

Before the
Pennsylvania Public Utility Commission

**West Trexlertown #1 & #2
138/69 kV Tap Line**

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

Application Docket No. _____

Submitted by: PPL Electric Utilities Corporation

SUMMARY

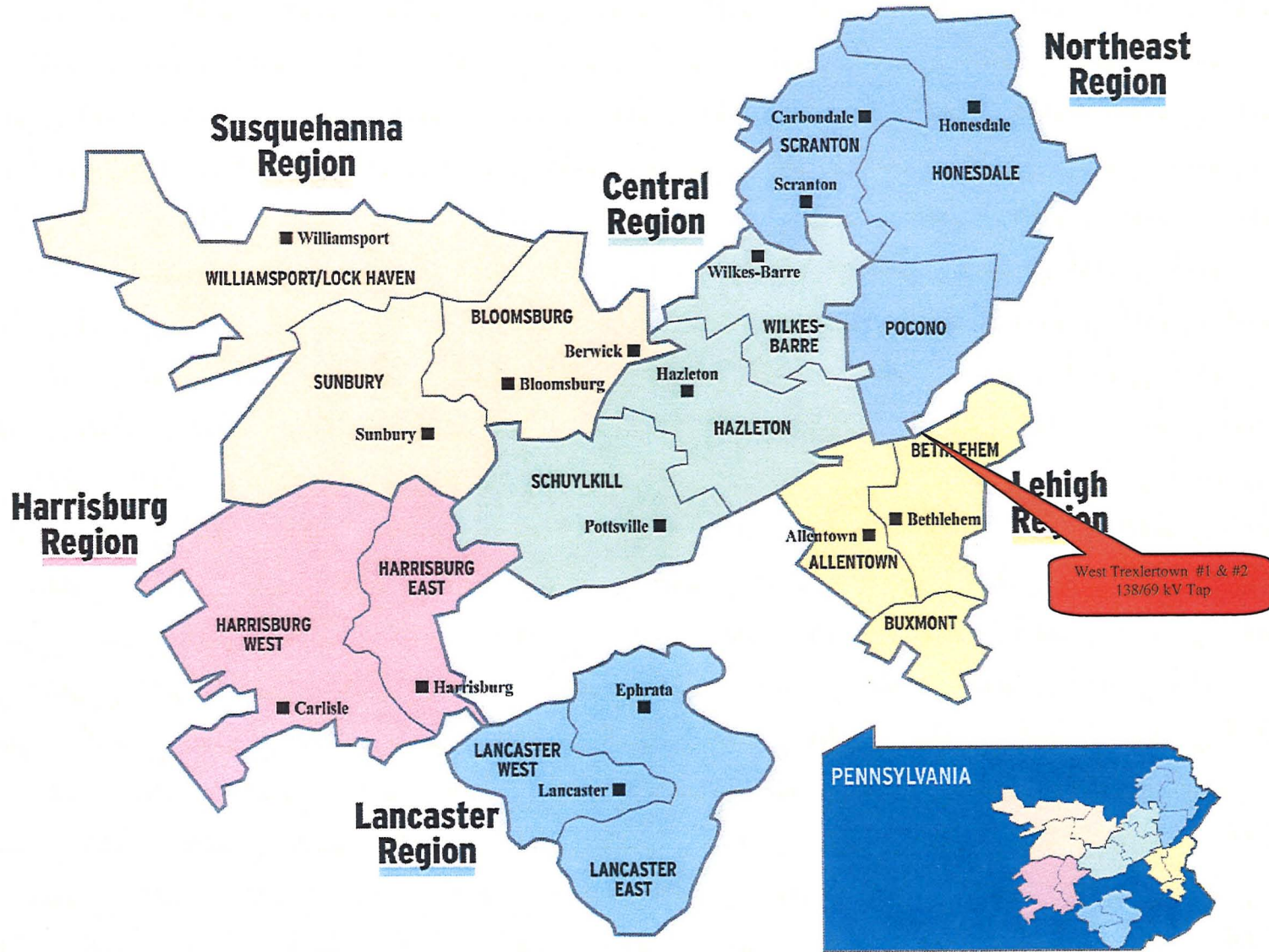
A Letter of Notification is being submitted by PPL Electric Utilities Corporation (PPL Electric) pursuant to the Pennsylvania Public Utility Commission's (PUC or the Commission) regulations at 52 Pa. Code §§ 57.71 through 57.77 for approval to site and construct the West Trexlertown #1 & #2 138/69 kV Tap Line to serve the planned West Trexlertown 69-12 kV Substation. Together, the Tap Line and Substation are required to improve reliability of service in the Trexlertown and South Fogelsville areas of Lehigh County. This project is located in Upper Macungie Township, Lehigh County. The proposed Tap Line will be designed and constructed for double-circuit 138 kV operation. Initially, only one circuit will be installed and it will initially operate at 69 kV.

The total estimated cost of the proposed transmission work associated with this project is approximately \$320,000. In addition, PPL Electric estimates that it will spend approximately \$2.4 million (including the transformer cost) for the substation and distribution work associated with this project. This project has a scheduled construction start date of April 2012, in order to meet an in-service date of May 2013.

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 Involved Governmental Agencies, Municipalities

PPL ELECTRIC UTILITIES SERVICE TERRITORY



Attachment

1

ATTACHMENT “1”
WEST TREXLERTOWN #1 & #2 138/69 kV TAP LINE
NECESSITY STATEMENT

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ATTACHMENT 1
WEST TREXLERTOWN #1 & #2 138/69 kV TAP LINE
NECESSITY STATEMENT

A. INTRODUCTION

PPL Electric proposes to install new 12 kV distribution lines that will be connected to the new West Trexlertown 69-12 kV Substation to resolve violations of reliability criteria and increase operating flexibility in the Trexlertown and South Fogelsville areas of Lehigh County. To accomplish this reinforcement, PPL Electric proposes to construct the West Trexlertown #1 & #2 138/69 kV Transmission Tap Line, which will extend approximately 1,200 feet in length and connect the existing AT&T R&D #1 & #2 138/69 kV Transmission Tap Line to the planned West Trexlertown 69-12 kV Substation in Upper Macungie Township, Lehigh County, Pennsylvania. The West Trexlertown #1 & #2 138/69 kV Transmission Tap Line, together with the two new 12 kV distribution lines and the West Trexlertown 69-12 kV Substation, is required resolve overload conditions and violations of reliability criteria, and to improve reliability and increase operating flexibility in the Trexlertown and South Fogelsville areas of Lehigh County.

The estimated cost to design and construct the proposed West Trexlertown #1 & #2 138/69 kV Transmission Tap Line is approximately \$320,000. Construction is scheduled to begin as soon as possible following Commission approval to meet a required in-service date of April 2013. The required in-service date is defined as the date the proposed facility needs to be placed in service to prevent equipment overloads that have the potential to damage existing facilities, and, thereby, cause the interruption of service to customers.

B. EXISTING SYSTEM

Presently the Trexlertown and South Fogelsville 69 - 12 kV Substations provide service to the Trexlertown and South Fogelsville areas of Lehigh County. The Trexlertown 69 -

12 kV Substation has two 69 - 12 kV transformers that are energized from the Wescosville – Trexlertown #1 and #2 138/69 kV Transmission Line. The Trexlertown 69 – 12 kV Substation currently supplies six 12 kV distribution lines, including the Trexlertown 47-5 12 kV distribution line, which serves customers in the Trexlertown area.

The South Fogelsville 69 – 12 kV Substation has two 69 – 12 kV transformers that are energized from the Wescosville – Trexlertown #3 and #4 138/69 kV Transmission Line. The South Fogelsville 69 – 12 kV Substation currently supplies five 12 kV distribution lines, including the South Fogelsville 53-3 distribution line, which serves customers in the Fogelsville area.

One-line diagrams of the existing transmission and distribution systems in the Trexlertown and South Fogelsville areas of Lehigh County are set forth in Figures 1 and 3, respectively.

C. DEFINITION OF THE PROBLEM

The project, including the West Trexlertown #1 & #2 138/69 kV Transmission Tap Line, will resolve four separate problems. First, due to increasing demand for electricity, the load on the Trexlertown 69 - 12 kV Substation increased to 48,900 kVA (kilovolt Ampere) in the summer of 2011, which exceeds the 6-hour rating of the substations smallest transformer which is 42,400 kVA.

Second, the Trexlertown 47-5 12 kV distribution line exceeds the normal planning guidelines based on PPL Electric’s Reliability Principles and Practices (RP&P). The existing Trexlertown 47-5 12 kV distribution line is a 477 kcmil¹ aluminum conductor. The planning guideline for this type of conductor is 11,000 kVA. In the summer of 2011, the Trexlertown 47-5 12 kV distribution line peaked at 13,200 kVA, which exceeds the

¹ 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 mm².

normal planning guideline of 11,000 kVA. Overloading on the Trexlertown 47-5 12 kV Distribution Line could result in conductor damage or failure, which would interrupt service to approximately 3,500 customers until repairs are made.

Third, Trexlertown 47-5 12 kV distribution line currently exceeds PPL Electric's RP&P guidelines for customer count per feeder. The RP&P provides that no more than 1,300 customers should be served from a 12 kV circuit. Presently, this circuit serves approximately 3,500 customers, which far exceeds the recommended customer count per feeder in the RP&P. This project will reduce the customer count per feeder to comply with the RP&P.

Finally, the South Fogelsville 53-3 12 kV distribution line served a peak load of 11,500 kVA in the summer of 2011 which exceeds the normal planning guidelines for this conductor. The existing South Fogelsville 53-3 12 kV distribution line is a 477 kcmil aluminum conductor. The planning guideline for this type of conductor is 11,000 kVA. Overloading the South Fogelsville 53-3 12 kV distribution line could result in conductor damage or failure, which would interrupt service to approximately 220 customers until repairs are made.

D. PROPOSED SOLUTION

To alleviate these problems discussed in Section C above, PPL Electric plans to construct and install two new 12 kV distribution lines that will be connected to the West Trexlertown 69 - 12 kV Substation, which will be supplied by the proposed West Trexlertown #1 & #2 138/69 kV Tap Line, to serve customer load in the Trexlertown and South Fogelsville areas of Lehigh County. The West Trexlertown #1 & #2 138/69 kV Transmission Tap Line will extend approximately 1,200 feet in length and connect the existing AT&T R&D #1 & #2 138/69 kV Transmission Tap Line to the planned West Trexlertown 69-12 kV Substation in Upper Macungie Township, Lehigh County, Pennsylvania. PPL Electric will own, operate, and maintain the new West Trexlertown #1 & #2 138/69 Tap Line, and the West Trexlertown 69 – 12 kV Substation.

