BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO

| | | |
|---|---|---|
| IN THE MATTER OF THE APPLICATION OF TRI-STATE GENERATION AND TRANSMISSION ASSOCIATION, INC. FOR A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE SAN LUIS VALLEY-CALUMET-COMANCHE TRANSMISSION PROJECT | ) ) ) ) ) ) | DOCKET NO. ____ |

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DIRECT TESTIMONY AND EXHIBITS OF
STEPHEN A. MUNDORFF

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## I. INTRODUCTION AND QUALIFICATIONS

**Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.**

A. My name is Stephen A. Mundorff. My business address is 1100 W. 116th Ave, Westminster, Colorado 80234.

**Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?**

A. I am employed by Tri-State Generation and Transmission Association, Inc. ("Tri-State"). My title is Senior Manager, Transmission Engineering.

**Q. PLEASE DESCRIBE YOUR RESPONSIBILITIES AS SENIOR MANAGER, TRANSMISSION ENGINEERING.**

A. I am responsible for managing the electrical, civil, telecommunication, and protection engineering functions, construction management, drafting, and project coordination resources supporting additions and modifications to the Tri-State transmission system.

**Q. HAVE YOU PREPARED A STATEMENT OF YOUR EXPERIENCE AND QUALIFICATIONS?**

A. Yes. My *curriculum vitae* is attached as **Exhibit No. SAM-1**.

**Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS DOCKET?**

A. I am testifying on behalf of Tri-State. I understand that my testimony may also be used to support the CPCN application that has been filed by Public Service Company of Colorado ("Public Service") for its participation in this joint project.

## II. PURPOSE OF TESTIMONY

**Q. ARE YOU FAMILIAR WITH THE SAN LUIS VALLEY—CALUMET—COMANCHE TRANSMISSION PROJECT (THE "PROJECT") THAT IS THE SUBJECT OF THIS PROCEEDING?**

A. Yes, I am.

**Q. PLEASE DESCRIBE YOUR INVOLVEMENT IN THAT PROJECT.**

A. As the Senior Manager of Transmission Engineering for Tri-State, I am responsible for overseeing the design and construction of the transmission lines, substations, and associated communications involved in the Project that are identified to be Tri-State's responsibility as outlined further in my testimony.

**Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?**

A. The purpose of my testimony is to discuss the engineering, design and construction for the proposed Project including the structures, conductors, and right-of-way widths. Specifically, I will be discussing the double-circuit 230 kV transmission segment between the San Luis Valley and Calumet Substations, and the 115/230 kV transmission segment between the Calumet and Walsenburg Substations. I will also explain the engineering criteria that were considered and the process involved in the selection of the specific design that is proposed for these two segments of the Project. Finally, I will discuss the design of these two segments relative to noise mitigation and reduction of magnetic field exposure. The specific noise and magnetic field analyses for these two transmission segments,

however, will be discussed in greater detail by Tri-State witness Dr. Robert Pearson.

## III. GENERAL PROJECT OVERVIEW

**Q. PLEASE DESCRIBE THE BASIC ENGINEERING DESIGN FOR THE PROJECT.**

A. The overall Project consists of four major components: (1) a new double-circuit 230 kV transmission line from the existing San Luis Valley Substation to a new Calumet Substation located north of Walsenburg; (2) a new double-circuit 345 kV transmission line from the Calumet Substation to Public Service's existing Comanche Substation; (3) a new Calumet Substation; and (4) a new double-circuit 230 kV capable transmission line from the Calumet Substation to Tri-State's existing Walsenburg Substation. A map showing the general location of the Project is attached as **Exhibit No. SAM-2** to my testimony. A one-line electrical diagram depicting the proposed Project is attached as **Exhibit No. SAM-3** to my testimony.

**Q. WHAT IS TRI-STATE'S ROLE IN THE PROJECT?**

A. In general, Tri-State will be responsible for constructing and operating the San Luis Valley – Calumet and the Calumet – Walsenburg line segments of the Project and the associated substation improvements.

**Q. WHAT IS PUBLIC SERVICE'S ROLE IN THE PROJECT?**

A. In general, Public Service will be responsible for constructing and operating the Calumet – Comanche segment of the Project and the

associated substation improvements.

**Q. WHO WILL OWN THE THREE TRANSMISSION SEGMENTS YOU HAVE JUST DESCRIBED?**

A. Ownership of and capacity rights on the San Luis Valley – Calumet and Calumet – Comanche transmission lines will be shared between Tri-State and Public Service with Tri-State owning 40% and Public Service owning 60%. Ownership of and capacity rights on the new Calumet – Walsenburg 230 kV transmission line will be shared between Tri-State and Public Service with Tri-State owning 80% and Public Service owning 20%. Tri-State witness Joel Bladow discusses the ownership and capacity sharing aspects of the Project in more detail in his testimony.

**Q. ONCE CONSTRUCTED, WHICH COMPANY WILL BE RESPONSIBLE FOR THE MAINTENANCE OF THESE TRANSMISSION LINE SEGMENTS?**

A. Tri-State will have maintenance responsibility for the San Luis Valley – Calumet and Calumet – Walsenburg transmission lines and the San Luis Valley, Walsenburg, and Calumet Substation additions. Public Service will have maintenance responsibility for the Calumet – Comanche transmission line and the Comanche Substation additions.

**Q. WHICH COMPANY WILL OWN THE RIGHT-OF-WAY FOR THE THREE TRANSMISSION SEGMENTS?**

A. Tri-State and Public Service will have joint ownership of the right-of-way for the San Luis Valley – Calumet, Calumet – Comanche, and Calumet –

Walsenburg line segments. This is described in more detail in the testimony of Tri-State witness Mark Murray.

**Q. WHAT IS THE TIMELINE FOR COMPLETION OF THE TWO TRANSMISSION SEGMENTS THAT TRI-STATE WILL BE CONSTRUCTING?**

A. It is anticipated that the construction of the San Luis Valley – Calumet and Calumet – Walsenburg segments will take approximately 24 months following the receipt of all necessary permits and easements required to commence construction.

