Feasibility Study For Generation Interconnection Request GEN-2006-047

SPP Tariff Studies
(#GEN-2006-047)

June 2007

Executive Summary

<OMITTED TEXT> (Customer) has requested a Feasibility Study for the purpose of interconnecting 240 MW of wind generation within the control area of Southwestern Public Service (SPS) in Deaf Smith and Randall counties, Texas. The proposed point of interconnection is a new switching station on the existing Deaf Smith – Bushland 230 kV transmission line owned by SPS. The proposed in-service date is December 1, 2009.

Power flow analysis has indicated that for the powerflow cases studied, it is possible to interconnect the 240 MW of generation with transmission system reinforcements within the local transmission system. In order to maintain acceptable reactive power compensation, the customer will need to install 48 MVARs of 34.5 kV capacitor banks in the Customer's collector substation on the 34.5 kV bus. Dynamic Stability studies performed as part of the impact study will provide additional guidance as to whether the required reactive compensation can be static or a portion must be dynamic (such as a SVC).

The requirement to interconnect the 240 MW of generation on the existing Deaf Smith – Bushland 230 kV transmission line consists of building a new 230 kV three-breaker ring-bus switching station. Customer did not propose a specific 230 kV line extending to serve its 230/34.5 kV facilities. It is assumed that obtaining all necessary right-of-way for the new switching station will not be a significant expense.

The total minimum cost for building the required interconnection facilities for this 240 MW of generation is approximately $3,000,000. These costs are shown in Table 2. Other Network Constraints in the American Electric Power West (AEPW), SPS, Sunflower Electric Power Corporation (SUNC), and Western Farmers Electric Cooperative (WFEC) transmission systems that may be verified with a transmission service request and associated studies are listed in Table 3. These Network Constraints are in the local area of the new generation when this generation is sunk throughout the Southwest Power Pool (SPP) footprint for the Energy Resource (ER) Interconnection request. With a defined source and sink in a Transmission Service Request (TSR), this list of Network Constraints will be refined and expanded to account for all Network Upgrade requirements. This cost does not include building the 230 kV line from the Customer substation into the new 230 kV ring bus. This cost does not include the Customer's 230/34.5 kV substation or the 34.5 kV, 48 MVAR capacitor bank(s).

In Table 4, a value of Available Transfer Capability (ATC) associated with each overloaded facility is included. These values may be used by the Customer for future analyses including the determination of lower generation capacity levels that may be installed. When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. If the loading of a facility is higher, the level of ATC will be lower.

There are several other proposed generation additions in the general area of the Customer's facility. It was assumed in this preliminary analysis that not all of these other projects within the SPS control area will be in service. Those previously queued projects that have advanced to nearly complete phases were included in this Feasibility Study. In the event that another request for a generation interconnection with a higher priority withdraws, then this request may have to be re-evaluated to determine the local Network Constraints.

Introduction

<OMITTED TEXT> (Customer) has requested a feasibility study for the purpose of interconnecting 240 MW of wind generation within the control area of Southwestern Public Service Company (SPS) in Deaf Smith and Randall counties, Texas. The proposed method of interconnection is to build a new three-breaker ring-bus switching station on the existing Deaf Smith – Bushland 230 kV transmission line, which is owned by SPS. The proposed in-service date is December 31, 2009.

Interconnection Facilities

The primary objective of this study is to identify the system problems associated with connecting the plant to the area transmission system. The Feasibility and other subsequent Interconnection Studies are designed to identify attachment facilities, Network Upgrades and other direct assignment facilities needed to accept power into the grid at the interconnection receipt point.

The requirements for interconnection of the 240 MW consist of constructing a new 230 kV three-breaker ring-bus station on the existing Deaf Smith – Bushland 230 kV transmission line owned by SPS. This substation shall be constructed and maintained by SPS. The Customer did not propose a route for its 230 kV line to serve its 230/34.5 kV facilities. It is assumed that obtaining all necessary right-of-way for the substation construction will not be a significant expense.

The total cost for building a new 230 kV three breaker ring switching station and the required interconnection facilities is estimated at $3,000,000. Other Network Constraints in the American Electric Power West (AEPW), SPS, Sunflower Electric Power Corporation (SUNC), and Western Farmers Electric Cooperative (WFEC) transmission systems that were identified are listed in Table 3. These estimates will be refined during the development of the impact study based on the final designs. This cost does not include building the 230 kV facilities from the Customer substation into the new 230 kV ring bus. The Customer is responsible for these 230 kV facilities up to the point of interconnection. This cost also does not include the Customer's 230/34.5 kV substation and capacitor which should be determined by the Customer.