The West Trexlertown #1 & #2 138/69 kV Tap Lines will be designed and constructed for double-circuit 138 kV operation, although initially only one circuit will be installed and operated at 69 kV. In the future, the second circuit will be installed and the operating voltage will be increased to 138 kV when conditions make it appropriate to install a second transformer at the substation.

The West Trexlertown #1 & #2 138/69 kV Transmission Tap Line will interconnect with the AT&T R&D #1 & #2 138/69 kV Transmission Tap Line using two Load Sectionalizing Air Break switches. Load Sectionalizing Air Break Switches will provide better reliability and operational flexibility in the event of an outage on the AT&T R&D #1 & #2 138/69 kV Transmission Tap Line.

The new West Trexlertown #1 & #2 138/69 Tap Line, together with the new West Trexlertown 69 - 12 kV Substation and the new 12 kV distribution circuits, will allow transfer of load to relieve the overloading on the Trexlertown 69 - 12 kV Substation and the Trexlertown 47-5 12 kV distribution line. Once this project is implemented, the peak load on this facilities will be reduced as follows: (1) the Trexlertown 69 – 12 kV Substation will see an overall load reduction of about 13,000 kVA; (2) peak loading on the Trexlertown 47-5 line will be reduced by approximately 8,000 kVA. Further, upon completion, the project will reduce peak loading on the South Fogelsville 53-3 12 kV distribution line by approximately 5,000 kVA, which also will reduce the loading at the South Fogelsville 69 – 12 kV Substation by 5,000 kVA.

Additionally, the new 12 kV circuits from the proposed West Trexlertown 69 - 12 kV Substation will reduce the customer count violations on the existing Trexlertown 47-5 12 kV distribution line. Once this project is implemented, the Trexlertown 47-5 12 kV distribution line will serve approximately 1,500 customers which is a substantial reduction from the present. Further, these new 12 kV circuits will provide an additional source for load transfers, which will improve reliability and operating flexibility in the Trexlertown and Fogelsville areas.

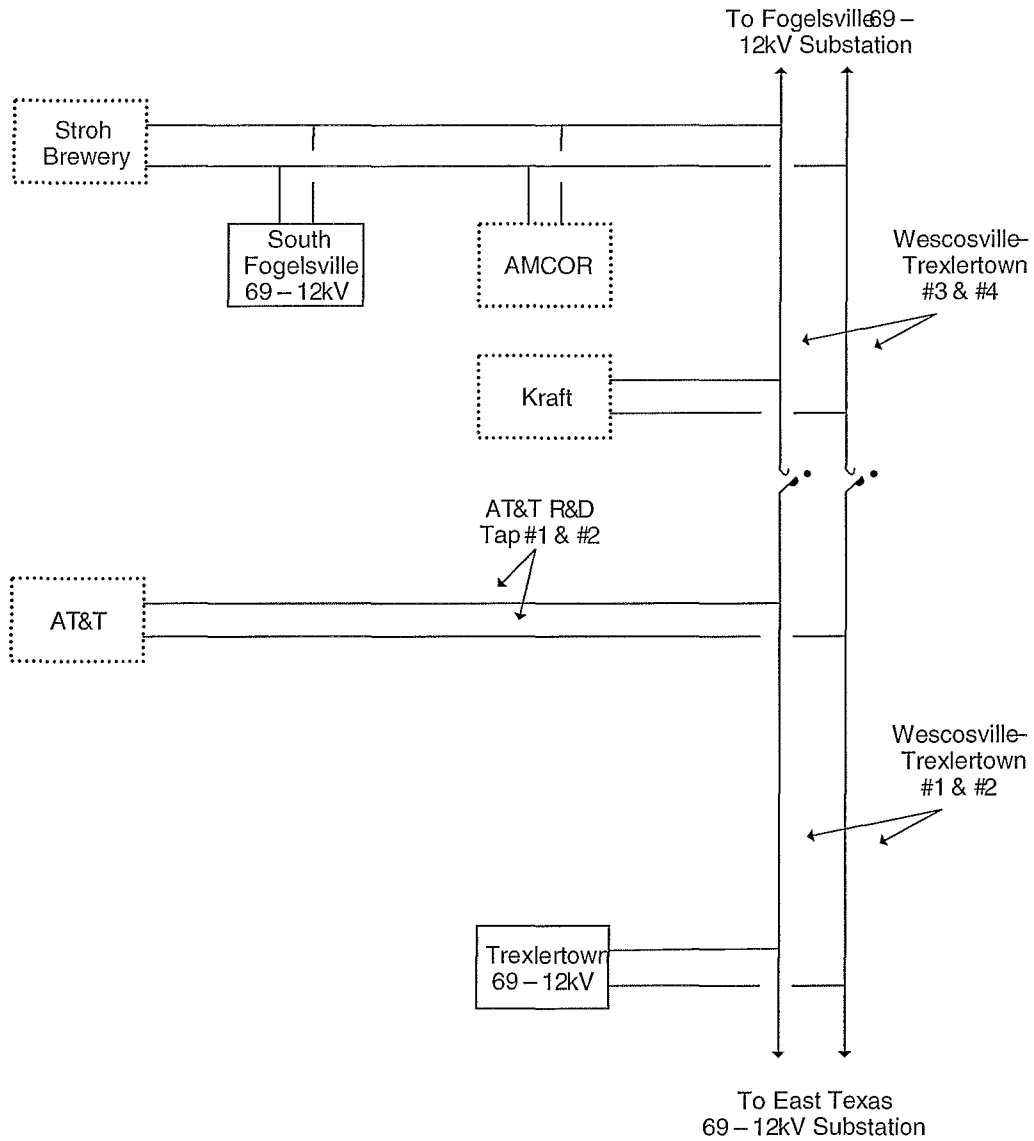
The total estimated cost of this solution is approximately \$2.7 million, which includes approximately \$320,000 for the transmission, \$1.5 million for the substation, and \$890,000 for distribution work.

E. FUNCTIONAL ALTERNATIVE

An alternative to building the new substation and transmission line would be to utilize the nearby Schoeneck 69-12 kV Substation. This alternative would involve adding a second 69 – 12 kV transformer, converting to Twin A operation, and constructing two new 12kV distribution lines at the Schoeneck 69-12 kV Substation. A Twin A substation contains two transformers served from different transmission lines and connected such that all 12 kV distribution circuits can be fed from either transformer. The first 12 kV line would run approximately 2 miles and tie into the Trexlertown 47-5 distribution line. This would relieve the loading issues currently present on the Trexlertown 69 -12- kV Substation as well as the Trexlertown 47-5 distribution line. The second new 12 kV distribution line would run approximately 3.5 miles north and tie into the South Fogelsville 53-3 line. Similar to the preferred alternative, this would allow for transfers from the South Fogelsville substation, which would increase its capability. The estimated cost for this alternative is about \$2.5 million.

PPL Electric has rejected this alternative because the preferred alternative described in Section D provides an additional source for electricity in a rapidly growing industrial and residential area. A new source will ultimately provide better sectionalizing during outages, lower customer counts per feeder, and lower circuit miles of conductor than the alternative mentioned in above.

**FIGURE 1
FUNCTIONAL ONE-LINE DIAGRAM OF EXISTING
TRANSMISSION FACILITIES**



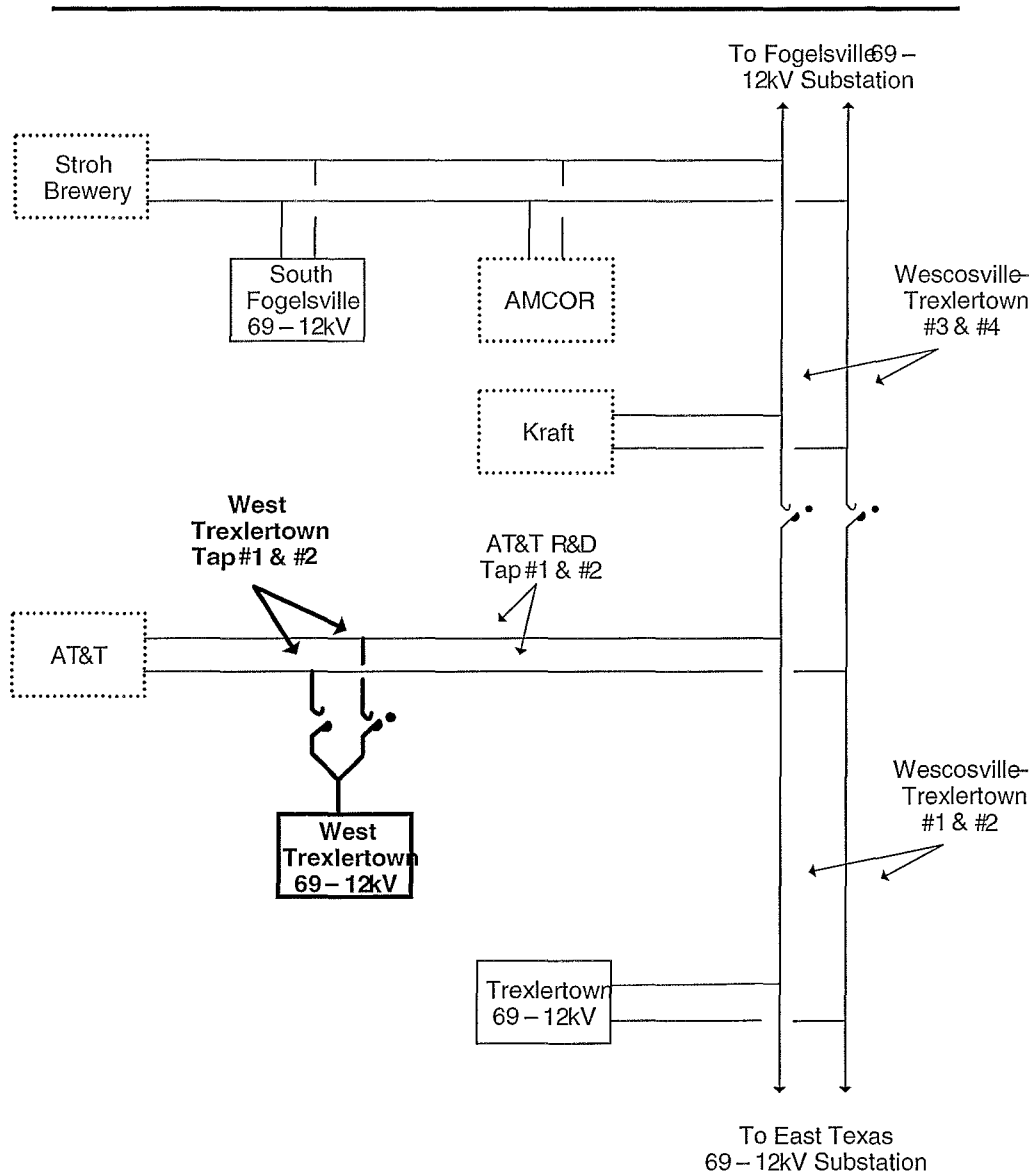
LEGEND

- Existing Construction
- New Construction
- ⌋ Load Air Break Switch
- Normally Open
- Customer Sub