**Q. WHAT IS THE SCHEDULE FOR COMPLETION OF THE OVERALL PROJECT?**

A. The anticipated completion for the overall project is May 31, 2013.

**Q. HOW WAS THIS PROJECT SCHEDULE ESTABLISHED?**

A. The project schedule was established by evaluating recent timelines for similar projects. The anticipated Project milestones are: CPCN approval by November, 2009; siting studies, and permitting for the Project completed by December, 2010; and final line connections, substation commissioning, and energization completed by May 31, 2013.

**Q. WHAT IS THE ESTIMATED TOTAL COST OF THE PROJECT?**

A. The estimated total cost of the project is $180,000,000. This estimate is in 2008 dollars and is based on cost-per-mile indicators in similar construction terrains, average unit material costs, and 2008 overhead and labor rates, without additions for allowance for funds used during

construction (AFUDC). At this stage of the project these are high level estimates within a range of +/- 30% of the total cost. The cost estimate breakdown by substation and transmission line segment for the proposed Project is attached as **Exhibit No. SAM-4** to my testimony.

**Q. WHAT IS TRI-STATE'S SHARE OF THE TOTAL PROJECT COST?**

A. Tri-State's share of the total project cost is $75,000,000. This estimate uses the same assumptions as stated in previous cost estimates.

**Q. WHICH COMPANY WILL BE RESPONSIBLE FOR ACQUIRING NEW RIGHT-OF-WAY FOR THE PROJECT?**

A. Tri-State will be responsible for acquiring any new right-of-way needed for the San Luis Valley – Calumet and Calumet – Walsenburg transmission lines. Public Service will be responsible for acquiring any new right-of-way needed for the Calumet – Comanche transmission line.

**Q. WHAT IS THE WIDTH OF THE NEW RIGHT-OF-WAY FOR THE SAN LUIS VALLEY – CALUMET AND CALUMET – WALSENBURG SEGMENTS OF THE PROJECT?**

A. The new right-of-way width will be 150 feet for the San Luis Valley – Calumet 230 kV line, while the Calumet – Walsenburg line is expected to utilize the existing 100 foot right-of-way of the existing Stem Beach – Walsenburg 115 kV line that is planned to be rebuilt as part of the Project.

## IV. PROJECT ENGINEERING DESCRIPTION

**Q. WHAT IS THE LENGTH OF THE PROPOSED SAN LUIS VALLEY – CALUMET DOUBLE-CIRCUIT 230 KV TRANSMISSION LINE?**

A. This transmission segment will extend approximately 95 miles from the San Luis Valley Substation, located approximately 7 miles west of the Town of Mosca, to the new Calumet Substation which will be located approximately 6 miles north of Walsenburg.

**Q. WHAT IS THE GENERAL ALIGNMENT OF THE PROPOSED TRANSMISSION LINE?**

A. Several possible alignments have been identified through the Alternative Evaluation and Macro Corridor Study Tri-State has been performing. These possible alignments are shown in greater detail in the Project map (**Exhibit No. SAM-2**), and are discussed in more detail in the testimony of Mr. Murray.

**Q. WHAT ARE THE NECESSARY COMPONENTS OF THE NEW TRANSMISSION LINES THAT WILL BE CONSTRUCTED?**

A. The proposed transmission lines will consist of the support structures, conductors, insulators, overhead ground wires, and overhead fiber optic wires.

**Q. WHAT TYPE OF SUPPORT STRUCTURES ARE PROPOSED TO BE USED IN THE SAN LUIS VALLEY - CALUMET SEGMENT?**

A. The typical or base structure is a single tubular steel pole with six horizontal steel arms attached to support the insulator/hardware assemblies. The insulators are suspended vertically from the end of the structure arms and support the conductor. There will also be two shorter arms placed at the top of the pole to support the overhead shieldwires.

The steel poles will attach at the base to a reinforced concrete foundation. The single pole steel structures will be approximately 115-150 feet in height. Tri-State is also proposing to use a steel lattice double-circuit structure in mountainous terrain. This structure will have a similar geometry to the steel pole structure but can be assembled in sub-sections which will provide flexibility for transportation and installation. The proposed structure designs are depicted in **Exhibit No. SAM-5**.

**Q. HOW WAS THIS SUPPORT STRUCTURE DESIGN SELECTED?**

A. The support structures proposed are typical double-circuit designs used by Tri-State, Public Service, and other utilities. The double-circuit structure requires less right-of-way than two separate lines and will significantly reduce construction costs. It also has benefits in limiting the footprint of audible noise and magnetic fields.

**Q. WHAT WILL BE THE TYPICAL SPAN LENGTH FOR THIS SEGMENT?**

A. Individual span lengths are determined by a number of factors including terrain, structure height, sag of the conductors, and the minimum clearances as prescribed in the National Electrical Safety Code. With that in mind, the typical span length for the San Luis Valley – Calumet transmission line will be 1000 feet. Tri-State will add a "buffer" of three feet to the minimum vertical clearance values as determined by the NESC to ensure continued safe operation of the line.

**Q. WHAT TYPE OF CONDUCTOR WILL BE USED FOR THIS 230 KV TRANSMISSION LINE?**

A. Tri-State is proposing to use a single 1272 kcmil aluminum, steel reinforced ("ACSR") "Bittern" conductor for the 230 kV San Luis Valley – Calumet transmission line.

**Q. WHAT CONSIDERATIONS WENT INTO THE SELECTION OF THIS CONDUCTOR?**

A. Conductor selection includes consideration of several factors including thermal capacity, sag characteristics, losses, corona/audible noise, maintenance practices, and inventory. The 1272 ACSR "Bittern" conductor has been used on numerous lines in the Rocky Mountain region. It has a high steel content which makes it efficient for minimizing sag from both thermal and weather loadings. Also, Tri-State has the existing inventory and tools to repair the 1272 ACSR that is already widely used in its system.

