



Before the  
Pennsylvania Public Utility Commission

**SUMMIT SUBSTATION 230 kV LINE  
EXTENSION PROJECT**

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

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

Submitted by: PPL Electric Utilities Corporation

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## **1.0 INTRODUCTION**

PPL Electric Utilities Corporation (PPL Electric) is requesting Pennsylvania Public Utility Commission (PUC or the Commission) approval to construct two new double circuit 230 kV transmission lines that will extend approximately 1.32 miles from the existing Stanton-Lackawanna #3 and #4 230 kV Transmission Lines to the new Summit 230-69 kV Substation (the Project). The proposed Project is located in Lackawanna County and will traverse the following municipalities: City of Scranton, Ransom Township, and Newton Township. As explained below, the Project is required to provide a source of supply to the new Summit 230-69 kV Substation. The new Summit 230-69 kV substation is required to improve reliability, reduce the potential for and duration of outages, and increase system operability in Lackawanna County.

Subject to the Commission's approval, construction is scheduled to begin in September 2016, to support the Project's scheduled in-service date of November 2017. The estimated cost of Project is \$12.3 million.

## **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.

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>1</sup> and non-Bulk Electric System (non-BES)<sup>2</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>3</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.

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<sup>1</sup> Bulk Electric System (BES) – Includes transmission facilities operated at voltages of 100 kV or higher.

<sup>2</sup> Non-Bulk Electrical System (non-BES) – Includes transmission facilities operated at voltages less than 100 kV.

<sup>3</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.

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 criteria set by NERC. PJM's manual 14B<sup>4</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>5</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 transmission facilities, and its non-BES 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

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<sup>4</sup> PJM Manual 14B is available at <http://www.pjm.com/~media/documents/manuals/m14b.ashx>

<sup>5</sup> <http://www.ferc.gov/industries/electric/indus-act/trans-plan.asp>

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.

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.

As explained below, the proposed Project is necessary to maintain the reliability of the transmission system serving Lackawanna County according to PPL Electric Transmission System Development Standards. The proposed Project has been presented at a PJM Mid-Atlantic Sub-Regional RTEP stakeholder meeting and has been approved as supplemental project s0974.3 in PJM's RTEP process.

### **3.0 DEFINITION OF THE PROBLEM**

The proposed Project is one element of a large comprehensive plan to improve the reliability of service to approximately 118,492 customers served from the Stanton, Lackawanna, and Jenkins 230-69 kV regional substations that provide supply to the greater Scranton area. The comprehensive plan is required to address the following:

- To convert network lines to radial configuration, which will reduce line exposure and, thereby, reduce the number of customers interrupted during a single outage event. As explained in greater detail below, this will result in greater reliability performance on the lines in this area and provide better power delivery to the customers at both the distribution and transmission level.
- To install smart devices called Motor Operated Load Break Air Break (“MOLBAB”), which will allow the system operators to isolate faults within minutes and restore service to the customers within a very short period of time. This benefit will be spread out across all of the 69 kV lines in this area and all substations served by those lines.
- To replace wooden poles with modern steel poles. The wood pole replacement work will increase the resiliency of 69 kV transmission systems serving this area.
- To rebuild old transmission lines with current design standards. Many of the transmission lines in the area were built 50-60 years ago. Over the past 5-10 years, the existing lines in this area have exhibited reduced reliability due to degrading structure and/or conductor health along with vintage transmission line designs that do not meet

current performance standards for reliable power delivery to customers, which directly correlates to an increase in the probability for material/structural failures and a resulting long-term power outages. The planned rebuilds of these lines will resolve these asset driven reliability concerns, while reconfiguring the system to reduce customer exposure during outage events in the future.

- To install fiber optic cables to provide communication connectivity to transmission and distribution substations.

This comprehensive plan will improve the reliability of the transmission and distribution systems serving the greater Scranton area by replacing facilities that have reached the end of their useful lives with modern facilities that meet current design standards and have the technical ability to reduce the frequency and duration of outages experienced by customers. The improved transmission and distribution systems will allow quicker load restoration after a system interruption, which will contribute to a higher level of reliability for the customers served from these lines. Importantly, the proposed Project is a critical part of the larger comprehensive plan to improve the reliability of electric service to 118,540 customers in the Scranton area.

### 3.1 Existing System

Presently, customers in Lackawanna County are supplied by the Lackawanna and Stanton 230-69 kV Substations. The double-circuit Stanton-Lackawanna #3 and #4 230 kV Transmission Line extends approximately 13.5 miles between the Stanton 230-69 kV Substation in Exeter Township and the Lackawanna 230-69 kV Substation in Blakely Township. A one-line diagram and map of the existing system are provided as **Figure 1-1** and **Figure 1-2**, respectively

The Stanton and Lackawanna 230-69 kV Substations are regional substations that supply power to several 69 kV transmission lines, which in turn supply power to various 69-12 kV distribution

substations in Lackawanna County. These regional substations serve approximately 99,287 customers in Lackawanna County, including 6 large transmission connected customers.

## **3.2 Reliability Risks**

### **3.2.1 Line Exposure**

The existing 69 kV system in Lackawanna County has been identified as having unacceptable line exposure along with a high momentary outage rate (outage less than 5 minutes in duration). These lines currently have excessive circuit lengths as well as a large number of customers being served from each line. Nine 69 kV lines in this area have experienced a total of 75 momentary outages in the past 10 years. Due to high load density in the greater Scranton area and the limited capacity of the existing 69 kV lines, the load transfer capability between the Stanton and Lackawanna 230-69 kV Substations is poor during peak loads. This leaves approximately 99,287 customers at risk of prolonged outage durations, especially as system load continues to increase.

### **3.2.2 Large Customer Count Exposure with Networked 69 kV Lines**

The following four 69 kV transmission lines are networked transmission lines that currently serve a significant number of customers in the greater Scranton area:

- Stanton-Providence #1 69 kV line - Approximately 14.14 miles in length and serves an approximate 3,221 customers.
- Stanton-Providence #2 69 kV line - Approximately 10.30 miles in length and serves an approximate 3,351 customers.
- Lackawanna-Providence #1 69 kV line - Approximately 7.27 miles in length and serves an approximate 4,854 customers.

- Lackawanna-Providence #2 69 kV line - Approximately 7.25 miles in length and serves an approximate 8,464 customers.

While the networked configuration appears to offer an advantage in keeping customers in-service for a fault at either regional substation bus, it also creates other serious technical issues. In a networked configuration, for an outage of a line due to a fault anywhere along the line, the breakers at each end of the line would be tripped (“opened”) to isolate the fault. If there was an outage of a line that is operating radially,<sup>6</sup> only the substation breaker(s) at the source or supply end would be tripped to isolate the fault. Therefore, an outage of a networked-configured line will interrupt more customer load than if that line was sectionalized somewhere near the middle of the line (using a normally open line switch) and operated radially from each end of the line to the normally open switch.

In addition, there are concerns operating the 69 kV transmission system in a networked configuration. When either a pre-arranged or unplanned outage occurs on the BES, the flow of electricity needs to find alternate paths to reach the load. In some contingency scenarios, that alternate path would be a lower voltage networked transmission line on the 69 kV or 138 kV system, which is not designed to accommodate BES network power flows. The 69 kV transmission level facilities are designed to serve load at the 69-12 kV distribution substations that ultimately serve the customers. On the PPL Electric system, a radial configuration is preferred for 69 kV transmission lines, using shorter line lengths and normally open ties (switches) with adjacent transmission lines for restoration in the event of an interruption.

