Independent Engineering Evaluation

Constructability Analysis
of
SVC Options for
Artificial Island, Orchard and New Freedom

Prepared for

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June 6, 2014

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To avoid sections being taken out of context, the report should be read in its entirety.

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1.0 Executive Summary

Burns and Roe has performed a constructability analysis of installing Static VAR Compensators (SVC) along the 500kV transmission network of Artificial Island (AI). Three (3) locations have been identified for possible SVC installation: 1) near Artificial Island connected to Hope Creek and Salem substations, 2) adjacent to the Orchard Substation, 3) near the New Freedom Substation. All these substations play an important role in the stability of the 500kV system in southern New Jersey, which is connected to two Nuclear Generating Stations, Hope Creek and Salem, and interconnected with other utilities in the PJM system.

PJM, in their Artificial Island Area Proposal Window Problem Statement and Requirements Document, provided the following scope of work:

1. *Generate maximum power (3818 MW total) from all AI Units (Salem1: 1253MW, Salem-2: 1245MW, Hope Creek: 1320MW) without a minimum MVAr requirement from the AI. Full maximum power must be maintained under both the baseline and all N-1 outage conditions of 500kV transmission lines in the AI area. For both the baseline and N-1 outage conditions, AI voltage must be maintained within operating limits and stable for all NERC Category B and C contingencies. NERC Category C3 contingencies "N-1-1 contingencies" do not need to be run on top of the N-1 outage condition.*
2. *Maximum MW output from AI should not be affected by the simultaneous outage of Power System Stabilizers (PSS) of Artificial Island units Hope Creek and Salem-2. The Salem-1 PSS is assumed to be on for all scenarios.*
3. *Reduce operational complexity.*
4. *Improve Artificial Island stability.*
5. *Maintain PJM System Operating Limits (SOLs)*

As part of this effort, PJM has requested the services of Burns and Roe to carry out the constructability analysis and examine the options of installing Static VAR Compensators connected to either Artificial Island, New Freedom or Orchard substations. This analysis reviews the overall constructability of the project and evaluates the cost and schedule.

Burns and Roe's evaluation is based on preliminary information of conceptual designs requested by PJM for the construction of SVCs connected to AI substations, Orchard Substation or New Freedom Substation. This review takes into account permitting issues, constructability, schedule, and the cost of the construction of substations and transmission lines. Burns and Roe has identified factors that could potentially affect the implementation of the SVC options.

As a result, the conclusions drawn in this report are based on past experience and good engineering and construction practices; and not necessarily on the detailed designs or in depth requirements for construction of substation and transmission lines upgrade and/or new construction.

2.0 Project Overview

The operational performance of the AI generating stations depends on the transmission efficiency of the associated transmission circuits. The Generating Station outputs are limited under outage conditions with increased strain in the transmission system. To maintain stability in the Artificial Island Area and improve operating conditions within the transmission system during outages, SVCs are proposed at the previously mentioned substations. The SVCs will allow the transmission of maximum power, albeit fluctuating reactive power during outage and other maintenance requirements.

Burns and Roe has evaluated the constructability of SVC systems connected to AI substations, Orchard Substation, or near New Freedom Substation. All substation options require internal modifications and connection to a separate SVC site located nearby. For AI, the new SVC construction will include a separate 500kV ring bus Air-Insulated Substation (AIS) that will connect to the SVCs.

This Burns and Roe study provides constructability assessment of the projects with respect to environmental impacts, schedule and capital cost estimates. The findings and recommendations for the Artificial Island SVC options are presented as part of the constructability analysis for PJM.

2.1 Overall Description of Proposed Project

2.1.1 Scope of Work

The Artificial Island SVC options consist of installing SVC systems in the 500kV transmission network in the AI region to alleviate voltage and stability issues observed in the area.

PJM requested the review of SVC installation options near the AI Hope Creek and Salem substations, Orchard Substation and near New Freedom Substation.

PJM originally specified a single SVC system rated -525/+525 MVAR. Subsequent to specification of this rating, two issues were identified, as follows:

- The necessary rating of the SVC system may need to be different, with a possible rating of -400/+650 MVAR. Technical analyses being performed by PJM are still in progress and the actual rating of the capacitive and inductive ratings of the SVC system have not been finalized, however, minor changes in the specific ratings do not affect this constructability analysis.
- One of the predominant SVC suppliers expressed concern that the total dynamic range of the SVC system (1150 MVAR) may cause excessive current ratings on the secondary side of the SVC system, which could be alleviated by splitting the SVC into two parallel systems.
- Another predominant supplier stated that the largest SVC system they have supplied in the US is rated -110/+650 MVAR, and a decision to split the SVC requirements into multiple smaller units is a preference, generally based on reliability.

As a result of the above concerns, this constructability analysis will consider the following concepts:

- For an SVC system located at Artificial Island, the PJM concept included two (2) 500kV circuits, one from Hope Creek and the second from Salem, connected to a new (local) 500kV ring bus substation which would serve two (2) parallel SVC systems.
- For an SVC system connected to either Orchard or New Freedom, the original PJM concept included a single 500kV circuit that would connect to a single SVC system. This will be considered the base case for both Orchard and New Freedom; however, this constructability analysis will provide commentary on the alternative concept of using two (2) 500kV circuits and splitting the SVC requirement into parallel SVC systems.
- For the Artificial Island case, and for the alternative cases at Orchard and New Freedom described above, each SVC installation will have its own dedicated step-down transformer. If each step-down transformer is a single three-phase unit, consideration can then be given to procurement of a spare step-down transformer, rated 500kV primary, to be used in the event that one of the SVC transformers has failed. Alternatively, if each step-down transformer bank consists of three single phase units, a single phase spare can be procured for a total of seven (7) transformers for the parallel SVC systems. (Costs and constructability of a spare step-down transformer are not included in this report.)

Both Hope Creek Substation and Salem Substation will require modification for upgrades as part of the proposed design in the AI area. At Salem Substation, a breaker will be added next to position eight (8), transmission line 5021, of the existing breaker-and-a-half center bay to create a new position for the SVC connection. At Hope Creek Substation, the six breaker ring bus AIS will be converted to breaker-and-a-half bay arrangements.

Additionally, a breaker-and-a-half bay will be added to the south of the existing substation for the connection to the SVC and the relocation of transmission line 5037 going to Salem Substation. The proposed property is bounded to the west by AI generating stations, to the north and the east by Hope Creek Road and to the south by Salem Road. At the SVC site, a four breaker ring bus AIS is proposed where two positions will connect the lines from Hope Creek and Salem substations. The other two positions will connect to two proposed SVC installations.

The design upgrades requested by PJM at the existing Orchard Substation include modifications to the existing three (3) breaker ring bus AIS to a four (4) position ring bus. Land will be purchased near the existing substation to install the new facility for the SVC installation and its associated equipment.

The upgrades at New Freedom Substation include the installation of an additional bay with two breakers extending the existing 500kV breaker-and-a-half AIS. The design as requested by PJM, proposes to build a new SVC facility near the New Freedom Substation.

This Burns and Roe study focuses on options from design upgrades requested by PJM and takes into account the constructability at the three (3) locations as presented in the following sections.

2.1.1.1 *AI Substation*

The electrical configurations for adding SVC to AI substations are shown in Pages 2 to 10 in Attachment 6 – Artificial Island Proposed SVC, Rev. 0. The scope of work for the installation of two SVC systems near AI consists of expansion and modifications at both the existing Hope Creek and Salem 500kV substations to add 500kV circuit breakers at the existing substations, connection between the existing substations and two new external connections to a newly installed four breaker ring bus, which will connect to two new SVC systems. (The proposal as described in Attachment 6 is not finalized and therefore, the scope of work may include more modifications not indicated below.)

Major elements of the work scope include:

- Hope Creek expansion and modification of the existing substation
    - Modify existing substation
        - Expansion of substation: addition of breaker-and-a-half bay to existing structures
        - Disconnect switches
        - Relocation of transmission line 5037
        - Transmission line to SVC ring bus: options include underground solid dielectric cable or gas-insulated transmission line
        - Additional protective relaying

        - Modify existing relaying
        - Bus tubing and post insulators
- Salem modification of the existing substation
    - Modify existing substation
        - Circuit breaker, 500kV dead tank (New position in existing breaker-and-a-half bay)
        - Disconnect switches
        - Transmission line to SVC ring bus: options include underground solid dielectric cable or gas-insulated transmission line
        - Additional protective relaying
        - Modify existing relaying
        - Bus tubing and post insulators
- SVC Site new substation
    - New AIS installation
        - New four breaker ring bus: circuit breakers, 500kV dead tank
        - Fencing
        - Foundations
        - Steel structures
- Installation of new two (2) SVC facilities
    - Site Work
        - Clearing and grading
        - Fencing
        - Grounding
        - Foundations
        - Steel structures
    - Major Equipment for each SVC station
        - Circuit breaker, 500kV dead tank
        - Single phase, step down transformers (three (3) per SVC system, with one (1) common spare, seven (7) transformers total)
        - Static Var Compensator System
            - Thyristor valves
            - Thyristor Controlled Reactors

        - Thyristor Switched Capacitors
        - 3 winding transformers for 12- pulse design to minimize harmonics
    - Cooling Plant
    - Harmonic filters
    - Foundation and structures: connectors, busbars and grounding
    - Control house
    - Station service power and backup power
    - All equipment should be designed to minimize ambient noise.

2.1.1.2 *Orchard Substation*

The electrical configurations for adding SVC to Orchard Substation are shown in Figure 1 in Attachment 1 to this Report. The scope of work at the Orchard Substation involves modifying the existing 500kV substation to add one 500kV circuit breaker and a new external connection to the modified ring bus that will connect to a new 500kV circuit breaker for the SVC system. From the new 500kV SVC circuit breaker, a step-down transformer (supplied as part of the SVC scope) will connect the 500kV substation to the SVC system.

Major elements of the work scope include:

- Expansion of existing substation
    - Modify Ring Bus
        - Circuit breaker, 500kV dead tank (New ring bus breaker)
        - Disconnect switches
        - Line Terminals for 500kV connection to SVC breaker
        - Additional protective relaying
        - Modify existing relaying
        - Bus tubing and post insulators
- Installation of new SVC facility
    - Site Work
        - Clearing and grading
        - Fencing
        - Grounding
        - Foundations
        - Steel structures

- Major Equipment
  - Circuit breaker, 500kV dead tank (New SVC breaker)
  - Single phase, step down transformers (3 + 1 spare)
  - Static Var Compensator System
    - Thyristor valves
    - Thyristor Controlled Reactors
    - Thyristor Switched Capacitors
    - 3 winding transformers for 12- pulse design to minimize harmonics
  - Cooling Plant
  - Harmonic filters
  - Foundation and structures: connectors, busbars and grounding
  - Control house
  - Station service power and backup power
  - All equipment should be designed to minimize ambient noise.

2.1.1.3 *New Freedom Substation*

The electrical configuration for adding SVC to New Freedom Substation is shown in Figure 2 in Attachment 1 of this Report. The scope of work for the New Freedom SVC option is divided into three group of activities: 1) modifications at the existing 500kV Substation, which involve the addition of a new bay containing two (2) breakers in the breaker-and-a-half AIS, 2) a new transmission line over the fence line to connect from the breaker-and-a-half bay to a new 500kV circuit breaker for the SVC system and 3) installation of a new SVC system.

Major elements of the work scope include:

- Expansion of existing substation
  - Site Work
    - Fencing relocation
    - Foundations
    - Steel structures
    - Expansion of substation: addition of breaker-and-a-half bay to existing structures
    - Expansion of ROW or new ROW for 500kV transmission line from substation property to the SVC installation
    - Line relocation
    - Modify breaker-and-a-half

        - Circuit breakers, 500kV dead tank (two breakers)
        - Disconnect switches
        - Line take-off structures for 500kV connection to SVC breaker
        - Additional protective relaying
        - Modify existing relaying
        - Bus tubing and post insulators
- Installation of new SVC facility
    - Site Work
        - Clearing and grading
        - Tree clearing (removal)
        - Fencing
        - Grounding
        - Foundations
        - Steel structures

    - Major Equipment
        - Circuit breaker, 500kV dead tank (new SVC breaker)
        - Single phase, step down transformers (3 + 1 spare)
        - Static Var Compensator System
            - Thyristor valves
            - Thyristor Controlled Reactors
            - Thyristor Switched Capacitors
            - 3-winding transformers for 12-pulse design to minimize harmonics
        - Thyristor valve cooling plant
        - Harmonic filters
        - Foundation and structures: connectors and busbar
        - Control house
        - Station service power and backup power
        - All equipment should be designed to minimize ambient noise

2.1.2 Summary of Transmission Lines

The SVC installations will be located adjacent to either AI generating stations, Orchard Substation or New Freedom Substation. New 500kV transmission lines will be needed from all substations to the SVC site. The existing substation will be modified to accommodate the proposed substation arrangements for the existing and new transmission to the SVC site.