**Q. WHAT WILL BE THE MAXIMUM DESIGN TEMPERATURE USED FOR THIS CONDUCTOR?**

A. The conductor will be designed to a maximum operating temperature of 100° C.

**Q. WHAT WILL BE THE THERMAL RATING OF THIS CONDUCTOR?**

A. The conductor thermal rating will be approximately 1,538 amps or 612 MVA.

**Q. PLEASE DESCRIBE THE INSULATORS AND HARDWARE THAT WILL BE USED ON THE SAN LUIS VALLEY – CALUMET TRANSMISSION LINE.**

A. The insulation for this line will consist of a composite polymer insulator with electric field grading rings at each end. The conductor will be supported at the end of the insulator string by a corona-control clamp that is specifically sized for the conductor. The corona-control clamps and grading rings are designed to minimize sharp edges or other protrusions that would promote corona and audible noise (Tri-State witness Dr. Robert Pearson discusses this issue further in his testimony). The proposed insulators and attachment hardware are depicted in **Exhibit No. SAM-6**.

**Q. WILL THE TRANSMISSION LINE ALSO EMPLOY OVERHEAD SHIELDWIRES AND FIBEROPTIC WIRES?**

A. Yes. The transmission lines will also include an Optical Groundwire ("OPGW") as well as the typical overhead shieldwire. The purpose of this wire is two fold. The primary purpose of the OPGW is to provide sacrificial shielding of the conductors from lightning strikes thereby reducing interruptions of power flow caused by lightning induced faults. The OPGW will also contain optical fibers that will provide for the communication of data used by Tri-State and Public Service to operate the transmission system.

**Q. WHAT IS THE LENGTH OF THE PROPOSED CALUMET-WALSENBURG DOUBLE-CIRCUIT 230 KV TRANSMISSION LINE?**

A. The proposed 115/230 kV circuit will extend approximately 6 miles from the new Calumet Substation to the existing Walsenburg Substation located approximately 1 mile west of the City of Walsenburg.

**Q. IS THERE AN EXISTING TRANSMISSION LINE THAT RUNS BETWEEN THE CALUMET SITE AND THE WALSENBURG SUBSTATION?**

A. There are three transmission lines that extend north from the Walsenburg Substation to the new proposed Calumet Substation site. There is an existing Tri-State 115 kV transmission line that connects the Stem Beach and Walsenburg Substations and runs through the proposed new Calumet Substation site. A portion of the existing Stem Beach – Walsenburg line coincides with the alignment of the proposed new 115/230 kV Calumet – Walsenburg transmission line. There is also an existing 115 kV transmission line not owned by Tri-State coming from the Walsenburg Substation that supports an industrial load west of the Calumet site. The third and final transmission line in this corridor is Tri-State's existing 230 kV transmission line that connects the Comanche and Walsenburg Substations.

**Q. WILL THE EXISTING STEM BEACH – WALSENBURG 115 kV LINE BE AFFECTED BY THE PROPOSED PROJECT?**

A. Yes. As part of this Project, Tri-State will rebuild the section of the Stem Beach – Walsenburg line between Walsenburg Substation and the new Calumet site using double-circuit 230 kV structures. One circuit will be operated at 115 kV to complete the existing Stem Beach – Walsenburg 115 kV transmission line, and the other circuit will be operated at 230 kV for purposes of an additional Calumet-Walsenburg transmission line

included in the proposed Project. This aspect of the Project is discussed in the study report submitted with Dr. Robert Pearson's testimony. (See Exhibit No. RLP-2, Figure 4)

**Q. WILL THE EXISTING 115 KV TRANSMISSION LINE RIGHT-OF-WAY BE SUFFICIENT FOR THE NEW DOUBLE-CIRCUIT 230 KV-CAPABLE TRANSMISSION LINE?**

A. The existing 115 kV Stem Beach – Walsenburg line right-of-way is 100 feet wide, and adjacent to two other transmission line right-of-way sections. Tri-State's Comanche-Walsenburg 230 kV line has a 150-foot right-of-way and is east of the Stem Beach – Walsenburg 115 kV line. The existing ARCO 115 kV radial line segment originating from the Walsenburg Substation has a 100-foot right-of-way and is adjacent to the west of the Stem Beach – Walsenburg 115 kV line. While more right-of-way may be required for a typical 230 kV double-circuit structure, with the existing adjacent transmission line corridors, the 100 foot right-of-way is sufficient. Tri-State will adjust span lengths as necessary to account for the existing right-of-way width.

**Q. WILL THE TWO TRANSMISSION LINES INCLUDED IN THE CALUMET - WALSENBURG SEGMENT INCLUDE THE SAME COMPONENTS AS YOU DESCRIBED PREVIOUSLY?**

A. Yes. The new 115/230 kV circuit will also consist of the support structures, conductors, insulators, overhead ground wires, and overhead fiber optic wires.

**Q. WHAT TYPE OF SUPPORT STRUCTURES ARE PROPOSED TO BE USED ON THIS SEGMENT?**

A. Like the San Luis Valley – Calumet line, the typical or base structure is a single tubular steel pole with six horizontal steel arms attached to support the insulator/hardware assemblies. However, there will be no need for lattice steel structures in this segment. The insulators are suspended vertically from the end of the structure arms and support the conductor. There will also be two shorter arms placed at the top of the pole to support the overhead shieldwires. The steel poles will attach at the base to a reinforced concrete foundation. The single pole steel structures will be approximately 115-135 feet in height. The proposed structure design is depicted in **Exhibit No. SAM-5**.

**Q. HOW WAS THIS SUPPORT STRUCTURE DESIGN SELECTED?**

A. The support structure proposed is a typical double-circuit design used by Tri-State, Public Service and other utilities. The double-circuit steel pole structure requires less right-of-way than two separate lines and will significantly reduce construction costs. The single steel pole may be considered less visually obtrusive in the suburban setting near the town of Walsenburg.

**Q. WHAT WILL BE THE TYPICAL SPAN LENGTH FOR THIS SEGMENT?**

A. Keeping in mind the same factors that determine individual span lengths as previously described, the typical span length for the Calumet – Walsenburg transmission line will be 800 feet.

**Q. WHAT TYPE OF CONDUCTOR WILL BE USED FOR THE NEW 230 KV CIRCUIT TO BE CONSTRUCTED ALONG THIS SEGMENT?**

A. Tri-State is proposing to use a single 1272 kcmil aluminum, steel reinforced ("ACSR") "Bittern" conductor for the 230 kV Calumet – Walsenburg transmission line.

