

ATTACHMENT:

A METHODOLOGY FOR THE ASSESSMENT AND ANALYSIS OF THE RESOURCE IMPACTS OCCURRING WITHIN A 14-MILE WIDE VIEWSHED OF THE NATIONAL PARK SERVICE UNITS

INTRODUCTION:

This analysis provides the basis for compensation measures to offset unavoidable impacts to existing public attributes and natural resources within and related to NPS units affected by the proposed Project. The National Environmental Policy Act supports these types of measures, which are to be used “to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation...”

The Applicants recognize that, even after full implementation of all possible measures to avoid and minimize impacts, the proposed Project will cause some adverse impacts on resources under NPS jurisdiction. Accordingly, the Applicants are proposing compensatory mitigation pursuant to a methodology and on a scale that recognize the great public value of the national parklands adjacent to the Applicants’ transmission corridor. The intent of the proposed methodology is to more than offset every potential unavoidable impact of the proposed Project, by creating and endowing a substantial fund to support acquisition and stewardship of lands and other resources in the DEWA region.

The methodology described in this document is very conservative in the sense that it resolves uncertainties in favor of benefiting NPS resources. The approach considers all NPS-recognized categories of potential impacts within a seven-mile zone on either side of the transmission line corridor where it crosses NPS lands. The methodology recognizes that the intensity of unavoidable impacts is likely in most cases to be greater on resources closer to the corridor than on the same resources located farther away. The approach applies to resources on more than 38,000 acres of NPS lands, an area equal to more than half of DEWA’s total acreage, even though the transmission corridor itself comprises less than 100 acres inside the federal park lands, and the incremental right-of-way requested by the Applicants is less than 5 acres, or approximately .007 percent of the DEWA area.

The precautionary approach being proposed by the Applicants is highly beneficial to the resource values of the park because the zone covered by the analysis is so wide and because it assumes that all NPS-recognized impact categories are present on all acres in the zone. The result is a very conservative quantitative estimate of the resources potentially affected by the Project, measured in acres, and a correspondingly conservative or protective estimate of the acreage of high resource value lands needed to compensate for the potential impact. This “worst-case” approach assures that the Applicants’ mitigation commitment will, at a minimum, be scaled to fully compensate for the unavoidable long-term impacts of the proposed Project.

The mitigation proposal prepared by the Applicants is designed to avoid, minimize, or otherwise compensate for the impacts of the proposed Project in order to ensure that the proposed activities are consistent with the goals and purposes of the National Environmental

Policy Act and the relevant authorities of the Department of the Interior. This document is concerned only with the compensatory mitigation portions of the Applicants' proposal, and does not address the extensive measures proposed by the Applicants to avoid impacts entirely or to minimize any impacts to insignificant levels.

The Applicants approach assumes that the zone where resource impacts may occur is contiguous with the viewsheds potentially affected by the Project. This assumption takes into full account the emphasis placed by the NPS and public on the potential incremental visibility of the Project's features. The Applicants' concept of the viewshed is based on leading scholarship on the concept. As described by Gaffney et al (1996b) in Van Leusen's Pattern to Process,

“A viewshed represents the area in which a location or monument may communicate visual information. Viewsheds may overlap, producing zones in which an observer might be aware of the presence of such locations, all of which may carry information. The increased density of such information can in some circumstances be interpreted as a measure of importance of a particular area. It provides a spatial index of perception, mapping the cognitive landscape within which the monuments operated.”

Actual viewshed impacts are not easy to quantify, in many ways because these impacts often fall within the eye of the beholder. A significant viewshed impact to one person may be of minor consequence to another. “Several studies have developed different approaches to measure scenic attractiveness of locations. These approaches range from administering a survey questionnaire, to experiential sampling methods, through the use of videos and virtual reality modeling” (Tassinari, 2006). “The perception of scenic attractiveness...involves the processes of knowing, believing and recognizing an object or view as being attractive. Such perception of scenic value is influenced by values, attitude, learning, disability and socio-economic background of the viewer.” (Chhetri, 2003).

GIS, DISTANCE RANGES & DISTANCE DECAY FUNCTION

The Applicants have used GIS to characterize the viewshed area. The use of GIS has been validated for viewshed analysis as demonstrated by Maloy (2001), Chhetri (2003) and Tassinari (2006). Through the use of ARC/GIS, the Applicants have been able to formulate a methodology or model that provides a reasonable estimate of the study area to be used to evaluate the *potential* impacts to the viewshed and other existing public attributes from the Project throughout the affected park properties. This model is an example of a cost-surface analysis, which “allows the simple ‘flat’ geographic space to be supplanted by a set of complex cost surfaces incorporating many relevant properties of the terrain.”¹ (Van Leusen, 2002). This approach is very conservative and more inclusive of potential impact areas compared to line-of-sight models, which use terrain and other natural features specifically to include or to exclude particular properties not “visible” to the computer.

