



Before the
Pennsylvania Public Utility Commission

**WEST SHORE –
HARRISBURG
#1 & #2 138/69 kV LINE**

**Attachments 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 construct a new transmission line named the West Shore - Harrisburg #1 & #2 138/69 kV Transmission Line. The 1.3 mile transmission line is located in Lower Allen Township, Cumberland County and, with Commission approval, will be constructed entirely within existing PPL Electric right-of-way or land owned by PPL Electric in fee. Additionally, certain reconnections of 69 kV lines will be performed. Together, these actions will resolve the issues as more fully described in Attachment 1.

This Project is needed to alleviate a first contingency overload on the West Shore – Cumberland #1 69 kV Line for the loss of the existing West Shore – Harrisburg #1 69 kV Line. Under this condition, all of the existing White Hill 69-12 kV Substation load would automatically transfer to the West Shore – Cumberland #1 69 kV Line causing the overload. The new transmission line will be designed and built for 138 kV operation, although initially, both circuits will operate at 69 kV.

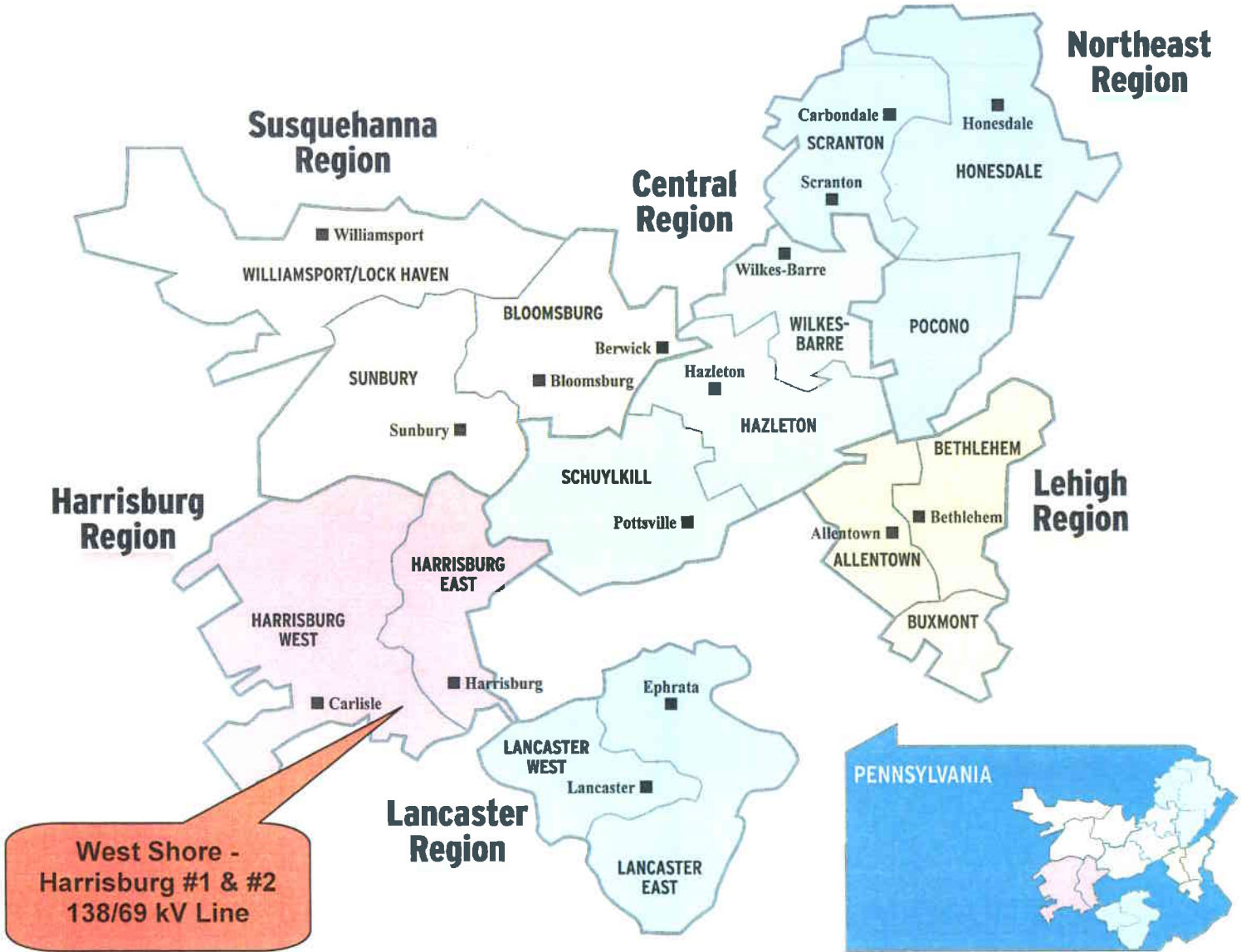
The estimated cost to site, design, and construct the new Harrisburg – West Shore #1 & #2 138/69 kV Line is \$1,895,400. Construction is scheduled to begin in April, 2012 to support the project's in-service date of May, 2013.

This document, which describes the need for the project and discusses the engineering and siting 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" - Magnetic Field Management at PPL
- Attachment "6" - List of Owners of Property With-in 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
WEST SHORE - HARRISBURG #1 & #2 138/69 kV TAP LINE
NECESSITY STATEMENT

TABLE OF CONTENTS

<u>SECTION</u>	<u>TOPIC</u>	<u>PAGE</u>
A.	INTRODUCTION.....	1
B.	EXISTING SYSTEM.....	2
C.	DEFINITION OF THE PROBLEM.....	2
D.	CONVERSION TO 138 kV.....	4
E.	PROPOSED SOLUTION.....	4
F.	ALTERNATIVES CONSIDERED.....	5

LIST OF FIGURES

FIGURE 1	FUNCTIONAL ONE-LINE DIAGRAM OF EXISTING TRANSMISSION FACILITIES.....	5
FIGURE 2	FUNCTIONAL ONE-LINE DIAGRAM OF PROPOSED TRANSMISSION FACILITIES.....	6
MAP 1	PPL ELECTRIC TRANSMISSION FACILITY MAP	ATTACHMENT 1 MAP POCKET

ATTACHMENT 1
WEST SHORE - HARRISBURG #1 & #2 138/69 kV TAP LINE
NECESSITY STATEMENT

A. INTRODUCTION

PPL Electric is requesting PUC approval to reinforce the 69 kV transmission facilities in Cumberland County by constructing a new double circuit transmission line from the West Shore 230 – 69 kV Substation to the White Hill 69 kV Taps, a distance of approximately 1.3 miles. At this location, the new transmission line will be connected to the existing West Shore – Harrisburg #1 and #2 Lines. Additional line rearrangements will be completed so that the White Hill Taps are supplied directly from the West Shore Substation.

The proposed transmission line will be designed and constructed for 138 kV operation, although initially, both circuits will operate at 69 kV. They will be upgraded to 138 kV operation when the increasing demand for electricity requires this conversion. As further explained below, this project is required to avoid overloading the West Shore – Cumberland #1 69 kV Line in the event that the West Shore – Harrisburg #1 69 kV Line trips out of service.

The estimated cost to site, design, and construct the new transmission line is approximately \$1,895,400. Construction is scheduled to commence in April, 2012 to meet a required in-service date of May, 2013. The required in-service date is defined as the date that the proposed facility must be placed in service to prevent overloads that could potentially damage equipment and result in service interruptions to customers.

A PPL Electric system map showing 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 existing and proposed transmission system in this portion of Cumberland County.

B. EXISTING SYSTEM

Figure 1 depicts the four existing 69 kV transmission circuits from the West Shore 230 – 69 kV Substation to the White Hill 69 kV Tap. Two of these 69 kV circuits, the West Shore-Cumberland #1 and #2, extend to the Cumberland 230 – 69 kV Substation. The other two circuits, the West Shore-Harrisburg #1 and #2, extend to the Harrisburg 69 – 12 kV Substation. The two existing transmission circuits to the White Hill 69 – 12 kV Substation are tapped from West Shore – Cumberland #1 69 kV Line and the West Shore – Harrisburg #1 69 kV Line.

These four 69 kV transmission lines from the West Shore 230-69 kV Substation provide electric power to eleven 69-12 kV distribution substations, five PPL Electric-owned and six customer-owned.

C. DEFINITION OF THE PROBLEM

PPL Electric plans its system in accordance with the guidelines found in the Reliability Principles and Practices (RP&P), so that PPL Electric can sustain probable contingencies and disturbances with only minimal customer service interruptions, and so that it can adequately serve each customer’s needs with regard to capacity, voltage and reliability for all load levels throughout the daily load cycle. System Planning is the process which assures that PPL Electric’s regional system can supply electricity to all customer load in a manner that is

reliable and economic. In addition, the system is planned so that system reliability can be maintained to prevent large scale, long term, or frequent service interruptions in order to avoid adverse effects and hazards to the public.

The planning process begins with the development of a computer model of the future system. A specific study year is chosen. The future system model is then developed using the existing system plus any planned modifications to the transmission system scheduled to be in service prior to the study year. Load levels used in the system model are based on the latest forecast prepared annually by PPL Electric, which is based on recent summer peak load forecasts that take into account ambient temperatures and humidity indices.

