



Before the
Pennsylvania Public Utility Commission

**ST. JOHNS – FREELAND
#1 & #2 138/69 kV
TRANSMISSION LINE
RECONSTRUCTION**

**Exhibits and Appendices in
Support of the
Letter of Notification**

Application Docket No. _____

Submitted by: PPL Electric Utilities Corp.

SUMMARY

This filing is submitted by PPL Electric Utilities Corporation (PPL Electric) pursuant to the Pennsylvania Public Utility Commission's (PUC or the Commission) regulations at 52 Pa. Code §§ 57.71 through 57.77 for PUC approval to site and reconstruct in place the existing St. Johns – Freeland 69 kV Transmission Tie Line (Project). This transmission line is approximately 5.18-miles long and is located in Butler and Foster Townships, Luzerne County. With Commission approval, the transmission line will be reconstructed on, and within, existing PPL Electric right-of-way or land owned by PPL Electric in fee.

The St. Johns – Freeland 69 kV Transmission Tie Line has been in-service since 1923. It cannot be relied upon to continue to provide reliable service into the future. PPL Electric, with Commission approval, proposes to reconstruct this line under its Asset Optimization Program, under which PPL Electric addresses deteriorated facilities across PPL Electric's transmission system.

The estimated cost to design and replace the transmission line is \$5.4 million. Construction is scheduled to begin in early 2014 and should be completed in the third quarter of 2014.

This document, which describes the need for the Project and discusses the engineering and environmental analysis for the proposed construction, consists of the following attachments:

Attachment 1	Necessity Statement
Attachment 2	Engineering Description
Attachment 3	Environmental Assessment
Attachment 4	PPL Design Criteria and Safety Practices
Attachment 5	PPL Electric Magnetic Field Management Program
Attachment 6	List of Owners of Property Within the Right-of-Way
Attachment 7	List of Involved Governmental Agencies, Municipalities and Other Public Entities

PPL ELECTRIC UTILITIES SERVICE TERRITORY



Attachment

1

ATTACHMENT “1”
ST. JOHNS – FREELAND 138/69 kV LINE REPLACEMENT
NECESSITY STATEMENT

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ATTACHMENT “1”
ST. JOHNS – FREELAND 138/69 kV LINE REPLACEMENT
NECESSITY STATEMENT

A. INTRODUCTION

PPL Electric is requesting Commission approval to rebuild the approximately 5.18 mile long PPL Electric-owned St. Johns – Freeland 69 kV Transmission Tie Line. The line begins at PPL Electric’s St. Johns 69 - 12 kV Substation located in the town of St. Johns (Butler Township) and ends at PPL Electric’s Freeland 69 - 12 kV Substation just outside the Borough of Freeland in Foster Township, all in Luzerne County. This Project is part of PPL Electric’s Asset Optimization Program to address deteriorated facilities across PPL Electric’s transmission system and to modernize those facilities. In order to more effectively address future load growth, PPL Electric proposes to construct this line for future double circuit 138 kV operation. Initially, however, only one circuit will be installed, and it will be operated at 69 kV. Conversion to double circuit operation will occur when load growth makes it appropriate to do so. The operating voltage will be increased to 138 kV when the transmission system in the area is converted from 69 kV to 138 kV operation.

The estimated cost to design and replace the transmission line is \$5.4 million. Construction is scheduled to begin in early 2014 and should be completed in the third quarter of 2014.

A PPL Electric system map showing the existing transmission facilities with a design voltage of 35 kV or greater is included in the Attachment “1” map pocket. This filing addresses only the reconstruction of the St. Johns – Freeland Tie Transmission Line located in Luzerne County.

B. DEFINITION OF THE PROBLEM

The St. Johns – Freeland 69 kV Transmission Tie Line has been in service approximately 90 years since 1923. The transmission line still utilizes the original #2/0 AWG¹ copper conductor that was installed when the line was built, and much of the line hardware and insulators are also original.

Based upon the age of the line and the need for a more detailed examination of the facilities, PPL Electric hired an outside engineering consultant, DiGioia, Gray and Associates,² to perform an independent field investigation and assessment of the line components. This assessment found significant deterioration of the structural components, foundations, insulators, line hardware, shield wire, grounding, signage, paint and galvanizing as well as outdated structure design. Non-compliance with current National Electrical Safety Code standards was also reported. DiGioia, Gray and Associates concluded:

“Normally, structure rehabilitation and replacement of select components (insulators, clamps, shield wire...) that are deemed deficient would be considered as an option for continued use of the line. However the line and structures are well beyond expected life and are no longer suitable candidates for rehabilitation. The grade of construction is also not acceptable due to the use of flexible bent type structures. The only reasonable option for this line is complete replacement.”

PPL Electric’s independent engineering consultant, DiGioia, Gray & Associates explained the reasons for their conclusion as follows:

“It is the opinion of DiGioia, Gray & Associates that the St. Johns-Freeland Tie Asset has reached the end of its useful life. Given the quantity of

¹ American Wire Gauge

² DiGioia Gray & Associates of Monroeville, PA 15146

conductor and shield wire damage on the line, it would be prudent to replace this line with a more reliable, redundant and robust transmission line. The following reasons listed below summarize why this line should be taken out of service:

- This type of construction is not permitted today as stated by the current NESC code, Section 261. Structures are not permitted to be supported by the wires they are intended to carry and support.
- The minimum loads and strengths used at the time of construction are significantly less than the current.
- It is highly unlikely that this transmission line would be strong enough to withstand the current prescribed loads of NESC and of PPL Electric Utilities. No amount of reinforcing would enable these structures to be self supporting.
- Any longitudinal imbalance, unbalanced ice, broken wire or tree falls have the potential to cause cascading failures of all flexible bent type structures located between two dead end strain towers.

Reconductoring therefore would not be an option. A decision to replace the existing line provides the company the opportunity to upgrade the line to current standards, as well as to install additional circuits and improved conductors to allow for future load growth.”

PPL Electric considered the possibility of abandoning the St. Johns – Freeland Tie Line. Abandoning the line, however, would cause a deterioration of service reliability in the area. The St. Johns – Freeland Tie line is the northern half of a 69 kV loop served from the Harwood 230 - 69 kV Regional Substation. This northern loop taps the Harwood-Jenkins # 1 69 kV circuit and supplies electrical power to the St. Johns 69 – 12 kV Substation and, under abnormal sectionalizing, the Freeland 69 - 12kV Substation. The southern half of the loop is also served by the Harwood Regional Substation. This southern loop supplies electrical power to the following 69 - 12 kV distribution substations -- Consolidated Cigar (customer-owned), P&E Kama (customer-owned), East Hazleton, Weatherly (customer-owned), White Haven, Jeddo Highland (customer-owned), and Freeland. The southern loop also serves as an outlet for the NEPCO independent power producer (IPP), which generates approximately 56 MW.

A “normally open” 69 kV switch, located on the St. Johns – Freeland Tie Line just west of Freeland Substation, separates the northern and southern loops under normal sectionalizing. Under maintenance conditions, this normally open switch would be closed, and the St. Johns – Freeland Tie Line would supply the Weatherly, White Haven, Jeddo Highland, and Freeland substations on the combined northern and southern loops. The aged #2/0 AWG copper conductors on the St. Johns – Freeland Tie Line, however, do not have sufficient capacity to serve the entire load of the northern and southern loops without exposing these loads to low voltage. Presently, the East Hazleton, P&E Kama, and Consolidated Cigar Substations cannot be supplied using the northern loop because the #2/0 AWG copper conductor does not have sufficient capacity for the entire existing load. The PPL Electric Reliability Principles and Practices (RP&P) guideline states that a transmission system shall be planned in such a manner to enable any system facility to be taken out of service at some time for scheduled maintenance without adversely affecting system reliability. The suggested maintenance would violate this reliability criteria. By reconductoring the St. Johns – Freeland Tie Line to the PPL Electric standard design, the 69 kV bus voltages at these substations will be improved under abnormal sectionalizing, and an alternate source of electrical power will continue to be available for these substations.

Without the availability of the St. Johns – Freeland Tie Line, the southern loop (Harwood – East Hazleton #1 or #2 circuits) would have no alternate supply for the above-mentioned PPL Electric and customer-owned distribution substations.

Also, an outage on the Harwood – East Hazleton circuits, between the East Hazleton and Weatherly substations, would interrupt the supply to four substations (Weatherly, White Haven, Jeddo Highland, and Freeland). Under a winter 2016 peak load, 34 MW of customer load would be interrupted. The PPL Electric RP&P guidelines allow up to 30 MW of load to be interrupted for a period of up to 10 hours or a long work day. Interrupting 34 MW of load would violate this reliability criterion.

Rebuilding and retaining the northern loop between the Harwood, St. Johns, Freeland, Jeddo Highland, White Haven, Weatherly, and East Hazleton substations is necessary for adequate reliability of the 69 kV transmission system. For this reason, the St. Johns – Freeland Tie line cannot be removed or abandoned.