Table 1 describes five distance ranges from the proposed transmission line that were used to calculate the gross land areas potentially affected within each of the three NPS Units. A distance decay function was then used to determine the *net affected land areas* within each range. Distance decay refers to the decrease or loss of similarity between two observations as the distance between them increases. The distance ranges and the distance decay function are based on Fisher (1994), who estimated that visibility based on distance decay for a viewshed under ideal conditions would diminish by 50% (0.5) at approximately 3 km (1.86 miles). Tassinari (2006) also considered the maximum distance of perception significance for a viewshed to be between 3 km and 10 km (1.86 to 6.2 miles). The distance decay function relationship for this analysis is shown within Table 1 below:

Table 1		
DESCRIPTION	DISTANCE RANGE	DISTANCE DECAY FUNCTION
Immediate foreground	0 feet to ½ mile	1.00
Foreground	½ - 1 mile	0.66
Middleground	1-2 miles	0.33
Background	2-3.5 miles	0.10
Near Horizon	3.5-7 miles	0.05

¹ Other complex modeling of viewsheds is also possible using ARC/GIS and raster and TIN based digital terrain data, but these have been shown to be no more valid than the Applicants’ methodology described in this document. The other methodologies also have considerable variability and practical limitations due to the significant amount of data being analyzed.

The Distance Ranges from Table 1 were applied to the three NPS Units as detailed below. For purposes of this analysis, impacts were limited to those caused by the Project within the boundaries of the NPS Units.

1. **Delaware Water Gap National Recreation Area (DEWA):** For this NPS Unit, the model calculated the area within the five Distance Ranges in relation to the transmission line through the Unit.
2. **Middle Delaware Scenic & Recreational River (MDSNR):** For this NPS Unit, the model calculated the area within the five Distance Ranges for the upstream and downstream area of the river at the point where the transmission line crosses the river plus one hundred feet from the top of the bank on both sides of the river.
3. **Appalachian National Scenic Trail (ANST):** For this NPS Unit, the model calculated the area within the five Distance Ranges at the location where the transmission line crosses the ANST for the ROW plus three hundred feet on each side of the ROW confined within the DEWA.

The areas of impact analysis under this methodology, in acres, are shown in Table 2 below. A total of 38,221 acres are affected within the three NPS units.

Table 2	Distance	Acres
Figure 1 Delaware Water Gap National Recreation Area	0-0.5 miles	2,918
	0.5-1 miles	2,592
	1-2 miles	5,429
	2-3.5 miles	8,149
	3.5-7 miles	16,749
	Area Subtotal	35,837
Figure 2 Middle Delaware Scenic & Recreational River	0-0.5 miles	114
	0.5-1 miles	147
	1-2 miles	359
	2-3.5 miles	465
	3.5-7 miles	882
	Area Subtotal	1,967
Figure 3 Appalachian National Scenic Trail Within DEWA	0-0.5 miles	74
	0.5-1 miles	45
	1-2 miles	91
	2-3.5 miles	136
	3.5-7 miles	72
	Area Subtotal	418
	Area Total	38,221

ESTIMATING THE INTENSITY LEVEL OF AN EFFECT

The Applicants have shaped this methodology with reference to modes of analysis previously used by the NPS in performing NEPA analyses. The NPS's Environmental Assessment² prepared for the installation of new cell towers within Yellowstone National Park analyzed impacts by using viewshed *Intensity Levels*, defined as "the magnitude of effect based on the number of park visitors that will view the effect, the amount of time their view would be affected and the number of locations where the vista would be affected." However, unlike the approach used by the NPS in Yellowstone, which employed a more traditional line-of-sight GIS analysis and excluded areas from analysis based on topography, we have taken a more conservative approach to account for all of the land within seven (7) miles on each side the transmission corridor. The zone of analysis, the area in which impacts are assumed to be possible, is 14 miles wide, and extends the length of the Applicants' corridor inside the NPS Units. We evaluated each of the park units independently as shown on Figures 1, 2, and 3. However, to be even more conservative, rather than excluding those acres that overlapped between the park units, the applicant's total acreage includes some locations that are actually double or triple counted. For example, the model accounts for the fact that a park visitor could stand along the bank of the Delaware River and be within two park units simultaneously. This approach was respectful of the three separate park units, but then recognizes that they also function well together in order to protect many sensitive environmental resources.

