



TRI-STATE

Generation and Transmission
Association, Inc.

A Touchstone Energy® Cooperative



Waverly – Plaza 115 kV Loop Project

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Background and Purpose

The San Luis Valley-Waverly 115 kV line and the San Luis Valley-Ramon 115 kV line provide power supply to the loads in San Luis Valley Rural Cooperative, Inc. (SLV). Under normal operating conditions, the majority of loads are served on the following three 69 kV radial lines owned by SLV:

- 1) Zinzer-Switch Rack-Carmel-Waverly-Stockade-San Acacio line, and
- 2) Ramon-South Fork-Highland-Creede line,
- 3) San Luis Valley-Hooper-Center-La Garita-Plaza line.

Their geographical transmission map and switching diagram are shown in Figure 1 and Diagram 1, respectively. Note that the South Fork-Switch Rack 69 kV line and the Plaza-Switch Rack 69 kV line are open under normal operating conditions.

For the outage of either the San Luis Valley-Waverly 115 kV line or the San Luis Valley-Ramon 115 kV line, the loads on the 69 kV line will be initially interrupted. Specifically, for the outage of the San Luis Valley-Waverly 115 kV line, the loads on the Zinzer-Switch Rack-Carmel-Waverly-Stockade-San Acacio 69 kV radial line will be initially interrupted. It appears that the loads on this line could be transferred to the Ramon 69 kV by closing the South Fork-Switch Rack 69 kV line, to San Luis Valley 69 kV by closing the Plaza-Switch Rack 69 kV line, or to Home Lake by closing the Home Lake-Zinzer 69 kV line. However, this results in unacceptable low voltages.

Their 2005 July peak loads served on these 69 kV radial lines are listed below:

<u>Substation (69 kV)</u>	<u>2005 July Peak Load (MW)*</u>	<u>Subtotal (MW)</u>
Zinzer	2.7	
Carmel	12.8	
Stockade	1.7	
San Acacio	2.5	
Subtotal for Waverly meter point		19.7
Creede	1.2	
Highland	2.5	
South Fork	1.8	
Subtotal for Ramon meter point		5.5
Hooper	8.1	
Center	13.9	
La Garita	8.8	
Plaza	2.4	
Subtotal for San Luis Valley meter point		<u>33.2</u>
Totals of three meter points		58.4
* Measured by 69 kV meter points at Ramon, Waverly and San Luis Valley.		

Consultant from San Luis Valley met with Tri-State to study this problem and proposed the Wavery-Plaza 115 kV loop project consisting of the following (Diagram 2):

- Establish a Waverly-Plaza 115 kV line by: (1) Rebuilding the existing 14 miles, 1/O ACSR, Carmel-Switch Rack 69 kV line to 115 kV with 477 ACSR, (2) Rebuilding the existing 13 miles, 1/O ACSR, Switch Rack-Plaza Junction 69 kV line to 115 kV with 477 ACSR, and (3) Constructing a new 3.5 miles, Plaza Junction-Plaza 115 kV line with 477 ACSR. Note that the existing 2 miles, Waverly-Carmel 69 kV line is originally insulated at 115 kV and needs not be rebuilt.
- Rebuild the existing Plaza 69 kV Substation to 115 kV.
- Loop the existing San Luis Valley-Ramon 115 kV line into Plaza 115 kV.

Tri-State has studied this proposed project and determined that it will reinforce the transmission system and service reliability to SLV in the following ways:

- The 115 kV transmission system will improve from two radial lines to a loop connection of three lines from San Luis Valley to Waverly to Plaza and back to San Luis Valley, plus the Plaza-Ramon 115 kV radial line. This improvement will not interrupt service to the 69 kV loads under any single 115 kV line outage of the looped project.
- The normally opened South Fork-Plaza 69 kV line can be closed at Plaza for a more reliable service to the loads on the Ramon-South Fork-Highland-Creede 69 kV line.
- The loads at Stockade and San Acacio will be served on 115 kV rather than 69 kV because the existing Waverly-Stockade-San Acacio 69 kV line is originally insulated at 115 kV and will be converted to 115 kV operation upon the completion of the loop project.