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<sup>6</sup> In a “radial” configuration, the transmission line has a voltage source and power supply available at only one end of the line. Power will flow from the transmission substation (230-69 kV) source to the loads along the line.

In order to minimize outages, ensure the safety of customers and the communities served, and to maintain the integrity and reliability of the electrical system, PPL Electric's transmission system is designed with a protective relaying scheme. PPL Electric uses a protective relaying scheme to identify, isolate and clear faults, and to communicate between transmission facilities. The protective relaying scheme opens and closes switches in the transmission facilities when a fault is detected.<sup>7</sup>

Due to the nature of the protection schemes, circuit breaker clearing times can be slower on networked lines than radially configured lines. With slower clearing times, transient voltage dips will last for a longer period of time with networked transmission lines than if the lines were operated radially. Slower clearing times for a fault may result in extended periods of transient voltage dips until the fault condition is cleared from the system. This may result in additional outages due to customer equipment tripping off due to low voltage.

With radial configuration, the protective relaying scheme is basic in design and configuration, and the Transmission Operators can be confident that the line is protected. For lines operated in a networked configuration, the protective relaying scheme is more complicated. Protective settings, recloser preference switches, and relay communication circuits must be changed in order to properly protect a networked circuit when it is abnormally configured to a radial line. Because of this issue, the protective relaying becomes more complicated in a network configured system in order to cover different topology scenarios.

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<sup>7</sup> Like a circuit breaker on household electric lines, the protective relaying scheme opens an electric switch and shuts off power when a fault occurs. Where a household circuit breaker remains shut off until it is manually reset, the protective relaying scheme tests the electrical line to determine whether the fault has been removed. If the fault is only temporary, the protective relaying scheme closes the switch and restores electric power.

The proposed new Summit 230-69 kV Substation would strengthen the power supply to the 69 kV system in the greater Scranton area such that PPL Electric could break the network configuration and operate the Stanton-Providence #1, Stanton-Providence #2, Lackawanna-Providence #1, and Lackawanna-Providence #2 69 kV transmission lines radially to improve system reliability.

### **3.2.3 The Regional Substations are Heavily Loaded**

The existing Stanton and Lackawanna 230-69 kV Substations are heavily loaded from a capacity standpoint. At the Lackawanna 230-69 kV Substation, there are two 230-69 kV transformers. Each transformer is supplied from its own 230 kV bus section. For the loss of one of these 230-69 kV transformers at Lackawanna Substation, the power flow through the remaining transformer will cause the transformer to approach its thermal emergency rating. Similarly, the loss of either 230 kV bus at the Lackawanna 230-69 kV Substation will cause one transformer to be removed from service and power will flow through the other remaining transformer, which will cause the transformer to approach its thermal emergency rating. Further, as vintage conductors on the system are gradually replaced with new, lower impedance conductors and demand on the electric system continues to grow, the 230-69 kV transformers at the Lackawanna 230-69 kV Substation will become further at risk for thermal overload during an event that results in the loss of one 230-69 kV transformer.

## **4.0 PROPOSED SOLUTION**

To address the issues identified in PPL Electric's system planning process, and to improve service to customers in Lackawanna County, PPL Electric proposes to construct the Summit 230-69 kV Substation in the City of Scranton. The new Summit 230-69 kV Substation will provide a new 230 kV backbone source that will be located more central to the load it will serve. The new Summit 230-69 kV Substation will improve the reliability of the 69 kV system in the greater

Scranton area. It also will relieve the long line exposures, networked line conditions, and heavy loading on the Stanton and Lackawanna 230-69 kV Substations described above.

The proposed Summit 230-69 kV Substation will be interconnected to the 230 kV system by construction of two new double circuit 230 kV transmission lines that will extend approximately 1.32 miles from the new Summit 230-69 kV Substation to interconnect with the existing Stanton-Lackawanna #3 and #4 230 kV Transmission Lines. Upon completion, one 230 kV double circuit will be designated as the Stanton-Summit #3 and #4 230 kV Transmission Lines, and the other 230 kV circuit will be designated as the Lackawanna-Summit #1 and #2 230 kV Transmission Lines.

The new Summit 230-69 kV Substation also will be interconnected with six 69 kV lines that will pick up load from the Stanton and Lackawanna 230-69 kV Substations. This Project will allow for the conversion of the Stanton-Providence #1, Stanton-Providence #2, Lackawanna-Providence #1, and Lackawanna-Providence #2 from networked operation to radial operation. The reconfiguration of the transmission lines into a radial configuration will reduce both the number of customers and the total line mileage per transmission line. This will reduce the likelihood for an outage on a given line as well as decrease the number of customers interrupted if an outage were to occur. The Project also allows for the reconfiguration of the existing radial lines in the area to further reduce customer count and line exposure by providing a new electric power supply more central to the load in the greater Scranton area,

The proposed Summit 230-69 kV Substation arrangement also will provide a redundant supply of power to the customers in this area. Redundancy provides a system operator with the operational flexibility to restore customers from another source in the event that the normal supply is interrupted, which will improve power restoration times and provide customers with

improved reliability. **Table 1-1** below illustrates the new customer counts per circuit and the number of line miles of exposure for each 69 kV transmission line.

**Table 1-1 - Line Exposure Before and After Proposed Project**

69kV			69kV
Before			AVERAGE LINE MILES
Line Name	CUST #	Circuit Mileage	
Lackawanna-Scranton 1	5238	15.51	<b>BEFORE (mi)</b>  <b>11.934</b>
Lackawanna-Scranton 2	5989	16.03	
Stanton-Suburban	10455	11.97	
Stanton-Brookside	8975	23.16	
Stanton-Providence 1	3221	14.14	
Stanton-Providence 2	3351	10.32	
Providence-Suburban	5558	1.76	
Lackawanna-Providence 1	4854	7.27	
Lackawanna-Providence 2	8464	7.25	
After			
Line Name	CUST #	Circuit Mileage	
Lackawanna-Scranton 1	5237	11.28	<b>AFTER (mi)</b>  <b>7.363</b>
Lackawanna-Scranton 2	5973	11.69	
Scranton Tap 1	5558	5.85	
Scranton Tap 2	6037	5.68	
Summit-Brookside	8732	11.30	
Summit-Morgan	3465	11.28	
Summit-Providence 1	8464	4.86	
Summit-Providence 2	4854	4.86	
Stanton-Summit 1	4434	7.12	
Stanton-Summit 2	3351	7.12	
Lackawanna-Bellmont 1	0	3.67	<b>% DECREASE IN AVERAGE LINE MILEAGE</b>  <b>38%</b>
Lackawanna-Bellmont 2	0	3.65	

The metrics used to quantify the effects of permanent and momentary outages are System Average Interruption Frequency Index (SAIFI) and Momentary Average Interruption Frequency Index (MAIFI) respectively. Through system analysis before and after the proposed Project, it was found that SAIFI would be decreased by 24% and MAIFI would be decreased by 73%. Not only would the forecasted metrics improve, but the SAIFI/MAIFI contribution of each circuit, if they were to experience either type of outage, would also decrease. A summary of metric improvement is provided in **Table 1-2**.