Once the system model is complete, comprehensive power flow simulations are performed to determine the ability of the system to comply with the PPL Electric transmission planning reliability criteria. All conditions where the system is not in conformance with the reliability criteria are identified, and system reinforcements are added to bring the system into conformance. Also identified are estimated costs and lead-times to implement the required reinforcements. Computer simulations of the system with the identified reinforcement alternatives are completed to identify the best overall reinforcement that will meet the needs of the region in a reliable and economic manner.

This Project is required to alleviate a first contingency overload on the West Shore – Cumberland #1 69 kV Line that would result from the loss of the West Shore – Harrisburg #1 69 kV Line. Presently the White Hill 69 – 12 kV Substation is supplied by two tapped 69 kV lines, one from the West Shore – Cumberland #1 69 kV Line and the other from the West Shore – Harrisburg #1 69 kV Line. In this configuration, the loss of the West Shore – Harrisburg #1 69 kV Line would cause all of the White Hill Substation load to transfer to the West Shore – Cumberland #1 69kV Line. This scenario would create an overload on

the West Shore – Cumberland #1 69 kV Line because its summer emergency rating is 124 MVA and adding the total load of White Hill Substation would load the line to 127 MVA. This is a violation of PPL Electric’s Non-Bulk Electric System RP&P regarding single contingency overloads.

D. CONVERSION TO 138 kV

Conversion to 138 kV will be required when load growth in the West Shore area approaches the capability of the 69 kV system. The decision to construct to 138 kV design at this time will facilitate future conversion to 138 kV and minimize interruption to customers’ electric service during the conversion.

E. PROPOSED SOLUTION

The proposed system (see Figure 2) will construct an approximate 1.3 mile long, double-circuit, high-capacity 138/69 kV transmission line between the West Shore 230 – 69 kV Substation and the present location of the White Hill Tap Line. At the tap point, the proposed line will be connected to the existing West Shore – Harrisburg #1 and #2 69 kV Lines. Line rearrangements will be completed so that the existing section of the West Shore – Harrisburg #1 Line between West Shore Substation and the White Hill Tap point will be reconnected to the Cumberland #2 69 kV Line. Also, the existing section of the West Shore – Harrisburg #2 Line between West Shore Substation and the White Hill Tap point will be reconnected to the White Hill #1 Tap Line establishing the new West Shore – White Hill #1 69kV Tap Line. Additional line rearrangements will be completed so that supply to the White Hill 69 – 12 kV Substation is directly from the West Shore 230 – 69 kV Substation.

Transferring the White Hill Substation load directly to the West Shore Substation reduces the loading on the West Shore – Cumberland #1 69 kV Line, eliminating the first contingency overload condition.

F. ALTERNATIVES CONSIDERED

One other alternative was considered for the needed reinforcement in the West Shore/White Hill area. That alternative would have reconductored approximately 6.6 miles of the West Shore - Cumberland #1 and #2 69 kV Line from West Shore Substation to Sporting Hill Substation utilizing high capacity conductors. It also would require upgrades to the West Shore Substation 69 kV terminal equipment to match the ratings of the higher capacity conductor. This alternative is estimated to cost approximately \$8.2 million.

While this alternative resolves the short-term overload concerns it is significantly more expensive than the preferred solution and does not provide longer term transmission capacity and transfer capability. Therefore, it was rejected in favor of the proposed Project.

FIGURE 1 – Functional One-Line Diagram of Existing System

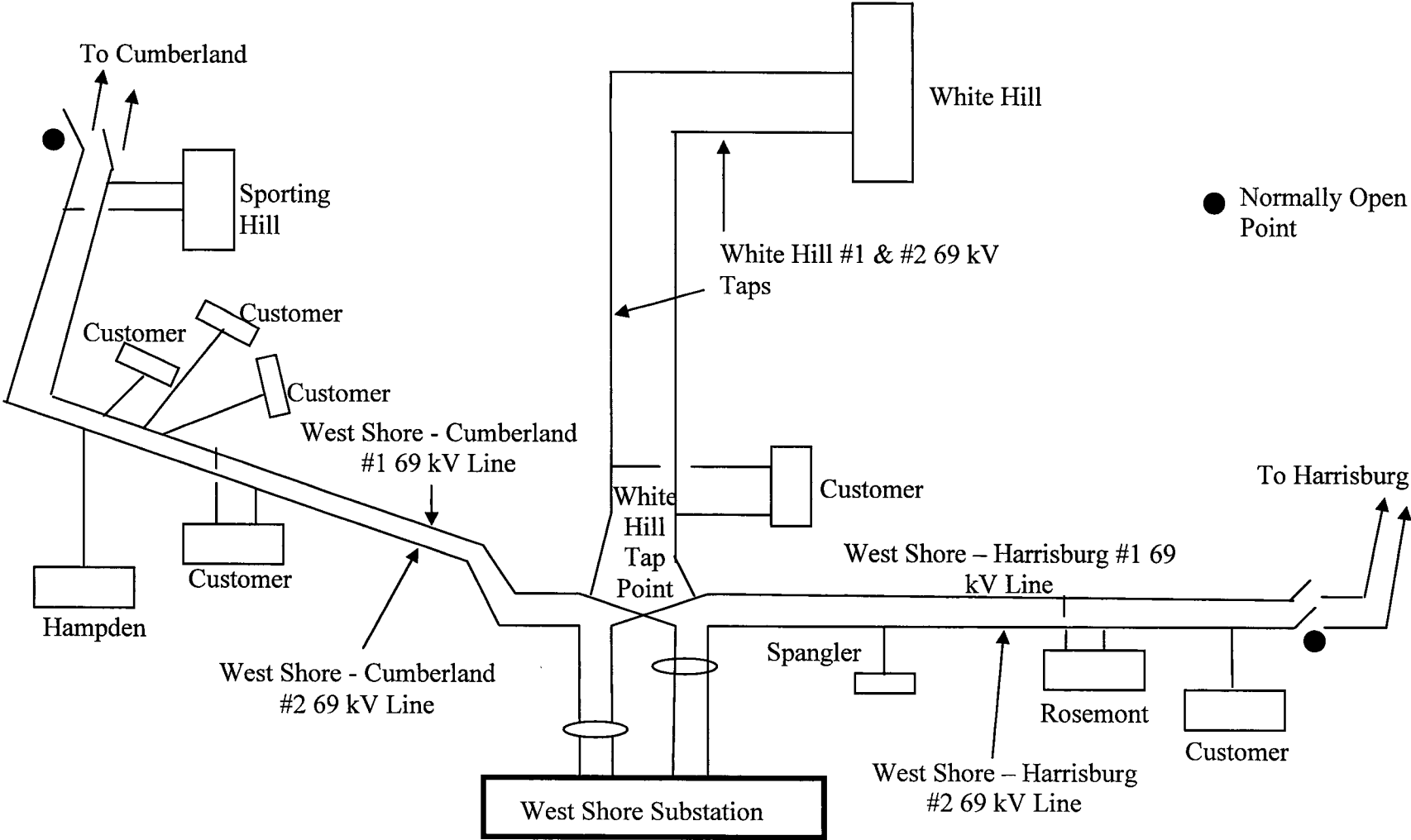
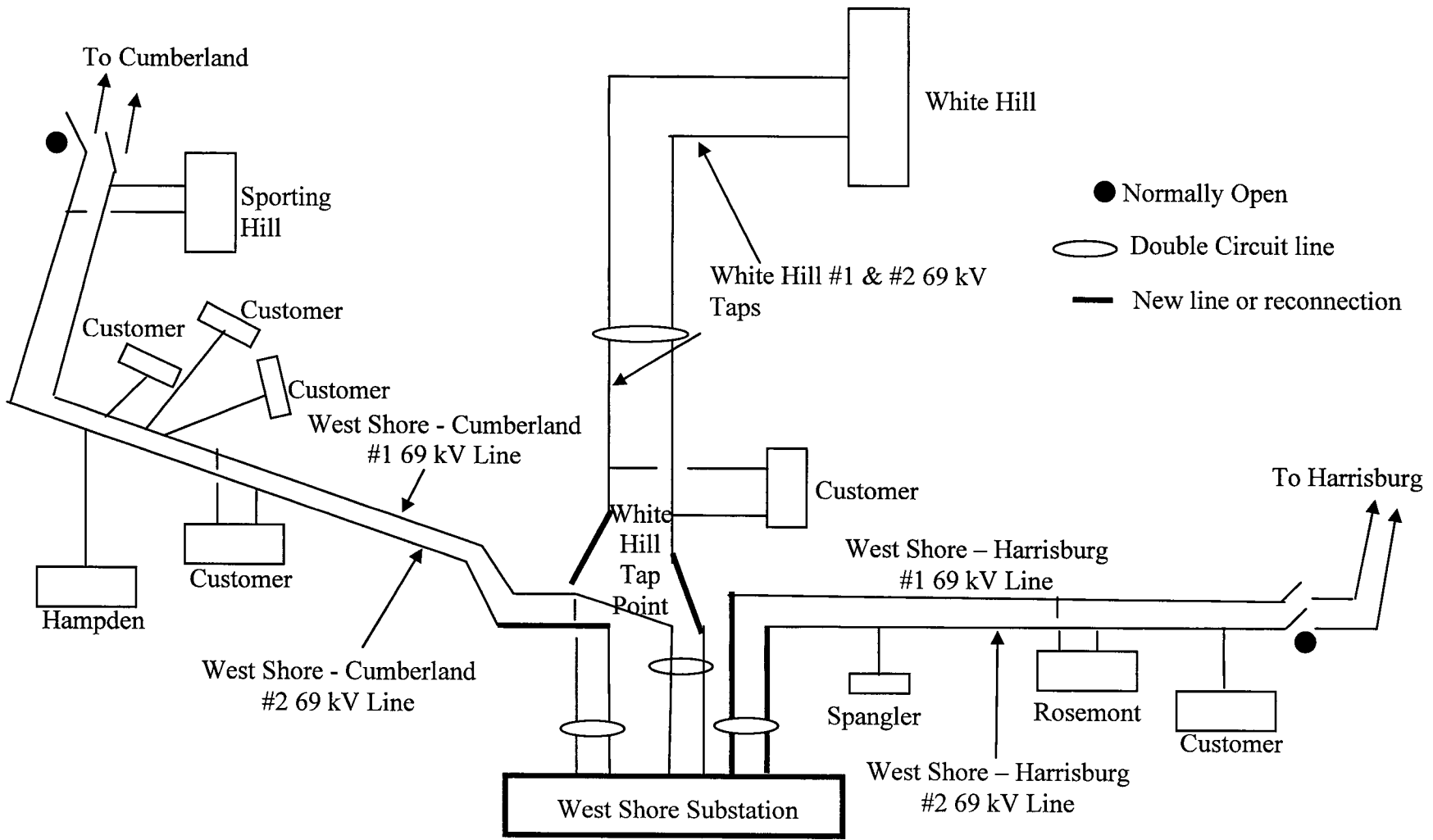


