PPA Comments on South Jersey Gas pipeline, January 24, 2017

Exhibit A

South Jersey Gas Pipeline Review:

Analysis of Likely Actual Use of Proposed South Jersey Pipeline by BL England Plant and Assessment of Excess Capacity Available to Serve Customers Primarily Outside of Pinelands

by

Greg Lander, President

Skipping Stone, LLC

For

Pinelands Preservation Alliance

January 2017

COPYRIGHT © 2017 Skipping Stone, LLC. All rights reserved

About Skipping Stone

Skipping Stone is an energy markets consulting firm that helps clients navigate market changes, capitalize on opportunities and manage business risks. Our services include market assessment, strategy development, strategy implementation, managed business services and talent management. Market sector focus areas are natural gas and power markets, renewable energy, demand response, energy technology and energy management. Skipping Stone's model of deploying only energy industry veterans has delivered measurable bottom-line results for over 270 clients globally.

Skipping Stone operates Capacity Center which is a proprietary technology platform and data center that is the only all-in-one Capacity Release and Operational Notice information source synced with the Interstate pipeline system. Our database not only collects the data as it occurs, it is a storehouse of historical Capacity Release transactions since 1994. We also track shipper entity status and the pipeline receipt and/or delivery points, flows and capacity. Our analysts and consultants have years of experience working in natural gas markets. Capacity Center has worked with over a hundred clients on a wide variety of natural gas market and pipeline related reports and projects.

Headquartered in Boston, the firm has offices in Atlanta, Houston, Los Angeles, and Tokyo. For more information, visit [www.SkippingStone.com.](http://www.SkippingStone.com)

###

Contents

Introduction

Skipping Stone, LLC ("Skipping Stone") was asked to review a number of documents and filings concerning a petition by South Jersey Gas ("SJG") to build a pipeline to serve the BL England electric generation plant ("BL England Plant" or the "Plant") and to address what SJG refers to variously as "reliability" or "redundancy" matters with respect to its system. The documents reviewed by Skipping Stone in preparation of this report are listed in the Appendix.

Skipping Stone will first provide its summary and analysis of the following:

- the Standard Gas Service Agreement by and between SJG and RC Cape May Holdings, LLC ("RCCM"), the owners of the Plant, governing certain economics and timing of the construction of SJG facilities to serve the Plant and the subsequent transportation of gas to the Plant;
- the BL England Plant's demand for natural gas and calculations of capacity usage by the Plant based upon reported Plant size; and
- the resulting excess of pipeline capacity as compared to peak and likely average annual usage by the Plant.

Next, Skipping Stone will provide its analysis of likely usage by SJG of the excess capacity remaining after calculated usage by the Plant. This analysis will also compare recent county and community population data to data provided by SJG in its presentation entitled "BL England & Reliability Project" dated September 27, 2013 (the "SJG 2013 Presentation"), and make observations about the relative number of customers within the Pinelands (versus customers outside of the Pinelands) that might see a benefit from the excess capacity.

Finally, Skipping Stone will also review and analyze SJG's assertions related to the "reliability" and/or "redundancy" provided by the proposed pipeline with respect to SJG's proposed route (as described in SJG's compliance statement submitted to the Pinelands Commission on May 21, 2015 (the "SJG Compliance Statement"), and identified therein as "Route A"). In particular, Skipping Stone will assess (1) who might be impacted by such reliability and redundancy, (2) the amount of such redundancy that would be provided by the proposed pipeline and (3) whether, absent other SJG system changes not currently proposed by SJG, SJG can provide redundancy or reliability attributes with the proposed pipeline to the areas it states will be provided such redundancy or reliability attributes.

I. Analysis of the Service Agreement by and between South Jersey Gas and RC Cape May Holdings, LLC

RCCM has a 20-year Standard Gas Service Agreement ("SA") with SJG with respect to the BL England Plant under SJG's rate schedule FES (Firm Electric Service).[1] SJG's rate schedule FES enables an electric generation customer of SJG to either receive gas transportation service from SJG or gas sales service from SJG or both as specified in the service agreement entered into by SJG and the generator. The RCCM SA is for transportation service only. The SA Commencement Date is defined in SA as the date that post-testing gas deliveries of gas to the Plant commence.

Key aspects of that contract are set forth below.

- The only delivery point of natural gas from SJG under the SA is the Plant.
- Receipts of gas into SJG for transport to the Plant can be made by the Plant at any one or more of the following SJG interconnections with Transcontinental Gas Pipe Line ("Transco"): (i) Harmony Rd, (ii) Prospect, (iii) Woodbury, (iv) Lawnside, (v) Repaupo, (vi) West Deptford, and (viii) Swedesboro.
- SA permits the Plant to use any point(s) of interconnection with Texas Eastern Transmission Company ("TETCO"), should SJG establish any in the future.
- All of the Terms and Conditions of SJG's rate schedule FES are incorporated by reference into the SA and apply to the service provided by SJG to the Plant.[2]
- The SA provides that "the pipeline and related facilities to serve [the Plant] will . . . generally follow the concepts and principles embodied in Cost and Allocation Study for a Proposed High Pressure Transmission Pipeline prepared by Black & Veatch dated October 2012 . . . ."
- The Addendum to the SA provides that the gas delivered to the Plant is to be used to fire a boiler converted from heavy oil-fired to gas-fired and to fire a combined cycle generating unit.
- Pursuant to Paragraph 11 of the Addendum, SJG will "within twelve months of completion of the Facilities . . . present to [RCCM] a statement of the actual total [BL England] Facility cost, which may include costs associated with [the costs of, or payments under any liquidated damages provisions in the SJG contract for construction] on the ***entire line*** described in the Black and Veatch study . . . ." (emphasis added).
- Pursuant to Paragraph 18 of the Addendum, SJG may interrupt the Plant on up to 15 winter days.

---

1 *See* South Jersey Gas Company Standard Gas Service Agreement (FES) dated April 15, 2013, with RC Cape May Holdings, LLC (i.e., the Plant) plus Addendum thereto.

2 The SA specifically states that Special Provision (I) related to expansion of SJG's system to provide service is excluded because the Addendum to the SA specifically states what sort of expansion SJG will construct for the Plant.

- The Addendum also states that no imposition of penalty charges shall serve to "restrict [SJG's] right to interrupt or curtail this service" and provides that no amount of SJG maintenance shutdowns shall reduce the 15 days of interruption.
- The SA provides that no payment of penalty or temporary agreement by SJG confers a right to service without interruption other than that stated in the Addendum. In addition, under the General Terms and Conditions of the SJG Tariff which are incorporated by reference into rate schedule FES, SJG has the right to interrupt service to the Plant in the event of a force majeure impacting SJG's system. Force majeure events include acts of God (i.e., storms, earthquakes etc.), strikes, insurrection, breakage or failure of lines of pipe and/or machinery, etc.

Taken all together, the BL England Plant has service only to the extent BL England Plant can deliver gas to SJG from Transco for redelivery to the Plant, SJG does not interrupt such service during up to 15 winter days and/or SJG does not experience a force majeure affecting its system.

II. BL England Plant Natural Gas Demand Analysis and Comparison to Proposed Pipeline Capacity

While the original natural gas service-related activity to be conducted at the BL England Plant and described in the Direct Testimony of Russell Arlotta of RCCM (see page 4 of Exhibit P-5A) involved a conversion of a heavy-oil fired conventional steam-turbine generator to natural gas fired and the addition of a natural gas fired combined cycle facility, the most recent description of the natural gas service related activity at the Plant provided by RCCM (also on page 4 of Exhibit P-5A) involves no conversion of existing generation to natural gas fired boiler and instead involves the building of a dual-fuel 447 MW combined cycle generation facility primarily fueled by natural gas.[3] Assuming a 6,500 Btu/KWh heat rate,[4] a 447 MW combined cycle facility will burn approximately 69,700 Dth[5] or approximately 67,224 Mcf of natural gas per day when operating at 100%. This amount is slightly more than just half the 125,000 Mcf per day ("Mcfd") Daily Contract Quantity of the SA with SJG.

Annualizing[6] the 67,224 Mcfd yields an annual quantity of 23,535,391 Mcf per Year, assuming the Plant runs at full capacity. We note that this number is likely to be somewhat smaller when taking into account normal maintenance, which requires shutdown(s) of the Plant. If one assumes a two-week (14 day) shutdown, then the Plant, running at full capacity, for 336 days per year (350 days minus 14 days) will use around 22,600,000 Mcf. This number is consistent with the Annual Minimum Quantity set forth under the SA of 20,797,397 Mcf per year.[7]

The Annual Minimum Quantity figures under the SA also indicate, as we would expect, that the operators of the BL England Plant with a 447 MW facility would be economically wise to only commit to a 20 year obligation to SJG that was near to and less than the capability of the Plant. That is, an obligation of 20,797,397 Mcf versus a calculated 100% utilization consumption of ~22,600,000 Mcf – assuming running at full load all days except both the 15 winter days and the estimated 14 days of typical planned maintenance at the Plant.

---

3 SJG states that the Plant will also have dual-fuel capability, meaning the Plant can also burn oil in the facility to generate electricity.

4 Heat rate is the amount of input energy to generate 1 Kwh of electricity in a typical latest generation combined-cycle facility of the size referred to by SJG as the current (i.e., 447 MW) proposed size of the BL England Plant. Typical current combined cycle generation units have heat rates in the 6,400 Btu/Kw to 6,500 Btu/kW range (see "Natural Gas Assessment New York State Energy Plan 2009" page 5 footnote 8; from which a 6,429 Btu/kW heat rate can be derived.) Use of the 6,500 Btu/kW heat rate may overstate the daily natural gas consumption by the Plant and accordingly understate the amount of excess capacity of the proposed line.

5 A Dth is 1,000,000 Btus. A typical Btu/cubic foot on the Transcontinental Gas Pipe Line system is 1,037 Btu/cf.

6 Here the "annual" quantity is assuming just 350 days of service as contemplated in the SA.

7 *See* South Jersey Gas Company Standard Gas Service Agreement (FES) dated April 15, 2013, with RC Cape May Holdings, LLC (i.e., the Plant) plus Addendum thereto.

Comparing the likely BL England Plant daily demand when operating to the capacity of the line (via Route A), we see that the demand at the Plant is far less than SJG's stated 125,000 Mcfd[8]. In fact, the likely BL England Plant daily demand is only 54% of the purported 125,000 Mcfd. Assuming the 125,000 Mcfd capacity is realistic, this means that SJG has use, if it chooses, of nearly 58,000 Mcfd (57,756 Mcfd) of the purported 125,000 Mcfd because the Plant as described by SJG cannot use more than the 67,224 Mcfd assuming he Plant runs at full output.

Inasmuch as transportation under the FES rate schedule can only be for electric generation and the only location to which RCCM can deliver gas under its SA is to the Plant, SJG will be able to use this approximately 58,000 Mcfd (57,776 Mcfd) of excess capacity for other purposes, such as service to additional locations outside the Pinelands.

Moreover, this excess 58,000 Mcfd estimated above vastly understates the actual capacity the proposed line will make available to SJG for other customers. In fact, after taking out the capacity to support the BL England Plant's demand, the proposed line will have much more remaining capacity than can be used by customers able to receive gas from the proposed pipeline. This is because gas travelling along the proposed route can only serve a limited number of customers (~60,000), the vast majority of which reside to the south of what SJG refers to as the "Interconnect Station." The Interconnect Station is where the proposed route meets the North-South line of SJG in Cape May County and from where the proposed route extends eastward to the BL England Plant. Under the current proposed project, gas flow northward to Atlantic County SJG customers (~80,000) is not practical without additional system changes not presently included in the project plan (as discussed further below). [9]

The proposed route starts at a section of SJG's system that SJG states operates at 435 psi[10]. To calculate capacity of a line, one has to assume certain parameters. One of those parameters is the allowable pressure drop per mile of line. Typically high pressure transmission systems operate with between a 5 psi and 10 psi per mile pressure drop. For the purposes of this analysis, Skipping Stone assumed a 7.5 psi per mile pressure drop.

---

[8] While the SA has a stated Maximum Daily Quantity of 125,000 Mcfd, which is the maximum the Plant can transport on the SJG system, the SA does not permit RCCM to transport gas to other than the Plant and there is no SJG or RCCM-stated use for the full 125,000 Mcfd at the Plant.

[9] The North-South 16" line into which the "Interconnect Station" could provide supplemental supply during a system upset, however, is isolated from the transmission line to the north that feeds the Atlantic County customers since the 16" line operates at a significantly lower pressure due to its lower design maximum operating pressure.

[10] While the line operates at 435 psi, according to Direct Testimony of Richard Bethke of SJG (see page 18), the pressures provided to Black and Veatch by SJG constrained Black and Veatch to modeling the line's capacity in its study, including the line feeding the proposed new line, to pressures typically in the 100 psi to 200 psi range. From an engineering point of view, it is highly unusual to operate a brand-new long-distance 24-inch transmission line capable of operating at 700 psi at such low pressures. Further, Black and Veatch states the reason the line size was set at 24 inches was to maintain system reliability or deliveries to the BL England Plant at pressures exceeding 100 psi at the winter operating conditions beyond 2021 specified by SJG. This runs completely counter to the provisions of the SA which states that in a circumstance of either the 15 coldest days of the winter or during a force majeure on the SJG system, the RCCM and the BL England Plant have no right to receive gas.

Thus, if pressure loss in the new 21.6 mile 24-inch pipeline is constrained to no more than 7.5 psi/mile and the inlet pressure to the new line is 435 psig, the carrying capacity of the pipeline for the first 10.3 miles (i.e., to the proposed interconnection to the existing North-South pipeline) would be approximately 309,000 Mcfd. That capacity could then be split into two components: 67,000 Mcfd to the BL England Plant and the remaining 242,000 Mcfd to the North-South line to serve its current or future customer base. SJG has stated that the North-South line at the Interconnect Station is a line that operates at a pressure not greater than 250 psi.

It is important to note here that this 242,000 Mcfd far exceeds the peak day consumption of the approximately 60,000 customers (as discussed below) that are south of the Interconnect Station directly connected to (i.e., served to the south off of) the North-South pipeline.[11]

A recent assessment for New York State found that the peak day consumption for residential customers for that colder region of the country was 1 Mcfd.[12] This means that the 242,000 Mcfd is sufficient to serve approximately 242,000 residential customers. For reliability purposes 60,000 Mcfd should be sufficient to serve the 60,000 total customers cited by SJG[13] that are near or south of the Interconnect Station, suggesting there is at least 182,000 Mcfd of excess capacity in the proposed 24-inch pipeline that presently has no defined purpose.

It is important to note here also that, as will be discussed below, SJG customers within the Pinelands near or south of the Interconnect Station are far fewer (i.e., 5.5% or 3,300 per SJG) than the overall 60,000 SJG customers within the area cited by SJG in the 2013 presentation (Figure 1 shown below)[14].

---

11 There are few customers in the northern extent of the 16-inch North-South line as it extends northward to a 350 psi section of that line.

12 *See* "Natural Gas Assessment New York State Energy Plan 2009" page 5 footnote 8; which cites 1 Dth per day of residential use at peak in New York. New Jersey residential peak use can be assumed to be approximately the same. For these purposes 1 Dth per day is ~1 Mcfd.

13 *See* SJG 2013 Presentation at page 8 entitled "Reliability Considerations."

14 *Ibid*.

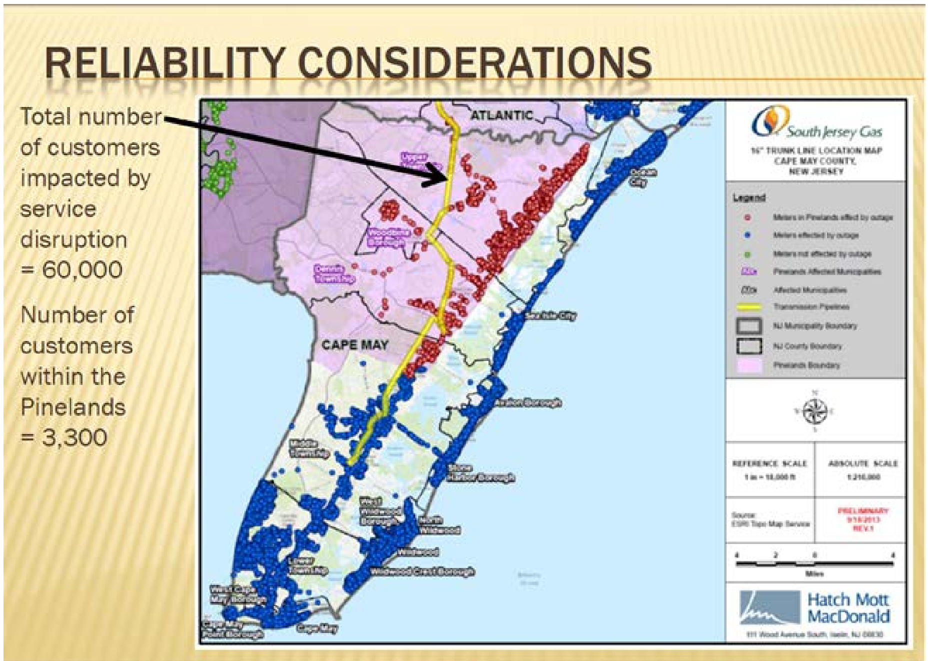


Table 1:South Jersey Gas 2013 Presentation

While SJG has stated that the proposed route can support both Cape May County to the south and Atlantic County to the north, this is not true given the current state of the SJG system in that area. To the north of the Interconnect Station along the North-South line, that 250 psi line connects to a line of higher pressure (350 psi). A 250-psi line simply cannot feed a 350 psi line absent a substantial operating pressure reduction of the higher pressure line. This means that, absent a future upgrade of the North-South Line to the north of the Interconnect Station, no assurance of providing either reliability or redundancy can reasonably be made.

Moreover, should such an upgrade of the North-South Line be made in the future, then, while Atlantic County customers of SJG could see a redundancy or reliability attribute from the proposed pipeline, once again (as discussed below) the number of SJG's Pinelands customers in Atlantic county is far fewer than the number of overall Atlantic County customers SJG asserts as potentially seeing such attribute.

In Figure 2 (pasted below, as modified by Skipping Stone), SJG states that there might be an additional 80,000 customers (140,000[15] customers in total including the 60,000 previously discussed) impacted by a service disruption impacting Atlantic and Cape May Counties, of which SJG states that 28,700[16] (~20%) reside in the Pinelands.

---

15 *See* SJG 2013 Presentation at 9.

16 *Ibid*.

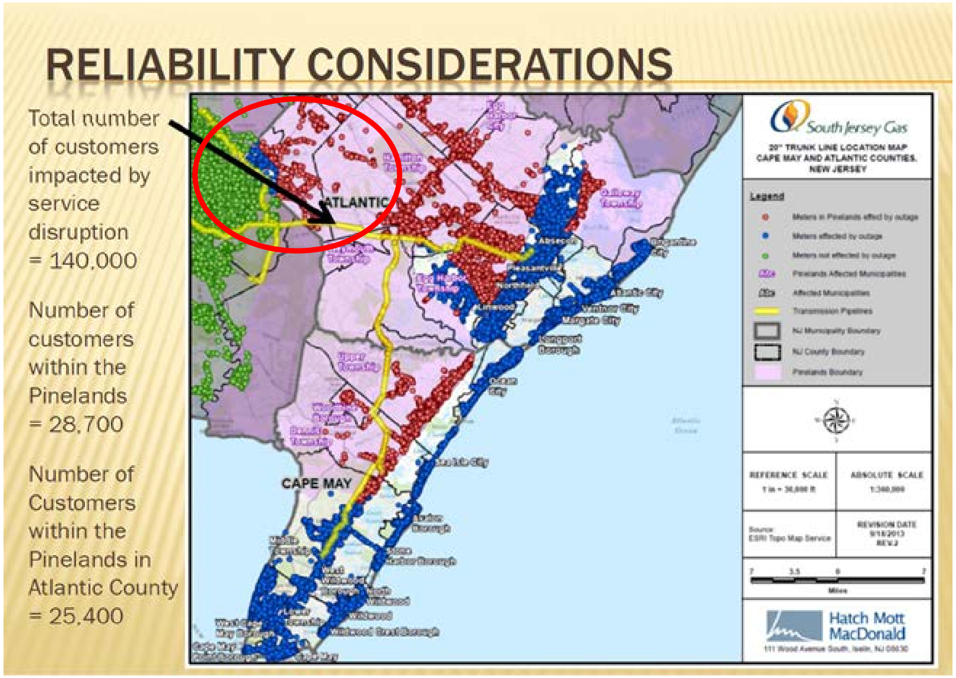


Table 2: South Jersey Gas 2013 Presentation

In our review of the SJG 2013 Presentation, two additional observations came into focus.

One is that many of the locations that SJG cites as potentially impacted (circled in red by Skipping Stone above[17]) are not served by the line that SJG indicates is affected by the disruption pointed to by its black arrow. All meters to the west and north of the arrow[18] would not likely be impacted by such disruption. Second, a disruption just a few miles west on the same line (i.e., at the junction where the 700 psi line and the 350 psi line feed both the 435 psi line feeding the proposed new line at the commencement of the proposed Route A and the west to east line referred to as the Vineland to Mays Landing segment) would render the proposed line unable to address such disruption because the gas would be disrupted prior to it reaching the proposed line. As a general matter, the locations of disruptions cannot be "planned for"; they happen where they happen. The only means of being perfectly immunized from a disruption to a main transmission trunk is to nearly entirely duplicate all such transmission infrastructure; a daunting economic undertaking to say the least.

In addition, as it relates to excess capacity, Skipping Stone's calculated and previously described 182,000 Mcfd of excess capacity are based entirely on the current system configuration of SJG (i.e., with no upgrades to the 435 psi line feeding the proposed line or upgrading the portion of the North-South line north of Interconnect Station).

---

17 As well as possibly others not circled, but potentially impacted to the east and north of the circled area.

18 *See* SJG 2013 Presentation at 9.

If, as has been suggested by SJG, those two upgrades were to occur and the inlet pressure to the upgrade feeding the proposed line was 570 psi[19], then SJG could serve (1) the 67,000 Mcfd to the Plant, (2) 116,400 Mcfd to the north (i.e., into Atlantic County), (3) another 74,400 Mcfd to the south (i.e., into Cape May County); and (4) still have an additional approximately 76,000 Mcfd to serve a currently unidentified load. This represents an ~333,800 Mcfd of potential capacity for the proposed 24-inch pipeline.

Moreover, should the two SJG suggested upgrades occur and the line operated at 700[20] psi, then SJG could serve (1) the 67,000 Mcfd to the Plant, (2) ~145,000 Mcfd to the north (i.e., into Atlantic County), (3) another 74,400 Mcfd to the south (i.e., into Cape May County); and (4) still have nearly 100,000 Mcfd (~95,000 Mcfd) serve a currently unidentified load. This represents more than 380,000 Mcfd of potential capacity for the proposed 24-inch pipeline.

Notably, as relates to the relative proportion of Pinelands customers versus non-Pinelands customers served by SJG and discussed below, in the 700 psi case, not only are the vast majority of SJG customers to the north and south outside of the Pinelands, but the excess 95,000 Mcfd of capacity is enough to meet the peak day demand of nearly 100,000 residential customers that do not exist at this time in either Cape May or Atlantic Counties, let alone in the Pinelands.

[19] One of the cases presented in response to a discovery request of the New Jersey Board of Public Utilities by C.F. Dippo in RCR-E-005 was for an inlet pressure into the Union Road upgrade that would feed the proposed line of 570 psi.

[20] The other case presented in by C.F. Dippo in RCR-E-005 was for 700 psi inlet pressure to the Union Road upgrade.

III. Gas Customers within the Pinelands Represent a Small Fraction of the Total Gas Customers Benefited by the "Redundancy" Benefit of the Proposed Pipeline

SJG maintains that the proposed line provides two benefit: (1) "to provide redundancy of service for the more than 140,000 natural gas customers in Cape May and Atlantic Counties", and (2) "supply natural gas to the existing [BL England Plant]." [21]

With respect to the first benefit (i.e., redundancy), the 142,000 customers cited by SJG in 2015 as being served in Cape May and Atlantic counties are, according to Platts,[22] in the towns listed in Column B in the table below:

A	B	C	D	E	F	G
No.	City_Name	State	County	Pinelands	Gas_Utility	2016 Population
1	Absecon	NJ	Atlantic		South Jersey Gas Co.	8,696
2	Atlantic City	NJ	Atlantic		South Jersey Gas Co.	39,693
3	Buena	NJ	Atlantic		South Jersey Gas Co.	4,603
4	Collings Lakes	NJ	Atlantic	Pinelands	South Jersey Gas Co.	1,759
5	Corbin City	NJ	Atlantic		South Jersey Gas Co.	470
6	Dorothy	NJ	Atlantic	Pinelands	South Jersey Gas Co.	2,734
7	Egg Harbor City	NJ	Atlantic	Pinelands	South Jersey Gas Co.	4,427
8	Elwood-Magnolia	NJ	Atlantic	Pinelands	South Jersey Gas Co.	1,362
9	Estell Manor	NJ	Atlantic	Pinelands	South Jersey Gas Co.	1,812
10	Folsom	NJ	Atlantic	Pinelands	South Jersey Gas Co.	1,870
11	Hammonton	NJ	Atlantic	Pinelands	South Jersey Gas Co.	14,859
12	Linwood	NJ	Atlantic		South Jersey Gas Co.	7,253
13	Longport	NJ	Atlantic		South Jersey Gas Co.	885
14	Margate City	NJ	Atlantic		South Jersey Gas Co.	6,265
15	Mays Landing	NJ	Atlantic	Pinelands	South Jersey Gas Co.	2,168
16	Nesco	NJ	Atlantic	Pinelands	South Jersey Gas Co.	6,056
17	Northfield	NJ	Atlantic		South Jersey Gas Co.	8,387
18	Pleasantville	NJ	Atlantic		South Jersey Gas Co.	20,088
19	Pomona	NJ	Atlantic	Pinelands	South Jersey Gas Co.	7,230
20	Port Republic	NJ	Atlantic		South Jersey Gas Co.	1,159
21	Somers Point	NJ	Atlantic		South Jersey Gas Co.	10,695
22	Ventnor City	NJ	Atlantic		South Jersey Gas Co.	10,674
23	Avalon	NJ	Cape May		South Jersey Gas Co.	1,288
24	Cape May	NJ	Cape May		South Jersey Gas Co.	3,753
25	Cape May Court House	NJ	Cape May		South Jersey Gas Co.	5,128
26	Cape May Point	NJ	Cape May		South Jersey Gas Co.	281
27	Dennisville	NJ	Cape May	Pinelands	South Jersey Gas Co.	6,327
28	Erma	NJ	Cape May		South Jersey Gas Co.	2,274
29	North Cape May	NJ	Cape May		South Jersey Gas Co.	3,081
30	North Wildwood	NJ	Cape May		South Jersey Gas Co.	3,910
31	Ocean City	NJ	Cape May		South Jersey Gas Co.	11,656
32	Rio Grande	NJ	Cape May		South Jersey Gas Co.	3,001
33	Sea Isle City	NJ	Cape May		South Jersey Gas Co.	2,512
34	Stone Harbor	NJ	Cape May		South Jersey Gas Co.	842
35	Villas	NJ	Cape May		South Jersey Gas Co.	9,061
36	West Cape May	NJ	Cape May		South Jersey Gas Co.	998
37	West Wildwood	NJ	Cape May		South Jersey Gas Co.	582
38	Whitesboro-Burleigh	NJ	Cape May		South Jersey Gas Co.	2,875
39	Wildwood	NJ	Cape May		South Jersey Gas Co.	5,355
40	Wildwood Crest	NJ	Cape May		South Jersey Gas Co.	3,128
41	Woodbine	NJ	Cape May	Pinelands	South Jersey Gas Co.	2,468

Table 3:Platts GIS, Pinelands GIS, and New Jersey Home Locator population data

21 *See* 2013 SJG Presentation at 9stating 140,000 customers); *see also* Pinelands Comprehensive Management Plan Compliance Statement dated May 21, 2015; page 1 of Addendum # 2 of Wood & Curran Report dated April, 2015 (stating 142,000 customers).

22 Platts provides GIS mapping software with layers. Among those layers are cities and towns and the utilities (gas and electric) serving those towns.

The population provided in Column G is as of July 1, 2016.[23] The total population was listed as being 231,665. The Atlantic County population was 163,145 (70.42% of the total) and the Cape May County population was 68,520 (29.58% of the total). SJG's 140,000 $^{+}$/- customer count is 61% of the 231,665 population count. Proportioning the SJG 2013 customer count of 140,000 by population derives an approximate customer count of 100,000 in Atlantic County and 40,000 in Cape May County. Then, comparing the Pinelands Commission GIS layer with the Platts GIS layer, we identified 10 communities in Atlantic County within the Pinelands served by SJG and another two communities in Cape May County within the Pinelands served by SJG. The Atlantic County Pinelands communities served by SJG have a population of 63,728 while the Cape May County Pinelands communities' served by SJG have a population of 4,338. Then proportioning the estimated customer counts by county using the within-Pinelands population to total county population (as with total county population versus SJG customers), we derived an approximate count of SJG customers in the Pinelands. That total approximate count is 41,271 broken out between Atlantic and Cape May Counties as 39,062 and 2,659, respectively. These figures, and this means of estimating, is consistent with both the data supplied by SJG in the 2013 Presentation and in the SJG Compliance Statement.

