

Before the  
Pennsylvania Public Utility Commission

**ELROY – HATFIELD #1 & #2 138/69 kV LINE**

ATTACHMENTS IN SUPPORT OF THE  
**Letter of Notification**

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

Submitted by: PPL Electric Utilities Corporation

## SUMMARY

On October 25, 2010, PPL Electric Utilities Corporation ("PPL Electric") petitioned the Pennsylvania Public Utility Commission ("Commission") for a waiver of certain provisions of the siting regulations in order to file a Letter of Notification in lieu of an Application for approval of the siting and construction of the new double-circuit Elroy – Hatfield 138/69 kV Transmission Line. The Petition was docketed at P-2010-2206466. The Commission granted approval of the petition on February 10, 2011, enabling PPL Electric to file this Letter of Notification.

This Letter of Notification is being submitted by PPL Electric pursuant to the Commission's regulations at 52 Pa. Code §§ 57.71 through 57.77, for approval to site and construct the new Elroy – Hatfield #1 & #2 138/69 kV Transmission Line, which will be approximately 2.03 miles long. The proposed transmission line will be constructed between the Elroy Substation and the existing Buxmont – Hatfield #3 & #4 Transmission Line adjacent to the Hatfield Substation. This new transmission line is required to increase reliability of service to 33,000 customers in Bucks and Montgomery Counties. This project is located in Hatfield and Franconia Townships, Montgomery County, as shown on the attached PPL Electric Utilities Service Territory figure located at the end of this section.

The proposed transmission line will be designed and constructed for two 138 kV circuits. Initially, both circuits will be operated at 69 kV and the line will be converted to 138 kV operation when load growth makes it appropriate to do so. The estimated cost to site, design and construct the Elroy – Hatfield #1 & #2 138/69 kV Transmission Line is \$4.25 million. Construction is scheduled to begin in June 2012, to support the project's in-service date of May 2013. This project will be conducted in concert with proposed upgrades to the 500-138-69 kV Elroy Substation and a new 500 kV transmission tie line between the PECO switch yard and the Elroy Substation. A Letter of Notification for the proposed 500 kV transmission tie line is being submitted concurrently with this submission.

This document, which describes the need for the project and explains the engineering and siting analysis for the proposed construction, consists of the following:

Attachment "1"	Necessity Statement
Attachment "2"	Engineering Description
Attachment "3"	Environmental Assessment
Attachment "4"	PPL Electric 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

# **Attachment**

**1**

# PPL ELECTRIC UTILITIES SERVICE TERRITORY



**ATTACHMENT "1"**  
**ELROY - HATFIELD #1 & #2 138/69 kV LINE**  
**NECESSITY STATEMENT**

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**MAP**

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**ATTACHMENT "1"**  
**ELROY - HATFIELD #1 & #2 138/69 kV LINE**  
**NECESSITY STATEMENT**

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**A. PROJECT NECESSITY**

PPL Electric's Elroy 500-138-69 kV Substation is supplied from a single 500 kV tap off the PECO Elroy 500 kV Switchyard. PPL Electric's Elroy Substation has one 500-138 kV transformer in series with one 138-69 kV transformer, which feed two 69 kV Lines. These two 69 kV Lines are named the Buxmont - Elroy #1 & #2 69 kV Lines. They serve approximately 18,000 customers in Hatfield and Lansdale Boroughs, and Hatfield, Franconia, and West Rockhill Townships. PPL Electric's Buxmont 230-69 kV Substation is supplied by two 230 kV Lines from Hosensack and Whitpain Substations. The Buxmont Substation has two 230-69 kV transformers which feed six 69 kV lines. Two of those lines, the Buxmont - Hatfield #3 & #4 69 kV Lines, serve approximately 15,000 customers in Sellersville Borough and Hilltown, West Rockhill, Franconia, and Hatfield Townships.

In order to guide its planning processes and to establish standards for its transmission and distribution systems which will enable it to provide safe and reliable service at a reasonable cost, PPL Electric has adopted its Reliability Principles and Practices ("RP&P"). PPL Electric relies on the standards set forth in the RP&P for guidance in determining when it is appropriate to reinforce its transmission and distribution systems.

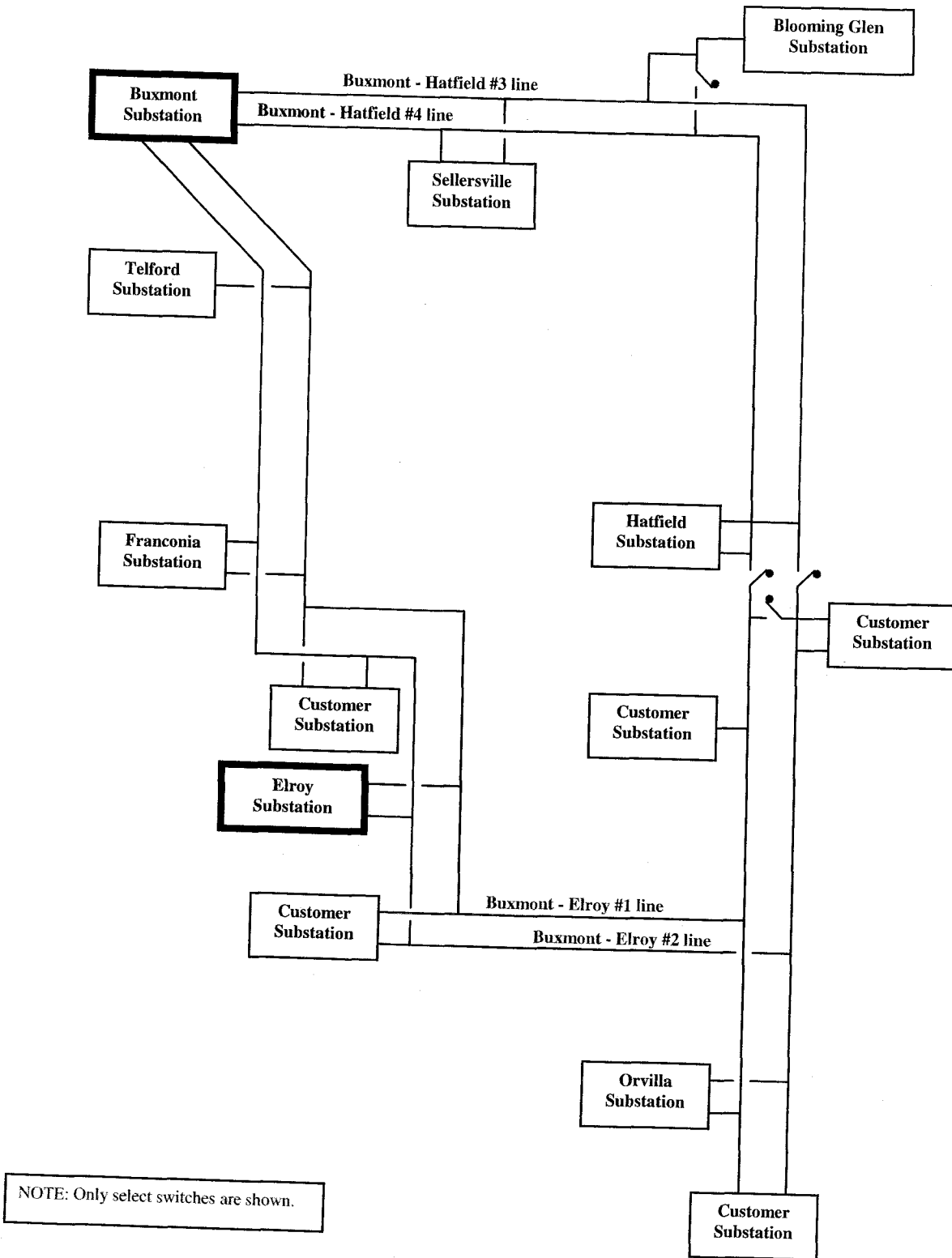
By the summer of 2013, certain facilities in Montgomery and Bucks Counties will not longer meet the standards set forth in the RP&P. The Buxmont - Elroy #1 & #2 69 kV Lines and the Buxmont - Hatfield #3 & #4 69 kV Lines are networked together with normally open switches in between. The purpose of this network tie is to allow for load transfer between the lines for load restoration in the event either line experiences an interruption.

The Buxmont - Elroy and Buxmont - Hatfield 69 kV Lines are heavily loaded. By the summer of 2013, load will not be able to be transferred from one line to another for load relief during

