MVEA. As mentioned previously, to meet a portion of this native load demand, Tri-State purchases 93 MW of firm transmission service from Western. Western markets and delivers the Colorado River Storage Project (CRSP) Preference Power allocations through the Salt Lake City Area/Integrated Projects (SLCA/IP) to Midway, and also delivers the firm point to point transmission service commitment from CRSP facilities reserved for Tri-State's Members (as previously assigned to Tri-State from Colorado Ute's prior entitlement). Currently, Western delivers 43 MW of CRSP Preference Power from SLCA/IP to Midway, and 50 MW of CRSP firm point to point transmission service (for a total of 93 MW).

Tri-State also purchases firm transmission service from Public Service Company of Colorado (Xcel Energy) for these loads, and also to meet its other existing transmission commitments. As noted previously, Tri-State is increasingly dependent on the other transmission providers in the region to provide service to its native loads, and therefore has need for additional transmission path rights. Specifically, no transmission service rights exist for serving MVEA when the 115 kV Midway-Geesen line is out of service. Therefore, construction of another Tri-State owned transmission line into the region is considered essential to reducing or eliminating the reliance on other transmission providers and enabling Tri-State to source its native loads from Tri-State generation resources.

The most recent Loads and Resources submittal by Tri-State Power Marketing to Tri-State Transmission (November, 2010) included the following:

- 50 MW wind addition at Lamar, CO in 2015
- 588 MW combined cycle addition at Lamar, CO in 2017
- 200 MW wind addition at Lamar, CO in 2020

Although the timing of these resources is dependent on Tri-State's system load growth, they are noted here to demonstrate that their expected location is in the southeastern Colorado area. These resource assumptions have been included in the Lamar-Front Range Transmission Study. That study, among other things, proposes the construction of high voltage transmission from these new resources to the existing Big Sandy Substation. Therefore, construction of a Big Sandy-Calhan transmission line would provide a direct transmission path from these new Tri-State generation resources in southeastern Colorado to Tri-State's native loads and integrate well with the proposed Lamar-Front Range project.

Cost Estimates

Below is the summary table of the planning level cost estimates prepared for each alternative. A more detailed description of what is included in each of these estimates appears in Appendix G.

#	Description of Alternative	Total Cost	Line Cost	Sub/Switchyard Cost
0	230 kV Big Sandy-Calhan Line	$42,890,000	$25,330,000	$17,560,000
1	Double Circuit 115 kV Big Sandy-Calhan Line	$65,020,000	$59,829,000	$5,191,000
2	230 kV Big Sandy-Rd 125-Calhan Line	$57,180,000	$41,293,000	$15,887,000
3	Tap 230 kV Lincoln-Midway Line & Build New 230 kV North Rush Rd-Calhan Line	$26,214,000	$8,779,000	$17,435,000
4	2nd 100 MVA, 230-115 kV Transformer at Jackson Fuller	$4,650,000	-	$4,650,000

Conclusion

The south and eastern Colorado transmission system, encompassing the bulk transmission system from Big Sandy to Midway, Midway to Jackson Fuller, and all of Tri-State's and Mountain View Electric Association's (MVEA) load serving transmission system, was analyzed for the ten year planning horizon. This analysis was performed to identify solutions to known transmission system deficiencies, evaluate various design alternatives that could improve the future reliability, capacity and load serving capability of the system, and to provide an additional transmission source to serve MVEA.

Prior planning studies have identified the benefits of constructing a bulk transmission tie to MVEA's system from the eastern Colorado transmission network. Of the alternatives studied, constructing a transmission tie between Big Sandy and Calhan provides the most benefits. The line would solve Tri-State's need for additional transmission path rights (even without new generation in southeastern Colorado) and would provide a way to deliver planned Tri-State resources to native load.

This study identified contingency loading limitations under heavy winter and heavy summer conditions with various configurations of new transmission line connections between Big Sandy and Calhan, and compared their performance against the addition of a second 230-115 kV transformer at Jackson Fuller. The study confirmed the need for additional transmission infrastructure to improve system reliability and load serving capability for certain system contingencies by the winter of 2018.

This study also evaluated the performance of the transmission system with the proposed Big Sandy to Calhan 230 kV line in service, and concluded that it meets the Study Objectives as outlined in this report. A review of the MACC results from both the 2018 HW and 2021 HS cases concluded that the proposed Big Sandy to Calhan 230 kV line:

1. Mitigated the projected overloads of Tri-State's 230-115 kV Fuller transformer,
2. Increased Tri-State's ability to deliver planned Tri-State resources in southeastern Colorado to MVEA, SIEA and SECPA.
3. Provided a bulk transmission connection (strong voltage source) to the eastern side of MVEA's load area.

The performance of the transmission system was studied for several system conditions and concluded that construction of a 230 kV Big Sandy-Calhan line provides the most overall benefit, including solving a few key transmission system deficiencies that are expected to arise in the next several years (the most notable of which is the overload by the winter of 2018 of Tri-State's existing 100 MVA, 230-115 kV transformer at Jackson Fuller Substation). The new line would provide a key missing link in Tri-State's eastern Colorado transmission system, substantially increasing the limit of the load serving path into this area.

As supported by the study results, load serving analysis, and comparison of alternatives documented in this report, the proposed construction of a 230 kV Big Sandy-Calhan line has been identified as the preferred project, because its construction would:

1. Improve the reliability of the transmission system
2. Increase Tri-State's load serving capability, and
3. Increase Tri-State's import capability for existing and planned generation.