



Before the  
Pennsylvania Public Utility Commission

**STANTON 230 kV LINE REARRANGEMENT  
PROJECT**

**ATTACHMENTS IN SUPPORT OF THE  
LETTER OF NOTIFICATION**

Application Docket No. \_\_\_\_\_

Submitted by: PPL Electric Utilities Corporation

# **Attachment 1**

**Table of Contents**

**1.0 INTRODUCTION.....1**

**2.0 TRANSMISSION SYSTEM PLANNING PROCESS .....1**

**3.0 EXISTING SYSTEM.....5**

**4.0 NEED FOR THE PROJECT.....6**

**5.0 PROPOSED SOLUTION.....7**

**List of Figures**

**Figure 1-1:** Existing One-line Diagram

**Figure 1-2:** Existing System Map

**Figure 1-3:** Proposed One-line Diagram

**Figure 1-4:** Proposed System Map

## **1.0 INTRODUCTION**

PPL Electric Utilities Corporation (PPL Electric) is requesting Pennsylvania Public Utility Commission (PUC or the Commission) approval to install approximately 0.20 miles of 230 kV transmission lines to reconfigure the existing Susquehanna-Mountain-Lackawanna 230 kV Transmission Line and Susquehanna-Mountain-Stanton 230 kV Transmission Line (the Project). As explained below, the proposed Project is required to ensure system reliability during the 12-month outage of the Susquehanna-Jenkins 230 kV Transmission Line during the rebuild of the existing Susquehanna-Jenkins 230 kV Transmission Line.<sup>1</sup> The proposed Project is located in Exeter Township, Luzerne County.

Subject to the Commission's approval, construction is scheduled to begin in November 2016, to support the Project's scheduled in-service date of March 2017. The estimated cost of Project is \$2.5 million.<sup>2</sup>

## **2.0 TRANSMISSION SYSTEM PLANNING PROCESS**

The nation's interconnected transmission grid serves as the backbone for the safe and reliable delivery of large amounts of electricity from generating stations over substantial distances to customers served by transmission and local distribution systems. It is critically important that this interconnected transmission system (transmission grid) be planned and designed to be highly reliable so that reliable electric service can be provided under peak and all loading conditions and when certain elements of the system are out of service (system contingencies) due to planned or unplanned outages.

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<sup>1</sup> The rebuild of the existing single-circuit Susquehanna-Jenkins 230 kV Transmission Line as a double-circuit 230 kV transmission line is required to resolve a thermal violation identified by PJM Interconnection, L.L.C ("PJM") in the 2013 Regional Transmission Expansion Plan ("RTEP") analysis. PJM's RTEP baseline project number is b2269. The rebuild of the existing Susquehanna-Jenkins 230 kV Transmission line was approved by the Commission on April 7, 2016. See *Letter of Notification of PPL Electric Utilities Corporation, Filed Pursuant to 52 Pa. Code Chapter 57 Subchapter G, for Approval to Rebuild Approximately 24.4 Miles of the Existing Susquehanna-Jenkins 230 kV Transmission Line Located in Luzerne County, Pennsylvania*, Docket No. A-2016-2526304 (April 7, 2016).

<sup>2</sup> The estimate cost for the proposed project is an order-of-magnitude estimate developed using averages of recent costs for similar projects and without an in-depth analysis of field investigation. The cost is subject to change as the constructability of the Project, sequence of construction, and other factors that may affect cost are identified and analyzed as the Project progress.

System Planning is the process that assures that the transmission system can supply electricity to all customer loads in a manner that is reliable and economical. This System Planning process assures that both the Bulk Electric System (BES)<sup>3</sup> and non-Bulk Electric System (non-BES)<sup>4</sup> are planned and constructed so that:

- They are able to accommodate forecasted system flows during summer and winter peak load;
- They can adequately serve each customer's need with regard to capacity, voltage and reliability for all load levels throughout the daily load cycle;
- They can sustain probable contingencies and disturbances with minimal customer service interruptions; and
- They are in conformance with North American Electric Reliability Corporation ("NERC"), PJM Interconnection, LLC ("PJM"), and the Transmission Owner's reliability criteria for all normal and emergency operating conditions.

PJM is a FERC-approved Regional Transmission Organization ("RTO") charged with ensuring the reliability of the electric transmission system under its functional control (100 kV and above), and coordinating the movement of electricity in all or parts of thirteen states and the District of Columbia, including most of Pennsylvania. In order to ensure reliable transmission service, PJM prepares an annual Regional Transmission Expansion Plan ("RTEP")<sup>5</sup> to identify system reinforcements that are required to, among other things, meet the NERC Reliability Standards, PJM reliability planning criteria, and Transmission Owner reliability criteria.

PJM conducts RTEP studies in conjunction with its Transmission Owners and applies NERC, regional, and Transmission Owner reliability criteria to specific conditions on the transmission system. PJM's RTEP is an annual process that encompasses a comprehensive series of detailed analyses to ensure power continues to flow reliably to customers under stringent reliability

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<sup>3</sup> Bulk Electric System (BES) – Includes transmission facilities operated at voltages of 100 kV or higher.

<sup>4</sup> Non-Bulk Electrical System (non-BES) – Includes transmission facilities operated at voltages less than 100 kV.

<sup>5</sup> PJM's RTEP process is currently set forth in Schedule 6 of PJM's Amended and Restated Operating Agreement ("Schedule 6"). Schedule 6 governs the process by which PJM's members rely on PJM to prepare an annual regional plan for the enhancement and expansion of the transmission facilities to ensure long-term, reliable electric service consistent with established reliability criteria. In addition, Schedule 6 addresses the procedures used to develop the RTEP, the review and approval process for the RTEP, the obligation of transmission owners to build transmission upgrades included in the RTEP, and the process by which interregional transmission upgrades will be developed.

criteria set by NERC. PJM's manual 14B<sup>6</sup> outlines the RTEP process and reliability criteria use for this process. As mentioned in manual 14B, every year PJM perform various reliability tests such as Baseline Thermal, Baseline Voltage, Load Deliverability, Generation deliverability and Baseline stability to ensure safe reliable of operation of electric grid.

When the studies show an inability of the transmission system to meet specific reliability criteria under these conditions, PJM opens an RTEP Window in accordance with FERC Order 1000<sup>7</sup> to identify the optimal solution to resolve the criteria violation.

PPL Electric, as a Transmission Owner and member of PJM, undertakes an independent analysis of both its BES<sup>8</sup> transmission facilities, and its non-BES<sup>9</sup> transmission facilities in concert with the PJM RTEP process. PPL Electric identifies all conditions where the future system does not meet the NERC criteria, PJM reliability criteria, or PPL Electric Transmission Owner criteria. In this way, PPL Electric actively participates in the PJM RTEP process, and through this participation PPL Electric provides results of its independent studies to PJM for consideration and inclusion in the PJM RTEP.

Alternatives that can mitigate violations to the reliability criteria are developed and analyzed to ensure that the PPL Electric transmission system meets the reliability criteria. Estimated costs and lead times to implement the reinforcements are prepared. PPL Electric then proposes solutions to PJM through an RTEP window. If the project is awarded to PPL Electric, it then becomes a baseline RTEP project.

PPL Electric's Transmission Owner criteria address thermal, voltage, short circuit, and stability limits specific to the PPL Electric zone and also ensure compliance with NERC and PJM reliability criteria. These criteria ensure adequate and appropriate levels of electric service to PPL Electric customers in accordance with good utility practices. In addition to these criteria, PPL Electric plans the system according to its own Transmission System Development Standards.

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<sup>6</sup> PJM Manual 14B is available at <http://www.pjm.com/~media/documents/manuals/m14b.ashx>

<sup>7</sup> <http://www.ferc.gov/industries/electric/indus-act/trans-plan.asp>

<sup>8</sup> Bulk Electric System (BES) - Includes transmission facilities operated at voltages of 100 kV or higher.

<sup>9</sup> Non-Bulk Electrical System (non-BES) - Includes transmission facilities operated at voltages less than 100 kV.

In addition to NERC, PJM, and Transmission Owner criteria-based projects, PPL Electric also initiates projects based on the Transmission System Development Standards. These projects address local load growth, provide load restoration flexibility, and replace poor performing transmission assets in order to provide an advanced level of reliability on the local system.

PPL Electric’s Transmission System Development Standards also consider transmission needs to support the development of the distribution system. When the distribution system needs to either expand existing distribution substations with new transformation or install new distribution substations to support local load growth on the distribution system, new transmission facilities are required to accommodate that expansion.

Projects created to support PPL Electric’s Transmission System Development Standards are presented to PJM stakeholders at either a TEAC or Sub-Regional RTEP meeting and are assigned a Supplemental project number in the RTEP. PJM incorporates these projects into the power flow model which they use to perform various reliability analyses for the RTEP.

During the 2013 RTEP year, PJM identified that thermal loading on the Susquehanna-Jenkins 230 kV line exceeds 100% of its Summer Emergency rating for Generation Deliverability test. Generation Deliverability is one of the five reliability tests that PJM performs in RTEP analysis. PJM performs a Generator Deliverability test in order to make sure generation can reliably be delivered to load. More information about the test is available in PJM manual 14B. In 2013, PPL Electric originally proposed rebuilding the existing Susquehanna-Jenkins 230 kV line to single circuit using higher capacity conductor.<sup>10</sup> PJM assigned the baseline number b2269 to track the progress of the project.<sup>11</sup>

When analyzing the system under the Susquehanna-Jenkins 230 kV line outage period, PPL Electric identified system thermal violations for certain contingency outages as described in the “Need for Project” section below. PPL Electric notified PJM that the Stanton 230 kV line rearrangement would be required in order to complete the construction of baseline project b2269

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<sup>10</sup> The analysis which showed the overload violation on the Susquehanna-Jenkins 230 kV line was performed in 2013 prior to the implementation of FERC Order 1000. At that time, the incumbent Transmission Owner was awarded the project to reinforce the facilities located within its own zone. FERC Order 1000 now requires proposal windows be opened to accept reinforcement ideas from all qualified entities.

