

Knob Hill – South Beatrice and Clay Center Junction – Greenleaf Transmission Line Study

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PUBLISHED: April 2008

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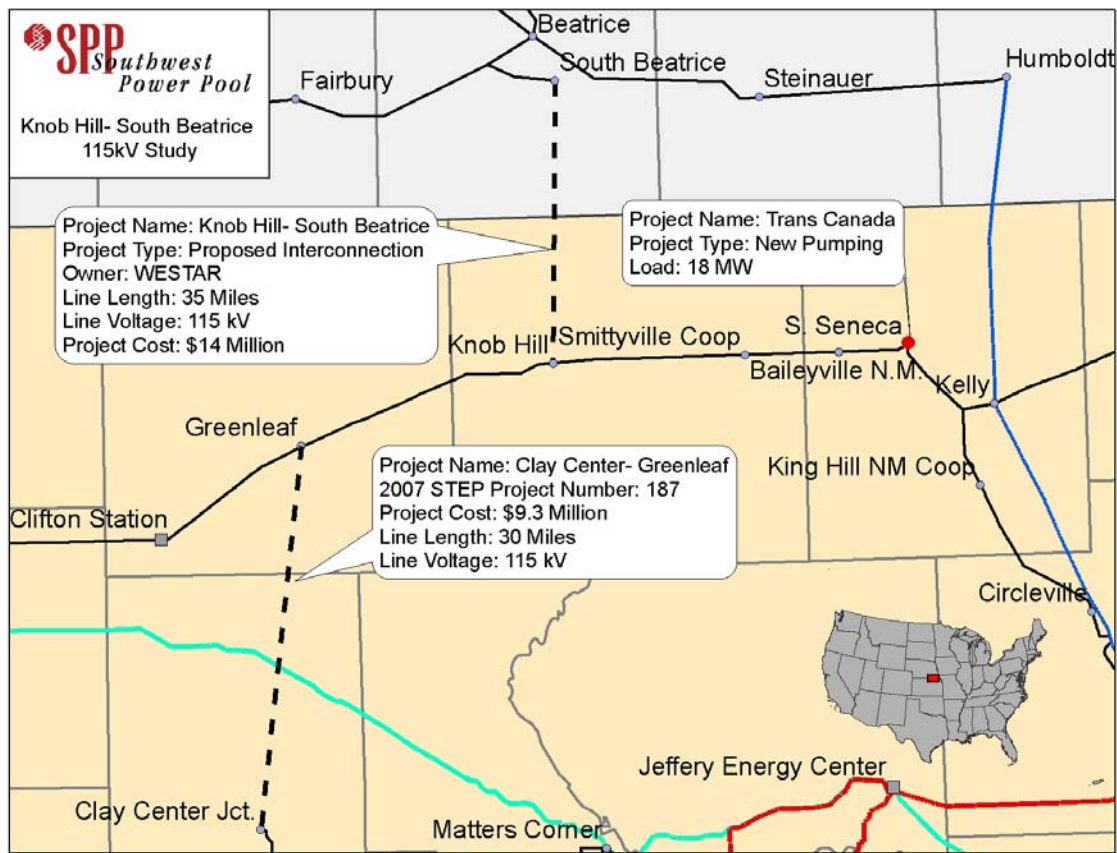
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1. EXECUTIVE SUMMARY

The objective of this study is to analyze the relative merits of two proposed transmission lines. Westar is proposing a new tie line between Westar and Nebraska Public Power District (NPPD). This would be a 115kV line from Westar’s Knob Hill to NPPD’s South Beatrice. A similar 115kV line was previously proposed to be built from Clay Center Junction to Greenleaf. Both proposed lines are intended to solve similar voltage and thermal problems along the 115kV line from Concordia to Kelly.

The general area studied is shown in the map below:



Map 1 - Study Area

An additional concern is a group of loads expected to be added in this region in the near future. These loads are two large pump stations for the TransCanada Pipeline. The loads were added to the models so that their impact would be included in the resulting recommendation.

Two sets of models were created. One included the Knob Hill – South Beatrice 115kV line, and the other included the Clay Center Junction – Greenleaf 115kV line. AC Contingency Analysis was performed on each set. Then, the results were compared to each other.

The results show that the Knob Hill – South Beatrice 115kV line does provide the best regional solution and is therefore the recommended alternative.

2. INTRODUCTION

A. Background

The TransCanada Keystone Pipeline project intends to build several new pump stations throughout Nebraska, Kansas, Oklahoma and Missouri. Two of these new pump stations are in Northeast Kansas. Westar conducted a study to evaluate the impact of these large pump stations on their transmission system. Westar's study concluded that the new loads would require the addition of a new line in the area and their study proposes a new Knob Hill to South Beatrice 115kV line to meet this need. This line is estimated to be about 35 miles long and would have a summer rating of 223/245MVA.

Prior to Westar's proposal, Southwest Power Pool's Board of Directors approved a project to build a new 115kV transmission line from Clay Center Junction to Greenleaf. This was Project ID #187 of the 2007 SPP Transmission Expansion Plan (STEP). It is estimated to be about 30 miles long and would have a summer rating of 120/130MVA. After discussions with Westar and OMPA staff it was decided to reevaluate both projects on their respective benefits and drawbacks. Therefore this SPP study was conducted to determine which project provides the best regional solution.