FIGURE 2 – Functional One-Line Diagram of Proposed System



SUBSTATION LISTING

- | | | | |
|------------------------|-------------------------|-------------------------------|------------------------|
| 1. WEST WILLIAMSPORT | 136. SELINGS GROVE | 271. HALIFAX | 404. APPENZELL |
| 2. FAIRFIELD | 137. SUMNER | 272. MILLERSBURG | 405. BLUE MOUNTAIN |
| 3. MONTGOMERY | 138. AUBURN | 273. MUNCY | 406. DAPPERS 69/12KV |
| 4. VARDEN | 139. ROHRSBURG | 274. HAUTO | 407. MEISERVILLE |
| 5. HONESDALE | 140. DERRY | 275. BERWICK | 408. LEDGEDALE |
| 6. JERSEY SHORE | 141. EAST GREENVILLE | 276. SHENANDOAH | 409. EAST TANNERSVILLE |
| 7. LOGANTON | 142. WEST DAMASCUS | 277. PINE GROVE | 410. TRUMB АуЕРSVILLE |
| 8. VALMONT | 143. NEW COLUMBIA | 278. STROUDSBURG | |
| 9. RIVER | 144. FARMERSVILLE | 279. FREEMANSBURG | |
| 10. LIMESTONE | 145. GREENVILLE | 280. ALLENTOWN | |
| 11. NORTHUMBERLAND | 146. NORTH STROUDSBURG | 281. BINGEN | |
| 12. REED | 147. TANNERSVILLE | 282. RHEIMS | |
| 13. WRIGHT | 148. ELIZABETHVILLE | 283. CLEVELAND | |
| 14. ST. JOHNS | 149. WYOMISSING | 284. LITTLE GAP | |
| 15. FREELAND | 150. EXETER | 285. ORVILLA | |
| 16. * | 151. CRACKERSPORT | 286. TUSCARORA | |
| 17. GILBERT | 152. SCHNECKSVILLE | 287. BARTONSVILLE | |
| 18. * | 153. HEMLOCK | 288. ALTON PARK | |
| 19. CHERRY HILL | 154. MT. ALLEN | 289. SALEM | |
| 20. SUSQUEHANNA 230KV | 155. PRINCE | 290. NORTH BRIDGEPORT | |
| 21. TAMAMEND | 156. WAKEFIELD | 291. HAMPDEN | |
| 22. WHITE HILL | 157. COOPERSBURG | 292. CAMELBACK | |
| 23. PALMERTON | 158. WERTZVILLE | 293. SILVER SPRING | |
| 24. HAMILTON | 159. WEST CARLISLE | 294. BRECKNOCK | |
| 25. HUNTER | 160. BENVENUE | 295. BENTON | |
| 26. FAIRVIEW | 161. HEGINS | 296. MCMICHAELS | |
| 27. * | 162. LEOLA | 297. HUGHSTOWN | |
| 28. * | 163. YATESVILLE | 298. NEWVILLE | |
| 29. MONTOUR PUMP | 164. CENTRAL ALLENTOWN | 299. POINTE NORTH | |
| 30. MT. CARMEL | 165. OBERLIN | 300. MARETTA | |
| 31. KELLY | 166. STRASBURG | 301. CENTER CITY | |
| 32. SPORTING HILL | 167. ATGLEN | 302. NEW KINGSTOWN | |
| 33. MAHANAY CITY | 168. BROOKSIDE | 303. REAMSTOWN | |
| 34. GREENWOOD | 169. WILLIAMSTOWN | 304. DUPONT | |
| 35. MOWERY | 170. EAST PETERSBURG | 305. HUMBOLT | |
| 36. ALTRAMOUNT | 171. WERSHBYVILLE | 306. CEDAR AVE. | |
| 37. HAMLIN | 172. NORTH BETHLEHEM | 307. INDIAN ORCHARD | |
| 38. ASHFIELD | 173. WEST ALLENTOWN | 308. NOTTINGHAM | |
| 39. SOUTH SLATINGTON | 174. FLEMINGTON | 309. NORTH COOLBAUGH | |
| 40. SOUTH MIDDLEBURG | 175. MECKESVILLE | 310. LETORT | |
| 41. WALKER | 176. DOVERVILLE | 311. EAST MOUNTAIN | |
| 42. FRALEY | 177. MILLERSVILLE | 312. JERMYN | |
| 43. MORGANTOWN | 178. SHILLINGTON | 313. BLOOMSBURG | |
| 44. EGYPT | 179. DUKE | 314. MIFFLINTOWN | |
| 45. CRESSONA | 180. MCALLISTERVILLE | 315. RIDGE ROAD | |
| 46. SOUTH WHITEHALL | 181. NEWFOUNDLAND | 316. SUSQUEHANNA | |
| 47. EAST TONHICKEN | 182. MARLIN | 317. T-10 SW. YARD | |
| 48. BEAR GAP | 183. WEST BERWICK | 318. CHRISTMANS | |
| 49. SALISBURY | 184. KEYSER AVENUE | 319. OTTER CREEK | |
| 50. SOUTH MILTON | 185. MICKLEYS | 320. STEEL CITY | |
| 51. HEIDELBERG | 186. EAST ALLENTOWN | 321. MCGOVERNVILLE | |
| 52. LIKENS | 187. PINE RIDGE | 322. ROBESONIA | |
| 53. UPPER HANOVER | 188. DALMATIA | 323. SOUTH FOGELSVILLE | |
| 54. RICHLAND | 189. PENNSBORO | 324. ELROY | |
| 55. MACADA | 190. NORTH COLUMBIA | 325. BUSHKILL | |
| 56. ROCKVILLE | 191. HUGHSVILLE | 326. WALLENPAUPACK | |
| 57. THOMPSONTOWN | 192. SOUTH ALLENTOWN | 327. ELK MOUNTAIN | |
| 58. PAXTON | 193. WEISSPORT | 328. JACK FROST | |
| 59. COCALICO | 194. HONEYBROOK | 329. HARWOOD 230/69KV | |
| 60. EAST ELIZABETHTOWN | 195. MOSCOW | 330. HARWOOD CTG | |
| 61. WARWICK | 196. * | 331. HARWOOD 69/12KV | |
| 62. EARL | 197. ROSSMOYNE | 332. NAZARETH | |
| 63. HEMPFIELD | 198. NORTHAMPTON | 333. ALBERTS | |
| 64. EAST LANCASTER | 199. WOODRICH | 334. FRACKVILLE | |
| 65. KINZER | 200. FAXON | 335. * | |
| 66. MT. NEBO | 201. ELIZABETHTOWN | 336. ELIMSPORT | |
| 67. MT. POCONO | 202. ENOLA | 337. ALLENWOOD | |
| 68. PENNS | 203. TERRE HILL | 338. * | |
| 69. GOULDSBORO | 204. BUCK | 339. GRATZ | |
| 70. DILLERVILLE | 205. MT. BETHEL | 340. HOCKERSVILLE | |
| 71. GIRARD MANOR | 206. RICHFIELD | 341. BLOOMING GROVE | |
| 72. KENMAR | 207. SCRANTON | 342. MONROE | |
| 73. GOWEN CITY | 208. TWIN LAKES | 343. LACKAWANNA # | |
| 74. * | 209. HARLEIGH | 344. STANTON | |
| 75. ELLIOT HEIGHTS | 210. TARTON | 345. JACKSON | |
| 76. ROHRERSTOWN | 211. BEAR CREEK | 346. EAST PALMERTON | |
| 77. MACUNGIE | 212. ORWIGSBURG | 347. SIEGFRIED | |
| 78. EAST HAZLETON | 213. EAST TEXAS | 348. HOSENSACK 230/69KV | |
| 79. WAGNERS | 214. CANDENSIS | 349. HOSENSACK 500KV | |
| 80. EAST CARBONDALE | 215. LINDEN | 350. CONESTOGA | |
| 81. EYON | 216. MT. JOY | 351. MANOR | |
| 82. MINOOKA | 217. WEST BLOOMSBURG | 352. CLINTON | |
| 83. OLD FORGE | 218. MINSI TRAIL | 353. EXCHANGE | |
| 84. FOUNTAIN SPRINGS | 219. LAKE NAOMI | 354. MILTON | |
| 85. SULLIVAN TRAIL | 220. LANARK | 355. DAUPHIN | |
| 86. * | 221. * | 356. QUARRY SUB. | |
| 87. SWATARA | 222. MONTOURSVILLE | 357. STEELTON | |
| 88. * | 223. PORT CARBON | 358. JUNIATA 500/230KV | |
| 89. HEPBURN | 224. BLYTHEBURN | 359. JUNIATA 230/69KV | |
| 90. * | 225. MILFORD | 360. CUMBERLAND | |
| 91. * | 226. TREICHLERS | 361. DONESVILLE | |
| 92. FRANCONIA | 227. ROSEVILLE | 362. JENKINS 230/69KV | |
| 93. EMMAUS | 228. RUTHERFORD | 363. JENKINS CTG | |
| 94. MORGAN | 229. HARTLAND | 364. WILKES-BARRE | |
| 95. THROOP | 230. PARRISH | 365. BUXMONT | |
| 96. * | 231. WEST NEW HOLLAND | 366. SOUTH AKRON 230/138/69KV | |
| 97. * | 232. POINT | 367. SOUTH AKRON 69/12KV | |
| 98. CHAPMAN | 233. LINCOLN | 368. SOUTH MANHEIM 69/12KV | |
| 99. SUBURBAN | 234. MIDDLETON | 369. SOUTH MANHEIM 230/69KV | |
| 100. * | 235. STATE HILL | 370. ENGLISIDE | |
| 101. * | 236. MILLVILLE | 371. COLUMBIA | |
| 102. * | 237. TINKER | 372. DANVILLE | |
| 103. PROVIDENCE | 238. LAKEVILLE | 373. SUNBURY | |
| 104. * | 239. NORTH MANHEIM | 374. HUMMELS WHARF | |
| 105. AVOCA | 240. HATFIELD | 375. LYCOMING | |
| 106. * | 241. HERSHEY | 376. LOCK HAVEN CTG | |
| 107. CASS | 242. SOUTH HERSHEY | 377. LOCK HAVEN 69/12KV | |
| 108. CATAQUA | 243. SOUTH WILLIAMSPORT | 378. HUMMELSTOWN | |
| 109. * | 244. FOGELSVILLE | 379. WEST SHORE | |
| 110. SUSQUEHANNA 500KV | 245. WINDSOR | 380. MONTAGE | |
| 111. SEIDERSVILLE | 246. WEST WILLOW | 381. SOUTH FARMERSVILLE | |
| 112. ROSEMONT | 247. WESTGATE | 382. WESCOVILLE | |
| 113. QUARRYVILLE | 248. EDCLA | 383. FISHBACH | |
| 114. LAWINTON | 249. SUMMERDALE | 384. BERKS | |
| 115. LITITZ | 250. DORNEYVILLE | 385. MONTOUR | |
| 116. RENOVO | 251. BOHEMIA | 386. SUBURBAN YARD | |
| 117. WALNUT | 252. WHITE HAVEN | 387. * | |
| 118. WATSON | 253. LAURELTON | 388. * | |
| 119. TREXLERSTOWN | 254. LINGLESTOWN | 389. MACK | |
| 120. LAVINO | 255. POCONO FARMS | 390. WILLIAMSPORT | |
| 121. SPRING | 256. HICKORY RUN | 391. HARRISBURG | |
| 122. COLONIAL PARK | 257. BLOOMING GLEN | 392. ELDRED | |
| 123. WEST LANCASTER | 258. SHERMANDSDALE | 393. * | |
| 124. MADISONVILLE | 259. * | 394. MILLWOOD | |
| 125. NEFFSVILLE | 260. LARRY'S CREEK | 395. TELFORD | |
| 126. BEAVERTOWN | 261. SPANGLER MILLS | 396. TWIN VALLEY | |
| 127. BELMONT | 262. EAST DANVILLE | 397. DEVONSHIRE | |
| 128. LAKE HARMONY | 263. DELANO | 398. BELTZVILLE | |
| 129. GEORGETOWN | 264. CARBON | 399. SCHOENECK | |
| 130. SCOTT | 265. SELLERSVILLE | 400. HAWLEY | |
| 131. NORTH HARRISBURG | 266. MECHANICSBURG | 401. EFFORT MOUNTAIN | |
| 132. MOUNT ROCK | 267. CARLISLE | 402. COPPERSTONE | |
| 133. GREENLAND | 268. CEDAR | 403. RED FRONT | |
| 134. LANDISVILLE | 269. ARROWHEAD | | |
| 135. GREEN PARK | 270. NEWPORT | | |