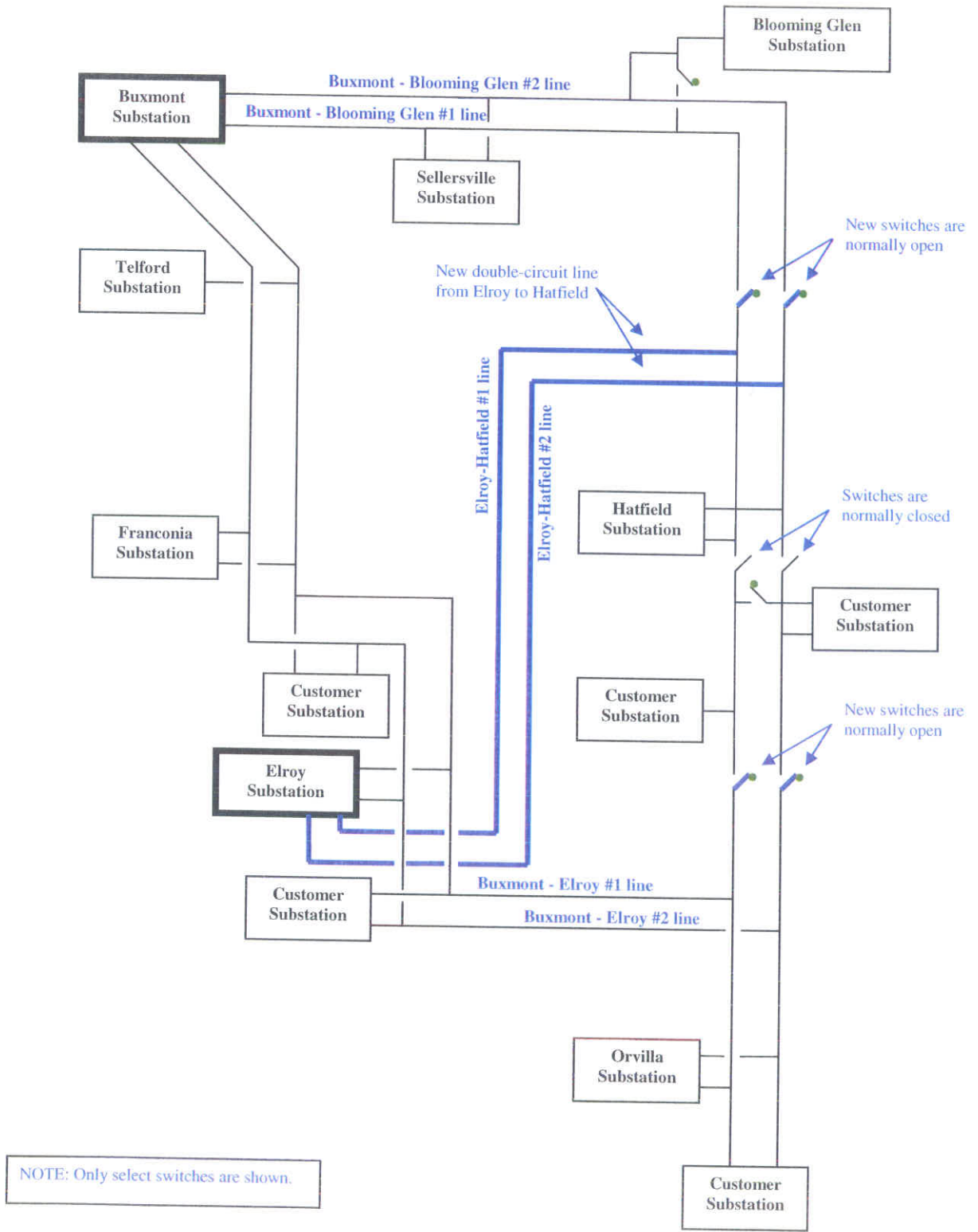
either planned outages for maintenance or unplanned outages. Specifically, loss of the Buxmont - Hatfield #4 69 kV Line would load the Buxmont - Hatfield #3 69 kV to 100% of its summer emergency rating of 124 MVA. In addition, loss of the double-circuit Buxmont - Hatfield #3 and #4 69 kV Lines would initially interrupt approximately 125 MW of load, which would interrupt service to approximately 15,000 customers in Bucks and Montgomery Counties. Loss of a double circuit line would result in a load that was 105% of the maximum acceptable load interruption guidelines specified in PPL Electric's RP&P. Restoration efforts would be limited by insufficient conductor capacity on the existing Buxmont - Elroy #1 and #2 69 kV Lines. Therefore, service to many customers would remain interrupted until the Buxmont Lines were restored.

Constructing the new Elroy - Hatfield #1 & #2 69 kV transmission line from Elroy, and resectionalizing the circuits, will relieve the Buxmont - Elroy #1 & #2 and Buxmont - Hatfield #3 & #4 69 kV Lines. These reinforcements will allow for improved transfer capability between Elroy and Buxmont Substations for load restoration, by eliminating transmission line capacity constraints. Approximately 33,000 customers served from these electric facilities in Bucks and Montgomery Counties will experience increased reliability of service.

**FIGURE 1**  
Existing One-Line Diagram



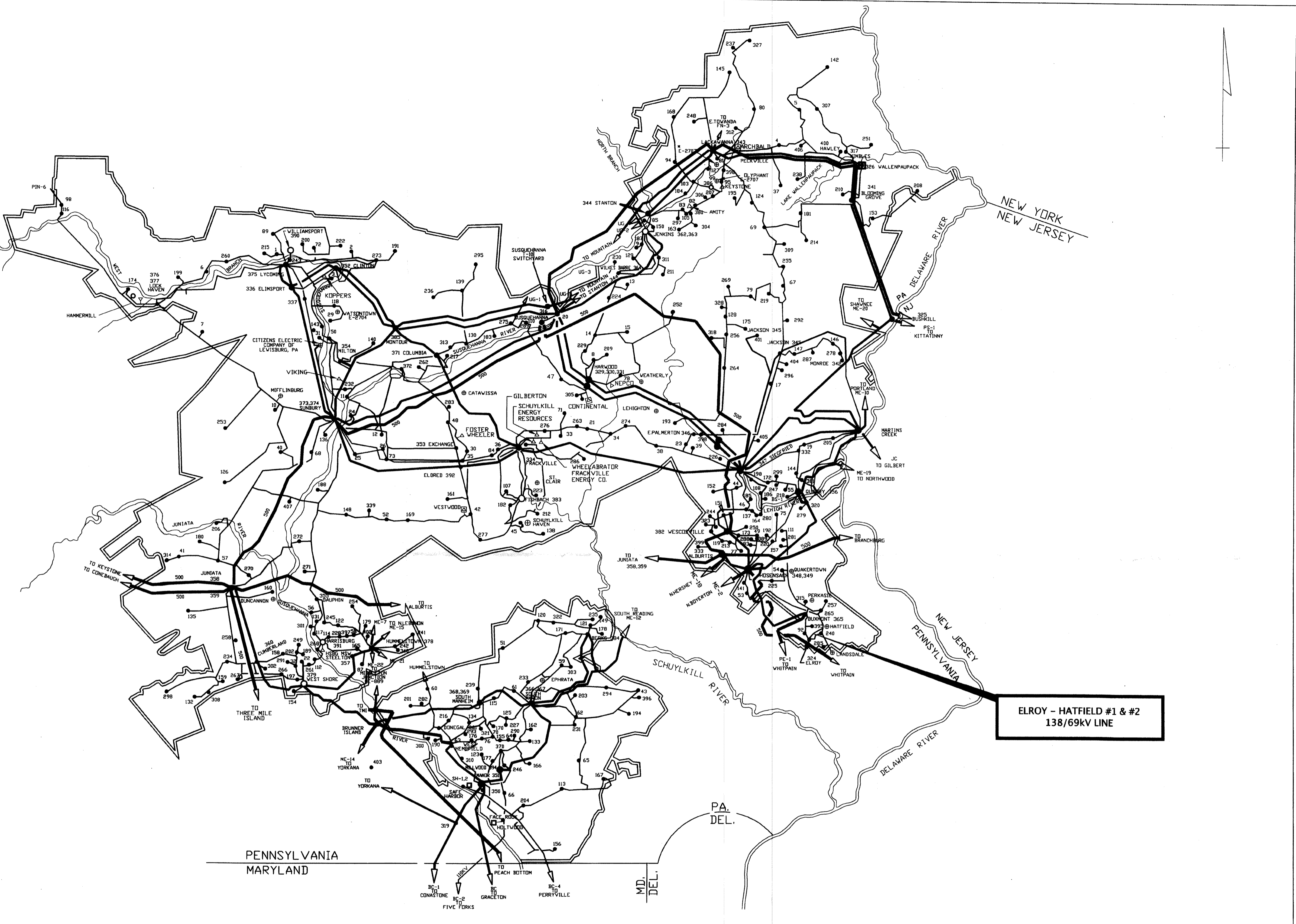
**FIGURE 2**  
**Proposed One-Line Diagram**