Project Work and Rough Cost Estimates

The Waverly-Plaza 115 kV loop project consists of the following work items (Diagram 2) and rough cost estimates:

1. Construct a 115 kV switching station at Waverly with a three-breaker 115 kV ring bus (\$1,750,000). One breaker is for the Waverly-San Luis Valley 115 kV line, one is for the Wavery-Carmel-Switch Rack 115 kV line, and the third one is for the Waverly-Stockade-San Acacio 115 kV, which now operates at 69 kV but is originally insulated at 115 kV.
2. Rebuild 14 miles, 1/O ACSR, Carmel-Switch Rack 69 kV line to 115 kV with 477 ACSR (\$2,380,000). Note that the existing 2 miles, Waverly-Carmel 69 kV line is originally insulated at 115 kV.
3. Rebuild 13 miles, 1/O ACSR, Switch Rack-Plaza Junction 69 kV line to 115 kV with 477 ACSR (\$2,210,000).
4. Construct a new 3.5 miles, Plaza Junction-Plaza 115 kV line with 477 ACSR (\$1,312,000).

5. Rebuild the existing Plaza 69 kV Substation to 115 kV with a three-breaker 115 kV ring bus (\$2,600,000). Loop the San Luis Valley-Ramon 115 kV line into Plaza and connect the 115 kV line between Plaza and Switch Rack.
6. Move the existing Waverly 115/69 kV transformer to Plaza (\$100,000). The existing two 69 kV breakers at Waverly contain oil and will be relocated or salvaged. This is because Engineering has advised that the moving cost could exceed the cost to purchase two new ones.
7. *Install two 69 kV line position at Plaza to connect the Plaza-South Fork line and the Plaza-La Garita-Center-San Luis Valley line.*
8. *Install a 115/12.5 kV transformer at Switch Rack (Zinzer).*
9. *Install a 115/12.5 kV transformer at Carmel.*
10. *Install a 115/25 kV transformer at Stockade.*

Note that project Items 1 through 6 are eligible transmission elements for the Waverly-Plaza 115 kV loop project cost sharing on a 50/50 basis. The total estimated cost for these items is \$10,352,000. Tri-State and SLV will each be responsible for half of the cost or \$5,176,000. These are the latest cost estimates provided by Jerry Hager of ESC in January 2007.

Project Items 7 through 10 are distribution elements and the full cost is expected to be paid for by SLV.

Planning Criteria

System normal criteria require that bus voltages be within the range of 0.95 to 1.05 per unit. Transmission line flows should not exceed 80 percent of its continuous rating, and transformer flows must not exceed 100 percent of its maximum nameplate rating. System adjustments including shunt capacitor and reactor switching, generator voltage regulation, transformer tap and phase shifter adjustments, and area interchanges are allowed to be changed.

Single contingency outage criteria require that bus voltages be within the range of 0.90 and 1.10 per unit. Furthermore, the voltage magnitude at a bus during a single contingency outage cannot drop by more than 0.05 per unit from the system normal condition. Transmission lines and transformers flows must not exceed 100 percent of their continuous ratings. All system adjustments were allowed in the outage simulations.

Tri-State's system planning criteria are consistent with the Western Electricity Coordinating Council (WECC) and the North American Electric Reliability Council (NERC) system reliability criteria.