<sup>11</sup> Presentation from PJM TEAC meeting showing PPL Electric proposal is available at <https://www.pjm.com/~media/committees-groups/committees/teac/20130411/20130411-reliability-analysis-update.ashx>

while avoiding these system thermal violations. PJM assigned PPL Electric the Stanton 230 kV Line Rearrangement Project due to the immediate needs nature of this work to support the Susquehanna-Jenkins 230 kV line rebuild. The baseline number for the Stanton 230 kV Line Rearrangement Project is b2269.1.

### **3.0 EXISTING SYSTEM**

The Scranton/Wilkes-Barre metropolitan area is primarily supplied by PPL Electric's Lackawanna, Stanton, and Jenkins 230-69 kV Substations, which in turn are supplied by the Susquehanna 500-230-69 kV Substation. Together, the Lackawanna, Stanton, and Jenkins substations serve about 700 MW of load during summer peak conditions. The load in the area is growing at about one percent annually.

The major 230 kV lines that supply the load in this area are as follows:

- The existing Susquehanna-Jenkins 230 kV Transmission Line is a single-circuit 230 kV transmission line that extends approximately 25 miles between the Susquehanna Substation in Conyngham Township to the Jenkins Substation in Plains Township, Luzerne County.
- The existing Susquehanna-Mountain-Stanton 230 kV Transmission Line extends approximately 17 miles between the Susquehanna Substation in Conyngham Township to UGI Utilities, Inc. - Electric Division's Mountain 230 kV Substation in Plymouth Township (approximately 15.9 miles double circuit with Susquehanna T10-Mountain-Lackawanna 230 kV Transmission Line), and the continues approximately 12.4 miles to the Stanton Substation in Exeter Township (double circuit with Susquehanna T10-Mountain-Lackawanna 230 kV Transmission Line).
- The existing Susquehanna T10-Mountain-Lackawanna 230 kV Transmission Line extends approximately 18.4 miles between the Susquehanna T10 Substation in Conyngham Township to UGI Utilities, Inc. - Electric Division's Mountain 230 kV Substation in Plymouth Township (approximately 15.9 miles double circuit with Susquehanna-Mountain-Stanton 230 kV Transmission Line), and the continues approximately 25.6 miles to the Lackawanna Substation in Blakely Borough,

Lackawanna County (double circuit with Susquehanna-Mountain-Stanton 230 kV Transmission Line and Stanton-Lackawanna 230 kV Transmission Line).

- The existing Jenkins-Stanton #1 and #2 230 kV Transmission Line is a double-circuit 230 kV transmission line that extends approximately 8.5 miles between the Jenkins Substation in Plains Township to the Stanton Substation in Exeter Township.
- The existing Stanton-Lackawanna 230 kV Transmission Line is a double-circuit 230 kV transmission line (with Susquehanna T10-Mountain-Lackawanna 230 kV Transmission Line) that extends approximately 13.5 miles between the Stanton Substation in Exeter Township to the Lackawanna Substation in Blakely Borough.

A one-line diagram and map of the existing system are provided as **Figure 1-1** and **Figure 1-2**, respectively.

#### **4.0 NEED FOR THE PROJECT**

As explained in PPL Electric's Commission-approved Letter of Notification filed at Docket No. A-2016-2526304, PPL Electric proposes to rebuild the existing single-circuit Susquehanna-Jenkins 230 kV Transmission Line as a double-circuit 230 kV transmission line to resolve a thermal violation identified by PJM in the 2013 RTEP. Specifically, the PJM 2013 RTEP identified that, by the summer of 2015, the Susquehanna-Jenkins 230 kV Transmission Line will exceed 100% of its summer emergency rating under peak conditions for the following N-1-1 contingency: the loss of the Susquehanna-Lackawanna 500 kV line, followed by the loss of the Mountain-Susquehanna T10 230 kV line. The thermal overload identified in the 2013 RTEP is a violation of the reliability criteria. To address this NERC violation, PPL Electric has proposed rebuild approximately 24.4 miles of the 26.5-mile existing single-circuit Susquehanna-Jenkins 230 kV Transmission Line for double-circuit operation. Additional details regarding the rebuild of the Susquehanna-Jenkins 230 kV Transmission Line are provided in the Letter of Notification pending at Docket No. A-2016-2526304.

In order to rebuild the existing single-circuit Susquehanna-Jenkins 230 kV Transmission Line as a double-circuit 230 kV transmission line, the Susquehanna-Jenkins 230 kV Transmission Line will have to be taken out of service for an approximately 12-month period during 2017 and 2018.

The required outage of the Susquehanna-Jenkins 230 kV Transmission Line will cause the Jenkins 230-69 kV Substation to lose its direct connection to the source of power at Susquehanna Substation. As a result, more than 500 MW of peak summer load served by the Jenkins and Stanton Substations will be supplied by a single source tie from the Susquehanna Substation, the Susquehanna-Mountain-Stanton 230 kV Transmission Line.

Further, during the required outage of the Susquehanna-Jenkins 230 kV Transmission Line, a contingency at the Stanton Substation bus will overload Transformer #2 at the Stanton Substation to 162% of summer emergency rating. Due to the current configuration, if Transformer #2 tripped due to an overload, this could lead to cascading outages in the area.

Additionally, any line breaker failure contingency at Stanton Substation during the required outage of the Susquehanna-Jenkins 230 kV Transmission Line could result in cascading outages in the area due to the single bus, four line tap transformer configuration at the Stanton Substation.

Finally, an N-1-1 contingency of the Stanton-Mountain 230 kV Transmission Line and Stanton-Lackawanna 230 kV Transmission Line during the required outage of the Susquehanna-Jenkins 230 kV Transmission Line could lead to cascading outages in the area.

## **5.0 PROPOSED SOLUTION**

To address the reliability issues during the required outage of the Susquehanna-Jenkins 230 kV Transmission Line, as described above, PPL Electric proposes to reconfigure the Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line and Susquehanna-Mountain-Stanton 230 kV Transmission Line to provide the Jenkins Substation with a second source of supply during the required outage of the Susquehanna-Jenkins 230 kV Transmission Line. As explained below, PPL Electric proposes to break both the Susquehanna-Mountain-Lackawanna 230 kV Transmission Line and Susquehanna-Mountain-Stanton 230 kV Transmission Line and tie the broken segments into the existing Jenkins-Stanton #2 230 kV Transmission Line and the Stanton Substation. The proposed reconfiguration will require the construction of a total of approximately 0.20 miles of new 230 kV transmission lines.

The Susquehanna-Mountain-Stanton 230 kV Transmission Line will be broken along the segment that extends between the Mountain Substation and the Stanton Substation (one segment will remain interconnected with the Mountain Substation and the other segment will remain interconnected with the Stanton Substation). The segment connected to the Mountain Substation will be interconnected with the Jenkins-Stanton #2 230 kV Transmission Line to make one continuous 230 kV line that extends from the Susquehanna Substation to the Mountain Substation, and continues from the Mountain Substation to the Jenkins Substation. Upon completion, the reconfigured line will be referred to as Susquehanna-Mountain-Jenkins 230 kV Transmission Line as shown in **Figure 1-3**. In order to interconnect the Susquehanna-Mountain-Stanton 230 kV Transmission Line with the Jenkins-Stanton #2 230 kV Transmission Line, PPL Electric proposes to construct a new 230 kV single circuit that will extend approximately 500 feet (0.09 miles) between the two existing lines.

The Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line will be broken along the segment that extends between the Mountain Substation and the Lackawanna Substation (one segment will remain interconnected with the Mountain Substation and the other segment will remain interconnected with the Lackawanna Substation). The segment connected to the Mountain Substation will be interconnected with the Jenkins-Stanton #2 230 kV Transmission Line to make one continuous 230 kV line that extends from the Susquehanna T-10 Substation to the Mountain Substation, and continues from the Mountain Substation to the Stanton Substation. Upon completion, the reconfigured line will be referred to as Susquehanna T-10-Mountain-Stanton 230 kV Transmission Line as shown in **Figure 1-3**. In order to interconnect the Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line with the Jenkins-Stanton #2 230 kV Transmission Line, PPL Electric proposes to construct a new 230 kV single circuit that will extend approximately 540 feet (0.1 miles) between the existing lines.

Finally, the segment of the broken Susquehanna-Mountain-Stanton 230 kV Transmission Line that remains interconnected with the Stanton Substation will be connected together with the segment of the broken Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line that remains interconnected with the Lackawanna Substation. This will form one continuous 230 kV line that extends from the Stanton Substation to the Lackawanna Substation. Upon completion, the reconfigured line will be referred to as Stanton-Lackawanna #4 230 kV Transmission Line as shown in **Figure 1-3**. In order to connect the two segments, PPL Electric proposes to install

approximately 40 feet (0.01 mile) of new 230 kV conductor (known as a “jumper wire”) between the Susquehanna-Mountain-Stanton 230 kV Transmission Line (segment that remains interconnected with the Stanton Substation) and the Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line (segment that remains interconnected with the Lackawanna Substation). This work will be conducted at one existing pole near the Stanton Substation and will not require any changes in the surrounding right-of-way.