Two (2) SVCs are planned near AI generating stations. Therefore, two (2) transmission lines will span from new terminators in the modified substations heading east to a new four breaker ring bus SVC AIS substation. For the transmission lines from Salem and Hope Creek substations to the SVC four breaker ring bus, underground solid dielectric cable and 500kV gas-insulated bus are considered as options. The physical arrangements of the substations and the location of the SVC AIS are the major factors for this design approach to route the transmission lines. From the four breaker ring bus, two short overhead lines will then be used to connect to the SVC system through SVC step-down transformers.

The new 500kV transmission line from Orchard will be short and will likely span from a new take-off structure in the existing substation, going either East or West, over the existing fence, to the SVC site. The new transmission line will connect to a new 500kV circuit breaker ahead of the SVC step-down transformers.

For New Freedom, the same concept will apply as for Orchard. Land appears to be available adjacent to the existing substation for the SVC installation.

2.1.3 Description of Substation Modifications

The existing substation sites have been examined using satellite aerial views to determine the feasibility of installing an SVC facility and its associated 500kV equipment on newly acquired land, and for performing modifications to the existing substation sites. At this time, the level of detail for this project is preliminary.

2.1.3.1 *AI substations*

The existing Hope Creek Substation is a six (6) breaker ring bus 500kV AIS. The Hope Creek Substation is located east of the Hope Creek nuclear plant. One position is connected to the generating station via a Generator Step-Up (GSU) transformer while the other three (3) positions are feeding Red Lion, New Freedom and Salem substations through transmission lines 5015, 5023 and 5037 respectively. Four (4) auxiliary transformers are located to the north of the 500 kV AIS.

The existing Salem Substation includes a three (3) bay breaker-and-a-half bay 500kV AIS. Two (2) transmission lines from Salem Unit 1 and Unit 2 connect to the 500kV AIS through two (2) GSU transformers. The other positions on the AIS connect Salem

Substation to Hope Creek Substation, Orchard and New Freedom through transmission lines 5037, 5021 and 5024 respectively. A total of four (4) auxiliary transformers are located north and south of the Salem 500kV AIS with two (2) transformers on each side.

The proposed modifications to the existing Hope Creek Substation consist of converting the six (6) breaker ring bus 500kV AIS to a three (3) bay breaker-and-a-half bay 500kV AIS by using the existing structure for an additional bay. The existing take-off structure for transmission line 5037 connected to Salem Substation will be modified to accommodate the new breaker-and-a-half bay. The additional bay modifications of the existing tubular bus will extend beyond the existing tower structure connection that serves the Salem transmission line. Since the existing Salem 500kV transmission line will remain connected to the existing tower, the modifications will include the scope of work in Section 2.1.1.1 above. The existing transmission line to Salem, although remaining on the existing tower structure, will connect to a new position on the additional breaker-and-a-half bay. As part of the new bay modification, the other tower structure will be extended with the addition of another breaker position feeding the new SVC system.

For the Salem Substation, a 500kV circuit breaker will be added to the center breaker-and-a-half bay 500kV AIS to create a new position. To accommodate a new position, the bus will be modified to include disconnect switches, terminators, and the circuit breaker as mentioned in Section 2.1.1.1. The modifications at Salem Substation will not increase the footprint of the existing substation, but will make use of the newly available position to connect to the SVC site.

From both Salem and Hope Creek, two options for connections from Hope Creek to the new SVC ring bus are proposed:

a) 500kV solid dielectric cable in precast cable trench
b) Gas Insulated Bus (GIB) routed above grade on support structures

2.1.3.2 *Orchard Substation*

The existing Orchard Substation is separated into three (3) sections with the northern section used for the 500kV substation and transmission circuits, and the southern section for the 230kV system. The middle section serves as a canal, protecting the Wentzell-Wilson Pond. The northern 500kV section of the substation contains a ring bus with a three (3) breaker AIS.

For the option of installing one SVC system, the design as requested by PJM proposes to modify the existing 500kV section of the substation by adding a breaker to the three (3) breaker ring bus to create a four (4) breaker ring bus 500kV AIS. Adding the fourth breaker will not require expansion of the fence line in Orchard; this applies to both the east and west connection as options. In the case where the alternative of two (2) SVC systems is preferred, one possibility is to add two (2) breakers to the three (3) breaker ring bus to create a five (5) breaker ring 500kV AIS. This configuration will allow for smaller physical size of SVC sites on both the east and the west sides of the current substation without increased footprint to the existing Orchard Substation. The SVC sites will thus be located on both the east and west sides of Orchard, requiring land purchases for both sites. Outages for this configuration will require de-energization of sections of Orchard for the physical installation as well as significant modifications to the relaying.

2.1.3.3 *New Freedom Substation*

The existing New Freedom Substation includes a four (4) bay breaker-and-a-half 500kV AIS substation and a five (5) bay breaker-and-a-half 230kV AIS substation, with both buses connected through transformers. The 230kV AIS bus is connected to a 200MVAR capacitor bank through a breaker and overhead circuits: W-2223 and C-2255 going to Silver Lake Substation connected to Phase Angle Regulators (PARs), K-2237 to Beaver Brook and R-2244 and M-2213 using the same ROW. In addition, there are four (4) building of varying size within the substation fence located to the southwest.

The proposed 500kV design, as requested by PJM, will add another bay to the PSE&G four (4) bay breaker-and-a-half 500kV AIS substation. The additional bay will have two (2) breakers if only one SVC system is installed and three (3) breakers for the alternative two (2) smaller rated SVCs. If the additional bay is installed either on the north or south side of the existing four (4) bay AIS, the substation will extend over the substation fence line and not fit in the present available space, and new AIS equipment may be close to the existing buildings. From the aerial view, a bay is approximately 60 ft. wide without clearance and 580 ft. long. Therefore, the required space would expand the AIS by 150 ft. wide to include clearance, which will displace a line pole running along the fence line and/or the existing buildings depending on the north or south location. The length will remain the same as the bays already installed are rated 500kV.

Examination of the Tax Map ID provided by PJM shows property boundaries around the New Freedom Substation where possible locations can be used to install the new SVC site and the expansion of the 500kV substation area to the north or south. Considerations should be given to forested area (Pinelands Reservation) when selecting the location of the SVC site as proximity to the station boundary may be a factor. Expanding the 500kV area to the southwest appears possible, but the additional bay will encroach upon present facilities including an overhead distribution pole line that will need to be relocated if the southern fence line is moved to the south. From the Tax Map ID, Attachment 7, the area southwest of the New Freedom Substation has the physical space for the SVC installations with the least amount of interruption to the 500kV system. However, the parcel of interest belongs to PSE&G and may be reserved for future expansion.

2.1.3.4 *SVC Station*

The SVC systems will include thyristor controlled reactors (TCR) with capacitor banks rated to meet the stability requirements in the range of -400/650 MVAR. This rating is relatively large when compared to SVC systems currently operating in the US. The alternative of installing two (2) smaller rated SVCs of equal rating may be considered for greater overall system reliability.

2.1.3.4.1 Artificial Island

The proposed SVCs are located east of the Salem Substation and the planned physical area for the installation of the SVC Substation and the SVC system is approximately 30 acres. This area is within the plant property, and is part of the Owner Controlled Area (OCA).

The diagrams presented in Artificial Island Proposed SVC – Attachment 6 provide conceptual configurations. However, there are physical interface issues with the proposed layout. The 500kV transmission lines from Hope Creek and Salem substations to the SVC site as proposed in the first option will use underground 500kV solid dielectric cables, in order to cross beneath other existing overhead 500kV transmission lines. The second option is to use gas-insulated bus to the SVC site. The underground trench for cables or support structures for gas-insulated bus will complicate this project. Using underground trenches might remove the issue of crossing beneath overhead 500kV transmission lines, but underground work may disturb the parking lot and possibly the Hope Creek Road leading to the nuclear plants. If the gas-insulated bus option is selected, the cost of the structures and the conductors to reach approximately 2600 ft.-3000 ft. per circuit will be a concern. In the provided proposal, the transmission lines connecting the Hope Creek and Salem substations are 500kV solid dielectric cables and are routed underground using precast cable trench.

Also to be considered is that 500kV solid dielectric transmission cables have rarely been used if at all in the United States. PSE&G has used high voltage solid dielectric transmission cables for inside plant purposes, but at lower voltage levels including 138kV and 230kV. Also, 500kV DC cables have been used in the past (Neptune), but 500kV AC solid dielectric transmission cables are not common.

The location of the Hope Creek and Salem substations is within the Protected Area (PA) of the nuclear plant. Careful planning between the transmission utilities and the generating plant owner is necessary to assure security integrity during the SVC project installation. At the SVC site, the available space is sufficient for the ring bus and for the installation of two (2) SVCs on each side of the ring. The installation of the SVCs will be within the OCA of the nuclear plant, requiring security clearance for contractors and equipment deliveries.

2.1.3.4.2 Orchard

Six (6) acres of land, adjacent to the Orchard Substation, will need to be purchased for a single SVC installation rated approximately -400/650 MVAR. For the alternative of two (2) smaller rated SVCs, the systems can be installed on both sides of the substation.

For the large SVC installation, placing the SVC site to the west of Orchard Substation appears to be a tight fit dependent on the actual space required for the SVC with the incoming 500kV circuit breaker placed ahead of the step-down transformers. With the SVC on the west side of Orchard, corners of the SVC site will encroach on the 500kV overhead line ROW on the northwest side, and encroach on the pond on the southwest side. If the Orchard west side position is selected, a possibility will be to merge the SVC site with the present substation site by removing a portion of the west substation fence, and extending the 500kV connection with rigid tubular bus. This concept may save space in the westerly direction so that the outside corners of the west side of the SVC site can avoid encroaching on the overhead line ROW and the pond. Purchase of land to the west is required; this land is presently active farmland.

Similarly, placing the SVC site to the east of Orchard requires land acquisition that is also active farmland. Dependent on how far to the east the new land can be acquired, the SVC site can be separated from the existing substation site, which is preferable for construction and operation. The 500kV overhead connection from Orchard to the east SVC site will need an overhead transmission line, with a relatively short span (approximately 300 – 500 ft.). Alternatively, the SVC site can also be merged with the substation site on the east side if land acquisition is limited, and the 500kV overhead connection will be shorter. An additional complication is an existing distribution pole line running along the east side of Orchard. The 500kV transmission line to the east SVC would cross over this distribution pole line, but if the SVC site is merged with the east side of Orchard, then this pole line would need to be relocated.

For the alternative of the smaller SVCs, these systems should be installed on both sides of the substation to maintain the same substation footprint. Nevertheless, the same concerns mentioned above remain. Two (2) new breakers would be added to the Orchard three (3) breaker ring AIS to create two (2) additional positions. Since the SVC will be smaller in size and physical dimensions, encroachment may be less of an issue for the installation on the west end of the substation, but still a concern. In this case, farmland will need to be acquired on both sides of the substation.

2.1.3.4.3 <u>New Freedom</u>

The location for the installation of the SVC facility near the New Freedom Substation has not been selected at this time. However, in order to accommodate this new facility, new land acquisition near the substation will be necessary. About 180 acres of property outside the existing fence line and surrounding New Freedom Substation belongs to PSE&G. Other parcels of land with minimal amount of issues are either close to Pineland Reserves, residential areas or belong to farmers. Regardless of the options selected for the installation of SVC systems near New Freedom Substation, new land will be required for the SVC site. The expansion of the substation will require a considerable effort as the present fence line will need to be moved to make space for the new 500kV connections. For the two (2) smaller SVCs alternative, the new breaker bay will include three (3) breakers creating two (2) new positions for 500kV connections.

At New Freedom, placing the SVC site to the east, north, or south of the existing substation may not be possible due to multiple issues including proximity to the Pinelands Reserve, encroachment on the ROW of existing overhead transmission lines and proximity of the 500kV system to the ROW. Placing the SVC site to the southwest of New Freedom will need PSE&G property that is not used at this time.

2.2 Milestone Schedule

An overall milestone schedule has not yet been developed for the SVC project. Since the actual location and configuration of connections to the existing substation(s) are not yet determined, only a conceptual schedule can be defined at this time. From the proposal requested by PJM for Orchard, a general timetable was given. An estimated field installation for one SVC system rated -400/650 MVAR may vary between 18 to 20 months. The first phase of the overall project will begin with land purchase and engineering design. Since minimal information is given for the overall project, the 20 months will serve as the starting point for the completion of the project.

There is no milestone schedule given for the New Freedom Substation and the AI substation projects. The field installation of the SVC facility can be assumed to be about the same as for Orchard: 20 months or less.

Where specific information has not been provided, estimated schedules have been developed, see Section 4.0 of this Report.