Most notably, this method of estimation shows that gas customers within the Pinelands represent less than 30% (as compared to ~20% derived above from earlier dated data provided by SJG) of total gas customers benefitted by the "redundancy" benefit purported by SJG. In short, the primary benefit of the proposed pipeline will accrue to customers outside of the Pinelands.

23 Source: http://newjersey.hometownlocator.com/references.cfm.

IV. The "Redundancy" Benefits of the Proposed Pipeline Will Primarily Serve Persons Outside of the Pinelands

The fact that gas customers within the Pinelands represent less than 30% (as compared to ~20% derived above from data previously provided by SJG) of total gas customers benefitted by the "redundancy" benefit purported by SJG is important because, in our analysis of the SA and the SJG FES Rate Schedule incorporated by reference therein, we determined that the total capacity of the line would be available to SJG to serve non-BL England customers on the highest demand days of the year and primarily serve a redundancy /reliability purpose and a potential SJG market growth of as many as 100,000 $^{+}$/- residential customers. This is due to the excess capacity of the line relative to the use that the Plant could make of the line.

This finding stems from two aspects of the SA. Under the SA, SJG can decline to serve the Plant on 15 winter days. This means 100% of the capacity of the line would be used for the existing SJG Atlantic County (to the extent such customer can be reached) and mostly Cape May customers,[24] of which at most 30% are Pinelands SJG customers. In addition, should a force majeure condition occur with respect to the SJG system, SJG could entirely interrupt service to the BL England Plant for the duration of the force majeure event. These two aspects of the SA lead us to conclude that the line can and would be used solely by SJG's existing customers in either of these circumstances and that RCCM and the BL England Plant have no firm rights to use the line. Thus, while the BL England Plant may use the capacity of the line, it is in no way guaranteed access to the line for either the 15 winter days of suspended service or in the event of a force majeure event.

Thus, the SJG customers, which have first call on the capacity of the line during the coldest winter days and during any force majeure event (that can be alleviated by the proposed redundant line), are principally (more than 70%) outside of the Pinelands.

---

[24] Mostly for Cape May customers, only ~3 – 4,000 of which are within the Pinelands absent an as yet unannounced upgrade to the northern extent of the North-South line north of the interconnect Station.

Conclusion

The foregoing analyses show that (1) the proposed pipeline is designed for a capacity several times the amount of natural gas that a new 447 KW power plant at the BL England site could consume, (2) that the agreement between SJG and the owners of the BL England Plant gives SJG's other customers first call on the capacity of the new pipeline, and (3) that the great majority of South Jersey Gas customers who could receive gas through the new pipeline are outside the Pinelands. Accordingly, it is our conclusion that the proposed pipeline will not "primarily serve the needs of the Pinelands."

###

Warranties and Representations. Skipping Stone endeavors to provide information and projections consistent with standard practices in a professional manner. Skipping Stone's work was limited to a review of the materials set forth on the Appendix to prepare a Report for submission to the New Jersey Pinelands Commission in regulatory proceedings related to the matters described in this report, and the report is not intended to be used or relied upon for any other purpose or context. SKIPPING STONE MAKES NO WARRANTIES HOWEVER, EXPRESS OR IMPLIED (INCLUDING WITHOUT LIMITATION ANY WARRANTIES OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AS TO THE MATERIALS RELIED UPON IN THE PREPARATION OF THIS REPORT. Specifically but without limitation, Skipping Stone makes no warranty or guarantee regarding the accuracy of any forecasts, estimates or analyses, or that such work products will be accepted by any legal or regulatory body.

Waivers. Those viewing this Report hereby waive any claim at any time, whether now or in the future, against Skipping Stone, its officers, directors, employees or agents arising out of or in connection with this Report. In no event whatsoever shall Skipping Stone, its officers, directors, employees, or agents be liable to those viewing this Report.

Disclaimer. This report was prepared as work sponsored by Pinelands Preservation Alliance. Neither the Pinelands Preservation Alliance nor any agency or affiliate thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process or service by trade name, trademark, manufacturer or otherwise does not necessarily constitute or imply its endorsement, recommendation or favoring by the Pinelands Preservation Alliance or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the Pinelands Preservation Alliance or any agency or affiliate thereof.

Appendix

Documents Reviewed:

1) Pinelands Comprehensive Management Plan Compliance Statement – South Jersey Gas Pipeline Reliability Project dated May 21, 2015 (reviewed in part)
2) Natural Gas Assessment New York State Energy Plan 2009
3) Data Response RCR-E-004 of C.F. Dippo
4) Data Response RCR-E-005 of C.F. Dippo
5) Testimony of Richard A. Bethke of South Jersey Gas Company in matter of the Petition of South Jersey Gas Company for a Determination Pursuant to the Provisions of N.J.S.A. 40:55D-19
6) Testimony of Russell S. Arlotta of RC Cape May Holdings in matter of the Petition of South Jersey Gas Company for a Determination Pursuant to the Provisions of N.J.S.A. 40:55D-19
7) South Jersey Gas BL England & Reliability Project Presentation dated September 27, 2013
8) SJG Response to PPA Brief Submitted to BPU November 4, 2015
9) SJG Tariff-No-11-January-2017
10) Standard Gas Service Agreement between RC Cape May Holdings and South Jersey Gas dated April 15, 2013
11) Black and Veatch Corporation report entitled "Cost Allocation Study for a Proposed High Pressure Natural Gas Transmission Pipeline" dated October 2012.
12) Black and Veatch Corporation report entitled "Supplement to Black and Veatch's October Report" dated February 12, 2013.
13) New Jersey Board of Public Utilities Order in Docket No. G013030202, "In the Matter of the Petition of South Jersey Gas Company for Authorization to Construct a 24" Pipeline" dated July 22, 2015
14) Supplemental Direct Testimony of Russell S. Arlotta of RC Cape May Holdings in matter of the Petition of South Jersey Gas Company for a Determination Pursuant to the Provisions of N.J.S.A. 40:55D-19

PPA Comments on South Jersey Gas pipeline, January 24, 2017

Exhibit B

Christopher Cooper[1]
New York, NY

REPOWERING THE B.L. ENGLAND POWER PLANT WILL NOT SERVE THE ENERGY OR ENVIRONMENTAL INTERESTS OF THE PINELANDS

January, 2017

[1] **Christopher Cooper** is currently Vice President of Content Development & Strategy for Marathon Strategies, a New York-based strategic communications and research firm. An acknowledged regulatory law and energy policy expert, Cooper formerly was Senior Research Fellow at the Institute for Energy and the Environment, and former Executive Director of the Network for New Energy Choices (now GRACE Energy Project). As a consultant, he has counseled members of Congress, advised the United Nations, coached legal teams and provided testimony before several state utility commissions. He is the author of dozens of peer-reviewed articles on transmission planning, renewable energy policy, and energy security and has authored or co-authored several books including: *Renewing America: The Case for Federal Leadership on a National Renewable Portfolio Standard, The Governance of Energy Megaprojects: Politics, Hubris, and Energy Security*, and SAGE Library of International Security's *Energy Security*. He holds a J.D. and certification in energy law from Vermont Law School and a Master Degree in communication theory from the University of Miami.

Executive Summary

- **The South Jersey Gas Pipeline Will Not Primarily Serve the B.L. England Plant.**

  Prior to South Jersey Gas filing its Compliance Statement with the Pinelands Commission, it repeatedly characterized the primary purpose of the pipeline as providing redundancy service to gas customers in Atlantic and Cape May counties, the majority of whom reside outside the Pinelands.

  Black & Veatch, the consultants South Jersey Gas hired both to evaluate the design of the pipeline and to justify allocation of the project's costs, declared that the ability to serve existing customers—not B.L. England—is of paramount importance, and all of the design improvements and alternative routes the consultants considered were intended solely to improve the project's ability to serve this primary purpose. Moreover, Black & Veatch concluded that 60 percent (60%) of the project's costs should be directly allocated to existing gas customers since the majority of the proposed infrastructure is designed only to serve these customers, not B.L. England.

  The previously-confidential Gas Supply Agreement (FES) between South Jersey Gas and R.C. Cape May Holdings (which owns the B.L. England plant) proves that the pipeline's primary purpose is to serve existing gas customers and provide the potential to expand South Jersey Gas's customer base south of the Tuckahoe interconnection. Under the agreement, existing gas customers have priority claim to the pipeline at all times and may exercise that claim indefinitely during the course of an emergency. Indeed, South Jersey Gas considered—and rejected as too expensive—pipeline designs that would have given B.L. England priority claim to the pipeline's capacity.

- **The Pipeline is Designed Larger—and to Operate at Higher Pressures—than is Necessary to Serve B.L. England.**

  In response to inquiries from the Commission, South Jersey Gas admitted that it intends to build the pipeline to operate at a pressure of 700 psig, but that it is only identifying and listing the pipeline's pressure as 435 psig "*for the foreseeable future*," implying that it intend to use the extra capacity at some point in the future.

South Jersey Gas's claim that the pipeline's large diameter is necessary to supply B.L. England with gas at sufficient pressures on the coldest winter days ignores the fact that its own design modeling assumed that all of B.L. England's gas would be diverted to other gas customers on those same days. Under normal operations, South Jersey Gas does not anticipate having to deliver gas to B.L. England at these higher pressures.

Moreover, Black & Veatch acknowledged that the only justification for building a 24-inch (24") pipeline with a maximum pressure of 700 psig (rather than a 20-inch (20") pipeline with a maximum pressure of 435 psig) is to allow future upgrades that will allow South Jersey Gas to provide service to as many as 46,000 new gas customers outside of the Pinelands.

- **B.L. England Is Not Needed for Reliable Electrical Service in the Pinelands**

South Jersey Gas relies principally on a report by engineering consultants PowerGEM as evidence that the majority of electricity generated by a repowered B.L. England would be consumed in the Pinelands. Not only does the report rely on obsolete models of New Jersey's electrical grid, but also the only way it can reach its conclusions is to make demonstrably false assumptions about the structure of New Jersey's power grid, the manner in which system operators dispatch electricity over it, and (incredibly) the laws of physics. The fact that the report contains multiple disclaimers provides a clue that the methodology employed was not intended to reach a scientifically rigorous conclusion, but the conclusion that South Jersey Gas prefers.

In fact, five (5) of B.L. England's seven (7) generating units have been deactivated entirely and, for the past three (3) years, one of the remaining units has been operating at approximately 60 percent (60%) of its capacity, while the other is operated less than 50 percent (50%) of the time, mostly on high demand days and only during the summer. Nevertheless, the regional transmission operator PJM has not identified a single reliability issue for the Pinelands that is associated with this phasing out of B.L. England's capacity.

While South Jersey Gas claims that electricity from B.L. England is particularly critical given the retirement of the Oyster Creek nuclear plant, PJM Interconnection (PJM) acknowledged as early as 2014 that deactivating both Oyster Creek and B.L. England poses no reliability issues because "*the market had already responded to the planned retirement of Oyster Creek by driving the construction of new natural gas plants in the service territory*."

In addition to more than 2,000 MW of new natural gas generation from plants built in West Deptford and Woodbridge, nearly 750 MW of new, cleaner generating capacity have come online in the service territory since the last time South Jersey Gas analyzed the issue.

Although presented as "updated" reports, the latest reliability analysis South Jersey Gas considered was in June/July, 2014 and was based on PJM's 2018 RTEP model. PJM's newer studies—from November, 2014 until present— based on its 2021/2022 RTEP model show no reliability issues resulting from B.L. England's closure.

In fact, South Jersey Gas has repeatedly mischaracterized reliability violations it claims are attributed to B.L. England's retirement, in some cases even characterizing as reliability concerns violations that PJM determined would only occur should B.L. England <u>NOT</u> retire.

In other cases, the company presented violations of PJM's "Generator Deliverability Test" as reliability concerns even though PJM itself admits that this test evaluates the system's ability to operate at optimal economic efficiency and does not identify required reliability upgrades.

- **Closing B.L. England Would Not Require Additional Transmission System Upgrades**

South Jersey Gas justifies the need to repower B.L. England in part on the basis of network upgrades that PJM identified in July, 2014 and which the company continues to mischaracterize as necessary to avoid reliability violations caused by the plant's retirement. In fact, PJM indicated that many of the upgrades South Jersey Gas identified (which are now planned, funded or in construction) were required because of aging infrastructure issues that had nothing to do with B.L. England. Moreover, Atlantic City Electric acknowledged in testimony before the New Jersey Board of Public Utilities that the identified upgrades would be necessary even if B.L. England is repowered, "*to maintain reliability during the process when the facility is offline*" being retrofitted with new gas turbines.

- **Repowering B.L. England Would Contribute to Reliability Concerns**

  Managing reactive power is critical for the voltage stability and transmission efficiency of the power grid. To maintain adequate reactive power after the retirements of B.L. England and Oyster Creek, PJM has already planned and approved installation of a new Static VAR Compensator (SVC) at the West Wharton substation. SVCs provide far greater grid stability benefits than even local generation sources. They can respond more quickly to voltage fluctuations and are small enough to be moved to where they are needed after a hurricane or other natural disaster. Moreover, they can boost transmission capacity by tens of percent in many cases, squeezing more electricity from existing generation sources. A repowered B.L. England would replace the need for this SVC and forgo its substantial reliability benefits.

- **Repowering B.L. England Could Create Additional Air Pollution in the Pinelands**

  PJM acknowledges that Demand Response (DR) programs—which pay customers to reduce electricity during periods of peak demand—can replace entirely the need for "peak demand" units like B.L. England, and can do so more cheaply than upgrading these units to operate beyond their designed lifetimes. Recently, the Federal Energy Regulatory Commission required PJM to change the way it compensates DR participants to "*better align market incentives with efficient market outcomes*," especially in the service territories near the Pinelands, where the value of DR has been artificially deflated.

  Rather than running the plant as a peaking unit, R.C. Cape May Holdings intends to operate a repowered B.L. England at peak capacity as "baseload" generation. The drawback to that strategy is that it requires the system to replace natural gas peaking facilities with older, coal plants that must ramp up and down in response to variations in customer demand. According to rigorous scientific models, when DR resources are available and valued appropriately, they can respond more quickly, more cheaply and with fewer air pollution emissions than coal-fired peaking units, but only if communities reject fossil fuel generation that ends up cornering the market on high-demand days. Repowering B.L. England, therefore, could end up displacing much cleaner DR resources that would otherwise fill any supply gaps, providing reliable electrical service and reducing air pollution in the Pinelands even more.

- **The Proposed Pipeline Would Not Primarily Serve Gas Customers in the Pinelands**

No matter how one calculates the number of customers that would benefit from the redundancy service supplied by the proposed pipeline, South Jersey Gas's customers within the Pinelands never represent more than 47 percent (47%) of the total, even using the company's own projections.

- **The Design Specifications of the South Jersey Gas Pipeline Increase the Risk of a Pipeline Leak or Explosion**

By designing the proposed pipeline larger than it needs to be either to supply B.L. England or to service gas customers within the Pinelands, South Jersey Gas nearly doubles the likelihood that the pipeline could rupture. By designing the proposed pipeline to operate at pressures far greater than necessary to supply B.L. England (and likely only necessary to serve future customers outside of the Pinelands), South Jersey Gas substantially increases future material fatigue that could rupture the pipeline and produce a massive explosion, causing hundreds of thousands of dollars in damage, potentially killing or injuring anyone within 300 meters, and inflicting irreparable damage to the Pinelands environment.

TABLE OF CONTENTS

Introduction

South Jersey Gas (SJG) proposes to construct almost twenty-two (22) miles of new, twenty-four inch (24"), high-pressure natural gas pipeline, with an alignment that runs through Cumberland, Atlantic, and Cape May Counties. The project is located entirely within the Pinelands National Reserve. SJG refers to the pipeline as consisting of two segments: (1) a "reliability" segment running from existing facilities at Union Road and Route 49 to a proposed regulating facility at Marshall Avenue in Tuckahoe, and (2) a "dedicated" segment running from the Marshall Avenue regulating facility to a metering station at the B.L. England power plant in Upper Township (BLE). The pipeline is subject to the land use management standards in the Pinelands Comprehensive Management Plan (CMP).[1] The proposed pipeline route lies almost entirely within the Forest Management Area (as defined in the CMP). The Forest Management Area standards permit construction of the pipeline only if it is "intended to primarily serve only the needs of the Pinelands."[2]

On May 21, 2015, SJG filed an updated Compliance Statement[3] (2015 Compliance Statement) with the Pinelands Commission claiming, among other things, that the proposed pipeline conforms to the strict land use standards of the CMP because (1) the pipeline is intended to provide natural gas supply to a facility within the Pinelands (BLE)[4], (2) the majority of the electricity generated by a repowered BLE would be consumed by Pinelands residents and businesses, [5] (3) repowering BLE is critical to providing reliable electrical service inside the Pinelands,[6] and (4) repowering BLE would serve the environmental needs of the Pinelands by reducing air pollution.[7]

I have analyzed these claims, along with research and data that postdates SJG's filing of its 2015 Compliance Statement, and conclude that all four (4) claims are demonstrably false. Updated data shows that the proposed pipeline does not meet the CMP requirement that public service infrastructure constructed in a Forest Management Area "primarily serve only the needs of the Pinelands."[8] The principal findings of the analysis are:

- The proposed pipeline will not primarily serve BLE.

- The proposed pipeline is designed larger—and to operate at higher pressures—than is necessary to serve BLE.

- BLE is not needed for reliable electrical service within the Pinelands

- Closing BLE will not require additional transmission system upgrades.

- Repowering BLE would <u>contribute</u> to reliability concerns.

- Repowering BLE could create additional air pollution within the Pinelands.

- The proposed pipeline would not primarily serve SJG customers within the Pinelands.

- The design specifications of the proposed pipeline would result in the risk of a pipeline leak or explosion.

- The proposed pipeline would create environmental risks that the residents and businesses in the Pinelands must assume without any concomitant economic or environmental benefits.

I. <u>The Pipeline Does Not Primarily Serve a Facility within the Pinelands</u>

In its public statements prior to the Commission's initial review of the pipeline, as well as in several documents filed with regulatory bodies, SJG revealed that the proposed pipeline is not intended or designed primarily to serve BLE.

A. The Pipeline Is Not *Intended* Primarily to Supply Gas to BLE

1. SJG Repeatedly Has Characterized Serving BLE as the Pipeline's Secondary Purpose

During regulatory proceedings, SJG and its agents have consistently stated that the proposed pipeline may be used to supply BLE only when the pipeline has already served its primary purpose of providing reliable service to SJG's existing customers. For example, in response to discovery requests from the New Jersey Board of Public Utilities (BPU), SJG stated:

"*When the pipeline is not needed for reliability to South Jersey Gas customers, it may be used to serve supply to BL England…with or without the BL England project, B&V recommended that this line be installed to protect the South Jersey Gas customers. The fact that this line also serves BL England is no different than the fact that the stations at Swedesboro and Repaupo also serve the needs of BL England when BL England is allowed to be in service. BL England is allowed to be supplied only when it does not put the South Jersey Gas customers at risk of outage*."[9]

A cost allocation study of the project prepared by Black & Veatch recognized that the primary purpose of the proposed pipeline is to provide redundancy service to existing customers, and that supplying BLE is a secondary concern. According to Black & Veatch, while the pipeline would supply gas to BLE, as well as serve as a redundant gas line to for SJG's gas customers outside of the Pinelands, "*it was clearly recognized that the ability to serve existing customers is of paramount importance*." [10] Indeed, Black & Veatch noted that serving existing customers "*would preclude serving the BLE facility if a major pipeline failure was to occur on SJG's gas system*."[11]

2. SJG's Consideration of Alternative Routes Demonstrates That the Pipeline's Primary Purpose Is to Serve Existing Customers, Not BLE

In evaluating alternative routes for the proposed pipeline, Black & Veatch focused almost exclusively on whether alternative routes would support reliable service to SJG's existing customers, not BLE. Black & Veatch's analysts noted that the need to provide redundant gas service to existing customers "*makes SJG's proposed pipeline interconnection with its existing gas system a necessity, with or without the service lateral required to connect the BLE facility to SJG's gas system*."[12] It strains credulity that a pipeline SJG claims is intended primarily to serve BLE would be characterized as a necessity to SJG's gas customers even if it is never connected to BLE at all.

3. SJG's Consideration of Additional Pipeline Improvements Demonstrates That The Pipeline's Primary Purpose Is to Serve Existing Gas Customers

Part of Black & Veatch's analysis included recommendations for additional improvements to the project. While analysts acknowledged that the business objective of the proposed pipeline is "*providing reliable gas service to SJG's existing gas customers and the BLE* *power plant*," every enhancement Black & Veatch recommended was intended only to support reliability service to existing gas customers.[13] For example, Black & Veatch recommended that SJG consider modifications to flow gas north through the Cape May Station and to upgrade the flow capacity of the north-south pipeline between the Cape May Station and the proposed interconnection with the new pipeline.[14] Neither of these suggestions would enhance the ability of SJG to provide uninterrupted gas supply to BLE, nor even involve portions of the pipeline that directly serve the power plant. The fact that every Black & Veatch recommendation focused on serving existing gas customers indicates that the primary purpose of the pipeline is to serve the company's current and future ratepayers, the majority of whom are located outside the Pinelands.

B. The Pipeline Is Not *Designed* Primarily to Serve BLE

An analysis of the proposed pressure and diameter of the pipeline reveals that it is designed primarily to serve SJG's existing customers and not BLE. SJG's 2015 Compliance Statement highlights its previously-confidential natural gas supply agreement with R.C. Cape May Holdings (RCCM) as evidence that customers outside of the Pinelands will rarely be served by the proposed pipeline.[15] This claim is misleading because it conflates the pipeline's capacity with the natural gas that flows through it.

Pipelines provide the ability to transport natural gas. Pipelines do not supply the gas that is actually delivered to customers.[ii] In this way, a pipeline is analogous to a toll road, and not the cars driven on the road. Capacity represents the total number of cars that are *capable* of traveling the road at any given time, while supply represents the actual number of cars that *are* traveling the road. When customers pay for capacity, they are paying for the right to use lanes when they require them, even if it means forcing other drivers off the road.

[ii] SJG's service agreement, for example, is not a contract to provide natural gas to BLE. Rather, RCCM is responsible for procuring its own supply of gas for BLE. The company is merely paying SJG for the right to transport that gas to the plant through the company's pipelines. *See* Woodard & Curran, Letter to Mr. Chuck Horner ("Horner Letter"), Director of Regulatory Programs, Pinelands Commission, July 31, 2015, 2.

1. *SJG's Gas Service Agreement with RCCM Proves That the Pipeline Is Designed Primarily to Provide Capacity to SJG's Existing Gas Customers and Any Future Expansion of Its Ratepayer Base, Not to Supply BLE*

While the terms of SJG's gas service agreement allow existing gas customers to limit BLE's use of the pipeline during a maximum of fifteen (15) days a year, the agreement permits those customers to exercise that right on *any given day*.[16] Under the agreement, SJG has contracted to provide BLE with interruptible ("non-firm") service, while the company provides uninterruptible ("firm") service to its existing customers. Firm service cannot be interrupted and generally is not subject to a prior claim from another customer. Non-firm service, on the other hand, is generally understood to mean that the gas supply is subject to a prior claim by another customer.[17]

Under the terms of its service agreement with RCCM, SJG may interrupt service to BLE up to 15 days a year in order to deliver gas to customers outside of the Pinelands who have contracted for firm service. SJG falsely characterizes these terms as limiting redundancy service to other customers to not more than 15 days per year, or during an emergency.[18] But redundancy service typically refers to reliability ensured through *connection* to a network that deploys multiple versions of the same component, not the commodity *supplied* when redundant components are employed.[19] In other words, redundancy service is the *right* to use the pipeline whenever it is needed, even if exercising that right leaves other customers without any service at all. Again, the right to use the pipeline's capacity belongs first to SJG ratepayers, and only secondarily to BLE's owners.

Redundancy is a reliability service continuously guaranteed to SJG's existing gas customers every day during which those customers have a prior claim to pipeline capacity – in this case, every day of the year –regardless of whether that capacity is actually used on a particular day. Even if SJG anticipates that it will interrupt service to BLE no more than 15 days in any 365-day period, *every day* during that period, customers with firm service agreements have a priority claim on *all* of the gas pumped through the proposed pipeline. In this way, the pipeline would offer a service analogous to a smoke detector, which serves a protective function every day that it is connected. By SJG's logic, the smoke detector only provides protection on days when its alarm is triggered. The rest of the time it is simply tacky ceiling art.

On its face, moreover, SJG's service agreement refutes the claim that existing customers are only permitted to curtail service to BLE for fifteen (15) days a year.[20] Under the terms of the agreement, customers with firm service agreements may claim the entire capacity of the pipeline during an emergency.[iii] Moreover, nothing in the agreement limits emergency service to fifteen (15) days in a year. Should an emergency arise that lasts longer than fifteen (15) days, the service agreement allows existing customers to claim all of the pipeline capacity for as long as the emergency lasts, without regard to BLE. When other customers may exercise unlimited, priority claim to the entire capacity of the pipeline, it cannot be said that the pipeline is intended primarily to serve BLE.

In addition, in a letter to the Pinelands Commission, SJG consultant Woodard & Curran clarified the service agreement's volume specifications, noting that:

> *"…it has been determined that 125,000 MCF is the maximum volume of natural gas that can reliably flow through SJG;'s system on the coldest winter days without impacting the Company's ability to serve the natural gas needs of our existing customers*."[21]

Thus, the 125,000 MCF per day capacity referenced in the service agreement with SJG was derived not from a concern over the volume needed to supply BLE, but with an assurance that doing so would not disrupt the pipeline's primary purpose: providing capacity for existing customers.

2. SJG Explicitly Rejected Designing the Proposed Pipeline to Provide Firm Service to BLE

When designing the proposed pipeline, SJG analyzed the infrastructure requirements that would be necessary to supply BLE with uninterrupted ("*firm*") natural gas service and determined that doing so would require installation of seven (7) miles of additional pipe looping

[iii] SJG claims that the pipeline's entire capacity is required to deliver 125,000 decatherms per day at high enough pressures to supply BLE on the coldest days of the year. However, SJG's own design models assumed that the company would be exempt from supplying gas to BLE *at all* during those days. *See* analysis on pages 11-12.

from Swedesboro City Gate, and installation of five (5) miles of additional pipe replacing an existing smaller pipeline along Union Road. [22] These installations would be <u>in addition</u> to the 21.6 miles of pipeline that SJG is proposing.

By SJG's calculation, these additional stretches of pipe would have added $50 million to the overall project cost. As a result, SJG concluded that, "*the provision of firm service to BL England was deemed to be feasible, but unreasonable*."[23] Consequently, the company explicitly rejected designing the proposed pipeline to provide firm natural gas supply to BLE, opting instead for a cheaper design that, nevertheless, guaranteed redundant supply to existing customers. This rejection indicates that the primary purpose of the proposed pipeline is not (and never was) primarily to supply BLE.

3. *The Proposed Allocation of Project Costs Shows the Pipeline Is Designed Primarily to Serve SJGs Existing Gas Customers and Not to Supply BLE*

Black & Veatch performed a cost allocation study to determine what percent of the total capital costs of the proposed pipeline should be assigned directly to SJG's existing customers and which should be allocated directly to BLE. Assuming the costs of securing the required easements and license agreements are included, Black & Veatch concluded that SJG should allocate 60.0% of the cost of the pipeline to existing gas customers and only 40.0% to BLE.[24]

Figure I: Results of Black & Veatch Proposed Cost Allocation Methodology

MAJOR PROJECT COMPONENTS	TOTAL CAPITAL COSTS	BLE POWER PLANT	SJG'S EXISTING GAS CUSTOMERS
Tie-in at Union Road & Route 49	$ 1,810,133		$ 1,810,133
Interconnection at Tuckahoe	$1,767,205		$1,767,205
Meter Station at BLE Power Plant	$1,794,551	$1,794,551	
24" Pipeline from Union Road & Route 49 to Tuckahoe Interconnection (13.3 miles)	$48,557,093		$48,557,093
24" Pipeline from Tuckahoe Interconnection to BLE Power Plant (8.4 miles)	$33,014,669	$33,014,669	
Total	**$86,943,651[10]**	**$34,809,220**	**$52,134,431**
Percent of Total	**100%**	**40.0%**	**60.0%**

[SOURCE: Black & Veatch, Cost Allocation Study, Table 10]

In justifying its calculation, Black & Veatch stated that existing customers should pay for the entire capital cost of the pipeline from Union Road to the Tuckahoe Interconnection, as well as the cost of the interconnection at Union Road and Route 49 because, "*while these facilities also will enable the delivery of gas to the BLE power plant, the specific design and capacity requirements of these facilities are not affected by the incremental gas loads placed on SJG's system by the BLE power plant*…."[25] Because the specific design and capacity requirements of this portion of the line are only necessary to provide redundancy service to existing gas customers, Black & Veatch recommended that the entire cost of these components (which represent the majority of the proposed infrastructure) should be paid by existing gas customers and not BLE.