PPL Electric herein seeks Commission approval to construct approximately 0.20 miles of new 230 kV transmission lines needed to complete the above-described reconfigurations required while the Susquehanna-Jenkins 230 kV Transmission Line is out of service. An engineering description of the new 230 kV single-circuits is provided in Attachment 2. The above-described work can be accomplished within existing rights-of-way. No additional rights-of-way or easements are required for the construction, maintenance, or operation of the reconfigured lines proposed in this Project as further explained in Attachment 3. A one-line diagram and map of the proposed system are provided as **Figure 1-3** and **Figure 1-4**, respectively.

The proposed reconfigurations will provide a second source of supply to the Jenkins 230-69 kV Substation while the Susquehanna-Jenkins 230 kV Transmission Line is out of service during construction. PJM agreed with PPL Electric’s analysis and proposed solution and designated the 230 kV rearrangements as a RTEP baseline project assigned to PPL Electric. The assigned RTEP baseline project number is b2269.1.<sup>12</sup> Because this configuration is more reliable than the existing configuration, the reconfigured lines will remain in place after the rebuild of the Susquehanna-Jenkins 230 kV Transmission Line is completed.

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<sup>12</sup> This project was not eligible to be open for a bid proposal window given the immediate needs nature of the work.

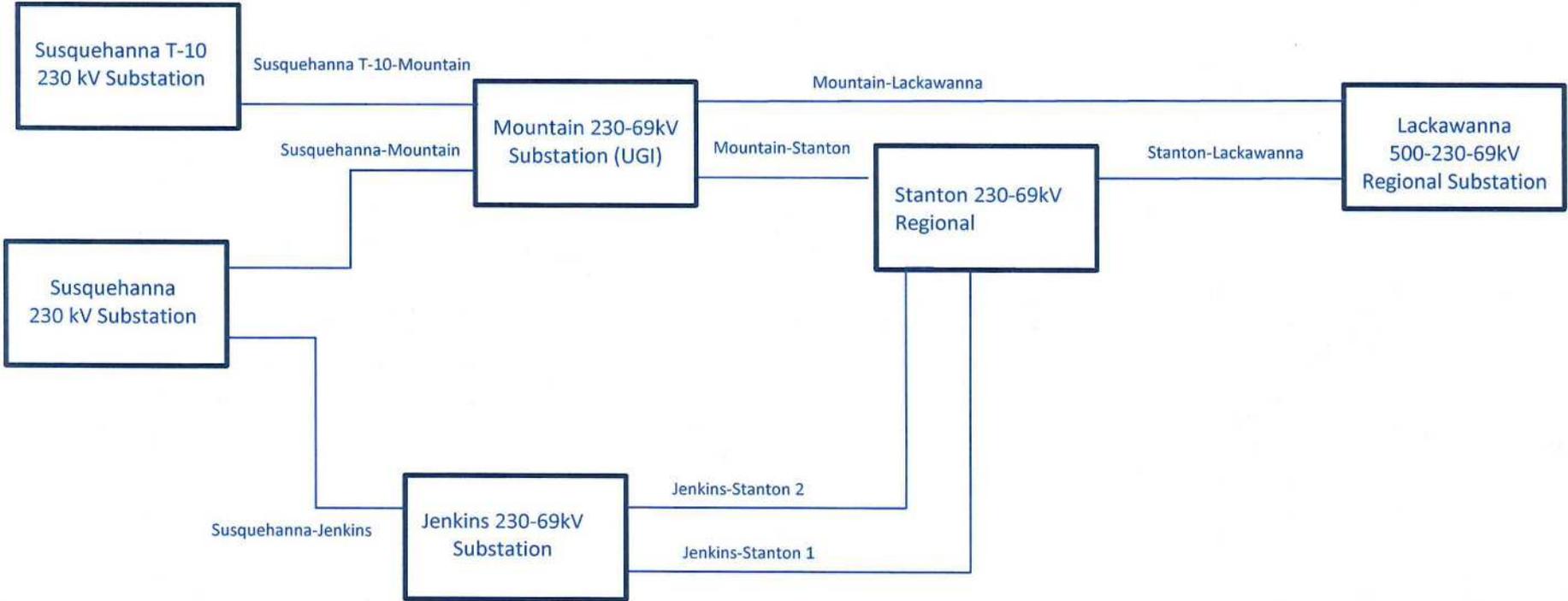