2.3 Overall Estimated Project Cost

A cost estimate for the SVC project near AI has not been prepared at this time.
The total cost estimate for the Orchard Substation is about $66.3M to include land acquisition, environmental, permitting and regulatory issues, engineering, substation material and construction, with project management, owner's overhead and Allowance for Funds Used During Construction (AFUDC) cost.

A conceptual level overall cost estimate for the SVC installation near and connected to the New Freedom Substation is provided as part of the design requested by PJM. The estimate is based on the Loudoun East Substation SVC project rated -300/500 MVAR (PJM RTEP project b1798), which had a detailed cost breakdown. Since the cost estimate is based on a previous project, the proposed total cost estimate amounts to $74M. The estimate does not include risk and contingency and land acquisition.

Where specific information has not been provided, estimated costs have been developed (see Section 5.0).

2.4 Potential Risks to Successful Project Completion

The options for SVC installation at either the AI substations, Orchard Substation or near the New Freedom Substation present risk and complexities as identified below:

2.4.1 Overall Risk Issues

Modifying an existing 500kV substation and installing a nearby SVC installation involves the following risk elements:

- Modification to the existing 500kV substation requires coordination with the operating utility because outages on segments of the 500kV system or substation will be required. At New Freedom, expansion of the substation fence line will be needed to install the additional bay. At Orchard, the modifications can be performed within the confines of the existing station, but multiple outages will be required. At AI, not only will modification of the existing substations be required in the protected area, the SVC site located at the owner controlled area will require coordination with the nuclear generating station and its security team.
- Transmission lines at AI may be a concern as proposed. Underground 500kV solid dielectric cables installed in underground cable trench have rarely been used in the US. Also, it may disturb the road and the parking at the nuclear site. Gas-insulated transmission lines at 500kV are a proven technology, but will greatly increase project cost because the connection to the SVC four ring AIS bus is approximately 2600 ft. from Hope Creek Substation and approximately 3000 ft. from Salem.
- Land acquisition for the SVC site is needed. Approximately 6 acres will be required for one SVC of the approximate rating of -400/650 MVAR. For the alternative of two (2) parallel SVCs, an approximate area of 4 acres per SVC is required to provide adequate space to include all the equipment with road access and a control building. The SVC site will be interconnected to the 500kV substation via overhead conductors for Orchard and New Freedom substations, whereas; underground or gas-insulated transmission lines will be used at AI. For New Freedom, the location of the SVC site is not known, but is likely to be in PSE&G-owned land to the southwest, to avoid the Pinelands around the other sides of the station. For Orchard, the SVC might fit to the west, but would fit better if placed to the east of the substation. Regardless of east or west sides, farmland would need to be purchased. Locating the SVC is dependent on a farmer willing to sell six acres. Also, in the case of two (2) parallel SVCs, a total of eight (8) acres or more will be need to be purchased, split between both sides of the Orchard Substation. Some wetlands exist around both Orchard and New Freedom; however, the SVC location and modifications to the substations will likely avoid wetlands intrusion, minimizing permitting risk due to wetlands. At AI, there are wetland areas around the proposed location and the location of the SVC site should be selected to minimize wetlands disturbance.
- SVC equipment is noisy and procurement of low noise reactors and transformers adds cost. Depending on results of a complete noise analysis, sound walls around several sides of the SVC site may be needed, adding cost. Placing sound walls on three (3) sides is anticipated as the worst case, requiring $1.5M to be added (may not be that necessary at AI).

- The overall project schedule is dependent on both the turnkey design, including fabrication and installation of the SVC system, as well as modifications to the substation and installation of the 500kV transmission lines connecting the substation to the SVC system. At least 24 months is required for the SVC system, with several additional months for completion of commissioning for Orchard and New Freedom. The substation modifications and transmission line installation can likely be done concurrently within the nominal 24 month time frame. Additional time should be included for permitting and approvals, as well as negotiations and procurement of the six acres needed for the SVC site. The overall project duration should be considered as a minimum of 30 months. For AI, additional time should be added for planning and negotiations with the generating stations, the utilities, the contractors, the Nuclear Regulatory Commission (NRC), and other regulating authorities. For AI, the project schedule should extend an extra 3 months for an overall project duration of a minimum 33 months.
- The requirements when performing work at a nuclear power plant are very stringent and the design requires NRC approval before the project moves forward. This can severely impact the schedule for project completion.
- The cost of the SVC system has been estimated without detailed geotechnical information that could impact the estimated costs of foundations and possibly require pile supported foundations. After a site is identified for the SVC system, geotechnical investigation should be performed and civil/structural costs should be re-estimated. For AI, underground solid dielectric cable or gas-insulated transmission lines will affect the cost of the overall project because the distance is approximately 2600 ft. - 3000 ft. from the existing substations to the location of the new 500kV ring bus serving the SVCs. The cost of GIB installed on steel structures with normal ground conditions is approximately $54M for the SVC project at AI. The estimated installed cost for 500kV solid dielectric cable is approximately $6M, significant less costly than GIB.
- The SVC system is state-of-the-art concerning FACTS (Flexible AC Transmission Systems). As such, technology is proven, but still evolving, especially with respect to active control of the reactive power components and mitigation of harmonic content. Restrictive specifications for precise control and lower harmonics will increase costs as well as design, fabrication and commissioning time. The use of 500kV XLPE solid dielectric cables for underground circuits is also a concern with regard to proven technology.

2.4.2 Artificial Island Substations

- For AI, there are approximately 30 acres available for the installation of two SVCs in the owner controlled area (OCA) at the nuclear plant. The proposed area is larger than necessary for the installation of the SVC systems. However, there are some issues associated with installing the SVC near Hope Creek and Salem Nuclear plants. First, the property in question is located in the OCA of PSEG Nuclear LLC. Working near and within protected areas (PA) of a nuclear plant requires coordination with the NRC, security and other regulating authorities. The owner of the SVC will have to coordinate with PSEG Nuclear including NERC and Plant Security, PSE&G, and contractors. Careful coordination, planning and negotiations between the transmission utilities, the generating plant owner, contractors and other parties involved is necessary for the SVC project completion at AI. Plant Security will be involved during this project as construction will take place in the PA of two (2) nuclear plants. Consequently, the project schedule and budget may be affected. In case the proposed land is not available, other sites outside of the nuclear plant OCA should be investigated.

- Wetlands around the proposed location next to the AI nuclear plants should be investigated in more details for updated wetlands information. The wetlands survey was produced in the 1990s and the SVC should be installed to mitigate disturbance to wetlands. However, if the land will be purchased outside of the OCA, wetlands should be investigated.
- Efforts for the SVC commissioning and testing, as well as protective relay setting and checkout, will also require increased attention and coordination as generation plant owners and transmission utilities, and PJM will have to be involved.
- Permitting activities may result in significant unanticipated delays in the project schedule, since the SVC will be located in the OCA and substation modifications are in the PA.

2.4.3 Orchard Substation

- Acquisition of land at Orchard may be difficult due to orchard fields and other farm land surrounding the substation. The present land is being used for active farming and the landowner may not be inclined to sell six (6) acres of land (See Figure 4, Attachment 2). It may be even more difficult to purchase a minimum of eight (8) acres in the case of the two (2) smaller SVCs. Land to the east of the substation has enough space for a potential SVC installation, but locating the SVC site to the east involves more complex modifications in the existing substation to add the ring bus breaker and the 500kV transmission line take-off structures, and the new transmission line to the SVC will be approximately 300 – 500 ft. in length. To the west of the substation, the modifications to the AIS ring bus will be less complex when compared to installing the SVC to the east; however, the property is bounded by Wentzell-Wilson pond and the 500kV overhead transmission lines and the SVC may not fit to the west, see Figure 3, Attachment 2. Regardless of whether the SVC is located to the east or west of the existing substation for any case, farmland must be purchased for the new SVC facility. Contact with the landowners should be initiated and negotiations should commence as soon as possible, to mitigate risks that the planned SVC station can actually be located as desired. Actual allowance for purchase costs of the needed land parcel should be at least higher than the $2M cost shown in the proposed estimate.
- The estimated cost for the Orchard Substation modifications and installation of the new SVC facility totals $66M. This amount does not include any risk and

contingency and only includes inductive reactors (negative MVARs). Budgetary costs of a turnkey SVC system are considered to be approximately $60M, not including the modifications to the existing substation and land purchase costs. Using the cost estimate data provided in the proposal, all costs other than the SVC system total approximately $14M.

2.4.4 New Freedom Substation

- Land acquisition at the New Freedom Substation is unknown at this time and depending on the location of the SVC facility, an overhead connection will be required from the added breaker-and-a-half bay at New Freedom Substation to the SVC facility. With Pinelands Reserve close to the New Freedom Substation on the east (Attachment 3), the better and viable location for the installation of a new facility for the SVC may be to the southwest of the New Freedom Substation on PSE&G owned land.
- Modifying the New Freedom substation for one or two new 500kV line positions to connect to SVC installation will require expansion of the 500kV breaker-and-a-half system at New Freedom. For modifying the 500kV AIS station, this interface may be time consuming and should be defined when a detailed project schedule is prepared.
- Permitting activities may result in significant unanticipated delays in the project schedule, depending on the SVC locations.
- The cost estimate from the proposal amounts to $74M for the SVC facility and the expansion at New Freedom. Although the cost estimate includes some margin as mentioned for the circuit breakers, this estimate does not include risk and contingency. Also, the land acquisition has not been finalized. This cost estimate is based on the Loudoun East Substation SVC project rated -300/500 MVAR (PJM RTEP project b1798), but does take into account substation modifications. This cost estimate was an expansion and installation of a new SVC facility at their own substation where an estimate can be more accurate with plans and future expansions readily available at their discretion. As the previous cost estimate may be a good starting point, the project cost can balloon rapidly as the project moves on to planning and implementation.

2.5 Executive Summary of Findings

This constructability assessment consists of modifying one or two existing 500kV substations, either at Artificial Island (two substations: Hope Creek and Salem), Orchard Substation or New Freedom Substation, to obtain one or two new 500kV line positions that will connect to a Static VAR Compensator (SVC) installation that will supply either positive or negative reactive power to the 500kV system. The SVC system may be one system or may be split into two parallel SVC systems. The proposed configuration for Artificial Island is based on two 500kV connections and two parallel SVC systems located adjacent to a new 500kV ring bus substation serving the SVC project. For Orchard and New Freedom, the base configuration is one new 500kV connection to one SVC system, with an alternate configuration with two new 500kV connections (from the single substation) serving parallel SVC systems. Each SVC system will be configured as an outdoor substation containing transformers, reactors and capacitors, with a complex control system contained in a building. The single SVC system requires a site that is approximately 500 ft. x 500 ft. For the configuration of two parallel SVC systems, each SVC system will need a site approximately 300 ft. x 300 ft.; the actual site configuration is dependent on configuration of the 500kV connections (incoming line connections, breakers and disconnect switches, etc.) and the configuration of the 500kV step-down transformers serving the SVC systems. Several factors (such as reliability, operating configuration and maintainability, etc.) that may affect the decision to use one SVC system or multiple parallel SVC systems are not within the scope of this constructability assessment.

The results of this study indicate that the SVC system project is considered feasible for installation at all the proposed locations, with some challenges and concerns for all sites. For AI, coordination with the nuclear plant for access within the secured areas and physical layout of the proposed interconnections are the most significant concerns. The 500kV solid dielectric cable installed in underground cable trench, or gas-insulated-bus (GIB), to connect the new line positions in Hope Creek and Salem to the new 500kV SVC ring bus, add significant cost and complexity to the project. An alternate configuration using overhead transmission lines from Hope Creek and Salem to the new SVC ring bus is possible if two existing overhead 500kV transmission lines are relocated in the vicinity of this project. Interconnections from Orchard and New Freedom are less complex and less costly, since these connections will be overhead via short transmission lines or possibly rigid aluminum tube buswork on station post insulators if the SVC systems are located close to the existing substation (which is more likely for Orchard than for New Freedom).

For the SVC installation at all sites, the owner of the substation(s) must provide new 500kV line positions to connect to the SVC installation. Complexity, cost, schedule and interfaces are more complex if the SVC project is executed by a different entity than the owner of the substation(s).

- Complete specific vendor quotations for a turnkey (i.e. design, fabricate, deliver, install, commission) supply of the SVC system (rated -525/525MVAR) have not been obtained for the submitted proposals. Burns and Roe obtained budgetary quotations from multiple suppliers in order to assess the cost and schedule duration for purposes of this study. In order to proceed further, a complete specification (in accordance with IEEE 1031, Guide for the Functional Specification of Transmission Static Var Compensators) should be prepared and real quotations from suppliers should be obtained. Geotechnical information for the proposed site(s) should be included so that the suppliers can include accurate costs for foundations. The results of the Burns and Roe budgetary quotations indicate that the SVC system cost is approximately $60M (installed, for a single

SVC system) and a schedule of 24 months (minimum) is required. Splitting the SVC system into two parallel SVC systems adds approximately 10 percent to the cost, not including the 500kV system modifications and interconnections. Although the budgetary quotations included commissioning of the SVC system in the cost and schedule, Burns and Roe recommends that additional time and cost allocation be included for the commissioning of the SVC system (as described in Sections 4.0 and 5.0 of this study, and as shown in the cost estimate prepared by Burns and Roe, Attachment 4).