The following thresholds were used by the NPS to describe the magnitude of effects on visual resources:

- **Major** - Impacts to the visual quality of the landscape would be significantly adverse, affect a majority of visitors or affect a large portion or all of the surrounding area. Visitors would likely express a strong opinion about the impacts.
- **Moderate** - Impacts to the visual quality of the landscape would be readily apparent and/or will affect many visitors, but would not preclude enjoyment of adjacent views by a majority of the visitors. Visitors would likely be able to express an opinion about the impacts.
- **Minor** - Impacts to the visual quality of the landscape would be slight but detectable, visible to a relatively small number of visitors and confined to a small portion of the surrounding area.
- **Negligible** - Impacts to the visual quality of the landscape are barely detectable, and/or will affect very few visitors."

Table 2 above details an estimate of the existing public parkland resources in zones segregated by distance from the transmission line. This estimate of the study area indicates that approximately 38,221 acres of land and resources under NPS jurisdiction are proximate to the transmission line and could experience a potential effect. This is not an estimate of the direct or

² http://www.nps.gov/yell/parkmgmt/upload/wireless%20ea%20september_9_08%20final.pdf

physical impacts of the Project. Instead, the area within the zone of analysis is an estimate of the location of resources under NPS jurisdiction that could experience impacts, such as the Project's impact on views. The intensity of any potential impact will vary in level by location and other factors and could range from major to negligible, and the actual set of resources affected will vary from place to place within the zone of analysis.

Again as noted above, this is a very conservative approach to reaching a method to compensate for the impacts that are not avoided or rendered insignificant through minimization measures. The "flat plane" analysis, which does not account for topography, starts with a much larger universe of "all-in" acres. The net affected acreage is calculated in the Applicants' model using adjustments based on the "intensity level factors" and "distance decay functions" as discussed below.

INTENSITY LEVEL FACTOR DEVELOPMENT

Chapter 3 of the Draft Environmental Impact Statement (DEIS) retained 18 environmental topics for detailed analysis. These are listed in Table 3 below. Eight (8) of these broad categories, or 44 percent of the total number of categories, are related to visual (including visitor experience, cultural landscapes and historic features) or wildlife movement concerns, including protected species. This subset of the potential total number of resource categories represents the suite of resources identified in the DEIS as potentially affected by the proposed Project that cannot otherwise be avoided or rendered insignificant by other means, such as through the proposed Wetlands and Riparian Zone Mitigation Plan for the Project.

In other words, the Applicants' mitigation methodology takes into account the level of impacts to every potential category of resource within the area of NPS lands in a zone seven (7) miles to either side of the proposed Project. The Applicants' approach assumes, based on the information in the DEIS, that for 10 of the 18 categories of potential resource impacts, actual impacts will be entirely avoided or reduced to a level of insignificance through implementation of direct environmentally responsible construction and restoration methods and techniques and other measures.

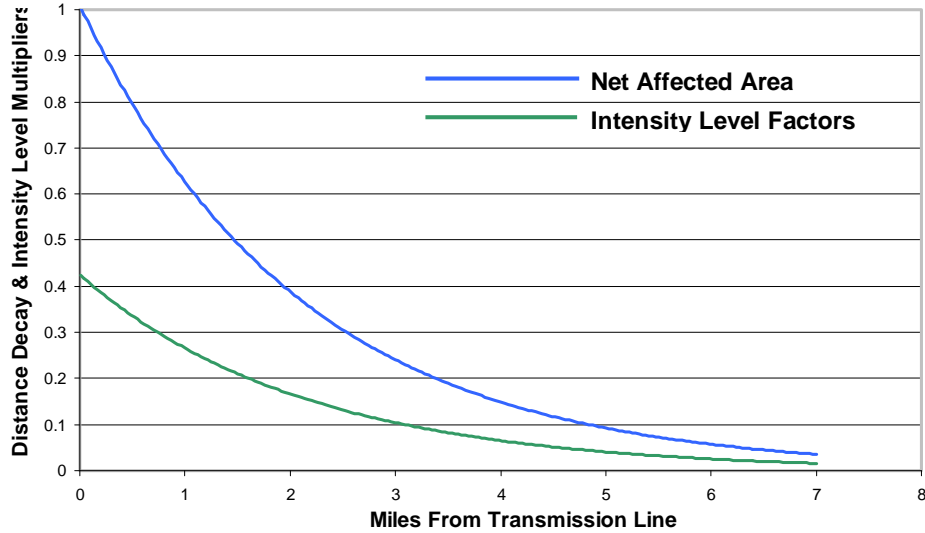
However, eight (8) categories of potential resource impacts (shown on Table 3) are more intangible and subjective, and cannot be avoided or be readily minimized to insignificance by some form of a direct mitigation. Instead, these resource categories become factors within the mitigation compensation formula, which accounts for the collective assembly of these resources issues as they may potentially exist or be affected by the Project within each acre of the 14 mile-wide zone of analysis.