**Trexlertown Area Existing
Transmission Facilities**

DSR7/7/11

**FIGURE 2
FUNCTIONAL ONE-LINE DIAGRAM OF PROPOSED TRANSMISSION
FACILITIES**



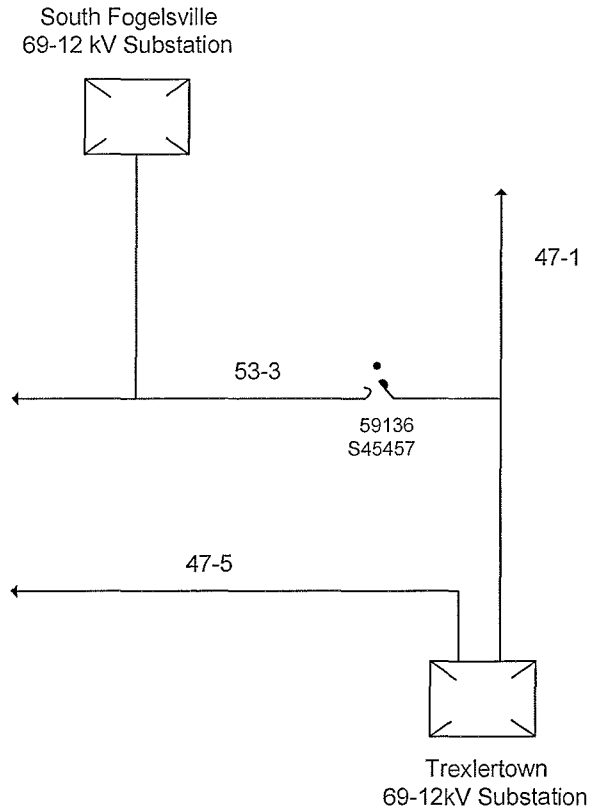
LEGEND

- Existing Construction
- New Construction
- ⌋ Load Air Break Switch
- Normally Open
- Customer Sub

**Trexlertown Area
Existing and Proposed New
Transmission Facilities**

DSR7/7/11

**FIGURE 3
FUNCTIONAL ONE-LINE DIAGRAM OF EXISTING DISTRIBUTION
FACILITIES**



LEGEND:

- | | | | |
|--|----------------------------|--|-----------------------|
| | Existing Construction | | Intelligent ROCS |
| | New Construction | | Air Break Switch |
| | Add Phases | | Load Air Break Switch |
| | Reconductor | | Disconnect Switch |
| | Underground Dip | | Sectionalizer |
| | Normally Open | | OCR |
| | Substation | | Telemetric OCR |
| | Intelligent Telemetric OCR | | ROCS |

**West Trexlertown 69/12 kV Substation
SP 50101 – New 69-12 kV Substation w/
Two New 12kV Distribution Lines
Existing Distribution One-Line Diagram
Required In-Service: 5/2013**

DSR 7/27/11

SUBSTATION LISTING

- | | | | |
|------------------------|-------------------------|-------------------------------|------------------------|
| 1. WEST WILLIAMSPORT | 136. SELINGROVE | 271. HALIFAX | 404. APPENZEL |
| 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. MONESDALE | 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. TRUMBACHERVILLE |
| 8. VALMONT | 143. NEW COLUMBIA | 278. STROUDSBURG | 411. WEST TREXLER TOWN |
| 9. RIVER | 144. FARMERSVILLE | 279. FREEMANSBURG | |
| 10. LIMESTONE | 145. GREENVILLE | 280. ALLEN TOWN | |
| 11. NORTH HUMBURLAND | 146. NORTH STROUDSBURG | 281. BINGEN | |
| 12. REED | 147. TANNERSVILLE | 282. RHEEMS | |
| 13. WRIGHT | 148. ELIZABETHVILLE | 283. CLEVELAND | |
| 14. ST. JOHNS | 149. WYOMISSING | 284. LITTLE GAP | |
| 15. FREELAND | 150. EXETER | 285. ORVILLE | |
| 16. * | 151. CRACKERSPORT | 286. TUSCARORA | |
| 17. GILBERT | 152. SCHNECKSVILLE | 287. BARRYSVILLE | |
| 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. CANELBACK | |
| 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. NEWVILL | |
| 29. MONTOUR PUMP | 164. CENTRAL ALLENTOWN | 299. POINTE NORTH | |
| 30. MT. CARMEL | 165. OBERLIN | 300. MARIETTA | |
| 31. KELLY | 166. STRASBURG | 301. CENTER CITY | |
| 32. SPORTING HILL | 167. ATGLEN | 302. NEW KINGSTOWN | |
| 33. MAHANOVY CITY | 168. BROOKSIDE | 303. REAMSTOWN | |
| 34. GREENWOOD | 169. SOUTH TOWNSHIP | 304. DUPONT | |
| 35. MOWERY | 170. EAST PETERSBURG | 305. HUMBOLT | |
| 36. ALTAMOUNT | 171. WERNERSVILLE | 306. CEDAR AVE. | |
| 37. HAMLIN | 172. NORTH BETHLEHEM | 307. INDIAN ORCHARD | |
| 38. ASHFIELD | 173. WEST ALLENTOWN | 308. NOTTINGHAM | |
| 39. SOUTH SLINGTON | 174. FLEMINGTON | 309. NORTH COOLBAUGH | |
| 40. SOUTH MIDDLEBURG | 175. MECKESVILLE | 310. LETORT | |
| 41. WALKER | 176. DONERVILLE | 311. EAST MOUNTAIN | |
| 42. FRAILAY | 177. MILLERSVILLE | 312. JERMYN | |
| 43. MORGANTOWN | 178. SHILLINGTON | 313. BLOOMSBURG | |
| 44. EGYPT | 179. DUKE | 314. MIFFLINTOWN | |
| 45. CRASSONA | 180. MCALLISTERVILLE | 315. RIDGE ROAD | |
| 46. SOUTH WHITEHALL | 181. NEWFOUNDLAND | 316. SUSQUEHANNA | |
| 47. EAST TOMHICKEN | 182. MARLIN | T-10 SW. YARD | |
| 48. BEAR GAP | 183. WEST BERWICK | 317. KIMBLES | |
| 49. SALISBURY | 184. KEYSER AVENUE | 318. CHRISTMANS | |
| 50. SOUTH MILTON | 185. MICKLEYS | 319. OTTER CREEK | |
| 51. HEIDELBERG | 186. EAST ALLENTOWN | 320. STEEL CITY | |
| 52. LYKENS | 187. PINE RIDGE | 321. MCGOVERNVILLE | |
| 53. UPPER HANOVER | 188. DALMATIA | 322. ROBESONIA | |
| 54. RICHLAND | 189. PENNSBORO | 323. SOUTH FOGELSVILLE | |
| 55. MACADA | 190. NORTH COLUMBIA | 324. ELROY | |
| 56. ROCKVILLE | 191. HUGHSVILLE | 325. BUSHKILL | |
| 57. THOMPSON TOWN | 192. SOUTH ALLENTOWN | 326. WALLENPAUPACK | |
| 58. PAXTON | 193. WEISSPORT | 327. ELK MOUNTAIN | |
| 59. COCALICO | 194. HONEYBROOK | 328. JACK FROST | |
| 60. EAST ELIZABETHTOWN | 195. MOSCOW | 329. HARWOOD 230/69KV | |
| 61. WARWICK | 196. * | 330. HARWOOD CTG | |
| 62. EARL | 197. ROSSMOYNE | 331. HARWOOD 69/12KV | |
| 63. HEMPFIELD | 198. NORTHAMPTON | 332. NAZARETH | |
| 64. EAST LANCASTER | 199. WOOLRICH | 333. ALBURTIS | |
| 65. KINZER | 200. FAXON | 334. FRACKVILLE | |
| 66. MT. NEBO | 201. ELIZABETHTOWN | 335. * | |
| 67. MT. POCONO | 202. ENOLA | 336. ELIMSPORT | |
| 68. PERNS | 203. TERRE HILL | 337. ALLENWOOD | |
| 69. GOULDSBORO | 204. BUCK | 338. * | |
| 70. DILLERVILLE | 205. MT. BETHEL | 339. GRATZ | |
| 71. GIRARD MANOR | 206. RICHLAND | 340. HOCKERSVILLE | |
| 72. KENMAR | 207. SCRANTON | 341. BLOOMING GROVE | |
| 73. GOWEN CITY | 208. TWIN LAKES | 342. MONROE | |
| 74. * | 209. HARLEIGH | 343. LACKAWANNA ## | |
| 75. ELLIOT HEIGHTS | 210. TAFTON | 344. STANTON | |
| 76. ROHRERSTOWN | 211. BEAR CREEK | 345. JACKSON | |
| 77. MACUNGIE | 212. ORWIGSBURG | 346. EAST PALMERTON | |
| 78. EAST HAZLETON | 213. EAST TEXAS | 347. SIEGFRIED | |
| 79. WAGNERS | 214. HOSENSACK 230/69KV | 348. HOSENSACK 230/69KV | |
| 80. EAST CARBONDALE | 215. LINDEN | 349. HOSENSACK 500KV | |
| 81. EYNON | 216. MT. JOY | 350. CONESTOGA | |
| 82. MINOOKA | 217. WEST BLOOMSBURG | 351. MANOR | |
| 83. OLD FORGE | 218. MINSI TRAIL | 352. CLINTON | |
| 84. FOUNTAIN SPRINGS | 219. LAKE NAOMI | 353. EXCHANGE | |
| 85. SULLIVAN TRAIL | 220. ANARK | 354. MILTON | |
| 86. * | 221. * | 355. DALPHIN | |
| 87. SWATARA | 222. MONTOURSVILLE | 356. QUARRY SUB. | |
| 88. * | 223. PORT CARBON | 357. STEELTON | |
| 89. HEPBURN | 224. BLYTHEBURN | 358. JUNIATA 500/230KV | |
| 90. * | 225. MILFORD | 359. JUNIATA 230/69KV | |
| 91. * | 226. TRECHLERS | 360. CUMBERLAND | |
| 92. FRANCONIA | 227. ROSEVILLE | 361. DONEGAL | |
| 93. EMMAUS | 228. RUTHERFORD | 362. JENKINS 230/69KV | |
| 94. MORGAN | 229. HARTLAND | 363. JENKINS CTG | |
| 95. THROOP | 230. PARRISH | 364. WILKES-BARRE | |
| 96. * | 231. WEST NEW HOLLAND | 365. BUXMONT | |
| 97. * | 232. POINT | 366. SOUTH AKRON 230/138/69KV | |
| 98. CHAPMAN | 233. LINCOLN | 367. SOUTH AKRON 69/12KV | |
| 99. SUBURBAN | 234. MIDDLETON | 368. SOUTH MANHEIM 69/12KV | |
| 100. * | 235. STATE HILL | 369. SOUTH MANHEIM 230/69KV | |
| 101. * | 236. MILLVILLE | 370. ENGLISIDE | |
| 102. * | 237. TINKER | 371. COLUMBIA | |
| 103. PROVIDENCE | 238. LAKEVILLE | 372. DANVILLE | |
| 104. * | 239. NORTH MANHEIM | 373. SUNBURY | |
| 105. AVOCA | 240. HATFIELD | 374. HUMMELS WHARF | |
| 106. * | 241. HERSHEY | 375. LYCOMING | |
| 107. CASS | 242. SOUTH HERSHEY | 376. LOCK HAVEN CTG | |
| 108. CATASAUQUA | 243. SOUTH WILLIAMSPORT | 377. LOCK HAVEN 69/12KV | |
| 109. * | 244. FOGELSVILLE | 378. HUMMELSTOWN | |
| 110. SUSQUEHANNA 500KV | 245. WINDSOR | 379. WEST SHORE | |
| 111. SEIDERSVILLE | 246. WEST WILLOW | 380. MONTAGE | |
| 112. ROSEHONT | 247. WESTGATE | 381. SOUTH FARMERSVILLE | |
| 113. QUARRYVILLE | 248. EDELA | 382. WESCOSVILLE | |
| 114. LAWNTON | 249. SUMMERDALE | 383. FISHBACH | |
| 115. LITZ | 250. DORNEVILLE | 384. BERKS | |
| 116. RENOVO | 251. BOHEMIA | 385. MONTOUR | |
| 117. WALNUT | 252. WHITE HAVEN | 386. SUBURBAN YARD | |
| 118. WATSON | 253. LAURELTON | 387. * | |
| 119. TREXLER TOWN | 254. LINGLESTOWN | 388. * | |
| 120. LAVINO | 255. POCONO FARMS | 389. MACK | |
| 121. SPRING | 256. HICKORY RUN | 390. WILLIAMSPORT | |
| 122. COLONIAL PARK | 257. BLOOMING GLEN | 391. HARRISBURG | |
| 123. WEST LANCASTER | 258. SHERMANSDALE | 392. ELDRD | |
| 124. MADISONVILLE | 259. * | 393. * | |
| 125. NEFFSVILLE | 260. LARRYS CREEK | 394. MILLWOOD | |
| 126. BEAVER TOWN | 261. SPANGLER MILLS | 395. TELFORD | |
| 127. BELMONT | 262. EAST DANVILLE | 396. TWIN VALLEY | |
| 128. LAKE HARMONY | 263. DELANO | 397. DEVONSHIRE | |
| 129. GEORGETOWN | 264. JESSUP | 398. BELTZVILLE | |
| 130. SCOTT | 265. SELLERSVILLE | 399. SCHOENECK | |
| 131. NORTH HARRISBURG | 266. MECHANICSBURG | 400. HAWLEY | |
| 132. MOUNT ROCK | 267. CARLISLE | 401. EFFORT MOUNTAIN | |
| 133. GREENLAND | 268. CEDAR | 402. COPPERSTONE | |
| 134. LANDISVILLE | 269. ARROWHEAD | 403. RED FRONT | |
| 135. GREEN PARK | 270. NEWPORT | | |