- Adding a single 500kV line position to Orchard will require modification of the existing ring bus, with one (1) 500kV circuit breaker and line take-off added. The modifications will not require expansion of the substation, and this issue does not present significant risk. Adding two line positions to Orchard will increase the modification to the ring bus, but risk is also minimal, except that additional outages will be required.
- Adding either a single 500kV line position or two new 500kV line positions to New Freedom is more complex, requiring the addition of a new bay to the 500kV AIS breaker-and-a-half station. By examination of satellite images, Burns and Roe considers that the New Freedom fence line (for the 500kV station area on the south side) will need to be moved to gain space for this new bay. The property outside the fence is owned by PSE&G, but permitting for this expansion will be more complex than the permitting for Orchard (because the Orchard fence line will not be expanded). The permitting does not present significant risk since the expansion area does not appear to be wetlands.
- The location of the SVC site is the most significant concern for this project. The ideal location is adjacent to the interconnecting substation. For Orchard, sufficient space is available on both the east and west sides of Orchard, however, the land is in active use as farmland. On the west side of Orchard, the available space is constrained by existing overhead transmission lines and a pond, causing the location and layout of the SVC system to possibly be constrained (depending on actual overall size to be determined by the supplier). On the east side, the available space does not have similar constraints, so the east side of Orchard appears preferable. Approximately six (6) acres of land must be purchased for a single SVC site, and the risk is that the present landowners (farmer to the east; farmer to the southwest) may not be willing sell six acres to a utility company. Burns and Roe has considered the land acquisition cost as $4M in the cost estimate. If two parallel SVC systems are considered, land acquisition cost will increase and land on both the east and west sides of Orchard will need to be acquired. The cost of land acquisition for parallel SVC systems will probably double, to approximately $8M. Permitting of the site(s) at Orchard (either east or west sides) will be necessary, but is not considered to be a significant risk, since the sites do not involve wetlands. The 500kV transmission line(s) from Orchard to the SVC site(s) will be short and each will likely require only one transmission structure (dead end terminus at SVC site), in addition to the take-off structure(s) that will located within the Orchard substation.

- Locating the SVC site near New Freedom is more complex and presents a moderate risk. The land directly to the east of New Freedom is forested and identified on the wetlands map as such; further to the east is the boundary of the Pinelands Reserve. Locating the SVC site to the east of New Freedom is not considered practical without further detailed investigation of the feasibility of land purchase (in the forested area, not in Pinelands Reserve) and permitting. North of New Freedom there are residential developments, so this direction is also not considered practical. Going southwest from New Freedom, satellite images indicate farmland, and locating the SVC site to the southwest of New Freedom is considered as the recommended location. The property outside the substation fence that is owned by PSE&G is more than sufficient for the SVC. If parallel SVC systems are connected to New Freedom, both SVC systems will likely share that same site, and the land acquisition (size and cost) will essentially remain the same as for the single SVC system. The interconnection from New Freedom to the parallel SVC systems will require two 500kV circuits, but these circuits could be routed on common structures, with an incremental cost adder of $2M (changing the transmission line cost to $8M).
- Locating the SVC system at Artificial Island presents the most challenging situation, since land acquisition from PSEG Nuclear is required, significant modifications to Hope Creek and Salem substations are required, 500kV transmission interconnections to the SVC 500kV ring bus are a significant problem due to location and cost, and the complexity of the project is more significant due to the design and construction of a complete new 500kV four-breaker ring bus substation in addition to the parallel SVC systems.

An overall project duration of 33 months has been considered for Orchard and New Freedom, allowing several months initially for site acquisition and commencement of permitting. The substation modifications are considered to be performed concurrently with the SVC fabrication and construction. For Artificial Island, however, the duration will be significantly longer, due to complexity of the project as well as coordination with the nuclear plants for access and outages and modifications to the site.

Overall costs are estimated as $85M for New Freedom and $77M for Orchard. A detailed cost estimate should be prepared after selection of the substation (either Orchard or New Freedom) and after supplier quotations have been obtained for the -525/525MVAR system. These total costs include 15% for risk and contingency.

A matrix summarizing the constructability criteria is provided in Attachment 9.

3.0 Regulatory Risk

The regulatory risks for the SVC project at Artificial Island, Orchard or New Freedom are presented in this report as a preliminary review of potential environmental and regulatory impacts and summarized as follows:

Overhead Transmission

- Wetland acquisition in the form of "Freshwater Forested/Shrub" may be required at New Freedom to support possible expansion of ROW or new ROW for transmission towers connecting the PSE&G New Freedom Substation to the SVC project. This is a minor issue as the amount of potential disturbance is small.

Substations

- For substation modifications for Orchard that do not involve expansion outside the present fence line, permitting and submittals to NJ DCA are somewhat routine and do not present any appreciable risk.
- For substation expansions or new substations outside the present fence line (New Freedom and Artificial Island), permitting and submittals to NJ DCA will likely be more complex, and may involve consideration of wetlands, flood elevations and remediation if required. These risks will require further assessment when more detailed information is available concerning the actual substation expansion.
- Acquisition of land adjacent to Artificial Island, or Orchard, or New Freedom, is not expected to require soil remediation, so there is minimal risk for remediation of contaminated soil. Land to the west of Orchard is bounded to the south by the Wentzell-Wilson pond and disturbance of the pond should be avoided.

3.1 General Path Feasibility

The information provided by PJM for this evaluation is very preliminary. Therefore, Burns and Roe used the satellite images to assess physical configuration based on a similar SVC project to support this evaluation for approximation of real estate requirements. In addition, budgetary information from major vendors was obtained and used for Burns and Roe's independent conceptual cost estimate evaluations.

3.2 Public Opposition

Orchard Substation is not located in a highly populated area, but near farm land. New Freedom on the other hand is located near residential neighborhoods and surrounded with transmission lines. Noise emitting equipment should be buffered to meet noise regulations near the residential area.

Obtaining municipal approvals and planning the necessary road closures/detours from each affected municipality and other concerned authorities can be a significant challenge. At Orchard Substation, the number of buildings affected by road closures/detours is limited and this issue may have a small impact. However, at New Freedom, road closures/detours may have a bigger affect as the substation is bounded by residential areas to the north, west and south.

Constructing the modifications to Hope Creek and Salem, and constructing the new ring bus substation and associated SVC systems at Artificial Island is not likely to be opposed since the area is entirely within the nuclear plant property.

3.3 Permitting and Environmental

New Jersey Department of Environmental Protection (NJDEP) freshwater wetlands permitting is required for each area where more than one acre of wetlands will be permanently disturbed as a result of this project. In accordance with NJDEP's "No Net Loss Policy", wetlands permitting will require creation of two acres of wetlands for every one acre of disturbed land. Joint U.S. Environmental Protection Agency (EPA) and U.S. Fish and Wildlife Services review will be required if more than five (5) acres are disturbed. Approximately 1.5 years is anticipated for the NJDEP freshwater wetlands permitting planning, submittal, and review and approval process.

A Notice of Proposed Construction or Alteration approval from the FAA is required for any structure greater than 200 feet above ground level or for a structure within 20,000 feet of a large airport or seaplane base with a height in excess of the slope criteria, i.e., 1 foot vertical per 100 feet horizontal.

Other permits may include:

- NJDEP Wetlands General Permit for aboveground utility work (tower installations and footings)
- NJDEP Wetlands General Permit for underground utility work
- NJDEP Stormwater Discharge Permit
- NJDEP Stream Encroachment Permit

The requirements of the NJDEP wetlands general permit for aboveground utility line work limits the temporary disturbance of wetlands during construction for vehicle and equipment access, if necessary, to no more than 60 feet wide from the Right-of-Way boundary with a requirement for the wetlands to revert to their natural condition. For any permanent disturbances of wetlands equal to or greater than one acre, an NJDEP freshwater wetlands permit application will be required and involve extensive permit preparation, planning, and possible review by the U.S. Fish and Wildlife Service.

Permitting for the SVC site is dependent on the identified location, which will be determined when the project has moved to the next stage.

3.3.1 Wetlands

The level of effort required to obtain approval for wetland disturbance will depend on the nature of the disturbance. To determine whether or not an area of freshwater wetlands, transition areas or State open waters may be disturbed by any proposed activity, detailed information about that wetland and the site must be obtained. In addition, an inspection of the property by a representative of the NJDEP is required. The NJDEP offers a "Letter of Interpretation" (LOI), which is a document that describes the location of wetlands on the proposed property.

Nevertheless, a review of the U.S. Fish and Wild Service (FWS) website did not indicate any large presence of wetlands in the proposed location for Orchard. A large portion surrounding the New Freedom Substation contains "Freshwater Forested/ Shrub." The location of the SVC is not specified at this time and permits will be needed for the disturbance of potentially six (6) acres of this type if the SVC is located to the east of New Freedom.

The SVC project sites (at Artificial Island and near Orchard or southwest of New Freedom) are not located in areas with a large presence of freshwater wetlands, so wetlands intrusion is a minimal issue for this report.

3.3.1.1 *Transmission Lines - Above Ground*

Regulatory agencies recognize the unique nature, in terms of environmental impact, of certain project types. Specific to the PJM Constructability evaluation, the upgrades of existing above ground utility lines can be permitted via General Permits offered by the NJDEP for the class of projects defined as "Above Ground Utility Lines". Requirements are addressed under "General Permit 21 or GP-21. To be eligible for a GP-21, the temporary disturbance during construction cannot be more than 60 feet wide, and the permanent disturbance at the conclusion of the project cannot be more than a 1/2 acre or wider than 20 feet.

Activities under this general permit must not interfere with the natural hydrologic characteristics of the freshwater wetland (FWW), transition area (TA), or State Open Water (SOW). If the applicant has to place the utility line on pilings to avoid this issue, that that may be a requirement to satisfy this condition. The main concern here is the inadvertent creation of a "French drain" or other type of structure that would act to drain or otherwise alter the FWW, TA or SOW. If the SVC project is located to the west of the Orchard Substation, the pond must be protected against drains or any disturbance/ contaminations that may occur during construction.

The Permittee is also required to mitigate for all permanent loss and/or disturbance of 0.1 acres or greater of freshwater wetlands and/or State open waters.

3.3.1.2 *Utility Lines - Below Ground*

General Permit 2 or GP-2 covers underground utility lines. GP-2 authorizes activities in freshwater wetlands, transition areas, and/or State open waters, necessary for the construction and/or maintenance of an underground utility line. This could be anything from a gas line to placement of fiber optic telecommunication cable; generally any linear disturbance intended for a utility line.

If a utility line is jacked or directionally drilled underground, so that there is no surface disturbance of any freshwater wetlands, transition areas, or State open waters and there is no draining or dewatering of freshwater wetlands, then NJDEP approval is not required. Directionally drilled utility lines, if improperly constructed, have the potential to act as "French drains", in essence creating a conduit for water to flow. As such, it is important to implement measures such as anti-seep collars to prevent movement of water. In addition, perched water on which a wetland system may depend could be the result of a "clay lens" which, if punctured by construction of a utility line, can alter a wetland system.

A GP-2 may be combined with other general permits or permits provided the total disturbance of all GPs do not exceed the one acre threshold for multiple general permits.

3.3.1.3 *Substation Installation or Expansion in Wetlands*

NJDEP freshwater wetlands permitting is required for each project where more than one acre of wetlands will be permanently disturbed as a result of an installation or expansion. In accordance with NJDEP's "No Net Loss Policy", wetlands permitting will require creation of 2 acres of wetlands for every one acre of disturbed land. Joint U.S. Environmental Protection Agency (EPA) and U.S. Fish and Wildlife Services (FWS) review will be required if more than five (5) acres are disturbed. The SVC Station near New Freedom may disturb approximately six (6) acres of forested shrubs and will trigger review from NJDEP and other concerned authorities.

3.3.2 Federal Aviation Administration (FAA)

A Notice of Proposed Construction or Alteration approval from the FAA is required for any structure greater than 200 feet above ground level or for a structure within 20,000 feet of a large airport or seaplane base with a height in excess of the slope criteria, i.e., 1 foot vertical per 100 feet horizontal.

This project will not involve high structures and thus FAA approval will not be required.