C. PROPOSED SOLUTION

The only viable solution to the problem is to rebuild the St. Johns – Freeland Tie Line. It will be designed for future double-circuit operation because PPL Electric intends to maximize use of the existing right-of-way to meet future load growth. The tie line is connected to the Harwood – Jenkins #1 and #2 69 kV lines through two switches, one of which is normally closed. The Harwood – Jenkins circuits will be converted to 138 kV operation in the future as part of the long-term plan to reinforce the existing line corridor between the regional substations at Jenkins and Harwood. In preparation for this conversion, the rebuilt St. Johns – Freeland Tie line must also be capable of operating at 138 kV at a future date. These requirements for rebuilding 69 kV lines for future double-circuit 138 kV operation are in accordance with the PPL Electric RP&P.

For all of the foregoing reasons, PPL Electric believes that reconstruction of the St. Johns – Freeland 69 kV Transmission Tie Line is necessary to enable PPL Electric to continue to provide reliable service in the future and requests approval of the PUC to complete this Project.

Attachment

2

**ATTACHMENT “2”
ST. JOHNS – FREELAND 138/69 kV LINE REPLACEMENT
ENGINEERING DESCRIPTION**

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MAP

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ATTACHMENT “2”
ST. JOHNS – FREELAND 138/69 kV LINE REPLACEMENT
ENGINEERING DESCRIPTION

A. PROPOSED LINE DESIGN

PPL Electric proposes to reconstruct approximately 5.18 miles of 69 kV transmission line between the Company’s St. Johns 69 -12 kV Substation and the Freeland 69 – 12 kV Substation. The new line will be constructed for future double-circuit 138 kV operation although initially, only one circuit will be installed and it will operate a 69 kV. The project is located in portions of Butler and Foster Townships in Luzerne County.

The St. Johns – Freeland Transmission Tie Line is supported by 61 lattice steel towers, averaging 65 feet tall and five wood poles averaging 60 feet tall. All of these structures will be removed and replaced with approximately 34 double-circuit, weathering steel monopoles equipped with straight weathering steel arms and glass 138 kV insulator assemblies. The new steel monopoles will average 110 feet in height. Average span lengths will increase from approximately 450 feet to approximately 775 feet. Therefore, the rebuilt line will utilize about half the number of structures as the old line. The new steel poles will be located as close as practical to the existing structures. Each of the new steel monopoles will be installed on concrete foundations. The reconstructed transmission line initially will consist of three 556.5 kcmil³, 24/7, stranding, ACSR⁴ power conductors (single-circuit initial operation) and two 0.752 inch diameter Optical Ground Wires (OPGW) that will provide lightning protection and communication between circuit breakers that remove the line from service when a faulted line is detected. Drawings of structures similar to the ones that will be installed for the proposed line reconstruction are shown on pages 5 – 7 at the end of Attachment 2.

³ 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 (.001) of an inch.

⁴ ACSR stands for aluminum conductor steel reinforced.

This reconstructed 138/69 kV line will be designed according to and will generally surpass minimum National Electrical Safety Code (NESC) standards. Additional design criteria and safety rules practiced by PPL Electric are included in Attachment 4. The minimum conductor to ground clearance will be 30.5 feet which occurs at a maximum conductor temperature of 125°C. The design minimum conductor ground clearances and conductor thermal ratings are as follow:

TABLE 1
DESIGN MINIMUM CONDUCTOR CLEARANCES
FOR 556.5 KCMIL 24/7 STRANDING ACSR*

<u>Condition</u>	<u>Double-Circuit Design Clearance-to-Ground</u>
Normal load, average weather (16° C, 60° F)	35.5 Feet
Predicted extreme thermal load (125° C, 257° F conductor temperature)	30.0 Feet
Predicted NESC extreme wind load (25 lbs. wind, 16° C, 60° F)	32.8 Feet
Predicted extreme weather conditions (1-inch ice, 4 lbs. wind, -18° C, 0° F)	32.5 Feet

*Clearances based on a maximum tension of 9,000 lbs. and a ruling span of 775 feet.

TABLE 2
CONDUCTOR THERMAL RATING
556.5 KCMIL 24/7 STRANDING ACSR
(257°F) 125°C MAXIMUM CONDUCTOR TEMPERATURE

<u>Condition</u>	<u>Ambient Temperature °C</u>	<u>Wind Speed Knots</u>	<u>Ampacity Amps</u>
Summer Normal	35	0	815
Winter Normal	10	0	926
Summer Emergency	35	1.5	1041
Winter Emergency	10	1.5	1163

B. MAGNETIC FIELD MANAGEMENT

PPL Electric’s Magnetic Field Management Program is summarized in Attachment 5 and applied to reconstruction and new line projects. In order to lower magnetic field exposures, the program generally prescribes the use of line design that provides 5 feet higher ground clearances and reverse phasing 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.

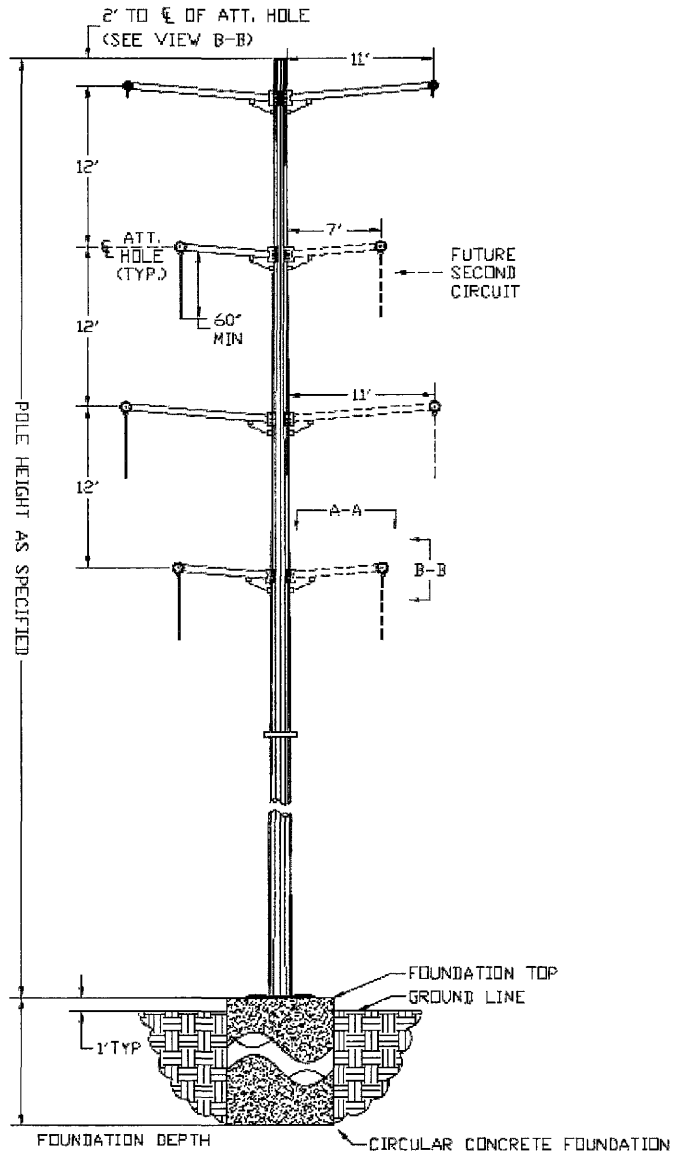
For this project, reverse phasing cannot be utilized to reduce magnetic field levels because, initially, only one circuit is being constructed. PPL Electric will evaluate reverse phasing when the second circuit is added in the future. However, some reduction in magnetic fields will be realized through the use of higher ground clearances.

C. RIGHT-OF-WAY STATUS

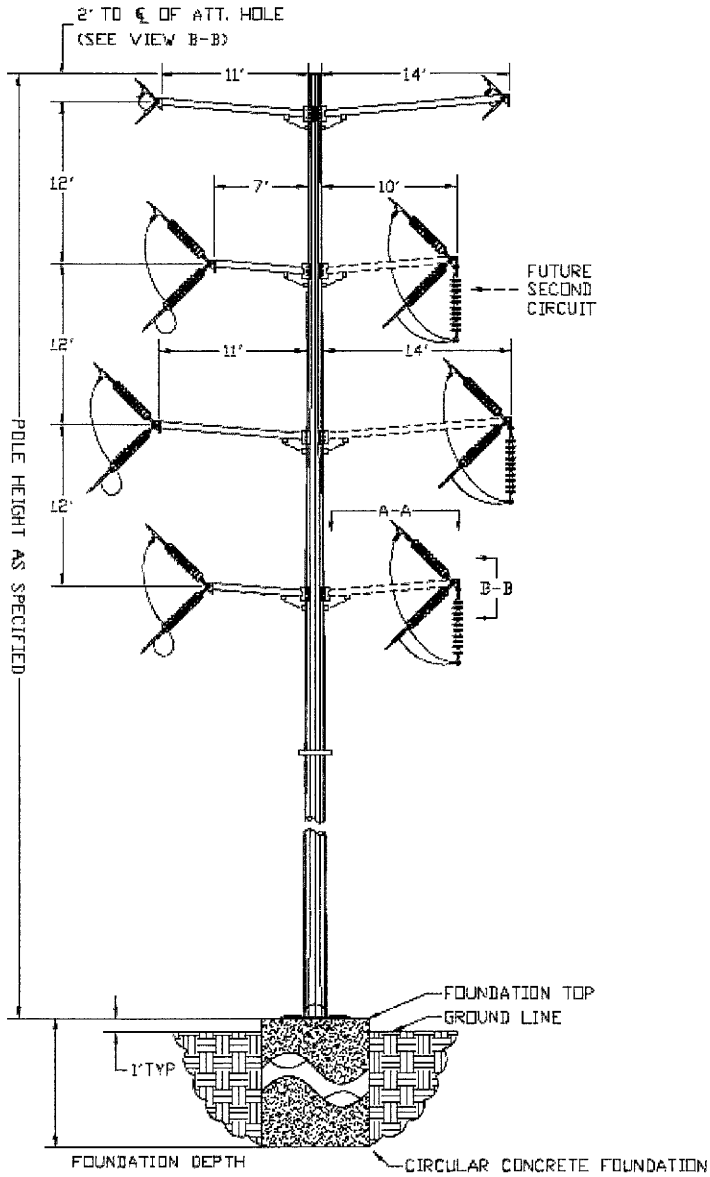
The route for the existing St. Johns – Freeland 69 kV Transmission Tie Line utilizes undefined width easements with tree clearing rights as well as tracts of land owned in fee by PPL Electric. All existing easement agreements allow for reconstruction of the facility. No additional right-of-way is required for this project.