# SUBSTATION LISTING

1 WEST WILLIAMSPORT	151 CRACKERSPORT	301 CENTER CITY
2 FAIRFIELD	152 SCHNECKSVILLE	302 NEW KINGSTOWN
3 MONTGOMERY	153 HEMLOCK	303 REAMSTOWN
4 VARDEN	154 MT. ALLEN	304 DUPONT
5 HONESDALE	155 PRINCE	305 HUMBOLDT
6 JERSEY SHORE	156 WAKEFIELD	306 CEDAR AVE.
7 LOGANTON	157 COOPERSBURG	307 INDIAN ORCHARD
8 VALMONT	158 VERTZVILLE	308 NOTTINGHAM
9 RIVER	159 WEST CARLISLE	309 NORTH COOLBAUGH
10 NORTHUMBERLAND	160 BENVENUE	310 LETORT
11 REED	161 HEGINS	311 EAST MOUNTAIN
12 WRIGHT	162 YATESVILLE	312 JERMYN
13 ST. JOHNS	163 CENTRAL ALLENTOWN	313 BLOOMSBURG
14 FREELAND	164 OBERLIN	314 MIFFLINTOWN
15 GILBERT	165 ST. RAUBS	315 RIDGE ROAD
16 HERRY HILL	166 ATLEN	316 SUSQUEHANNA
17 SUSQUEHANNA 230KV	167 BROOKSIDE	317 T-10 SW. YD.
18 TAMANEND	168 CHERRY HILL	318 KIMBLE
19 WHITE HILL	169 SUSQUEHANNA	319 CHRISTMANS
20 PALMERTON	170 E. PETERSBURG	320 OTTER CREEK
21 HAMILTON	171 VERNERSVILLE	321 STEEL CITY
22 HUNTER	172 N. BETHLEHEM	322 MCGOVERNVILLE
23 FAIRVIEW	173 W. ALLENTOWN	323 ROBESONIA
24 MOUNTAIN PUMP	174 FLEMINGTON	324 S.FOGELSVILLE
25 MT. CARMEL	175 MECKESVILLE	325 ELROY
26 KELLY	176 DIMERSVILLE	326 BUSHKILL
27 SPORING HILL	177 MILLERSVILLE	327 WALLENPAUPACK
28 MANDY CITY	178 SHILLINGTON	328 JACK FROST
29 GREENWOOD	179 MCALLISTERVILLE	329 HARWOOD 230/69KV
30 MDVRY	180 NEWFUNDLAND	330 HARWOOD CTG
31 ALTAHOUNT	181 MARLIN	331 HARWOOD 69/12KV
32 HAMLIN	182 WEST BERWICK	332 NAZARETH
33 ASHFIELD	183 KEYSER AVENUE	333 ALBURTIS
34 SOUTH SLATINGTON	184 MICKLEY	334 FRACKVILLE
35 MIDDLEBURG	185 EAST ALLENTOWN	335 ELMSPORT
36 WALKER	186 PINE RIDGE	336 ELIMSPORT
37 MORGANTOWN	187 DALMATIA	337 ELLENWOOD
38 EGYPT	188 PENNSBURG	338 *
39 CRESSONA	189 NORTH COLUMBIA	339 GRATZ
40 SOUTH WHITEHALL	190 HUGHESVILLE	340 HOCKERSVILLE
41 EAST IDMHICKEN	191 SOUTH ALLENTOWN	341 BLOOMING GROVE
42 BEAR GAP	192 MORGANTOWN	342 MONROE
43 SALISBURY	193 EGYPT	343 LACKAWANNA ##
44 PALMERTON	194 HONEYBROOK	344 STANTON
45 HEIDELBERG	195 MOSCOW	345 JACKSON
46 LYKEN	196 SOUTH WHITEHALL	346 EAST PALMERTON
47 RICHLAND	197 ROSSMOYNE	347 SIEGFRIED
48 MACADA	198 NORTHAMPTON	348 HOSENSACK 230/69KV
49 ROCKVILLE	199 VICTOR	349 HOSENSACK 500KV
50 THOMPSONTOWN	200 SOUTH WILTON	350 CONESTOGA
51 COCALICO	201 ELIZABETHTOWN	351 MANOR
52 EARL	202 ENOLA	352 CLINTON
53 HENFIELD	203 UPPER HILL	353 EXCHANGE
54 EAST LANCASTER	204 BUCK	354 MILTON
55 KINZER	205 MT. BETHEL	355 DAUPHIN
56 MT. NEBO	206 RICHFIELD	356 QUARRY SUB.
57 MT. PICCINO	207 SCRANTON	357 STEELTON
58 PENNS	208 TWIN LAKES	358 JUNIATA 500/230KV
59 GOULDSBORO	209 HARLEIGH	359 JUNIATA 230/69KV
60 DILLERSVILLE	210 EAST ELIZABETHTOWN	360 CUMBERLAND
61 GIRARD MANOR	211 BEAR CREEK	361 DONEGAL
62 KENMAR	212 DRIVSBURG	362 JENKINS 230/69KV
63 GOVEN CITY	213 EAST TEXAS	363 JENKINS CTG
64 ELLIOT HEIGHTS	214 CANDENSIS	364 WILKES-BARRE
65 ROHRERS TOWN	215 KINZER	365 BUXMONT
66 MACUNGIE	216 MT. JOY	366 SOUTH AKRON 230/138/69KV
67 EAST HAZLETON	217 W. BLOOMSBURG	367 SOUTH AKRON 69/12KV
68 WAGNERS	218 MINSI TRAIL	368 SOUTH MANHEIM 69/12KV
69 CARBONDALE	219 LAKE NADMI	369 SOUTH MANHEIM 230/69KV
70 EYOND	220 LAMARK	370 ENGLESDALE
71 MINDOKA	221 MONTGURSVILLE	371 COLUMBIA
72 OLD FORGE	222 FORT CARBON	372 DANVILLE
73 FOUNTAIN SPRINGS	223 BLYTHEBURN	373 SUNBURY
74 SULLIVAN TRAIL	224 MILFORD	374 HUMMEL'S WHARF
75 SWATARA	225 TRECILERS	375 LYCDING
76 HEPBURN	226 TRECHLERS	376 LOCK HAVEN CTG
77 HATFIELD	227 RUTHERFORD	377 LOCK HAVEN 69/12KV
78 HERSHEY	228 HARTLAND	378 HUMMELSTOWN
79 FRANCONIA	229 PARRISH	379 WEST SHORE
80 ECHOLS	230 WEST NEW HOLLAND	380 MONTAGE
81 MORRISON	231 POINT	381 SOUTH FARMERSVILLE
82 THROOP	232 LINCOLN	382 WESCOSVILLE
83 *	233 MIDDLETON	383 FISHBACH
84 *	234 STATE HILL	384 BERKS
85 *	235 MILLVILLE	385 MONTAUR
86 *	236 LAKEVILLE	386 SUBURBAN YARD
87 *	237 NORTH MANHEIM	387 *
88 *	238 HATFIELD	388 *
89 *	239 HERSHEY	389 MACK
90 *	240 S. HERSHEY	390 WILLIAMSPORT
91 *	241 S. WILLIAMSPORT	391 HARRISBURG
92 *	242 FOGELSVILLE	392 ELDRED
93 *	243 VINDSOR	393 *
94 *	244 WEST GATE	394 MILLWOOD
95 *	245 EDELA	395 TELFORD
96 *	246 SUMMERDALE	396 TWIN VALLEY
97 *	247 BERRYVILLE	397 DEVONSHIRE
98 *	248 BOHEMIA	398 JESSUP
99 *	249 WHITE HAVEN	399 BELTZVILLE
100 *	250 LAURELTON	400 HAWLEY
101 *	251 LINGLESTOWN	401 EFFORT MOUNTAIN
102 *	252 POCONO FARMS	402 COPPERSTONE
103 *	253 HICKORY RUN	403 RED FRONT
104 *	254 BLOOMING GLEN	404 APPENZEL
105 *	255 SHERMANSDALE	405 BLUE MOUNTAIN
106 *	256 HARRY'S CREEK	406 DAPPERS 69-12KV
107 *	257 SEIDERSVILLE	407 MEISERVILLE
108 *	258 SPANGLER MILLS	
109 *	259 E. DANVILLE	
110 *	260 DELAND	
111 *	261 CARBON	
112 *	262 SELLERSVILLE	
113 *	263 MECHANICSBURG	
114 *	264 CARLISLE	
115 *	265 CEDAR	
116 *	266 ARROWHEAD	
117 *	267 NEWPORT	
118 *	268 HALIFAX	
119 *	269 MILLERSBURG	
120 *	270 MUNNY	
121 *	271 HAITO	
122 *	272 BERWICK	
123 *	273 SHENANDOAH	
124 *	274 PINE GROVE	
125 *	275 STRUDSBURG	
126 *	276 FREEMANSBURG	
127 *	277 ALLENTOWN	
128 *	278 BINGEN	
129 *	279 RHEIMS	
130 *	280 CLEVELAND	
131 *	281 LITTLE GAP	
132 *	282 ORVILLE	
133 *	283 TUSCARORA	
134 *	284 BARTONSVILLE	
135 *	285 ALTON PARK	
136 *	286 SALEM	
137 *	287 NORTH BRIDGEPORT	
138 *	288 HAMPDEN	
139 *	289 CAMEL BACK	
140 *	290 SILVER SPRING	
141 *	291 BRECKNOCK	
142 *	292 BENTON	
143 *	293 MCMICHAEL'S	
144 *	294 HIGHESTOWN	
145 *	295 NEWVILLE	
146 *	296 POINTE NORTH	
147 *	297 MARIETTA	
148 *	298	
149 *	299	
150 *	300	

\* - SUBSTATIONS THAT HAVE BEEN RETIRED.  
## - SITE OF THE EXISTING 230KV SUBSTATION AND PROPOSED 500KV SUBSTATION



## INTERCONNECTIONS

PS PUBLIC SERVICE ELECTRIC AND GAS CO. OF N.J.  
ME METROPOLITAN EDISON CO. (FIRST ENERGY)  
PE PHILADELPHIA ELECTRIC CO. (PECO ENERGY)  
BC BALTIMORE GAS AND ELECTRIC CO.  
SH SAFE HARBOR WATER POWER CORPORATION  
UP THE UNITED GAS IMPROVEMENT CO. - LUZERNE ELECTRIC DIVISION  
PN PENNSYLVANIA ELECTRIC CO. (FIRST ENERGY)  
JC JERSEY CENTRAL POWER AND LIGHT CO. (FIRST ENERGY)

COMBUSTION TURBINE	●	500KV OPERATION
HYDRO ELECTRIC	○	230KV OPERATION
COMBINATION	◻	138KV OPERATION
FIRM SALES	⊕	69KV OPERATION
SUBSTATION / SWITCHING STATION	⊙	
STEAM ELECTRIC	◻	
NON-UTILITY GENERATION	△	
INDEPENDENT POWER PRODUCERS	◻	

ACCT - 805201  
SCALE - NONE  
BY - CDW

ELECTRICAL SYSTEM MAP  
ELROY - HATFIELD #1 & #2  
138/69KV LINE

APPROVED G. HAKUN III DATE 7/17/05  
PPL DRAWING NO. D191830 SHEET NO. 1 REV. 84

# **Attachment**

# **2**

**ATTACHMENT "2"**  
**ELROY - HATFIELD #1 & #2 138/69 kV LINE**  
**ENGINEERING DESCRIPTION**

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**MAP**

MAP 1	AERIAL EXHIBIT – DRAWING.....	ATTACHMENT "2" MAP POCKET
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**ATTACHMENT "2"**  
**ELROY - HATFIELD #1 & #2 138/69 kV LINE**  
**ENGINEERING DESCRIPTION**

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**A. DESCRIPTION OF PROPOSED LINE**

PPL Electric proposes to design and construct the Elroy – Hatfield #1 & #2 138/69 kV Transmission Line. The proposed line will exit the existing Elroy 500-138-69 kV Substation and will extend approximately 2.03 miles to the existing Buxmont – Hatfield #3 & #4 138/69 kV Transmission Line just north of the existing Hatfield 69-12 kV Substation. The transmission line will be designed and constructed for double-circuit 138 kV operation, although it will initially be operated at 69 kV. The transmission line will be converted to 138 kV operation when future load increases make it appropriate in order to maintain service reliability. The location of the proposed transmission line is depicted on the Aerial Exhibit included in the map pocket located at the end of Attachment "2".