**Q. WHAT CONSIDERATIONS WENT INTO THE SELECTION OF THIS CONDUCTOR?**

A. Similar considerations to those outlined in the selection of the conductor for the San Luis Valley – Calumet line section were taken into account.

**Q. WHAT TYPE OF CONDUCTOR WILL BE USED FOR THE REBUILT 115 KV CIRCUIT TO BE CONSTRUCTED ALONG THIS SEGMENT?**

A. Tri-State is proposing to use a single 1272 kcmil ACSR "Bittern" conductor for this circuit.

**Q. WHAT CONSIDERATIONS WENT INTO THE SELECTION OF THAT CONDUCTOR?**

A. Although Tri-State has no immediate plans to operate this circuit at 230 kV, there are reasons to construct it using 230 kV insulation and using the same conductor as the 230 kV circuit. Although the existing Stem Beach – Walsenburg 115 kV line has 477 ACSR conductor, there is a minimal material cost adjustment between the existing 477 ACSR conductor and the proposed 1272 ACSR conductor And, there would be similar labor costs to install either conductor. Also, if 477 ACSR were used to match the existing Stem Beach – Walsenburg 115 kV line, a future uprate to 1272

ACSR would be much more costly in comparison. Using the same conductor and hardware will also make maintenance more efficient. Additionally, the symmetry of the two circuits on the double-circuit structure would improve the appearance of the line. The use of 1272 ACSR on the 115 kV circuit will also reduce audible noise.

**Q. PLEASE DESCRIBE THE INSULATORS THAT WILL BE USED ON THE CALUMET - WALSENBURG TRANSMISSION LINE.**

A. The insulators and hardware will be the same as the San Luis Valley – Calumet 230 kV segment previously described. The proposed insulators and attachment hardware are depicted in **Exhibit No. SAM-6**.

**Q. WILL THE CALUMET – WALSENBURG TRANSMISSION LINES ALSO EMPLOY OVERHEAD GROUND WIRES AND FIBEROPTIC WIRES?**

A. Yes. Tri-State plans to install an OPGW fiberoptic static wire on the Calumet – Walsenburg line for the same reasons stated for installation on the San Luis Valley – Calumet line.

**Q. DOES THE PROJECT REQUIRE ANY IMPROVEMENTS OR ADDITIONS TO THE SAN LUIS VALLEY OR WALSENBURG SUBSTATIONS?**

A. Yes. At the existing San Luis Valley Substation Tri-State will expand the existing three breaker ring bus to a five breaker ring with the addition of two new 230 kV circuit breakers and associated equipment for the two new 230 kV line connections. At its existing Walsenburg Substation, Tri-State will add one 230 kV circuit breaker and associated equipment for the

new 230 kV line bay. Additional improvements will also be needed at Public Service's Comanche Substation and those improvements are described by Public Service witness Gerry Stellern

**Q. PLEASE DESCRIBE THE NEW CALUMET SUBSTATION THAT WILL BE CONSTRUCTED AS PART OF THE PROJECT.**

A. The new 345/230 kV Calumet Substation will consist of a 345 kV four position ring bus built to be expandable to a six position breaker-and-a-half arrangement, two 560 MVA 345/230 kV autotransformers, and a 230 kV seven position breaker-and-a-half arrangement. This arrangement and the associated line connections are shown in one-line diagram **Exhibit No. SAM-3**.

**Q. WHICH COMPANY WILL BE RESPONSIBLE FOR CONSTRUCTING THE SAN LUIS VALLEY AND WALSENBURG SUBSTATION MODIFICATIONS AND THE NEW CALUMET SUBSTATION?**

A. Tri-State will be responsible for constructing the San Luis Valley and Walsenburg Substation modifications and the new Calumet Substation.

## V. NOISE MITIGATION

**Q. WHAT NOISE MITIGATION MEASURES WILL TRI-STATE USE WHEN DESIGNING THE SAN LUIS VALLEY–CALUMET 230 KV AND CALUMET-WALSENBURG TRANSMISSION LINES?**

A. Tri-State will use several techniques to mitigate noise on this project including using large conductors, corona-control attachment hardware,

assuring conductor quality, careful handling of conductors during installation, and providing adequate right-of-way width.

**Q. FOR THE SEGMENTS TRI-STATE WILL BE CONSTRUCTING, HAS TRI-STATE STUDIED THE POTENTIAL NOISE LEVELS AT THE EDGE OF THE RIGHT-OF-WAY THAT WOULD RESULT FROM THE PROPOSED PROJECT?**

A. Yes. Tri-State has commissioned studies of the potential noise levels relative to right-of-way based on the proposed construction of these line segments. Tri-State witness Dr. Robert Pearson discusses these studies in greater detail in his testimony.

**Q. WHAT CONCLUSIONS DID TRI-STATE REACH AS A RESULT OF THESE VARIOUS NOISE STUDIES?**

A. Tri-State concluded that the transmission line design proposed for these double-circuit lines provides the appropriate balance of cost-effective noise mitigation and operating capabilities to meet both Tri-State's and Public Service's present and future transmission requirements.

## VI. PRUDENT AVOIDANCE OF EXPOSURE TO MAGNETIC FIELDS

**Q. WHAT ACTIONS OR TECHNIQUES RELATING TO PRUDENT AVOIDANCE OF EXPOSURE TO MAGNETIC FIELDS DID TRI-STATE CONSIDER IN CONNECTION WITH THE DESIGN OF THE SAN LUIS VALLEY – CALUMET AND THE CALUMET – WALSENBURG TRANSMISSION SEGMENTS?**

A. Tri-State will use several techniques to provide prudent avoidance of exposure to magnetic fields which include design alternatives for the spatial arrangement and phasing of conductors, line routing to avoid population concentrations and group facilities, installing taller structures, increasing mid span ground clearance, and providing additional right-of-way width. The most significant design opportunity for reducing electro-magnetic fields ("EMF") on this project is the use of "reverse phasing". The phases of each circuit on the double-circuit structures will be matched against a dissimilar phase of the other circuit. The fields of each phase will partially cancel each other thereby reducing the overall EMF for the line. The use of structures that arrange the conductor phases vertically will also mitigate EMF by reducing the horizontal spread out from the support structures. This helps reduce the EMF levels at the edge of the right-of-way. The right-of way widths will be more than is strictly required for NESC electrical clearances. The right-of-way widths are intended to provide mitigation for audible noise and limit possible long term exposure to EMF.