The Aerial Exhibit at the end of Attachment 2 shows the existing line route and the properties it crosses. The numbers on the Aerial Exhibit correspond to the properties crossed by the transmission line as presented in Attachment 6.

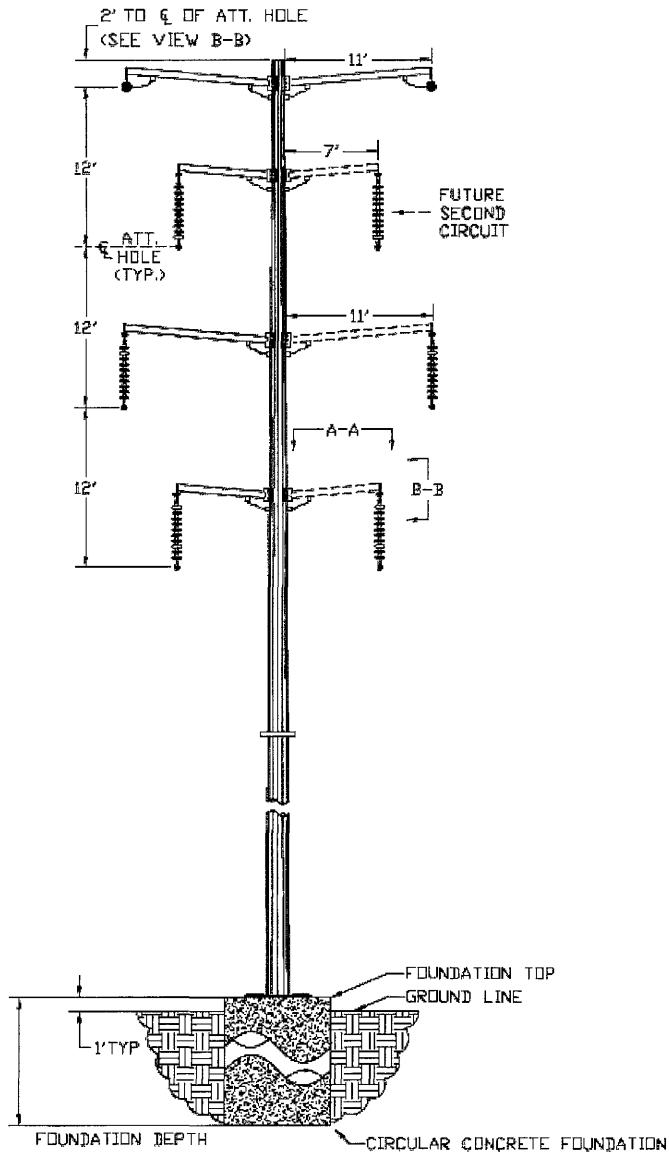
945 (+) POSITIVE C/F0
 TYPE 1DPITLTU
 DOUBLE CIRCUIT TANGENT TENSION STRUCTURE



945 (+) POSITIVE CIFO
 TYPE 1DPATLTU
 DOUBLE CIRCUIT ANGLE TENSION STRUCTURE



945 (+) POSITIVE C/FD
 TYPE 1DPTSLTU
 DOUBLE CIRCUIT TANGENT SUSPENSION STRUCTURE



Attachment

3

**ATTACHMENT “3”
ST. JOHNS – FREELAND 138/69 kV LINE REPLACEMENT
ENVIRONMENTAL ASSESSMENT**

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ATTACHMENT “3”
ST. JOHNS – FREELAND 138/69 kV LINE REPLACEMENT
ENVIRONMENTAL ASSESSMENT

A. INTRODUCTION

PPL Electric proposes to rebuild approximately 5.18 miles of the single-circuit St. Johns – Freeland 69 kV Transmission Line. The existing line and all of the lattice steel towers along with a few wood poles will be removed and replaced with single-shaft steel poles capable of accommodating two circuits. The line will be rebuilt utilizing the existing right-of-way.

The proposed Project was reviewed with Butler and Foster Townships and with Luzerne County. Neither the Townships nor the County had any objections. A list of involved governmental agencies, municipalities and other public entities is presented in Appendix D.

B. LAND USE

The proposed line reconstruction will result in little, if any, environmental or social impacts. In fact, land use impacts are expected to decrease because the footprint of the proposed single-shaft steel poles and support foundations is much less than the existing four-legged lattice steel towers.

No pipelines, communication towers, or other utilities will be affected by the proposed project. Hazleton Municipal Airport is approximately 2.7 miles away. PPL Electric will file the appropriate documentation with the Federal Aviation Administration and PennDOT Bureau of Aviation to ensure that the proposed reconstructed line will not be a hazard to the airport’s flight operations.

CULTURAL RESOURCES

The project was reviewed by the Pennsylvania Historical and Museum Commission (PHMC) for potential impacts to both historic and archaeological resources. The PHMC has determined that there are no National Register eligible or listed historic or archaeological properties in the area⁵. Therefore, no impacts to such resources are anticipated, and no further investigations are required.

C. NATURAL FEATURES

The proposed project will not affect any unique scenic or natural areas. Hell's Kitchen, a narrow, steep-sided valley on the north flank of Green Mountain is listed in "Outstanding Geologic Features of Pennsylvania" is approximately 0.75 miles north of the proposed project. Visual impact, if any, will be minimal because of intervening vegetation and terrain.

No National Natural Landmarks or parks are located near the project area. Edgewood Golf and Banquet Facility is located approximately 0.25 miles north of the proposed project and will not be impacted due to intervening terrain and vegetation.

Tree clearing will be minimal and PPL Electric will apply its "Specification for Initial Clearing and Control of Vegetation On or Adjacent to Electric Line Right-of-Way Through Use of Herbicides, Mechanical and Hand Clearing Techniques" to mitigate any impacts.

The St. Johns – Freeland Transmission Tie Line crosses the Nescopeck Creek and two wetlands. PPL Electric will acquire, and adhere to the terms and conditions of all required permits and soil erosion and sedimentation control plans.

⁵ (File No. ER 2010-0293-079-B)

E. THREATENED AND ENDANGERED SPECIES

PPL Electric has coordinated with the relevant state and federal agencies, to obtain information regarding endangered and threatened species that could occur in the vicinity of the proposed project. The Pennsylvania Fish and Boat Commission (PFBC) requested a habitat evaluation for the Timber rattlesnake (*Crotalus horridus*). PPL Electric contracted with Herpetological Associates, Inc. to perform that assessment. Based upon their field assessment, Herpetological Associates submitted documentation to the PFBC indicating that no Timber rattlesnake habitat was found. In their letter concurring with the habitat assessment results, PFBC noted that as long as best management practices are employed and strict erosion and sedimentation control measures are maintained, no adverse impact to species under PFBC jurisdiction is anticipated. PPL Electric will employ best management practices and implement strict erosion control measures.

Also, the U. S. Fish and Wildlife Service and the Pennsylvania Game Commission (PGC) note the potential for impact to the Indiana bat (*Myotis sodalis*) and recommends that any required tree clearing occur between October 15 and March 31. The PGC also notes the same tree clearing window to avoid impacts to the Northern myotis (*Myotis septentrionalis*) The Department of Conservation and Natural Resources (DCNR) reports that no impact to species of special concern under DCNR jurisdiction is anticipated. PPL Electric will comply with the recommendations that tree clearing should occur only between October 15 and March 31.

Attachment

4

ATTACHMENT 4
ST. JOHNS – FREELAND 138/69 kV LINE REPLACEMENT
PPL ELECTRIC DESIGN CRITERIA AND SAFETY PRACTICES

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.

Engineering Design Criteria and Parameters

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 crossarm 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. The tables below compare PPL Electric and NESC ground clearances for lines of various voltages.

