Before the Public Service Commission of
The State of North Dakota

In the Matter of the Application of
BASIN ELECTRIC POWER COOPERATIVE
For a Waiver of Procedures and Time Schedules
and a Consolidated Certificate of Corridor Compatibility
and Route Permit for the
North Killdeer Loop Phase I 345-kV Transmission Project

Case No. PU-14-813

Pre-filed Testimony
of
Gary Christenson

Q. **Mr. Christenson, please give us your name, business address and your occupation?**

A. My name is Gary Christenson. I have been retired since February 2015, but worked as a Civil Engineer for Basin Electric the prior 42+ years. Basin Electric's address is 1717 East Interstate Avenue, Bismarck, North Dakota 58503.

Q. **Please state your educational background.**

A. I have a Bachelor of Science degree in Civil Engineering and have been a registered engineer in the state of North Dakota since 1982. My registration, however, is currently in retirement status.

Q. **What is your employment history and work experience with Basin Electric?**

A. I began work in September 1972. I have been involved in the design and construction of most of the transmission lines Basin Electric has built since that time.

Q. **What have been your responsibilities in connection with the North Killdeer Loop Phase I 345 kV Transmission Project?**

A. I have served as both Project Engineer and Project Manager. I transitioned from Project Manager to Project support to retirement during the last year. As Project Engineer, I was responsible for all engineering aspects of the line, including routing and providing support to the Project Management team.

Q. **Please describe the proposed structure design?**

A. Structures for the proposed 345 kV, single-circuit transmission line segment and the 345/345 kV double-circuit transmission line segment will be constructed using self-supporting galvanized steel single poles. All segments will be constructed within a 150-foot-wide right-of-way. These structures will minimize the impact on any land crossed. The angle structures will also be single poles and will have concrete foundations with no guy wires. In-line structures will either be directly buried in the

ground or erected on concrete foundations, especially where longer spans are required and/or wet conditions exist. Structures will have permanent working ladders, which are not accessible from the ground.

Approximately 155 structures will be needed for the Project. The typical tangent structure will be about 120 feet tall. The top of the pole will be about 18 inches in diameter and the bottom at ground line will be about 55 inches in diameter. Angle and dead-end structures will typically be shorter, but larger in diameter. For the entire Project, the total land area the structures occupy would equal approximately 15% of an acre.

Q. **Why is Basin Electric using a 150-foot right-of-way?**

A. The right-of-way width is determined by the distance the suspended conductor will blow out during high wind conditions plus the distance needed to maintain safe electrical clearances. In addition, space is needed for construction and maintenance activities.

Q. **What factors determine the height of the structures?**

A. Engineering studies show the optimum span length for this kind of design to be near 1,000 feet. Conductor sag and required ground clearance then determine structure height. Topography also affects structure heights.

Q. **How have landowner concerns influenced the structural design of the proposed Project?**

A. Landowners prefer transmission lines with self-supported steel mono-pole structures with no guy wires, over traditional H-frame or 4-legged lattice structures. Single poles obviously minimize impact to land use.

Q. **What conductors is Basin Electric proposing to use for the Project?**

A. The transmission line will have three current carrying conductors. The conductors will be 1.8 inches in diameter. Each conductor has 76 strands of aluminum and 19 strands of steel. Above the conductors will be one ½-inch diameter optical ground wire and one 7/16-inch diameter steel wire. These wires provide lightning protection and optical fibers for communications. The minimum conductor clearance to ground will be 30 feet at 212° F conductor temperature.

Q. **What is the type and depth of foundations for the structures?**

A. Some structures may be direct embedded and be backfilled with crushed rock aggregate. Embedment depths vary with structure height. A typical structure is 120-feet above ground from the top of the structure to the ground line with 24-feet of embedment depth.

Many in-line (tangent) structures, all angle and dead-end type structures, and the double circuit structures will be placed on concrete piers. Pier depth and diameter are designed based on a geotechnical investigation conducted in the summer of 2014. Diameters can range from 7-feet to12-feet and depths can range from 24-feet to 34-feet deep.

Q. **What standards has Basin Electric adopted for the design of this line?**

A. The transmission line will be constructed according to standards of the Rural Utilities Service, the National Electric Safety Code, the Institute of Electrical and Electronics Engineers, the American Society of Civil Engineers, the American Institute of Steel Construction and the American Concrete Institute. In addition, Basin Electric has its own standards.

Q. **In addition to the various standards, what other factors did you consider when designing the proposed Project?**

A. When we look at the design, we look at a number of different areas. One is the amount of load, the amount of power that has to be transmitted from one end to the

other, where the energy comes from, operating parameters, terrain, water bodies, environmental impacts, constructability and long term operation and maintenance.

Q. **On average, how many structures are needed for every one mile of transmission line?**

A. Approximately five to six structures per mile with spans ranging from 650 to 1100 feet. Special structure spotting considerations are necessary when crossing roads and bodies of water. The right-of-way width of 150 feet amounts to 18.2 acres per mile of transmission line.

Q. **What are the minimum clearances over cultivated land, pasture, roads, and other utility lines?**

A. The minimum clearances are:

- Cultivated or Pasture Land, Roads & Highways - 30'
- Railroad - 38'
- Line Crossings - 15' – 19' depending on the voltage of the line being crossed

These clearances are provided at a maximum conductor temperature of 212°F. The clearance at lower temperatures will be greater. These clearances meet or exceed code standards.

Q. **What was Basin Electric's philosophy when routing the proposed Project?**

A. First, Basin Electric routed the proposed Project to minimize impacts to the environment and to accommodate existing and planned uses. Further, the proposed route also minimizes construction and maintenance costs, as much as possible. Specifically, we evaluated the following criteria/objectives in routing the proposed Project:

1. PSC avoidance and exclusion criteria;
2. Minimize disturbance to cultivated croplands;
3. Avoiding areas with identified recreational significance when possible;
4. Minimizing interference with oil and gas development;

5. Minimizing engineering, construction and maintenance hazards;
6. Spanning wetlands when possible; and
7. Avoiding areas less suitable for construction and operation, including river valleys, rugged terrain, steep slopes, areas requiring unusually long spans and areas lacking reasonable access.

Q. **Once the structures are located, can any single structure be moved easily?**

A. Every structure height, position, and type is very specific to its location. Changes to any one structure location could require changes to adjacent structure locations.

Q. **Did Basin Electric consider placing this Project and its facilities underground?**

A. Yes.

Q. **Would it be reasonable or feasible to place this Project underground?**

A. No. Placing this line underground is neither feasible nor reasonable for this Project. The cost would be near ten times greater than overhead construction. Also, underground cable requires extensive excavation which would create significantly more environmental disturbance than overhead construction. Further, maintenance activities on underground lines causes a considerable amount of disturbance, which landowners would not be in favor of.

Q. **What will the maintenance on the proposed Project typically be like?**

A. The normal maintenance on transmission lines revolves around inspection. Every six months, the line is flown by Basin Electric personnel to view if the line is in good condition. Periodically, linemen perform detailed inspections of individual structures.

Q. **Can you describe the two new substations that are a part of the proposed Project?**

A. The Project includes the Kummer Ridge Substation, which is approximately 11 acres and the Patent Gate Substation, which is approximately 17 acres. Adjacent to those proposed two substations will be substations, which will be owned by our member Cooperative, McKenzie Electric. The Kummer Ridge and Patent Gate Substations will contain a 345kV/115kV transformer, current breakers, disconnect switches, grounding switches and protection and control equipment.

Q. **Does this complete your testimony?**

A. Yes.