The proposed transmission line will be supported by approximately 27 steel monopoles with an average height of approximately 85 feet and an average span of 450 feet (see Figures 1 and 2). The proposed steel monopoles will be either direct embedded or installed on concrete foundations. This work will be completed entirely within an existing utility corridor. This corridor includes property owned in fee by PPL Electric, right-of-way owned by PPL Electric, property owned in fee by PECO and right-of-way owned by PECO. No additional right-of-way is required, because PPL Electric and PECO have entered into an agreement under which PPL Electric may utilize the portions of the utility corridor which are owned by PECO or subject to a right-of-way owned by PECO that are required for the Elroy-Hatfield Transmission Line.

The proposed transmission line will consist of six power conductors and one overhead ground wire. The power conductors will be 556.5 kcmil,<sup>1</sup> 24/7 strand ACSR<sup>2</sup> and one 0.562" optical

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<sup>1</sup> A kcmil is a thousand circular mils. A circular mil is the cross-sectional area of a wire one mil in diameter, where 1 kcmil = 0.5067 mm<sup>2</sup>.

<sup>2</sup> Aluminum conductor steel reinforced.

ground wire (“OPGW”). The overhead ground wire will provide lightning protection for the proposed tap line. Additionally, two self-supporting high-low tap poles will be placed near the connection point near the Hatfield Substation (Figure 3). These two tap poles will likely be placed on foundations. The tap poles will be used to tie the new line into the existing Buxmont - Hatfield #3 & #4 lines. These poles are at two different heights in order to allow clearance for one circuit to pass over the other at this “T” point where these lines meet. Five new load sectionalizing air brakes (“LSABs”) and associated poles will be added on the existing transmission lines near the Elroy and Hatfield substations. Additionally, two existing poles adjacent to the Elroy Substation will be relocated as part of this project in order to accommodate the new transmission line.

The new double-circuit 138/69 kV transmission line will be designed according to, and will generally surpass, National Electrical Safety Code (“NESC”) minimum standards. Additional design criteria and safety rules practiced by PPL Electric are explained in Attachment “4”. The minimum conductor-to-ground clearance will be 30.5 feet for the new 138/69 kV line. This minimum clearance occurs at a maximum thermal conductor temperature of 125°C. The design minimum conductor clearances and conductor thermal rating are provided in Table 1 and Table 2 respectively.

**TABLE 1**

**DESIGN MINIMUM CONDUCTOR CLEARANCES  
FOR 556.5 KCMIL 24/7 STRAND ACSR<sup>3</sup>**

<u>Condition</u>	<u>Double-Circuit Design Clearance-to-Ground</u>
Normal load, average weather (16°C ambient, 60°F temperature)	35.5 feet
Predicted extreme thermal load (125°C conductor, 257°F temperature)	30.5 feet
Predicted NESC extreme wind load conditions (25 lbs., 16°C, 60°F temperature)	32.8 feet
Predicted extreme weather conditions (1-inch ice, 4 lbs. wind, -18°C, 0°F)	32.5 feet

**TABLE 2**

**CONDUCTOR THERMAL RATING  
556.5 KCMIL 24/7 ACSR  
125°C MAXIMUM CONDUCTOR TEMPERATURES**

<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

<sup>3</sup> Clearances based on an initial maximum tension of 9,000 pounds and a ruling span of 450 feet.

## **B. MAGNETIC FIELD MANAGEMENT**

PPL Electric's Magnetic Field Management Program is summarized in Attachment "5" and is applied to all reconstruction and new line projects. In order to lower magnetic field exposures, the program generally prescribes a line design that provides for ground clearances that are five feet higher than those required under the NESC, and reverse 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 that those modifications can be made at low or no cost and will not interfere with the operation of the line.

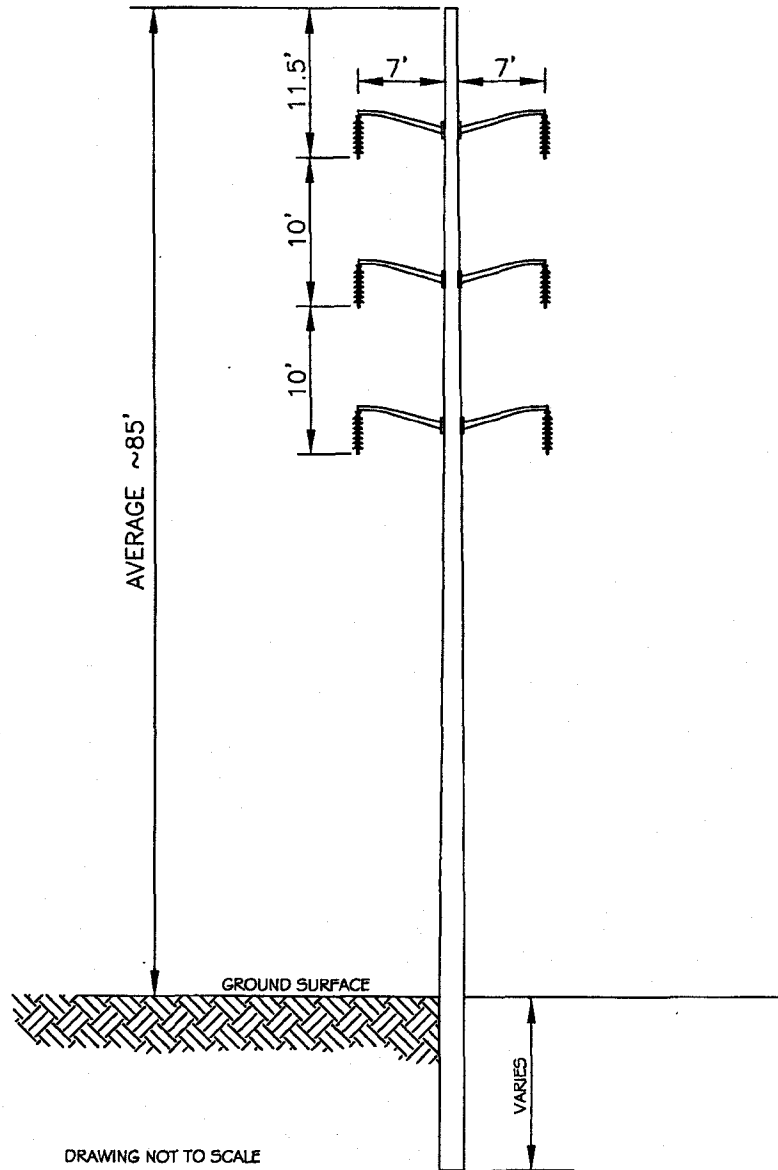
For this project, increased structure height and reverse phasing will be incorporated in the design of the new transmission line to reduce magnetic field exposures.

## **C. RIGHT-OF-WAY STATUS**

This work will be completed entirely within an existing utility corridor. This corridor includes property owned in fee by PPL Electric, right-of-way owned by PPL Electric, property owned in fee by PECO and right-of-way owned by PECO. This utility corridor is shown on the aerial exhibit included within this Attachment. In addition, a typical cross section of the right-of-way is included as Figure 5. No additional right-of-way is required, because PPL Electric and PECO have entered into an agreement under which PPL Electric may utilize the portions of the utility corridor which are owned by PECO or subject to a right-of-way of PECO that are required for the Elroy-Hatfield Transmission Line.

One railroad crossing will be required over a Southeast Pennsylvania Transportation Authority (SEPTA) rail line near the northern terminus of the line.