4. The Designed Size and Maximum Operating Pressure of the Proposed Pipeline Indicates that Supplying BLE Is Not Its Primary Purpose

a. <u>The diameter of the proposed pipeline is larger than necessary to deliver gas at adequate pressure to BLE on the coldest days that SJG actually intends to deliver gas to BLE</u>

Black & Veatch's analysis provided a single explanation for why a twenty-four inch (24") pipeline was required to supply BLE, rather than a twenty-inch (20") pipeline. The study notes that "*although a 20" pipeline may have seemed adequate based on the* [flow analyses presented], *it was found that adequate system pressures at Union Road and Route 49 could not be attained to reliably deliver 100 psig to the BLE power plant on cold winter days when projected to the year 2021*."[26]

While technically correct, this statement is also misleading. As noted, under SJG's service agreement with BLE, the company is permitted to curtail supply to the power plant up to fifteen (15) days per year or during an emergency where other pipeline infrastructure fails and firm service to existing gas customers is threatened. The *non-emergency* situations during which SJG expects to curtail service to BLE include the coldest winter days each year, when falling temperatures have a tendency to generate hydrates that decrease the cross-section of the pipeline and, consequently, reduce the volume of gas that can flow through it efficiently.[27]

In modeling how the proposed pipeline would perform in cold conditions, SJG performed network flow and pressure simulations for the Design Day (when the average temperature was 2 degrees F.), the second coldest day projected for winter 2021-22, the 16th coldest day projected for winter 2021-22, and at 10 degrees F and 20 degrees F. SJG's simulations, therefore, included the fifteen coldest days projected for the model year. For all but the 16th coldest day, SJG assumed that the entire supply to BLE would be diverted to existing customers with firm supply contracts.[28] According to SJG's own simulations, the company assumed that it would cut-off the entire supply to BLE during the coldest winter days, when temperatures are projected to fall below 20 degrees F.

Black & Veatch performed its own analysis of various pipeline sizes to determine which design would be necessary to generate the required pressure of 100 psig, assuming that gas supply to BLE could not be interrupted. When Black & Veatch evaluated how different designs would impact supply to BLE on the coldest winter days (projected to the year 2021), therefore, its analysts assumed that existing gas customers would not have the right to curtail supply to BLE, even when frigid temperatures caused precipitates that threatened adequate supply to SJG's existing customers.

However, the days Black & Veatch simulated are the same days SJG's simulations assumed that the gas flow to BLE would be turned off completely in order to guarantee firm service to existing gas customers. Hence, under the most realistic model of the practical application of the proposed pipeline (SJG's simulations), it would be unnecessary to deliver gas to BLE at the 100 psig that Black & Veatch indicated was the sole justification for a 24-inch (24") diameter pipe. If SJG's service agreement does not anticipate supplying BLE with any gas on the frigid winter days Black & Veatch simulated, then the need for adequate gas pressure on those days cannot itself justify the pipeline's additional diameter.

b. <u>The 24-inch diameter of the pipeline indicates that its primary purpose is to facilitate future gas service to customers other than BLE</u>

In the 2015 Compliance Statement, SJG defines "intended primarily to serve" as "…a purpose or goal…expected to be such in the future."[29] This definition implies that the CMP requires that infrastructure constructed in a Forest Management Area be intended to primarily serve the needs of the Pinelands not only at the time of its construction, but also in the future. According to design specifications, however, SJG chose a larger diameter and higher operating pressure solely to accommodate future upgrades intended to service existing and new customers outside of the Pinelands.

The 24-inch (24") diameter of the pipeline is not necessary to supply BLE. SJG modeled various pipeline diameters for the "reliability" section of the proposed pipeline (from the intersection of Union Road & Route 49 to Tuckahoe).[30] According to SJG's own modeling, a sixteen-inch (16") diameter pipe would sufficiently provide adequate pressure to supply BLE at temperatures as low as 2 degrees F. projected to the winter season of 2021-22.[31] A twenty-four inch (24") pipe of standard wall thickness, however, has a maximum operating pressure (MAOP) of 700 psig, far greater than the 100 psig necessary to reliably supply BLE on the coldest winter days.[32] Indeed, the proposed pipeline is designed to provide gas at pressures up to 60 percent (60%) higher than necessary to fulfill the BLE service agreement, a fact which is evidenced by SJG's own clarifications to members of the Pineland Commission in 2014:

> "*The construction of SJG's proposed pipeline will meet all the requirements of a 700 psig rated pipeline …However, <u>for the foreseeable future</u>, the new pipeline will be identified and listed by SJG as a 435 psig Maximum Allowable Operating Pressure . . ..*"[33]

Also, the pipeline's large diameter cannot be justified by SJG's need to supply redundant gas service to 100% of its customers within the Pinelands.[34] The company also modeled the "reliability" section of the proposed pipeline, assuming both a 20-inch (20") and 24-inch (24") diameter pipe, with various additional structural upgrades. According to these simulations, a 20-inch (20") pipe provided redundancy service to more customers than a 16-inch (16") pipe, while a 24-inch (24") pipe provided redundancy service to a few more. Notably, the number of additional customers covered by moving from a 20-inch (20") pipe to a 24-inch (24") pipe was *less* than the number of additional customers covered by moving from a 16-inch (16") pipe to a 20-inch (20") pipe. However, even with a 24-inch (24") pipe, SJG's models concede that a number of existing gas customers in Cape May and Atlantic counties would not receive redundancy service.[35]

According to SJG's own simulations, therefore, no single pipeline design provided reliability to 100% of customers without upgrading the existing 16-inch (16") pipeline north of Tuckahoe (and receiving approval from the BPU to increase the maximum operating pressure of the line).[36] Rather, SJG's modeling revealed that redundancy service improved along a continuum corresponding with the increased diameter of the pipeline, with a proportionately greater number of additional customers served with a 20-inch (20") pipe than a 24-inch (24") pipe.

These results are consistent with the conclusions reached by Black & Veatch in its 2012 Cost Allocation Study, which found that <u>either</u> "*the installation of a 20" or 24" gas pipeline…offers a significant level of reliability improvement*…."[37] Black & Veatch recommended installation of a 24-inch (24") pipe, however, because, "<u>*only the installation of a 24" gas pipeline also offers the ability to further increase SJG's gas system reliability by…future enhancements…*</u>"[38]

c. <u>SJG justified the pipeline's financing on the basis of its ability to supply future gas customers, not BLE</u>

The proposed pipeline is designed to be larger than would be required to serve the Pinelands solely to accommodate SJG's future plans to enlarge parts of its pipeline outside of the Pinelands (enabling the company to serve thousands of new customers equally outside of the Pinelands). Indeed, in justifying the financing of the project, Black & Veatch noted that, "*SJG's reasoning for designing the new pipeline to 700 psig instead of 435 psig is, among other reasons, to allow for the possible future upgrading of the supply piping between Union Road Station and the beginning of the new pipeline installation at Union Road and Route 49.*"[39] Indeed, SJG has admitted as much in its response to Pineland Commission members when it indicated that the pipeline would be listed as 435 psig "*for the foreseeable future*."[40]

SJG's own modeling estimated that enlargement of the pipeline would allow the company to provide gas service to 26,621 additional customers in Cape May County (with the proposed pipeline operating as a redundant feed for the North/South supply into the county), and some 20,370 additional customers in *both* Atlantic and Cape May Counties (if the proposed pipeline operates as a redundant feed for the East/West supply into both counties).[41]

II. **Repowering BLE Would Not Primarily Serve the Electricity Demands of the Pinelands**

SJG's 2015 Compliance Statement asserts both that the majority of the electricity generated by BLE will be consumed by customers within the Pinelands[42], and that BLE is necessary to protect electric reliability inside the Pinelands.[43] To support these claims, the company relies principally on a 2012 report by Power Grid Engineering & Markets (PowerGEM), which the consultants updated in October, 2013 and again in October, 2015.

The PowerGEM report is replete with methodological errors and misleading statements that contradict the conclusions of regional transmission operator PJM Interconnection (PJM), which found that deactivating BLE created no long-term reliability issues for the Pinelands or surrounding areas.

A. Deactivation of Multiple Units at BLE Proves That the Facility Is Not a Critical Source of Electricity for the Pinelands

BLE consists of seven (7) combustion-based units that together generate a maximum of 447 MW of power. BLE unit #1 is a coal-fired steam turbine generating up to 129 MW of electricity. Due to air pollution violations and restrictions imposed by the New Jersey Department of Environmental Protection (NJDEP), the unit was retired in May, 2014. At that time, PJM identified no reliability impacts resulting from the unit's deactivation.[44]

BLE unit #2 is a coal-fired boiler that has operated at about 60% of its capacity since 2010 due to restrictions the NJDEP placed on its output of sulfur dioxide (SO_2), nitrous oxides (NO_x), and particulate matter (PM).[45]

BLE unit #3 is an oil-fired boiler, but primarily operates only in the summer as a "peaking unit" during high energy demand days.[46]

BLE units #4, #5, #6, and #7 are identical diesel-fired combustion units that were deactivated on May 31, 2016 with PJM finding no resulting reliability impacts.[47]

Since May 31, 2016, therefore, five (5) of seven (7) BLE units (representing at least 31% of the plant's total maximum capacity) have been deactivated with no resulting reliability impacts. Moreover, for almost three (3) years, BLE has been operating with nearly 30% of its total capacity deactivated entirely. During that time, PJM has not identified any reliability violations that can be attributed to the substantial drop in BLE's electricity output.

B. BLE's Limited Operations Over the Last Several Years Prove That Its Full Capacity Is Not Vital to Electric Reliability in the Pinelands

Since 2010, air pollution regulations permit BLE unit #2 to operate no more than 4,300 hours per year, less than half of the time that R.C. Cape May is seeking to operate the repowered unit.[48] While BLE's permit limits the maximum time that unit #2 may operate, since a 2006 Administrative Consent Order (ACO) with NJDEP, the unit has operated on a limited basis as a "peaking" facility, [49] and its actual hours of operation may have been fewer than the maximum allowed by permit.

While BLE unit #3 is permitted to run more hours than unit #2, RCCM has operated the unit primarily during the ozone season (May to September) and only as a high electric demand day (HEDD) unit.[50] According to the NJDEP, most HEDD units in New Jersey are required only when maximum temperatures in Trenton exceed about 87 degrees F., and all units have use factors less than 50%.[51] Thus, for many years BLE unit #3 has been generating far less power than its maximum permitted capacity, a fact made apparent when comparing its air emissions over the last five (5) years of operation to the unit's potential to emit (PTE) if it is repowered and permitted to operate at full capacity.[52]

Thus, during the last several years, the total amount of power that BLE has contributed to the grid serving the Pinelands has been a fraction of the plant's maximum output, and substantially less than the total output of the repowered facility under the conditions that RCCM intends to operate it. Over that same period, PJM has not identified a single reliability violation attributed to BLE's limited operation. Indeed, Pinelands customers have enjoyed reliable electric service despite the substantial drop in BLE's output. The practical operation of BLE over the last several years, therefore, contradicts SJG's assertion that the full capacity of the plant "*is strategically vital for energy reliability in the southern New Jersey region*."[53]

C. Claims that a Repowered BLE Is Vital to Reliable Electrical Transmission in the Pinelands Are Misleading and Based on Outdated Data.

1. SJG Has Mischaracterized Reliability Violations Attributed to BLE's Retirement

PowerGEM's report analyzing the electric reliability impacts of repowering BLE notes that the plant's retirement would "*negatively impact eight (8) transmission circuits in proximity to the Pinelands Area*.[54] The "negatively impact" wording is telling, because the 2018 RTEP Model that PowerGEM's analysis used tested how the retirement of BLE and three (3) other generators with planned retirements would impact transmission within the Atlantic Electric transmission zone.[55] In its 2015 Compliance Statement, SJG mischaracterizes these reliability violations as "caused" by BLE's closure.[56] But PJM's model revealed that in seven (7) cases, overloaded circuits included contribution from a generator other than BLE that was expected to retire prior to 2019.[iv]

PowerGEM's use of the term "in proximity" also is telling, because it attributes overloads "in proximity" to the Pinelands to BLE even though these modeled overloads have little to do with the retirement of BLE. PowerGEM's report, for example, notes nine (9) required upgrades "*in proximity*" to BLE that were identified at PJM's June, 2014 Transmission Expansion Advisory Committee (TEAC) meeting (and approved by PJM's Board in July, 2014).[57] When pressed on this issue, PowerGEM clarified that the upgrades identified "in proximity" to BLE merely "*illustrate the dependence of the area load (including the Pinelands area load) on BL*

[iv] PJM identified the eighth overload as resulting from a specific planned generator that had signed a Facilities Study Agreement (FSA) agreement, but not an Interconnection Service Agreement (ISA). Thus, PJM concluded that this overload would not constitute a reliability criteria violation and would revisit the analysis and recommend a solution if (or when) the queued generator signed an ISA. *See* TEAC Reliability Analysis Update, September 2, 2014, slide 118.

England generation."[58] This statement is a far cry from the claim that BLE's retirement will *cause* these overloads.[59] In fact, the overloads were merely identified on circuits near the Pinelands and could be attributed to a number of different factors, including the retirement of several other generating facilities in the area.

Additionally, PowerGEM characterizes upgrades required if BLE does not retire as upgrades PJM recommends if BLE does retire. For example, PowerGEM refers to "*another 7 overloads*" identified at PJM's July, 2014 TEAC meeting, claiming that upgrades were proposed "*to address the additional 7 overloads due to BL England retirement*," and that "*these upgrades/overloads…caused by a retirement of BL England are within the Pinelands*."[60]

Most readers would assume from PowerGEM's wording that PJM had identified a total of fourteen (14) overloads due to BLE's retirement, when the opposite is the case in at least seven (7) of the identified overloads.[v] The seven (7) overloads PJM presented after the June, 2014 TEAC meeting resulted not from BLE's retirement, but from failing to retire BLE (and three other generators: Clinch River, Tanner Creek, and Kammer) as planned. When PJM stated that "*the need to upgrade these facilities will be re-evaluated if the generation does not deactivate*,"[61] it was referring to the fact that its reliability testing had indicated that loading on the seven (7) circuits identified "*would be within applicable ratings*" assuming that the generators (BLE, Clinch River, Tanner Creek, and Kammer) retired as planned.[62] PowerGEM itself provides evidence of this more accurate reading of PJM's reliability analysis when it noted that the upgrades proposed to resolve the second seven (7) overloads were "*on hold*" and would be re-evaluated by PJM staff "*if the generation does not deactivate*."[63]

Nevertheless, after filing its initial report with the BPU, PowerGEM issued a "Review of Pinelands Preservation Alliance Declaration" on November 4, 2015 that characterized the second seven (7) overloads as "*substantial reliability problems*" that are a "*direct result of PJM analysis related to the retirement of the local generation at BL England*."[64] PowerGEM's subtle change

---

[v] It appears this is exactly how the BPU misinterpreted PowerGEM's statements. The BPU's Order permitting construction of the proposed pipeline, for example, notes the upgrades presented by PJM at the June, 2014 TEAC meeting, and then refers to "*seven (7) additional overloads attributed to the retirement of B.L. England*" that PJM presented later. *See* State of New Jersey Board of Public Utilities, Decision and Order In the Matter of the Petition of South Jersey Gas Company for a Determination Pursuant to the Provisions of N.J.S.A. 40:55D-19, Docket No. GO13111049, December 16, 2015, 31 (emphasis added).

in wording from the report it filed to its review of PPA's Declaration is telling. In its review, PowerGEM admitted that the referenced overloads are not a direct result of BLE's retirement, but directly result from PJM's analysis (not of BLE's retirement, but) related to the retirement of other generation in the same area. In this case, "related to retirement of" generation actually refers to BLE's repowering, not its deactivation. The intentionally vague (and contradictory) descriptions have created the misimpression that half of the overloads PowerGEM has identified in its initial report would occur if BLE is not repowered. In fact, PJM's model clearly indicated that these overloads would occur only if BLE does not retire.

2. *Newer Reliability Assessments Indicate that BLE's Retirement Creates No Long-Term Reliability Concerns*

Updated PJM analyses show that retiring BLE will not cause any long-term reliability concerns. The PowerGEM report, which SJG uses as its primary evidence that BLE's retirement would create reliability issues, went through several revisions. The latest "updated analysis" was submitted on October 9, 2015 and contains additional mischaracterizations regarding the dates of particular findings.[65] For example, the report makes reference to "October 2015 Results" followed by the heading "Overloaded Circuits" and a graph of transmission upgrades PJM has suggested would be necessary, should BLE not be repowered.[66]

A casual reader might easily assume that, as of an October, 2015 analysis, PJM had identified the need for the listed transmission upgrades. In fact, all of the upgrades identified in PowerGEM's October, 2015 "update" refer to those identified by PJM in June, 2014.[67] Thus, they are the result of reliability assessments PJM had performed seventeen (17) months before PowerGEM's "update" and do not reflect the results of any of PJM's reliability analysis updates after June, 2014. PJM's newer data and more accurate models indicate that BLE's retirement will not have the long-term reliability concerns SJG first identified.

a. PJM's November 11, 2014 Reliability Analysis Update

In November, 2014, PJM analyzed long-term system reliability by modeling its transmission grid using a 2022 base case, an update of its 2018 RTEP base case that includes newer data.[68] The 2022 base case more accurately models changes to PJM's power grid that have occurred since its June, 2014 recommendations. Under the 2022 model, PJM assumed that BLE was retired as planned. But the newer analysis found no "single contingency" reliability violations in the Atlantic Electric transmission zone and only two Generator Deliverability violations, both involving the parts of the Mickleton-Monroe 230 kV line west of the New Freedom substation (and, therefore, unlikely to be caused by BLE).[69] Those "violations," however, have since been resolved in part by the replacement of four (4) 69 kV circuit breakers at the Mickleton substation with newer, more robust 63 kA breakers, which PJM expects to be in service by June 1, 2018.[70] PJM identified no long-term reliability concerns for the Atlantic Electric transmission zone where BLE is located, assuming the plant retires completely.[71]

b. PJM's December 4, 2014 Reliability Analysis Update

In December, 2014, PJM analyzed system reliability under a scenario that assumed that the study areas were subject to a polar vortex under winter peak loads.[72] In this analysis, PJM assumed that BLE's turbines were not repowered and anticipated the deactivation of the remaining 137 MW of the plant's generation.[73] The analysis found no loss of load expectation in either of the transmission zones (Atlantic Electric and Jersey Central Power & Light) that serve customers in the Pinelands.[74]

c. PJM's January 7, 2016 Reliability Analysis Update

In January, 2016, PJM again updated its reliability analysis.[75] Under this model, PJM assumed that all of BLE's remaining generation (including 8 MW supplied by its diesel units), as well as all generation from the Oyster Creek nuclear plant, would be deactivated as of 2021.[76] This updated analysis revealed that Oyster Creek's retirement would create no reliability impacts,[77] and BLE's complete deactivation would create only Generator Deliverability violations, not long-term reliability concerns (see below).[78]

3. Many of the Upgrades PJM Recommended in July, 2014 Were Not Due Solely to BLE's Retirement and Would Be Required Whether or Not BLE is Retired

In its 2015 Compliance Statement, SJG characterized network upgrades that PJM suggested in July, 2014 as necessary to address reliability issues caused by BLE's retirement.[79]

However, PJM itself noted that a number of the upgrades it recommended were also needed to address aging infrastructure on roughly forty (40) circuit miles of existing 138 kV line that would require upgrading regardless of the status of the BLE plant.[80] Indeed, SJG concedes that Atlantic City Electric (ACE) "*still intends to pursue some of the transmission upgrades whether or not BLE is repowered to address 'aging infrastructure' issues.*"[81]

4. *Atlantic City Electric Has Admitted That All of the Upgrades PJM Identified Will be Required Anyway to Ensure System Stability While BLE's Units Are Being Retrofitted*

On September 17, 2015, ACE filed a petition with the BPU to permit the utility to work on public land to upgrade the Orchard – Lewis 138 kV transmission line in order to address five (5) of the circuit overloads PJM initially identified by as resulting from BLE's retirement.[82] ACE's petition sought permits for the upgrades even in the event that BLE is repowered, explicitly noting:

> "*Over a period of months, [ACE] and PJM identified certain transmission system upgrades which would, upon completion, mitigate the identified transmission system overloads and voltage issues [associated with BLE]. These upgrades in total impact eleven (11) different substations and numerous transmission lines through a combination of replacing, rebuilding, upgrading, reconfiguring and/or installing new transmission lines and substation equipment.* ***Further, should the Facility repower using natural gas, the transmission system upgrades would likely be needed to maintain reliability during that process when the Facility is offline***."[83]

Additionally, ACE's petition conceded that it had already planned to upgrade forty-one (41) miles of 138 kV transmission lines to 230 kV by 2020, "*because of deteriorated hardware issues and issues with ground line deterioration of the lattice tower legs.*"[84] The company also noted that portions of the Upper Pittsgrove – Landis line, would have to be replaced because a comprehensive 2014 inspection of the infrastructure revealed "*corrosion and abrasion issues . . . in more than half of the structures*."[85]

The fact that these network upgrades were required to address issues unrelated to BLE's retirement is one reason SJG's 2015 Compliance Statement concedes that ACE, "*still intends to pursue some of the transmission upgrades whether or not BLE is repowered to address 'aging* *infrastructure' issues*[vi].'[86] ACE's petition outlines in detail the transmission upgrades for which it sought approval from the BPU, including upgrades that are required to replace aging infrastructure. ACE's planned upgrades have the additional benefit of addressing any reliability concerns that will result whether BLE is retired or repowered.[87]

5. *PJM Admits That Many of the Violations PowerGEM Identified Do Not Pose a Threat to Reliability in the Pinelands*

PJM regularly conducts a series of detailed analyses to ensure reliability under the most stringent of applicable criteria. Under PJM's models, all generation capacity is required to contribute to the deliverability of electricity within PJM's service territory in two ways. First, when an area is experiencing a localized reliability event, power must be deliverable from the aggregate of available generators throughout PJM to the identified customers. Second, generators within a given electrical area must, in aggregate, be able export their power to all other areas of the PJM region.

a. <u>Load deliverability violations vs. generator deliverability violations</u>

PJM has developed two tests to verify compliance with each of these reliability requirements: the PJM Load Deliverability Test and the PJM Generator Deliverability Test. The <u>Load Deliverability Test</u> considers the ability of the transmission system to deliver adequate power to a given transmission zone during an emergency, where certain generators are lost or cannot be accessed because of downed power lines, etc.[88] PJM acknowledges that its Load Deliverability Test addresses reliability only, without regard for the economic performance of the system. That is, PJM concedes that the load deliverability test alone verifies that PJM can maintain reliable electrical service to specific customers during an emergency by importing sufficient power from other areas.[89]

[vi] SJG follows this admission with an assertion that a repowered BLE will still provide significant reliability benefits to the Pinelands, but provides no immediate warrant for the claim. SJG's admission fundamentally denies its own claim that, "*closure of BLE will cause reliability violations*."

The Generator Deliverability Test, on the other hand, evaluates the ability of PJM's transmission system to assure that all remaining power during an emergency can be delivered to all points in the PJM system at peak load.[90] The test is designed to ensure that bottled capacity conditions during an emergency in one transmission zone do not limit the economic dispatch of capacity resources throughout the rest of PJM's service territory.[91] In other words, the Generator Deliverability Test determines whether PJM's power grid will continue to operate at optimal economic efficiency during an emergency affecting one transmission zone, not whether the transmission network will operate at all.

b. Generator deliverability violations are not reliability concerns

As early as 2006, PJM acknowledged that the assumptions behind the Generator Deliverability Test are outdated. In testimony directed at improving the locational pricing of Demand Response (DR) resources, Audrey Zibelman (then PJM's Chief Operating Officer) and Andrew Ott (PJM's current Vice President of Markets) noted:

> "*The current PJM capacity construct utilizes the concept of "universal deliverability;" namely, that a generator anywhere within the PJM footprint is deemed to be able to deliver everywhere within PJM…Universal deliverability arguably worked adequately when PJM was smaller and the transmission system was more robust, given the demands on the system at the time. But that concept breaks down as the transmission system becomes more constrained and the footprint larger. Clearly, infinite transfer capability is an impractical and, likely, an economically undesirable condition. In fact, under this construct, PJM has been forced to rely on Reliability Must Run contracts to defer retirements of generators in transmission-constrained locations in order to preserve reliability*."[92]

PJM acknowledges that in actual operating conditions, system operators responding to an emergency will import any power that is available rather than prioritizing the cheapest sources, even if it means that congestion increases on some lines (which may raise the real-time price of power, at least for the duration of the emergency).[93] Moreover, in testimony before the BPU, PJM has admitted that transmission congestion—like that identified through the Generator Deliverability Test—does not itself represent a reliability violation, but merely could indicate the need for future upgrades.[94] Indeed, when PJM studies the system impact of interconnecting a proposed generator, it recognizes that operational restrictions are capable of limiting the output of power from a facility with much larger capacity to avoid circuit overloads, and explicitly notes that any identified network upgrades to eliminate the need for these kinds of operational restrictions are "*not required reliability upgrades*."[95]

c. SJG mischaracterizes generator deliverability violations as reliability violations

Despite PJM's reticence about characterizing violations of its Generator Deliverability Test as reliability violations, SJG uses them as a fundamental justification for its claim that "closure of BLE will cause reliability violations."[96] SJG's 2015 Compliance Statement identifies as "*reliability violations*" four (4) voltage and thermal overloads that PJM presented in June, 2014 as partial justification for the transmission upgrades it recommended a month later.[97] At least some of those overloads, however, include "violations" identified through PJM's Generator Deliverability Test, not its Load Deliverability Test.[vii] For example, the 107.61% overload identified on the Croydon – Burlington 230 kV line is clearly marked a "Generator Deliverability Violation."[98] Additionally, the 104.78% overload on the Mill#1 – Lewis #1, which PJM first identified in its October, 2014 System Impact Study, is under the heading "Generator Deliverability" (along with an explanation from PJM that the violations identified through its simulations were, "*for the Capacity portion only of the interconnection*," and are not attributed to the amount of power that the generator would actually contribute to the grid[viii]).[99] While SJG groups all of these reliability issues together, overloads identified through PJM's Generator Deliverability Test should not be considered violations that threaten reliable electrical service to customers in the Pinelands (or "in proximity" to it).

[vii] It is important to note that all of the violations assume overloaded circuits or transformers, an odd outcome given PowerGEM's assertion that BLE's retirement would result in a loss of power "in proximity to" the Pinelands.

[viii] In other words, the "overloaded" circuits could simply be solved by decreasing the amount of power local generators sent through the circuits rather than by rebuilding the lines to withstand the maximum output of every local generator. This simple operational procedure is one reason these "violations" disappeared when PJM updated its System Impact Study in October, 2016 to reflect a 39 MW reduction in the Maximum Facility Output of the repowered BLE facility. By characterizing this smaller power output as a "capacity reduction," PJM's models no longer identified the resulting "overloads." But, in an emergency, system operators functionally would do the same thing by reducing generator output. *See* PJM Generation Interconnection System Impact Study Report for PJM Generation Interconnection Request Queue Position Y1-077, "BL England 138 kV" (revised), October, 2016.