138 kV

<u>Surface Underneath Conductors</u>	<u>Vertical Clearance to Ground</u>	
	<u>NESC Standard</u>	<u>PPL Electric Design</u>
Roads, streets, alleys	21 Ft.	30 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	21 Ft.	30 Ft.
Spaces accessible to pedestrians only	17 Ft.	30 Ft.
Railroad tracks	31 Ft.	35 Ft.

230 kV

<u>Surface Underneath Conductors</u>	<u>Vertical Clearance to Ground</u>	
	<u>NESC Standard</u>	<u>PPL Electric Design</u>
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.	36 Ft.

500 kV

<u>Surface Underneath Conductors</u>	<u>Vertical Clearance to Ground</u>	
	<u>NESC Standard</u>	<u>PPL Electric Design</u>
Roads, streets, alleys	28 Ft.	53 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	28 Ft.	53 Ft.
Spaces accessible to pedestrians only	24 Ft.	53 Ft.
Railroad tracks	38 Ft.	53 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.

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.

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 the following required minimum clearances is used to test that the line has been de-energized and to apply temporary safety grounds:

<u>Voltage-kV</u>	<u>Minimum Clearance</u>
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.

Attachment

5



**MAGNETIC
FIELD
MANAGEMENT
PPL Electric Utilities
Corporation**

DECEMBER 2004

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INTRODUCTION

At PPL Electric Utilities Corp. (PPL EU), magnetic field management means investigating and implementing methods at low or no cost to reduce magnetic fields in new or rebuilt transmission and distribution lines. This document explains PPL EU's Magnetic Field Management Program, which is part of PPL EU's larger Electric and Magnetic Fields (EMF) policy.

PPL EU's View

Some people are worried that electric and magnetic fields are harming their health. Others think the scientific research does not show a problem at all, and still others believe there's just too much scientific uncertainty to draw any conclusions.

Here's what we do know now. Various panels of scientists that have reviewed the EMF research generally have drawn two main conclusions. First, the large body of evidence does not demonstrate that EMF are harmful. Second, additional research is recommended to explore questions raised in some studies.

Given these conclusions, PPL EU is taking a reasoned approach in responding to the EMF issue. PPL EU's approach to the EMF issue consists of five elements:

- Providing EMF information to customers and employees
- Providing magnetic field measurements
- Establishing and implementing a magnetic field management program to reduce magnetic fields in new or rebuilt facilities when it can be done at no, or low, cost
- Integrating EMF in the public involvement process that PPL EU undertakes in the siting of transmission lines
- Have supported additional research

EMF Are All Around Us

Electric and magnetic fields occur in nature and in all living things. The earth, for instance, has a magnetic field, which makes the needle on a compass point north.

Electric fields and magnetic fields of a different type also surround every wire that carries electricity. In everyday life, these EMF arise from several basic sources, including power lines, electrical appliances, home and building wiring, other utility lines and cables, and currents flowing on water pipes. Though they often occur together, EMF are made up of two separate components:

Electric Fields

Electric fields are produced by the voltage—or electrical pressure—on a wire. The higher the voltage, the higher the electric field. As long as a wire is energized—has voltage present—an electric field is present (see Figure 1). In other words, an appliance, or an electric power line, doesn't actually have to be turned on to create an electric field. It just has to be plugged in. Electric fields diminish with distance and can be blocked or partially shielded by objects such as trees and houses.

Magnetic Fields

Magnetic fields are created by the current or flow of electricity through a wire. Generally speaking, the higher the current, the higher the magnetic field. Because they only occur when current is flowing, magnetic fields are present only when the power is turned on (see Figure 1). Magnetic fields also diminish with distance, but—unlike electric fields—are not blocked by common objects. In recent years, public and scientific interest has turned toward the magnetic field component of EMF because of some scientific studies regarding these fields.

Figure 1

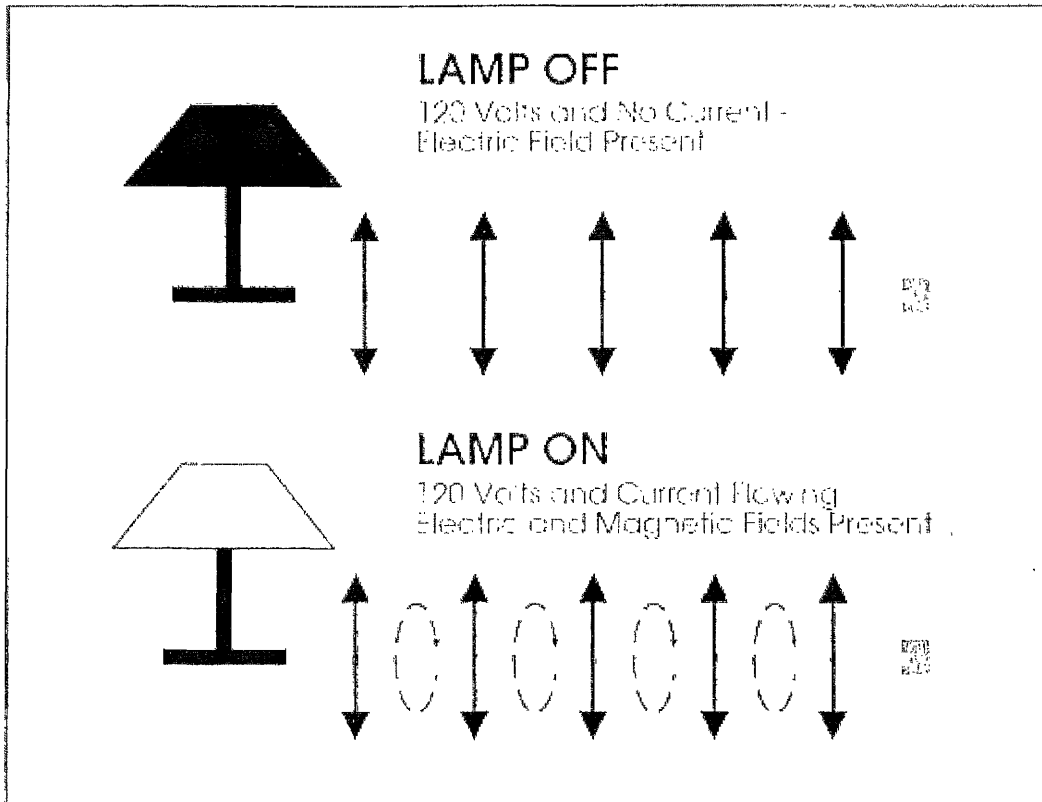


Figure 2




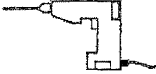




Magnetic field strengths decrease with distance		Source: "EMF In Your Environment", U.S. Environmental Protection Agency 1992		
Magnetic fields are measured in milligauss		At 6 inches	At 1 foot	At 2 feet
Clothes dryer		2 to 10	* to 3	*
Microwave oven		100 to 300	1 to 200	1 to 30
Toaster		5 to 20	* to 7	*
Power drill		100 to 200	20 to 40	3 to 6
Can opener		500 to 1500	40 to 300	3 to 30
Mixer		30 to 600	5 to 100	* to 10
Hair dryer		1 to 700	* to 70	* to 10
Color television		Data not available	* to 20	* to 8

FIGURE 2 * The magnetic field measurement at this distance from the operating appliance could not be distinguished from background measurements taken before the appliance had been turned on.

Measuring Magnetic Fields

Magnetic fields usually are measured in a unit called a milligauss. Magnetic field levels found in the living areas of homes typically range from less than 1 milligauss to about 4 milligauss according to the U.S. Environmental Protection Agency. They can be higher in some cases. The levels next to appliances can exceed 1,000 milligauss (1 gauss). Figures 2 and 3 show how the strength of the field falls off as you move away from the source, just as the heat of a campfire grows weaker as you walk away from it. For overhead power lines, the strength of the magnetic fields is dependent upon a number of factors that will be explained later. Those factors produce a magnetic field that drops off rapidly as you move away from the power line.

Figure 3

Sample Magnetic Field Levels in Milligauss				
Type of Overhead Power Line	Distance from the line			
	Under the line	50 ft.	100 ft.	200 ft.
220 kV and 500 kV	5-400	5-250	1-75	0.5-20
69 kV and 138 kV	3-80	0.5-2.5	0.1-10	0.1-3
12 kV and below	0.4-20	0.1-1	-	-

The magnetic field values provided in this table represent a general range of values associated with the types of overhead power lines listed and are provided for illustration. There will be circumstances in which there will be magnetic field levels above or below the range of values provided due to variations in such factors as height of the wires, current flow and so on.

DEVELOPMENT OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM

One element of our response to EMF concerns expressed by some of our customers is PPL EU's Magnetic Field Management Program. The program was initiated in March 1991 because PPL EU believes it makes good sense, as a matter of policy, to respond to the concerns expressed by some of our customers and to reduce magnetic fields in new and rebuilt facilities where it can be done with either no-cost or low-cost design changes.

This document updates the original program which has been revised several times since 1991. These guidelines were developed by PPL EU's EMF Working Group.