Figure 1-1: Existing Configuration

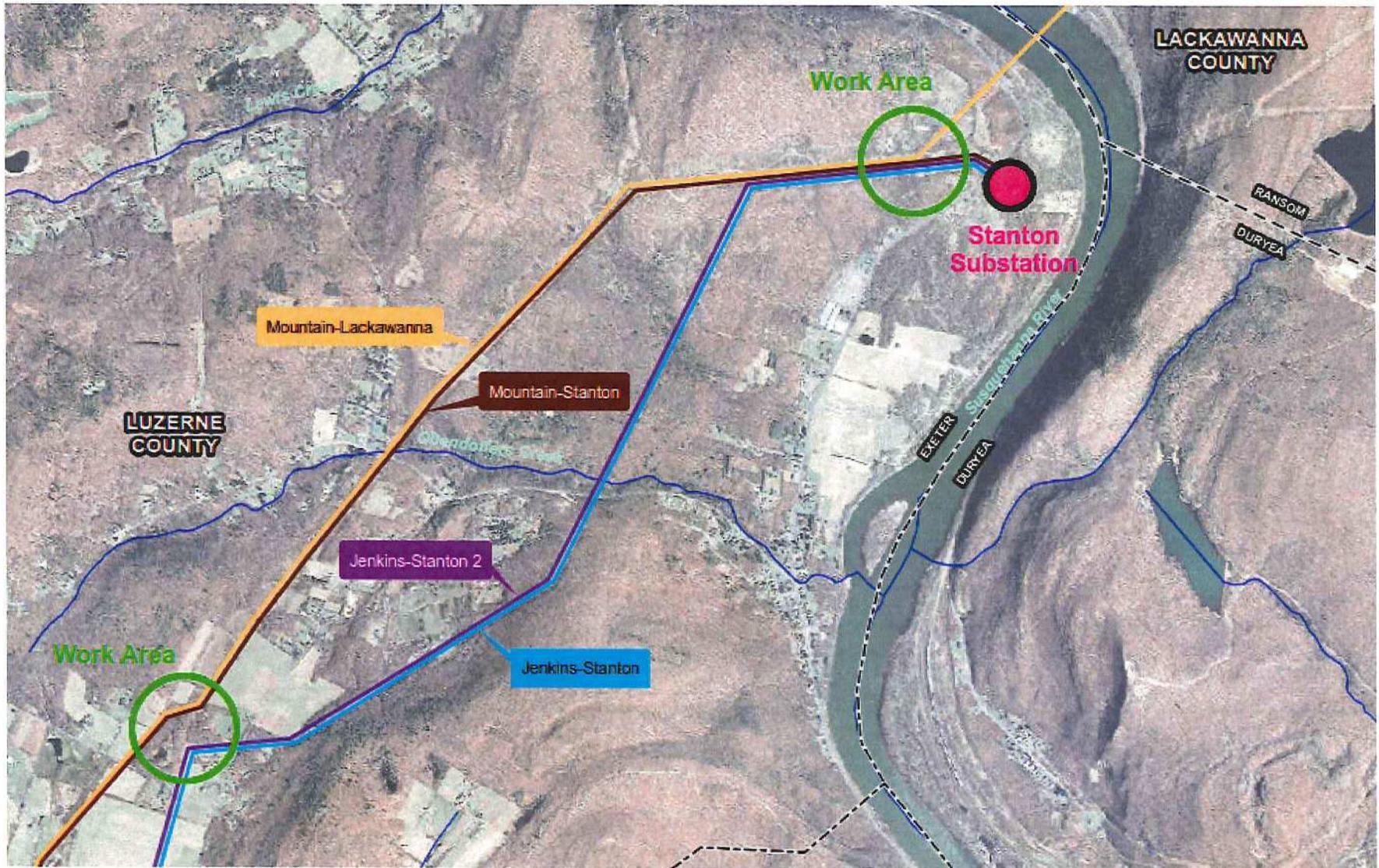


Figure 1-2: Existing System Map

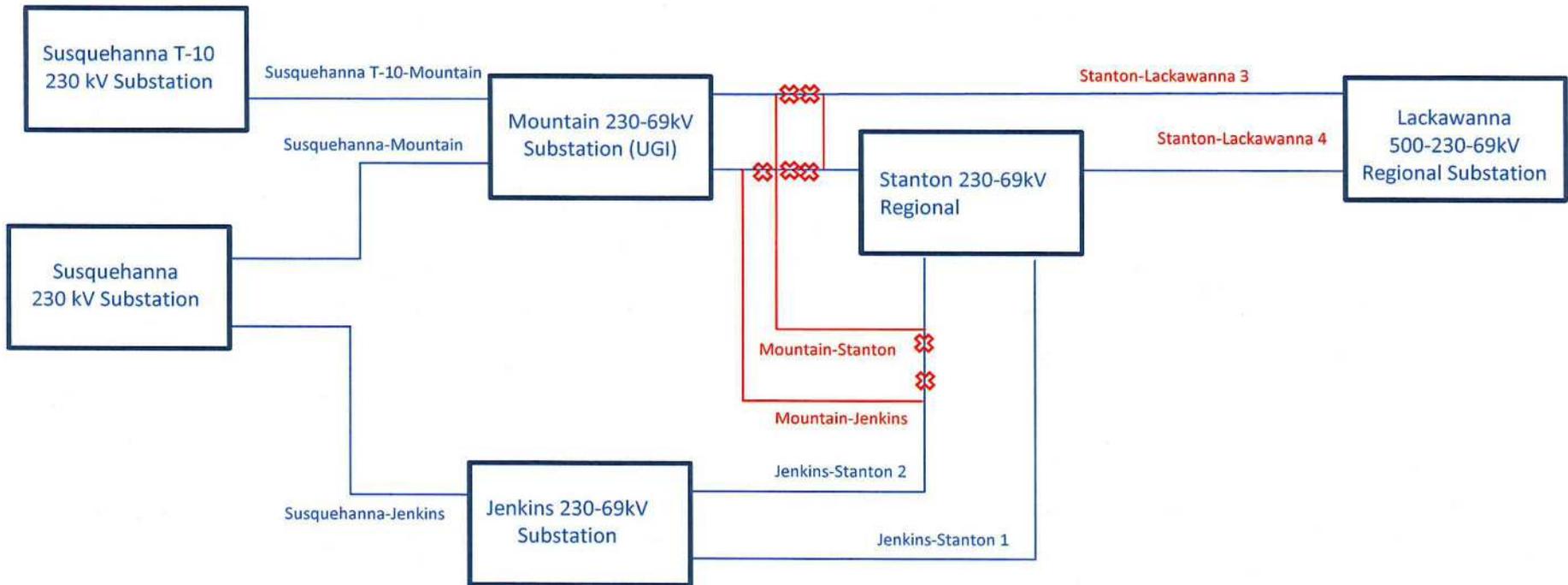


Figure 1-3: Proposed Configuration

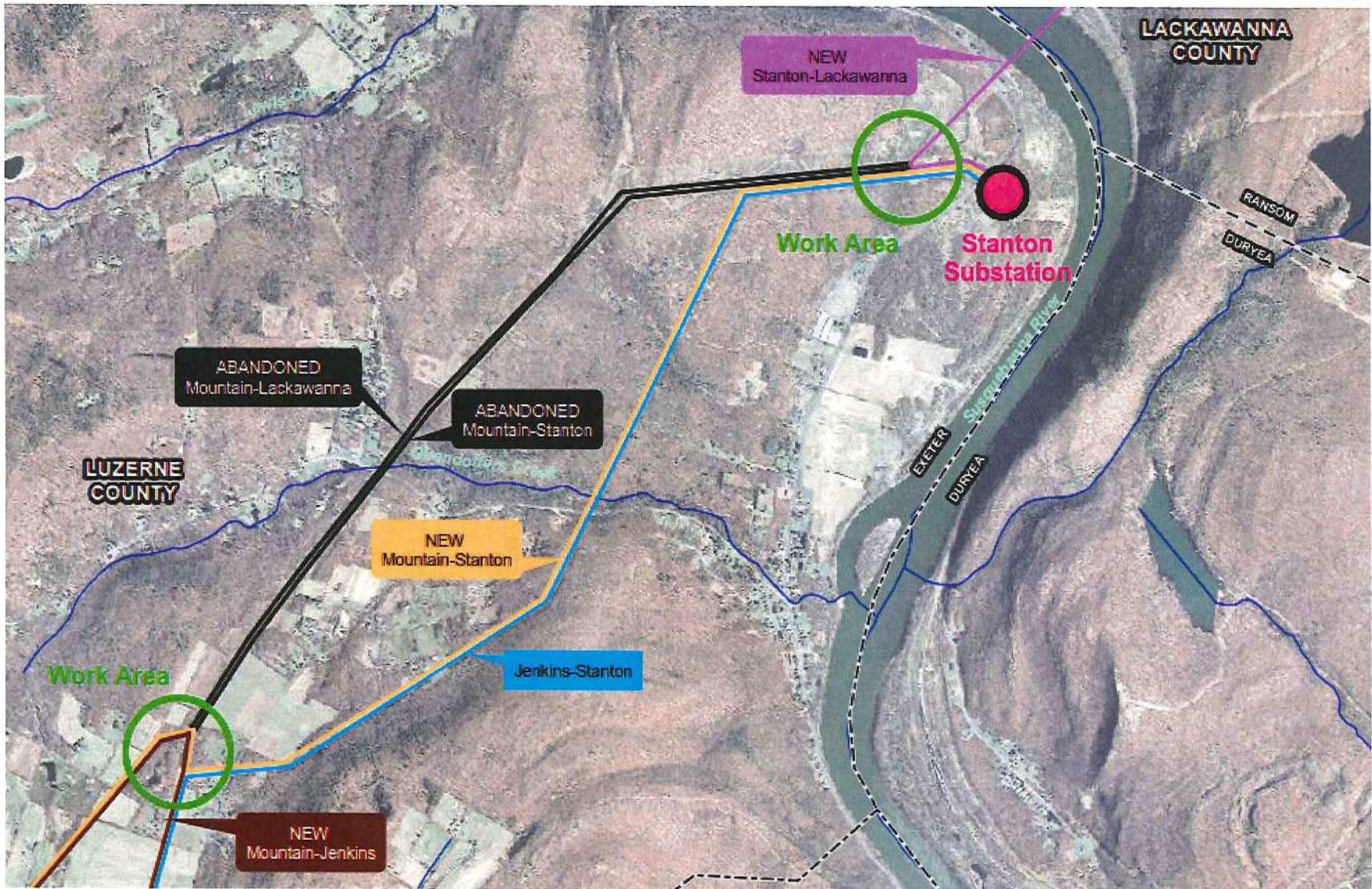


Figure 1-4: Proposed System Map

# **Attachment 2**

**Table of Contents**

**1.0 INTRODUCTION..... 1**  
**2.0 PROPOSED ACTIVITY..... 1**  
**3.0 CONSTRUCTION TECHNIQUES ..... 5**  
**4.0 MAGNETIC FIELD MANAGEMENT..... 8**

**List of Tables**

**Table 2-1:** Design Minimum Conductor Clearances

**Table 2-2:** Conductor Thermal Ratings

**List of Figures**

**Figure 2-1:** Existing 230 kV Lines Near Jenkins-Stanton 230 kV Lines

**Figure 2-2:** Proposed New 230 kV Lines

**Figure 2-3:** Existing 230 kV Lines at Stanton Substation

**Figure 2-4:** Proposed New 230 kV Configuration

**Figure 2-5:** Typical 230 kV Structure Drawing

**Figure 2-6:** Typical 230 kV Structure Drawing

## **1.0 INTRODUCTION**

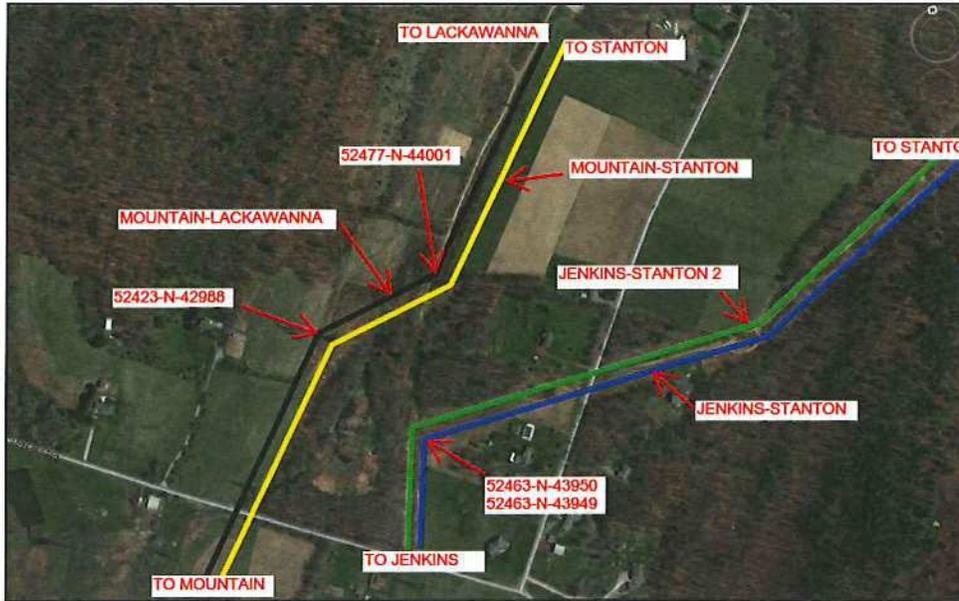
PPL Electric Utilities Corporation (PPL Electric) is requesting Pennsylvania Public Utility Commission (PUC or the Commission) approval to install approximately 0.20 miles of new 230 kV transmission lines to reconfigure the existing Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line and Susquehanna-Mountain-Stanton 230 kV Transmission Line (the Project). As explained in Attachment 1, the proposed Project is required to ensure system reliability during the 12-month outage of the Susquehanna-Jenkins 230 kV Transmission Line during the rebuild of the existing Susquehanna-Jenkins 230 kV Transmission Line.