**Table 1-2 – Reliability Metrics Before and After Proposed Project**

69kV			69kV	
<b>Before</b>			<b>TOTAL METRIC IMPROVEMENT IN AREA</b>	
<b>Circuit Contribution Per Event</b>	<b>Per Year Average</b>			
<b>SAIFI/MAIFI</b>	<b>SAIFI-Historic</b>	<b>MAIFI-Historic</b>		
0.00374	0.00000	0.00412		
0.00428	0.00000	0.00385		
0.00747	0.00000	0.00299		
0.00641	0.00128	0.00962		
0.00230	0.00046	0.00138		
0.00239	0.00000	0.00048		
0.00397	0.00000	0.00000		
0.00347	0.00035	0.00520	<b>BEFORE</b>	
0.00605	0.00000	0.00786	<b>SAIFI</b>	<b>MAIFI</b>
<b>After</b>			0.00209	0.03549
<b>Circuit Contribution Per Event</b>	<b>Per Year Average</b>		<b>AFTER</b>	
<b>SAIFI/MAIFI</b>	<b>SAIFI-Future</b>	<b>MAIFI-Future</b>	<b>SAIFI</b>	<b>MAIFI</b>
0.00374	0.00000	0.00127	0.00159	0.00972
0.00427	0.00000	0.00150	<b>% SAIFI &amp; MAIFI DECREASE</b>	
0.00397	0.00000	0.00070	<b>24%</b>	<b>73%</b>
0.00431	0.00000	0.00073		
0.00624	0.00049	0.00211		
0.00248	0.00024	0.00084		
0.00605	0.00034	0.00088		
0.00347	0.00000	0.00051		
0.00317	0.00051	0.00068		
0.00239	0.00000	0.00051		
0.00000	0.00000	0.00000		
0.00000	0.00000	0.00000		

Line exposure on the 230 kV system would also be decreased by implementing the proposed solution. In addition to decreased line exposure, the 99,287 customers served from the Stanton and Lackawanna 230-69 kV Substations would be divided amongst three 230-69 kV regional substations, decreasing customer vulnerability to outages and providing the required supplemental capacity for customers to be quickly transferred to unaffected lines in case an outage does occur. A summary of the Project’s benefits on the 230 kV system is provided in **Table 1-3**.

**Table 1-3 – 230 kV Line Exposure & Customer Counts Before and After Proposed Project**

<b>230kV</b>			
<b>Before</b>			
<b>Line Name</b>	<b>Circuit Mileage</b>	<b>Substation Name</b>	<b>Total # Customers</b>
Stanton-Lackawanna 3	13.36	Stanton	52869
Stanton-Lackawanna 4	13.36	Lackawanna	46418
<b>After</b>			
<b>Line Name</b>	<b>Circuit Mileage</b>	<b>Substation Name</b>	<b>Total # Customers</b>
Stanton-Summit 3	9.05	Stanton	29094
Stanton-Summit 4	9.05	Lackawanna	37104
Lackawanna-Summit 1	6.94	Summit	33089
Lackawanna-Summit 2	6.94		

A one-line diagram of the proposed system and a map of the proposed Project are provided as **Figure 1-3** and **Figure 1-4**, respectively. An engineering description of the new and rebuilt 230 kV transmission lines is provided in **Attachment 2**.

PPL Electric presented the proposed Project before stakeholders at the Mid Atlantic Sub-Regional RTEP meeting on July 29, 2015. The Project was assigned as supplemental project s0974.3 by PJM.

The total estimated cost of the Project is approximately \$12.3 million. Subject to the Commission’s approval, construction is scheduled to begin September 2016 to meet an in-service date of November 2017.