VARIABLES THAT AFFECT MAGNETIC FIELDS

Magnetic fields from transmission and distribution lines are a function of a number of design variables. The following parameters affect the magnetic field levels produced by transmission and distribution lines:

- Current
- Height of conductors above ground
- Configuration of conductors
- Distance from the line

EFFECT OF PHASE CURRENT ON MAGNETIC FIELDS

At power frequencies (i.e., 60 hertz), the magnetic field level is a function of the current or flow of electricity through a wire. Keeping all other parameters the same, the magnetic field is proportional to the current. Hence, if the current increases by 25 percent, the resulting magnetic field level will increase by 25 percent.

The overall load current on any line varies with the demand for power. It's usually highest during daytime hours and lowest at night. There also are weekly, monthly, seasonal and yearly variations.

The difference in the currents between each phase in a multiphase line also can affect the magnetic field. This difference is called phase unbalance. For a constant load, a statistical analysis of this phase unbalance can be made to determine its effect on the magnetic field. Close to the line, there is very little effect. However, the phase unbalance slows the rate at which the magnetic field decreases with distance from the line.

EFFECT OF CONDUCTOR CONFIGURATION ON MAGNETIC FIELDS

In the transmission and distribution of power, utilities like PPL EU presently use both three-phase and single-phase lines. Each phase on a three-phase power line has either a single conductor or a bundle of two or more conductors. In a three-phase system, the ground-level magnetic field is a result of the fields produced by the currents in each of the phases. Placing the three phases as close together as possible (compaction) creates some field cancellation, and the ground-level magnetic field is reduced. However, appropriate phase separation is required for the reliable operation of the line. In addition, the arrangement of the phases can create some; field cancellation and reduction of the ground-level magnetic field.

EFFECT OF DISTANCE FROM THE MAGNETIC FIELD SOURCE

Magnetic field strength diminishes with the vertical and lateral distances from the magnetic field source. Increasing the height of the conductors above ground is useful for magnetic field reduction at ground level, but may result in increased structure costs and increased aesthetic impact of the structures. Another possible method of increasing the distance to the magnetic field source is to increase the right-of-way requirements. By keeping buildings off increased rights of way, thereby requiring the public to live and work further away from lines, exposure to magnetic fields produced by the lines can be reduced. Increases in right of way are not always practical and may increase costs significantly, however.

SUMMARY OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM

Under its Magnetic Field Management Program, PPL EU has changed the way it builds and rebuilds some of its transmission and distribution lines. These design changes reduce magnetic field levels (assuming balanced circuit loadings and phase currents) by up to 69 percent in most of the company's new transmission lines. These guidelines now are being applied to new and reconstructed transmission facilities, based on this program.

The distribution component of the program focuses on 12 kV lines, the company's standard distribution voltage. It concentrates on the three-phase, primary 12 kV lines, since these are the most heavily loaded facilities and often are located in densely populated areas. The guidelines in this program are being applied to these three-phase, primary 12 kV lines.

A maximum 3-5 percent change in estimated cost was used as the limit for the guidelines since this value is consistent with low cost, is within estimating accuracy and is likely to have little impact on overall line costs.

The magnetic field calculations used in this document for the design of PPL EU's overall magnetic field management plan assume balanced load conditions among the phases and a fixed level of current, not necessarily representative of specific transmission or distribution lines. These levels were calculated using the Electric Power Research Institute's ENVIRO computer program. Under actual operating conditions, the magnetic field levels that result may vary due to such things as actual load per circuit, overall current on each phase conductor and the electrical configuration and operation of each line.

MAGNETIC FIELD MANAGEMENT PROGRAM GUIDELINES

The guidelines for magnetic field management are noted below, with discussion points for each.

OVERHEAD LINES

NEW OR REBUILT TRANSMISSION LINES

1. **Balance transmission circuit loads and phase currents as much as possible.**
 - PPL EU should continue to make every effort to balance loadings between the two circuits of a double circuit line when planning new or rebuilt facilities to maximize the effects of reverse phasing.
 - PPL EU should continue the practice of balancing single-phase loads across the three phases of the distribution system. (Unbalanced phase currents on the distribution system are reflected through to the transmission system.)
 - Unbalanced phase currents result in higher magnetic fields that do not drop off as quickly with distance as do the fields resulting from balanced phase currents.
 - For a 5 percent phase current unbalance, the magnetic field 50 feet from the centerline of a single circuit 138 kV line could be more than twice the value than if the same line had balanced phase circuits.
 - Balanced phase currents on each three-phase distribution circuit also reduce magnetic fields from the distribution circuits themselves. In addition, they reduce magnetic fields on the transmission system from which the distribution system circuits are supplied and connected through substations.
 - Apart from magnetic field considerations, balanced phase currents on each three-phase distribution circuit also reduce line losses and improve the system voltage.

2. Continue with the present practice of using long-span construction as the PPL EU 138/69 kV standard

- Structure designs for short-span and long-span construction are illustrated on Charts I and II, respectively.
 - Short-span design does not significantly reduce magnetic fields when compared to long-span design even though it is more compact than long-span design. Comparison of the magnetic field values from Chart III indicates essentially the same values. Therefore, short-span design should not be used solely to reduce magnetic fields.
 - PPL EU will continue to use long-span construction for 138/69 kV double-circuit lines and for single-circuit/future-double-circuit lines.
 - For single-circuit/future-double-circuit lines, PPL EU will continue to install two conductors on the top positions and one in the middle position as shown in Chart IV.
 - This arrangement minimizes magnetic fields as shown in Chart V by placing the three initial conductors higher on the structure, which increases the ground clearances, and by placing the conductors in a triangular configuration.

3. Compact design structures are not a low-cost alternative and should be used for magnetic field reduction only in special applications.

Chart VI illustrates the compact design structure.

- The compact design increases the initial installation costs by 79 percent when compared to the long-span design but reduces the magnetic field from 9 mG to 3 mG (about 67 percent) at the edge of the 100-foot-wide right of way as shown on Chart III.

4. Reverse phase new or rebuilt double-circuit transmission lines for all voltage levels.

- Reverse phasing was adopted by PPL EU in March 1991 for double-circuit 138/69 kV transmission lines and in April 1992 for all other double circuit transmission lines. Reverse phasing is shown in Chart VII. Reverse phasing will reduce the magnetic fields when the current flow on both circuits is in the same

direction. Calculated values contained here are based on balanced and equal phase currents on both circuits.

- Reverse phasing reduces the magnetic field of a double circuit 138 kV single pole transmission line from 29 mG to 9 mG (about 69 percent) at the edge of the 100-foot-wide right of way as shown on Chart III.
- Reverse phasing reduces the magnetic field of a double circuit 230 kV single pole transmission line from 49 mG to 16 mG (about 67 percent) at the edge of the 150-foot-wide right of way as shown on Chart VIII.
- Reverse phasing reduces the magnetic field of a double-circuit 500 kV single pole transmission line from 37 mG to 21 mG (about 43 percent) at the edge of the 200-foot-wide right of way as shown on Chart IX.
- When new or rebuilt double-circuit lines require tapping existing double-circuit lines, PPL EU will review the existing lines to determine if reverse phasing can be provided at low cost.
- Computer modeling is required to develop the optimum phasing and overall conductor arrangements for lines added to, or rebuilt in, multiple-line corridors.
 - Merely adding a reverse-phase double-circuit line to an existing transmission line corridor or reverse phasing a rebuilt line in the multiple-line corridor will not necessarily produce lower magnetic field levels at the edge of the corridor right of way.
 - The corridor must be computer modeled with all the lines, existing phase conductor locations and currents. Then, magnetic field calculations must be made varying the phase arrangements of the new or reconstructed line to determine the appropriate phasing arrangement.
 - Current flow direction on a line also must be considered. For example, a reverse-phased line should have the current flowing in the same direction on both circuits. If the current flow is in the opposite direction for one circuit, reverse phasing will not produce the lowest magnetic field and another phase arrangement that produces lower fields may need to be utilized.

5. **Increase the minimum ground clearance for all new transmission lines.**

138/69 kV Transmission Lines

- Increasing the minimum line design ground clearance from 25 feet to 30 feet may add up to about 5 percent to the installed cost of a new double-circuit single pole 138/69 kV line. For a given project, such cost may be substantially less, however. In fact, PPL EU frequently uses higher-than-minimum ground clearances due to such features as road crossings, line crossings and site-specific terrain. With long-span reverse-phase design, the magnetic field is reduced from 9 mG to 7 mG (about 22 percent) at the edge of a 100-foot-wide right of way as shown in Chart X.
 - In the actual design of transmission lines to include higher minimum ground clearances, there may be limited segments (such as highway crossings, severe slopes and transmission line crossing locations) where National Electrical Safety Code (NESC) minimum ground clearances may need to be used. The NESC minimum ground clearances are less than the increased ground clearance discussed previously.