## **2.0 PROPOSED ACTIVITY**

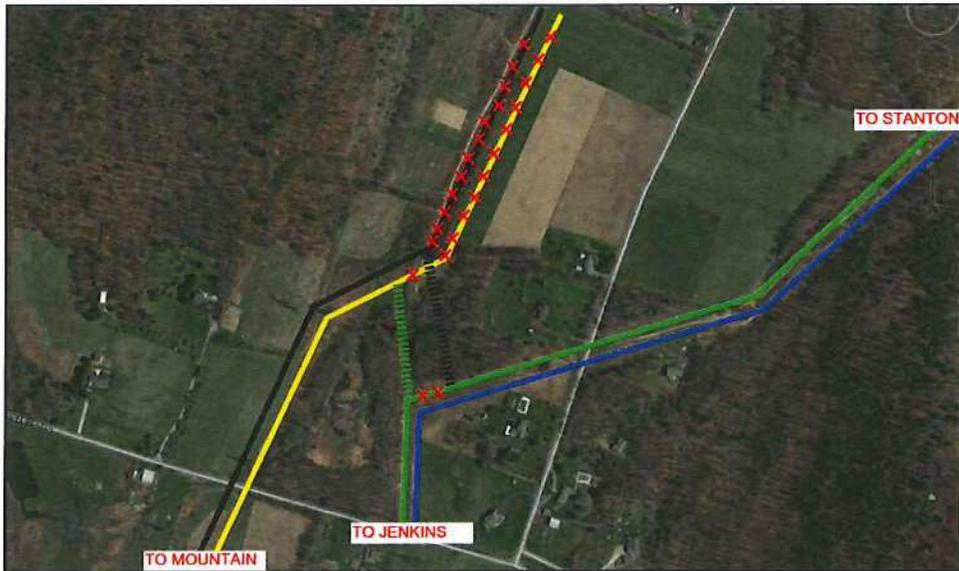
As explained in Attachment 1, PPL Electric proposes to reconfigure the Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line and Susquehanna-Mountain-Stanton 230 kV Transmission Line to provide the Jenkin Substation with a second source of supply during the required outage of the Susquehanna-Jenkins 230 kV Transmission Line. This requires the construction of two new single-circuit 230 kV transmission lines to interconnect the Susquehanna-Mountain-Stanton and Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Lines with the Jenkins-Stanton #2 230 kV Transmission Line, and the construction of a third new single-circuit 230 kV transmission line to interconnect the Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line with the Stanton Substation.

In order to interconnect the Susquehanna-Mountain-Stanton 230 kV Transmission Line with the Jenkins-Stanton #2 230 kV Transmission Line, PPL Electric proposes to construct a new 230 kV single circuit that will extend approximately 500 feet (0.09 miles) between the two existing lines. In order to interconnect the Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line with the Jenkins-Stanton #2 230 kV Transmission Line, PPL Electric proposes to construct a new 230 kV single circuit that will extend approximately 540 feet (0.1 miles) between the existing lines. Installation of these two new circuits will require three new monopole structures with an average height of approximately 125 feet. **Figures 2-1** and **2-2** show the existing and proposed 230 kV transmission lines.

**FIGURE 2-1: Existing 230 kV Lines**



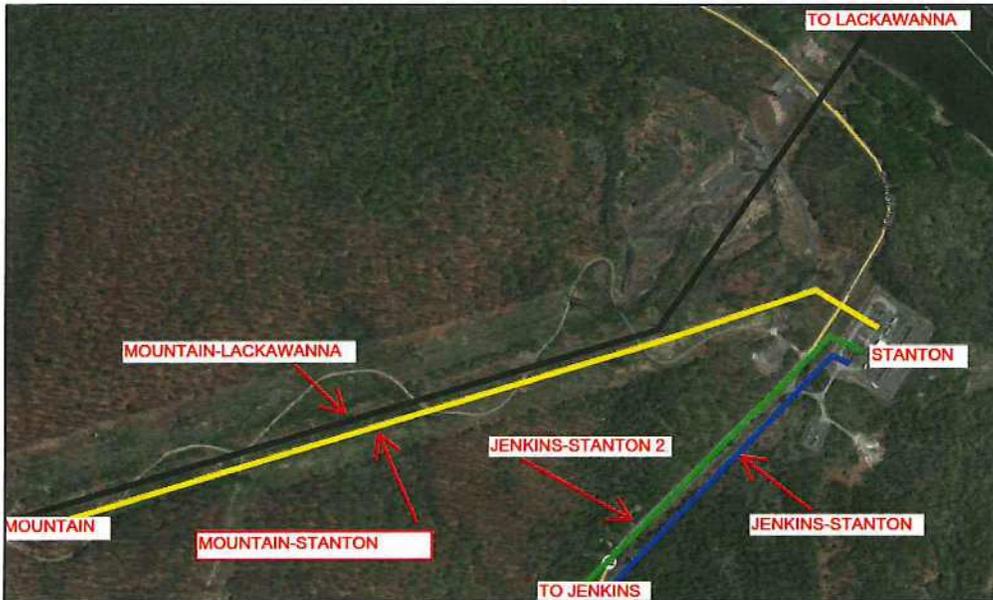
**FIGURE 2-2: Proposed New 230 kV Lines**



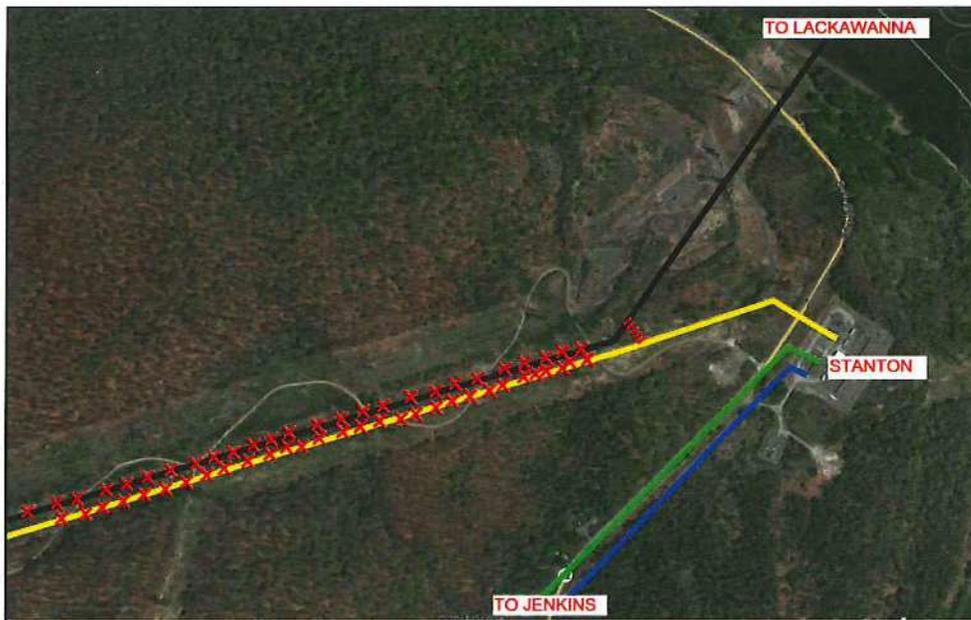
PPL Electric also proposes to install approximately 40 feet (0.01 mile) of new 230 kV conductor (known as a “jumper wire”) near the Stanton Substation to connect the Susquehanna-Mountain-Stanton 230 kV Transmission Line (segment that remains interconnected with the Stanton Substation) and the Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line

(segment that remains interconnected with the Lackawanna Substation). This jumper wire will be located on one existing pole near the Stanton Substation and will not require new tower structures or other any changes to the right-of-way. **Figures 2-3** and **2-4** show the existing and proposed 230 kV transmission lines near the Stanton Substation.

**FIGURE 2-3: Existing 230 kV Lines at Stanton Substation**



**FIGURE 2-4: Proposed New 230 kV Configuration**



In total, the proposed reconfiguration will require the installation of a total of approximately 0.20 miles of new 230 kV transmission lines. The 230 kV design will utilize three power conductors per circuit and two overhead ground wires. The power conductors will be 1590 kcmil<sup>1</sup> 45/7 ACSR<sup>2</sup> “Lapwing”<sup>3</sup> conductors. The overhead ground wires will be 48 count single mode fiber optical ground wires.

The new 230 kV transmission lines will be designed to meet, and generally exceed, National Electrical Safety Code (NESC) minimum standards. Design specifications and safety rules practiced by PPL Electric are included in **Attachment 4**. The minimum conductor to ground clearance for the proposed 230 kV line will be 33 feet, which occurs at a maximum conductor temperature of 125° C. The designed minimum conductor clearances and conductor thermal ratings are set forth in **Table 2-1** and **Table 2-2** below.

**TABLE 2-1: Design Minimum Conductor Clearances\*\***

Condition	Design Clearance-to-Ground
Normal load; average weather (16°C ambient temperature)	33.0 feet
Predicted extreme thermal load (125°C conductor temperature)	33.0 feet
Predicted PPL Extreme wind load (100 mph, 16°C)	33.0 feet
Predicted extreme weather conditions (1inch ice, 8 lbs. wind, -18°C)	33.0 feet
*Clearances based on a maximum tension of 20,000 pounds at 1.5 inch ice, 0° F, 0# wind and a ruling span of 500 feet.	

\*\*Based on 1590 kcmil 45/7 stranding ACSR “LAPWING”

<sup>1</sup> kcmil stands for thousand circular mils. kcmil wire size is the equivalent cross sectional area in thousands of circular mils. A circular mil is the area of a circle with a diameter of one thousandth (0.001) of an inch.

<sup>2</sup> ACSR stands for aluminum conductor steel reinforced.

<sup>3</sup> Lapwing is the technical term for a 1590 kcmil 45/7 ACSR conductor as defined in the American Society for Testing and Materials.