In order to account for the fact that the intensity of impacts will vary from place-to-place within the zone of analysis (e.g., the Project features will not be visible from every place in the zone), and to avoid an impractical and likely unreliable acre-by-acre analysis of impact intensities, the initial 0.44 net value was multiplied by the distance decay function shown in Table 1. These calculations create Intensity Level Factors from **Major** (0.44) to **Negligible** (0.022) shown in Table 4.

Table 3 DEIS NPS AFFECTED ENVIRONMENT TOPICS RETAINED FOR DETAILED ANALYSIS (Page XVI)	Visual or Wildlife Movement Concerns (Y/N)	Y=1; N=0
Geologic Resources	N	0
Floodplains	N	0
Wetlands	N	0
Vegetation	N	0
Landscape Connectivity, Wildlife Habitat & Wildlife	Y	1
Special-Status Species	Y	1
Rare and Unique Communities	Y	1
Archeological Resources	N	0
Historic Structures	Y	1
Cultural Landscapes	Y	1
Socioeconomics	N	0
Infrastructure, Access & Circulation	N	0
Visual Resources	Y	1
Soundscapes	N	0
Visitor Use and Experience	Y	1
Wild and Scenic Rivers	Y	1
Park Operations	N	0
Health and Human Safety	N	0
1. TOTAL APPLICABLE TO ANALYSIS		8
2. TOTAL DEIS AFFECTED ENVIRONMENT TOPICS		18
Line 1 divided by line 2		0.44

Table 4 Distance	Distance Decay Function	Intensity level Factors (ILF)
0.5	1	0.44
1	0.66	0.293
2	0.33	0.147
3.5	0.1	0.044
7	0.05	0.022

Chart 1: SR Project Intensity Levels on Net Affected Areas



PER-ACRE CONTRIBUTION ESTIMATE

The Applicants have assumed for the purpose of this analysis that the average cost to acquire an acre of land in the DEWA area with resource values equivalent to the acres inside the NPS Units is \$9,500 per acre. This specific figure is an adjusted average drawn from broad sample of transactions, and is biased upward to avoid under-estimation of possible costs. Many thousands of acres of high value land in the DEWA area could be placed in conservation status under agreements with considerably lower price terms.

COMPENSATION

The Applicants derived an estimate of the cost of compensating for the potential impacts of the Project by multiplying the size of the impact area by the various Intensity Levels and by the per-acre cost estimate (area x intensity x cost). Table 5 shows the total cost estimate for compensation as \$36,494,241.