230 kV Transmission Lines

- Increasing the minimum line design ground clearances from 27 feet to 32 feet may add up to about 5 percent to the cost of a single-circuit single-pole line (current standard). For a given project, such cost may be substantially less, however. In fact, PPL EU frequently uses higher-than-minimum ground clearances due to such features as road crossings, line crossings and site-specific terrain. By increasing the clearances, the magnetic field is reduced from 30 mG to 28 mG (about 7 percent) at the edge of a 150-foot-wide right of way.
- Increasing clearances from 27 feet to 32 feet could theoretically add up to about 2.8 percent to the cost of a double-circuit single-pole line (current standard) and reduce the magnetic field of a reverse-phase line from 16 mG to 15 mG (about 6 percent) at the edge of a 150-foot-wide right of way. Chart XI is a summary of this data.
- Studies are required for each new 230 kV line to determine optimum structure types, ground clearances, configurations and designs to reduce field levels. Such

studies could include analysis of reduction measures such as additional minimum ground clearances, increasing conductor tensions, using reduced phase spacing (a "Delta" configuration on a single-circuit line), installing the second circuit initially, and/or adding a second set of conductors that are reverse phased and operated in parallel with the first set (bundled/split phase).

500 kV Transmission Lines

- Increasing ground clearances from 33 feet to 53 feet may add up to about 4.5 percent to the cost of a single-circuit "H-frame" line (current standard). For a given project, such cost may be substantially less, however. In fact, PPL EU frequently uses higher-than-minimum ground clearances due to such features as road crossings, line crossings and site-specific terrain. By increasing the clearances, the magnetic field is reduced from 42 mG to 35 mG (about 17 percent) at the edge of a 200-foot-wide right of way.
- Increasing ground clearances from 33 feet to 53 feet could theoretically add up to 2.8 percent to the cost of a double-circuit "H-frame" line (current standard) and reduces the magnetic field of a reverse-phase line from 21 mG to 16 mG (about 24 percent) at the edge of a 200-foot-wide right of way. Chart XII is a summary of this data.
- Studies are required for each new 500 kV line to determine optimum structure types, ground clearances, configurations and designs to reduce field levels. Such studies could include analysis of reduction measures such as additional minimum ground clearances, increasing conductor tensions, using reduced-phase spacing (a "Delta" configuration on a single circuit line), installing the second circuit initially, and/or adding a second set of conductors that are reverse phased and operated in parallel with the first set (bundled/split phase).

RECONDUCTORING OR ADDING ADDITIONAL CIRCUITS TO EXISTING TRANSMISSION LINES

When reconductoring or adding additional circuits to existing transmission lines, PPL EU will evaluate low-cost or no-cost options for magnetic field management on a case-by-case basis.

When reconductoring existing transmission lines or adding additional circuits, low-cost alternatives may not exist; however, the following steps will be taken:

- For a single-circuit line, the use of a Delta arrangement or other modifications on the existing structure, with reduced-phase spacing, will be evaluated.
- For double-circuit lines, application of reverse phasing may reduce the magnetic field under the line and within the right of way and will be evaluated.
- For single- and double-circuit lines, evaluate using higher conductor tensions that can increase the minimum line design ground clearance.

DISTRIBUTION LINES

At the 12 kV distribution level, new main three-phase lines will continue to be constructed with five feet of additional ground clearance.

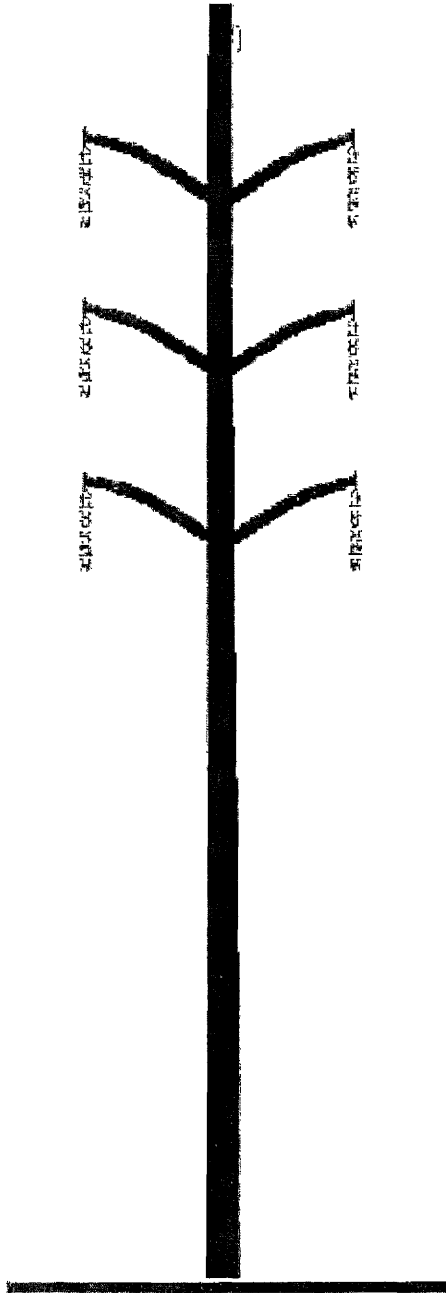
- Main lines are the most heavily loaded sections of a distribution line and therefore have the highest magnetic fields associated with them.
- Increasing the ground clearance by five feet reduces the magnetic field under the line from 14 mG to 11 mG using the standard eight-foot crossarm design. These values are based on increasing pole heights from 45 feet to 50 feet and a typical operating current of 300 amps per phase.
- Chart XIII is a summary of this data. Increasing ground clearance by five feet could theoretically add about 5 percent to the cost of a typical distribution line.

UNDERGROUND TRANSMISSION LINES

Underground transmission lines are required due to environmental or land use factors or restrictions on available clearances, PPL EU will evaluate options for magnetic field management techniques on a case-by-case basis.

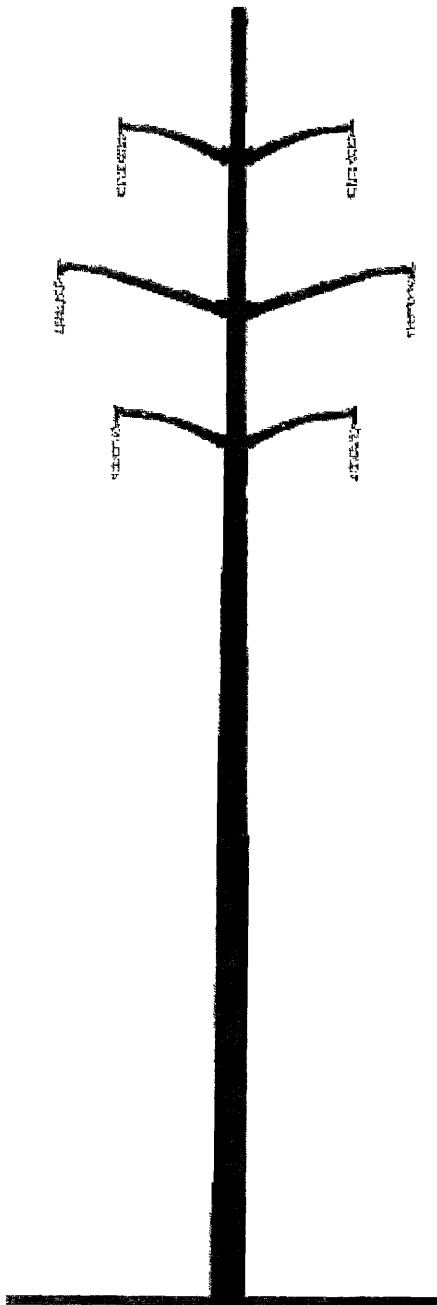
- The phase arrangement that produces the lowest field will be determined.
- The depth of burial of the line will be determined considering the cost of excavation and the location of other buried utilities in the area.
- The use of steel pipe ferromagnetic shielding that reduces magnetic fields will be evaluated.

Short-Span Construction



- More compact design
- Should not be used solely to reduce magnetic fields
- Typical conductor data:
 - 1 3/8" HS steel overhead ground wire - 7.3 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 10.0 feet sag
 - Average span - 400 feet