3.3.3 Streams and Rivers

The Flood Hazard Area (FHA) Control Act Rules New Jersey Administrative Code (N.J.A.C.) 7:13, adopted on November 5, 2007, implement the New Jersey Flood Hazard Area Control Act, N.J.S.A. 58:16A-50 et seq.,

Unless properly controlled, development within flood hazard areas can exacerbate the intensity and frequency of flooding by reducing flood storage, increasing stormwater runoff and obstructing the movement of floodwaters. In addition, structures that are improperly built in flood hazard areas are subject to flood damage and threaten the health, safety and welfare of those who use them. Furthermore, healthy vegetation adjacent to surface waters is essential for maintaining bank stability and water quality. The indiscriminate disturbance of such vegetation can destabilize channels, leading to increased erosion and sedimentation that exacerbates the intensity and frequency of flooding. The loss of vegetation adjacent to surface waters also reduces filtration of stormwater runoff and thus degrades the quality of these waters.

The Flood Hazard Area Control Act rules, therefore, incorporate stringent standards for development in flood hazard areas and adjacent to surface waters in order to mitigate the adverse impacts to flooding and the environment that can be caused by such development. Attachment 5 of this Report contains a copy of the NJDEP Stream Encroachment Administrative Checklist.

A utility line or substation that is proposed in a tidelands area may require a tidelands license if the activities are taking place at or below the mean high water line of a tidal waterway or a tidelands grant if any portion of the activities are taking place in an area that is currently landward of the mean high water line but was, at some point, flowed by the tide.

None of the SVC sites are located in flood areas and as such the risks associated with floods and permit issues are minimal to the development of the project.

3.3.4 Other Possible Permits / Requirements

Depending on the nature of the project, additional permits may be required, as noted below.

3.3.4.1 *NJDEP Stormwater Discharge Permit*

The stormwater discharge permit program is responsible for protecting New Jersey's ground and surface water quality by assuring the proper treatment and discharge of wastewater (and its residuals) and stormwater from various types of facilities and activities. With respect to the expansion or installation of new substations including the SVC project, this permit would cover construction activities, as well as discharges during operation (which from a substation, would mostly involve assurance that vessels containing transformer oils and lubricants are properly operated, maintained and inspection in terms of minimizing the chance of potential spill. A temporary operation such as a concrete batch plant to support tower foundation construction would be permitted under a General Permit for Concrete Products Manufacturing (CPM).

3.3.4.2 *NJDEP Air Permit*

The installation of a temporary concrete batch plant could also trigger a requirement for obtaining a NJDEP air permit for emissions associated with raw and final product material handling. Pollutants of concern would be dust from dry material handling (aggregate, sand, etc.). Use of fabric filter controls during material handling and transfer may need to be applied.

3.3.4.3 *Local Noise Requirements*

Local or overriding state noise requirements would need to be reviewed in determining acceptable construction practices (i.e., limits on evening construction activities that would generate noise or use of helicopters in erecting transmission line towers.

3.3.4.4 *Spill Prevention Control and Countermeasure (SPCC)*

Under 40 CFR 110 & 112, and the legal authority of the Clean Water Act, the Discharge of Oil regulation, more commonly known as the "sheen rule", provides the framework for determining whether an oil spill to inland and coastal waters and/or their adjoining shorelines should be reported to the federal government. In particular, the regulation requires the person in charge of a facility or vessel responsible for discharging oil that may be "harmful to the public health or welfare" to report the spill to the federal government. The regulation establishes the criteria for determining whether an oil spill may be harmful to public health or welfare, thereby triggering the reporting requirements, as follows:

- Discharges that cause a sheen or discoloration on the surface of a body of water;
- Discharges that violate applicable water quality standards; and
- Discharges that cause a sludge or emulsion to be deposited beneath the surface of the water or on adjoining shorelines.

Because the Oil Pollution Act of 1990, which amended the Clean Water Act, broadly defines the term "oil," the sheen rule applies to both petroleum and non-petroleum oils (e.g., vegetable oil).

Oil contained within a substation (i.e., transformers) or within underground piping would likely be regulated under the SPCC regulations provided minimum applicability threshold quantities are exceeded (aggregate above ground capacity of 1,320 gallons, including the totals of all material stored in containers greater than 55 gallons in volume). An interpretation of whether oil contained in underground piping would or would not be counted in the 1,320 gallons above ground capacity applicability threshold once the pipe is brought above ground to change out the cable would need to be made. Regardless of applicability, it is recommended that a standard operating procedure governing safe handling of oil contained in the underground pipes during cable change-out should be developed and implemented to minimize the risk of an accidental spill.

3.3.5 Permitting and Environmental Review Conclusions

The SVC project was reviewed with respect to potential regulatory issues. This preliminary review was performed for potential environmental and regulatory implications associated with this project at Artificial Island, Orchard and New Freedom. The review was based on a desktop assessment, using Google Maps, of wetlands, FAA limitations, Pinelands, FEMA flood data and stream encroachments at the substations. These regulations could include, but not be limited to, stormwater management/sediment control, spill prevention, noise limits and NJDEP air permitting.

At this point, nothing was found that could be considered a fatal flaw to the project. The review indicated:

- Wetlands may be impacted for the new transmission line between New Freedom and the SVC site. Use of the NJDEP General Permit for Above Ground Utility lines would expedite the approval process, although wetland issues will pose the greatest challenge in terms of project schedule owing to typical long-lead times in gaining approvals.
- Stream encroachment permits may need to be filed to the NJDEP; again general permits are available.

For the SVC project at Artificial Island, the Nuclear Regulatory Commission (NRC) must be informed. Detailed plans to maintain security and allow access to the substations and site areas must be prepared.

4.0 Schedule Analysis and Assessment

Detailed schedules have not been developed at this time, but the SVC project duration can vary from a minimum of 33 months (Orchard) to a maximum of 48 months (Artificial Island).

A total duration of less than 33 months is possible, but aggressive and may be a difficult target for this project. Interface with SVC suppliers indicates that 24 months is a recommended duration for the SVC design, fabrication and installation. At least 3 months additional is recommended for commissioning. A detailed project schedule should be prepared to demonstrate that the schedule is achievable. The detailed project schedule should include permitting approval of various regulating authorities, engineering, site preparation and development, EPC contracts and modifications for interconnection with the selected existing substation.

In order to allow adequate time for land acquisition, permitting and planning, an additional 6 months should be added at the front end of the project schedule, thus resulting in a total duration of 33 months:

- 6 months land acquisition and permitting submittals
- 24 months for SVC design, fabrication and installation
- Substation modifications concurrent with SVC for Orchard; for New Freedom an additional 6-7 months are considered due to modification of substation.
- 3 months commissioning

Additional time should be added for the Artificial Island SVC project as more coordination with generation plant owner is needed and the scope of work is greater. Also, the requirements for NRC approval will have an impact on design and schedule.

5.0 Cost Analysis and Assessment

There were some conceptual cost data provided in the design proposals provided by PJM. These cost estimates are preliminary and did not cover all potential costs and also did not match the desired capability of -400/650MVAR (which may be revised as described in 2.1.1).

In order to provide an assessment of the cost estimates, Burns and Roe obtained budgetary pricing of a turnkey SVC installation rated -525/525MVAR from several suppliers. The SVC turnkey costs are thus estimated at $60M for a single SVC system; note that the foundation costs included in this $60M are not based on complete geotechnical information.

In order to completely assess the total project costs for each possible site, an estimate has been prepared as shown in Attachment 4 of this Report.

The project costs for the installation of one SVC system include:

- Adding one (1) 500kV dead tank breaker to Orchard, or adding two (2) 500kV dead tank breakers to New Freedom. Total costs for the breaker additions need to include disconnect switches, structures, foundations, and a take-off structure for the overhead line that will connect to the remote SVC site.
- One (1) 500kV dead tank circuit breaker to serve as an incoming circuit breaker ahead of the step-down transformers at the SVC site.
- One complete turnkey SVC installation (includes single phase step-down transformers and entire SVC system). SVC pricing excludes the 500kV input breaker. Foundation costs for the SVC system have been estimated without the benefit of geotechnical information.

- 500kV overhead transmission line from the substation to the SVC site. For Orchard on the west, this line will be short (approximately 200 ft.); for Orchard on the east, the line will be slightly longer (approximately 400 ft.). For New Freedom, the transmission line may be as long as 1 mile, to reach a suitable SVC site going southeast of New Freedom.

For the modifications to the substations for the 500kV connection to the SVC system, the cost of a 500kV dead tank circuit breaker is estimated at $350K. An additional $200K per breaker is considered for disconnect switches, buswork and structures, and $300K per breaker is considered for installation labor and testing/commissioning. There is no geotechnical information that would allow accurate estimating of foundation designs, however, an allowance of $200K per breaker position is included for foundations. $200K will also be included for modification of protective relaying at Orchard, and $300K for modification of protective relaying at New Freedom. Using these values, one additional circuit breaker at Orchard is estimated at $1,250K; the two additional breakers at New Freedom are estimated at $2,400K.

For the likely configuration of parallel SVC systems, additional breakers are required as detailed in Attachment 4.

For a single SVC system, the estimate for the incoming circuit breaker at the SVC site will be the same as the single breaker at Orchard: $1,250K.

For the 500kV transmission line costs to connect the substation to the SVC system, a budgetary cost of $6M per mile will be assumed. For the New Freedom 500kV transmission line to the unknown SVC location, $6M will be included in the cost estimate. For the short transmission lines needed for Orchard, a cost of $500K will be used for both east and west configurations. These transmission line costs include the conductors, insulators and structures.

Using the above estimating basis, the costs for a single SVC system at either Orchard or New Freedom are estimated as follows:

- SVC located adjacent to Orchard: $77.6M (includes $4M for land purchase; and 15% on the total to cover risk and contingency)

- SVC located approximately one mile southwest of New Freedom: $85.3M (includes $4M for land purchase; and 15% on the total to cover risk and contingency)

The above cost estimate totals are considered budgetary and preliminary and do not include sound walls (estimated at $1.5M if required). The most significant variable in these cost estimates is the cost of land, presently estimated at $4M for acquiring six (6) acres of farmland, either adjacent to Orchard or within one mile southwest of New Freedom. Also, for New Freedom, the substation modifications will require expansion of the New Freedom station on the south side of the 500kV area and will require moving the fence line.

Based on budgetary pricing information from several suppliers, the cost of the SVC equipment itself (not including 500kV step-down transformers) for two (2) parallel SVC installations will have approximately the same cost as one large SVC system,

In order to account for the second transformer and likely separate SVC area (separate fence, separate control building, etc.), the turnkey cost of parallel SVC systems has been computed as follows:

One large SVC:	$60M
Assumed transformer cost:	-$5M
Assumed control house:	-$1M
Total cost for SVC only:	**$54M**

Split into two (2) parallel SVC systems:

SVC systems:	$54M
Two transformers:	+$10M
Two control houses:	+$2M
Total cost:	**$66M**

This result indicates that splitting one large SVC system into two parallel SVC systems adds 10% to the SVC cost.

The cost of the 500kV connections and substation modifications must be added to this $66M.

The project costs for the installation of two parallel SVC systems include:

- Adding two (2) 500kV dead tank breakers to Orchard, or adding three (3) 500kV dead tank breakers to New Freedom. Total costs for the breaker additions need to include disconnect switches, structures, foundations, and a take-off structure for the overhead line that will connect to the remote SVC site.
- Two (2) 500kV dead tank circuit breaker to serve as an incoming circuit breaker ahead of the step-down transformers at the SVC site for Orchard and New Freedom. At Artificial Island, a four (4) breaker ring bus is considered at the SVC site.
- One complete turnkey SVC installation (includes single phase step-down transformers and two entire SVC systems). SVC pricing excludes the 500kV input breaker. Foundation costs for the SVC system have been estimated without the benefit of geotechnical information.
- Two (2) 500kV overhead transmission lines from the substation to the SVC site. For Orchard on the west, this line will be short (approximately 200 ft.); for Orchard on the east, the line will be slightly longer (approximately 400 ft.). For New Freedom, the transmission line may be as long as 1 mile, to reach a suitable SVC site going southeast of New Freedom.

Options for routing the two 500kV circuits from Hope Creek and Salem to the new SVC ring bus are limited due to the presence of existing 500kV overhead lines from Hope Creek and Salem. Two options have been identified:

- Underground solid dielectric cable at 500kV
- Above-ground 500kV gas-insulated bus on support structures.

The distance from Hope Creek and Salem to the new SVC ring bus substation is approximately 2500 – 3000 ft. for each circuit.

500kV underground solid dielectric cable can be considered for the two new 500kV transmission lines (one line from Salem and the second line from Hope Creek) that will serve the new SVC ring bus substation. Note, however, that solid dielectric cable for 500kV service has very limited experience in the US. Some international projects have used solid dielectric cable at 500kV and higher voltages, but again experience is limited.

Using gas-insulated bus (GIB) at 500kV is possible, but is very costly. The 500kV GIB budgetary pricing from several suppliers indicates that the installed cost can approach $3,000 per linear foot for a single phase. The approximate cost for one circuit would approach $27M based on a 3,000ft. distance from either Hope Creek or Salem to the new SVC ring bus. For two circuits, this would be over $50M, which greatly exceeds a reasonable cost for short 500kV transmission lines.