Base Case Data

The WECC 2005 heavy summer case was selected to perform the study. This base case was modified to show the following 2005 July peak load in SLV:

Bus No.	Bus Name	Base KV	ID	2005 Summer Peak				2015 Sum Peak (2.5% Growth)			
				MW	MVAR	MW	MVAR	MW	MVAR	MW	MVAR
70028	ANSEL TS	69	TS	4.7	1.5			6.0	2.0		
70090	CARMEL	69	TS	12.8	4.2			16.4	5.4		
70092	CENTER	69	TS	13.9	4.6			17.8	5.8		
70129	CREEDE	69	TS	1.2	0.4			1.6	0.5		
70221	HILANDSL	69	TS	2.5	0.8			3.2	1.0		
70229	HOOPER	69	TS	8.1	2.7			10.4	3.4		
70245	LAGARITA	69	TS	8.8	2.9			11.2	3.7		
70289	MOFFAT	69	TS	3.7	1.2			4.8	1.6		
70325	PLAZA	69	TS	2.4	0.8			3.1	1.0		
70373	S.ACACIO	69	TS	2.5	0.8			3.2	1.0		
70383	SFORK SL	69	TS	1.8	0.6			2.3	0.8		
70411	STANLEY	115	TS	10.6	3.5			13.6	4.5		
70414	STOCKADE	69	TS	1.7	0.6			2.2	0.7		
70477	ZINZER	69	TS	2.7	0.9			3.5	1.1		
70024	ALMSA ST	69	1			3.9	2.0			5.0	2.5
70025	ALMSA TM	115	1			14.8	4.0			19.0	5.2
70029	ANTONITO	69	1			3.3	1.4			4.2	1.8
70118	COCENTER	69	1			0.6	0.0			0.7	0.0
70143	DELNORTE	69	1			1.8	1.0			2.3	1.3
70187	FTGARLND	69	1			9.6	3.5			12.3	4.5
70228	HOMELAKE	69	1			4.3	1.6			5.5	2.1
70509	KERBERCK	69	1			0.0	0.0			0.0	0.0
70289	MOFFAT	69	1			0.1	0.1			0.2	0.1
70292	MOSCA	69	1			1.3	0.3			1.6	0.3
70360	RIOGRAND	69	1			4.6	2.2			5.9	2.8
70367	ROMEO	69	1			4.5	1.5			5.7	1.9
70506	SAGUACHE	69	1			3.3	1.2			4.3	1.5
70379	SARGENT	115	1			4.0	2.9			5.1	3.7
Tri-State Total				77.4	25.5			99.3	32.5		
Xcel Energy Total						56.1	21.7			71.8	27.7
Total in San Luis Valley:				133.5 MW in 2005 and 171.1 MW in 2015.							

Note that the loads of Xcel Energy in San Luis area are existing loads in the WECC base case.

The total SLV load of 2005 July peak is 77.4 MW and the total load of Xcel Energy is 56.1 load. The combined total is 133.5 MW in San Luis area. The total SLV load is expected to grow with an annual rate of 2.5%. A study case was developed with the above projected 2015 load to determine whether the proposed 115 kV loop project is capable to handle this higher load level. With this 2015 load projection, the total SLV load will be 99.3 MW and the total Xcel Energy load will be 71.8 MW. The combined total will be 171.1 MW.

Normal and single contingency power flow studies were performed to identify any transmission loading and voltage violations using the PTI/PSSE power flow program.

Study Results

The power flow results, plotted in Plots 1 through 12, along with the overloading and under voltage summary, are shown in the attached "Attachment1.pdf" file.