CONCLUSION

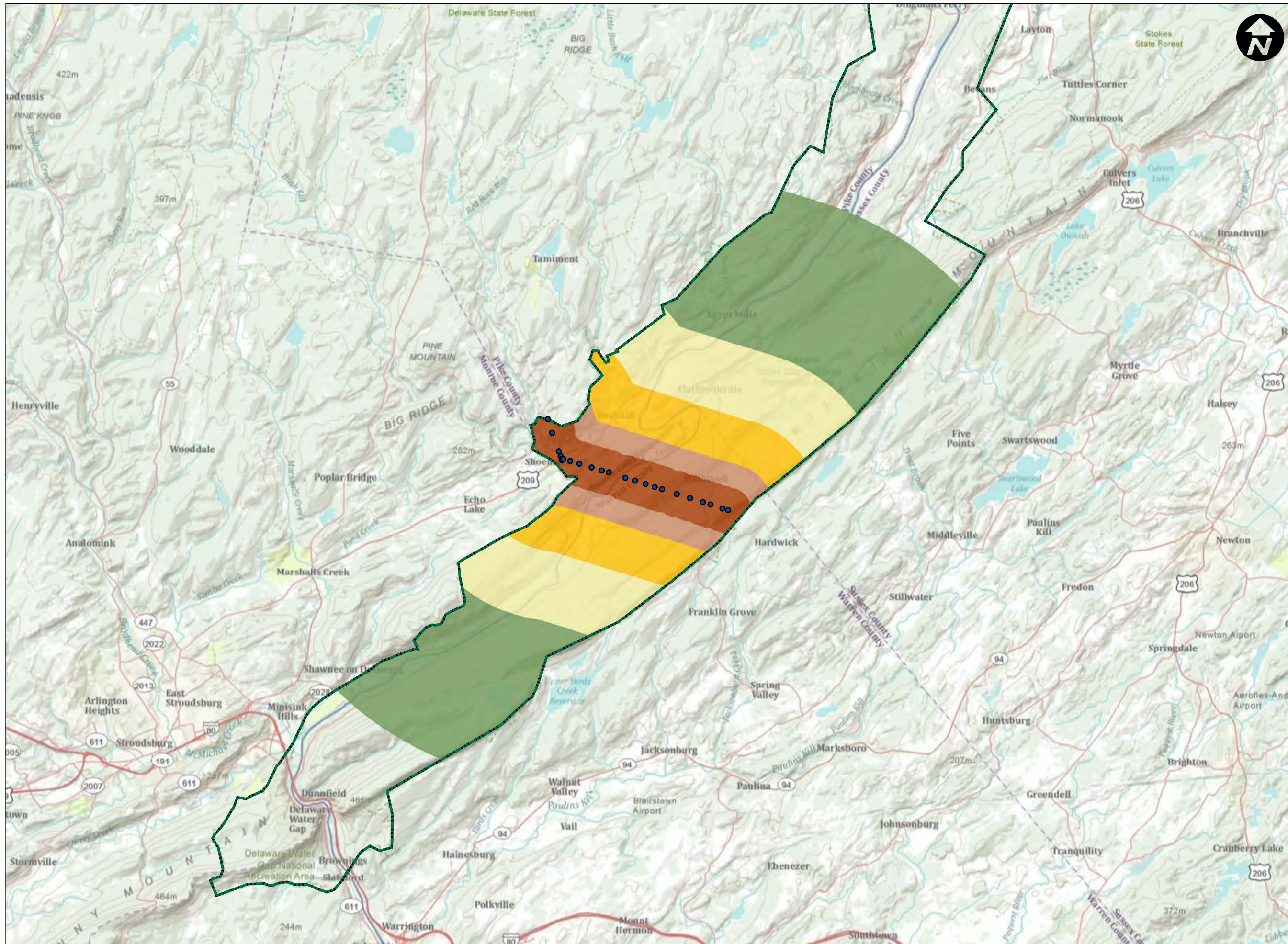
The proposed compensation is intended to more than offset the potential diminution of resources resulting from the proposed Project's impacts that cannot otherwise be avoided or minimized to insignificance. This estimate was based on a methodology that was created and validated by a GIS analysis process specifically designed for the Project, but supported by various technical references. Through this analysis the Applicants provide a reasonable and repeatable methodology to quantify the intangible impacts on a resource, such as viewshed. The approach recognizes that distance is a major factor in determining impacts. This analysis brings together an analytical and qualitative method of assessment and expands the discussion on how to address multiple resources issue simultaneously through appropriate compensation formulas and resource assessment methods.

Table 5 Affected Resource Analysis - Impacts Tiered By Distance and Affected Resource

Delaware Water Gap National Recreation Area			
Miles from Line	Acres	Per Acre	\$Value/ILF
0.5	2,918	\$ 9,500.00	\$12,320,487
1	2,592	\$ 9,500.00	\$7,222,093
2	5,429	\$ 9,500.00	\$7,564,198
3.5	8,149	\$ 9,500.00	\$3,440,799
7	16,749	\$ 9,500.00	\$3,535,864
Area Subtotal	35,837	SUBTOTAL	\$34,083,440
Middle Delaware Scenic and Recreational River			
0.5	114	\$ 9,500.00	\$482,178
1	147	\$ 9,500.00	\$408,943
2	359	\$ 9,500.00	\$499,914
3.5	465	\$ 9,500.00	\$196,253
7	882	\$ 9,500.00	\$186,253
Area Subtotal	1,967	SUBTOTAL	\$1,773,541
Appalachian National Scenic Trail			
Within DEWA			
0.5	74	\$ 9,500.00	\$312,444
1	45	\$ 9,500.00	\$125,400
2	91	\$ 9,500.00	\$126,793
3.5	136	\$ 9,500.00	\$57,422
7	72	\$ 9,500.00	\$15,200
Area Subtotal	418	SUBTOTAL	\$637,260
Area Totals	38,221	TOTAL	\$ 36,494,241