* - SUBSTATIONS THAT HAVE BEEN RETIRED.

- SITE OF THE EXISTING 230KV SUBSTATION AND PROPOSED 500KV SYBATION.

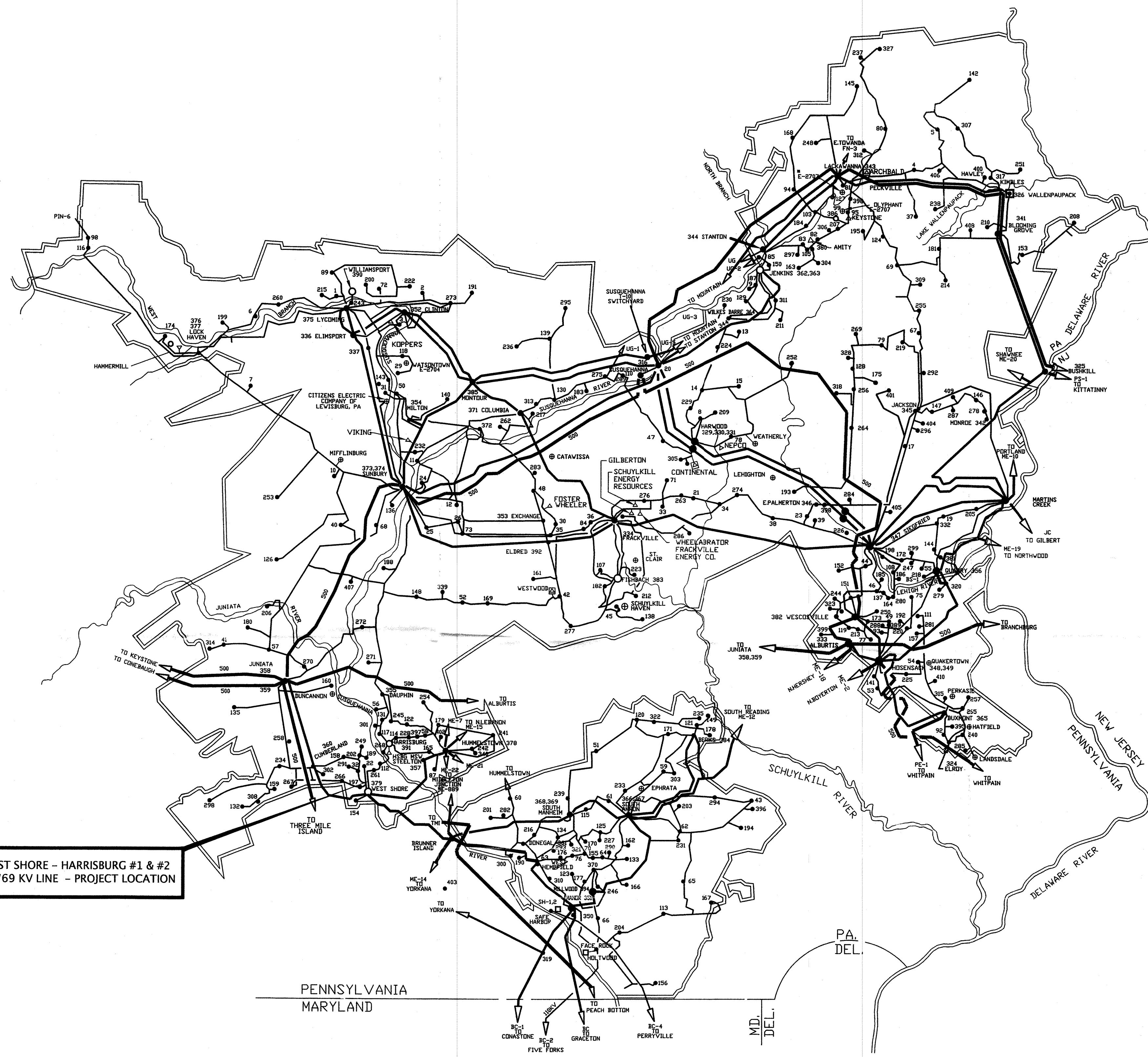
INTERCONNECTIONS

- 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
- HYDRO ELECTRIC
- COMBINATION
- FIRM SALES
- SUBSTATION /SWITCHING STATION
- STEAM ELECTRIC
- NON-UTILITY GENERATION
- INDEPENDENT POWER PRODUCERS