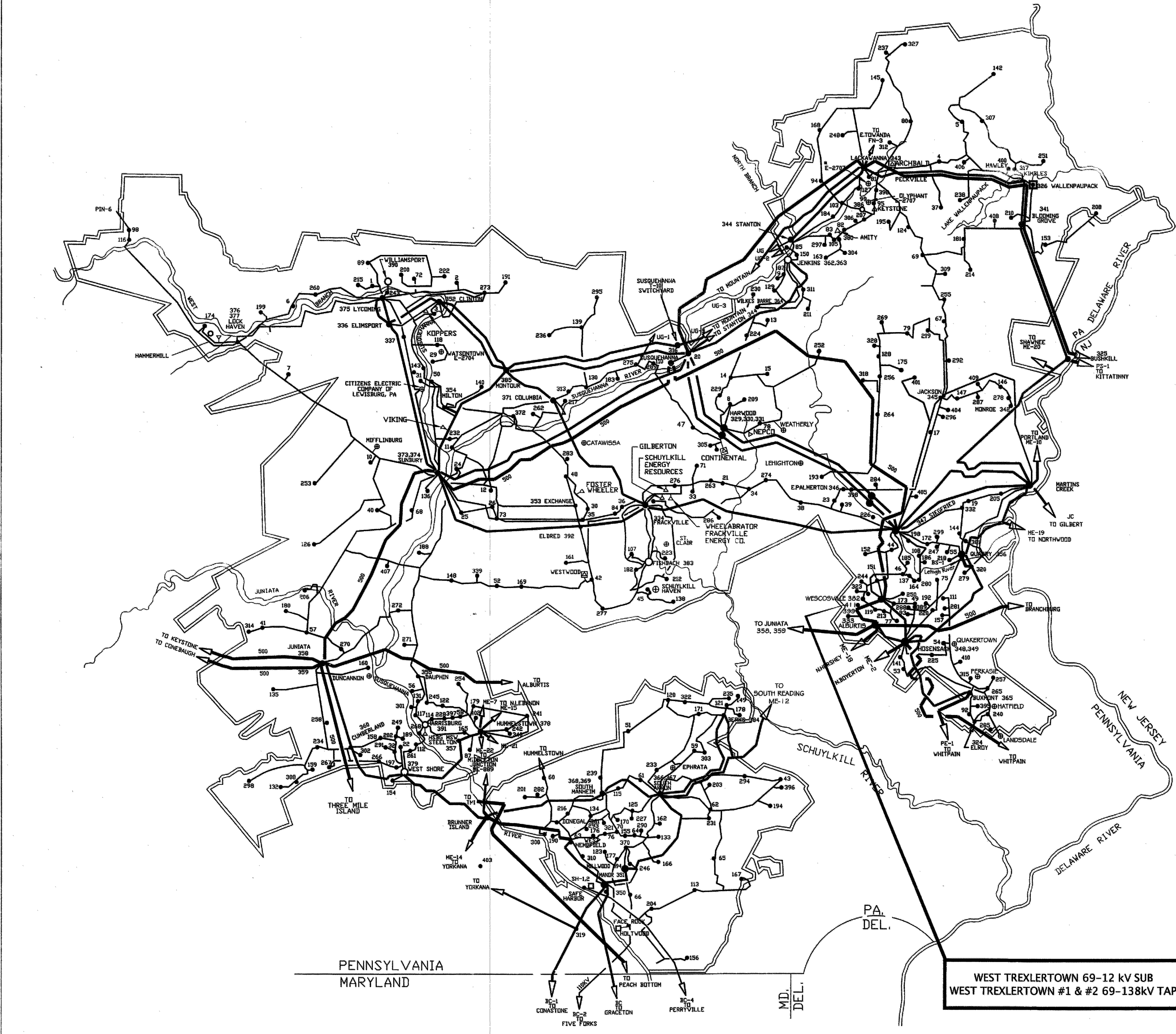
* - SUBSTATIONS THAT HAVE BEEN RETIRED.
 ## - SITE OF THE EXISTING 230KV SUBSTATION AND PROPOSED 500KV SUBSTATION.

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
- 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 TREXLER TOWN 69-12 kV SUB
 WEST TREXLER TOWN #1 & #2 69-138KV TAP

ACCT- 805201	ELECTRICAL SYSTEM MAP	
SCALE- NONE	WEST TREXLER TOWN 69-12 kV SUBSTATION	
BY- CDW	WEST TREXLER TOWN #1 & #2 69/138 kV TAP	
REVIEWED	APPROVED G. HAKUN III	DATE 7/1/85
PPL DRAWING NO. D191830	SHEET NO.	REV. 1 99

NO.	DATE	ACCT.	REFERENCE TITLE	NUMBER	NO.	DATE	ACCT.	REFERENCE TITLE	NUMBER
96	7/1/81	169003	ADDED BLOOMING GROVE - JACKSON # PECKVILLE - JACKSON 138/69 KV LINE		96	7/1/81	169003	ADDED BLOOMING GROVE - JACKSON # PECKVILLE - JACKSON 138/69 KV LINE	
99	2/20/81	10016114	ADDED WEST TREXLER TOWN 69-12 kV SUB AND WEST TREXLER TOWN #1 & #2 69/138KV TAP		99	2/20/81	10016114	ADDED WEST TREXLER TOWN 69-12 kV SUB AND WEST TREXLER TOWN #1 & #2 69/138KV TAP	
98	2/20/81	10016984	ADDED SUSQUEHANNA - HARWOOD #1 & #2 230KV LINES PROJECT LOCATION		98	2/20/81	10016984	ADDED SUSQUEHANNA - HARWOOD #1 & #2 230KV LINES PROJECT LOCATION	
97	11/30/81	169989	ADDED WEST SHORE - HARRISBURG #1 & #2 138/69KV LINE - PROJECT LOCATION		97	11/30/81	169989	ADDED WEST SHORE - HARRISBURG #1 & #2 138/69KV LINE - PROJECT LOCATION	

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Attachment

2

ATTACHMENT “2”
West Trexlertown #1 & #2 138/69 kV Tap Line
ENGINEERING DESCRIPTION

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ATTACHMENT “2”
West Trexlertown #1 & #2 138/69 kV Tap Line
ENGINEERING DESCRIPTION

A. DESCRIPTION OF PROPOSED LINE

PPL Electric proposes to construct the West Trexlertown #1 & #2 138/69 kV Transmission Tap Line, which will extend approximately 1,200 feet in length and connect the existing the AT&T R&D #1 & #2 138/69 kV Transmission Tap Line to the planned West Trexlertown 69-12 kV Substation. The proposed West Trexlertown #1 & #2 138/69 kV Transmission Tap Line will be located in Upper Macungie Township, Lehigh County. The location of these proposed facilities is shown on the Aerial Attachment at the end of Attachment “2.”