6. New, Cleaner Generators Have Entered the Market Since PowerGEM's Last Analysis

In its compliance statement, SJG characterizes the "overloaded" circuits identified in PowerGEM's report as contributing to electric transmission outages caused by New Jersey's lack of sufficient in-state generation[100] But SJG's evaluation does not consider a substantial amount of new generating capacity in proximity to the Pinelands that has entered the market since PowerGEM's last analyzed the system in 2014.[101]

a. Middlesex 560MW natural gas generator

As of this report, PJM's base case model includes a new natural gas-fired generator constructed in Middlesex County and expected to come into service in May, 2018.[102]

b. Injection of additional 96.5MW capacity at Bus 228203

> Among the new generating capacity noted in PJM's most recent generator queue list is nearly 100 MW of capacity from an existing generator at a substation at bus location 228203 within the JCP&L transmission zone.[103]

c. Melrose 70MW natural gas unit

PJM's latest generator queue list includes 70 MW of new natural gas-fired generation from the Melrose Power Plant in Middlesex County.[104]

d. Additional 10MWfrom Pedricktown combined-cycle generator

PJM's latest model includes an additional 10 MW of output from the existing combined-cycle generator at Pedricktown.[105]

e. Monmouth County 20MW solar facility

PJM's latest queue list includes a 20MW Conti Enterprises-owned solar farm at Monmouth County, which was not included in PowerGEM's analysis.[106]

f. <u>Additional 88MW of energy storage "capacity"</u>

PowerGEM's analysis also does not consider a total of 88 MW of new energy storage capacity constructed in the Jersey Central Power & Light transmission zone[ix].[107]

7. PJM Admits That Power from New Generators Eliminates the Need for BLE to Replace Power from Oyster Creek

SJG's 2015 Compliance Statement refers to the September, 2013 version of PowerGEM's flawed analysis to support its claim that power from BLE is critical to prevent reliability issues resulting from retirement of the Oyster Creek nuclear plant in 2019.[108] But, in 2014 (after PowerGEM's analysis), <u>PJM acknowledged that the closing of *both* B.L. England and Oyster Creek "*won't be an issue*" because</u> <u>the market had already responded to the planned retirement of Oyster Creek by driving the construction of new natural gas plants in the service territory</u>:[109]

> "*[Oyster Creek's retirement] is an opportunity for new projects that are developing to actually get value and know they have a market to sell to," PJM spokeswoman Paula Dupont-Kidd noted.*[110] *"It's provided incentive for a lot of new generation to come into the area*."[111]

Specifically, Dupont-Kidd referred to more than 2,000 MW of new generation from the 700 MW natural-gas fired facilities being built in West Deptford and Woodbridge, as well as the Newark Energy Center's 655 MW combined-cycle gas and heat recovery plant, which began operating in May, 2015.[112]

Additionally, because Oyster Creek's retirement had been anticipated so early, PJM had already planned, financed, and constructed transmission upgrades designed to avoid any reliability issues associated with loss of the nuclear facility. Indeed, PowerGEM's analysis concedes that PJM had by 2013 recommended $100 million in new transmission upgrades designed to solve any potential for overloaded circuits.[113] Partially because of these upgrades,

---

[ix] Technically, PJM considers energy storage as energy not capacity, since storage facilities are not themselves capable of generating electricity. They do, however, extend the capacity of existing generation sources and provide a critical source of electricity to serve the Pinelands and areas in proximity.

PJM's 2016 RTEP model identified "*no impacts*" from the planned retirement of Oyster Creek.[114]

D. The Structure of New Jersey's Power Grid Disproves that Repowering BLE Is Critical to Providing the Pinelands with Reliable Electrical Service

The PowerGEM analysis purports to identify generating units "in proximity" to the Pinelands[x], and concludes that a repowered BLE would contribute 39% of the electricity demand of the Pinelands Area based upon the assumption that "*local generation all contributes in equal proportion to the Pinelands Area load*."[115] Although never articulated, PowerGEM also assumes that all power generated by units "in proximity" to the Pinelands will be consumed within the Pinelands, and that none of the power from those units will travel outside the Pinelands Area. PowerGEM must note the first assumption so explicitly (and repeatedly[xi]) because it flies in the face not only of the protocols by which PJM dispatches power in New Jersey, but of the laws of physics by which all electricity grids operate.

Electric power does not observe geographic boundaries. Rather, it flows through the power grid according to well-established physical principles, including as their foundation the difference in voltage between any two terminals in the system.[116] Transmission lines are generally configured as mesh networks, meaning that there are multiple paths between any two points in the network. This redundancy allows the system to provide power to loads even when a particular transmission line or generating unit goes offline.

These multiple routes mean that power flow within the system cannot be specified at will, and the electrical energy generated in one place can rarely be "tracked" to its consumption at another. Instead, power flows along all available paths from the generating unit to the load,[117] like water flowing through a network of interconnected pipes, or a river basin with multiple tributaries.[118] If one pipe (or power line) is full, power will seek another path. Thus, it is no more possible to claim that an electrical charge created by a particular generator is consumed by a

[x] The authors never define "in proximity," nor provide a single justification for including or excluding generating units on the basis of the definition.

[xi] The report repeats the phrase "assuming that the local generation all contributes in equal proportion to the Pinelands Area load" no less than six (6) times over its seven (7) pages.

particular customer than it is to claim that someone drawing a gallon of water from a river is consuming the same gallon poured into the river miles upstream. Power produced by any connected generator is pushed into a sprawling network of interconnected transmission lines, where it follows the paths of least resistance. As a result, "*an Upper Township family is as likely to power their television with electricity generated at a station in Pennsylvania as it is the B.L. England plant a mile away*"[119] and PowerGEM cannot claim (without noting the flawed assumption) that power generated "in proximity" to the Pinelands will necessarily be consumed by Pinelands customers.

E. PJM's Dispatch Protocols Prove That BLE Is Not Critical to Electric Reliability

Implicit in PowerGEM's calculation is the assumption that customers within the Pinelands would automatically receive priority claim to the power generated by any generator identified as "in proximity" to them and that the *entire* capacity of those generators will be so directed.[xii] As mentioned, it is not physically possible to direct power within an interconnected grid in this manner. Nonetheless, PowerGEM's assumptions are also false because they are inconsistent with the actual protocols system operators use to distribute electricity within PJM.

Transmission system operators manage New Jersey's power grid with free-flowing transmission lines, in accordance with PJM's Operating Agreement.[120]This agreement mandates that operators use a procedure known as "economic dispatch" to distribute electricity to every consumer while minimizing fuel costs for every utility. Under economic dispatch, system operators try to make the maximum use of generating units with the lowest operating cost, and to use more expensive units only when the less expensive ones are already running at maximum capacity. This system provides costs savings for PJM member-companies and for New Jersey's consumers.

[xii] More precisely, PowerGEM assumes that the aggregate amount of power produced by generators (operating at maximum capacity and identified as "in proximity" to the Pinelands) will somehow first be directed to customers anywhere within the Pinelands before serving any other customers, even those customers outside the Pinelands who are actually located closer to the power plant.

The specific type of economic dispatch PJM employs, known as "locational marginal pricing" (LMP), takes into account the effect of actual operating conditions in determining the price of electricity at different locations in the PJM region.[xiii] The locational marginal price at a particular location is defined by PJM as "*the cost to serve the next MW of load at a specific location, using the lowest production costs of all available generation while observing all transmission limits*."[121] This marginal cost calculation accounts not only for the cost of generating the next megawatt, but also the transmission constraints and line losses associated with delivering that megawatt to a specific location (known as a "node.").[122] The demand for electricity at each node affects the overall demand on the system, as well as how system operators direct electricity within the entire system.[xiv] Under the LMP model of economic

---

[xiii] PJM employs LMP using this (simplified) process:

First, each generating plant makes an offer of power at the minimum price for which it is willing to sell electricity.

Second, PJM uses an algorithm to solve an optimization problem that yields the least-cost set of all generator offers required to serve all loads, subject to transmission and other operational constraints. This mathematical operation generates what are called "shadow prices," which can be used to calculate the price of delivering electricity at each node (more specifically, the incremental overall value of an increase or decrease in the consumption of electricity at each location) (LMP). The LMPs are determined hourly and serve as a signal to system operators for how to dispatch power into the system in near real-time.

Third, if the LMP is at or above a generator's offer price, the offer is taken, power is dispatched from the generator into the system, and the generator is paid at the LMP. If the LMP is below the generator's offer price, the offer is not accepted and the generator is not used. As a result, the generator in the closest proximity often will not be used to power the closest node.

See Ezra Hausman et al., LMP Electricity Markets: Market Operations, Market Power, and Value for Consumers, Synapse Report prepared for the American Public Power Association, February 5, 2006, 1-2. Available at: http://www.publicpower.org/files/PDFs/SynapseLMPElectricityMarkets013107.pdf.

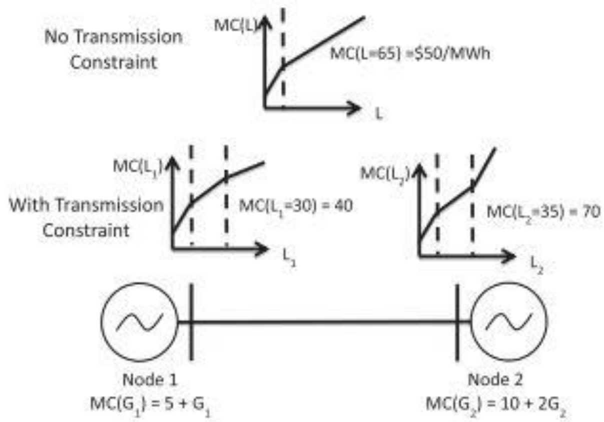
[xiv] For example, the figures below show the marginal cost functions, demand curves and simple schematic of a power grid with two nodes. There is a single generator and a single customer or "load" at each node. The generators are assumed to have simple linear marginal cost functions ($MC(G_1) = 5 + G_1$ for the generator at node 1; $MC(G_2) = 10 + 2G_2$ for the generator at node 2).

dispatch, proximity is rarely a major factor. Which generators are employed to ensure that the system can serve *all* loads is complex and dynamic. It is more a function of transmission congestion and market economics than of the physical proximity between any one generator and customers in one particular area. Contrary to the assumptions of the PowerGEM model, in many

---

Figure 1. Simplified Example of Transmission-Constrained Supply Curve in LMP Market

$$MC_1(L_1, L_2) = \begin{cases} \dfrac{2(L_1 + L_2) + 20}{3} & \text{if } -20 \le \dfrac{-L_1 + 2L_2 + 5}{3} \le 20 \\ 5 + (L_1 + 20) & \text{if } \dfrac{-L_1 + 2L_2 + 5}{3} > 20 \\ 5 + (L_1 - 20) & \text{if } \dfrac{-L_1 + 2L_2 + 5}{3} < -20 \end{cases} \tag{1a}$$



For the purposes of this example, we will ignore any capacity constraints on the two generators, but we will assume that the transmission line connecting the two nodes has a capacity limit of 20 MW. If the demand at node 1 in a certain hour is given by $L_1 = 30\ MWh$ and the demand at node 2 is given by $L_2 = 35\ MWh$, then the total demand in the system is $L = 65\ MWh$ and there is no transmission congestion. The supply curve for the system is thus the vertical sum of the individual supply curves: $G = 1.5P - 10$ *for* $G > 5$, where $G = G_1 + G_2$ and P is the market price of electricity. At a demand of 65 MWh, we thus have $65 = 1.5P - 10$, and the market clearing price for electricity is \$50/MWh. Under this scenario, $G_1 = 45$ MWh and $G_2 = 20$ MWh. Thus, 15 MWh of electric energy, rather than being supplied by the generator closest to node 2, is transferred from the further generator across the transmission line from node 1 to node 2.

Demand at any one node affects aggregate demand within the system, which in turn impacts the supply curve for every node. A policy that, for example, would reduce demand at node 2 by 10 MWh would reduce the market-clearing price for all consumers in this system to \$43.3/MWh. At higher levels of demand, however, the transmission constraints prevent some lower-cost generation from being delivered across the transmission line. Higher-cost generation, local to the downstream node, must be dispatched instead. The dispatch of higher-cost generation, in turn, introduces kinks into the supply curve for each location. The manner in which LMP impacts how electricity is directed, therefore, can hardly be simplified to PowerGEM's assumption that power is directed first toward loads "in proximity" to the generator. *See* Mostafa Sahraei-Ardakani et al., Estimating zonal electricity supply curves in transmission constrained electricity markets, Energy 80 (2015), 10–19, 11–12.

cases the generator located closest to the customer may not be the lowest-cost source of power used to serve that customer.[123] Likewise, it is impossible to claim how much of the electricity generated at BLE will serve customers in the Pinelands, without making assumptions that run counter to the actual operating protocols PJM employs.

F. Repowering BLE Is Not Necessary to Provide a Local Source of Reactive Power, and May Reduce Grid Stability in the Pinelands by Replacing More Useful Static VAR Compensators

SJG claims that repowering BLE provides additional reliability benefits by providing a local source of reactive power that helps avoid voltage instabilities.[124] Transmitting power on a bulk electricity grid requires both the electrical charge ("real power") and the energy required to move that charge from node to node ("reactive power"). Reactive power is critical for maintaining voltages on transmission lines within an acceptable window.[125] It is measured in MVARs (Mega Volt Amps Reactive) and is supplied either as a product of real power from generating stations (often located far from load centers), or is generated by capacitor banks or static VAR compensators (SVCs) distributed throughout the grid.

SJG claims that, by providing a local source of real power, BLE provides grid benefits over reliance on reactive power supplied by generators located further away.[126] Of course, because BLE has been operating at a fraction of its capacity (and only during limited periods), it is not currently serving as a significant source of reactive power for the Pinelands. The vast majority of reactive power providing voltage stability in the Pinelands currently comes from other sources.

Nevertheless, in anticipation of BLE's deactivation, PJM's Board approved plans in June, 2016 to expand the reactive power output from the West Wharton substation. Specifically, PJM approved a proposal to upgrade the existing MVAR reactor at the substation with a new -260/+40 MVAR SVC designed specifically to replace the loss of any reserve reactive power provided by BLE.[127]

As an efficient, non-emitting source of reactive power, SVCs offer significantly greater grid reliability benefits even than a local supply of real power. First, SVC's are far more dynamic and can respond to voltage fluctuations much faster than reactive power supplied by generating stations, whose output is not as quick to adjust to drops in line voltages.[128] Second, because SVC's are modular (and considerably smaller than boilers), many SVCs can be relocated within weeks.[129] As a result, during a natural disaster like Hurricane Sandy, when significant portions of the transmission system may be damaged, SVCs offer greater flexibility than local generating stations, whose real power may not even be accessible at the time.

SVCs offer substantial benefits in the transmission of real power as well. While reactive power can be supplied as a product of real power injected into the grid at generating stations, it does so at a substantial energy cost. The more reactive power is required by generators, the more it reduces their capacity to produce real power.[130] By supplying reactive power independently, SVCs can boost transmission capacity by tens of percent in many cases.[131] As a result of supplying reactive power to the Pinelands through an SVC, therefore, local generators are capable of providing more actual energy to Pinelands customers. Should the SVC planned for West Wharton be abandoned as a result of BLE's repowering, the Pinelands would forego the significant grid reliability benefits of a more effective and efficient SVC.

G. New Jersey's Exportation of Electricity to New York Proves That BLE Is Not a Critical Source of Power, and Nothing Prevents Electricity from a Repowered BLE from Being Exported Similarly

Although it provides no citation for the claim, SJG asserts in its 2015 Compliance Statement that BLE is critical to reliable electrical service in the Pinelands in part because New Jersey itself is vulnerable to outages from "*a critical shortage of in-state electric [sic] generation capacity*."[132] It is important to note that even PJM admits that reliability issues associated with generation deactivations are concentrated in northern New Jersey, where there are a cluster of recent power plant retirements, not the areas in proximity to the Pinelands.[133] Nevertheless, New Jersey's energy shortage is not due to a lack of in-state generation so much as the exportation of New Jersey's electricity—including BLE's contribution to baseline transmission networks—to New York State. In 2010, for example, merchant transmission companies completed lines from New York to New Jersey with a firm transfer capacity of almost 1,000 MW (more than double the amount of power that could possibly be generated by a repowered BLE).[134] In 2013, merchant companies planned to complete a transmission project exporting an additional 660MW from New Jersey to New York.[135] In fact, PJM's Regional Transmission Expansion Plans routinely include merchant projects that export to New York more in-state generation than could possibly be supplied by a repowered BLE.[136]

Moreover, because PJM operates its power grid under FERC's "Open Access" rules, nothing guarantees that a repowered BLE will not contribute to the increasing amounts of in-state generated electricity exported to New York. Likewise, because "Open Access" rules prevent New Jersey from restricting exportation of wholesale electricity, there is no guarantee that the electricity generated by a repowered BLE will alleviate any of the state's electric reliability concerns, let alone reliability issues in the Pinelands.

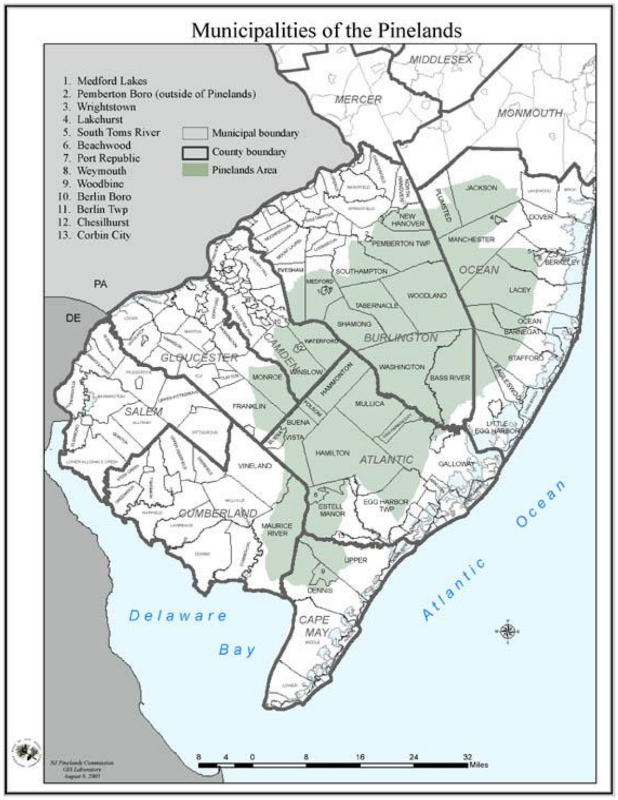
III. Repowering BLE Would Not Primarily Serve the Natural Gas Demands of the Pinelands

Even if the proposed pipeline is built, neither existing SJG gas customers within the Pinelands, nor future Pinelands customers would represent a majority of the gas customers served by the pipeline. Under the simulations SJG evaluated when determining pipeline size and route, no design resulted in a project that provided redundancy service primarily to the Pinelands. According to SJG's own models, the proposed pipeline would provide redundancy service to no more than 28,700 customers in the Pinelands, approximately 20% of the total number of gas customers that would be served by the pipeline, even before considering the future customers that will be served by upgrading parts of SJS's network north of Tuckahoe.[137]

Under the most generous scenario possible, the project would still primarily serve customers outside the Pinelands. Black & Veatch estimates that approximately 61,000 customers are directly served by the single pipeline now providing gas to customers in the southern portion of SJG's service territory, from the Cape May Station south.[138] Even if we assume that every one of SJG's customers in the Pinelands is currently served *only* by this line, Pineland customers would represent only 47% of the total number of customers for which the proposed line would provide a redundant feed.

The majority of the Pinelands Area includes land north of Atlantic and Cape May counties. A small part of Cape May County, and a larger part of Atlantic County, is within the boundaries of the Pinelands.

Figure II: Pinelands Area with County and Municipal Boundaries



[Source: http://www.pineypower.com/geninfopbpg10.html]

While the proposed pipeline enhances reliability to customers within both counties, it only provides *additional* redundancy benefits to customers in Cape May County and south. For customers in Atlantic County, the proposed pipeline provides additional reliability enhancement by looping SJG's *primary* west-to-east, 20-inch (20") pipeline into Atlantic County. Customers in that county (approximately 25,400 of whom reside within the Pinelands), however, already receive redundancy service provided through *secondary* west-to-east supply feeds. Thus, the proposed pipeline does not provide a unique benefit to these customers.

For SJG customers south of the Cape May Station (approximately 3,300 of whom reside in the small area of the Pinelands that runs into Cape May County), the proposed pipeline provides the *only* redundancy service (by looping SJG's *only* north-to-south 16-inch (16")/20-inch (20") pipeline supply feed into Cape May County).[139] The number of Pinelands customers for which the pipeline *establishes* redundancy service, therefore, includes only the 3,300 customers that reside within the small area of the Pinelands that runs into Cape May County.[140] According to SJG's own estimates, therefore, the proposed pipeline provides little additional benefit for the vast majority of Pinelands customers, whose neighborhoods, nevertheless, would be most directly impacted by the pipeline.

IV. <u>Repowering BLE Would Contribute to Emissions in the Pinelands by Displacing Demand Response Resources that Otherwise Supply Reliable Power to the Pinelands</u>

Each year, utilities spend billions to operate "peaking" plants like BLE. These plants provide a reserve supply during extreme temperatures or unplanned surges in demand, but are otherwise rarely used.[141] Traditionally, economic dispatch has meant that system operators would meet unexpected spikes in demand by adding additional supply. But, this incremental increase in generation can be enormously expensive because it requires operators to call for the most expensive and inefficient plants to ramp up to meet unanticipated peak demand (especially on the hottest summer days).[142]

An alternative way to respond to insufficient supply is to enable electricity customers to sell to grid operators pre-determined reductions in their demand, a program known as "demand response" (DR). DR pays consumers for commitments to reduce their electricity consumption during peak demand periods when energy is most expensive, thereby offsetting the need to fire up the most costly generators.[143] PJM believes DR resources can be available in a manner largely comparable to generation sources.[144] But, traditional generators have largely opposed DR because it can be dispatched to replace their most profitable units (peaking plants).[145]

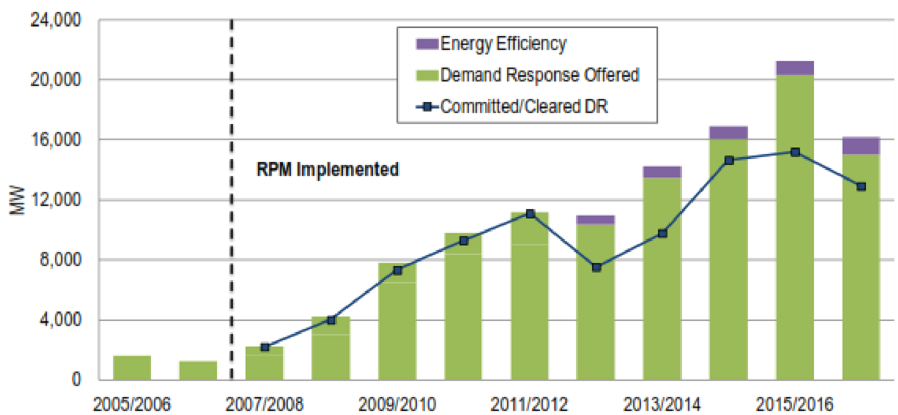
A. Demand Response Resources Have Effectively Filled Any Supply Gap Left by Retiring Fossil Fuel Generators, and Will Continue To Do So If BLE Retires as Planned

DR has been a major source of PJM's growing capacity. From 2006 to 2016, new generation added a little over 28,000 MW of capacity to PJM's Base Residual Auctions, while DR resources provided 14, 370 MW.[146] In other words, DR provided the equivalent of half of all of the new installed capacity added to these PJM markets since 2007.

PJM has itself lauded the ability of capacity resources like DR to replace baseload generators – like a repowered BLE – that are retired due to aging infrastructure that cannot meet stricter pollution controls. Andrew Ott, PJM's Executive Vice President of Markets, noted in 2013 that, "*in the face of nearly 22,000 MW of generation retirements since January 1, 2011, only about 1,700 MW of short-term reliability must run contracts have been required.*"[147]

Moreover, with one exception, the amount of DR resources bid into PJM's capacity markets has steadily increased over time, ranging from 2,000 MW during the 2007/2008 auction to over 14,000 MW in the 2015/2016 auction.[148] As Figure III demonstrates, however, the one exception was in 2012, when the amount of DR resources bid into PJM's market plunged precipitously.

Figure III: Demand Side Participation in PJM Capacity Market (2005-2016)



[Source: Statement of Andrew Ott Executive Vice President – Markets, PJM Interconnection Before the Federal Energy Regulatory Commission (FERC), 2013, Docket No. AD13-7-000, 15.]

The main reason for the decline of DR in 2012 was the drop in prices that the market paid for capacity resources like DR. According to Ott, competition from new natural gas suppliers (and less demand due to a sluggish economy) caused capacity prices to fall, providing less incentive for PJM to use DR to fill in supply gaps.[149]

Importantly, while DR resources have been employed to reduce the aggregate electricity demand in PJM, the amount of DR resources actually employed in the Atlantic City Electric Company (AECO) service territory (which services most of the Pinelands) lags far below any other New Jersey service territory. As Figure IV demonstrates, the total amount of energy AECO offset through DR in 2016 (January-November) was 110 MWh, compared to 3,054 MWh in the JCP&L service territory, and more than 10,000 MWh in PSEG's territory.[150]

Figure IV: 2016 Economic Demand Response Monthly MWh Reductions

State	Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
DC	PEPCO							44		16		
DE	DPL							210	4	0		
IL	COMED	193	6	20	143	458	514	1,092	1,575	1,082	414	
MD	BGE							8,607	2			
	DPL							165		31		
	PEPCO							798		150		
NJ	AECO					8	1	42	40	19		
	JCPL		5					2,307	739			
	PSEG	2,156	1,011	143	2,236	1,142	919	974	891	601	250	
OH	ATSI	1,009	667	610	1,190	328	1,105	1,442	1,883	1,038	490	
	DEOK							211	46	29		
PA	METED							30	12	37	31	8
	PECO	5	4	0		0	1	353	31	97		
	PENELEC	1,185	534	493	1,208	815	1,335	1,084	1,222	1,077	815	
	PPL	1					1	770	122			
VA	DOM	3,374	2,311	2,059	3,445	2,413	1,935	215	1,374	827	1,569	133
WV	APS	205		47		111	212		334	303	81	
Total		**8,128**	**4,538**	**3,373**	**8,222**	**5,275**	**6,024**	**18,345**	**8,275**	**5,308**	**3,651**	**141**

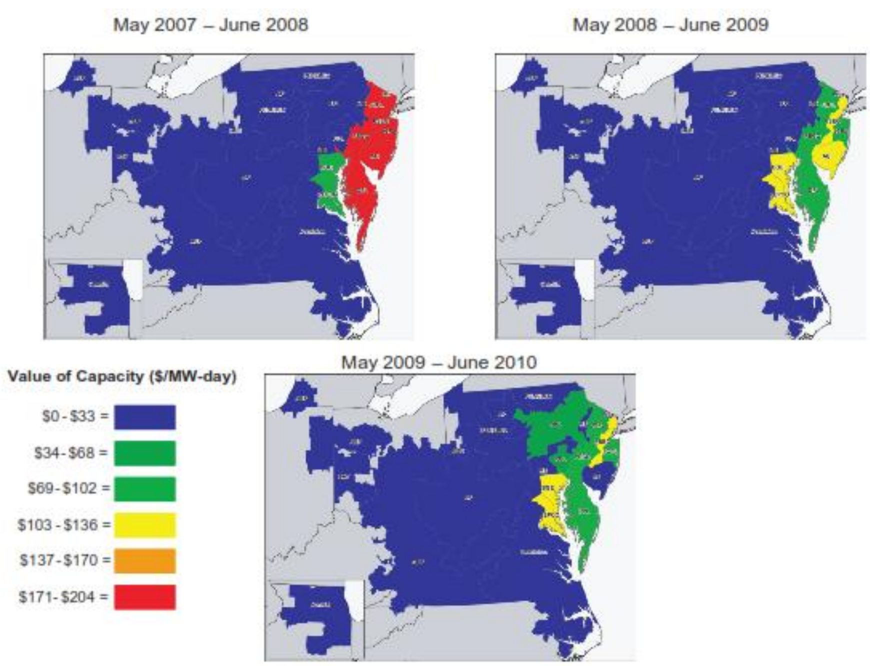
Total MWh: **71,279**

[Source: James McAnany, December 26, 2016, Demand Response Operations Markets Activity Report: December 2016, Figure 27.]

In its 2015 Compliance Statement, SJG asserts that generation from a repowered BLE plant running at maximum capacity is critical for reliable electrical service in the Pinelands, especially as some fossil fuel generators within the Atlantic Electric transmission zone retire.[151] However, if there was insufficient capacity to serve the Pinelands (either because BLE has not been operating at full capacity, or because of recent generation retirements), we would expect to see the market respond by increasing the value of DR resources bid into PJM's capacity market. Instead, PJM's own numbers indicate that there has been very little use of DR to meet demand "in proximity to" the Pinelands. There are only two possible explanations: either there is sufficient supply to meet demand within the area (and BLE is not needed), or the value of DR resources within the Atlantic Electric transmission zone has been artificially deflated (preventing DR from filling the supply gap SJG now uses as justification for repowering BLE).

Until recently, PJM's capacity markets provided price signals without sufficiently accounting for the location of capacity resources. Thus, a generator anywhere within the PJM footprint was deemed able to deliver capacity everywhere within PJM.[152] However, PJM has admitted that, as its footprint becomes larger, this assumption breaks down. Providing incentives for DR resources from service territories far removed from the source of immediate demand not only ignores the physical reality of power delivery, it creates price signals that generate substantial market manipulation.[153] PJM's own simulations of capacity markets (see Figure V) demonstrate how this assumption has, until recently, reduced the value of DR resources in areas like the Pinelands, where they could effectively offset "peaking" generators.[154]

Figure V: RPM Simulations of Capacity Values Across Service Territories



[Source: Audrey A. Zibelman and Andrew Ott, February 3, 2006, Statements Filed by PJM Interconnection, LLC for Technical Conference Re: Reliability Pricing Model, FERC Docket No. ER05-1410-000, 14.]