**FIGURE 1**  
**PROPOSED 138/69 kV TANGENT STRUCTURE**  
**AVERAGE HEIGHT – APPROXIMATELY 85'**



**POLE STATISTICS**

**Average Height – 85 feet**

**Top Phase Arm Length – 7 feet**

**Middle Phase Arm Length – 7 feet**

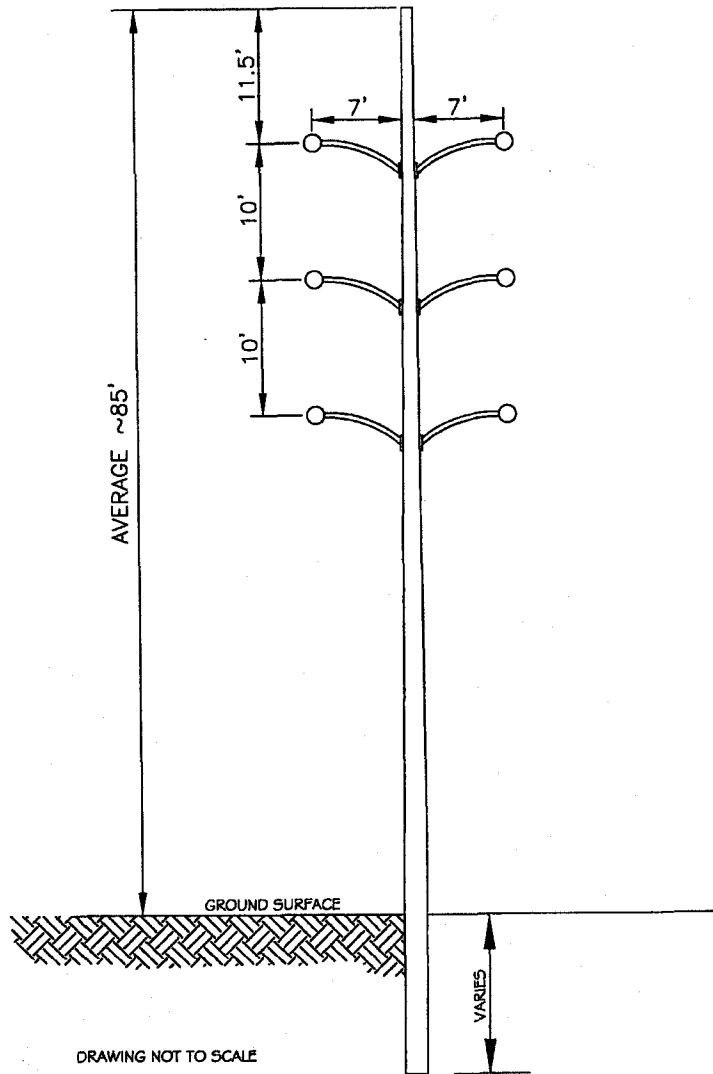
**Bottom Phase Arm Length – 7 feet**

**Vertical Spacing:**

**Overhead Shield Wire to Top Phase – 11.5 feet**

**Conductor Attachment Spacing – 10 feet**

**FIGURE 2**  
**PROPOSED 138/69 kV TENSION STRUCTURE**  
**APPROXIMATE AVERAGE HEIGHT – 85'**



**POLE STATISTICS**

**Average Height – 85 feet**

**Top Phase Arm Length – 7 feet**

**Middle Phase Arm Length – 7 feet**

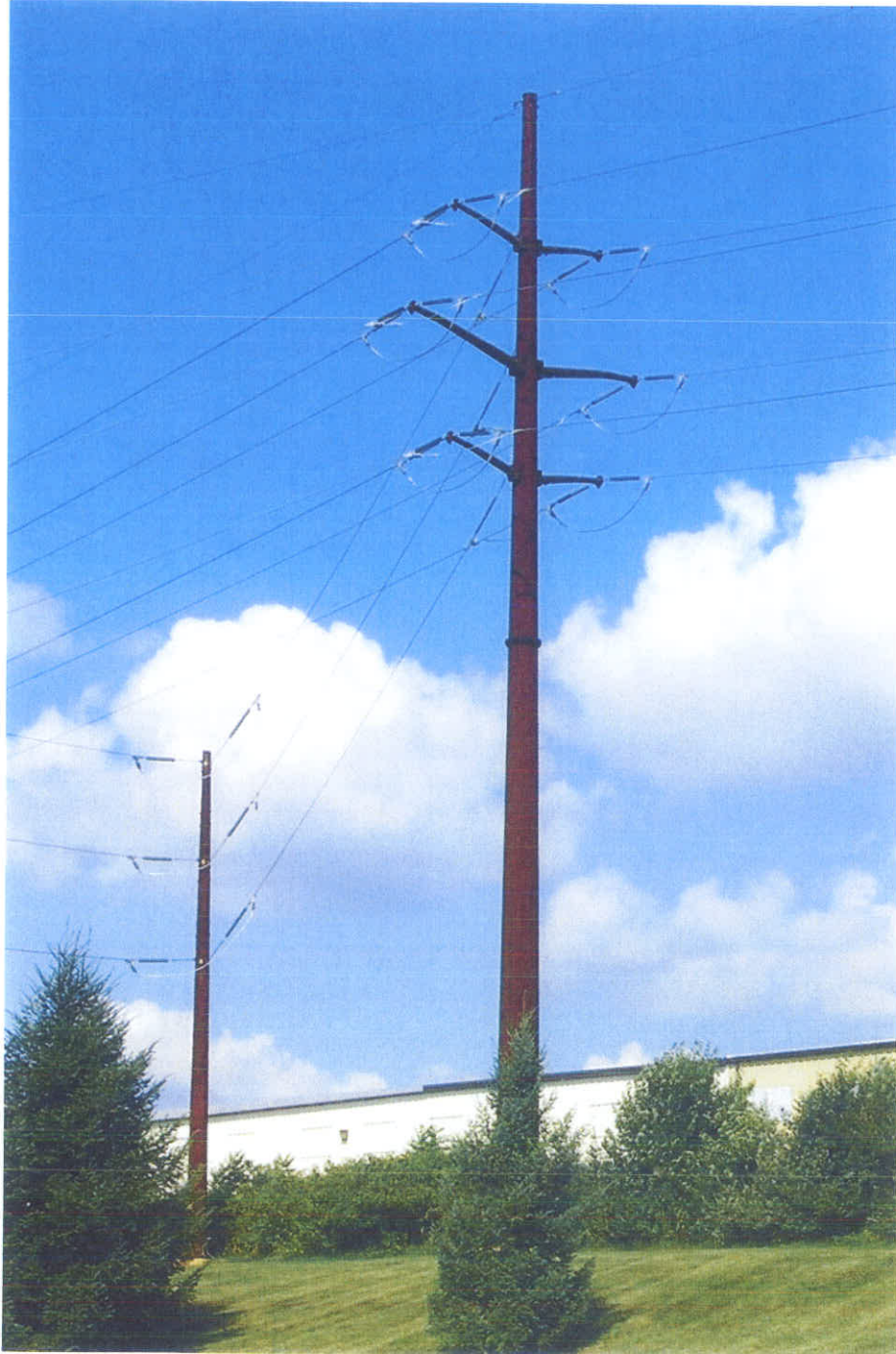
**Bottom Phase Arm Length – 7 feet**

**Vertical Spacing:**

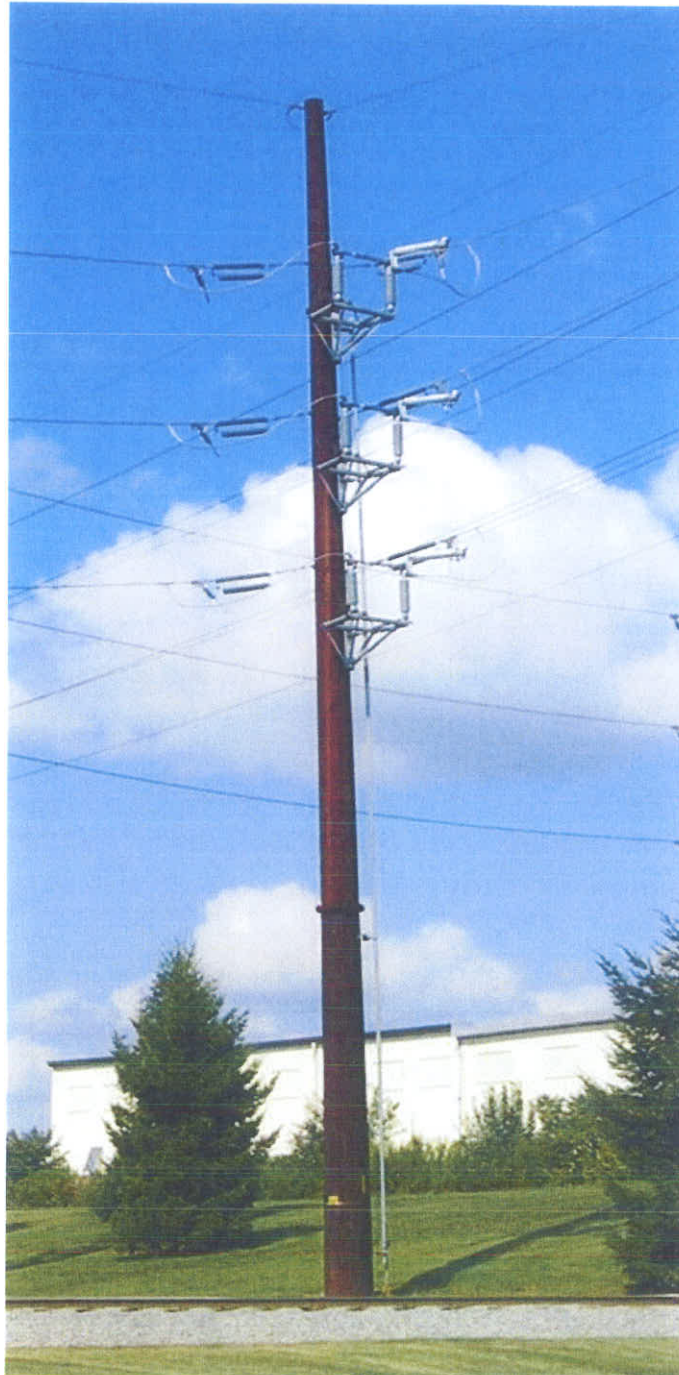
**Overhead Shield Wire to Top Phase – 11.5 feet**

**Conductor Attachment Spacing – 10 feet**

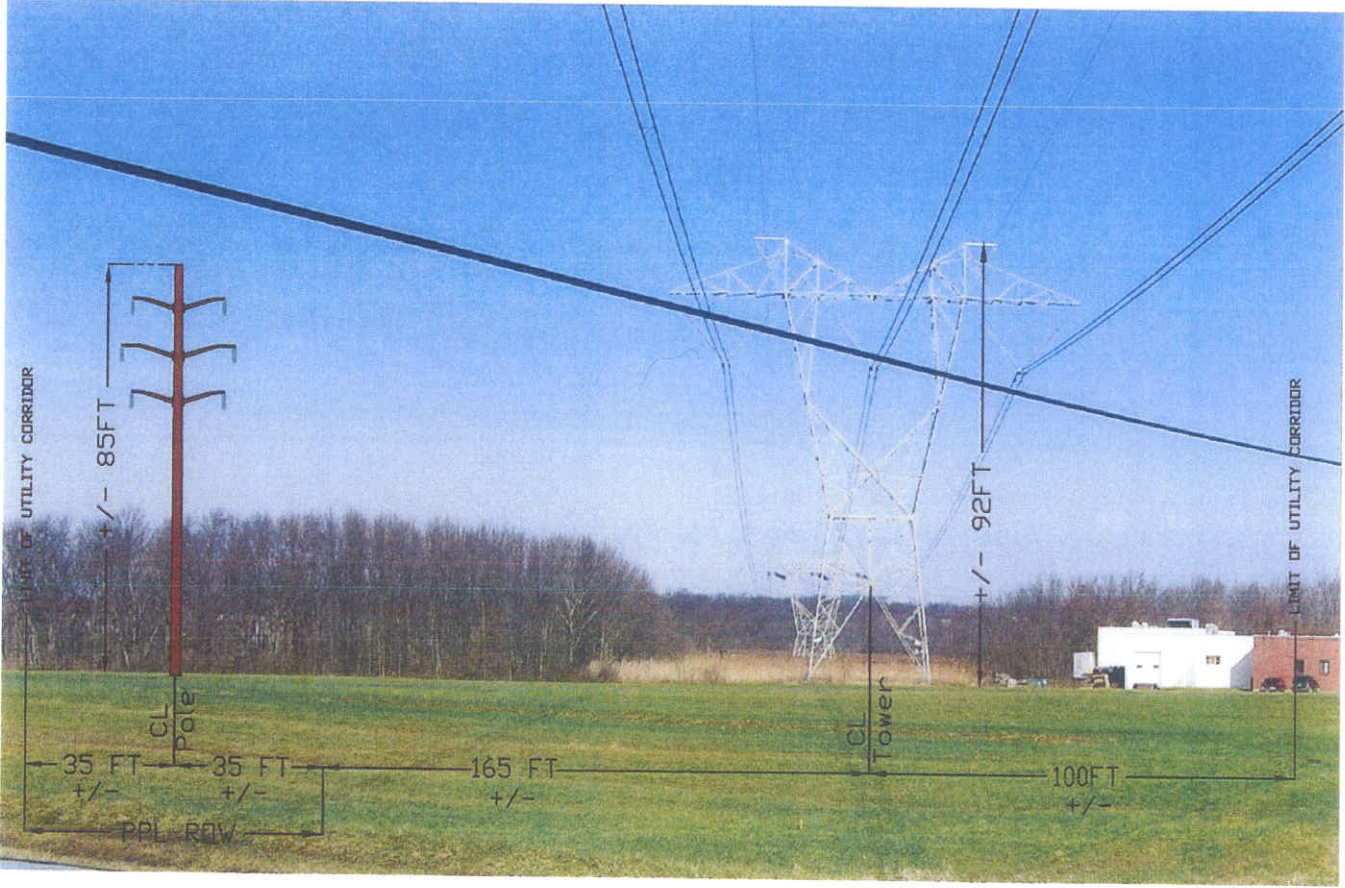
**FIGURE 3**  
PROPOSED 138/69 kV HIGH-LOW TAP POLES  
APPROXIMATE AVERAGE HEIGHT – 105' & 65'