The West Trexlertown #1 & #2 138/69 kV Transmission Tap Line will be designed for double-circuit 138 kV operation. Initially, however, it will be constructed as a double-tap, single feed circuit that initially will operate at 69 kV. The second circuit will be added and both circuits will be converted to 138 kV operation when future load increases make it appropriate to maintain service reliability.

The West Trexlertown #1 & #2 138/69 kV Transmission Tap Line will be approximately 1,200 feet in length and be supported by steel mono-poles. The double-circuit tap pole will be approximately 125 feet tall and will be installed on concrete foundations. The double-circuit tap pole will be located in-line with the AT&T R&D #1 & #2 138/69kV Transmission Tap Line (see Figure 1). The remaining steel poles will range in height from 70 to 100 feet (see Figures 2 and 3). Angle structures will either be self-supporting on foundations or direct embedded and guyed. Tangent, or no-angle, structures will be direct embedded.

The double-circuit West Trexlertown #1 & #2 138/69 kV Transmission Tap Line will consist of six power conductors, three per circuit, and one or two overhead ground wire(s). The power

conductors will be 556.5 kcmil,¹ 24/7 strand ACSR.² A 3/8-inch steel overhead ground wire(s) will provide lightning protection for the proposed tap line. In addition, two Load Sectionalizing Air Brake (LSAB) switch poles will be installed in the proposed West Trexlertown #1 & #2 138/69 kV Transmission Tap Line (see Figure 4).

The new 138/69 kV tap 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 feet for the new tap. This minimum clearance occurs at a maximum thermal conductor temperature of 125°C. The design minimum conductor ground clearances and conductor thermal ratings are as follow:

**TABLE 1
DESIGN MINIMUM CONDUCTOR CLEARANCES
FOR 556.5 KCMIL 24/7 STRAND ACSR³**

<u>Condition</u>	<u>Single-circuit Design Clearance-to-Ground</u>
Normal load, average weather (16°C ambient, 60°F temperature)	34.3 feet
Predicted extreme thermal load (125°C conductor, 257°F temperature)	30 feet
Predicted NESC extreme wind load conditions (25 lbs., 16°C, 60°F temperature)	32.6 feet
Predicted extreme weather conditions, 0°F (1-inch ice, 4 lbs. wind, -18°C)	32.6 feet

¹ 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 mm².

² Aluminum conductor steel reinforced.

³ Clearances based on a maximum tension of 8,000 pounds and a ruling span of 385 feet.

TABLE 2
CONDUCTOR THERMAL RATING
556.5 KCMIL 24/7 ACSR
125°C MAXIMUM CONDUCTOR TEMPERATURE

<u>Condition</u>	Ambient Temperature °C	Wind Speed Knots	Ampacity Amps
Summer Normal	35	0	815
Winter Normal	10	0	926
Summer Emergency	35	1.5	1041
Winter Emergency	10	1.5	1103

B. MAGNETIC FIELD MANAGEMENT

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

Increased structure height will be utilized in the design of the new West Trexlertown #1 & #2 138/69 kV Transmission Tap Line to reduce magnetic field exposures. Reverse phasing of the West Trexlertown #1 & #2 138/69 kV Transmission Tap Line cannot be utilized because only one circuit initially will be installed. Reverse phasing requires a double-circuit line. PPL Electric will consider reverse phasing when the planned second circuit is installed in the future.

C. RIGHT-OF-WAY STATUS

The West Trexlertown 69-12 kV Substation and West Trexlertown #1 & #2 138/69 kV Transmission Tap Line both will be constructed entirely on property owned by PPL Electric. No additional rights-of-way are required for the construction of either the Tap Line or Substation because there is sufficient property to contain the equipment and maintain all required NESC clearances.

FIGURE 1
PROPOSED 138/69 kV DOUBLE CIRCUIT TAP STRUCTURE
APPROXIMATE HEIGHT - 125'



FIGURE 2
PROPOSED 138/69 kV ANGLE STRUCTURE
APPROXIMATE HEIGHT – 70' to 125'

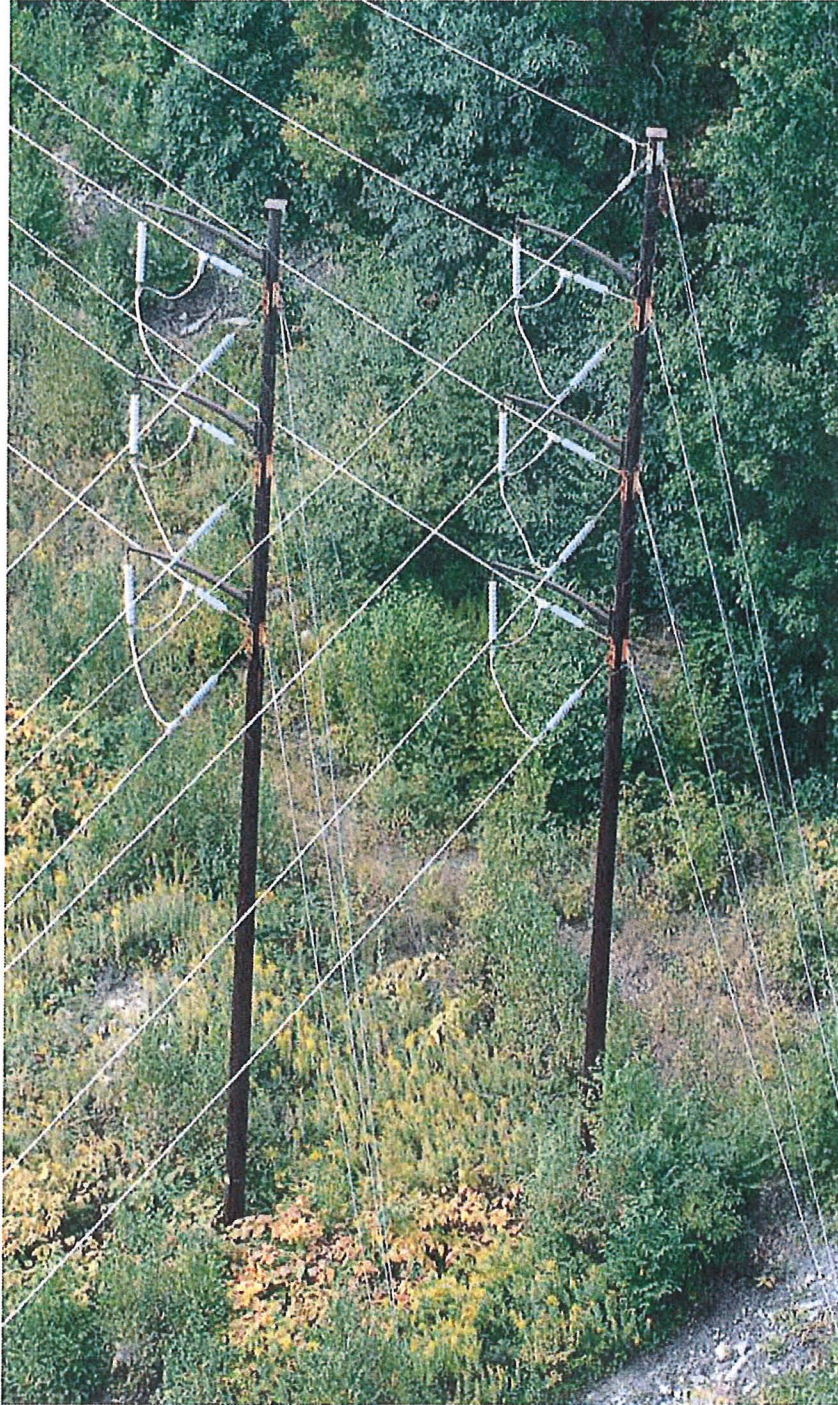


FIGURE 3
PROPOSED 138/69 kV TANGENT STRUCTURE
APPROXIMATE HEIGHT – 70' to 100'