In examining the existing overhead lines at Salem and Hope Creek with respect to the conceptual location of the SVC ring bus, another conceptual configuration would be to modify the existing line location for the circuit between Hope Creek and Salem (5037), and locally re-route the Orchard circuit (5021), which would facilitate routing two new 500kV lines (one from Hope Creek and the second from Salem) to the new SVC ring bus substation. This concept is shown in Attachment 8. The anticipated cost basis for this alternative overhead scheme can be quantified as follows:

- Relocation of 5037: $0.5M
- Relocation of 5021: $1.5M
- Two new lines to SVC: $4M

This alternative overhead scheme can be considered at $6M including contingency, which is much less than GIB, and avoids the consideration of underground 500kV solid dielectric cable.

Using the above estimating basis, the costs for the two parallel SVC systems at Artificial Island, Orchard, and New Freedom are estimated as follows:

- Two parallel SVC systems located adjacent to Orchard: $93M (includes $8M for land purchase; and 15% on the total to cover risk and contingency)

- Two parallel SVC systems located approximately one mile southwest of New Freedom: $98M (includes $4M for land purchase; and 15% on the total to cover risk and contingency)

- Two parallel SVC systems located adjacent to Artificial Island: $99M (includes $4M for land purchase; and 15% on the total to cover risk and contingency) (This cost is based on overhead transmission lines including line re-routs per Attachment 8; the same cost applies if 500kV solid dielectric cable in trench is considered.) If GIB is considered, the cost will increase to approximately $154M.

6.0 Attachments

6.1 List of Attachments

- Attachment 1 – Orchard and New Freedom One-Line Diagram for One SVC System
- Attachment 2 –Orchard and New Freedom Satellite Views with SVC Site
- Attachment 3 – Artificial Island, Orchard and New Freedom Environmental Maps
- Attachment 4 – SVC Cost Estimate for Artificial Island, Orchard and New Freedom
- Attachment 5 – NJDEP Stream Encroachment Administrative Checklist
- Attachment 6 – PJM - Artificial Island Proposed SVC, Rev. 0
- Attachment 7 – Tax Map ID Around New Freedom
- Attachment 8 – Burns and Roe's Proposed SVC at Artificial Island
- Attachment 9 – Constructability Review Summary

ATTACHMENT 1

ORCHARD AND NEW FREEDOM ONE-LINE DIAGRAMS FOR ONE SVC SYSTEM

ATTACHMENT 2

ORCHARD AND NEW FREEDOM SATELLITE VIEWS WITH SVC SITE

New Breaker

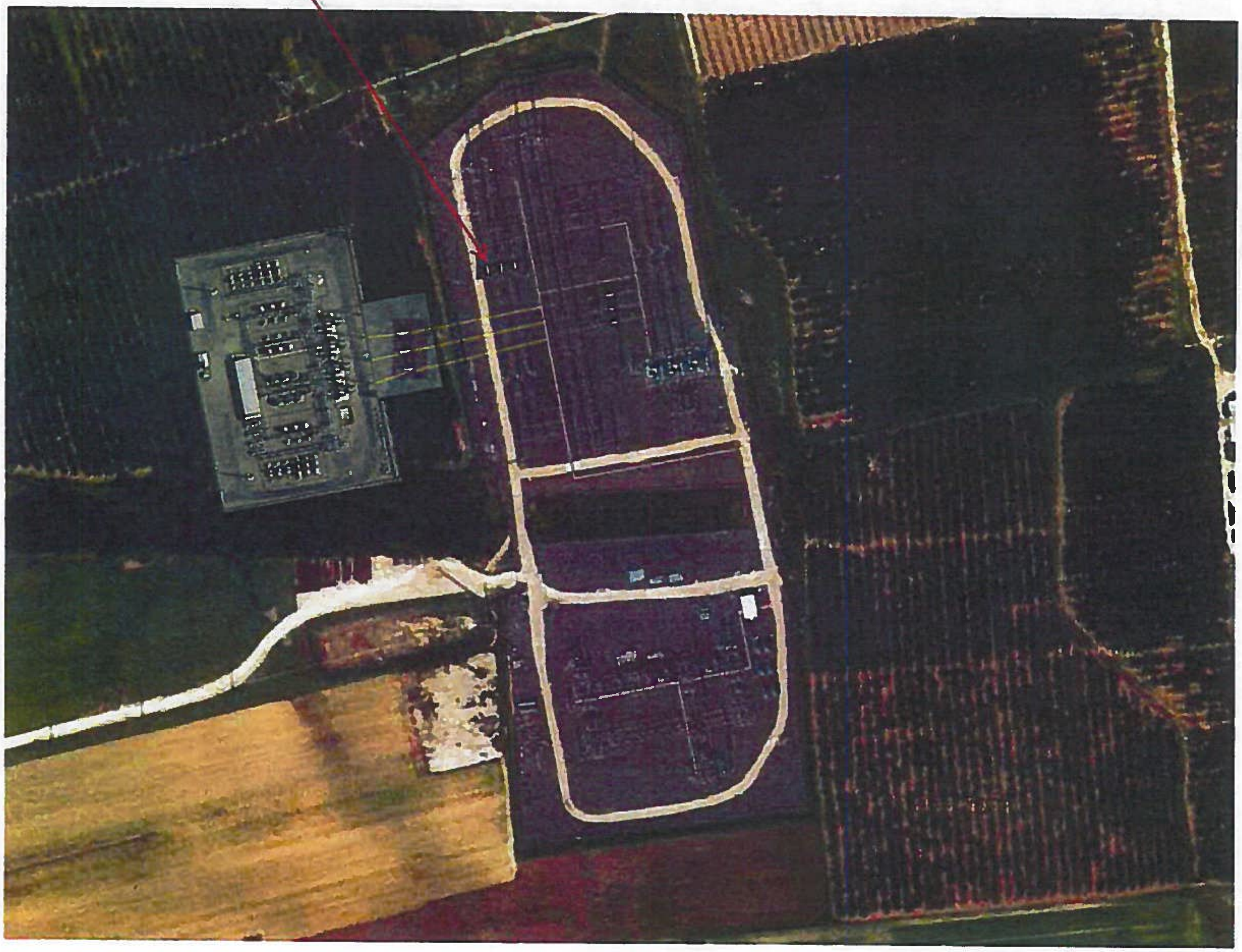


FIGURE 3
Orchard Substation with SVC Site on the West Side

FIGURE 4
Orchard Substation with SVC Site on the East Side

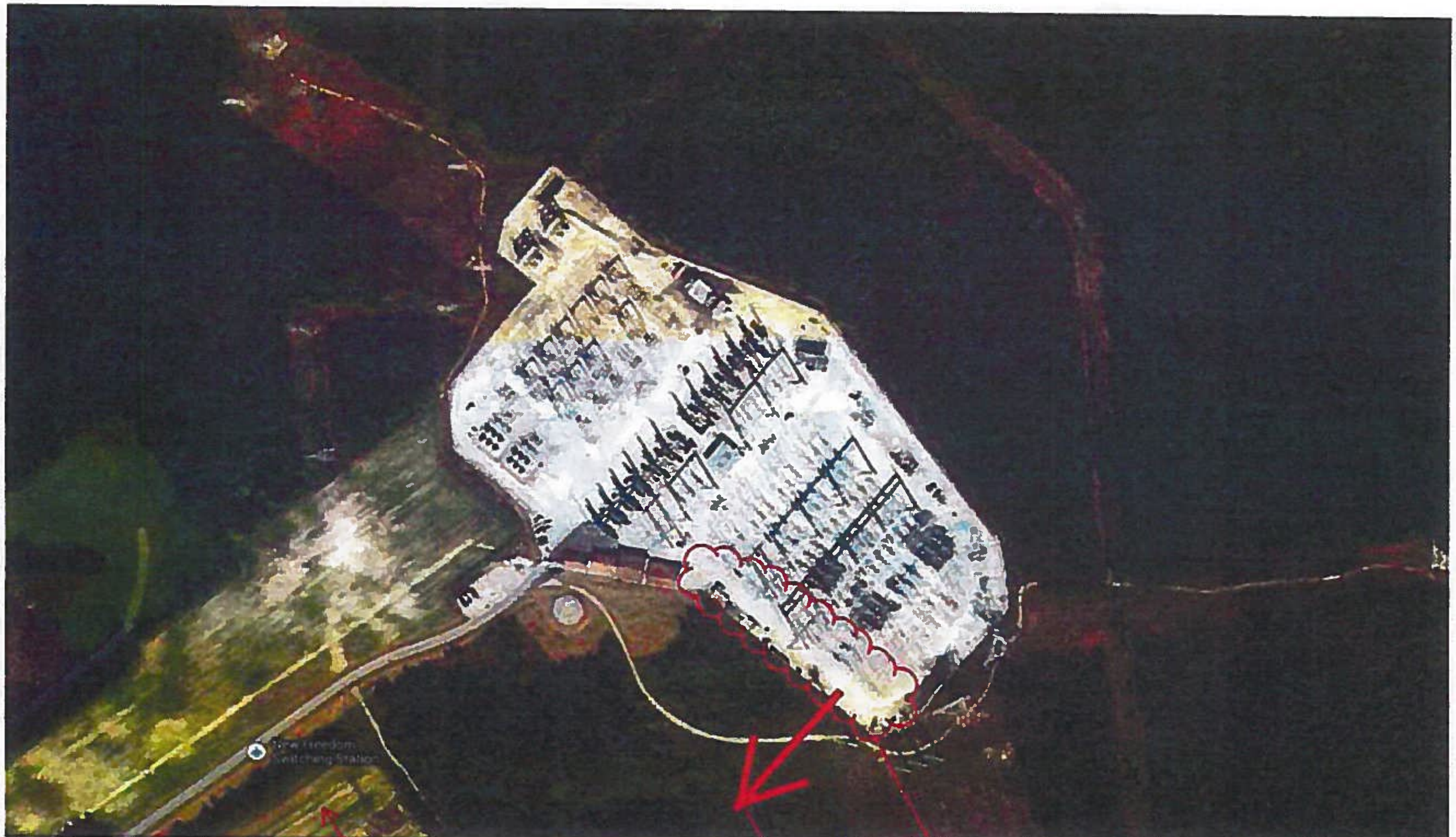


FIGURE 5
New Freedom Substation

ATTACHMENT 3

ARTIFICAL ISLAND, ORCHARD, AND NEW FREEDOM ENVIRONMENTAL MAPS

PINELANDS AREA (SHOWN IN RED)

U.S. Fish and Wildlife Service

National Wetlands Inventory

Orchard Substation

Dec 17, 2013

Wetlands

- Freshwater Emergent
- Freshwater Forested/Shrub
- Estuarine and Marine Deepwater
- Estuarine and Marine
- Freshwater Pond
- Lake
- Riverine
- Other

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

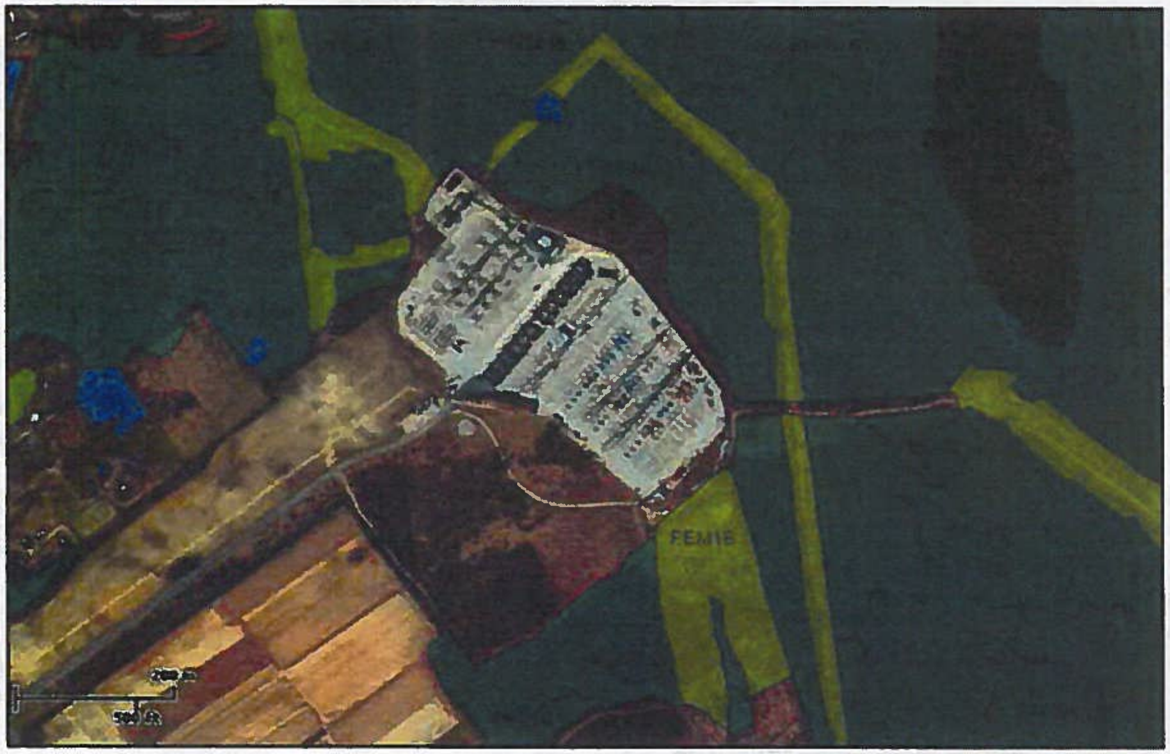
User Remarks:

U.S. Fish and Wildlife Service

National Wetlands Inventory

New Freedom Substation

Dec 17, 2013



Wetlands

- Freshwater Emergent
- Freshwater Forested/Shrub
- Estuarine and Marine Deepwater
- Estuarine and Marine
- Freshwater Pond
- Lake
- Riverine
- Other

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

User Remarks:

HOME **FEMA Flood Hazard Resources Map** MODIFY M

Details Basemap Share Print Measure

Legend

Preliminary Work Maps (supersede ABFEs)

Limit of Moderate Wave Action (LiMWA) (zoom in to make visible)

Floodplain Boundaries (zoom in to make visible)

- 0.2 Pct Annual Chance Flood Hazard
- 1 Pct Annual Chance Flood Hazard
- Floodway

Gutters (zoom in to make visible)

Coastal Shoreline (zoom in to make visible)

Floodplain Areas (zoom in to make visible)

- A
- AE
- AO
- VE
- Shaded X

Advisory Base Flood Elevation Layers

Advisory Zone V-A Boundary (zoom in to make visible)

Limit of Moderate Wave Action (LiMWA) (zoom in to make visible)

HOME

FEMA Flood Hazard Resources Map

MODIFY M

Details Basemap

Share Print Measure

Legend

Preliminary Work Maps (supersede ABFEs)

Limit of Moderate Wave Action (LiMWA) (zoom in to make visible)

Floodplain Boundaries (zoom in to make visible)

- 0.2 Pct Annual Chance Flood Hazard
- 1 Pct Annual Chance Flood Hazard
- Floodway

Gutters (zoom in to make visible)

Coastal Shoreline (zoom in to make visible)

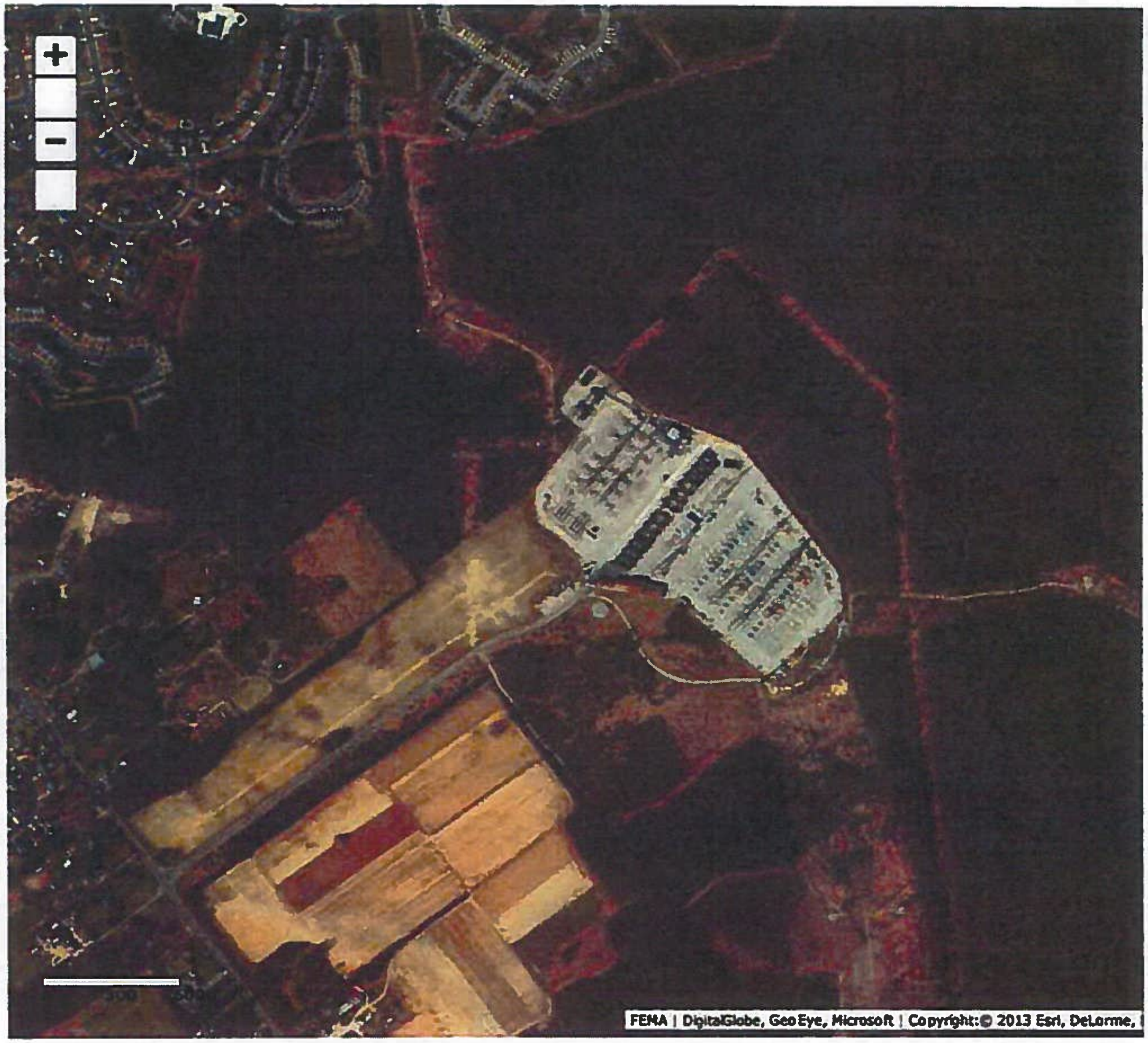
Floodplain Areas (zoom in to make visible)

- A
- AE
- AO
- VE
- Shaded X

Advisory Base Flood Elevation Layers

Advisory Zone V-A Boundary (zoom in to make visible)

Limit of Moderate Wave Action (LiMWA) (zoom in to make visible)

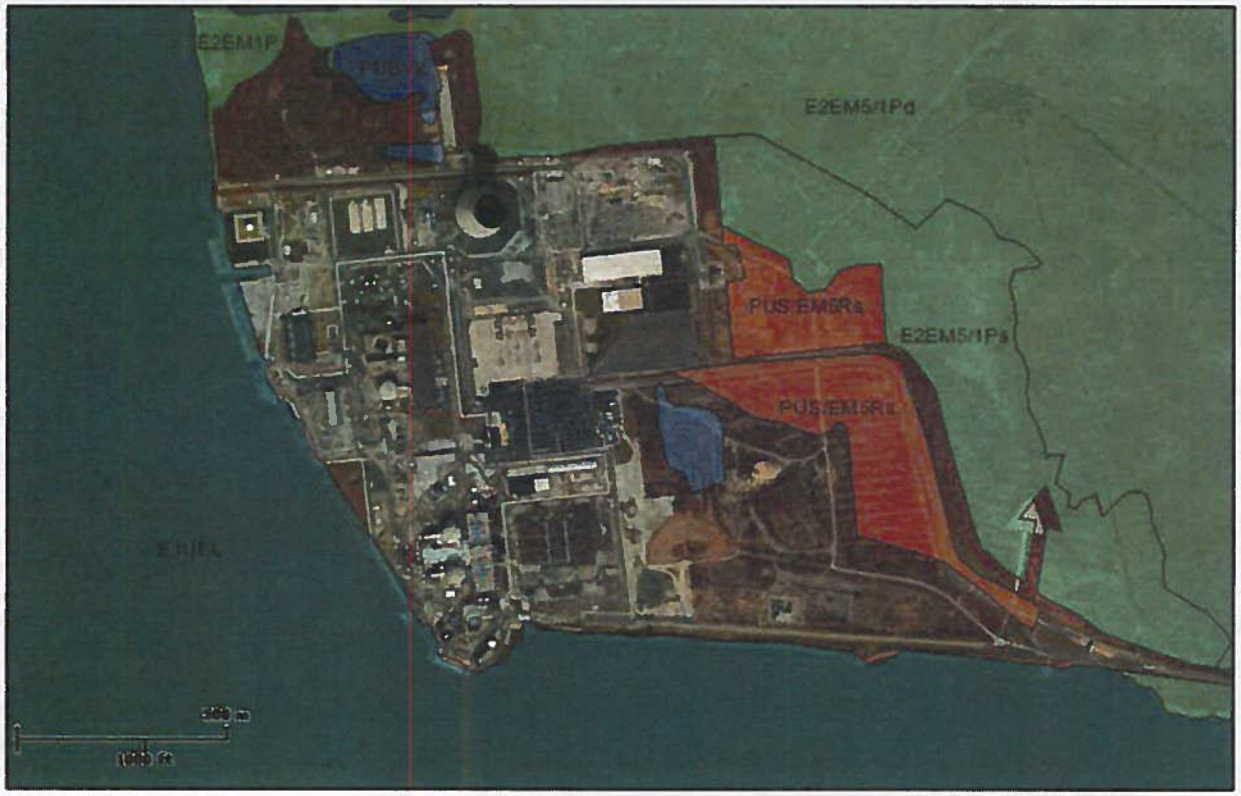


U.S. Fish and Wildlife Service

National Wetlands Inventory

Artificial Island

Feb 7, 2014



Wetlands

- Freshwater Emergent
- Freshwater Forested/Shrub
- Estuarine and Marine Deepwater
- Estuarine and Marine
- Freshwater Pond
- Lake
- Riverine
- Other

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

User Remarks:

ATTACHMENT 4

SVC COST ESTIMATE FOR ARTIFICAL ISLAND, ORCHARD, AND NEW FREEDOM

SVC Cost Estimate for Orchard and New Freedom

	Orchard		New Freedom		Artificial Island		
	One SVC	Two Parallel SVC's	One SVC	Two Parallel SVC's	Two Parallel SVC's (OH Connections)	Two Parallel SVC's (U/G Connections)	Two Parallel SVC's (GIB)
	Cost x$1000	Cost x$1000	Cost x$1000	Cost x$1000	Cost x$1000	Cost x$1000	Cost x$1000
Modify Existing Substation							
Add breaker to existing substation	$ 1,250				$ 1,250	$ 1,250	$ 1,250
Add 2 breaker bay to existing breaker-and-a half configuration			$ 2,400				
Add 2 breakers to existing ring bus		$ 2,400					
Add 1 breaker-and-a-half bay				$ 3,550	$ 3,550	$ 3,550	$ 3,550
500kV transmission line from substation to SVC site							
500kV Overhead Lines	$ 500	$ 1,000	$ 6,000	$ 8,000	$ 6,000		
500kV Solid Dielectric Cable						$ 6,000	
Gas Insulated Bus							$ 54,000
500kV System for SVC	$ 1,250	$ 2,400	$ 1,250	$ 2,400	$ 4,200	$ 4,200	$ 4,200
SVC system	$ 60,000	$ 66,000	$ 60,000	$ 66,000	$ 66,000	$ 66,000	$ 66,000
Commissioning	$ 500	$ 1,000	$ 500	$ 1,000	$ 1,000	$ 1,000	$ 1,000
Land Acquisition	$ 4,000	$ 8,000	$ 4,000	$ 4,000	$ 4,000	$ 4,000	$ 4,000
Risk and Contingency 15%	$ 10,125	$ 12,120	$ 11,123	$ 12,743	$ 12,900	$ 12,900	$ 20,100
Total	**$ 77,625**	**$ 92,920**	**$ 85,273**	**$ 97,693**	**$ 98,900**	**$ 98,900**	**$ 154,100**

Burns and Roe 500kV AIS Cost Estimate

All costs x $1000

500kV Dead tank breaker, 4000A, 63kA	$350	
Disconnect Switches, buswork, structures (per breaker position)	$200	
Foundations and piles (per breaker position)	$200	
Installation and testing/commissioning (per breaker position)	$300	
Total	$1,050	per breaker position

Protective relaying modifications for one breaker added to ring bus	$200
Protective relaying modifications for two breakers added to existing substation	$300
Protective relaying modifications for breaker and a half	$400

500kV transmission line from substation to SVC site: $6M per mile

ATTACHMENT 5

NJDEP STREAM ENCROACHMENT ADMINISTRATIVE CHECKLIST

State of New Jersey
Department of Environmental Protection
STREAM ENCROACHMENT ADMINISTRATIVE CHECKLIST

Revised: April 5, 2006 Website: www.state.nj.us/dep/landuse

A stream encroachment permit is required for most construction activities along streams and in floodplains. Examples of regulated activities include new buildings, roads, bridges, utility lines and stormwater discharges. Storing material, placing fill and clearing vegetation can also be regulated. Some minor activities

To apply for a permit complete this checklist and send the material required below to the following address:

Postal Mailing Address:
NJDEP Division of Land Use Regulation
P.O. Box 439
Trenton, NJ 08625

Street Address (For courier service and hand deliveries only):
NJDEP Division of Land Use Regulation
501 East State Street, Station Plaza Five, 2nd Floor
Trenton, NJ 08609

CONTACT A STREAM ENCROACHMENT ENGINEER AT (609) 292-0060 IF YOU HAVE ANY

PART A: The following is required for all projects (please do not send more copies of items than required):

- ☐ One completed copy of this checklist.
- ☐ One completed LURP-1 application form with original signatures (available from DEP website above).
- ☐ Check or money order for the project review fee payable to: *Treasurer, State of New Jersey* (see Part F).
- ☐ Two sets of location maps (USGS quad map is required; local tax, county soil and flood maps where available).
- ☐ Two sets of color photographs showing the entire project area (mounted on 8½" by 11" paper).
- ☐ Three copies of an environmental report (see Part E) including State plane coordinates of the site.
- ☐ Six sets of individually folded, signed and sealed construction plans referencing 1929 NGVD. Show all proposed work and provide soil erosion/sediment control plans, cross-sections, profiles and details as appropriate.