The costs of interconnecting the facility to the SPS transmission system are listed in Tables 1 & 2. **These costs do not include any cost that might be associated with short circuit study results or dynamic stability study results**. These costs will be determined when and if a System Impact Study is conducted.

A preliminary one-line drawing of the interconnection and direct assigned facilities are shown in Figure 1. An approximate location of the proposed interconnection facilities is shown in Figure 2.

Table 1: Direct Assignment Facilities

FACILITY	ESTIMATED COST (2007 DOLLARS)
Customer – 230/34.5 kV Substation facilities.	*
Customer – 230 kV transmission line facilities between Customer facilities and the new 230 kV ring bus.	*
Customer - Right-of-Way for Customer facilities.	
Customer – 34.5 kV, 48 MVAR capacitor bank(s) in Customer substation.	*
Total	*****

*Note: * Estimates of cost to be determined by Customer.*

Table 2: Required Interconnection Network Upgrade Facilities

FACILITY	ESTIMATED COST (2007 DOLLARS)
SPS – Build 230 kV, 3-breaker ring-bus switching station. Station to include breakers, switches, control relaying, high speed communications, metering and related equipment and all structures	**$3,000,000**
Total	**$3,000,000**

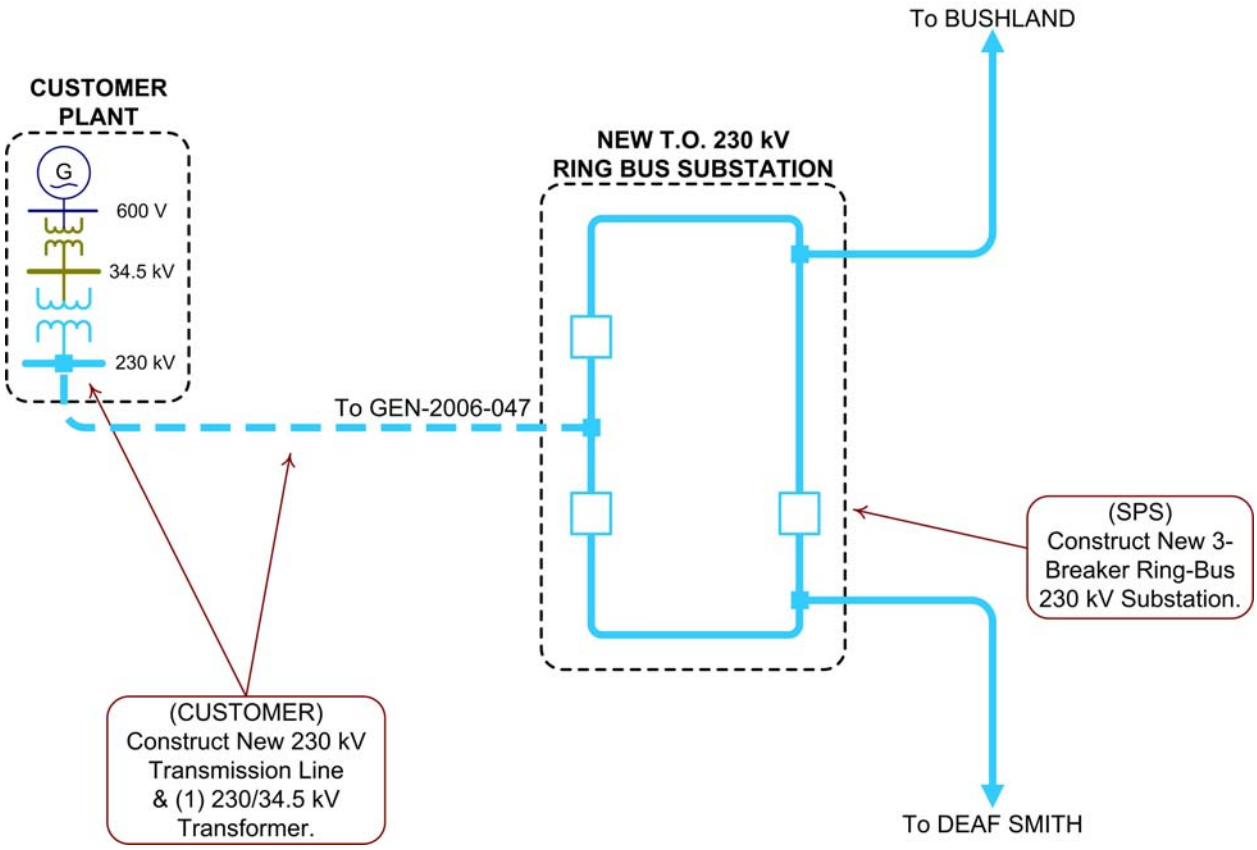

Figure 1: Proposed Interconnection
(Final substation design to be determined)