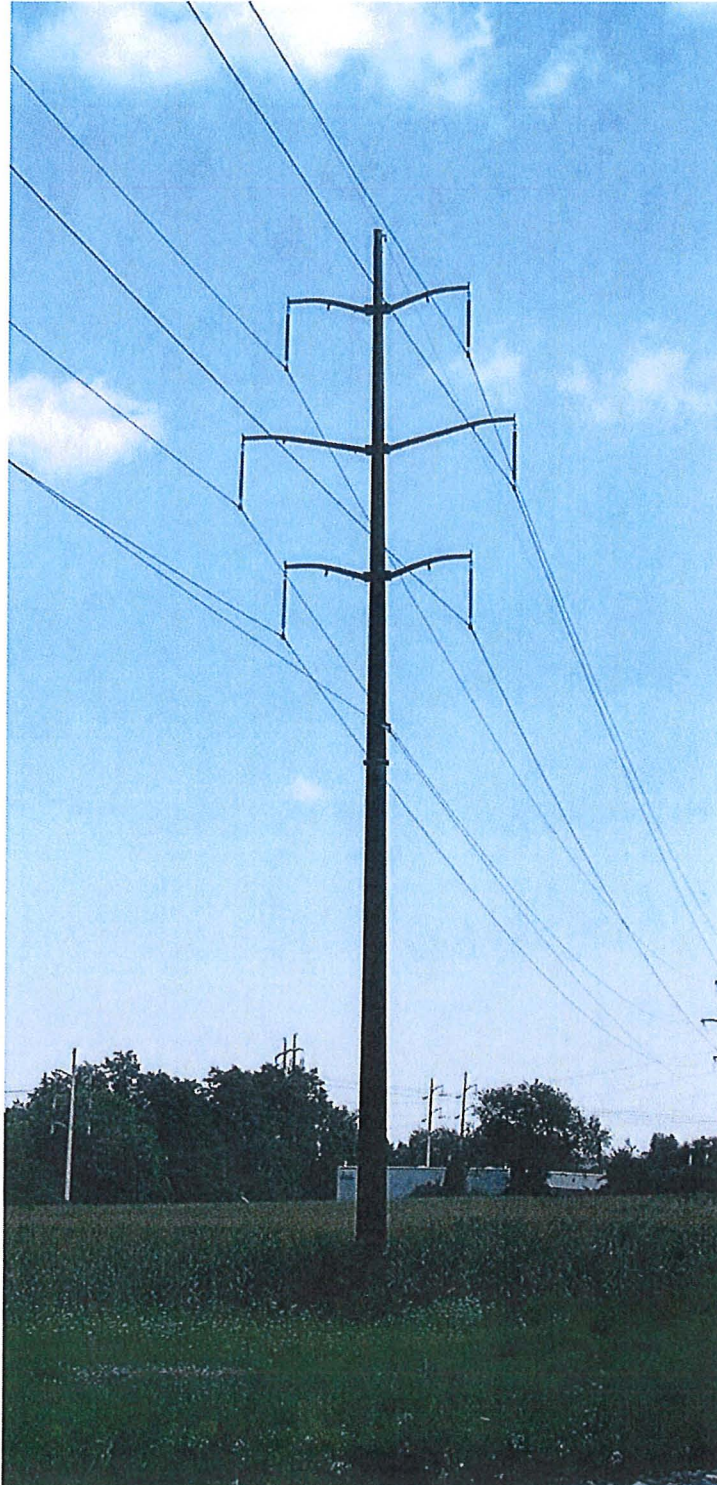
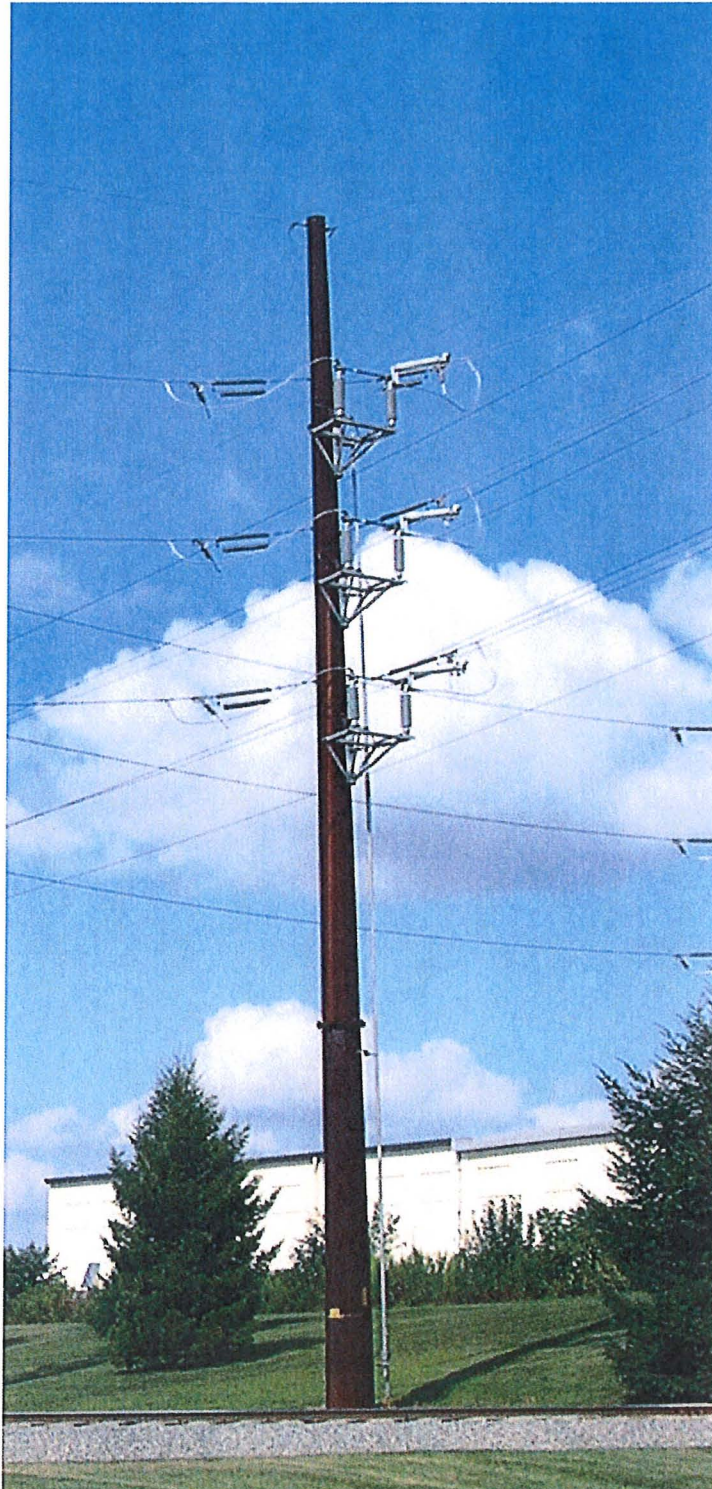
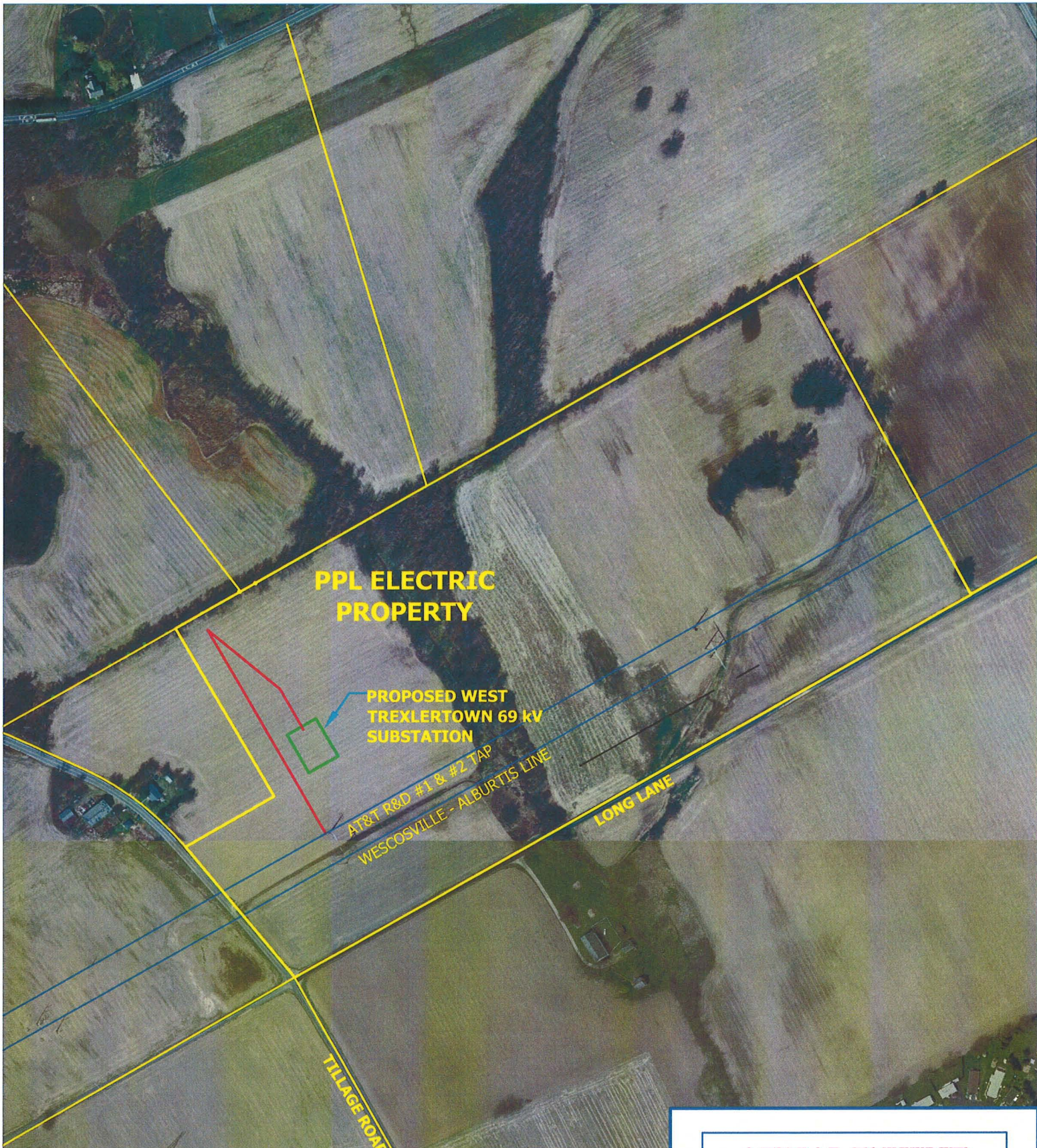


FIGURE 4
PROPOSED 138/69 kV LSAB SWITCH STRUCTURE
APPROXIMATE HEIGHT – 85'





**PPL ELECTRIC
PROPERTY**

**PROPOSED WEST
TREXLERTOWN 69 kV
SUBSTATION**

**AT&T R&D #1 & #2 TAP
WESCOVILLE - ALBURTIS LINE**

LONG LANE

TILLAGE ROAD

LEGEND

- EXISTING TRANSMISSION LINE
- PROPOSED TRANSMISSION TAP
- PROPERTY LINE (APPROXIMATE)
- PROPOSED SUBSTATION (APPROX.)

SCALE 1" = 400'

AERIAL EXHIBIT

WEST TREXLERTOWN SUBSTATION
UPPER MACUNGIE TOWNSHIP
LEHIGH COUNTY, PA.



PREPARED BY:
PPL ELECTRIC UTILITIES CORP.