Fortunately, this market manipulation is being addressed with new DR incentives. In October, 2016, FERC found defects in the methods PJM was using to verify load reductions by certain DR facilities.[155] In many case, DR participants in PJM's markets were not receiving payments that accurately reflected the load reductions they induced.[156] As a result, FERC directed PJM to change how it compensates DR resources to "*improve the accuracy of PJM's Demand Response energy settlements and better align market incentives with efficient market outcomes*."[157]

These recent findings support the conclusion that, not only are there sufficient capacity resources to meet electricity demand in – and "in proximity to" – the Pinelands, but that <u>the combination of PJM's assumptions about generator deliverability and its inaccurate pricing structures have artificially devalued the DR resources that otherwise would have filled supply gaps in the Pinelands without the need to replace retiring fossil fuel generators</u>. Should demand in the Pinelands (and areas "in proximity") exceed projections, however, the new DR compensation policies FERC has ordered should correct market inefficiencies and send accurate price signals to DR resources that can respond to fill supply gaps more efficiently and with less environmental impact than fossil fuel generators.

B. Repowering BLE Would Displace Cheaper, and More Reliable Demand Response Resources That Serve the Pinelands

Not only has PJM acknowledged that DR "*consistently has been dependable and reliable,*" independent simulations have verified that DR resources—many of which can be dispatched on a moment's notice to respond to demand spikes—are critical to maintaining grid reliability without system operators resorting to selective black outs.[158] For example, in May, 2015, researchers at Cornell simulated multiple generator outages and found that system operators would almost universally have to selectively curtail supply to certain load centers. However, "*with real-time demand response available as an additional recourse available to manage variability, the need to resort to load curtailment is eliminated – reliability is restored*."[159]

Moreover, simulations revealed that DR resources—which have already entered the market and are committed to reducing demand in a moment's notice—are almost always the cheapest method of responding to reliability emergencies. According to researchers, "*demand* *response is shown to be effective in that the average electricity price is lower with demand response, with even the higher distribution mean well below the cost of load shedding*."[160]

C. By Displacing Demand Response Resources, a Repowered BLE Would Increase Pollution Emissions

A potential draw-back to switching to more natural gas-fired generation is that natural gas facilities normally used as "peaking" plants are used as baseload generation instead and, therefore, operate closer to their maximum output levels.[161] Indeed, it appears that this may be how RCCM intends to operate a repowered BLE.[162] Researchers found that switching to natural gas, therefore, "*leaves less capacity available to ramp up and down in response to wind [power] and load variability, and also <u>forces the system to turn more often to coal plants for the ramping response…</u>*"[163]

If DR resources are available (and valued appropriately), researcher found that "*greater emissions reduction will be possible with targeted use of real-time demand response programs*" that offset the need to ramp up dirtier coal-fired "peaking" units.[164] However, researchers were quick to warn that the market must properly value DR resources on equal footing with generation resources and accounting for the congestion constraints imposed on the location of generating stations.[165] Without proper pricing, "*the system is shown to not use demand response even when it is available*."[166] Indeed, simulations revealed that, "*when transmission constraints are not binding or have been relieved through new construction, the apparent emissions reductions would evaporate*."[167] Thus, by displacing non-emitting DR resources in proximity to the Pinelands, which finally are being valued appropriately, a repowered BLE offsets these emissions reductions without any additional reliability benefits.

V. <u>The Proposed Pipeline Would Require the Pinelands to Assume Additional Environmental Risks That Are Not Associated with Any Service to the Pinelands</u>

A. Because It Is Designed To Be Larger Than Necessary, the Proposed Pipeline Would Increase the Risk That the Pinelands Will Suffer a Major Pipeline Leak

Because SJG's pipeline must have a diameter above 20 inches (20") to provide adequate capacity to serve new customers outside the Pinelands, it creates a larger risk of rupture than would otherwise be necessary to service customers within the Pinelands. A statistical study undertaken by the Bureau of Economic Geology concerning the probability and causes of natural gas pipeline leakage and ruptures found that pipelines above 20 inches (20") in diameter have a much greater chance of failure than pipelines less than 20 inches (20").[168] Unlike smaller pipelines, where incidents only led to rupture 28% of the time, larger pipelines saw incidents leading to ruptures 44.5% of the time (almost twice the risk). The authors also found that for large-size transmission pipes, about 50.4% of ruptures are 2 inches (2") or larger, and that 45.4% of ruptures are greater than 10 inches (10") long.[169] Thus, when large-diameter transmission pipelines fail, they do so with both greater frequency and with more severe impacts.

B. By Designing the Pipeline to Operate at Higher Pressures Than Necessary, the Proposed Pipeline Would Increase the Risk That the Pinelands Will Suffer a Catastrophic Explosion

SJG reports that the proposed pipeline will have a wall thickness of only 0.375 inches (0.375'), which translates into a delta thickness of about 0.15 inches (0.15"). The same research team from the Bureau of Economic Geology cited above cautioned that nearly 75% of significant incidents occurred in pipelines with a delta thickness less than 0.2 inches (0.2").[170] Low pipeline wall delta thickness has also been associated with higher chances of stress corrosion cracking as well as external corrosion.[171]

As noted, however, the pipeline is designed to operate at significantly higher pressures than necessary to supply sufficient gas to BLE, and SJG's own statements imply that it intends to operate at these higher pressures in the future.[172] These higher pressures increase the risk of material fatigue—from internal pressure surges and fluctuations, or from external forces such as induced vibration—that, combined with the relatively modest wall thickness of the pipeline, substantially increases the risk of rupture

C. By Increasing the Size and Pressure Beyond What Is Necessary to Service the Pinelands, The Proposed Pipeline Adds Substantial Risk That a Pipeline Failure Will Cost the Pinelands in Life, Limb, and Property

The two most consistent impacts of pipeline failure involve leakage and rupture, both of which can lead to fires and explosions.[173] Immediately following a rupture, there will be rapid depressurization of the pipeline in the vicinity of the failure. For buried pipelines, the overlying soil will be ejected, forming a crater.[174]

Initially, the gas flow rates from each side of the ruptured pipe will be balanced and the flow out of any crater that is formed will tend to be in a vertical (upwards) direction. Researchers describing the resulting mushroom cloud in academic terms make it no less lethal:

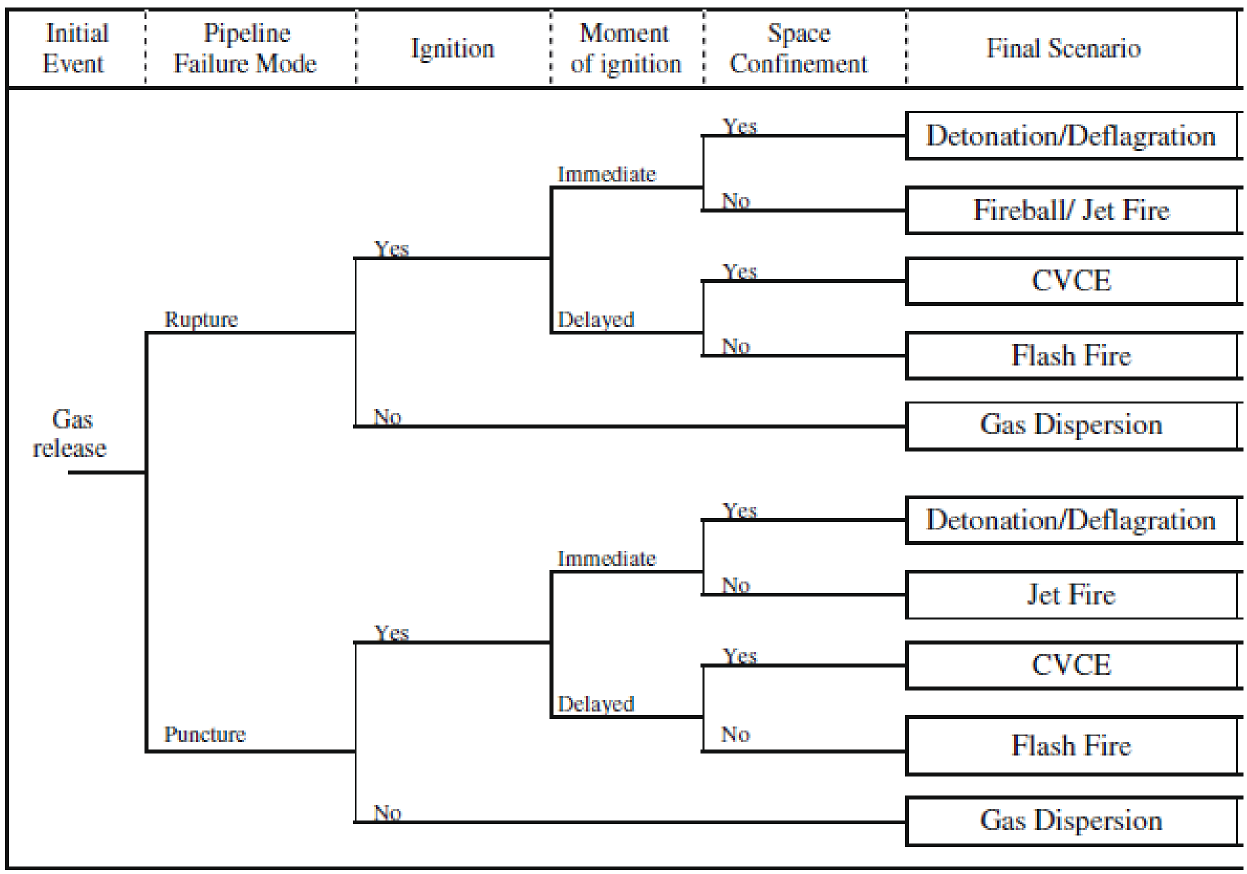
> "*Ignition can occur at any time following the pipeline failure, and the discharge of flammable material can result. If it occurs immediately or, or shortly, after a rupture, a transient fire could occur as a result of the combustion of the mushroom-shaped cap that is fed from below by the established part of the fire. Typically, this resembles a fireball which can last for up to thirty seconds, depending on the pipeline size and its initial pressure*."[175]

What happens next is commonly referred to as "deflagration and detonation." Engineers found that:

> "*after a rupture or a puncture of the pipe walls, when leaked gas is sufficiently mixed with air, it can find an ignition source and quickly combust with even a moderate increase in pressure. This phenomenon is called deflagration . . . . In a more critical situation, if there is considerable confinement and, simultaneously, the proportion of oxygen inside the gas cloud is close to the stoichiometric Zero Oxygen Balance, the propagation speed of the fire increases, and a strong and abrupt overpressure with shock waves develops. This is called detonation*."[176]

As Figure VI indicates, there are multiple pathways that can lead a leak or rupture to become a serious fire, flash fire, or explosion. The hazard distance for larger pipelines (transmission pipelines greater than 20 inches (20”) in diameter) rises to as much as 300 meters, placing adjacent homes, bridges, roads, and other property at risk of serious consequences.[177]

Figure VI: Event Tree for Natural Gas Pipeline Leaks and Accident Scenarios



[Source: Anderson J. Brito et al., A multicriteria model for risk sorting of natural gas pipelines, European Journal of Operational Research 200 (2010) 812–821.]

When pipeline failure rates are computed, the fatality and injury record is normalized to the unit of fatality/injuries per kilometer of pipeline per year. As mentioned, the conditional probability of ignition of leakages and ruptures is higher for pipelines with diameters greater than 20 inches (20”)—and is especially high for ruptures. Normalized property damage (in 2010 U.S. dollars), moreover, increases with the diameter of the pipeline. For pipelines with diameters greater than 20 inches (20”), the median damage from an ignition incident is $610,000.[178]

An article published in the *Journal of Loss Prevention in the Process Industries* notes that vapor cloud explosions resulting from transmission pipelines can be especially difficult to contain.[179] When objects, such as buildings, are near or within an ignited gas cloud, they restrict the free expansion of combustion products and cause a significant over-pressure that only worsens the process destroying the building and adding (in a quite literal sense) fuel to the fire. The major hazards are, therefore, the heat effect of thermal radiation from a short-lived fireball, followed by the possible collapse of buildings from the explosive shock wave. When a person is exposed to these two events at the same time, their probability of immediate death is high.[180]

Conclusion

Based on the entirety of the facts and circumstances outlined above, no reasonable assessment of the proposed pipeline can conclude that the project serves the electrical reliability or environmental interests of the Pinelands. The pipeline is designed to be larger than necessary to supply gas to BLE. The additional size and pressure of the pipeline, which is likely intended only to supply redundancy service to new customers and SJG's existing customers outside the Pinelands, substantially increases the risk of a pipeline leak or catastrophic rupture.

Additionally, supplying gas to repower BLE is unnecessary to provide reliable electrical service to the Pinelands, either now or into the foreseeable future. SJG's 2015 Compliance Statement mischaracterizes PJM's analyses to make it appear that there are reliability violations that the servicing utility acknowledges are solved by upgrades already planned, and would be required in the event BLE repowers anyway. Moreover, by displacing SVCs that have already been planned, a repowered BLE reduces voltage stability benefits, while decreasing generation from existing sources.

Perhaps most importantly, while any reliability issues associated with retiring BLE will be solved more effectively with Demand Response resources, repowering the facility locks these resources out of the capacity market serving the Pinelands, replacing a solution that could provide even greater air pollution benefits to New Jersey without requiring the residents of the Pinelands to assume a greater risk of destroying protected parts of New Jersey's most valued forests.

---

[1] State of New Jersey Board of Public Utilities (2015). In the Matter of the Petition of South Jersey Gas Company for a Determination Pursuant to the Provisions of N.J.S.A. 40:55D-19 ("BPU Order"), December 26, 2015, 3.
[2] *See* N.J.A.C. 7:50-5.23(b)12.

[3] Pinelands Comprehensive Management Plan Compliance Statement, South Jersey Gas Pipeline Reliability Project ("Compliance Statement"), May 21, 2015.

[4] Compliance Statement, *supra* note 1 at 2.

[5] *Ibid.*

[6] *Ibid*. at 5.

[7] *Ibid*. at 2.

[8] N.J.A.C. 7:50-5.23(b)12.

[9] South Jersey Gas, Response to Discovery Request ("Discovery Response"), In the Matter of the Joint Petition of South Jersey Gas and RC Cape May Holdings, LLC for Approval of a Standard Gas Service Agreement (FES) and Standard Gas Service Agreement (FES) Addendum, BPU Docket No. GO13010052, RCR-P-035.

[10] Black & Veatch, Supplement to Black & Veatch's October 2012 Report, Cost Allocation Study for a Proposed High Pressure Natural Gas Transmission Pipeline, February 12, 2013, 1-2.

[11] *Ibid.*

[12] Black & Veatch, Cost Allocation Study for a Proposed High Pressure Natural Gas Pipeline ("Cost Allocation Study"), October, 2012, 19.

[13] Black & Veatch, Cost Allocation Study, 6.

[14] *Ibid.*

[15] Compliance Statement, *supra* note 1 at 5.

[16] Compliance Statement, *supra* note 1 at 6; *see also* South Jersey Gas Company, Standard Gas Service Agreement (FES) with R.C. Cape May Holdings, LLP ("Service Agreement"), B.P.U.N.J. No. 10-Gas, Addendum, para. 18.

[17] Energy Information Administration, Deliverability on the Interstate Natural Gas Pipeline System, Glossary, May, 1998, 144. Available at: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/deliverability/pdf/deliver.pdf.

[18] Compliance Statement, *supra* note 1 at 6.

[19] Nicholas R. May et. al. (2009), "Service redundancy strategies in service-oriented architectures," Proceedings of the 35th Euromicro Conference on Software Engineering and Advanced Applications, Patras, Greece, August 27-29, 2009, 2.

[20] South Jersey Gas Company, Standard Gas Service Agreement (FES) with R.C. Cape May Holdings, LLP ("Service Agreement"), B.P.U.N.J. No. 10-Gas, Addendum

[21] Woodard & Curran, Letter to Mr. Chuck Horner ("Horner Letter"), Director of Regulatory Programs, Pinelands Commission, July 31, 2015, 2.

[22] South Jersey Gas, Discovery Response, RCP-P-048.

[23] *Ibid*.

[24] Black & Veatch, Cost Allocation Study, 40.

[25] *Ibid*.

[26] Black & Veatch, Cost Allocation Study, 42, Appendix A.

[27] Z. Guangdaet al. (2014). "Natural gas transmission pipeline temperature drop calculation," *Advances in Petroleum Exploration and Development*, 7(2), 127.

[28] South Jersey Gas, Discovery Response, RCR-E-012, 3.

[29] Compliance Statement, *supra* note 1 at 38. Note South Jersey Gas's definition of "intended" in the context of N.J.A.C. 7:50-5.23(b)12.

[30] South Jersey Gas, Discovery Response, RCR-E-001, 2.

[31] *See* South Jersey Gas, Discovery Response, RCR-E-001, 3 (emphasis added).

[32] South Jersey Gas, Discovery Response, RCR-E-004

[33] Email from Peter Fontaine (Cozen O'Connor) to Stacey Roth (Pinelands Commission) ("Fontaine Email"), "Response to Operating Pressure Question," January 7, 2014, para. 3 (emphasis added).

[34] *See generally* South Jersey Gas, Discovery Response, RCR-P-009.

[35] *Ibid*.

[36] South Jersey Gas, Discovery Response, RCR-E-006.

[37] Black & Veatch, Cost Allocation Study, 18 (emphasis added).

[38] *Ibid.* (emphasis added).

[39] South Jersey Gas, Discovery Response, RCR-E-004 (quoting Black & Veatch)

[40] Fontaine Email, *supra* note 33, para. 3 (emphasis added).

[41] Discovery Response, RCR-P-009. Compare the estimated number of residential customers that could be potentially supplied by the Reliability Line noted in response (c) to the total number of customers supplied using the current line noted in response (a).

[42] Compliance Statement, *supra* note 1 at 2.

[43] *Ibid*. at 5.

[44] *See* PJM "Generator Deactivations," as of December 28, 2016, 4. Available at: https://www.pjm.com/~/media/planning/gen-retire/generator-deactivations.ashx.

[45] *See* Technical Addendum to the Final BART Determinations for Affected BART-eligible Sources in the State of New Jersey ("BART Technical Addendum"), State of New Jersey Department of Environmental Protection, Division of Air Quality, December 7, 2011, 6 –7.

[46] *Ibid*.

[47] *See* PJM, "Generator Deactivations," s*upra* Note 44 at 7.

[48] *See* Letter from Theresa Garrod (GET Consulting) to Jaclyn Rhoads (Pinelands Preservation Alliance) RE: Revised - Review of Title V Permit Application ("Garrod Letter"), B L England Generating Station, September 16, 2016, Attachment 2.

[49] Memorandum from Jaclyn Rhoads (Pinelands Preservation Alliance) to United States Environmental Protection Agency, Region II, Air Compliance Branch Re: Petition on Title V Permit for the BL England Generating Station, Beasley's Point, Upper Township, NJ, Program Interest No. 73242, Permit Activity No. BOP140002, November 8, 2016, 1.

[50] *See* Technical Addendum, supra note 45 at 7.

[51] T. McNevin, What is a High Electric Demand Day, NJDEP, Bureau of Air Quality Planning, TAP Webinar Presentation, July17, 2008, slides 4 & 11. Available at: https://energy.gov/sites/prod/files/2014/07/f17/tap_webinar_20080717_mcnevin.pdf.

[52] Garrod Letter, *supra* note 48, Attachment 1.

[53] Compliance Statement, *supra* note 1 at 6.

[54] Scott Gass, PowerGEM Review of Pinelands Preservation Alliance Declaration ("PowerGEM Review", November 4, 2015, 3.

[55] PJM Transmission Expansion Advisory Committee Reliability Analysis Update ("PJM September 2014 TEAC Update"), September 2, 2014, slide 113. Available at: https://www.pjm.com/~/media/committees-groups/committees/teac/20140902/20140902-reliability-analysis-update.ashx.

[56] Compliance Statement, *supra* note 1 at 15-16.

[57] Scott Gass, Benefit to Pinelands Area of BL England Repowering – Updated Analysis ("PowerGEM Report"), October 9, 2015 at 6.

[58] Scott Gass, PowerGEM Review of Pinelands Preservation Alliance Declaration ("PowerGEM Review"), November 4, 2015, 3.

[59] *Ibid.; see also* Compliance Statement, *supra* note 1 at 15-16.

[60] *Ibid*.

[61] PJM September 2014 TEAC Update, slide 114.

[62] *Ibid*. at slide 113.

[63] PowerGEM Review, 3.

[64] *Ibid* at 3.

[65] PowerGEM Report, *supra* note 57.

[66] *Ibid.*, 6.

[67] *Ibid.*

[68] *See* PJM TEAC Reliability Analysis Update, November 11, 2014. Available at: https://www.pjm.com/~/media/committees-groups/committees/teac/20141111/20141111-teac-reliability-analysis-update.ashx.

[69] *Ibid.*, slide 52.

[70] PJM TEAC 2016 Reliability Analysis Update, November 3, 2016, slide 45

[71] November 11, 2014 TEAC Reliability Analysis Update, *supra note* 68, slide 52.

[72] *See* PJM TEAC Reliability Analysis Update, December 4, 2014. Available at: https://www.pjm.com/~/media/committees-groups/committees/teac/20141204/20141204-reliability-analysis-update.ashx.

[73] *Ibid.*, slide 29.

[74] *Ibid.*, slide 65.

[75] PJM TEAC Reliability Analysis Update and 2016 RTEP Assumptions, January, 7, 2016. Available at: www.pjm.com/~/media/committees/teac/20160107/20160107-reliability -analysis-update-and-2016-rtep assumptions.ashx.

[76] *Ibid.*, slide 14.

[77] *Ibid.*

[78] *Ibid.*, slides 9 & 14.

[79] Compliance Statement, *supra* note 1 at 15-16.

[80] PJM 2014 Regional Transmission Expansion Plan ("RTEP"), February 28, 2015, 9. Available at http://www.pjm.com/~media/documents/reports/2014-rtep/2014-rtep-book-1.ashx.

[81] Compliance Statement, *supra* note 1 at 17.

[82] Atlantic City Electric, Petition to the State of New Jersey Board of Public Utilities for a Determination Pursuant to the Provisions of *N.J.S.A.* 40:55D-19 That the Use of Certain Lands Within the Township of. . .Are Reasonably Necessary for the Service, Convenience or Welfare of the Public . . . . .("ACE Petition"), September 17, 2015, 4.

Available at: www.atlanticcityelectric.com/uploadedFiles/wwwatlanticcityelectriccom/Content/Page_Content/2016/2%20Petition%20ACE-Orchard-Lewis%20-%20PETITION%20%20-%209-17-15%20FINAL%20%20FORMATTED.pdf.

[83] *Ibid*., 4-5 (emphasis added).

[84] *Ibid*., 5.

[85] *Ibid*., 5.

[86] Compliance Statement, *supra* note 1 at 17.

[87] *See* ACE Petition, 9-16

[88] *See* Paul F. McGlynn, Filed Direct Testimony on Behalf of Public Service Electric and Gas Company in Support of Susquehanna-Roseland Transmission Line Project, 2008, 7–8. Available at: https://www.pseg.com/family/pseandg/powerline/pdf/testimony/mcglynn.pdf.

[89] Sovacool, B.K., Direct Testimony on Behalf of the Municipal Interveners in Opposition to the Susquehanna-Roseland Transmission Line Project, New Jersey Board of Public Utilities, BPU Docket No. EM09010035, July 9, 2009, 31. Available at: http://www.stopthelines.com/downloads/Sovacool_Need_Testimony.pdf.

[90] McGlynn, *supra note* 88, 7-8.

[91] *Ibid.*

[92] Audrey A. Zibelman and Ott, Andrew, February 3, 2006, Statements Filed by PJM Interconnection, LLC for Technical Conference Re: Reliability Pricing Model, Federal Energy Regulatory Commission (FERC), Docket Nos. ER05-1410-000 and EL05-148-000, 14-15 (emphasis added). Available at: https://www.ferc.gov/CalendarFiles/20130911144119-Ott%20Comments.pdf.

[93] McGlynn, *supra note* 88, 3.

[94] Sovacool, *supra note* 89, 32.

[95] PJM, Generation Interconnection System Impact Study for PJM Generation Interconnection Request Queue Position Y1-077, “BL England 138 kV” (revised), October 2014, 7 (emphasis in original).

[96] Compliance Statement, *supra* note 1 at 15.

[97] *Ibid.*, 16.

[98] *Ibid.*, 16.

[99] PJM, *supra note* 95, 3.

[100] Compliance Statement, *supra* note 1 at 13.

[101] Many of these new generation sources were identified by comparing PJM’s generator queue list for its 2018 RTEP Base Case to its 2021 RTEP machine list for the JCP&L transmission zone and identifying generators through their queue numbers.

[102] PJM TEAC 2016 Queue Posting, October 6, 2016, slide 21. Available at: http://www.pjm.com/~media/committees-groups/committees/teac/2016006/20161006-teac-queue-posting.ashx.

[103] 2021 RTEP Machine List, February, 10, 2016, 15. Available at: www.pjm.com/~/media/committees-groups/committees/teac/20160211/20160211-2021-rtep-machine-list.ashx.

[104] PJM 2016 Queue Posting, *supra note* 102, slide 21.

[105] 2021 RTEP Machine List, *supra note* 103, 6.

[106] PJM 2016 Queue Posting, *supra note* 102, slide 21.

[107] *Ibid.*

[108] Compliance Statement, *supra* note 1 at 13.

[109] Paula Dupont-Kidd, cited by Cambell, Braden, “Power grid expected to be stable without Oyster Creek, B.L. England plants,” Press of Atlantic City, March 22, 2014, 3. Available at:

http://www.pressofatlanticcity.com/communities/hamilton/power-grid-expected-to-be-stable-without-oyster-creek-b/article_a7faf0b2-b236-11e3-bbdc-001a4bcf887a.html.

[110] *Ibid.*, 2.

[111] *Ibid.*

[112] *Ibid.*

[113] PowerGEM Report, *supra* note 57 at 2.

[114] PJM TEAC Reliability Analysis Update, *supra note* 75, slide 17.

[115] Scott Gass, Benefit to Pinelands Area of BL England Repowering – Updated Analysis, *supra* note 113 at 6.

[116] Paul Cuffe et al., A Power System is Not a River Basin: Geography Doesn't Matter, Electrical Structure Does, Working Paper, Authorea, July 15, 2015, at 5. Available at: https://www.authorea.com/users/16824/articles/44430.

[117]John G. Kassakian et al., The Future of the Electric Grid: An Interdisciplinary MIT Study, December 5, 2011, Appendix B, 251. Available at: https://mitei.mit.edu/system/files/Electric_Grid_Full_Report.pdf.

[118] Matthew H. Brown and Sedano, Richard P., Electricity Transmission: A Primer, National Council on Electric Policy, June, 2004, 29.

[119] Campbell, B., Power grid expected to be stable without Oyster Creek, B.L. England plants, Press of Atlantic City, March 22, 2014. Available at: http://www.pressofatlanticcity.com/communities/hamilton/power-grid-expected-to-be-stable-without-oyster-creek-b/article_a7faf0b2-b236-11e3-bbdc-001a4bcf887a.html.

[120] *See* PJM Open Access Transmission Tariff, Effective Date 9/17/2010, FERC Docket # ER10-2710-000. Available at: http://www.pjm.com/media/documents/merged-tariffs/oatt.pdf.

[121] Juan Rosellon et al., Incentives for Transmission Investment in the PJM Electricity Market: FTRs or Regulation (or Both?), Deutsches Institut fur Wirtschaftsforschung Discussion Paper 1026, June 2010, 5 (quoting PJM Member Training Department, 2007).

[122] Green, Richard, Nodal pricing of electricity: how much does it cost to get it wrong?, Journal of Regulatory Economics (2007), 31:125-149, 126.

[123] Mostafa Sahraei-Ardakani et al., Estimating zonal electricity supply curves in transmission constrained electricity markets, Energy 80 (2015), 10–19, 11–12.

[124] Compliance Statement, *supra* note 1 at 18.

[125] *Ibid.*, 18.

[126] *Ibid.*, 17.

[127] PJM 2016 TEAC Reliability Update, June 23, 2016, slide 19.

[128] ABB, Static Var Compensator: An insurance for improved grid system stability and reliability, March 8, 2013, 3. Available at: www.delhisldc.org/Resources/08-Mar-2013-svc.pdf.

[129] *Ibid.*, 10.

[130] Edward Kahn and Baldick, Ross, Reactive Power is a Cheap Constraint, The Energy Journal, 15:4, 1994, 194.

[131] ABB, *supra* note 128 at 4.

[132] Compliance Statement, *supra* note 1 at 12.

[133] Robert M. Fagan, Affidavit on Behalf of the New Jersey Division of Rate Counsel ("Fagan Affidavit"), Federal Energy Regulatory Commission (FERC), PJM Power Providers Group v. PJM Interconnection, L.L.C., Dockets No. EL11-20-000 & EL11-2875-000 (not consolidated), March 4, 2011, 8 (Citing PJM 2009 RTEP, 269).