**Q. HAS TRI-STATE STUDIED THE POTENTIAL MAGNETIC FIELD LEVELS AT THE EDGE OF THIS SEGMENT'S RIGHT-OF-WAY THAT WOULD RESULT FROM THE PROPOSED PROJECT?**

A. Yes. Tri-State has commissioned studies of the potential magnetic field levels relative to right-of-way based on the proposed construction of these

line segments. Tri-State witness Dr. Robert Pearson also discusses these studies in greater detail in his testimony.

**Q. WHAT CONCLUSIONS DID TRI-STATE REACH AS A RESULT OF THESE VARIOUS MAGNETIC FIELD STUDIES?**

A. Tri-State concluded that the transmission line design proposed for these double-circuit transmission lines includes appropriate steps to reduce magnetic field exposure at reasonable costs while still meeting both Tri-State's and Public Service's present and future transmission requirements.

**Q. WAS UNDERGROUND CONSTRUCTION CONSIDERED IN THE PROPOSED DESIGN OF THIS PROJECT?**

A. An underground construction alternative was not specifically considered given that the magnetic fields resulting from the proposed overhead design are well within typical exposure guidelines. The magnetic field exposure levels estimated for this Project are consistent with those this Commission and other states' regulatory bodies have previously found to be reasonable. In light of the minimal benefits that might be obtained from burial of the 230 kV circuits in terms of magnetic field exposure, this alternative was not considered to be a reasonable cost.

**Q. DOES THIS CONCLUDE YOUR TESTIMONY?**

A. Yes.

# EXHIBIT SAM-1

## STEPHEN A. MUNDORFF

**Statement of Qualifications**

Stephen A. Mundorff, P. E.
Sr. Manager Transmission Engineering

Tri-State Generation and Transmission Association, Inc.

**Education:**

Bachelor of Science, Civil-Structural Engineering (ABET), 1980
Portland State University, Portland, Oregon

Bachelor of Science, Psychology, 1971
Portland State University, Portland, Oregon

**Registrations:**

| | |
|---|---|
| Registered Professional Engineer in | Colorado (25069) |
| | Nebraska (E-7800) |
| | Wyoming (6481) |
| | New Mexico (15202) |

**Professional Experience:**

| | |
|---|---|
| 12/06-Present | Sr. Manager Transmission Engineering , Tri-State G & T Assn., Inc., Denver, CO<br>Responsible for managing electrical, civil, telecommunications and protection engineering functions, capital construction management, drafting and project coordination resources dedicated to transmission system additions and modifications. Responsible for oversight of scope, schedule and budget for transmission capital projects. Responsible for oversight of engineering and design functions including construction specifications. Responsible for certifications to Rural Utilities Service (RUS) of compliance of Tri-State transmission construction with the National Electrical Safety Code (NESC) and RUS regulations.<br>Manage staff of 77 engineers and technicians. |
| 3/02 – 12/06 | Transmission Engineering Manager, Tri-State G & T Assn., Inc., Denver, CO<br>Responsible for managing civil engineering, electrical engineering, drafting and project coordination resources dedicated to transmission system additions and modifications. Responsible for finalizing scope, schedules and budgets for transmission capital projects. Responsible for oversight of engineering and design functions including construction specifications. Responsible for certifications to Rural Utilities Service (RUS) of compliance of Tri-State transmission construction with the National Electrical Safety Code (NESC) and RUS regulations.<br>Manage staff of 32 engineers and technicians. |
| 4/92 – 3/02 | Civil Engineering Manager. Tri-State G&T Assn., Inc. Denver, CO<br>Responsible for civil engineering, surveying and construction inspection functions on transmission system additions and modifications. Responsible for developing civil engineering components of scope, schedules and budgets for transmission capital projects. Responsible for civil engineering and design functions including construction |

specifications. Responsible for certifications to Rural Utilities Service (RUS) of compliance of Tri-State transmission construction with NESC code and RUS regulations. Managed staff of 9 engineers and technicians.

12/80 – 4/92 Senior Transmission Engineer, Colorado-Ute Electric Assn., Inc., Montrose, CO
Responsible for project engineering, design and construction of numerous transmission lines in western and southern Colorado varying from 69kV to 345kV. Project engineer for the 250 mile long Rifle-San Juan 345kV Project in western Colorado. Experience in route development, cost estimates, budgets, schedules, project coordination and construction management. Extensive experience on design and analysis of insulator/conductor/structure/foundation structural systems using wood, lattice and tubular steel materials. Responsible for interpretation, application and compliance with NESC, RUS and other industry design guides and safety codes. Prepared material and construction specifications and administered construction contracts. Responsible for all phases of project.

1974 –12/80 Engineering Technician, Portland General Electric Co., Portland, OR
Engineering technician in the transmission engineering department. Responsible for surveying, structure spotting and plan/profile drawings for 115kV to 500kV transmission lines.