- Plot 1 shows the normal system of 2005 summer peak load of 133.5 MW in San Luis area without any planning violation in SLV transmission system. However, the Fort Garland and Saguache 69 kV buses of Xcel Energy show marginally low voltage of 0.948 per unit and 0.942 per unit, respectively.
- Plot 2 is same as Plot 1 but with the San Luis Valley-Waverly 115 kV line out. The Switch Rack/Zinzer-South Fork 69 kV line is switched in to provide back-up service to the loads at Zinzer, Carmel, Stockade and San Acacio. The power flow shows that this back-up service plan is not acceptable because the voltage on these load buses drop way below 0.95 per unit. At San Acacio, the voltage drops to 0.797 per unit.
- Plot 3 is same as Plot 1 but with the San Luis Valley-Waverly 115 kV line out. The Switch Rack/Zinzer-Plaza 69 kV line is switched in to provide back-up service to the loads at Zinzer, Carmel, Stockade and San Acacio. The power flow shows that this back-up service plan is not acceptable because the voltage on these load buses drop way below 0.95 per unit. At San Acacio, the voltage drops to 0.607 per unit.
- Plot 4 is same as Plot 1 but with the San Luis Valley-Waverly 115 kV line out. The Home Lake-Zinzer 69 kV line is switched in to provide back-up service to the loads at Zinzer, Carmel, Stockade and San Acacio. The power flow shows that this back-up service plan is not acceptable because the voltage on these load buses drop below 0.95 per unit. At San Acacio, the voltage drops to 0.915 per unit. In addition, Home Lake Substation is owned by Xcel Energy.
- Plot 5 shows the normal system of 2015 summer peak load of 171.1 MW in San Luis area with the proposed Waverly-Plaza 115 kV loop project. This simulation results in no planning violations in SLV 69 kV transmission system. However, the San Luis Valley 230 kV is marginally low at 0.943 per unit. Moreover, Fort Garland, Saguache, Moffat and Mirage Jct. 69 kV buses of Xcel Energy show low voltage ranging from 0.914 per unit to 0.943 per unit.
- Plot 6 is same as Plot 5 but with the San Luis Valley-Waverly 115 kV out. This simulation shows no planning violations.
- Plot 7 is same as Plot 5 but with the San Luis Valley-Stanley 115 kV line out. This simulation shows no planning violations.
- Plot 8 is same as Plot 5 but with the Plaza-Ramon 115 kV line out. This simulation shows no planning violations.
- Plot 9 is same as Plot 5 but with the Waverly-Carmel 115 kV line out. This simulation shows no planning violations.

Plot 10 is same as Plot 5 but with the Plaza-Switch Rack 115 kV line out. This simulation shows no planning violations.

Plot 11 is same as Plot 5 but with the Plaza-La Garita 69 kV line out. This simulation shows no planning violations for the SLV loads except for some existing low voltages in Xcel Energy's system.

Plot 12 is same as Plot 5 but with the San Luis Valley-Hooper 69 kV line out. For this outage, power flow shows that the loads at Hooper, Center and La Garita cannot be backed up at Plaza. It shows overloads on the Plaza 115/69 kV transformer and unacceptable low voltages at Hooper, Center, La Garita, Plaza, etc. For example, the Hooper voltage is 0.642 per unit.

Conclusion and Recommendation

Base on this power study with the WECC 2005 heavy summer case and the projected 2015 loads in San Luis Valley area, the proposed Waverly-Plaza 115 kV loop project, at a rough estimated cost of \$8,260,000 to be shared by SLV and Tri-State on a 50/50 basis, will sufficiently reinforce the existing SLV 69 kV system and provide adequate service to SLV through 2015 and longer. Note that SLV will incur additional cost for distribution transformers and protection.

Future Shunt Capacitors

Note that in Plot 5, the power flow shows that with the 2015 loads in San Luis Valley, Fort Garland, Saguache, Mirage and Moffat all show voltages below 0.95 per unit. This indicates the need for 69 kV shunt capacitors. Since these are the Substations of Xcel Energy, a copy of this report is sent to them for their consideration of adding future shunt capacitors. It is also suggested that Xcel Energy should conduct a study to seek other solution options.

Also note that in Plot 5, the San Luis Valley 230 kV voltage decreased to 0.943 per unit. The future Walsenburg-San Luis Valley 230 kV line is expected to mitigate this low voltage problem.