Powerflow Analysis

A powerflow analysis was conducted for the facility using modified versions of the 2009 and the 2012 winter peak models and the 2012 and the 2017 summer peak models. The output of the Customer's facility was offset in each model by a reduction in output of existing online SPP generation. This method allows the request to be studied as an Energy Resource (ER) Interconnection request. The proposed in-service date of the generation is December 31, 2009. The available seasonal models used were through the 2017 summer peak which is the end of the current SPP planning horizon.

The analysis of the Customer's project indicates that, given the requested generation level of 240 MW and location, additional criteria violations will occur on the existing AEPW, SPS, SUNC, and WFEC transmission systems under steady state and contingency conditions in the peak seasons.

In Table 4, a value of Available Transfer Capability (ATC) associated with each overloaded facility is included. These values may be used by the Customer to determine lower generation capacity levels that may be installed. When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. When a facility is overloaded for more than one contingency, only the highest loading on the facility for each season is included in the table.

In order to maintain a zero reactive power flow exchanged at the point of interconnection, additional reactive compensation is required at the point of interconnection. The Customer will be required to install 48 MVAR of capacitor banks in its substation on the 34.5 kV bus. Dynamic Stability studies performed as part of the impact study will provide additional guidance as to whether the reactive compensation can be static or a portion must be dynamic (such as a SVC or STATCOM). It is possible that an SVC or STATCOM device will be required at the Customer facility because of FERC Order 661A Low Voltage Ride Through Provisions (LVRT) which went into effect January 1, 2006. FERC Order 661A orders that wind farms stay on line for 3 phase faults at the point of interconnection even if that requires the installation of a SVC or STATCOM device.

There are several other proposed generation additions in the general area of the Customer's facility. Some of the local projects that were previously queued were assumed to be in service in this Feasibility Study. Those local projects that were previously queued and have advanced to nearly complete phases were included in this Feasibility Study.

Powerflow Analysis Methodology

The SPP criteria states that: "The transmission system of the SPP region shall be planned and constructed so that the contingencies as set forth in the Criteria will meet the applicable *NERC Planning Standards* for System Adequacy and Security – Transmission System Table l hereafter referred to as NERC Table l) and its applicable standards and measurements".

Using the created models and the ACCC function of PSS\E, single contingencies in portions or all of the modeled control areas of Sunflower Electric Power Corporation (SUNC), Missouri Public Service (MIPU), Westar (WESTAR), Kansas City Power & Light (KCPL), West Plains (WEPL), Midwest Energy (MIDW), Oklahoma Gas and Electric OKGE, American Electric Power West (AEPW), Grand River Dam Authority (GRDA), Southwestern Public Service Company (SPS), Western Farmers Electric Cooperative (WFEC) and other control areas were applied and the resulting scenarios analyzed. This satisfies the 'more probable' contingency testing criteria mandated by NERC and the SPP criteria.