Long-Span Construction Remains PPL EU 138 kV Standard



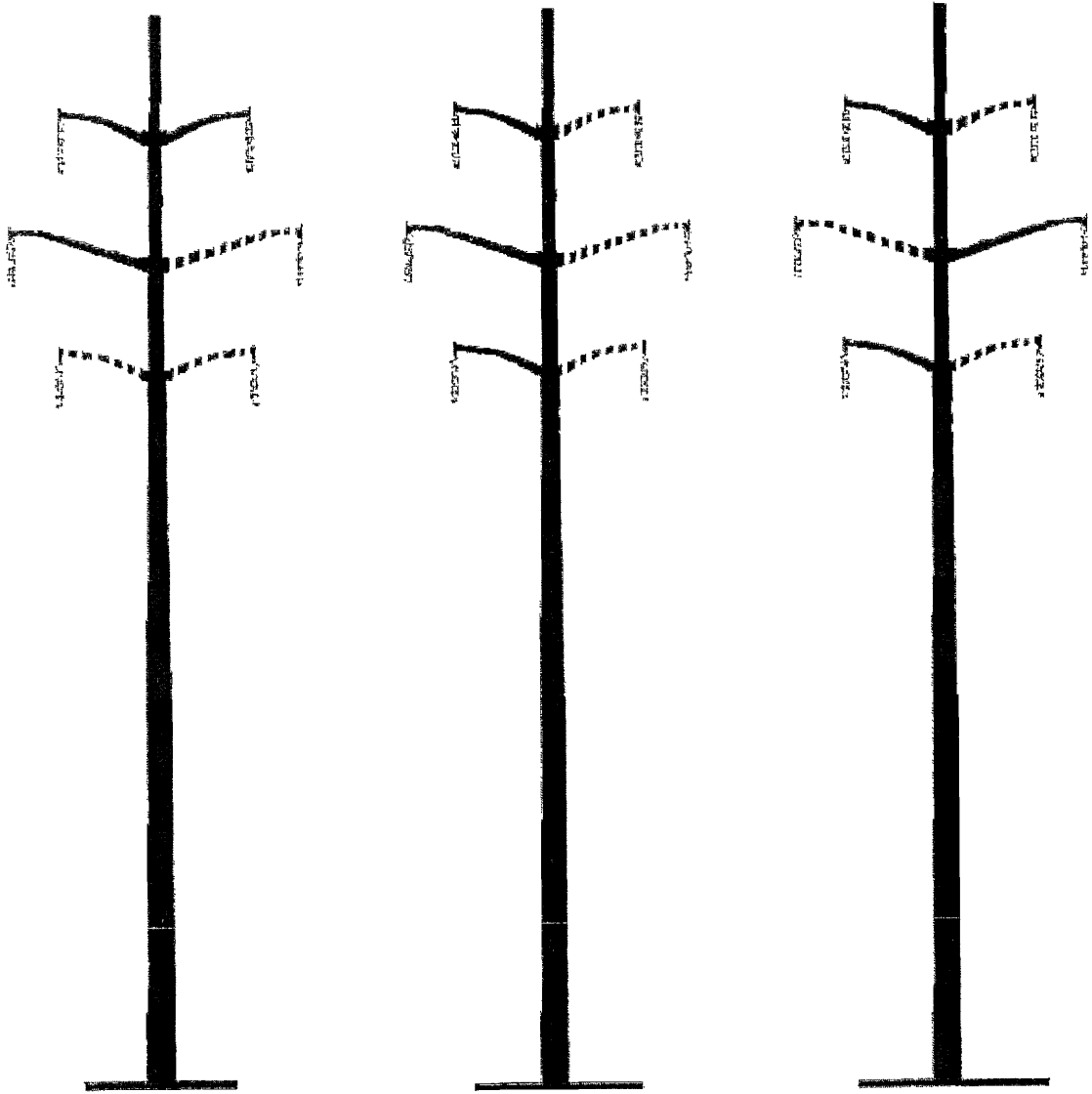
- Lower cost alternative
- Reduces magnetic fields due to higher structures
- Typical conductor data:
 - 1 3/8" HS steel overhead ground wire - 17.3 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
 - Average span - 600 feet

**138/69 kV REVERSE-PHASE TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 400 AMPERES**

TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SHORT SPAN (CHART I)	30
SHORT SPAN (REVERSE PHASE)	8
LONG SPAN (CHART II)	29
LONG SPAN (REVERSE PHASE)	9
COMPACT (CHART VI)	14
COMPACT (REVERSE PHASE)	3

The edge of right of way is 50 feet from the line centerline.
 The 400 ampere phase current is balanced between phases.
 Calculations are based on a minimum ground clearance of 25 feet.
 LONG SPAN, SHORT SPAN and COMPACT are double-circuit lines.

Typical Single-Circuit Structure Designs



Top/Middle

Vertical

Top/Middle/Bottom

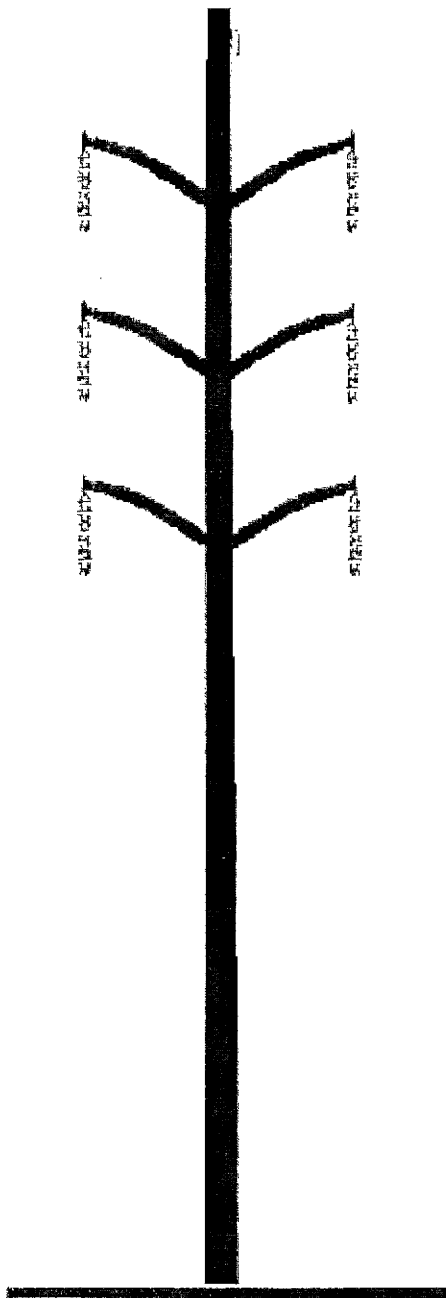
————— initial single circuit
- - - - - future second circuit

**138/69 kV SINGLE CIRCUIT TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 400 AMPERES**

TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
TOP/MIDDLE/BOTTOM	20
VERTICAL	17
TOP/MIDDLE	12

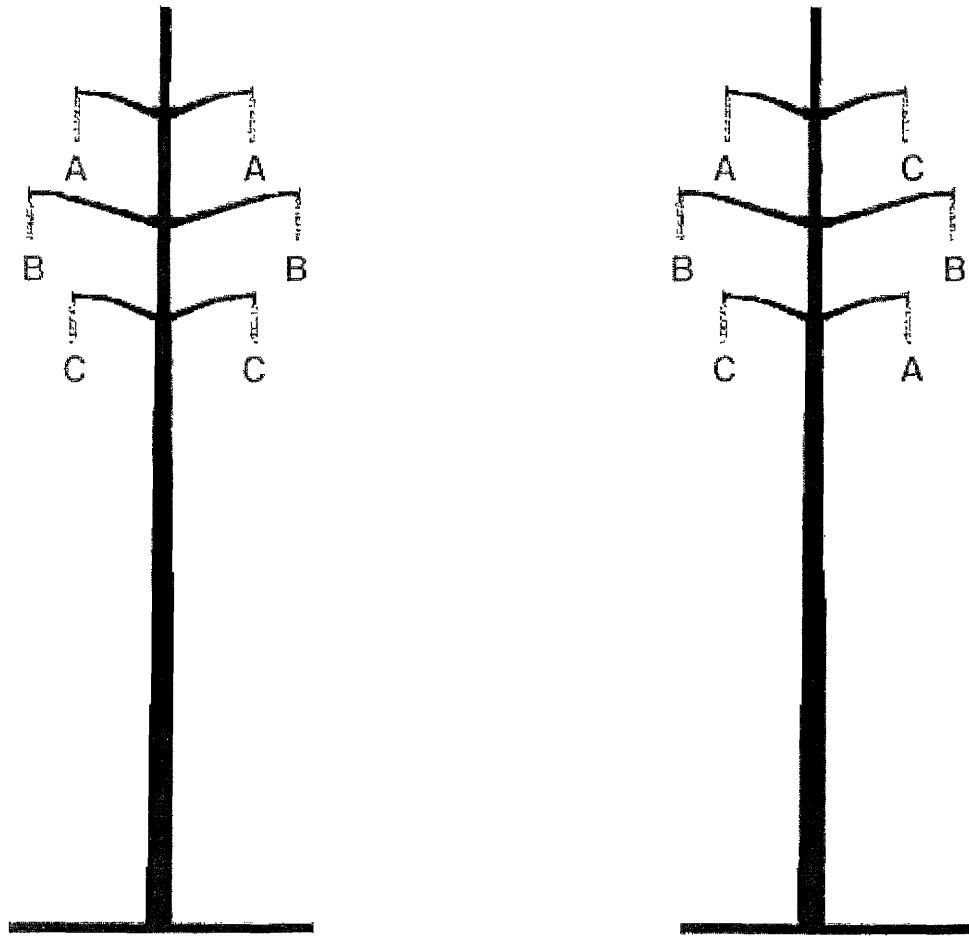
The edge of right of way is 50 feet from the line centerline.
 The 400 ampere phase current is balanced between phases.
 Calculations are based on a minimum ground clearance of 25 feet.

Compact Design Structure



- Minimize magnetic fields due to compact design
- Not a low-cost alternative
- Typical conductor data:
 - 1 3/8" HS steel overhead ground wire - 9.0 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 9.0 feet sag
 - Average span - 300 feet

Reverse Phasing of Double-Circuit Transmission Lines



From: → → → → To:

Reverse phasing also can be one of the following phase arrangements:

A	B		B	A		B	C		C	A		C	B
C	C	or	C	C	or	A	A	or	B	B	or	A	A
B	A		A	B		C	B		A	C		B	C

**230 kV REVERSE-PHASE TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 800 AMPERES**

TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
DOUBLE CIRCUIT POLE	49
DOUBLE CIRCUIT POLE (REVERSE-PHASE)	16

The edge of right of way is 75 feet from the line centerline.
The 800 ampere phase current is balanced between phases.
Calculations are based on a minimum ground clearance of 27 feet.