[134] Fagan Affidavit, 6-7.

[135] *Ibid*. at 7.

[136] *See ibid. See also* PJM 2009 RTEP, 272.

[137] Compliance Statement, *supra* note 1 at 4.

[138] Black & Veatch, Cost Allocation Study, 10.

[139] South Jersey Gas, Discovery Response, RCR-E-019, 1.

[140] Compliance Statement, *supra* note 1 at 31.

[141] Bradley J. McAllister, Prioritizing demand response: How federal legislation and technological innovation changed the electricity supply market and the need to revitalize FERC Order 745, Journal of Technology Law & Policy, v.XV, Spring 2015, 163.

[142] *Ibid.*

[143] *Ibid.*, 164.

[144] Andrew Ott, Centralized Capacity Markets in Regional Transmission Organizations and Independent System Operators, Statement of Andrew Ott Executive Vice President – Markets, PJM Interconnection Before the Federal Energy Regulatory Commission (FERC), Docket No. AD13-7-000, 11, 2013

[145] McAllister, *supra note* 141, 179.

[146] Ott, *supra note* 144, 9.

[147] *Ibid.*, 7.

[148] *Ibid.*, 10.

[149] Marianne Hedin, Demand Response Drops at PJM Capacity Auction, Navigant Research, June 10, 2013. Available at: www.navigantresearch.com/blog/demand-response-drops-at-pjm-capacity-auction#.

[150] James McAnany, 2016 Demand Response Operations Markets Activity Report: December 2016, December 9, 2016, Figure 27.

[151] Compliance Statement, *supra* note 1 at 13.

[152] Zibelman and Ott, *supra note* 92, 14.

[153] *Ibid.*, 15.

[154] *Ibid.*

[155] *See* Federal Energy Regulatory Commission (FERC), October 31, 2016, Order Accepting Tariff Revisions, 157 FERC 61,067, Docket No. ER16-2460-000.

[156] *Ibid.*, 2.

[157] *Ibid.*, 6.

[158] *See* Judith Cardell and Anderson, Catherine L., Targeting existing power plants: EPA emission reduction with wind and demand response, Energy Policy, v.80, May 2015, 11-23.

[159] *Ibid.*, 20.

[160] *Ibid.*, 21.

[161] *Ibid.*, 20.

[162] Garrod Letter, *supra* note 48

[163] *See* Cardell and Anderson, *supra* note 158 at 20.

[164] *Ibid.* at 19.

[165] *Ibid.*

[166] *Ibid.*

[167] *Ibid.*, 21.

[168] Hui Wang et al., Likelihood, causes, and consequences of focused leakage and rupture of U.S. natural gas transmission pipelines, Journal of Loss Prevention in the Process Industries 30 (2014) 177, 178.

[169] *Ibid.*

[170] *Ibid.*, 177, 181.

[171] E. Sadeghi Meresht et al., Failure analysis of stress corrosion cracking occurred in a gas transmission steel pipeline, Engineering Failure Analysis 18 (2011) 963.

[172] *See* Fontaine Email, *supra note* 33.

[173] Dong Yuhua et al., Estimation of failure probability of oil and gas transmission pipelines by fuzzy fault tree analysis, Journal of Loss Prevention in the Process Industries 18 (2005) 83, 84.

[174] R.P. Cleaver et al., A model for the initial stages following the rupture of a natural gas transmission pipeline, Process Safety and Environmental Protection 95 (2015) 202, 203.

[175] *Ibid.*

[176] Anderson J. Brito et al., A multicriteria model for risk sorting of natural gas pipelines based on ELECTRE TRI integrating Utility Theory, European Journal of Operational Research 200 (2010) 812, 813.

[177] Young-Do Jo et al., Individual risk analysis of high-pressure natural gas pipelines, Journal of Loss Prevention in the Process Industries 21 (2008) 589, 589.

[178] Hui Wang et al., *supra note* 168, 177, 182.

[179] Young-Do Jo et al., Individual risk analysis of high-pressure natural gas pipelines, Journal of Loss Prevention in the Process Industries 21 (2008) 589, 591.

[180] *Ibid.*

Exhibit C

HydroQuest

414 E. Kerley Corners Rd.
Tivoli, New York, 12583
845-657-8111
hydroquest@yahoo.com

January 24, 2017
Paul A. Rubin

Environmental and Geotechnical Considerations Regarding the Proposed South Jersey Gas Natural Gas Pipeline Crossing Through the Pinelands of New Jersey

Comments are provided below detailing potential adverse environmental impacts associated with construction of a 24-inch, high pressure, natural gas pipeline through the Pinelands of New Jersey.

Introduction

South Jersey Gas (SJG) has proposed the installation of a 21.7-mile long pipeline directly through the Pinelands of New Jersey. The 24-inch high pressure pipeline would transport natural gas at a design pressure of 700 psig and a design temperature of 100° F. Review of the Pinelands Comprehensive Management Plan Compliance Statement (SJG, 2015), related pipeline profiles and of the hydrogeology of the Pinelands (Walker et al., 2008) accent the vulnerability of the underlying Kirkwood-Cohansey aquifer system should pipeline failure occur. Direct burial of pipelines in open cut trenches and deeper pipeline burial via horizontal directional drilling (HDD) methods both pose a substantial threat to water quality should excursions of hydrocarbon-rich condensates or methane gas occur. Protection of "*high quality*" surface and groundwater resources is key to the Pinelands Act, effective June 28, 1979 where the "*continued viability of such area and resources is threatened by pressures from residential, commercial and industrial development* ..." The Pinelands Act was passed to protect the waters of this pristine and environmentally unique area from degradation (Coppola, 2015).

The Kirkwood-Cohansey aquifer system, comprised of some 17 trillion gallons of groundwater, is important to residents of New Jersey, as are the protection and preservation of valuable habitats that thrive within the Pinelands. It is a vast groundwater reservoir largely characterized by unconsolidated sand and gravel deposits under unconfined, water table, conditions. Because of their high permeability and ability to store and provide large quantities of high quality groundwater, sand and gravel aquifers are the most sought after and used groundwater resources. For this reason, great efforts are made to protect them and their recharge/watershed areas.

Perhaps the most important action that municipalities take to protect their aquifer water quality is to prohibit storage and use of assorted chemicals above and near them (e.g., hydrocarbons, pesticides, herbicides, road salt, septic waste). Essentially, they seek to protect vulnerable groundwater resources by removing contaminant threats above and proximal to aquifers (i.e., source protection).

In stark contrast to accepted aquifer/water quality protection measures invoked by municipalities, the proposed South Jersey Gas pipeline would jeopardize an important aquifer system by continuously transporting hydrocarbon-laced natural gas directly within and over it. The composition of natural gas being transmitted in pipelines may include a condensate or liquid fraction (*i.e.*, wet gas; natural gas liquids) containing hydrocarbons. The liquid volume can vary from very little (dry or non-associated gas) to thousands of gallons depending on numerous factors including gas composition, liquid content, liquid saturation, gas density, pressure, velocity, and pipe orientation. Depending on gas velocity within the pipeline, areas of U-shaped pipeline curvature within arcuate HDD pipeline segments may result in liquid holdup. In this scenario, pipeline rupture within the soft, permeable, substrate of the Pinelands could potentially result in a significant release of hydrocarbon-tainted liquids to aquifers. This has the potential of degrading or destroying the biologic integrity of the Pinelands and its water quality.

Even small quantities of contaminants can have significant and far-reaching water quality impacts. This includes both liquid and gas phase contaminants. Coppola (2015) addressed numerous water quality and aquatic habitat concerns associated with upward, downward and laterally migrating dissolved gas releases into aquifers, overlying surface waterbodies and wetlands. This situation is likely to be exacerbated as a result of the highly-pressurized nature of gas in the proposed SJG pipeline. Should pipeline rupture occur, methane gas would be directly released into the aquifer and surface water, potentially along 7 miles of HDD pipeline segments. Together, these issues raise questions regarding the environmental risk and prudence of pipeline installation through the Pinelands, especially as relates to alternate pipeline routing options.

Infiltration of precipitation occurs through highly permeable materials, thus rapidly recharging the aquifer that, in turn, discharges to streams, wetlands and springs. Pipeline failure represents a major threat to aquifer water quality. Mean values of groundwater flow rates (i.e., from 84 to 130 ft/day; Walker et al., 2008) through highly porous and permeable sediments would quickly spread contaminants should excursions occur, making remediation expensive or impossible. It is important to recognize that these flow rates are very high (vs. many aquifers with groundwater flow velocities of less than one foot per day) and that they have the potential to rapidly degrade significant portions of aquifers. Pipeline failures (i.e., incidents) continue today at high rates, despite seemingly improved protection and installation procedures.

As proposed, the South Jersey Gas pipeline would install 29 HDD segments ranging in length from 208 feet to 5,274 feet, for a total length of 37,805 feet (7.16 miles). Maximum HDD pipeline depths would range from 23 feet to 79 feet below the ground surface with most of the

HDD segments being constructed below the water table directly within the Kirkwood-Cohansey aquifer system.

While HDD pipeline installation methods do have benefits (e.g., ability to avoid direct contact with shallow river sediments [e.g., Mill Creek, Cedar Swamp Creek], wetlands, buildings, infrastructure), they also have drawbacks. Drawbacks include enhanced potential of external corrosion in some locations, direct placement within aquifers, and limited or no ability to fully inspect or remediate failing pipelines. In light of the high vulnerability of the sandy aquifer to contaminants, the environmental risk presents a significant concern. Public need must be contrasted with potential adverse environmental impacts to determine what are acceptable risks to aquifer water quality and Pinelands ecosystems. And, importantly, justification must be provided to rationalize installation of a continuous source and threat of contamination within an environmentally sensitive area protected by the Pinelands Act when other alternative pipeline routes could be used.

Installation of a natural gas pipeline through the Pinelands of New Jersey poses significant environmental concerns, especially relative to aquifer water quality and ecosystem integrity. This is true for both open cut trench and horizontal directional drilling (HDD) segments of the proposed pipeline installation. Here, comments emphasize issues associated with HDD pipeline segments because 1) there are many, 2) physical inspection is nearly impossible, 3) remediation or replacement, if needed, may be difficult or impossible, 4) pipeline failure from external corrosion is a risk, and 5) aquifer degradation stemming from pipeline rupture is a serious environmental threat. It is important to recognize that HDD installations are not necessarily environmentally sound alternatives to open cut trench pipeline installations. Potential problems with HDD installation are discussed below.

In sum, the Kirkwood-Cohansey aquifer system is a high quality/high capacity aquifer that provides a "*high quality*" groundwater resource. Construction of a high pressure natural gas pipeline directly over and within it poses a significant water quality and environmental threat. Aquifer protection would be served best by selecting an alternate pipeline route.

Details of the Proposed SJG HDD Segments

Examination of SJG direct burial and horizontal directional drilled segments, as portrayed on Woodard & Curran pipeline profiles documents the extensive nature of 29 planned HDD installations (Table 1).

HydroQuest Table 1: Data from SJG pipeline profiles – HDD segments

SJG Profile Sheet AS#s	Horiz. Length (feet)	~Maximum HDD Depth Below GS (ft)	Blow Count Range[A]	~Depth to H_2O Table (feet)[F]	Number of Borings[BDE]	HDD Risk to Aquifer	Notes[C]
1&2	2392	62.7	2-69	6	2	Yes	
15&16	208	41.4	4-51	7	1	Yes	
16	775	27.5	4-64	13	1	Yes	
17&18	1266	25.2	5-44	7	1	Yes	
19&20	769	23.2	no boring	?	0	Yes	
20&21	754	29.5	6-41	7	1	Yes	
21-23	2241	55.5	2-100	4	1	Yes	One blow count above 34
23&24	1540	26	7-23	14	1	Yes	
24&25	788	26.9	8-52	11	1	Yes	
26&27	768	27.0	6-33	10	1	Yes	
27&28	699	27.6	7-56	7	1	Yes	
31&32	1098	61.2	2-23	6	1	Yes	
34&35	1294	27.2	no boring	?	0	Yes	
35	775	28.8	6-58	4	1	Yes	
36	777	25.6	3-34	5	1	Yes	
37&38	942	25.6	5-23	4	1	Yes	
40	780	26	8-39	6	1	Yes	
41&42	2076	58.4	1-42	4	2	Yes	
42&43	845	26	8-53	7	1	Yes	
44	763	27	4-48	4	1	Yes	One blow count above 26
47	759	23.6	10-31	6	1	Yes	
48	716	28	19-48	6	1	Yes	
63-67	4376	79	1-100	5	2	Yes	
67&68	1770	37	no boring	?	0	Yes	
72&73	715	28	4-32	4	-	Yes	Boring not on traverse
74	912	46	2-35	4-10	3	Yes	
75	855	34	5-60	6-12	3	Yes	One boring off traverse; 2 partial
77-81	5274	61	2-71	7	3	Yes	BS-07 data; One blow count above 24
77-81	------	61	3-38	6	-	Yes	BS-08 data; One blow count above 27
77-81	------	61	WOR[G]-51	2	-	Yes	BS-09 data; One blow count above 23
81&82	878	42	WOR[G]-24	2	3	Yes	One full boring; 2 partial

Total HDD Length: 37,805 feet (7.16 miles over 29 HDD segments).

[A]: Blow counts provide an important means of estimating soil properties. They reflect Standard Penetration Test results where a 140-pound weight is dropped and the number of blows to advance a split spoon sampler one (1) foot is counted. The greater the number of blows, the harder the soil. **Loose or soft soils will show blow counts of less than 10. Blow counts of 10 to 50 blows per foot usually mean the ground may be fairly easily excavated.** For blow counts of greater than 50, heavy equipment may be needed to rip or excavate the ground. Here, values represent the blow count range in borings along HDD traverses and above maximum planned HDD depth, exclusive of uppermost few feet of boring columns. Data obtained from Woodard and Curran pipeline profiles. Detailed boring logs referred to in Cherry, Weber & Associates (2013 and 2014) were not available.

[B]: Includes borings near but not necessarily along a HDD traverse.

[C]: Blow count maximum value is sometimes high compared to others.

[D]: Notes on HDD profiles indicate that there is a geotechnical data report which was not available for review. [Cherry, Weber & Associates (2013 and 2014)]

[E]: Woodard & Curran HDD General Notes address planned pipeline inspection during the pullback process. While visual inspection will be conducted to examine for a number of factors (e.g., scratches, scrapes, cuts, coating integrity, damage), this inspection is limited to 20 feet of pipe. This does not confirm a lack of pipeline damage on the remaining pipeline.
[F]: Approximate depth below ground surface to water table at boring location, estimated from small boring depictions on pipeline profiles. The water table grades to creeks where creek surfaces reflect the water table. Portions of some creeks are influenced by the tide.
[G]: WOR (Weight of Rods). Very soft soil or sediment.

Data presented in Table 1 documents that HDD pipeline segments would be installed beneath the water table, generally at shallow depths, directly within the Kirkwood-Cohansey aquifer system. As stated in footnote A above, blow counts of below 50 blows per foot reflect soft, unconsolidated, sediments that can easily be excavated. USGS hydrogeologic characterization of Pinelands sands and gravels documents high permeability values. Contaminant excursions from ruptured or failing SJG Pinelands pipelines would degrade the Kirkwood-Cohansey aquifer system.

Pipeline Integrity and Public Safety

Placement of a pressurized natural gas pipeline may adversely impact the environment and public safety. While natural gas is lighter than air, high pressure and high volume gas releases stemming from pipeline failure have the real potential, at least initially, of rapidly dispersing into the subsurface environment. Coppola (2015) details transport and fate of methane released into the environment. Catastrophic pipeline ruptures are documented as creating large craters (to 40 feet deep and 167 feet long) into surrounding geologic materials (e.g., Sklavounos and Rigas, 2006). This is another scenario that poses a threat to the Pinelands.

Pipeline incidents continue to occur, regardless of safety measures taken (Figure 1). One solution that may help decrease incidents is to establish guidelines of essential elements necessary in any pipeline risk assessment (Alfano et al., 2013). However, as is discussed below, assessment of pipeline failure risk and consequence scenarios must be based on pipeline-specific geotechnical information with verifiable units (e.g., measurement of data required to manage corrosion threats). Failure to obtain this information, as is the case for the proposed South Jersey Gas pipeline system, may result in adverse environmental and public health impacts.

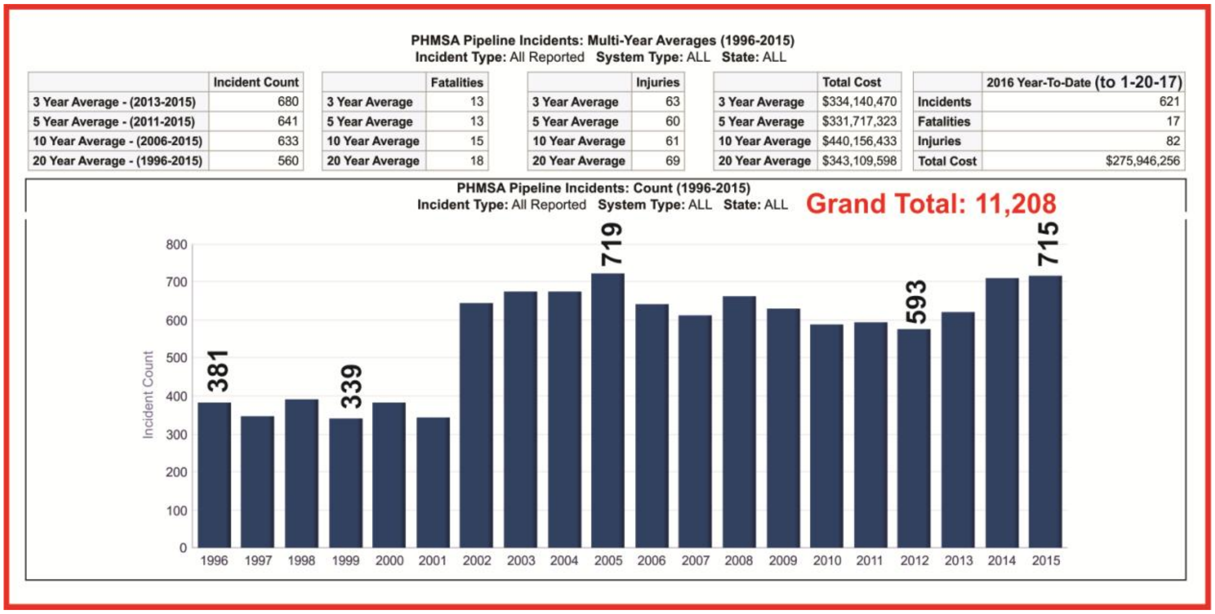


Figure 1. Pipeline Incidents: 1996-2015. Source: US DOT Pipeline and Hazardous Material Safety Administration (PHMSA).

External Corrosion

Buried pipelines are subject to numerous physical elements that both individually and in combination present possible causes of pipeline failure. Many factors or elements influence pipeline corrosion. Integrity and failure potential hinge on numerous variables, many of which have a high degree of uncertainty. Many of these elements cannot be directly inspected. In response, the oil and gas industry has developed models to assess potential pipeline corrosion. These models examine numerous known factors that contribute to pipeline corrosion, including pipeline inspection, pipeline-specific soil materials and groundwater chemistry, and pipeline coating materials. These factors are either very difficult to quantify or have a high degree of uncertainty (Jain et al., 2015). This critical information has not been adequately presented.

Horizontal directional drilling has fast become the preferred pipeline installation method for avoiding environmental harm when crossing rivers, streams, wetlands and other obstacles. It is, however, not without environmental risk, including that of pipeline failure caused by external corrosion. External pipeline corrosion and the probability of failure have not been adequately addressed in the proposed South Jersey Gas pipeline system within the Pinelands. External corrosion represents the main cause of failures in hazardous liquid transmission pipelines and natural gas distribution pipelines. More than half of the failures registered in those pipelines between 1994 and 1999 were due to external corrosion (Beavers and Thompson, 2006; Jain et al., 2015). In an effort to assess failure probability, various industry experts have sought to link field data with modeled physical factors. Many of these factors are not well quantified, thus resulting in a high degree of uncertainty in the results. Nonetheless, modeled pipeline assessments have value in assessing environmental risk, in identifying pipeline-specific physical elements that require added attention to increase pipeline integrity or as a tool to determine if the probability of pipeline failure exceeds acceptable risk. Completion of a South Jersey Gas Pinelands pipeline failure risk assessment requires much detailed information that has not been assessed. Thus, the inherent risk has not been adequately addressed. Model studies by various industry experts support collection of field data to advance corrosion probability assessment.

Environmental threat and risk assessment attendant to installation of a Pinelands pipeline have not been adequately addressed. External corrosion is a dominant active threat to pipeline integrity in the oil and gas industry, especially because visual pipeline inspection is seldom possible. Existing risk assessment methodologies are not capable of providing the essential element information required (Alfano et al., 2013). Risk is compounded where deep pipeline burial is conducted because access and inspection ability is limited. Some of the critical elements of concern relative to pipeline integrity and the authors risk model include measurements of corrosion feature depths, calculated or estimated corrosion growth rates (e.g., as based on the various sources such as atmospheric corrosion, soil-based corrosion, coating types, soil acidity, or AC induced corrosion), gaps in cathodic protection, failure probability or frequency, consequence assessment, and in-line inspection data. Because many of these essential elements (i.e., potential pipeline failure mechanisms) are difficult to physically inspect and quantify, risk assessment is difficult. It is for this reason that models have been constructed to assess the risk of external corrosion using a combination of field data, information regarding the pipeline (e.g., coating material), and reasoned assumptions. Some of the many parameters that influence pipe corrosion potential are detailed by Alfano et al. (2013), Jain et al. (2015), Norman and Argent (2007), and Roche (2005). In the absence of detailed risk assessment of this nature, it is impossible to reasonably quantify threats to Pineland resources that the Pinelands Act seeks to avoid.

Jain et al. (2015) document the uncertainty in pipeline related risk assessments:

> "*Quantitative risk assessment due to external corrosion requires an estimation of corrosion rates which is a challenging task for pipeline engineers because of the uncertainty in data related to environmental and physical variables such as soil type, drainage, soil chemistry, CP effectiveness, coating type and coating properties. Unfortunately, the research into quantitative assessment of external corrosion rates and the probability of failure of a buried pipeline is limited and has not progressed significantly. The reason is the complex mechanism of external corrosion, numerous factors affecting it, and the uncertainty in the knowledge of the variables*."

A thorough discussion of all these elements has not been conducted (pipe wall thickness, cathodic protection [CP] off potential, drainage, burial depth, soil type, soil conditions, temperature, wetting and drying cycles, surface preparation, sulfates, chlorides, total dissolved solids, pH, groundwater chemistry, CO_2 pressure in soil, soil wetness, pipe surface conditions, dents, protective coating type, microbiologically influenced corrosion [MIC], stray current, pipeline design lifetime). Some of the most critical elements are addressed in Figure 2 below. This critical information has not been addressed, thereby leaving threats envisioned in the Pinelands Act unknown.

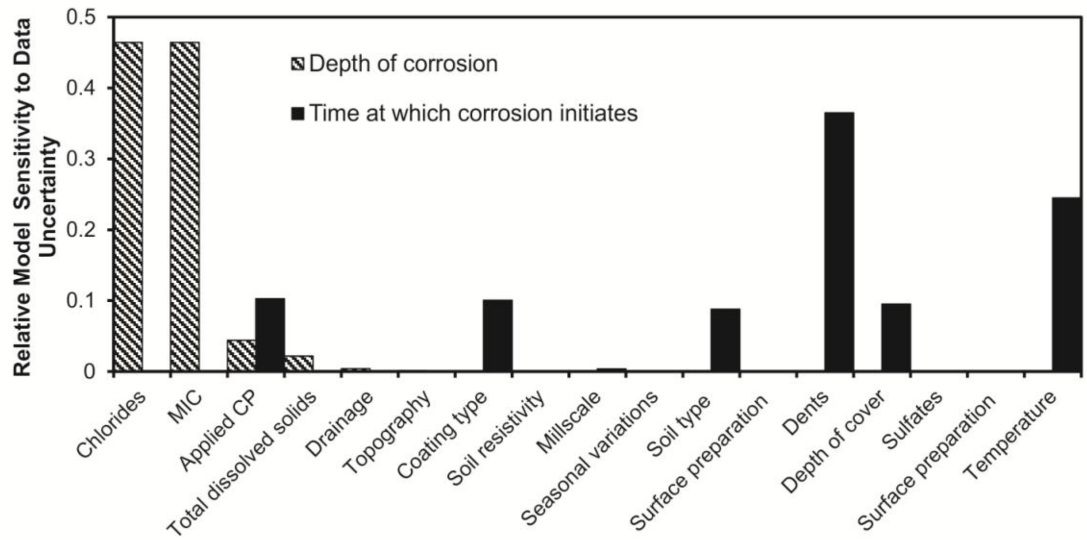


Figure 2. Relative model outcome sensitivity to data uncertainty of the depth of corrosion and time at which corrosion initiates to various parameters. Note that the uncertainty in certain model data fields have a disproportionally large effect on the calculation of probability corrosion depth (e.g., chlorides, MIC, cathodic protection, soil type, temperature). From Jain et al. (2015).

Pipeline Failure Caused by Corrosion and Hydrogeologic Conditions

South Jersey Gas has not adequately assessed the subsurface geology, hydrogeology and geochemistry along the proposed pipeline route. The Pinelands are an environmentally sensitive area that warrant exceptional protection, as was contemplated with passage of the Pinelands Act. The introduction of a pipeline conducting highly-pressurized natural gas and, most likely, hydrocarbon-rich condensate material poses a substantial threat to the environment should pipeline leakage or rupture occur. Because much of the planned transmission pipeline targets burial by HDD methods (7.16 miles), it would be difficult if not impossible to fully inspect and monitor external pipeline corrosion. The seriousness and risk of rupture is the subject of numerous studied by experts and, as such, warrants additional discussion here.

The external corrosion of buried metallic on-shore ferrous piping has been identified as a serious threat to the mechanical integrity of pipelines around the world (Kowalski and Sánchez, 2016; Field and Greenfield, 2011; Andersen and Misund, 1983). Pitting and corrosion rates are soil specific (Kroon et al., 2004), thus emphasizing the need to conduct corrosion risk assessments specific to individual South Jersey Gas project segment soil profiles as part of the evaluation process. Assessment of soil corrosiveness requires detailed evaluation of soil resistivity chemistry, at a minimum (Luciani and Gutierrez, 1998). A disproportionally high percentage of pipeline failures occur from external corrosion vs. internal corrosion (e.g., 80% vs. 20% for natural gas transmission pipelines in the Andersen and Misund study).

Zamanzadeh and Xu (2016) stress the need to analyze water chemistry of groundwater surrounding pipelines, particularly when conducting corrosion risk assessments. For example, acidic groundwater conditions should signal the need for SJG to conduct geochemical analyses of groundwater conditions along the proposed pipeline route. This information is important because acidic subsurface conditions can contribute to high external pipe corrosion rates. Furthermore, once geochemical data has been obtained, SJG should provide detailed discussion of applicable pipeline coating materials, along with conclusions as to what they would use and why they are needed for the subsurface geochemical conditions present.

Both internal and external corrosion phenomenon represent threats to pipeline integrity. External corrosion of pipelines is a major factor in subsurface environments high in dissolved oxygen (Roche; 2005, 2007), such as the conditions associated with shallow pipeline burial depths. SJG has not submitted hydrogeologic assessment of groundwater (e.g., flow direction, hydraulic gradient, velocity, chemical composition) so that threats may be fully assessed. This is important relative to external corrosion risk because active shallow groundwater flow provides continuous renewal/replacement of dissolved oxygen which enhances pipeline corrosion (Roche, 2007; Zamanzadeh and Xu, 2016). This information is also essential relative to baseline groundwater chemistry and contaminant flow direction assessment should an excursion occur.

A high oxygen content and acidic groundwater environment may further increase external pipeline corrosion rates as this combination degrades or disbonds protective pipeline coatings and cathodic protection. Disbonded pipeline coatings can cause metal loss from external corrosion (Luciani and Gutierrez, 1998) and may lead to various forms of environmentally induced cracking (Roche, 2007). The downwardly curved pipe cross sections planned beneath crossings may present a physical situation where increased corrosion may occur. Because SJG has yet to obtain comprehensive geochemical and hydrogeologic data, there is not have sufficient information needed to address potential means of assessing and reducing the risk of external corrosion.

The scientific literature establishes that the greatest threats to pipelines are internal and external corrosion and third party damage (see, e.g., Eguiguren, 2015). Other common pipeline failure mechanisms include seam corrosion, coupling failures, stress cracks, stress corrosion cracking

(SCC), over pressurization, and inadequate cathodic protection. According to the U.S. Pipeline and Hazardous Material Safety Administration, Pipeline Safety Trust's analysis of federal data, new pipelines are failing at a rate on par with gas transmission lines installed before the 1940s. The gas industry's concept that new pipeline installations are inherently safer than older installations is erroneous. Thus, new pipeline installations pose an ongoing and serious threat to the Pinelands, one that passage of the Pinelands Act sought to avoid.