**TABLE 2-2: Conductor Thermal Rating\***

Condition	Ambient Temperature °C	Wind Speed ft/sec	Ampacity Amps
<b>NORMAL</b>			
Summer Normal (Day)	35	0	1671
Summer Normal (Night)	35	0	1808
Winter Normal (Day)	10	0	1925
Winter Normal (Night)	10	0	2044
<b>EMERGENCY</b>			
Summer Emergency (Day)	35	3	2063
Summer Emergency (Night)	35	3	2176
Winter Emergency (Day)	10	3	2323
Winter Emergency (Night)	10	3	2423

\*Based on 1590 kcmil 45/7 stranding ACSR "LAPWING" (257°F) 125°C maximum conductor

### **3.0 CONSTRUCTION TECHNIQUES**

The following is a summary, non-technical explanation of the typical construction activity that is associated with new transmission line construction for single poles, which are either directly embedded into the ground or installed on a concrete foundation. This is not to be misconstrued as all-encompassing and may vary based on specific site/service conditions at each project. Actual construction steps may not necessarily occur in this particular order:

- The project manager will review the construction plans with PPL Electric personnel that will be constructing the line, including all permits and conditions that apply (such as erosion and sediment control, wetland encroachments, and storm water management), as well as any agreements made with specific property owners for work done on their lands.
- Surveyors will stake the locations of all poles to be constructed, as well as the edge of right-of-way and locate any wetland or streams previously sited during field work.

- All wetlands/waters are delineated in the field, located by land surveyors, and specifically shown to the construction manager prior to work commencing.
- During the installation of access roads, poles, and hanging of the wire, approved “best management practices” are implemented to assure that the soil will be stabilized and not erode during storm events while the Project is under construction. Any temporary wetland encroachments (usually roads) will be removed according to the permit conditions. Whenever practical, PPL Electric will utilize timber matting in wetland areas to minimize disturbance to the wetland vegetation and topography.
- Construction roads will be constructed, approximately 14 to 16 feet in width, with a stone surface to support the equipment that will be transporting materials to the pole sites. Those vehicles are usually cranes, concrete trucks (if foundations are involved), boom trucks, and pickups. The roads will be built as provided for in the construction drawings as per the erosion and sediment control plan, the NPDES permit plan, and/or the wetland encroachment permit plan. The plan may require these roads to be temporary in nature, returning to vegetative cover when the work is complete. Landowners may wish to have the roads remain intact for shared use between PPL Electric for line inspection and maintenance and property owner use. Much of the routine maintenance to the line, once built, will be by helicopter or 4 wheel drive pickup truck.
- The direct embedded poles will be installed by the use of auger and then a crane. After the hole is drilled, usually 4 to 6 feet in diameter, the bottom section of pole is placed directly into the hole and backfilled with native soil or engineered material, then the remaining sections are installed along with any cross arms. A pole that is at an angle in the line, or for another specialized reason, may be required to have a concrete foundation. These foundations are seldom more than 12 feet in diameter and are filled with reinforced concrete. The top of the foundation may extend an average of 1 foot above the ground.
- Once the poles are in place along the line route, the wires will be installed using bucket trucks to attach the wires to each pole and equipment and manpower will be used to pull the wires along from pole to pole. Helicopter stringing/pulling may be utilized in restricted access or environmental sensitive areas.

- The project manager will oversee the stabilization of the site including the successful establishment of vegetation on all previously disturbed areas during construction.

Typical examples of the proposed structures are depicted in **Figure 2-5** and **Figure 2-6**.

#### **4.0 MAGNETIC FIELD MANAGEMENT**

PPL Electric’s Magnetic Field Management Program is applied to new and reconstructed transmission line projects. The Company does not believe that the current scientific evidence demonstrates that magnetic fields cause any adverse health effects or pose a health or safety danger to the public. Nevertheless, PPL Electric has determined, as a matter of policy, to design its new and rebuilt transmission lines to reduce magnetic fields when that can be done at low or no cost and consistent with functional requirements. PPL Electric’s Magnetic Field Management Program has been developed to implement that policy decision. To reduce magnetic field exposures, the program generally prescribes the use of a line design with ground clearance that is five feet higher than NESC standards and reverses phasing of new double-circuit lines where it is feasible to do so at low or no cost.

The new 230 kV transmission lines will be single-circuit and, therefore, reverse phasing is not possible. However, the Project will be designed with structures that have a ground clearance that is five feet higher than NESC standards. This measure will reduce the potential for exposure to magnetic fields.

FIGURE 2-5: Typical 230 kV ROW Cross-Section:

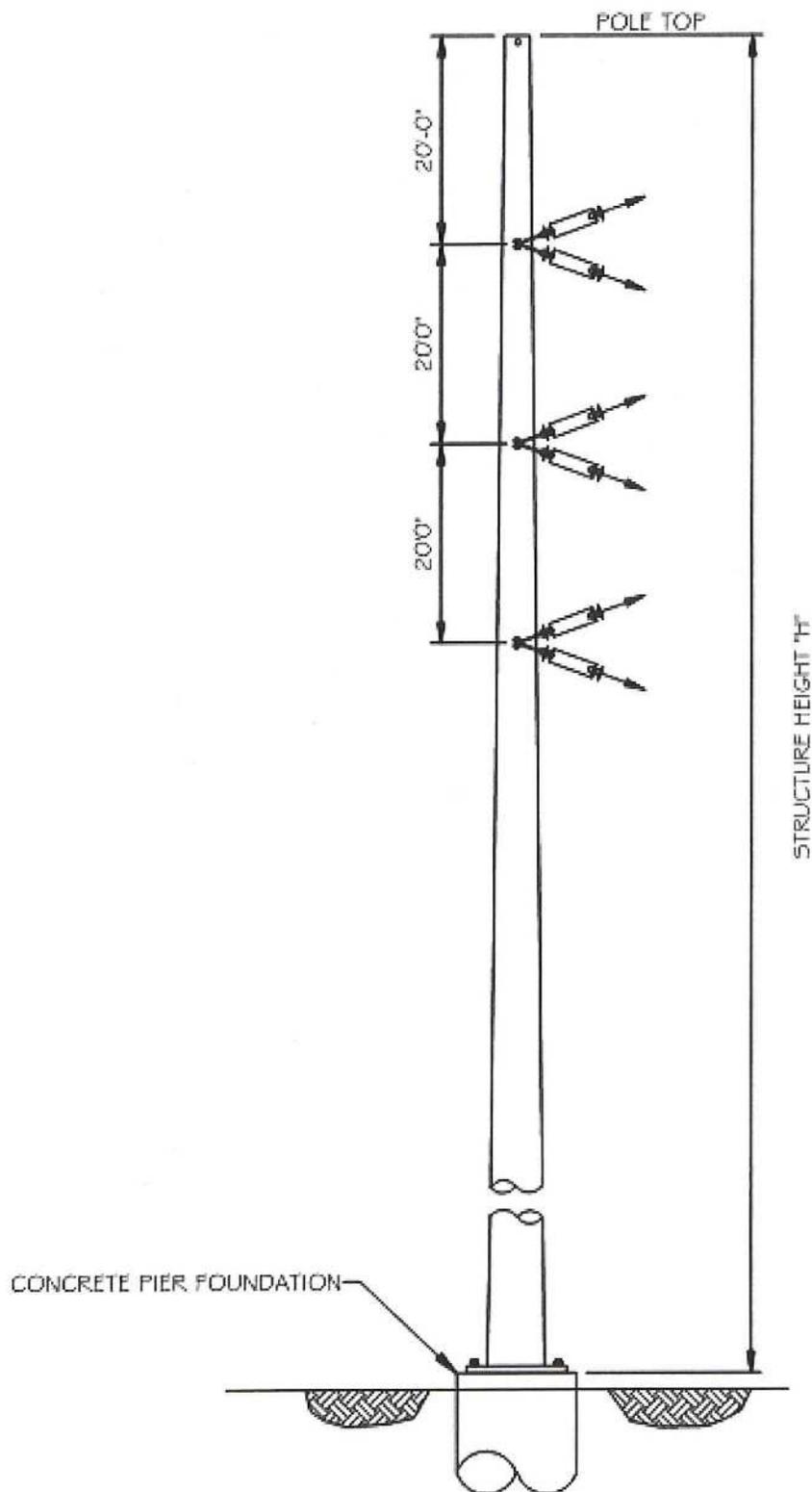
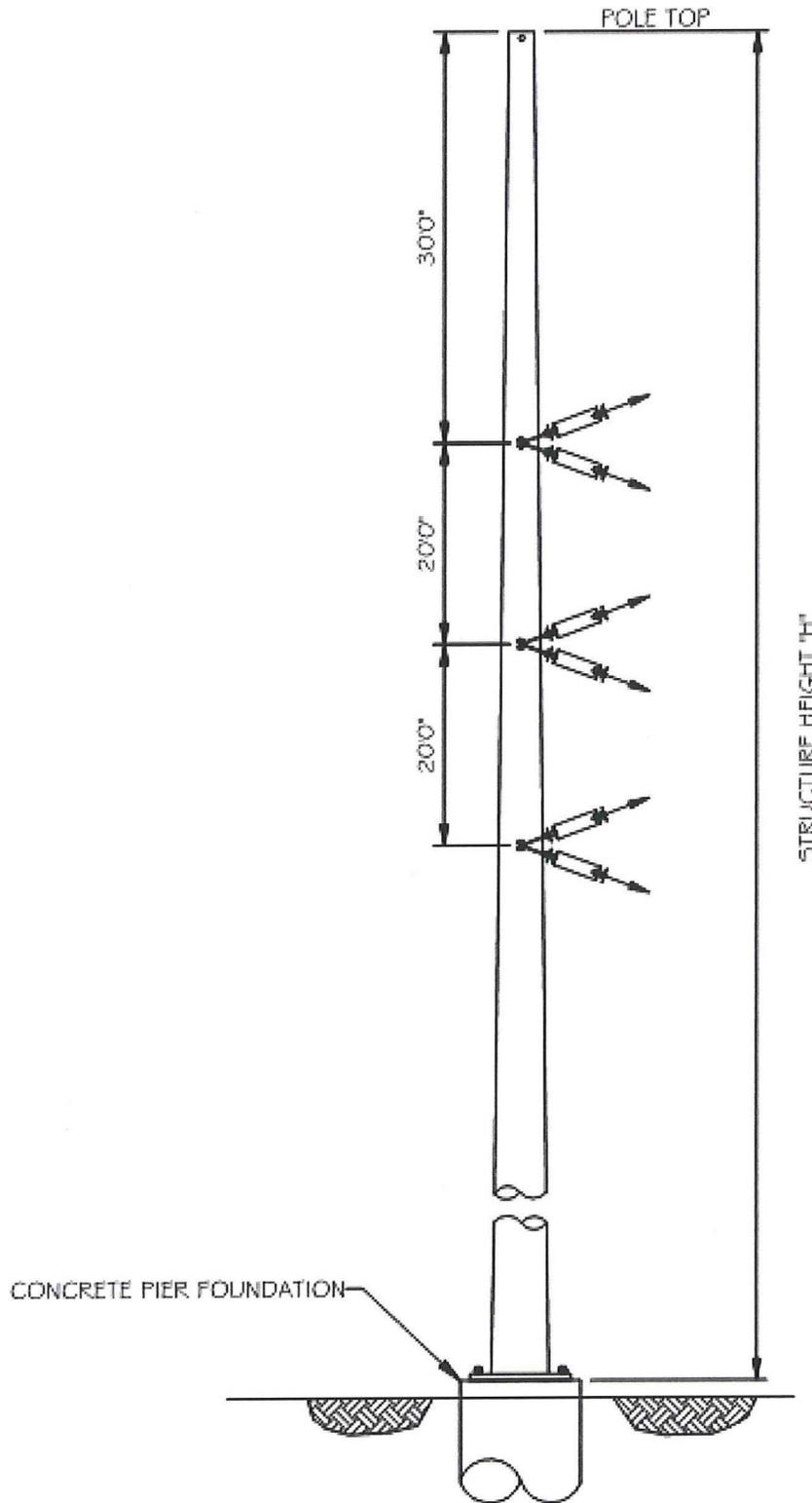