- 500KV OPERATION
- 230KV OPERATION
- 138KV OPERATION
- 69KV OPERATION

WEST SHORE - HARRISBURG #1 & #2
138/69 KV LINE - PROJECT LOCATION



ACCT - 805201		ELECTRICAL SYSTEM MAP	
SCALE - NONE		WEST SHORE - HARRISBURG #1 & #2	
BY - CDW		138/69 KV LINE	
APPROVED	DATE	PPL ELECTRIC UTILITIES	
G. HAKUN III	7/1/85		
PPL DRAWING NO.		SHEET NO.	REV.
D191830		1	97

NO.	DATE	ACCT.	DESCRIPTION	BY	REVIEWED	APPROVED
96	10/25/11	169003	ADDED BLOOMING GROVE - JACKSON # PECKVILLE - JACKSON 138/69 KV LINE	MG		JBW
95	09/01/11	169017	ADDED TRUMB АуЕРSVILLE #1 & #2 138/69 KV TAP LINE	mg		KBK
94	01/01/11	161723	ADDED EAST PETERSBURG #1 & #2 138KV TAP # PARK CITY #1 & #2 138KV TAP	mg		JBW
97	11/30/11	169989	ADDED WEST SHORE - HARRISBURG #1 & #2 138/69KV LINE - PROJECT LOCATION	mg		KBK

PPL ED FORM 4877 (7/03)

Attachment

2

**PROPOSED 138 kV DOUBLE-CIRCUIT
TANGENT STRUCTURE**



POLE STATISTICS

Average Height – 85 Feet
Arm Length (Top & Bottom) – 7 Feet
Arm Length (Middle) – 7 Feet or 11 Feet

Conductor Spacing:
Overhead Groundwire to Top Phase – 12 Feet
Phase to Phase – 12 Feet

FIGURE 1

**ATTACHMENT “2”
WEST SHORE - HARRISBURG #1 & #2 138/69 kV LINE
ENGINEERING DESCRIPTION**

TABLE OF CONTENTS

<u>SECTION</u>	<u>TOPIC</u>	<u>PAGE</u>
A.	DESCRIPTION OF PROPOSED LINE	1
B.	MAGNETIC FIELD MANAGEMENT.....	3
C.	RIGHT-OF-WAY STATUS.....	4

LIST OF TABLES

TABLE 1	DESIGN MINIMUM CONDUCTOR CLEARANCES.....	2
TABLE 2	CONDUCTOR THERMAL RATINGS	3

LIST OF FIGURES

FIGURE 1	PROPOSED TANGENT STRUCTURES.....	
FIGURE 2	PROPOSED ANGLE STRUCTURES.....	

MAP

SHEET 1	AERIAL EXHIBIT.....	ATTACHMENT “2” MAP POCKET
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ATTACHMENT “2”
WEST SHORE - HARRISBURG #1 & #2 138/69 kV LINE
ENGINEERING DESCRIPTION

A. DESCRIPTION OF THE PROPOSED LINE

PPL Electric proposes to construct a new 1.3 mile long double circuit line between the existing West Shore 230 – 69 kV Substation and the existing White Hill 69 kV Taps. This line will be constructed for double circuit 138/69 kV operation but will initially operate at 69 kV until load growth in the area makes an increase appropriate. The proposed Project will be located in Lower Allen Township, Cumberland County. Transmission line rearrangements will occur at the White Hill Tap point so that White Hill 69 – 12 kV Substation will be served directly from the West Shore 230 – 69 kV Substation. Refer to the Aerial Exhibit at the end of Attachment 2 which depicts the location of these facilities.

The proposed West Shore – Harrisburg #1 and #2 138/69 kV Transmission Line will utilize 29 single-shaft steel monopoles equipped with steel upswept conductor support arms. An additional eight monopoles will be replacing existing structures to effect the rearrangement at the White Hill Tap point. The average height of these monopoles will be 85 feet. Tangent structures (see Figure 1 at the end of Attachment 2) will be direct embedded. Angle structures will either be installed on concrete foundations or direct embedded and guyed (see Figure 2 at the end of Attachment 2). Six power conductors and one Fiber Optic Overhead Ground Wire (OPGW) will be installed. The conductors will be 556.5 kcmil¹, 24/7 stranding ACSR². The 0.567 inch diameter OPGW will be installed for

¹ Kcmil wire size is the equivalent cross sectional area in thousands of circular mills. A circular mil is the area of a circle with a diameter of one thousandth (.001) of an inch.

² ACSR stands for aluminum conductor steel reinforced.

lightning protection and for communication between circuit breakers that remove the line from service when a faulted line is detected.

This Project is located in Lower Allen Township, Cumberland County. A plot plan for the transmission line Project is provided in the Attachment “2” map pocket.

The proposed line will be designed to, and will generally exceed, National Electrical Safety Code (NESC) minimum standards. Design specifications and safety rules practiced by PPL Electric are included in Attachment 4. The minimum conductor to ground clearance will be 30 feet, which occurs at a maximum thermal conductor temperature of 125° Celsius.

The designed minimum conductor clearances and conductor thermal ratings for the line 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 ambient temperature)	33 feet
Predicted extreme thermal load (125°C conductor temperature)	30 feet
Predicted NESC extreme wind load (16°C ambient temperature)	32 feet
Predicted extreme weather conditions (1-inch ice, 4 lbs. wind, -10°C)	33 feet

*Clearances based on a maximum tension of 6000 lbs. at 1 inch ice, 4 lbs. wind, -10°C and a ruling span of 345 feet.

TABLE 2

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

<u>Condition</u>	Ambient Temperature <u>°C</u>	Wind Speed <u>Knots</u>	Ampacity <u>Amps</u>
Summer Normal	35	0	815
Winter Normal	10	0	885
Summer Emergency	35	1.5	1030
Winter Emergency	10	1.5	1070

B. MAGNETIC FIELD MANAGEMENT

PPL Electric’s Magnetic Field Management Program is summarized in Attachment 5 and is 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 five feet higher ground clearances 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 those modifications can be made at low or no cost.

For this Project, reverse phasing is beyond the no cost/low cost threshold of the Program due to the number of substations supplied by the line that would require alteration. However, some reduction of the magnetic field will be achieved by utilizing structures that will increase the ground clearance by five additional feet.

C. RIGHT-OF-WAY STATUS

All work will be completed on existing easements or land owned by PPL Electric in fee. No additional right-of-way or other property interest is required. All owners of land subject to the right-of-way have been notified by letter of the proposed line construction.

**PROPOSED 138 kV DOUBLE-CIRCUIT
TANGENT STRUCTURE**



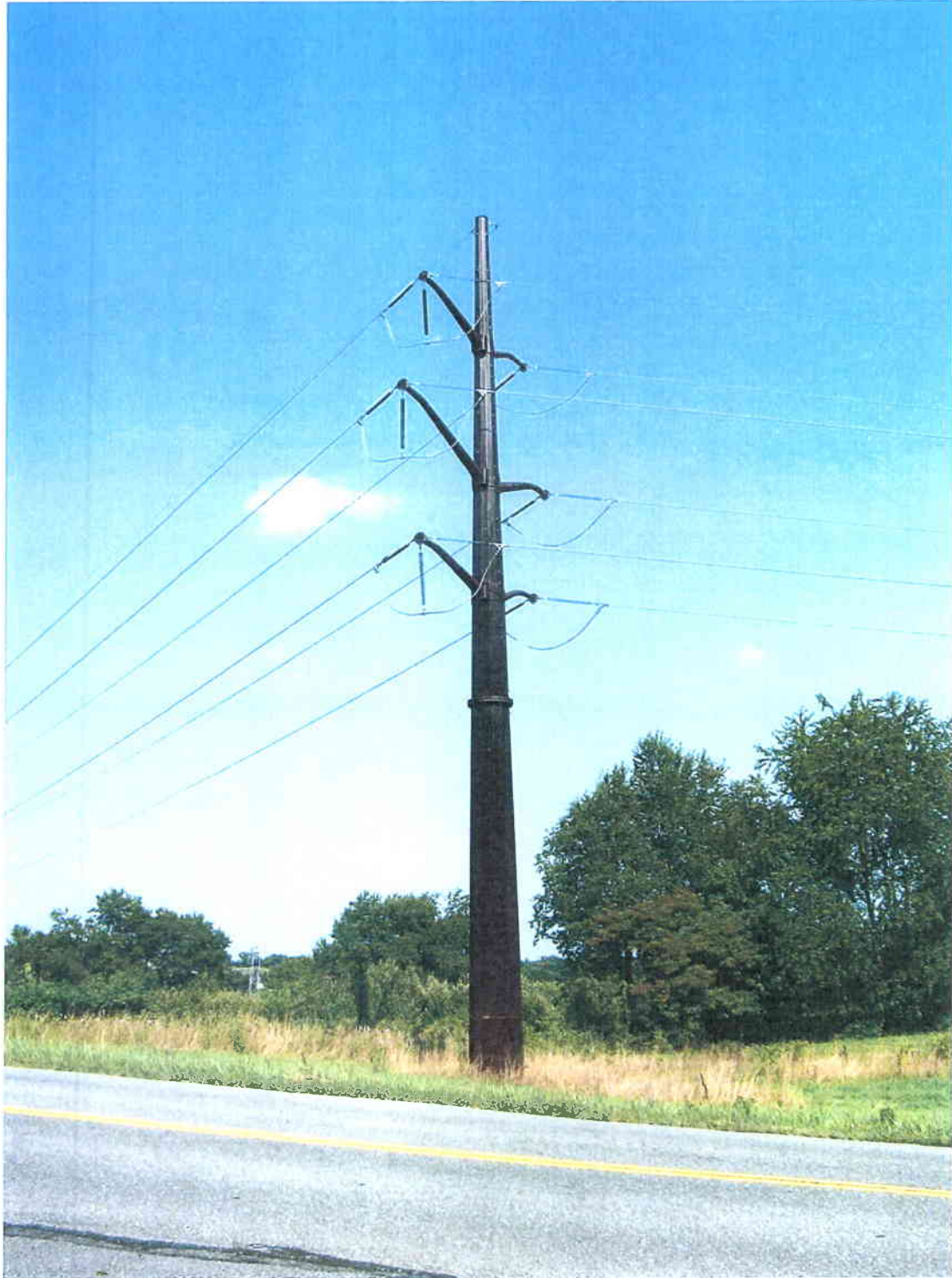
POLE STATISTICS

Average Height – 85 Feet
Arm Length (Top & Bottom) – 7 Feet
Arm Length (Middle) – 7 Feet or 11 Feet