**Affiliations:**

American Society of Civil Engineers, Associate Member

Structural Engineering Institute

Rocky Mountain Electrical League

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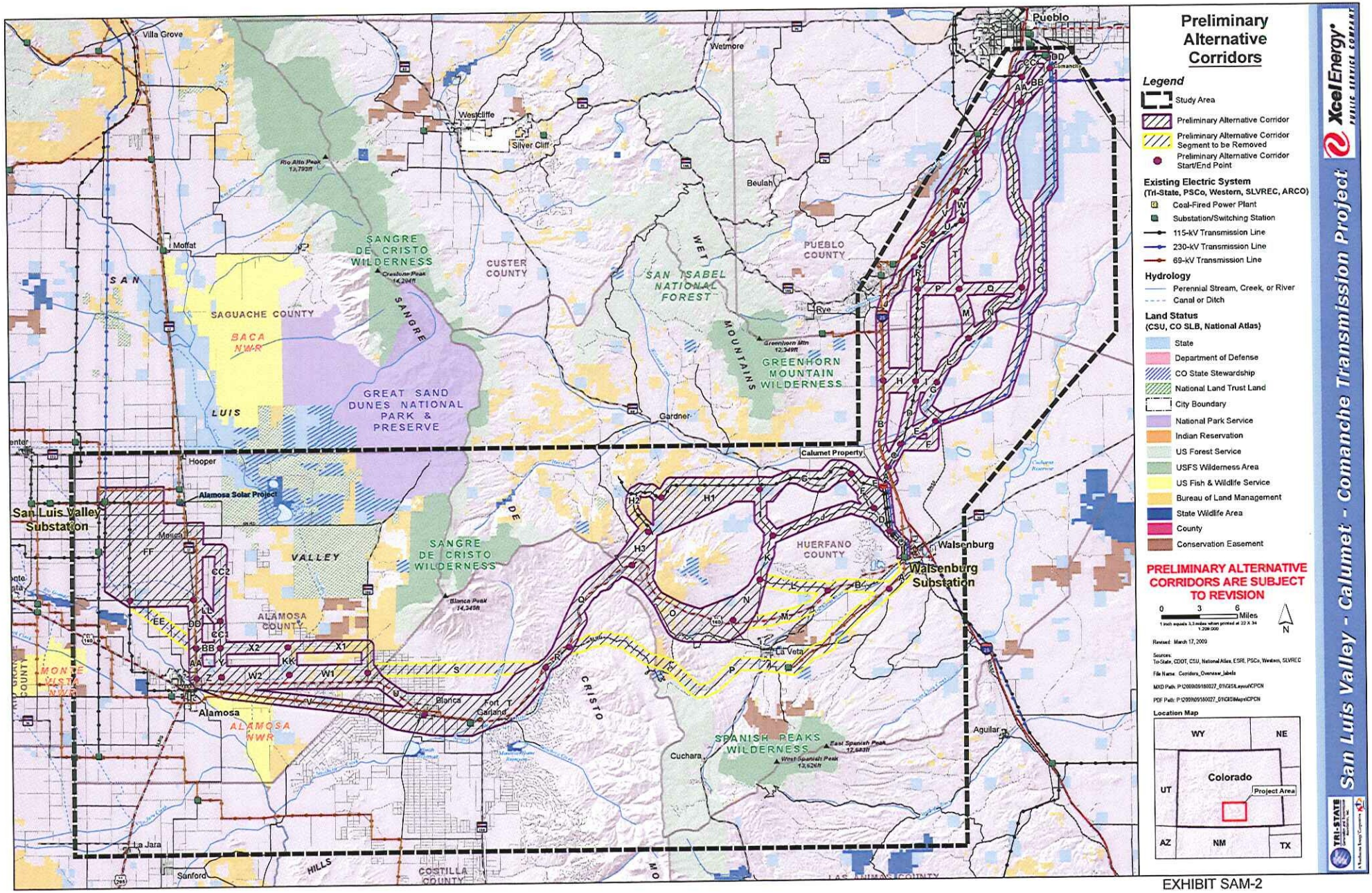