References Cited

- Chhetri, P and Arrowsmith, C. "MAPPING THE POTENTIAL OF SCENIC VIEWS FOR THE GRAMPIANS NATIONAL PARK" in the Proceedings of the 21st International Cartographic Conference, Durban, South Africa, August 10-16, 2003.
- He; J. Tsou J.T. "GIS-BASED VISUAL PERCEPTION ANALYSIS OF URBAN NATURAL LANDSCAPE FOR URBAN PLANNING SUPPORTING: A CASE STUDY OF JINZISHAN HILL REGION (CHINA) 2001 in Modeling & City Planning – 17 Urban Planning & Representation
- Fisher, P. F. (1994). Probable and fuzzy models of the viewshed operation. Innovations in GIS: selected papers from the First National Conference on GIS Research UK. M. F. Worboys. London, UK, Taylor and Francis: 161-175.
- Tassinari, P and Torreggiani, D. "VISUAL IMPACT ASSESSMENT METHODOLOGIES FOR RURAL BUILDING DESIGN". Agricultural Engineering International: the CIGR Ejournal. Manuscript BC 05 009. Vol. VIII. January 2006.
- Maloy, Mark A and Dean, Denis J. "AN ACCURACY ASSESSMENT OF VARIOUS GIS-BASED VIEWSHED DELINEATION TECHNIQUES" Photogrammetric Engineering & Remote Sensing. Vol. 67, No. 11 November 2001, pp 1293-1298.
- National Park Service, Yellowstone National Park "WIRELESS COMMUNICATIONS SERVICES PLAN", Environmental Assessment, September 2008 Pg. 118
- Van Leusen, A. "LINE OF SIGHT AND COST SURFACE ANALYSIS USING GIS" Chapter 6 of Pattern to Process
- Workshop 2009, No 1 – Viewshed and Cost Distance – Practical GIS Workshop in Arcmap 9.2 <http://mapaspects.org/book/export/html/3743>



Legend

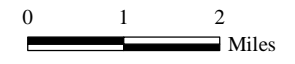
- Proposed Tower Locations
- ▭ Delaware Water Gap National Recreation Area Boundary

Distance from Proposed Towers

Distance/Potential Impact Area

- 0 - 0.5 miles / 2,918.01 acres
- 0.5 - 1 miles / 2,591.66 acres
- 1 - 2 miles / 5,428.85 acres
- 2 - 3.5 miles / 8,149.26 acres
- 3.5 - 7 miles / 16,748.83 acres

Source:
 Tower Locations from PSE&G, 2009.
 Delaware Water Gap National Recreation Area Boundary from National Atlas of the United States, 2005.
 Background Topography from ArcGIS Online, 2010.