Figure 1-1 - Existing 230 kV Configuration

## Before Summit 230-69kV Substation 230kV

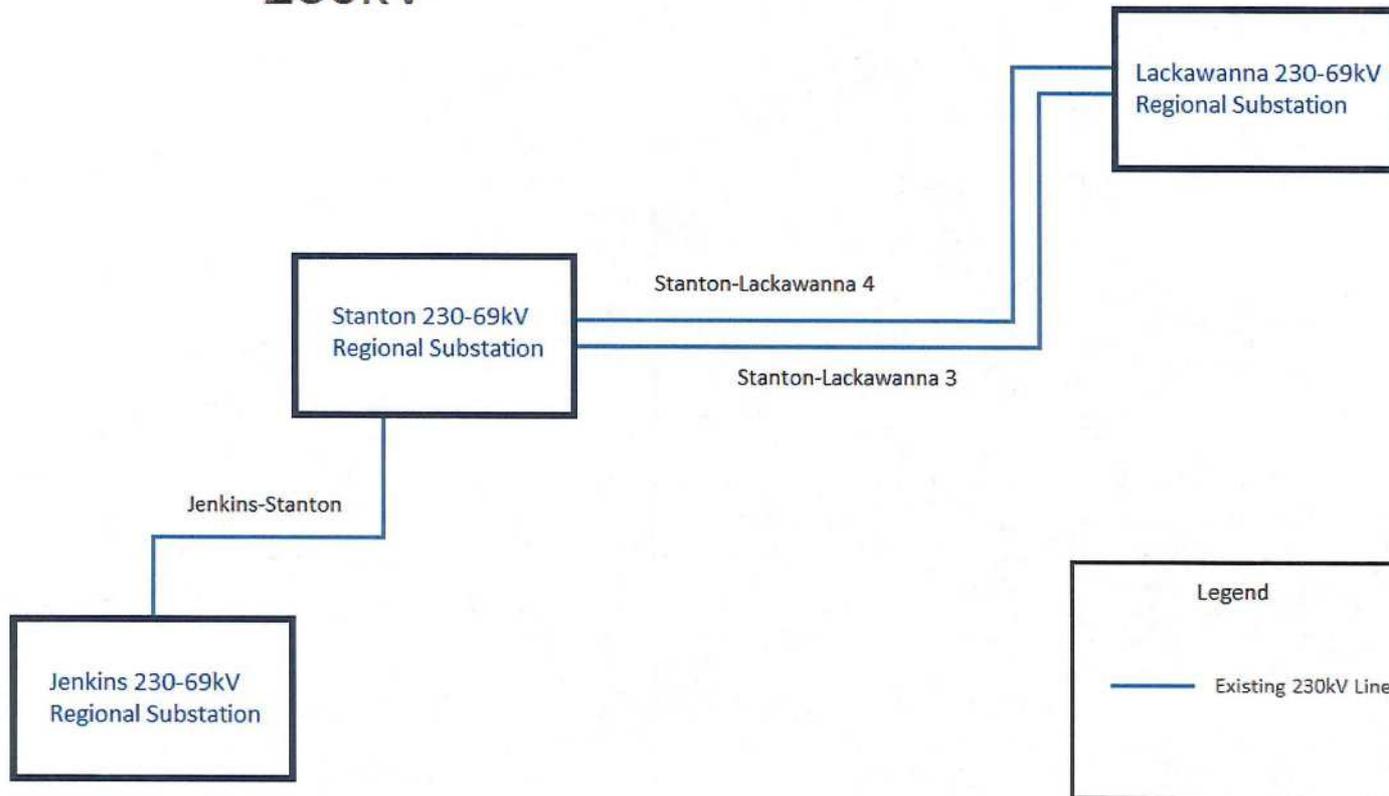


Figure 1-2 - Existing System Map

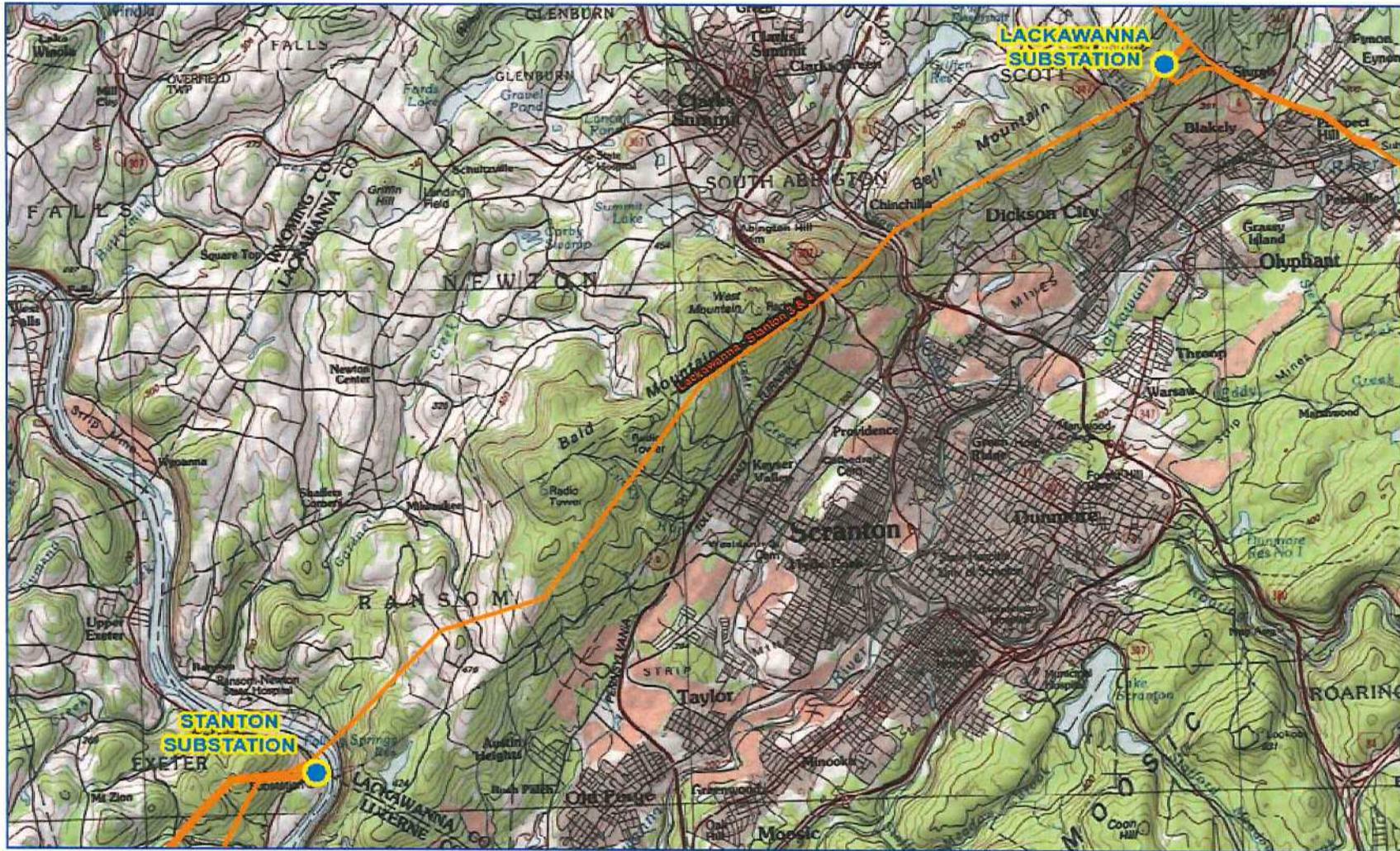


Figure 1-3 - Proposed 230 kV Configuration

# After Summit 230-69kV Substation

## 230kV

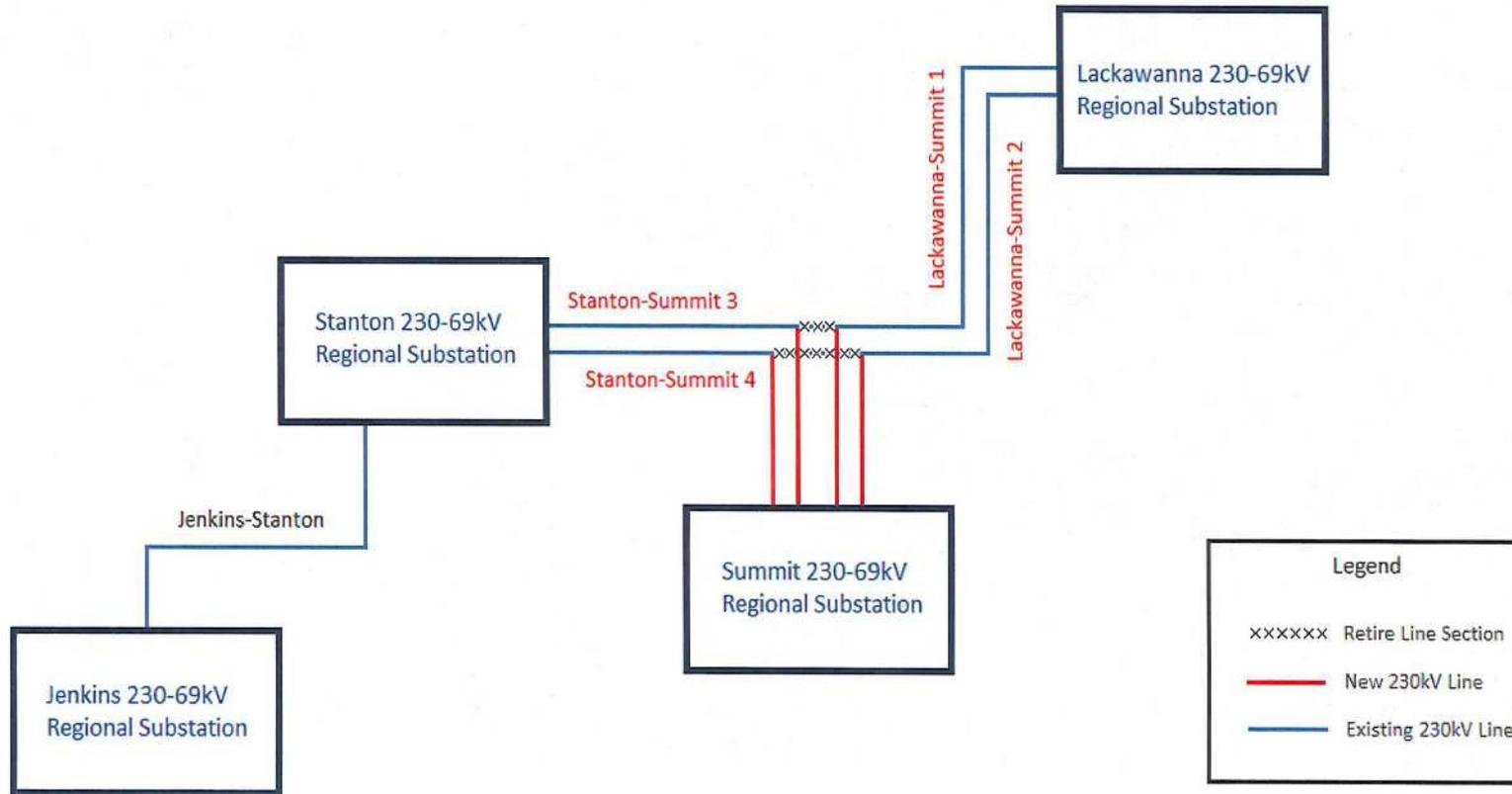
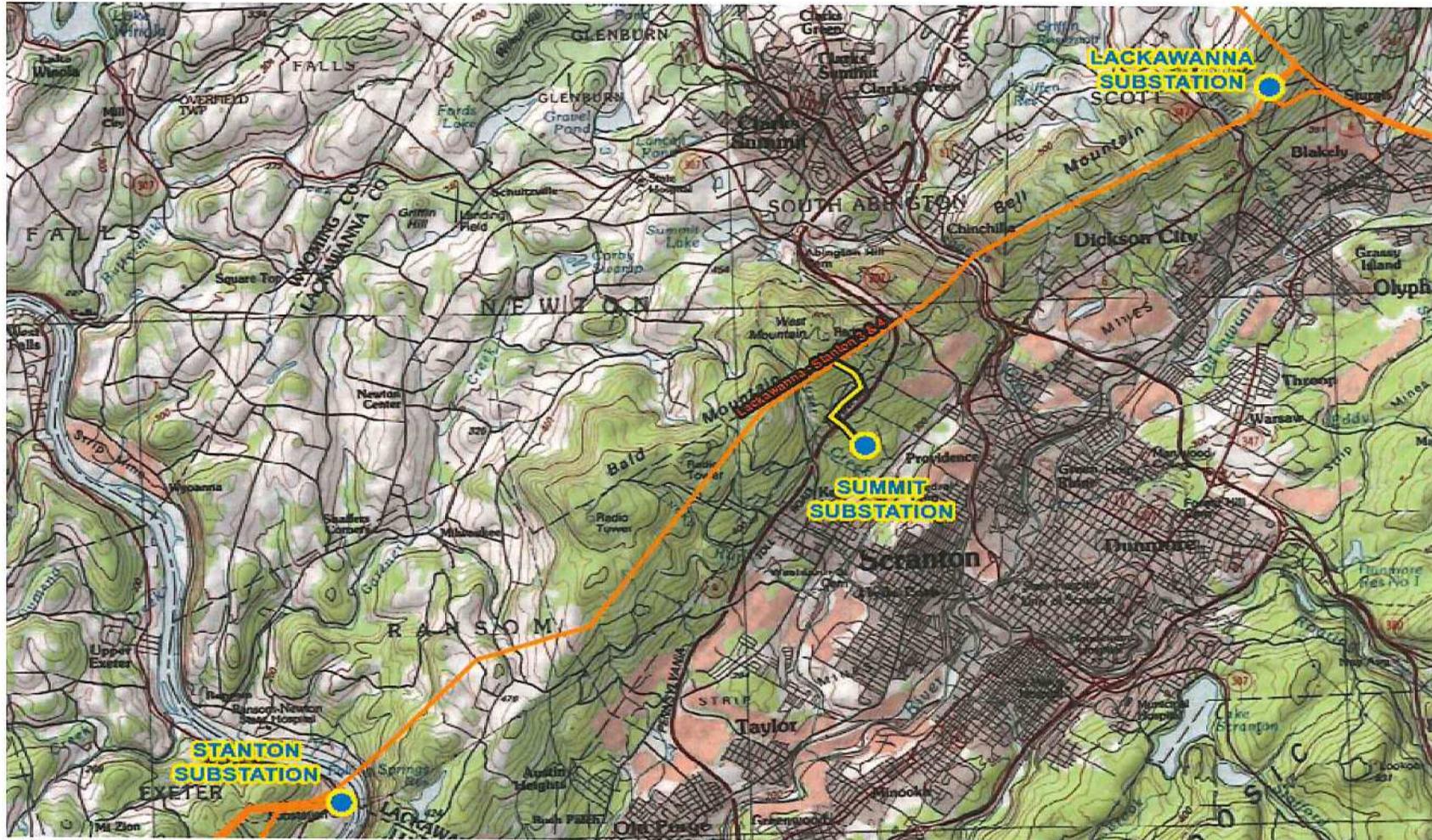


Figure 1-4 - Proposed System Map



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## **1.0 INTRODUCTION**

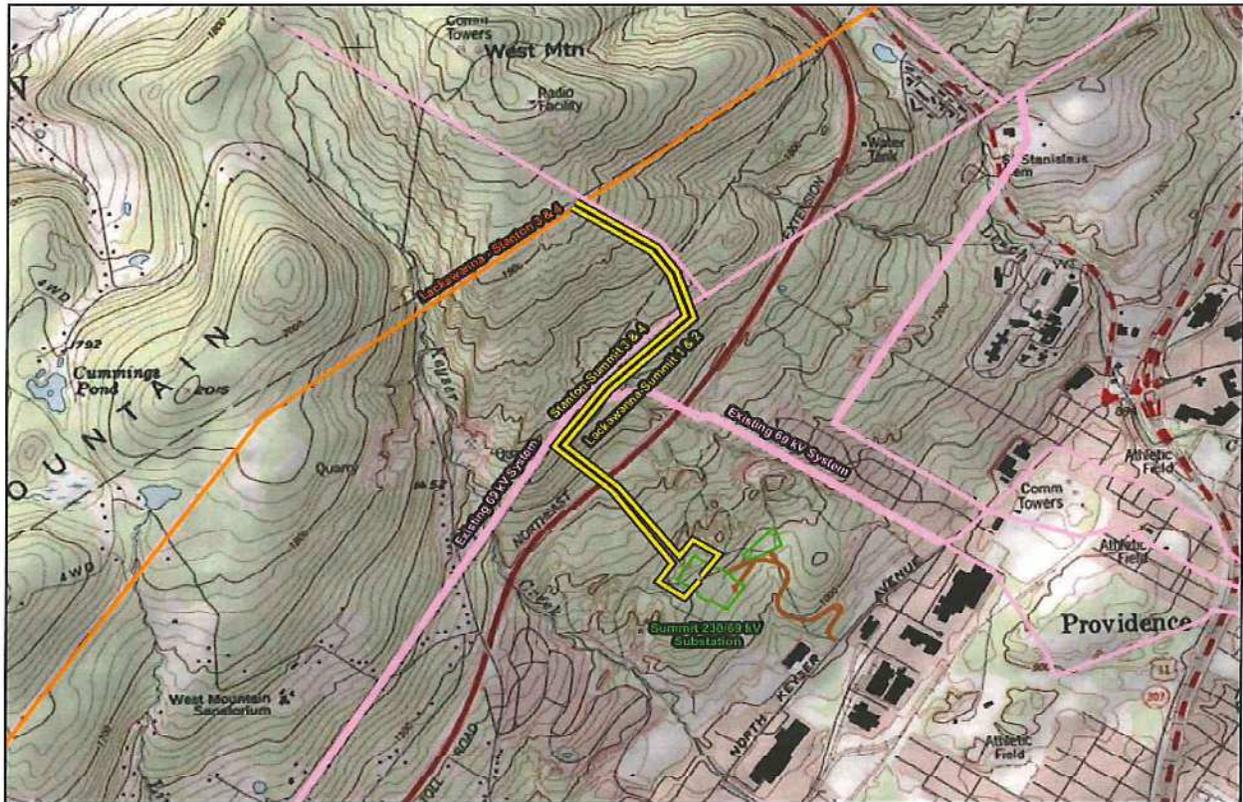
PPL Electric Utilities Corporation (PPL Electric) is requesting Pennsylvania Public Utility Commission (PUC or the Commission) approval to construct two new double circuit 230 kV transmission lines that will extend approximately 1.32 miles from the existing Stanton-Lackawanna #1 and #2 230 kV Transmission Lines to the new Summit 230-69 kV Substation (the Project). As explained in **Attachment 1**, the Project is required to supply the new Summit 230-69 kV Substation with a 230 kV transmission source. The new Summit 230-69 kV Substation is required to improve reliability, reduce the potential for and duration of outages, and increase system operability in Lackawanna County.