FIGURE 2-6: Typical 230 kV ROW Cross-Section



# **Attachment 3**

**Table of Contents**

**1.0 INTRODUCTION ..... 1**

**2.0 DESCRIPTION OF THE RIGHT-OF-WAY ..... 1**

**3.0 LAND USE ..... 2**

**4.0 ENVIRONMENTAL FACTORS ..... 3**

**5.0 VEGETATION MANAGEMENT ..... 4**

**List of Figures**

**Figure 3-1:** Aerial Map of the Project

## **1.0 INTRODUCTION**

PPL Electric Utilities Corporation (PPL Electric) is requesting Pennsylvania Public Utility Commission (PUC or the Commission) approval to install approximately 0.20 miles of new 230 kV transmission lines to reconfigure the existing Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line and Susquehanna-Mountain-Stanton 230 kV Transmission Line (the Project). As explained in **Attachment 1**, the proposed Project is required to ensure system reliability during the 12-month outage of the Susquehanna-Jenkins 230 kV Transmission Line during the rebuild of the existing Susquehanna-Jenkins 230 kV Transmission Line.

## **2.0 DESCRIPTION OF THE RIGHT-OF-WAY**

As explained in **Attachment 2**, PPL Electric proposes to construct approximately 500 feet of new 230 kV transmission line between the Susquehanna-Mountain-Stanton 230 kV Transmission Line with the Jenkins-Stanton #2 230 kV Transmission Line. Additionally, approximately 540 feet of new 230 kV transmission line will be constructed between the Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line with the Jenkins-Stanton #2 230 kV Transmission Line. These two new single-circuit 230 kV transmission lines will parallel each other within an existing 200-foot wide transmission line right-of-way that contains an existing 69 kV transmission line and access road. The existing right-of-way is sufficient to accommodate the construction, operation, and maintenance of the two new proposed single-circuit 230 kV transmission lines. Therefore, no additional rights-of-way are required for the construction and operation of these new transmission lines.

As explained in **Attachment 2**, PPL Electric also proposes to install approximately 40 feet of new 230 kV conductor (“jumper wire”) to connect the Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line with the Stanton Substation. This new jumper wire will be located on one existing pole near the Stanton Substation and will not require new tower structures or other any changes to the right-of-way. The jumper wire will be constructed entirely within the existing rights-of-way for the Susquehanna-Mountain-Stanton 230 kV Transmission Line and the Susquehanna T-10-Mountain-Lackawanna 230 kV Transmission Line. The existing rights-of-way are sufficient to accommodate the construction, operation, and maintenance of the new 230

kV jumper wire. Therefore, no additional rights-of-way are required for the construction and operation of these new transmission lines.

**Figure 3-1** is an aerial map that identifies the location and the properties crossed by the Project.

### **3.0 LAND USE**

Impacts to land use are anticipated to be minimal because the work will be performed within rights-of-way that are partially cleared for existing transmission lines and access roads. Changes in the surrounding land uses will be further minimized because PPL Electric will use previously established access roads for construction. Further, no new structures will be placed on any property that currently does not have an existing structure. No nearby communication towers, pipelines, or other utilities will be affected by the proposed Project.

#### *Airports*

The closest airports include the Wilkes-Barre Wyoming Valley Airport, a public facility, which is located approximately 4.3-miles southwest of the Project area, and the Wilkes-Barre Scranton International Airport, also a public facility, which is located about 6.0-miles east of the Project area. PPL Electric does not anticipate any interference with airport operations because of the distance from the Project area, the presence of existing electrical structures in the Project area, and the similar height of the new facilities and the existing facilities. However, PPL Electric will file any required documentation with both the Federal Aviation Administration and the Pennsylvania Department of Transportation Bureau of Aviation.

#### *Conserved Lands*

There are no state lands, national parks, state parks, local parks, recreational areas or natural landmarks located within the Project area.

#### *Cultural Resources*

PPL Electric has not initiated communication with the Pennsylvania Historical and Museum Commission (PHMC) for the construction of the new 230 kV lines because the potential earth disturbance is below specific thresholds and no stream or wetland impacts are anticipated, thus no state or federal permits are required for the Project at this time. If the permitting needs for the

Project change, and PHMC coordination is required, PPL Electric will work with the PHMC and perform any reviews and field survey/sampling work required to avoid, minimize, and mitigate impacts to archaeological or historic architectural resources that may be located within the Project area.

#### **4.0 ENVIRONMENTAL FACTORS**

Environmental factors reviewed for the Project included unique natural features, threatened and endangered species, waterways and wetlands, and soils.

##### ***Unique Natural Features***

The proposed Project will not affect any unique geological, scenic or natural areas.

##### ***Threatened and Endangered Species***

Similarly, PPL Electric has not initiated communications with state and federal agencies regarding threatened and endangered (T&E) species within or in close proximity to the Project area because no permits are required for the Project at this time. If the permitting needs for the Project change, and T&E species coordination is required, PPL Electric will conduct the necessary Pennsylvania Natural Diversity Inventory (PNDI) review, which evaluates T&E species under the jurisdiction of the Pennsylvania Department of Conservation and Natural Resources, the Pennsylvania Fish and Boat Commission, the Pennsylvania Game Commission, and the U.S. Fish and Wildlife Service. Based on this review, PPL Electric will, to the extent required, coordinate with these jurisdictional agencies, acquire any required permits, and comply with any conditions placed on those permits.

##### ***Waterways and Wetlands***

The proposed Project will involve crossing a stream and be constructed in an area where wetlands have been noted. PPL Electric does not anticipate any impacts to the stream, which passes under an access road in a stable culvert. However, PPL Electric will need to conduct a delineation of the wetlands to determine if temporary impacts (timber matting) to these regulated features can be avoided. Based on the findings of the wetland delineation and evaluation of construction activities, if wetland impacts cannot be avoided, PPL Electric will obtain permits

from the Pennsylvania Department of Environmental Protection (PADEP) and the United States Army Corps of Engineers, as needed, and will comply with all of the terms and conditions placed on those permits.

### *Soils*

As noted above, the extent of earth disturbance for the Project is anticipated to be below the threshold level that requires a National Pollutant Discharge Elimination System (NPDES) permit. PPL Electric will develop a standard erosion and sedimentation (E&S) control plan to address stormwater flow during construction of the project, but this plan does not require county or state approval. If the level of earth disturbance increases above the threshold level, PPL Electric will initiate the acquisition of a NPDES permit and will comply with any conditions placed by the County Conservation District or PADEP on those permits.