3. STUDY METHODOLOGY

A. SCOPE

This study was performed according to the Study Scope. The Study Scope outlined the methods for creating the load flow models and for performing the reliability analysis. For convenience, a copy of the Study Scope is included below:

- **Model Assumptions**
 - Use 2007 SPP Transmission Expansion Plan (STEP) models
 - Version "R3" without STEP upgrades to allow for reevaluation of upgrades proposed in 2007 STEP
 - All seasons (2008 April Minimum – 2017 Summer Peak)
 - All base and transactional scenarios (0-5)
 - Total of 66 models
 - Add Westar's anticipated loads for TransCanada Keystone Pipeline
 - Pump Station 29 = 18 + j8.6 MVA at S. Seneca 115kV
 - Pump Station 30 = 18 + j8.6 MVA at Walnut 115kV
 - Remove Westar monthly service which was erroneously included in the original MDWG models
 - All dispatch adjustments will follow SPP tariff studies merit order

- **Reliability Analysis**

- AC contingency analysis (N-1) on all load flow models using PSS/E
- Contingencies
 - Single element (N-1) outages of:
 - SPP facilities 69kV and above
 - SPP generators
 - NPPD, OPPD and LES facilities 69 kV and above
 - Entergy and AECI facilities 100kV and above
 - First tier companies 230kV and above
 - Multi-terminal outages as provided for the 2007 STEP by SPP members and first tier companies
- Monitored Elements
 - SPP facilities 69kV and above (overload & voltage)
 - NPPD, OPPD and LES facilities 69kV and above (overload & voltage)
 - Entergy and AECI facilities 100kV and above (overload)
 - First tier companies 230kV and above (overload)
- Apply SPP and NERC reliability standards

B. Model Assumptions

This study used the 2007 SPP Transmission Expansion Plan (STEP) models without the STEP upgrades included to allow for reevaluation of the two upgrades. All seasons and all transactional scenarios were used. The new TransCanada Pipeline pump station loads were added to the models as provided by Westar. To feed these loads, generation within Westar was dispatched according to merit order. In 2012 and 2017 Summer Peak seasons, additional power from IPP plants throughout SPP is used to supplement Westar generation.

The Clay Center Junction – Greenleaf 115kV line was added to one set of models and the Knob Hill – South Beatrice 115kV line was added to a second set of models.

C. Reliability Analysis

The reliability analysis was performed on the load flow models using PSS/E's AC contingency analysis (N-1). All contingencies 69kV and above were taken in SPP, NPPD, OPPD, and LES. All overload and voltage violations were then reported for these same areas.

The reported violations from the Clay Center Junction – Greenleaf 115kV analysis were then compared to violations from the Knob Hill – South Beatrice 115kV analysis. The differences can be attributed directly to one line or the other. This data was annotated to describe which upgrades are associated with each violation and to describe whether that upgrade needs to be moved forward or backward in time.

4. RESULTS OF ANALYSIS

A. Clay Center Junction – Greenleaf 115kV

The results of the analyses show that the Clay Center Junction – Greenleaf 115kV line did not cause the need for any additional upgrades and did not reduce the need for other upgrades from the 2007 STEP.

Another issue has surfaced though. The additional load of TransCanada Keystone Pipeline Pump Station #29 is connected to the South Seneca 115kV bus. This increased load causes overloading of Clifton – Greenleaf 115kV, Greenleaf – Knob Hill 115kV and Kelly – South Seneca 115kV. The Clay Center Junction – Greenleaf 115kV line does not relieve these overloads. Reconductoring these lines is the anticipated upgrade to relieve them. Estimated costs for the upgrades are outlined below:

Clay Center Junction – Greenleaf 115kV	30.0mi.	\$9,300,000
Clifton – Greenleaf 115kV	14.4mi.	\$5,700,000
Greenleaf – Knob Hill 115kV	20.9mi.	\$8,200,000
Kelly – South Seneca 115kV	10.3mi.	\$4,100,000
Total		\$27,300,000

One added benefit of the Clay Center Junction – Greenleaf 115kV line is that it provides a second feed into Clay Center Junction. This significantly increases power reliability to that substation, but the reliability benefit is difficult to quantify.

B. Knob Hill – South Beatrice 115kV

The results show that the Knob Hill – South Beatrice 115kV line did not cause the need for any additional upgrades, however, it did reduce the need for some other upgrades.

The 2007 STEP found the need for a 10.9MVAR capacitor at South Seneca in the summer of 2008. The need for this capacitor is moved out to 2017 by adding the Knob Hill – South Beatrice 115kV line. The \$588,600 cost of this project can be delayed for 9-years.

A project that upgrades CT ratios on the Chapman – Clay Center Junction 115kV line is also moved from the summer of 2008 to 2017. This upgrade is driven directly by the Clay Center Junction – Greenleaf 115kV project. The \$10,000 cost of this project can be delayed for 9-years.

Overloading on the Clifton – Greenleaf 115kV, Greenleaf – Knob Hill 115kV and Kelly – South Seneca 115kV lines is relieved by the addition of the Knob Hill – South Beatrice 115kV line. Therefore these lines would not need to be upgraded.

The estimated cost of the Knob Hill – South Beatrice 115kV line is \$14,025,000. This estimate includes the new line and terminal equipment.

5. CONCLUSIONS AND RECOMMENDATIONS

When the new TransCanada Keystone Pipeline pump station loads are taken into account, the Knob Hill – South Beatrice 115kV line appears to provide a more attractive regional solution than the Clay Center Junction – Greenleaf 115kV line. Therefore the Knob Hill – South Beatrice 115kV line is the recommended option.