Subject to the Commission's approval, construction is scheduled to begin in September 2016, to support the Project's scheduled in-service date of November 2017. The estimated cost of Project is \$12.3 million.

## **2.0 DESCRIPTION OF THE PROPOSED 230 kV LINES**

As explained in **Attachment 1**, the proposed two new double-circuit 230 kV transmission lines will tap into the existing Stanton-Lackawanna #3 & #4 230 kV Transmission Lines located approximately 1.32 miles northwest of the substation site for the new Summit 230-69 kV Substation. Upon completion, one 230 kV double circuit will be designated as the Stanton-Summit #3 and #4 230 kV Transmission Line, and the other 230 kV circuit will be designated as the Lackawanna-Summit #1 and #2 230 kV Transmission Line (**Figure 2-1**).

FIGURE 2-1: Lackawanna-Summit #1 & #2 and Stanton-Summit #3 & #4



As explained in **Attachment 3**, the new double-circuit 230 kV transmission lines will share a common new right-of-way, and will be separated by approximately 75 feet. The new double-circuit 230 kV transmission lines will consist of thirty-two (32) self-weathering steel monopoles equipped with steel arms and glass 230 kV insulator assemblies, high capacity conductors, and two optical ground wires. All new poles will be self-supported on concrete caisson foundations. The new structures are expected to range between 120 and 200 feet in height, with an average height of approximately 150 feet. A typical 230 kV monopole is shown in **Figure 2-2**.

The new transmission lines will be designed and constructed for 230 kV double circuit capabilities. The 230 kV double-circuit design will utilize six power conductors 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 and will provide lightning protection and communication between circuit breakers that remove the line from service should a fault in the line be detected.

The new Lackawanna-Summit #1 & #2 and Stanton-Summit #3 & #4 230 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 32 feet. The conductor thermal ratings are set forth in **Table 2-1** below.

**TABLE 2-1: Conductor Thermal Rating\***

Condition	Ambient Temperature °C	Wind Speed ft/sec	Ampacity Amps
Summer Normal	35	0	1788
Winter Normal	10	0	2010
Summer Emergency	35	2.533	2172
Winter Emergency	10	2.533	2399

\*Based on 1590 KCMIL 45/7 Stranding ACSR “LAPWING” (257°F) 125°C Maximum Conductor

### **3.0 CONSTRUCTION TECHNIQUES AND EXECUTION FOR TYPICAL SINGLE POLE 230 KV TRANSMISSION STRUCTURES**

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:

<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> Falcon is the technical term for a 1590 kcmil 54/19 ACSR conductor as defined in the American Society for Testing and Materials.

- 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.
- Professional land 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, and 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.

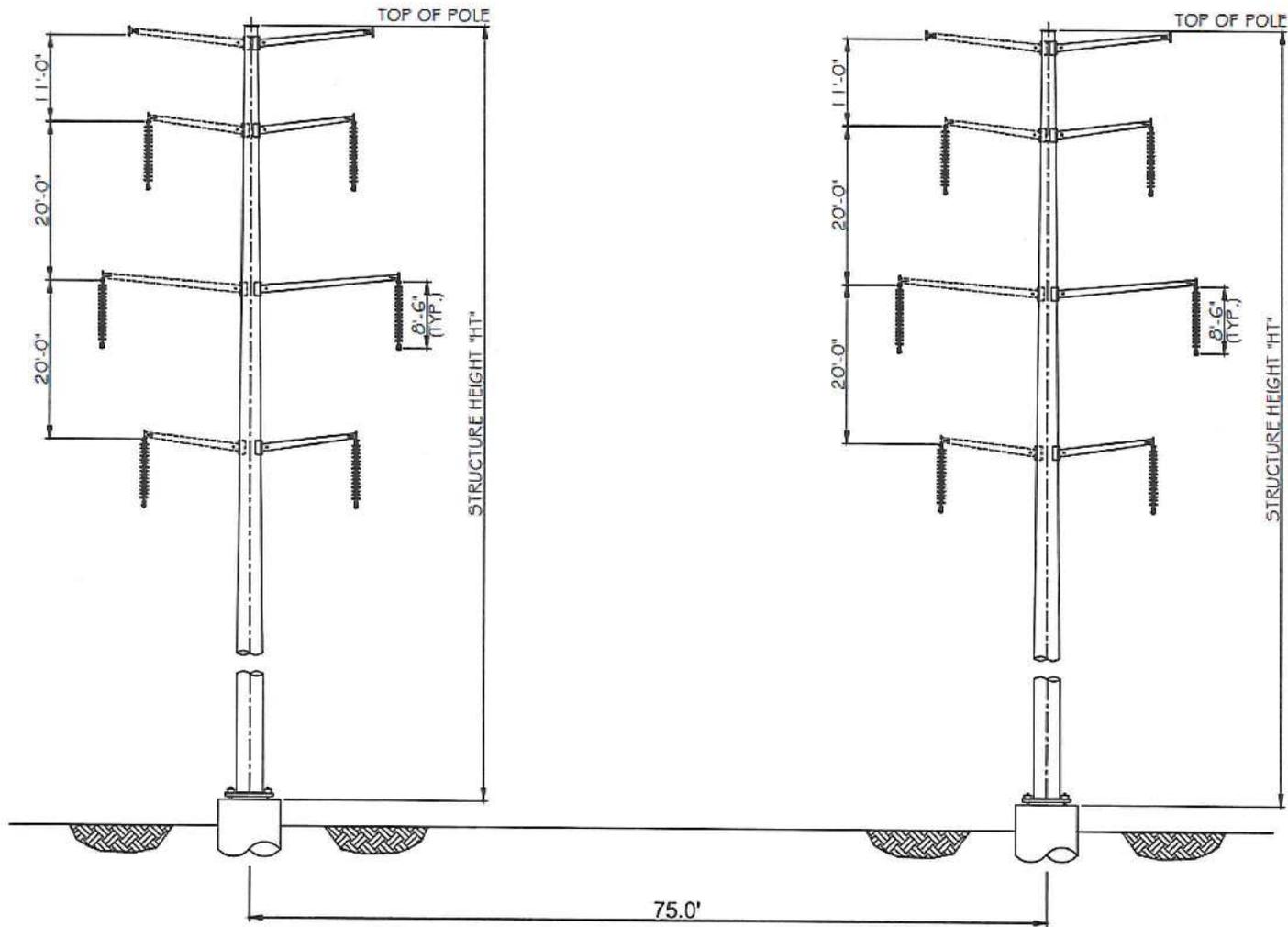
- Once the poles are in place along the line route, the wires will be installed using bucket trucks to attach the wires to each pole and equipment and manpower will be used to pull the wires along from pole to pole. Helicopter stringing/pulling may be utilized in restricted access or environmental sensitive areas.
- The project manager will oversee the stabilization of the site including the successful establishment of vegetation on all previously disturbed areas during construction.