Table 3: Network Constraints

AREA	ELEMENT
AEPW	CLINTON JUNCTION - ELK CITY 138KV CKT 1
AEPW	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1
AEPW	SHAMROCK (SHAMRCK1) 115/69/14.4KV TRANSFORMER CKT 1
AEPW - WFEC	LAKE PAULINE - RUSSELL 138KV CKT 1
SPS	BOWERS INTERCHANGE 115/69KV TRANSFORMER CKT 1
SPS	BUSHLAND INTERCHANGE 230/115KV TRANSFORMER CKT 1
SPS	CUNNINGHAM STATION 230/115KV TRANSFORMER CKT 1
SPS	DALHART INTERCHANGE - RITA BLANCA REC-HOGUE 115KV CKT 1
SPS	DEAF SMITH COUNTY INTERCHANGE - DEAF SMITH REC-#21 115KV CKT 1
SPS	DEAF SMITH COUNTY INTERCHANGE - HEREFORD INTERCHANGE 115KV CKT 1
SPS	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1
SPS	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 2
SPS	GRAPEVINE INTERCHANGE 230/115KV TRANSFORMER CKT 1
SPS	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1
SPS	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2
SPS	KINGSMILL INTERCHANGE - MCCULLOUGH SUB 69KV CKT 1
SPS	KIRBY SWITCHING STATION - MCCLELLAN SUB 115KV CKT 1
SPS	LAMB COUNTY REC-SOUTH OLTON - LAMTON INTERCHANGE 115KV CKT 1
SPS	LAMB COUNTY REC-SOUTH OLTON - PLANT X STATION 115KV CKT 1
SPS	LEA COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1
SPS	MCCLELLAN SUB - MCLEAN RURAL SUB 115KV CKT 1
SPS	MOORE COUNTY INTERCHANGE E. - RITA BLANCA REC-HOGUE 115KV CKT 1
SPS	NORTHEAST HEREFORD INTERCHANGE 115/69KV TRANSFORMER CKT 1
SPS	PLANT X STATION 230/115KV TRANSFORMER CKT 1
SPS	PRINGLE INTERCHANGE - SPEARMAN INTERCHANGE 115KV CKT 2
SPS	TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1
SPS	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1
SPS - AEPW	ELK CITY 230KV - GRAPEVINE INTERCHANGE 230KV CKT 1
SUNC	HOLCOMB - PLYMELL 115KV CKT 1
SUNC	PIONEER TAP - PLYMELL 115KV CKT 1
SUNC	SPEARVILLE (SPEARVL) 345/230/13.8KV TRANSFORMER CKT 1
AEPW	AMERICAN ELECTRIC POWER WEST
SPS	SOUTHWESTERN PUBLIC SERVICE COMPANY
SUNC	SUNFLOWER ELECTRIC POWER CORPORATION
WFEC	WESTERN FARMERS ELECTRIC COOPERATIVE

Table 4: Contingency Analysis

ELEMENT	SEASON	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
2009 Winter Peak Model					
CUNNINGHAM STATION 230/115KV TRANSFORMER CKT 1	09WP	168	116.0	0	LEA COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1
ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1	09WP	287	124.9	0	FINNEY SWITCHING STATION - HOLCOMB 345KV CKT 1
HARRINGTON STATION - NICHOLS STATION 230KV CKT 1	09WP	706	117.2	0	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2
HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2	09WP	706	116.9	0	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1
LEA COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1	09WP	168	118.4	46	CUNNINGHAM STATION 230/115KV TRANSFORMER CKT 1
ELK CITY 230KV - GRAPEVINE INTERCHANGE 230KV CKT 1	09WP	351	120.9	79	FINNEY SWITCHING STATION - HOLCOMB 345KV CKT 1
CLINTON JUNCTION - ELK CITY 138KV CKT 1	09WP	143	105.0	194	FINNEY SWITCHING STATION - HOLCOMB 345KV CKT 1
LAKE PAULINE - RUSSELL 138KV CKT 1	09WP	72	102.5	212	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1
TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1	09WP	560	102.5	221	FINNEY SWITCHING STATION - HOLCOMB 345KV CKT 1
BUSHLAND INTERCHANGE 230/115KV TRANSFORMER CKT 1	09WP	187	100.5	237	BUSHLAND INTERCHANGE - POTTER COUNTY INTERCHANGE 230KV CKT 1
2012 Summer Peak Model					
DALHART INTERCHANGE - RITA BLANCA REC-HOGUE 115KV CKT 1	12SP	99	168.0	0	ETTER RURAL SUB - MOORE COUNTY INTERCHANGE E. 115KV CKT 1
HARRINGTON STATION - NICHOLS STATION 230KV CKT 1	12SP	635	120.7	0	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2
HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2	12SP	635	120.4	0	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1
MOORE COUNTY INTERCHANGE E. - RITA BLANCA REC-HOGUE 115KV CKT 1	12SP	99	188.0	0	ETTER RURAL SUB - MOORE COUNTY INTERCHANGE E. 115KV CKT 1
NORTHEAST HEREFORD INTERCHANGE 115/69KV TRANSFORMER CKT 1	12SP	84	120.3	0	DEAF SMITH COUNTY INTERCHANGE - HEREFORD INTERCHANGE 115KV CKT 1
SPEARVILLE (SPEARVL) 345/230/13.8KV TRANSFORMER CKT 1	12SP	336	112.6	0	HOLCOMB - SETAB 345KV CKT 1
DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1	12SP	172	110.7	56	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 2
DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 2	12SP	172	110.7	56	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1
ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1	12SP	287	116.4	69	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1
ELK CITY 230KV - GRAPEVINE INTERCHANGE 230KV CKT 1	12SP	351	113.2	138	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1
BUSHLAND INTERCHANGE 230/115KV TRANSFORMER CKT 1	12SP	172	112.0	169	BUSHLAND INTERCHANGE - POTTER COUNTY INTERCHANGE 230KV CKT 1