Conductor Spacing:
Overhead Groundwire to Top Phase – 12 Feet
Phase to Phase – 12 Feet

FIGURE 1

**PROPOSED 138 kV DOUBLE-CIRCUIT
SELF-SUPPORTING ANGLE STRUCTURE**

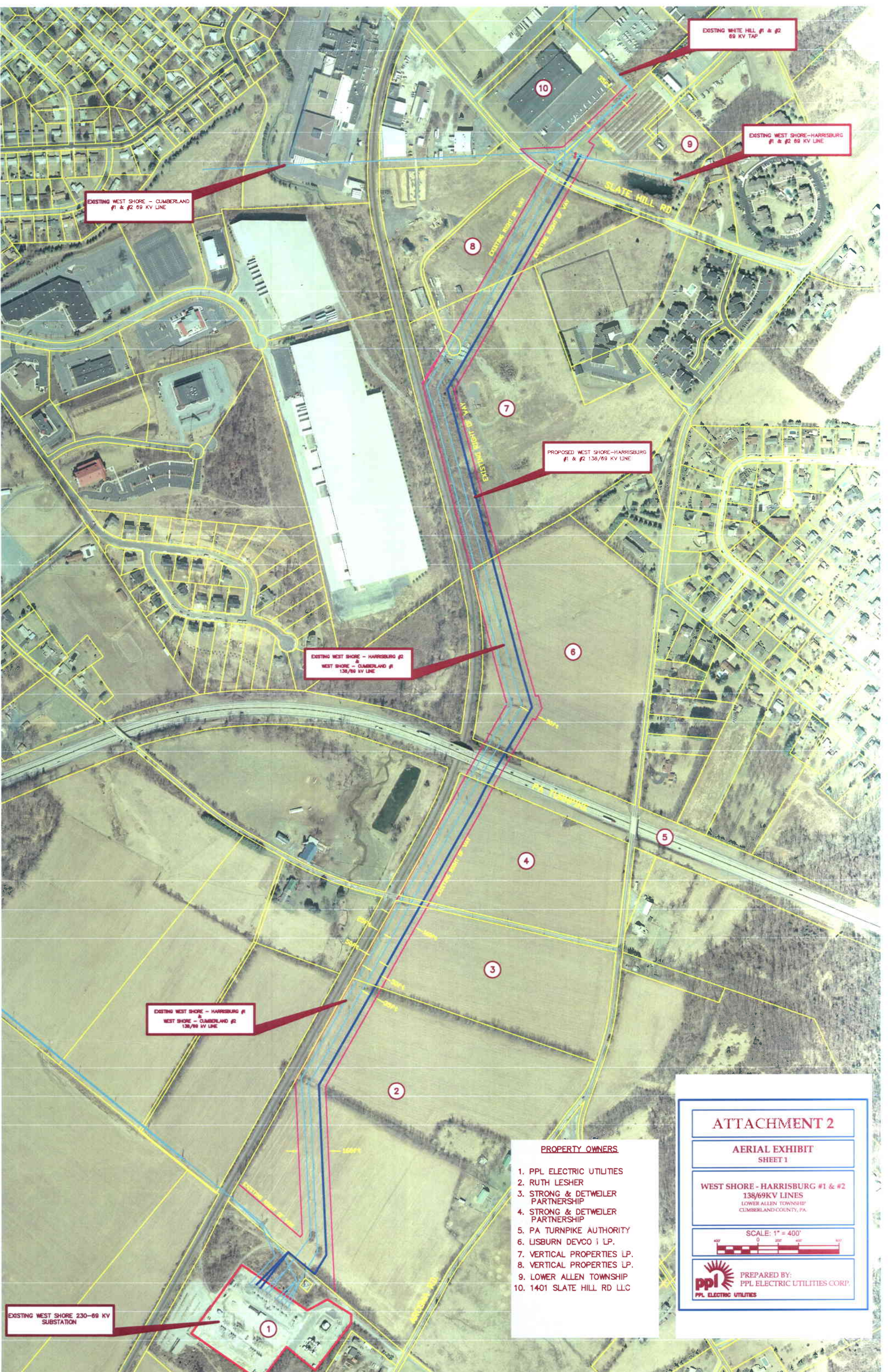


POLE STATISTICS

Average Height – 85 Feet
Arm Length (Top & Bottom) – 7 Feet
Arm Length (Middle) – 11 Feet

Conductor Spacing:
Overhead Groundwire to Top Phase–12 Feet
Phase to Phase – 12 Feet

FIGURE 2



EXISTING WEST SHORE - CUMBERLAND #1 & #2 69 KV LINE

EXISTING WHITE HILL #1 & #2 69 KV TAP

EXISTING WEST SHORE-HARRISBURG #1 & #2 69 KV LINE

PROPOSED WEST SHORE-HARRISBURG #1 & #2 138/69 KV LINE

EXISTING WEST SHORE - HARRISBURG #2 & WEST SHORE - CUMBERLAND #1 138/69 KV LINE

EXISTING WEST SHORE - HARRISBURG #1 & WEST SHORE - CUMBERLAND #2 138/69 KV LINE

EXISTING WEST SHORE 230-69 KV SUBSTATION

- PROPERTY OWNERS**
1. PPL ELECTRIC UTILITIES
 2. RUTH LESHER
 3. STRONG & DETWEILER PARTNERSHIP
 4. STRONG & DETWEILER PARTNERSHIP
 5. PA TURNPIKE AUTHORITY
 6. LISBURN DEVCO I LP.
 7. VERTICAL PROPERTIES LP.
 8. VERTICAL PROPERTIES LP.
 9. LOWER ALLEN TOWNSHIP
 10. 1401 SLATE HILL RD LLC

ATTACHMENT 2

AERIAL EXHIBIT
SHEET 1

WEST SHORE - HARRISBURG #1 & #2
138/69KV LINES
LOWER ALLEN TOWNSHIP
CUMBERLAND COUNTY, PA.

SCALE: 1" = 400'

PREPARED BY:
PPL ELECTRIC UTILITIES CORP.
PPL ELECTRIC UTILITIES

Attachment

3

ATTACHMENT 3
WEST SHORE - HARRISBURG #1 & #2 138/69 kV LINE
ENVIRONMENTAL ASSESSMENT

TABLE OF CONTENTS

<u>SECTION</u>	<u>TOPIC</u>	<u>PAGE</u>
A.	INTRODUCTION.....	1
B.	LAND USE.....	1
C.	CULTURAL RESOURCES.....	2
D.	NATURAL FEATURES.....	2
E.	THREATENED AND ENDANGERED SPECIES.....	3

ATTACHMENT 3
WEST SHORE - HARRISBURG #1 & #2 138/69 kV LINE
ENVIRONMENTAL ASSESSMENT

A. INTRODUCTION

PPL Electric is requesting PUC approval to site and construct a double circuit 138/69 kV transmission line. The proposed line will be designed and constructed to support future 138 kV operation. This Project is needed to alleviate a first contingency overload on the West Shore – Cumberland #1 69 kV line for the loss of the West Shore – Harrisburg #1 69 kV line.

The proposed Project was reviewed with representatives of Lower Allen Township and Cumberland County, and neither the Township nor the County has any objection. A list of involved governmental agencies, municipalities, and other public entities is presented in Attachment 7.

B. LAND USE

The proposed transmission line begins at PPL Electric’s West Shore Substation and heads north-northeast approximately 1.3 miles to its northern terminus at the White Hill Tap point. The proposed line will be constructed entirely within an existing PPL Electric right-of-way or land owned by PPL Electric in fee. No new right-of-way across private property is required to construct this Project. For most of its length the line parallels an active railroad line. The proposed line crosses the Pennsylvania Turnpike approximately half a mile north of the West Shore Substation. There will be no impact to the turnpike because the proposed line will easily span the highway.

The proposed line crosses three distinct zoning districts. Beginning at the West Shore Substation (southern terminus of the proposed line) and proceeding

northerly, they are: Single Family Rural Residential (R-2); Multi-Family Residential (R-3); and General Industrial (I-1). As can be seen on the Aerial Exhibit, such development has not occurred in the vicinity of the proposed line route.