#### **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 Project will be designed with structures that have a ground clearance that is five feet higher than NESC standards. The new 230 kV transmission line will be a double-circuit that will use reverse phasing. This measure will further reduce the potential for exposure to magnetic fields.

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



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

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**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 construct two new double circuit 230 kV transmission lines that will extend approximately 1.32 miles from the existing Stanton-Lackawanna #1 and #2 230 kV Transmission Lines to the new Summit 230-69 kV Substation (the Project). Upon completion, one 230 kV double circuit will be designated as the Stanton-Summit #3 and #4 230 kV Transmission Line, and the other 230 kV circuit will be designated as the Lackawanna-Summit #1 and #2 230 kV Transmission Line. The proposed Project is located in Lackawanna County and will traverse the following municipalities: City of Scranton, Ransom Township, and Newton Township.

As explained in **Attachment 1**, the Project is required to supply the new Summit 230-69 kV Substation with a 230 kV transmission source. The new Summit 230-69 kV Substation is required to improve reliability, reduce the potential for and duration of outages, and increase system operability in Lackawanna County.

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

As explained in **Attachment 2**, the two new double-circuit 230 kV transmission lines will require the construction of thirty-two (32) new 230 kV monopole structures that will extend the new lines from the new Summit 230-69 kV Substation to the existing Stanton-Lackawanna #1 and #2 Transmission Lines. The two new double-circuit 230 kV transmission lines will share a common new 225-foot wide right-of-way. The two double-circuits will parallel each and will be separated by approximately 100 feet. The new 225-foot wide right-of-way is sufficient to accommodate the construction, operation, and maintenance of both new 230 kV double circuits.

Of the total 1.3 miles of new 230 kV transmission lines to be constructed, 0.24 mile will be located on the Summit 230-69 kV Substation property and 1.08 miles will be located within the new 225-foot wide right of way. The new right-of-way will traverse four private properties, for

which PPL Electric has negotiated and obtained all the necessary easement rights. **Figure 3-1** is an aerial map that identifies the location and the properties crossed by the Project.

The proposed right-of-way is currently undeveloped and composed primarily of upland forest except for where it crosses two existing PPL Electric 69 kV right-of-ways and spans the Pennsylvania Turnpike.

### **3.0 LAND USE**

Evaluation of the existing land uses reviewed the uses within the proposed 225-foot wide right-of-way and within 0.25 mile (1,320 feet) beyond of the edge of the right-of-way. This broader area was reviewed to provide a sense of the landscape in which the Project is located. Land uses were determined based on review of the 2011 National Land Cover Data (NLCD).

Assessment of the data shows that forested land is the dominant land use accounting for over 60% of the review area. Industrial and commercial developments are the next largest land uses covering approximately 30% of the review area. The remaining 10% is a mix of moderate density residential development, highways, open fields, and a quarry. Impacts to the forested land use are anticipated to develop the new right-of-way.

This Project will be constructed using surrounding state and secondary roads. Where possible, PPL Electric will also use and update previously established access roads that are associated with the surrounding 230 kV and 69 kV right-of-ways for construction to further reduce interference with existing land uses. Several sections of new access road will be required that PPL Electric is anticipating can be located within the new right-of-way.

### *Airports*

The closest airport to the Project area is the Wilkes-Barre/Scranton International Airport, which is located approximately 6.5 miles southwest of the Summit Substation. PPL Electric does not anticipate any interference with airport operations because the Project is located in an area where there are existing electrical facilities and because the new facilities will be a similar height as 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*

The proposed Project will not affect any state lands, national parks, state parks, local parks, recreational areas or natural landmarks. None of these features are located within the Project area.

### *Cultural Resources*

PPL Electric is in the initial stage of coordination with the Pennsylvania Historical and Museum Commission (PHMC) for the construction of the new 230 kV line. This coordination will be required for the permits necessary to construct the Project and will be conducted in the near future.

Based upon the response provided by PHMC, PPL Electric will 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, soils, waterways, wetlands, 100-year floodplains, vegetation, and threatened and endangered species.

### *Unique Natural Features*

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

### *Soils*

Erosion and sedimentation control plans will be developed and implemented for the Project that will minimize the displacement of soils. These plans will require prior approval from the local county conservation district. National Pollutant Discharge Elimination System (NPDES) permits will also be required from the Pennsylvania Department of Environmental Protection (PADEP) as needed. Any conditions of the NPDES permit will be adhered to as part of the construction process. As such, impacts to local soil resources are anticipated to be minimal.

### *Waterways*

The proposed 230 kV transmission lines will span at least one waterway as it extends from the Summit 230-69 kV Substation to the tap point along the existing 230 kV lines. This unnamed tributary to Leach Creek has a designated classification of Trout Stocked Fisheries (TSF) – Migratory Fishes (MF) water, which is not an anti-degradation special protection classification water. This stream does not have any additional special protections provided by the Pennsylvania Fish and Boat Commission (PFBC) such as Class “A” Wild Trout Stream, Wild Trout (Natural Reproduction) Stream, or a Wilderness Trout Stream.

This stream will be spanned by the new 230 kV transmission lines, which is an activity that is waived of needing a permit from PADEP. The access road system to be used to develop the new right-of-way and construct the new structures also crosses this stream, which extends under the road in an existing culvert. Minor permanent impacts to this stream are anticipated through the installation of a new culvert required to address the necessary construction equipment. Permits to construct this permanent stream crossing will be obtained from PADEP and the United States Army Corps of Engineers. PPL Electric will comply with all of the terms and conditions placed on those permits.

### *Wetlands*

Based on review of the U.S. Fish and Wildlife Service's (USFWS) National Wetlands Inventory (NWI), the proposed 230 kV transmission line right-of-way will not cross any wetland systems. The NWI only provides a general overview of the potential wetlands that may be located within an area. For federal and state permitting purposes, the wetlands and waterways within the Project area will be delineated, surveyed, and illustrated according to regulatory standards. This information will be used minimize wetland impacts where feasible. PPL Electric will avoid impacts to wetlands where possible by aerially spanning these features.

### *100-year Floodplains*

The National Flood Hazard Layer (NFHL) for Pennsylvania was obtained through the Pennsylvania Spatial Data Access (PASDA) database and analyzed for 100-year floodplains within the Project area and surrounding landscape. The NFHL data incorporates all Flood Insurance Rate Map (FIRM) databases published by the Federal Emergency Management Agency (FEMA), and any Letters of Map Revision (LOMRs) that have been issued against those databases since their publication date.

The proposed 230 kV transmission line right-of-way will not be located within or span over any FEMA100-year floodplains along the alignment.

### *Vegetation*

Vegetative cover in the Project area has been influenced by the historic development of the area. Areas to the southeast have been generally stripped of native vegetation through the construction of roads, parking lots, supply warehouses and other commercial buildings. Residential developments along the northeastern and southwestern sides have removed most native species and introduced numerous non-native and cultivar species. The forested hillside to the northwest may provide the best opportunity for native vegetation cover, but this section too has been influenced by the development of transmission line corridors, a quarry, and the Pennsylvania

Turnpike. Although the property on which the Summit Substation and portions of the right-of-way will be built is primarily forested, these lands have been affected by the historic mining activities that have occurred on the site, which are evident by the deep removal pits and associated spoil mounds.