Table 4: Contingency Analysis (continued)

ELEMENT	SEASON	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
2012 Summer Peak Model (continued)					
KIRBY SWITCHING STATION - MCCLELLAN SUB 115KV CKT 1	12SP	90	104.2	170	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1
MCCLELLAN SUB - MCLEAN RURAL SUB 115KV CKT 1	12SP	90	102.2	203	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1
GRAPEVINE INTERCHANGE 230/115KV TRANSFORMER CKT 1	12SP	128	100.4	226	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1
2012 Winter Peak Model					
HARRINGTON STATION - NICHOLS STATION 230KV CKT 1	12WP	706	121.0	0	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2
HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2	12WP	706	120.7	0	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1
ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1	12WP	287	110.0	105	NORTH MEMPHIS REC - NW MEMPHIS 69KV CKT 1
BUSHLAND INTERCHANGE 230/115KV TRANSFORMER CKT 1	12WP	187	105.0	207	BUSHLAND INTERCHANGE - POTTER COUNTY INTERCHANGE 230KV CKT 1
LAKE PAULINE - RUSSELL 138KV CKT 1	12WP	72	101.7	221	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1
2017 Summer Peak Model					
BOWERS INTERCHANGE 115/69KV TRANSFORMER CKT 1	17SP	96	119.2	0	GRAY COUNTY INTERCHANGE 115/69KV TRANSFORMER CKT 1
DEAF SMITH COUNTY INTERCHANGE - DEAF SMITH REC-#21 115KV CKT 1	17SP	161	109.8	0	BAILEY COUNTY REC-EARTH INTERCHANGE - PLANT X STATION 115KV CKT 1
DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1	17SP	172	116.9	0	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 2
DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 2	17SP	172	116.9	0	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1
HARRINGTON STATION - NICHOLS STATION 230KV CKT 1	17SP	635	120.8	0	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2
HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2	17SP	635	120.5	0	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1
HOLCOMB - PLYMELL 115KV CKT 1	17SP	143	114.5	0	HOLCOMB - SPEARVILLE 345KV CKT 1
NORTHEAST HEREFORD INTERCHANGE 115/69KV TRANSFORMER CKT 1	17SP	84	131.9	0	DEAF SMITH COUNTY INTERCHANGE - HEREFORD INTERCHANGE 115KV CKT 1
PIONEER TAP - PLYMELL 115KV CKT 1	17SP	143	110.5	0	HOLCOMB - SPEARVILLE 345KV CKT 1
PRINGLE INTERCHANGE - SPEARMAN INTERCHANGE 115KV CKT 2	17SP	161	129.3	0	PRINGLE INTERCHANGE - SPEARMAN INTERCHANGE 115KV CKT 1
PLANT X STATION 230/115KV TRANSFORMER CKT 1	17SP	252	105.9	23	TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1
LAMB COUNTY REC-SOUTH OLTON - PLANT X STATION 115KV CKT 1	17SP	161	108.9	31	TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1
SPEARVILLE (SPEARVL) 345/230/13.8KV TRANSFORMER CKT 1	17SP	336	109.5	60	HOLCOMB - SETAB 345KV CKT 1

Table 4: Contingency Analysis (continued)