No communication towers, pipelines or other utilities will be affected by the proposed Project. Capital City Airport is located approximately 4.4 mile east-northeast of the project area. Impacts to air traffic are not expected because the intervening terrain is higher than the structures being proposed for the new line. Nonetheless, PPL Electric will file the appropriate documentation with both the Federal Aviation Administration and the PennDOT Bureau of Aviation to ensure the proposed tap line will not be a hazard to the airport's flight operations.

C. CULTURAL RESOURCES

This Project was reviewed with the Pennsylvania Historical and Museum Commission (PHMC). PHMC has determined that, based upon their survey files which include both archaeological sites and standing structures, there are no National Register eligible or listed historic or archaeological properties in the area of this proposed Project and therefore, no further archaeological investigations are required.³

D. NATURAL FEATURES

The proposed tap line will not affect any unique geological, scenic, or natural areas. No National Natural Landmarks, parks, or recreational facilities are located near the project area. 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 proposed tap line will not

³ (File No. ER 2011-0192-041-A).

cross any wetlands or other aquatic resources. As required, PPL Electric will acquire and adhere to the terms and conditions of any required soil erosion and sedimentation control plans as appropriate.

B. 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. One of the agencies, the Pennsylvania Fish and Boat Commission (PF&BC) reported a potential conflict. PPL Electric provided the PF&BC with additional information that cleared the conflict. All other agencies report that, except for occasional transient species of wildlife, no threatened or endangered plant or animal life is found in the project area.⁴

⁴ Pennsylvania Natural Diversity Inventory (PNDI) Search ID: 20111014321361.

Attachment

4

ATTACHMENT "4"

PPL ELECTRIC DESIGN CRITERIA AND SAFETY PRACTICES

The National Electrical Safety Code (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 Utilities Corp. (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

TABLE OF CONTENTS

INTRODUCTION	1
DEVELOPMENT OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM.....	6
VARIABLES THAT AFFECT MAGNETIC FIELDS	6
Effect of Phase Current on Magnetic Fields	6
Effect of Conductor Configuration on Magnetic Fields	7
Effect of Distance from the Magnetic Field Source	7
SUMMARY OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM.....	8
MAGNETIC FIELD MANAGEMENT PROGRAM GUIDELINES	9
Overhead Lines	9
New or Rebuilt Transmission Lines	9
Reconductoring or Adding Additional Circuits to Existing Transmission Lines	14
Distribution Lines	14
Underground Transmission Lines.....	15
CHARTS.....	16

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

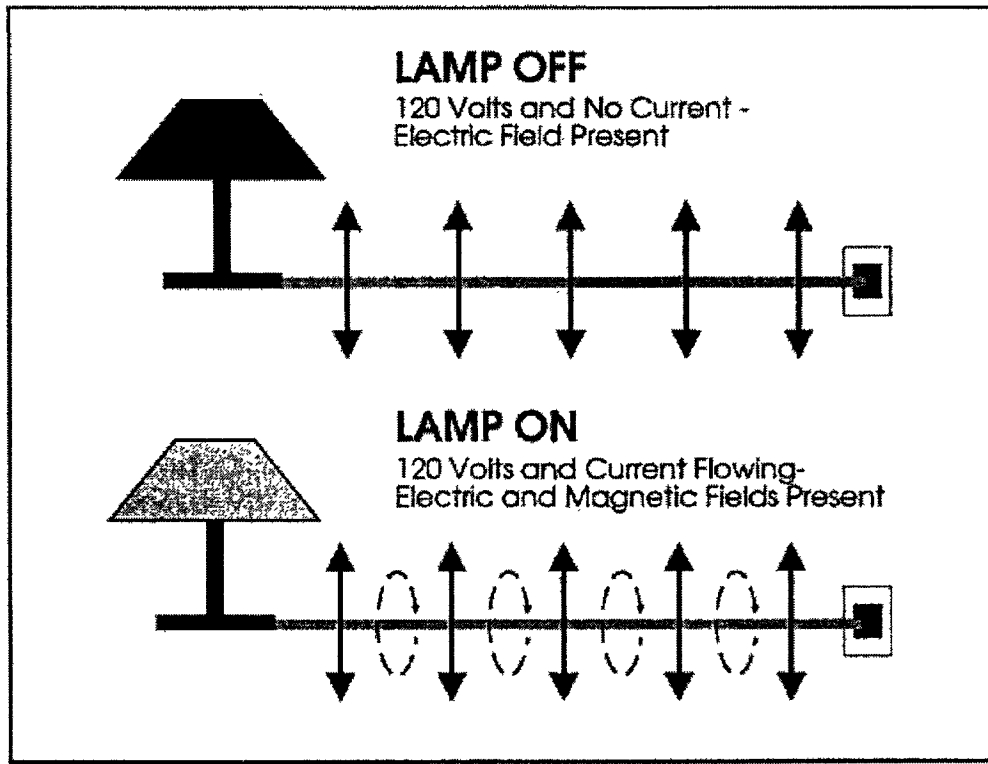


Figure 2








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

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.

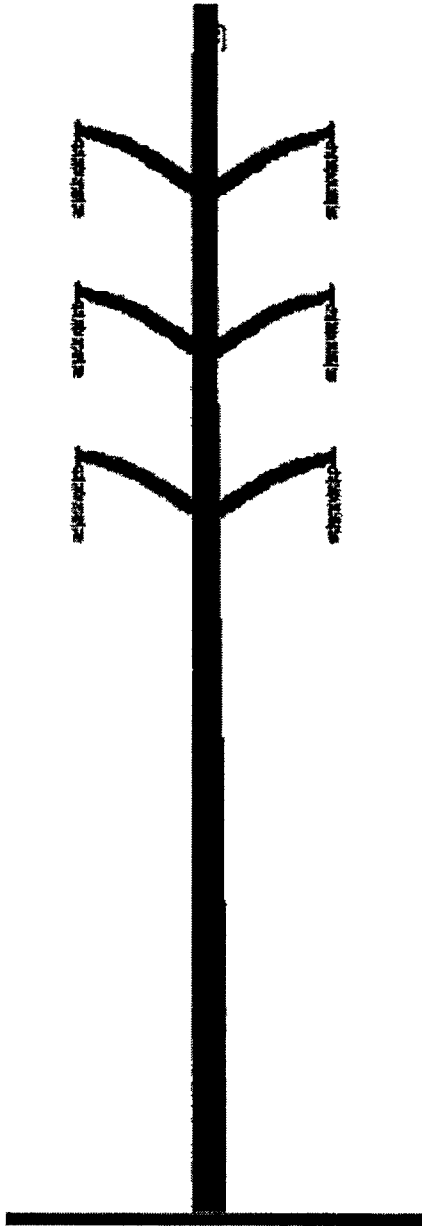
- Main lines are the most heavily loaded sections of a distribution line and therefore have the highest magnetic fields associated with them.
- Increasing the ground clearance by five feet reduces the magnetic field under the line from 14 mG to 11 mG using the standard eight-foot crossarm design. These 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.

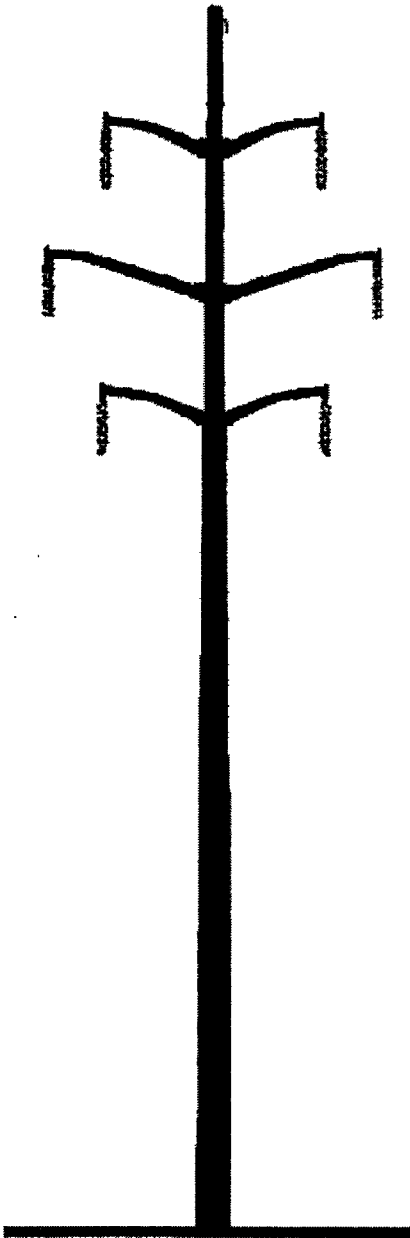
- The phase arrangement that produces the lowest field will be determined.
- The depth of burial of the line will be determined considering the cost of excavation and the location of other buried utilities in the area.
- The use of steel pipe ferromagnetic shielding that reduces magnetic fields will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