PPL ELECTRIC UTILITIES

Attachment

3

ATTACHMENT “3”
West Trexlertown #1 & #2 138/69 kV Tap Line
ENVIRONMENTAL ASSESSMENT

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B. Land Use	1
C. Cultural Resources	2
D. Natural Features	3
E. Threatened and Endangered Species	3

ATTACHMENT “3”
West Trexlertown #1 & #2 138/69 kV Tap Line
ENVIRONMENTAL ASSESSMENT

A. INTRODUCTION

PPL Electric proposes to install new 12 kV distribution lines that will be connected to the new West Trexlertown 69-12 kV Substation to resolve violations of reliability criteria and increase operating flexibility in the Trexlertown and South Fogelsville areas of Lehigh County. To accomplish this reinforcement, PPL Electric proposes to construct the West Trexlertown #1 & #2 138/69 kV Transmission Tap Line, which will extend approximately 1,200 feet in length and connect the existing the AT&T R&D #1 & #2 138/69 kV Transmission Tap Line to the planned West Trexlertown 69-12 kV Substation in Upper Macungie Township, Lehigh County, Pennsylvania. The West Trexlertown #1 & #2 138/69 kV Transmission Tap Line, together with the two new 12 kV distribution lines and the West Trexlertown 69-12 kV Substation, is required resolve overload conditions and violations of reliability criteria, and to improve reliability and increase operating flexibility in the Trexlertown and South Fogelsville areas of Lehigh County.

PPL Electric provided information describing the project to Upper Macungie Township and Lehigh County, and neither the Township nor the County objected to the project. A list of involved governmental agencies, municipalities, and other public entities is presented in Attachment 6.

B. LAND USE

The proposed West Trexlertown #1 & #2 138/69 kV Transmission Tap Line and West Trexlertown 69-12 kV Substation are located on a 61-acre parcel in Upper Macungie Township, Lehigh County that is owned by PPL Electric. The southern portion of the property is traversed by the existing AT&T R&D #1 & #2 138/69 kV Tap Line and the Wescosville – Alburtis 500 kV Transmission Line. The property is bordered by

agricultural parcels to the north and east. To the south the property is bordered by Long Lane and to the west by Tillage Road. Additional agricultural properties are located immediately across Tillage Road and Long Lane. Due to the existing transmission lines on this parcel, the incremental visual impacts of the proposed project will be minimal.

No nearby communication towers, pipelines, or other utilities will be affected by the proposed project. Zettlemoyer Airport in Kutztown, PA, located approximately 3.1 miles west of the project site, is the nearest private airport. Allentown Queen City Airport, located approximately 8.1 miles from the project site, is the closest public Airport to the project site. Impacts to these airports are not expected due to the location of the project in relation to the orientation of the runways, and the fact that the property presently contains several transmission structures that are similar to the proposed structures. Nonetheless, the appropriate notifications will be filed with the Federal Aviation Administration and PennDOT Bureau of Aviation to confirm that the proposed tap line will not be a hazard to the airports' flight operations.

C. CULTURAL RESOURCES

The project was reviewed by the Pennsylvania Historical and Museum Commission (PHMC). The PHMC has identified significant archeological sites in the proximity of the proposed project and additional studies were warranted (File No. ER 08-0299-077-A). As a result, PPL Electric engaged the services of Dr. Frank Vento of the Quaternary Research Institute to conduct a Phase I Archeological Survey of the subject property. Results of this Survey uncovered no significant archeological artifacts at the portion of the subject property where these proposed facilities will be constructed. Significant artifacts were found on other portions of the property, and Dr. Vento is preparing a Final Phase 2 Report to be submitted to PHMC for the entire property

D. NATURAL FEATURES

The project will not affect any unique geological, scenic, or natural areas. The nearest public recreational area is the Bob Rodale Cycling and Fitness Park, which is located approximately 1.2 miles east of the project site. It is not anticipated that the proposed project will have an adverse impact on this park due to the distance from the project area, existing development between the project area and the park, and the relatively small project size.

Substantial tree clearing is not required for this project since the property is already cleared of trees. 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” if minor tree or brush clearing is required along the edges of the property.

The transmission tap line will not cross any wetlands or areas designated as “Waters of the U.S.” or “Waters of the Commonwealth.” PPL Electric will acquire any required soil erosion and sedimentation control permit and comply with all conditions. Additionally, any required permits will be obtained 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 the permits.

E. THREATENED AND ENDANGERED SPECIES

PPL Electric has coordinated with different 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 the potential presence of threatened and endangered species and/or special concern species and resources (PNDI Search ID: 20111007320187). Based on the initial PNDI response, PPL Electric contracted Mellon Biological Services to conduct a survey of the entire property to determine whether the identified species were present. Based on this

survey, the identified species were not found on the portion of the property where these proposed facilities will be constructed. The results of the survey were submitted to Pennsylvania Fish and Boat Commission (PFBC) for its review, along with a recommendation that no further investigation be conducted on this portion of the property. On October 26, 2011, PFBC issued a letter concurring with the recommendations of the report and agreeing that the proposed project would not have an adverse impact on the identified species.

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 Involved Governmental Agencies, Municipalities
and Other Public Entities

ATTACHMENT "4"

West Trexlertown #1 & #2 138/69 kV Tap Line

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, 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 that 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, with; 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 cross arm dimensions, larger-minimum conductor size, and increased safety factors.

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

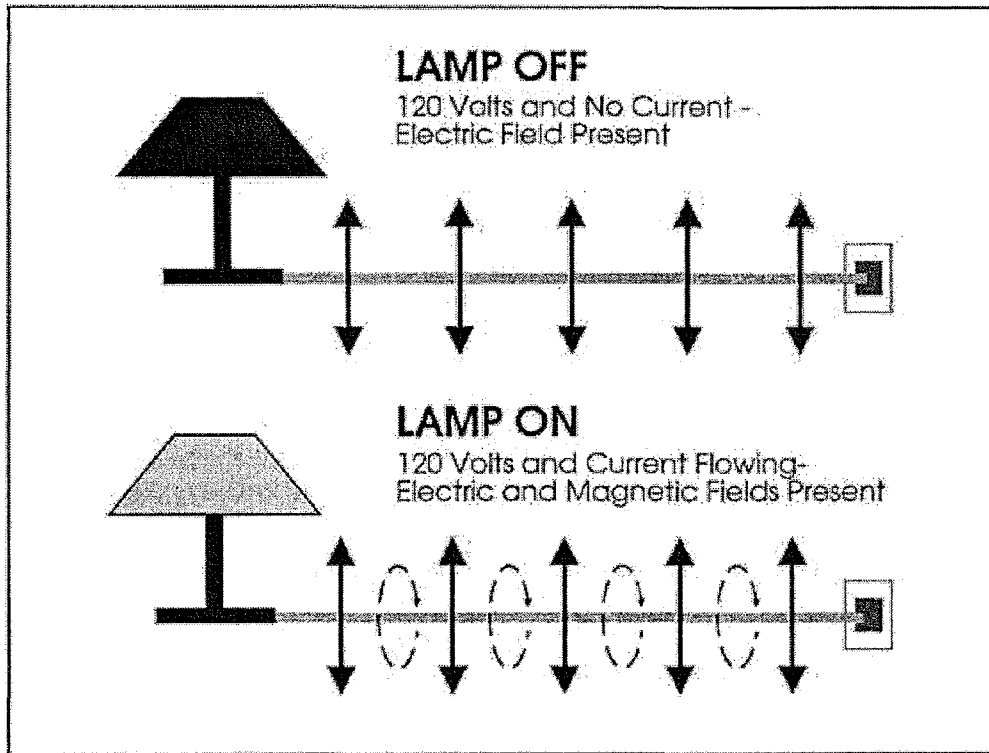


Figure 2









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

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.

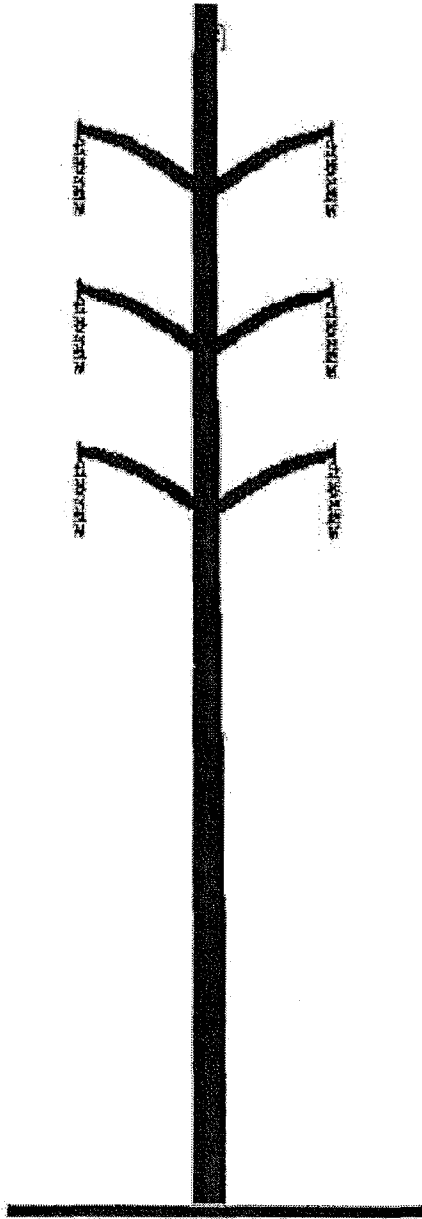
- Main lines are the most heavily loaded sections of a distribution line and therefore have the highest magnetic fields associated with them.
- Increasing the ground clearance by five feet reduces the magnetic field under the line from 14 mG to 11 mG using the standard eight-foot crossarm design. These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