ELEMENT	SEASON	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
2017 Summer Peak Model (continued)					
BUSHLAND INTERCHANGE 230/115KV TRANSFORMER CKT 1	17SP	172	123.1	95	BUSHLAND INTERCHANGE - POTTER COUNTY INTERCHANGE 230KV CKT 1
TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1	17SP	497	105.6	126	PLANT X STATION - SUNDOWN INTERCHANGE 230KV CKT 1
DEAF SMITH COUNTY INTERCHANGE - HEREFORD INTERCHANGE 115KV CKT 1	17SP	161	104.8	146	NORTHEAST HEREFORD INTERCHANGE 115/69KV TRANSFORMER CKT 1
SHAMROCK (SHAMRCK1) 115/69/14.4KV TRANSFORMER CKT 1	17SP	69	103.0	176	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1
KINGSMILL INTERCHANGE - MCCULLOUGH SUB 69KV CKT 1	17SP	97	103.2	197	SPP-SWPS-03
KIRBY SWITCHING STATION - MCCLELLAN SUB 115KV CKT 1	17SP	90	102.2	205	SPP-SWPS-02
LAMB COUNTY REC-SOUTH OLTON - LAMTON INTERCHANGE 115KV CKT 1	17SP	161	100.6	225	TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1
MCCLELLAN SUB - MCLEAN RURAL SUB 115KV CKT 1	17SP	90	100.1	238	SPP-SWPS-02

Note: When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. If the loading of a facility is higher, the level of ATC will be lower.

Conclusion

The minimum cost of interconnecting the Customer's interconnection request is estimated at $3,000,000 for Direct Assignment facilities and Network Upgrades listed in Tables 1 and 2. These costs exclude upgrades of other transmission facilities that were listed in Table 3 which are Network Constraints. At this time, the cost estimates for other Direct Assignment facilities including those in Table 1 have not been defined by the Customer. In addition to the Customer's proposed interconnection facilities, the Customer will be responsible for installing 48 MVAR of 34.5 kV capacitors in the Customer substation for reactive support. Dynamic stability analysis will determine if a portion of this should be dynamic (SVC). As stated earlier, some but not all of the local projects that were previously queued are assumed to be in service in this Feasibility Study.

In Table 4, a value of Available Transfer Capability (ATC) associated with each overloaded facility is included. These values may be used by the Customer to determine lower generation capacity levels that may be installed. When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. When a facility is overloaded for more than one contingency, only the highest loading on the facility for each season is included in the table.

These interconnection costs do not include any cost that may be associated with short circuit or transient stability analysis. These studies will be performed if the Customer signs a System Impact Study Agreement.

The required interconnection costs listed in Table 2 and other upgrades associated with Network Constraints listed in Table 3 do not include all costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies if the Customer requests transmission service through SPP's OASIS.

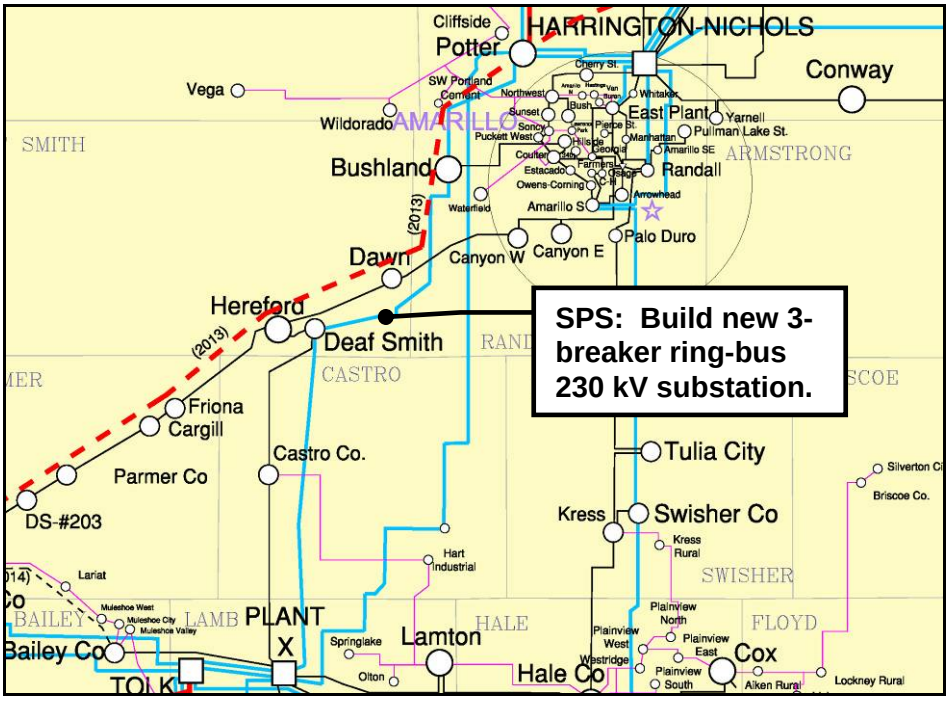

FIGURE 2. MAP OF THE LOCAL AREA