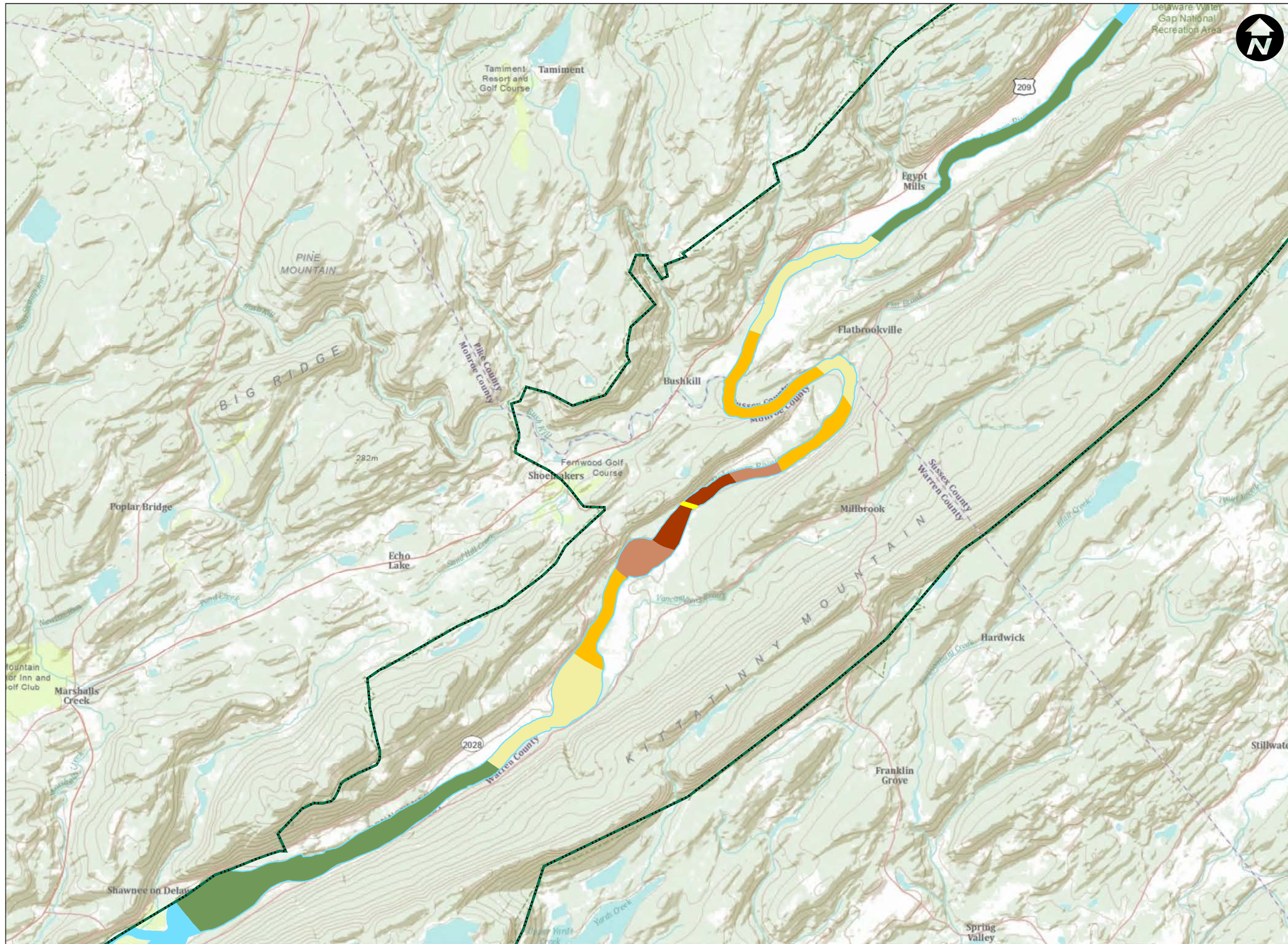


PS&S
 integrating design & engineering
 PAULUS, SOKOLOWSKI and SARTOR, LLC.
 67A MOUNTAIN BOULEVARD EXTENSION
 P.O. BOX 4039
 WARREN, NEW JERSEY 07059
 PHONE: (732) 560-9700

PSE&G and PPL
 Susquehanna - Roseland Line
 National Park Service
 Delaware Water Gap National
 Recreation Area

**DELAWARE WATER GAP
 NATIONAL RECREATION AREA**

Drn By: EB	Scale: 1" = 2 miles	Project: 01315.071.030
Chkd By: PD	Date: 11/11/10	Figure No.: 1



Legend

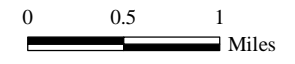
- Delaware Water Gap National Recreation Area Boundary
- Middle Delaware Scenic and Recreational River
- ROW Crossing the River

Distance from ROW along River

Distance/Potential Impact Area

- 0 - 0.5 miles / 114.2 acres
- 0.5 - 1 miles / 146.75 acres
- 1 - 2 miles / 358.79 acres
- 2 - 3.5 miles / 464.81 acres
- 3.5 - 7 miles / 882.25 acres

Source:
 Tower Locations from PSE&G, 2009.
 Delaware Water Gap National Recreation Area Boundary from National Atlas of the United States, 2005.
 Delaware River from ESRI StreetMap USA, 2007.
 Background Topography from ArcGIS Online, 2010.