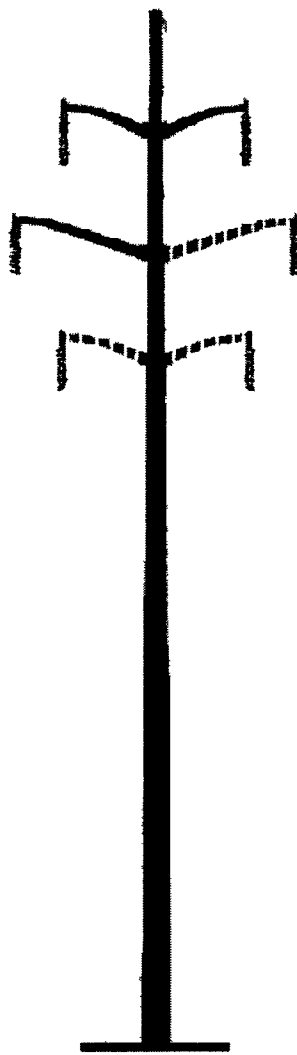
- Lower cost alternative
- Reduces magnetic fields due to higher structures
- Typical conductor data:
 - 1 3/8" HS steel overhead ground wire - 17.3 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
 - Average span - 600 feet

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

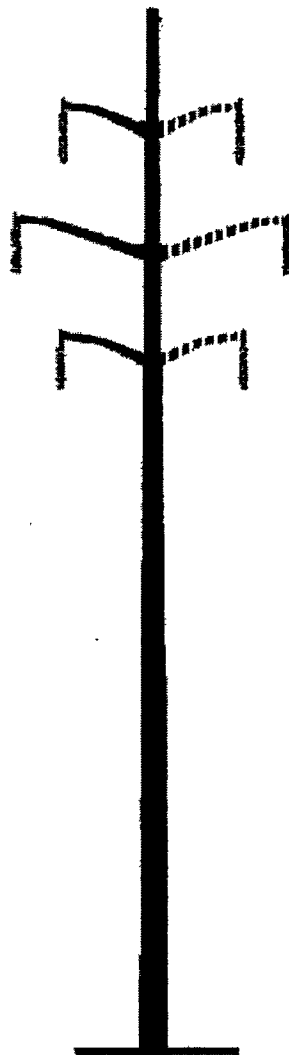
TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SHORT SPAN (CHART I)	30
SHORT SPAN (REVERSE PHASE)	8
LONG SPAN (CHART II)	29
LONG SPAN (REVERSE PHASE)	9
COMPACT (CHART VI)	14
COMPACT (REVERSE PHASE)	3

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.

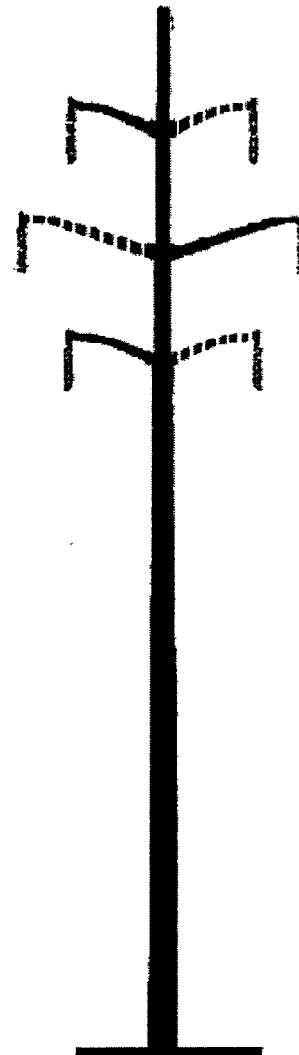
Typical Single-Circuit Structure Designs



Top/Middle



Vertical



Top/Middle/Bottom

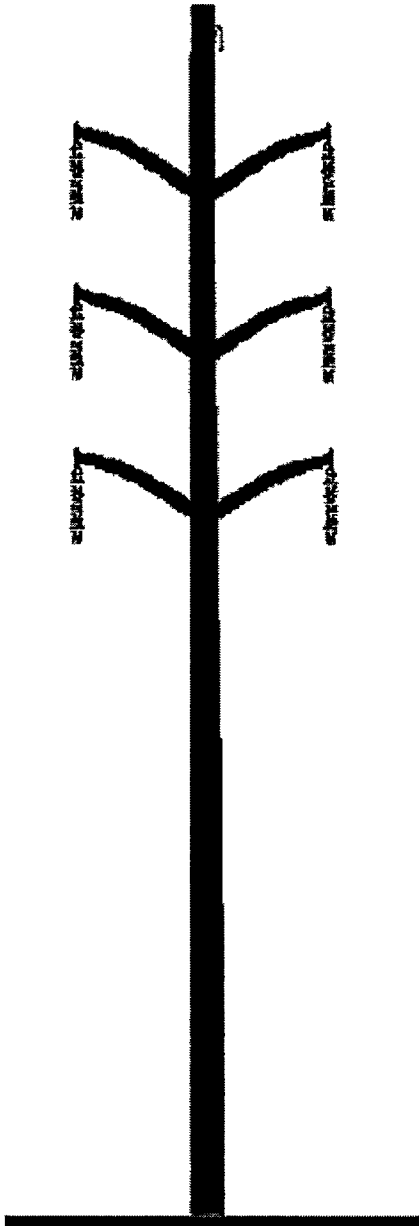
——— initial single circuit
- - - - - future second circuit

**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

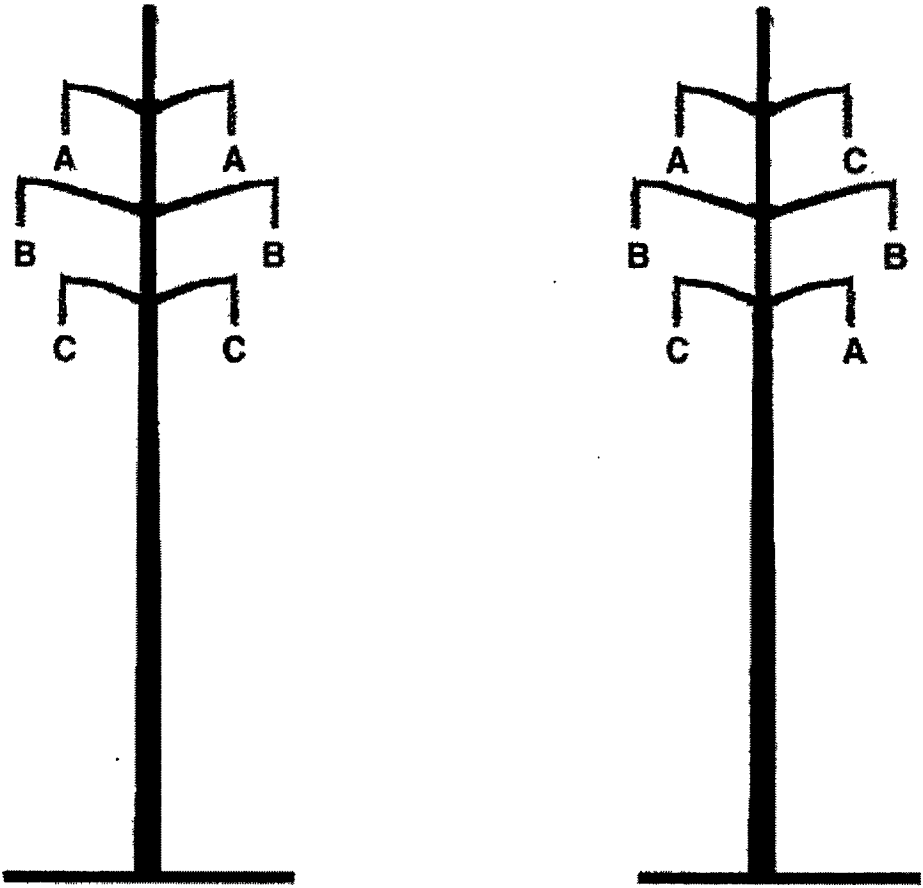
The edge of right of way is 50 feet from the line centerline.
The 400 ampere phase current is balanced between phases.
Calculations are based on a minimum ground clearance of 25 feet.

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"

LIST OF OWNERS OF PROPERTY WITHIN THE RIGHT-OF-WAY

<u>Property Owner/Address</u>	<u>Parcel Number</u>
PPL Electric Utilities Corp.	1
Ruth D. Leshner 1445 & 1449 Arcona Road Mechanicsburg, PA 17055	2
Strong & Detweiler Partnership Rossmoyne Road Mechanicsburg, PA 17055	3, 4
Pennsylvania Turnpike Commission P. O. Box 67676 Harrisburg, PA 17106-7676	5
Lisburn Devco I LP Suite 300 1650 Crooked Oak Drive Lancaster, PA 17601	6
Vertical Properties LP 4400 Gettysburg Road Camp Hill, PA 17011	7, 8
Lower Allen Township 1400 Saint Johns Road Camp Hill, PA 17011	9
1401 Slate Hill Road LLC 1401 Slate Hill Road Camp Hill, PA 17011	10

Attachment

7

ATTACHMENT "7"

**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
Commonwealth Keystone Building
400 North Street, 8th Floor
Harrisburg, Pennsylvania 17120
Attn: The Honorable Allen D. Biehler, P.E., Secretary

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

4. Cumberland County Board of Commissioners
1 Courthouse Square
Carlisle, PA 17013
Attn: Gary Eichelberger, Chairman

5. Cumberland County Planning Commission
18 North Hanover Street
Third Floor
Carlisle, PA 17013
Attn: Kirk Stoner, AICP, Director

6. Lower Allen Township Board of Supervisors
2233 Gettysburg Road
Camp Hill, PA 17011
Attn: John Titzel, President

7. Lower Allen Township Planning Commission
2233 Gettysburg Road
Camp Hill, PA 17011
Attn: Brett McCreary, President