SJG should be required to address the design life of its pipelines as related to the geochemical conditions present in the subsurface, with discussion of the risk of external corrosion and monitoring and remedial actions needed to maintain long-term pipe integrity.

All told, gas pipelines present a dangerous threat to the environment, as well as to homes and businesses proximal to leakage or rupture sites. Natural gas releases from corroded or damaged pipelines have the potential to erupt and escape into homes, potentially resulting in death by asphyxiation and/or explosion. Methane is an extremely flammable chemical, making accidents along natural gas transmission pipelines dangerous and life-threatening.

Added Pipeline Risk Stemming from Horizontal Directional Drilling Installations

Much of the proposed South Jersey Gas pipeline targets use of HDD technology where external pipeline inspection and repair are not practicable. Pipeline installations completed via horizontal directional drilling (HDD) have an increased risk of corrosion and damage over pipeline installations completed via open trench methods. Cathodic protection (an electrochemical means of corrosion control) monitoring, for example, is limited to pipeline entry and exit locations, with mid-region pipeline status unknown. Krissa et al. (2016) identify this risk:

> "*Pipelines installed by HDD have an increased likelihood of experiencing coating damage as opposed to those constructed through conventional open trench techniques. Currently available methods for identifying damaged coating regions within pipe installed by HDD cannot always provide absolute or accurate information on the location, size and geometry of the holidays. Although cathodic protection monitoring at HDD locations can be validated within the entry/exit extremities; the region between is either assumed or speculated. Additionally, soil resistivity variations may adversely affect CP current distribution, leaving coating some coating defects in high resistivity areas unprotected and susceptible to corrosion. ... Monitoring CP through a HDD section is extremely challenging, if not impossible, due to the depth of pipe installation and access challenges presented by the physical obstruction which necessitated the HDD. ... it is difficult to validate the CP effectiveness for critical, inaccessible regions of the HDD's and design an effective functioning CP system.*"

Comprehensive assessment of pipeline corrosion risk should include discussion of what constitutes acceptable environmental and safety risk for each pipeline location. Krissa et al. provide a pipeline coating-based impact example that encompasses geologic boring data and measurements that should be included in HDD assessments but are not sufficiently examined along the proposed South Jersey Gas pipeline route. Importantly, the authors document that information on the amount, size, location and polarization level of the coating defects was not available, thereby making it difficult to validate the CP effectiveness for critical, inaccessible regions of the HDD's. In the absence of real data, they conclude that for particular situations modeling can provide valuable insight into the effectiveness of cathodic protection. Clearly, safety and risk associated with HDD installations cannot be effectively assessed because HDD pipeline segments are both inaccessible and may not be readily repaired.

Sufficient geologic boring and geophysical survey information was not collected along the proposed South Jersey Gas Pinelands pipeline route, as evidenced by long distances between geologic borings or, in some instances, the absence of borings for entire planned HDD traverses (see Table 1). Comprehensive geotechnical information detailing soil layers and their competency is needed in advance of pipeline construction to insure proper pipeline design, avoid inadvertent returns, and provide empirical data regarding the likely success of HDD installations. This is stressed by numerous oil and gas industry experts (e.g., Moati et al., 2013). Significant gaps in geologic information make it impossible to fully assess the environmental threats to Pinelands water quality, ecosystems and natural resources.

Groundwater Contamination Caused by Pipeline Failure

Coppola (2015) addresses the risk of aquifer contamination and degradation of aquatic habitat stemming from the release of methane from ruptured pipelines. An additional, and perhaps more significant risk, is that of the loss of liquids from the proposed South Jersey Gas pipeline project in the event of pipeline leakage or rupture, which may jeopardize water quality and Pinelands ecosystems.

Natural gas is a mixture of hydrocarbon compounds (*e.g.*, benzene, toluene, xylenes, and ethylbenzene) with quantities of various non-hydrocarbons. The composition of natural gas being transmitted in pipelines may include a condensate or liquid fraction (*i.e.*, wet gas; natural gas liquids) containing hydrocarbons. Hanger et al. (2015) discuss this while pointing out that deposits and liquids build up inside pipelines, at low water accumulation points in pipelines (*e.g.*, beneath rivers), and create local environments that can be more corrosive than the bulk wet gas environment.

The liquid volume can vary from very little (dry or non-associated gas) to thousands of gallons depending on numerous factors including gas composition, liquid content, liquid saturation, gas density, pressure, velocity, and pipe orientation. Depending on gas velocity within the pipeline, areas of U-shaped pipeline curvature within arcuate HDD pipeline segments may result in liquid holdup. In this scenario, pipeline rupture within the soft, permeable, substrate of the Pinelands could potentially result in a significant release of hydrocarbon-tainted liquids to aquifers. This has the potential of degrading or destroying the biologic integrity of the Pinelands and its water quality.

Examples of liquid releases from natural gas pipelines include:

- A September 3, 2001 rupture in Mid Lousiana Gas Pipeline Company's 22-inch natural gas transmission line (22" T-ML Pipeline) near the Black Bayou in Louisiana resulted in the release of an estimated 8.00 mmcf to 13.00 mmcf of natural gas and an estimated liquids loss of 15,000 gallons (USDOT, 2001).

- On June 19, 2014, Energy Transfer Partners, L.P./Panhandle Eastern Pipe Line Company system (ETP/PEPL) released liquid from the Olpe 100 compressor station discharge in preparation to repair a leak that was downstream of the station. The leak was from a 3" crack in a long seam. While there were no local residents evacuated as a result of the liquid released from the natural gas pipeline, media attention occurred and a local golf course five ponds, two small areas with standing water, one small drainage ditch on various properties, five houses, soybean crops, gardens, and pasture land were affected (USDOT, 2014).

Alteration of Groundwater Hydrology

While highly permeable sands and gravels are prominent in the Pinelands, silts and clays are also present. In areas with heterogeneous geology, trenches dug to contain pipelines may disrupt and significantly increase the natural porosity and permeability of soils and sediments. Under this condition, the high porosity and permeability of backfilled trench material may result in pipeline trenches functioning as zones of low hydraulic head, effectively acting as interceptor trenches that may preferentially shunt shallow groundwater flow into and then along them. Increased pipeline permeability may promote and increase drainage efficiency in substrates of lower permeability. Depending on the physical, topographic, geologic and hydrogeologic setting, trench construction may cause a number of unnatural changes which require detailed evaluation, with emphasis on potential adverse impacts stemming from release of hydrocarbon condensates and methane.

These potential changes and related impacts include but are not limited to:

- Influx of contaminants into wetlands and waterbodies along trenches;

- Increased recharge leading to increased (*i.e.*, stimulated) drainage efficiency with increased infiltration into underlying aquifers;

- Diversion of shallow groundwater flow into and along pipeline trenches which may redirect flow away from areas formerly receiving flow;

- Drainage of wetlands in certain physical settings (*e.g.*, wetlands elevated on hill slopes); and

- Pipeline trenches as preferential contaminant transport pathways stemming from pollutant influx into trenches from beyond them or from contaminant loss resulting from pipeline rupture (*e.g.*, black powder compounds, corrosion products, hydrocarbon condensate).

The SJG pipeline proposal does not provide adequate characterization of potential adverse hydrogeologic-groundwater resource impacts associated with pipeline installation. Additional analyses of potential, avoidable, and unavoidable hydrologic impacts along the entire proposed pipeline route is warranted.

Inadvertent Drilling Fluid Returns & Risk of SJG Seeking Approval for Open Cut Pipe Installations Following Collapse of HDD Bores via Trenchless Technology

As identified by De Medeiros et al. (2013), the most frequent kind of environmental injury associated with HDD is frac-out, an involuntary return of drilling fluids to the surface. Occurrences take place when the mud pressure in the borehole exceeds the confined pressure of the overburden. Frac-out is also probable when drilling the pilot hole or in back-reaming operations that are performed at an excessive speed and high rate, not allowing satisfactory time for cuttings to be washed and trip out of the borehole (Gelinas & Mathy, 2001).

De Medeiros et al. (2013), for example, address the need to perform a risk analysis that details the potential for failures, including inadvertent discharge of drilling fluid at an intermediate point of the drill (frac-out). Low blow count (i.e., soft, weak and high porosity unconsolidated sediments; see Table 1) soils and sediments documented in borings constructed by SJG (2015) may present a risk of inadvertent releases in shallow, granular, Pinelands soil conditions along proposed HDD traverses. It is incumbent upon SJG to provide a risk analysis and a detailed emergency response plan for inadvertent drilling fluid returns. These important items should be required as part of the application process.

Hair (2011) discusses difficulties in maintaining open hole conditions over long horizontally drilled lengths in soft cohensionless soils, along with potential means of decreasing soil shear strength by fluidizing soils. The non-cohesive nature of soft sediments, characterized by low blow counts (e.g., Table 1; HDD traverses portrayed on Alignment Sheets 23&24 and 31&32), may present challenging HDD situations where ground conditions may not permit the bore stability needed to allow for continued borehole circulation and pipe pullback. **This may result in borehole collapse that may ultimately result in South Jersey Gas seeking approval to use open cut pipe installation methods that will pose risk to resources trenchless technology seeks to reduce (i.e., effectively seeking to change numerous HDD installation targets to open cut trench installations).** Risk avoidance (vs. "*needed*" method alteration) associated with this scenario should be factored into consideration of an alternate non-Pinelands pipeline route that does not traverse over and through the Kirkwood-Cohansey aquifer system.

Reference to Table 1, and Woodard & Curran profiles, show that the number of SJG borings completed over long distances is generally limited one or few per HDD segment and sometimes none. Walker et al. (2008) and others have documented heterogeneity in subsurface Pinelands geology. Thus, limited geologic information gleaned from widely-spaced borings may not accurately reflect subsurface conditions that may be encountered during HDD operations. For example, the HDD profile depicted on Alignment Sheets #77 to #81 shows a distance of about 3,532 feet (1/3 mile) between borings BS-07 and BS-08. The logs presented on the profiles also indicate lateral variability in geologic material composition, including sediment so soft that the blow count is recorded as Weight of Rod (WOR) alone (BS-09). Non-uniform and non-to poorly cohesive sediments may cause inadvertent drilling fluid return excursions into the Kirkwood-Cohansey aquifer and overlying waterbodies. Project advancement without full characterization of geologic and geochemical threats would not be sound.

Large quantities of bentonite and any drilling additives present may adversely impact aquatic ecosystems and Pinelands habitat. Break out of bentonite and fine sediments during the pipeline installation process could blanket wetlands and creeks with resultant degradation of fauna and ecosystems. The technology required for placement of a 24-inch gas transmission line in soft, saturated, sediments via horizontal directional drilling methods is well established (Hair, 2011). However, Hair further points out that while HDD operations are routinely successful in placing pipelines in soft sediments, an open hole condition is difficult to achieve in soft cohesionless soils over long horizontally-drilled lengths. Non-cohesive sediments encountered beneath river bottoms have been the subject of assorted technical papers dealing with tunnels and pipelines (e.g., Guatteri et al., 2000). The lack of sediment cohesiveness could easily result in the upward release of drilling fluids and entrained fine-grained sediments to Pinelands wetlands and waterbodies, even with the use of bentonite in the drilling fluid. This could result in highly turbid surface water and the deposition of fine sediments and bentonite within fragile ecosystems (i.e., sedimentation). Howitt et al. (2012) identified these same environmental issues of concern in a shallow coastal shoreline HDD pipeline installation. Their paper details the methods they used to identify and map sediment plumes and deposition of drilling fluids and bentonite associated with the HDD. While it is important to have a plan in place to deal with this situation should it occur, embracing the attendant environmental risk is contrary to the intent of the Pinelands Act.

Monitoring, Assessment & Maintenance

Pipeline protection via coating materials and cathodic protection would provide important safeguards designed to protect water quality, the environment and SJG project investment, if functioning fully. Nonetheless, as described by numerous industry experts and documented in incident and accident reports, pipeline failures do occur (e.g., see Figure 1 above). Implementation of a comprehensive corrosion risk management program from design stage to pipeline abandonment should be addressed (Roche, 2005). Adherence to the intent of the Pinelands Act would dictate that pipeline installation and continuous operation through the Pinelands is in direct conflict with this act which was adopted because "*continued viability of such area and resources is threatened by pressures from residential, commercial and industrial development* ..." The SJG pipeline project exemplifies a threat the Pinelands Act seeks to eliminate.

Lack of Accessibility to HDD Installations

An important issue is the lack of ready accessibility should pending pipeline failure be suspected (e.g., based on the presence of surface gas leaks; drop in pipeline pressure) or should external corrosion issues be suspected. Similarly, pipeline accessibility is an issue for deeply buried pipelines with significant internal corrosion. Deeply buried HDD pipelines cannot be quickly excavated and replaced without endangering the wetlands, waterways, environmentally sensitive areas, buildings, roads and infrastructure features they originally sought to protect. Thus, access to developing problem areas identified by Pipeline Inspection Gauges (PIGs) or leaks confirmed at the ground surface must be factored into decisions regarding the suitability of HDD installation at individual locations vs. alternate route selection that best protects natural resources and other features. Remediation or replacement of failed pipeline sections within the Pinelands may violate the intent of the Pipelines Act should natural resources be impacted.

As discussed above, buried HDD pipelines, like pipelines installed via open cut methods, are subject to exterior corrosion. This can present energy operational problems should pipeline failure occur or appear likely based on internal smart PIG-based monitoring. HDD pipelines cannot readily be excavated to replace or repair segments because they are often very deep and are emplaced beneath sensitive areas that were intentionally avoided by deep subsurface burial. If alternate gas delivery pipelines are not available, this could result in energy and economic hardship. SJG application material should be expanded to include discussion of the means of correcting actual or suspected HDD pipeline failures. This discussion should include documentation of remedial means and discussion of likely delays in gas delivery and related adverse impacts. If SJG's fall back pipeline correction option requires degradation of surface features initially avoided by HDD, alternate pipeline routing options should be considered.

Conclusions

The Kirkwood-Cohansey aquifer system is a high quality/high capacity aquifer that provides a valuable groundwater resource. Construction of a high pressure natural gas pipeline directly over and within it poses a significant, unnecessary and continuous water quality and environmental threat.

Protection of "*high quality*" surface and groundwater resources is integral to the Pinelands Act which was adopted because the "*continued viability of such area and resources is threatened by pressures from residential, commercial and industrial development* ..." The Pinelands Act was passed to safeguard water resources vital to the protection and preservation of an environmentally unique area. Clearly, passage of this act sought to thwart development of the nature proposed which, in sum, far exceeds environmental risks that might accompany construction of a singular development unit. Construction of the proposed South Jersey Gas pipeline would directly conflict with the intent and spirit of the Pinelands Act.

Aquifer and resource protection would best be served by selecting an alternate pipeline route.

Literature Cited

Alfano, T., Bubenik, T. and Muhlbauer, K. (2013, March 17). Absolute Risk Estimates of External Corrosion. NACE International.

Andersen, T. and Misund, A. (1983, April 1). Pipeline Reliability: An Investigation of Pipeline Failure Characteristics and Analysis of Pipeline Failure Rates for Submarine and Cross-Country Pipelines. Society of Petroleum Engineers. doi:10.2118/10467-PA.

Beavers, J.A. and Thompson, N.G., 2006, External corrosion of oil and natural gas pipelines, ASM Handbook 13C, Corrosion: Environments and Industries; 05145.

Cherry, Weber & Associates (2013, July 10). Boring Logs and Geotechnical Engineering Report: 24-inch BL England Pipeline Supply Project; Cumberland, Atlantic, & Cape May Counties New Jersey; **Revised September 4, 2014**. Distributed by SJG Resources.

Coppola, E.A. Jr., 2015, The Risks to Waters within the Pinelands from the Proposed South Jersey Gas Natural Gas Pipeline.

De Medeiros, A.R., Jacob, B.P., Chaves, A.M., da Silva, D.M.L., Maria, E.S., & Alessandri, R. (2013, June 30). Quality Assurance and Quality Control Considerations in HDD Shore Approach Crossings. International Society of Offshore and Polar Engineers.

Department of Transportation, 2001, Corrective Action Order in the Matter of Mid Louisiana Gas Company, Respondent (CPF No. 4-2001-1006-H). Order issued by the Associate Administrator for Pipeline Safety, Office of Pipeline Safety, 6 p.

Eguiguren, G. (2015, November 18). Pipeline Integrity Management in High Environmental Consequence Areas. Society of Petroleum Engineers. doi:10.2118/177098-MS.

Field, S.C. and Greenfield, A. (2011, January 1). Reducing Pipeline Failures in a Complex System Using Statistical Methods. NACE International.

Gelinas, M., & Mathy, D. (2001). Horizontal directional drilling: lessons learned in conduit installation. Proceedings of The International Conference on Underground Infrastructure Research, Kitchener, Ontario, pp. 247-256.

Guatteri, G., Koshima, A., Lopes, R. and Altan, V.D. (2000, November 19). 360° Jet-Grouted Conical Chambers Allow Safe Tunnelling Under a River Within An Highly Pervious Environment. International Society for Rock Mechanics.

Hair, J.D. (2011, January 1). Considerations in the Application of Horizontal Directional Drilling to Pipeline Construction in the Arctic. Offshore Technology Conference. doi:10.4043/22086-MS.

Hanger, N., Tossey, B. and Eckert, R. (2015, October 13). Management of Internal Corrosion Threats Can Improve Long Term Integrity of Midstream Pipelines. Society of Petroleum Engineers. doi:10.2118/177292-MS.

Horton, J.W. and Williams, R.A., 2012, The 2011 Earthquake: What are scientists learning?, EOS, Transactions, American Geophysical Union; Vol. 93, No. 33, 14 August 2012, p. 317-324.
Hu, Y., Zhang, H., Guo, X., Jin, Z. and Chen, J. (2016, June 14). Managing Uncertainty when Assessing External Corrosion of a Buried Oil Pipeline Segment. NACE International.

Howitt, L., Lincoln-Smith, M., Blount, C. and Branson, P. (2012, January 1). Coastal Shoreline Crossing Using Horizontal Directional Drilling for Pipeline Installation Achieves Excellent Environmental and Social Outcomes. Society of Petroleum Engineers. doi:10.2118/156643-MS.

Jain, S., Sánchez, A.N., Guan, S., Wu, S., Ayello, F., Sridhar, N., Feng, Q. and Yan, B. (2015, May 12). Probabilistic Assessment of External Corrosion Rates in Buried Oil and Gas Pipelines. NACE International.

Kowalski, A.R. and Sánchez, A.N. (2016, June 14). Soil Corrosivity in Buried Onshore Pipelines: A Bayesian Network Approach. NACE International.

Krissa, L.J., Baeté, C. and DeWitt, J. (2016, June 14). CP Effectiveness at Horizontal Directionally Drilled Crossings. NACE International.

Kroon, D.H., Lindemuth, D.D., Sampson, S.L. and Vincenzo, T. (2004, January 1). Corrosion Protection of Ductile Iron Pipe. NACE International.

Luciani, B. and Gutierrez, X.B. (1998, January 1). External Corrosion Assessment in a LNG Pipeline. NACE International.

Moati, W.H.A., Boiero, D. and Socco, L.V. (2013, March 20). A Tool for Fast Underground Characterization for Trenchless Pipeline Construction by Horizontal Directional Drilling Technology. Offshore Mediterranean Conference.

Norman, D. and Argent, C. (2007, January 1). Pipeline Coatings, External Corrosion and Direct Assessment. NACE International.

Roche, M. (2005, January 1). External corrosion of pipelines: What risk? Society of Petroleum Engineers. doi:10.2118/93600-MS.

Roche, M. (2007, January 1). Corrosion Management: A Key Issue in Pipeline Integrity. International Petroleum Technology Conference. doi:10.2523/IPTC-11385-MS.

Sklavounos, S. and Rigas, F., 2006, Estimation of safety distances in the vicinity of fuel gas pipelines *in* Journal of Loss Prevention in the Process Industries 19(1):24-31.

South Jersey Gas Company (SJG) (2015, May 21). Pinelands Comprehensive Management Plan Compliance Statement; Pipeline Reliability Project.

US Department of Transportation, 2014, Notice of Proposed Safety Order issued to Energy Transfer Partners, L.P./Panhandle Eastern Pipe Line Company system (ETP/PEPL) (Re: CPF No. 3-2014-10088) [27 pages].

Walker, R.L., Reilly, P.A. and Watson, K.M., 2008, Hydrogeologic framework in three drainage basins in the New Jersey Pinelands, 2004-06: U.S. Geological Survey Scientific Investigations Report 2008-5061, 147 p.

Zamanzadeh, M. and Xu, H. (2016, June 14). Corrosion Risk Assessment and Failure Analysis in Industrial Water Systems. NACE International.

Paul A. Rubin

414 E. Kerley Corners Rd.; Tivoli, New York 12583 (845-657-8111)

E-mail contact: hydroquest@yahoo.com

EDUCATION:

M.A. - Geology, May 1983, State University of New York at New Paltz. Major fields of study: Hydrogeology, Water Quality and Pollution, Structural Geology, Photogeologic Interpretation. Thesis topic: *Hydrogeology and Structure of the Shawangunk Mountains, Ulster County, NY.*

B.A. - Anthropology, minor Geology, May 1977. State University of New York at Albany.

EXPERIENCE:

HYDROLOGIST/HYDROGEOLOGIST/GEOLOGIST:

1993 - Present

Independent Geologic & Hydrologic Consultant. Consulting firm: *HydroQuest.* Provide hydrologic, geologic and land use technical consulting services to environmental groups, Towns, business associations, law firms, and individuals. Assist groups in identifying issues and developing strategies designed to protect groundwater and surface water resources, community character, and wildlife habitat.

***HydroQuest* work includes SEQRA reviews, review and analysis of consultant reports and environmental impact statements (EISs); environmental scoping report preparation; contaminant characterization and geologic investigations; technical coordination of scientific case development for environmental groups and attorneys; field characterizations; gas pipeline assessments; stream and wetland evaluations; hydrologic and geologic mapping; water quality assessments; watershed delineations; viewshed analyses; slope analyses; aquifer analyses; hydrogeologic analyses; regulatory assessments; GIS map preparation; public presentations; technical presentations to judges; coordination work with attorneys and Technical Committees; direction and coordination of sub-contract work as needed; strategy development; panel member at Town meetings with legislators; press interactions; report and affidavit preparation. Recently authored reports and affidavits on gas drilling & hydraulic fracturing.**

Recent project work examples include hydrogeologic analyses of well field pumping tests designed to assess impacts on groundwater and surface water from major projects; assessment of karst aquifers & groundwater vulnerability; photogrammetric analyses; hydrogeologic assessments of spring water sources being considered for bottled water use; hydrogeologic-aquifer analysis of a groundwater supply proposed for a Shawangunk Ridge retreat center; SEQRA assessments; assessment of a gas field impoundment liner failure; river flooding, mine impact, land & cell tower evaluations; MTBE contaminant transport evaluation; FL-GA-AL gas pipeline route environmental analysis; rattlesnake migration analyses; geologic analysis of cause of United Flight 93 granite monument failure; and flood frequency and earthquake probability analyses.

KARST HYDROLOGIST

2004 - April 2007

Howe Caverns, Inc. Cobleskill, New York. 2nd largest natural tourist attraction in NYS. Conducted hydrologic and geologic research, produced professional GIS maps and figures, developed educational programs and materials, developed new tourist route, trained guides, provided land use assessments and recommendations, advised the Board of Directors on land use concerns including potential water quality degradation and potential blast-related impacts to cave. Developed and proposed revenue generating strategies. Coordinated with outside educational institutions, professional geologists, learning institutions, and scout groups. Formerly worked in this position half-time prior to change in ownership.

INSTRUCTOR:

Jan. 2001- Dec. 2004 **SUNY Ulster, Stone Ridge, New York.**
Taught ArcGIS, Environmental Geology, Geology, Hydrology, Geography, and Crime Analysis. Coordinator of a Geographic Information Systems certificate program. Developed, obtained, and completed a NYSDEC grant to assess assorted hydrologic and environmental aspects of the Black Creek watershed in Ulster County. Supervision and oversight of numerous professional adult "students", directed GIS-based technical presentations, and coordinated and produced grant products.

College of the Atlantic, Bar Harbor, Maine.
Taught a two week graduate level summer field hydrology and environmental science course for several years, including Rosgen stream assessment.

HYDROLOGIST:

New York City Department of Environmental Protection (NYCDEP), Division of Drinking Water Quality Control, Shokan, New York.

April 1993- Jan. 2001 **Conducted research and field studies designed to assess the water quality of watersheds. Responsible for directing geologic research designed to assess the sources, geomorphic context and best management practices (BMPs) related to sediments causing turbidity water pollution problems. Hydrologic and geologic work included geologic mapping of glacial sediments, field evaluation of stream channel armoring, morphologic characterization of stream channels (including Rosgen analyses), bedload transport studies, assessment of critical shear stresses, particle size analysis, stream gauging, water quality sampling and trend analysis, chemical and sediment loading calculations, graphic production, report preparation and technical presentations. Assisted other governmental divisions in evaluating lands for possible purchase, conducted geotechnical assessments of structurally unstable stream reaches, evaluated BMP designs. Supervised several Research Assistants.**

RESEARCH SCIENTIST:

Martin Marietta Energy Systems, Inc. April 1993 under contract with the U.S. Dept. of Energy; Oak Ridge National Lab; Environmental Sciences Division, Oak Ridge, TN.

Aug. 1991- April 1993 **Responsible for hydrogeologic evaluation of groundwater issues (e.g., characterization, monitoring network setup, data analysis, remedial design evaluation) at multiple Oak Ridge Reservation hazardous waste sites. Developed and documented conceptual model of carbonate and shallow storm flow systems comprising pathways of rapid contaminant transport. Work also involved characterization of hydrologic and geochemical trends and thermal infrared photo analysis. Presented results of research at conferences, as well as to DOE management and State and Federal officials.** ***Served in a Resource Management Organization as the hydrologic lead for the Environmental Sciences Division.***

HYDROGEOLOGIST:

New York State Attorney General's Office; Environmental Protection Bureau, Albany, New York.

Feb. 1983- Aug. 1991 **Responsible for the design, protocols, coordination, implementation, evaluation, characterization and remediation of many major water and soil contamination sites throughout New York State (e.g., Love Canal, Superfund sites). Designed, performed and supervised chemical field sampling at hazardous waste sites. Evaluated geotechnical and chemical data sets.**

Primary responsibilities included coordination of multiple companies along with their respective legal and scientific consultants. Worked with all parties involved to produce test plans and consent decrees to facilitate site remediation. Responsible for the management of the testing, site characterization and technical assessment. Worked with attorneys on summary judgment motions, complaints, trial preparation and depositions. Attorney General's spokesperson at public meetings. Expert witness at SEQRA hearings. Testimony given before the Assembly Standing Committee on Environmental Conservation and Grand Jury. Worked with DOL staff and attorneys to develop office initiatives (e.g., Racketeering; bottled water contaminants). Initiation, development and drafting of legislation.

Supervision of personnel: expert witnesses, consultants, research assistants, interns. Responsible for selection, job descriptions, work schedules, and products.

HYDROGEOLOGIST:

Stone & Webster Engineering Corp., Geotechnical Division, Boston, Massachusetts.

Oct. 1981- Feb. 1983 **Directly responsible for the planning, preparation, execution, and analysis of pumping tests and a fluid sampling program designed to investigate deep basin groundwater characteristics for the siting of a nuclear waste repository within the Permian Basin of the Texas panhandle. Planned, managed, coordinated, directed, and provided oversight of field operations of a multi-million dollar project, inclusive of acidizing geologic formations. Sub-contractors included Halliburton, Schlumberger, and others.**

ACTIVITIES:

Hiking, kayaking, geologic and hydrologic research, and exploration. Former Captain: Albany-Schoharie County Cave Rescue Team. Made a Fellow of the National Speleological Society in recognition of karst research and water resource protection.

PUBLICATIONS & REPORTS **Over 50 technical publications and over 100 reports and affidavits, many for private clients, environmental groups, towns, and law firms. Projects include land, wetland, water quality, and species protection; aquifer and watershed characterization; mine proposals; development proposals; contaminant assessments; stream hydrology grant work; and flood risk. Some reports are confidential. Leader of geology conference field trips for groups including the New York State Geological Association, the American Institute of Professional Geologists, the Hudson-Mohawk Professional Geologists' Association, the National Ground Water Association, the National Speleological Society, GSA, and the International Association of Geochemists and Cosmochemists.**

ADDENDUM - SELECTED PUBLICATIONS

SELECTED PUBLICATIONS FROM PROFESSIONAL AND PERSONAL RESEARCH

Rubin, P.A., Burmeister, K.C. and Bartholomew, A., 2018, ***Karst Hydrogeology of the Kingston-Rosendale Karst Aquifer Region within the Hudson Valley Fold-Thrust Belt.*** Fieldtrip Guidebook paper for the Geological Society of America NE Section 54th Annual Meeting.