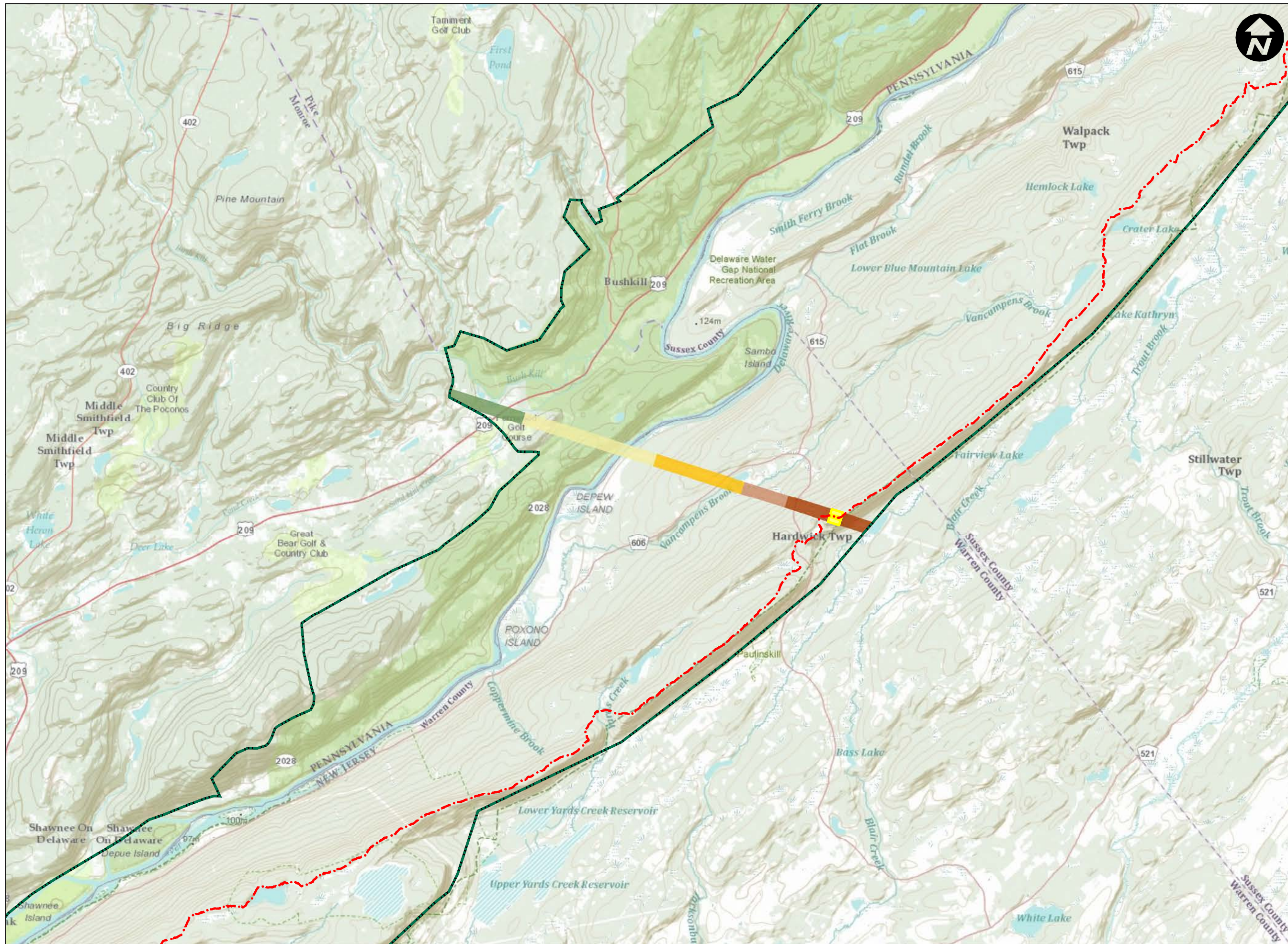


PS&S
 Integrating design & engineering
 PAULUS, SOKOLOWSKI and SARTOR, LLC.
 67A MOUNTAIN BOULEVARD EXTENSION
 P.O. BOX 4039
 WARREN, NEW JERSEY 07059
 PHONE: (732) 560-9700

PSE&G and PPL
 Susquehanna - Roseland Line
 National Park Service
 Delaware Water Gap National
 Recreation Area

**MIDDLE DELAWARE SCENIC
 AND RECREATIONAL RIVER**

Drn By: EB	Scale: 1" = 1 mile	Project: 01315.071.030
Chkd By: PD	Date: 11/11/10	Figure No.: 2

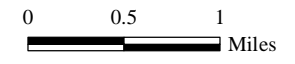


- Legend**
- Delaware Water Gap National Recreation Area Boundary
 - Appalachian National Scenic Trail
 - ROW Crossing the Trail

- Distance from ROW**
- Distance/Potential Impact Area
- 0 - 0.5 miles / 73.86 acres
 - 0.5 - 1 miles / 45.45 acres
 - 1 - 2 miles / 90.91 acres
 - 2 - 3.5 miles / 136.36 acres
 - 3.5 - 7 miles / 72.23 acres

Note:
Analysis included 300-foot offset from Right-of-Way and was limited to the Park's boundary.

Source:
Delaware Water Gap National Recreation Area Boundary from National Atlas of the United States, 2005.
Appalachian Trail from Appalachian Trail Conference and National Park Service Appalachian Trail Park Office, 2001.
Background Topography from ArcGIS Online, 2010.



PS&S
integrating design & engineering
PAULUS, SOKOLOWSKI and SARTOR, LLC.
67A MOUNTAIN BOULEVARD EXTENSION
P.O. BOX 4039
WARREN, NEW JERSEY 07059
PHONE: (732) 560-9700

PSE&G and PPL
Susquehanna - Roseland Line
National Park Service
Delaware Water Gap National
Recreation Area

**APPALACHIAN NATIONAL
SCENIC TRAIL**

Dm By: EB	Scale: 1" = 1 miles	Project: 01315.071.030
Chkd By: PD	Date: 02/08/11	Figure No.: 3