EXHIBIT SAM-2

**TRI-STATE**
Generation and Transmission Association, Inc.

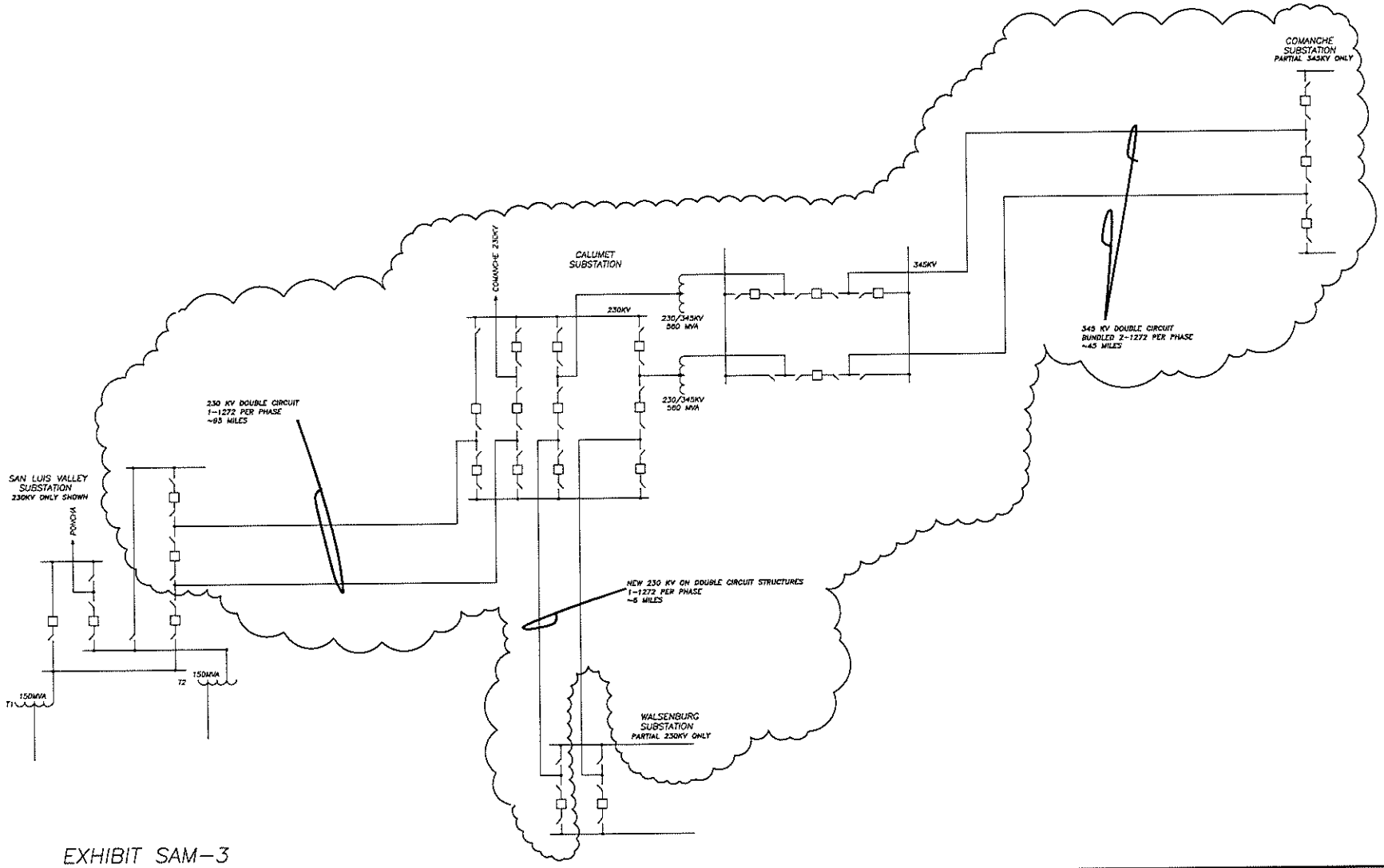


EXHIBIT SAM-3

| PROJECT | REV. NO. | DATE | REVISION | SCALE | DRAWN | APPROVED |
|---|---|---|---|---|---|---|
| SLV-CALUMET-COMANCHE TRANSMISSION PROJECT | | 03/02/09 | | N.T.S. | | |

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5/6/2009

Cost Estimates for Joint Participation in the Southern Colorado Transmission Addition Projects
San Luis Valley-Calumet-Comanche Transmission Project