Rubin, P.A., 2009, ***Geological Evolution of the Cobleskill Plateau; New York State, USA,*** in Veni et al. (eds), Proceedings of the Speleogenesis Symposium of the 15th International Congress of Speleology (joint National Speleological Society & Union Internationale de Speleologie); Symposium: Speleogenesis in Regional Geological Evolution and its Role in Karst Hydrogeology and Geomorphology, Kerrville, Texas. Proceedings, Volume 2, Symposia Part 2, pages 972-978 (published July 2009).

Palmer, A.N. and Rubin, P.A., 2007, ***Karst of the Silurian-Devonian Carbonates in Eastern New York State, with emphasis on the Cobleskill Plateau***. Guidebook for the Hudson-Mohawk Professional Geologists' Association Spring 2007 Field Trip, *"Carbonate Geology of the Howes Cave Area, Schoharie County, New York"*, p. 17-35, Trip coleader with Arthur Palmer (April 28, 2007).

Rubin, P.A., Burmeister, K.C. and Folsom, M., 2006, ***Karst Resource Management: groundwater protection and developmental considerations in the Kingston-Rosendale aquifer system***; Ulster County, N.Y., Poster Presentation at the 2005 National Cave and Karst Management Symposium. Report prepared for Scenic Hudson.

Stokowski, S., Rubin, P.A. and Guenther, B., 2006, ***History of resource management: conflict and resolution, Howes Cave, N.Y.***, in Rea, G.T., (ed), Proceedings of the 2005 National Cave and Karst Management Symposium.

Rubin, P.A and Stokowski, S., 2004, ***Karst, Caves, and Quarries***. Guidebook paper for ***the*** American Institute of Professional Geologists (AIPG), Annual Meeting. Field trip co-leader.

Rubin, P.A. and Washington, G., 2004, ***Water quantity and quality considerations specific to development on the flank of the Shawangunk Mountain Ridge***, ***Southeastern NYS.*** Abstracts Northeast Natural History Conference VIII. N.Y. State Museum Circular 66: p. 53.

Rubin, P.A., Adickes, D.M., Cunningham, T., Davidson, D., Hurld, J. Kiyan, J.R., Preuss, P., Ramsay, W., Schultz, B. and Washington, George, 2004, ***Application of GIS technology to assess visual impacts of development: Shawangunk Ridge case study, southeastern NYS***. Abstracts Northeast Natural History Conference VIII. N.Y. State Museum Circular 66: p. 52-53.

Adickes, D.M., Preuss, P., Rubin, P.A., and Thompson, J., 2004, ***GIS assessment and study of rare and threatened avian species living in the Shawangunk Mountains in Southeastern NYS***. Abstracts Northeast Natural History Conference VIII. N.Y. State Museum Circular 66: p. 38.

Kiyan, J.R., Washington, G., and Rubin, P.A., 2004, ***GIS visual impact analysis of a proposed housing development below Minnewaska State Park Preserve in the Shawangunk Mountains of the Mid-Hudson Valley in New York State***. Abstracts Northeast Natural History Conference VIII. N.Y. State Museum Circular 66: p. 47.

Cunningham, T., Davidson, D., Hurld, Rubin, P.A., and Ehrensaft, P., 2004, ***Using GIS technology to project various land-use and economic scenarios for the northern Shawangunk Ridge area; Southeastern NYS***. Abstracts Northeast Natural History Conference VIII. N.Y. State Museum Circular 66: p. 41-42.

Palmer, A.N., Rubin, P.A., Palmer, M.V., Engel, T.D., and Morgan, B., 2003, ***Karst of the Schoharie Valley, New York.*** Guidebook for the New York State Geological Association Diamond Jubilee Field Conference (75th Annual Meeting), p. 141-176, Trip coleader.

Rubin, P.A., Morgan, B., and Palmer, A.N., 2003, ***Howe Caverns resource protection: hydrology and land-use analysis; Schoharie County***, New York State. Abs. Northeastern Science Foundation Silver Jubilee Anniversary Symposium, Proceedings volume, p. 25-26.

Rubin, P.A., Hubsch, R., Albrechtsen, C.A., Black, G., Folsom, M., Keller, J., Morgan, B., Ortega, A., Rodden, M., Schultz, B., Terzella, D., and Washington, G., 2003, ***Watershed management and protection planning based delineation of critical environmental areas via GIS analysis***. Abs. Northeastern Science Foundation Silver Jubilee Anniversary Symposium, Proceedings volume, p. 13.

Hubsch, R., Morgan, B., Black, G., Folsom, France, N., Keller, J., Ortega, A., Post, J., and Rubin, P.A., 2003, ***Development of a GIS-based land-use coverage: Black Creek and Swarte Kill watersheds, southeastern New York State***. Abs. Northeastern Science Foundation Silver Jubilee Anniversary Symposium, Proceedings volume, p. 9-10.

Rubin, P.A., Waines, R., Washington, G., Ortega, A., Albrechtsen, C.A., Hubsch, R., Folsom, M., Keller, J., Morgan, B., and Schultz, B., 2003, ***Hydrology and geology of the Swarte Kill and Black Creek basins, eastern New York State***. Abs. Northeastern Science Foundation Silver Jubilee Anniversary Symposium, Proceedings volume, p. 12.

Rubin, P.A., Engel, T., Nardacci, M. and Morgan, B.E., 2002, ***Geology and paleogeography of Mount Desert Island and surrounding area, Maine.*** Guidebook paper National Speleological Society annual meeting, Camden, Maine, p. 47-91, Trip leader.

Rubin, P.A., Schultz, B. and Haberland, P., 2002, ***Hydrologic, land use, and historic concerns relative to the Rosendale mining industry.*** Abs. National Speleological Society annual meeting, Camden, Maine, p. A-27.

Rubin, P.A. and Morgan, B., 2002, ***Relict sea caves record temporary coastal stillstands.*** Abs. National Speleological Society annual meeting, Camden, Maine, p. A-26-A-27.

Morgan, B., Albrechtsen, C., Dido, R., Hubsch, R., Rubin, P.A., Sheeley, D., Skerritt, F. and Vaeth, L., 2002, ***Development of a GIS-based land-use coverage: Black Creek Watershed, Southeastern NYS.*** Abs. Northeast Natural History Conference VII. N.Y. State Museum Circular 64: p. 50-51.

Hubsch, R., Albrechtsen, C., Dido, R., Morgan, B., Rubin, P.A., Sheeley, D., Skerritt, F., Terzella, D. and Vaeth, L., 2002, ***Critical environmental area delineation in the Black Creek Watershed, NYS via GIS analysis.*** Abs. Northeast Natural History Conference VII. N.Y. State Museum Circular 64: p. 51.

Sheeley, D.A. and Rubin, P.A., 2002, ***Land-use preservation scenarios in the Black Creek Watershed using GIS; NYS.*** Abs. Northeast Natural History Conference VII. N.Y. State Museum Circular 64: p. 51.

Schultz, B., Rubin, P.A. and Haberland, P., 2002, ***GIS-based historic inventory of early cement district industrial artifacts: Southeastern NYS***. Abs. Northeast Natural History Conference VII. N.Y. State Museum Circular 64: p. 40.

Rubin, P.A. and Morgan, B., 2002, ***Geomorphic reconstruction of emerged and submerged coastlines using GIS technology, Mount Desert Island, ME.*** Abs. Northeast Natural History Conference VII. N.Y. State Museum Circular 64: p. 39.

Rubin, P.A. and Privitera, J.J., 1997, ***Engineered and*** **unregulated degradation** ***of karst aquifers: Two case studies in New York State, USA.*** *In* The Engineering Geology and Hydrogeology of Karst Terranes, Beck & Stephenson (eds), Proceedings of The Sixth Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst; Balkema, Rotterdam; p. 467-476.

Rubin, P.A., Engel, T., and Nardacci, M., 1995, ***Geomorphology, paleoclimatology and land use considerations of a glaciated karst terrain, Albany County, New York.*** Guidebook for joint meeting of the New York State Geological Association (67th Annual) and the American Association of Petroleum Geologists. Trip leader, p. 81-107.

Rubin, P.A., 1995, ***The geology of Clarksville Cave, Albany County, New York.*** Guidebook for joint meeting of the New York State Geological Association (67th Annual) and the American Association of Petroleum Geologists. Trip leader, p. 251-273.

Rubin, P.A., 1995, ***The geology of Cherokee Caverns; Tennessee***. *In* Karst Geohazards (ed. by B. Beck), Proceedings of: The Fifth Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst; Sponsors include the National Ground Water Association and the American Society of Civil Engineers, Gatlinburg, TN, p. 541-547.

Rubin, P.A., 1994, ***Paleohydrology of the Kämper Avenue area; Mammoth Cave National Park, Kentucky.*** Mammoth Cave National Park's Third Science Conference; Sponsored by Mammoth Cave National Park and The Cave Research Foundation, Mammoth Cave National Park, Kentucky, p. 265-279.

Rubin, P.A., Zerr, B., Davies, G.J., Lemiszki, P.J., Neuhoff, P.S., and Aiken, J., 1993, ***Preliminary hydrogeologic studies in carbonate aquifers of the Oak Ridge Reservation, Tennessee.*** Abs. Fourth Annual Walker Branch Watershed Research Symposium, Oak Ridge, TN, p. 15-16.

Davies, G.J., Rubin, P.A., and Quinlan, J.F., 1993, ***Indirect observation of the rapid-flow and slow-flow components of recharge to the Knox aquifer, Oak Ridge, Tennessee.*** Abs. Fourth Annual Walker Branch Watershed Research Symposium, Oak Ridge, TN, p. 17.

Rubin, P.A., Lemiszki, P.J., and Poling, R.S., 1992, ***Strategy for definition and protection of East Tennessee karst groundwater basins.*** Tennessee Water Resources Symposium (5th, Nashville, TN., Oct. 1992), Proceedings. American Water Resources Association, Nashville, TN, p.7-10.

Rubin, P.A. and Lemiszki, P.J., 1992, ***Structural and stratigraphic controls on cave development in the Oak Ridge area, Tennessee.*** Tennessee Water Resources Symposium (5th, Nashville, TN., Oct. 1992), Proceedings. American Water Resources Association, Nashville, TN, p. 111-117.

Rubin, P.A., Lietzke, D.A., and Schmidt, V.A., 1992), ***Aspects of the geomorphology of Oak Ridge, Tennessee.*** Abs. National Speleological Society Convention, Salem, IN.

Rubin, P.A., 1992, ***Strategy for aquifer and stream protection in karst terranes.*** Abs. The New York Natural History Conference II, New York State Museum Circular 54, p. 61, Albany, New York.

Rubin, P.A., 1992, ***Karst hydrology of Oak Ridge, Tennessee.*** Abs. Third Annual Walker Branch Watershed Research Symposium, Oak Ridge, TN, p. 34.

Rubin, P.A., 1992, ***Land-use planning and watershed protection in karst terranes.*** Hydrogeology, Ecology, Monitoring, and Management of Ground Water in Karst Terranes Conference (3rd, Nashville, Tenn., Dec. 1991), Proceedings. National Ground Water Association, Dublin, Ohio, p. 769-793.

Rubin, P.A., Ayers, J.C., and Grady, K.A., 1992, ***Solution mining and resultant evaporite karst development in Tully Valley, New York.*** Hydrogeology, Ecology, Monitoring, and Management of Ground Water in Karst Terranes Conference (3rd, Nashville, Tenn., Dec. 1991), Proceedings. National Ground Water Association, Dublin, Ohio, p. 313-328.

Palmer, A.N., Rubin, P.A., and Palmer, M.V., 1991, ***Interaction between karst and glaciation in the Helderberg Plateau, Schoharie and Albany Counties, New York.*** Guidebook for New York State Geological Association Annual Meeting, Oneonta, New York, p. 161-190.

Palmer, A.N., Palmer, M.V., Porter, C.O., Rubin, P.A., and Mylroie, J.E., 1991, ***A geological guide to the karst and caves of the Helderberg Mountains, Schoharie and Albany counties, New York.*** Guidebook paper for National Speleological Society annual meeting, Cobleskill, New York, p. 105-167.

Rubin, P.A., 1991, ***Modification of preglacial caves by glacial meltwater invasion in East-Central New York.*** Appalachian Karst Symposium, Proceedings. National Speleological Society, Radford, Virginia, p. 91-100.

Rubin, P.A., 1991, ***Flow characteristics and scallop forming hydraulics within the Mill Pond Karst Basin, East-Central New York.*** Appalachian Karst Symposium, Proceedings. National Speleological Society, Radford, VA., p. 101-108.

Rubin, P.A., 1991, ***Emerged sea caves and coastal features as evidence of glacio-isostatic rebound, Mount Desert Island, Maine.*** Appalachian Karst Symposium, Proceedings. National Speleological Society, Radford, Virginia, p. 75-83.

Rubin, P.A., 1983, ***Structural geology and geomorphology of the Shawangunk Mountain caprock, Southeastern New York.*** Abs. Geol. Soc. Amer. N.E. Ann. Mtg., Kiamesha Lake, New York; and Abs. Mohonk Research Associates Conference, Mohonk Lake, New York.

Rubin, P.A. and Briedis, J., 1982, ***Acid precipitation and volcanism linked to Mesozoic dinosaur extinction.*** Abs. Geol. Soc. Amer. Ann. Mtg., New Orleans, Louisiana.

Rubin, P.A., Smiley, D., and Egemeier, S.J., 1981, ***Acid precipitation in the Shawangunk Mountains, Southeastern New York.*** Abs. AMS/CMOS International Conference on Long-Range Transport of Airborne Pollutants, Albany, New York; and Abs. Geol. Soc. Amer. N.E. Ann. Mtg., Bangor, Maine.

Rubin, P.A., 1981, ***New Aspects of the stratigraphy and structure of the Shawangunk Mountains, Southeastern New York.*** Abs. Geo. Soc. Amer. N.E. Ann. Mtg., Bangor, Maine.

Egemeier, S.J., Liff, C.I., Smiley, D., and Rubin, P.A., 1981, ***The safe yield of the "sky" lakes of the Shawangunk Mountains of Southeastern New York***. Abs. Geol. Soc. Amer. N.E. Ann. Mtg., Bangor, Maine.

Exhibit D

GET Consulting
55 Meadow Drive
Middletown, DE 19709
(302) 440-4848
DE License: 2016605929

September 8, 2016

VIA ELECTRONIC MAIL

Ms. Jaclyn Rhoads, Ph.D.
Assistant Executive Director
Pinelands Preservation Alliance
17 Pemberton Road
Southampton, NJ 08088

RE: Revised - Review of Title V Permit Application
B L England Generating Station
Beesley's Point, New Jersey
DEP Facility ID No. 73242

Dear Ms. Rhoads:

At your request, GET Consulting has completed review of the New Jersey Department of Environmental Protection (NJDEP) Title V air application and associated draft permit for B L Generating Station in Beesley's Point, New Jersey. Additionally, an evaluation of the site's compliance record from January 2005 to August 2016 was completed. This correspondence outlines the findings of this evaluation.

The permit application was submitted in four parts; documents dated October 8, 2014, September 2015, November 13, 2015, and December 18, 2015. Subsequently, the draft permit was issued on December 29, 2015.

Comparison of Actual Emissions to Proposed Potential to Emit (PTE)

The Title V permit application includes documentation of actual emissions for the preceding 5-year period. These actual emissions were compared to the potential to emit (PTE) for the operating scenarios for the proposed new equipment. Although not detailed in the permit application, it is understood that the actual emissions for the preceding 5-year period were generated at reduced operating hours (i.e., equipment did not operate 8,760 hours per year). Conversely, the potential emissions noted for the proposed equipment assumes maximum operation of 8760 hours per year. Attachment 1 includes a table with the summary of the actual emissions over the past 5 years and the proposed potential to emit values under the draft Title V permit. The findings are summarized as:

- An annual increase of VOC emissions was identified: from 4.51 tons (Year 5 actual) to 29.52 tons (PTE). Both of these values are below the current permissible potential to emit of 283 tons per year of VOC.
- An annual decrease of NOx emissions was identified: from 402 tons (Year 5 actual) to 98 tons (PTE). Again, both of these values are below the current permissible potential to emit is 6,885 tons per year of NOx.

In review of the draft permit and the permit application documents, specific to Boiler 2 and Boiler 3, several inconsistencies were recognized within the draft permit regarding PTE. Discrepancies were noted in comparison of the draft permit limits: in ton/year limits versus converted annualized limit (from lb/hr to ton/yr). Attachments 2 and 3 illustrate these inconsistencies. For both boilers, the particulate emissions are unclear. The pollutant PM-10 is understood to be a sub-set of TSP. However, the PM-10 limits are greater than the TSP limits. Additional conclusions are as follows:

- Regarding U2, the draft permit limit (ton/yr) has not been revised from current active permit to restrict operational hours[1]
- Regarding U2, the emission limits were not reduced to restrict operation to 4,300 hours per year.
- Regarding U3, the converted annualized limit (lb/hr -- ton/yr) exceeds draft permit limit.

Fire Pump – Emergency

Although perfectly legitimate, a permitting strategy was employed to avoid Prevention of Significant Deterioration (PSD) regulations under 40 CFR §52.21. By self-limiting operation time of the fire pump, the facility is positioned as a minor source with respect to PSD regulations; thereby, it is not required to conduct a Best Available Control Technology (BACT) analysis and air quality impact analyses. Under the PSD regulation, a source is considered minor if the *total* facility-wide PTE, for each non-Greenhouse Gas pollutant, is below 100 tons per year.

In the draft Title V permit, the fire pump (U6) was re-classified for emergency use only; re-classification imposes an operational time limit of 100 hour per year, which includes testing and maintenance activities. Self-limiting the permissible operating time from 8760 hours to 100 hours reduces the annual PTE for NOx from 21.6 tons to 0.25 tons[2] per year. With this

[1] For current permit limits, refer to the Title V Renewal document dated October 8, 2014, page 9.
[2] See Trinity Consultants letter dated December 18, 2015 to NJDEP.

reduction of hours, the annual facility-wide emission potential for NOx is reduced from 119.5 tons to 98.16 tons, which is below 100 tons for trigger of PSD regulation.

Also note that the 100 hours per year time allotment is specific to routine testing and maintenance activities. An affirmative defense can be requested and granted for operational time above this limit for operation during an actual emergency.

Enforcement Records

The NJDEP enforcement actions at the site were reviewed from January 2005 to August 2016. Numerous emission violations were issued for the site for various parameters and permit requirements. Of particular concern are violations for stack test results and continuous emission monitoring results, which are discussed below.

Violations associated with stack testing were cited for Boiler 3 (Emission Unit 003) and Diesel Electric Generators #1, #2, #3, and #4 (all four under Emission Unit 005). Attachment 4 is a list of stack test violations for Boiler 3 and Diesel Engines (U5). Table 1 on the following page summarizes theses violations, the pollutants, and stack test dates.

Table 1: Summary of Violations for Stack Test Results

Emission Unit	Parameter	Test Date of Violations
U3, Boiler 3	Selenium	7/31/2007
	Cobalt	7/31/2007
	Ammonia	1/16/2009
U5, Eng. 1	Ammonia	3/27/2008
U5, Eng. 2	Carbon Monoxide	8/11/2006 & 3/26/2007
	Ammonia	3/26/2008
U5, Eng. 3	Carbon Monoxide	8/11/2006, 3/28/2008 & 5/16/2013
	Ammonia	11/14/2007 & 3/28/2008
U5, Eng. 4	Carbon Monoxide	11/13/2007 & 5/17/2013
	Ammonia	11/13/2007 & 3/25/2008

Within the draft Title V permit, the emission units itemized in Table 1 are ultimately to be permanently decommissioned. However, this equipment would be permitted to operate until such time the combined cycle combustion turbine becomes operational, which could be years from the date the permit is finalized. It is possible that follow-up stack testing was completed to demonstrate compliance with the permit criteria. However, neither follow-up stack test results nor other information (e.g., reports of equipment optimization) are readily available to Illustrate permit compliance.

Further, the draft permit does require stack testing for both U3 and U5; but, the permit would allow operation for a full 3.5 years before such testing was required. If the equipment has not been fully optimized and consistently maintained, it could discharge pollutants above permit requirements for this duration without corrective action. As evidenced by the repeated stack testing failures noted in Table 1, there is little confidence that the equipment will operate within the permit terms.

The list of enforcement actions also notes violations for both Boiler 2 (U2) and Boiler 3 (U3) from their respective continuous emission monitoring systems. Both units had violations for carbon monoxide, nitrogen oxide, and opacity of emissions. Attachment 5 and Attachment 6 itemize these violations for Boiler 2 (U2) and Boiler 3 (U3), respectively. Table 2 on the following page summarizes the number of exceedances, by pollutant, for each emission unit.

Table 2: Summary of Violations for Continuous Emission Monitoring Results

Emission Unit	Parameter	No. of Violations from 2005 to 2016	No. Listed as "Satisfied"	No. Listed as "Affirmative Defense Approved"
U2	Carbon Monoxide	25	23	2
	Nitrogen Oxide	2	2	~
	Opacity of Emissions	7	7	~
U3	Carbon Monoxide	1	1	~
	Nitrogen Oxide	7	6	1
	Opacity of Emissions	54	49	5

As shown in Table 2, the status for each of the continuous emission monitoring system violations is noted as either "satisfied" or "affirmative defense approved." A majority are listed "satisfied." In the case of opacity violations for Boiler 2, all 7 violations are listed as "satisfied." The draft permit has an exemption for opacity under GR1, reference 2, specific to operation of Boiler 2 on FGD (flue-gas desulfurization). FGD operates when the boiler is combusting coal (and/or combination of coal and No. 6 fuel oil). It is recognized that this exemption was likely applied to these 7 violations. However, there is no comparable exemption for the 54 opacity violations for Boiler U3, or for any of the other violations for carbon monoxide and nitrogen oxide. The rationale for the "satisfied" status for the remaining violations is unclear and it is presumed to be related to payment to NJDEP of the assessed penalty.

Additionally, it is presumed that items noted as "affirmative defense approved" had follow-up documentation that negated the violation findings. With the exception of malfunctioning equipment (which would be a violation unto itself), it is unclear how these violations could be negated thereby sanctioning an affirmative defense.

For reference, Attachment 7 has the NJDEP Data Miner report that indicates all violations found from January 2005 to August 2016, including penalty assessments. This report is itemized by violation date.

Summary

This correspondence documents the findings from review of the Title V air permit application for the B L Generating Station and evaluates the site's compliance record. Although the permit application and draft version appear to be sound and in alignment with air permit regulations, the compliance record is concerning and clearly shows a history of non-compliance.

I hope that this report brings you value and satisfies your needs. If you have any questions about my comments within this report, please feel free to call me to discuss. Thank you for this opportunity.

Sincerely,
GET Consulting

T.C. Garrod

Theresa C. Garrod
Owner

Attachments:
1: Summary of Emissions – Actual and PTE
2: Attachment 3: Summary of Discrepancies in Permit Limits for Boiler 2
3: Attachment 3: Summary of Discrepancies in Permit Limits for Boiler 3
4: Summary of Stack Test Violations for Boiler 3 and Diesel Engines (U5)
5: Summary of Violations for Boiler 2 (Jan 2005 to Aug 2016)
6: Summary of Violations for Boiler 3 (Jan 2005 to Aug 2016)
7: NJDEP Data Miner Violation Report (Jan 2005 to Aug 2016)

Exhibit E

GR JUELG CONSULTING
79 GRASSY LAKE ROAD
SHAMONG, NJ 08088
609-654-4047
grjuelg@gmail.com

October 19, 2015

Pinelands Preservation Alliance
Attention: Carleton Montgomery
17 Pemberton Road
Southampton Township, NJ 08088

Dear Mr. Montgomery,

I am the Senior Land Steward for the New Jersey Conservation Foundation, managing preserves and resources in the New Jersey Pinelands. I am an expert in the identification and ecology of Pinelands plants. I teach courses for professional consultants, government personnel and members of the public interested in Pinelands botany and have made a particular study of the threatened, endangered and rare plant species of the Pinelands region.

At your request, I have reviewed the document "Threatened & Endangered Species Habitat Suitability Assessment & Survey Report" dated February 4, 2013, by Trident Environmental Services. I note the following:

(1) The applicant states on p. 4, "The proposed pipeline avoids environmentally sensitive areas by following existing linear features of roadway, electrical transmission line, and railroad. For the majority of its length the alignment is within existing road shoulder, and there is minimal clearing of woodlands proposed." This statement is not necessarily true, and, generally, the situation is quite the opposite. The linear features listed above are, in fact, some of the very places where rare plants are often expected to occur. Road shoulders, power line rights-of-way, and railroad lines often represent early-successional habitat suitable for many rare plant species, and it is commonly known that roadsides, especially, harbor many rare plant "hotspots."

(2) Regardless of the extent to which the applicant may satisfy the Pinelands Commission that the project meets the requirements of the CMP, the public ought to be aware that the applicant and the Commission appear to be conspiring to disregard entirely the possibility that certain rare plant populations are at risk. These are rare plant populations composed of species that the State of New Jersey has identified as conservation priorities, but which the Pinelands Commission continues to arbitrarily decline to officially protect. Examples explicitly provided in the report include, p. 12: "Occurrences are identified for wooly ragwort (*Senecio tomentosus*), coastal violet (*Violabrittonia* var. *brittonia*), and bog

goldenrod (*Solidago uliginosa*). However, none of these species are state endangered or Pinelands threatened/endangered and will not be further discussed in this assessment."

(3) The Pinelands Commission sometimes implements a protocol which is biased toward non-discovery of rare plant populations. That protocol consists of allowing or perhaps directing applicants to focus on species that have been previously detected at specific locations, rather than search for any and all rare plant populations that may occur on the proposed development site. This protocol runs contrary to both common sense and common experience among local field botanists, seeing that currently-recorded rare plant populations, whether by the Pinelands Commission or by the NJ Natural Heritage Program, represent a mere subset of the extant rare plant populations. There is no way to evaluate the degree to which the subset of existing records reflects the actual extant rare plant occurrences on any given site without performing intensive and thorough field surveys. The applicant can be seen taking advantage of this protocol on p. 23: "The Natural Heritage database searches; the Natural Heritage Grid Map; and the Pinelands Commission correspondence were reviewed to establish the plant species to be assessed."

(4) The applicant proposes to satisfy with general and vague statements what actually ought to be *demonstrated*, namely, that the proposed area of disturbance avoids all rare plant populations by virtue of the following: (a) that the proposed pipeline route will be "near the edge of pavement (p. 27); and (b) "the maintained grassed shoulder is not suitable habitat for threatened and endangered plant species (p. 28)."

   a. With respect to the former point, while it may be true that the suitability of the habitat for rare plants decreases the nearer one gets to the pavement, it is not the relative proximity to the pavement that matters; rather it is the exact distance, the exact place and nature of the proposed disturbance, and the exact nature of the habitat at any particular location. As the applicant admits, p. 28, "There are discontinuous and very narrow strips between the grassed shoulder and adjacent woodlands…" (largely redacted thereafter). These "strips" consist of natural plant communities that gradually transition to the deliberately cultivated cool season turf-grass and weed community that runs closer to the pavement (personal observation). There is no "bright line" between the natural community and the cultivated one, thus the suitability of the roadside for rare plants depends on *exactly where you are*, not whether you are, in some vague sense, "near the edge of the pavement."

   b. With respect to the latter point, a "maintained grassed shoulder" may or may not be suitable habitat for rare plants. Many road shoulders that may be described as "maintained grassed" are indeed rare plant hotspots. Everything depends on a variety of factors, including whether or not the soil has been degraded, whether or not the specific site has been sown with non-natives, and whether or not native plants have been able to colonize the site. Further, the fact that the road shoulder is "maintained," in some sense, is a factor that is entirely impossible to assess, unless studies were to be conducted during a time when the current mowing regime were halted or interrupted. Some forms of maintenance actually enhance conditions for certain rare plants. Moderate mowing, for example, is actually *prescribed* in order to manage certain rare plant populations. The biggest problem with regularly repeated mowing of a rare plant population is not that it necessarily renders a site unsuitable for rare plants, but rather that it prevents existing plants from flowering and fruiting. Thus, regularly repeated mowing may or may not create unsuitable habitat for rare plants, depending of the species and a variety of factors, but it certainly can make it impossible, or nearly so, to detect them and/or to positively identify them. As emphasized in my earlier report, the regularly repeated mowing on these road shoulders makes it virtually impossible to determine most of the plant species, which in turn, makes survey work, in those areas, largely meaningless.

Having reviewed the applicant reports available to me, it is my expert opinion that the applicant has failed to demonstrate that the proposed pipeline development will avoid adverse impacts to local populations of species identified as threatened or endangered by N.J.A.C. 7:50-6.27 and, therefore, has failed to demonstrate compliance with Pinelands regulations regarding rare plants.

Sincerely,

GR Juelg

G. Russell Juelg