**500 kV REVERSE-PHASE TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 1100 AMPERES**

TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
DOUBLE CIRCUIT POLE	37
DOUBLE CIRCUIT POLE (REVERSE PHASE)	21

The edge of right of way is 100 feet from the line centerline.
The 1,100 ampere phase current is balanced between phases.
Calculations are based on a minimum ground clearance of 33 feet.

**INCREASED 138/69 kV MINIMUM GROUND CLEARANCE
CALCULATED MAGNETIC FIELDS AT 400 AMPERES**

TYPE CONSTRUCTION	MINIMUM GROUND CLEARANCE FEET	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SINGLE CIRCUIT TOP/MIDDLE	25	12
SINGLE CIRCUIT TOP/MIDDLE	30	10
LONG SPAN	25	29
LONG SPAN	30	26
LONG SPAN (REVERSE PHASE)	25	9
LONG SPAN (REVERSE PHASE)	30	7

The edge of right of way is 50 feet from the line centerline.
The 400 ampere phase current is balanced between phases.

**INCREASED 230 kV MINIMUM GROUND CLEARANCE
CALCULATED MAGNETIC FIELDS AT 800 AMPERES**

TYPE CONSTRUCTION	MINIMUM GROUND CLEARANCE FEET	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SINGLE CIRCUIT TOP/MIDDLE	27	30
SINGLE CIRCUIT TOP/MIDDLE	32	28
DOUBLE CIRCUIT POLE	27	49
DOUBLE CIRCUIT POLE	32	46
DOUBLE CIRCUIT POLE (REVERSE PHASE)	27	16
DOUBLE CIRCUIT POLE (REVERSE PHASE)	32	15

The edge of right of way is 75 feet from the line centerline.
The 800 ampere phase current is balanced between phases.

**INCREASED 500 kV MINIMUM GROUND CLEARANCE
CALCULATED MAGNETIC FIELDS AT 1,100 AMPERES**

TYPE CONSTRUCTION	MINIMUM GROUND CLEARANCE FEET	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SINGLE CIRCUIT "H" STRUCTURE	33	42
SINGLE CIRCUIT "H" STRUCTURE	53	35
DOUBLE CIRCUIT POLE	33	37
DOUBLE CIRCUIT POLE	53	31
DOUBLE CIRCUIT POLE (REVERSE PHASE)	33	21
DOUBLE CIRCUIT POLE (REVERSE PHASE)	53	16

The edge of right of way is 100 feet from the line centerline.
The 1,100 ampere phase current is balanced between phases.

**12 kV DISTRIBUTION LINES
CALCULATED MAGNETIC FIELDS AT 300 AMPERES**

TYPE CONSTRUCTION	POLE HEIGHT FEET	MAGNETIC FIELD IN MILLIGAUSS*	
		AT CENTERLINE	AT 30 FEET FROM CENTERLINE
STANDARD CROSSARM	45	14	7
STANDARD CROSSARM	50	11	6

* Field level under the line at mid-span based on 300 amps, balanced loading, one meter above ground level.

Attachment

6

ATTACHMENT 6
ST. JOHNS – FREELAND 138/69 kV LINE REPLACEMENT LIST OF
OWNERS OF PROPERTY WITHIN THE RIGHT-OF-WAY

<u>Property Owner/Address</u>	<u>Parcel Number</u>
PPL Electric Utilities Corp.	1, 41, 45, 47, 48
David J. Gronski, Et al 534 E 6 th Street Hazleton, PA 18201	2
Dennis and Bonnie Miller P. O. Box 1 Saint Johns, PA 18247	3
Donald B. and Diane E. Stefanick 881 St. Johns Road Drums, PA 18222	4
Joseph and Dorothy Callavini Barry Callavini PO BOX 256 Lattimer Mines, PA 18234	5, 6
Robert L and Anne L Stackhouse C/O Anne L Brewer 36093 Silcott Meadow Place Purcellville, VA 20132	7
Robert and Anne Stackhouse 825 Old Fritztown Rd Sinking Spg, PA 19608-9151	8
Scott Horlacher 140 West Thirwell Avenue Hazleton, PA 18201	9
Susan R and Jeffrey W Sauers PO Box 77 Kings Rd Saint Johns, PA 18247-0077	10
Anthony M and Bernadette Debias 713 Station Square Blvd Lansdale, PA 19446	11, 12, 13, 14

<u>Property Owner/Address</u>	<u>Parcel Number</u>
Gloria C Benderavich John W Osmond Jr 182 N Old Turnpike Rd Drums, PA 18222-1914	15
Jack C and Mary P Lamont 536 Grant St Hazleton, PA 18201-4859	16
Elizabeth L Lamont Po Box 702 Conyngham, PA 18219-0702	17
Michael P and Sharon Sabia 186 N Old Turnpike Rd Drums, PA 18222-1914	18
Edward & Deborah Telatovich PO Box 112 168 N Old Turnpike Road Saint Johns, PA 18247	19
Robert Jr and Helen James 175 N Old Turnpike Rd Drums, PA 18222	20, 21
David M Jr and Renee A Katona 141 S Glendale Ln Drums, PA 18222-2237	22
Bruce and Beverly Hilliard PO Box 655 Conyngham, PA 18219-0655	23
Ronald G and Deborah J Zimmerman 151 S Glendale Ln Drums, PA 18222-2237	24
Christopher P James 158 S Glendale Ln Drums, PA 18222	25

<u>Property Owner/Address</u>	<u>Parcel Number</u>
Kathleen M and David A Purcell 161 S Glendale Ln Drums, PA 18222	26
Jason J James 152 Church St Apt A Mountville, PA 17554	27
Joseph R and Ralph M Ferdinand 67 N Church St Hazleton, PA 18201-5801	28
Mark A and Maureen T Zane PO Box 423 Drums, PA 18222-0423	29
Edward S and Jessica B Polashenski 227 West Butler Drive Drums, PA 18222	30
Craig L and Elizabeth Wallen 199 West Butler Drive Drums, PA 18222	31
Michael A and Nancy Washinsky 131 W Butler Dr Drums, PA 18222	32, 33
Giovanna Fellin Mira Val Apt # 4 55 W. Butler Drive Drums, PA 18222-0116	34, 35
Adam R Lee 49 W Butler Dr Drums, PA 18222-2308	36
Celeste F Kosko Etal 40 N Vine St Hazleton, PA 18201-5846	37

<u>Property Owner/Address</u>	<u>Parcel Number</u>
Kevin Lamont 330 W Butler Dr Drums, PA 18222-2313	38
Victor F and Mary Jean Greco 50 Drasher Rd EZ Acres Drums, PA 18222-2614	39, 40
William Lubrecht III C/O Dorothy White 521 7th ST New Cumberland, PA 17070-1504	42
Jeffrey R Jenkins David W Jenkins IV 57 Silo Hill Dr Richboro, PA 18954-1146	43
George Alberts Jr PO Box 397 Pittston, PA 18640	44
Joseph P. Semasek 331 Monroe St. McAdoo, PA 18237	46

Attachment

7

ATTACHMENT 7
ST. JOHNS – FREELAND 138/69 kV LINE REPLACEMENT
LIST OF INVOLVED GOVERNMENTAL AGENCIES, MUNICIPALITIES AND
OTHER PUBLIC ENTITIES RECEIVING APPLICATIONS

1. Pennsylvania Historical and Museum Commission
Bureau for Historic Preservation
Commonwealth Keystone Building, Second Floor
400 North Street
Harrisburg, Pennsylvania 17120-0053
Attn: Mr. Douglas C. McLearen, Chief

2. Pennsylvania Department of Transportation
Honorable Barry Schoch, P.E., Secretary
c/o Office of Chief Counsel
Commonwealth Keystone Building
400 North Street, 9th Floor
Harrisburg, PA 17120
Attn: William J. Cressler

3. Department of Environmental Protection
P.O. Box 2063
Market Street State Office Building
Harrisburg, Pennsylvania 17105-2063
Attn: Office of Field Operations

4. Luzerne County Council
200 North River Street
Wilkes-Barre, PA 18711
Attn: Tim McGinley, Chair

5. Luzerne County Planning Commission
Penn Place
20 North Pennsylvania Avenue
Wilkes-Barre, PA 18711
Attn: Adrian Merolli, Chair

6. Butler Township Board of Supervisors
415 West Butler Drive
Drums, PA 18222
Attn: Brian Kisenwether, Chair

7. Butler Township Planning Commission
415 West Butler Drive
Drums, PA 18222
Attn: Paul Feno, Chair

8. Foster Township Board of Supervisors
1000 Wyoming Avenue
P. O. Box 465
Freeland, PA 18224
Attn: John Brogan, Chair

9. Foster Township Planning Commission
1000 Wyoming Avenue
P. O. Box 465
Freeland, PA 18224
Attn: Greta Zoshak, Chair