Figure 1: San Luis Valley Transmission System (Geographical)

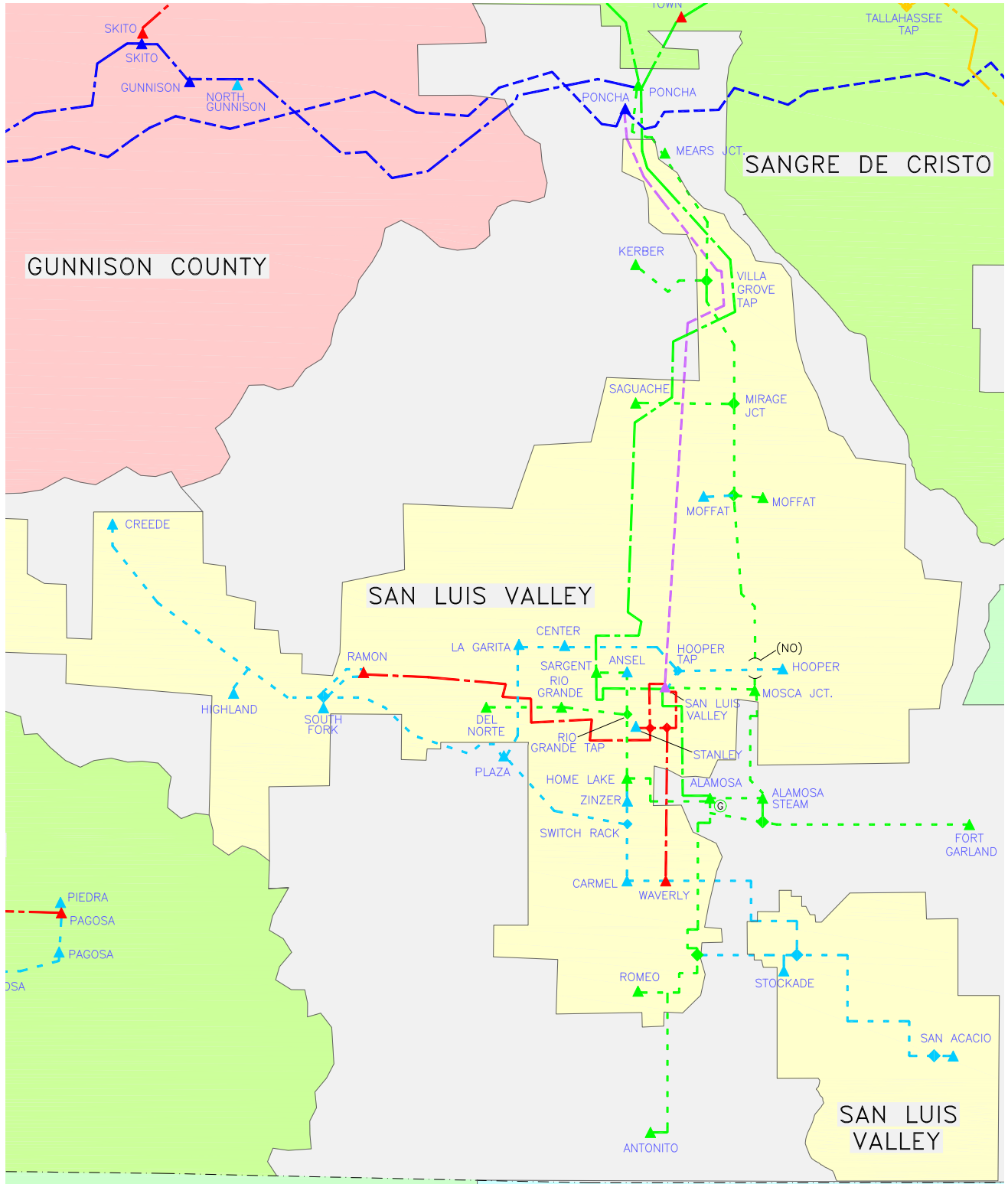
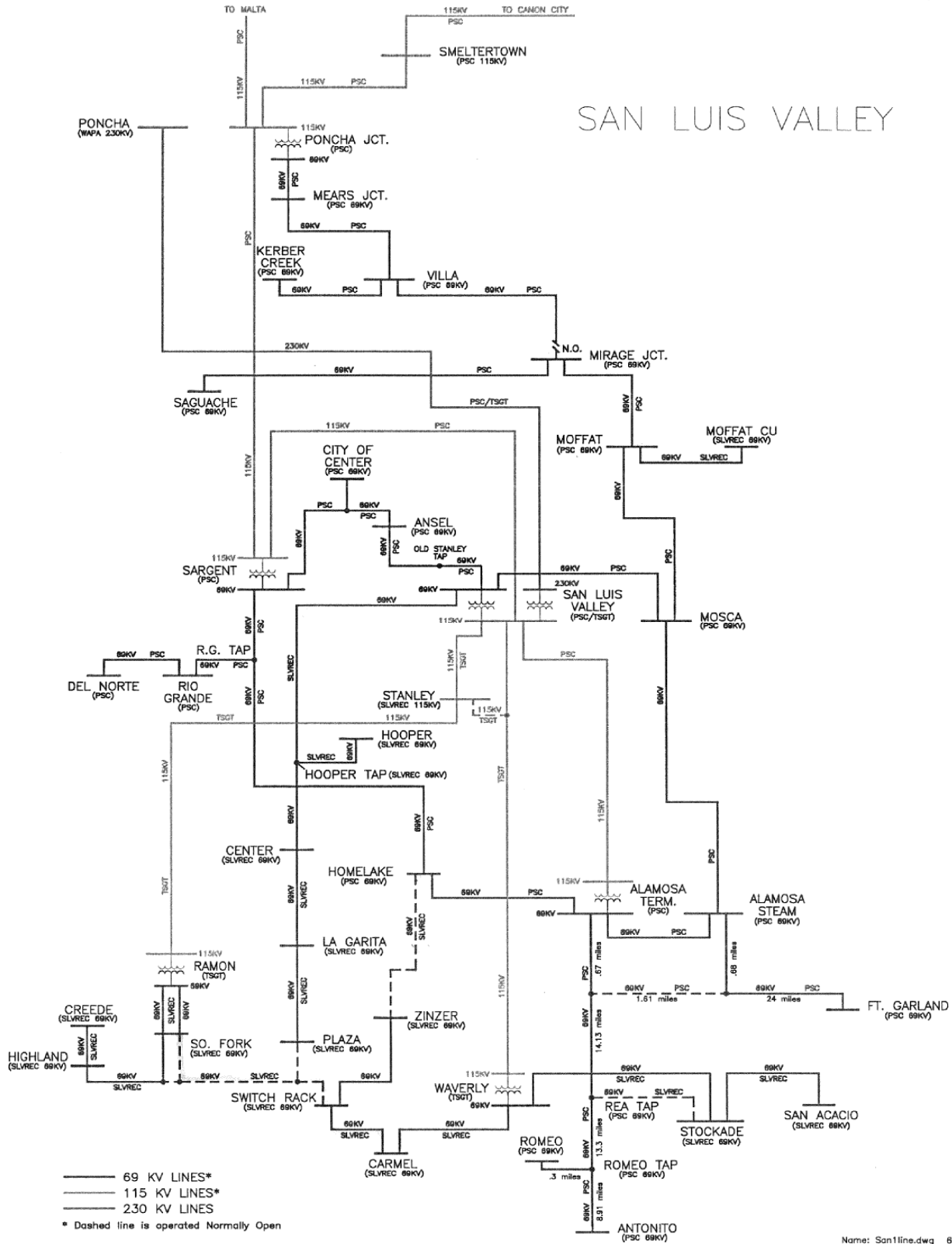


Diagram 1: San Luis Valley Switching



Name: San1line.dwg 6/13/01

Diagram 2: Waverly – Plaza 115 kV Loop Project