**FIGURE 4**  
PROPOSED 138/69 kV SWITCH POLE  
APPROXIMATE AVERAGE HEIGHT – 85'



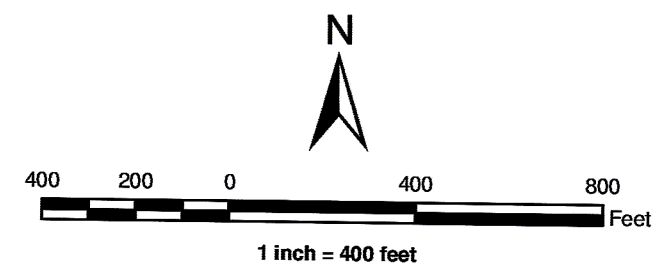
**FIGURE 5**  
PROPOSED UTILITY CORRIDOR LAYOUT





Owners of Property within the Right of Way				
Label	Owner Name	Mailing Address	Mailing City State Zip	
1	PECO Energy Company	2301 Market St	Philadelphia PA 19103	
2	Southeastern Pennsylvania Transportation Authority	1234 Market Street	Philadelphia PA 19107	
3	Craft-Bilt Manufacturing Co.	53 Hatfield Pike	Souderton PA 18964	
4	Izzybop Properties LLC	70 Souderton Pike Ste 200	Souderton PA 18964	
5	PECO Energy Company	2301 Market St	Philadelphia PA 19103	
6	PECO Energy Company	2301 Market St	Philadelphia PA 19103	
7	PECO Energy Company	2301 Market St	Philadelphia PA 19103	
8	PECO Energy Company	2301 Market St	Philadelphia PA 19103	
9	PPL Electric Utilities	9th & Hamilton St	Allentown PA 18101	
10	PECO Energy Company	2301 Market St	Philadelphia PA 19103	
11	Robert & Linda Roth	1578 Heebners Way	Lansdale PA 19446	
12	Coatings for Industry	319 Township Line Rd	Souderton PA 18964	
13	PECO Energy Company	2301 Market St	Philadelphia PA 19103	
14	PECO Energy Company	2301 Market St	Philadelphia PA 19103	
15	PECO Energy Company	2301 Market St	Philadelphia PA 19103	
16	PECO Energy Company	2301 Market St	Philadelphia PA 19103	
17	TH Properties LP	345 Main St	Harleysville PA 19438	
18	PPL Electric Utilities	Two N Ninth St	Allentown PA 18101	

Notes:  
 Montgomery County Parcel Data 2010  
 Montgomery County 2008 PAMAP Imagery  
 PPL Electric Utilities' Data  
 NAD 1983 StatePlane Pennsylvania South  
 Projection: Lambert Conformal Conic  
 Linear Unit: US Foot



## Aerial Exhibit Elroy - Hatfield #1 & #2 138/69 kV Transmission Line

**Hatfield & Franconia Townships  
 Montgomery County, Pennsylvania**

- Legend**
- Proposed Elroy-Hatfield Transmission Line
  - Right of Way
  - Property Boundary from PECO tax maps
  - Property Line (Approx)
  - Municipalities



# **Attachment**

# **3**

**ATTACHMENT "3"**  
**ELROY - HATFIELD #1 & #2 138/69 kV LINE**  
**ENVIRONMENTAL ASSESSMENT**

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**ATTACHMENT "3"**  
**ELROY - HATFIELD #1 & #2 138/69 kV LINE**  
**ENVIRONMENTAL ASSESSMENT**

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**A. INTRODUCTION**

PPL Electric proposes to reinforce the 138/69 kV electric delivery system in Montgomery and Bucks Counties. To accomplish this reinforcement, PPL Electric requests approval to construct the Elroy – Hatfield #1 & #2 138/69 kV Transmission Line. This new double-circuit transmission line will begin at the existing Elroy 500-138-69 kV Substation and tie into the existing Buxmont – Hatfield #3 & #4 69 kV transmission line just north of the existing Hatfield 69-12 kV Substation. The transmission tap will be designed for double-circuit 138 kV operation, although it initially will be operated at 69 kV. The proposed transmission line will be constructed within an existing utility corridor.

PPL Electric provided information describing the project to Hatfield and Franconia Townships and Montgomery County, and neither the Townships nor the County objected to the project. A list of involved governmental agencies, municipalities, and other public entities is listed in Attachment "6".

**B. LAND USE**

Construction of the proposed line will have minimal incremental impacts, as it will be constructed within an existing utility corridor. The minimum width of the existing utility corridor is 300 feet. It was sized to provide adequate space to accommodate multiple transmission lines. Currently, the entire length of the utility corridor is occupied by a PECO single-circuit 500 kV transmission line. The existing structures for PECO's transmission line are lattice towers that range from 90 to 110 feet in height.

In addition, the southern portion of the utility corridor, near PPL Electric's Elroy 500-138-69 kV Substation and PECO's Elroy 500kV Switchyard, is occupied by PPL Electric's Elroy #1 and #2 69 kV Taps ("Elroy Taps"), which are supported by structures that are 60 to 95 feet in height, and Hatfield Quality Meats' #1 and #2 69 kV Taps ("Hatfield Taps"), which are supported by structures that range from 75 to 95 feet in height. The structures that support these tap lines are either wood or steel.

Due to the presence of the existing, larger 500 kV transmission line in the right-of-way, the incremental visual impacts from PPL Electric's proposed Elroy-Hatfield #1 and #2 138/69 kV Transmission Line will be minimal.

No nearby communication towers, pipelines or other utilities will be affected by the proposed project. Pennridge Airport, located in Sellersville, is the nearest airport and is located approximately 5.8 miles to the north of the project site. Impacts to this airport are not expected due to the distance between the project and the airport, the orientation of the runways with respect to the project location and the presence of the existing, larger 500 kV transmission line of PECO. PPL Electric will file the appropriate notifications with the Federal Aviation Administration and PennDOT Bureau of Aviation to confirm that the proposed transmission line will not be a hazard to the airport's flight operations.

One railroad crossing will be required over a SEPTA rail line near the northern terminus of the line.

A combination of new and existing access roads will be used for construction. All disturbed areas will be stabilized after construction. As the new transmission line is located in an existing utility corridor, widespread tree clearing will not be required. Some tree clearing will be required along the edge of the corridor and to access some work areas. In addition, some brush removal and limited tree clearing may be required to access the work areas. PPL Electric will apply its "Specifications for Initial Clearing and Control of Vegetation on or Adjacent to Electric Right-of-Way Through Use of

Herbicides, Mechanical, and Hand Clearing Techniques” when performing these activities.

### **C. CULTURAL RESOURCES**

The project was reviewed by the Pennsylvania Historical and Museum Commission (PHMC). The PHMC has determined that this project will not affect any historic buildings, structures, districts or objects that are eligible for the National Register of Historic Places. Furthermore, it is PHMC’s opinion that no archeological resources will be affected by this project (File No. ER 10-1181-091-A). Therefore, no impacts to such resources are anticipated and no further investigations are required.

### **D. NATURAL FEATURES**

The project will not affect any unique geological, scenic, state parks, game lands or forests, or natural areas due to their distance from the project site. The recreational areas located closest to the project site include two small local parks, John S. Clemens Memorial Park located approximately 0.5 miles from the project site and Enos Godshall Park located approximately 0.9 miles from the project site. There are no anticipated impacts to these features since: (1) the proposed transmission line will be constructed adjacent to an existing 500 kV transmission line within an established utility corridor, (2) the distances from the project area and the parks, and (3) the existing vegetative buffer between the project area and the parks.

The transmission line will cross 6 wetlands and 2 streams. All wetlands and waters have been delineated and have been added to the construction drawings. All wetlands and waters are easily spanned and, therefore, no impacts to these features are anticipated. PPL Electric will obtain all required permits from the Pennsylvania Department of Environmental Protection and the United States Army Corps of Engineers prior to construction, and PPL Electric will comply with all conditions placed on those permits.

In addition, PPL Electric will obtain any required soil erosion and sedimentation control permits and comply with conditions placed on those permits.