## **5.0 VEGETATION MANAGEMENT**

The Project is being completed within PPL Electric rights-of-way that presently contain transmission lines. Areas around these transmission lines and adjacent access road have already been cleared of vegetation. However, in order to accommodate the construction of the new segment of 230 kV line associated with this Project and to maintain proper clearances between the 230 kV conductors and vegetation in the area, vegetation management will be required on the site to clear approximately 1.2 acres of forested land. In areas where vegetation management is required to complete the transmission line construction, PPL Electric will apply its "*Specifications for Transmission Vegetation Management LA-79827*" to mitigate any impacts.

**FIGURE**



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the

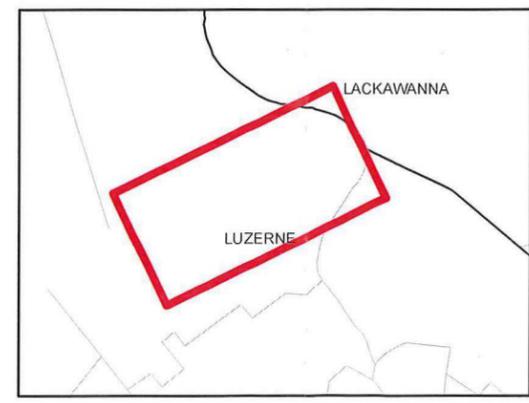
**Legend**

- 69 kV Lines
- 230 kV Lines
- Right-Of-Way (200 ft)
- Parcels in Work Area
- Other Parcel Boundary

**REFERENCES:**  
 Luzerne County Parcel Data (2015)  
 Existing Transmission Lines (Platts POWERmap 2012)  
 World Imagery Basemap (NAIP 2013)

0 500 1,000 2,000  
 Feet  
 1 inch = 1,000 feet

Coordinate System: NAD 1983 StatePlane Pennsylvania North FIPS 3701 Feet  
 Projection: Lambert Conformal Conic; Units: Foot US



**AECOM**

**Figure 3-1: Aerial Map of the Project  
 Stanton 230 kV Lines  
 Rearrangement Project**

**Luzerne County, Pennsylvania**

Prepared For: PPL Electric Utilities Corporation,  
 Allentown, Pennsylvania

Prepared By: NB	Checked By: DY
Job: 60388181	Date: 5/10/2016

# **Attachment 4**

**Table of Contents**

**1.0 DESIGN CONSIDERATIONS.....1**

**2.0 PERIODIC MAINTENANCE PROGRAM ON ALL TRANSMISSION LINES .....2**

**3.0 PERSONNEL SAFETY RULES .....3**

**4.0 MAGNETIC FIELD MANAGEMENT PLAN.....5**

**List of Tables**

**Table 4-1:** 230 kV Vertical Clearance to Ground

**Table 4-2:** Required Minimum Clearance for Nonconductive Working Stick

## **1.0 DESIGN CONSIDERATIONS**

The new 230 kV transmission line will be designed according to, and generally exceed, all NESC minimum standards. The NESC is a set of rules to safeguard people during the installation, operation, and maintenance of electric power lines. The NESC contains the basic provisions considered necessary for the safety of employees and the public. Although it is not intended as a design specification, its provisions establish minimum design requirements. PPL Electric has developed design specifications and safety rules which meet or surpass all requirements specified by the NESC.

The NESC includes loading requirements and clearances for the design, construction, and operation of power lines. The "loads" on conductors and supporting structures are the mechanical forces that develop from the weight of the conductors, the weight of ice on the conductors, plus wind pressure on the conductors and supporting structures. Loading requirements are the loads on the conductors and structures that are anticipated assuming certain ice and wind conditions. Loading requirements always contain "safety factors" to allow for unknown or unanticipated contingencies. The clearances and loading requirements contained in the NESC were developed to ensure public safety and welfare.

PPL Electric transmission line design standards meet or surpass the NESC standards. For example, the relative order of grades of construction for conductors and supporting structures is B, C, and N; Grade B being the highest. According to the NESC standards, construction Grades B, C, or N may be used for transmission lines (except at crossings of railroad tracks and limited access highways where Grade B construction is specified). However, PPL Electric designs all of its transmission lines for Grade B construction. The use of Grade B design and construction specifies enhancements such as larger-minimum cross-arm dimensions, larger-minimum conductor size, and increased safety factors.

Another example is the design parameters utilized to account for ice and wind loadings on the overhead ground wire (OHGW) and power conductors. The NESC standard ice and wind design magnitudes for the PPL Electric territory are 0.5 inch thickness of radial ice combined with four pounds per square foot horizontal wind pressure (equivalent to 40-mile per hour wind velocity). The conductor sags and tensions used in line designs are the result of various ice and wind combinations, depending on the elevation at the line location and line design voltage. The conductor sags and tensions used in the design of all PPL Electric transmission lines are at least 0.5-inch ice combined with eight pounds wind pressure (equivalent to 57 miles per hour wind velocity). This means that PPL Electric lines are designed to operate safely and reliably during inclement weather even more severe than assumed by the NESC. In addition, PPL Electric transmission lines are designed with more clearance to the ground than required by the NESC. **Table 4-1** compares PPL Electric and NESC ground clearances for lines of various voltages.

**TABLE 4-1: 230 kV Vertical Clearance to Ground**

Surface Underneath Conductors	NESC Standard	PPL Electric Design
Roads, streets, alleys	22.4 Ft.	33 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	22.4 Ft.	33 Ft.
Spaces accessible to pedestrians only	18.4 Ft.	33 Ft.
Railroad tracks	30.4 Ft.	35 Ft.

A relay protection system is used to protect the public safety and welfare as well as equipment and the transmission system. Relay protection is installed for all transmission lines to automatically de-energize the line in the unlikely event that the line or supporting structure fails and the line contacts the ground.

## **2.0 PERIODIC MAINTENANCE PROGRAM ON ALL TRANSMISSION LINES**

To ensure continued public safety and integrity of service, a periodic maintenance and inspection program is implemented for every transmission line. The program is administered through the use

of helicopter patrols, with supplemental foot and structure climbing patrols. A number of helicopter patrols are performed on all lines annually. The two-man helicopter crew flies parallel, to the left, and above the line so that the observer can look for signs of line damage or deterioration and observe clearances between vegetation and conductors. The observations are included in a report that is forwarded to the appropriate department for corrective action.

Foot and structure climbing patrol programs for a transmission line begin approximately three to five years after the line is energized, unless a helicopter patrol reports a need for earlier action. The frequency of foot patrols varies from once every year to once every several years depending on line type and age.

An assigned foot patroller checks right-of-way conditions, including access roads, bridges, pole washouts, tower footers, vegetation height and clearance to conductors, pole and tower deterioration and, with the use of binoculars, insulators, and condition of hardware. Identified problems are included in a report that is forwarded to the appropriate department for corrective action.

A scheduled line outage is required to perform an overhead patrol because of "hands-on" inspection of hardware. Overhead patrols are conducted on a schedule determined by line age, operating record, and observed general condition. The necessary repairs are also done during the inspection outage.

### **3.0 PERSONNEL SAFETY RULES**

The following are a few of the PPL Electric safety rules that demonstrate the Company's concern for employee safety:

- Work procedures have been developed to allow work to be performed on energized facilities in a safe manner. When lines or apparatus are removed from service to be worked on, the Energy Control Process system is applied. This system provides that a red tag must be physically placed on the control handle of the de-energized equipment.

- The red tag may be removed only after proper authorization to energize the equipment.
  - Various other tags are used for limited operations and informational purposes.
  - Employees will not apply or remove a tag or change the status of tagged equipment unless authorized.
- Temporary safety grounds are used on de-energized facilities for employee safety during maintenance, construction, or reconstruction work. Safety grounds are wires connecting the de-energized facility to an electrical ground. If the facility should be energized, the safety grounds will divert the current directly to ground and reduce the likelihood of personal injury. The conductor size and attachment clamps of temporary safety grounds must be capable of conducting anticipated fault currents. Rubber gloves, rubber sleeves, and additional rubber protective equipment are used as required when applying or removing temporary safety grounds to or from the lines or apparatus to be grounded. An approved nonconductive working stick of sufficient length to allow workers to maintain required minimum clearances (**Table 4-2**) is used to test that the line has been de-energized and to apply temporary safety grounds:

**TABLE 4-2: Required Minimum Clearance for Nonconductive Working Stick**

Voltage-kV	Minimum Clearance
138	4'-4"
230	5'-3"
500	14'-2"

- Before applying grounds, a test is done to confirm that the line is de-energized. The voltage test device is checked before and after use to assure reliability. When ground pins are used to establish proper ground points, they are driven to a depth of not less than four feet as near vertical as possible.
- Poles or structures are inspected and examined for structural integrity before climbing. If there is any reason to believe that a pole is unsafe, it is stabilized before work is performed.

Appropriate safety gear in the form of body belts, safety straps, hard hats, gloves, etc., is worn by linemen during line work activity.

#### **4.0 MAGNETIC FIELD MANAGEMENT PLAN**

PPL Electric's Magnetic Field Management Program is applied to new and reconstructed transmission line projects. In order to lower magnetic field exposures, the program generally prescribes the use of a line design that provides ground clearances of five feet higher than the required minimum NESC ground clearance and reverses phasing of new double circuit lines where it is feasible to do so at low or no cost. The implementation of additional modifications will be considered, provided those modifications can be made at low or no cost and will not interfere with the operation of the line.

Consistent with its Magnetic Field Management Program, PPL Electric will build the new 230 kV transmission line for ground clearances that are a minimum of five feet higher than the required NESC minimum ground clearance for 230 kV lines. The new 230 kV transmission line extensions will be a double-circuit that will use reverse phasing. This measure will further reduce the potential for exposure to magnetic fields.