Vegetation management will be required to build the new double-circuit 230 kV transmission line. In areas where vegetation management is required, PPL Electric will apply its “*Specifications for Transmission Vegetation Management LA-79827*” to minimize any potential impacts.

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

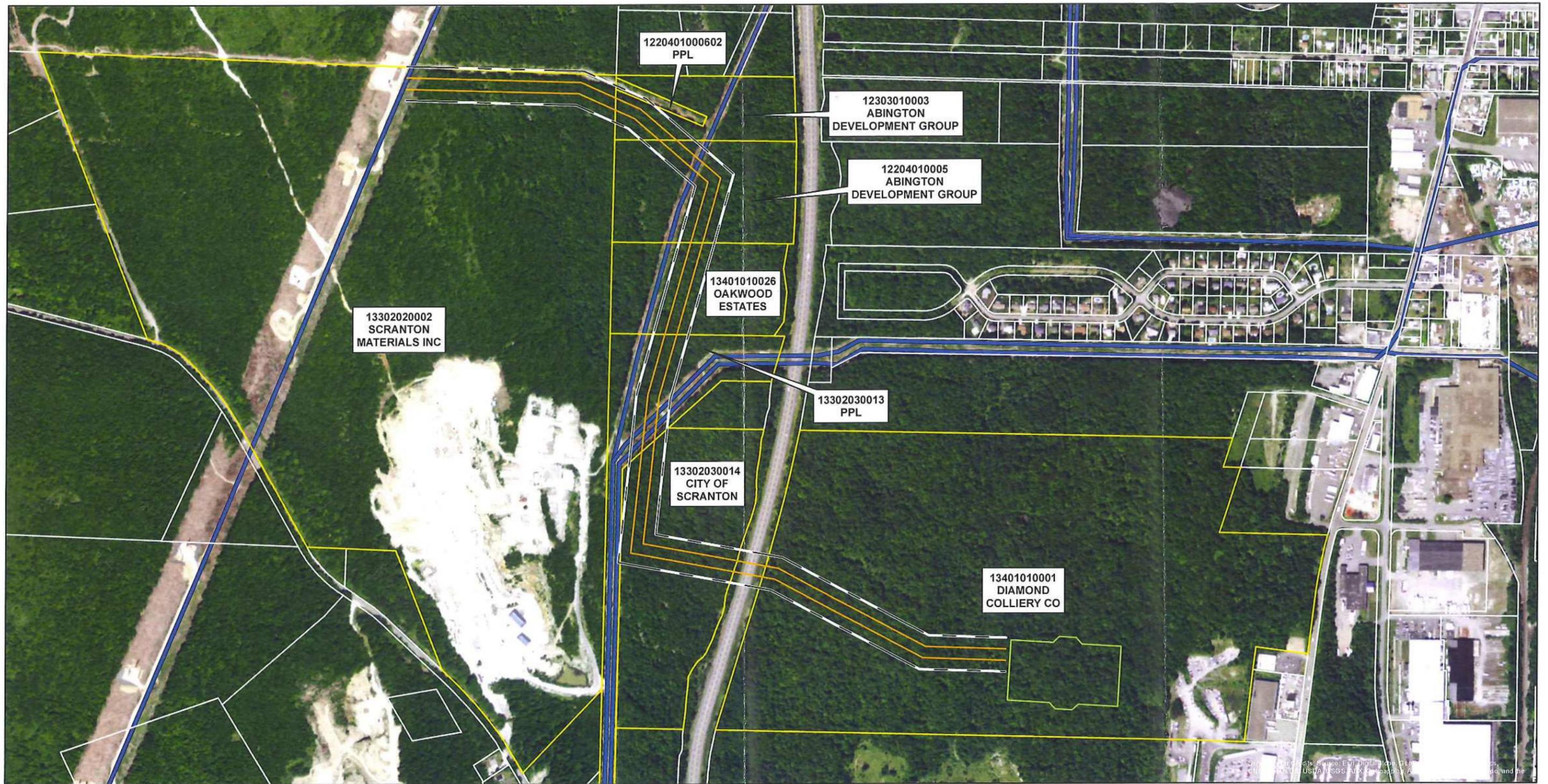
Review of the threatened and endangered species that may be encountered within and along the new 230 kV right-of-way includes evaluation of the Project related responses provided by federal and state agencies that have protective jurisdiction over the surrounding animals, plants, and ecological communities.

An on-line Pennsylvania Natural Diversity Inventory (PNDI) Project Environmental Review was performed for the Project that evaluates the databases of the USFWS, PFBC, Pennsylvania Game Commission (PGC), and the Pennsylvania Department of Conservation and Natural Resources (PADCNR). The PNDI concluded that no species of concern under the jurisdiction of the USFWS, PFBC, or PGC are located in the vicinity of the Project.

The PNDI review did indicate the potential presence of two plant species of concern identified by the PADCNR. The PADCNR requires that a qualified botanist conduct a botanical survey of the Project area for each plant species. PPL Electric will conduct the required botanical survey and coordinate with PADCNR to implement measures to avoid impacts to any plant species of concern identified.

PPL Electric will continue to consult with the jurisdictional agencies regarding potential impacts to protected species. PPL Electric will obtain all approvals and permits necessary for the construction of the Project, and will comply with any conditions placed on those permits.

**FIGURE**



**Legend**

- Proposed Transmission Lines
- Right-Of-Way (225 ft)
- Existing Transmission Line
- Substation

**Lackawanna County Parcels (2015)**

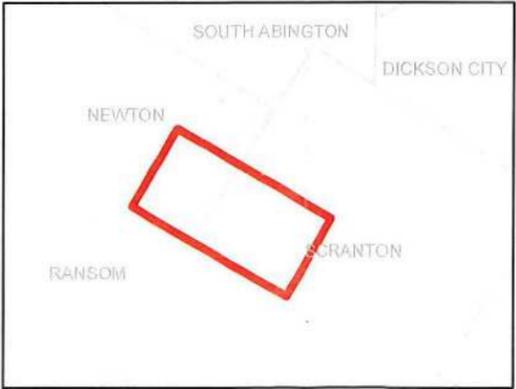
- Parcels Crossed by ROW
- Other Parcel Boundary

**REFERENCES:**

- Lackawanna County Parcel Data (2015)
- Lackawanna County Parcel Metadata (2012)
- Existing Transmission Lines (Platts POWERmap 2012)
- World Imagery Basemap (NAIP 2013)

0 325 650 1,300  
Feet  
1 inch = 650 feet

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



**AECOM**

**Figure 3-1: Aerial Overview Map  
Summit Substation  
230 kV Line Extension**

**Lackawanna County, Pennsylvania**

Prepared For: PPL Electric Utilities Corporation,  
Allentown, Pennsylvania

Prepared By: NB	Checked By: DY
Job: 60388181	Date: 4/11/2016

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## **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	23 Ft.	32 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	23 Ft.	32 Ft.
Spaces accessible to pedestrians only	19 Ft.	32 Ft.
Railroad tracks	31 Ft.	34 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	3'-7"
230	5'-3"
500	11'-3"

- 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 Summit Substation 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.