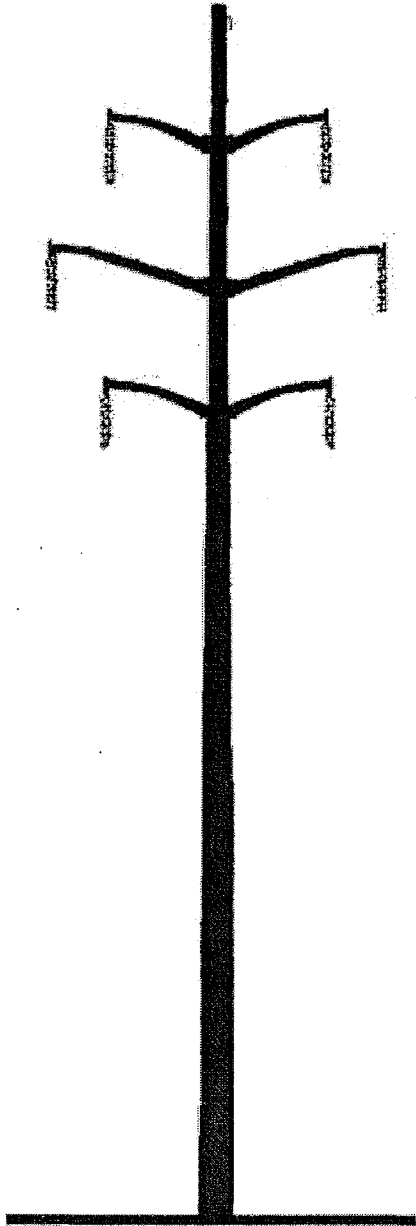
- The phase arrangement that produces the lowest field will be determined.
- The depth of burial of the line will be determined considering the cost of excavation and the location of other buried utilities in the area.
- The use of steel pipe ferromagnetic shielding that reduces magnetic fields will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



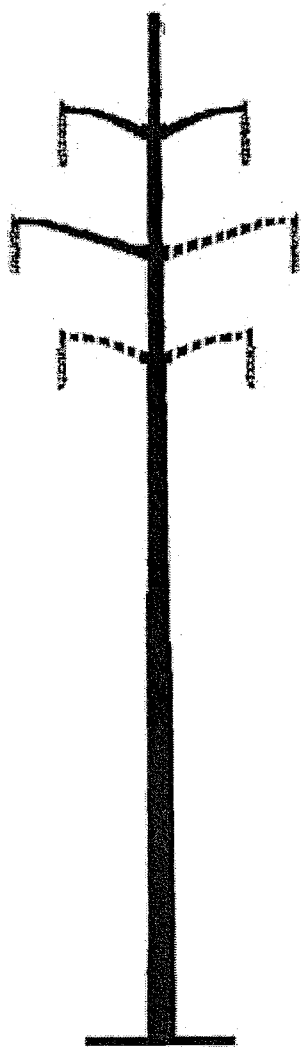
- Lower cost alternative
- Reduces magnetic fields due to higher structures
- Typical conductor data:
 - 1 3/8" HS steel overhead ground wire - 17.3 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
 - Average span - 600 feet

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

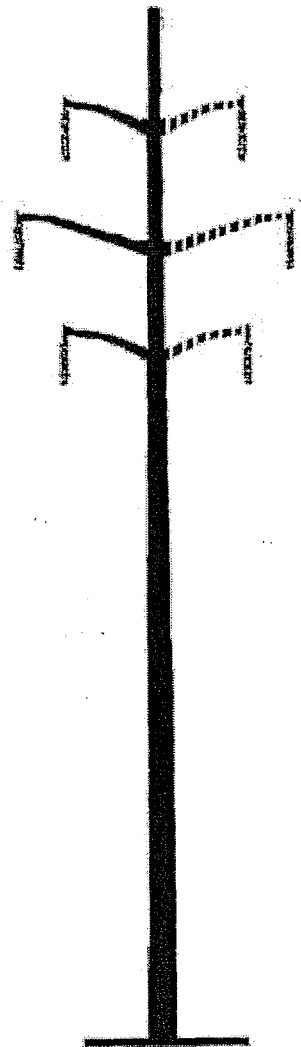
TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SHORT SPAN (CHART I)	30
SHORT SPAN (REVERSE PHASE)	8
LONG SPAN (CHART II)	29
LONG SPAN (REVERSE PHASE)	9
COMPACT (CHART VI)	14
COMPACT (REVERSE PHASE)	3

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.

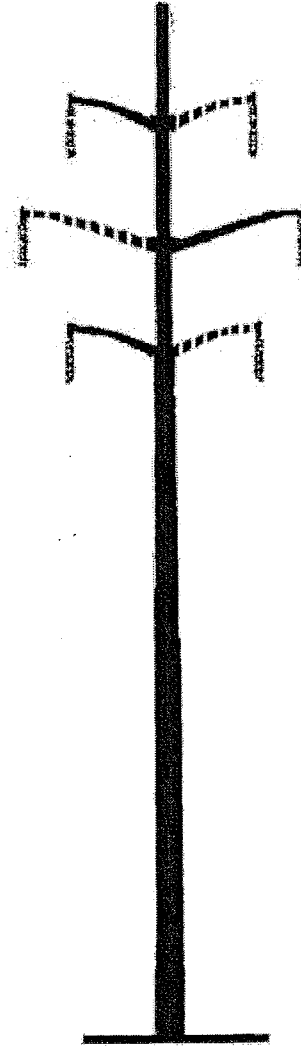
Typical Single-Circuit Structure Designs



Top/Middle



Vertical



Top/Middle/Bottom

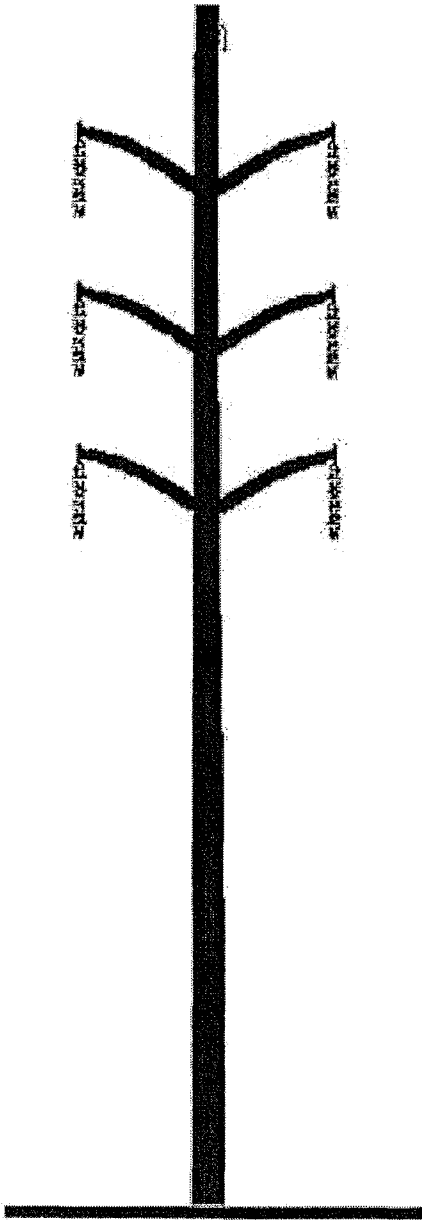
——— initial single circuit
- - - - - future second circuit

**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

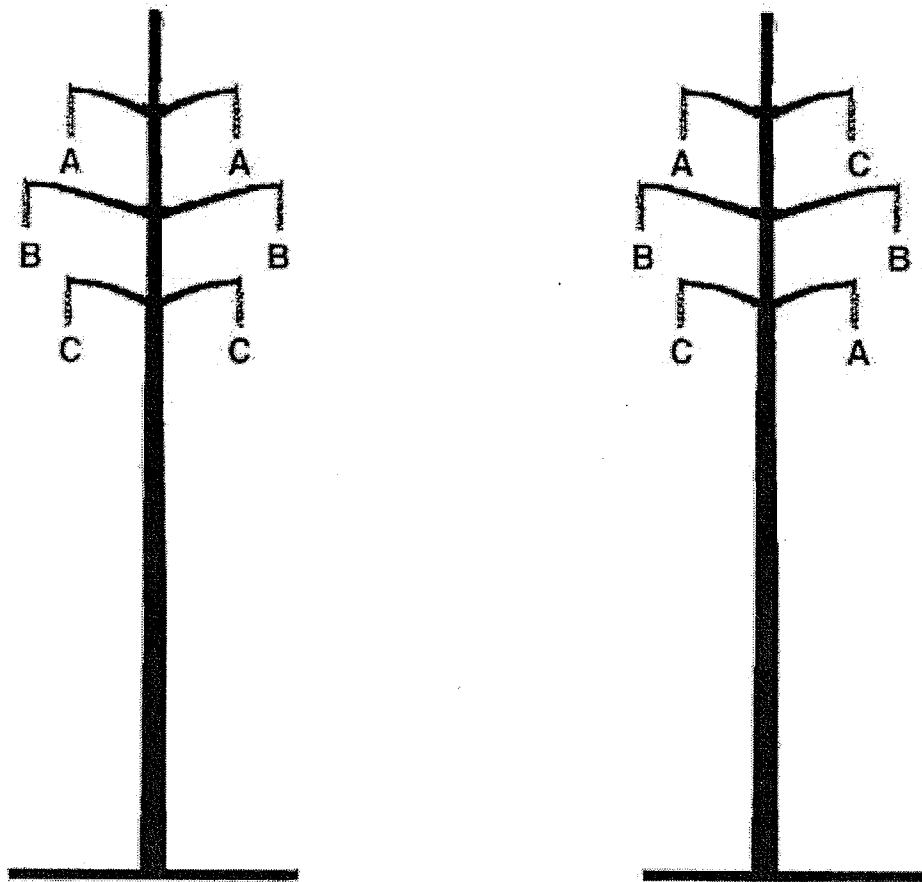
The edge of right of way is 50 feet from the line centerline.
 The 400 ampere phase current is balanced between phases.
 Calculations are based on a minimum ground clearance of 25 feet.

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: $\longrightarrow \longrightarrow \longrightarrow \longrightarrow$ 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"

West Trexlertown #1 & #2 138/69 kV Tap Line

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

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. McLearn, Chief

Pennsylvania Department of Transportation
Commonwealth Keystone Building
400 North Street, 8th 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

Lehigh County Commissioners
17 S. Seventh Street
Allentown, PA 18101
Attn: Mr. Dean N. Browning, Chairman

Lehigh Valley Planning Commission
961 Marcon Boulevard, Suite 310
Allentown, PA 18103
Attn: Steven L. Glickman, Chairman

Upper Macungie Township Board of Supervisors
8330 Schantz Road
Breinigsville, PA 18031-1510
Attn: Edward J. Earley, Ed.D., Chairperson

Upper Macungie Township Planning Board
8330 Schantz Road
Breinigsville, PA 18031-1510
Attn: David C. Etowski, Chairperson