PART B: The following is required for certain projects depending on your answers in Part C below:

- ☐ One copy of proof of local notice to all parties listed at N.J.A.C. 7:13-4.2 (see Part C question 1).
- ☐ One copy of a signed and sealed engineering report (see Part D).
- ☐ One copy of a hardship waiver request, if the project does not meet all regulations (see N.J.A.C. 7:13-4.8).

PART C: Please answer the following questions:

1. Proof of local notice (under N.J.A.C. 7:13-4.2) is required if any of the following occur (check all that apply):
   - ☐ The project includes one or more major element under Part F.
   - ☐ The project will disturb the channel or buffer of a trout-associated water (see question 3 below for buffer widths).
   - ☐ The project will expose acid-producing soils.
   - ☐ The project involves a hardship waiver request (see N.J.A.C. 7:13-4.8).
2. In most cases the extent of the floodplain must be known in order to issue a permit (check one of the following):
   - ☐ Floodplain was taken from a State flood hazard area delineation (get State maps at (609) 292-2296).
   - ☐ Floodplain was taken from a tidal FEMA map that shows flood elevations (get FEMA maps at (800) 358-9616).
   - ☐ Floodplain was taken from a non-tidal FEMA map that shows flood elevations in a fully developed watershed.
   - ☐ Floodplain is unknown and calculations have been submitted to delineate it (see question 5 below).
   - ☐ Floodplain is unknown and does not need to be delineated for the project (explain why).
3. All streams have a buffer (measured from the top of the bank) within which vegetation is protected as follows:
   - ☐ 300 ft Along Category-One waters if stormwater management <u>does</u> apply under question 6 below.
   - ☐ 50 ft Along Category-One waters if stormwater management <u>does not</u> apply under question 6 below.
   - ☐ 50 ft Along waters that are trout-associated associated with threatened or endangered species
   - ☐ 50 ft Along waters associated with threatened or endangered species.
   - ☐ 50 ft Along waters where acid-producing soils will be exposed.
   - ☐ 25 ft Along all waters not listed above.
4. The placement of fill is restricted in a flood fringe and no obstruction is allowed in a floodway (check all that apply):
   - ☐ No fill is proposed within either the flood fringe or the floodway.
   - ☐ A negligible amount of fill is proposed within the floodway, which obviously does not obstruct flow.
   - ☐ A negligible amount of fill is proposed within the flood fringe, which obviously meets the rules by inspection.
   - ☐ Fill is proposed in the flood fringe and proof that the standards at N.J.A.C. 7:13-2.14 and 15 are met is included.
5. Hydrologic and hydraulic calculations are generally required if any of the following occur (check all that apply):
   - ☐ The peak 100-year flow in the stream will be significantly increased or decreased.
   - ☐ The size, shape, skew, location and/or alignment of the stream channel will be altered.
   - ☐ A new bridge or culvert will be constructed where none currently exists.
   - ☐ A replacement bridge or culvert will be constructed, which is different in size, length, shape, material, skew, location and/or alignment from the existing structure.
   - ☐ The floodplain limits are unknown and need to be delineated in order to demonstrate compliance with the requirements of the rules, such as for net-fill calculations or determining lowest floor elevations.
   - ☐ The floodplain limits are unknown and need to be delineated to establish stream encroachment lines.

6. Stormwater management must be provided as described below (see www.njstormwater.org). Explain if the project:
☐ is exempt from this section at N.J.A.C. 7:8-5.2(d) or ☐ Meets the public roadway waiver at N.J.A.C. 7:8-5.2(e)

Part 1: Enter the total amount of land that will be disturbed onsite: __________ ft^2 or acres (circle one).
If at least 1 acre (43,560 ft^2) of land will be disturbed, submit the following (in the engineering report):
- ☐ One completed Low Impact Design checklist (see Appendix A of BMP manual at www.njstormwater.org).
- ☐ One copy of a USGS map, showing the site and its HUC-14 watershed and indicating any 300-ft buffers onsite.
- ☐ Proof that the groundwater recharge standards at N.J.A.C. 7:8-5.4(a)2 are met (unless exempted at 5.4(a)2ii).
- ☐ Proof that the runoff quantity standards at N.J.A.C. 7:8-5.4(a)3 are met (unless project lies in a tidal floodplain).
- ☐ Proof that the use of nonstructural stormwater strategies has been maximized onsite via one of the following:
  - ☐ A completed Nonstructural Stormwater Strategies Point System spreadsheet (see www.njstormwater.org).
  - ☐ A detailed narrative (including an alternative analysis where necessary), explaining how the project does (or does not) implement all nine nonstructural strategies required at N.J.A.C. 7:8-5.3.

Part 2: Enter the net-increase in impervious area onsite: _________ ft^2 or acres (circle one). Include all new impervious areas, as well as existing impervious areas from which stormwater currently sheet-flows, but which will be collected into a basin or storm sewer system. Subtract any impervious areas being removed onsite. **If a net-increase of at least ¼ acre (10,890 ft^2) of impervious area will occur, submit all material in Part 1 and the following:**
- ☐ Proof (in the engineering report) that the water quality standards at N.J.A.C. 7:8-5.5 are met.

PART D: **Engineering report:** Must be signed and sealed by a NJ licensed professional engineer. Detail all regulated activities onsite and explain how the submitted calculations demonstrate compliance with the rules. Provide complete printouts (and electronic copies if possible) of all calculations. Check all that apply:

- ☐ Net-fill calculations (see Part C question 4). Explain the methodology used to demonstrate compliance. Include both existing and proposed flood storage calculations and depict all cross-sections and other relevant data.
- ☐ Hydrologic and hydraulic calculations (see Part C question 5). Include any State or FEMA flood maps or profiles that were referenced (with site outlined to scale on maps). If flow rates were determined for a stream, depict the contributory drainage area on USGS maps and provide a hydrologic description of the watershed.
- ☐ Stormwater management (see Part C question 6). Explain how the groundwater recharge, runoff quantity and water quality standards at N.J.A.C. 7:8 are met. Detail how TSS removal is achieved, provide detention, retention and infiltration calculations for all basins, and compare existing and proposed recharge and discharge rates.
- ☐ Stability analysis for any retaining wall that is at least 4 ft high. Include both sliding and overturning analyses.

PART E: **Environmental report:** Address all proposed environmental impacts including, at minimum, the following:

- ☐ A complete description of the project, including justification for its size and location, an evaluation of all anticipated environmental impacts and a demonstration that such impacts have been minimized where possible.
- ☐ A description of anticipated access points to streams and proposed disturbance to near-stream vegetation.
- ☐ Adverse effects of any stormwater management basins on the stream's biota and on mosquito breeding.
- ☐ An evaluation and mitigation plan if acid-producing soils will be exposed.
- ☐ An evaluation of whether threatened and endangered species will be impacted.
- ☐ The qualifications of the report's preparer and all relevant data that was used in the report's preparation.

PART F: The total review fee is $ __________ and was calculated as follows (indicate number of each element):

Stormwater review fee (if any) $ __________
(Attach stormwater fee worksheet)

Major element ($4,000)
___ Hardship waiver request[1]
___ Review of net-fill calculations[1,2]
___ Bridge, culvert or footbridge[3]
___ Retaining wall at least 4 ft high

Major element ($3,000 plus $300 per each 100-ft segment of stream)[4]
___ Flood hazard limit delineation[3]
___ Stream channel modification[3,5]
___ Stream bank stabilization or protection project[3]

Major element ($2,000)
___ Bridge or culvert to a private residence or duplex[6]

Minor element ($1,000 plus $100 per each 100-ft segment of stream, not to exceed $4,000)[4]
___ Stream cleaning or pond/lake dredging project[7]

Minor element ($1,000)
___ Utility crossing
___ Stormwater outfall structure
___ Retaining wall less than 4 ft high[8]
___ One private residence or duplex[5]
___ Residential addition, garage, shed or barn
___ Bridge, culvert or footbridge[8]
___ Stream channel modification[5,8]
___ Stream bank stabilization or protection project[8]
___ Grading not associated with another project[8]
___ Any regulated activity not listed in this table[8]

Minor element ($500)
___ Flood hazard limit delineation[1,8]

Footnotes for fees:
1. No fee if associated with one private residence or duplex not being constructed as part of a larger residential subdivision.
2. No fee if associated with a bridge or culvert that lies nearly perpendicular to a stream.
3. Provided a review of hydrologic and/or hydraulic calculations is required.
4. Length of stream is measured along centerline of channel.
5. No fee if associated with (and located within 100 ft upstream or downstream of) a new bridge or culvert.
6. Provided private residence or duplex is not being constructed as part of a larger residential subdivision.
7. No fee and different procedure if submitted under "stream cleaning" provisions at N.J.S.A. 58:16A-67. Call DEP for details.
8. Provided no review of calculations is required. Otherwise this is considered a major element

ATTACHMENT 6

ARTIFICIAL ISLAND PROPOSED SVC – REV. 0

ATTACHMENT 7

TAX MAP ID AROUND NEW FREEDOM

ATTACHMENT 8

BURNS AND ROE'S PROPOSED SVC AT ARTIFICIAL ISLAND

ATTACHMENT 9

CONSTRUCTABILITY REVIEW SUMMARY

ATTACHMENT 9

Constructability Review Summary

	Artificial Island	Orchard	New Freedom
Total Overall Cost (based a 2 parallel SVC systems)	$99M (based on OH or U/G 500kV transmission lines)	$92M	$98M
Anticipated Schedule	48 months due to higher complexity and security issues (on nuclear plant site)	33 months	40 months
ROW Acquisition	Land belongs to PSEG Nuclear and is on nuclear plant site, line routes are complex.	500kV transmission line(s) to SVC site(s) will be short, no problems anticipated.	Length of 500kV transmission line(s) to SVC site(s) are dependent on location of SVC site(s), no problems anticipated.
Land Acquisition	Land belongs to PSEG Nuclear and is on nuclear plant site.	Existing farmland must be purchased.	Vacant land around substation is owned by PSE&G. Land acquisition issues will be minimal if SVC system is owned by PSE&G. Purchase of land outside the PSE&G property is limited to southwest of substation to avoid Pinelands and residential area encroachment.
Siting/ Permitting	Permitting is feasible, minor wetlands issues.	Permitting will be possible but will be complicated due to change in use of land (from farming to substation). Avoidance of wetlands and pond area is necessary.	Permitting complexity is dependent on SVC system location, should not be a problem if SVC is located on existing PSE&G vacant land.
Project Complexity	Significantly more complex than other choices, due to o Modifications to two substations serving nuclear generation plants. o New 500kV circuits to SVC ring bus are complex and costly. o New 500kV ring bus increases project cost and complexity	Modifications to existing substation are straightforward, addition of two breakers to ring bus within existing fenced area	Modifications to existing substation for new breaker position(s) to connect to SVC require expansion of substation fenced area and additional 500kV breaker-and-a-half bay.
Staging	Outages of nuclear plant generation required for modifications to substations.	Outages of Orchard ring bus sections and 500kV transmission lines must be coordinated with system operations.	Minor outages will be needed for addition of 500kV bay to existing substation, no appreciable impact to system operations.