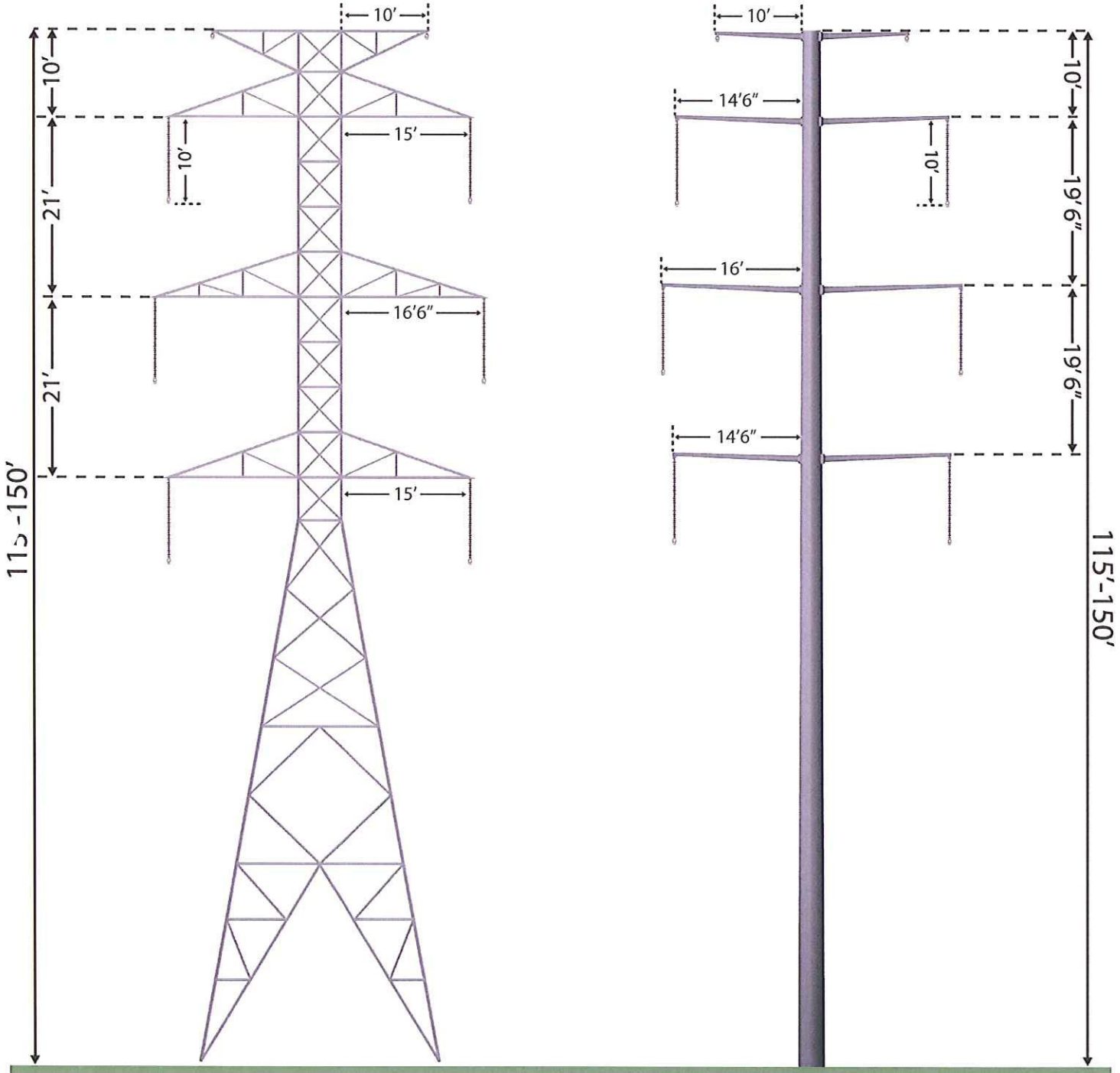
# Exhibit SAM-4

| | Party | Current Project Estimate Total | Cost Responsibility and Capacity Rights | Cost Share | Current Project Scope |
|---|---|---|---|---|---|
| San Luis Valley Substation | TS | $2,400,000 | 40% | $960,000 | Add two 230 kV circuit breakers and associated equipment for two new 230 kV line bays. Expand 3 breaker ring to 5 breaker ring. |
| | PSCo | | 60% | $1,440,000 | |
| San Luis Valley-Calumet 230 kV Line | TS | $89,800,000 | 40% | $35,920,000 | Approximately 95 miles. 230 kV Double Circuit structures with both circuits strung. 1-1272 Bittern per phase |
| | PSCo | | 60% | $53,880,000 | |
| Calumet Substation | TS | $27,000,000 | 40% | $10,800,000 | Four 345kV breakers in ring bus expandable to breaker and a half, and eleven 230kV breakers in breaker and a half arrangement. Includes 2-560 MVA 345/230 kV xfmrs. |
| | PSCo | | 60% | $16,200,000 | |
| Calumet-Comanche 345 kV line | TS | $47,700,000 | 40% | $19,080,000 | Approximately 45 miles - 345 kV Double Circuit structures with both circuits strung, 2-1272 Bittern per phase |
| | PSCo | | 60% | $28,620,000 | |
| Comanche 345 kV Additions | TS | $5,000,000 | 40% | $2,000,000 | One full new 345 kV breaker and a half bay addition with three breakers and associated equipment. |
| | PSCo | | 60% | $3,000,000 | |
| Calumet - Walsenburg 230 kV line | TS | $7,000,000 | 80% | $5,600,000 | Approximately 6 miles - Double Circuit 1-1272 Bittern on double circuit structures. One circuit will be new 230 kV line, other circuit estimated to replace existing 115 kV line. |
| | PSCo | | 20% | $1,400,000 | |
| Walsenburg Substation Additions | TS | $1,100,000 | 80% | $880,000 | Add one 230 kV circuit breaker and associated equipment for one new 230 kV line bay in main and transfer bay configuration. |
| | PSCo | | 20% | $220,000 | |
| Total | TS | $180,000,000 | 41.8% | $75,240,000 | |
| | PSCo | | 58.2% | $104,760,000 | |

These are scoping level estimates with a +/- 30% accuracy, in 2008 dollars with appropriate escalation and contingency applied and AFUDC excluded.

# San Luis Valley Electric System Improvement Project

## Structure Diagrams




Lattice Structure

Steel Mono-Pole

San Luis Valley Rural Electric Cooperative

TRI-STATE Generation and Transmission Association, Inc.

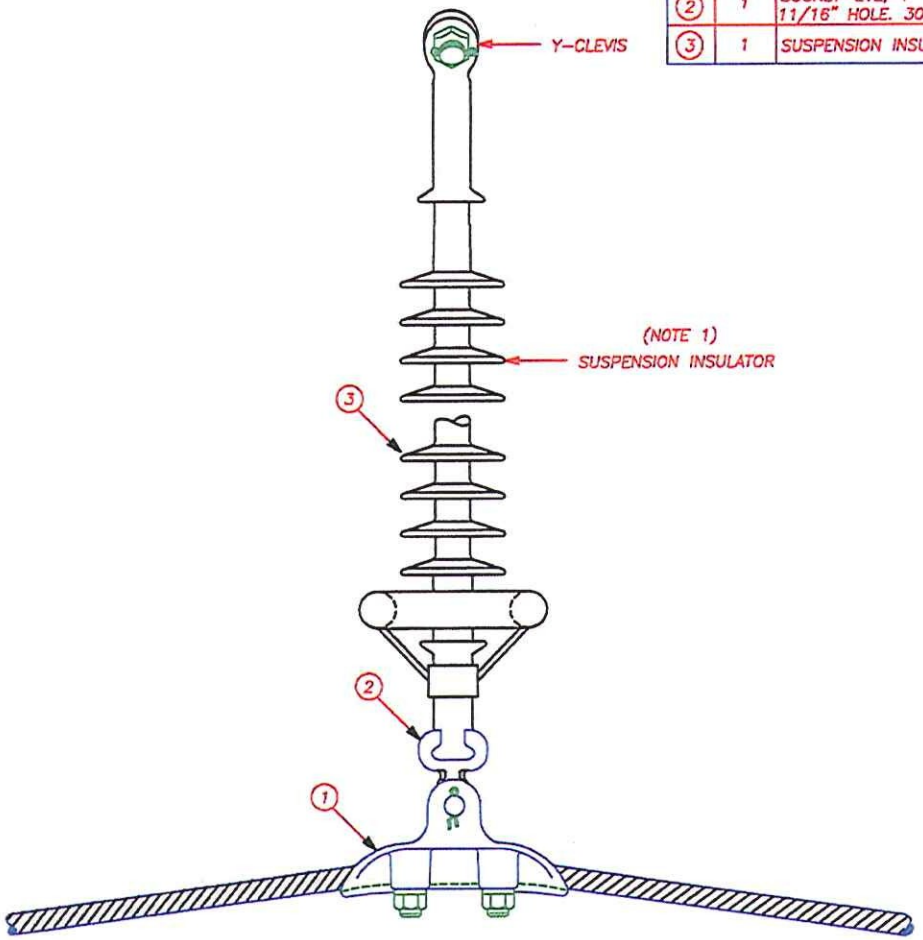
A Touchstone Energy® Cooperative

San Isabel Electric Association, Inc.

Exhibit SAM-5

TRI-STATE
GENERATION & TRANSMISSION ASSOCIATION INCORPORATED

| | | MATERIAL LIST | | | | |
|---|---|---|---|---|---|---|
| REF. | REQ'D | DESCRIPTION | MANUFACTURER | CAT. NO. | RUS CODE | INVENTORY CODE |
| (1) | 1 | SUSPENSION CLAMP, 1272 kcmil, 45/7 ACSR | AEC | HAS-147-N | ei | 22717 |
| (2) | 1 | SOCKET-EYE, 1" WIDE 11/16" HOLE. 30M | AEC | SA-10 | ei | 22743 |
| (3) | 1 | SUSPENSION INSULATOR | - | - | - | - |




FRONT VIEW

| INSULATOR TABLE | | | | | |
|---|---|---|---|---|---|
| ELEVATION | | STRENGTH | ANSI CODE | APPROXIMATE LENGHT | INDUS NUMBER |
| <7,500 | >7,500 | | | | |
| X | | 10k | 60-4 | 66" | |
| | X | 10k | 60-5 | 72" | |

NOTE:

1. SEE MATERIAL LIST FOR INSULATOR TO BE USED.
2. CORONA FREE.

SUSPENSION CLAMP TM-1B (1272 kcmil, 45/7 ACSR "BITTERN")

| PROJECT | REV. NO. | DATE | REVISION | SCALE | DRAWN | APPROVED | |
|---|---|---|---|---|---|---|---|
| T - LINE STANDARD | - | 1-2-08 | - | | SJG | | EXHIBIT-SAM-6 |