**E. THREATENED AND ENDANGERED SPECIES**

PPL Electric has coordinated with state and federal agencies to obtain information regarding threatened and endangered species in close proximity to the project area. A review of the Pennsylvania Natural Diversity Inventory (PNDI) records indicates that no species of concern are located on the project site (Reference PNDI # 20100318234513). Given the presence of wetlands on the project site, PPL Electric contracted URS Corporation to conduct a bog turtle habitat assessment to identify whether these wetlands provide suitable bog turtle habitat. Results of this assessment indicated that, although there was typical vegetation and spring fed hydrology, the wetlands did not contain the mucky soil that bog turtle habitat requires. Therefore, there are no bog turtles in the right-of-way.

# **Attachment**

**4**

**LIST OF SUPPLEMENTAL ATTACHMENTS**

**ATTACHMENT "4"** PPL Design Criteria and Safety Practices

**ATTACHMENT "5"** PPL Magnetic Field Management Program

**ATTACHMENT "6"** List of Property Owners Within the Right-of-Way

**ATTACHMENT "7"** List of Involved Governmental Agencies, Municipalities  
and Other Public Entities

**ATTACHMENT "4"**  
**ELROY - HATFIELD #1 & #2 138/69 kV LINE**  
**PPL ELECTRIC DESIGN CRITERIA AND SAFETY PRACTICES**

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The National Electrical Safety Code (NESC) is a set of rules to safeguard people during the installation, operation, or 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 provisions 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 such things 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. Numerous 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

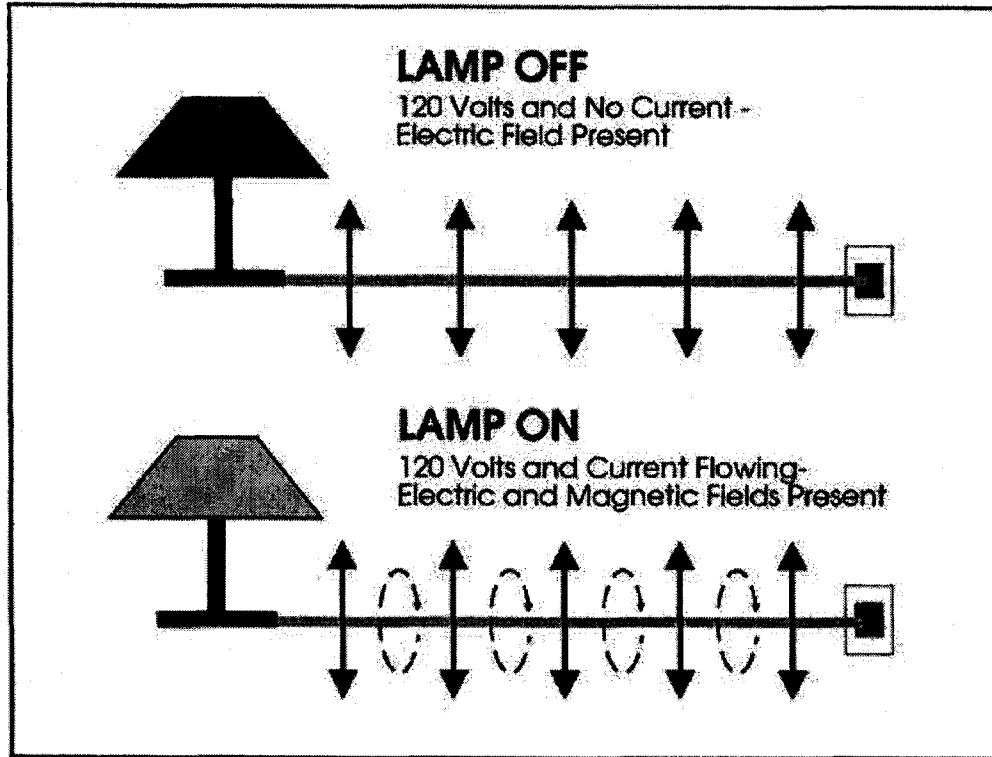


Figure 2









Magnetic field strengths decrease with distance Magnetic fields are measured in milligauss		Source: "EMF in Your Environment", U.S. Environmental Protection Agency 1992		
		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

<b>Sample Magnetic Field Levels in Milligauss</b>				
<b>Type of Overhead Power Line</b>	<b>Distance from the line</b>			
	<b>Under the line</b>	<b>50 ft.</b>	<b>100 ft.</b>	<b>200 ft.</b>
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**

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### **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.

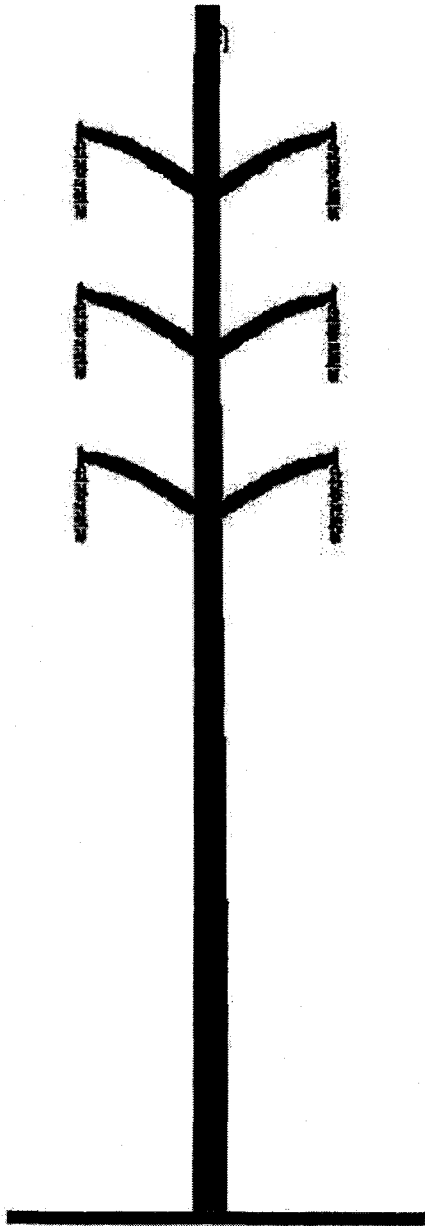
## **UNDERGROUND TRANSMISSION LINES**

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**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.**

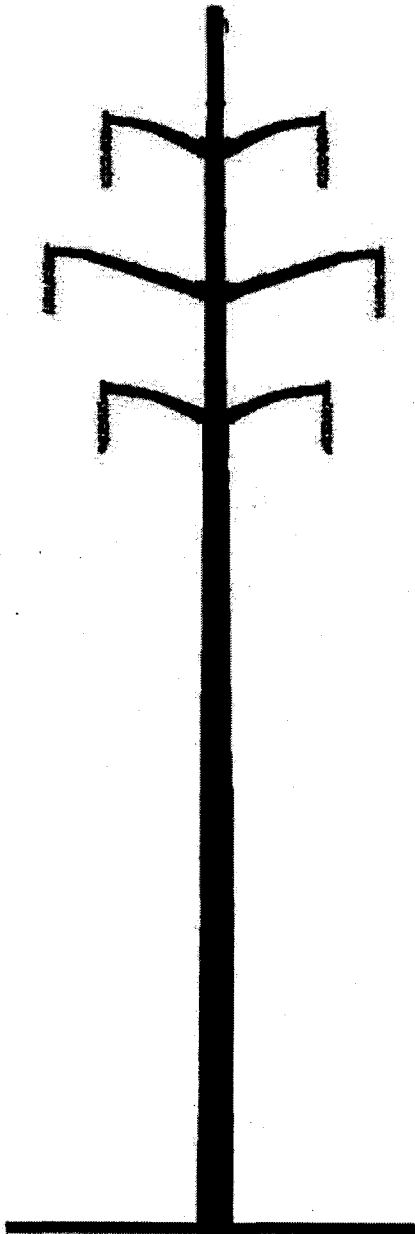
- The phase arrangement that produces the lowest field will be determined.
- The depth of burial of the line will be determined considering the cost of excavation and the location of other buried utilities in the area.
- The use of steel pipe ferromagnetic shielding that reduces magnetic fields will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



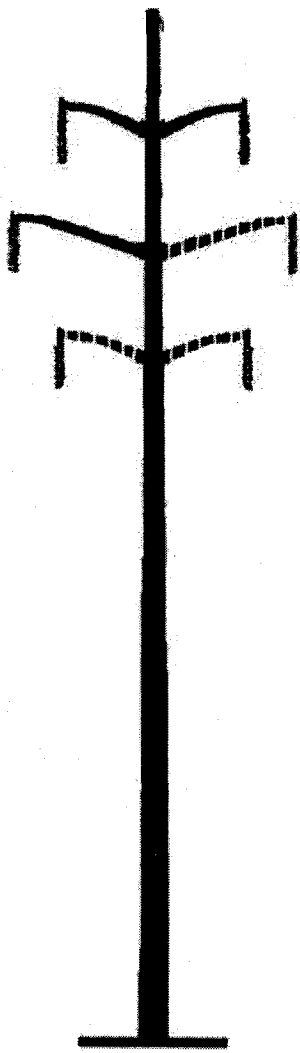
- Lower cost alternative
- Reduces magnetic fields due to higher structures
- Typical conductor data:
  - 1 3/8" HS steel overhead ground wire - 17.3 feet sag
  - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
  - Average span - 600 feet

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

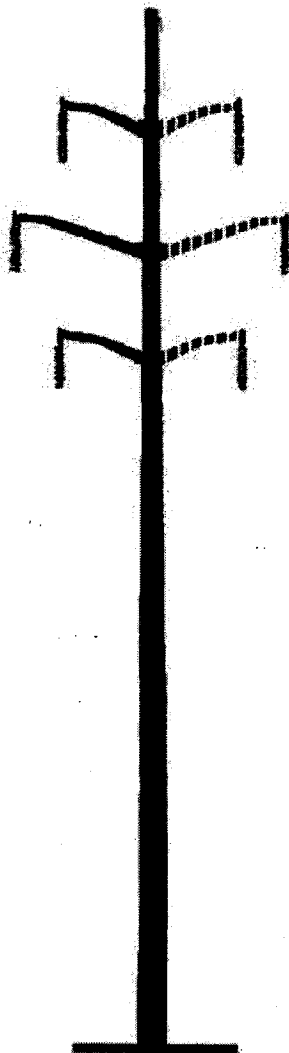
TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SHORT SPAN (CHART I)	30
SHORT SPAN (REVERSE PHASE)	8
LONG SPAN (CHART II)	29
LONG SPAN (REVERSE PHASE)	9
COMPACT (CHART VI)	14
COMPACT (REVERSE PHASE)	3

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.

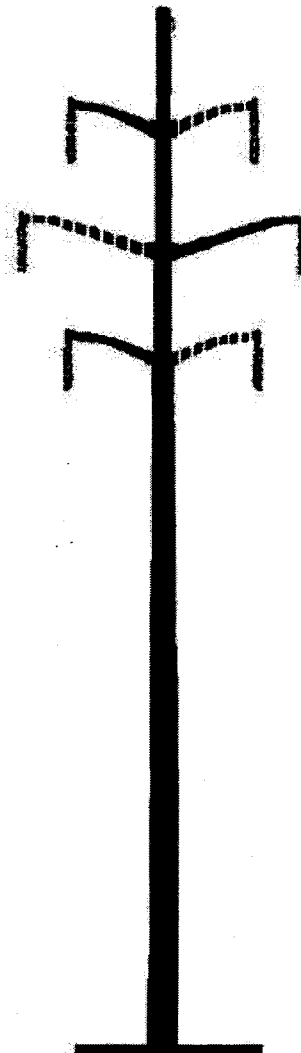
# Typical Single-Circuit Structure Designs



**Top/Middle**



**Vertical**



**Top/Middle/Bottom**

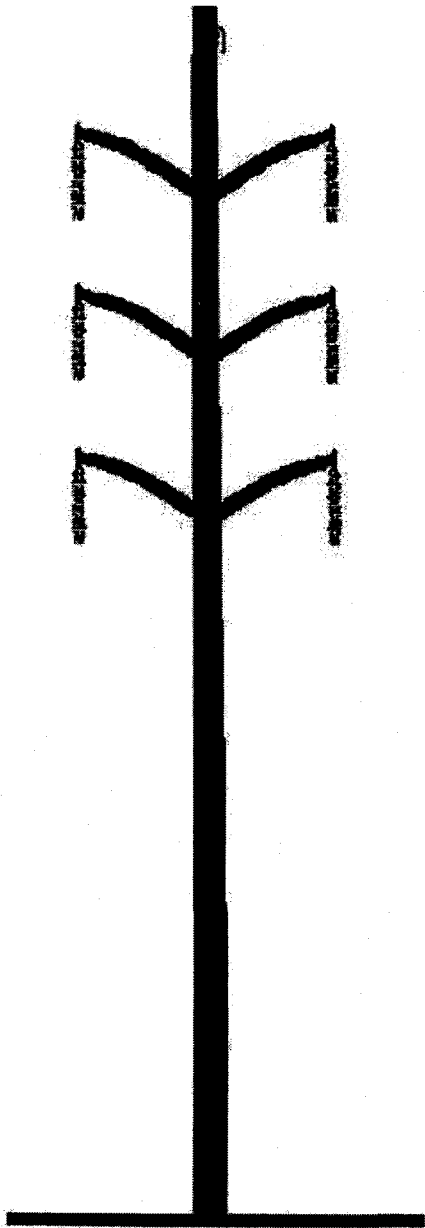
——— initial single circuit  
- - - - future second circuit

**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

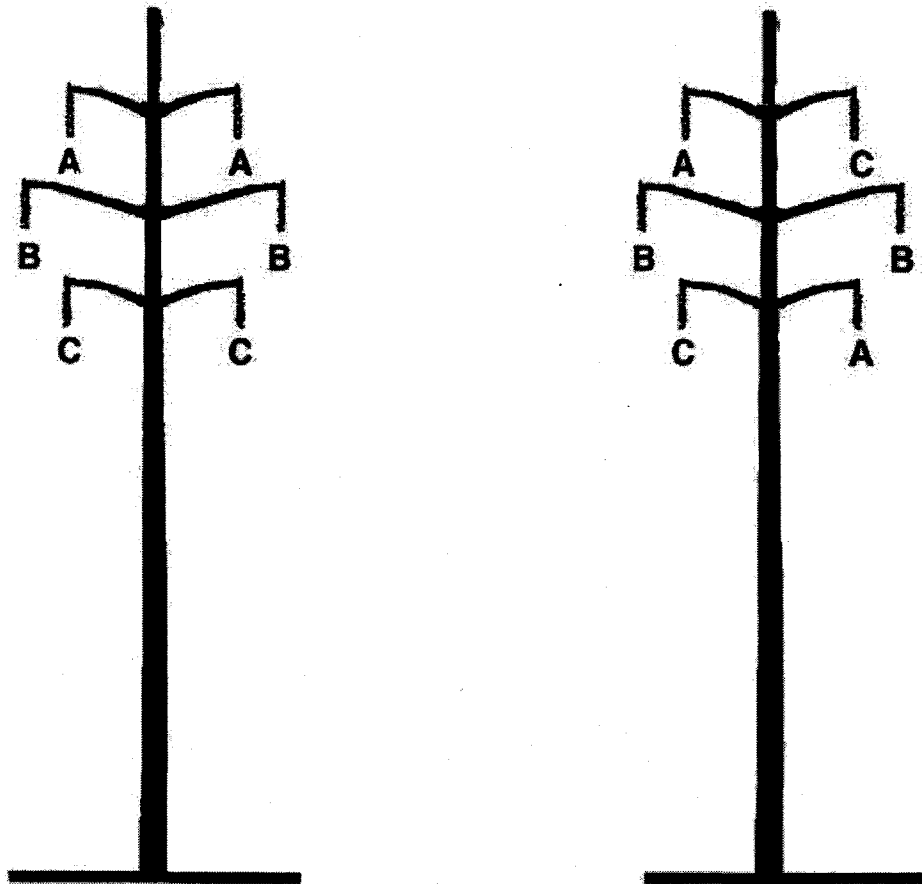
The edge of right of way is 50 feet from the line centerline.  
The 400 ampere phase current is balanced between phases.  
Calculations are based on a minimum ground clearance of 25 feet.

# 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"**  
**ELROY - HATFIELD #1 & #2 138/69 kV LINE**  
**LIST OF OWNERS OF PROPERTY WITHIN THE RIGHT-OF-WAY**

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**Property Identification Number  
(as shown on Aerial Exhibit)**

**Owners of Property and Mailing Address**

1	PECO Energy Company 2301 Market Street Philadelphia, PA 19103
2	Southeastern Pennsylvania Transportation Authority 1234 Market Street Philadelphia, PA 19107
3	Craft-Bilt Manufacturing Co. 53 Hatfield Pike Souderton, PA 18964
4	Izzybop Properties LLC 70 Souderton Pike Ste 200 Souderton, PA 18964
5	PECO Energy Company 2301 Market Street Philadelphia, PA 19103
6	PECO Energy Company 2301 Market Street Philadelphia, PA 19103
7	PECO Energy Company 2301 Market Street Philadelphia, PA 19103
8	PECO Energy Company 2301 Market Street Philadelphia, PA 19103
9	PPL Electric Utilities 2 North Ninth Street Allentown, PA 18101
10	PECO Energy Company 2301 Market Street Philadelphia, PA 19103

ATTACHMENT 6 – LIST OF OWNERS OF  
PROPERTY WITHIN THE RIGHT-OF-WAY

**Property Identification Number  
(as shown on Aerial Exhibit)**

**Owners of Property and Mailing Address**

11	Robert & Linda Roth 1578 Heebners Way Lansdale, PA 19446
12	Coatings for Industry 319 Township Line Rd Souderton, PA 18964
13	PECO Energy Company 2301 Market Street Philadelphia, PA 19103
14	PECO Energy Company 2301 Market Street Philadelphia, PA 19103
15	PECO Energy Company 2301 Market Street Philadelphia, PA 19103
16	PECO Energy Company 2301 Market Street Philadelphia, PA 19103
17	TH Properties LP 345 Main Street Harleysville, PA 19438
18	PPL Electric Utilities 2 North Ninth Street Allentown, PA 18101

# **Attachment**

# **7**

**ATTACHMENT "7"**

**ELROY - HATFIELD #1 & #2 138/69 kV LINE**

**LIST OF INVOLVED GOVERNMENTAL AGENCIES, MUNICIPALITIES AND  
OTHER PUBLIC ENTITIES**

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

Pennsylvania Department of Transportation  
Commonwealth Keystone Building  
400 North Street, Eighth Floor  
Harrisburg, Pennsylvania 17120  
Attn: The Honorable Allen D. Beihler, P.E.,  
Secretary

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

Montgomery County Commissioners  
Montgomery County Courthouse  
PO Box 311  
Norristown, PA 19404-0311  
Attn: Mr. James R. Matthews, Chairman

Montgomery County Planning Commission  
Montgomery County Courthouse  
PO Box 311  
Norristown, PA 19404-0311  
Attn: Mr. P. Gregory Shelly, Executive Director

Franconia Township  
671 Allentown Road  
Telford, PA 18969-2205  
Attn: Mr. Kevin D. Baver, Township Manager

Franconia Township Board of Supervisors  
671 Allentown Road  
Telford, PA 18969-2205  
Attn: Mr. Steven P. Barndt, Chairman

Franconia Township Planning Commission  
671 Allentown Road  
Telford, PA 18969-2205  
Attn: Mr. Gerald R. DeLong, Chairman

Hatfield Township  
1950 School Road  
Hatfield PA 19440-1992  
Attn: Mr. Andrew S. Haines, Township  
Manager

Hatfield Township Board of Commissioners  
1950 School Road  
Hatfield PA 19440-1992  
Attn: Mr. Scott Brown, President

Hatfield Township Planning Commission  
1950 School Road  
Hatfield PA 19440-1992  
Attn: Mr. George Zisk, Chair

ATTACHMENT 7 – LIST OF INVOLVED  
GOVERNMENTAL AGENCIES,  
MUNICIPALITIES AND OTHER PUBLIC  
ENTITIES